GoDAG: Learning Workflow Scheduling in Multi-Resource Clusters
Yang Hu, Cees de Laat and Zhiming Zhao
System and Networking Lab, Informatics Institute, University of Amsterdam

GoDAG
GoDAG is a machine learning based approach that can learn workflow scheduling in multi-resource clusters, which can
- learn the scheduling policy from experience through deep reinforcement learning
- minimize the average makespan of workflows
- outperform the state-of-the-art schedulers in different scenarios

Deep Reinforcement Learning
An reinforcement learning agent interacts with an environment over a number of discrete time steps. At each time step $t$, the agent:
- receives a state $s$ through observation of the environment
- selects an action $a$ according to its policy $\pi$
- receives a scalar reward $r$ after taking the action

The goal is to maximize expected return with discount factor $\gamma$:
$$R = \sum_{t=0}^{\infty} \gamma^t r_t$$

Design
The basic design of GoDAG is the reinforcement learning agent continuously observes the state of workflow system, and makes scheduling decisions through the policy neural network. In the figure, task1 is completed; task2 is running in the cluster; task3 and task4 are ready to run. The agent feeds the policy neural network with the information of pending tasks and the status of cluster. According to the output of the policy neural network, the agent schedules the task3 to the cluster at this time step. This process will continue until all tasks are completed.

Evaluation
Compared to the state-of-the-art schedulers: Multi-resource Packer (PACK), Shortest Task First (STF) and Critical Path First (CPF), GoDAG outperforms the baselines with running 300 different workflow jobs in the experiment. According to the average makespan curve along the training, GoDAG outperforms other heuristics after 300 iterations, and tends to be stable after 1,000 iterations.