人工智能

The ShanghAI Lectures

上海授课

The ShanghAI Lectures
An experiment in global teaching

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Today from University of Plymouth, UK

欢迎您参与
“来自上海的人工智能系列讲座”

Lecture 3

Group Project “Kōans”

公案

31 October 2013

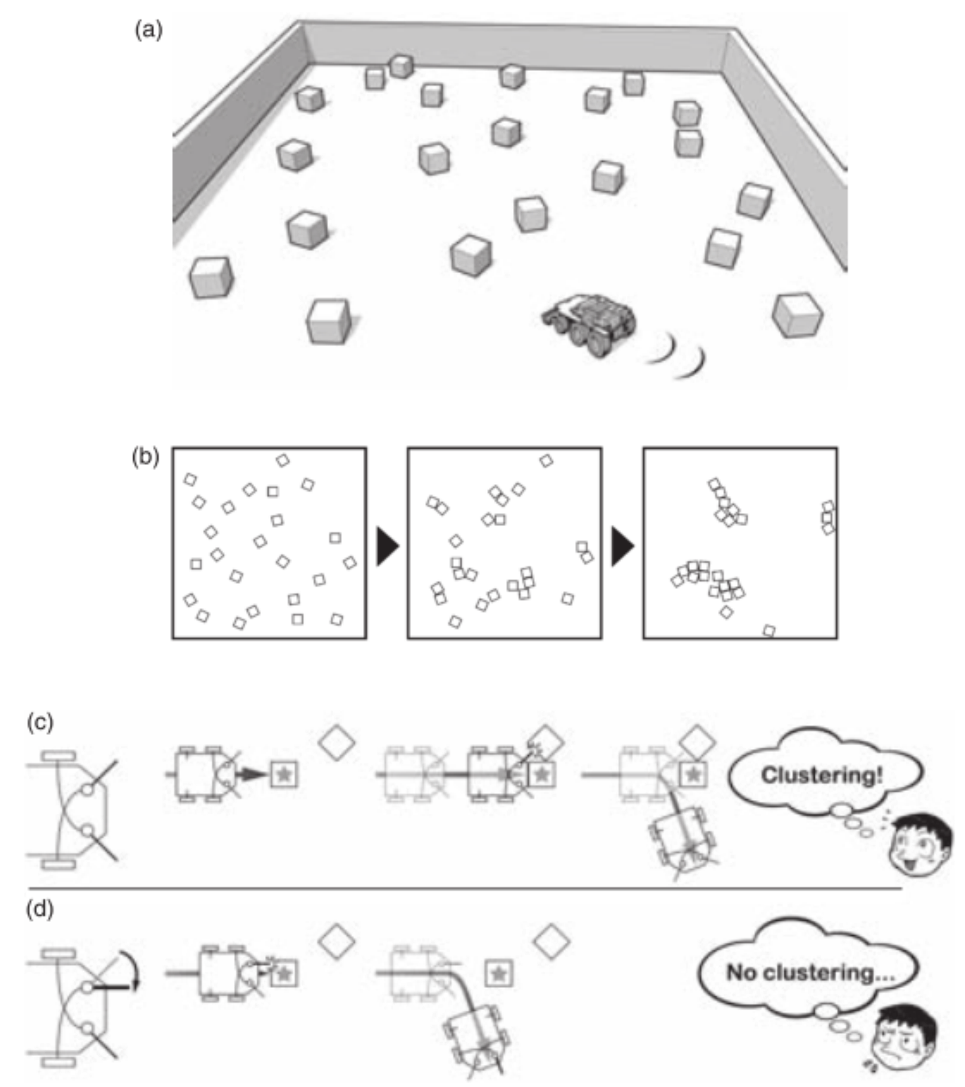
Student project timeline

- **30 October:** Kōans published
- **5 November:** Deadline for students: Select two Kōans (1st and 2nd choice)!*
- **6 November:** Student groups published
- **~12-19 December:** Group presentations (Second Life or similar)

