Intelligent Negotiation Technology

Pamela N. Gray[1], Xenogene Gray[2], John Zeleznikow[3]

[1]Centre for Research in Complex Systems, Charles Sturt University,
Bathurst, NSW 2795, Australia +61 2 6338 4278 pgray@csu.edu.au
[2]Grays Knowledge Engineering Sydney, Australia +61 4 0501 9832
xen@grayske.com; www.grayske.com
[3]School of Management and Information Systems
Victoria University
Melbourne, VIC 8000 Australia
+61 3 9505 3323
john.zeleznikow@vu.edu.au

Abstract: There have been many decision support systems that provide advice for resolving disputes. However, little effort has been devoted to dispute avoidance. Through the use of the intelligent eGanges shell, this work expands on interest-based negotiation support systems, to develop dispute avoidance ontologies and software for negotiation planning systems. It is suggested that intelligent negotiation technology may add to alternate dispute resolution techniques and further diminish litigation.
An example eGanges application that blends minimax contractual transaction strategy and forward planning of a cohabitation agreement, is used to explain the potential of negotiation planning to avoid commercial and domestic conflict.

Keywords: Dispute Avoidance, Legal Expert Systems, Legal Ontologies, Negotiation Planning, Negotiation Support Systems

1. Background for intelligent negotiation technology

In writing about the Vanishing American Trial, Galanter (2004) argues that, whilst litigation in the United States is increasing, the number of trials decided by US judges has declined drastically**;** litigants are using alternative forms of Dispute Resolution. Galanter claims that in the federal courts, the percentage of civil cases reaching trial has fallen from 11% in 1962 to 1.8% in 2002. In spite of a five-fold increase in case terminations, the absolute number of civil trials was 20% lower in 2002 than it was 40 years earlier. The use of intelligent negotiation technology to prevent legal conflict may further diminish litigation.

Most negotiations in the legal domain are often conducted in the shadow of the Law i.e. bargaining in legal domains mimics the probable outcome of litigation. Mnookin and Kornhauser (1979) introduced the concept of bargaining in the shadow of the trial. By

examining divorce law, they contended that the legal rights of each party could be understood as bargaining chips that can affect settlement outcomes.
The shadow of trial model now dominates the literature on civil settlements. Bibas (2004) argues that the conventional wisdom is that litigants bargain towards settlement in the shadow of expected trial outcomes. In this model, rational parties forecast the expected trial outcome and strike bargains that leave both sides better off by splitting the saved costs of trial.

The provision of intelligent legal decision support requires tools to provide advice about negotiation; the practice of law requires knowledge of negotiation as well as knowledge of law. Because most negotiation in law uses the potential decision of the judiciary as a starting point, it is important to know the potential legal outcome of a dispute. Indeed, Lodder and Zeleznikow (2005), in their development of a model for Online Dispute Resolution, determined the order in which online disputes are best resolved. They suggested the following sequencing:

1. The negotiation support tool should provide feedback on the likely outcome(s) of the dispute if the negotiation were to fail.
2. The tool should attempt to resolve any existing conflicts using dialogue techniques.
3. For those issues not resolved in step two, the tool should employ compensation/trade-off strategies in order to facilitate resolution of the dispute.
4. If the result from step three is not acceptable to the parties, the tool should allow the parties to return to step two and repeat the process recursively until either the dispute is resolved or a stalemate occurs.

If a stalemate occurs, arbitration, conciliation, conferencing (or any other Alternative Dispute Resolution technique), or litigation can be used to reach a resolution on a reduced set of factors. The number of issues in dispute can be narrowed to reduce the costs and time taken to resolve the dispute.

Principled negotiation (Fisher and Ury 1981) promotes deciding issues on their merits rather than through a haggling process focused on what each side says it will and will not do. Amongst the features of principled negotiation is knowing your *BATNA* (*B*est *A*lternative *T*o a *N*egotiated *A*greement). Knowing one's BATNA is important because it influences negotiation power. Parties who are aware of their alternatives will be more confident about trying to negotiate a solution that better serves their interests.

The Lodder-Zeleznikow model of Online Dispute Resolution suggests that the important first step in dispute resolution is the provision of BATNA advice. In this paper, we shall focus upon how an expert System Shell, eGanges, can provide intelligent BATNA advice.

Bellucci and Zeleznikow (2006) and Zeleznikow and Vincent (2007) consider how to provide negotiation decision analysis techniques whilst Lodder and Zeleznikow (2005) examines the issue of argumentation for providing intelligent negotiation decision support. However, as Gray et al (2007) point out, even better than providing negotiation support for dispute resolution is providing negotiation support for planning to avoid disputes.

There has been limited research on how to develop negotiation planning support systems which help avoid conflicts. In the domain of family law, (Bellucci and

Zeleznikow 2006) have focused upon building negotiation support systems to help resolve marital conflict. Zeleznikow (2004) discusses how the Split-Up system of Stranieri et al (1999) can be used to provide advice about BATNAs in Australian Family Law.

