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Biologically-inspired approaches to robotics

Embodied artificial intelligence, neurorobotics and biorobotics

Bionics
Biomimetics
Biologically-inspired Robotics
BioRobotics
Embodied Artificial Intelligence
NeuroRobotics

Biologically-inspired robotics

using biological systems as inspiration for robotic design...



Why study animals?

SPRINTING

USAIN BOLT



27.4
MPH

OSTRICH



39.5
MPH

HORSE



43
MPH

CHEETAH



54.7
MPH

CAT



29.8
MPH

MPH

LONG JUMP



MIKE POWELL

29.4
FEET



SNOW LEOPARD

49
FEET

SWIMMING

CESAR CIELO



5.34
MPH

OCTOPUS

TUNA

BLACK MARLIN

PENGUIN

22
MPH

25
MPH

43
MPH

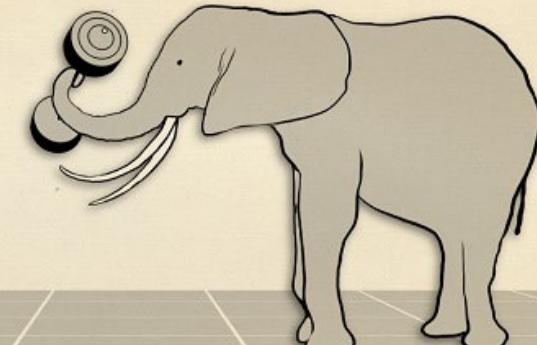
80
MPH

LIFTING



LEONID TARANENKO

586.4
POUNDS



ELEPHANT

661
POUNDS

Why study animals?

HUMAN VISION



FLY VISION



HUMAN VISION



SHARK VISION



HUMAN VISION



SNAKE VISION



HUMAN VISION



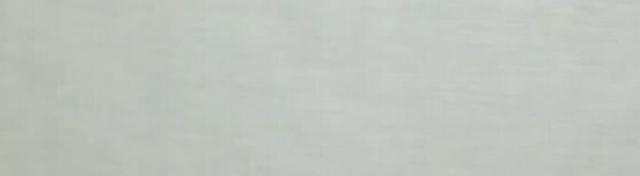
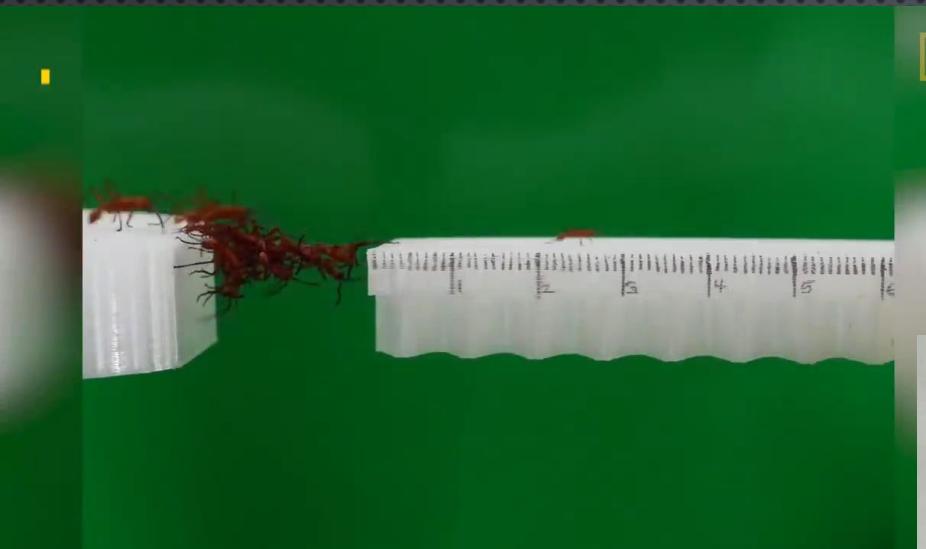
RAT VISION



EYE 1

EYE 2

Why study animals?



Still not convinced? Try doing this...



Or this...



