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Legal analogical reasoning - the interplay between legal theory and artificial intelligence

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Abstract

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'Legal analogical reasoning - the interplay between legal theory and artificial intelligence'

Master of Jurisprudence 1997

This thesis examines and critiques attempts by researchers in the field of artificial intelligence and law to simulate legal analogical reasoning. Supported by an analysis of legal theoretical accounts of legal analogising, and an examination of approaches to simulating analogising developed in the field of artificial intelligence, it is argued that simulations of legal analogising fall far short of simulating all the is involved in human analogising. These examinations of legal theory and artificial intelligence inform a detailed critique of simulations of legal analogising. It is argued that simulations of legal analogising are limited in the kind of legal analogising they can simulate - these simulations cannot simulate the semantic flexibility that is characteristic of creative analogising. This thesis argues that one reason for current restrictions on simulations of legal analogising is that researchers in artificial intelligence and law have ignored the important role played by legal principles in legal analogising. It is argued that improvements in simulations of legal analogising will come from incorporating the influence of legal principles on legal analogising and that until researchers address this semantic flexibility and the role that legal principles play in generating it, simulations of legal analogising will be restricted and of benefit only for limited uses and in restricted areas of the law.

Building on the analysis of legal theoretical accounts of legal reasoning and the examination of the processes of analogising, this thesis further argues that legal theoretical accounts of legal analogising are insufficient to account for legal analogising. This thesis argues that legal theorists have themselves ignored important aspects of legal analogising and hence that legal theoretical accounts of legal analogising are deficient. This thesis offers suggestions as to some of the modifications required in legal theory in order to better account for the processes of legal analogising.

Legal analogical reasoning - the interplay between legal theory and artificial intelligence.

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Contents

None of the material contained in this thesis has previously been submitted for a degree in this or any other university. This thesis is entirely the author's own work.

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1   Introduction

The law can be extremely complex and producing reasoned arguments in response to legal problems can be laborious and time consuming. In his recent book, 'The Future of Law', Susskind notes this complexity and the acute problems it causes in what he calls a 'hyper regulated' society.[1] According to Susskind

> we are all subject, in our social and working lives, to a body of legal rules and principles that is so vast, diverse, and complicated that no one can understand their full applicability and impact.[2]

In this situation, one might turn to computers for assistance.

In the introduction to his work investigating the automatic generation of precedent-based arguments, Ashley outlined a hypothetical scenario.[3] In this hypothetical an associate in a New York law firm is sitting in his Wall Street Office. It is 5:55pm and he has just been confronted by a partner who requires a well argued and referenced legal memorandum by the next morning. The associate has exactly one hour and twenty minutes to research and write the memorandum before a crucial engagement. Pressed for time, the attorney resorts to his computer. After the attorney has described the facts of the dispute, the computer helpfully outlines the arguments that (a)the attorney can make for his client, (b)what the likely responses to those arguments will be from the opposition, and (c)suggested hypotheticals indicating how the arguments for the plaintiff and defence could be respectively strengthened and weakened. For each of these, a list of authorities is provided which can be cited in support of the arguments. Armed with this computer program, the legal memorandum was rapidly and painlessly prepared.

Unfortunately the program that Ashley envisaged was a hypothetical program. However, a program that automatically locates authorities, constructs arguments for a position based on those authorities and anticipates likely counter arguments would be of immeasurable value. Indeed a program which automates some of the tasks that lawyers perform may becoming a necessity. Susskind argues that

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[1]Susskind R.E., The Future of Law. Facing the Challenges of Information Technology (1996) Oxford University Press, 13.
[2]Ibid.
[3]Ashley Kevin D., Modelling Legal Argument: reasoning with cases and hypotheticals (1990) MIT Press, Ch. 2.

current methods for managing legal materials (dominated by paper and print) are not capable of coping with the quantity and complexity of the law which now governs us.[4]

Unfortunately the production of computer programs of the sort envisaged by Ashley remains a goal tantalisingly out of reach. According to Susskind we are currently experiencing a 'technology lag',

our ability to use computer technology to capture, store, retrieve, and reproduce data, wildly surpasses our ability to use technology to help analyse, refine and render more manageable the mass of data which data processing has spawned.[5]

While computers are good at processing data, they are currently little help in managing all important knowledge. Dealing with hyper regulation requires the development of knowledge processing techniques.[6] The field of 'artificial intelligence and law' is concerned with developing and improving legal knowledge processing techniques.

A central strand of research in artificial intelligence and law is the simulation of legal reasoning. Analogical reasoning is an important form of legal reasoning. This research scrutinises and critiques attempts by researchers in the field of artificial intelligence and law to construct computer systems that simulate legal analogical reasoning. In the following chapters it is argued that attempts to simulate legal analogical reasoning only achieve a trivial simulation of human legal analogical reasoning. Attempts to simulate legal analogical reasoning fail to capture the essential element of creativity that the perception of legal analogies involves. It is argued that one reason for the failure of research in artificial intelligence and law to successfully simulate all that is involved in legal analogical reasoning is that researchers have ignored important insights about legal analogising developed by legal theorists. Legal theorists argue that legal principles play a crucial role in legal analogising. Researchers in artificial intelligence and law have almost totally ignored the importance of legal principles in legal analogising. Consequently, approaches to simulating legal analogising developed by researchers in artificial intelligence and law are restricted in the type of analogising they can simulate. Systems are limited to comparatively uncreative analogising.

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[4]Susskind, above n 1.
[5]Ibid, 58.
[6]Ibid 59.

Secondly, it is argued that legal theoretical accounts of legal analogising focus solely on one narrow aspect of legal analogising. Legal theoretical accounts of legal reasoning focus on providing 'rational reconstructions' for legal analogies. Informed by an examination of research into analogical reasoning undertaken in fields such as psychology, cognitive science and artificial intelligence, this research argues that legal theoretical accounts of legal analogising fail to fully account for the process of legal analogising. Legal theory leaves many important aspects of legal analogising unexplored. It is argued that ignoring these aspects of analogising undermines attempts to provide rational reconstructions for legal analogies. This requires a reconception of theories of legal analogising.

This research proceeds in nine parts. Following this introduction, chapter 2 briefly introduces the concept of analogical reasoning and analogising. Chapter 3 reviews major legal theoretical accounts of legal analogical reasoning. Chapter 4 shows why legal theoretical accounts of legal analogical reasoning are insufficient in that they ignore an important aspect of legal analogical reasoning. This chapter argues that reformulated theories of legal analogising are required. Chapter 5 examines general approaches to simulating analogical reasoning developed by researchers in artificial intelligence. Chapter 5 is used as the basis for the examination undertaken in chapter 6 which reviews and discusses attempts to simulate legal analogical reasoning undertaken by researchers in artificial intelligence and law. Chapter 7 discusses the limitations in attempts to simulate legal analogical reasoning that were highlighted in chapter 6 and discusses how improvements can be made in attempts to simulate legal analogical reasoning. Chapter 8 returns to the topic of legal theory and to the argument presented in chapter 4 that legal theoretical accounts of legal analogical reasoning are insufficient. Chapter 8 briefly explores how legal theoretical accounts of legal analogical reasoning need to be reconsidered in light of their insufficiencies. This examination concludes in chapter 9 which summarises the arguments made during this research.

2   Preliminary clarifications

When examining the concept of analogy a useful starting point would be a definition of what an 'analogy' is. Amongst other things, such a definition would discuss how the concept of analogy relates to the concepts of 'analogical reasoning' and 'analogical problem solving'. Such a definition would discuss whether analogical reasoning is even a valid source of reasoning. It would describe how analogies occur, what analogies are used for and how analogical reasoning relates to other forms of human reasoning. Such a definition would also determine how the topic of analogy relates to the topic of metaphor.[7] A short examination of the literature existing under the heading 'analogy' reveals what a huge task this would be. Investigations of analogy arise in fields as diverse as theology, philosophy, linguistics, psychology, literature, cognitive science, artificial intelligence and law.[8] A definition of analogy would have to account for the concept of analogy as it is used in all of these diverse fields. Moreover, such a definition would also need to account for the changing conception of analogy through time, from perhaps the earliest discussion by Greek philosophers to the conceptions of analogy investigated by current researchers in artificial intelligence.[9]

This research is much less ambitious than this. Wide ranging discussions of analogy and analogical reasoning are provided elsewhere.[10] This research is concerned with the restricted field of legal analogical reasoning and attempts that have been made to simulate legal analogical reasoning. As such this research focuses on accounts of legal analogical reasoning provided by legal theorists and attempts made be researchers in the field of artificial intelligence and law to simulate legal analogical reasoning.

Despite the diversity of research which occurs under the name of analogy, at a broad level there is consensus amongst recent research as to what constitutes analogy. Essentially analogy is a 'mapping between elements of a source domain and a target

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[7] E.g.: Gentner Dedre, Falkenhainer Brian and Skorstad Janice, 'Viewing Metaphor as Analogy' p.171, in (Helman D.H.) (Ed) Analogical Reasoning: Perspectives of Artificial Intelligence, Cognitive Science, and Philosophy (1988) Kluwer.

[8] For interesting collections of work examining analogical reasoning see: Ortony A. and Vosniadou S., Similarity and analogical reasoning (1989) Cambridge University Press and Helman David H., Analogical reasoning: Perspectives of Artificial Intelligence, Cognitive Science and Philosophy (1988) Kluwer.

[9] Hoffman R.R., 'Monster analogies' (1995) 16 AI Magazine 11, 15.

[10] E.g., see the authorities above n 8.

domain.'[11] More intuitively, analogy and analogical reasoning are a way to use knowledge about old problems when reasoning about new problems. For example, with knowledge that one German shepherd is friendly we reason that another German shepherd is friendly.[12] With knowledge that one car starts when the right key is inserted in the steering column and turned clockwise we reason that that another car will start when the right key is inserted into the steering column and turned clockwise. Similarly in law. We know when particular behaviour is negligent, for example, by referring to precedents where a court has determined negligence was present.

The particular focus of this research is on attempts to 'simulate' legal analogical reasoning. But what precisely is being simulated? Is it only the observable results achieved when a person reports engaging in analogical reasoning? With this conception, if a person reports that 'A is analogous to B' then if a computer program can be created which when presented with the same information reports 'A is analogous to B', this computer program is said to simulate analogical reasoning. Alternatively, simulating analogical reasoning could be understood to mean the attempt to program a computer to recreate the mental processes that occur inside a person's mind when they report themselves as engaging in analogical reasoning. In this examination the term 'simulation' is used in the former sense. A computer program will be referred to as simulating analogical reasoning if the program produces the same analogy as does a person presented with the same information.

However, while this view of simulating analogical reasoning does not stipulate that reproducing mental processes is by definition necessary, as a practical matter reproducing the mental processes performed by people when they engage in analogical reasoning may provide the only visible path to achieving the results of that reasoning. It is known that certain mental processes engaged in by people produce analogies. If alternative means can be devised to achieve the results produced by people when they reason analogically, these alternatives could be used to simulate analogising. In the absence of such alternative means however, the mental processes engaged in provided the only known path to simulating analogising. Simulating analogical reasoning may

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[11] Hall Rogers P., 'Computational Approaches to Analogical Reasoning: A Comparative Analysis' (1989) 39 <u>Artificial Intelligence</u> 39, 40.

[12] Sunstein Cass R., 'On Analogical Reasoning' (1993) 106 <u>Harvard Law Review</u> 741 herafter 'On Analogical Reasoning', 743.

often involve the attempt to simulate the processes engage in by people when they reason analogically however, it will not here be defined in this way. Hence understanding the processes involved when people reason analogically is extremely informative in attempting to produce a computer program that simulates analogical reasoning.

Despite broad consensus as to what constitutes analogy, there is great diversity amongst accounts of analogical reasoning. In the next chapter, accounts of analogical reasoning provided by legal theorists are examined.

3   Legal theory and analogical reasoning

Legal reasoning takes many forms. In various ways legal reasoning appears to be deductive, to be inductive, to be abductive and to be analogical.[13] It is sometimes argued that legal reasoning involves other forms of reasoning. For example it is said that legal reasoning involves the application of 'top-down general theories' and the search for 'reflective equilibrium'.[14] These various forms of reasoning will not be examined further. This discussion will focus on the place of analogical reasoning within legal reasoning. It is argued that legal theoretical accounts of legal analogical reasoning focus on one narrow aspect of legal analogical reasoning. Legal theoretical accounts of legal analogical reasoning focus on providing 'rational reconstructions' for analogies and do not examine important aspects of legal analogical reasoning. However, in that it focuses on one aspect of legal analogical reasoning, legal theory provides limited guidance for attempts to simulate legal analogising.

Analogical reasoning permeates legal reasoning.[15] The use of analogical reasoning in law is a central pillar of the legal system. Cross states that it

> is a basic principle of the administration of justice that like cases should be decide alike.[16]

While it might inferred from this statement that analogical reasoning is only relevant when reasoning with cases, to do so would be fallacious. MacCormick notes that 'analogy is used both in case and statute law'[17] and says that it

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[13] Golding Martin P., Legal reasoning (1984) Alfred Knopf hereafter 'Legal reasoning', ch 2; Brewer S., 'Exemplary reasoning - semantics, pragmatics, and the rational force of legal argument by analogy' (1996) 109 Harvard Law Review 923, 942-9.

[14] Sunstein 'On Analogical Reasoning', above n 12, 749-54.

[15] Contra Posner Richard A., The Problems of jurisprudence (1990) Harvard University Press, who argues that analogical reasoning is merely reasoning by induction, 87-9. C.f.: Golding 'Legal reasoning', above note 13, 44 who argues that induction is just a form on analogy. A more sustained criticism of the place of legal analogical reasoning has recently been provided by Alexander: Alexander Larry, 'Bad Beginnings' (1996) 145 University of Pennsylvania Law Review 57. Alexander's criticism is directed at both descriptive and normative theories of legal analogical reasoning. To the extent that Alexander criticises descriptive accounts of legal analogical reasoning for failing to fully account for the processes of legal analogising, the arguments presented here are in accord with Alexander. However, to the extent that Alexander argues that analogical reasoning should not be applied in law, this research seeks to show why such arguments are unhelpful.

[16] Cross Rupert, Precedent in English Law (1977) Clarendon Press, 4.

[17] MacCormick N., Legal Reasoning and Legal Theory (1978) Oxford University Press hereafter 'Legal Reasoning', 193.

is false to suppose that there is an essential difference between statute and common law as to the function of arguments from analogy.[18]

In this light, it would be wiser to read Cross's statement about 'like cases' as referring to 'like circumstances'. This was noted early in English jurisprudence, Blackstone stated that if

> any new and unwonted circumstances shall arise, then, if any-thing analogous
> has happened before, let the case be adjudged in like manner, proceeding *a*
> *similibus ad similia.*[19]

Given the pervasive nature of analogical reasoning in law, it is surprising that, as Sunstein concludes, 'The legal culture lacks a description of its own most characteristic way of proceeding.'[20]

3.1   The goal of theories of legal reasoning

When examining a theory of legal reasoning, a fundamental question is 'exactly what is the theory of reasoning seeking to explain?' Is the theory attempting to explain how we reason - the particular steps we engage in during reasoning? Is the theory seeking to explain why we reason in particular ways - that some reason is more 'intuitive' or more 'natural'? Is the theory seeking to explain why we should or should not reason in particular ways? Or is the theory seeking to do something else, or perhaps a combination of all of these things? To various extents theories of legal analogical reasoning explore all of these questions. However, as will become apparent, theories of legal analogical reasoning provide very little explanation as to how we reason analogically. Legal theory provides very little guidance as to the processes that occur in the mind during legal analogising.

The disinterest within legal theory as to the mental processes that occur during legal reasoning can be traced back at least to the jurist Wasserstrom. According to Wasserstrom, in law it is necessary to distinguish between the processes by which solutions to problems are created and the processes by which solutions to problems are justified.[21] Wasserstrom argued that in law processes of creation are irrelevant and that

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[18] Ibid 194. As Levi demonstrates, analogical reasoning is also central in interpretation of the constitution: Levi E.H., An Introduction to Legal Reasoning (1949) University of Chicago Press.
[19] Cited in Cross, above n 16, 24.
[20] Sunstein 'On Analogical Reasoning', above n 12, 741.
[21] Wasserstrom R.A., The Judicial Decision (1961) Stanford University Press, 26-7, ch 2.

only processes of justification need be investigated and explained. Inherently intertwined with examinations of the processes of creation and the processes of justification are questions as to what it means to reason 'rationally' and to be 'objective' in law. According to the distinction between processes of creation and processes of justification, providing an account of how results are created is unimportant if it is possible to give and account of why those results are justified. According to this conception of legal analogical reasoning, any of the personal input, the influence of personal views and values that occurs in law occurs during processes of creation. Wasserstrom argued that these personal aspects of reasoning can validly be ignored because legal propositions are only acceptable to the extent they can be justified, in which case that fact that they are legally justified makes it irrelevant that they may also be personally felt.

The legacy of Wasserstrom's distinction between processes of creation and processes of justification is evident in theories of legal analogical reasoning. Theories of legal analogical reasoning do not attempt to explain how legal analogies are created. It is argued in the next chapter that this distinction between processes of creation and between processes of justification is itself problematic. However, for present purposes the distinction provides a useful framework within which to examine theories of legal analogical reasoning.

3.1.1 A multitude of legal theories

As MacCormick states, a 'theory of legal reasoning requires and is required by a theory of law.'[22] Problematic for an investigation of theories of legal analogical reasoning is that theories about the nature of law abound. Every legal theory either expressly or implicitly supplies its own theory of legal reasoning. Each of these theories of legal reasoning in turn either expressly or implicitly dictates what is involved in legal analogical reasoning and the role analogical reasoning plays in law. Consequently, theories about the nature of legal analogical reasoning abound. In this context a comprehensive examination of theories of legal analogical reasoning would require an examination of every existing theory of law. This is not possible in a work of this restricted length. Instead, the work of several leading jurists is surveyed for the accounts provided of legal analogical reasoning.

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[22] MacCormick 'Legal Reasoning', above n 17, 229.

Given the wide acceptance of the distinction between processes of creation and processes of justification, it is perhaps unsurprising that legal theories of analogical reasoning have almost nothing to say about the creation of analogies. They are silent as to the process by which concepts and ideas arise in the mind and the processes by which they are related and an analogy created.[23] Further, legal theory only partially explains the process of justification. Legal theory only partially explains how and why legal analogies are justified.

3.2   The creation of analogies

What prompts the creation of particular analogies? Why do we see injury caused by defectively produced underpants[24] as analogous to injury caused by a decomposing snail in a bottle of ginger beer?[25] What are the processes which lead us to this conclusion?

In seeking to understand the processes by which an analogy between two situations arises, that 'blinding flash of insight' in which the analogy between situations is perceived, jurisprudential literature unfortunately provides no guidance. A consequence of the general acceptance of Wasserstrom's distinction is that processes of creation are rarely discussed.

Levi provides the most famous examination of the nature of legal analogical reasoning which he argues occurs in three steps:

1. similarity is seen between cases,

2. the rule of law inherent in the first case is announced; and

3. the rule of law is made applicable to the second case.[26]

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[23] For a discussion of some of the considerations relevant here see: Golding Martin P., 'A Note on Discovery and Justification in Science and Law' p.109, in (Aarnio Aulis and MacCormick D. Neil) (Eds) Legal Reasoning (1986) New York University Press herafter 'A Note', 119-21. This was also something discussed by Frank: Frank Jerome, Law and the Modern Mind (1949) Stevens & Sons Limited, 104.

[24] *Grant v Australian Knitting Mills* [1936] AC 85.

[25] *Donoghue v Stevenson* [1932] A.C. 562.

[26] Levi, above n 18, 1. Burton Steven J., An introduction to law and legal reasoning (1985) Little, Brown & Co, 26-39 gives a similar taxonomy. Levi's view has been criticised by Murray James R., 'The Role of Analogy in Legal Reasoning' (1982) 29 UCLA LAW Review 833, 848-50 and also by Sunstein 'On Analogical Reasoning', above n 12, footnote 63 and Cross, above n 16, 182 footnote 2. The substance of these criticisms differ. This exploration of analogy is in accord with these criticisms in arguing that Levi's examination of analogy leaves many questions unaddressed. Levi's examination is nevertheless commendable for its clarity.

According to Levi, the 'finding of similarity or difference is the key step in the legal reasoning process.'[27] However, while Levi provides several detailed examples to support his thesis, these examples provide very little insight as to how this finding of similarity is achieved. Levi concludes that the finding of similarity is a function of the individual judge.[28]

Following Levi, noted jurists provide similarly scant discussion of the processes by which the finding of similarity is achieved. When discussing the doctrine of *stare decisis*, Cross merely states that the 'discovery of the *ratio decidendi* of the previous case is primarily a psychological problem.'[29] Similarly MacCormick is content to state that acts

> are not determined by logic, they are determined by the choices of agents, and by whatever, if anything, that determined those choices.[30]

More explicit, if ultimately just as unhelpful is Hutcheson. Hutcheson opaquely states that the result of cases, and by implication the creation of analogies, is determined by judges 'hunching out' their decisions.[31] Jerome Frank argued that these hunches were the result of the particular judge's personality.[32] Frank concluded that since cases are decided according to personal opinions, prejudices and hunches not articulated in judicial decisions this undermined the objectivity of the law. Indeed, it is was in response to Frank's attack on the objectivity of law, an attack based on the inability to articulate and explain why particular positions are arrived at, that Wasserstrom proposed the distinction between processes of creation and processes of justification.[33]

In this context, Kennedy has provided an interesting discussion. In examining the processes of adjudication, Kennedy argues that judges and lawyers have a particular viewpoint towards individual cases, which he labels 'how-I-want-to-come-out'.[34] As the name suggests, this viewpoint indicates how a judge or lawyer would like the case to be

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[27] Levi, above n 18, 2.

[28] Ibid.

[29] Cross, above n 16, 187.

[30] MacCormick 'Legal Reasoning', above n 17, 33.

[31] Hutcheson Joseph C., 'The Judgement Intuitive' (1929) 14 Cornell Law Quarterly 274, 278.

[32] Frank, above n 23, 103. See Part One Ch XII for a discussion of this process. Similar views are held by the jurists cited in Wasserstrom, above n 21, 20-1.

[33] Wasserstrom, above n 21, 25-31.

[34] Kennedy Duncan, 'Freedom and Constraint in Adjudication: A Critical Phenomonology' (1986) 36 Journal of Legal Education 518, 518.

resolved. According to Kennedy, legal reasoning is a matter of trying to make 'the law' and 'how-I-want-to-come-out' converge with each other.[35] Kennedy's theory is interesting for the importance it places on people's views and feelings about cases in affecting how they interact with and interpret the law yet without concluding that legal results are determined by such views and feelings. Like those jurists examined above however, Kennedy does not discuss the basis by which 'how-I-want-to-come-out' is arrived at and although he describes a number of factors which influence change in 'how-I-want-to-come-out'[36] he does not describe the processes by which change occurs.

After examining the characteristics, validity and uses of legal analogical reasoning, Sunstein asks two key questions: 'What is the relationship between cognition and emotions in law?' and 'How does analogical reasoning involve different cognitive and affective capacities?'[37] Unfortunately, although perhaps understandably faced with the silence highlighted above, Sunstein does not attempt to answer these important questions.

Apart from broad examinations such as provided by Levi, it can thus be seen that legal theory lacks a detailed description of how analogies are created. In one sense this is unsurprising. If Wasserstrom's distinction between processes of creation and processes of justification is accepted then how analogies are created becomes unimportant. However, it is argued in the following chapter that in legal analogical reasoning processes of creation and processes of justification are not as clearly separable as Wasserstrom suggests. This means that a theory explaining how legal analogies are created becomes more interesting and more important and it makes the current lack of such a theory all the more stark.

In order to create a computer program that simulates legal analogical reasoning it is necessary for that program to create legal analogies. Legal theory provides little guidance. Other disciplines such as psychology, cognitive science and artificial intelligence investigate how analogies are created.[38] Attempts to simulate legal analogical

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[35] Ibid 557.
[36] Ibid 548-58.
[37] Sunstein 'On Analogical Reasoning', above n 12, footnote 108.
[38] For useful collections of work in these fields see the authorities cited above n 8.

reasoning can draw upon this research. This possibility is explored in subsequent chapters.

While legal theory is uninformative about the processes by which analogies are created, following the distinction between processes of creation and processes of justification, legal theory abounds with discussion about the role and substance of legal justification.

3.3   Justification

The scarcity of legal theory considering the processes involved in the creation of analogies is in stark contrast to legal theory that examines justification in law. The importance of justification in law is readily apparent. Perelman and Olbrechts-Tyteca provide an insightful discussion. According to Perelman disagreement is possible even when there is agreement on the general standards to be applied, for while

> we can all invoke certain universal values like truth, justice and beauty; we all
>
> agree that they exist .... our agreement lasts only so long as we remain on the
>
> level of generalities. ... The fact that all admire and respect truth, justice and
>
> beauty does not mean that all agree on what is to be qualified as being true,
>
> just and beautiful.[39]

When differences of opinion arise it is simply because multiple interpretations of a situation are possible.[40]

According to Perelman and Olbrechts-Tyteca, what we qualify as being true, just and beautiful is the result of our personal hierarchy of values, a hierarchy imposed by the need to make choices between the simultaneous pursuit of several values.[41] It is because we make choices within our own hierarchy of values that the need for justification arises. For if law were completely deterministic where results followed deductively from facts and legal rules then justifications could be completely reconstructed from the facts and the legal rules. This is not the case in legal reasoning, our hierarchy of values determines what analogies we create and how we use them.

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[39] Perelman Chaim, The Idea of Justice and the Problem of Argument (1963) Routledge & Kegan Paul, 66.

[40] Perelman Chaim and Olbrechts-Tyteca L., The New Rhetoric: A Treatise on Argumentation (1969) University of Notre Dame Press, 59.

[41] Perelman and Olbrechts-Tyteca, above n 40, 82.

It is the conclusion that we each have a hierarchy of values that is to some extent different that leads Perelman and Olbrechts-Tyteca to reject 'classic' logic as a model of human reasoning. As Perelman states, the rules of logic demand that

> the same signs preserve always the same meaning without which the most
> self evident logical laws cease to be valid.[42]

Whenever proofs are questioned recourse to argument is unavoidable.[43] As Perelman makes clear

> Legal reasoning is thus a very elaborated individual case of practical
> reasoning, which is not a formal demonstration, but an argumentation aiming
> to persuade and convince those whom it addresses[44]

The means by which such persuasion is achieved is largely through the giving of reasons for a position. According to Perelman and Olbrechts-Tyteca strictly

> legal reasons are adduced only for the purpose of justifying the decision to
> another audience.[45]

However, while Perelman and Olbrechts-Tyteca demonstrate the importance of justification in law, Wasserstrom argued it was the only process of importance. In the wealth of literature discussing justification in law[46] it is Wasserstrom's conception that is widely adopted. For example, MacCormick states

> the essential notion is that of giving ... good justifying reasons for claims
> defences or decisions. The process which is worth studying is the process of
> argumentation as a process of justification.[47]

As a system and process of argument, justification is central to the law. Only justifiable arguments are acceptable. However, the implication that processes of justification are the only processes worth studying, that processes of creation can be validly ignored is a view that is challenged in the next chapter.

In a system involving conflicting values, and choices between those values, the need to justify analogies can readily be appreciated. Regardless of how we initially arrive at an

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[42] Perelman, above n 39, 126.
[43] Perelman and Olbrechts-Tyteca, above n 40, 8.
[44] Perelman, above n 39, 129.
[45] Perelman and Olbrechts-Tyteca, above n 40, 43.
[46] See e.g. Wasserstrom, above n 21; MacCormick 'Legal Reasoning', above n 17; Dworkin Ronald, Taking Rights Seriously (1977) Gerald Duckworth & Co; Kennedy, above n 34; Burton Steven J., Judging in Good Faith (1992) Cambridge University Press. For an examination of reason giving in law and what this involves see: Schauer Frederick, 'Giving Reasons' (1995) 47 Stanford Law Review 633.
[47] MacCormick 'Legal Reasoning', above n 17, 15.

analogy the creation of analogies involves choices as to what similarities and differences, amongst the multitude of ways in which situations are similar and different, are an acceptable basis on which to create and analogy. As Hart states,

> any set of human beings will resemble each other in some respects and differ
>
> from each other in others.[48]

However, not all similarities and differences are important, the

> problem for the law is: When will it be just to treat different cases as though
>
> they were the same? A working legal system must therefore be willing to
>
> pick out key similarities and to reason from them to the justice of applying a
>
> common classification.[49]

Until it is established what similarities and difference are relevant and until it is established why it is justified to focus on and stress particular similarities and differences, the imperative 'Treat like case alike' must remain an empty form.[50]

The relevance of particular similarities and differences is established through argument. Consequently, analogies need to be justified. MacCormick goes so far as to say that it is doubtful whether it is possible to understand case law without an adequate theory of justification.[51] In this light the narrow focus of jurisprudential accounts of legal analogical reasoning can be appreciated. Drawing upon Wasserstrom's distinction, jurists are almost exclusively concerned with exploring the 'rational force'[52] of analogies in law. For example Brewer discusses why judges should be interpreted as structuring analogies with deductive 'analogy warranting rules'. According to Brewer this is necessary to satisfy liberal 'rule of law' ideals which in turn explains why analogies are justified.[53] According to Golding, analogies should be analysed as involving five steps which together clarify why analogies are justified.[54] MacCormick regards analogical reasoning as a form of reasoning with principles and analyses analogical reasoning in terms of how reasoning with legal principles can be justified.[55] Jurisprudential accounts of legal analogical reasoning focus on the

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[48] Hart H.L.A., The Concept of Law (1961) Oxford University Press, 155.

