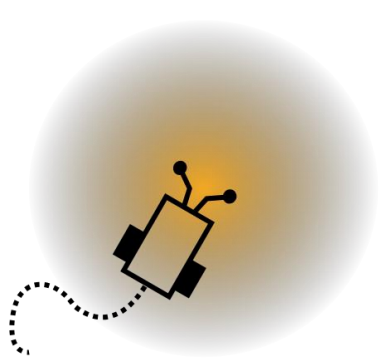




Little Brain Project

Hugo Gravato Marques

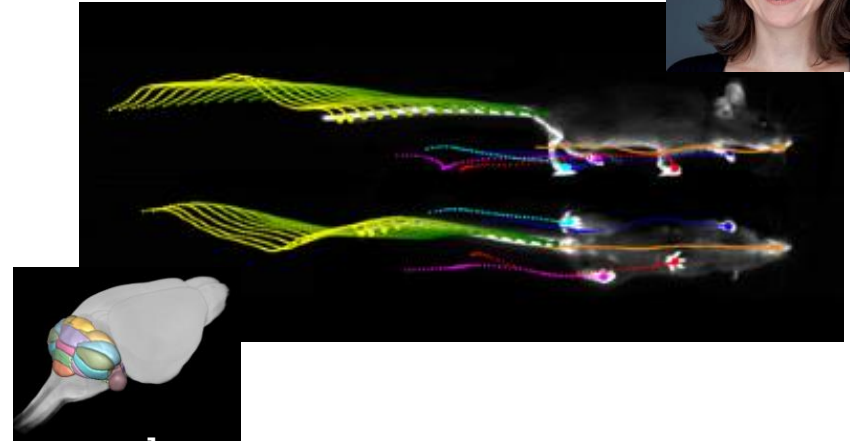
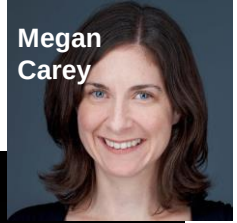
ISR Open Day

23rd of September 2026

Personal background: motor coordination



Eccerobot



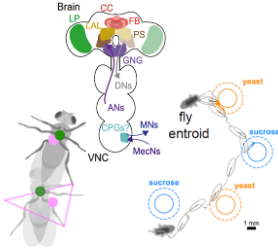
mouse brain

Brain is made for movement, if understand motor control I understand *the Brain*

TeachingLab: Beyond motor coordination

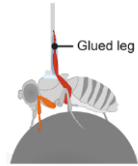


sleep
@Gilestro

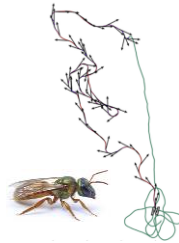


pursuit
@Chiappe

foraging
@Ribeiro



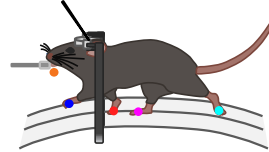
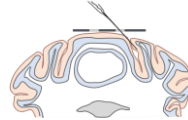
freezing
@Moita



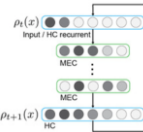
navigation
@Webb



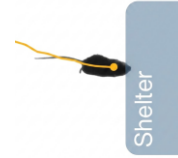
sexual behavior
@Lima



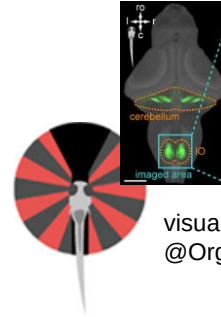
motor coordination
@Carey



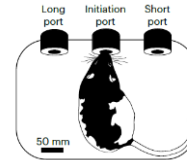
reinforcement learning
@McNamee



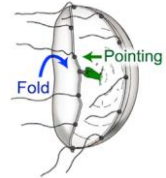
escape, homing
@Branco



visual responses
@Orger



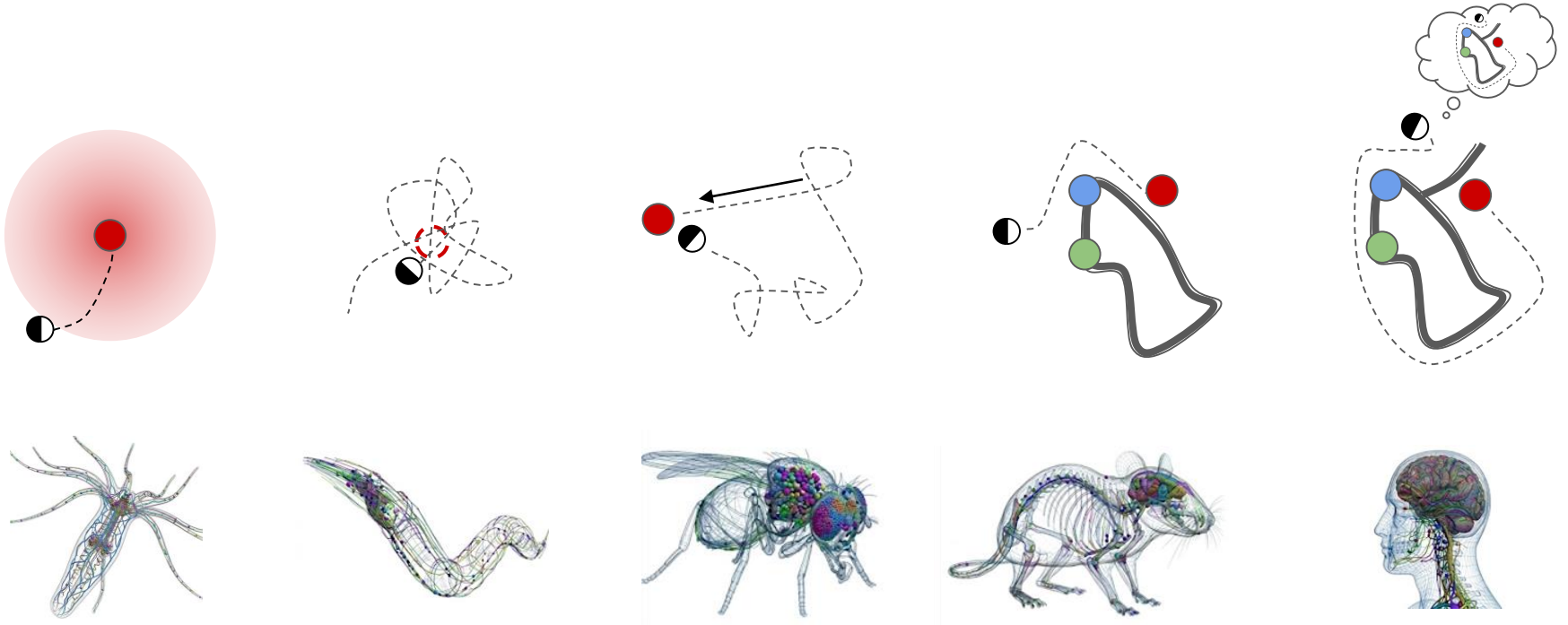
time, motor control
@Paton



feeding
@Kennedy

"Nothing in biology makes sense except in the light of evolution"