The bigger (and confusing) picture

Embodied artificial intelligence

Biologically-inspired robotics

Body morphology and mechanics

Biomimetic robotics

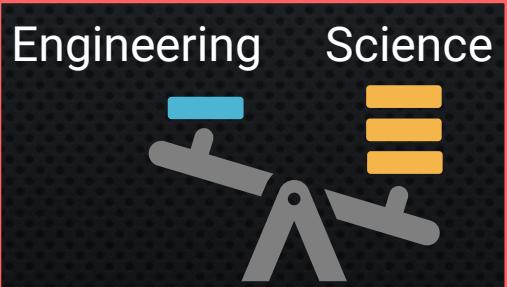
Neurorobotics

Brain computation

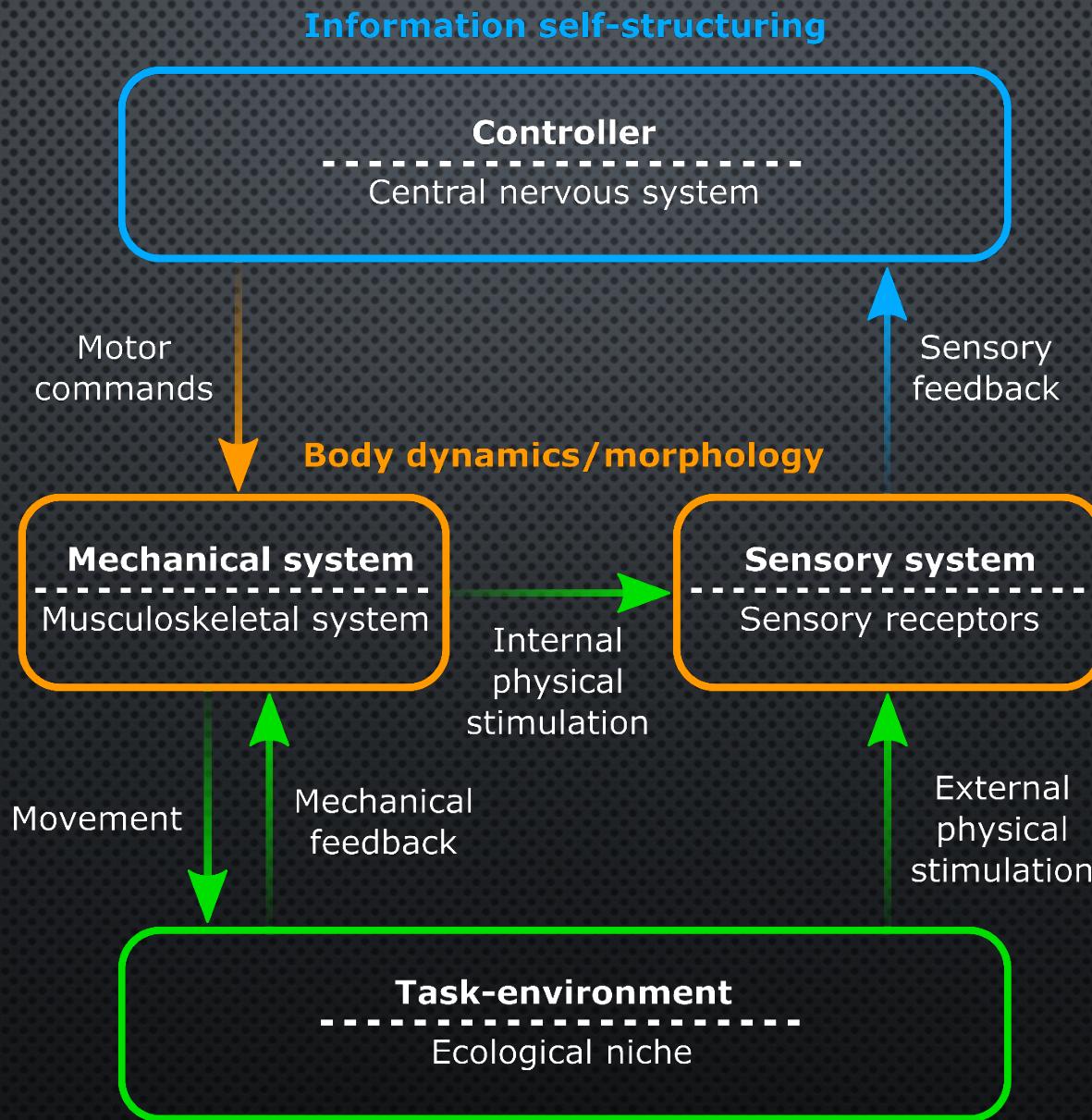
BioRobotics

Bionics

Computational neuroscience



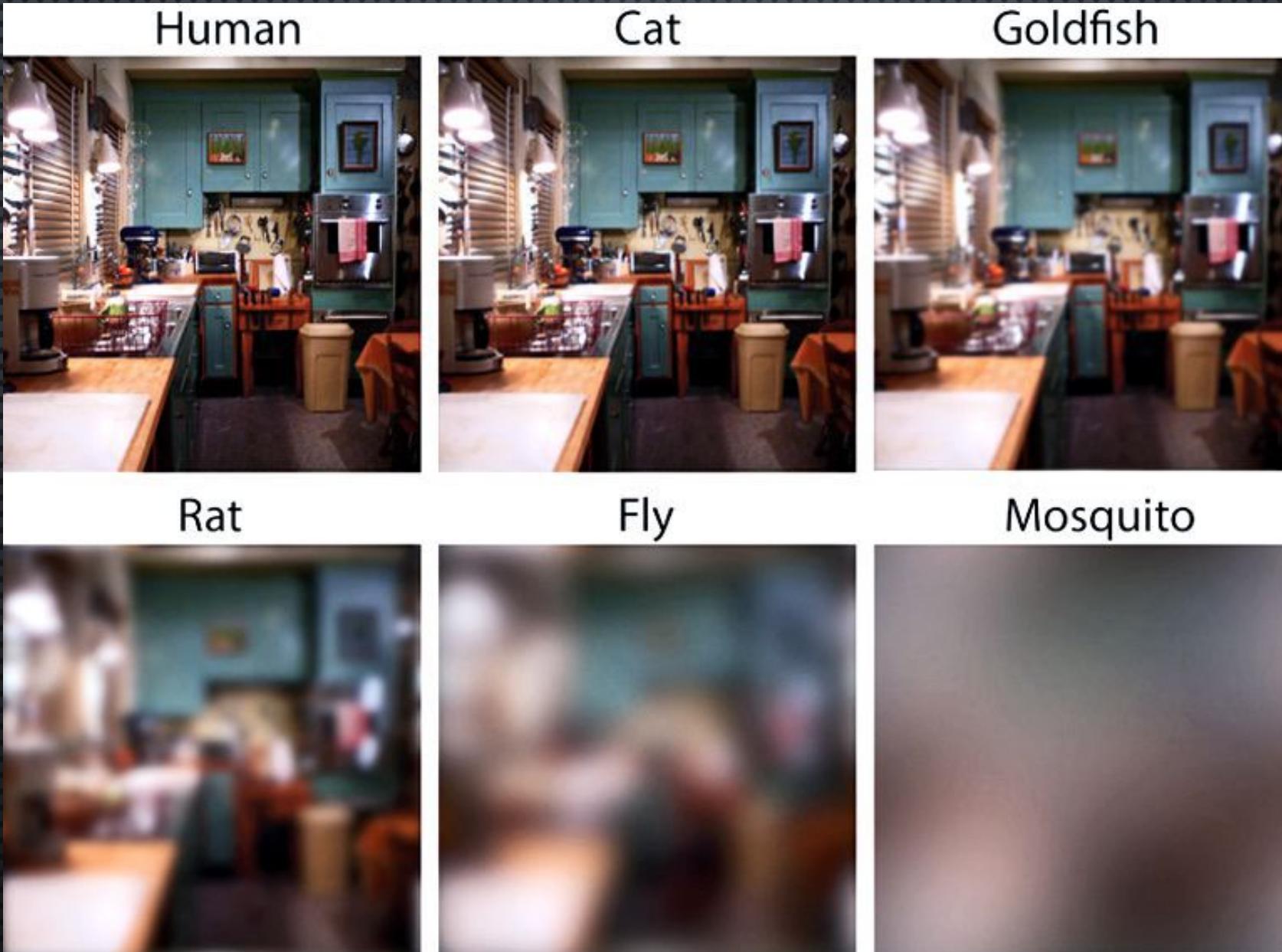
Embodied artificial intelligence



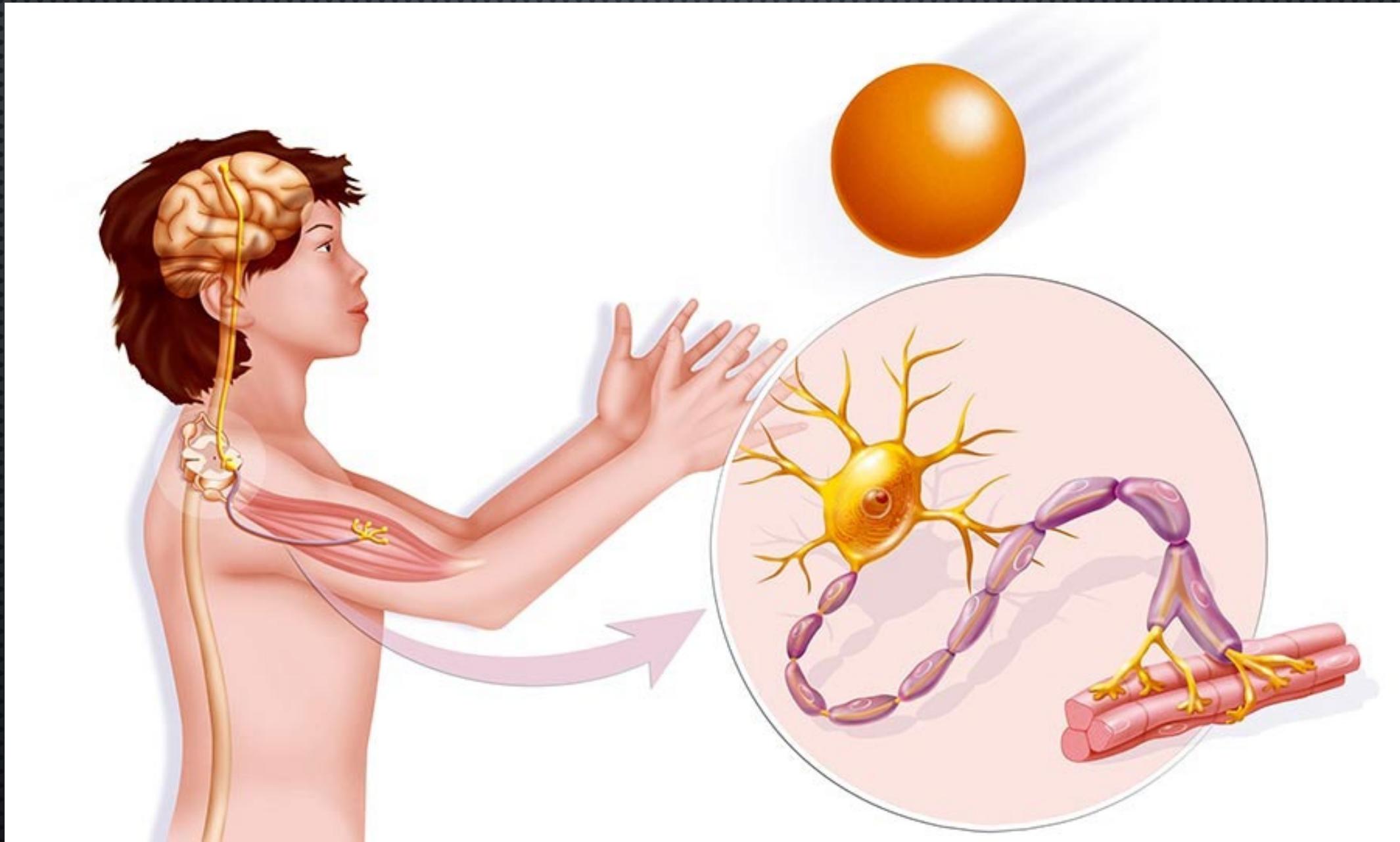
