Practical: EvoRob Report

8 May 2025

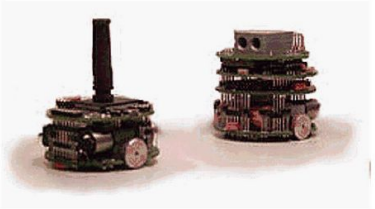
09.15 - 10.30

Lecture:

- Competitive and cooperative coevolution

10:30 - 12:00
EvoRobo (report session):

- Full body and brain evolution



Lecture: Competitive and Cooperative Evolution

Check points: Competitive and Cooperative Evolution

Report template

Group choice: EvoRob report

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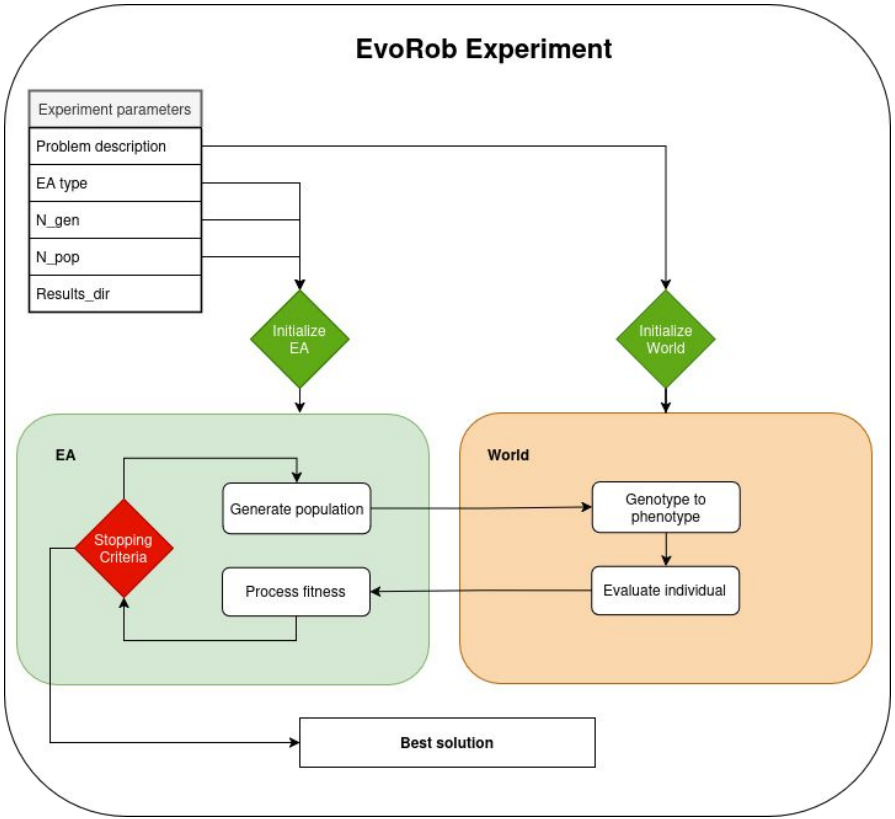

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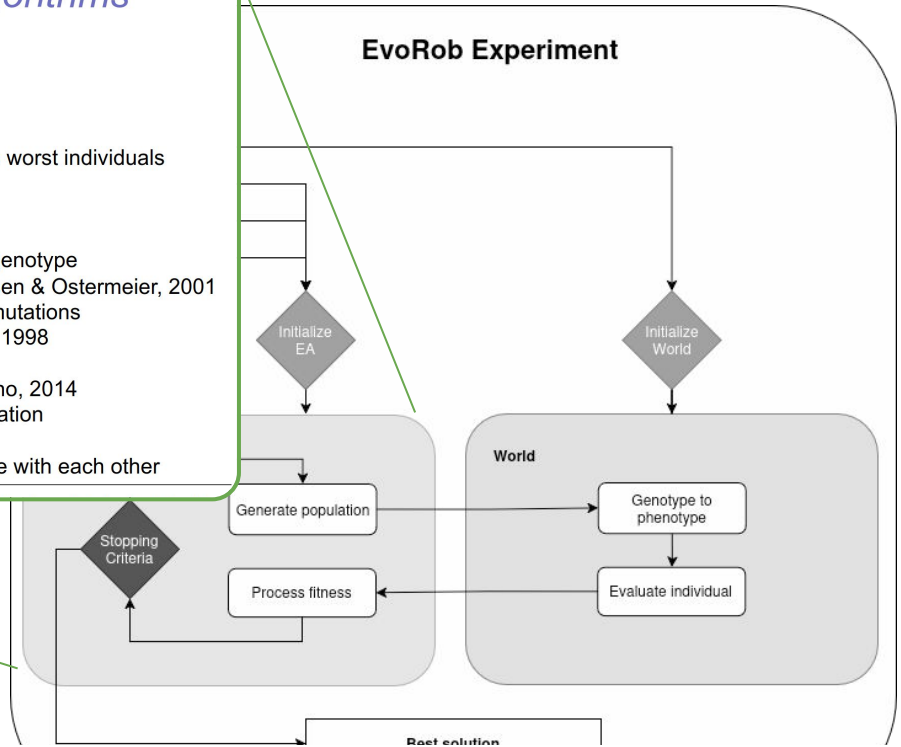
Examples of Evolutionary Algorithms