Evolution: The additive machine

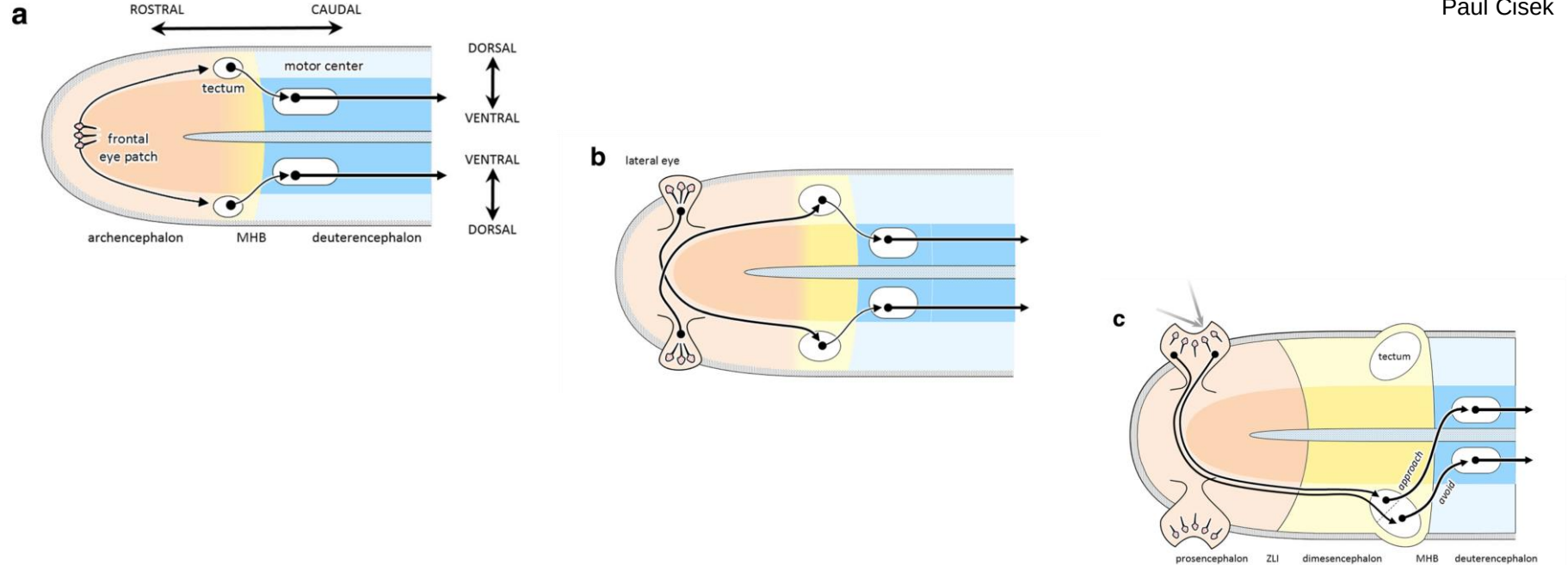


New capabilities continually subsume, rather than replace, existing neural machinery.

Resynthesizing behavior through phylogenetic refinement



Paul Cisek

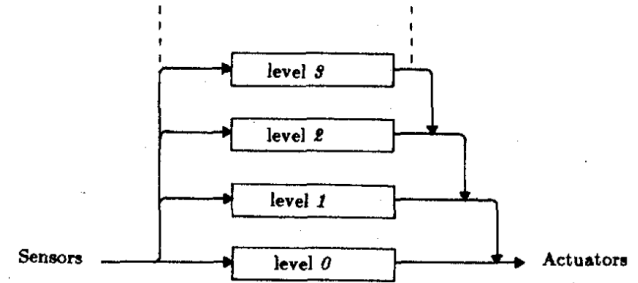
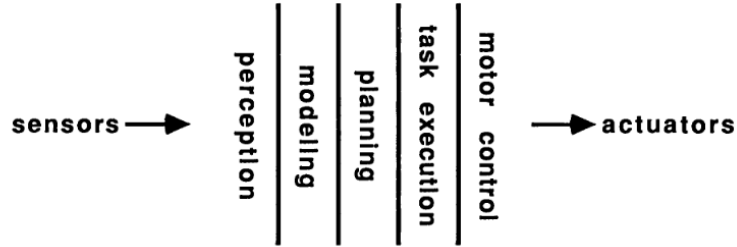


With a small change nature transformed an escape response into predation

Layering feedback loops: Subsumption architecture



Rodney Brooks



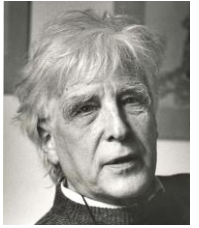
Autonomous robots should be programmed in hierarchical layers of autonomous behaviors

Brooks (1991) *Science*

Brooks (1991) *Artificial Intelligence*

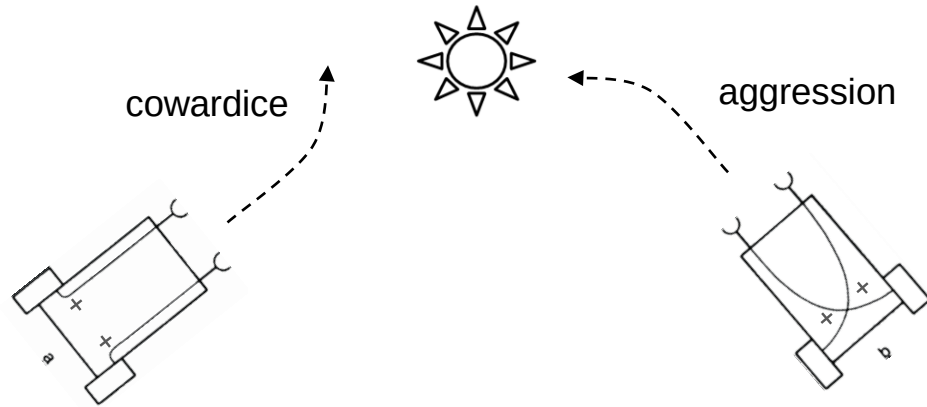
Brooks (1986) *IEEE Journal on Robotics and Automation*