Condliffe (2008) argues that some conflicts cannot be resolved at all, and certainly not easily; thus it is all the more important to avoid conflicts. Blum (2007) argues that protracted armed rivalries are often better managed rather than solved, because the act of seeking full settlement can invite endless frustration and danger, whilst missing opportunities for more limited but stabilising agreements. Once again, all the more reason to avoid conflicts arising. Similarly, rather than resolve a family dispute, should we just manage it so that minimal conflict or disruption occurs?

Eventually, the dispute might be more easily resolved or due to the progress of time, the dispute may no longer exist – such as when dependant children become adults; avoidance of these conflicts may improve the quality of family life for its duration. Dispute avoidance ontology may assist conflict avoidance; if disputes can be anticipated, it is more intelligent to avoid them.

2. Negotiation planning and cohabitation agreements

There is minimal research on building decision support systems which help avoid conflicts. The development of pre-nuptial and co-habitation agreements may avoid domestic conflicts; they can help avoid future disputes about financial resources. The considerations which are necessary for the development of a cohabitation plan, should lead to an increased possibility of a successful relationship.

Gray (1973) proposed a modern cohabitation contract that is negotiated between the intending spouses, as a framework for planning to avoid conflicts. Ancient cohabitation contracts dating back to the Babylonian laws of Hammurabi written in stone (c.2081 B.C.), were negotiated between the parents of the intending spouses.

Cohabitation agreements became enforceable in the state of New South Wales, Australia, under the De facto Relationships Act 1984 NSW; they offer an alternative to marriage and the avoidance of the traumas that can arise in bitter disputed divorce settlements. Such contracts do bring benefits to the relationship. They indicate how a couple intend to conduct their relationship and if the partnership eventually dissolves, appropriate dispute resolution mechanisms.

Although negotiation support systems have been extensively researched over the past twenty years, there has been little research on negotiation and conflict ontologies. Tamma et al (2005) discuss ontologies for supporting automated negotiation. They note that interest in automated negotiation in multi-agent systems has been stimulated to a great extent by the vision of software agents negotiating with other software agents to buy and sell goods and services on behalf of their owners in a future Internet-based global marketplace.

Because most negotiations are domain dependent, very little research has been conducted on developing ontologies to support human negotiators. Stolarski et al (2008) consider a practical example of developing negotiation ontologies for risk management in the travel insurance industry. Gray et al (2007) considers an amalgamation of integrative bargaining and negotiation planning, and develops a prototype negotiation support system that helps avoid domestic conflicts. Considerations in the ontology of possible cohabitation conflict may assist formation of pre-nuptial and cohabitation agreements, and lead to an increased likelihood of a successful arrangement, with ease of renegotiation as circumstances change, and ease of termination. With other appropriate potential conflict ontologies, such as in commerce, environmental use, industrial and cultural relations, inter-governmental matters, and war, similar negotiation support systems might be constructed.

The knowledge structures that are useful in negotiation can be derived from relevant conflict ontologies which may have some conjunctions and some disjunctions. eGanges' can represent clearly these sort of knowledge structures and process them through epistemological heuristics.

3. Intelligent negotiation aid

eGanges (Gray and Gray, 2003), an expert system shell, designed primarily for the domains of law, quality control management, and education, is especially helpful where negotiation requires consideration of a great many possible conflicts, and complex combinatorial reasoning in respect thereof. The shell can provide a visualisation for the management of the conflict ontology as a system of knowledge, and automated intelligent processing of that knowledge.

Choices and their consequents are made clear in the visualisation, and can be freely and randomly navigated and selected for processing. Selections can be made and are processed cumulatively, so that the complex reasoning about the ontology of conflict is automated by way of assistance throughout the negotiation process.

Students in law learn what is required for the formation of a contract whereas, for commercial negotiation purposes, it might be prudent to negotiate a contractual transaction by planning the most advantageous bargain but also by having predetermined acceptable compromises for a fallback contract. At the same time the commercial perspective will predetermine when it is best to avoid the formation of a contract. Where domestic agreements are negotiated, the same realities apply: each party may have preferred bargains, fallback compromises and criteria for avoidance.

The eGanges River visualisation of conjunctions and disjunctions clearly express criteria and alternatives, relative to each other. The fine-graining of negotiation ontology in hierarchical tributaries of conjunction and disjunction introduces intelligent refinement to the negotiation.

In an eGanges map, a soccerball node indicates even finer negotiation pathways. For instance, the initial map of an eGanges application to achieve the Final result of a

minimax contractual transaction (Gray and Gray, 2008) is shown in Figure 1, in the Rivers window of the eGanges interface. In the main stream, the first antecedent node is *Minimax conclusion to formation stage*. There are three alternative ways of achieving this antecedent: by *Minimax contract formed*, by *Fallback contract formed*, or by *No contract formed*. The soccerball node *Minimax contract formed* has the submap shown in Figure 2. The soccerball node in Figure 2, *Binding form of negotiation to effect agreement*, also has a submap of further details. This nesting of submaps may be as deep and detailed as the knowledge requires.

