人工智能

The ShanghAI Lectures

上海授课

Kōans for group projects 2015

ShanghAI Lectures

http://shanghailectures.org/

“A **Kōan** (公案) … is a story, dialogue, question, or statement, which is used in Zen-practice to provoke the ‘great doubt’, and test a student's progress in Zen practice.”

Wikipedia

ShanghAI Lectures in Osaka

Students attending the ShanghAI Lectures 2011 at Osaka University, Japan

News

Live stream

Submitted by Martin F. Stoelen on Wed, 2015-10-21 19:43

Here is the link to the live stream for the lectures, tune in tomorrow Thursday at 09:00 CET! Have questions for the speakers? Registered users have access to a dedicated chat that you can use for this purpose.

Recordings

Submitted by Martin F. Stoelen on Tue, 2015-10-20 10:46

Missed last week's lecture? No worries, you can watch the recordings here: https://cast.switch.ch/vod/clips/2lo40boqjw/link_box

Goals of the ShanghAI Lectures

The ShanghAI Lectures project aims at

- building a sustainable community of students and researchers in the area of Embodied Intelligence
- making education and knowledge on cutting-edge scientific topics accessible to everyone
- exploring novel methods of knowledge transfer
- overcoming the complexity of a multi-cultural and interdisciplinary learning context
- bringing global teaching to a new level

These lectures about Natural and Artificial Intelligence are held via videoconference at the University of Zurich in Switzerland, Scuola Superiore Sant'Anna of Pisa, Italy, Humboldt University Berlin in Germany, Plymouth University in the UK, Osaka University in Japan, Shanghai Jiao Tong University in China, and about 10 other universities and research organizations around the globe. Students from the participating universities work together on the exercises, using a powerful robotics simulator software, Cyberbotics Webots. Live streaming of the lectures is provided by University Carlos III of Madrid.

Follow @shanghailecture

Partner Sites 2015

Weekly participants

Timeline

29 October: Kōans published
5 November: Deadline, select a Kōan
8 November: Student groups published
3 December: Preliminary design report
25-29 January: Group presentations