Braitenberg machines: synthetic brains



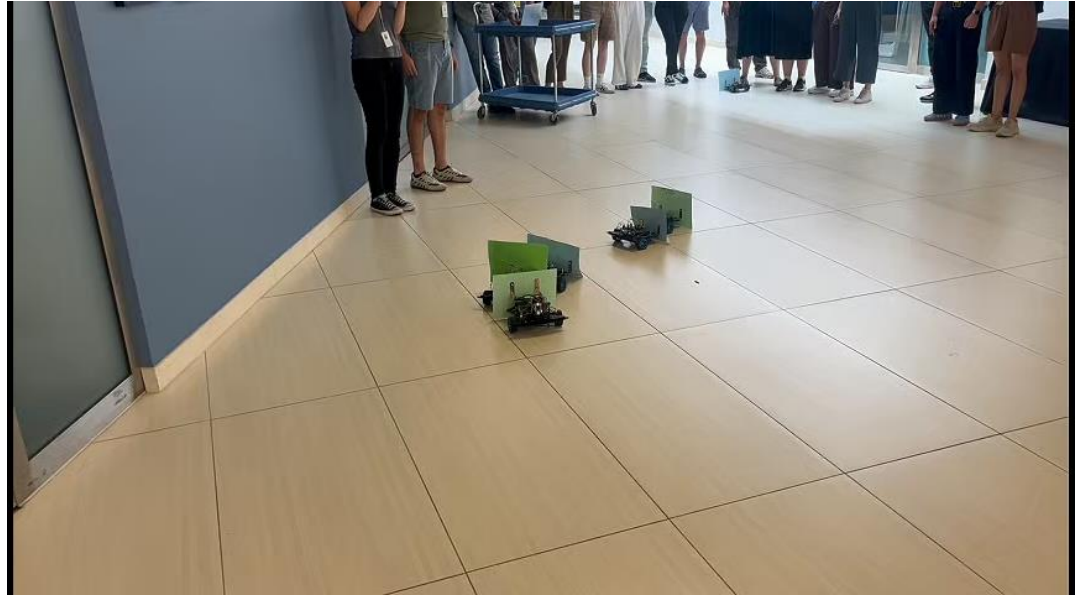
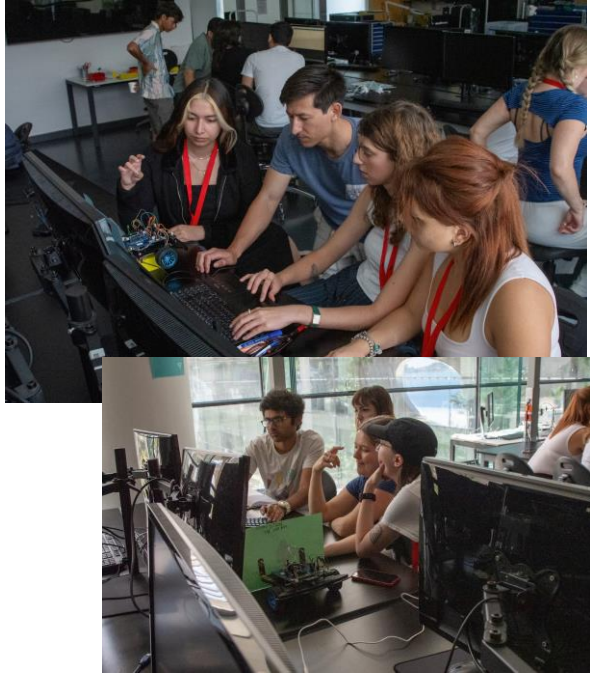
Valentino Braitenberg

Braitenberg vehicles: "... an exercise in fictional science, or science fiction in the service of science [...]. Or just science, if you agree that fiction is part of it, and always will be as long as our brains are only minuscule fragments of the universe, much too small to hold all the facts of the world but not too idle to speculate about them".

