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Modelling discretion in the Split Up system

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Executive Summary
There are many decision support systems to aid decision making in structured domains. Such domains are characterised by involving repetitive and routine tasks. They involve definite procedures for supporting decision making. Far fewer tools are available for reasoning in discretionary domains. Nevertheless, most management decision making is indeed unstructured — the decision maker must provide judgement, evaluation and insights into the problem definition. In this paper we focus upon decision making in a discretionary domain — namely how Australian judges distribute marital property upon divorce. Our system, Split Up provides such advice. The system has been developed in the object oriented expert system tool knowledgePro.

We commence by considering the nature of judicial discretion. We describe how we have developed a methodology for measuring the degree of discretion judicial decision makers are given. The important features in determining the amount of discretion in a legal domain are the number and nature of open textured and bounded predicates.

The task of determining what property a Family Court judge may distribute is determined to be narrow and bounded. A rule—based system (using directed graphs) has been developed to perform this task.

The task of deciding what percentage of the Common Pool the husband is to receive is deemed to be wide and bounded. A hybrid rule-based/neural network provides advice in this domain.

Neural networks provide no explanation for their answers. Critical legal theorists claim judges reach their decisions based on their value systems. In their written judgement, they provide a rationalisation to support the decision(s) they have made. In a similar manner our system provides a rationalisation for the conclusion reached using. The explanation is reached through using the argumentation theory of Toulmin (1958).

To show that our knowledge discovery techniques are applicable in practice, we have provided an in depth evaluation of the Split Up system.

1. The nature of discretion

Stranieri, Zeleznikow, Gawler and Lewis (1997) concluded that the important features for modelling legal domains are the extent to which a task is both open textured and bounded. Open textured legal

predicates contain questions that cannot be structured in the form of production rules[1] or logical propositions and which require some legal knowledge on the part of the user in order to answer. A domain may be said to be bounded if the problem space can be specified in advance, regardless of the final definitional interpretation of the terms in the problem space. A problem space is unbounded if one cannot specify in advance which terms lie within the problem space. We concluded that legal domains could be divided into four quadrants depending upon their degree of boundedness and open texture. Figure 1 illustrates these quadrants.

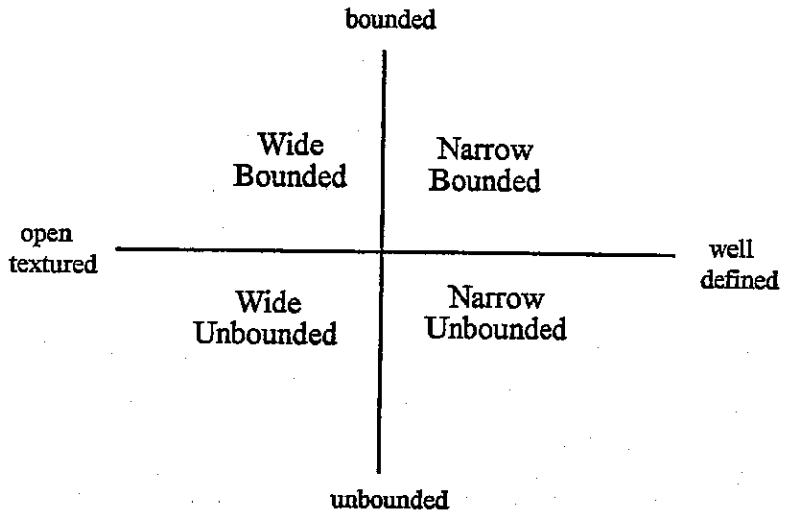

Figure 1. -Quadrants for classifying open texturedness and boundedness of legal domains

The dimension open textured — well defined refers to our belief as to the extent to which a task is open textured. Although every possible extension for an open textured concept cannot be predicted, we believe that it is possible to estimate the extent to which the known extensions represent all possibilities. Practitioners seem to estimate the degree of open texture of a statute in order to offer a prediction. For example the concept of *liability to pay child support* under the Child Support Act (1988)[2] is far less subject to new uses than the concept of *paramount interests of the child*, which is the sole criterion in determining the custody of and access to children.

The bounded — unbounded dimension refers to the extent to which an expert believes that all terms relevant for the performance of a task are explicitly known. Because we are confident about what factors are involved in both common pool determination and the percentage split determination (see later), we claim both tasks are bounded. The task of predicting custody arrangements is quite unbounded since we do not believe all, or even most, factors relevant for this determination are known. Each judge has her/his own set of family values, which cannot be automated. Figure 2 tabulates these family law tasks according to our classification.

The task of creating property orders (following the common pool and percentage split determination) is also unbounded.[3] Few features relevant for this task are known, though judges generally avoid forcing a

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1 A rule based expert system is a collection of rules of the form : IF <condition(s)> THEN <action>.

2 The Child Support Act (1988) specifies the financial liability of a non-custodial parent for his children. The formula is a function of both parents' incomes and the number of children and other dependants both parents have.

3 Although it is not open textured

sale of any asset and they also attempt to minimise the disruption to the everyday life of children. There are no other obvious relevant factors or heuristics. The statute provides no guidance and there have been very few litigated cases which specifically relate to the court order created.

