



UNIVERSITÀ DI TRENTO

Dipartimento di Ingegneria e Scienza dell'Informazione

Corso di Laurea in

Ingegneria Informatica, delle Comunicazioni ed Elettronica

Promoting Quality Diversity in Soft Robot co-design evolution

Supervisore

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Laureanda

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Background

Soft robot

- corpo flessibile
- adattabilità
- migliore interazione con l'uomo

Recenti studi

- Evolution Gym [1]
(MIT CSAIL)

Difficoltà

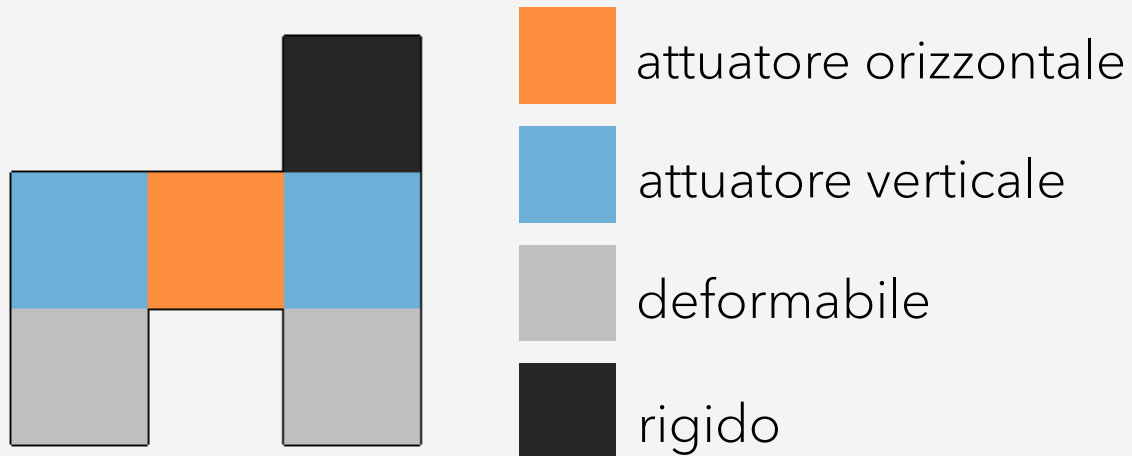
- corpi flessibili e ben performanti
- co-ottimizzazione
 - Algoritmi Evolutivi
 - Reinforcement Learning

[1] Jagdeep Bhatia, Holly Jackson, Yunsheng Tian, Jie Xu, and Wojciech Matusik. Evolution gym: A large-scale benchmark for evolving soft robots. *Advances in Neural Information Processing Systems*, 34, 2021