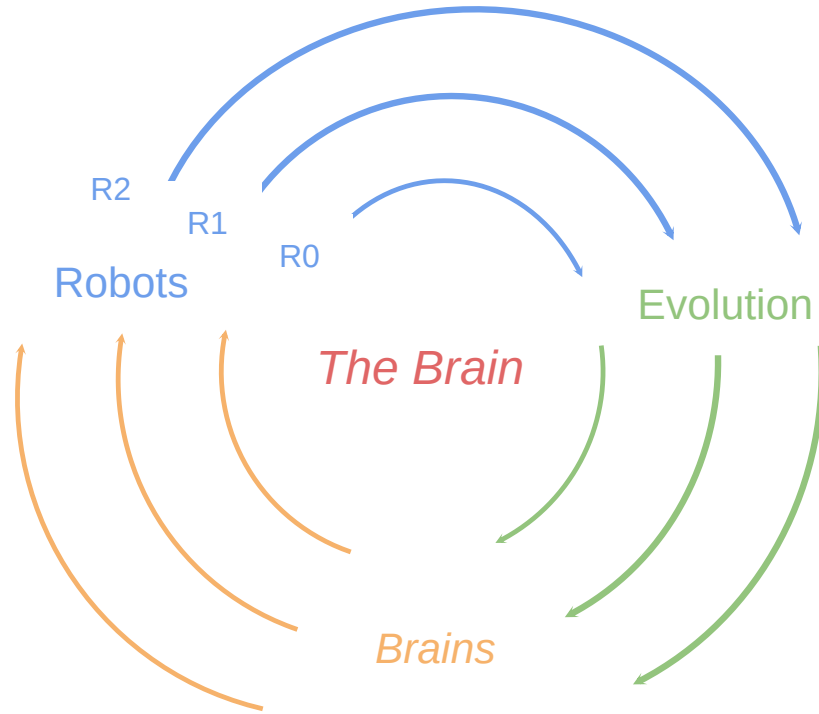


Simple can circuits drive complex behavior

Braitenberg in the Cajal QABVR2026

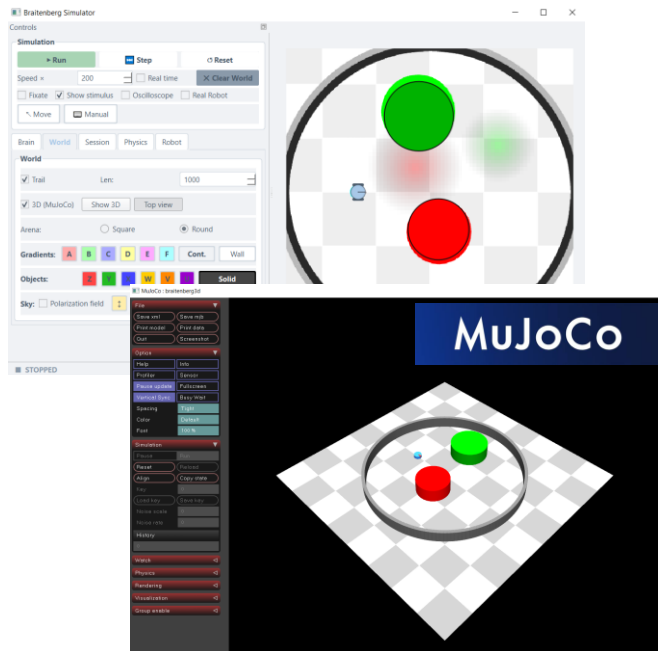


How can we study *The Brain*?

