PhD Open Days

Solving Distributed Systems' Problems using Reinforcement Learning

PhD in Computer Science and Engineering

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Problem

- Distributed algorithms are the support of modern technologies such as:

  IoT Blockchain

- However, implementing distributed algorithms is:

  Complex Time-consuming

Can AI help us generating distributed algorithms ?

Objectives

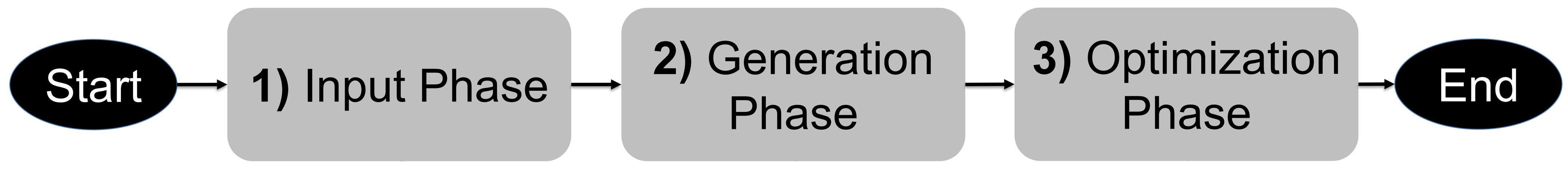
1. Automatically generate correct and efficient fault-tolerant distributed algorithms
2. Use Reinforcement Learning techniques to:
   1. Generate known algorithms for specific cases
   2. Generate new algorithms to advance the state-of-the-art

Methodology

- An automatic generation process that learns to generate algorithms based on *Reinforcement Learning*
- An automatic verification process that uses a model-checking tool (*Spin*) to validate the correctness of the generated algorithms
- No need for concrete solutions of prior distributed algorithms
- First work to adopt a machine learning technique on the generation of fault-tolerant distributed algorithms

Proposed Solution

Architecture of the solution



1) Definition of the requirements to generate and verify the algorithms (e.g. type of failures, fault-tolerance ratio, thresholds, ...)

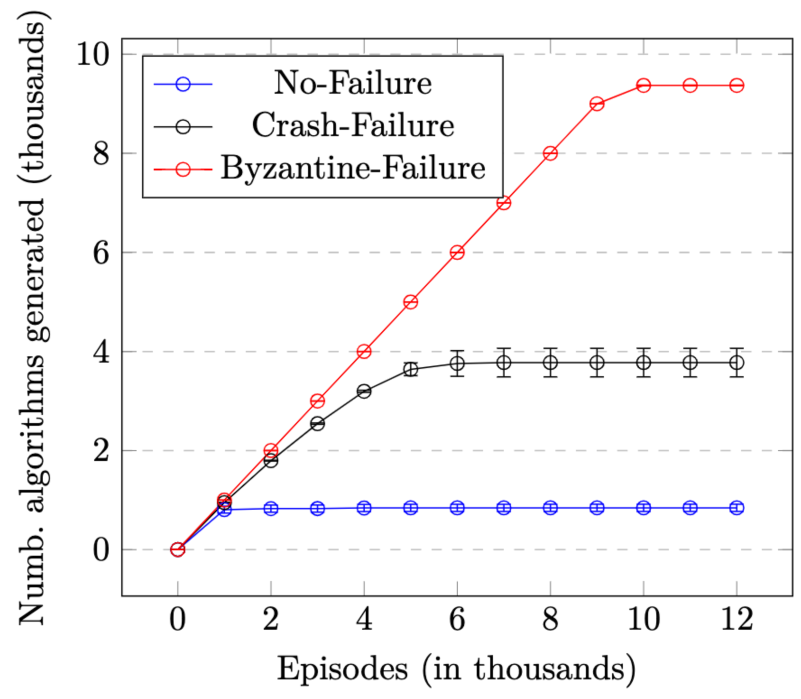
2) Based on the requirements, our solution generates and verifies multiple algorithms, receiving positive and negative rewards, based on the correctness of the algorithms generated

3) A correct and efficient algorithm (*optimal algorithm*) is generated based on the knowledge from the Generation Phase

Experimental Evaluation

```
when RB-Broadcast(m) do:
    SEND to neighbours(<type0,m>) if true and not already sent;
    STOP if true;

when receive(<t,m >) do:
    SEND to neighbours(<type1,m>) if received (<type0,m>) from 1 distinct parties and not
  already sent;
    SEND to neighbours(<type1,m>) if received (<type1,m>) from F+1 distinct parties and
  not already sent;
    DELIVER(<m>) if received (<type1,m>) from F + 1 distinct parties and not already delivered;
    STOP if true;
```



- First study applied to the generation of *Reliable Broadcast* algorithms
  - New Byzantine-tolerant Reliable Broadcast algorithm generated

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