[49] Levi, above n 18, 3.

[50] Hart, above n 48, 155.

[51] MacCormick Neil, 'Why Cases have Rationes and what these are' p.155, in (Goldstein Laurence) (Ed) Precedent in Law (1987) Clarendon Press.

[52] Brewer, above n 13, 928.

[53] Ibid 992.

[54] Golding 'Legal Reasoning', above n 13, ch 3.

[55] MacCormick 'Legal Reasoning', above n 17, ch VII.

'formal' reasons adjudicators offer for deciding a case on way rather than another.[56]

However, while a theory of justification may be necessary to understand case law, it is not itself sufficient. While the importance of justification is evident, this should not imply that processes of creation are unimportant. Indeed, as argued in the following chapter, understanding the processes by which analogies are created is itself essential to understanding the processes by which analogies are justified.

While legal theory clearly establishes the importance of justifying analogies, legal theory is less clear as to what justification consists of. At the most abstract level an analogy can be justified by saying that it is the result of the formal principle of justice that requires 'treating like cases alike'.[57] This however, avoids this issue as it provides no guidance in concrete cases as to when cases will be regarded as relevantly similar.[58] What is needed is theory that indicates when we regard it as justifiable to regard individual cases and aspects of a case as similar.

A theme commonly emphasised by jurists is the need for coherence within the legal system.[59] Accordingly, justification is an attempt to view the law as a

> consistent and coherent body of norms who's observance secures certain
> valued goals which can intelligently be pursued all together.[60]

Within this framework, a justification must fit coherently within the existing legal system and correspondingly, a justification can be regarded as the explanation of a decision that fits most coherently within the existing legal system.

Theorists differ however, on the precise criteria that are applied when constructing coherent arguments. According to MacCormick, analogies 'only make sense if there are reasons of principle underlying them'.[61] Consequently arguments by analogy are

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[56] Lucy William N.R., 'Criticizing and constructing accounts of legal reasoning' (1994) 14 Oxford Journal of Legal Studies 303, 305.

[57] Cross, above n 16.

[58] Hart, above n 48, 155.

[59] E.g. MacCormick 'Legal Reasoning', above n 17; Dworkin, above n 46; Burton, above n 46; Kennedy, above n 34. As discussed below, jurists differ however, on what is involved in this requirement.

[60] MacCormick 'Legal Reasoning', above n 17, 106, ch VII.

[61] Ibid 186.

essentially arguments about principles.[62] Whether it is justifiable to draw a particular analogy in a particular set of circumstances, or more fundamentally, whether the principle underlying the analogy applies in a particular set of circumstances is determined by consequentialist arguments.[63]

Cross provides a similar description. According to Cross, whether situations are similar or different is a matter of the 'desirability'[64] of so regarding them,

> everything will depend on whether the judge considers that the rule by which
>
> the previous case was decided is one that should be extended or restricted.[65]

However, Cross does not specify when so regarding situations will be desirable. Stone is more specific on this point arguing

> this necessarily involves advertence to factors of justice and social policy ...[66]

Similarly, Hart states that we are guided by many complex factors including the aims and purposes of the legal system,[67] moral principles[68] and common sense.[69]

In a controversial theory, Dworkin argues that when reaching a decision, one has to consider the principles that underlie the law.[70] The decision that coheres best with all existing legal knowledge is the justified decision.[71] In this respect Dworkin's theory of law and legal reasoning is much like many others. An interesting aspect of Dworkin's jurisprudence is that he regards there as being only one right answer to legal disputes, one answer that is most justified.[72] Whilst jurists emphasise the importance of principles, the claim that such principles determine unique solutions is controversial.[73]

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[62] Ibid 161.

[63] Ibid 192. Briefly, a consequentialist argument is an evaluative form of argument in which the consequences of making a ruling one way or another are considered important: ibid 105.

[64] Cross, above n 16, 25. Citing Cohen.

[65] Ibid 187.

[66] Stone Julius, Legal System and Lawyer's Reasonings (1964) Stevens & Sons Limited, 316.

[67] Hart, above n 48, 124.

[68] Ibid 200.

[69] Ibid 122.

[70] Dworkin, above n 46, 26.

[71] Ibid 116-7.

[72] Dworkin, above n 46.

[73] Contra Dworking, above n 46. C.f. Sartorius Rolf, 'The Justification of the Judicial Decision' p.127, in (Aarnio Aulis and MacCormick D.Neil) (Eds) Legal Reasoning (1992) New York University Press who argues that there may not always be a right decision but since there is no way to tell whether there is a right decision in a particular case, judges should act as if the case before them has a right decision. However, it is unclear why a judge should act as if there is a right decision in the situation where it is felt that the law does not bind. In contrast, Lyons David, 'Justification and Judicial Responsibility' p.145, in (Aarnio Aulis and MacCormick D. Neil) (Eds) Legal Reasoning (1992) New York University Press, simply says that if there are right moral answers then there may be right legal answers also.

How tightly the requirement of coherence binds is a point of important divergence amongst jurists. In contrast to Dworkin's 'right answer' thesis, according to Kennedy, when you try to make a case come out as you would like you feel the laws influence as a restriction on the arguments you can make and the results you can achieve. On this view the law restricts what is possible. However, Kennedy leaves unanswered whether the law ever prevents a decision based solely on to how you want a case to come out.[74]

More explicit than Kennedy are other jurists within the critical legal studies movement some of whom argue that law does not bind at all; that it is so indeterminate that it allows any decision to have the appearance of coherence.[75] Even on radical critical examinations of law however, justification is regarded as important and involves an attempt to refer to law in an attempt to adopt the authoritative cloak of the law in order to better persuade. Persuasion is achieved through constructing a coherent framework of laws, principles and perhaps other standards, in which to fit the result that is reached.

Whether law does or does not allow any decision to be reached and to nevertheless have the appearance of legal justification is a interesting jurisprudential question, but it is not one that will be explored further. It is peripheral to the present examination. However, the question is informative for another reason. As Dworkin acknowledges it is only the hypothetical Hercules who can find the decision that coheres best with existing legal knowledge.[76] For fallible humans, the search for coherence stops short of the decision that coheres best with all existing legal knowledge. However, why do we then feel something to be justified despite not being able to show that it is coherent with all existing legal knowledge? If we do not have any 'rational' reason, in the sense of a reason that fully coheres with the law, we are left with scope for choice. Not being able to demonstrate which justification and thus which result coheres best, we must choose between possible multiple justifications each of which coheres with parts of legal knowledge.

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[74] Kennedy, above n 34, 548.
[75] See the authorities cited in Burton, above, n 46, 10 footnote 21.
[76] Dworkin, above n 46, 129-30.

Because they do not operate unconstrained and because the values the influence these choice are informed by more widely held community values it may be undesirable to call these choices 'personal'.[77] Nevertheless, a choice is exercised and theories of legal justification do not explain why one choice is made rather than another. In this sense, theories of legal justification do not fully explain how justifications are reached. Theories of legal justification indicate what criteria are applied when constructing a justification. However, theories of justification do not explain how or why particular choices are exercised when choosing amongst several possible results and justifications.

The analogies we create and apply in law are influenced by the overall purposes that we perceive the legal system as trying to achieve, these assessments occur in a whole body of knowledge and theory that we use to make sense of the world.[78] When deciding between competing classifications our evaluation inherently involves considerations of the consequences of each classification on our model of the world and in this way the existence and application of analogies is individually determined. However, it does not occur unconstrained: in law the analogies we create are restricted by the necessity that they be justifiable and by the requirement that such justification cohere with the law.[79]

3.4 Conclusion

From the above examination, jurisprudential accounts of legal analogical reasoning can be seen to have several shortcomings. Fundamentally, these accounts they do not provide a comprehensive theory of legal analogical reasoning. The reason for this stems from the widespread acceptance of the distinction drawn by Wasserstrom between processes of creation and processes of justification. Jurists argue that *if it is possible to explain why analogies are justified then it is unimportant to investigate the processes by which analogies are created.* Consequently legal theory focuses on theories of justification. However, theories of justification do not fully explain how decisions are justified. Justification rest on an element of choice. Theories of justification do not explain why particular choices are exercised. For this reason, legal theory does not fully explain the processes of justification. Moreover, as discussed in the following chapter, in its

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[77] Bell John, 'The Acceptability of Legal Arguments' p.45, in (MacCormick Neil and Birks Peter) (Eds) The Legal Mind: Essays for Tony Honoré (1986) Clarendon Press.
[78] MacCormick 'Legal Reasoning', above n 17, 103.
[79] Alexy Robert, A Theory of Legal Argumentation (1989) Clarendon Press, 212.

application to legal analogical reasoning the distinction between processes of creation and processes of justification is not absolute. In legal analogical reasoning process of creation and processes of justification interact. This interaction further undermines the validity of ignoring processes of creation in legal analogising.

To create a computer program that simulates legal analogising it is necessary for that program to create analogies and to justify those analogies. Legal theory indicates why justifying analogies is important and indicates what the substance of justification involves. However, legal theory does not explain the processes by which legal analogies are created and does not fully explain the processes by which legal analogies are justified.

4   Re-examining the distinction between processes of creation and processes of justification

In the previous chapter, theories of legal analogical reasoning were examined. This examination highlighted a key distinction in theories of legal reasoning. When examining legal reasoning, legal theorists distinguish between processes of creation and between processes of justification. Legal theory focuses on examining how legal results, and legal analogies are justified. The processes by which legal analogies are created is regarded as unimportant.

However, it is argued in this chapter that the distinction between processes of creation and between processes of justification is not an absolute one. In legal analogising processes of creation influence processes of justification and processes of justification influence processes of creation. That processes of creation interact with processes of justification in legal analogising highlights that theories of legal analogical reasoning are incomplete. This interaction has implications for attempts to create computer systems that simulate legal analogical reasoning. The implications of this interaction for attempts to simulate legal analogising and for theories of legal analogical reasoning is discussed in subsequent chapters.

4.1   The privileging of theories of justification

The distinction championed by Wasserstrom between processes of creation and between process of justification in legal reasoning suggests legal analogical reasoning occurs, on a broad scale, as a linear two step process (figure 1).

Creation of
analogies

↓

Justification
of analogies
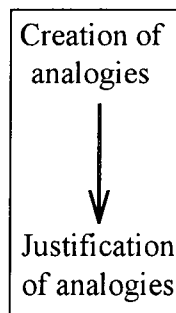
Figure 1: The linear conception of legal reasoning

Theories of legal analogical reasoning are wholly concerned with examining the formal reasons offered to support legal analogies. In a context in which the distinction between processes of creation and processes of justification is accepted, it is understandable that the logical structure of legal analogies, as reconstructed from judicial decisions, is all that is investigated. However, as will become apparent, the interaction between processes of creation and processes of justification undermines the exclusive attention paid to examinations of processes of justification.

While Levi's conception of legal reasoning can be criticised for failing to indicate what the finding of similarity involves, an apparently more precise definition of analogy can be provided as per Golding (figure 2).

i.x has characteristics F, G ... ii.y has characteristics F, G ... iii.x also has characteristic H. iv.F, G ... are H-relevant characteristics.
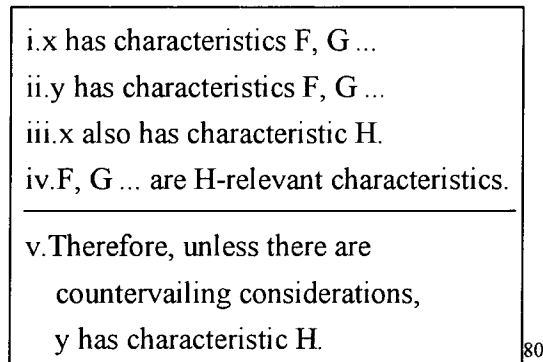
v.Therefore, unless there are
   countervailing considerations,
   y has characteristic H. [80]

Figure 2: A reconception of legal analogical reasoning

Whilst Levi's account of legal reasoning left unclear what will be regarded as similar for the purposes of a legal analogy, Golding's account specifies, through premise (iv), what characteristics are relevant to establishing similarities. Golding's account thus specifies what characteristics are to be compared for the purpose of creating analogies. Knowing what characteristics are relevant for the purposes of creating an analogy it is hence possible to determine when an analogy is justifiable. An analogy between precedents or between a precedent and a problem is justifiable if the precedent and the problem share relevant characteristics. However, a number of questions remain with Golding's account. For instance, how is it known that x has characteristics F and G? How is it known that y has characteristics F and G? How is it known that x has characteristic H? How is it known that characteristic H is important? How is it known that characteristics F and G are relevant to H? How is it known whether there are countervailing considerations?

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[80] Golding, above n 13, 107. Based on Golding's work Brewer has provided a similar conception, Brewer, above n 13, 966. Brewer's conception of analogy differs however in that it places even more weight on the deductive aspects of analogy: Brewer, above n 13, footnote 135.

Golding does not discuss how particular characteristics are perceived in particular circumstances. Golding does not discuss how 'x' and 'y' are perceived to have characteristics 'F', 'G' and 'H'. However, in specifying what characteristics are 'relevant' premise (iv) determines what characteristics are searched for in problems and precedents. Premise (iv) thus provides an important pointer to the way in which legal analogies are created.

According to Golding premise (iv) rests in a fundamental way on underlying considerations of principle.[81] If premise (iv) rests on considerations of principle then it is these considerations of principle which ultimately determine which characteristics are relevant and thus focused on when assessing precedents and problems. This view that legal principles play an indispensable role in legal analogising is strongly advocated by other jurists. For example, MacCormick argues that

> no clear line of distinction can be drawn between argument from legal principle and argument from analogy. Analogies only make sense if there are reasons of principle underlying them.'[82]

4.2 The interaction between processes of creation and processes of justification.

However, if analogies ultimately rest on considerations of principle this has implications for the analogies we construct. Returning to Golding's scheme for analogy, with a different governing principle, a different characteristic H', may be regarded as relevant in precedent x. Thus, different characteristics, F' and G', in precedent x would be relevant to establishing H'. Consequently different characteristics would also be relevant in problem y (figure 3).

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[81] Ibid. More precisely, Golding states that premise (iv) will rest on considerations of principle or policy. A distinction between policy and principle is not important for present purposes - even if such a distinction is sustainable c.f. Dworkin, above n 46, 22-3 and MacCormick 'Legal Reasoning', above n 17, ch 10. For the sake of simplicity these two together are referred to under the term 'principle'. What is emphasised is that premise (iv) will rest in a more fundamental way on an evaluative standard.

[82] MacCormick 'Legal Reasoning', above n 17, 186.

Principle A	Principle B
i.x has characteristics F, G ...	i.x has characteristics F', G' ...
ii.y has characteristics F, G ...	ii.y has characteristics F', G' ...
iii.x also has characteristic H.	iii.x also has characteristic H'.
iv.F, G ... are H-relevant characteristics.	iv.F', G' ... are H'-relevant characteristics.
---	---
v.Therefore, unless there are countervailing considerations, y has characteristic H.	v.Therefore, unless there are countervailing considerations, y has characteristic H'.

Figure 3: Competing analogies

That the adherence to different principles can result in the creation of different analogies has implications for the processes by which analogies are created. Ultimately these principles determine the way in which situations are perceived and hence the analogies that are created. Golding leaves unclear what is meant by a 'characteristic'. It is unclear whether a 'characteristic' is something abstract or is a factual characteristic. In both situations though, principles determine the way situations are perceived. If a characteristic is regarded as something abstract, such as whether 'reasonable care' was exercised, the presence or absence of this characteristic has to be established by specific facts. However the influence of a different principle, requiring different abstract characteristics to be established, will in turn require different facts to establish these abstract characteristics. Hence principles influence which facts are perceived as important and unimportant. Alternatively, if characteristics are regarded at the factual level, principles again influence what facts are regarded as relevant. Governed by Principle A, facts F and G are required. Governed by principle B however, facts F' and G' are required. Ultimately, the principle that governs the analogy determines what facts are relevant to establishing the analogy.

That principles influence the construction of analogies is supported by research on analogical reasoning from areas outside law. This research highlights that our goals intimately affect the analogies that we create.[83] Anecdotal evidence for the influence of principles on the construction of analogies is also provided by reports from judges and

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[83] See chapter 5 and the discussion of analogy therein.

jurists who note the phenomena that a decision 'Just won't write.'[84] A decision won't write because it is not felt justifiable. This forces a re-examination of the problem, it prompts the creation of a new, tentative solution. The need for justification affects the solutions that are created and proposed.

Principles influence which facts are required to establish an analogy. Stated alternately, with a particular set of facts, which precedents are regarded as analogous is influenced by the principles that the reasoner adheres to. The focus when constructing legal analogies, from the generalisation we say governs the analogy, to the characteristics used to demonstrate that the generalisation applies, to the particular facts of cases which demonstrate the presence of those characteristics, are all dependent on the principles to which the reasoner adheres. If different principles are adhered to then a different generalisation may be regarded as relevant between two precedents, different characteristics may be regarded as relevant to establishing that generalisation and different facts may be sought to demonstrate the presence of these characteristics.

That the principles which a reasoner adheres to influences the analogies that the reasoner constructs undermines the linearity of legal reasoning suggested by the distinction between processes of creation and processes of justification. The justification of legal propositions ultimately rests on considerations of legal principle.[85] Legal principles underlie the justifications for legal propositions. However, as demonstrated above principles influence the construction of legal analogies. This indicates a link between the processes of justification and the processes of creation. The analogies that are created are influenced by the principles adhered to and which underlie the justification that will be offered for the analogy.

In legal analogical reasoning, just as processes of justification influence processes of creation, processes of creation influence processes of justification. While a scheme for analogy such as Golding's can be used to demonstrate that principles influence the creation of analogies, such a scheme obscures an important aspect of this process. Principles do not exist pre-packaged to be applied in the determination of problems.

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[84] E.g.: Wald Patricia M., 'The Rhetoric of Results and the Results of Rhetoric: Judicial Writings' (1995) 62 University of Chicago Law Review 1371, 1375.
[85] See discussion, above ch 3.

Intertwined with the influence of principles on legal analogical reasoning is the role that analogising plays in determining the scope of principles themselves. As Sunstein states, although analogical reasoning depends on principles, analogical reasoning

> is an important part of the development of those principles. ...We cannot know what it is that we think until we explore a range of cases. Principles are thus both generated and tested through confrontation with particular cases.[86]

The application of principles itself results in change to those principles. This is a subject explored in depth by jurists.[87]

Thus, while for the purposes of reconstruction it can be said that

> Principle A supports the inference that F, G ... are H-relevant characteristics; or
>
> Principle B supports the inference that F', G' ... are H'-relevant characteristics

this leaves unanswered from where principles A and B arise. It is argued that the principles which underlie analogies, and which can be referred to as supporting an analogy in its reconstruction, are the result of the interaction of and compromise between other principles. The application of principles during legal analogising changes the conception of those principles.[88]

That the scope of principles is refined and demarcated in their application in concrete situations demonstrates a link between processes of creation and processes of justification in legal analogical reasoning. The justification of legal propositions depends in part on the principles that a reasoner adheres to. However, the scope of these principles is dependent on their application during the construction of analogies. Hence

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[86] Sunstein 'On Analogical Reasoning', above n 12, 775. Levi noted this early on stating that the 'rules change as the rules are applied': Levi, above n 18, 3-4.

[87] E.g.: Brewer, above n 13; Golding 'Legal Reasoning', above n 13; Sunstein 'On Analogical Reasoning', above n 12; MacCormick 'Legal Reasoning', above n 17; Levi, above n 18. To the extent that theorists accept that the application of principles in individual cases influences the scope of those principles it is ironic that they nevertheless accept the distinction between processes of creation and process of justification. As argued in chapter 8, the interaction between processes of creation and processes of justification undermines the exclusive focus on process of justification.

[88] In this context it is interesting to consider the relationship between analogical reasoning and reasoning by 'reflective equilibrium'. Brewer argues that reflective equilibrium, the

> process of reflective adjustment between specific examples ... and general normative principles is a common and vitally important instance of example-based reasoning.

Brewer, above n 13, 938-9, citations omitted. In contrast, Sunstein concludes that while analogical reasoning and the search of reflective equilibrium have much in common they are also sufficiently different as to be irreducible to one another: Sunstein 'On Analogical Reasoning', above n 12, 781-3. It is not the purpose of this discussion to explore this issue in depth, however the debate emphasises the important role that the application of principles in concrete situations plays in modifying those principles.

the way that analogies are perceived influences the justifications that are offered for those analogies.

4.3 Demonstrating the interaction between processes of creation and process of justification.

The interaction between the processes of creation and the processes of justification that occurs in legal analogical reasoning is demonstrated with reference to *Donoghue v Stevenson* [1932] A.C. 562. This case has been chosen simply because it provides a particularly clear demonstration of the influence of principles on legal analogical reasoning.

In *Donoghue v Stevenson*

> the appellant drank a bottle of ginger-beer, manufactured by the respondent, which a friend had bought from a retailer and given to her. The bottle contained the decomposed remains of a snail which were not, and could not be, detected until the greater part of the contents of the bottle had been consumed. As a result she alleged, and at this stage her allegation must be accepted as true, that she suffered from shock and sever gastro-enteritis.[89]

At the time the case was decided, it was unclear whether an injured party could claim against the manufacturer of a product causing injury in the absence of any contractual relationship between them. Their lordships in *Donoghue v Stevenson* referred to numerous cases, these cases having differing results. Commenting on the law, Lord Salmon has noted

> [h]ere is an age long conflict of theories which is to be found in every system
>
> of law. "A man acts at his peril" says one theory "A man is not liable unless
>
> he is to blame" answers the other. It will not surprise ... to find that between
>
> these theories a middle way, a compromise has been found.[90]

The influence of these two principles can be seen on the opposing judgements of Lord Buckmaster and Lord Aitkin.

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[89] [1932] A.C. 562, 566.
[90] *Read v J Lyons & Co Ltd* [1947] A.C. 156, 180.

Lord Buckmaster dissented in the case and would have denied the appeal. According to Lord Buckmaster, the general principle governing such cases was that the

> breach of the defendant's contract with A. to use care and skill in and about the manufacture or repair of an article does not itself give any cause of action to B. when he is injured by reason of the article proving to be defective.[91]

Two exceptions were contemplated

> (1)In the case of an article dangerous in itself; and (2)where the article not in itself dangerous is in fact dangerous by reason of some defect or for any other reason.[92]

According to Lord Buckmaster no one could 'suggest that ginger-beer was an article dangerous in itself.'[93] Further, the second exception rested on the 'obligation to warn', the concealment of which is in the 'nature of fraud'.[94] Lord Buckmaster considered there to be no indication of fraud in the present case.

Thus, regarding the general situation as governed by contract and admitting only strict exceptions, Lord Buckmaster refused the appeal. The facts could not be analogised to any of the precedents cited by counsel in argument because the bottle of ginger-beer was not regarded as an inherently dangerous item and nor was there any evidence on which to establish fraud.

In contrast, the majority opinion of Lord Aitkin rested on the much wider statement that you

> must take reasonable care to avoid acts or omissions which you can reasonably foresee would be likely to injure you neighbour. Who, then, in law is my neighbour? The answer seems to be - persons who are so closely and directly affected by my act that I ought reasonably to have them in contemplation as being affected when I am directing my mind to the acts or omissions which are called in question.[95]

With this conception, the examination undertaken by Lord Aitkin focused on different characteristics than did the examination of Lord Buckmaster. Lord Aitkin focused on

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[91] *Donoghue v Stevenson*, 569. Quoting Lord Summer in *Blacker v Lake & Elliot Ltd* 106 L.T. 533, 536.
[92] Ibid, 569.
[93] Ibid.
[94] Ibid.
[95] Ibid, 580.

things such as whether the product was 'used immediately' and whether there was a 'reasonable opportunity of inspection' - whether there was a 'proximate relationship'.[96] It is readily apparent that this is a search for a different type of characteristic, which will require different facts to prove or disprove, than is the search for a product that is 'inherently dangerous' or for 'fraud'. With the examination focused in this way, Lord Aitkin regarded the case as analogous to several precedents and found for the appellant.

Clearly, the different conceptions of the principles thought by their Lordships to govern the problem resulted in the construction of different analogies with different precedents. Lord Buckmaster's view that principles of contract governed resulted in a series of analogies to cases involving 'inherently dangerous' items or involving fraud. Lord Aitkin's view that 'sufficient attention' must be given 'to the general principle which governs the whole law of negligence'[97] resulted in the problem being regarded as analogous to several precedents favouring the plaintiff. The principles that their lordships adhered to determined how they perceived the problem. These principles determined what precedents were relevant, what characteristics were relevant in those precedents and the problem and what facts were relevant to establishing those characteristics in the precedents and the problem.

As the judgements in *Donoghue v Stevenson* demonstrate, the analogies drawn between cases, and ultimately the interpretations of the facts upon which those analogies rest depend on the legal principles to which the reasoner adheres. As Justice Wald has stated

> the facts can - and indeed must - be retold to cast a party as an innocent victim or an undeserving malefactor, to tow the story line into the safe harbour of whatever principle of law the author thinks should control the case.[98]

However, the principles which Lord Buckmaster and Lord Aitkin applied did not exist *a priori* to be applied in the analogies their Lordships proposed. Analogical reasoning is an important way in which the scope of principles is refined and demarcated. *Donoghue v Stevenson* also illustrates how principles interact and are compromised during legal analogical reasoning.

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[96] Ibid, 582.
[97] Ibid, 594.
[98] Wald, above n 84, 1386.

As Lord Salmon has noted, this area of law demonstrates a conflict between the two principle that "A man acts at his peril" and "A man is not liable unless he is to blame."[99] The opposing judgements of Lord Buckmaster and Lord Aitkin each express a different compromise between these principles. Neither judgement applied either principle in full. Lord Buckmaster's requirement that a contract is generally necessary to found liability can be regarded as strongly influenced by the principle that 'a man is not liable unless he is to blame'. However, the acknowledgement of exceptions in cases involving 'inherently dangerous' objects or fraud is a small concession to the principle that 'a man acts at his peril.'[100] In contrast, Lord Aitkin reached a different compromise between these principles - this compromise itself having come to be called the 'neighbour principle'. Lord Aitkin placed more influence on the principle that 'a man acts at his own peril.' However, Lord Aitkin did not fully apply this principle and the neighbour principle is a succinct expression of the balance to be drawn between the principle that 'a man acts at his peril' and the principle that 'a man is not liable unless he is to blame.' Thus each judge was influenced by both principles though neither applied either principle in totality. It was the dynamic interaction between and influence of these principles that resulted in two different conceptions of principle which ultimately founded the different analogies that were argued in *Donoghue v Stevenson*. The case thus succinctly illustrates the way that processes of creation interact with processes of justification in legal analogical reasoning.

Legal principles both underlie legal justifications and influence the creation of analogies. Adhering to different principle, or with a different conception of principles, different analogies may be created. Hence aspects of the processes of justification influence processes of creation in legal analogical reasoning. However, the legal principles that an reasoner adheres to are themselves altered during the creation of legal analogies. A reasoner's conception of principles is influenced by the application of those principles. Legal principles are refined and compromised as they are applied. Since justifications depend on legal principles, with a different conception of those principles, different

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[99] *Read v J. Lyons & Co Ltd*, 180.

[100] It could be argued that all Lord Buckmaster was actually doing was re-affirming a line of old cases, he was not thinking about principles at all. Apart from the question of why Lord Buckmaster focused on the particular cases that he did, even if this is accepted, it is argued that this line of old cases expresses the compromise between principles discussed above.

justifications may be required. Hence, aspects of the processes of creation of legal analogies influence aspects of the processes of justification of those analogies.

4.4 Reconceptualising legal analogical reasoning

The distinction between processes of creation and processes of justification suggests that these processes occur separately in legal analogising. However, it has been informally shown that in legal analogical reasoning processes of creation affect processes of justification and that processes of justification affect processes of creation.

The interaction between the processes by which analogies are created and the processes by which analogies are justified undermines the linearity of legal reasoning that is implied by the distinction between these processes. Given the mutual interaction and influence between processes of creation and processes of justification in legal analogical reasoning, the distinction between process of creation and processes of justification, and the linearity of reasoning that it implies, require modification in their application to legal analogical reasoning. A modified conception of legal analogical reasoning should acknowledge the interaction between the processes of creation and the processes of justification in legal analogical reasoning (figure 4).
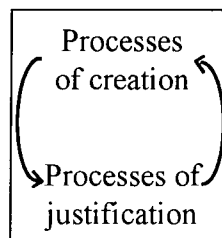
Figure 4: The interaction of creation and justification

Such a revised conception of legal analogical reasoning has several consequences for theories of legal analogising. Foremost, such a revised conception undermines the validity of legal theory's exclusive focus on justification in legal analogising. Once the influence of processes of creation on processes of justification is acknowledged it becomes impossible to study comprehensively justification without also investigating processes of creation. This is a topic that is discussed in more depth in chapter 8. While such a conception of legal analogical reasoning indicates that reasoning is more complex than suggested by Wasserstrom, it does not undermine the argument that justification is extremely important in law. Such a conception of legal analogising does however, place more importance on understanding the processes of creation themselves. A more

complex conception of the processes of legal reasoning is required - one which acknowledges and explains this interaction.