* *Log in to your account on ShanghAI Lectures website and send a message to Avinash Ranganath with Koan numbers in subject. Thanks!*
http://shanghailectures.org/users/avinash-ranganath

Kōan 1: “Swiss Robots” with adaptive morphology

- So, “Swiss Robots” depend on sensor morphology for performing a complex collective behavior (collecting boxes in piles) with extremely simple controllers and no explicit communication in-between robots.
- What if the sensor morphology could be adapted by the robot’s controller, e.g. changing the pitch/yaw of the proximity sensors?
- Student could for example explore the ability to collectively adapt to a given box size, to optimize behavior, or to show specialization.



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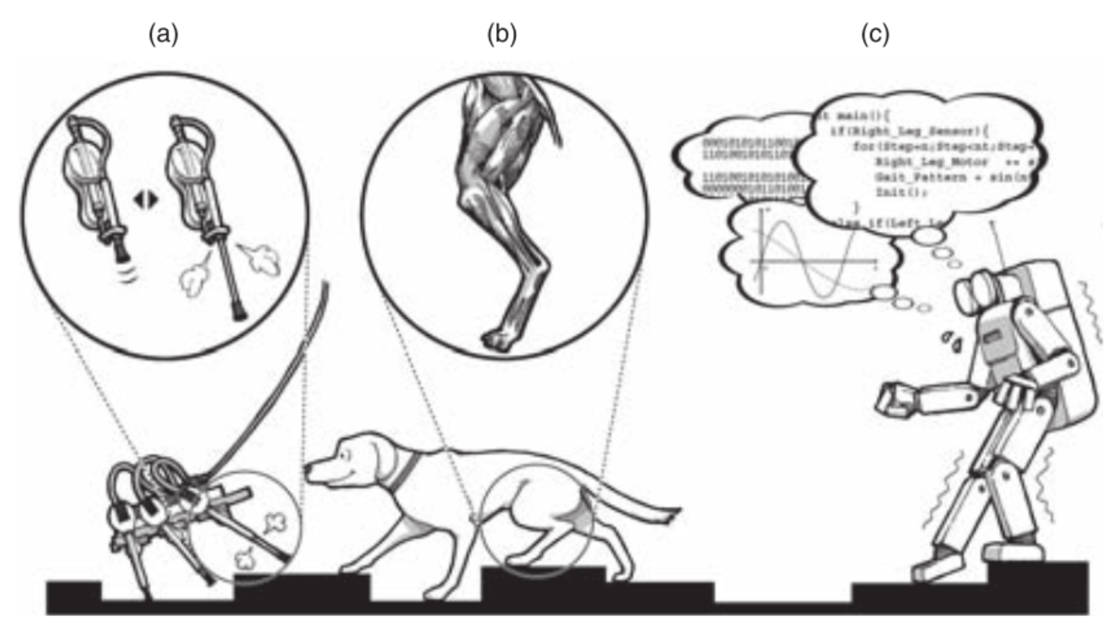
Kōan 2: How can actuation (or locomotion) drive sensing?

- In engineering we usually think about how to use sensing to drive actuation, but embodiment means actuation also affects what you sense.
  - See example on the right – how does the robot's actuation simplify the sensing?
- The students can use a simpler mobile platform if desired (think Swiss Robots)
  - E.g. when starting to push a loose object, there may be a reduction in the optical flow in parts of the view of an onboard camera.

Page 147 in "How the body shapes the way we think"

Kōan 3: Demonstrate morphological computation in locomotion

- Students can for example start from Webots passive walker example:
  - E.g. add sensors to sole of feet – reflexes? Walk on a flat surface?
- The Puppy robot (also in Webots) is another possible starting point:
  - E.g. robust locomotion in uneven terrains? Can quantify performance?
- Other ideas? Feel free to be creative!