Soft Robot

Corpo

- voxel



Controller

- rete neurale



Ottimizzazione

Corpo

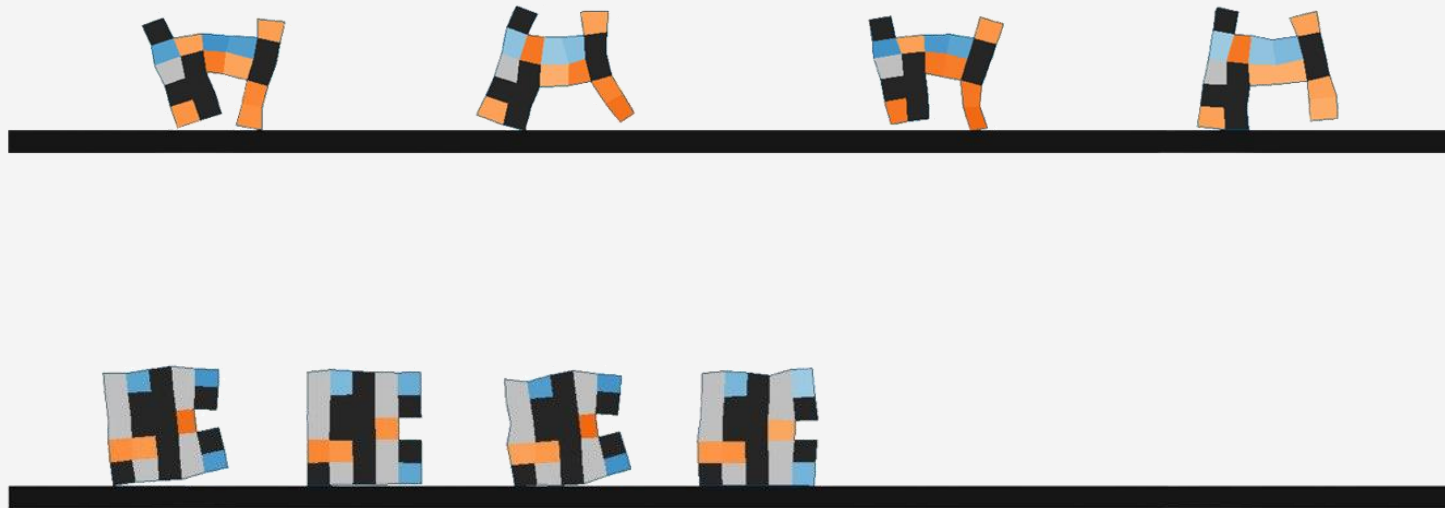
Algoritmi Evolutivi

- Algoritmo Genetico
- MAP-Elites

Controller

Reinforcement Learning

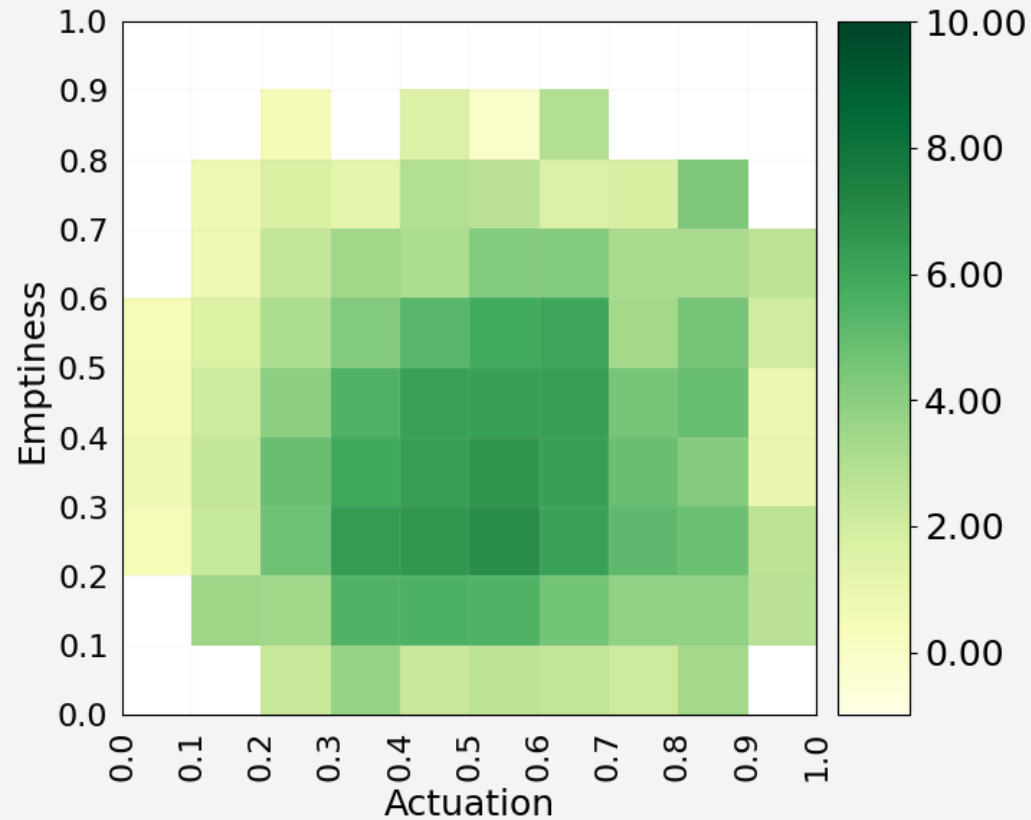
- PPO



MAP-Elites

Features

- Actuation
- Emptiness



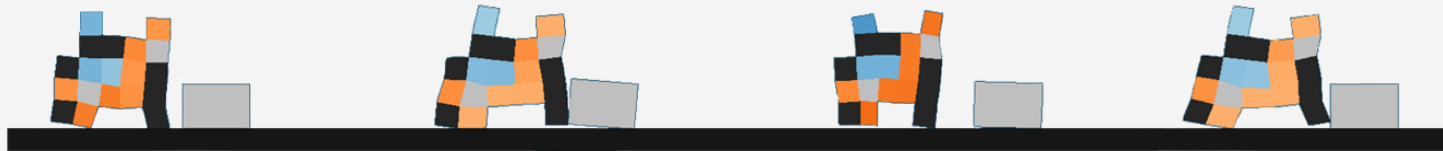
Task



Walker

Premio:

- Posizione robot



Pusher

Premio:

- Posizione robot
- Posizione box

Penalità:

- Distanza box-robot



Carrier

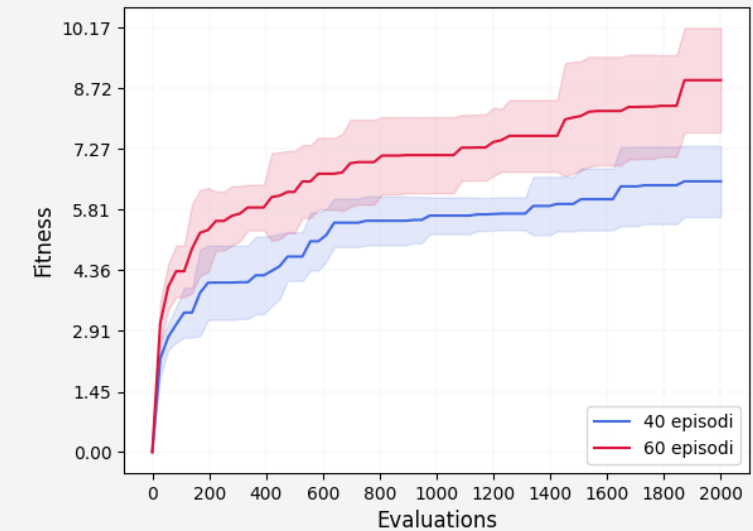
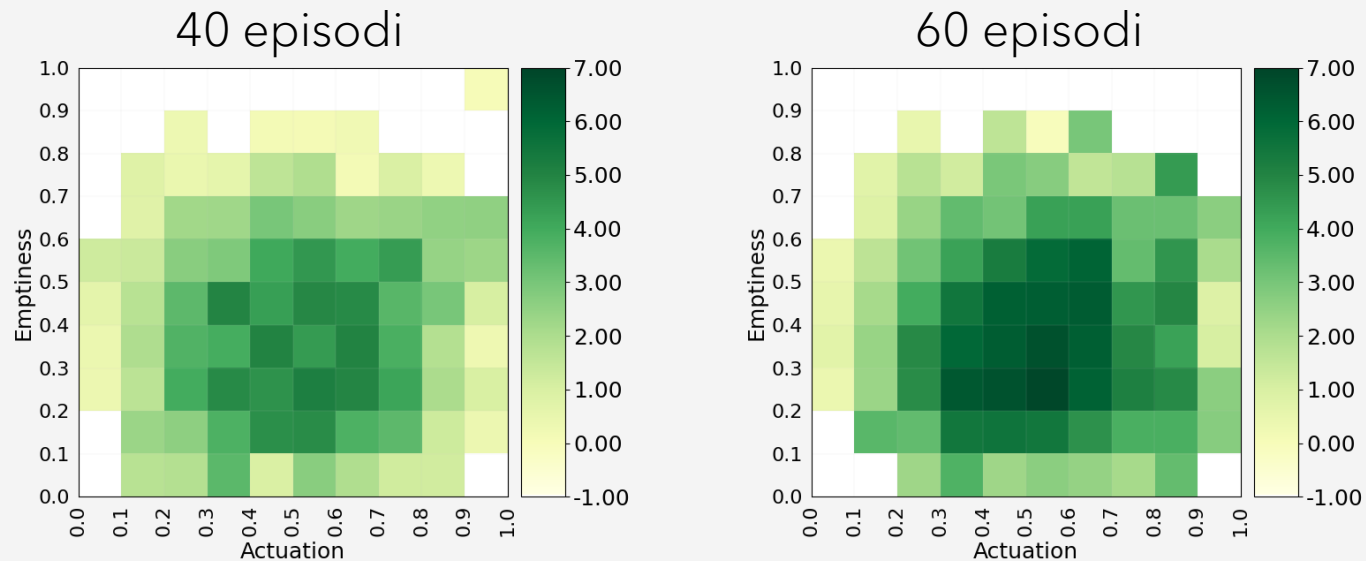
Premio:

- Posizione robot
- Posizione box

Penalità:

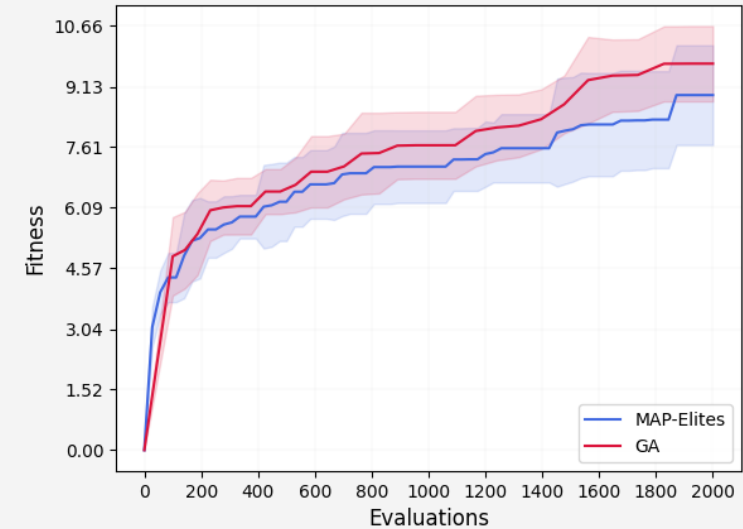
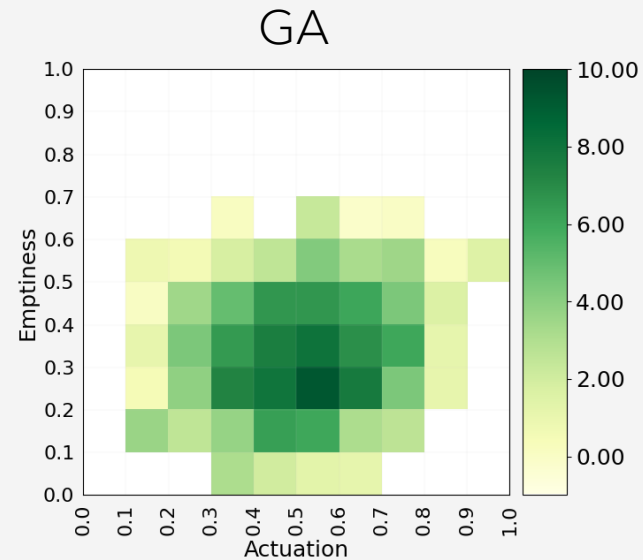
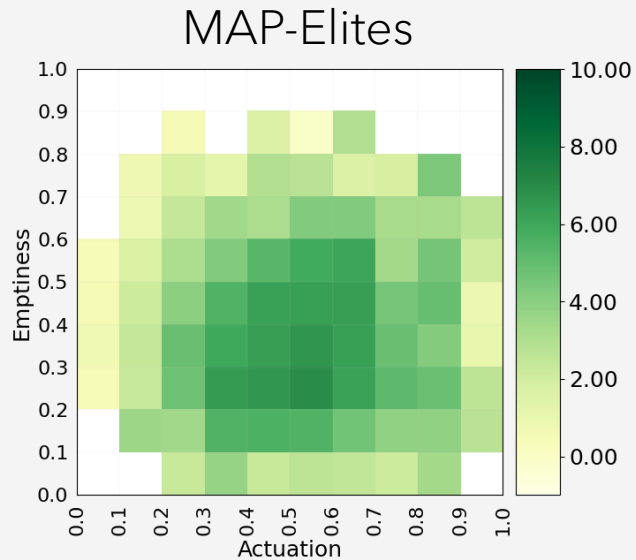
- Caduta box