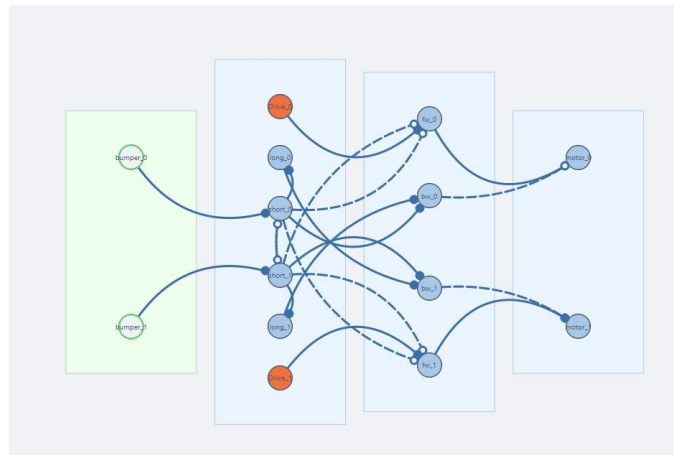


The LBP Simulator

“Physics” / Graphics

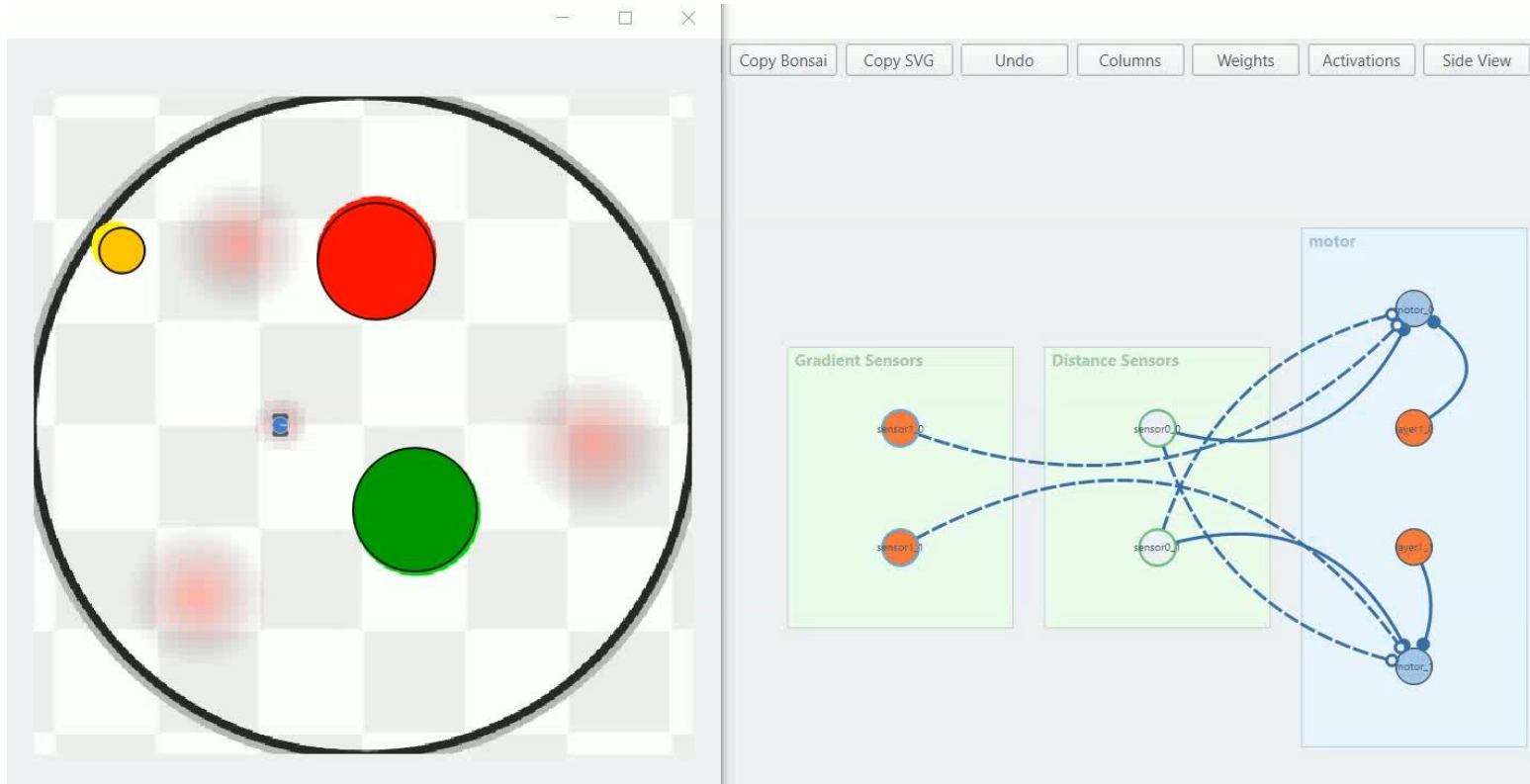


Neural networks