- Ecological niche is the **role a species plays in the ecosystem** and includes
 - the habitat (environment in which it is **situated**)
 - the way it **interacts** with other species as well as the environment via sensing and acting



Why is the environment / ecological niche important?



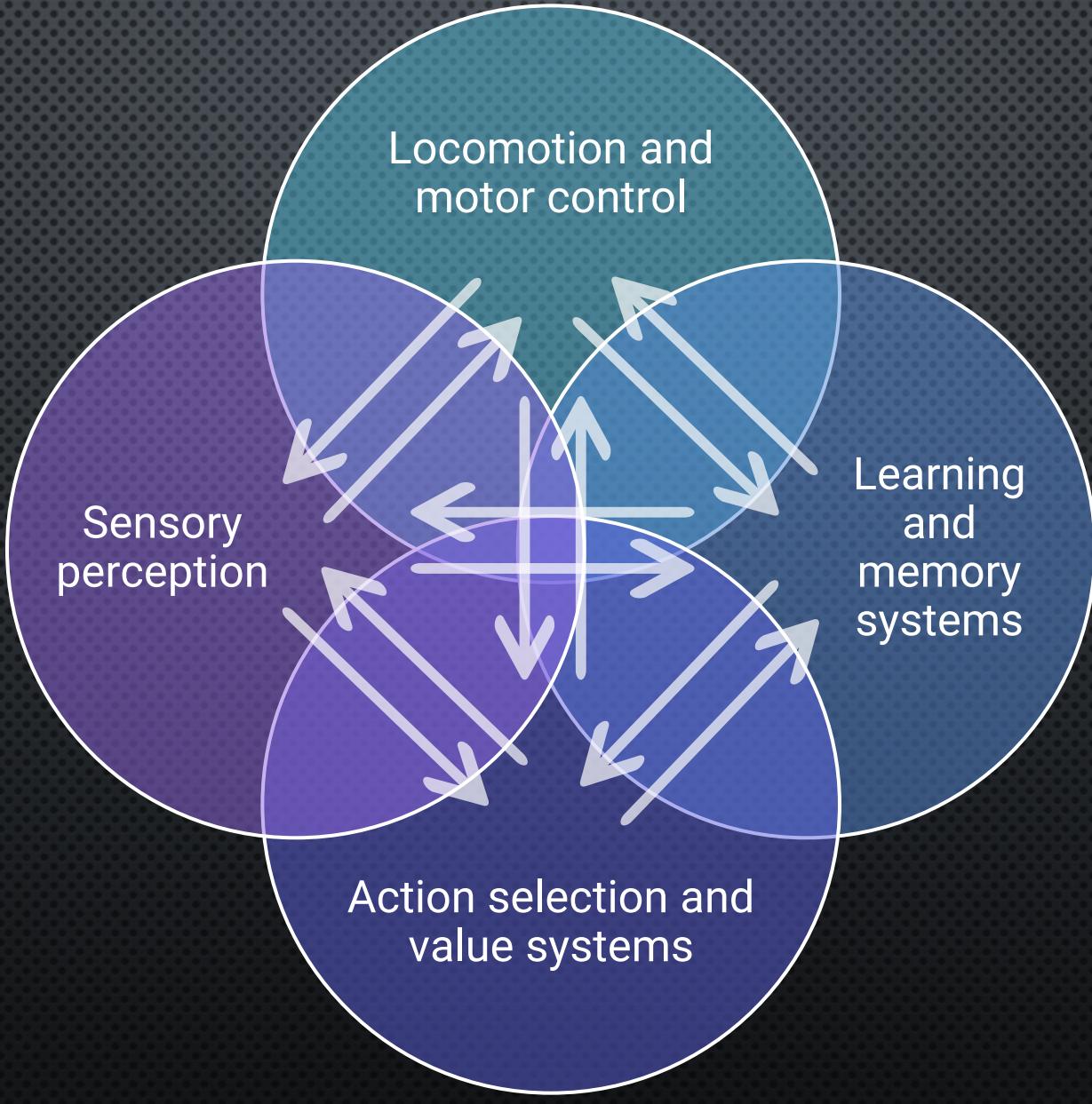
Sensorimotor control and learning: a holistic view of embodied AI