Walker - ottimizzazione controller



Le mappe e i trend sono il risultato della media di 6 simulazioni

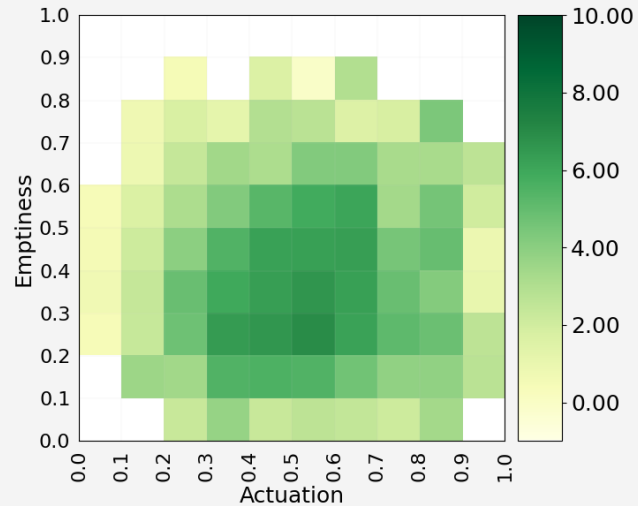
Walker - ottimizzazione corpo



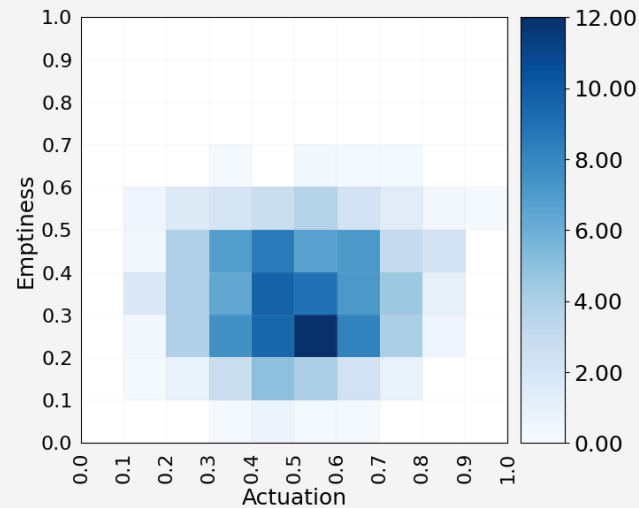
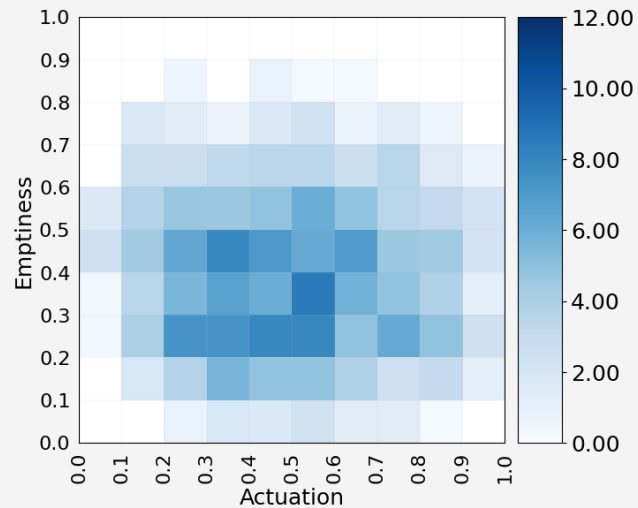
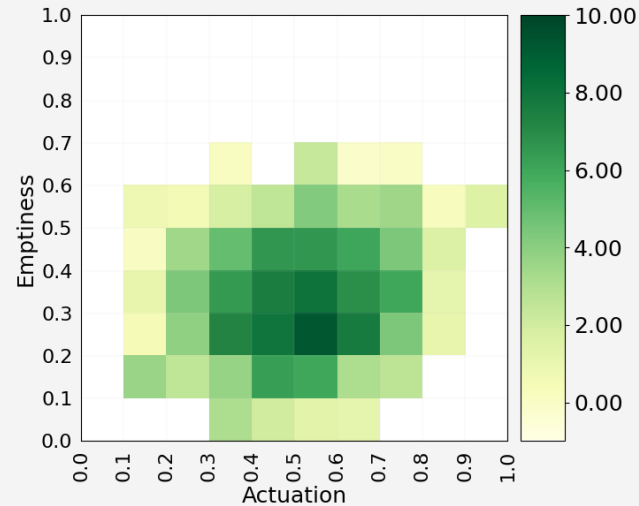
Walker - ottimizzazione corpo



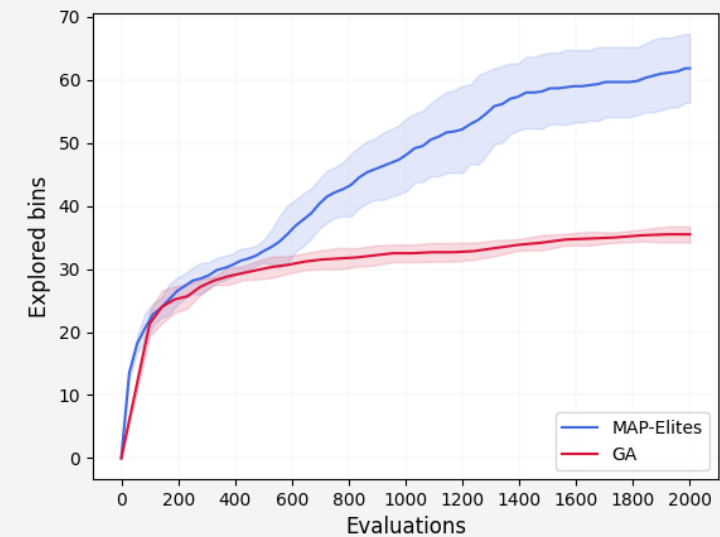
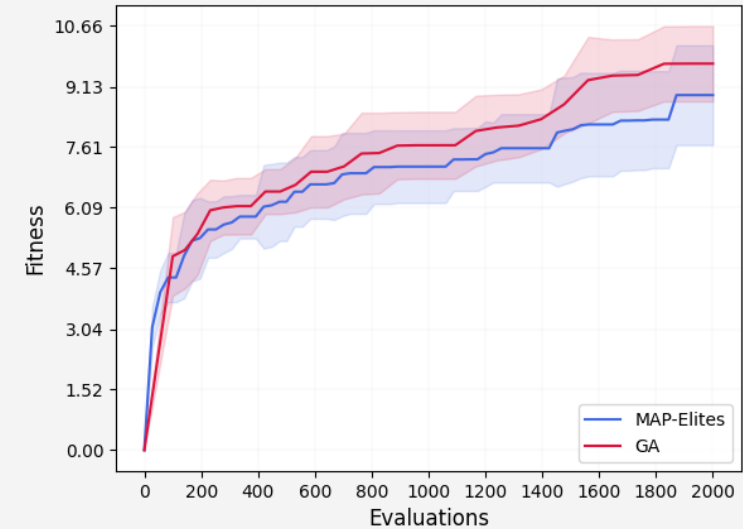
MAP-Elites