Task	Open textured - Well defined	Bounded - Unbounded	Quadrant
Determining whether an asset is to be placed in the Common Pool	Well defined. Most of the Act comprises definitions of terms used within the Act.	Bounded. No discretionary provisions. Judges follow leading cases	Narrow Bounded
Creating a property order	Some *open textured* terms.	Unbounded. No leading cases. Experts unable to predict a judicial order.	Narrow Unbounded
Determining custody of a child	Many *open textured* terms. Prime one is the paramount interests of the child	The decision maker is allowed a great deal of discretion.	Wide Unbounded
Percentage Split determination	Many *open textured* terms	Quite bounded in that relevant terms can be specified with confidence.	Wide Bounded

Figure 2. - Classification of certain legal domains

Gorry and Scott-Morton (1971) define unstructured decisions as those in which the decision maker must provide judgement, evaluation and insights into the problem definition. Structured decisions are repetitive, routine and involve a definite procedure for handling decision making in such domains. Zeleznikow and Hunter (1994) argue that one can used rule-based systems to model structured domains.

Tasks that fall in the narrow bounded quadrant (top right in figure 1) are well structured and suited to implementation with rule—based reasoning or within a logic programming paradigm. Logic limits its inferences to deduction and cannot represent uncertainty. But these limitations are not restrictive for narrow bounded tasks. A representation of uncertainty is not required here because the terms relevant for a solution are known as is the manner in which these terms combine. The common pool determination in Split Up was thus implemented as a rule—based reasoner.

Tasks that fall in the wide bounded quadrant (top left in figure 1) can be modelled using neural networks, as we shall show later. Unbounded tasks, whether or not they contain open textured terms, cannot be modelled using any existing paradigm, since the relevant factors cannot be determined in advance. Such examples include executing a property order and determining child custody.

We accept that the classification of a task along the bounded — unbounded axis is subjective. Three factors that effect of an expert's perception of the degree of boundedness of a task are:

- Prevalence of discretionary provisions in a statute, These provisions encourage a decision maker to take any factor deemed relevant into account.
- The expert's perception of the broader social and political environment.
- The expert's estimation of the completeness of her/his knowledge.

A classification of a task along the open texture — well defined axis is also subjective. The same task may be classified in different ways, depending upon the expert involved. The classification reflects the expert's beliefs about four factors:

- The extent to which the domain contains ambiguous definitions.

Our laboratory has been approached by two organisations who hoped we could build decision support systems to help them model discretionary decision-making: the Refugee Review Tribunal of Australia and the Family Court of Australia. Both the Refugee Review Tribunal and the Family Court wish to develop some consistency amongst decision-makers whilst not fettering their discretion.

Our work on modelling how members of the Refugee Review Tribunal make decisions regarding the right of a visitor to Australia to be granted permanent residency due to his/her refugee status is only preliminary. However even our early work has helped develop a set of criteria for determining which attributes should be used in making a decision with regard to refugee status.

In November 1991, Graham, J. of the Melbourne registry of the Family Court of Australia asked us to build a knowledge based system to model that part of the Family Law Act (1975) which dealt with the distribution of assets upon the dissolution of a marriage. We were originally reluctant to become involved in such a venture because we felt the Act was too discretionary to be modelled. Indeed, this is true for that part of the Act which deals with the welfare of children. This is because the under section 64(1) (a) *the court must regard the welfare of the child as the paramount consideration.* Neither parliament nor the courts have clearly defined what are the paramount interests of the child, and so we viewed this as an extremely open textured term.

However, we noted that there are established mechanisms for determining the distribution of marital property upon divorce. In this paper, we discuss the development of the Split Up system which offers advice upon the distribution of marital property upon divorce. Our system uses an integrated rule based system/neural network to advise upon how the property is distributed. It then provides arguments as to why the advice is accurate. We next discuss how the system's knowledge was validated. We conclude by considering the limitations of the Split Up system.

2. Decision making in Australian Family Law

Few legal reasoning systems have been developed in discretionary domains. Edwards and Huntley (1992) applied rule—based reasoning to the discretionary domain of Family Law in Scotland and reported some inadequacies of that approach. Following the original request of Graham, J. we first built a rule—based system which advised upon marital property division upon divorce. This was reported by Stranieri and Zeleznikow (1992). Whilst this system gave us reasonably accurate answers, it failed to take into account either legal theory or the notion of discretion.

Our research is based upon the theory of legal realism — that judges make decisions for a range of reasons which cannot be articulated or at least are not apparent on the face of the judgement written. According to legal realists it is meaningless to argue that a judicial decision is made according to any existing rules, rather a decision is more a reflection of the judge's biases. As Zeleznikow and Hunter (1994) note, once the judge has made the decision based on these biases then she will find a legal rule on which to justify the decision, *ex post facto.*

Ingleby (1993) notes that Australian family law allows its judges much discretion in decision making. Until 1990, Family Court judges were not required to give reasons as to why they reached their decision. Despite the requirement for Family Court judges to justify their decision-making, we would argue that the manner in which judges reach their decisions can be quite different from the manner in which they justify them. To model judicial decision making with respect to the division of property under Australian Family Law we needed to discover the relative significance of each of those issues which judges use to distribute marital property.