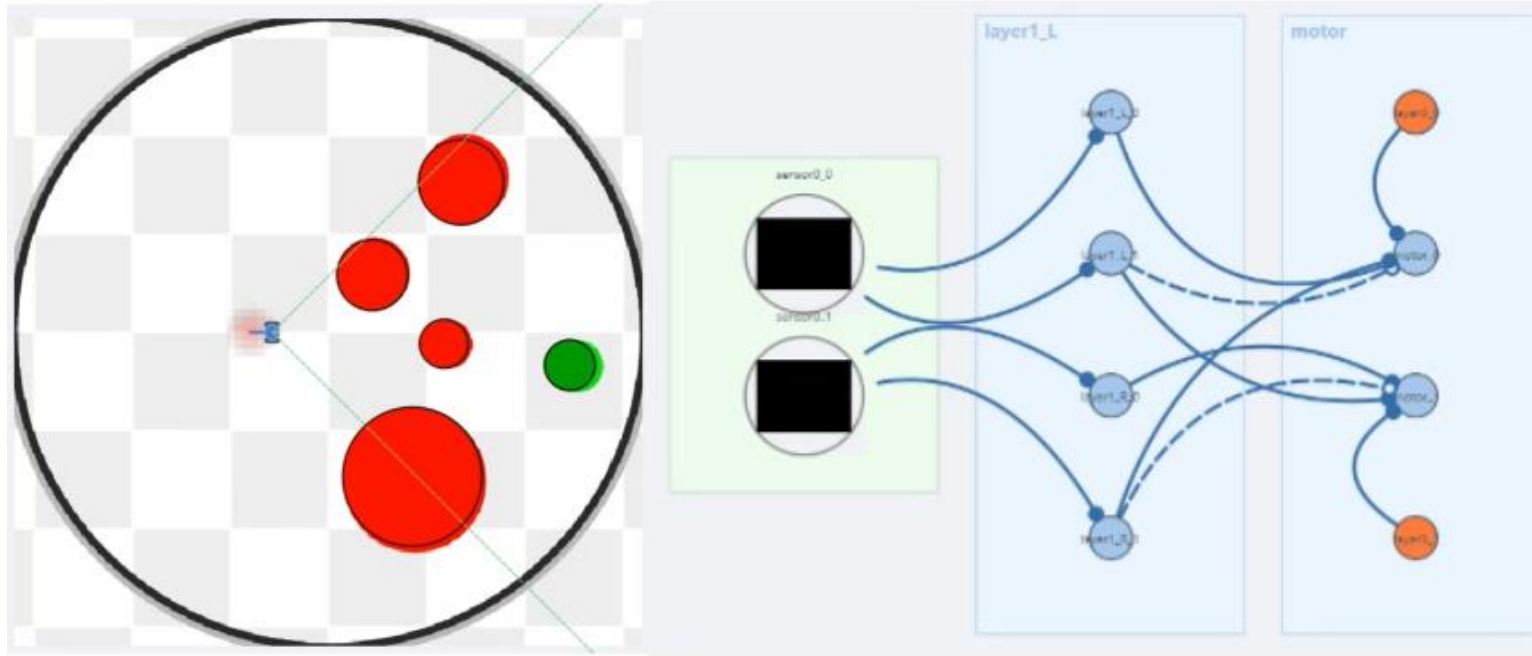


 **PyTorch**
+ dynamics

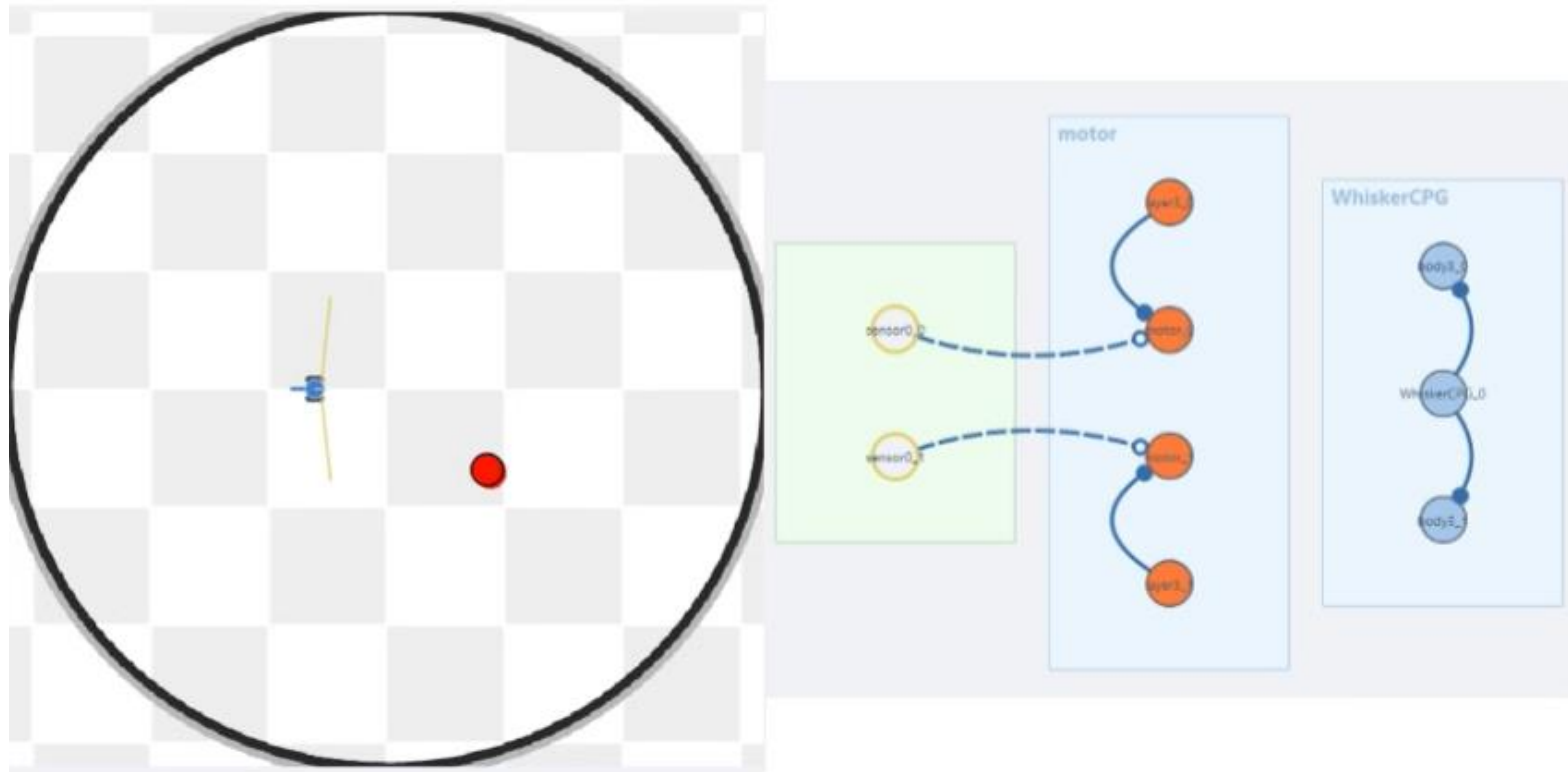
Taxis: Braitenbergs using distance and gradient sensors