Having argued for a view of legal analogical reasoning in which analogising is dependent on legal principles, it must be briefly emphasised what is not being argued. It is not argued that any plausible analogy can be created between a problem and any chosen precedent. Nor that the adherence to different principles will necessarily lead to the creation of different analogies. Nor that people always fundamentally disagree about analogies that are created in particular legal situations. For many reasons there is agreement within the legal system and there are constraints on what people do. To again quote Justice Wald,

> I do not mean to suggest there are not real constraints in the process itself: judges cannot run roughshod over the factual findings of lower bodies or the relevant law. Their discretion in deciding the outcome in the first place is constrained by the degree to which they can (reasonably) mold the facts and the law to tell a coherent story.[101]

It is argued that within constraints the construction of different analogies in law is in part driven by the principles that the reasoner adheres to.

Further, it is not argued that legal analogical reasoning always involves an interaction between processes of creation and processes of justification. In this context psychological research is informative. According to Gentner, when discussing analogy it is necessary to distinguish between different types of similarity.[102] Gentner argues that there is a difference between 'mere appearance matches' and 'true analogies.'[103] In mere appearance matches the finding of similarity is constituted solely by correspondences between attributes of objects.[104] Gentner argues however, that the similarity in true analogies is based on more abstract relationships.[105] The use of the term 'analogy' in

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[101] Wald, above n 84, 1388.

[102] Gentner Dedre, 'The mechanisms of analogical learning' p.199, in (Ortony A. and Vosniadou S.) (Eds) Similarity and Analogical Reasoning (1989) Cambridge University Press, 206-8. This is a point also made by Rumelhart: Rumelhart David E., 'Toward a microstructural account of human reasoning' p.298, in (Ortony A. and Vosniadou S.) (Eds) Similarity and Analogical Reasoning (1989) Cambridge University Press hereafter 'Toward a microstructural account', 301.

[103] Gentner, above n 102.

[104] For example, in the statement 'The glass tabletop gleamed like water' Gentner argues that the similarity depends on the facts that both the glass tabletop and the water are shiny, 'little beyond physical similarity is shared between the tabletop and water': ibid 207.

[105] In such similarities a 'common relational system holds for the two domains': ibid.

legal theory is certainly not used in the restricted sense argued for by Gentner. However, Gentner's discussion does highlight a useful aspect of the finding of similarity which underlies analogising. The finding of similarity ranges from the less evaluative to the more creative and abstract. Some legal analogies may rest on comparatively straightforward assessments of similarity. The similarities between two precedents both involving drivers stopped for driving erratically and then arrested for driving with a blood alcohol content above the legal limit is comparatively straightforward. The similarity between the injury caused by the decomposing snail in *Donoghue v Stevenson* and the injury caused by the defectively manufactured underpants in *Grant v Australian Knitting Mills* is less obvious and involves the perception of more abstract relationships. It is argued that it is in the perception of such abstract relationships that the interaction between processes of creation and between processes of justification is most apparent. It may thus be that the interaction between processes of creation and process of justification is more apparent at the appellate level than at trial level. This interaction may be more apparent in certain areas of law than in others. This interaction may also be more evident during particular stages of development in the law than at others. However, any complete theory of legal analogical reasoning must account for the mutual interaction between processes of creation and processes of justification that can occur in legal analogical reasoning.

4.5   Conclusion

Legal theoretical accounts of legal analogising are based on a distinction between processes of creation and justification. These accounts focus solely on processes of justification. However, in legal analogising the distinction between processes of creation and processes of justification is not absolute. As is discussed in chapter 8, this undermines the exclusive focus on processes of justification in theories of legal analogising. The interaction between processes of creation and processes of justification also has implications for attempts to simulate legal analogising. These implications are explored in chapter 6 and chapter 7 which review and critique attempts to simulate legal analogising. Before examining these implications however, general approaches to simulating analogical reasoning developed in the field of artificial intelligence are examined.

5   Artificial intelligence and analogical reasoning

5.1   Introduction

In chapters 3 and 4, theories of legal reasoning were examined in order to understand the processes involved in legal analogical reasoning. In this chapter, approaches to simulating analogical reasoning developed in artificial intelligence are examined. This examination discusses the three major approaches by which analogical reasoning is simulated in artificial intelligence: case-base reasoning, computational analogy and neural networks. It is argued that current approaches developed in artificial intelligence only provide a very shallow simulation of human analogical reasoning. Current approaches to simulating analogical reasoning are subject to several shortcomings that prevent them from simulating anything beyond straightforward matching Simulations of analogical reasoning are severely restricted by their inability to determine similarities between situations. To date, research on simulating analogical reasoning has not fully addressed the implications of the 'semantic flexibility' that is characteristic of analogical reasoning. It is argued that this semantic flexibility underlies current restrictions on simulations of analogising.

The approaches discussed here to simulating analogical reasoning underlie approaches to simulating legal analogical reasoning that are examined in the next chapter. Hence simulations of legal analogising are subject to the same limitations as are the approaches to simulating analogising examined here. In order to better understand the limitations in simulations of legal analogising, and hence how these limitations might be addressed, it is necessary to closely examine these general approaches to simulating analogical reasoning. After briefly discussing the role of analogy in artificial intelligence, case-based reasoning, computational analogy and neural networks are examined in turn.

5.2   Simulating analogising

Before examining approaches to simulating analogical reasoning, a clarification in terminology is worthwhile. In the artificial intelligence literature there is confusion between the terms 'case-based reasoning' and 'analogical reasoning'.[106] One distinction

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[106] Aamodt Agnar and Plaza Enric, 'Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches' (1994) 7 Artificial Intelligence Communications 39, 43-4. Indeed a moratorium on the use of the term analogy has been proposed: Dejong Gerald, 'Comments on Part II:

that is often made between these terms is that 'case-based reasoning' involves reasoning with experiences that are confined to a single domain, whereas 'analogical reasoning' refers to reasoning involving experiences drawn from different domains.[107] However, this does not seem a solid distinction. According to Riesbeck and Schank, two leading researchers in artificial intelligence, the essence of case-based reasoning is simply reasoning from experience and remindings of all types including 'across contextually bounded structures' are covered by the term case-based reasoning.[108] Numerous researchers however, confine the term 'case-based reasoning' to reasoning from experiences confined to the same domain and in contrast utilise the term 'analogy' for reasoning involving experiences that come from distinct domains.[109]

Defining analogy according to whether the experiences reasoned with are from the same domain can be problematic. It is to some degree arbitrary to distinguish where one domain begins and another ends. For example, does noting a similarity between the play 'Romeo and Juliet' and the play 'West Side Story' involve reasoning with cross-domain knowledge? In one sense not, after all both works are plays and are thus in the same domain. However, in another sense the plays are in quite different domains. One is a love-story set in medieval Venice performed without music, while the other is a musical set in modern New York. Rather than getting overly tangled in this terminology, the pragmatic approach suggested by Aamodt and Plaza is helpful. Aamodt and Plaza suggest that work on analogy in artificial intelligence has focused on the particular problem of determining under what criteria cases can be regarded as similar.[110] Research in case-based reasoning, while of necessity examining what similarity between cases involves, also examines wider issues.

Adopting this distinction, the terms 'case-based reasoning' and 'analogical reasoning' are used in this discussion simply to identify research that itself identifies itself as belonging to one of these research traditions.

The role of explanation in analogy; or, The curse of an alluring name' p.346, in (Ortony A. and Vosniadou S.) (Eds) Similarity and Analogical Reasoning (1989) Cambridge University Press.

[107] Aamodt and Plaza, above n 106, 43-4.

[108] Riesbeck and Schank, above n 111, 19.

[109] Aamodt and Plaza, above n 106, 40. In this context Aamodt and Plaza confusingly refer to case-based reasoning as a form of 'intra-domain analogy', ibid 40. Holyoak and Thagard too have claimed that CBR is a form of intra-domain analogy, Holyoak Keith J. and Thagard Paul, 'Analogical Mapping by Constraint Satisfaction' (1989) 13 Cognitive Science 295, 318.

[110] Aamodt and Plaza, above n 106, 44.

A widespread approach to simulating intelligence that is adopted in artificial intelligence is fundamentally based on the premise 'that the knowledge of an expert can be embodied in a set of rules.'[111] Numerous systems have been created on this premise, including systems in law.[112] The accuracy of this premise however, is increasingly questioned. The view that human knowledge can be accurately stated as a set of rules implies that reasoning is only a matter of applying rules and that problem solving always involves resorting to first principles and logical deductions made from those principles.[113] An increasing amount of psychological evidence indicates that this is not how human reasoning operates.[114] Rather than always reasoning from first principles, people refer to past experiences when solving new problems. As Riesbeck and Schank state, the problem is that it

> is tempting for experts to cite rules that they follow, but it is often the case that each rule has many exceptions. In fact, in very difficult cases, where the situation is not so clear cut, experts frequently cite previous cases that they have worked on that the current case reminds them of.[115]

For this reason, Riesbeck and Schank argue that this 'conception of the nature of human reasoning' is wrong.[116]

Research on simulating analogising has arisen in response to this perceived inability of rule-based approaches to capture all that is involved in human reasoning. In this vein Riesbeck and Schank argue that

> [c]ase-based reasoning is the essence of how human reasoning works. People reason from experience.[117]

Before embarking further, one clarification is necessary. To lawyers, the very term 'case-base reasoning' is laden with meaning. Legal cases are vital in the common law and

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[111] Riesbeck Christopher K. and Schank Roger C., Inside case-based reasoning (1989) Lawrence Erlbaum Associates, Inc, 2.

[112] One of the earliest and most often cited examples is: Sergot M., Sadri F., Kowalski R., Kriwaczek F., Hammond P. and Cory T., 'The British Nationality Act as a Logic Program' (1986) 29 Communications of the ACM 370.

[113] Riesbeck and Schank, above n 111, 9.

[114] Kolodner Janet, Case-Based Reasoning (1993) Morgan Kaufmann, 27. See generally the collection of essays in Ortony and Vosniadou, above n 8.

[115] Riesbeck and Schank, above n 111, 10.

[116] Ibid 2.

[117] Ibid 7.

lawyers use legal cases when reasoning about legal problems. However, when used in artificial intelligence the term 'case' has much wider meaning than that of a legal case. The term 'case' refers generally to any experience. As such case-based reasoning is not generally directly concerned with reasoning with legal cases or legal precedents. However, the application of case-based reasoning to the legal domain is examined in the following chapter.

5.3 Case-based reasoning

A thorough review of the literature on case-based reasoning is impossible in the space available here.[118] Instead this discussion will focus on two key problems inherent in case-based reasoning. These two problems are (i)representing cases in a computer manipulable form, and (ii)finding similar cases. An analysis of these two problems highlights the restrictions on case-based reasoning as a means to simulate analogical reasoning.

The central idea in case-based reasoning is straightforward,

> [a] case-based reasoner solves new problems by adopting solutions that were used to solve old problems.[119]

Within this broad framework however, case-based reasoning systems vary widely. Systems have been created in diverse areas and to perform diverse tasks.[120] Systems vary according to the degree they operate independently of human supervision.[121] Amongst this diversity however, all case-based reasoning systems involve several common steps (figure 5).

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[118] See Kolodner, above n 114, for a detailed discussion of the field including discussion and explanation of numerous case-based reasoning systems. A detailed categorised bibliography of the literature relevant to case-based reasoning has recently been produced: Marir Farhi and Watson Ian, 'Case-based reasoning - a categorized bibliography' (1994) 9 The Knowledge Engineering Review 355. The first international conference on case-based reasoning was held in Sesimbra, Portugal on October 23, 1995 and the proceedings of this conference provide an interesting cross-section of current research in case-based reasoning.

[119] Riesbeck and Schank, above n 111, 25.

[120] Amongst other things, case-based reasoning systems have been created that engage in planning, diagnosis, design, and justification: Kolodner, above n 114, 77, 87.

[121] Automated reasoners accept a problem description and then produce a solution, human involvement is limited to providing feedback on the solution: Kolodner, above n 114, 60. In contrast, aiding and advisory systems interact with people to help them solve problems: Kolodner, above n 114, 60. Aiding and advisory systems are a largely unexplored application of CBR: ibid.
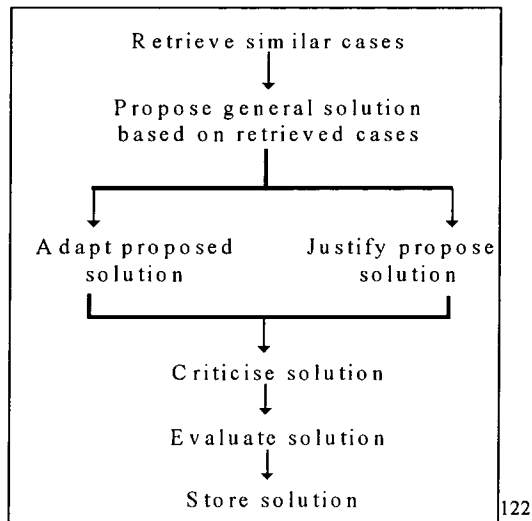
Figure 5: The general case-based reasoning path

Building a case-based reasoning system requires choosing how to tackle each of these issues. The choices that are made determine the abilities of the system that is created. While all of these issues are important, how cases are represented in a case-based reasoning system, and the methods used to determine similarities between cases are together the two most important and difficult issues in case-based reasoning. These two issues determine the ability of a case based reasoning system to simulate analogical reasoning.[123]

5.3.1 Representing cases

The behaviour of a case-based reasoning system is fundamentally dependent on the cases it has access to. For a case-based reasoning system to perform usefully the system must contain useful cases and the system must be able to access those cases at appropriate times. Obtaining the cases to put in a system may itself be problematic. Even when an expert in the field in which the system is being constructed is available, eliciting the appropriate cases from the expert and eliciting the appropriate aspects of those cases from the expert may be difficult.[124]

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[122] Kolodner, above n 114, figure 1.1, 18.. A largely similar figure is provided by Riesbeck and Schank, above n 111, figure 2.1, 32.

[123] Together these two issues determine the solutions adopted for the other issues. For a good detailed discussion of the remaining issues, see Kolodner, above n 114; Aamodt and Plaza, above n 106.

[124] Kolodner, above n 114, 550-3.

More problematic is making that knowledge useable by a computer. At present computers are not able to understand natural language.[125] It is not possible to simply connect a microphone into a computer, or present a computer with a page of text and have the computer automatically and independently extract the knowledge presented to it. Rather, knowledge must be interpreted by a 'knowledge engineer'[126] who converts the knowledge into a form that computers are capable of manipulating. This is problematic however, as it is extremely difficult to represent the full complexity, richness and flexibility of human knowledge in a computer manipulable form.[127] Making human knowledge amenable to computer manipulation is also extremely time consuming. For efficiency it is desirable to include only those cases and only those aspects of cases which are useful to the case-based reasoning system. However, it is difficult to separate that knowledge that might be useful from the knowledge that might not be useful. Researchers in case-based reasoning have developed guidelines to aid in this task.[128] Even with such guidelines though, designers must make fundamental choices about what cases to include in a system and what knowledge to include in those cases.[129] Thus, case-based reasoning systems necessarily involve a trade-off between the number of cases contained in the system and the amount of knowledge represented in each of those cases, and between the amount of work needed to create and maintain the system. Even the most sophisticated case-based reasoning systems operate with shallow representations of knowledge.[130] Case-based reasoning systems containing large numbers of cases have less detailed knowledge of those cases and perform less reasoning with those cases than do

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[125] Natural languages are to be contrasted with programming languages. Programming languages have limited vocabularies which are in turn well defined. Natural languages in contrast have large numbers of terms often with ambiguous meanings. See generally: Shapiro Stuart C., <u>Encyclopedia of Artificial Intelligence</u> (1990) Wiley.

[126] A knowledge engineer is a person who acts as an intermediary between an expert in a particular field and a computer. It is the task of a knowledge engineer, through interviews and discussion, to elicit knowledge from the expert and then convert that knowledge into a form that is manipulable by a computer: ibid.

[127] For and interesting attempt to do this though refer to the CYC project. Perhaps the best source of information about the CYC project is the world wide web site: http://www.cyc.com/.

[128] Kolodner, above n 114, chapter 5. According to Kolodner, those cases the 'teach something fundamental to the goals of the reasoner' should be included in the system, ibid 13. The aspects of cases that should be recorded are: (1)the problem situation/description (2)the solution, and (3)outcome, ibid 147.

[129] Kolodner, above n 114, 14, 160.

[130] Case-based reasoning systems are sometimes referred to as 'deep' and 'shallow' in the case-based reasoning literature. 'Deep' systems are systems that have some representation of general knowledge apart from the actual knowledge contained in cases. However, 'deep' and 'shallow' are relative terms and even in 'deep' case-based reasoning systems, the depth of knowledge is far less than in human knowledge.

systems with smaller numbers of more detailed cases.[131] As discussed in more detail in the examination of computational analogy, the difficulty in representing the richness and flexibility of human knowledge in computer manipulable form restricts the kind of analogising that case-based reasoning systems can simulate.

Once the cases, and the aspects of cases have been chosen for a case-based reasoning system, for the system to be useful it must be able to retrieve those cases at appropriate times. The case-based reasoning system must determine when cases are similar. Case-based reasoning requires that labels be assigned to cases that are placed into a case-based reasoning system. Essentially, these labels operate as an index to the cases in system. Like an index in a book, which attempt to provide and indication of the contents of a book, these labels attempt to indicate the contents of cases.[132] Reflecting this similarity, and the difficulty in choosing labels for use in a case-based reasoning system, this task is called the 'indexing problem'.[133]

The difficulty in choosing indexes arises because cases can serve multiple purposes. It cannot be pre-determined with certainty all future situations in which cases might be useful. Cases can be similar based on the sharing of surface similarities or they can be similar based on shared deeper similarities, such as the plans or goals the cases exemplify.[134] The indices assigned to a case must designate all the ways in which cases could be regarded as similar. The choice of indexes to be used in a system and the assignment of particular indexes to particular cases are both choices that must be made by the creator of the case-based reasoning system.[135] While researchers in case-based reasoning have developed guidelines for choosing indexes,[136] ultimately the system designer must choose what indexes are thought most appropriate for all future situations and uses. The usefulness of the system will depend on these choices.

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[131] Indeed. according to Kolodner, the biggest technological issue in case-based reasoning is 'scale-up'. While case-based reasoning has proved interesting in the laboratory, applying it in the 'real-world' poses problems: Kolodner, above n 114, 572.

[132] Ibid 193.

[133] Ibid. There are actually several aspects to this problem. First, it is necessary to assign labels to cases when they are entered into the system to ensure they can be retrieved at appropriate times, ibid. Secondly, the cases in the system must be organised so that they can be retrieved efficiently, ibid. Finally, retrieval algorithms must be written to retrieve the appropriate cases, ibid.

[134] Ibid 196.

[135] Ibid 249.

[136] Ibid ch 6 and ch 7.

The operation of case-based reasoning systems is thus fundamentally dependent on the cases that it is decided to place in a system, on the amount of information that it is contained in each case and in the choice of indices used to index those cases. The choices made for each of these involve trade-offs between the comprehensiveness and expressiveness of the cases contained in a system and between the time and effort needed to construct a system.

5.3.2 Determining similarities

Once it has been decided how to represent cases in a case-based reasoning system, and how to index those cases, techniques are needed to determine which cases in the system are similar. Retrieving all the cases, and only those cases that are similar to a problem is the goal of all case-based reasoning systems. The huge problem, however, is determining all the subtle ways in which cases can be similar.[137] The methods used in case-based reasoning to determine similarities are comparatively crude.

Case-based reasoning systems use four main techniques to assess similarity:

1. matching shared indexes,
2. using common sense heuristics,
3. using a causal model,
4. matching indexes that share structural roles.[138]

These techniques range from the most simple to the most complex. As will become apparent however, even the most complex approaches to determining similarities are incapable of simulating the subtleties displayed by people in their assessments of similarity.

Noticing cases share common indexes is the simplest method to determine similarity. For example the two cases in figure 6 are similar in several ways.

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[137] Indeed, the problem is slightly more complicated than 'simply' retrieving similar cases. It may be necessary to rank those cases in some order of similarity: ibid 321. This has its own issues and problems: ibid ch 9. The problems surrounding determining rankings of similarity will not be discussed here as these issues are similar to those surrounding the determination of similarity - the problems relating to case retrieval can be highlighted with reference to these.

[138] Ibid 331.

Case 101	Problem
Indices:	Indices:
cuisine: vegetarian ingredients: snowpeas service: buffet	cuisine: vegetarian ingredients: broccoli service: family-style

139

Figure 6: Comparing common attributes

Such a case representation would allow Case 101 to be retrieved when assessing the new problem situation as both cases involve vegetarian cuisine. In this respect both case 101 and the problem are similar. However, this approach misses many important aspects of similarity that can exist between cases. For example, focusing on the ingredients of the cases in figure 6, the two cases appear different. One case involves a recipe which contains snow peas while the other case involves a recipe which contains broccoli. In this respect the two cases appear different. However, in another respect the two cases are similar - both cases involve recipes containing green vegetables. As Kolodner notes, for the matching of shared indices to work as a method for determining similarity, it must be possible to completely and unambiguously index cases - this is not always possible.[140] Simply matching indices is thus a crude means to determine similarity.

To overcome some of the problems inherent in relying on matching based on shared indices, common-sense heuristics can be used. Such heuristics attempt to capture common-sense knowledge about how objects match.[141] For example knowing that snow peas and broccoli are both green vegetables allows a guess that a recipe that uses one is similar to a recipe that uses the other.[142] For example suppose a third case exists (figure 7).

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[139] Adapted from Kolodner: ibid 333.
[140] Kolodner, above n 114, 332-4. Cases can actually have overloaded as well as unfilled slots.
[141] Ibid 335-6.
[142] Ibid 336.

