Learning a distributed algorithm

Can we teach a neural network to solve a distributed computing problem? On the surface, designing a distributed is not much different from any other problem in reinforcement learning: we train a neural network on a subset of executions with rewards a punishments adjusted to the problem specification in the hope that it will figure out an algorithm that runs correctly in *every* execution. But will it work in practice. The goal of this (simply formulated but extremely bold) project is to test this idea on a collection of simple "toy" problems, and then, if we succeed, to proceed to more relevant ones.

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Active dynamic conflicts in distributed systems

Detecting and resolving conflicts between concurrent operations is the major synchronization challenge. Intuitively, if concurrent operations commute (i.e., theire effects do not depend on the order in which they are applied), there is no need to synchronize and the operations can proceed in parallel. The goal of the project is to understand if such a parallelization can be achieved each time no *active dynamic* conflict is encountered, i.e., no two *active* operations conflict *given the current system state*. One can argue that this is the most refined way of dealing with conflicts, but can it be implemented?

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Conflict-freedom in the wild

Conflict-freedom is a recently proposed liveness condition that guarantees a process to make progress if it encounters no conflicting operation. Conflict-freedom allows a concurrent universal construction in read-write shared-memory system, where the process are subject to crash failures. The goal of this project is to extend this idea to distributed message-passing systems, subject to Byzantine failures.

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Performance analysis of DAG-based blockchains

Maintaining shared data in the form of a DAG (Directed Acyclic Graph) showed a lot of promise in large-scale distributed systems. We observe, however, a trade-off between the "density" of the shared graph and the performance of the system running on top of it. The goal of the project is to explore these performance trade-offs experimentally.

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