eGanges: A MOBILE PEDAGOGY

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ABSTRACT

eGanges is a new generation, cost-effective, user-friendly, expert system shell; suited to learning on the run. The interactive visualisation of the shell, called rivers; are identical to Ishikawa's fishbone diagrams. Rivers may be schemed to small size, nested as deeply as required, and arranged in mnemonic shapes. The user can freely navigate the river maps, and apply them transparently to real or hypothetical situation, by way of automated deduction, to see the result. Applications may be constructed quickly by an expert using a hand-held device. The shell epistemology is the pedagogy.

KEYWORDS

computational epistemology, inferencing strategy, fishbone, knowledge structures, pedagogy, rule maps

1. Introduction

Mobile learning software must suit technical limits of hand-held devices and encapsulate a pedagogy that is epistemologically sound and swift. eGanges (**e**lectronic **G**lossed **a**dversarial **n**ested **g**raphical **e**xpert **s**ystem), a user-friendly, shell does both. This paper explains how, with application examples from the legal domain.

2. eGanges: an expert system shell

eGanges is less than 0.25 MB and its applications can be expected to be less than 1MB. Written in Java; it is independent of any hardware and operating system; Java Runtime Environments (JREs), are available free on the web for PDAs, mobile phones, as well as for 32 and 64 bit versions of Windows, Linux, Unix and Apple Macs. Thus eGanges, can be run on any mobile computer with a JRE. The interface of eGanges (See Figure 2) has one major window that displays an interactive visualisation of diagrammatic representations of rule, procedure or strategy (RPS) maps. If appropriately designed, the shape of the maps can serve as mnemonic aids. A glance at a map can be sufficient for learning the complexity of the knowledge that it represents.

3. eGanges epistemology

McCarthy and Hayes (1969), pioneers of artificial intelligence, explicitly acknowledged that epistemological adequacy was required for intelligent programs; they saw knowledge representation as the focus of epistemological adequacy. A generic epistemology is provided in the design of the eGanges shell that is sound in many domains. This generic epistemology has the following three features: (1)knowledge structures, (2) knowledge processing structures, and (3) functionality

3.1 Knowledge structures

The epistemology of eGanges, partitions available premises of the domain knowledge into **d**eductive, **i**nductive and **a**bductive (**DIA**lectic) sections that can be applied to real or hypothetical situations.

3.1.1 Deductive premises

The deductive premises of the expertise are captured in the RPS maps that have a tributary structure, called a river (Gray, 1988, 2002), that is like an Ishikawa (1985) fishbone diagram (see also Morgan, 2002 pp.122-5). An example from the legal domain is set out in Figure 1; it represents the Australian Environment Protection and Biodiversity Conservation Act 1999 (Cth) s.18(1) which states:

> A person must not take an action that:
>
> (1) has or will have a significant impact on a listed threatened species included in the extinct in the wild category; or
>
> (2) is likely to have a significant impact on a listed threatened species included in the extinct in the wild category.
> Civil Penalty:
>
> (a) for an individual - 5,000 penalty units;
>
> (b) for a body corporate - 50,000 penalty units.

One Final Result implicit in the text of the system of rules of s.18(1) is: Successful prosecution of an Environment Protection and Biodiversity Conservation Act 1999 s.18(1) offence (abbreviated as EPBCA s.18(1) offence). Alternatively the Final Result may be: No successful prosecution of EPBCA s.18(1) offence. In constructing an application, a choice must be made from the available Final Results. In Figure 1, the Final result selected as the Positive Final result of the application is Successful prosecution.
The rules of law must be fully formalised as river systems if they are to be systematically used as premises in an extended deductive argument that produces a valid legal expert opinion. The formalism is sufficiently precise for automation. It is also suitable for the quick learning pedagogy that is ideal for mobile learning. If a knowledge river is too complex and extensive to be shown wholly on one screen, eGanges allows nesting of submaps as required by the builder of an application. Wherever a node has the appearance of a soccer ball, this indicates that there is a submap. Submaps can be nested as deeply as required by the knowledge.

Figure 2 shows the Initial map of the United Nations Convention on Contracts for the International Sale of Goods, known as the Vienna Convention, that is an extensive and complex system of rules, set in the Rivers window of the eGanges interface. It contains numerous soccerball nodes. Figure 3 shows the submap for the Concluded contract node on the primary river of the Initial map. It can be seen that Figure 3 also contains soccerballs that indicate further levels of submaps. Writing is minimalized to node labels.

A river representation portrays alternative, overlapping sets of necessary and sufficient conditions in their choice system. The river flows represent the chaining paths implicit in extended deductive arguments. The antecedents on all streams must be established to reach the Final result, subject to the resolution of fan alternatives, such as the two alternative ways of establishing Proposal in Figure 3: either one proposal or a series of proposals must be established. It is the fans that create the alternative overlapping sets of necessary and sufficient conditions.