Negotiation may require levels of varying ontological depth. The use of theoretical and factual antecedents in negotiation rules may vary within any particular rule or any system of rules; negotiation may be concerned with factual or abstract antecedents, and the factual particularisation of abstract concepts may assist in the negotiation.

The user of an application may freely navigate the eGanges River system, and provide input anywhere in the River system at any time, in whatever order the user chooses. Only the eGanges epistemological processing of the River premises will qualify the effect of random input.

The intelligence features of the eGanges shell make up an epistemology commonly used in the legal domain. There may be other epistemologies also used by lawyers, particularly in the analysis of evidentiary conflicts and gaps. The eGanges epistemology is also suitable for quality control, so that an eGanges application may amount to quality control teaching of law, legal strategy, or a compliance adviser.

The eGanges shell uses intelligent knowledge representation and intelligent processing of that representation through an intelligent communication system. The following are the intelligent features of eGanges that are adopted in an application:

1. Knowledge representation. The largest window in the interface of the eGanges communication system, shown in Figure 7, is the Rivers window, where applications are constructed or consulted. The Rivers window shows a visualisation of a system of interlocking hypothetical premises that may be nested as far as required by the complexity and extent of the knowledge.

The River graphics in the legal domain are the rules of law or expertise used in the application. They are also the negotiation tributaries or pathways in a legal dispute. The interlocking of antecedents and consequents where they are common to separate rules, creates the hierarchical tributary structure of the River.

2. Through its intelligent communication system, eGanges collects input via its question window which shows the question for the current node under consideration and the answer buttons which show 3 alternative answers for each question. The answers are placed on buttons which are labelled according to the Final conclusion they support. Sometimes all possible answers support a positive conclusion to the negotiation; this is why there are a total of five answer buttons, shown in Figure 7, three of which are all positive.

As answers are selected, the label of the node is recoded as the user's categorical premise in the appropriate adversarial feedback window. Thus the communication system is intelligent. It allows for contradictory categorical premises, although the River visualisation does not show the corresponding contradictory hypothetical premise that is applied. A visualisation of additional contradictory and uncertain hypothetical premises requires a three dimensional graphic (Gray, 1990, 1997).

Once the user has provided the answer input as the categorical premises of the user's case, then eGanges will automatically and cumulatively carry out the combinatorics to give effect to the hierarchy of mixed hypothetical and categorical syllogisms of the negotiation ontology. The combinatorics of the syllogisms are deductive, according to the multiple mixed hypothetical and categorical syllogisms. At any point in a consultation, the current result may be displayed in the Current result window, by pressing the Current result button. Sometimes the Current result is the Final result; sometimes it is a *pro tem* result.

Legal expertise uses and requires four valued logic for automation. This is because, in practice, lawyers must provide for uncertainties in the client's categorical premises. In the cumulative processing of a user's case, the programmer must provide for incomplete instructions. If a Current result is to be given at any point in a consultation, then that result may be the fourth value, unanswered.

Combinatoric automation is only valid if there is a finite set of premises; otherwise Godel's theorem invalidates the processing. The fourth value, unanswered closes the boundaries of the premises for automation. The heuristics of eGanges make provision for the expert and programming four value logic, and implement the prioritisation of consequents in accordance with eGanges' four value de Morgan rules.

For instance, in Figure 6, if the answer to *Co-ed* is negative, indicating that one or both of the parties do not agree to send the children to a co-ed school, then "(neg) Co-ed" will appear in the positive window list indicating a negative disjunction; provided the *Same sex* node is either unanswered or positive. If the *Same sex* node is also answered negative, indicating that the parties can not agree to send the children to a same sex school, then as all options to establish *Sex mix* are negative so *Sex mix* will be established as negative; thereby establishing the nodes *School identity*, *Schools* and *Arrangements for both parties' child(ren)* as negative, regardless of any other node's answers. If *No children of both parties'* is also answered negatively, i.e. there are children, then by deductive flow down the river system it will be established that *Parenting partnership specific* will be negative, i.e. the sex mix of the children's school will be a risk of conflict in the cohabitation.

If instead, *Same sex* is answered as uncertain, and *No children of both parties'* is either negative or uncertain, then uncertainty will propagate down to *Parenting partnership specific*. If *Same sex* is answered as uncertain, and *No children of both parties'* is either unanswered or positive, then "(unc) Same sex" will appear in the positive window list along with "(neg) Co-ed" as these problems won't matter until it is established that the parties have children, but the (neg) and (unc) labels indicate they may become a concern.

The *pro tem* reporting of (neg) and (unc) in the positive adversarial window ensures that the alternatives of a disjunction are available until they are exhausted. Following a four value extension of de Morgan's laws, the negation of a positive disjunction is a negative conjunction that will not be satisfied until the positive disjunction is exhausted.