In determining the distribution of property under the Family Law Act (1975) a judge performs the following functions:

1. She determines the assets of the marriage the Court is empowered to distribute. This task is known as the common pool determination;
2. She determines what percentage of the common pool each party is empowered to receive;

3. She determines a final property order in line with the decisions made in 1 and 2.

The common pool determination task was suited to a rule based reasoning approach although the reasoning process for this task is not explicitly governed by any statute. The elicitation of expert heuristics for a rule based system was initiated using a structured interview technique with a domain expert, Renata Alexander who has over twenty years experience with the Legal Aid Commission of Victoria.[4]

The creation of if-then rules from transcripts of structured interviews proved to be a time consuming and cumbersome process. In order to attempt to accelerate this process, we encouraged the expert to represent her own dialogue with a hypothetical client as a directed graph. In this way, fifty one graphs containing two hundred and thirty nodes were elicited in thirteen, one hour sessions. An example of a directed graph which determines if a vehicle is to be placed in the common pool is given in figure 3.

A method was developed by Stranieri, Massey and Zeleznikow (1994) called sequenced transition networks (STN) that automatically translates a directed graph into an inferencing system obviating the need for rules and decreasing the involvement of knowledge engineers. A sequenced transition network is a representation of paths through a directed graph. Each node in a graph is labelled with a path identifier that represents the path traversed to reach the node. The path identifiers associated with each node are generated by the STN program and can be seen in figure 3. The paths, identified and stored independently from the graph, are traversed efficiently in a forward or backward chaining manner. Explanation is enhanced because sequenced transition networks allow for the use of hypotheticals. Sequenced transition networks use both backward and forward chaining. They support three types of explanations — how, why and why not. Dr. Richard Ingleby, a Melbourne barrister and adjunct professor of law at the University of Melbourne has commented very favourably on our sequenced transition networks and claims the intellectual property involved in them is both significant and valuable.

However, this approach of itself is insufficient when attempting to deal with open texture and discretion. Having completed the common pool determination, the judge then determines what percentage of the common pool each partner is to receive. A rule based approach is inappropriate for constructing this module. The section of the Act dealing with the percentage of the common pool each partner receives is highly discretionary. This is because the Family Law Act (1975) lists a number of factors to be considered for a percentage split determination yet provides no guidance on the relative significance of each factor or on how they are to be combined.

This domain is considered discretionary because of what is described as a 'shopping list' of relevant factors. Different judges may, and do, reach different conclusions based on the same facts, since each judge assigns different relative weights to each factor. Ascertaining knowledge about how a judge weights and combine factors is difficult in that a guessed numerical weighting is unlikely to represent the actual weight of the factor in the context of a large number of interdependent factors.

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4 The Legal Aid Commission of Victoria is a government funded organisation which specialises in legal advice and representation for low income clients.

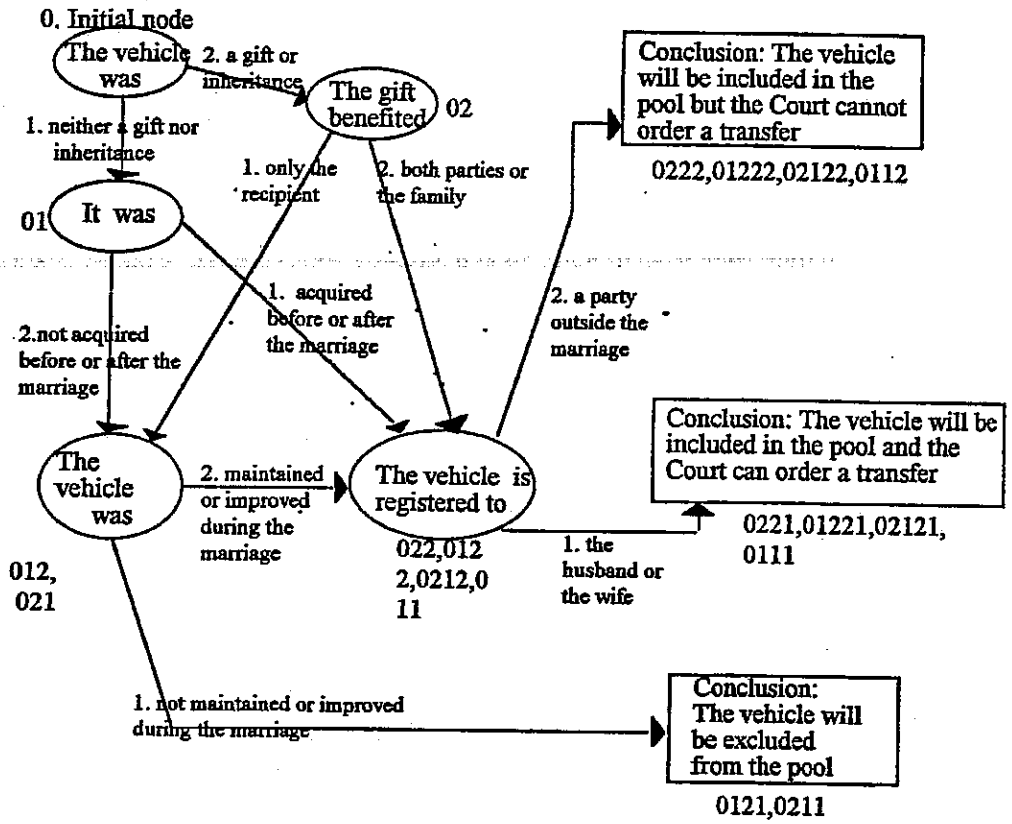

Figure 3. Sequenced Transition Network for Common Pool determination of vehicles

Although the statute presents a flat list of relevant factors without specifying how these factors relate to each other, we believe domain specific knowledge is crucial in specifying relationships between factors. Domain expertise is also critical for the elicitation of the other factors which are relevant but not explicitly mentioned in the statute. Figure 4 illustrates ninety nine factors which domain experts indicated were relevant for a percentage split prediction. These factors are placed in a hierarchy by experts though no attempt was made at this stage to elicit the way in which factors combine. The way some factors combine was later learnt by machine learning algorithms known as neural networks. The way other factors combined was modelled with rules that derived from expert heuristics.

