Snapshots et Détection de Propriétés Stables dans les Systèmes Distribués Anonymes

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Anonymous message passing system

This environment relies on:
- port-to-port communications,
- asynchronous communications,
- anonymous entities,
- no central architecture such as server or router,
- multihop communications.

Topic of this talk

Study the snapshot computation and stable properties detection problems occurring on this kind of systems.
Motivation of this work

- **Goal:** monitoring a distributed system.
- **Knowledge:** the **diameter** (or a bound on) of the network.
- **Drawbacks:** no central architecture, anonymous processes, no global clock and asynchronous communications.

Questions

Under these hypothesis:

- How to monitor the **behaviour** of this system?
- How to make **checkpoints and rollback recoveries**?
- How to check if a **stable property** on the network currently holds?
More precisions on the model

A network is represented as a graph $G$ with port-numbering $\delta$ in which each process can:

- modify its state,
- send a message via port $p$,
- receive a message via port $q$. 

![Diagram of a network graph with port-numbering]
More precisions on the model

Our hypothesis:

- asynchronous systems,
- FIFO and reliable networks,
- (potentially) anonymous systems.

Anonymous system

- Memory at any process is bounded and uniqueness of identities cannot be ensured [AAER07],
- for privacy and security reasons, identities are not shared [GR05].

Every process executes the same algorithm.
Motivations

Problem 1: Snapshot Computation
A snapshot computation algorithm:
- computes a local snapshot at any process,
- eventually local snapshots are merged in a particular process to compute a global snapshot.

Problem 2: Stable Properties Detection
- A stable property is a property that once it becomes true, it remains true thereafter,
- a stable property detection algorithm may detect stable property from snapshots.
## Motivations

### Challenge 1: Anonymity and Initiators
- Snapshot computations and stable properties detection have to be computed in the context of **anonymous systems**,
- fully distributed solutions which admits **several initiators**.

### Challenge 2: Initial Knowledge
Reduce the **minimum initial knowledge** each process needs to have about the networks to solve these problems:
- a bound on the diameter of the network,
- the size of the network.
Recall

We consider an asynchronous communication model and anonymous systems. 
Corollary of Angluin [Ang80]: no process can compute a snapshot.

Our Contribution

◮ knowledge: processes only know the diameter of the network,
◮ result: original algorithms for snapshot computation and stable properties detection.
Question

how can we use local snapshots?

- Combination and adaption of the Chandy-Lamport algorithm with a termination detection algorithm (Szymanski, Shy, and Prywes [SSP85]):
  - checkpoint and rollback recovery,
  - termination detection of the execution of a distributed algorithm.
Question

how to anonymously detect stable properties of a network?

Coverings

- First introduced by Angluin [Ang80],
- Coverings are graph homomorphisms that "express" symmetry in anonymous networks,
- If a network $G$ can be “collapsed” onto another one $D$ through a covering:
  - any computation on $D$ can be lifted on $G$,
  - $D$ summarizes the behaviour of $G$.

Detection of stable properties:

- Chandy-Lamport algorithm: local snapshots computations,
- Adaptation of the Mazurkiewicz algorithm: snapshot computation up to a covering at any process but does not terminate,
- SSP algorithm: termination of the snapshot computation.
Summary and Future Works

Summary

▶ Characterizations of stable properties which can be detected in a fully distributed system:
  ▶ no distinguished process,
  ▶ several initiators,
  ▶ anonymous networks,
  ▶ knowledge on an upper bound on the diameter of the network.

▶ Termination detection of the Chandy-Lamport algorithm can be detected with SSP:
  ▶ termination detection of an underlying algorithm,
  ▶ checkpoint and rollback recovery.

▶ Introduction of the notion of weak snapshots as the maximal information a process can compute anonymously.

Open Question

Study the efficiency and the complexity of our snapshot computation and stable properties detection algorithms.
That’s all folks!

Merci !

Plus de détails ?

Jérémie Chalopin, Yves Métivier, and Thomas Morsellino.  
Dana Angluin, James Aspnes, David Eisenstat, and Eric Ruppert.

D. Angluin.
Local and global properties in networks of processors.

R. Guerraoui and E. Ruppert.
What can be implemented anonymously?

B. Szymanski, Y. Shy, and N. Prywes.
Synchronized distributed termination.