The Chair of Artificial Legal Intelligence

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Wisdom's chair of legal reasoning

The chair of legal reasoning of Cambridge Professor, John Wisdom[1], was taught in Melbourne as legal method by Professor Louis Waller[2]:

> *Professor Wisdom made a penetrating remark: he proposed that lawyers' arguments "are like the legs of a chair, not the links of a chain". Common sense, history, analogy and so on, support one another if the issue is at all complex. This is the type of logic that the ancients knew well and valued highly under the name of rhetoric. It was extensively used in medieval times for practical judgments. Only in the last three years did logic – in a vain effort to make thinking mechanical and perfect – come to include only formal logic. But throughout these centuries lawyers have gone ahead using rhetorical reasoning with excellent results.("Rhetorical" here is not to be confused with fulsome oratory, unfair appeals to emotions and extravagant language.)*

Wisdom's "legs" of the chair include both constrained reasoning with rules of law (extended deduction), and the unconstrained reasoning of taking into account, in relation thereto, any other relevant matter or perspective (legal ontology, induction, including analogy, and abduction).

In our meagre experience, working with him as instructing solicitor, the former Chief Justice, Gerard Brennan, was a master of legal extended deduction; listening to his *ex tempore* judgments, given in the Court to one's clients who were anxious that their position was understood, Lord Denning, as Master of the Rolls, was a genius of legal abduction; busy magistrates, moving all day along the spectra of various instances in their lists of repetitive matters, are extraordinarily efficient at legal induction – he sped up a hill, he sped down a hill, he sped round a corner, he sped through a shopping centre, he sped past a school, and so on.

As the law expands in volume and complexity, it is increasingly unmanageable without the aid of computers. Retrieval of black letter law is now taken for granted with the pioneer services of austlii and bailii everywhere in the world. The automation of Wisdom's chair, as a seat of legal intelligence may assist further, without presenting concerns that machines are not fit to direct human life. However, to program rhetoric, as a rhetoric retrieval process, it is necessary to transform it to computational categories of data, data retrieval and data processing.

Grays chair of artificial legal intelligence

With the development of the expert system shell, eGanges (electronic, glossed, adversarial, nested, graphical expert system), Wisdom's legal epistemology was transformed into a four legged chair of artificial legal intelligence, complete with a user-friendly seat (the interface) and back (back end) to drive it. This Australian software was demonstrated at the International Jurix Conference at Utrecht University in Holland in 2003[3], subsequently at other international conferences[4], and most recently in June 2008 at the first International eLearning and the Workplace Conference held at Columbia University in New York. Soon after it was programmed, it was also demonstrated to the Australian Computer Society by Philip Argy, then Senior IT partner at Mallesons Stephen Jaques, who became President of that Society. It was Argy who, in 2002, asked Pamela Gray, soon after she commenced full time doctoral candidature, to design a legal expert system shell; this became the endeavour of her thesis and the outcome was her design of eGanges. An eGanges applet, which she uses in teaching finance law, can be trialled online at:

www.grayske.com/FinLawTrial/index.html

The epistemological design of eGanges can be found in the doctoral work of Gray (2007). It was programmed by her son, Xenogene Gray, who is a computational physicist. The doctoral design problem was to identify the automatable part of legal reasoning for data processing, and locate other aspects of legal reasoning in relation to this for data retrieval by way of support. Accordingly, the legs of Wisdom's chair were more clearly specified for computation as fourfold:

1. Legal ontologies, particularly legal concepts and terms of black letter law;
2. Legal deduction, particularly extended deduction of rule systems;
3. Legal induction, particularly the spectra of case instances with a gradation of instances to suit analogous reasoning, in factual particularisation of rule antecedents; and
4. Legal abduction, particularly reasons and authorities for rules or part thereof.

Mixed as rhetoric, these four aspects of legal reasoning are non-monotonic. However, when extended deduction is distinguished, using formalised rules, as monotonic necessary reasoning, it is identified as the part suitable for automation. The major form of legal reasoning is the application of the rules of law to cases; this process is by extended deduction whereby the rules of law are the Major premises and the established facts are the Minor premises. As soon as the Minor premises are established, the consequent prescribed in the Major premise necessarily applies as the outcome of the case. For a simple example:

- If there are damages, then there is a remedy
- There are damages
- Therefore (necessarily) there is a remedy

Usually the law is more complex than this and extended deduction is required. Aristotelian prior analytics are required to formalise rule statements as conditional propositions (if antecedent(s) then consequent) in order to identify and locate, relative to each other, the overlapping tributaries of extended deduction. A simple paradigm example of the prior analytics required for developing an eGanges application of is shown in the sequence of Figures 1-6 (below). The formalisation of the rules in Figure 1 identifies where there is an overlap of an antecedent or consequent in one rule that is an antecedent or consequent in another rule, for the River construction in Figures 2-6. Setting out the rules in this way allows for the identification of the tributary structure to which the overlaps give rise. Adaptations required by new cases, may then be accommodated with the least change.

The confluence of the overlap provides the flow of extended deduction. In formal logic, the inference arrow, → ,stands for 'then' in the conditional proposition. In the formalisation of an eGanges River, this arrow is kept to show the direction in which the argument flows; like a River in a forest the direction of flow downstream saves the explorer from getting lost in the trees.

Similarly, lawyers arguments can always be located relative to the Final consequent sought.

Legal ontologies provide the content for the rules of law, and black letter law determines the logic of the ontologies. Statements of law are either deductive, inductive or abductive premises. Legal knowledge engineers, trained in the law, can categorize them as such.

In 1998, before the High Court handed down its decision in *Sullivan v Moody* (2001) 207 CLR 562, for the purpose of teaching concrete learners, the system of negligence rules which establishes an action in negligence, was visualized using its inherent tributary structure as shown in Figure 7; the software, Paint, was used to draw this Figure. The mainstream of Figure 7 is the most general rule of negligence: if there is a duty of care, a breach of the standard of care, damage and no defences, then there is an action in negligence. Secondary streams particularise each of these four antecedents in the mainstream. Tertiary streams then may particularise antecedents in a secondary stream, and so on with hierarchical detail.