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Kōan 4: Demonstrate morphological computation in manipulation

- Students can for example start from Webots passive walker example:
  - How can an arm be modeled with a similar approach? A direct (multiple) pendulum?
- How to perform grasping? A passive elastic trap?
- Where you would add sensors? In the hand? On the arm's skin? In the shoulder? In the eyes (camera)? An IMU in the head, too?
- Other ideas? Feel free to be creative!

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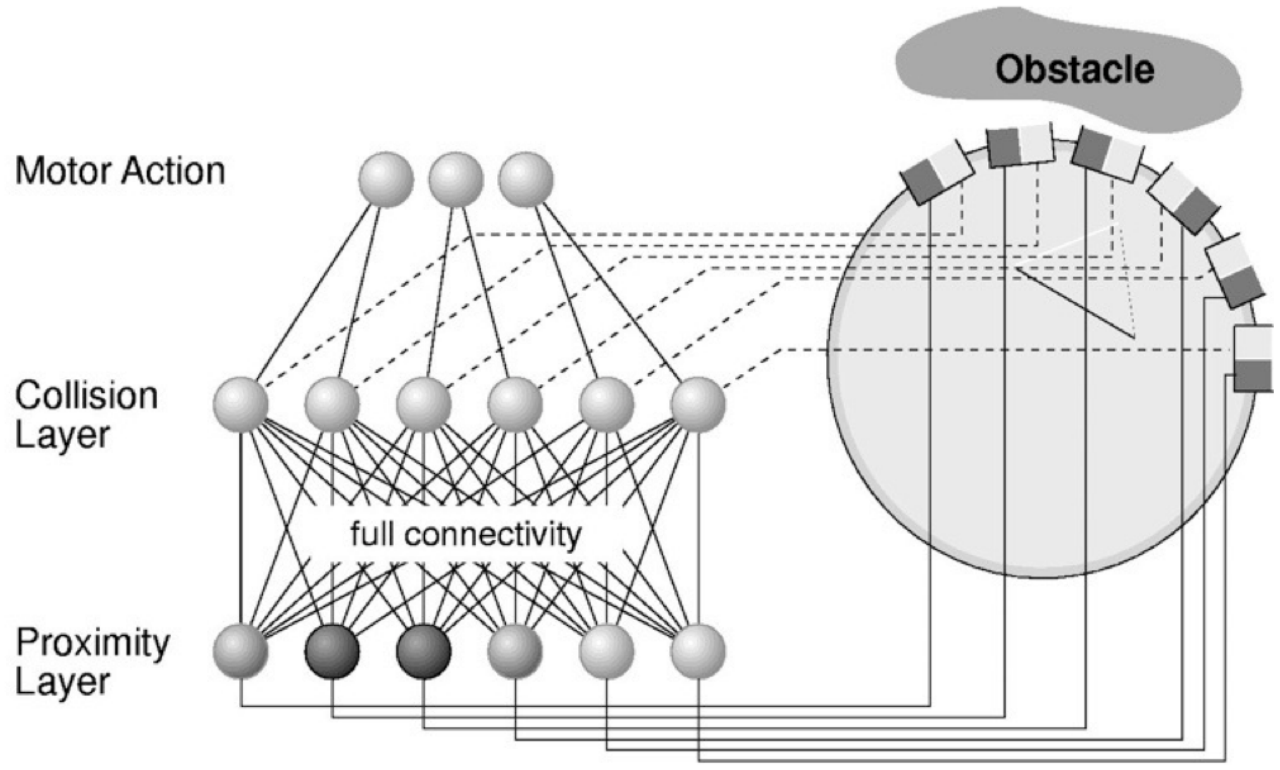
Kōan 5: Where exactly is memory?

- Can an agent perform a "useful" task with no explicit representation of the "world" or the "task"?
- The students may for example implement a DAC* like behavior in a simulated mobile robot.
- Perhaps with one collision avoidance reflex, and one attraction, e.g. a colored object.

