Snapshots et Détection de Propriétés Stables dans les Systèmes Distribués Anonymes[1]

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Context of this Work

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

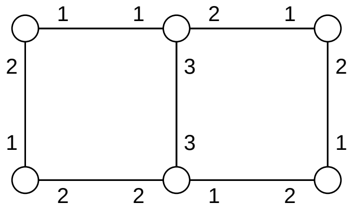
Under these hypothesis:

- 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 δ in which each process can:

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



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.

Outline

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.

Ideas (1)

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.

Ideas (2)

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 ?

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