Discussion group 'Gossip problems and protocols'

Lorentz Center Workshop 'To Be Announced'

August 27, 2015

As part of the Lorentz Center workshop 'To Be Announced! Synthesis of Epistemic Protocols' (17 - 21 Aug 2015) some themes were addressed in discussion groups. This is the report of the discussion group on the theme 'Gossip'. This group was active during the second half of the week.

Given a network where node represent agents and links between agents the ability to make a telephone call, and where each agent typically holds a unique secret, *gossip protocols* investigate how to distribute all secrets to all agents by way of sequences of such calls. (An agent who knows all secrets is an expert.) A recent development is the investigation of distributed (or 'agent-based') versions of such protocols: *epistemic gossip protocols*, see for example:

- Hans van Ditmarsch, Jan van Eijck, Pere Pardo, Rahim Ramezanian and Franois Schwarzentruber. *Gossip in Dynamic Networks.* `http://homepages.cwi.nl/~jve/papers/15/pdfs/DG.pdf`
- Maduka Attamah, Hans van Ditmarsch, Davide Grossi, Wiebe van der Hoek, *The Pleasure of Gossip.* `http://personal.us.es/hvd/FrohitFest.pdf`
- The chapter Gossip in the book 'One Hundred Prisoners and a Light Bulb'.

About 10 different protocols have been studied, for example ('until all agents are experts, do:')

- *learn new secrets* (call someone whose secret you don't know)
- *known information growth* (call someone such that you know there is information growth in the call — so this can also be when you know that you have a secret to tell to the receiver of the call)
- *possible information growth* (as previous, only now you consider it possible that there is information growth, this protocol allows for infinite executions!)
- ...

Different implementations of epistemic gossip protocols have been made or are in the process of being made: Nancy (Pardo, Schwarzentruber), Amsterdam (van Eijck, Gatting), Toronto/Melbourne (Muise).

There was a call for a *classification of different kinds of gossip problems.* This focussed the remainder of the discussion.

Goal

- everybody knows all secrets (EK all secrets)
- EK^n all secrets (for example, EK^2 is 'everybody knows that everybody knows all secrets')
- common knowledge of all secrets

Nature of knowledge that is modelled

- only knowledge of the secret is relevant (s_i for the secret of agent i)
- knowledge of the secret but also epistemic information, for example: $K_j s_i$, $K_j K_j s_k$, ...
- histories, i.e., sequences of prior calls (secret + when I got it + from which source + where the source got it from, ...)

Nature of information that is exchanged

This is related to the kind of knowledge that is modelled, but in principle the knowledge representation of the exchanged messages can be different from the knowledge representation of the agent's knowledge. Additional message-related issues are

- how much does the agent say per turn? (one/all/some secrets/all agent knows/...)
- only the caller informs the callee of the secret(s) (the so-called 'push' mode), or only vice versa (the 'pull' mode)
- games involving exchange of secrets, or negotiation of secrets; values of secrets

Nature of the network

- whether the communication graph is completely connected (universal relation) or not (special topologies, e.g., tree, line, circle, 'sun graph')
- Does the network change while calls are being executed ('dynamic gossip') or not?

Synchronisation

- global clock or not?

- when can an agent conclude termination?
- role of the scheduler?

What may be (or may not be) common knowledge between the agents?

- how many agents there are
- how many secrets there are (e.g., one per agent)
- that initially each agent only knows its own secret
- the structure of the communication graph
- the protocol
- ...

Achievability of common knowledge

- only if the system synchronized, can the agents achieve common knowledge of all secrets (or of other secret-related information)
- Is, additionally, common knowledge of the protocol essential to obtain common knowledge of all secrets?
- ...?

Actions of the global scheduler, and global versus distributed scheduling

- "agent i, you must call agent j"
- "agent i, call someone whose secret you don't know"
- "agent i, it's your turn"
- "tick" (i.e., a global tick, but it could actually be also private)

Distributed scheduling
An example of a distributed protocol is:

```
while I don't know that everybody is an expert do
    choose some agent j;
    check that I don't know j's secret;
    call j
```

This protocol has the same execution traces as the global scheduler's protocol defined as follows:

```
while there is a non-expert do
  choose some agents i and j;
  check that i doesn't know j's secret;
  i calls j
```

Kinds and levels of formalisation

- natural language
- epistemic logic
- dynamic epistemic logic
- whether agents have names or roles