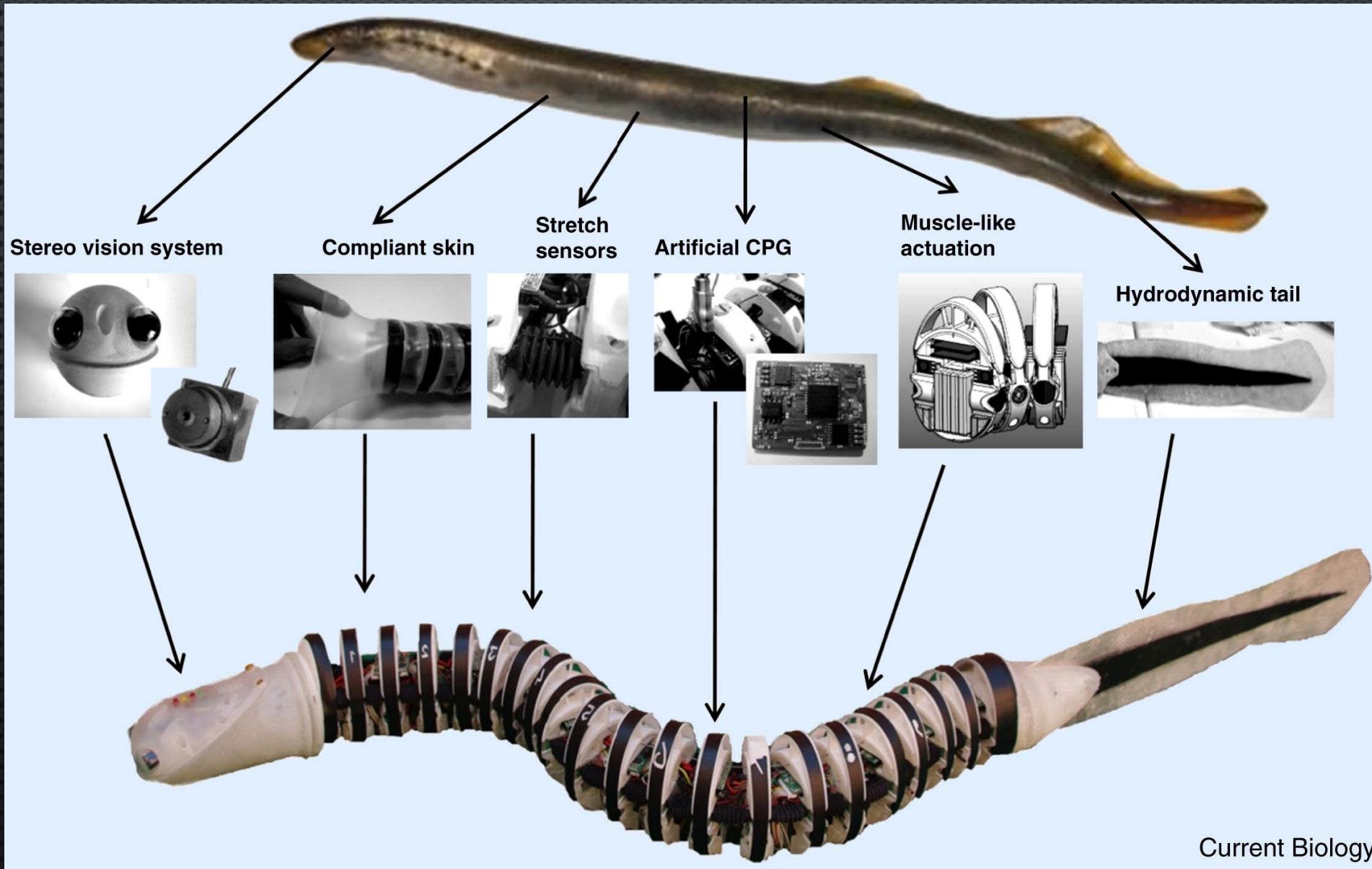
Neurorobotics

- Neurorobotics deals with the study and application of science and technology of **embodied, autonomous, brain-inspired** algorithms
- A neurorobot is a robot
 - that engages in a **behavioural task**
 - that is **situated** in a real-world environment
 - that has a means to **interact** with other agents via sensing and acting
 - whose behaviour is controlled by a simulated nervous system having a design that reflects, at some level, the brain's **architecture** and **dynamics**