Figure 8 is the eGanges version of Figure 7, which also shows the logic modification required by *Sullivan v Moody*; it accommodates the rules in *Sullivan v Moody* by a modification of the proximity rules. The modification retains the existing types of proximity but requires that there is no constraint, either a statutory obligation or other constraint. However, it might be argued that some other modification is more correct; Figure 9 suggests another alternative where something other than proximity might found the duty but again there must be no constraint. The map assists a common understanding of variations; judges could make explicit their differences and developments by reference to the same logic map. *Sullivan v Moody* was difficult to accommodate and was omitted from Latimer[5] altogether. An electronic picture says a thousand words speedily. Natural language may produce logical ambiguities and obscure choices.

eGanges provides the River visualisation of Major deductive premises for extended deduction as derived from the computational epistemology of 3d legal logic[6]. The visualisation is called a River because of its hierarchical tributary structure; it is the same deductive structure as the quality control fishbone of Ishikawa[7]. The fishbone was developed as a management tool in Japan to improve the quality of manufactured goods after World War 2. Figure 10 is Ishikawa's fishbone; he did not recognise it as a deductive structure. Major deductive premises structured as Rivers provide quality control details and compliance details; they are hierarchical with confluence leading to a Final result that might be a strategic objective or outcome.

Figures 11-15 show part of the nesting of the large complex system of contract law; nodes that look like soccer balls indicate a sub-map where the rules are too dense for one page. This technique of nesting was first conceived by Fraunce[8], an Elizabethan lawyer of Gray's Inn, although he used common alphabet symbols rather than soccer ball nodes to indicate a sub-map in his graphical representation of the legal arguments in the Earl of Northumberland's Case (1568), an Exchequer mining royalties dispute reported in Plowden's Reports.

Fraunce followed the graphical logic representations of the Ramus[9] school at the Sorbonne, the University of Paris, whose work was taken to Harvard by the Pilgrim Fathers, as the new Protestant logic. The three dimensional logic of these French Reformation logicians is illustrated in Figures 16 and 17.

Once the legal ontology of rules of law is particularised as a River, it can be rearranged for other purposes. For instance Figures 11-15 show a rearrangement of contract law that is *in personam* in nature, providing equity perspectives from which to judge a litigant. While common law is concerned with damages for breach of contract, equity might be concerned to recognise the source of the conflict as what the defendant did wrong. A litigant may seek a minimax outcome for a contractual transaction, but to achieve this, there must first be minimax preparations to contract. The concept of minimax is taken from game theory; it means minimum losses and maximum gains; some rules of law indicate how to avoid losses and ensure gains. The litigant must decide what consideration exchange qualifies as minimax in the circumstances, and what is the acceptable fallback position in this regard; however, the rules of formation of contract must be followed to give effect to these decisions. Lack of planning of the negotiation could lead to problems such as the enforceable promissory estoppel in *Waltons Stores (Interstate) Ltd v Maher & Anor* (1988)164 CLR 387; it is possible to avoid equity judgments.

The legal epistemology of Wisdom's chair was adapted and transformed to the computational epistemology of eGanges. For the purposes of artificial intelligence, data may be categorized and stored for retrieval or processing. Wisdom's chair consists of data for retrieval and processing. eGanges is designed according to data categorization, retrieval and processing which accommodates all of Wisdom's chair. While the eGanges River is the basis for taking instructions as answers to questions constituting Minor deductive premises for extended deductive processing, the additional inductive and abductive premises supporting the antecedents and rules of the River, are located as glosses on the River structures, available for data retrieval.

Examples of the range of available eGanges glosses can be seen in the online FinLawTrial applet. ASIC policy in the interpretation of the definition of financial market is available in a text gloss, and an inductive spectrum gloss distinguishes offer from invitation to treat etc. Answers may be given after considering a spectrum of instances as predetermined answers, and the effect of each.

Combinatoric processing – the eGanges superexpert interface

A consultation of the applet by giving answers to the questions which are provided to establish the Minor premises in the user's case, also allows an understanding of the combinatoric processing that makes eGanges a superexpert. All possible cases that fall within the rules of the definition are processed with electronic speed to produce the *pro tem* or Final result of a given set of answers from available alternatives. Results are produced in the Adversarial case windows, shown in the eGanges interface in Figure 8 as Negative case, Positive case and Uncertainties, and by pressing the Current result button at any stage of the consultation. Feedback is given in the Adversarial case and Current result windows.

Legal reasoning includes the application of rules of law to possible user cases that fall within the scope of existing rules. Potential cases may introduce new rules that require modification of the necessary reasoning of the existing rules. eGanges does not automate the requirement for modification, which is thought to require the exercise of judicial judgment; however, existing rule maps may assist the judicial process of deciding upon the modification. Thus, eGanges does not process cases which require a modification of the rule system but its system can assist judicial decision-making and judicial adjustment to the rule maps. The

construction and maintenance of a River is easy; the software could run on a PDA or suitable mobile phone to be used while waiting in an airport or travelling on public transport.

Once there is a finite system of rules for extended legal deduction, processing of possible cases involves combinatoric alternatives subjected to adversarial heuristics. Thus, there may be various alternative combinations of selected answers, yes, no, uncertain for each of the antecedent nodes in a River system. Heuristics determine the consequent after each answer selection, until a Final consequent is produced or sustained.

Instructions are taken from the user as answer input given for each antecedent node in the River. Alternative possible answers for each question are valued as Positive, Negative and Uncertain. A positive answer supports the Final result in the map; for example a question in Figure 8 for the antecedent node, Duty of care, might be: Is there a duty of care owed to the claimant by the defendant? The answer yes is Positive, the answer no is Negative and the answer uncertain is Uncertain. It is possible to set an answer no as Positive if the natural language of the question so requires; it is also possible to set all answers as Positive if the nature of the rules are neutral. For instance an enquiry as to the meaning of an offer is neutral to the Final result, not a necessary antecedent.

Through the predetermined answer choice process, instructions are taken at face value. There is no automated evaluation of the whole selection, as a lawyer evaluates the consistency of evidence. Only the legal logic is automated. Processing heuristics are based on the full mapping of 3d legal logic. Generally, the adversarial nature of the legal domain requires a set of rules for one party to litigation, and a contradictory set of rules for the opponent; uncertainties must also be provided for until judicial resolution of these in the litigation.