Genetic Algorithms (GA) - Holland, 1975
Binary genotypes, crossover and mutation
Genetic Programming (GP) - Koza, 1992
Tree-based genotypes, crossover and mutations
Steady-State GA (SSGA) – Whitley et al., 1988
Gradual replacement: Best individuals replace replace worst individuals
Differential Evolution (DE) – Storn & Prince, 1996
As SSGA, but with differential factor
Evolutionary Strategies (ES) - Rechenberg, 1973
Real-valued genotypes, mutation step(s) encoded in genotype
Covariance Matrix Adaptation ES (CMA-ES) – Hansen & Ostermeier, 2001
Evolutionary Strategies with correlated and adaptive mutations
Non-dominated Sorting GA (NSGA)– Srinivas, Deb, 1998
Multi-objective evolutionary optimization
Viability Evolution (ViE)– Maesani, Mattiussi, Floreano, 2014
Evolution without fitness ranking and diversity preservation
MAP Elites – Mouret and Clune, 2015
Preserve diversity by making similar solutions compete with each other

Use test-functions to test your EA implementation



Lecture 1-3

Tjanaka, B., Fontaine, M. C., Lee, D. H., Zhang, Y., Balam, N. R., Dennler, N., ... & Nikolaidis, S. (2023, July). pyribs: A bare-bones python library for quality diversity optimization. In *Proceedings of the Genetic and Evolutionary Computation Conference* (pp. 220-229).

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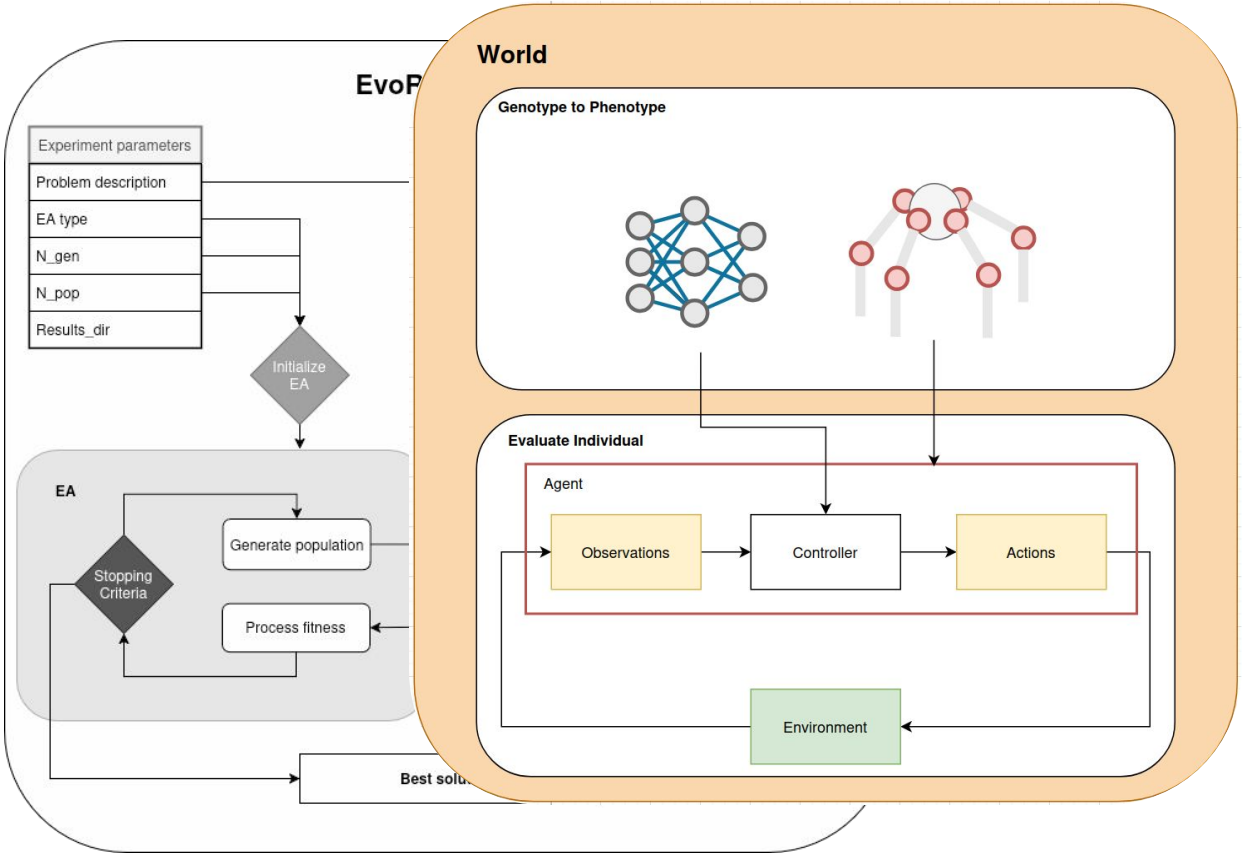