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┌─────────────────────┐
│ ┌─────────────────┐ │
│ │    Case 103     │ │
│ ├─────────────────┤ │
│ │    Indices:     │ │
│ │        ¦        │ │
│ │        ¦        │ │
│ │ cuisine: vegetarian│
│ │ ingredients: mushrooms│
│ │  service: buffet │ │
│ └─────────────────┘ │
└─────────────────────┘
```
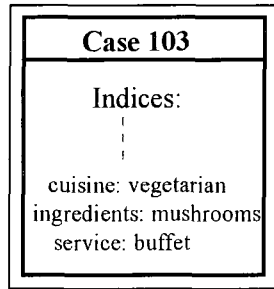
Figure 7: A new recipe

According to the 'green vegetable' heuristic proposed above, this case is different to the cases in figure 6 because it does not involve a green vegetable. However, for some recipes mushrooms can be substituted for snow-peas. Hence these two cases are in this sense similar. The drawback with heuristics is that they are only useful to find similarities which are foreseen by the designer of the system and thus specified in a heuristic. Apart from being hugely dependent on the foresight of the designer of the system, given that situations resemble each other and differ from each other in multitude of ways, it is doubtful whether it is even possible to *a priori* express all the ways in which cases can be similar.

More complex than using heuristics is the use of a model of the domain in which the case-based reasoning system is being built. Such a domain model can be used to aid the determination of similarity.[143] For example, in medial case-based reasoning systems a theoretical model of the physiology of the human body can be used to improve matching between cases.[144] When domain models are available they can improve case-based reasoning systems. However, detailed and non-controversial domain models are not always available.[145]

The most flexible, and most complex, method to determine similarities between cases is to match indices that perform the same abstract role in cases. For example, at first glance football and chess appear to involve few similarities. Football involves two teams in opposition - chess involves two individuals in opposition. Football involves a large playing field on which the teams play - chess involves a small board covered in chess pieces. However, at a more abstract level the games are similar. Both chess and football

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[143] Ibid 336-46.
[144] Ibid 336-46.
[145] The lack of a non-controversial domain model is a particularly acute problem in law.

are competitive games involving two opposing sides governed by a set of rules.[146] While football and chess share few surface similarities, many abstract aspects of the two games are similar. It is investigating methods of determining such abstract similarities between cases that research in computational analogy has focused.[147] However, as seen in the following examination of computational analogy, there is no universal means to determine abstract similarities between cases. Methods developed to determine abstract similarities are comparatively crude.

The ability of case-based reasoning systems to simulate analogising is thus inherently limited by the ability to determine similarities between cases. While generally applicable techniques exist to determine similarities between cases, these methods are crude and unsubtle. More subtle methods can be employed for specific areas where heuristics or domain models are available. However, as will become evident during the examination of computational analogy below, no broadly applicable method exists to determine abstract similarities. This inability to determine abstract similarities and differences limits the ability of case-based reasoning systems to simulate analogical reasoning. Case-based reasoning systems are limited to simulating analogising that depends on similarities that are pre-defined by the creators of the system. Case-based reasoning systems cannot simulate the subtle determinations of similarity that occur in creative analogising.[148]

5.4   Computational analogy

The techniques employed in case-based reasoning to determine similarities between cases are either shallow or highly application dependent. The most sophisticated techniques developed to determine similarities between cases have been developed by researchers in computational analogy. Research on computational analogy has focused on investigating the general circumstances in which situations can be regarded as similar. This section examines computational approaches to analogical reasoning. It is argued that even the sophisticated general strategies for determining similarities that have been developed

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[146] Kolodner, above n 114, 340-1.

[147] Aamodt and Plaza, above n 106, 44.

[148] Johnson-Laird argues that computers cannot be programmed in a way guaranteed to perform creative analogising: Johnson-Laird Philip N., 'Analogy and the exercise of creativity' p.313, in (Ortony A. and Vosniadou S.) (Eds) Similarity and Analogical Reasoning (1989) Cambridge University Press. However, stating that there is no guaranteed way to program a computer to perform creative analogising is a very different from stating that computers can never perform creative analogising. It would be interesting to see Johnson-Laird's comments on the work of FARG, who's programs intuitively do appear to simulate aspects of what is involved in creative analogising.

during research on computational analogy are only crude simulations of the human ability to determine similarities between situations. Hence computational analogy is only capable of providing a crude simulation of human analogising.

As with case-base reasoning, a comprehensive review of computational analogy is impossible in the space available here.[149] Approaches to simulating analogical reasoning are extremely diverse in amongst other things the particular aspect of analogy investigated, in the implementation environment chosen to conduct the investigation and in the domain used to demonstrate the particular approach.[150] To aid comparison Hall suggests an abstract framework which any relatively complete account of analogical reasoning would conform with:

1. recognition of similarity between situations,

2. elaboration of a mapping between two situations,

3. evaluation of the mapping in some context of use, and

4. consolidation of the analogy so that it can be usefully re-used in other contexts.[151]

Thagard provides a further criteria for comparison: the way in which knowledge is represented.[152] Unsurprisingly these five criteria mirror the important issues in case-based reasoning. As in the examination of case-based reasoning this discussion will focus on examining the techniques used to represent knowledge in computer systems that attempt to simulate analogical reasoning and the strategies adopted in these systems to recognise similarities between situations.

Analogies and the similarities that underlie analogies can be analysed according to their structural, pragmatic and semantic elements.[153] The following discussion will focus on

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[149] For a useful, though not comprehensive, review of the field see Hall, above n 11. Notably Hall's review lacks detailed discussion of Gentner's structure mapping theory, work by Holyoak and Thagard, neural network approaches to analogy or the approach pioneered by the Fluid Analogies Research Group, see this chapter below for a discussion of each of these. For useful discussions of many systems and analogy generally, see the collections in: Ortony and Vosniadou, above n 8, and Helman, above n 8.

[150] Hall, above n 11, 42-3.

[151] This is a slightly simplified version of the criteria provided by Hall: ibid 43. Burnstein gives a similar but slightly expanded conception 179-80. For the purposes of the present examination it is not necessary to consider all the detail discussed by Burnstein.

[152] Thagard Paul, 'Dimensions and Analogy' p.105, in (Helman D.H.) (Ed) Analogical Reasoning: Perspectives of Artificial Intelligence, Cognitive Science, and Philosophy (1988) Kluwer, 109-11.

[153] Holyoak and Thagard, above n 109, 304; At other times Holyoak and Thagard refer to 'similarity', 'structure' and 'purpose': Holyoak Keith and Thagard Paul, Mental leaps : analogy in creative thought (1995) MIT Press, 5-6. It is clearer however to adopt the terminology of FARG and refer to constrains of 'similarity' as 'semantic' constraints: Hofstadter Douglas and The Fluid Analogies Research Group,

three recent and influential approaches to simulating analogical reasoning. These three approaches are the Structure Mapping Engine, the Analogical Constraint Mapping Engine and the group of systems developed by the Fluid Analogies Research Group (FARG). Each of these three systems emphasises one of the three aspects of similarity proposed by Holyoak and Thagard. While many more systems than these exist the major issues surrounding the simulation of analogical reasoning can be highlighted and critically discussed using this examination.

5.4.1 Structural criteria

One of the most famous and often discussed simulations of analogical reasoning is the Structure Mapping Engine. Underlying the Structure Mapping Engine is a theory of analogy which proposes that analogies are governed by the principle of 'systematicity'.[154] Broadly, this principle asserts that analogies are based on the sharing of attributes which exist in a common relational structure.[155] For example, Gentner discusses the analogy between heat flow and water flow illustrated in figure 8.
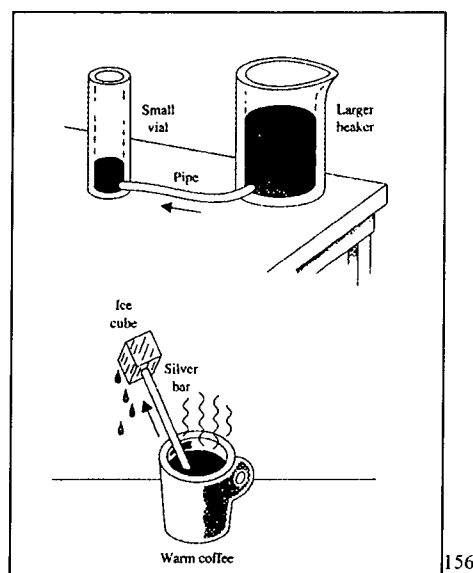
Figure 8: Heat flow is analogous to water flow

Fluid Concepts and Creative Analogies: Computer Models of the Fundamental Mechanisms of Thought (1995) Basic Books.
[154] Gentner, above n 102, 201.
[155] More precisely, Gentner states that:
    1.   correspondences between relations between objects in a situation, rather than attributes of objects, and
    2.   relations that are part of a coherent interconnected system are preferred.
Ibid 201.
[156] Ibid 202.

It is claimed that when people create analogies they ignore surface details such as that both water and coffee are liquids, that both water and coffee have flat tops and that the water is stored in a transparent beaker.[157] Rather, it is claimed that people prefer more 'systematic', more abstract similarities between situations. According to Gentner, knowing that the greater pressure in the beaker causes water to flow into the vial through the pipe, by analogy it can be concluded that the greater temperature in the coffee causes heat to flow into the ice cube through the silver bar.[158] The principle of systematicity is purely structural. Both the use of the analogy and the objects being reasoned with are regarded as irrelevant. The principle of systematicity thus appears an extremely concise way of expressing what is involved in the concept of 'similarity'. If the theory of analogy underlying the Structure Mapping Engine is an accurate reflection of human analogising then it presents a huge advance in attempts to simulate analogical reasoning.

The Structure Mapping Engine has been presented with numerous problems and its authors claim it produces sophisticated analogies in each situation. When presented with a computer manipulable representation of the situation illustrated in figure 8, according to Gentner the Structure Mapping Engine produces the analogy that 'heat flow is like water flow.'[159] Producing an analogy between heat flow and water flow is an impressive feat. Even for a person concluding that heat flow is like water flow is a non-trivial analogy. Creating this analogy requires knowledge and insight into the behaviours of both heat and water and the concepts of pressure, temperature and causation. However, the claim that the Structure Mapping Engine is an accurate model of human analogical reasoning requires careful consideration. This claim is examined in more detail after examining a second recent and often discussed computerised analogical reasoning system.

5.4.2 Pragmatic criteria

The Analogical Constraint Mapping Engine[160] developed by Holyoak and Thagard is in many ways similar to the Structure Mapping Engine. However, Holyoak and Thagard argue that to successfully simulate analogical reasoning, semantic and pragmatic

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[157] Ibid 221-31.
[158] Ibid 213.
[159] Ibid 212-5.
[160] Holyoak and Thagard, above n 109.

constraints on reasoning must also considered - structural criteria are insufficient.[161] According to Holyoak and Thagard, structural criteria are by themselves insufficient because such criteria are not sufficiently restrictive. Holyoak and Thagard argue that there are often many abstract relational similarities between situations and some method is needed to choose between them in order to analogise. Holyoak and Thagard argue that in analogical reasoning this choice is determined by the goals a reasoner is attempting to achieve and by the semantic content of the concepts being reasoned about. For example, a reasoner might be searching for an analogy between the solar system and the atom, which would make and analogy involving these concepts more likely. Similarly, a reasoner might know *a priori* that two things are similar, such as heat flow and water flow again making an analogy involving these more likely. Mitchell and Hofstadter also argue that the principle of systematicity is by itself insufficient[162] - there are many, perhaps innumerable, possible systematic correspondences between situations and the only way to choose between them is through an understanding of semantic meaning.[163] Holyoak and Thagard's model of analogy claims to capture the interaction of the structural, semantic and pragmatic elements that constitutes analogising.[164] This theory of analogy is implemented in the Analogical Constraint Mapping Engine.

In their discussion of the Analogical Constraint Mapping Engine Holyoak and Thagard provide numerous examples of analogies they argue were created by the system. For example, the Analogical Constraint Mapping Engine was presented with the same water flow/heat flow analogy as used to demonstrate the Structure Mapping Engine. According to Holyoak and Thagard the Analogical Constraint Mapping Engine also produced the analogy that water flow is like heat flow.[165] The precise details of how the Analogical Constraint Mapping Engine operates will not be discussed here. However, as with the Structure Mapping Engine, the claim that the Analogical Constraint Mapping Engine is capable of simulating analogising requires scrutiny.

[161] Ibid 296.
[162] Mitchell Melanie and Hofstadter Douglas, 'Perspectives on Copycat: Comparisons with Recent Work' p.275, in (Hofstadter Douglas and Fluid Analogies Research Group) (Eds) Fluid Concepts and Creative Analogies: Computer models of the Fundamental Mechanisms of Thought (1995) Basic Books, 280.
[163] Ibid 281.
[164] Holyoak and Thagard, above n 109, 304.
[165] Ibid 333-7.

5.4.3 Restrictions of the Structure Mapping Engine and the Analogical Constraint Mapping Engine

The necessity of translating human knowledge into computer manipulable form to enable analogising was emphasised in the discussion of case-based reasoning. A central problem with this requirement is that it is extremely difficult to represent the complexity, richness and flexibility of human knowledge in computer languages. One method by which knowledge is provided to computers is by using predicate calculus. Predicate calculus is a method for representing human knowledge in computer manipulable form. Using predicate calculus, knowledge about the situation illustrated in figure 8 can be provided to a computer. For example the statement 'LIQUID(water)' is used to state that water is a liquid and the statement 'FLOW(beaker, vial, water, pipe)' is used to state that water flows from the beaker to the vial through the pipe.[166] Both the Structure Mapping Engine and the Analogical Constraint Mapping Engine operate using predicate calculus representations of situations. This requirement imposes enormous practical limits on the ability of these programs to simulate analogical reasoning.

Both the Structure Mapping Engine and the Analogical Constraint Mapping Engine appear able to perform impressive feats of analogical reasoning. They apparently reason with and draw analogies between complex real world situations. However, when examining these and other analogical reasoning systems great care must be taken to avoid reading

> far more understanding than is warranted into strings of symbols - especially
> words - strung together by computers.[167]

Seeing pictures of beakers filled with water and cups filled with hot coffee invokes a rich imagery about such things as water, coffee, heat, liquids, and metal. A strong critic of these approaches to simulating analogical reasoning, Hofstadter states

> a lot of implications follow in the minds of many if not most readers, such as
> these: computers - at least some of them - understand water and coffee and
> so on; computers understand the physical world; computers make analogies;

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[166] See the representations in: Gentner, above n 102.
[167] Hofstadter call this the 'ELIZA' effect after the famous program, 'ELIZA', developed by Joseph Wizenbaum and to which many people spuriously attributed immense powers of perception an understanding: Hofstadter and Farg, above n 153, 157.

computers reason abstractly, computers make scientific discoveries; computers are insightful cohabitors of the world with us.[168]

In fact the information contained in programs such as the Structure Mapping Engine and the Analogical Constraint Mapping Engine is much shallower. Both the Structure Mapping Engine and the Analogical Constraint Mapping Engine reason with assertions such as:

- LIQUID(water),
- LIQUID(coffee),
- FLOW(beaker, vial, water, pipe),
- FLOW(coffee, ice, heat, bar),
- CAUSE{GREATER[TEMP(coffee), TEMP(ice)], FLOW(heat, bar, coffee, ice)}[169]

The systems have no deeper representation of any of these concepts. There is no representation of the concept of what a liquid is. There is no representation of the differences between liquids and solids or liquids and gases. The only information that the Structure Mapping Engine and the Analogical Constraint Mapping Engine have is that explicitly provided by the creators of these systems. This is far from the rich imagery invoked when seeing a picture of beakers and hot coffee.

In a recent examination of approaches to computational analogy, Hoffman notes that

formal schemes for the computational analysis of analogy will be limited by (at least) the depth, breadth, flexibility, and dynamics of the world knowledge that they can represent.[170]

Programs such as the Structure Mapping Engine and the Analogical Constraint Mapping Engine represent very minimal knowledge, which is in turn shallow and inflexible.

As Gentner notes, the representational decisions made when encoding knowledge are crucial to the operation of the algorithm. Differences in the way things are construed can cause two situations to fail to match even if they are informationally equivalent.[171]

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[168] Ibid.
[169] Gentner, above n 102, 211-3; Holyoak and Thagard, above n 109, 333-7.
[170] Hoffman, above n 9, 27.
[171] Gentner, above n 102, 210.

For example, although invoking the same meaning for readers, the use of the predicate

GREATER[PRESSURE(beaker), PRESSURE(vial)],

which is used to indicate that the pressure in the beaker is greater than the pressure in the vial, and

LESS-THAN[PRESSURE(vial), PRESSURE(beaker)]

which is used to indicate that the pressure in the vial is less than the pressure in the beaker would prevent a mapping in the Structure Mapping Engine. Programs such as the Structure Mapping Engine and the Analogical Constraint Mapping Engine require uniform and unambiguous definitions of the concepts being reasoned about.

The need to provide rigid, uniform and unambiguous definitions for the concepts being reasoned about however, contradicts one of the confounding aspects of analogical reasoning. As Hoffman notes,

> one really important phenomenon at hand is semantic flexibility: People can relate anything to anything on the basis of anything.[172]

This flexibility is a hallmark of analogical reasoning, as Holyoak and Thagard themselves note, to

> propose an analogy - or simply to understand one - requires taking a kind of mental leap. An idea from the source analogy is carried over to the target. The two might initially seem unrelated but the act of making an analogy creates new connections.[173]

A humorous illustration of this is provided by Hofstadter who poses the question - 'Who is the First Lady of England?'[174] At first glance several answers might be proposed: Queen Elizabeth, Betty Boothroyd or Anitta Rodick for example. Each of these is a prominent lady. Out of these however, the Queen is perhaps the most eminent and so might be regarded as the First Lady. However, the term 'First Lady' is widely used in the United States of America to refer to the wife of the president. Who then is the First Lady of England? Is it still Queen Elizabeth? Tony Blair plays a role in the United Kingdom that is in many ways similar to the role played by Bill Clinton in the United States of America. Should the First Lady of England thus be regarded as Cherie Blair? The term

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[172] Hoffman, above n 9, 19.
[173] Holyoak and Thagard, above n 153, 7.
[174] Hofstadter, above n 153, 196.

'First Lady' implies choosing the most prominent women in the country. This implies choosing Queen Elizabeth. In the United States the first lady is the spouse of the president. This implies choosing Cherie Blair. However, in another sense Queen Elizabeth also plays a role in some ways reminiscent of the presidential role, so should her spouse be chosen? Could the First Lady of England be regarded as Prince Philip? While this has some nice similarities between the positions of the people involved, the term 'First Lady' strongly implies that a women should be chosen.[175] Several competing pressures can be observed here: the pressure induced by the phrase 'First Lady' to find a woman to play this role; the pressure to choose the spouse of the most powerful political figure; the feeling that the 'First Lady' should be just that, the most powerful or popular lady in the country. According to Hofstadter, whom is eventually chosen is determined by the result of the interplay between these pressures and what is felt involved in the concept of 'First Lady'. With foreseeable stretching, the concept could be allowed to slip and cover Prince Philip as being England's First Lady.

As FARG convincingly argue, there is a fundamental problem with the way knowledge is represented in systems such as the Structure Mapping Engine and the Analogical Constraint Mapping Engine. The way knowledge is represented is extremely brittle. It is difficult to see how systems such as the Structure Mapping Engine and the Analogical Constraint Mapping Engine, and others that rely on pre-defined static representations of knowledge can capture the fluidity, illustrated above, that is the hallmark of analogical reasoning. Importantly, solving this problem is not a matter of the mere addition of a greater amount of ever more detailed knowledge about the objects represented in the system.[176] While this may help, some way is still needed to select the important similarities out of the virtually infinite number of ways in which things can be similar or different.[177]

Holyoak and Thagard argue that this is possible in the Analogical Constraint Mapping Engine through the imposition of semantic and pragmatic constraints. In the Analogical Constraint Mapping Engine, semantic and pragmatic constraints on analogical reasoning

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[175] For a subtle twist on this example see Hofstadter: ibid.

[176] Hofstadter Douglas and French Robert, 'Tabletop, BattleOp, Ob-Platte, Patelbat, Belpatto, Platobet' p.323, in (Hofstadter Douglas and Fluid Analogies Research Group) (Eds) Fluid Concepts and Creative Analogies: Computer models of the Fundamental Mechanisms of Thought (1995) Basic Books.

[177] Hoffman, above n 9, 21.

are imposed in an apparently straightforward manner. A semantic constraint is imposed by the programmer simply by stating 'SIMILAR <concept-1><concept-2><degree>'.[178] This is supposed to reflect an estimated numerical degree of similarity between two concepts.[179] Pragmatic constraints are imposed by the programmer stating 'IMPORTANT <element>' or 'PRESUMED <hypothesis>' which are respectively designed to reflect that a certain element is regarded as important and that a certain hypothesis is regarded as correct.[180] Designating inputs as similar, important or presumed means that the concepts so designated are more likely to be involved in the analogy produced by the system. While this certainly imposes semantic and pragmatic restraints, it is subject to the same objection as is the representation of knowledge in general. This method of representing semantic and pragmatic constraints is inflexible. As illustrated in the question 'Who is the First Lady of England?' what aspects of situations are regarded as important in an analogy and what aspects of situations are regarded as similar in an analogy can change during analogising. Holyoak and Thagard's proposals ignore this fundamental aspect of flexibility that is inherent in analogical reasoning.

While the Structure Mapping Engine and the Analogical Constraint Mapping Engine appear able to create impressive analogies this is because these systems are provided with solely the information necessary to create the analogy desired and they are provided this information in the precise form necessary to create the analogy that is desired. In reality, knowledge does not come neatly pre-packaged in this way. Any computer system that performs analogical reasoning must have more flexible knowledge representation mechanisms.

Gentner's proposed solution to this brittleness is to add tools that can re-represent knowledge.[181] Such tools

> would allow us to model the use of analogy in reconstructing one situation in
> terms of another.[182]

Despite scepticism at the plausibility of such a scheme[183] this possibility will not be examined further because the Structure Mapping Engine and the Analogical Constraint

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[178] Holyoak and Thagard, above n 109, 313.
[179] Ibid.
[180] Ibid.
[181] Gentner, above n 102, 210.
[182] Ibid 211.

Mapping Engine do not utilise such knowledge re-representation tools. These systems are limited to finding correspondences between the representations initially provided by the creators of the system. This is implausible in a complete model of analogical reasoning.

The Structure Mapping Engine and the Analogical Constraint Mapping Engine face several other problems as complete and accurate models of analogical reasoning. When humans create analogies they do so with experiences selected from a massive memory of experience. Out of this multitude of experiences, those experiences that are similar are selected. In stark contrast both the Structure Mapping Engine and the Analogical Constraint Mapping Engine are presented at the outset with precisely those two experiences which will form the final analogy. The huge complexity in simply finding the episode with which to analogise is avoided. In presenting just those experiences necessary to create the final analogy, and in a representation highly amenable to the analogy, lacking almost any extraneous diverting information, the complexity of the task is massively reduced. With the necessary information conveniently presented, the Structure Mapping Engine and the Analogical Constraint are able to simply calculate all possible correspondences between the situations, and choose the most systematic through brute force search.[184] As a cognitive model, this is highly implausible. In decomposing the concept of similarity into structural, semantic and pragmatic aspects, Gentner and Holyoak and Thagard provide valuable insights into the processes of analogising. However, the approaches to implementing these constraints and to representing the knowledge used in analogising trivialise the difficulty involved in retrieving a source candidate from memory and elaborating the similarity. It is doubtful whether these methods would be viable if a greater number of richer experiences were available.

5.4.4 Conceptual fluidity and analogy making

In contrast to the approaches to simulating analogical reasoning presented above, Hofstadter, Mitchell, French, Defrays and other members of FARG have developed a

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[183] Chalmers David, French Robert and Hofstadter Douglas, 'High-level Perception,Representation,and Analogy: A Critique of Artificial-intelligence Methodology' p.169, in (Hofstadter Douglas and Fluid Analogies Research Group) (Eds) Fluid Concepts and Creative Analogies: Computer models of the Fundamental Mechanisms of Thought (1995) Basic Books, 185-9.
[184] Mitchell and Hofstadter, above n 162, 284.

very different model of analogy making. At the heart of this model is the view that the analogies people create are fundamentally dependent on the way in which people perceive the situations that they are analogising about.[185] Entailed in this idea are a number of others, including:

1. concepts, which are at the heart of analogies are fluid and slippable,

2. slippages in concepts are induced by pressures present when perceiving a situation, and

3. analogies eventually produced emerge from the interaction of the pressures that cause conceptual slippages.

The members of FARG argue that it is interplays of pressures on our conceptual categories and the resulting changes in our concepts, as discussed in the question 'Who is the First Lady of England?', that underlie all analogy making. As such any attempt to simulate analogical reasoning must simulate the conceptual fluidity inherent in the perception of analogies. According to the members of FARG, for this reason attempts to simulate analogising based on the use of rigid knowledge representations are bound to fail. The members of FARG have produced several computer models of analogy making based on their underlying philosophy.[186] None of these implementations are examined in depth. However, the common idea underlying all these implementations are outlined.

Underlying the FARG's work on analogy is a belief that analogical reasoning fundamentally involves changes in the content of and relation between concepts that are being reasoned about. According to FARG it is simulating the semantic flexibility that is inherent in analogising that is central to simulating analogical reasoning. Consequently, at the centre of the FARG's architecture is a model of the concepts which are being reasoned about. However, these concepts and the relations between these concepts are not rigidly defined - they can change as an analogy is perceived and constructed. In the FARG architecture concepts are stored in an interconnected network in which links between objets indicate a relation between those objects. The 'length' of the links between objects can change, indicating that these objects are becoming more

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[185] Hofstadter Douglas and Mitchell Melanie, 'The Copycat Project: A Model of Mental Fluidity and Analogy Making' p.205, in (Hofstadter Douglas and Fluid Analogies Research Group) (Eds) Fluid Concepts and Creative Analogies: Computer models of the Fundamental Mechanisms of Thought (1995) Basic Books, 210.

[186] For an overview see: Hofstadter, above n 153, 95.

conceptually similar or more conceptually dissimilar.[187] The operation of the FARG architecture is thus inherently dependent on the model that is created of the concepts in the domain being reasoned about. This is noted by Hofstadter who states that the concepts modelled must be 'Platonic concepts' that are relevant to the domain.[188]

For example the Copycat program attempts to create analogies between strings of alphabetic letters.[189] Given that the string of letters 'abc' is analogous to the string of letters 'abd', what string of letters is analogous to 'ijk'?[190] Central to the Copycat program is its 'Slipnet' of concepts relevant to the Roman alphabet.[191] A portion of the Slipnet used in Copycat is shown in figure 9.
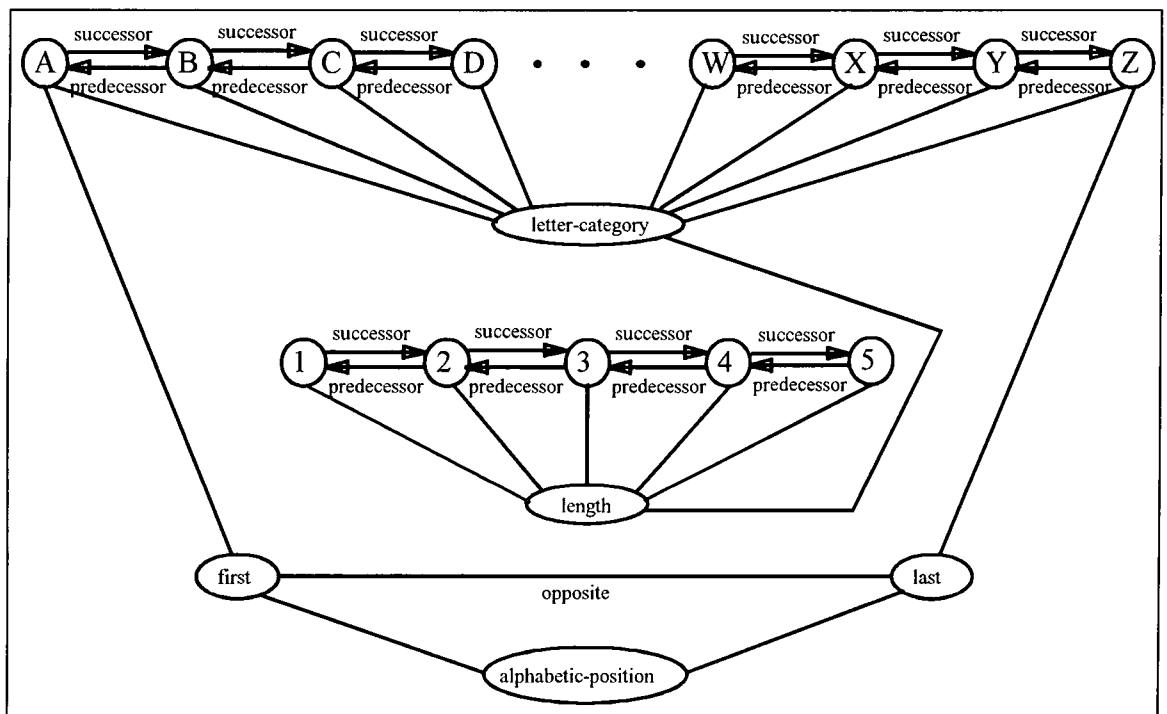
192

Figure 9: A portion of Copycat's slipnet

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[187] Hofstadter and Mitchell, above n 185, 212.

[188] Ibid 211.

[189] Mitchell Melanie, Analogy making as perception (1993) MIT Press.

[190] Ibid 11.

[191] Since concepts are linked in a network and the relations between objects can change - the objects 'slip' towards or away from on another - this network of Platonic concepts is thus called a 'Slipnet': Hofstadter and Mitchell, above n 185, 211. The terminology for each of these components differs in the Numbo program. However, the roles played are the same.

[192] Simplified from: Mitchell, above n 189, 47.

The Slipnet in Copycat stores not only the twenty six alphabetic letters themselves, but also a few simple relations between the letters, such as that the letter 'b' succeeds the letter 'a' and that the letter 'b' precedes the letter 'c'.

As an analogy is perceived and constructed, concepts in the Slipnet are used to construct a representation of the problem. The particular representation that is constructed indicates how the program 'perceives' the analogy. Notably, the way in which a particular representation is perceived influences the relationships between concepts in the Slipnet. In turn, concepts in the Slipnet that are active make it more likely that these and related concepts will influence the way in which the situation is perceived. Using this approach the 'top-down' pressures imposed by general knowledge of a domain to perceive a situation in a particular way combine with the 'bottom-up' pressures imposed by the particularities of the circumstance being reasoned about. FARG argue that through the interaction of these pressures emerges the way a situation is finally perceived and an analogy created.[193]

The importance of top-down and bottom-up pressures in analogising has been noted by other researchers in analogy.[194] By modelling the interaction of these top-down and bottom-up pressures a much more fluid and flexible form of analogical reasoning is made possible. How concepts relate to the actual problem and to each other is allowed to dynamically evolve. Rather than being lumbered with brittle problem-representations hand-coded into the system, the FARG architecture is able to fluidly adapt knowledge for use in particular situations.

The approach to analogical reasoning developed by FARG displays and innovative way to simulate the semantic flexibility that is a hallmark of analogical reasoning. This approach to simulating analogising suggests a partial way to overcome the rigidities in the representations of knowledge that plague systems such as the Structure Mapping Engine and the Analogical Constraint Mapping Engine. However, such problems are still present in the FARG architecture. The operation of the FARG architecture is crucially

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[193] Hofstadter, above n 153, 92 calls this a 'parallel terrace scan'.

[194] E.g. While Hofstadter refers to the parallel terrace scan, Holyoak and Thagard refer to 'biderectional search': Holyoak Keith J. and Thagard Paul R., 'A computational model of analogical problem solving' p.242, in (Ortony A. and Vosniadou S.) (Eds) Similarity and Analogical Reasoning (1989) Cambridge University Press, 244.

dependent on the concepts that are placed in the Slipnet and on the relations that it is chosen to define between those concepts. As Hofstadter notes, these have to be 'Platonic concepts'.[195] In the areas in which the architecture developed by FARG has been applied, such as creating analogies between strings of alphabetic letters, Platonic concepts may be comparatively easy to determine. It is far from a straightforward task however, to determine what the Platonic concepts might be in wider areas. For instance, to return to the analogy between water flow and heat flow. What should the Platonic concepts be considered to be? Should 'water' and 'heat' be regarded as Platonic concepts? Or should more fundamental concepts such as 'fluid' be used? Should the concept 'beaker' be included? It is difficult to consider any of these concepts as Platonic as they can all be broken down into numerous other interrelated concepts. Unfortunately FARG provide no guidelines as to how Platonic concepts are to be chosen. All the implementations of the architecture developed by FARG have been in 'micro-domains',[196] small relatively well defined areas in which the Platonic concepts are comparatively obvious. While the members of FARG argue that the underlying structure is universally applicable[197] no 'real-world' implementation has yet been created.[198]

As a complete model of analogising the architecture developed by FARG has several other limitations. Hofstadter lists five improvements that could be made to the architecture.[199] Perhaps the most salient for present purposes is that the architecture has no memory. It does not store past experiences or retain any trace of the analogies that it creates. This is a fundamental aspect of human analogical reasoning that any complete model of analogising would have to address. To utilise past experiences however, involves addressing further issues, such as how useful experiences are retrieved from memory and how they are utilised, in conjunction with the perception of the current situation, to create an analogy. The FARG architecture does not address such issues.