GA

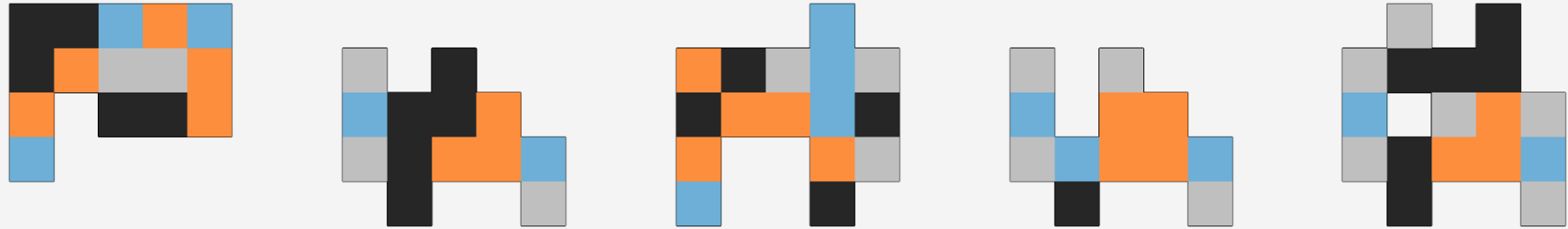


Promoting quality diversity in soft robot co-design evolution

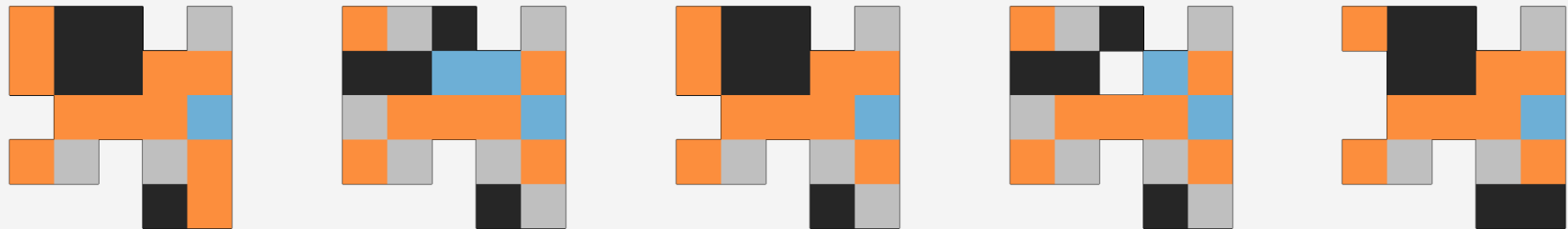


Walker - ottimizzazione corpo

MAP-Elites

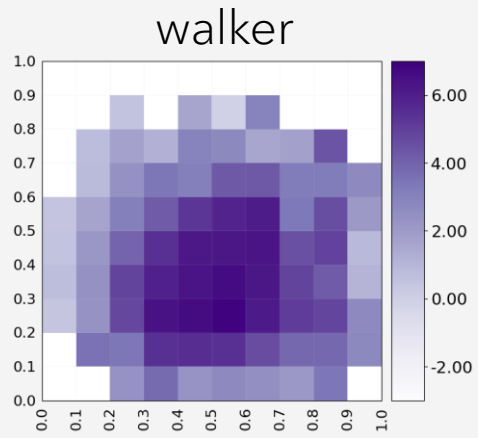


GA

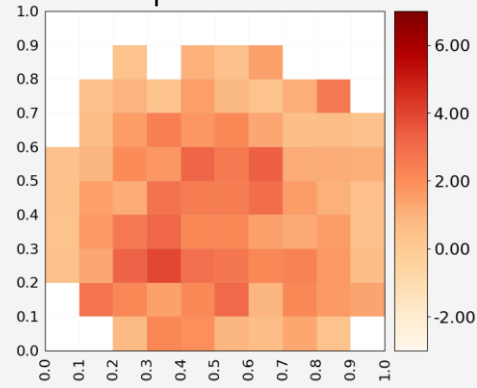




