Knowledge Modeling in Law

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User Requirements for Decision Support for Criminal Investigation

- In examining legal evidence we need to be aware of:
- 1) stature of the person providing the evidence;
- 2) the legal domain in which the evidence is presented;
- 3) In criminal law, the severity of the possible evidence.

Software tools for evaluating specialised evidence

- At the Joseph Bell Centre, University of Edinburgh (www.cfslr.ed.ac.uk) we have developed software tools to examine specialised evidence in:
- A) evaluation of eyewitness evidence;
- B) the determination whether a death was a homicide, a suicide or occurred by natural causes.

The vital question in building decision support systems

- When building criminal investigation DSS, we must ask the vital question – who is the intended user and what is her goal.
- Is the goal of the decision support system to:
- support crime prevention,
- crime reduction,
- crime detection or
- the prosecution of criminals?

User needs when building crime support DSS

- We also need to consider

- what is the level of authority of the user,
- how much access to knowledge does the user require and
- is this knowledge being shared with others

User requirements - police

- Police and other intelligence agencies wish to find the culprit(s)
- They do not have a requirement to prove their evidence beyond reasonable doubt
- At the pre-trial investigation stage there is the notion of ‘free proof’ - find the culprits using any means.

User requirements - police

- When requesting a search warrant, police need only a reasonable suspicion (not even proof of 'on the balance of probabilities')
- Police see the law of evidence as 'case law' rather than the laws of 'logic and science'.
- They do not differentiate clearly between the role of logic and the role of human made law.

User requirements - prosecutors

- Prosecutors must prove their case beyond reasonable doubt.
- They must conform to all legal requirements.
- In particular they are constrained by ‘admissibility questions affecting proof’ which occur in the post investigation stage.

User requirements – intelligence agencies

- Intelligence agencies wish to prevent crimes being committed.
- Their legislative authority varies from domain to domain.
- However, the burden of proof placed on them, is generally minimal.
- Investigators have to consider facts in the context of a diverse world where the unexpected happens.

User requirements – journalists

- Newspapers also wish to investigate potential crimes.
- The only limitations faced by their owners, is the possibility that they will be sued for defamation.
- Because of legal differences, the role of newspapers in investigating evidence varies greatly from country to country.

Knowledge Management in Criminal Investigations

- The different actors in the fact investigation process (police, prosecutors, judges, intelligence agencies, media) often have minimal knowledge about how the other actors operate.
- Given the afore-mentioned difficulties in using computers to analyse evidence, we believe the major role of decision support systems should be in the pre-trial process.

Knowledge Management in Criminal Investigations

- The development of knowledge management techniques and decision support systems should lead to best practice by those investigating evidence.
- Before we build such decision support systems, we must be clear how knowledge is managed when investigating fact situations.

Criminal Investigation

- Our goal is to build decision support systems that advise upon criminal investigation.
- Investigators use the legal system as a guide to HOW they should set about investigating events; when, in reality, the law of logic and science has a much more important role to play in pre-trial investigations.
- Case law is important in outlining the activities and ‘things’ investigators can undertake.

Criminal Investigation

- However case law provides very little advice and guidance about what [Wigmore 1913] defines as the ‘ratiocinative psychological processes’ needed to undertake the imaginative and creative discovery of new facts.
- It provides little advice on testing old or accepted facts.

Criminal Investigation

- Law enforcement agencies and intelligence analysts frequently face the problems of identifying possible relationships among a specific group of entities in a criminal network.
- However, such tasks can be fairly time-consuming and labour-intensive without the help of link analysis tools.

FLINTS and Wigmore diagrams

- Richard Leary used the notion of Wigmore diagrams in the developing the FLINTS methodology and software system.
- FLINTS was developed to support the detection of high volume crimes within the West Midlands, through a judicious choice of queries to evidential databases of DNA, fingerprints, footwear and tool-marks.