The arguments in figure 4 are inferenced by either rules ('solid line') or neural networks ('broken line'). The choice of inferencing mechanism chosen depended upon the open texturedness and boundedness of the factor. Figure 4 demonstrates that the factors relevant for a percentage split determination (extreme right of figure) are past contributions of a husband relative to those of the wife, the husband's future needs relative to those of the wife and the wealth of the marriage. The factors relevant for a determination of past contributions are the relative direct contributions, relative indirect contributions, the length of the marriage and the relative contributions of both parties to the home-making role.

No attempt is made in figure 4 to represent the way in which relevant factors combine to infer factors higher in the hierarchy.

As will be discussed later, the Split Up system has been heavily tested by judges, judicial registrars, mediators, counsellors, legal aid lawyers and private practitioners expert in the domain of family law. As well as being impressed by the system, most have stressed that the 'hierarchy of relevant factors for percentage split determination' provides an incredible source of knowledge as to how a systematic decision with regard to the distribution of marital property, can be made.

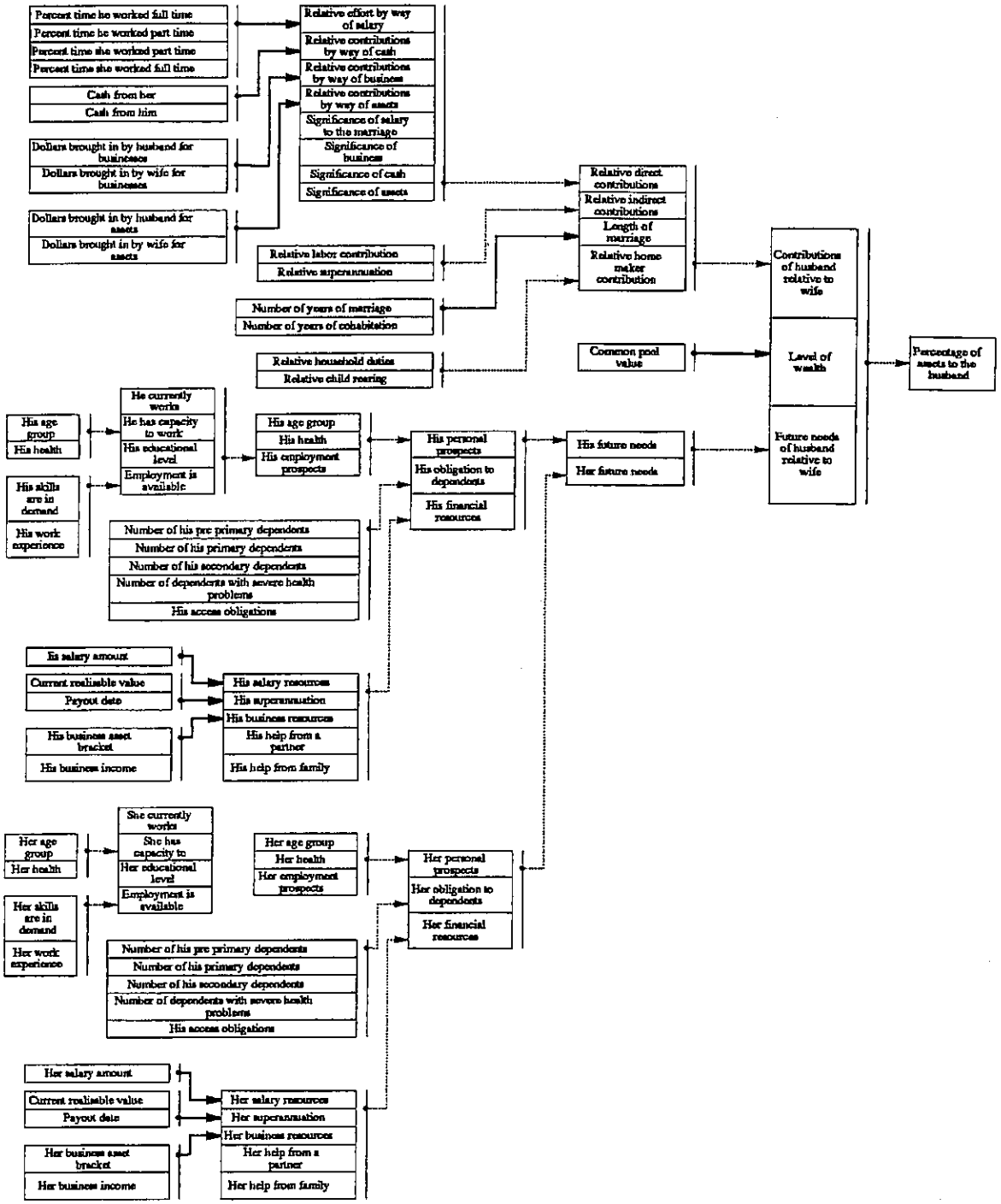

Figure 4. Hierarchy of factors for percentage split determination

3. Using neural networks to model discretionary decision making

A neural network receives its name from the fact that it resembles a nervous system in the brain. It consists of many self-adjusting processing elements cooperating in a densely interconnected network. Each processing element generates a single output signal which is transmitted to the other processing elements. The output signal of a processing element depends on the inputs to the processing element: each input is gated by a weighting factor that determines the amount of influence that the input will have on the output. The strength of the weighting factors is adjusted autonomously by the processing element as data is processed. For our purpose a neural network will be considered as a pattern matching statistical technique for learning the weights of each of the relevant attributes used in the decision making process.