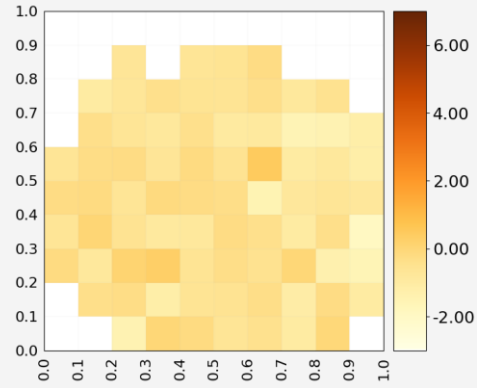
walker



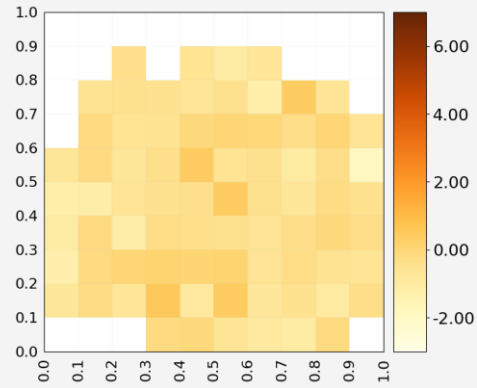
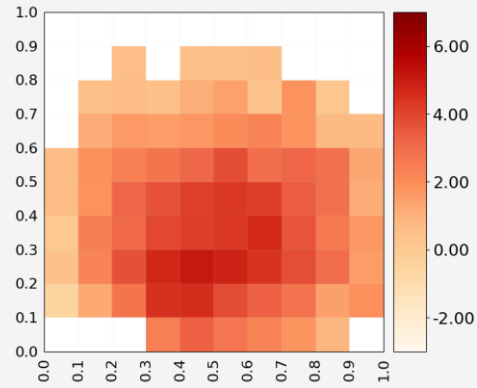
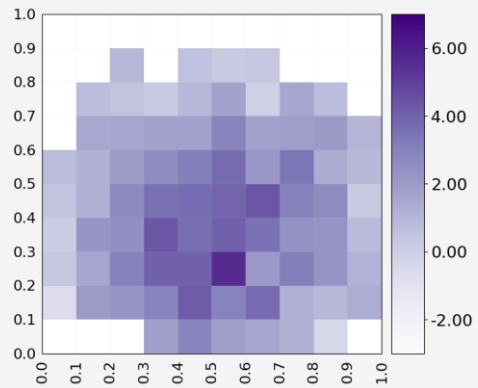
pusher



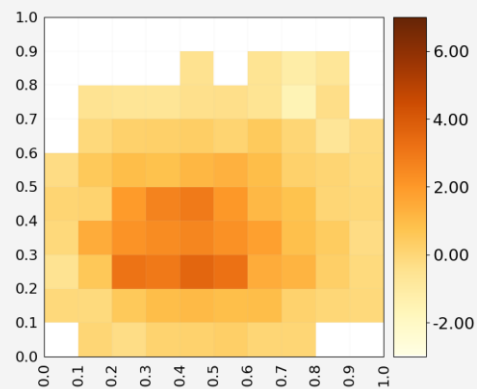
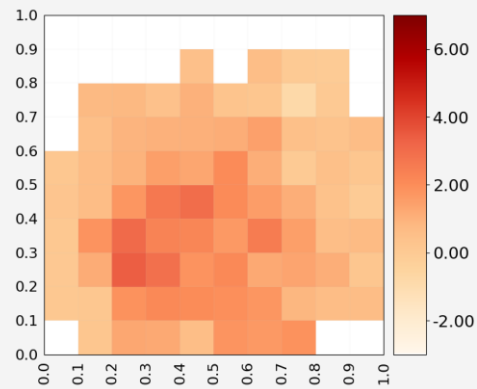
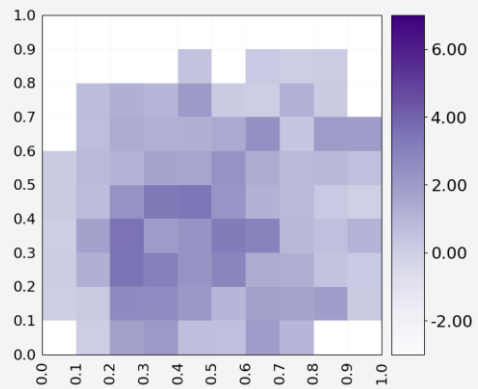
carrier