3.1.2 Inductive premises

Inductive premises can be created for each node by a spectrum gloss which has three sectors: negative, positive and uncertain. In each sector, entities may be listed to detail what is available to establish the node (positive sector), what is available that will not establish the node (negative sector) and what is not certain to establish the node (uncertain sector). Where an entity that is listed is similar to the a fact in the user's case, it may be used to formulate an argument by analogy; the user's fact will have the same affect. Without this similarity, an inductive argument depends upon iteration of the inductive constituents. A dissimilar entity may or may not support an argument that the node is not established in the user's case, depending on the spectrum sector in which it is located.

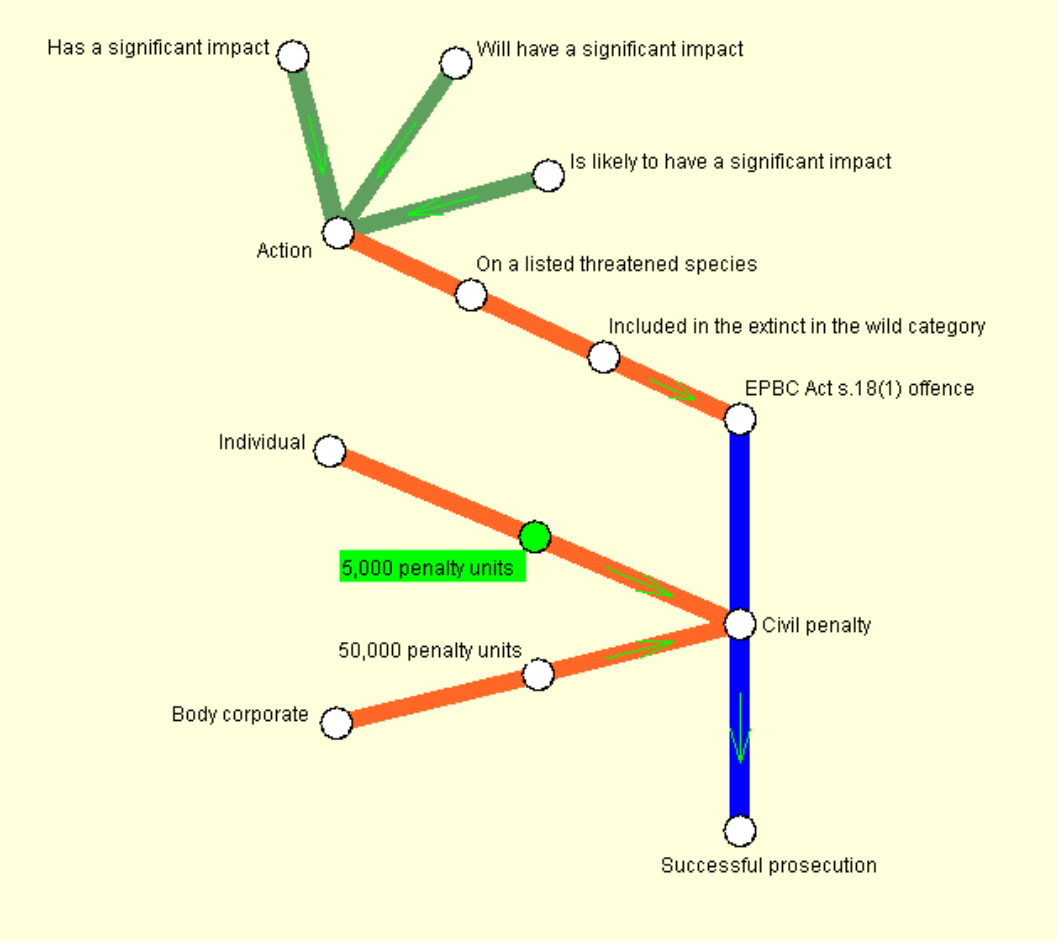

Figure 1. EPBCA s.18(1) – Successful prosecution map

3.1.3 Abductive premises

Abductive premises can also be made available as glosses. Apart from the inductive spectrum gloss, eGanges offers the builder four types of abductive glosses: (1) text, (2) intra-river node links, (3) links to parallel rivers, and (4) links to other files, programs or websites

What characterizes abductive premises is that they are outside the deductive river system; yet they might lend weight to the extended deductive argument of the river, although they do not carry deductive necessity in the river argument.

3.2 Knowledge processing structures

Three epistemological processing structures appear in the eGanges interface, as shown in Figure 2

a. The question/note windows and 5 answer buttons labeled 1 negative, 3 positive and 1 uncertain
b. Three adversarial windows: negative, positive and uncertain
c. Current result button and window

Three possible answers may be placed on the available answer buttons by reference to the sense of the natural language of the question. Answers such as yes, no and uncertain may be placed with uncertain on the Uncertain button or a Positive button, yes on the Negative button or a Positive button and no on the Negative button or a Positive button. Where an antecedent is inconsequential or neutral to the Final result, all three available answers are placed on the three Positive buttons.