For example, consider the issue as to whether an accused person should be released on bail. Criminologists have determined that the relevant inputs are:

Is the accused facing drug use charges? Is the accused facing sexual abuse charges? and *Is the accused a repeat offender?*

The outputs (possible outcomes) are that the accused is released on low bail, on high bail, or not released prior to the trial. The resulting neural network is given in figure 5.

On each arc there is a statistical weight. Using back propagation we can 'teach' the neural network the necessary patterns to recognise for prediction. Neural networks use statistical reasoning. They are trained by repeatedly exposing them to examples of the problem the network must solve and learning the significance ('weights') of each of the input nodes.

Neural networks determine and represent weights of factors sub-symbolically and thus are well suited to capturing the weighting of factors which predict a judge's performance. They were thus our preferred option for performing knowledge discovery amongst our Australian Family Law cases. A detailed description of how neural networks are used in the Spit—Up project can be found in Zeleznikow and Stranieri (1996).

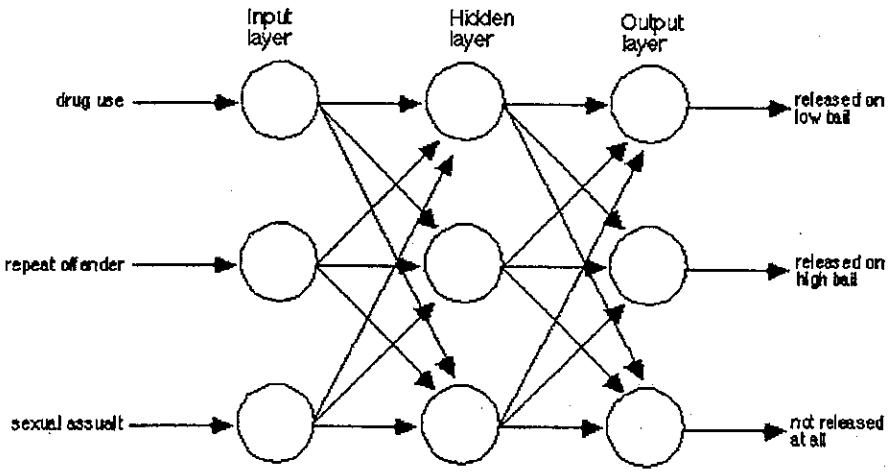

Figure 5. Example of a neural network

Factors specified by the statute as relevant for a percentage split determination can be selected as inputs into a neural network and the output can be the percentage of the assets awarded to the parties. A supervised network was preferred over an unsupervised network as the output, namely the percentage split reported in a judgment, is known in all cases.

A pool of four hundred unreported cases was used as an initial source for the extraction of case facts so that a training set may be assembled. Many of the cases available to us proved to be unsuitable

because they involved a custody decision in addition to a property determination. Data was extracted manually from one hundred and fifty cases that revolved exclusively around a property determination. The extraction of variable values from case judgments was performed by two raters. Inter rater comparisons were performed at random intervals by having both raters extract data on the same case.

The hierarchy of figure 4 can be seen to provide a framework for the decomposition of the task of predicting a percentage split into thirty five sub tasks. Outputs of tasks further down the hierarchy are used as inputs into tasks further along the hierarchy. In Split—Up, outputs in twenty-one tasks were inferred from their respective inputs with the use of neural networks. The remaining task outputs were inferred with the use of rule sets.

Figure 6 illustrates the framework for inferring a percentage split outcome with the use of a neural network. The inputs to the neural network are values on each of the three relevant factors, contributions, future needs and wealth. The neural network's output is the percentage split predicted.

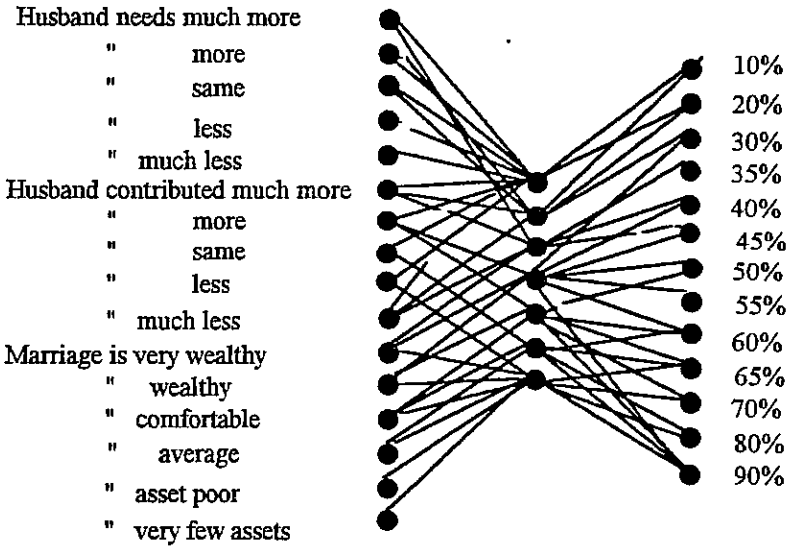

Figure 6 — Neural network for percentage split determination

Three fundamental difficulties are apparent in our approach:

- how to ascertain which features of a case to extract;
- how to glean anything of worth from a small data set;
- how to provide explanations for neural network outputs. In law a basis for the expert outcome is vital — lawyers are hardly likely to accept the output of a knowledge discovery algorithm without further justification.

