Fraunhofer Institute for Integrated Circuits IIS
Division Engineering of Adaptive Systems
Konstantin Wrede

Dresden University of Technology (TU Dresden)
Institute of Electromechanical and Electronic Design
Christoph Steinmann

FMUGym: From Uncertainty-Aware Simulation to Learning-Based Control with FMI and Python

Tutorial @ 16th International Modelica & FMI Conference

Motivation

Some Quotes from Smart People

"All models are wrong, but some are useful"

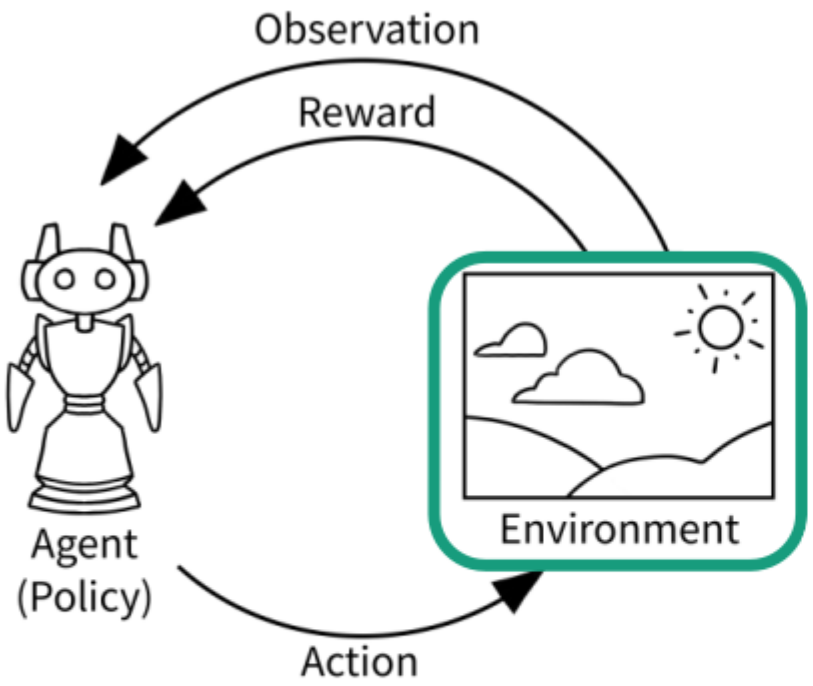
- George E. P. Box

"Very wrong models, can be very useful"