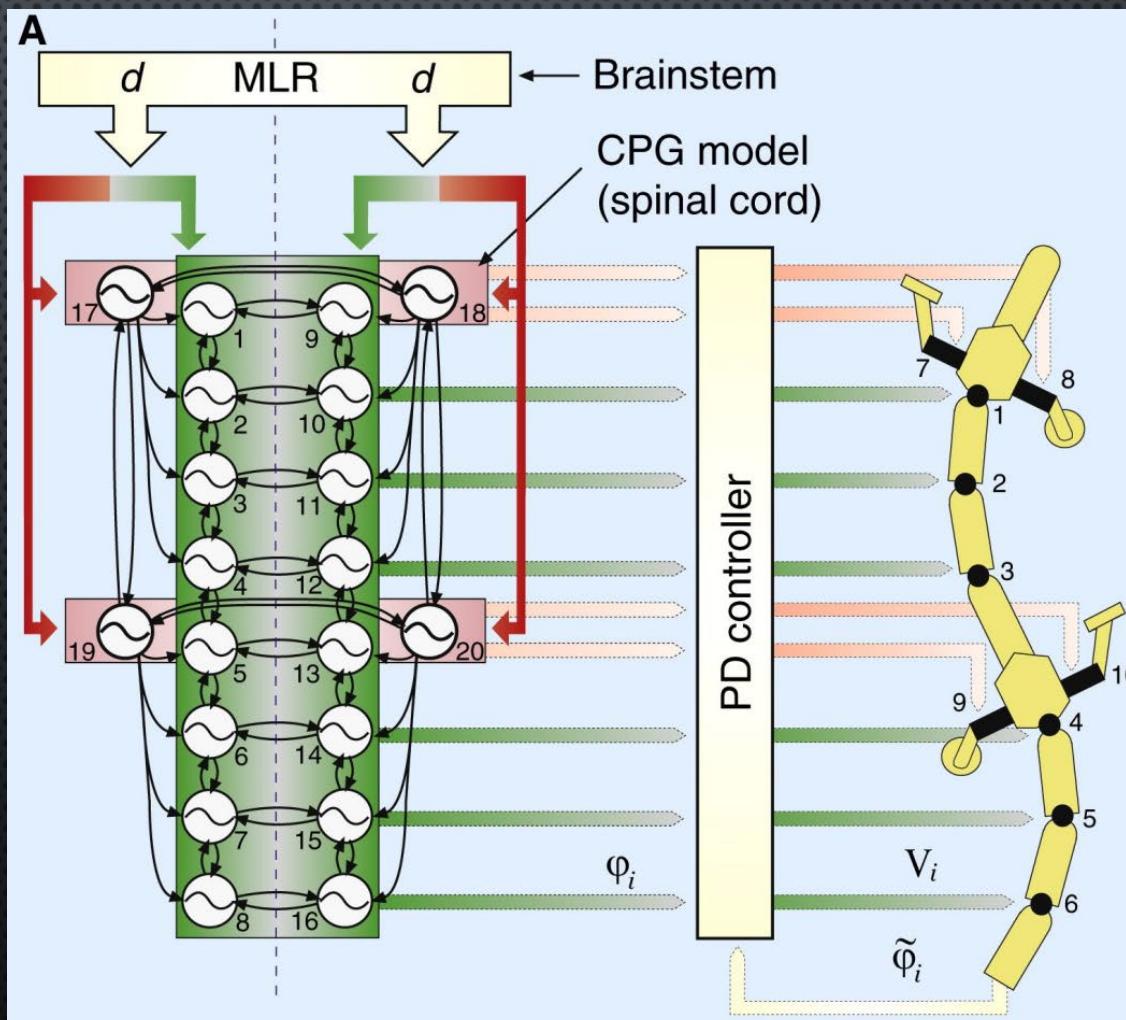
Classes of neurorobot models



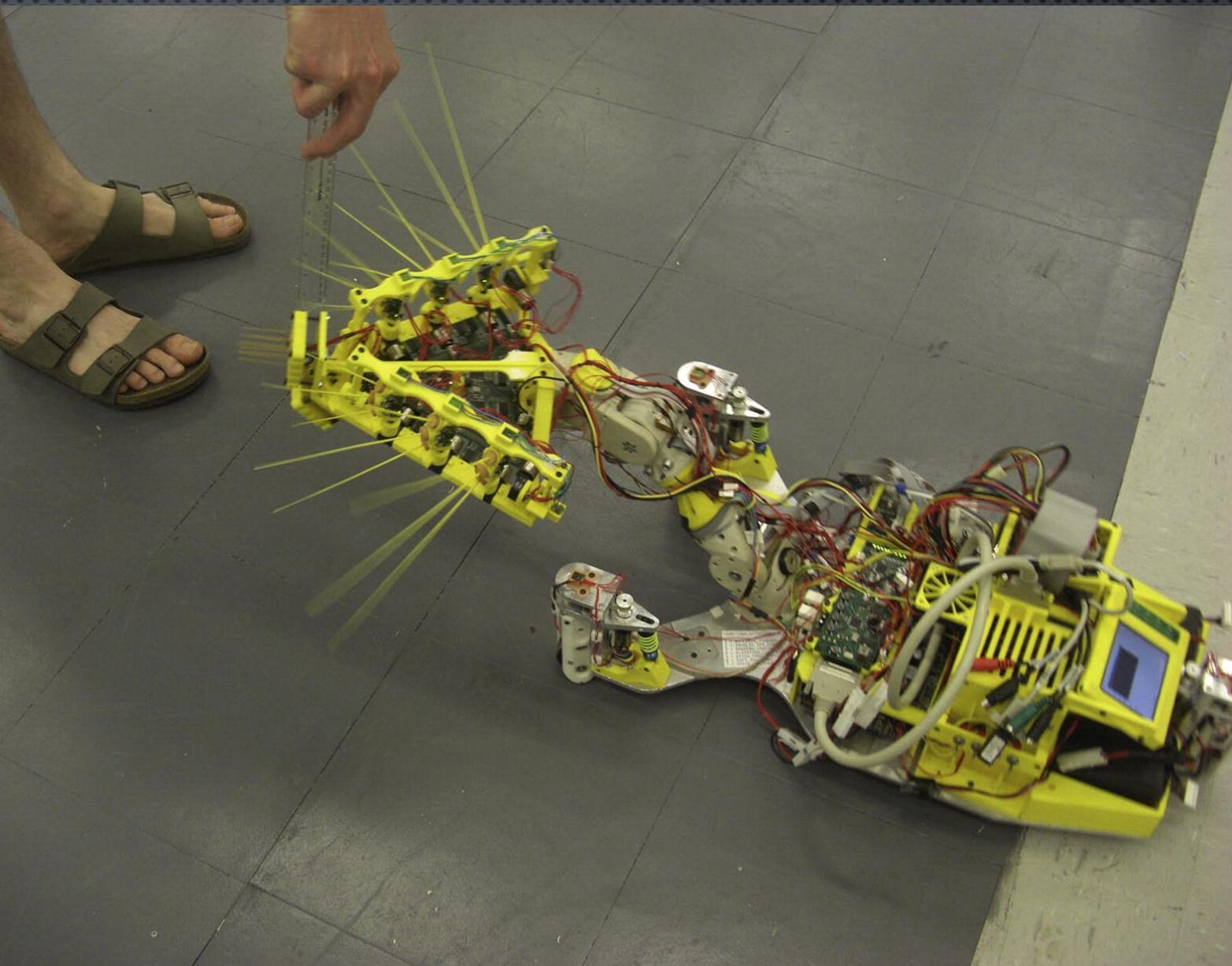
Models for locomotion



Models for locomotion



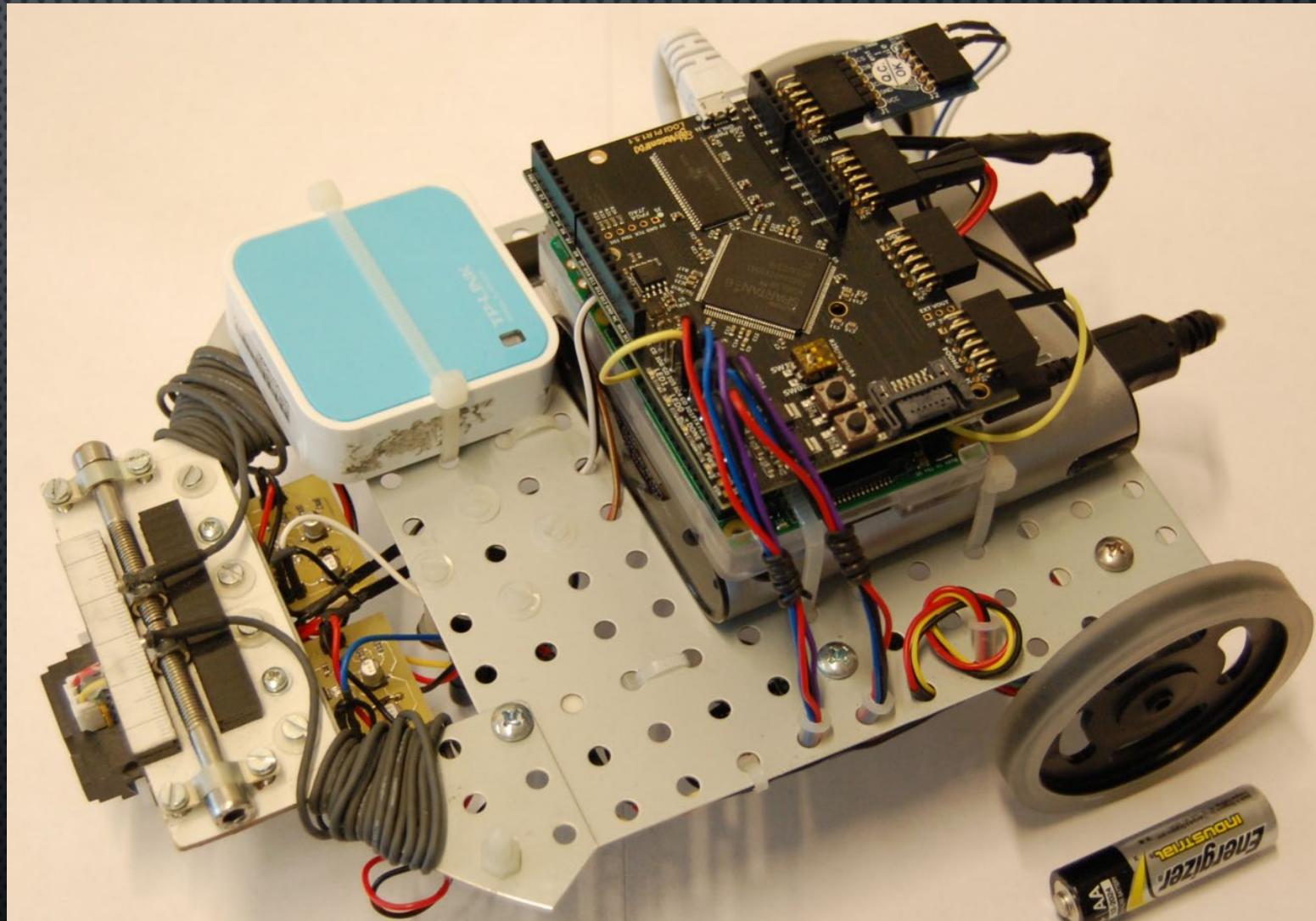
Models for sensorimotor integration



Models for perception

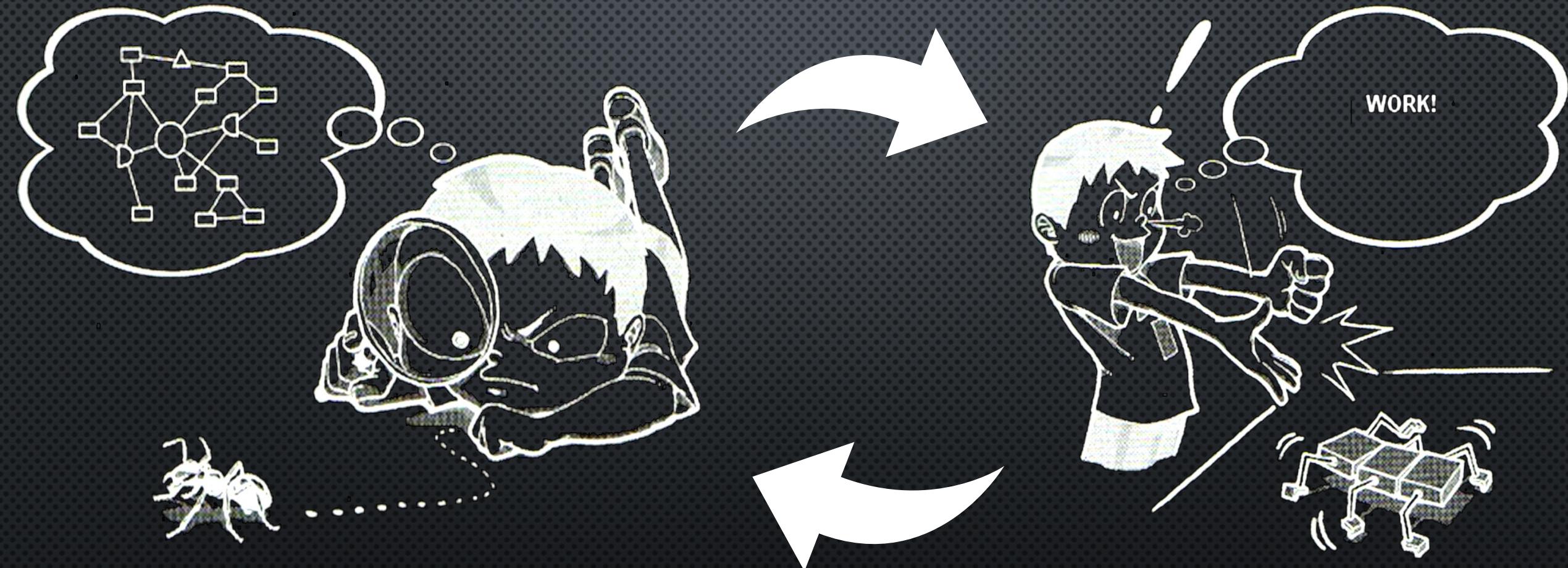