The de Morgan laws, the Godel validation of the combinatorics with unanswered finiteness, and the four-value logic for uncertainty and incomplete instructions, complicate the processing heuristics but extend the intelligence of the negotiation aid. The extended intelligence may provide validation of the negotiation, and ensure its success.

Static eGanges glosses of inductive and abductive negotiation premises, available as data for retrieval at relevant points in the deductive River system, allow a mix in as non-monotonic without being processed as non-necessary reasoning. This may assist agreement and construction of the negotiation River, and selection from the communication system.

Glosses may be used to list pros and cons of a negotiation rule; this may allow acceptance of a compromise rule as negotiation knowledge. They may also introduce ethics to the negotiation process as well as inductive, abductive, and non-monotonic reasoning and issues.

Where the knowledge River has to be agreed by the parties as part of the negotiation process, the construction of the eGanges application precedes its consultation, and may be ongoing. Godel's theorem requires completion of the knowledge before the eGanges combinatoric processing is valid; it may be said that the knowledge must be holistic for the time being. However, potential ontologies may be always emerging as problematic (Gray, 2007).

4. How eganges supports cohabitation agreements

The negotiation between cohabitees of an agreement to minimise the risk of domestic conflict, can be located in the framework of a minimax contractual strategy that is for the avoidance of commercial conflict. Thus, a richer appreciation of the bargaining aspects of the cohabitation agreement can be gained. Some aspects of cohabitation planning are commercial.

This calls for a review of social evolution that might be suited to an international civilisation in the age of science and technology. Negotiations for domestic and commercial agreements could rest on survival needs and wants of the parties, as well as, or rather than, individual attributes such as physical beauty, sexuality, emotional reactions, and social relationships that might be more tenuous.

What negotiation derives from technological aids such as eGanges provides for (1) an overall objective (Final result), sub-goals (Consequents), and targets (Antecedents), (2) the quality control detailing of means to the objective, goals, and targets, including provisions for choices, and (3) the logical processing for consistency in selections. These characteristics of intelligent technology may both support and characterise negotiation.

Figure 3 (Gray et al, 2007) is the Initial map of the Cohabitation application, originally prepared prior to and separately from the Minimax contractual application shown in the

sample maps of Figures 1 and 2. The processing of the River knowledge requires clear specification of its logical characteristics and potential for automation. Each stream in the tributary structure of an eGanges River represents a formalised rule or conditional proposition. Thus, in Figure 3, which is the Initial map of the eGanges cohabitation application, the mainstream signifies the following hypothetical premise: if duration, nomenclature, property, finance, children, chores, personal matters, variation and termination are agreed on, then there will be minimized risk of conflict in cohabitation. The formalisation is: if (antecedent(s)), then (consequent).

Secondary streams arise from antecedents in the mainstream also as rules or conditional propositions; tertiary streams may arise from an antecedent in a secondary stream as rules or conditional propositions, quaternary streams arise as rules or conditional propositions from an antecedent in a tertiary stream, and so on. At some point a sub-map may be required to further the particularisation, due to the limits of screen size and cognitive map design. Thus the ontology is laid down in its hierarchy of specifications. The eGanges application is finite; it is only as accurate as its River knowledge.

In the specification of the eGanges River hierarchy, the rules of the negotiation that are formalised are also the hypothetical premises in a mixed hypothetical and categorical syllogism. The hierarchy of tributaries represents the hierarchy of such syllogisms. In law, unlike science, the truth of the hypothetical premises is presumed. The exercise of law-making power in making rules obviates the need to establish the truth of the hypothetical premise scientifically.

In the processing of an eGanges application, each antecedent must be established by user input as the categorical premise for the syllogism. Each antecedent node has a question with three alternative answers; the selection of an answer provides the user's input, which is then reported as feedback in the appropriate adversarial window. Like the adversarial windows, each answer is labelled as positive, negative or uncertain to indicate the adversarial window in which the answered node label will, prima facie, be reported.

Thus it can be seen in Figure 1 that, in order to manage a contractual transaction so that risks and losses are minimised and gains are maximised, the first requirement is the *minimax conclusion to formation stage*. If a cohabitation agreement conforms to this requirement, it can be assumed that a minimax cohabitation contract provides minimisation of the risk of domestic conflict. The domestic arrangement then rests on compelling commercial soundness. However, with social studies, the commercial framework may be shown not to be sound for domestic agreements.

If the eGanges application limited to the Final result of *Minimised risk of conflict in cohabitation*, separately posed by Gray et al (2007), is to be reconciled with the minimax contract application, then the Final result of Minimax contractual transaction will broaden and subsume the Final result of *Minimised risk of conflict in cohabitation*. In the amalgamation, Figure 1 can serve as the initial map without change. Effectively, the domestic emphasis shifts from pacifying partners to mutual satisfaction by sharing and exchange of benefits and detriments. The commercial framework brings equality to the negotiation; prima facie, the domestic is dominated by the commercial.