FLINTS

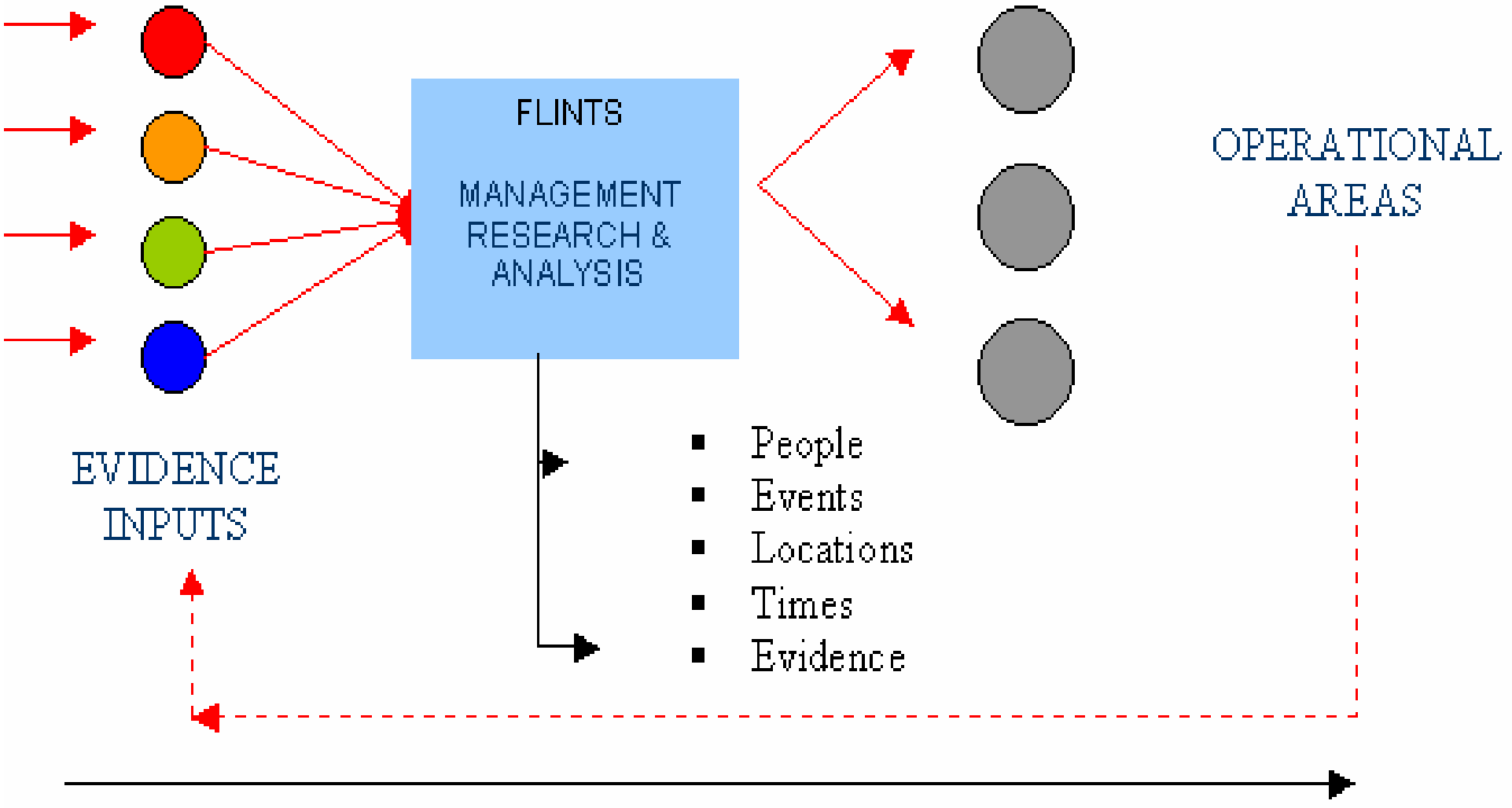
- Analysis of the data reveals patterns, associations and links which would not have been detected had each evidence type been managed in separate systems.
- Through a judicious choice of questions, knowledge about scenarios, links, stories and connections between many types of data and many types of events as well as many people and many locations can be inferred.

FLINTS

- Results are visualized to aid analysts understand the chains of links and then contemplate new searches for new links.
- FLINTS is a decision support system for analysts and investigators that helps them identify relevant information amongst a mass of data.