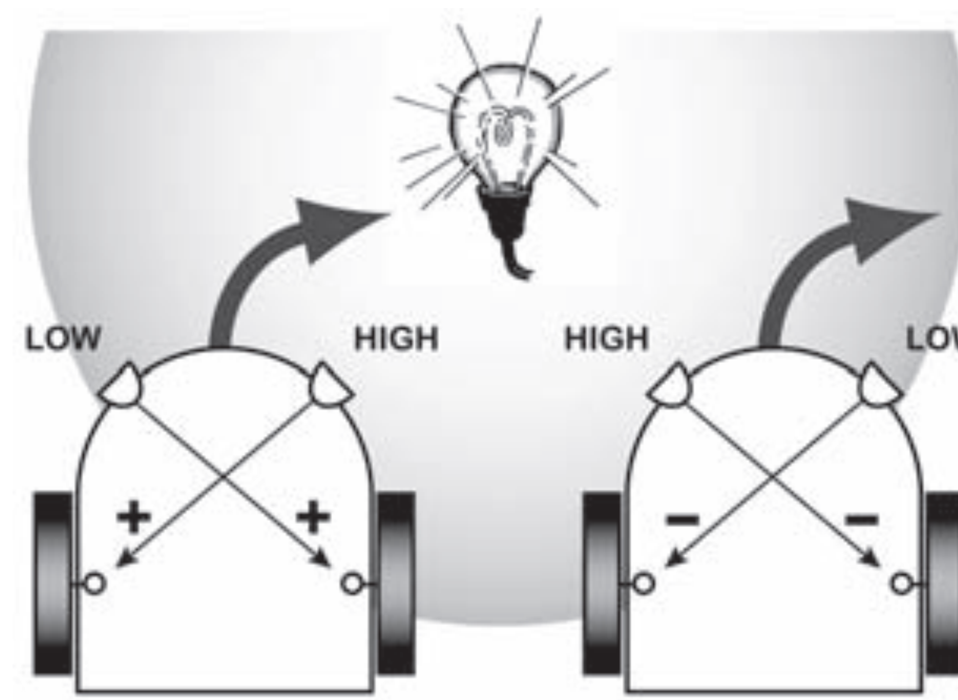
From p. 102:
http://www.ifi.uzh.ch/ailab/teaching/neuralnets2013/NN20120315.pdf



* *DAC: Distributed Adaptive Control. See: P.F.M.J. Verschure, B.J.A. Krose and R. Pfeifer, "**Distributed adaptive control: The self-organization of structured behavior**," Robotics and Autonomous Systems, vol. 9, no. 3, pp. 181-196, 1993.*

Kōan 6: Braitenberg vehicles

- Students could use the pioneer mobile robot platform, with a mounted omnidirectional camera, along with proximity sensors.
- Develop a layered controller architecture.
- One layer for simple obstacle avoidance behaviour.
- Another layer for attraction/repulsion behaviour towards/from other pioneer robots in the environment.
- Other ideas: Explore Braitenberg vehicles for rough terrain, or underwater (e.g. guided by ultrasound)…