The mainstream antecedents in Figure 3 will then be relocated as either *Selection of consideration* or *Selection of terms* in the stream establishing *Minimax preparations for negotiation of contract* in Figure 2. *Property*, *Finance* and *Chores* are known in commercial consideration; children are not. *Children* belong in terms. *Duration*, *Nomenclature*, *Variation* and *Termination* are also matters of terms, similar to *Commercial terms*. *Personal matters*, depending on what they are, may be matters of consideration or matters of terms. Figures 4-6 suggest reconciliations in the amalgamated application, called here, the Commercial and Domestic Minimax Agreement Negotiation (CDMan) application. Figure 6 replaces the *Children* sub-map indicated in Figure 3, with a sub agreement of *Parenting partnership specific*.
The two applications, reconciled as one, may then employ the same AI techniques of processing input on the particularised hypothetical premises of the substantive negotiation.

5. Future research and conclusion

Current research of negotiation systems have focused upon resolving disputes once they have occurred. But it is easier to avoid disputes, rather than satisfactorily resolve them.

Our research has focused upon designing improved negotiation support processes. On this basis, further measures could be developed for legal fairness in interest based negotiation support systems in family mediation, plea bargaining and housing and condominium disputes.
In this article we have explored the need for intelligent negotiation planning to avoid rather than resolve disputes. The eGanges software has been used to assist development of cohabitation agreements that can help avoid conflicts before and following the breakdown of relationships.

Anti-Violence Worker, Shalini Kumari of the Cumberland Women's Health Centre, in Sydney, has undertaken the development of an eGanges River with the Final result, Minimization of the risk of violence, in which she will encapsulate an ontology of domestic violence that she has formulated over the past 5 years from her 23 years of experience in India and in Australia, working with victims of violence. eGanges allows whole River systems to be pasted into an existing application. When the violence River is completed, consideration will be given to where it might expand the CDMan application.

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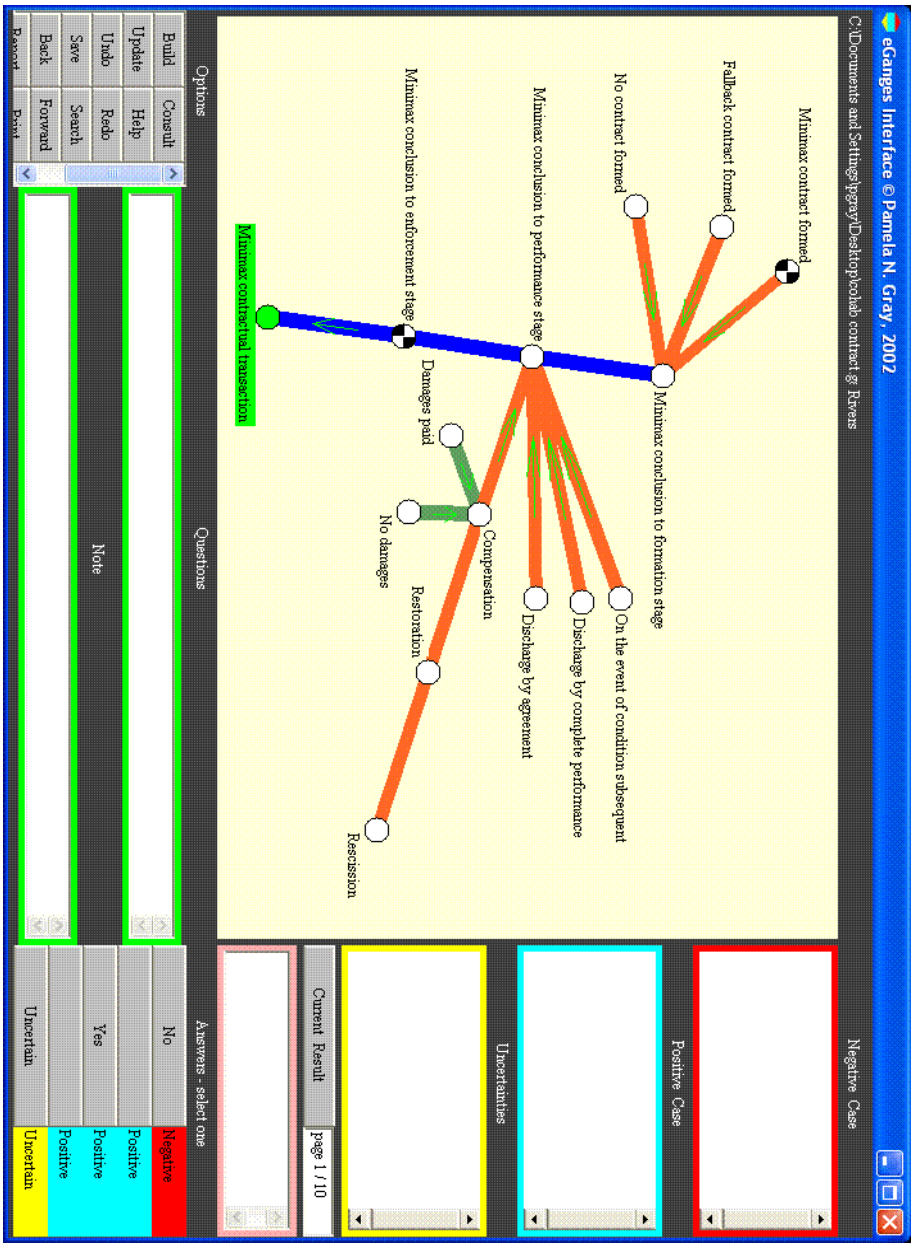