The inference arrow of formalised rules of law as conditional propositions, is adopted in the eGanges River as the direction of flow of the extended deduction, so that the user can see how all the fragments fit together, and where the arguments are leading in relation to each other. Positive answers lead to the Final result shown in the River. Negative answers may produce a Negative result, and Uncertain answers may produce an Uncertain result, depending on the availability of logical disjunctions. The heuristics take account of the logical processing of disjunctions, and nested disjunctions.

Data logic

Extended deduction is a form of monotonic reasoning. However legal reasoning often mixes into the line of argument the non-monotonic structures of induction and abduction which sometimes depend on semantics, the actual meaning of the content of the inductive and abductive premises. Interspersed non-monotonic premises corrupt the necessary reasoning of deduction. By distinguishing inductive and abductive data from the deductive rules of law, and locating them precisely in relation to the deductive rules, the automation of extended deduction can be supported by the use of the deductive map to locate data retrieval that is relevant and supportive.

In eGanges, the data of inductive and abductive premises are called Glosses, denoting a similarity to the Bologna glossing of the Roman code in the eleventh century AD and thereafter.

Big complex rule systems

eGanges manages law no matter how extensive and complex; its superexpertise has computer memory and electronic speed of processing of massive combinatorics. Its nesting may be as deep as the expertise requires. Thus it may provide a solution for the problem of unrepresented litigants who waste valuable judicial time as well as the problem for the legal profession of logical reconciliation of massive black letter law.

eGanges – 5GL

Because eGanges offers intelligent processing of visualisations of knowledge, it is regarded as a 5GL (Fifth Generation Language) shell. In 2007 it was short-listed by the British Computer Society for its Machine Intelligence Competition held at Cambridge University. Its user-friendliness may go some way to supporting the thesis[10] that English law will be codified electronically. If this codification is artificial legal intelligence, this may also support the views of Susskind in his forthcoming book, "The End of Lawyers?" If such a codification is largely used for administration by governments, then bureaucracy, as it did in the last stage of the Roman legal system, may largely replace the judicial system.

Law is concerned with large, complex social organisation, and business is concerned with large, complex commercial organisations. eGanges aids may be learned in these higher education vocational courses and then, applied seamlessly in the workplace. A major feature of these aids is that they can effect quality control because they permit precise, pre-planned micro-management with electronic memory and speed; they are super-agile aids that can be ubiquitous and foster common, comprehensive understanding of large, complex matters. They show how a science of intelligence

supports a leap in the coherence and co-ordination required for big societies and large work forces. The mind tools developed during the post-modern period in the second half of the twentieth century, may have provided the means for creation of an advanced age of scientific civilization, with a common new graphical language of logic for the informed negotiation of social and commercial organisation of human survival.

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[1] Wisdom, J. (1951, 1973 originally published in 1944): Gods, in A. Flew, (ed.), Logic and language, Basil Blackwell, Oxford, England, at 195.

[2] Waller, L. (1995): Derham, Maher and Waller An introduction to law, LBC Information Services, Sydney, Australia at 181

[3] Gray, P.N. and Gray, X. (2003): A map based expert-friendly shell, *Legal Knowledge and Information Systems,* D. Bourcier (ed.), IOS Press, Amsterdam, Holland

[4] Gray, P.N. (2004): Intellectual Artefacts and Expert Systems Meta-epistemology, *Conferences in Research and Practice in Information Technology*, Vol 37, J. Weckert and Y. All-Saggaf (eds), Australian Computer Society, Sydney; Gray, P.N. (2005): eGanges: Epistemology and Case Reasoning in Argumentation, *Artificial Intelligence and Law,* P.E. Dunne and T. Bench-Capon (eds), Wolf Legal Publishers, Nijmegen, Netherlands; Gray, P.N. (2005): Ontology and Epistomology in Legal Knowledge Engineering, *Legal Ontologies and Artificial Intelligence Techniques,* in J. Lehmann, M.A. Biasiotti, E. Francesconi and M.T. Sagri (eds), Wolf Legal Publishers, Nijmegen, Netherlands; Gray, P.N. (2007): Ontology of Legal Possibilities and Legal Potentialities in Proceedings of the Workshop on Legal Ontologies and Artificial Intelligence Techniques, International Conference on Artificial Intelligence and Law, Stanford University; Gray, P.N. (2007): Legal Knowledge Engineering Methodology for Large Scale Expert Systems, PhD thesis, University of Western Sydney, Australia: http://library.uws.edu.au/public/adt-NUWS20071010.121246/index.html; Gray, P.N. and Gray, X. (2005): Ganges: computational legal pegadogy, in *Artificial Intelligence and Legal Education*, H. Yoshino, K.D. Ashley and K. Nitta (eds), Gedit Edizioni, Bologna, Italy; Gray, P.N. and Gray, X. (2005): eGanges: A Mobile Pedagogy, *Proceedings of the IADIS International Mobile Learning Conference,* P. Isaias, C. Borg, P. Kommers and P. Bonanno (eds), IADIS Press, Malta; Gray, P.N., Gray, X. and Treanor, L.M. (2006): Handheld intelligence for contemporary free trade, *Proceedings of third International Conference on Contemporary Business* (CD), Charles Sturt University; Grah, P.N., Gray, X. and Treanor, L.M. (2007): Clues, Cues, Combinatorics and Super-agile Management Androgogy, in Proceedings of the International Business Research Conference, University of Technology, Sydney; Gray, P.N., Tierney, R., Gray, X. and Treanor, L.M. (2006): eGanges: Pervasive Peacemaker, *Proceedings of The First International Symposium on Pervasive Computing and Applications,* Urumchi China; Gray, P.N., Gray, X., and Zeleznikow, J. (2007): Negotiating Logic: For richer or poorer in Proceedings of the International Conference on Artificial Intelligence and Law, Stanford University, ACM; Gray, P.N., Gray, X. and Richards, D. (2007): Godel, Escher, Bach and Superexpertise, *KSEMO7 Lecture on Artificial Intelligence*, Springer

[5] Latimer, P. (2008): Australian Business Law, CCH, Sydney.

[6] Gray, P.N. (1990): *Choice and jurisprudential systems,* LL.M. thesis, University of Sydney, Sydney, Australia; Gray, P.N. (1995): Scaling up to a three dimensional graphic trace, *Verso un sistema esparto giuridico integrale*, Vol. 1, C. Ciampi, F. Socci Natali, and E.G. Taddei (eds), Edam, Padua, Italy; Gray, P.N. (1997): *Artificial Legal Intelligence,* Dartmouth, Aldershot, England.