Grading

1. **Preliminary design report (25%)**

   Repository Wiki* (preferred) **or** 4 p. report

   Ideas, plans and current progress

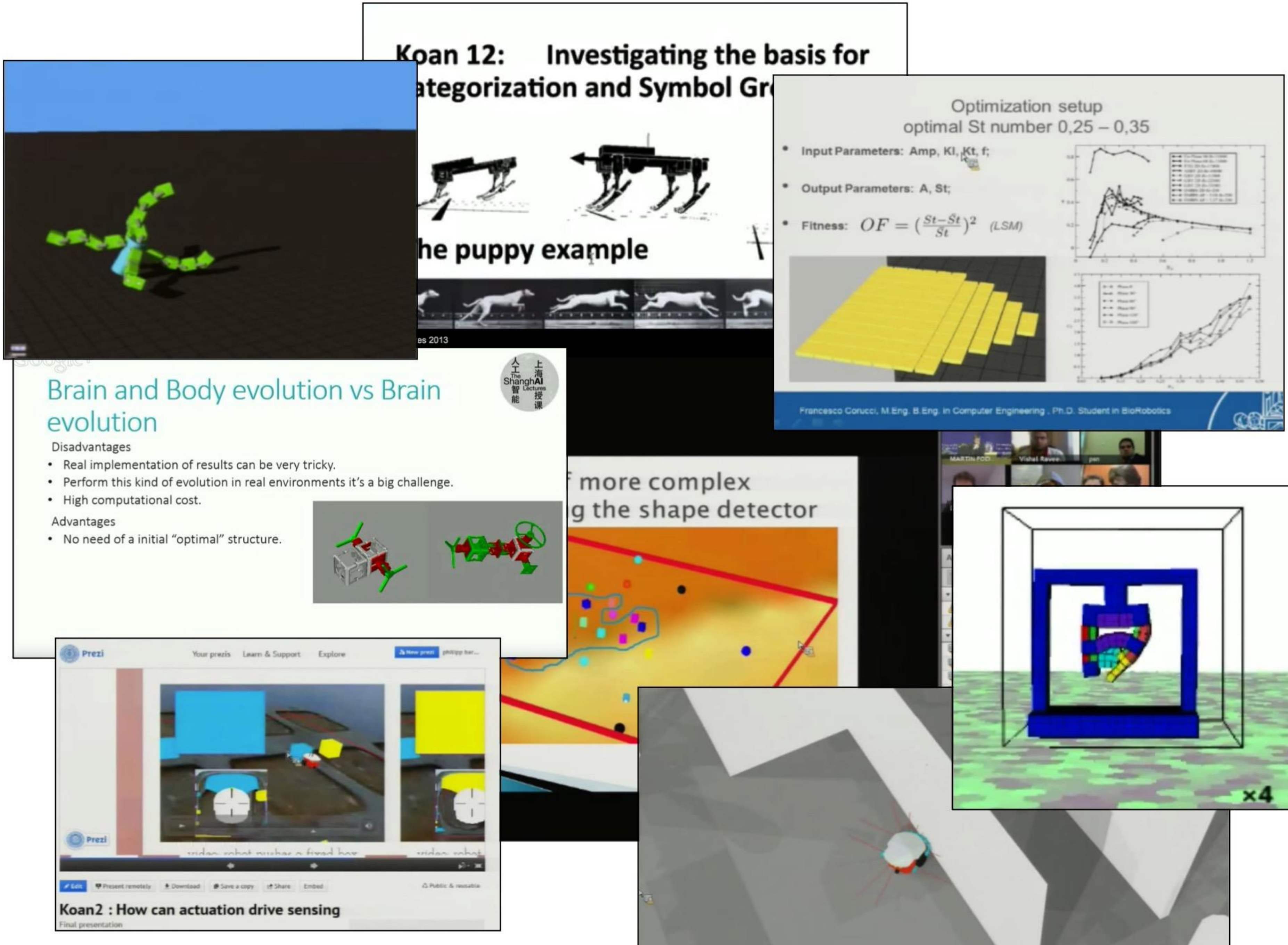
   Graded by your tutor(s)

2. **Group presentations (75%)**

   Google Hangouts (typically)