Models for perception



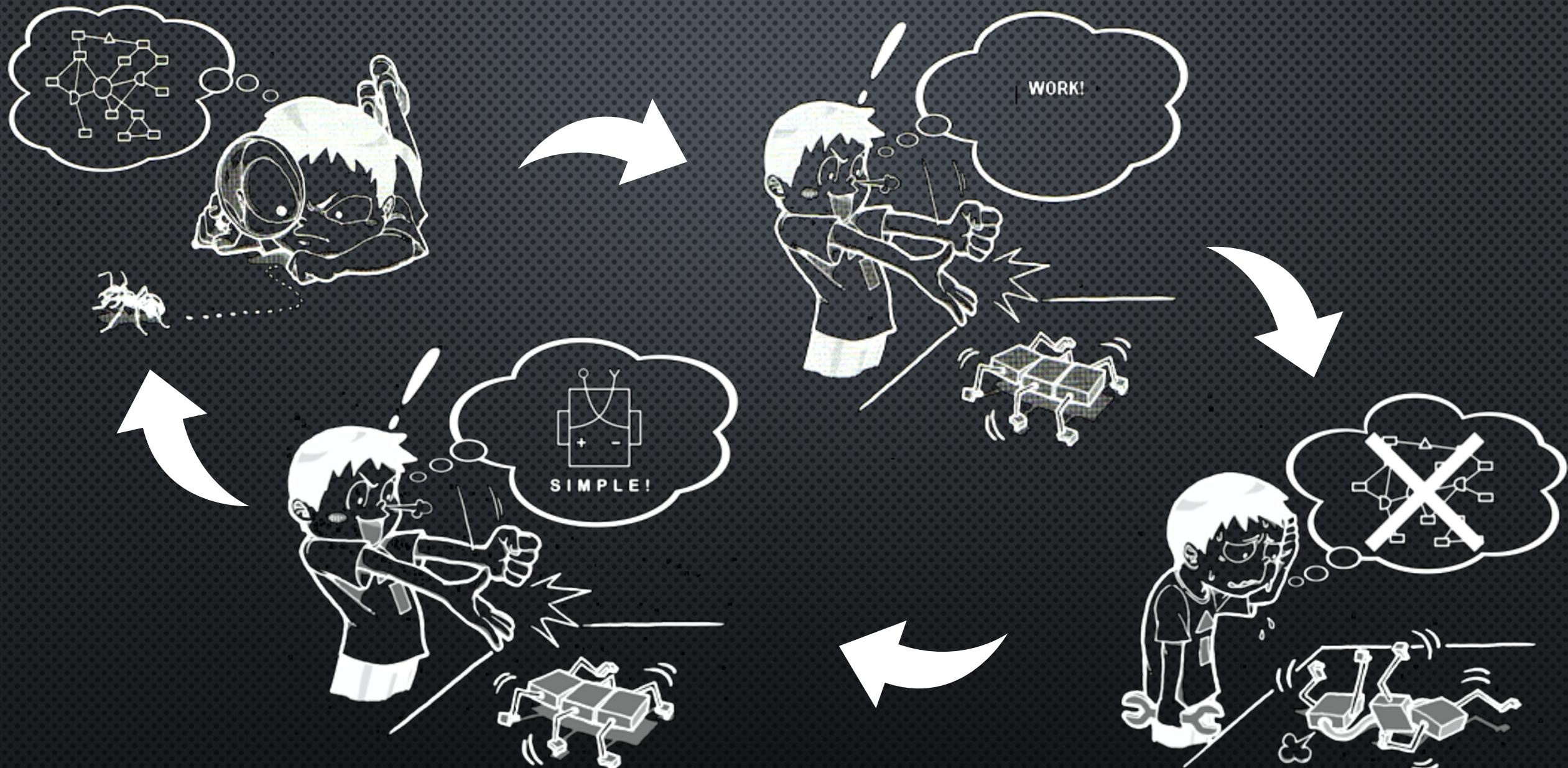
BioRobotics

using biological systems as inspiration for robotic design...



using robotic systems to understand biological design...

Reality check



A world full of model organisms!