Our approach to determining a case template was to use domain experts to advise about which factors to include. Thus even though our project involves automated knowledge discovery (learning the weights of certain attributes through the use of neural networks) we made extensive use of domain expertise. By subdividing the task of percentage split determination into a sequence of smaller sub tasks (see figure 4) we managed to construct an intelligent system using one hundred and fifty cases.

4. Providing explanations in the Split Up system

Despite having judicial discretion Australian Family Court judges are required to justify their decisions. We believe that the use of Toulmin argument structures can provide adequate explanations for advice proffered from a knowledge discovery algorithm.

Toulmin (1958) concluded that all arguments consist of four invariants: claim, data, warrant and backing. The assertion of an argument stands as the claim of the argument. Knowing the data and the claim does not necessarily convince one that the claim follows from the data. A mechanism is required to justify the

claim given the data. This justification is known as the warrant. The backing of an argument supports the validity of the warrant. In the legal domain it is typically a reference to a statute or a precedent.

Figure 7 provides an example of two Toulmin argument structures in the Split Up system. The claim of the argument on the left serves as data for the argument on the right.

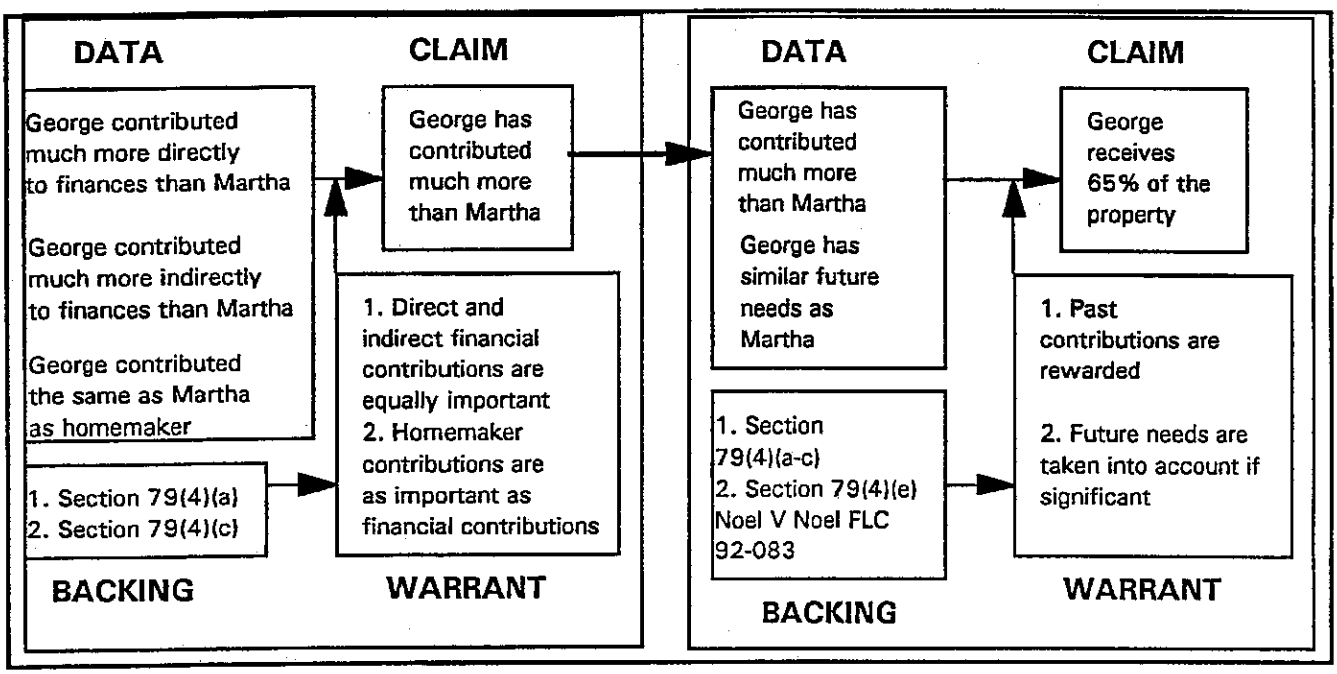

Figure 7 — Two Toulmin arguments in Split—Up

Thirty five arguments were identified in consultation with domain experts for the determination of an appropriate percentage split of the assets of a marriage. In asking our experts to develop each argument structure we are not eliciting heuristics because a claim is inferred from data within an argument structure by a neural network trained with cases and not by domain expert heuristics. However, ascertaining which elements are relevant for each argument was determined by domain experts.