[7] Ishikawa, K. (1985): What is total quality control? The Japanese way, translated by David J. Lu., Prentice Hall Inc., Englewood Cliffs, N.J., USA

[8] Fraunce, A. (1588): *Lawiers Logike*, (Reproduced in 1969 as *The lawyer's logic* from the original manuscript in the British Museum, *Lawiers Logike*, first published by William How, London, The Scholar Press Limited, Menston, Yorkshire, England.)

[9] Ramus, P. (1543): Dialecticke, translated in 1574 as *The logicke of Peter Ramus* by Roland MacIlmaine, 1969, C.A. Dunn (ed.), San Fernando Vallue State College, Northbridge, California, USA.

[10] Gray, P.N. (1990): *Choice and jurisprudential systems*, LL.M. thesis, University of Sydney, Sydney, Australia; Gray, P.N. (1997): *Artificial Legal Intelligence,* Dartmouth, Aldershot, England.

eGanges formalisation

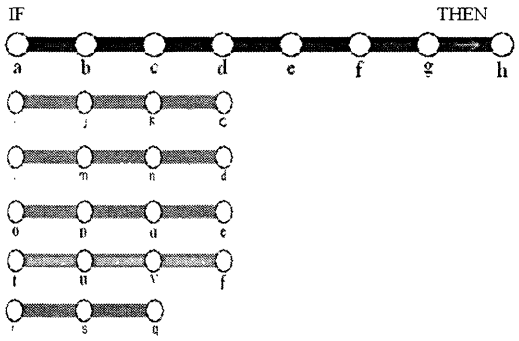


Figure 1

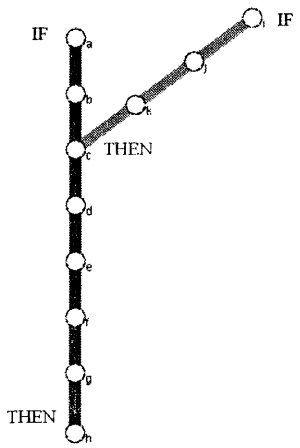


Figure 2

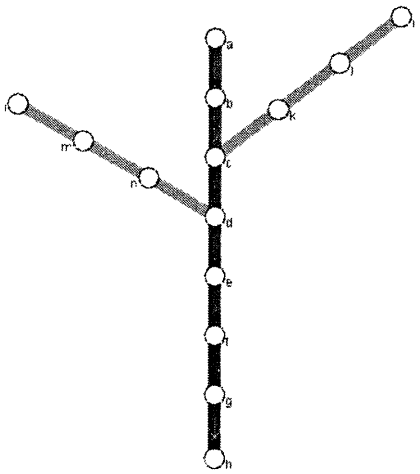


Figure 3

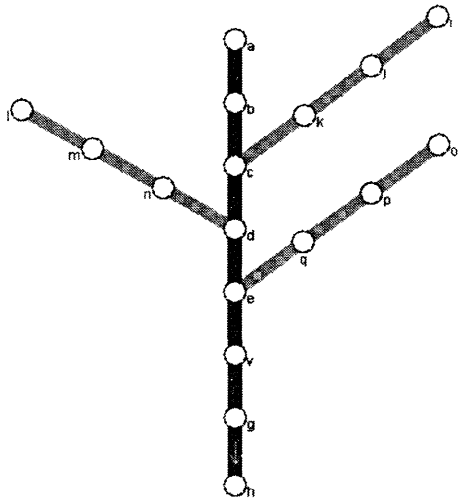


Figure 4

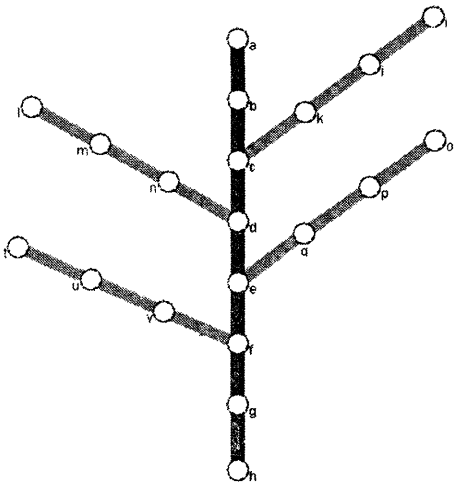


Figure 5

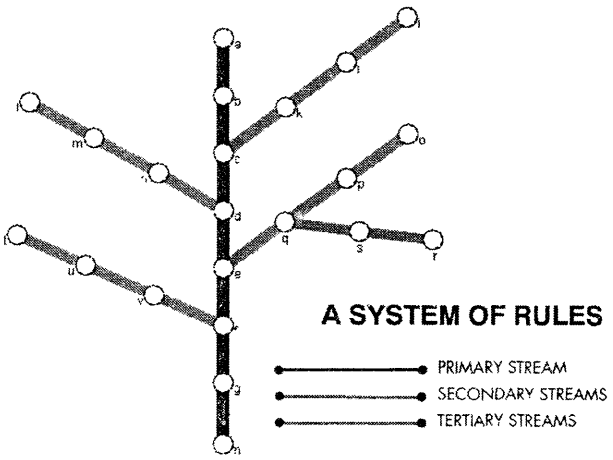


Figure 6

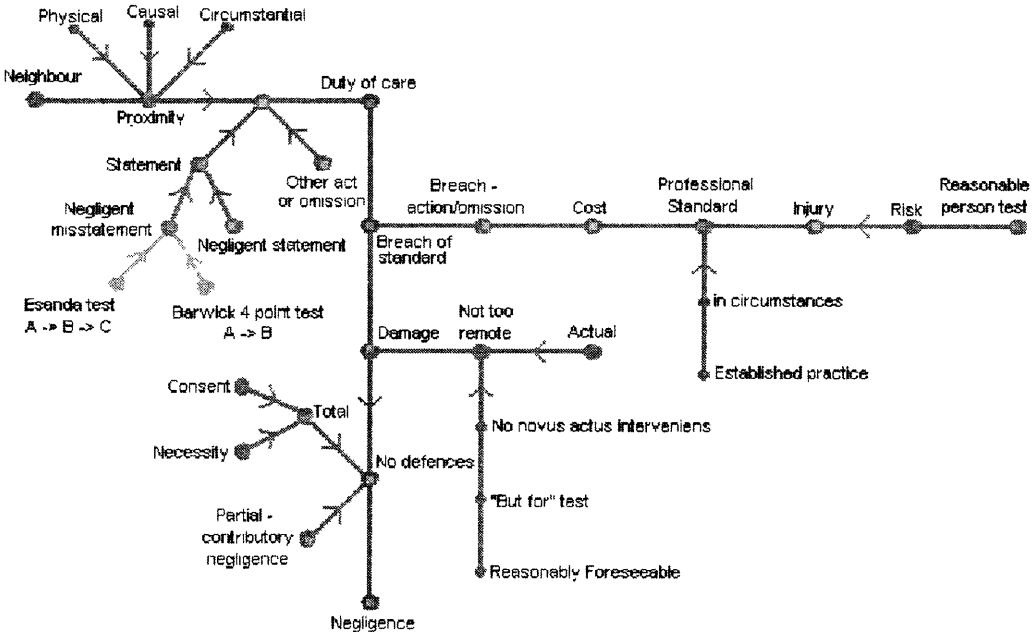


Figure 7

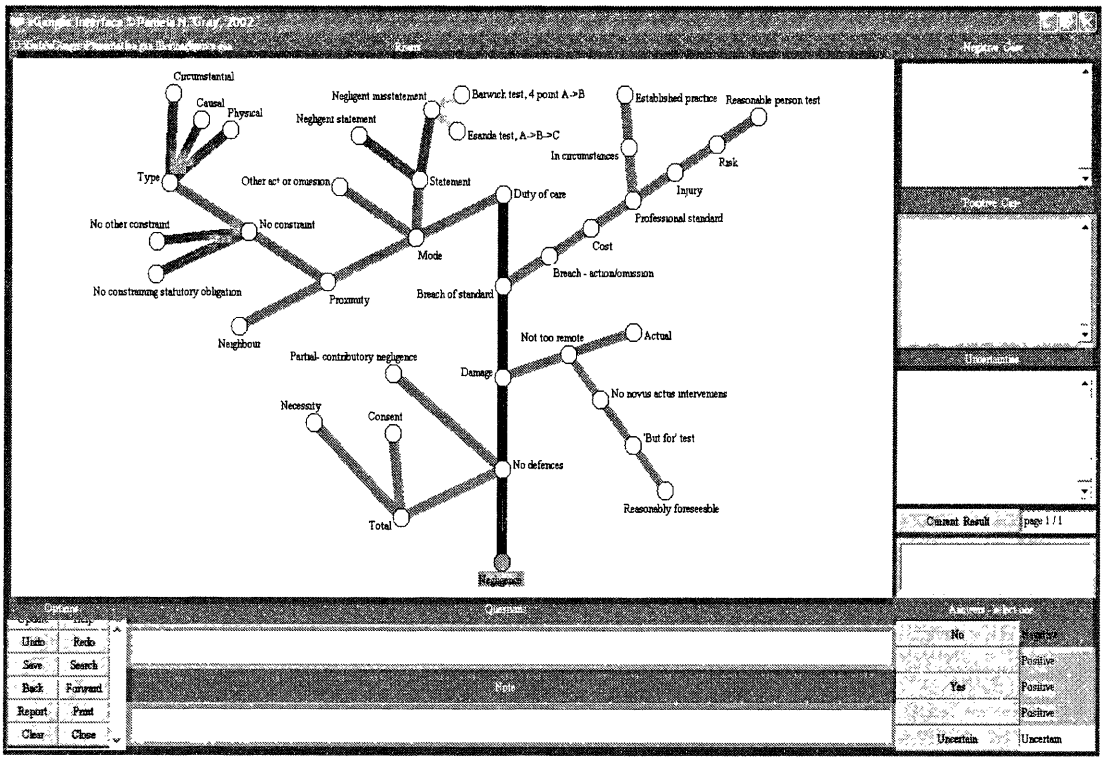


Figure 8

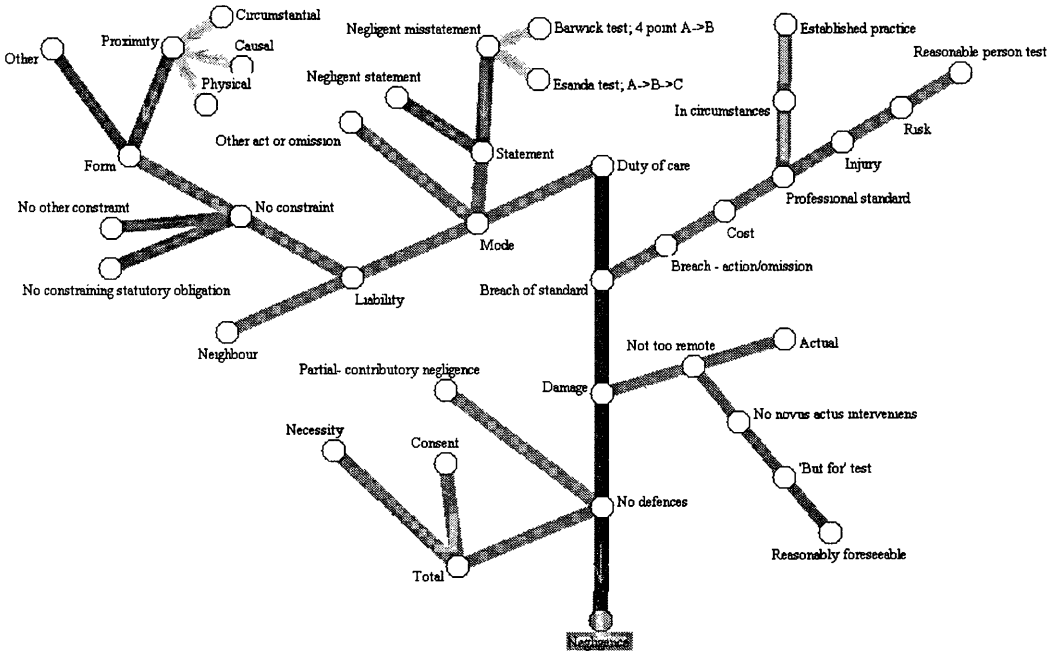
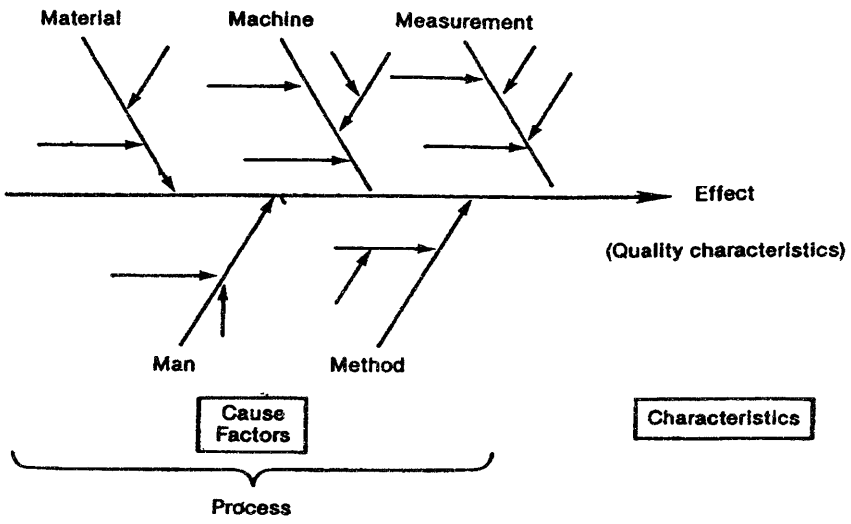