[195] Hofstadter and Mitchell, above n 185, 211.
[196] Hofstadter, above n 153, 86.
[197] Chalmers, French and Hofstadter, above n 183, 191.
[198] This should not be interpreted as an argument that the 'real-world' domains commonly chosen for research into analogical reasoning result in more realistic models of analogy, only that the wider applicability of the architecture remains to be demonstrated.
[199] Hofstadter, above n 153, 315-8.

While not a complete model of analogical reasoning the architecture developed by FARG, provides a sophisticated model of the fluid application and change in concepts that occurs as analogies are created.

5.5   Neural networks and analogising

The final approach to simulating analogical reasoning that is briefly discussed is based on the use of neural networks. Neural networks are structures inspired by the structure of the human brain. Frustrated by the slow progress made by traditional artificial intelligence, some researchers argue that to simulate intelligence it is necessary to more closely simulate the structure of the human brain. Neural networks are composed of neurodes, which are models of biological nerve cells, linked together in an intertwined multi-layer network (figure 10).
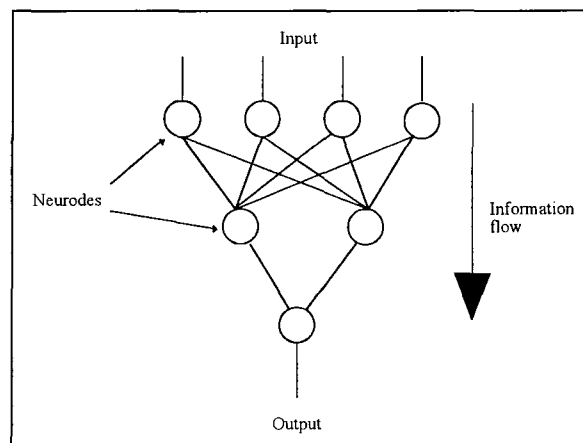
Figure 10: General structure of an artificial neural network

Neural networks generally consist of an input layer, at which the network is presented with information, hidden layers, and an output layer at which the network provides a result.[200] Researchers are interested in neural networks because amongst other reasons, they are good at tasks involving the classification of patterns.[201] Further, neural networks can be made to generalise their inputs. When presented with a series of patterns, neural networks will group patterns together. Thus when presented with input, neural networks classify that input in terms of these general groups. Analogising can be regarded as a form of pattern classification. Given a description of a problem, finding an analogous case is a matter of finding a case with a similar description, or a general class to which

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[200] For a good introduction to the uses of neural networks and their uses see: Caudill Maureen and Butler Charles, Naturally intelligent systems (1990) MIT Press.
[201] See generally: ibid.

the description belongs. In performing classification neural networks thus appear useful for simulating analogical reasoning.

All possible uses of neural networks to simulate analogical reasoning will not be discussed in detail here. There is a vast literature on the construction and use of neural networks.[202] However, one major problem with simple approaches to simulating analogising using neural networks, approaches which underlie the use of neural networks to simulate legal analogising, is that like the above discussed approaches to simulating analogising these uses of neural networks ignore the semantic flexibility inherent in analogising.

The difficulties for neural network based simulations of analogising resulting from semantic flexibility is demonstrated by referring to a proposal by Rumelhart, one of the most famous researchers in neural networks. Rumelhart has proposed a model of analogical reasoning in which neural networks are central.[203] According to Rumelhart, a neural network could be used to simulate analogical reasoning by requiring it to retrieve cases which share ever more abstract attributes.[204] When the neural network retrieves cases based solely on shared abstract attributes, according to Rumelhart the network would be simulating analogising. For example, imagine trying to discover the analogy between sailing on stormy seas and marriage.[205] When experiences are retrieved based on non-abstract features, straightforward similar situations are recalled, e.g. an experience of sailing on stormy seas on week or one month ago. Under Rumelhart's proposals, while the neural network has retrieved similar experiences it has not analogised. The similarity between the episodes is not abstract. However, if experiences were retrieved that share abstract features, for example experiences that 'have their highs and lows' then the experience of marriage would be recalled. In such a situation the neural network is said to have created an analogy.

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[202] For a detailed early examination of the field see: Rumelhart David, McClelland James and The PDP Research Group, <u>Parallel Distributed Processing: Explorations in the Microstructure of Cognition</u> (1986) MIT Press
[203] Rumelhart 'Toward a microstructural account', above n 102.
[204] Ibid 301-6
[205] This example was proposed by Dejong: Dejong, above n 106, 349.

However, this account of analogical reasoning has been criticised on a number of grounds.[206] While the sharing of abstract similarities is an important aspect of analogising, Rumelhart gives no indication of the means by which the network will distinguish abstract similarities from non-abstract similarities. Implicit in Rumelhart's proposals is the pre-categorisation of attributes by the creator of the system into those that are abstract and those that are non-abstract. However, as highlighted in the above discussion of the semantic flexibility inherent in analogising, it is during analogising itself that those attributes which are abstract and those attributes which are less abstract, emerge. The pre-classification of attributes into those that are abstract and those that are not abstract thus misrepresents an important aspect of analogising.

While neural networks are used in many more ways than discussed above, as is seen in the next chapter, the use of neural networks to simulate legal analogising operates in the way described above. This application of neural networks in the simulation of analogising is insufficient to simulate all that is involved in analogising.

5.6   Conclusion

Having examined three major approaches to simulating analogical reasoning developed in artificial intelligence it is apparent that artificial intelligence has not yet succeeded in developing a comprehensive and convincing model of analogical reasoning. Research diverges as to the very concept of what an analogy is and the processes by which analogies are created.

One of the major difficulties with simulating analogical reasoning is successfully simulating the semantic flexibility which is characteristic of analogical reasoning. Dealing with the semantic flexibility inherent in analogising raises complex issues about the way that human knowledge is to be represented in computer manipulable form. The architecture developed by FARG, with its ability to fluidly and dynamically interpret situations and construct analogies based on these interpretations, displays and exciting approach to simulating semantic flexibility. However, the FARG architecture has only

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[206] Dejong, above n 106, 349; Hofstadter Douglas and McGraw Gary, 'Letter Spirit: Aesthetic Perception and Creative Play in the Rich Microcosm of the Roman Alphabet' p.407, in (Hofstadter Douglas and Fluid Analogies Research Group) (Eds) Fluid Concepts and Creative Analogies: Computer models of the Fundamental Mechanisms of Thought (1995) Basic Books, 466.

been applied in a small number of situations and is potentially limited by the need to choose Platonic concepts to be used by the architecture. The approaches to simulating analogising discussed here underlie attempts to simulate legal analogising. As discussed in the following chapters, approaches to simulating legal analogising are restricted by their inability to accommodate the semantic flexibility inherent in legal analogising. Simulations of legal analogising are thus limited in the kind of legal analogising that can be simulated.

However, while research in artificial intelligence has not succeeded in simulating the full complexities of analogical reasoning, case-based reasoning does demonstrate techniques by which cases sharing surface similarities, less abstract and creative similarities than those characteristic of creative analogising, can be retrieved and used in problem solving.

6   Artificial intelligence and legal analogical reasoning

6.1   Introduction

The previous chapter examined approaches to simulating analogical reasoning developed in artificial intelligence. This chapter examines attempts to simulate legal analogical reasoning by researchers in the field of artificial intelligence and law. Informed by the examination of theories of legal analogical reasoning undertaken in chapter 3 and chapter 4 and by the examination of computational approaches to simulating analogising provided in the previous chapter it is argued that current attempts to simulate legal analogical reasoning only provide a shallow imitation of human legal analogical reasoning. It will be seen that attempts to simulate legal analogising are confronted with problems in representing legal knowledge and in simulating the semantic flexibility demonstrated in legal analogising. Simulations of legal analogising are currently limited to simulating straightforward matchings between precedents. This critical examination forms the basis for subsequent chapters which examine how approaches to simulating legal analogical reasoning might be improved as well as examining how research in simulating legal analogical reasoning informs on jurisprudential accounts of legal analogising.

6.2   The split between reasoning and information retrieval

In the field of artificial intelligence and law, two major branches of research relevant to analogy are evident. The first of these branches is intimately concerned with simulating the processes and results of human legal reasoning. The second branch of research is concerned not with simulating legal reasoning itself but with providing the information necessary for reasoning, the statutes, cases, regulations and other information needed to decide legal controversies. This branch of research is concerned with information retrieval.

Prima facie, only research concerned with simulating legal reasoning is relevant to an examination of attempts to simulate legal analogical reasoning. However, as will be discussed, information retrieval is itself a task which overlaps with legal reasoning. Some of the techniques developed by researchers in this area are thus relevant in attempts to

simulate legal analogical reasoning. For this reason, each of these branches of research is examined in turn.

6.3 Artificial intelligence and law, and legal reasoning

Numerous computer systems have been built which attempt to simulate aspects of legal reasoning. As with computer systems constructed to simulate analogical reasoning, computer systems constructed to simulate legal reasoning are extremely diverse. Systems can be distinguished by the tasks they perform[207] and the particular context they operate in.[208] Such distinctions are undoubtedly necessary however, analogical reasoning is crucial to legal reasoning. Hence, whatever task a system performs and whatever context a system operates in, the better the ability of that system to simulate legal analogical reasoning, the better will be the ability of that system to perform in its particular context. Consequently, this chapter will focus on the approach taken to simulating legal analogical reasoning.

There are several approaches to simulating legal analogical reasoning. These approaches closely reflect the approaches adopted in artificial intelligence generally to simulating analogical reasoning and are examined in turn.

6.3.1 Analogy in a formalism.

It is ironic that a widely adopted approach to simulating legal analogising is based on the use of production rules and logics to formalise the *ratio decidendi* of precedents.[209] Underlying these attempts to simulate legal analogising is the view that legal precedents contain an unambiguous *ratio decidendi* which can be applied to new problems. Legal

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[207] Visser Pepijn R.S., Knowledge Specification for Multiple Legal Tasks: A Case Study of the Interaction Problem in the Legal Domain (1995) Kluwer Law International, 6

[208] Lambert Kenneth A. and Grunewald Mark H., 'Legal Theory and Case-Based Reasoners: The Importance of Context and the Process of Focusing' p.191, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press.

[209]These approaches have been adopted in numerous systems e.g.: Weiner Steven S., 'CACE: Computer-Assisted Case Evaluation in the Brooklyn District' p.215, in The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press; Yoshino Hajime, Haraguchi Makoto, Sakurai Seiichiro and Kagayama Sigeru, 'Towards a Legal Analogical Reasoning System: Knowledge Representation and Reasoning Methods' p.110, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press; Nitta Katsumi, Shibasaki Masato, Sakata Tsuyoshi, Yamaji Takahiro, Xianchang Wang, Ohsaki Hiroshi, Tojo Satoshi, Kokubo Iwao and Suzuki Takayuki, 'New HELIC-II: A Software Toll for Legal Reasoning' p.287, in The Fifth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1995) ACM Press.

analogising is regarded solely as the application of the *ratio decidendi* of precedents to new problems. For example, in *Donoghue v Stevenson* Lord Aitkin stated that

> a manufacturer of products which he sells in such a form as to show that he intends them to reach the ultimate consumer in the form in which they left him, with no reasonable possibility of intermediate examination, and with the knowledge that absence of reasonable care in the preparation or putting up of the products will result in injury to the consumer's life or property, owes a duty to the consumer to take that reasonable care.[210]

From this passage the following rule could be constructed:

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If (manufacturer of products) and
   (sold in form showing he intends them to
   reach the ultimate consumer in the form which
   they left him) and
   (knowledge that absence of reasonable care
   will result in injury to consumer's life or
   property)
Then (manufacturer owes a duty to the
   consumer to take reasonable care)
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Figure 11: Formalisation of a *ratio decidendi*

Representing cases in this way appears a simple way to capture the notion of *ratio decidendi* and seems to provide a simple implementation of the idea that 'like cases should be decided alike'. Similar precedents are simply regarded as those precedents in which the pre-requisites of the formalism are satisfied. However, there are at least two objections to this approach to simulating legal analogising. First, this approach to legal analogical reasoning is jurisprudentially suspect. Secondly, this approach essentially reduces analogical reasoning to a form of deductive reasoning.

The use of formalisms to simulate legal analogical reasoning is based on the jurisprudential view that the rule for which cases stand can be unambiguously extracted from precedents themselves.[211] The essential notion is that precedents have specific holdings for which they stand and that these holdings can be explicitly and satisfactorily

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[210] [1932] A.C. 562, 599.

[211] Alternatively it has been argued that these rules should be formulated based on the idea of 'deep structure': Smith J.C. and Deedman C., 'The Application of Expert Systems Technology to Case-Based Law' p.84, in The First International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1987) ACM Press. This has been applied in subsequent systems e.g.: MacCrimmon Marilyn T., 'Expert Systems in Case-Based Law: The Hearsay Rule Advisor' p.68, in The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press; Kowalski Andrezj, 'Case-Based Reasoning and the Deep Structure Approach to Knowledge Representation' p.21, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press.

expressed using formalisms. For numerous decades however, jurists such as Stone have emphasised the difficulty in determining the *ratio* of precedents.[212] According to Stone precedents have multiple, perhaps conflicting *rationes*.[213] When applying a precedent one of those *rationes* must be chosen. Existing systems do not attempt to represent these multiple *rationes*. Hence this approach to formalising the *ratio* of precedents involves a large amount of choice as to which particular *ratio* it is chosen to formalise. Systems that rely on the formalisation of the *ratio* of precedents only have the formalisation of the developer's view of what proposition a precedent embodies. This misrepresents the way that precedents are used in law. The *ratio* of a case may change through time with subsequent application and reinterpretation.[214] An inflexible statement of the proposition that a case is presumed to express does not reflect the flexible and changing nature of *ratio*.

Using a formalism to represent a *ratio* of a precedent, and then reasoning only with this formalism, also misrepresents an important aspect of precedents and the use of precedents. As discussed in chapter 3 providing arguments for the propositions contained in precedents is extremely important. Precedents contain reports of the arguments supporting and detracting from the various propositions that can be regarded as the *ratio* of a precedent. The expression of a *ratio* of a precedent expresses the outcome of these arguments for the particular facts in the precedent.[215] In a different situation, involving different facts, the *ratio* of the earlier precedent may not be directly applicable. However, the arguments and justifications from the earlier precedent may nonetheless be relevant. Hence, the use of cases in legal analogical reasoning involves more than reference to a *ratio* of a prior precedent. The arguments that support the *ratio* are extremely important. These arguments influence the finding that precedents are similar to each other and that they are similar to a problem. Approaches to simulating legal analogical reasoning that rely on the formalisation of the *ratio* of precedents ignore an important way in which precedents are used in legal analogical reasoning.

The straightforward formulation of the *ratio* of cases is also problematic in that it reduces analogical reasoning to deductive reasoning. This is ironic in that psychologists

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[212] Stone, above n 66, 37.
[213] Ibid.
[214] Levi, above n 18, 8-27.
[215] Ibid 5-6.

and cognitive scientists argue that analogical reasoning is a fundamental aspect of the way in which humans reason.[216] It was in response to the failings of rule-base attempts to simulate human reasoning that research in analogising arose in artificial intelligence. It has been said that legal expert systems should engage in the

> application of deductive logic in selection of legal rules and their application
>
> to the facts to be subsumed.[217]

However, legal rules require the subsumption of specific facts into the general categories present in the antecedents of rules. Legal analogical reasoning is a method by which this subsumption occurs. Hence the use of such formalisms to simulate legal analogising ignores the very problems inherent in their own application.

Bench-Capon in particular has defended the rule-based approach to handling open texture.[218] He argues that in an environment where a computer is being used to support a human decision maker, rule-based representations provide useful support. This view is not disputed here. However, if we ask 'How can computers be programmed to simulate legal analogical reasoning?', rather than to support humans in their decision making then this observation is less relevant. The issue then is not how computers can be used in law to support human decision makers, but rather whether and if so how, computers can themselves be made to simulate legal analogical reasoning. The formalisation of the *ratio* of precedents is not sufficient to simulate what jurists argue to be involved in legal analogical reasoning.

6.3.2 Semantic flexibility and the problem of similarity

Simulations of legal analogising are based on approaches to simulating analogising developed in artificial intelligence. Researchers in artificial intelligence and law have utilised techniques from case-based reasoning, computational analogy and neural networks. However, attempts to simulate legal analogising are subject to the same problems, discussed in the previous chapter, inherent in these techniques. First, it is difficult to represent all the knowledge contained in precedents in a computer

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[216] The work of FARG best expresses this: Hofstadter and FARG, above n 153.

[217] Susskind Richard E., 'The Latent Damage System: A Jurisprudential Analysis' p.23, in The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press, 28.

[218] Bench-Capon Trevor M., 'In Defence of Rule-based representations for Legal Knowledge-based systems' (1994) 3 Law, computers & artificial intelligence 15.

manipulable form. Secondly, the semantic flexibility inherent in legal analogising results in crude determinations of similarity between precedents. The following examination of simulations of legal analogising highlights these problems and the restrictions they impose on simulations of legal analogising.

6.3.2.1 Simple matching

The most straightforward attempt to simulate legal analogical reasoning relies on the simple matching of indices developed in case-based reasoning. Analogous precedents are regarded simply as those which share common indices. In the construction of such systems an expert lawyer in the field in which the system is being built must first determine those features of the field that are important to determine the outcome of problems.[219] For example, in Dutch landlord-tenant law some of the features that influence the decision as to how much rent must be paid are: the age of the tenant, the temperature of the house and the season.[220] Existing precedents in the area are then analysed to determine whether or not they exemplify the features that were identified. Thus, after analysis a group of precedents will exist each one classified according to the features it exemplifies. For example, figure 12 shows part of one case used by PROLEXES which operates in the are of Dutch landlord - tenant law.

Tenant age > 65	10
Room temperature < 13°C	20
Season name = "winter"	15
etc.	

[221]

Figure 12: Features in landlord - tenant law

When a new problem needs to be solved it is also analysed to determine which indices it exemplifies. Knowing what features are important in the current problem allows precedents that share common indices with the problem to be retrieved.[222] Since the

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[219] In slightly more complex systems, the legal expert may provide an indication of how important each particular index is to determining the outcome of problems. The importance of each index can be reflected by the assignment of a number to each index to reflect to reflect its relative importance.

[220] Walker R.F., Oskamp A., Schrickx J.A., van Opdorp G.J. and van den Berg P.H., 'PROLEXS: creating law and order in a heterogeneous domain' (1991) 35 International Journal of Man-Machine Studies 35, 56.

[221] Ibid.

[222] In more complex approaches only those precedents which share indices with the problem and where the aggregate value of those indices is above a certain score are retrieved.

problem and the retrieved precedents share indices, they are in this sense similar and analogous. Several systems adopt this approach to simulating legal analogical reasoning.[223]

There are numerous difficulties with this approach to simulating legal analogical reasoning.[224] Simulating legal analogising simply by matching indices revolves around the features regarded by the expert as important for determining the outcome of problems. This is problematic if experts differ as to what features are important in a particular area. If features that one expert regards as relevant are not included in a system then the system will not be able to find similarities based on that feature. If an expert regards two precedents as analogous because they both share a common feature and that feature is not included in a system, then that system will not be able to simulate this analogy. The simulation of analogising is dependent on the features by which it is decided to index the area of law.

A related problem results from the need to classify precedents and problems as containing particular features. Experts can reasonably differ as to whether precedents and problems exemplify individual features. However, if a problem is classified by one expert as exemplifying a particular group of features, and classified by another expert as exemplifying an even slightly different group of features, then different precedents will be regarded as analogous to the problem in each situation. Again, the simulation of analogising is dependent on the features used to index the area of law. Matching indices requires precedents to be unambiguously indexed. The significance of these problems depends on how controversial or non-controversial is the choice of features in the particular area of law in which the system will operate.

A more fundamental problem with simple index matching is that it does not account for the semantic flexibility that is a hallmark of analogical reasoning. In simple index matching the concepts that are regarded as relevant to a particular area, their content and

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[223] E.g.: MacCrimmon, above n 211; Kowalski, above n 211; Walker et al, above n 220.

[224] As a practical matter it is difficult to assign meaningful numerical values to indices to indicate their importance and it is difficult to determine at what score precedents are to be regarded as analogous: van Opdorp G.J., Walker R.F., Schrickx J.A., Groendijk C. and van den Berg P.H., 'Networks at Work: A connectionist approach to non-deductive legal reasoning' p.278, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press. The use of neural networks may ease these problems: ibid.

their relationships with each other, are all fixed at the time a system is created. However, over time the concepts relevant to a domain, the content of these concepts and the relationships between these concepts may all change. Some concepts become relevant while new concepts become relevant.[225] Such changes can be incorporated within the index matching approach to simulating legal analogical reasoning. For example when a feature ceases to be relevant every precedent contained in a system could be re-examined and that feature removed from the precedents. When a new feature becomes relevant every precedent contained in the system could be re-examined to determine whether each precedent exemplifies the new feature. However, incorporating such changes is time consuming and involves the same problems, discussed above, as does the initial assignment of features to precedents.

While this aspect of conceptual change can be accommodated in the index matching approach to simulating legal analogising, the semantic flexibility inherent in analogising cannot. In semantic flexibility, as illustrated by the question 'Who is the First Lady of England?', the content of concepts and the relationships between concepts changes during analogising. During analogising distant and unconnected concepts can come to be regarded as similar. Cognitive scientists argue that this aspect of conceptual change is fundamental to analogical reasoning.[226] As Holyoak and Thagard state, 'the act of making an analogy creates new connections.'[227] The simple index matching approach to simulating legal analogising cannot accommodate this aspect of conceptual change. Hence, simple index matching can only provide a very limited simulation of legal analogical reasoning.

A final objection to current systems based on the simple index matching approach to simulating legal analogising is that they do not account for the environment of argument in which legal analogical reasoning occurs. As argued in chapter 3 and chapter 4, the acceptability and persuasiveness of legal analogies depends in part on the justifications that are provided for those analogies. Many different analogies can exist between situations and hence in law it is important to justify the particular analogy that is created. Many systems do not attempt to justify analogies that are proposed. It is left to the user

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[225] Levi, above n 18, 8.
[226] E.g. see: Hofstadter and FARG, above n 153.
[227] Holyoak and Thagard, above n 153, 7.

of the system to infer why a problem was similar to one precedent and dissimilar to another precedent. This may be more acceptable in a context where a system is being used as an *aide memoir*, to guide an experienced person in their decision making. However, when the aim is to create a computer system that can simulate legal analogical reasoning, leaving the user of the system to make such inferences is insufficient.

Hence as a means to simulate all that is involved in legal analogical reasoning, the simple matching of indices is insufficient. This approach, this approach is dependent on the choice of features that an expert in a field regards as important to that field. This can cause problems if experts differ as to which features are important. More problematic, the simple matching of indices cannot simulate all that is involved in the semantic flexibility inherent in analogising. This approach to simulating legal analogising is limited to finding surface correspondences between problems and precedents. Further, this approach to simulating legal analogising does not attempt to justify legal analogies which are proposed. Simple index matching is thus only able to provide a shallow simulation of legal analogical reasoning.

6.3.2.2 Neural networks

In many ways attempts to simulate legal analogising using neural networks resemble attempts to simulate legal analogising based on simple index matching. The use of neural networks to simulate legal analogising is subject to many of the same objections as simple index matching.

In artificial intelligence, researchers are interested in neural networks because these networks are good at pattern matching.[228] Analogical reasoning and legal analogical reasoning can be regarded as an aspect of pattern recognition and pattern classification[229] As in simple index matching, precedents are analysed by an expert who selects features that are thought important in those precedents. For example, in the law governing theft some of the features relevant to determining the outcome of cases are: whether the defendant was acting dishonestly; whether the defendant believed they had a legal right to the property; whether the defendant believed the property was lost and whether the

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[228] See generally: Caudill and Butler, above n 200.
[229] Sunstein 'On Analogical Reasoning', above n 12, 755-7.

defendant had the intention to permanently deprive the owner of the property.[230] A neural network is constructed using these features (figure 13).
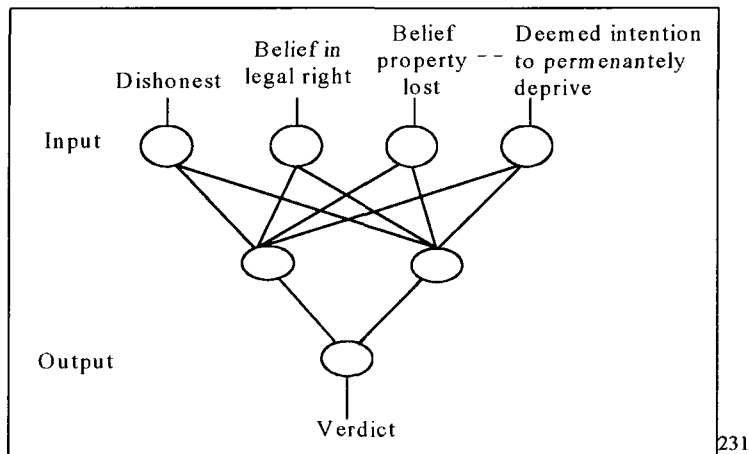
Figure 13: Theft artificial neural network

The network is then 'trained' with the precedents that have been analysed for the presence or absence of the features selected by the expert.[232]

Trained in this way the network will group precedents that share similar patterns of features together(figure 14).
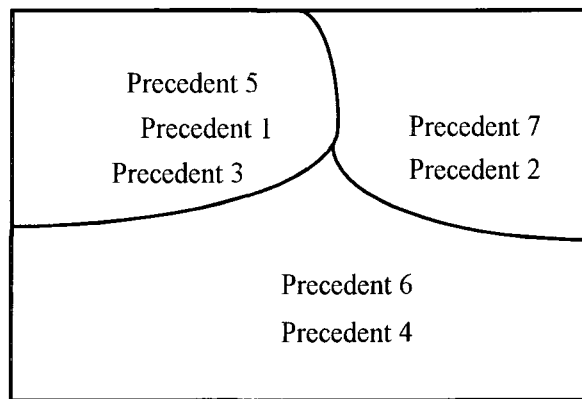
Figure 14: Neural networks group similar precedents together

When a problem needs to be solved, it too is first analysed for the presence or absence of those features indicated as important by the expert. After such analysis, the problem can

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[230] Hobson John B. and Slee David, 'Indexing the Theft Act 1968 for Case Based Reasoning [CBR] and Artificial Neural Networks' p., in   Proceedings of the Fourth National Conference on Law, Computers and Artificial Intelligence (1994).

[231] This is a reconstruction of the network used by Hobson and Slee.

[232] In the most common form of training, a neural network is presented both with an input pattern and the output that is desired when that input pattern is presented. The neural network is repeatedly presented with patterns until they are classified to an acceptable degree of accuracy. The neural network learns to associate input pattern with the output patterns. See generally: Caudill and Butler, above n200.

be presented to the network. When a problem is presented to a neural network that has been created and trained in this manner, the network will classify the problem as belonging to one of the general groups created during its training. The network classifies the problem according to the general group of precedents to which the problem is analogous. In this way it appears possible to use neural networks to simulate legal analogical reasoning. This use of neural networks has been proposed by several researchers.[233] For example Hobson and Slee have created a neural network which attempts to classify cases covered by the Theft Act 1968.[234] When presented with a problem possessing a certain combination of features, the network indicates which general legal class the problem is a member of. This classification is a result of the training conducted with precedents. The network can thus loosely be said to classify the problem by 'analogy' with the precedents used to train it.

Apart from the numerous practical problems involved in using neural networks in the way discussed above[235] as a means to simulate legal analogical reasoning there are also theoretical concerns. First, as with simple index matching, the ability of a neural network to simulate legal analogising is dependent on the features chosen by an expert as important in the particular domain. This is subject to the same concerns as is the selection of features required by simple index matching. Further, analogical reasoning also involves semantic flexibility. As analogies are perceived and constructed the semantic content of the concepts being analogised can subtly change. Researchers who use neural networks to simulate legal analogical reasoning do not account for or discuss how such semantic flexibility can be accommodated. Moreover, neural networks operate as 'black boxes', they simply accept an input pattern and oracularly classify it as belonging to a particular class. By themselves neural networks are not able to explain or justify why a particular input results in a particular output.[236] As in simple index

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[233] E.g. van Opdorp et al, above n 224; Bench-Capon Trevor, 'Neural Networks and Open Texture' p.292, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press; Hobson and Slee, above n 230; Philipps Lothar, 'Distribution of Damages in Car Accidents Through the Use of Neural Networks' (1991) 13 Cordozo Law Review 981.
[234] Hobson and Slee, above n 230.
[235] For more detail see: Aikenhead Michael, 'The Uses and Abuses of Neural Networks in Law' (1996) 12 Santa Clara Computer and High Technology Law Journal 31.
[236] For more detail see Aikenhead, above n 235. Several approaches have been proposed to justify the outputs of neural networks. One of the most interesting is to justify the output of artificial neural networks using other mechanisms: Zeleznikow John and Stranieri Andrew, 'The Split-Up system: Integrating neural networks and rule-based reasoning in the legal domain' p.185, in The Fifth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1995) ACM Press. This approach is extremely interesting however, the systems discussed here do not

matching this inability to justify results and to provide the argumentative context in which the result is achieved renders the use of neural networks, by themselves, insufficient to provide a deep simulation of the processes of legal analogising. For these reasons there must be scepticism as to the usefulness of this means of using neural networks to simulate in legal analogical reasoning. As with simple index matching, this use of neural networks is limited to finding surface correspondences between problems and precedents.

In another sense however, some of the ideas underlying neural networks may prove valuable in simulations of legal analogising. For example the FARG architecture is based on the idea of a network of interconnected Platonic concepts. The FARG architecture displays an interesting approach to dealing with the semantic flexibility demonstrated in analogical reasoning. Hence insights from the neural network paradigm could prove extremely valuable in simulating legal analogising. Indeed, ideas underlying neural networks have been incorporated in systems that perform legal information retrieval. As discussed below, such ideas could find application in systems that simulate legal analogising. However, researchers who use neural networks to simulate legal analogising in the manner discussed above ignore problems inherent in doing so.

6.3.2.3 Analogy as argument