pusher

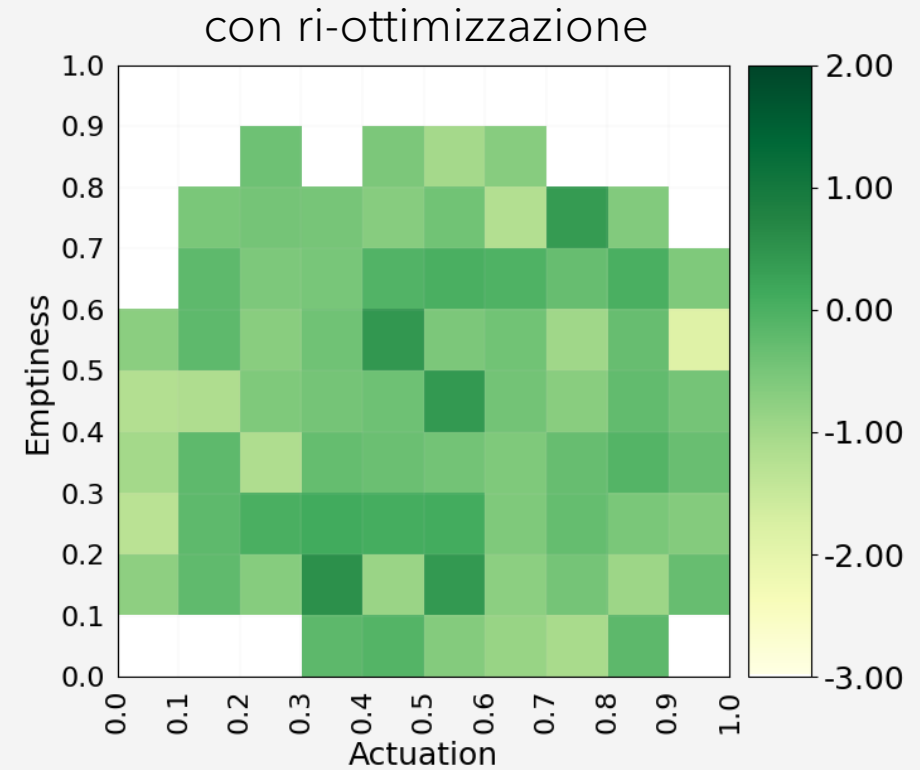
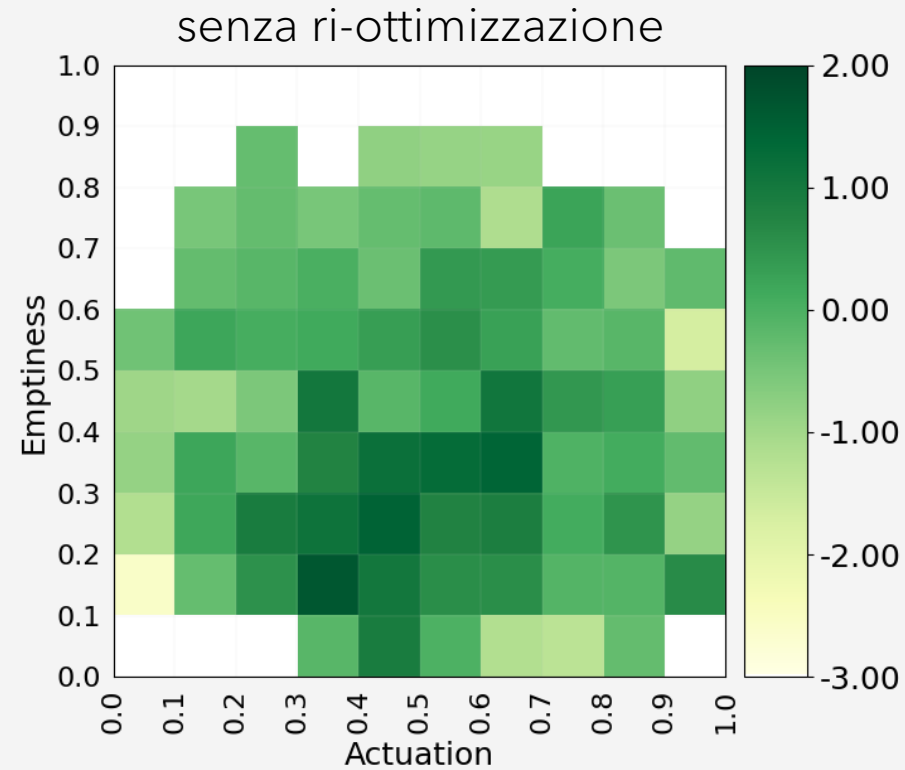


carrier



Multitasking

Multitasking - pusher



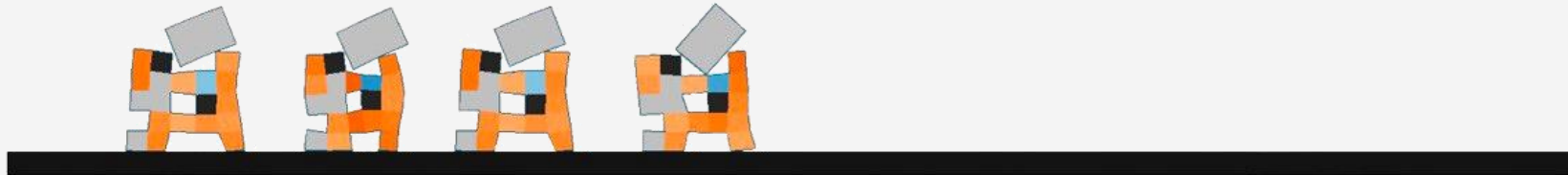
Multitasking - pusher

senza ri-ottimizzazione



Reward:
2.09

con ri-ottimizzazione



Reward:
0.58

Conclusioni

Considerazioni finali

- ottimizzazione:
 - corpo
 - controller
- multitask
 - senza ri-ottimizzazione controller
 - con ri-ottimizzazione controller

Spunti di miglioramento

- altre features
- task più complessi

Caratteristiche

- flessibilità
- simili a sistemi biologici

Applicazioni future

- applicazioni mediche
- migliore interazione

Grazie per l'attenzione