- Roberto Calandra

Motivation

Self-learning Control Systems: Reinforcement Learning and FMI Standard



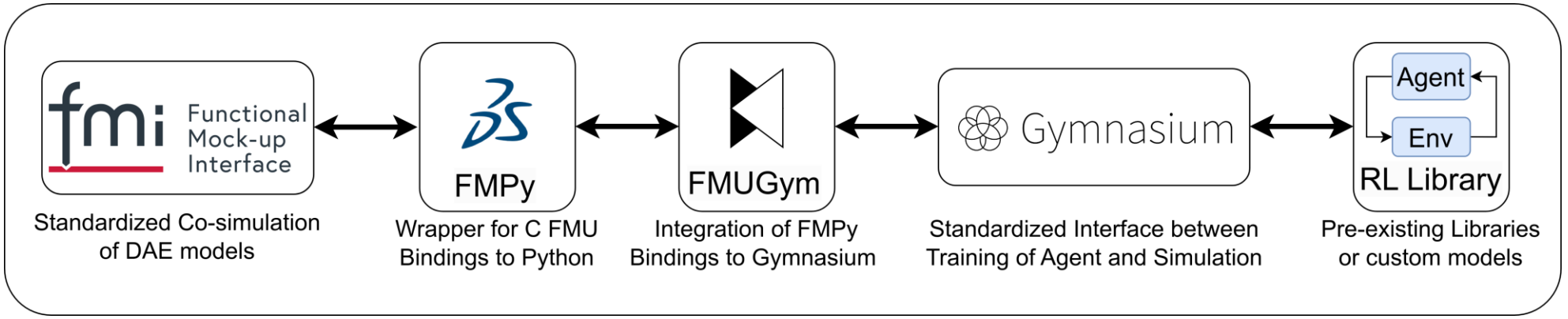
fmi Functional Mock-up Interface

Modelica Language

MATLAB

FMUGym Interface

Connecting FMI with Reinforcement Learning Agents

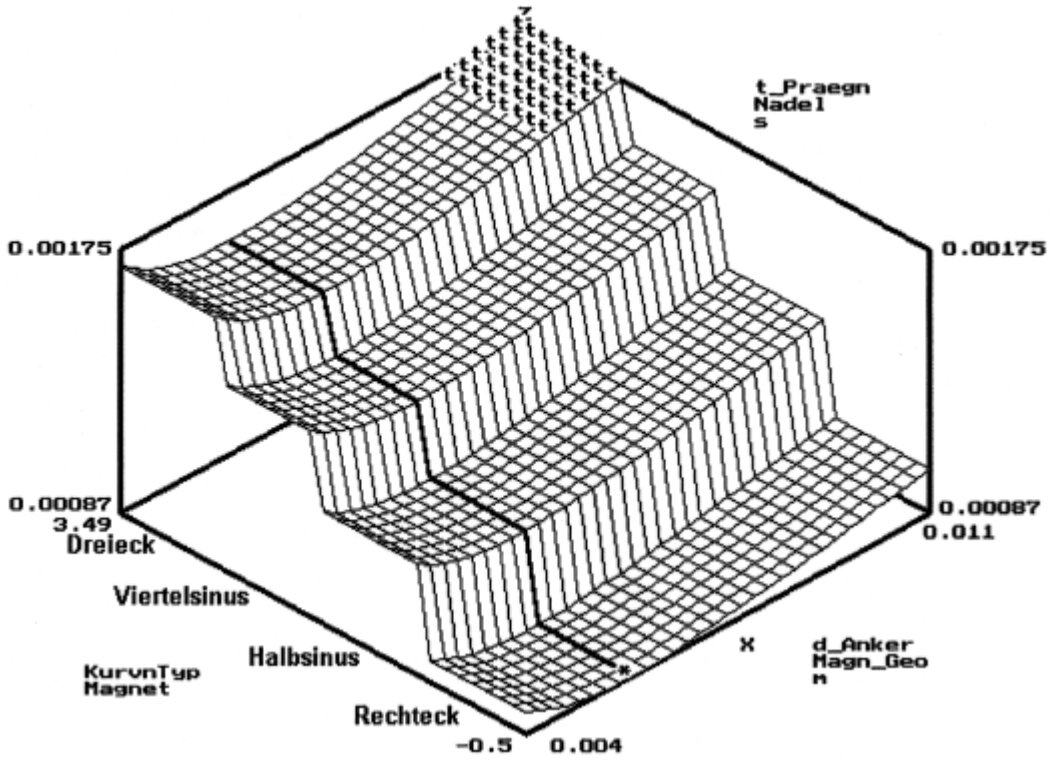


Tutorial Participation:

- **Windows** with Google Account**:** Colab https://tinyurl.com/fmugym-colab (**suggested**)
- **Windows** without Google Account**:** Binder https://tinyurl.com/fmugym-binder (very slow Reinforcement Learning)
- Additional for **Linux**: clone repo and follow local Installation https://github.com/Fraunhofer-IIS/fmugym (best to continue)

Tuning PID Controller

Evolutionary Algorithm

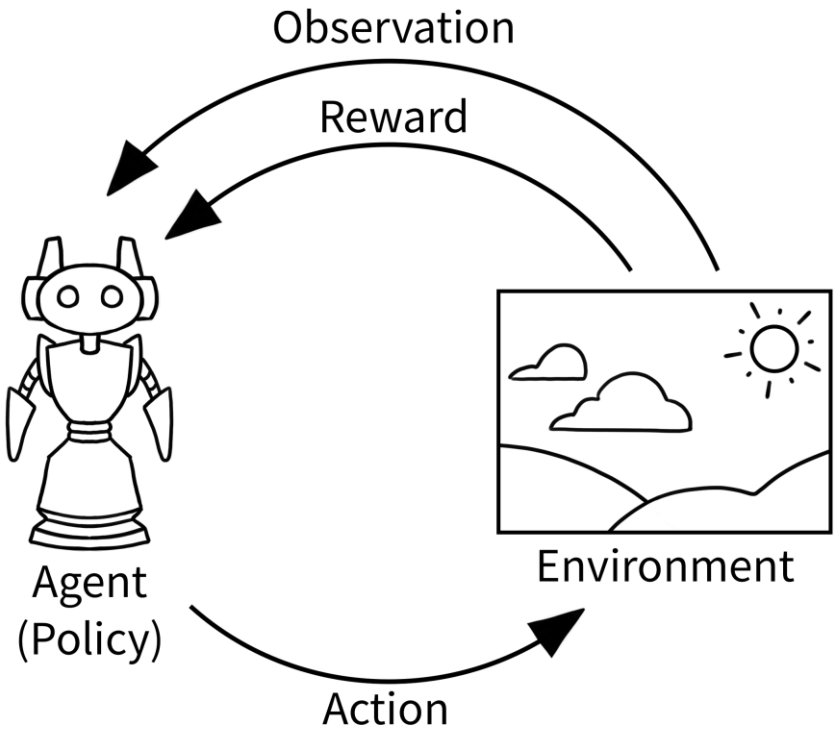


Optimization by diferential evolution:

- **Evolutionary algorithms**: Generate child generations via mutation and recombination; selection based on fitness.
- Population-based, real-valued search without gradients
- **DE**: Offspring via weighted vector differences; selection by fitness
- Configuration aspects: Parent/child ratio, selection type / strategy, recombination method, mutation step-size control.
- Strong on noisy, discontinuous, high-dimensional problems

Reinforcement Learning

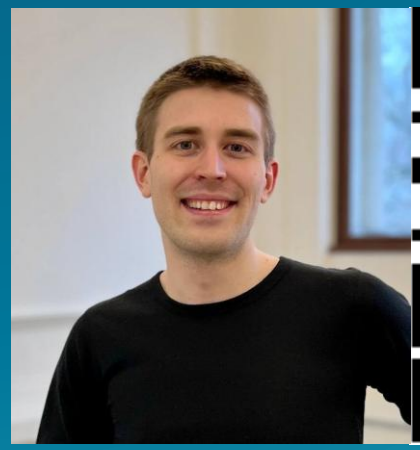
Connecting FMI with Reinforcement Learning Agents



Reinforcement learning (RL) as a type of machine learning:

- An **agent** interacts with its (simulated) **environment**
- The agent takes **actions** based on its current **policy** and **observations**
- The environment provides a **reward** based on its current state
- The (cumulative) reward is a metric to **optimize** the agent's policy
- While **training**, randomized actions for **exploration** can be selected
- Especially for **inference** the the experience gained is **exploited**

Feel free to reach out!



Konstantin Wrede
Research Scientist
Fraunhofer IIS Dresden
konstantin.wrede@iis.fraunhofer.de