As discussed in chapter 3, providing arguments in support of legal analogies is extremely important. Simulations of legal analogising based on simple index matching and neural networks do not accommodate this aspect of legal analogising. However, several systems constructed to simulate legal analogising do. These systems thus appear able to overcome this problem with simple index matching and neural networks. However, it will be seen that these approaches are still restricted by their ability to simulate the semantic flexibility inherent in analogising.

The most famous approach to simulating legal analogical reasoning within an argumentative context was pioneered by Ashley.[237] It is worthwhile examining this approach in depth first because it appears possible to provide a sophisticated simulation

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implement such justification mechanisms. This discussion will thus be confined to discussion of the use of artificial neural networks other than as part of such justification mechanisms.

[237] Ashley, above n 3.

of legal analogising and secondly because this approach forms the basis for many subsequent attempts to simulate legal analogising.

The central aim of Ashley's work is to explore and simulate how precedents that are similar to a problem can be used to construct and support arguments about how the problem should be resolved. This mirrors the way that legal practitioners use precedents to construct and support arguments for particular propositions and the way in which alternative precedents are cited in order to undermine these arguments. Under Ashley's approach to simulating legal analogising, a domain of law is first analysed to determine what 'dimensions' are important for predicting the outcome of disputes within the domain.[238] As with features in simple index matching and neural networks, dimensions are what an expert in the field regards as important to determining the outcome of cases. Dimensions do not specify the necessary and sufficient conditions for a classification but instead represent considerations that are relevant to constructing arguments for and against a classification.[239] According to Ashley, dimensions

> are a conceptual link between various clusters of operative facts ... and the
> legal conclusions that they support or undermine.[240]

For example, United States trade secrets law can be broken down into various factors such as: 'common-employee-paid-to-change-employers', 'exists-express-non-competition-agreement' and 'security-measures-adopted'.[241] Figure 15 indicates a precedent analysed according to the dimensions it exemplifies. The dimensions that were important in the precedent are indicated in the 'Dimensions List'.

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[238] To be precise, Ashley's theory of argument is based on the use of 'factors'. When factors are implemented in a computer program that are approximated using dimensions: Ashley, above n 3, 37-8. However, for simplicity it is sufficient to here refer solely to dimensions.
[239] Ibid 112-3.
[240] Ibid 38.
[241] For a complete list of dimensions used by the HYPO program see: ibid Appendix F.

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Case: USM Corp. v. Marson Fastener Corp.
SHORT TITLE: "USM v. Marson"
CITATION: 379 Mass. 90
DATE: August 29, 1979
PARTIES:
Plaintiff Corporate-Party: USM
Defendant Corporate-Party: Marson

DECISION FOR: Plaintiff Corporate-Party: USM

CLAIMS DECIDED: Type-of-Claim: Trade-Secrets-Misappropriation
Won by: Plaintiff Corporate-Party: USM

DIMENSIONS LIST:
Competitive-Advantage-Gained
Security-Measures-Adopted

CASES CITED:
Eastern Marble v. Roman Marble
Healy v. Murphy
                                                            242
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Figure 15: A top-level HYPO precedent frame

It is these dimensions that analogising revolves around.

The presence of some dimensions and the absence of others will strengthen the plaintiffs case while the presence of other dimensions and the absence of others will strengthen the defendant's case. According to Ashley, a precedent is a historical collection of conflicting dimensions to which a judge has assigned an outcome with respect to a legal claim.[243] A dispute will involve competing dimensions and since there is no 'deductive or mathematical process' by which to resolve the conflicts between dimensions, precedents are used to support arguments about how to resolve conflicting dimensions in a problem.[244] By focusing on dimensions, arguments can be constructed for and against a particular classification and precedents that have shared dimensions can be cited in these arguments as support.

Analogising within this framework is straightforward. A problem is first analysed for the dimensions it exemplifies. Precedents analogous to the problem can then be found. A similarity between the problem and a precedent is defined as the presence of a shared dimension between a precedent and the problem.[245] A problem and a precedent have a difference if there are either unshared dimensions that lead to a different outcome than the desired outcome or there is a shared dimension that differs in magnitude.[246]

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[242] Ibid 90. Note that this is only the top most frame which is actually used to represent this precedent.
[243] Ibid 28.
[244] Ibid 28.
[245] Ibid 107.
[246] Ibid.

Ashley has implemented this theory of legal analogising in the program 'HYPO'. Once a dispute is analysed to determine the dimensions present, HYPO is able to determine what claims are possibly relevant, to retrieve precedents which share similarities and differences and to construct arguments and hypotheticals for and against claims using these precedents. HYPO is a landmark in attempts to simulate legal analogical reasoning. The dimension based approach to simulating legal analogical reasoning has been adopted in numerous subsequent systems.[247] The model of analogy as argument embodied in HYPO is more sophisticated than anything implemented in previous programs. By placing legal analogical reasoning within the context of argument the theory of legal analogising underlying HYPO appears to overcome the limitations of simple index matching and neural network approaches to simulating legal analogising. However, as a means to simulate legal analogising, dimensional analysis is itself subject to several limitations.

In the context of analogy as argument an interesting extension to HYPO has been made by Skalak and Rissland in their CABARET system.[248] CABARET extends HYPO by adding knowledge of 'typical' types of arguments that are made and how precedents can be used to make such arguments. For example, if a precedent does not favour a particular claim, one argument strategy would be to distinguish the precedent. CABARET has knowledge of how to make such arguments and how to cite precedents in support of these arguments. With explicit knowledge of such argument strategies, the types of argument that CABARET can make are more sophisticated than HYPO is able

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[247] E.g.: Lambert Kenneth A. and Grunewald Mark H., 'LESTER: Using Paradigm Cases in a Quasi-Precedential Legal Domain' p.87, in   The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press; Vossos George, Zeleznikow John, Moore Allan and Hunter Dan, 'The Credit Act Advisory System (CAAS): Conversion from an Expert System Prototype to a C++ Commercial System' p.180, in   The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press; Murbach Ruth and Nonn Eva, 'Similarity in Harder Cases: Sentencing for Fraud' p.236, in   The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press; Hutton N., Patterson A., Tata C. and Wilson J., 'Decision Support for Sentencing in Common Law Jurisdiction' p.89, in   The Fifth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1995) ACM Press; Aleven Vincent and Ashley Kevin D., 'What Law Students Need to Know to WIN' p.152, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press; McLaren Bruce M. and Ashley Kevin D., 'Context Sensitive Case Comparisons in Practical Ethics: Reasoning about Reasons' p.316, in   The Fifth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1995) ACM Press.

[248] Rissland Edwina L. and Skalak David B., 'Interpreting Statutory Predicates' p.46, in   The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press; Skalak David B. and Rissland Edwina L., 'Argument Moves in a Rule-Guided Domain' p.1, in   The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press.

to. However, the approach to analogising adopted in CABARET is essentially the same as in HYPO. CABARET adopts the dimensional analysis pioneered in HYPO. While an interesting application of dimensional analysis it does not extend the model of analogical reasoning embodied in HYPO.

The dimension based approach to simulating legal analogising embodied in HYPO provides significant benefit over simple index matching and neural network approaches to simulating analogising. However, as a complete model of legal analogising this approach has several limitations.[249] Dimensional analysis shares a common limitation with simple feature matching and neural network approaches to simulating legal analogising. The limitation stems from the need to select a limited number of dimensions with which to describe a particular area of law. As was discussed in relation to simple index matching and neural networks, this presents problems for simulating the semantic flexibility that is characteristic of analogical reasoning. Dimensional analysis is limited in its ability to simulate semantic flexibility. The ability of HYPO to create analogies is limited to those types of legal analogy and those aspects of legal analogising in which the analogy revolves around matching shared dimensions. For example, HYPO can retrieve precedents that share the dimension 'competitive-advantage-gained'. Based on the fact that both these precedents a competitive advantage was gained through misappropriation of a trade secret, HYPO can be considered to have created an analogy with these precedents. As discussed in relation to simple index matching however, problems arise if dimensions cease to be relevant to an area or if new dimensions become relevant. Both problems can be accommodated by either deleting obsolete dimensions from precedents or by re-analysing precedents to determine if they contain a newly relevant dimension. However, this is time consuming.

More problematic, the subtle changes in the content and relationships between concepts that can occur during analogising cannot be accommodated by dimensional analysis. HYPO relies on the static classification of precedents and problems in terms of the dimensions used to analyse a domain. The initial set of precedents in HYPO were classified by Ashley. Problems presented to the system must be classified in terms of these dimensions by the user of the system. Once presented to the system the

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[249] Ashley, above n 3, 238-46.

classification of precedents and problems in terms of dimensions is static. While HYPO is able to produce arguments for and against a position based on these classifications, all such argument occurs within the context of these prior classifications.

According to Ashley, HYPO would be improved by amongst other things, allowing it: to reason with abstract legal predicates; to pose sophisticated hypotheticals to test the meaning of predicates; to argue by analogy from other kinds of claims and to learn dimensions.[250] While each of these would undoubtedly improve HYPO they are all indications of a deeper problem. The problem is that the model of analogy at the heart of HYPO is insufficient to perform more complex analogising. As Mendelson highlights, dimensional analysis is only useful in some domains of law.[251] The problem that Mendelson highlights exists because in some areas of law the content of dimensions is fluid. As FARG argue, central to deep analogising is the ability to reclassify situations in terms of the concepts relevant to a field, to re-assess the content of concepts relevant to a field and to re-assess the inter-relations of concepts relevant to a field. HYPO cannot perform any of these.[252] A more sophisticated simulation of legal analogising must simulate the dynamic interactions and change that legal concepts undergo during legal analogising. A method is needed to simulate the semantic flexibility inherent in the assessment of similarity,

As discussed in the previous chapter, it is in research on computational analogy that the most detailed work has been conducted into the conditions under which situations can be regarded as similar. This work has been applied in attempts to simulate legal analogising. One of the most interesting such systems is 'GREBE' created by Branting'[253] which attempts to create precedent-based arguments in the area of Texas workers compensation law.

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[250] Ibid 238.

[251] Mendelson Simon, 'An Attempted Dimensional Analysis of the Law Governing Government Appeals in Criminal Cases' p.128, in The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press.

[252] While the dimensions in HYPO can in some senses be regarded as the equivalent of the Platonic concepts that are central to the FARG architecture, HYPO has no equivalent to the dynamic change in concepts that is central to the FARG architecture.

[253] See Branting Karl L., 'Representing and Reusing Explanations of Legal Precedents' p.103, in The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press hereafter 'Reusing Explanations'; Branting L. Karl, 'Reasoning with Portions of Precedents' p.145, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press hereafter 'Reasoning with Portions'.

Unlike HYPO in which matching relies on shared dimensions, GREBE utilises detailed representations of the precedents in the area of law in which it operates. An aspect of one of the leading precedents in Texas workers compensation law is show in figure 16.
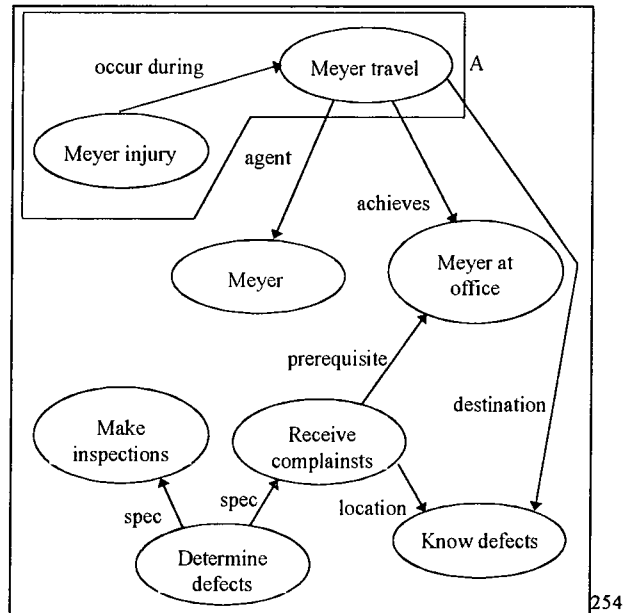
Figure 16: A GREBE case representation

For example the section of figure 16 labelled 'A' indicates that the injury suffered by the plaintiff, Meyer, occurred while Meyer was travelling.

When a problem needs to be solved, the facts of the problem must first be converted into a representation of the form in figure 16. For example, a hypothetical problem involving a plaintiff, Smith, injured during travelling could be represented as in figure 17.
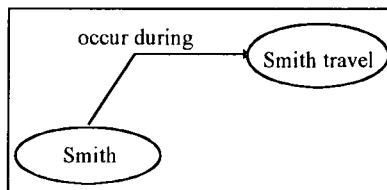
Figure 17: Hypothetical problem for GREBE

With this representation of the problem, precedents that are similar can be found.. For example the portion of the hypothetical problem illustrated in figure 17 matches the portion of the precedent labelled 'A' in figure 16. Both involve a plaintiff injured while travelling. Thus the problem and the precedent are analogous.

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254 Adapted from: Branting 'Reusing Explanations', above n 253, 106.

Using such similarities arguments can be constructed as to why a problem should be decided for the plaintiff, counter arguments can be constructed as to why the problem should be decided for the defendant, and precedents can be cited to support these arguments. In this way GREBE appears able to perform legal analogical reasoning and to create precedent-based argument. One problem with HYPO is that similarities can only be found between precedents and a problem if they share a dimension. GREBE appears to overcome this limitation by representing the detailed facts of precedents and problems. This appears to allow a finer assessment of similarities between cases - a similarity dependent on the sharing of individual facts and not just general dimensions.

In addition, the search for similarities that GREBE undertakes is performed recursively. If a relationship of similarity cannot be inferred between a problem and a precedent because an aspect of the problem and the precedent do not match, GREBE will attempt to construct an argument as to why this aspect should also be regarded as similar in the precedent and problem. This argument will itself rely on analogising further precedents. GREBE thus uses precedents not only to argue why whole situations are analogous, but to argue why parts of these precedents are analogous. Branting argues that often only a portion of a precedent is relevant to a particular dispute and so it is necessary to be able to reason with portions of precedents.[255] HYPO cannot utilise portions of precedents in the construction of similarity and the building of precedent-based arguments. GREBE's ability to utilise portions of precedents in legal analogical reasoning is an important advance. However, GREBE shares numerous limitations with other approaches to simulating legal analogising.

GREBE determines similarities between problems and precedents by searching for shared systematic relationships between representations of problems and representations of precedents.[256] However, as discussed above during examination of the Structure Mapping Engine, this conception of analogising is limited. The finding of similarities based on shared systematic structures is completely dependent on the way in which the designer of the system chooses to represent knowledge in the system. For example, the two representations illustrated in figure 18 would not be matched as similar.

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[255] Branting 'Reasoning with Portions', above n 253.
[256] The conception of analogy embodied in GREBE is based on the work of Gentner: ibid 152.
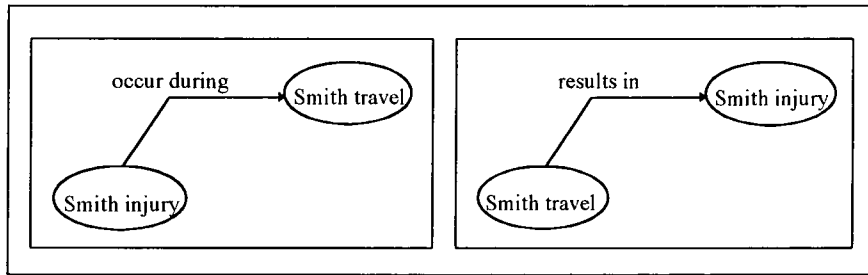
Figure 18: Problems with matching in GREBE

Even though these two situations represent the same information, GREBE would not match these two situations as their structures are different. The way that precedents and problems are represented in GREBE is dependent on the interpretation given to them by the designer of the system. Like the Structure Mapping Engine on which GREBE is based, GREBE cannot accommodate the semantic flexibility that is characteristic of analogical reasoning. GREBE contains no technique to flexibly re-represent legal knowledge.[257] Like HYPO, GREBE's ability to simulate legal analogical reasoning is severely limited by the inability of the program to accommodate the semantic flexibility characteristic of analogical reasoning.

HYPO and GREBE are two of the most sophisticated attempts to simulate legal analogical reasoning. Both programs are distinguished by the use made of precedents to construct precedent-based arguments. However, as in approaches to simulating analogical reasoning generally, HYPO and GREBE are severely limited by their ability to determine similarities between problems and precedents. HYPO and GREBE are unable to accommodate the semantic flexibility inherent in analogical reasoning.

As argued in chapter 4 one of the causes of semantic flexibility in legal analogical reasoning is the influence of legal principles on legal analogising. The creation of analogies is influenced by the principles that a reasoner adheres to. A step towards accommodating semantic flexibility would thus be to accommodate the influence of principles on legal analogising. Neither approaches based on simple index matching,

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[257] While the way that knowledge contained in GREBE is illustrated for the purpose of readers, as in figure 16 may appear similar to the way knowledge is represented in a slipnet, such as in figure 9, in fact they are very different. A slipnet is used to represent knowledge about Platonic concepts relevant to a whole area, this knowledge is flexibly related. In contrast, the representation used in GREBE is used to represent knowledge about specific facts of specific precedents, this information is inflexibly represented. The representations of precedents illustrated in figure 16 are in fact equivalent to the use of predicate calculus discussed in relation to the Structure Mapping Engine and the Analogical Constraint Mapping Engine discussed in chapter 5.

neural networks, nor HYPO or GREBE have the ability to reason with the legal principles that underlie the law. However, researchers have proposed methods to reason with legal principles. Whether these proposals can improve simulations of legal analogical reasoning is examined next.

6.3.3 Reasoning with legal principles.

The inability to simulate the semantic flexibility inherent in legal analogising plagues attempts to simulate legal analogising. One of the causes of flexibility in legal analogical reasoning is the influence of legal principles. Recent research in artificial intelligence and law attempts to incorporate reasoning with legal principles. Diverse approaches are adopted in these attempts. However, as will be seen no approach fully simulates the role of legal principles in legal analogising.

An increasing amount of research in artificial intelligence and law investigates the logical structure of legal argument. Fundamental to this work is the issue of what constitutes a legal argument. This research focuses on questions such as: when one argument is contrary to another argument; when one argument defeats another argument and when an argument provides support for another argument. This research is relevant to attempts to simulate legal analogising for two reasons. First, as highlighted in chapter 3 the arguments provided to justify legal analogies are extremely important. Secondly, as discussed in chapter 3, underlying legal arguments are considerations of legal principle. A comprehensive investigation of legal argument necessarily involves an investigation of the role of legal principles in argument. Consequently, an ability to simulate the influence of legal principles on legal argument would benefit attempts to simulate legal analogising.

Unfortunately, this work on argument has largely occurred without attempt to apply it to legal analogical reasoning, it has not been shown how such models of argument could be used in a legal analogical reasoning system. Further, the models of argument investigated in such research often appear insufficient to model the type of arguments that often occur in legal analogical reasoning. Primarily, this research on legal argument does not discuss how reasoning with principles will occur or often implicitly assumes simple mechanisms for such reasoning.[258] While these investigations have a potentially huge role in

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[258] For a more detailed discussion of these problems, see: Aikenhead Michael, 'A Discourse on Law and Artificial Intelligence' (1996) 5 Law Technology Journal 13.

simulations of legal analogising, this research currently provides little guidance for simulating the role of legal principles in legal analogical reasoning.

One notable exception amongst this work that does explore legal analogising is the Language for Legal Discourse (LLD) developed by McCarty and Sridharan.[259] Underlying LLD is the view that to simulate legal reasoning successfully it is necessary to have a strong theory of the legal domain.[260] LLD is extremely ambitious and involves modelling legal primitives such as time, causation, rights and duties.[261] Amongst other things, such a theory would specify what the scope of legal concepts is, how legal concepts relate to each other and how legal concepts change and evolve. With such a strong domain theory it would be possible to determine what legal analogies are and are not allowable and what justifications are acceptable for those analogies.

In LLD, legal analogical reasoning would be simulated using 'prototypes' and 'deformations'.[262] A prototype is an exemplar precedent in a domain and deformations are the allowable changes that can be made to that exemplar precedent in its application to new situations. The allowable deformations are determined by LLD. With LLD much more abstract forms of similarity could be created between problems and precedents than is possible with simple index matching, neural networks, HYPO or GREBE. Two situations would be similar if both those situations exemplify the same legal concept. More abstractly, two situations would be regarded as similar if the legal concepts they exemplify could be transformed into a common concept utilising LLD. In this way a large aspect of semantic flexibility would be simulated - extremely abstract similarities could be created which would allow complex forms of legal analogising.

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[259] Many papers have been published on LLD, an early paper is: McCarty L.Thorne, 'A Language for Legal Discourse: I. Basic Features' p.180, in   The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1989) ACM Press hereafter 'Basic Features'. A more recent partial implementation of LLD is discussed in: McCarty L.Thorne, 'An implementation of Eisner v Macomber' p.276, in   The Fifth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1995) ACM Press hereafter 'An implementation'.

[260] It was noted in the discussion of case-based reasoning that domain theories can be used to aid the finding of similarities between cases: see chapter 5. LLD is an ambitious attempt to build a theory of the legal domain.

[261] Interestingly these could be regarded as legal Platonic concepts.

[262] McCarty 'Basic Features', above n 259, 184-5.

Unfortunately LLD remains an unimplemented proposal and so it is not possible to assess the workings or the problems of an implementation.[263] However, Ashley raises an important theoretical problem with LLD, that the notion of legal primitives at the centre of the system is misguided.[264] According to Ashley it is not possible to unambiguously define a set of legal primitives. Ashley argues that the content and meaning of legal primitives is determined in precedents on a situation by situation basis. Hence it is not legal primitives that determine the result of precedents, but precedents that determine the meaning and content of legal primitives. Ashley's criticism of LLD echoes a dispute in jurisprudence over whether right answers exist for legal problems.[265] If LLD can be specified then right answers will be determinable from it. Conversely however, if right answers do not exist in law, the prospects for developing LLD seem remote.

Whatever the outcome of this dispute, it highlights an important aspect of legal analogical reasoning. On the one hand legal analogies are judged according to abstract principles that transcend the particular facts of precedents. On the other hand, the content of these abstract principles are themselves explored and determined on a situation by situation basis. Thus while it may not be possible to unambiguously *a priori* state an abstract set of legal principles by which to compose legal analogies, as argued in chapter 4, nor can analogising occur without regard to such principles. What is needed is a way to simulate the influence of abstract principle on the perception of specific problems and precedents and the mutual influence of those problems and precedents on the content and relation of abstract principles. In this sense both McCarty and Ashley's analyses of legal analogical reasoning are informative. Neither analogising without reference to higher principle, nor inflexible representations of principle are sufficient to capture the fluidity present in legal analogising. Unfortunately LLD does not demonstrate how to achieve this.

In contrast to the attempt in LLD to create a comprehensive domain theory, several more modest techniques have been proposed for simulating the influence of principles on legal analogising.

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[263] For a discussion of some of these problems see: Ashley, above n 3, 224-5.
[264] Ibid 225.
[265] Refer to the authorities cited above, n 73.

An early system that incorporated knowledge of legal principles was STARE developed by Goldman et al.[266] STARE was designed as a means to investigate the cognitive issues involved in the understanding of contractual problems and decisions.[267] In pursuit of this aim, STARE is based upon a complex model of the storage and indexing of legal precedents, and their interaction with more general legal and other knowledge. In STARE, situations are analysed and classified according to amongst other things, their relation to legal principles investigated by the jurist Hofeld.[268] With precedents indexed in this way, STARE is able to retrieve precedents that do not share surface features, but that relate to the same underlying principle. STARE thus appears to perform complex analogical reasoning. However, STARE shares limitations similar to programs such as HYPO and GREBE. In STARE, cases are hand coded by the programmers.[269] Hence while apparently utilising knowledge of legal principles to aid analogising, none of the influence of principles in the perception of situations and the construction of analogies is simulated. Principles are used simply as another index within the simple index matching approach to simulating analogising. In ignoring the complexity involved in the analysis of situations and the process of interpretation and reinterpretation of situations that is central to analogising STARE shares all the limitations of simple index matching.[270] STARE does not simulate the ways in which legal principles create the semantic flexibility evident in legal analogical reasoning. Thus while ostensibly reasoning with legal principles, STARE does not simulate the influence of legal principles on legal analogical reasoning.

Motivated by the inadequacies of GREBE Branting has subsequently argued that it is insufficient to merely represent the facts present in a case and argues that it is necessary to reason with the legal theory under which precedents are decided.[271] Branting has proposed a representation of the *ratio* of precedents that incorporates this idea. Under

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[266] Goldman Seth R., Dyer Michael G. and Flowers Margot, 'Precedent-based Legal Reasoning and Knowledge Acquisition in Contract Law: A Process Model' p.210, in The First International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1987) ACM Press.

[267] Ibid 212.

[268] Ibid 214.

[269] Ibid 216.

[270] See discussion of the FARG architecture: chapter 5

[271] Branting Karl L., 'A Reduction-Graph Model of Ratio Decidendi' p.40, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press hereafter 'A Reduction-Graph'.

this proposal the way that facts of precedents exemplify a particular legal theory is represented, as in figure 19.
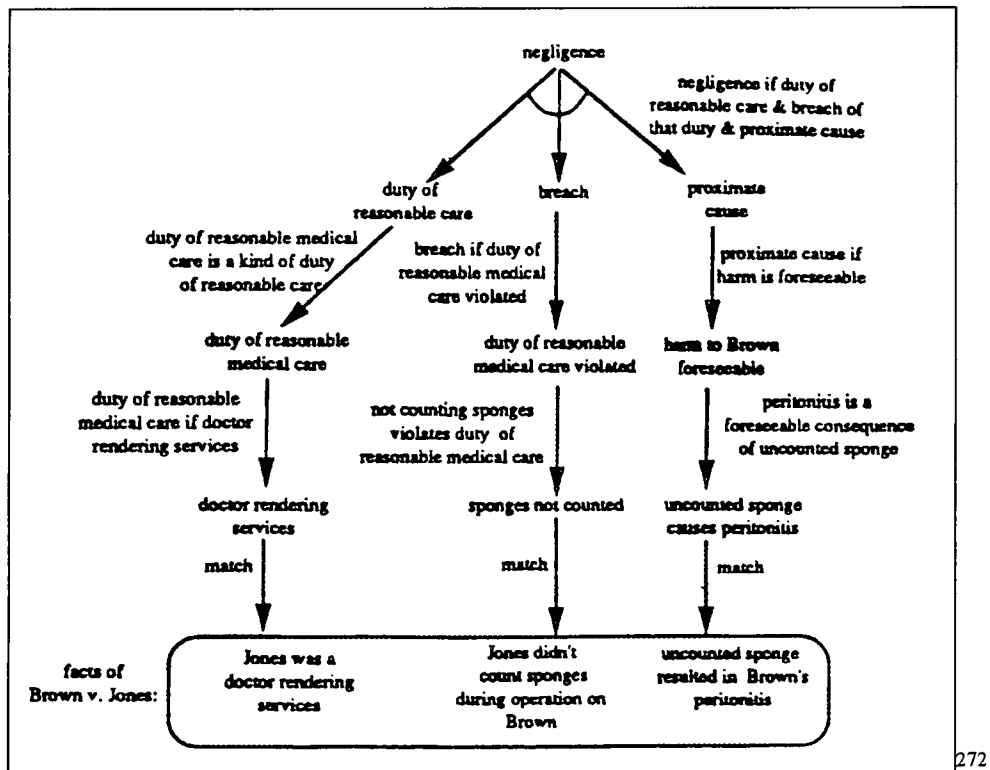
Figure 19: Representing the theory underlying precedents

It is difficult to dispute that representing structures and relations beyond the mere facts of precedents is necessary to accurately reason with those precedents. Branting has proposed a structured way to represent the theory under which cases are decided. Unfortunately, Branting gives very little indication of how this theory of *ratio* would be included in a system to simulate legal analogising. Moreover, two problems are apparent. First, the representation of the theory under which precedents are decided is subject to the same limitations as is the representation of the facts of precedents in GREBE. This representation reflects a single interpretation of a precedent by the programmer of the system. A slightly different representation of the precedent, even though containing the same information, will not match. The representation of precedents and the theory underlying them is brittle and heavily dependent on choices made by the programmer when creating a computer manipulable representation of the precedent.

Secondly, although the theory underlying precedents is represented, Branting does not discuss how those theories can be utilised to simulate the fluid interpretation of problems

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[272] Ibid 43.

and precedents. As discussed in chapter 4, legal principles influence the way that the facts of problems are perceived. Branting's proposal does not address this fundamental role of principles in legal analogising.

Rissland, Skalak and Friedman also propose that the theory of law under which precedents are decided is important to their precedential effect.[273] They have developed a program, BankXX, in which legal theories are represented.[274] In BankXX dimensions are used to indicate the important elements of a legal theory and whether the presence or absence of these dimensions favours or discourages the application of the theory.[275] With a representation of the legal theories underlying precedents, amongst other things, BankXX is able to retrieve cases that apply the same theory as well as precedents that share the application of similar theories.[276] BankXX produces arguments for and against propositions based on the retrieval of precedents and the legal theories underlying those precedents.[277] In this way, some of the influence of legal theories on legal analogical reasoning is simulated. Further, with a representation of the legal theories underlying the law it is possible to provide more detailed justificatory arguments for legal analogies.

While apparently providing a sophisticated simulation of legal analogising, BankXX is nevertheless subject to several limitations. Primarily, the approach to analogising embodied in BankXX is an extension of dimensional analysis. While BankXX apparently extends this with a representation of the legal theories underlying precedents, these theories are themselves represented using dimensional analysis. Hence the representations of legal theory utilised in BankXX is subject to the restrictions with dimensional analysis discussed previously. As in HYPO, precedents must be statistically classified by the creator of the system as exemplifying particular dimensions. This approach to simulating legal analogising does not completely capture the semantic

[273] Rissland Edwina L., Skalak David B. and Friedman M.Timur, 'BankXX: A Program to Generate Argument through Case-Base Search' p.117, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press. The relationship between a legal theory as proposed in BankXX and legal principles is unfortunately not elaborated. While a comprehensive legal theory would have to incorporate legal principles, the legal theory utilised in BankXX does not discuss this.
[274] Ibid.
[275] Ibid 120.
[276] Ibid 121.
[277] Ibid. In addition, BankXX contains knowledge about common 'legal stories' that are present in the domain and which underlie cases, ibid 120. Unfortunately the authors do not provide detailed discussion of how these stories are used and so they will no be considered further.]

flexibility that is inherent in analogising. Similar problems are inherent in the use of dimensions to represent legal theories. The dimensions that constitute a theory, and whether a particular precedent exemplifies one of those dimensions is a decision made by the creators of the system. Hence the content and scope of theories, and the relation of those theories to particular precedents is static. However, like legal principles, legal theories dynamically influence the way in which the facts of precedents are perceived. BankXX does not address how this will occur. While BankXX extends aspects of HYPO, the approach to simulating legal analogising is largely the same in the two programs. This approach is insufficient to simulate the flexibility characteristic of legal analogising.

Berman and Hafner have proposed an approach to reasoning with legal principles similar to that demonstrated in BankXX.[278] Berman and Hafner argue that it is necessary to represent the teleological element present in legal reasoning, and propose an extension to the HYPO architecture that would incorporate this.[279] In this extension, dimensions are linked to the legal purposes they advance and each legal purpose indicates whether it favours the plaintiff or the defendant(figure 20).[280]

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[278] Berman Donald H. and Hafner Carole D., 'Representing Teleological Structure in Case-Based Legal Reasoning: The Missing Link' p.50, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press hereafter 'Representing Teleological Structure'.

[279] Ibid.

[280] Ibid 56.

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┌─────────────────────────────────────────────────────────────────┐
│  Relevant Dimensions:              ┌──────────────┐               │
│                                    │ Current Case │               │
│  Dimension1 (Purpose A ..)         ├──────────────┤               │
│  Dimension2 (Purpose B ..)         │ Dimension 1  │               │
│  Dimension3 (Purpose C ..)         │ Dimension 2  │               │
│                                    │ Dimension 3  │               │
│                                                                   │
│                    ┌──────────────┐      ┌──────────────┐         │
│                    │ Precedent 1 (D)│    │ Precedent 2 (P)│       │
│                    ├──────────────┤      ├──────────────┤         │
│  Legal Purposes:   │ Dimension 1  │      │ Dimension 1  │         │
│                    │ Dimension 2  │      │ Dimension 3  │         │
│  Purpose A, Favours D                                             │
│                    Purpose A, Favours D                           │
│           Purpose A, Favours D                                    │
└─────────────────────────────────────────────────────────────────┘
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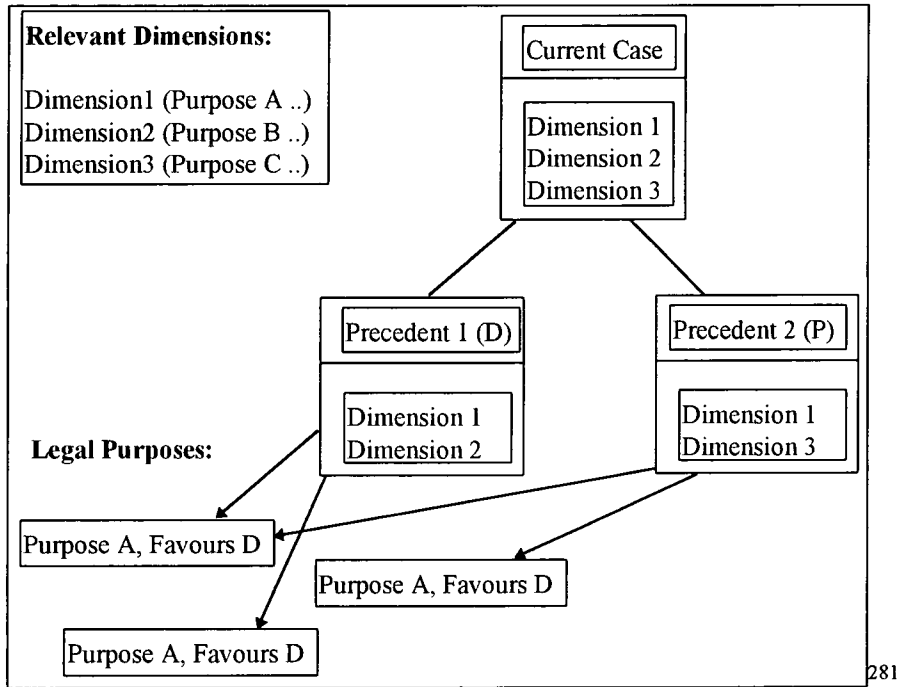
Figure 20: Factors and legal purposes

With this extension, deeper forms of case-matching and legal argument would apparently be possible.