Figure 1: Initial map CDMan

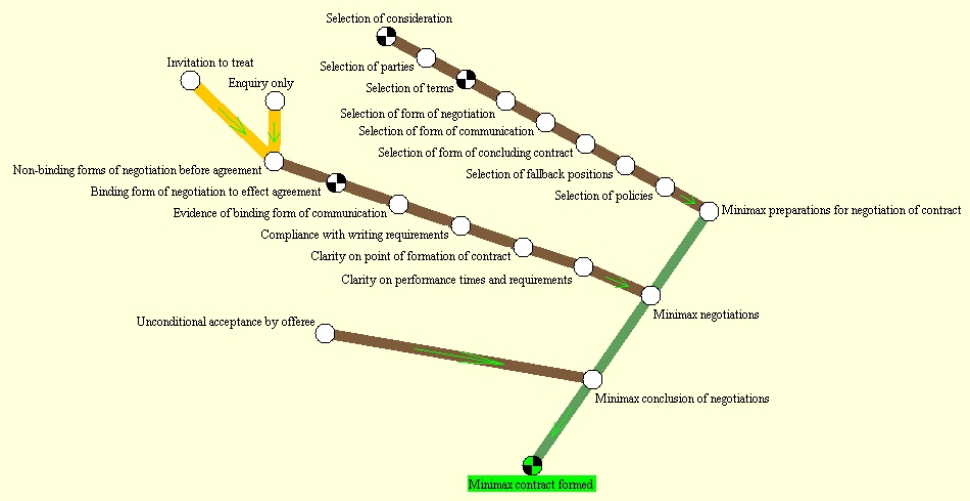

Figure 2: Submap - Minimax contract formed

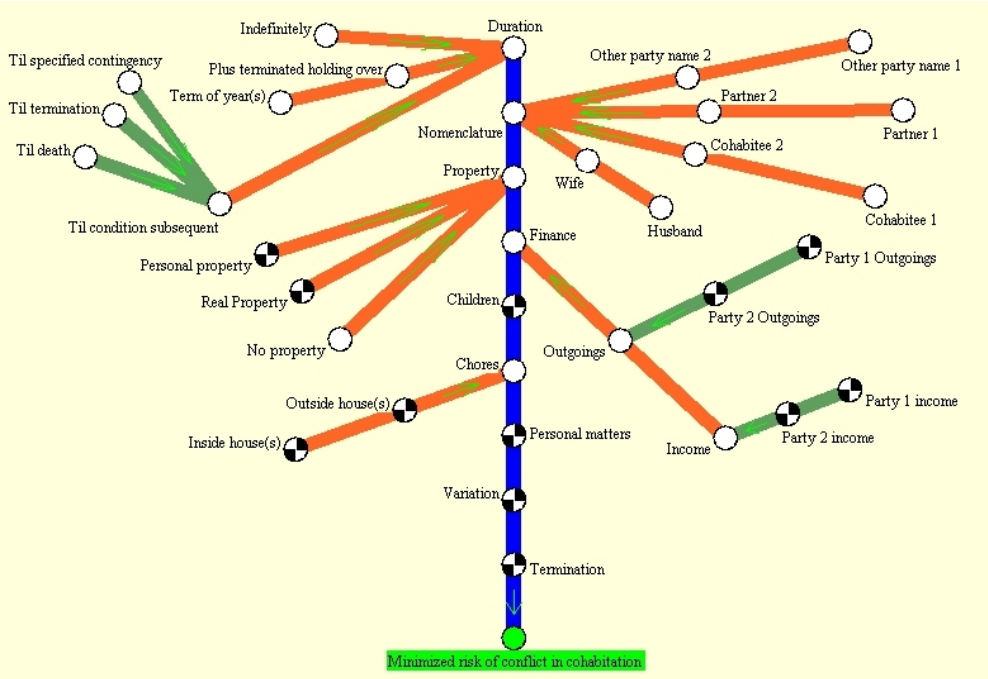

Figure 3: Initial map - Cohabitation application (2007)