World's first biologically-inspired robots

Elmer and Elsie (ELectroMEchanical Robot, Light-Sensitive)



William Grey Walter

Cool robot videos for motivation...



fb.com/ScienceNaturePage

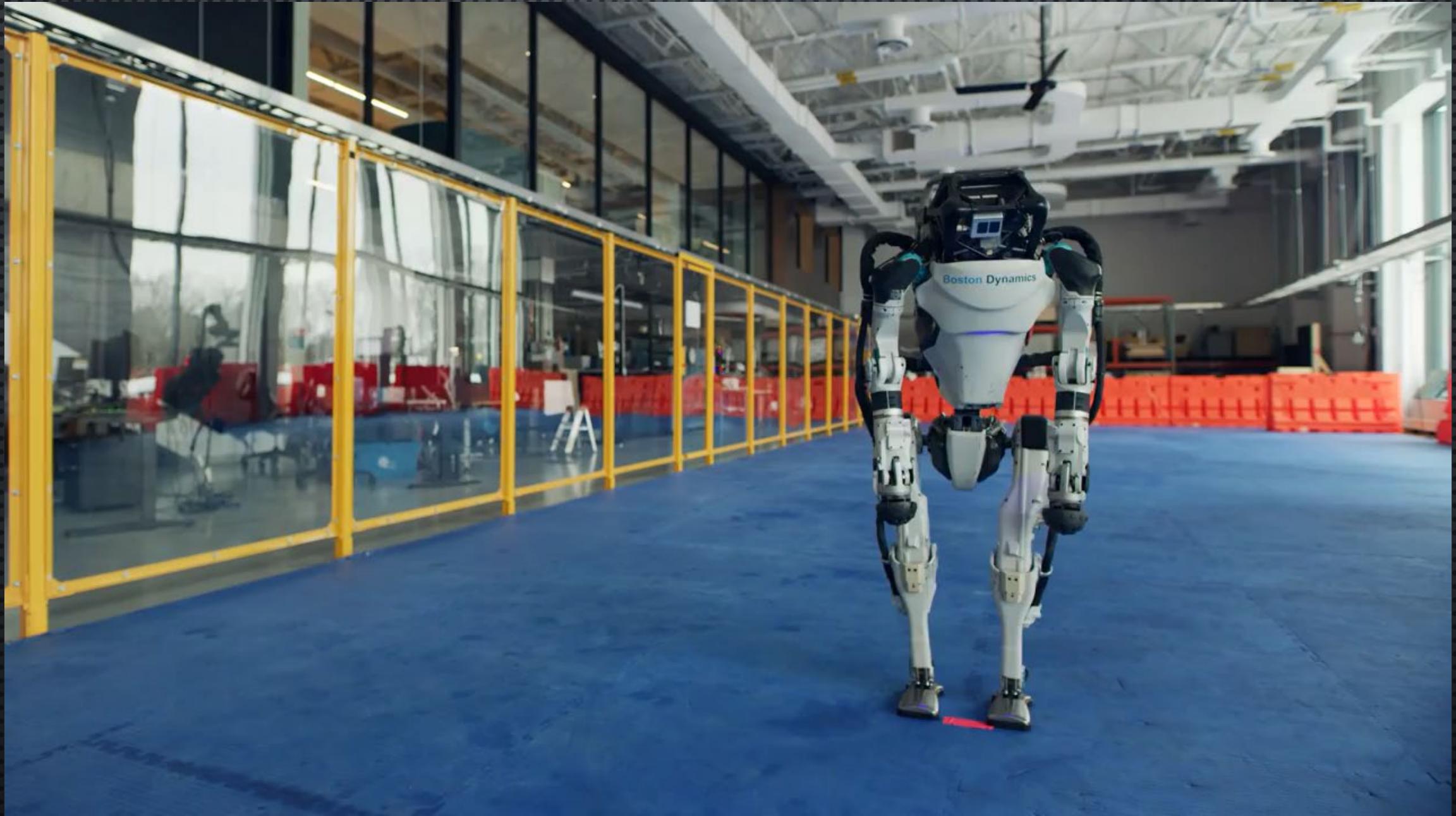


T-800: the ultimate biologically-inspired robot



MASTER_GOW

Dance break...