The Toulmin argument structure enabled us to decompose the task of determining a percentage split outcome into thirty five sub-tasks where each sub task represents an argument. Many of these arguments produced claims which were in turn used as data for other arguments. All arguments contribute to a culminating argument— the percentage split illustrated on the right of figure 7.

The claim of each argument is inferred from data values from the same argument. The inference for an argument is performed by feeding data values forward through a neural network associated with that argument. Most neural networks are small because the entire task has been decomposed into smaller sub tasks.

The generation of an explanation commences once a claim has been inferred. The user may question this claim. The data items that were involved in inferring the claim are then presented as an initial explanation. If the user cannot accept the data item value as valid, the argument which produced those items is found and an explanation is generated for it. If the validity of the data items is not in question but the rationale is questioned, the warrant of the argument is produced. This is augmented with the backing if the user is still dissatisfied.

An explanation generated in this way, is independent of the inferencing method used to produce the claim. Thus, an explanation can be generated whether a rule set, or a neural network or any other inferencing method had been used to produce the claim. The explanations are implemented in Split Up

as hypertext links to Toulmin argument components. The percentage split module of Split Up has been implemented using the object oriented knowledge based system development tool, knowledgePro. The hypertext facilities built into knowledgePro allow the warrant and backing based explanations to draw on statutes and past cases. Those arguments which are rule based make use of knowledgeProis forward and backward chaining inferencing facilities Neural network based arguments call on Split—Up's facilities to determine the claim for an argument.

5. Knowledge evaluation in the Split Up system

The approach we have followed in the Split Up project is to have domain experts evaluate the knowledge discovery performance of the system. After each neural network was trained, the domain expert involved in Split—Up's development analysed the output and suggested resultant alterations.

In June 1996, ten family lawyers gathered at the University of Melbourne Law School to analyse the Split Up system. They were asked to analyse the three cases which are listed in the Appendix. The system has also been trialed before judges and judicial registrars of the Melbourne registry of the Family Court of Australia (Monday 9 September 1996), the offices of Harwood Andrews Solicitors (Geelong — Friday September 20) as well as with family lawyers at the Legal Aid Commissions of Victoria and Tasmania and counsellors of both the Family Court and Relationships Australia. The system has also been trialed by the General Public — at Open Days held by the University of Ballarat and La Trobe University and by a large number of callers who have learned about the system through the media.[5]

Given the difficulty in finding a large number of family lawyers to evaluate our system, we did not use any statistical techniques to assess Split—Up's output. However, we are currently conducting further trials on Split—Up's performance. When these tests are completed, we shall conduct a detailed analysis of the system.

All ten lawyers at the University of Melbourne gave the husband in Case B 50% of the Common Pool. This coincided with the determination of the Split Up system. The reasons the lawyers gave for their decisions were also similar to the justifications given by the Split Up system.

In case C, Split Up awarded the husband 40% of the Common Pool. It also suggested that whilst the Family Court could not make any orders with regard to the Porsche owned by the husband's legal practice, it could demand that the value of the Porsche ($100,000) be placed in the pool for later distribution. All ten lawyers suggested the same course of action. With the exception of one lawyer who suggested the husband should receive 50% of the Common Pool, the others suggested Mr. C should receive 35%, 40% or within the range 35-40%. This concurs with Split—Up's reasoning.

The only disagreement within the group and between the group and the Split Up system came in case A. In case A, the Split Up system claimed the husband contributed more financially than the wife, and that they both contributed equally in non-financial terms. It also suggested the wife's resources for the future are much less than the husband. It thus awarded the husband 55% of the large Common Pool. Analysing the lawyers' responses for this case was not easy since they disagreed amongst themselves. One awarded the husband 55-60%, one awarded 55%, one awarded 50-55%, one awarded 45%, two awarded 45-50%, three awarded 40-50% and one awarded 20-25%. Given that we suggest any answer in the range 50-60% is acceptable, then three of the lawyers coincide with our conclusion and another five overlap in an acceptable manner. Two results (45% and 20-25%) are clearly at variance with our system. When we investigated the reasoning of the family lawyers we discovered some interesting factors.

Choosing the correct data and attributes — when using neural networks we need to consult domain experts to choose the correct attributes. In building the Split Up system we then needed to encode free

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5 The system has been discussed on BBC radio, Radio New Zealand, the London Daily Telegraph, A Current Affair, Today/Tonight, most metropolitan newspapers and over twenty metropolitan and regional radio stations.

text judicial decisions into our template. But what occurred in Case A was not something that we envisioned when building the system. Examining their reasoning in Case A it appears that many of the lawyers failed to accept the data in the case as valid. They could not believe that in a marriage of thirty years, where the husband was heavily occupied in his medical practice, the wife would not have contributed much more, in non-financial terms, to the family than did the husband. This allowed them to conclude that the husband and wife contributed equally during the marriage.

When we entered into the Split Up system that the wife contributed much more, in non-financial terms, than did the husband, then the system awarded 45% to the husband. This illustrates the dictum that only humans can make decisions with regard to facts and that humans will disregard information they find inconceivable.

Schlimmer (1987) defines concept drift as the change in concepts over time. The commonplace cases used in Split—Up's training set were decided by judges in 1993. At that time judges were required to assess the contributions of each partner. Since then there may have been a considerable change in judges' attitudes to determining past contributions. There have indeed been calls from politicians to amend the Family Law Act to imply a presumption that both parties to a marriage contributed equally. Further a departure from this presumption would occur only in exceptional circumstances.