FLINTS

- FLINTS identifies ‘obvious’ links between people and crimes that are hidden in mixed masses of data.
- We have extended the FLINTS methodology with enhanced data visualisation tools to help crime investigators focus upon relevant data.


FLINTS
MANAGEMENT
RESEARCH &
ANALYSIS
OPERATIONAL
AREAS
EVIDENCE
INPUTS
People
Events
Locations
Times
Evidence
Time

CAST - Criminal Analysis System Techniques

- Many crime detection decision support systems use sophisticated techniques (such as Bayesian networks or data mining) to make decisions about the perpetrators of crime.

- The purpose of the CAST paradigm is to help improve the performance of crime investigators and not replace their critical faculties.

CAST

- The methodology focuses upon identifying links between criminal acts, criminal actors and their locations.
- The resulting software has been tested in various areas of financial fraud, including
- car insurance fraud,
- VAT abuse and
- investment fraud.

CAST

- The CAST modeling of user requirements uses the following abstract model of propositions law and evidence, where the following questions are asked:
- 1.What is the Ultimate Intended Aim (Proposition).
- 2.What is the Substantive Law that will be breached if the Ultimate Intended Aim is breached.

CAST

- 3.What are the acts or omissions that need to be undertaken (or not undertaken) if the Ultimate Intended Aim is to be achieved.
- 4.What acts or omissions are generally seen if the Ultimate Intended Aim is to be achieved.
- 5.What acts or omissions are generally not seen if the Ultimate Intended Aim is to be achieved.

CAST – Investment Advice Example

- The following model was extracted in part from a case of solicitation that occurred within the jurisdiction of the Italian Financial Market regulated by CONSOB.

- Investors were solicited by a WWW Page advertising financial investment services.

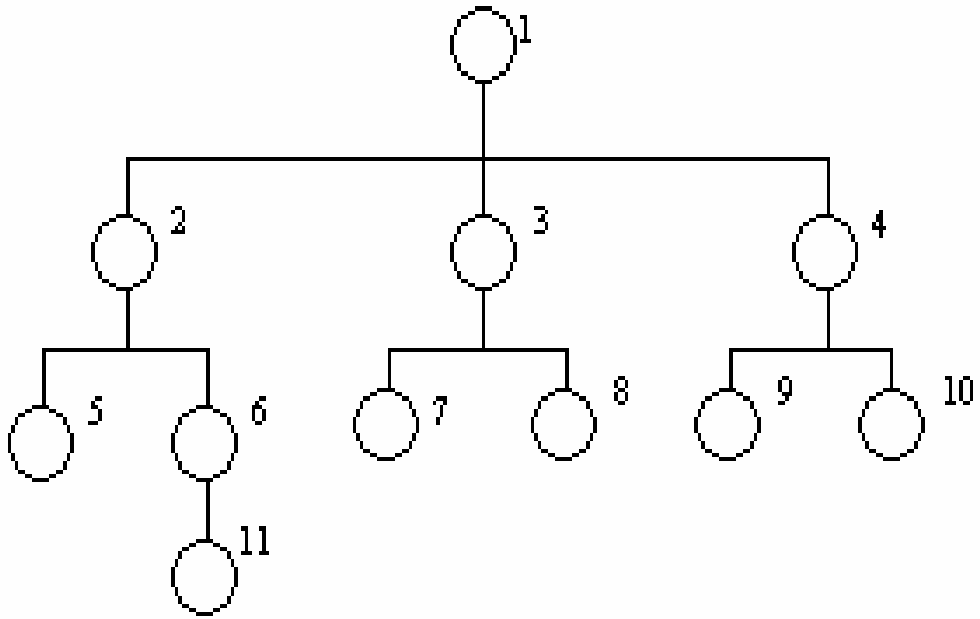
CAST – Investment Advice Example

- The soliciting agent was not licensed to trade as required under EEC 93/6 EEC 0322E and false statements were made on the Web Page.
- The illustration is an abstract model of the fraud.

CAST – Investment Advice Example

- Node 10 is a false statement aggravating the fact that the company, although properly constituted in law in UK, was not licensed to solicit investment services.

- Note that the model is comprised of true claims (signals) as well as false claims.