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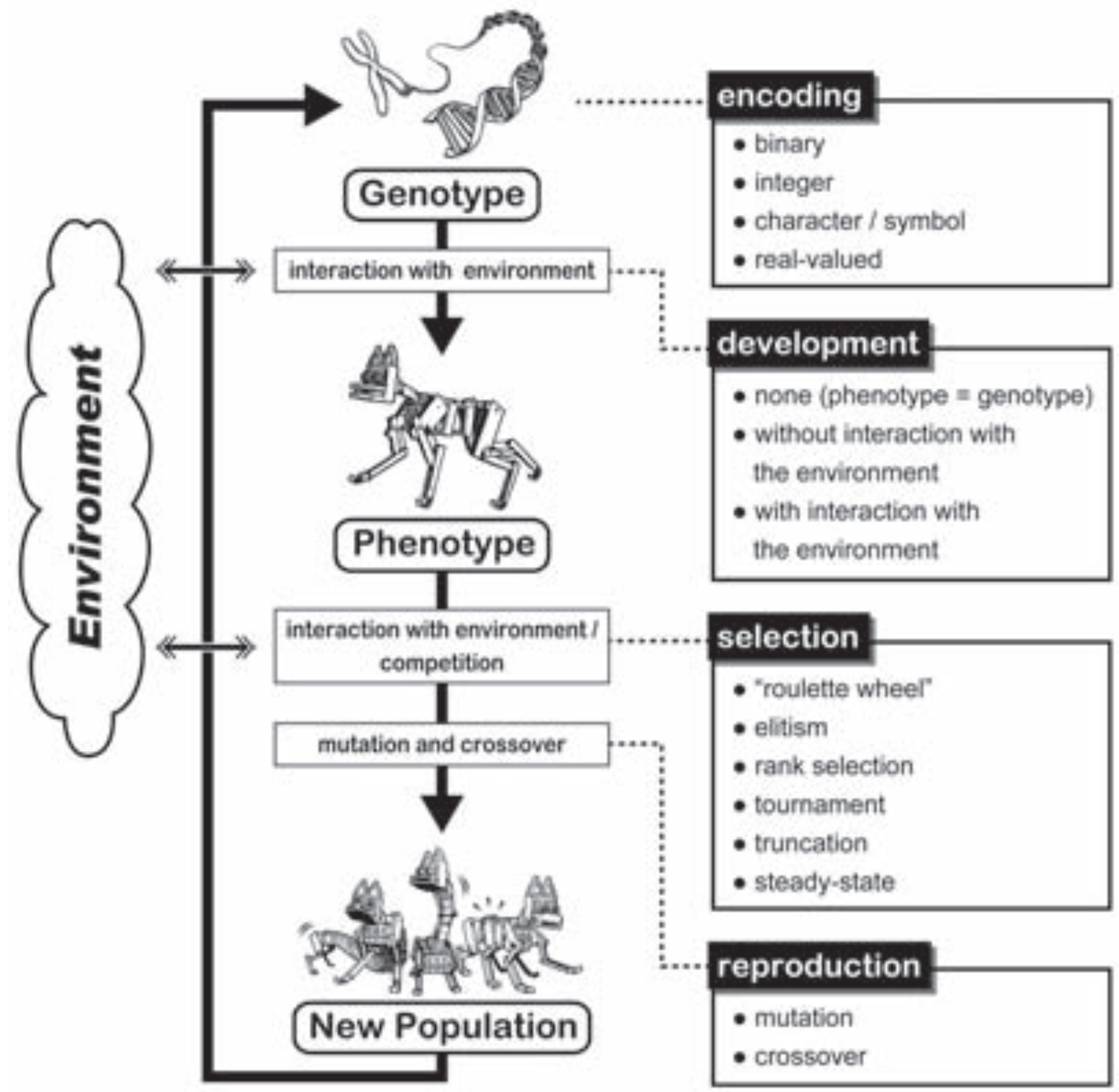
Kōan 7: Evolution of locomotion gait in modular robots

- Use the YAMOR modular robot model available in Webots.
- Come up with interesting morphologies by interconnecting modules.
- Can use simple sinusoidal oscillators as distributed locomotion controllers.
- Use Genetic Algorithms (GA) to optimize the controller parameters (Amplitude, offset, frequency and phase), to evolve optimal locomotion gaits.