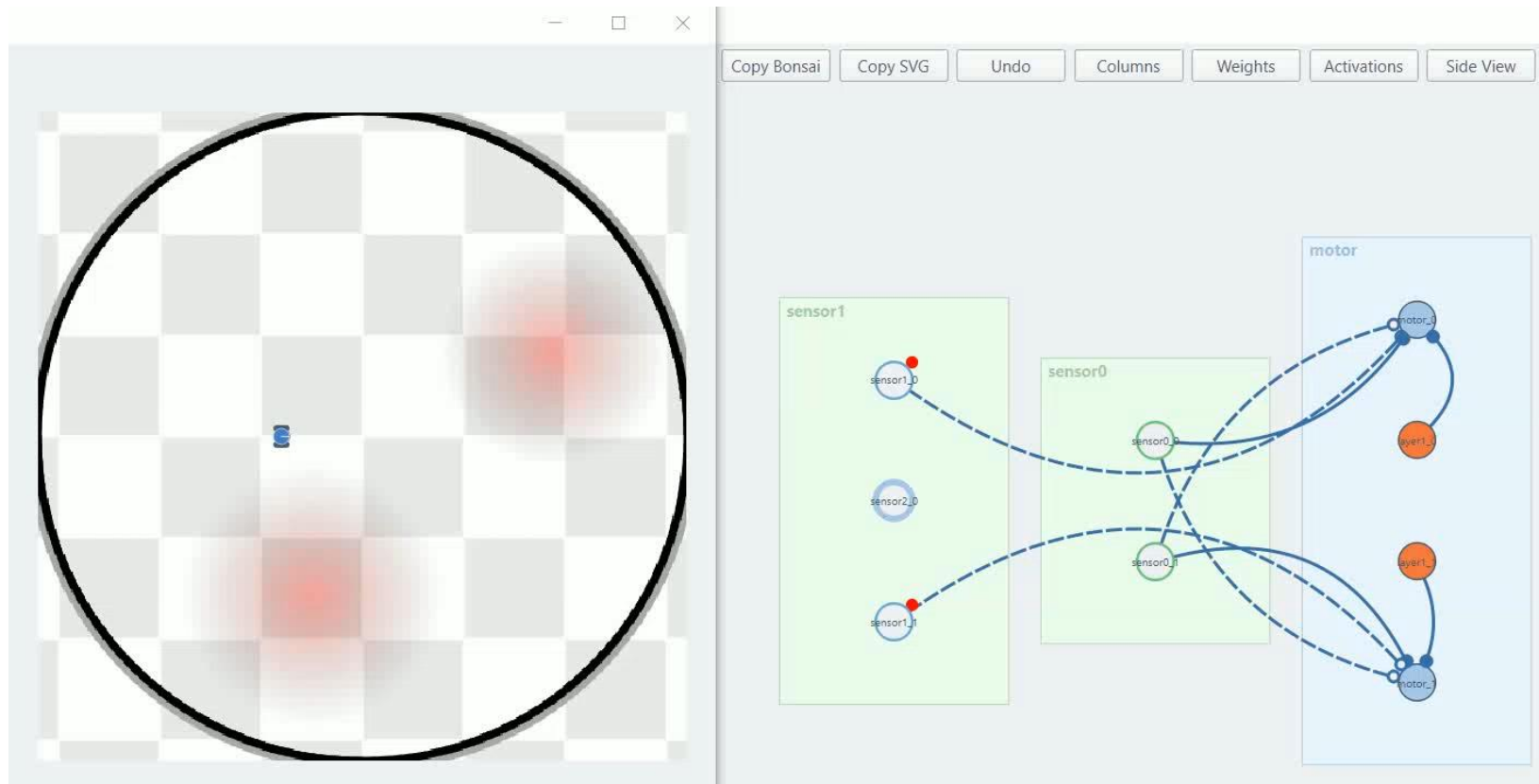
Taxis: Braitenbergs using vision



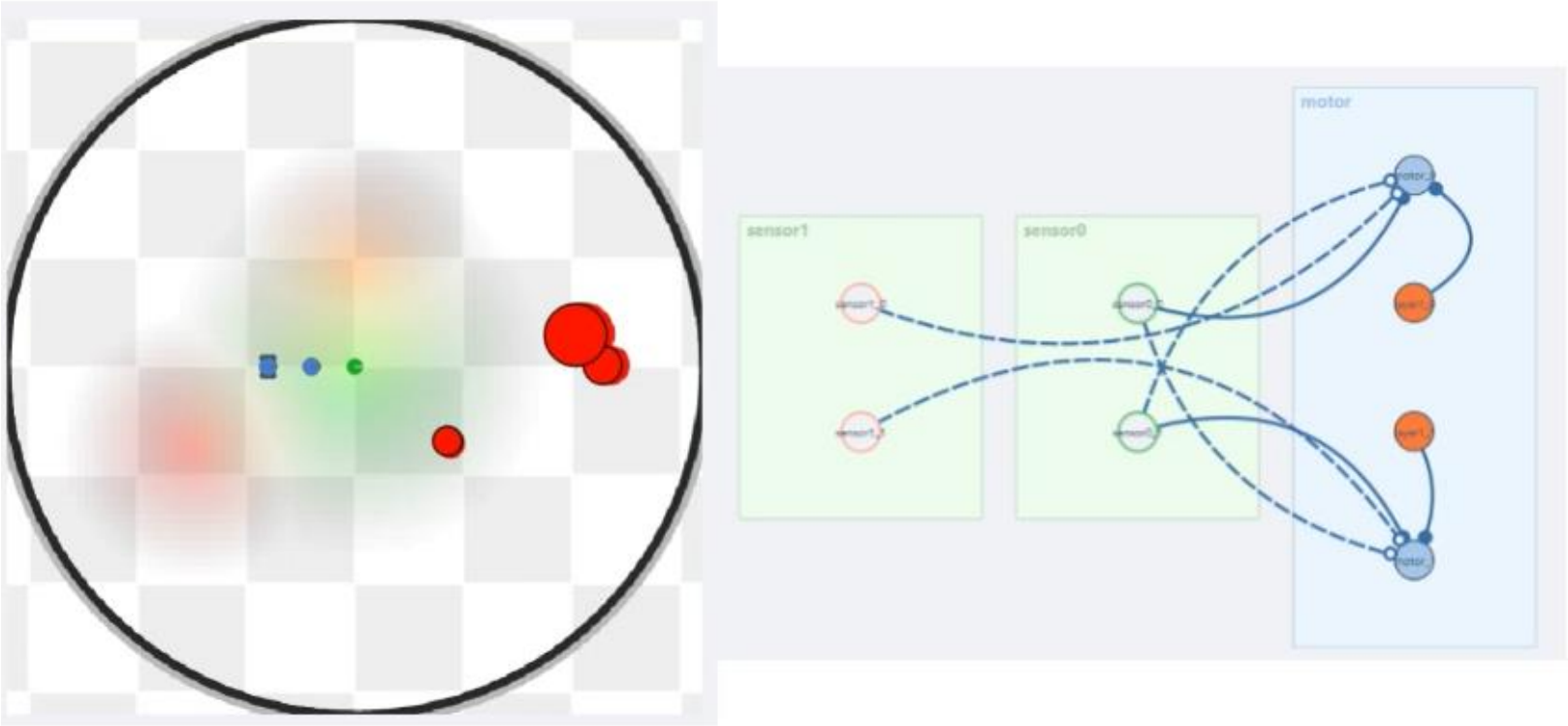
Active sensing



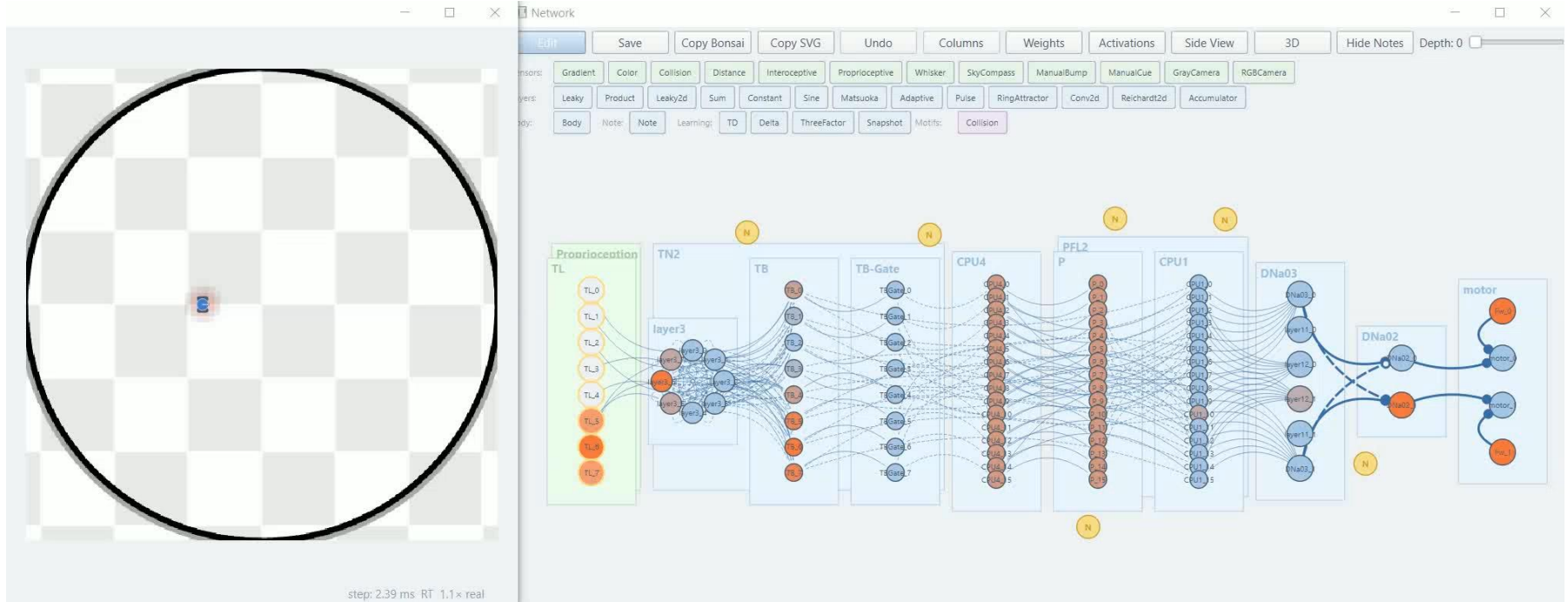
Action selection via sensory inhibition



Multi-agent simulation

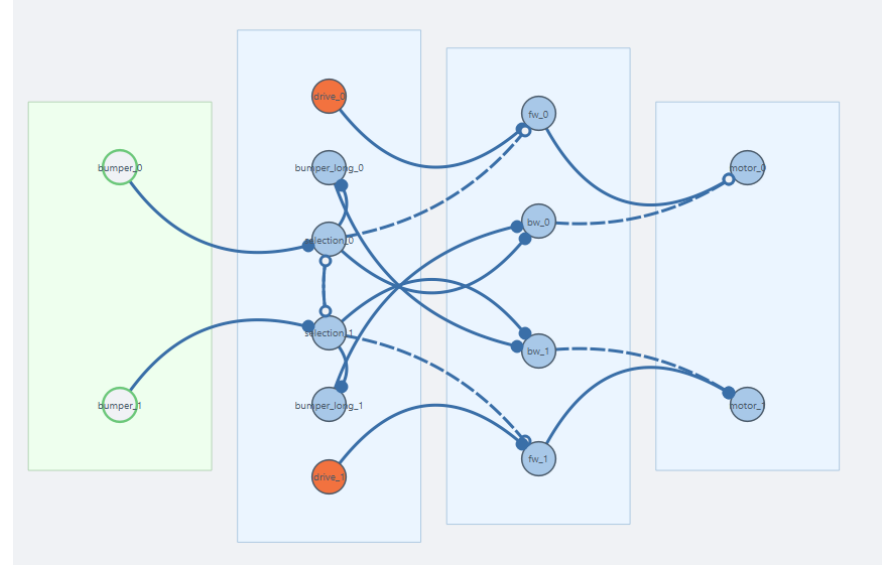
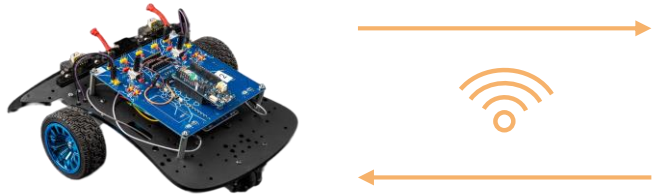
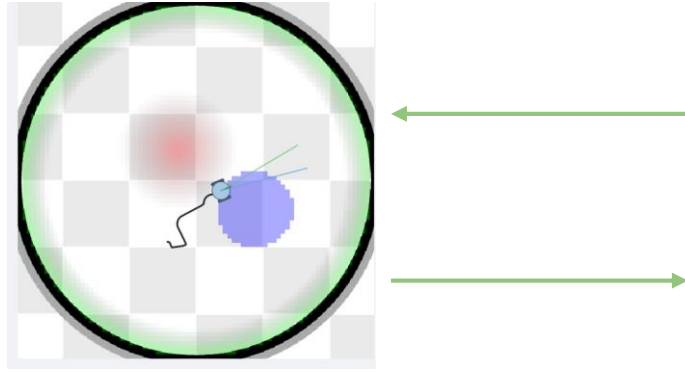


Insect vector-based navigation

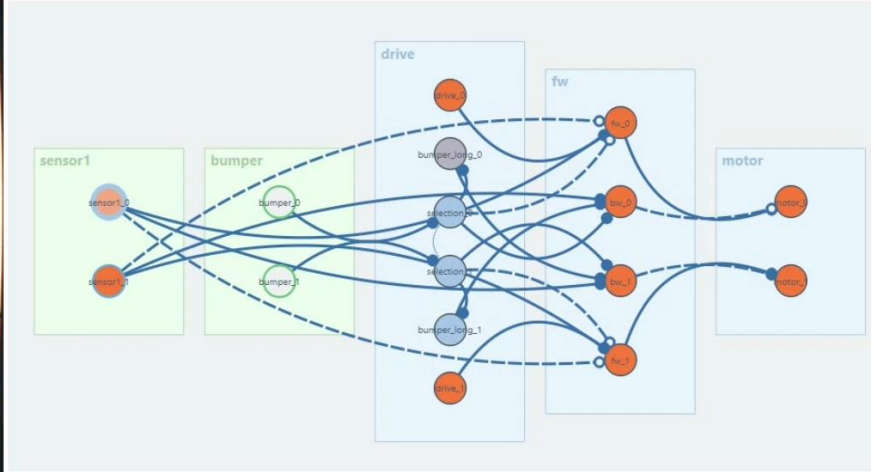
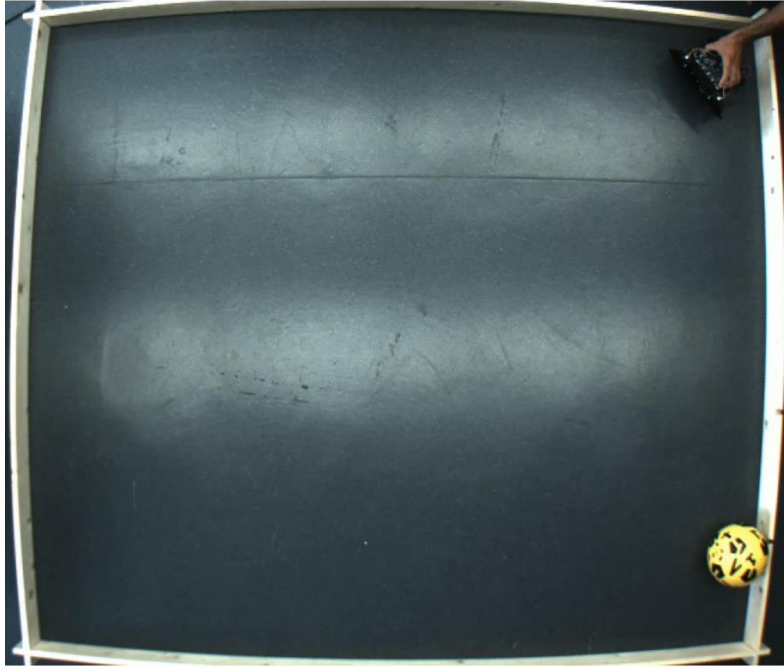


Stone et al (2017). *Current Biology*
Le Moël et al (2019). *Frontiers in Psychology*
Westeinde et al (2024). *Nature*