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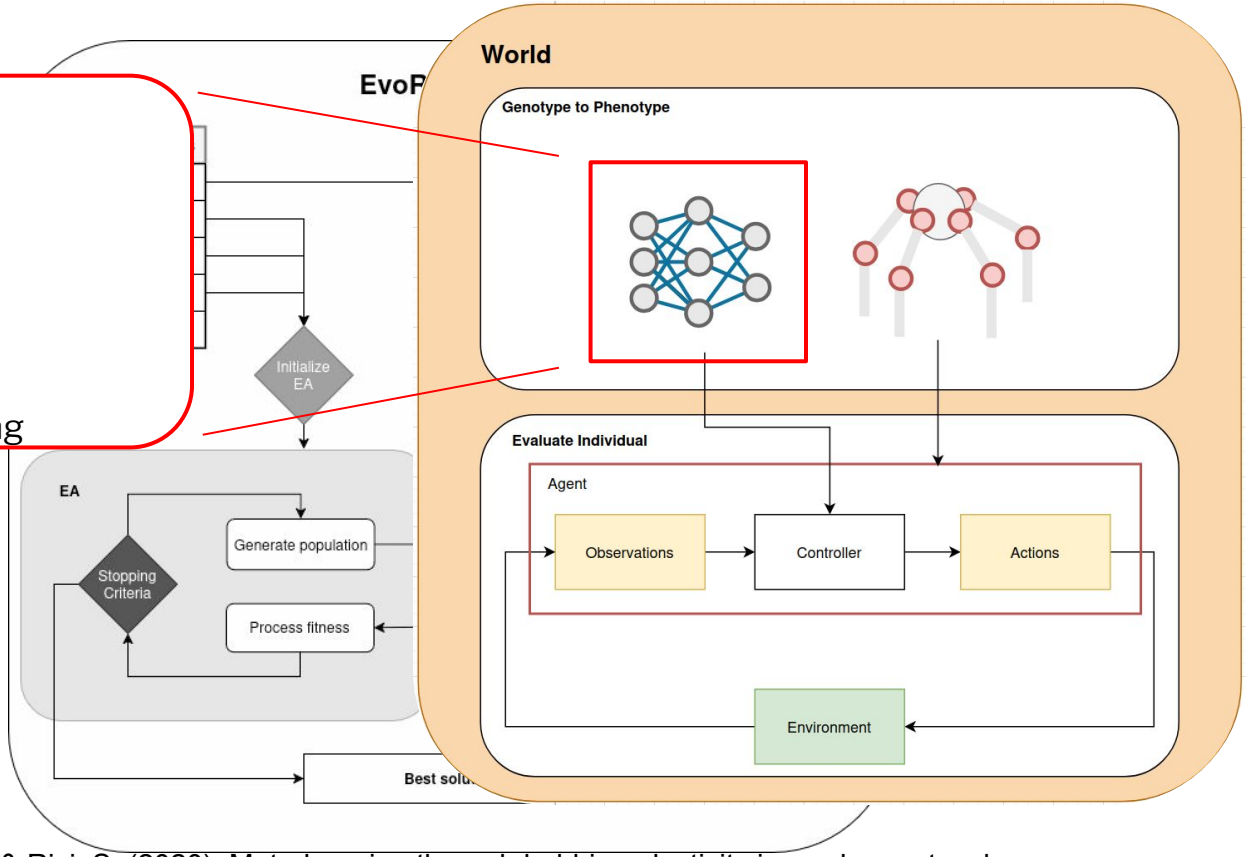
Control architecture
CPG
CPPN-(hyperneat)
NEAT

Evolving+learning
Hebbian learning
Reinforcement learning



Lecture 4-7

Najarro, E., & Risi, S. (2020). Meta-learning through hebbian plasticity in random networks. *Advances in Neural Information Processing Systems*, *33*, 20719-20731.