Key List:

1. Charles Brown Investment Services fraudulently solicited investment services on the WWW.
2. Charles Brown Investment Services is incorporated as an investment broker.
3. Charles Brown Investment Services solicited on WWW for investors to hire the service.
4. Charles Brown is required under 93/6 EEC 9322E to be licensed to solicit financial investment services.
5. Charles Brown Investment Services became incorprated in UK in 1997 as an investment service provider.
6. Charles Brown Investment Services lodged annual accounts between 1997 and 2000.
7. Http//WWW.Charles Brown Investments is a Web Site hosted and managed by Charles Brown Investment Services.
8. Paul Smith of ABC Investigations Inc. was offered investment services by Charles Brown vica E Mail dated August 30
9. At the time of the offer to Paul Smith, August 30 2002, Charles Brown Investment Services was not licensed to trade.
10. At the time of the offer to Paul Smith, August 30th 2002, Charles Brown Investment Services claimed they were licenc

CAST

- In the FF POIROT project (www.ffpoirot.org) we have used the CAST methodology to develop ontologies for
- the abuse of VAT regulations in Europe;
- the illegal dissemination of investment advice on the World Wide Web (together with the Italian stock market regulator CONSOB)

CAST – Insurance Fraud

- In conjunction with legal firms in the North of England (acting on behalf of Insurance Agencies) Advanced Forensics Solutions Limited is using the CAST methodology to detect car insurance fraud.

- Because of the network of links and associations displayed by the CAST software,over ten million pounds of car insurance fraud has been detected.

Modeling Civil Law Domains

- We have modeled a number of civil and criminal law domains:

- Workers Compensation
- Credit Law
- Family Law Property Distribution
- Family Law Negotiation

Modeling Civil Law Domains

- Refugee Law
- Copyright Law
- Eligibility for legal aid
- Sentencing
- Building Industry
- We now consider in some detail modeling property distribution under Australian Family Law

Modeling Family Law Property Distribution

- The Split Up project applies Knowledge Discovery from Databases (KDD) to predict property division decisions made by judges of the Family Court of Australia following a divorce.
- We have noted that:
- KDD is particularly suited to the discovery of knowledge in discretionary domains

Modeling Family Law Property Distribution

- KDD is particularly suited to the discovery of knowledge in discretionary domains.
- The discernment of tasks suited to KDD from those more appropriately suited to other methods relies heavily on the jurisprudential concept of open texture.
- The argumentation theory proposed by Toulmin can be used for the representation of domain knowledge in the data transformation phase.

Modeling Family Law Property Distribution

- In the Split-Up project we wished to model how Australian Family Court judges exercise discretion in distributing marital property following divorce.
- Section 79(1) of the *Family Law Act (1975)* empowers the Family Court to make orders altering the property interests of parties to the marriage but does not lay down procedural guidelines for judicial decision makers.
- In practice, judges of the Family Court follow a five-step process in order to arrive at a property order:

Modeling Family Law Property Distribution

- 1. Ascertain the property of the parties.
- 2. Value all property of both parties.
- 3. Determine which assets will be paramount in property considerations. This is referred to as common pool property.
- 4. Determine a percentage of the property to be awarded to each party.
- 5. Create an order altering property interest to realise the percentage.