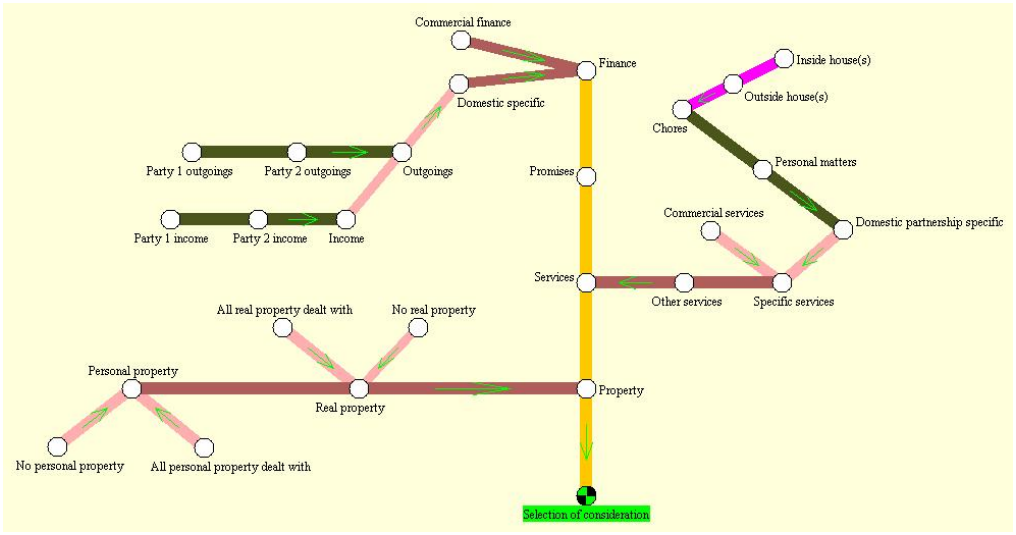

Figure 4: Submap - Selection of consideration

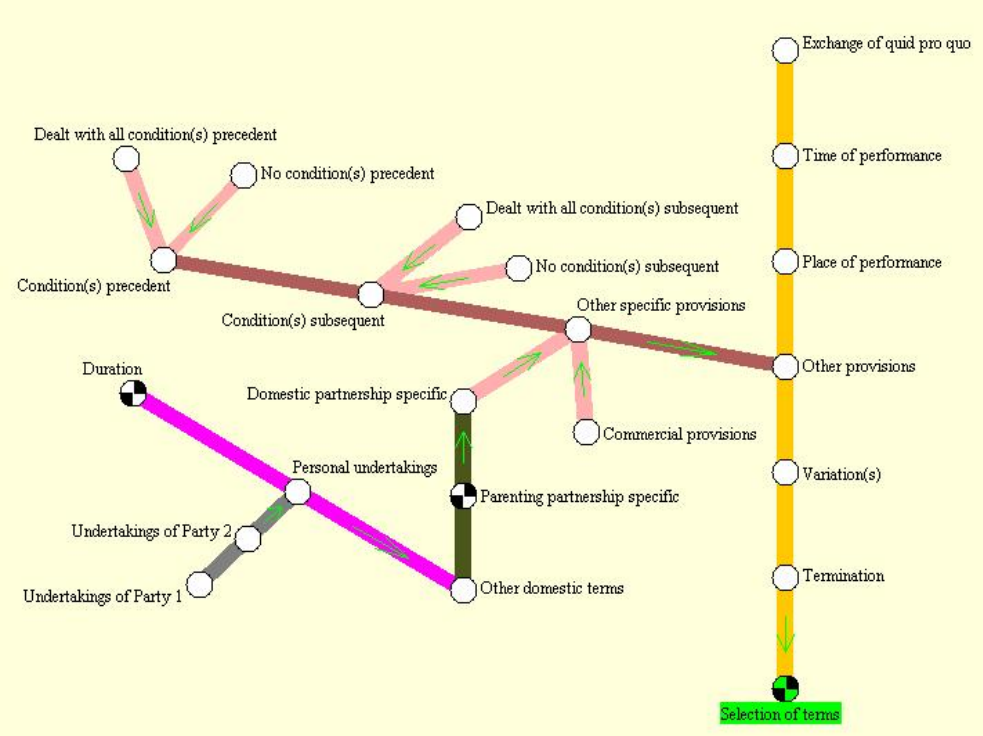

Figure 5: Submap - Selection of terms