However, this approach to simulating legal analogising is problematic. Apart from being as yet unimplemented, as Berman and Hafner indicate, the purposes that underlie the law change over time and this method of reasoning with legal purposes does not accommodate this change.[282] Further, the level of abstraction at which purposes are represented in the system has to be arbitrarily selected.[283] As with the representations of legal theories in BankXX, legal purposes are represented using dimensions and are thus subject to the problems with dimensional analysis discussed previously.

Moreover, Berman and Hafner do not discuss how their proposals can be used to simulate the influence of legal principles in creating the semantic flexibility inherent in legal analogising. Berman and Hafner do suggest a way in which knowledge about the purposes underlying precedents could be used to simulate the manner in which the force of precedents changes through time.[284] This is an interesting proposal and the change in

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[281] Adapted from: ibid.

[282] Ibid 57.

[283] Ibid.

[284] Berman Donald H. and Hafner Carole D., 'Understanding Precedents in a Temporal context of Evolving Legal Doctrine' p.42, in The Fifth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1995) ACM Press.

the force of precedents through reinterpretation is an important aspect of precedent-based reasoning in law. However, Berman and Hafner's proposed use of legal purposes do not address the manner in which these purposes influence the perception of problems and precedents. As such, Berman and Hafner's proposals do not simulate an important aspect of legal analogical reasoning.

Having examined numerous influential attempts to simulate legal analogising, it can be seen that researchers in artificial intelligence and law have explored a diverse range of approaches in these attempts. However, these simulations of legal analogising are shallow and brittle. Researchers in artificial intelligence and law have borrowed widely from artificial intelligence. However, as discussed in chapter 5 artificial intelligence is unable to provide a complete simulations of analogising. Systems in law relying on these techniques do not provide a complete simulation of legal analogising. One promising branch of research in computational analogy, that explored by FARG, has not been explored by researchers in AI and law. While far from a complete model of analogising, the architecture pioneered by FARG suggests numerous promising ideas for research in simulating legal analogising. This is examined in more detail in the next chapter. Having examined attempts at simulate legal analogising, one further branch of research in artificial intelligence and law relevant to legal analogical reasoning will be examined - legal information retrieval.

6.4   Artificial intelligence and law, and information retrieval

Information retrieval is a general term used to describe methods of using computers to retrieve stored documents relevant to a users requirements.[285] When presented with a legal issue, lawyers ideally require all the documents, and only those documents which are relevant to that issue. Unfortunately, determining which documents are and which documents are not relevant to an issue is a complex task. This task has many overlaps with legal reasoning. Retrieving documents based solely on the presence of surface similarities is insufficient, the ability to perform conceptual searches is necessary.

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[285] Zeleznikow John and Hunter Dan, Building intelligent legal information systems: representation and reasoning in law (1994) Kluwer, 29.

Both legal analogical reasoning systems and legal information retrieval systems require the determination of conceptual similarities between documents. Hence, techniques developed in research on analogy are relevant to information retrieval. Conversely, techniques from information retrieval that retrieve documents based on their conceptual similarity are relevant to attempts to simulate legal analogical reasoning.[286]

6.4.1 The need for conceptual retrieval

The simplest approach to information retrieval is to search for 'key-words' in a document.[287] For example, searching a database of precedents for the word 'lawyer' will display all those precedents which contain the word 'lawyer'. However, this will not retrieve precedents not containing the word 'lawyer' but instead containing the words 'practitioner', 'solicitor' or 'barrister'. The use of thesaurus can partly overcome this problem.[288] However, this method of retrieval also retrieves cases in which one word is used with diverse meanings. For example, a case where a solicitor is being sued for negligence and a case where a solicitor is commended for their conscientiousness. This problem can be reduced by using Boolean operators to combine words and thus narrow searching.[289] However, a fundamental problem with key-word searching is that it is subject to the 'Boolean lottery'.[290] The more searches are widened to ensure all relevant documents are retrieved, the greater the number of irrelevant documents are also retrieved. The more searches are narrowed to restrict the number of irrelevant documents retrieved the more potentially relevant documents are not retrieved. Hence there is a trade-off between the need to recall all relevant documents and the relevance of the documents retrieved. It cannot be guaranteed that all but only the relevant documents are retrieved. What is needed is a method to retrieve documents containing only the concepts of interest.

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[286] The overlap between information retrieval and reasoning has been noted by several researchers: e.g. Bing Jon, 'Designing Text Retrieval Systems for Conceptual Searching' p.43, in The First International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1987) ACM Press; Hafner Carole D. and Wise Virginia J., 'SmartLaw: Adapting "Classic" Expert System Techniques for the Legal Research Domain' p.133, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press; Rissland Edwina L. and Daniels Jody J., 'A Hybrid CBR-IR Approach to Legal Information Retrieval' p.52, in The Fifth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1995) ACM Press.

[287] Zeleznikow and Hunter, above n 285, 30.

[288] When a thesaurus is used, a search for 'lawyer' would also search for synonymous words such as 'solicitor' or 'barrister'.

[289] Zeleznikow and Hunter, above n 285, 31.

[290] Ibid 35.

There are many approaches to conceptual information retrieval. The most straightforward simply involves editorially enhancing documents. Documents are read by an expert who assigns standardised subject classifiers to them. Indexes, such as the 'Current Law Index' operates with such a system. Precedents and other documents are classified by an editorial team into subjects such as 'Negligence - professional'. With an indication of the concepts a document relates to, conceptual retrieval can be performed.

Editorial enhancement also underlies numerous computer systems that perform conceptual retrieval. These systems in turn involve varying degrees of editorial enhancement. For example, Mital and Johnson argue that litigation support is a highly specialised task.[291] As such they outline a system that aids users in performing various forms of editorial enhancement. This in turn facilitates conceptual retrieval of the documents that have been stored in the system. More radically, Dick has argued that not only is it necessary that the concepts exemplified by a document be made explicit, but also that the arguments in those documents be made explicit.[292] According to Dick this better supports lawyers in the retrieval of the information required to build an argument in response to a problem.[293] Dick however, has not provided a new technique for conceptual retrieval - her system still relies on the manual editorial enhancement of precedents. Dick's approach to conceptual retrieval is notable for the degree and kind of editorial enhancement used.

The various forms of editorial enhancement all provide benefits in information retrieval over keyword searching. However, as a full means to conceptual retrieval editorial enhancement is limited. Editorial enhancement is limited by the ability of the editor to classify documents as exemplifying particular concepts. Conceptual searching can only be performed on those concepts which have been editorially assigned.[294] However, researchers in analogy argue that situations can be similar in infinite numbers of ways.

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[291] Mital Vijay, Stylianou Agathoclis and Johnson Les, 'Conceptual Information Retrieval in Litigation Support Systems' p.235, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press.

[292] Dick Judith, 'Conceptual Retrieval and Case Law' p.106, in The First International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1987) ACM Press hereafter 'Conceptual Retrieval'; Dick Judith P., 'Representation of legal text for conceptual retrieval' p.244, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press hereafter 'Representation of legal text'.

[293] Dick 'Representation of legal text', above n 292, 244.

[294] This is the same problem as arises in assigning indices in case-based reasoning, in interpreting cases in computational analogy and in selecting inputs for a neural network.

When retrieving documents, it may potentially be necessary to retrieve documents based on any of these similarities. Editorially enhancing documents only captures particular conceptual similarities between documents. It is not possible to perform conceptual retrieval based on similarities that an editor has not previously foreseen and classified. Hence the conceptual searching facilitated by editorial enhancement is limited.

As an alternative to manual editorial enhancement, researchers have investigated the automatic processing of text and the automatic extraction of conceptual information from texts. An early system was demonstrated by Tong et. al. in RUBRIC.[295] RUBRIC automatically located documents relating to particular concepts through the use of lexical rules. For example, in the area of United States mergers and acquisitions law, a rule such as:

> EVIDENCE friendly((SENTENCE "BOARD" "OFFER"
> "RECOMMENDED")0.9))[296]

indicates that if the words 'board', 'offer', and 'recommend' occur in the same sentence then this strongly indicates that the document relates to a friendly take-over bid. With such rules, documents relating to the same concepts can be located. The lexical rules contained in the system determine the extraction of concepts from a piece of text.

A similar approach to conceptual retrieval is implemented in FLEXICON.[297] FLEXICON extends the approach in RUBRIC with a large 'dictionary' of legal concepts.[298] This dictionary is created by the creators of FLEXICON.[299] In this dictionary each concept is linked to words or parts of words which indicate the presence of the concept.[300] With this dictionary, it is argued that the concepts exemplified in a

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[295] E.g. Tong Richard M., Reid Clifford A., Crowe Gregory J. and Douglas Peter R., 'Conceptual Legal Document Retrieval Using the RUBRIC System' p.28, in <u>The First International Conference on Artificial Intelligence and Law: Proceedings of the Conference</u> (1987) ACM Press.

[296] Ibid 31.

[297] Gelbert Daphne and Smith J.C., 'Beyond Boolean Search: FLEXICON, A Legal Text-Based Intelligent System' p.225, in <u>The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference</u> (1991) ACM Press hereafter 'Beyond Boolean Search'; Gelbart Daphne and Smith J.C., 'FLEXICON, An Evaluation of a Statistical Ranking Model Adapted to Intelligent Legal Text Management' p.142, in <u>The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference</u> (1993) ACM Press hereafter 'An Evaluation'.

[298] FLEXICON also contains more facilities than does RUBRIC, such as the ability to search for precedents and statute citations and the ability to automatically generate 'summaries' of cases. However, the approach to the conceptual classification of precedents in RUBRIC and FLEXICON is essentially the same.

[299] Gelbart and Smith 'An Evaluation', above n 297, 146.

[300] Ibid..

document can automatically be extracted and conceptual information retrieval be performed.

However, these means to automatically determine conceptual similarities share a limitation with approaches based on manual editorial enhancement. Only those concepts specifically defined by lexical rules or linked to words in the dictionary can be searched for. If the designers of the rules in RUBRIC or the dictionary in FLEXICON omit a concept from the rules or from the dictionary then conceptual searching cannot be performed on that concept.

Further, whilst saving time and effort in the processing of documents, the automatic extraction of conceptual information is subject to a limitation that editorial enhancement is not. For example, the following piece of text describes a hypothetical event:

> While drunk John swung from the chandelier, which unable to support his bulk, detached from the ceiling. John plummeted to the floor injuring several people below.

This text would be relevant to a claim of negligence against John. An editor would realise this and could label the piece of text as relevant to the concept of negligence. However, automatic text processing techniques that rely on dictionary based approaches to determining the concept exemplified by a piece of text would not identify this text as relevant to the concept of negligence. The, automatic detection of legal concepts is limited.

Moreover, approaches to conceptual retrieval based on editorial enhancement and the automatic extraction of conceptual information do not address the semantic flexibility inherent in analogising and conceptual retrieval. Which concepts a document exemplifies, and the relationships between concepts are both statically defined in these approaches. Hence these approaches cannot simulate the conceptual change in concepts that can occur during conceptual retrieval.

In accommodating the flexibility inherent in analogising, a notable approach to conceptual retrieval is demonstrated in SCALIR.[301] Like many other systems, SCALIR

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[301] Rose Daniel E. and Belew Richard K., 'Legal Information Retrieval A Hybrid Approach' p.138, in The Second International Conference on Artificial Intelligence and Law: Proceedings of the Conference

relies on the editorial enhancement of documents.[302] However SCALIR augments this with other information. SCALIR contains information about 'micro-features' of documents.[303] This information records facts such as that two documents refer to another common document, such as the same precedent, or a common piece of legislation, or more simply that two documents are commonly retrieved together.[304] For the purpose of determining similarities between documents, such information can be useful. For instance SCALIR's creators argue that the fact that two documents cite a common precedent is a good indication that those documents are about a similar concept.[305]

With a more subtle notion of what is covered by the concept of 'similarity' SCALIR is thus able to construct similarities between documents that would be beyond the other approaches discussed. All the information about micro-features that SCALIR contains is automatically extracted from documents. A system that accommodates the semantic flexibility inherent in analogising must be able to automatically re-assess the content of concepts and the relationships between concepts. While SCALIR is thus an advance in information retrieval, its potential lies not only in information retrieval. As the creators of SCALIR envision, the combination of the approaches adopted in SCALIR with approaches developed in research on simulating analogising suggests ways to improve the simulation of legal reasoning.[306] More work is required however to fully explore the potential of this approach.

Legal information retrieval is a task that has many overlaps with legal analogical reasoning. Utilisation of techniques developed in research on legal reasoning has been proposed to improve legal information retrieval systems.[307] Conversely, techniques

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(1989) ACM Press, hereafter 'Legal Information Retrieval'; Rose Daniel E. and Belew Richard K., 'A connectionist and symbolic hybrid for improving legal research' (1991) 35 International Journal of Man-Machine Studies 1, hereafter 'A connectionist and symbolic hybrid'. SCALIR is an extension of work undertaken by Belew: Belew Richard K., 'A Connectionist Approach to Conceptual Information Retrieval' p.116, in The First International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1987) ACM Press.

[302] Rose and Belew 'Legal Information Retrieval', above n 301, 138.

[303] Rose and Belew 'A connectionist and symbolic hybrid', above n 301, 11.

[304] FLEXICON also utilises a more limited for of such information than is used in SCALIR.

[305] Rose and Belew 'A connectionist and symbolic hybrid', above n 301, 16.

[306] Ibid, 29-30.

[307] E.g. Hafner Carole D. and Wise Virginia J., 'SmartLaw: Adapting "Classic" Expert System Techniques for the Legal Research Domain' p.133, in The Fourth International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1993) ACM Press; Dick 'Conceptual Retrieval', above n 292; Rissland and Daniels, above n 286.

developed in legal information retrieval could be useful in simulating legal analogising. However, while offering many benefits in legal information retrieval, approaches to conceptual retrieval currently offer limited benefit to attempts to simulate legal analogising. In both areas the representations of legal knowledge encoded in these systems is inflexible. This makes it unsuitable for simulating the flexibility demonstrated in analogising. However, the automatic extraction and use of micro-feature information demonstrated in SCALIR indicates an innovative way to determine similarities between documents. This is a useful source of information to use in systems that simulate legal analogising. As the creators of SCALIR indicate, these techniques could be used in future legal reasoning systems.

6.5 Conclusion

Having examined approaches to simulating legal analogising developed by researchers in artificial intelligence and law it is apparent that these systems only provide a shallow simulation of human legal analogising. Researchers in psychology, cognitive science and artificial intelligence argue that analogising is a creative act that can involve the perception of new connections between situations. Systems that simulate legal analogising must accommodate the flexible interaction and change in knowledge that occurs when analogies are constructed. Current systems that simulate legal analogising do not adequately accommodate this. Current attempts to simulate legal analogising only simulate limited aspects of legal analogising. Current simulations are limited to finding similarities based on straightforward correspondences between situations. This severely restricts the kinds of analogies that these systems can create. According to legal theorist, legal principles have a large influence in the perception of legal analogies. However, currents approaches to simulating legal analogising ignore this influence of legal principles on the creation of analogies. The limitations that this imposes on attempts to simulate legal analogical reasoning and some possibilities for improving systems that attempt to simulate legal analogical reasoning are examined in the next chapter.

7   Improving simulations of legal analogical reasoning

The preceding examination of theories of legal analogising and of attempts to construct computer systems that simulate legal analogising, highlights that these attempts fall far short of simulating all that occurs during human analogising. Analogical reasoning involves the perception of similarity between situations. Similarities that are perceived between situations can be more or less abstract and more or less creative. In law, legal principles influence the perception of abstract similarities. Attempts to simulate legal analogising do not account for the importance of these principles on legal analogising. This limits the kind of legal analogical reasoning that systems can simulate. In this chapter the limitations that exist in attempts to simulate legal analogical reasoning are discussed in more depth. Suggestions are offered as to how these limitations could begun to be dealt with.

7.1   Two limitations

As discussed in chapter 4, a common distinction drawn by jurists in theories of legal reasoning is between processes of creation and processes of justification of decisions. While this distinction is itself problematic it usefully highlights two limitations that exist in current simulations of legal analogising. Even the most sophisticated simulations of legal analogising adopt overly simplistic models of the processes of creation and processes of justification.

7.1.1   Limitations of creation

The perception of an analogy depends on the perception of similarity between situations. How do we come to view two situations as similar? In current simulations of legal analogising this is achieved by the matching of pre-defined attributes between situations. If situations share common attributes then they are regarded as in some respect similar. However, this ignores a central aspect of analogising and is thus insufficient to account for the creation of all legal analogies.

The central aspect of analogising that is ignored is the way in which the perception of problems and precedents can radically differ in different situations. Some philosophers suggest that situations can potentially be regarded as similar in infinite ways. The way in

which a situation is perceived determines the analogies that can potentially be formed with that situation.

Current simulations of legal analogising ignore the importance of perception in legal analogising. Current simulations of legal analogising force the perception of problems and precedents into categories pre-defined by the creators of the particular system. Thus only analogies consistent with this initial perception of the environment can be created. Forcing situations to be perceived in particular ways restricts the type of analogising that is possible. Analogising is limited to determining matches between the designated attributes. In these simulations, analogising cannot involve similarities that are either more abstract or indeed less abstract than the attributes designated as important. Researchers such as Gentner and Rumelhart restrict the term 'analogising' to designate creative and abstract similarity and use the term 'mere matching' to refer to the sort of attribute matching which simulations of 'legal analogising' involve. While this restricted us of the term 'analogising' is not universally adopted, on this view it becomes difficult even to refer to these simulations as simulating legal analogising.

The problems inherent in current approaches to simulating legal analogising can be seen in programs such as HYPO. While this discussion will focus on HYPO, the problems inherent in this program are also present in other programs that simulate legal analogising such as GREBE and those programs based on simple index matching and neural networks.

HYPO is one of the most sophisticated attempts to simulate legal analogising. Nevertheless HYPO is extremely limited in the kind of legal analogising that it can simulate. The ability of HYPO to create legal analogies is limited by the inability of the program to perceive situations in ways other than those designated by its creator. HYPO relies on the breakdown and classification of the facts of problems into seemingly non-controversial, apparently basic dimensions. These dimensions form the basis for all the subsequent matching and argument that HYPO performs. However, the seeming simplicity of the dimensions used in HYPO in many cases masks choices that must be made in any categorisation. For example, while determining whether 'THERE IS A CORPORATE PLAINTIFF' or 'THERE IS A CORPORATE DEFENDANT' may not be controversial, other dimensions such as 'PLAINTIFF AND DEFENDANT'S

PRODUCTS COMPETE' and 'EMPLOYEE RECEIVED SOMETHING OF VALUE TO SWITCH EMPLOYMENT'[308] pose more difficulties.

For example, hypothesise two drink manufacturers, one producing fizzy cola drinks the other producing fizzy lemon drinks. Do these products compete? They are different drinks which suggests that they are not in competition. However, they are both 'soft-drinks' which suggests they are in competition. What if one manufacturer produces 'sports-drinks'? The two drinks now appear to serve different functions, again suggesting that they are not in competition. But what if sports people are shown to often drink cola drinks after playing sport? Are the products then in competition? Clearly the dimensions with which it is required to analyse situations themselves involve important choices and elements of perception. Similarly with the second attribute. Hypothesise an employee who receives a direct payment to change employment. Something of value has been received. What if the employee is offered a pay rise instead of a direct payment? This still seems a reception of something valuable. However, this inference may be weakened if the employee also has to adopt more responsibilities. What if an employee's spouse, previously unemployed, is offered a job in return for the employee changing employment? Or the employee's children? Has something of value then been received by the employee to change employment? It becomes more and more difficult to say so. Clearly, in some circumstances whether something of value has been received by the employee is a matter of perception and argument and is not a value-free classification.

It could be argued that overcoming this difficulty is simply a matter of adding sufficiently detailed information, rather than using general dimensions such as 'PLAINTIFF AND DEFENDANT'S PRODUCTS COMPETE' or 'EMPLOYEE RECEIVED SOMETHING OF VALUE TO SWITCH EMPLOYMENT'. However, Hofstadter and French strongly argue that as a general strategy this is inadequate.[309] This approach is subject to recursion of the original problem for the new attributes themselves.[310] While the addition of more detailed information may reduce the problem inherent in categorising situations in terms of the attributes chosen by the designer of the system, a fundamental problem remains. Amongst those multitude of attributes used to analyse

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[308] For a list of all the 'factual' predicates used in HYPO see: Ashley, above n 3, appendix D.
[309] Hofstadter and French, above n 176.
[310] Ibid 342-51.

situations, it is necessary to determine which are important in a particular finding of similarity and what relationships exist between those attributes. It is not sufficient to have masses of information; the determination of similarity depends on the perception of relationships between pieces of information,

Because programs such as HYPO focus on matching pre-defined attributes of situations the creators of such systems can *a priori* specify the role of each attribute in the finding of similarity. Once the important attributes are pre-defined, the complexity in determining the important attributes can be ignored. However, once it is accepted that matching pre-defined attributes is insufficient, it becomes necessary to determine how the selection of particular attributes for use in analogising occurs, how the perception of particular relationships between attributes occurs during analogising and how these can be simulated.

Donoghue v. Stevenson illustrates the problems inherent in current attempts to simulate legal analogising. discussed Chapter 4 highlighted how the analogies relied upon by Lord Buckmaster and Lord Aitkin were totally different. Their lordships perceived the case in totally different ways. In their different treatments of the case, Lord Buckmaster and Lord Aitkin focused on different attributes of the case. In part the legal principles that each of their lordships adhered to drove the choice of the particular attributes that each of their lordships focused on. As jurists examining analogy emphasise,

> when we speak of relevant similarities in the context of analyzing analogies,
>
> ... similarities are made and not found.[311]

Amongst other things, legal principles influence how concepts are constructed, how they interact and ultimately how the facts of a case are classified. As Justice Wald says in her illuminating discussion of the processes of judging,

> [t]he conventional wisdom is that the "Facts" portion of an appellate opinion merely recites neutral, pre-determined "facts" found by the lower court .... Yet nothing could be further from the truth. When an appellate judge sits down to write up a case, she knows how the case will come out and she consciously relates a "story" that will convince the reader that it has come out right.[312]

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[311] MacCormick 'Legal Reasoning', above n 17, 185.
[312] Wald, above n 84, 1386.

Attempts to simulate legal analogising that rely on the classification of facts into pre-defined categories cannot provide a complete simulation of legal analogising. The influence of principles on the way the facts of cases are perceived and categorised needs to be accommodated.

Programs that simulate legal analogising such as HYPO, ignore these complex aspects of analogising. According to Mendelson, the approach embodied in HYPO is only applicable in limited areas of law.[313] Mendelson argues that this approach is more suited to settled and non-discretionary areas of law. Indeed it is precisely in unsettled and discretionary areas of law that legal principles would be expected to be most influential upon reasoning. Current systems are not capable of predicting landmark cases.[314]

Researchers in artificial intelligence and law claim to be aware of current problems with attempts to simulate legal analogising and the important role that legal principles play in analogising.[315] Although valuable suggestions, these approaches do not address the problems identified above. While Branting argues for the need to represent the theory under which cases are decided he does not discuss the importance of those theories in determining the very way that problems are perceived. The way a problem is perceived determines which precedents are regarded as analogous and thus is at least as important as knowing the theory under which precedents were decided. A similar criticism exists with respect to the approach adopted by Rissland and Skalak. Rissland and Skalak represent the legal theory under which precedents were decided. Like Branting however, they do not discuss the importance of these theories and legal principles on the very perception of problems.

Finally, Berman and Hafner propose an extension to the approach to simulating legal analogising pioneered in HYPO. In this extension, factors are linked to the legal principles that they support. [316] In this way a system would be able to make arguments based on legal principles. However, this proposal is simply aimed at providing 'deeper'

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[313] Mendelson, above n 251.
[314]Hunter Dan, Representation and reasoning in law: Legal theory in the artificial intelligence and law movement. (1995) LLM Thesis, University of Melbourne, Melbourne.
[315] See the discussion of systems that simulate reasoning with legal principles, chapter 6.
[316] Berman and Hafner 'Representing Teleological Structure', above 278.

justifications for analogies. Like Branting, and Rissland and Skalak, Berman and Hafner do not discuss the influence of principles on the very perception of legal problems.

While some researchers in artificial intelligence and law are aware of the importance of legal principle in legal analogising, no research in artificial intelligence and law has investigated the importance of legal principles on the very perception of problems. Until researchers address the influence that legal principles have on the perception of similarity during analogising, simulations of legal analogising will be restricted to finding 'mere matches' rather than creating truly creative analogies.

7.1.2 Limitations of justification

The second limitation of systems that simulate legal analogising arises from the importance of the processes of justification in legal analogising. This limitation is closely related to the limitation involved in the creation of analogies discussed above. The limitation of justification arises because law is an argumentative endeavour. Legal analogies are both used to support other arguments and are themselves based on underlying arguments. The arguments underlying a legal analogy justify the creation of that analogy. Hence a legal analogy is only as convincing as the justifications that can be provided in support of it. It is thus essential to be able to provide, the justifications that underlie legal analogies.

Approaches to simulating legal analogising, such as simple index matching and neural networks do not attempt to justify analogies that are proposed.[317] To the extent that systems do not provided justifications for the analogies they create, they are incomplete simulations of legal analogising. Other systems, notably GREBE and those based around dimensional analysis do attempt to provide argument about the analogies they propose. Systems such as HYPO argue about the appropriateness of analogies drawn between a problem and precedents by comparing and contrasting analogies with each other. Under this approach, justification is based wholly on the principle that 'like case should be decided alike'. If it can be shown that a problem is like a precedent, referring to the existence of the precedent is regarded as sufficient justification. However, the principle 'like cases should be decided alike' justifies the outcome of a problem only once a

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[317] Though work is being done on justifying the output of neural networks: Zeleznikow and Stranieri, above n 236

precedent is shown to be similar. The likeness between a problem and a precedent must itself be justified. Justifying why precedents and problems are alike is however, a task which current approaches to simulating legal analogising do not completely address.

Limitations in current approaches to justifying analogies are closely linked to the limitations on the creation of analogies discussed above. First, problems must be to an extent pre-classified as displaying certain attributes. Systems cannot provide argument as to whether these attributes are in fact present in the problem. To return to the example provided above. It would not be possible to justify a classification that the fizzy cola drink and the sports-drink do or do not compete. This is subsumed within the attribute 'PLAINTIFF'S AND DEFENDANTS PRODUCTS COMPETE.' As discussed above however, the attribute 'PLAINTIFF'S AND DEFENDANTS PRODUCTS COMPETE' itself masks choices about the classification of facts. To completely justify an analogy those choices must be justified. Current systems cannot justify those choices.

Just as it is necessary to justify the classification of particular problems within the attributes used in a system, it is necessary to justify the use of those attributes themselves. For example, consider another example from the area of trade secrets misappropriation. Hypothesise a plaintiff claiming for trade secrets misappropriation. Assume that the employee in this case was paid to change employment. Indeed, the plaintiff cites a precedent where an employee was paid to change employment and where the court found trade secrets misappropriation. Assume however, that the defendant cites a precedent in which an employee was paid to change employment but the court found there was no trade secrets misappropriation.[318] This second precedent undermines the importance of the attribute 'EMPLOYEE RECEIVED SOMETHING OF VALUE TO SWITCH EMPLOYMENT'. Justifying the analogy with the initial precedent requires justifying why this attribute is itself important. Systems that simulate legal analogising do not provide such justifications.

Proposals to incorporate reasoning with legal theories and legal principles would address the problem of justifying the importance of particular attributes. However, these proposals do not address the justification of the choices that occur during the perception

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[318] Refer to the discussion of HYPO's processing of the hypothetical Amexxco case: Ashley, above n 3, appendix H.

of legal analogies. Providing justification for these choices requires an understanding of the influence on the way situations are perceived during legal analogising. Research on analogy has not completely uncovered what drives such choices. However research on analogy, as does legal theory, emphasises the important influence of principles in the perception of analogies.

Reasoning with the principles that underlie the law is clearly necessary. No research in artificial intelligence and law fully addresses the importance of legal principles in legal analogical reasoning. While the use of legal principles has been investigated to improved justification, such proposals do not address the influence of principles on the very perception of analogies. Moreover these proposals ignore an important aspect of the interaction between principles and analogising. During analogising, principles themselves change. Systems that simulate the interaction between legal principles and analogising must accommodate this change.