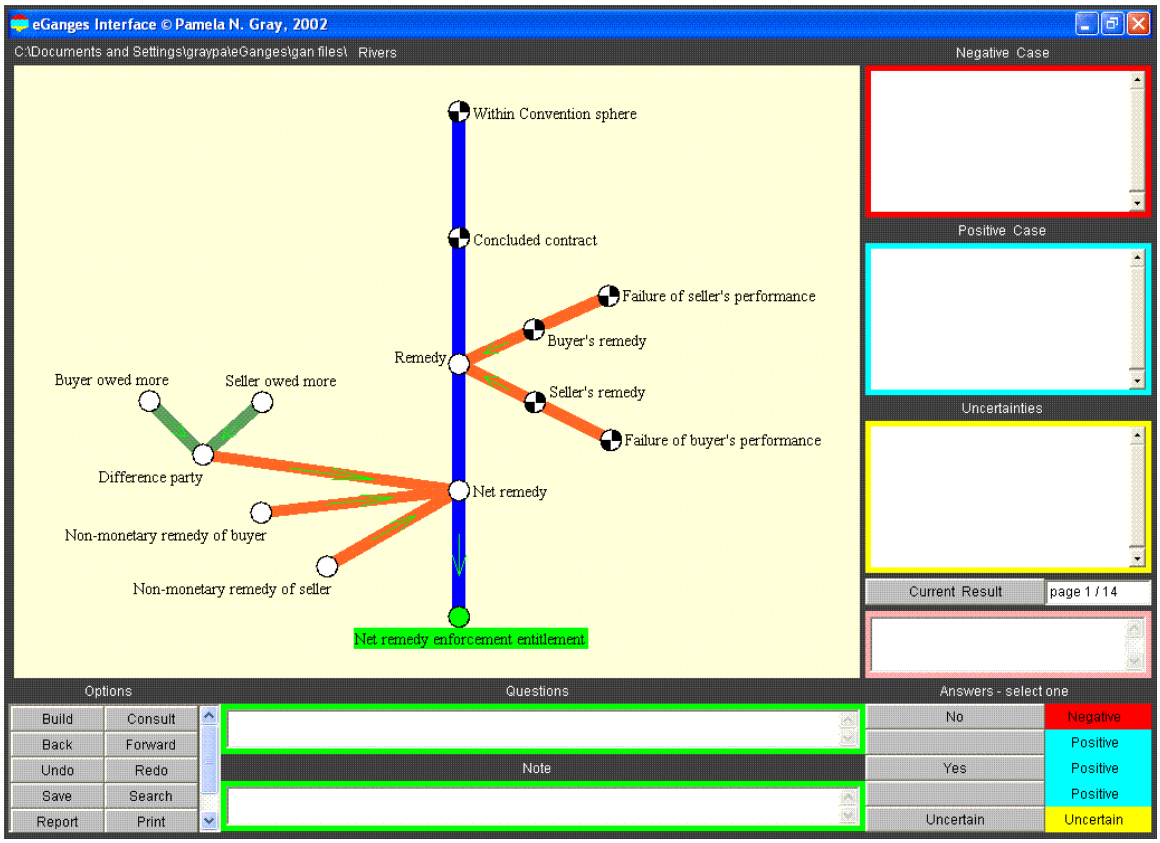

Figure 2. Main map of the Vienna Convention
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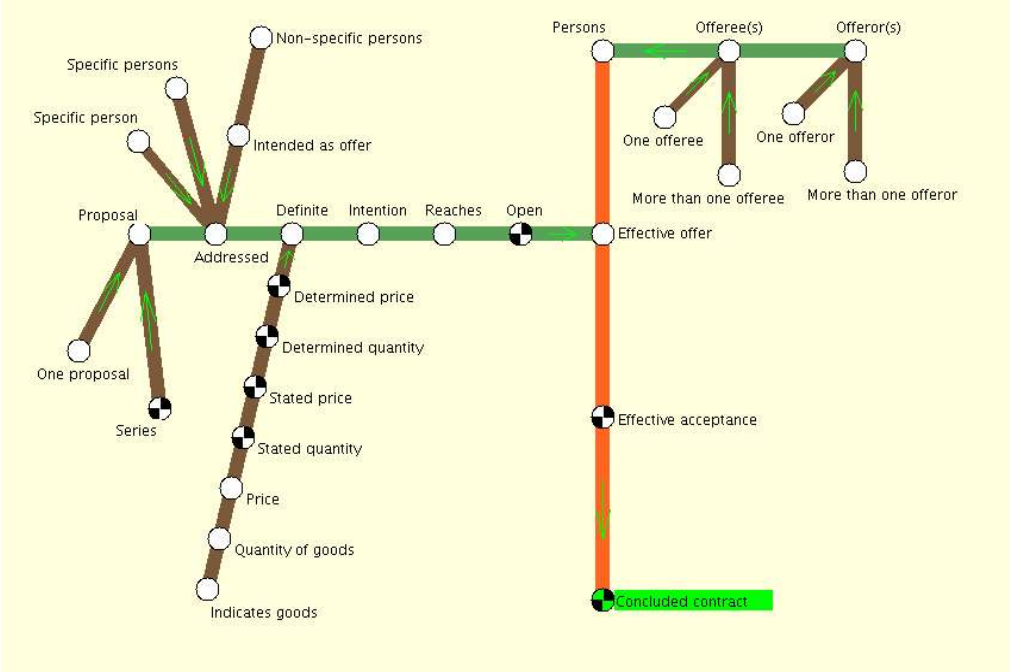