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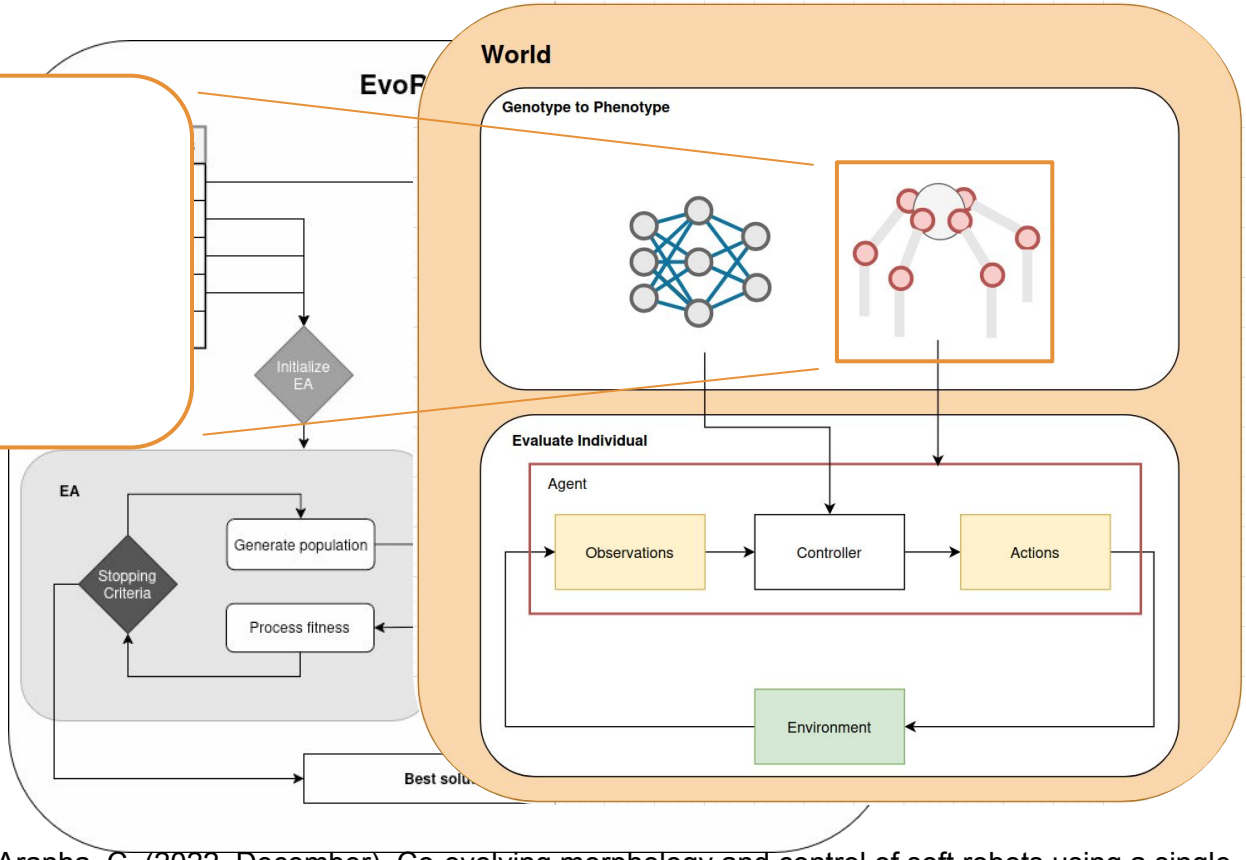
Abstraction-layer
CPPN-HyperNEAT

Mapping
Motor range
Joint orientation
Architecture



Lecture 8-9

Tanaka, F., & Aranha, C. (2022, December). Co-evolving morphology and control of soft robots using a single genome. In *2022 IEEE Symposium Series on Computational Intelligence (SSCI)* (pp. 1235-1242). IEEE.