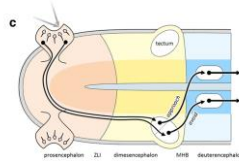
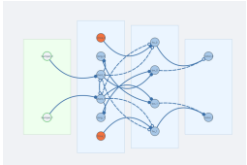
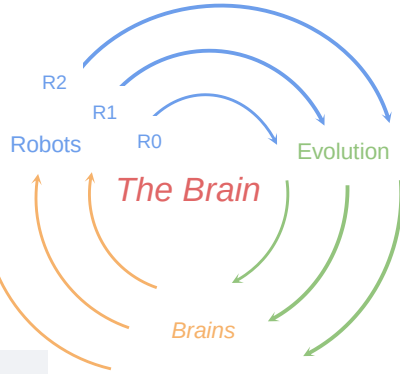
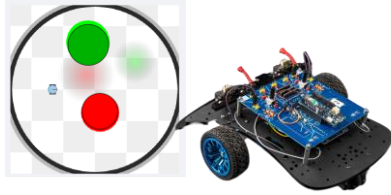
Neural simulator interacts with the real robots



The neural simulator controlling a real robot



Little Brain Project: Summary



Outlook

Scientific

- Expand circuit repertoire
- Scale behavioral integration beyond basic taxis and navigation

Educational & Community

- Launch CF Neuro-Robotics Club @TeachingLab
- Organize a Cajal course (with Eugenia)
- Make simulator fully open-source & public

Thank you!