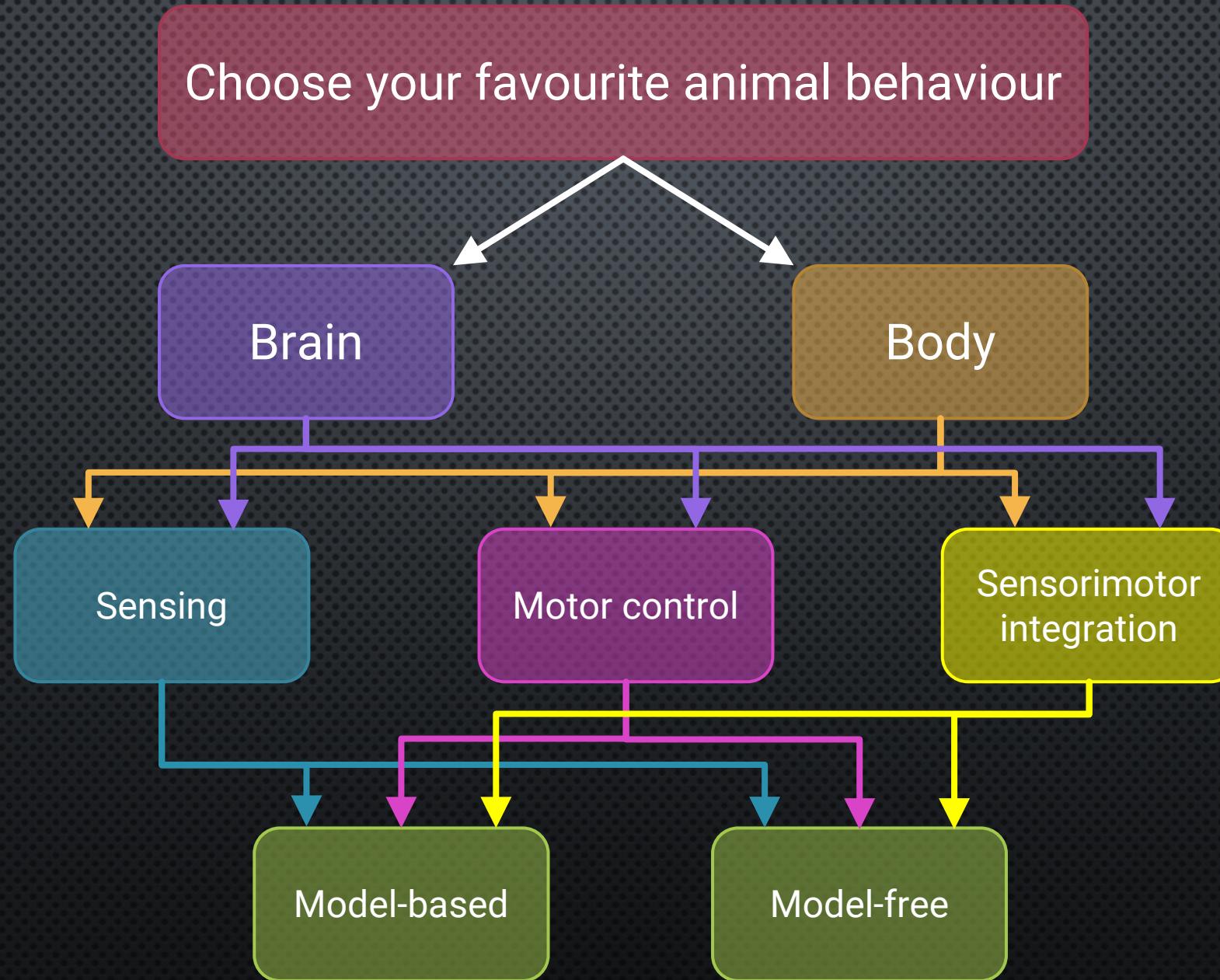


Reality check...

Desert Locusts

(*Schistocerca gregaria*)

So how and where do I start?



Meet the robot...



8-microphone array

- Alexa voice recognition
- sound direction estimation

18-LED array

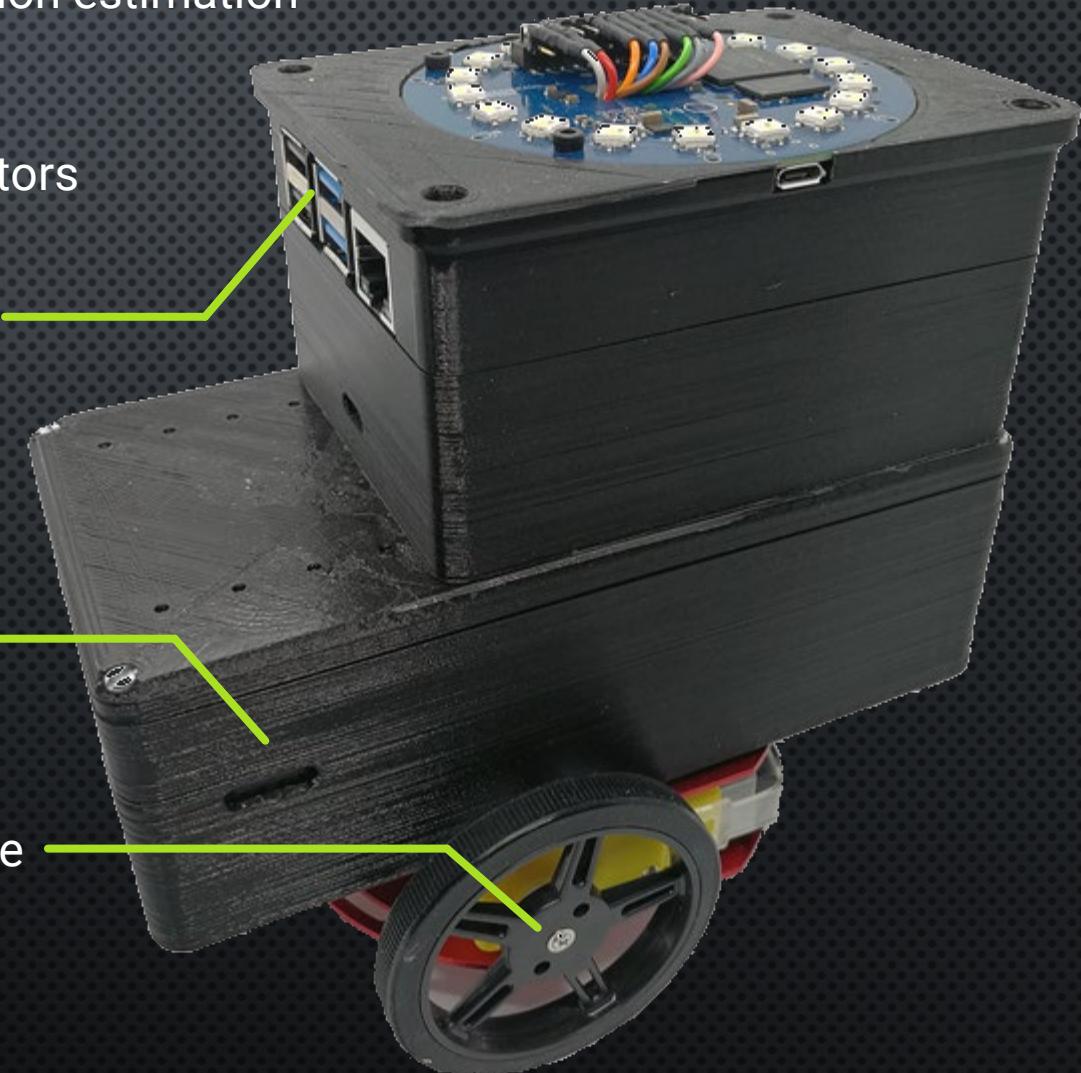
- visual indicators

Raspberry Pi 4

RGB camera

30000 mAh
rechargeable
battery

Differential drive
kinematics



Questions?