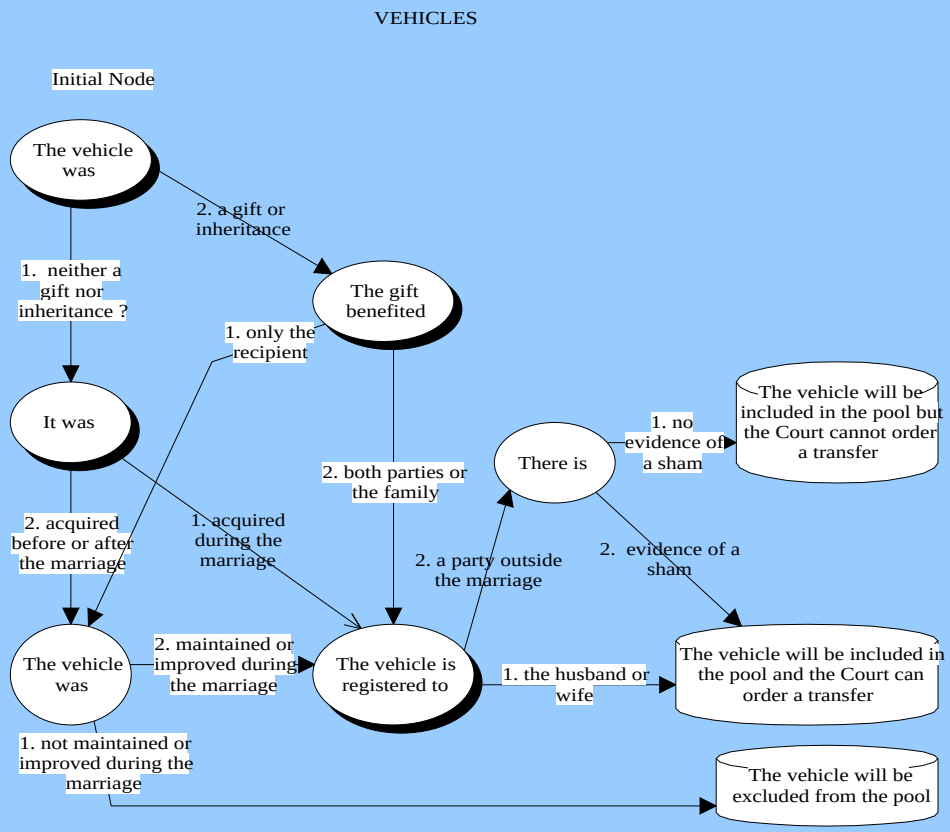
Modeling Family Law Property Distribution

- The Split-Up system implements steps 3 and 4 above, the common pool determination and the prediction of a percentage split.

- According to domain experts, the common pool determination task (Step 3) does not greatly involve the exercise of discretion, in stark contrast to the percentage split task (Step 4).

Modeling Family Law Property Distribution

- Consequently, Split-Up implements the common pool determination by eliciting heuristics as directed graphs from domain experts using a methodology we have called sequenced transition networks.
- The following represents knowledge about whether a vehicle is considered marital property.



Knowledge Modeling in Law

Modeling Family Law Property Distribution

- Domain expertise in family law is represented in the Split-Up system as Toulmin arguments.
- The Toulmin Argument Structure we use facilitates the development of hybrid systems and the generation of explanations.
- Ninety-four variables were identified as relevant for a determination in consultation with experts.
- The way the factors combine was not elicited from experts as rules or complex formulas

Modeling Family Law Property Distribution

- Values on the 94 variables were to be extracted from cases previously decided, so that a neural network could learn to mimic the way in which judges had combined variables.
- Toulmin concluded that all arguments, regardless of the domain, have a structure that consists of six basic invariants: claim, data, modality, rebuttal, warrant and backing.
- Every argument makes an assertion based on some data.

Toulmin Arguments

- The assertion of an argument stands as the claim of the argument.
- Knowing the data and the claim does not necessarily convince us that the claim follows from the data.
- A mechanism is required to act as a justification for the claim.
- This justification is known as the warrant.

Toulmin Arguments

- The backing supports the warrant and in a legal argument is typically a reference to a statute or a precedent case.
- The rebuttal component specifies an exception or condition that obviates the claim.
- The *Family Law Act (1975)* directs a decision maker to take into account the past contributions of each party to a failed marriage in addition to their resources for coping with life into the future.