7.2   Fluid principles and analogising

As explored in chapter 4 while it can be said that legal principles underlie legal analogies, legal analogising is itself an important way in which the scope of legal principles are themselves demarcated. Systems that simulate legal analogising must accommodate the influence of analogising on changing legal principles. Current proposals for utilising knowledge of legal principles in simulating legal analogising do not accommodate change within these principles. For example Berman and Hafner note that the 'level of abstractness' at which principles and policies are represented must be arbitrarily chosen.[319] According to jurists legal principles exist at varying levels of abstraction.[320] A complete system for simulating legal analogising would involve reasoning with principles at various levels of abstraction and would simulate the way in which the scope of principles is itself demarcated during legal analogising.

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[319] Berman and Hafner 'Representing Teleological Structure', above 278, 57.
[320] Sunstein discusses this in the context of analogical reasoning: Sunstein Cass R., 'Incompletely Theorized Agreements' (1995) 108 Harvard Law Review 1733.

As Bratley et al discuss, accommodating change in the law is a highly neglected aspect of artificial intelligence and law research.[321] Bratley's et al comments were made in the context of accommodating changes in statute law based legal expert systems. To an extent the development of systems that simulate legal analogising itself addresses some of the problems originally raised by Bratley et al. However, an examination of analogical reasoning emphasises that during analogising subtle changes in legal concepts and principles can occur. Berman and Hafner acknowledge that their proposals for incorporating legal principles into legal analogical reasoning systems face problems when the legal principles originally incorporated into the system themselves change.[322] However, the type of change to legal principles apparently envisaged by Berman and Hafner is unsubtle. This examination of legal analogising demonstrates that legal principles undergo subtle changes as part of the process of legal analogical reasoning itself. Berman and Hafner appear unaware of this aspect of change to legal principles. Change in legal knowledge is still a highly neglected aspect of research in artificial intelligence and law.

7.3   Future directions in simulating legal analogising

Commentators have raised several criticisms with systems that simulate legal analogising. Berman and Hafner argue for the need to account for the procedural context in which cases are decided.[323] Bratley et al highlight the crucial need to be able to handle changes in the law.[324] Berman has raised several objections to current systems.[325] However, while each of these criticisms is valid, none of them is necessarily insurmountable. Berman and Hafner themselves propose an approach to accounting for the procedural context of cases.[326] Brately's et al observation about the need to deal with change in the law was made in reference to rule -based systems. One of the claimed attractions of case-based reasoning is its ability to accommodate change simply through the addition of new cases.

[321] Bratley Paul, Fremont Jacques, Mackaay Ejan and Poulin Daniel, 'Coping with change' p.69, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press.

[322] Berman and Hafner 'Representing Teleological Structure', above 278, 57.

[323] Berman Donald H. and Hafner Carole D., 'Incorporating Procedural Context into a Model of Case-Based Legal Reasoning' p.12, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press hereafter 'Incorporating Procedural Context'.

[324] Bratley et al, above n 321.

[325] Berman Donald H., 'Developer's Choice in the Legal Domain: The Sisyphean Journey with CBR or Down Hill with Rules' p.307, in The Third International Conference on Artificial Intelligence and Law: Proceedings of the Conference (1991) ACM Press, 307-8.

[326] Berman and Hafner 'Incorporating Procedural Context', above n 323.

Berman's criticisms have been discussed by Hunter.[327] While each of the criticisms raised by commentators is important, it is argued that the two greatest difficulties facing attempts to simulate legal analogising stem from difficulties simulating the processes by which analogies are created and the processes by which analogies are justified.

Limitations related to the creation of analogies and limitations related to the justification of analogies are the two largest problems confronting simulations of legal analogising. A large step towards addressing these limitations requires fully acknowledge the role of legal principles in legal analogising. In this context, Branting has argued for the need to model the role of 'purposes and policies and social justice in case matching'.[328] According to Branting a

> preliminary step towards incorporating purposes, policies, and principles into
>
> precedent-based reasoning was taken by Berman and Hafner, who showed ...
>
> how to associate purposes with dimensions in a manner that permits much
>
> more idiomatic and persuasive legal arguments.[329]

However, as argued above, Berman and Hafner's proposals do not address central issues in the role of purposes in legal analogising. Simulating the influence of legal principles on legal analogising must account for the influence of legal principles on the perception of similarity in legal analogising and the change in legal principles themselves that can occur

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[327] Hunter, above n 314, 151-7

[328] Branting L.Karl, 'Four Challenges for a Computational Model of Legal Precedent' (1994) 3 Think hereafter 'Four Challenges'. Branting discusses four specific challenges for computational models of legal reasoning:
- relating case representation to precedent use
- single-precedent and multiple-precedent arguments
- purposes, policies and models of justice in case-matching
- extending the applicability of precedents.

The second challenge Branting raises relates to the dual necessities of being able to reason with portions of precedents and of being able to detect and reason with trends displayed by a group of precedents. Each of these abilities is undoubtedly necessary in any simulations of the uses of precedents in argument. However, a pre-requisite to both of these uses of precedent is the ability to create legally justifiable analogies. Branting's fourth challenge argues for the need to develop models of the ways in which precedents are used in legal tasks that do not involve classification. Branting cites advising, negotiating, planning and document drafting as such tasks. It would be difficult to argue that these tasks do not involve any aspects of legal analogising. Branting has certainly not provided such argument. Thus to the extent that these tasks do involve legal analogising, the ability to simulate legal analogising is necessary. To the extent Branting was suggesting that these tasks do not involve legal analogising, while an interesting issue, how these tasks might be modelled is outside the scope of this examination. While each of these challenges must be addressed in a complete simulation of legal analogising, neither of these challenges addresses the very problem with the simulation of the perception of similarities that occurs when simulating legal analogising. This discussion will thus focus on Branting's first and third challenges.

[329] Ibid citation omitted.

during legal analogising. Berman and Hafner's proposals do not address either of these issues.

There are several issues that must be addressed in simulating the role of legal principle in legal analogising. Amongst other things it is necessary to better understand precisely how legal principles influence the perception of similarity in legal analogising. It is necessary to better understand how principles interact with and influence each other during this perception of similarity. It is necessary to better understand how principles are themselves altered during analogising. Such questions are questions concerning the information and knowledge that lawyers utilise during legal analogising and how that knowledge is utilised during analogising. As discussed in chapter 3 legal theoretical accounts of legal analogising are primarily concerned with discussing the 'rational force' of legal decisions. Legal theoretical accounts of legal reasoning regard issues such as these as uninteresting matters of psychology. Consequently legal theoretical accounts of legal analogising do not provide insight into these questions. Addressing these questions requires the tools and techniques of disciplines such as psychology and cognitive science.

Once it is better understood precisely what is involved in legal analogising, especially the role of legal principles in legal analogising, the simulation of legal analogising can be better addressed. As discussed in chapter 5, a central issue here is how knowledge is to be expressed in computer manipulable form. The legal knowledge necessary for legal analogising must be represented in a form that is manipulable by a computer yet retains the real-world richness and flexibility of that knowledge. Ideally all knowledge would be represented, although as FARG argue it would still be necessary to know what to do with that knowledge.[330] However, as a practicality this is unrealistic - it is too time and labour intensive. Consequently choices must be made as to what knowledge is represented. In this context, interesting wok has recently been performed that investigates the possibility of creating general, universally applicable representations of legal knowledge.[331] However, this work is at an early stage and has not yet investigated the applicability of the proposed approaches to simulating legal analogising.

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[330] Chalmers, French and Hofstadter, above n 183.
[331] See: Valente A., Legal Knowledge Engineering: A modelling approach (1995) IOS Press, Ohmsha; van Kranlingen Robert W., Frame-Based Conceptual Models of Statute Law (1995) Kluwer Law International; Visser, above n 207. The First International Conference on Legal Ontologies is the be held in July in Melbourne, Australia.

The inability to fully represent knowledge and the consequent need to choose what aspects of knowledge are represented inevitably restricts the reasoning abilities of any system using that knowledge. Hence there is a compromise. Deciding what knowledge to represent will depend in part on the use to be made of the system that is based upon that knowledge. As Branting states, the representation of precedents must be related to the use of those precedents.[332] This means that for any system that simulates legal analogising, assessing the feasibility of the system requires careful assessment of the goals underlying the creation of the system.

Simulations of legal analogising are limited to determining comparatively straightforward matches between situations. Simulations of legal analogising are not capable of simulating the more creative aspects of legal analogising. This imposes two criteria for the assessment of systems that simulate legal analogising:

1. the proposed use of the system must be restricted to acting as a sophisticated *aide memoir* to the user of the system

2. the system must operate in a comparatively settled area of law.

Systems cannot simulate the less obvious and more creative aspects of legal analogising. Hence their applicability is inherently restricted essentially to reminding a user of possible analogies and possible lines of argument. That systems cannot simulate the more creative aspects of analogising means that their use should be restricted to areas of law that do not routinely require such creative analogising. These two criteria should inform the creation of practical systems that simulate legal analogising.

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[332] Branting 'Four Challenges', above n 328.

The above examination of simulations of legal analogising also results in three guidelines for researchers in artificial intelligence and law to follow when attempting to improve the simulation of legal analogising:

1. researchers must fully acknowledge the role of legal principles in legal analogising

2. simulations of legal analogising must accommodate the influence of legal principles in the finding of similarity and the creation of analogies

3. simulations of legal analogising must accommodate the role of analogising in shaping and demarcating the scope of legal principles

7.4   Conclusion

In this chapter limitations of simulations of legal analogising were discussed in depth. It was argued that a key step in resolving limitations in these simulations requires the incorporation of an ability to reason with legal principles. Even the most sophisticated existing attempts to simulate legal analogising are only able to perform straightforward forms of matching. These systems are unable to simulate the more creative aspects of legal analogising. To create simulations of the more creative aspects of legal analogising researchers in artificial intelligence and law must fully address the importance of legal principles in legal analogising. The current inability to represent the full richness and flexibility of human knowledge in a computer manipulable form also restricts the scope of legal analogising that can be simulated. Simulating analogising is restricted to the less creative of analogies. Consequently designers of systems that simulate legal analogising must be clear about the goals a system is being designed to serve to ensure these goals are realistically achievable.

Attempts to simulate legal analogising are also important for understanding legal analogising itself. Legal theoretical accounts of legal analogising leave many unresolved questions. Attempts to simulate legal analogising help illuminate these questions. This is discussed in more detail in the following chapter.

8   Jurisprudence and simulating legal analogical reasoning

The field of artificial intelligence and law plays a symbiotic role with the study of legal reasoning. While theories of legal reasoning should be used to inform to simulate legal reasoning, attempts to simulate legal reasoning themselves inform on theories of legal reasoning. According to Hanneman computers and computer simulation are valuable tools which aid theorising in three general ways:

- to test existing theory,
- to make predictions, and
- to propose new theory.[333]

These benefits of computer simulation are echoed in the context of investigations of legal theory.[334] In these ways attempts to simulate legal analogising provide insight into theoretical accounts of legal analogising themselves.

In previous chapters it was argued that attempts to simulate legal analogising fail to account for two important aspects of legal analogising. Simulations of legal analogising fail to account for the importance of legal principles in legal analogising and the importance of legal analogising in shaping legal principles. Simulations of legal analogising ignore the interaction between processes of creation and processes of justification in legal analogising. Attempts to simulate legal analogical reasoning however, provide insight into the processes of legal analogising themselves. These insights have implications for legal theoretical accounts of legal analogising. In this chapter it is argued that addressing the failure of legal theory to explain the interaction that occurs between processes of creation and processes of justification in legal analogising requires a reconception of the content of those theories.

8.1   Constructing analogies and legal theory

As discussed in chapter 3, a common distinction drawn by jurists in theories of legal reasoning is between processes of creation and processes of justification. Theories of legal reasoning are almost exclusively concerned with providing 'rational

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[333] Hanneman Robert A., Computer Assisted Theory Building (1988) Sage Publications, 85

[334] Nagel Stuart S., The Legal Process: Modelling the System (1977) Sage Publications, 9-19; Evan William M., Social Structure and Law: Theoretical and Empirical Perspectives (1990) Sage Publications, 230.

reconstructions' of the formal processes by which legal results are justified. The processes by which legal results are created are regarded as unimportant matters of psychology.

However, as examined in chapter 4, processes of creation and the processes of justification cannot be completely separated in legal analogising. Processes of justification affect processes of creation and processes of creation affect processes of justification. The legal principles that a reasoner adheres to influences the analogies that the reasoner constructs. Different reasoners, adhering to different principles or different conceptions of principles, can perceive different analogies when presented with the same 'facts'. However, legal principles are also refined and compromised as they are applied. A reasoner's conception of principles is influenced by the application of those principles in concrete situations, the conception of principles changes as they are applied. Justifications ultimately rest on considerations of principle. Hence with a different conception of principles, a different justification will be required. However, if the justification that is offered for a decision depends on analogies that are perceived and the perception of a situation depends on the principles that are adhered to, then the separation between processes of justification and processes of creation is undermined. In legal analogising processes of justification and processes of creation interact. This interaction requires a revised conception of legal analogising.

A revised conception of legal analogising has several consequences. First, it becomes strikingly apparent that theories of legal analogising that focus solely on describing how decisions are justified are deficient. Providing a rational reconstruction for an analogy is insufficient to explain how decisions are justified. A rational reconstruction focuses on an analysis of the process of justification 'after the fact', that is, after an analogy has been created and justified. However, this does not explain how particular justifications themselves arise. Why is one justification provided for a decision rather than another justification? If outcomes in law were rigidly determined, if there were only one right answer to legal controversies, then the answer to this question would be straightforward. While it has been argued that there are single right answers to individual problems, it is conceded that these right answers are only attainable by the hypothetical Herculean

judge.[335] Attaining right answers, or at least proving they have been attained, is beyond the power of human reasoning. Consequently, in the realm of human reasoning the question remains as to how and why one justification is chosen in preference to another. As discussed in chapter 3, while justification is a topic much examined in legal theory, legal theoretical examinations of justification focus on the formal reasons offered for decisions. However, if all legal results cannot be proved 'right' or 'wrong' it becomes more interesting and more important to know why particular justifications are offered for particular decisions. This examination of legal analogy does not attempt to completely explain why particular justifications are offered for particular legal analogies. However, this examination argues that in seeking to understand why particular justifications are offered account must be taken of the processes by which analogies are created.

Once it is realised that processes of creation affect processes of justification, and hence that processes of justification cannot be studied in isolation, a theory of creation becomes more interesting and more important. In focusing on providing rational reconstructions for analogies, theories of legal analogising leave totally unexplored the processes by which analogies are created. The interaction between processes of creation and processes of justification however, undermines the privileged place given to examinations of the processes of justification. Once the influence of creation is seen more clearly, the importance and possibility of a 'logic of creation' becomes more possible, more interesting and more important.[336] For this reason, the value of descriptive theory that simply provides a rational reconstruction for analogies is questionable.

Secondly, the value of normative theories of legal reasoning that ignore human cognitive processes and the limitations that these might impose on us must be questioned. To the extent that normative theory seeks to advocate what people should actually do, to the extent that such theory aims to provide guidance to those actually dealing with the law, then it must be based on what is cognitively possible. An examination of analogy and the development of a complete theory of legal analogising calls into question the value of some normative theories of legal reasoning. For example, McCormac has argued that legal reasoning should follow a deductive pattern.[337] Cognitive theories of reasoning

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[335] See the discussion of Dworkin: chapter 3.

[336] Golding has argued that it is possible and valuable to investigate a 'logic of creation' in law: Golding 'A Note', above n 23.

[337] McCormac John W., 'Reason Comes Before Decision' (1994) 55 Ohio State Law Journal 161.

however strongly suggest that reasoning is not purely deductive. According to cognitive scientists human perception fundamentally relies on processes akin to analogising. Since thinking and perception are not purely deductive, and cannot be purely deductive, legal theory that ignores this cognitive aspect of human reasoning and requires legal reasoning to be purely deductive is of questionable value. It might be argued that while the deductive model of reasoning is unobtainable it is nevertheless something to strive for. One response would be to question why is it something to strive for. What is the benefit of trying to force reasoning into an artificial mould? It is counter-intuitive to think artificially constraining reasoning will in some way lead to better reasoning than would acknowledging the role of analogy in legal reasoning and then with such an acknowledgement developing criteria for 'good' and 'bad', 'acceptable' and 'unacceptable' legal reasoning. In any case, arguing that reasoning thus constrained will lead to 'better' outcomes is something that its proponents must demonstrate rather than simply assert. Dworkin is one theorist who has cautioned against rejecting a theory of adjudication on the ground that it is not humanly applicable.[338] However, Dworkin's caution is based on a minimal argument of one paragraph, refuting two straw-arguments against his own theory of the Herculean decision.[339] Dworkin fails to provide any substantial argument why acknowledging human limitations and developing theories of adjudication which account for these is inferior to an impossible to attain theory of perfect judgement. To the extent that normative accounts of legal analogising and legal reasoning ignore cognitive processes and the limitations these impose, these accounts are of questionable value.

In other ways, a revised conception of legal analogising requires a revised conception of legal reasoning generally. This occurs in two ways which can be labelled the 'weak' and the 'strong'. According to the weak conception, theories of legal reasoning require revision because they do not fully account for the processes of analogising themselves nor the role of analogising in legal reasoning more widely. As argued above, theories of legal analogising focus on only a very small conception of legal analogising - namely the *ex post facto* provision of rational reconstructions for legal analogies. However this leaves unexplained many aspects of the process of justification themselves. Explaining these aspects of justification requires investigating the processes by which analogies are

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[338] Dworkin, above n 46, 129-30.
[339] Ibid 130.

created. Ultimately, theories of legal analogising must adopt an altered conception of the processes of reasoning in which the processes of creation and justification are seen as intertwined. This requires investigating the processes by which analogies are created.

However, once the distinction between processes of creation and justification is undermined in analogical reasoning, this implicitly undermines the value of the distinction in theories of legal reasoning more generally. Theories of legal reasoning have to at least account for the interaction that occurs between creation and justification in legal analogical reasoning. This requires some modification to the distinction in theories of legal reasoning. It may be the case that the modification required is minimal. Perhaps it could be argued that while processes of creation and process of justification interact in legal analogising, they do not do so in other aspects of legal reasoning. However, the ubiquity of analogical reasoning in human reasoning suggests otherwise.

According to cognitive scientists analogical reasoning plays an extremely wide role in human reasoning. These cognitive models highlight how the knowledge that we reason with is interpreted, through analogy, as we reason. It is not a simply case of having static unchanging knowledge, which is then reasoned with. Rather knowledge itself evolves as it is reasoned with. This view of reasoning is perhaps best expressed and explored by Hofstadter and his colleagues. According to Hofstadter, when we reason about concepts the content we give to those concepts is determined by the analogies we draw between those concepts and other concepts. The very content of concepts is determined during analogising. The role of analogising thus changes from being a tool applied to knowledge to a fundamental and indispensable tool for the construction and use of that knowledge. This view of the ubiquity of analogising in human thinking argues for a revised view of the place of analogical reasoning in legal reasoning. According to this revised view the use of analogical reasoning is not limited simply to the creation of formally offered arguments when no other approach is open but actually occurs every time legal categories are constructed and applied.

The ubiquity of analogical reasoning in human reasoning also impliedly undermines the place given to legal analogising within a framework of legal reasoning. It is sometimes argued that legal reasoning is a technique resorted to only as a last resort - once the rules have run out. However, work by psychologists and cognitive scientists suggests that

analogising cannot be restricted solely to filling gaps. Such a view of the ubiquity of analogising in perception and reasoning requires an altered theory of legal reasoning - a theory in which analogising is moved from the periphery and regarded as central to legal reasoning. However, reconceiving the place of analogical reasoning within legal reasoning implies that the degree of reconception in the distinction between processes of creation and processes of justification in theories of legal reasoning is not minimal.

In contrast to the above outlined weak form of reconception of theories of legal reasoning, a 'strong' form of reconception can be envisaged. Such a strong reconception would argue that the arguments that apply to undermine the distinction between process of creation and processes of justification in theories of legal analogising apply, with modification, to undermine the distinction between processes of creation and processes of justification in theories of legal reasoning more generally. Such a reconception would argue that just as processes of creation interact with processes of justification in legal analogising, processes of creation interact with processes of justification in legal reasoning more widely. Such an argument thereby questions the privileged place currently given to theories of legal justification in theories of legal reasoning generally. Providing an argument for such a re-conception is well beyond the scope of this discussion. However, it is hoped that the value of such an examination has been demonstrated.

With a new conception of the processes of legal analogising, and to an extent of legal reasoning more generally, a new conception of various legal concepts is required. For instance, 'objectivity' is valued in legal reasoning. The relation between objectivity and law is a topic that is too wide to enter into here. However, two observations can be made. One argument by which law is argued to be objective is that the process of justification is argued to be objective. However, the process of justification is affected by the values a reasoner adheres to. Any notion of objectivity must take this into account. If law is to be regarded as objective it thus cannot be founded on a linear separation of an separation between processes of creation and justification. Once the process of justification is demonstrated to be influenced by the process of creation, the link between justification, justifiability and objectivity requires reconception. Secondly, in noting that multiple analogies and multiple justifications are possible, is not to suggest that any analogy and any justification is possible. That processes of creation interact with

processes of justification is not to suggest that legal reasoning is totally unconstrained. Reports by judges of judging indicate the constraints that the requirement of justification imposes. Further, there are likely to be psychological constraints on analogising. What we perceive and classify together do not range unconstrained.[340] This would provide an area for fertile empirical testing. To the extent that people do not, and cannot consciously make themselves, perceive situations as analogous, the claim of unrestrained subjectivity would be undermined. Such investigations would allow a more solid conception of what objectivity involves and perhaps a form of quantification of the concept. With a better understanding of the actual cognitive processes that occur in legal analogising we can make more informed and intelligent comment on and analysis of what judges and lawyers do. Cognitive insights into how thinking and analogising actually occur will force reconsideration of what it means to think 'rationally', what it means for the law to be 'objective', what it means to 'apply the law', to 'think like a lawyer', to 'uphold the law', and what 'good' and 'bad' reasoning might involve.

This discussion has highlighted why theories of legal analogising are currently deficient and why a detailed examination of the processes of creation of analogies is interesting and valuable. In this respect, theories of analogising developed in artificial intelligence do not provide a comprehensive answer. Such theories do not provide a comprehensive theory as to when situations will be regarded as similar and why they will be regarded as similar. However, in testing and examining the processes by which people actually decide, they provide insight into these processes. These insights are important for theories of legal analogising and for theories of legal reasoning.

8.2 Conclusion

Legal theoretical accounts of legal analogising are insufficient in that they leave mysterious what is involved in the key step in analogising - the finding of similarity or difference between situations. This is a result of the accepted distinction between creation and justification. However this distinction is not absolute. Examining how the finding of similarity occurs will inform about legal reasoning in general and legal analogising in particular. Central to such an examination is an understanding of the cognitive processes involved in reasoning and analogical reasoning in particular.

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[340] For discussion of psychological data suggesting constraints on analogising, see the collections of works cited above n 8.

9   Conclusion

In an article entitled 'The potential of artificial intelligence to help solve the crisis in our legal system' Berman and Hafner optimistically argued that the application of artificial intelligence in law would release the strain experienced by legal services.[341] This is a theme recently returned to by Susskind who argues that the application of computer technology in law will help tackle fundamental problems in the legal system.[342] More radically, Susskind argues that this application of technology will result in an underlying change in the model by which legal services are delivered. However, there are many obstacles before such changes can be realised. As Susskind argues, significant advances are required in legal knowledge processing techniques before artificial intelligence can be widely applied in law.

This research has investigated ways of improving legal knowledge processing techniques. An examination of legal reasoning highlights the importance of analogical reasoning in legal reasoning. In common law countries, the law develops on a case by case basis - lawyers refer to precedents when confronted with novel problems and it is a fundamental principle of justice that 'like case be decided alike.'. This necessarily involves analogical reasoning. Thus any attempt to simulate the tasks that lawyers perform must simulate the processes of legal analogising that lawyers engage in.

Much research has been conducted in the field of artificial intelligence and law on simulating legal analogising. Numerous programs have been created that attempt to simulate the processes involved when lawyers reason analogically. In these attempts to simulate legal analogising, researchers in artificial intelligence and law have drawn from numerous techniques in artificial intelligence. However, all these techniques, and all attempts to simulate legal analogising fall far short of simulating all that is involved in human legal analogising.

Using theoretical accounts of legal reasoning as a basis, this research investigated the processes involved in legal analogising. Despite themselves leaving various questions

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[341] Berman Donald H. and Hafner Carole D., 'The potential of artificial intelligence to help solve the crisis in our legal system' (1989) 32 Communications of the ACM 928.
[342] Susskind ' The Future of Law', above n 1.

surrounding legal analogising unexplored, legal theoretical accounts of legal analogising emphasise the importance of legal principles in legal analogising. Legal principles influence the way situations are perceived and the way analogies are constructed. However, research on simulating legal analogising undertaken in artificial intelligence and law almost completely ignores the importance of legal principles in legal analogising. Consequently, attempts to simulate legal analogising provide a shallow simulacrum of human analogising. Attempts to simulate legal analogising are unable to simulate anything other than the straightforward finding of predefined matches between situations. This is a far cry from the creative analysis that lawyers engage in during legal analogical reasoning. Attempts to simulate legal analogising also face difficult issues about how to represent knowledge in computers. These issues must be addressed before simulations of legal analogical reasoning can be improved. Until the role of legal principles in legal analogising is fully acknowledged and until knowledge representation strategies and guidelines are improved, the kind of legal analogising that can be simulated will remain limited.

An examination of attempts to simulate legal analogising also informs about legal theory. Legal theoretical accounts of legal analogising almost exclusively focus on one narrow aspect of legal analogising - the rational reconstruction of legal analogies. This leaves numerous aspects of legal analogical reasoning unexplored. Legal theorists justify the focus on rational reconstruction by reference to the distinction between process of creation and process of justification. However, examinations of legal analogising show that during legal analogising, processes of creation and process of justification interact. Hence the exclusive focus on processes of justification in theories of legal analogising cannot itself be justified. To understand how analogies are justified it is necessary to understand the processes by which analogies are created. However, while the detailed examination of legal theory required by attempts to simulate legal analogising highlight deficiencies in legal theory itself, attempts to simulate legal analogising do not provide a complete answer to these deficiencies..

Until our understanding of ourselves and of our own thought processes improves, attempts to simulate legal analogical reasoning will be limited. This in turn limits our ability to create computer systems that engage in legal knowledge processing. The time may have arrived for a cognitive theory of law.

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