Figure 3. Concluded contract submap - Vienna Convention

3.3 Functionality

eGanges sorts answers into the adversarial windows, according to the match indicated; for example, a positive answer will place the node label into the Positive case window. Fan alternatives are accommodated by a provisional sorting until the whole fan is resolved; (Neg) or (Unc) beside a label in a window indicate this temporary sorting. A fan stream with more than one antecedent becomes Negative if only one antecedent is Negative; a multi-antecedent fan stream becomes Uncertain if only one antecedent is Uncertain and there are no antecedents that are answered Negatively. An Uncertain fan stream overrides a Negative fan stream in the fan resolution. Whenever a set of necessary and sufficient conditions are established, a Final result is reported in the Current result window. An Uncertain Final result is overridden by a subsequent Negative Final result The inferencing strategy that manages the RPS maps is only apparent to the user as a game.

Notionally, the Positive tributary structure is part of a spherical logic structure in which there is a Negative tributary structure corresponding to the Positive tributary structure and an Uncertain tributary structure corresponding to the Negative tributary structure (Gray, 1990, 1995, 1997, 2004; See also Terrell, 1984). Both the Negative tributary structure and the Uncertain tributary structure respectively give rise to pole structures. The pole structures represent the premises that, subject to fan resolution, any Negative antecedent establishes a Negative Final result and any Uncertain antecedent establishes an Uncertain Final result. Nesting, raises the understanding of direct and indirect logical implications. Failure of a deeply nested positive antecedent will implement the automated domino effect on rulestreams through to the Final result.

5. Conclusion

eGanges shows that a computational epistemology introduces a new pedagogy particularly suited to mobile learning. The interactive interface is a simple communication system that manages extensive complex knowledge and its processing: its one click knowledge selects a sub-map, inputs an informed answer to a node question or produces the Current result at any time during a consultation. Maps can be freely navigated; answers can be changed. eGanges pictures say much more than their words and its computation manages deduction, induction and abduction in the context of the combinatorial explosion of choice.

Bibliography

Gray, P.N. (2004): Intellectual Artefacts of Expert Systems Meta-epistemology. In *Computers and Philosophy 2003,* Weckert, J. and Al-Saggaf, Y. (eds), Australian Computer Science Communications, Vol 37, pp.51-8.

Gray, P.N. (1997): *Artificial Legal Intelligence*. Aldershot, England, Dartmouth Publishing Co.

Gray, P.N. (1995): Scaling Up To A Three Dimensional Graphic Trace. In *Verso Un Sistema Esperto Giuridico Integrale*, Ciampi, C., Socci Natali, F. and Taddei E.G. (eds), Padua, Italy, Cedam.

Gray, P.N. (1988): The CLIMS (Contract Law Information Management System) Pilot - Automatable Law. In *Proc. of the 4th International Congress on Computers and Law*, Rome.

Gray, P.N. and Gray, X. (2003): A Map-Based Expert-Friendly Shell. In *LegalKnowledge and Information Systems*. Bourcier, D. (ed.). Amsterdam, IOS Press.

Ishikawa, K. (1985): *What Is Total Quality Control? The Japanese Way*, translated by David J. Lu. Englewood Cliffs, N.J., Prentice-Hall Inc.

McCarthy, J. and Hayes, P.J. (1969): Some Philosophical Problems from the Viewpoint of Artificial Intelligence. In *Machine Intelligence 4*. Meltzer, B. and Mitchie, D. (eds). Edinburgh, Edinburgh University Press.

Morgan, T., (2002): *Business Rules and Information Systems*, Boston, Addison-Wesley.

Terrell, T.P. (1984): Flatlaw: An Essay on the Dimensions of Legal Reasoning and the Development of Fundamental Normative Principles. Calif. L.R. 72(3): 288-343.