Figure 9



Ishikawa (1985) Fishbone: Cause and Effect Diagram

Figure 10

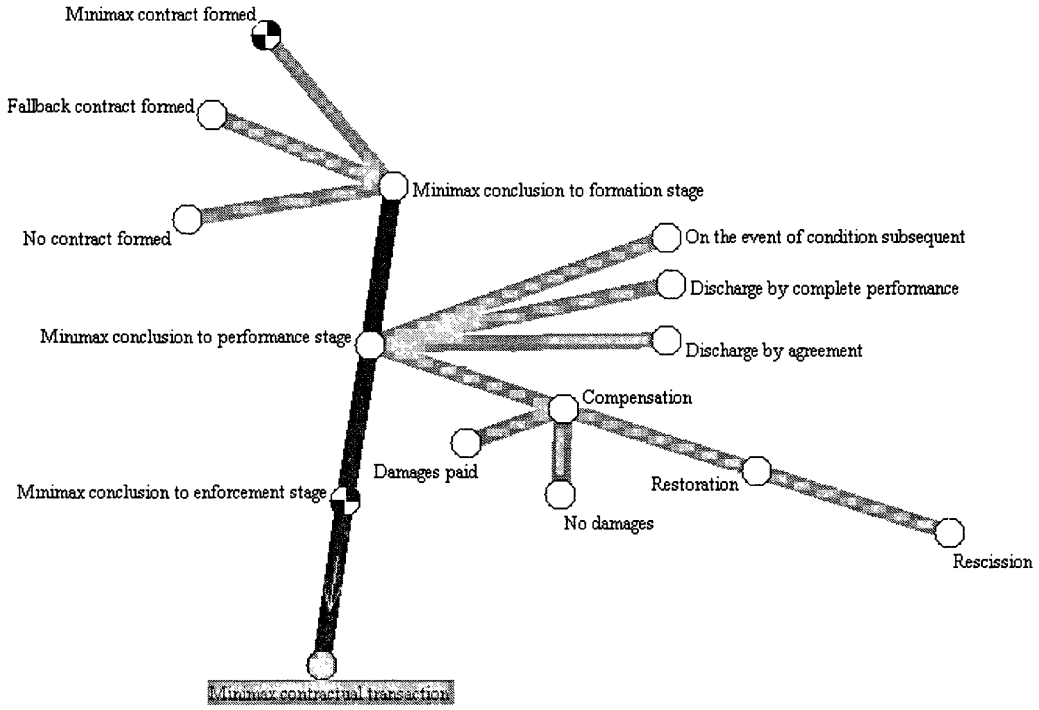


Figure 11

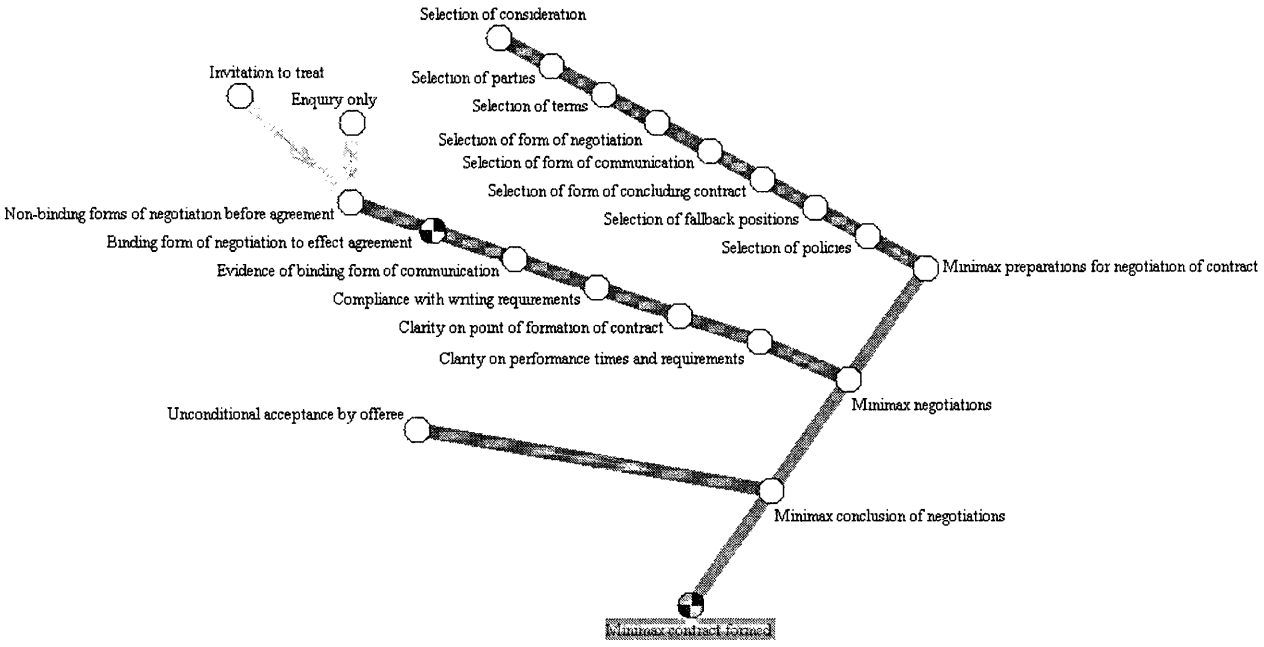


Figure 12

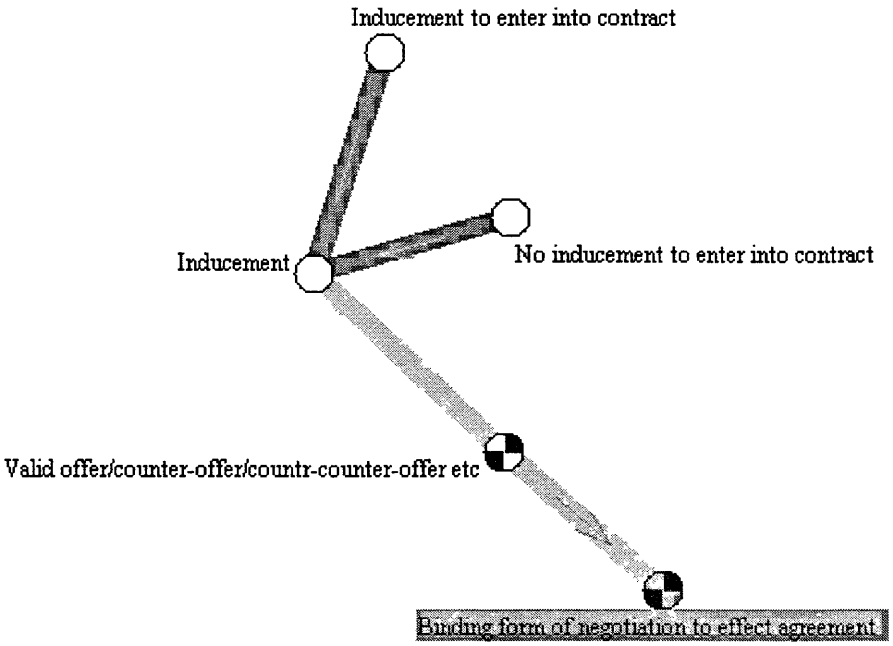


Figure 13

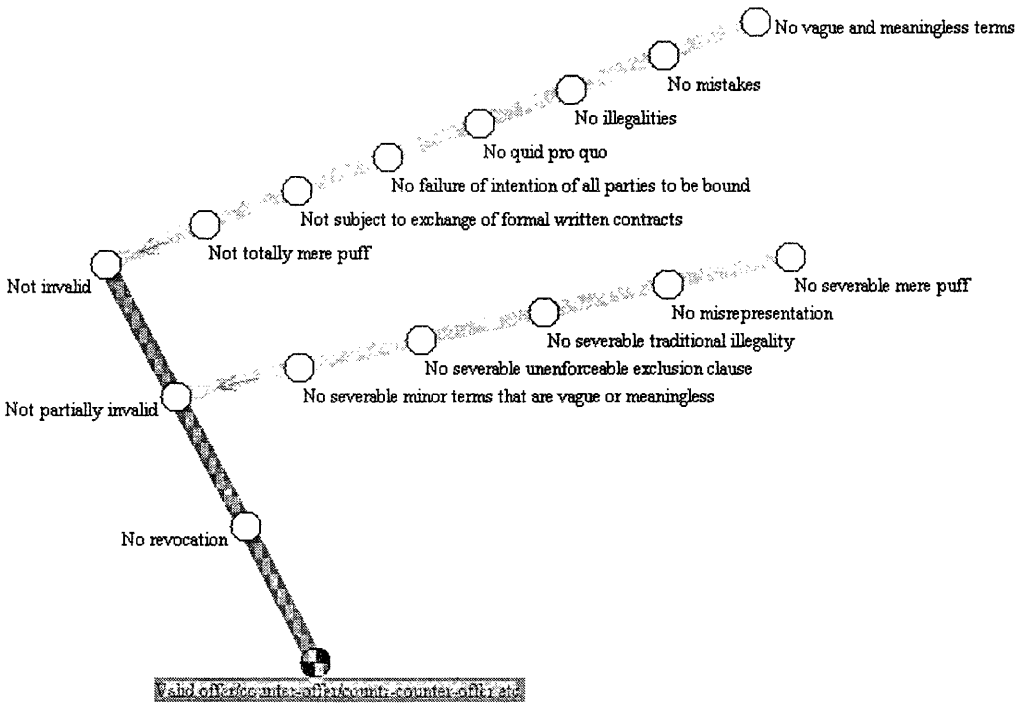