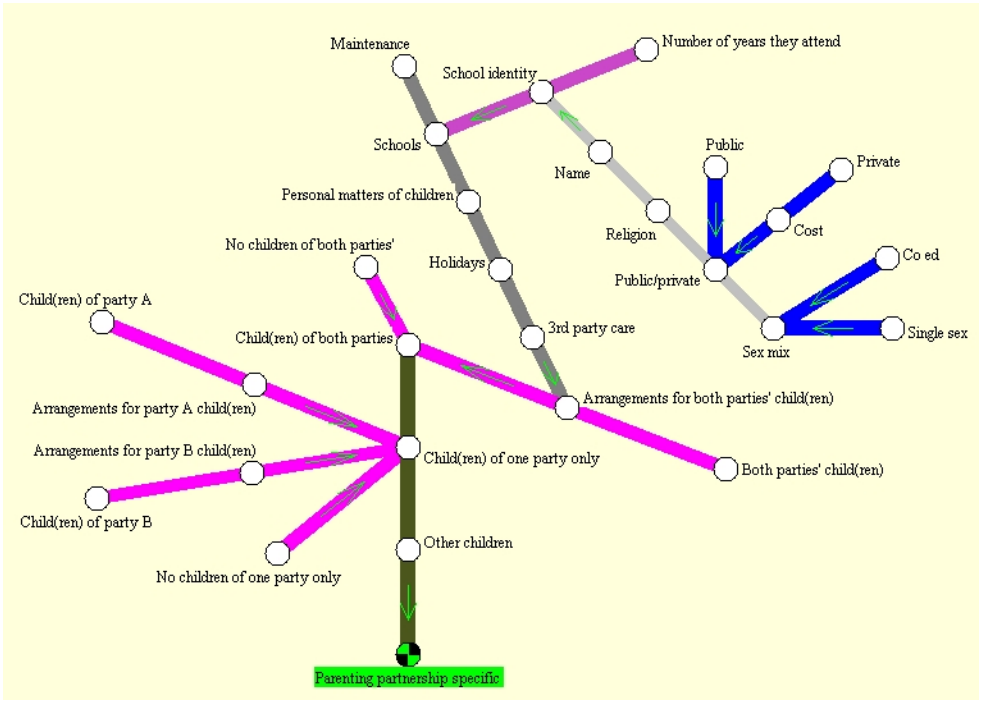

Figure 6: Submap - Parenting partnership specific

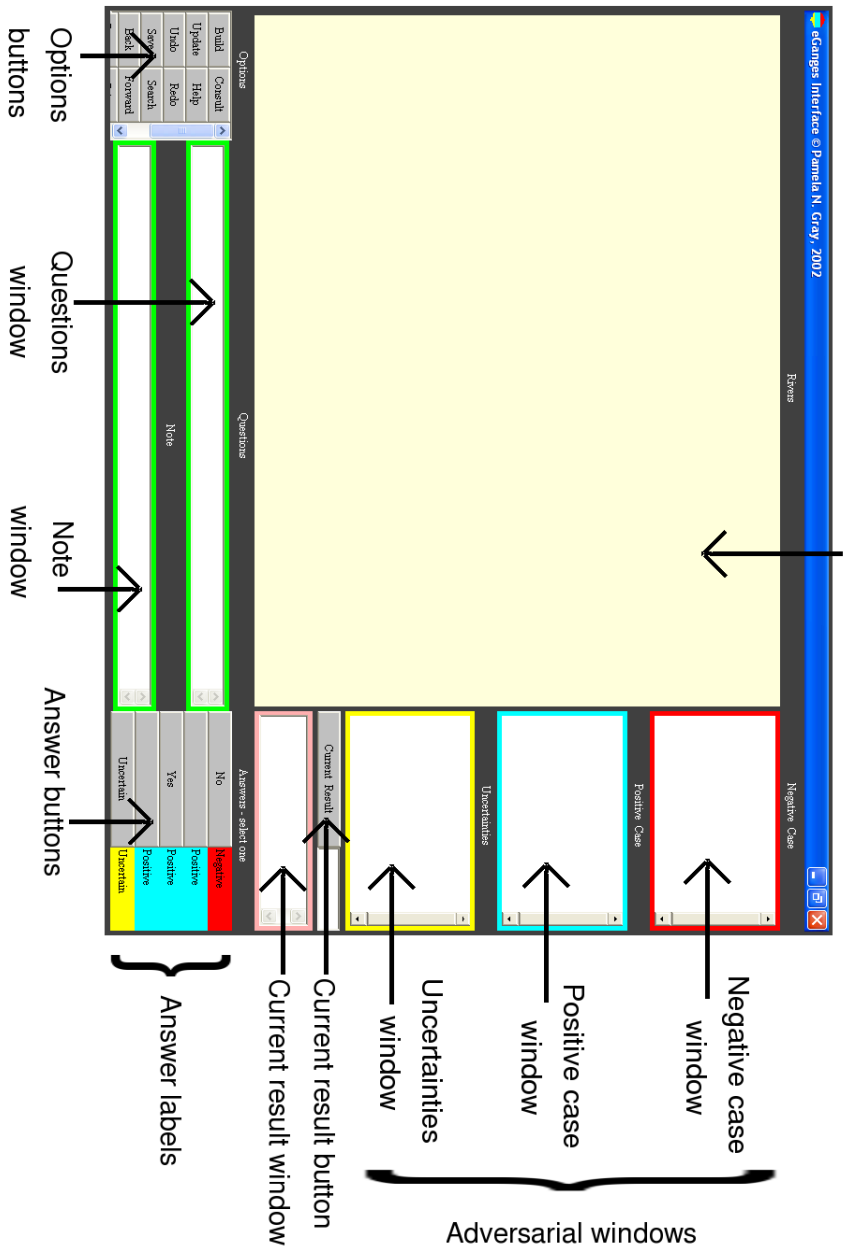

Figure7:eGangesinterface