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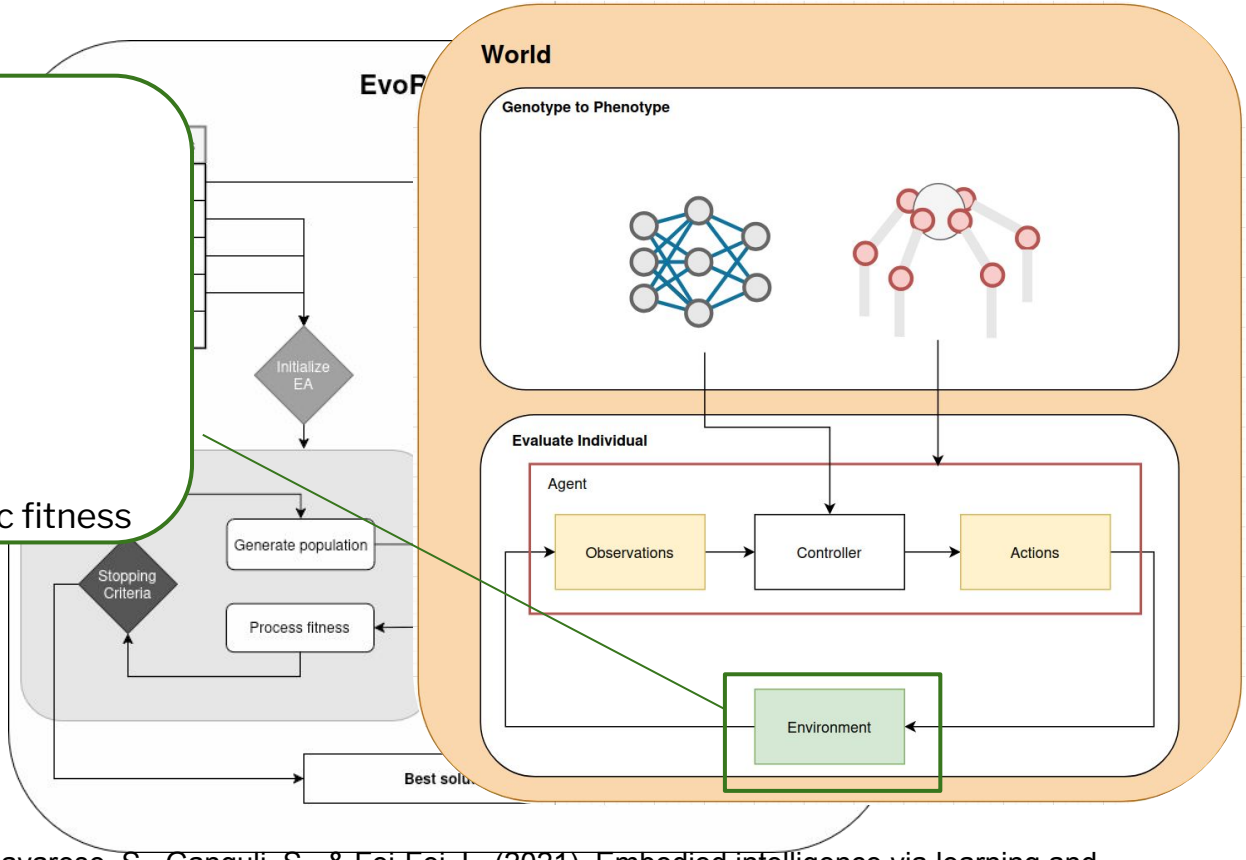
World
Obstacles
Parkour
Staircase

Task
Object manipulation
Collecting resources
Jumping/rolling/gaits
Co- evolution/dynamic fitness



Lecture 1-11

Gupta, A., Savarese, S., Ganguli, S., & Fei-Fei, L. (2021). Embodied intelligence via learning and evolution. *Nature communications*, *12*(1), 5721.

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Limit comparison to one domain:

- Comparison between EAs
- Different geno2pheno mappings/representations
- Different types of controllers
- Evolution & learning
- Different types of environments
- Different types of tasks

Hypothesize what difference in results you expect

Compare:

- performance (fitness curves)
- morphology & behaviors (video)


Statistics refresher

IEEE citation style [1]

[1] https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf

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- Start on now! Use last exercise as template
  - Limit a comparison within a domain (e.g. different tasks)
- Groups of 2 student
- Max 2 pages
- Follow the Word template

Final grade = (report grade + exam grade) / 2