Figure 14

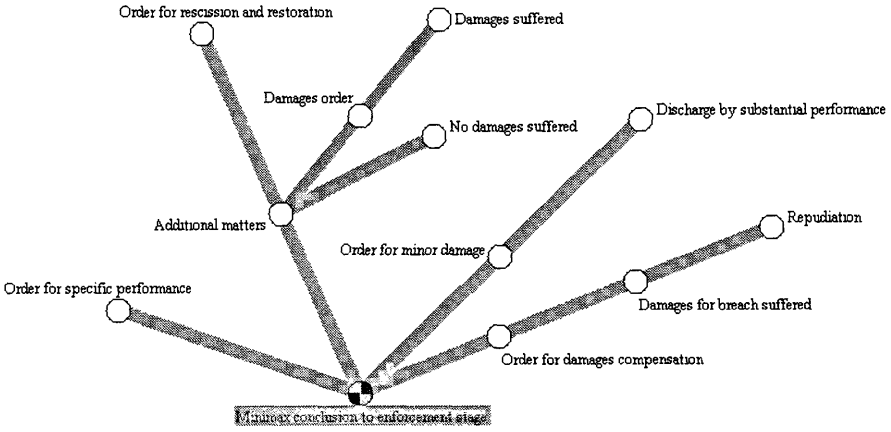
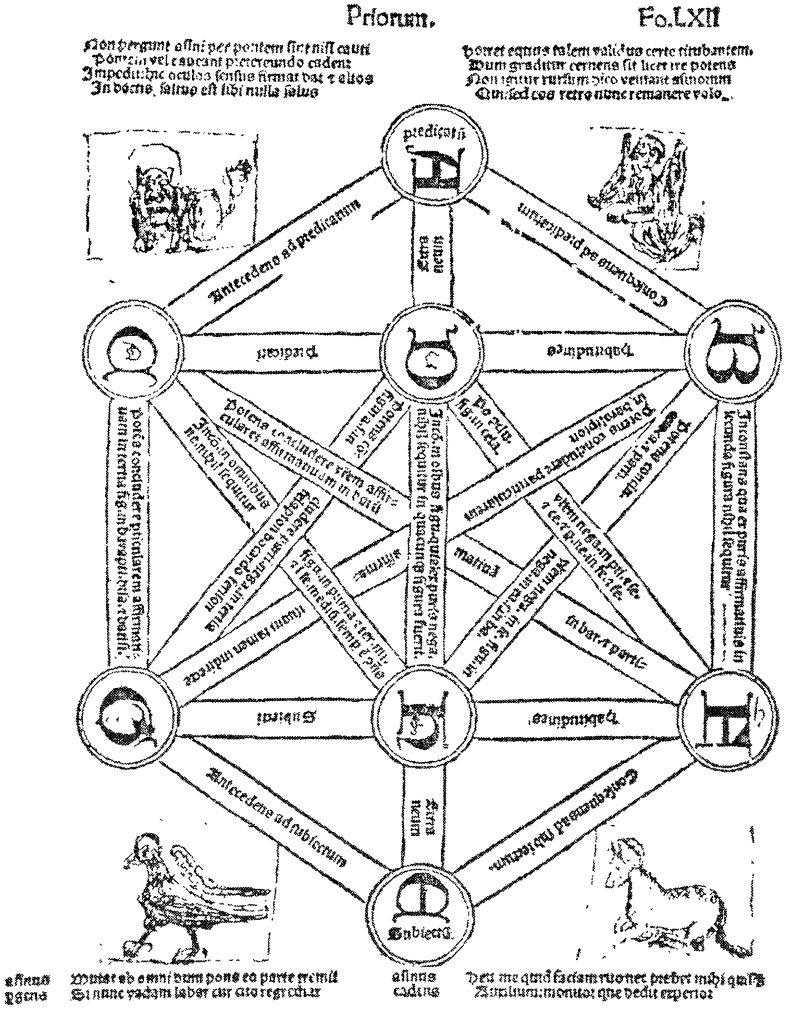


Figure 15



IV. LOGIC IN SPACE (TARTARET)

Figure 16: Tartaret's Logic in Space
Source: W.J. Ong (1958): Ramus method and the decay of