Currently judges need to make a determination on each partner's contributions. However, the ten lawyers who considered our hypothetical cases believed that except in very asset rich marriages (of which case A was not an example) the presumption of both parties contributing equally should hold. If the legislation were thus amended, we would need to include a rule to the effect that contributions are to be considered as equal save for exceptional circumstances.

Both the lawyers and the system agreed that in case A the wife had greater future needs than her husband (due to her limited employment opportunities).

Political correctness — lawyers and judges state they believe financial and non-financial contributions should be equally considered when distributing property. But whilst they may utter these politically correct statements our analysis of cases tends to show that in practice judges are more influenced by financial contributions.

It should be noted that most of the cases used in the Split Up training set come from the Southern registry of the Family Court of Australia. This is because data from the other registries was unsuitable for inclusion in our system. However this means that the Split Up system models the thinking of judges in Melbourne, rather than the more conservative outlying states. Feedback from users of the system appears to stress this fact. Thus we need to consider concept drift over both time and location.

6. Conclusion and Future Research

In the Split Up system we have considered modelling judicial decision-making in the domain of Australian Family Law. Family law varies from other legal domains is that in general:

1. There are no winners or losers — in most common law domains one party to a legal dispute wins a case whilst the other loses. In civil matters, under the cost indemnity rule, the loser of a litigated case plays the costs of the winner. Admittedly in child welfare matters, it might be the case that one parent is given sole custody — but save for exceptional circumstances the other parent will be given access and joint guardianship.

   Thus Family Law negotiation and decision making has more in common with management decision making than do most legal domains.

2. There are a vast amount of litigated Family law cases each year — In Australia there are approximately 100,000 divorces each year, of which 5,000 cases are litigated and 1,000 go to

judgement. In most other civil domains[6] the number of litigated cases which go to judgement are less than a score. Thus the use of neural networks to model discretionary decision-making in Australian Family law is at least feasible.

3. Parties to a family law case often need to communicate after the litigation has concluded. Hence the Family Court encourages negotiation rather than litigation.

Fisher and Ury (1981) developed the concept of Principled Negotiation. This concept promotes deciding issues on their merits rather than through a haggling process focussed on what each side says it will and will not do. A major feature of Principled Negotiation is to know your best alternative to a negotiated agreement (BATNA) since the reason you negotiate with someone is to produce better results than would otherwise occur. In Bellucci and Zeleznikow (1996), we indicate how the Split Up system can be used to determine the BATNA for each party to a family law dispute

We have concluded that we can model judicial discretion-making through the use of a hybrid rule-based/neural network system. The major drawback of such a system is however its inability to provide explanations.

Since our research is based upon the theory of legal realism, we use the argumentation theory of Toulmin to provide explanations which are independent of the technique used to provide the original determination.

Problems we are currently addressing include:

Concept drift — how do cases vary over both regions and time
Comparing negotiated and tried cases — we are currently using the Split Up system and negotiated cases supplied to us by Relationships Australia to determine if there is a major difference in outcomes between negotiated and litigated cases.
Building computer tools to support human negotiation.

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6 Australia does not allow plea bargaining in criminal law cases. Hence, in contrast to the United States, many criminal law disputes are litigated. We have been reluctant to model discretion in criminal law, since as with child welfare determinations, it is an unbounded domain — lawyers have great flexibility in the issues which they can raise in court

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8. Appendix — Hypothetical cases used in the evaluation of the Split Up system

The following is the set of hypothetical cases given to ten Australian Family Lawyers who were asked to evaluate the Split Up system.

Marriage A
Couple A have been married 30 years with three independent sons aged 28, 25 and 22. Both ex-partners are 60 years old. Mr. A has worked throughout the marriage being a partner in a pathology practice. He currently earns $250,000 per annum. His wife has not worked during the marriage. Both parties have done little around the house — they have relied on domestic help for maintenance, domestic chores and child care. They own a house worth $800,000, have $500,000 in shares and the husband is the half owner of a medical practice valued at $1,000,000. They each own cars worth $50,000. Both parties are in good health. Neither party brought any significant finances into the marriage.

Marriage B
Couple B have been married 5 years and have no children. Both ex-partners are 30 years old. The husband earns $30,000 per annum whilst the wife earns $25,000 per annum. They both work as school teachers. They own a house worth $100,000 and two cars, each worth $15,000. Neither party brought any significant finances into the marriage. The husband has $10,000 in superannuation entitlements whilst the wife has $8,000 in entitlements. The superannuation assets are not realisable for 30 years. Both parties are in good health.

Marriage C
Couple C have been married for fifteen years and have two sons aged thirteen and eleven. Each partner is 45 years old. The husband is the sole partner in a legal company valued at $250,000. The own a house (worth $400,000) and Mrs C's Volvo car (worth $20,000). The legal practice has a Porsche car (worth $100,000) which is driven solely by Mr. C. Mr C. has superannuation entitlements valued at $200,000 and realisable in 20 years time.

Mr C earns $50,000 per annum whilst Mrs C earns $25,000 per annum working as a secretary. Mrs C has performed most of the domestic work and maintenance of the house. She will have custody of both children. Both parties are in good health. Neither party brought any significant finances into the marriage. Mrs C worked full-time for the first 2 years of the marriage and for the past 6 years. She has no superannuation benefits.