Split-Up

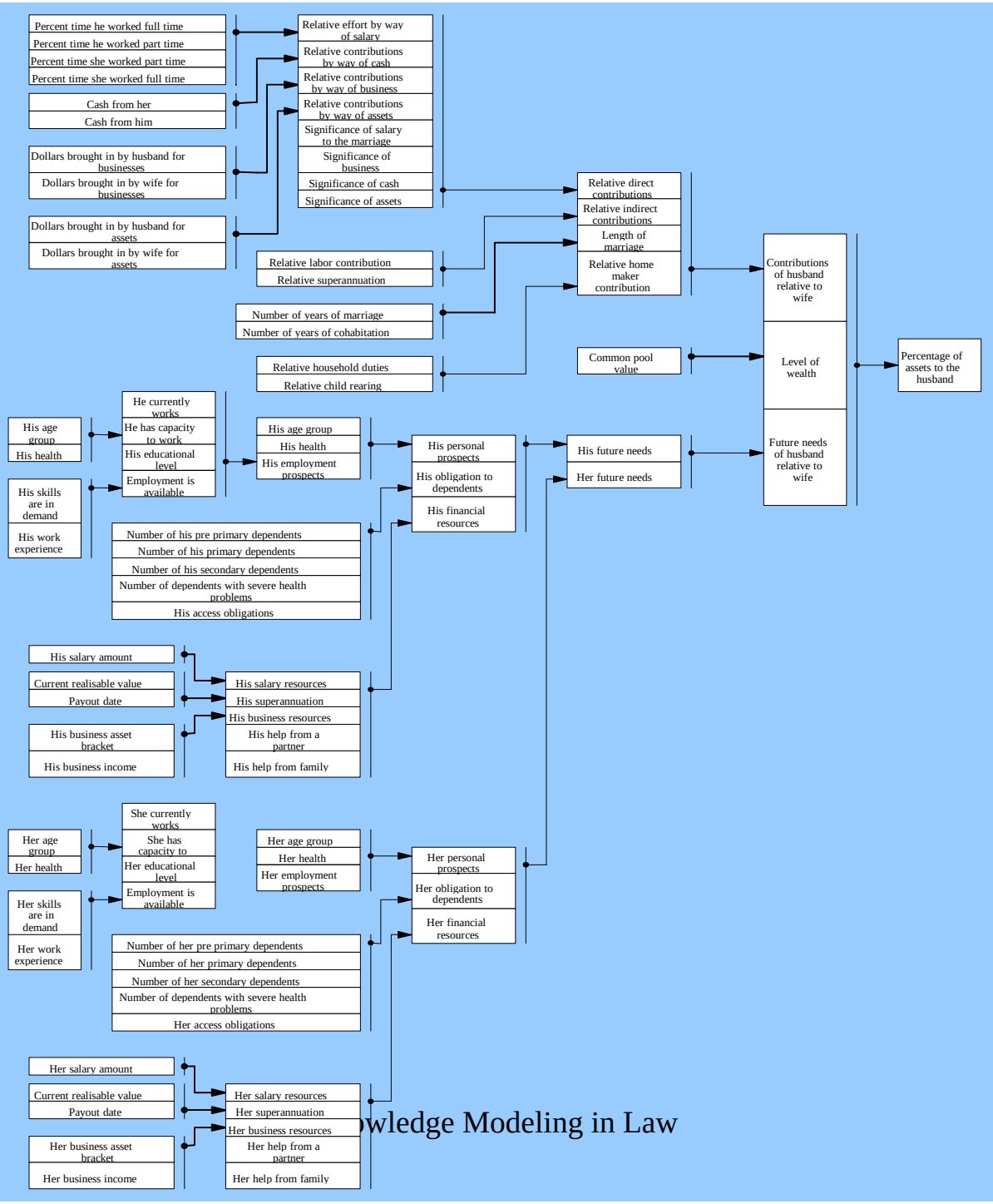
- Rather than offering one definition for *contributions* and one for *needs*, the statute presents a *'shopping list'* of factors to be taken into account in arriving at a property order.
- Although the statute presents a flat list of relevant factors without specifying how these factors relate to each other, we realised that the factors could be placed in a hierarchy.
- The development of the hierarchy required specific knowledge supplied by domain experts.

Split-Up

- A sophisticated hierarchy of ninety-four factors was elicited.
- The hierarchy provides a structure that was used to decompose the task of predicting an outcome into thirty-five sub-tasks.
- Outputs of sub-tasks further down the hierarchy are used as inputs into sub-tasks higher in the hierarchy.

Split-Up

- Solid arcs in the following figure represent inferences performed with the use of rule sets
- Whereas dashed arcs depict inferences performed using neural networks (or indeed any other KDD technique).



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Toulmin Arguments

- The classification scheme has been used to classify tasks in the domain of
- family law (35 arguments),
- refugee law (200 arguments),
- copyright law (50 arguments),
- eligibility for legal aid (8 arguments) and
- the evaluation of eye-witness evidence