dialogue, Harvard University Press, Cambridge, MA, USA., p.80

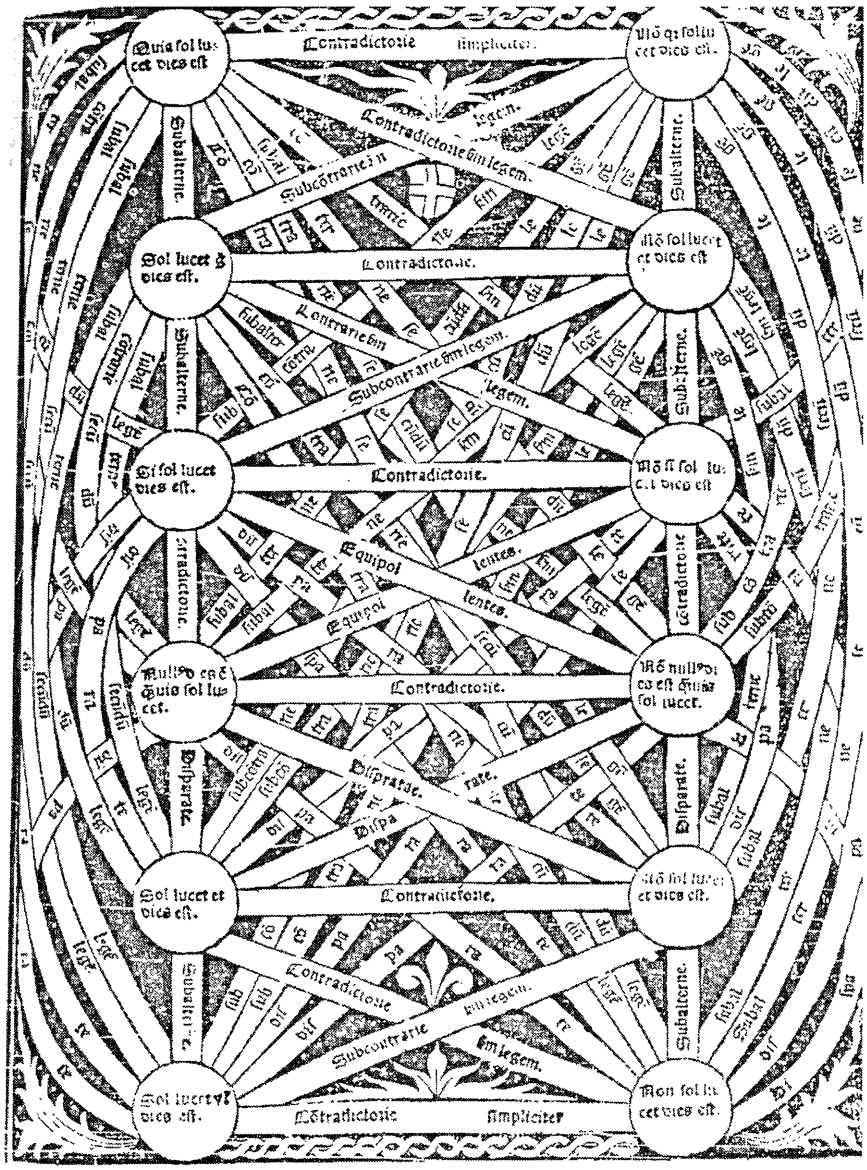


Figure 17: Celaya's The Geometry of the Mind
Source: W.J. Ong (1958): Ramus method and the decay of dialogue, Harvard University Press, Cambridge, MA, USA., p.81