Distributed Knowledge Elicitation through the Dempster-Shafer theory of Evidence: a simulation study

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Extended Abstract

By *Distributed Belief Revision* we mean the study of how the adoption of a local model of *Belief Revision* (*BR*: it consists in removing contradictions by evaluating the credibility of the various pieces of information and the reliability of the informants) affects the group's emergent epistemic behavior. Specific questions are (Dragoni 94):

1. does the proposed (local) strategies for *BR* and communication assure the various agents to converge gradually toward the same knowledge space?
2. if this global beliefs convergence is assured, how long will it take to achieve it?
3. is it possible for the various agents to detect those among themselves which are particularly unreliable?
4. if 1 and 3 are possible to what extent they are? what happens if most of the agents are largely unreliable?
5. is the overall group reliable? i.e., does it converge to the most credible knowledge or not?,
6. is it possible that an agent realizes that it itself is unreliable?

The kind and the importance of the global effects of local strategies (of *BR*, partner selection etc.) can be evaluated only on a simulation basis. We present the results of a first experiment. There are two knowledge repositories, one containing true propositions and the other containing their correspective negations. Five agents in turn access one of these files. Each agent is characterized by a *capacity* that will be used as the frequency with which the agent accesses the file with the correct knowledge. Agents randomly exchange information with the others. Since they have limited (a-priori fixed) degrees of capacity, their knowledge bases become inconsistent. Each agent is equipped with the same *BR* mechanism to detect and solve these contradictions. This embodies the Dempster-Shafer theory of evidence to evaluate the credibility of the various pieces of information (from the reliability of their respective sources) and estimate the new reliability of the other agents (through bayesian conditioning). We call this global process *Distributed Knowledge Elicitation*. We want estimate the (eventual) convenience that the agent had in the interaction with the others. For each agent we evaluated three parameters: the *quality* and the *quantity* of its beliefs, and its average *reliability* estimated by all the agents. The first two parameters are differences between the cases with and without communication.

$Quality = Ql - Ql_{\text{without communication}}$ where:

$$Ql = \frac{|\text{believed true propositions}| + |\text{unbelieved false propositions}|}{|\text{propositions available to the agent}|}$$

$$Quantity = |\text{b. t. p.}| - |\text{b. t. p.}|_{\text{without communication}}$$

Reliability of the i^{th} agent $R_i = \frac{\sum_{k=1}^{k=5} rel_{ki}}{5}$ where rel_{ki} is the reliability of the i^{th} agent, estimated by the k^{th} one

Results

Quality. Interaction increases the quality of the knowledge of an incapable agent and decreases the quality of a capable one. The average quality remains at zero. This means that if there are few incapable agents, then they gain much in correctness while the others lose very little.

Quantity. Interaction always increases quantity. However, incapable agents gain more than the capable ones.

Reliability. All the agents lose reliability, but it holds what we called *majority effect*. If the average capacity of the group is more than 0.5, then the capable agents lose less than the incapable ones. On the opposite, if the average capacity is less than 0.5, then the capable agents lose more than the incapable ones. In this case, since the capable agents are in minority, they are considered as unreliable by the group. These results were expected, since this group looks like a class without teacher, or a scientific community without experimental evidence. They are positive in the sense that the members of the group acquire knowledge without loosing (averagely) in correctness.

References

Dragoni A.F; Giorgini; and Puliti 1994. Distributed Belief Revision versus Distributed Truth Maintenance, in Proc. 6th IEEE Conf. on Tools with A.I., IEEE Computer Press.