Brief Announcement:

Partition Approach to Failure Detectors for $k$-Set Agreement

Wei Chen, Microsoft Research Asia
Jialin Zhang, Tsinghua University
Yu Chen, Microsoft Research Asia
Xuezheng Liu, Microsoft Research Asia
Background

System model:
- asynchronous message-passing,
- processes may fail by crashing

$k$-Set Agreement:
- $n$ distributed processes, each proposes one value
- agree on at most $k$ different proposed values
- $k=1$ is the classic consensus problem
- $k$-set agreement is impossible when $k$ processes may fail

Failure detectors
- abstract synchrony and failure conditions
Failure Detectors for $k$-Set Agreement

Several FD variants known, among them:

- [Mostefaoui, et.al, PODC’06]: $\Omega_k$, the weakest among the known FDs that solves $k$-set agreement (with a majority of correct processes)
- Weakest FD for $k$-set agreement (for any $k>1$) is an open problem: “… remains one of the greatest research challenges in the fault-tolerant asynchronous computing theory community.” [Raynal, Travers ’06]
- $\Omega_k \times \Sigma$: the weakest one known in the message-passing model
Our Contribution

- We introduce the **partition approach**
  - A general approach to weaken FDs for \( k \)-set agreement
- We apply the partition approach to \((\Omega_k \times \Sigma)\) in the message-passing model, and define:
  - \(\Pi_k\): statically partitioned FD, strictly weaker than \(\Omega_k \times \Sigma\)
  - \(\Pi^S_k\): splittable partitioned FD, strictly weaker than \(\Pi_k\)
  - \(\Pi_k\) and \(\Pi^S_k\) strong enough to solve \(k\)-set agreement
Defining Partitioned FDs via the Partition Approach

For $\Pi_k$, Informally,

- FD decides a **static partition** of processes \{P_1, \ldots, P_s\} in each run

- For all $P_i$, FD on $P_i$ satisfies all safety properties of $\Omega_{k_i} \times \Sigma$ restricted on $P_i$, such that $k_1 + k_2 + \ldots + k_s \leq k$.

  - to guarantee at most $k$ decisions for $k$-set agreement.

- There exists a $P_j$ (live component), FD on $P_j$ satisfies all liveness properties of $\Omega_{k_j} \times \Sigma$ restricted on $P_j$

  - to guarantee that eventually processes make decisions.

For $\Pi^S_k$, informally allow dynamic splitting
Relationship Lattice
Relationship Lattice
Summary

- Introduce a general partition approach
- Apply the approach to weaken existing FDs in the message-passing model
- We also have results in shared-memory model (DISC’06)
- Open a new dimension in studying weak FDs for $k$-set agreement

Future work:
- Formally define partitioned FDs and study the weakest partitioned FDs
- Implementation of partitioned FDs to match network partitions