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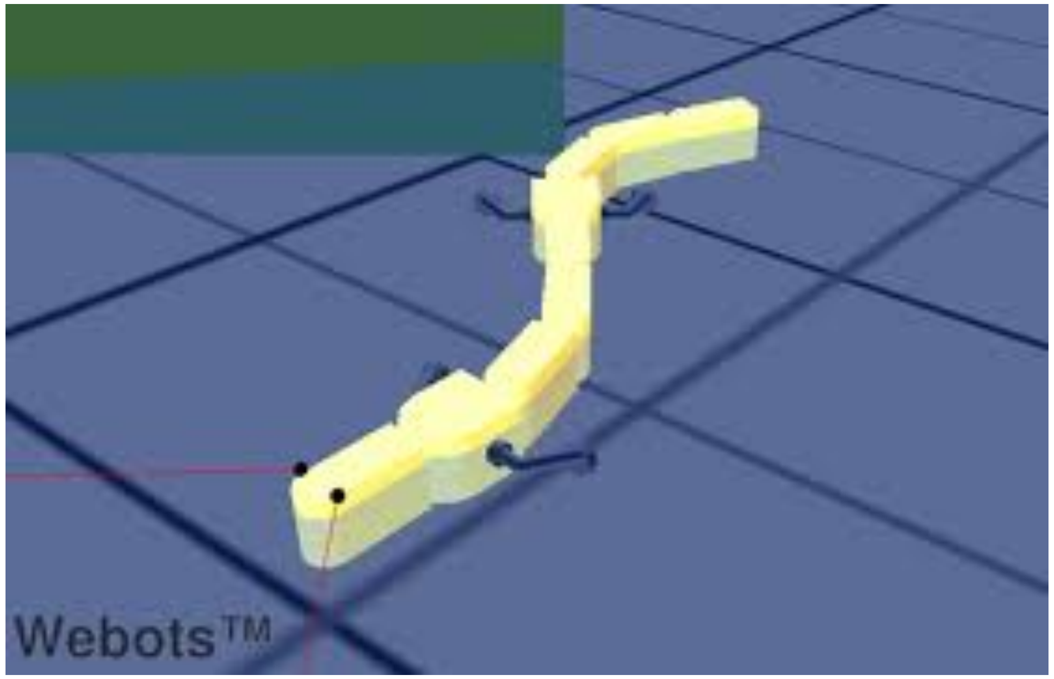
Kōan 8: Evolution of lateral-line system sensors and morphology in a fish

- Consider, for example, a salamander model in Webots (Crespi and Ijspeert). Increase the vertical height and do changes to adapt it to model a simple fish (remove the legs ☺)
- Model the 'sixth sense' of the fish with a number of sensors on the two sides of body of the fish.
- You can use simple sinusoidal oscillators along with the distributed sensors for creating distributed swimming controllers.
- Use Genetic Algorithms (GA) to optimize the controller parameters (Amplitude, offset, frequency and phase), to evolve optimal swimming AND sensor morphological distribution.

Salamander model in Webots (Crespi and Ijspeert):



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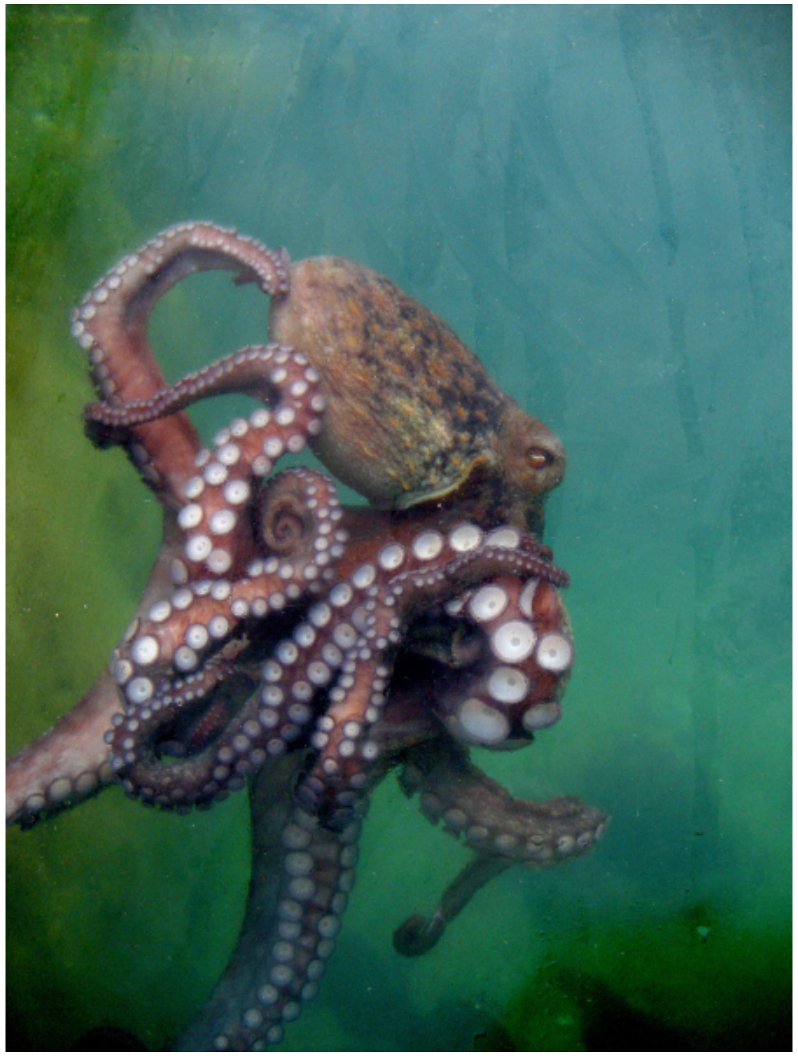
Kōan 9: Evolution of locomotion gait and manipulation skills in underwater modular robots (e.g. Octopus)

- Use the YAMOR modular robot model available in Webots.
- Model the morphology of an Octopus.
- Can use simple sinusoidal oscillators as distributed locomotion controllers.
- Use Genetic Algorithms (GA) to optimize the controller parameters (Amplitude, offset, frequency and phase), to evolve optimal locomotion gaits AND morphology.
- How you could evolve a couple of tentacles as 'arms'?
- How could you better model 'softness'?



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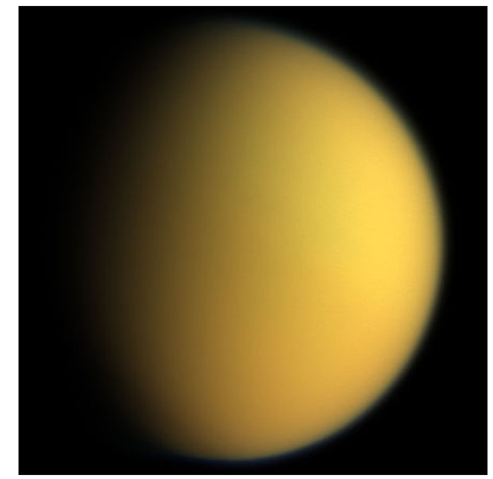
Kōan 10: Evolution of morphology and control for a Titan Manta ray

- Titan (a moon of Saturn) has big liquid methan oceans.
- Build a model of a Manta with a passively compliant wings, for Titan's oceans.
- Can you use simple sinusoidal oscillators as distributed locomotion controllers for the 'wings'? May you model the manta as a kind of Braitenberg vehicle?
- Use Genetic Algorithms (GA) to optimize the controller parameters (Amplitude, offset, frequency and phase) AND morphology, to evolve optimal flapping.
- How it would differ on earth?



Titan (Wikipedia)

Manta ray (Wikipedia):

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Cyberbotics Webots

- Download Webots simulator from: http://www.cyberbotics.com/
- Register for 30 day trial of Webots Pro
- **IMPORTANT: Use email registered with ShanghAI Lectures website account (let us know if not)**
- License will be extended until end of semester (participating students/teaching assistants)

Questions?

- If you have questions or ideas, please contact:
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