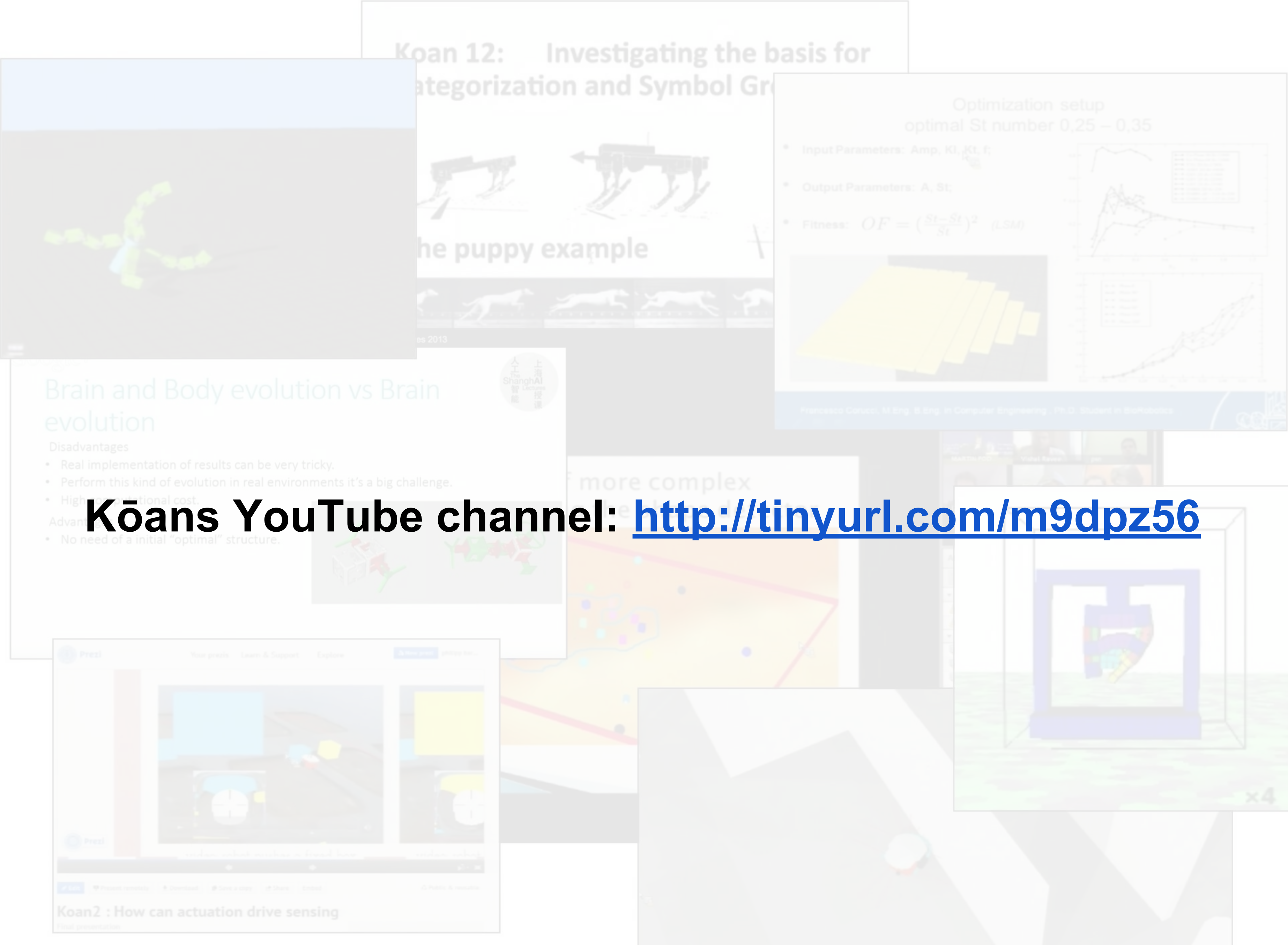
   Evaluated by a presentation panel

* All groups are encouraged to publish material openly on for example Bitbucket, GitCafé or GitHub.



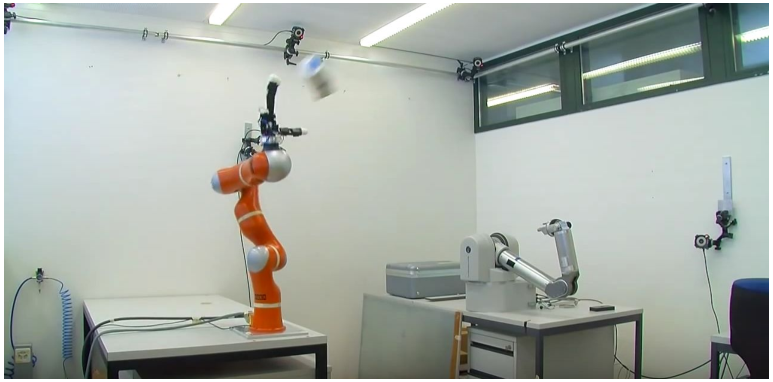
Koan 12: Investigating the basis for
ategorization and Symbol Gr
he puppy example
es 2013
Optimization setup
optimal St number 0,25 – 0,35
Input Parameters: Amp, Kl, Kt, f;
Output Parameters: A, St;
Fitness: $OF = (\frac{St-\hat{S}t}{\hat{S}t})^2$ (LSM)
Francesco Corucci, M.Eng, B.Eng. in Computer Engineering , Ph.D. Student in BioRobotics
Brain and Body evolution vs Brain evolution
Disadvantages
Real implementation of results can be very tricky.
Perform this kind of evolution in real environments it's a big challenge.
High computational cost.
Advantages
No need of a initial "optimal" structure.
The Shanghai AI Lectures
f more complex
g the shape detector
Prezi
Your prezis
Learn & Support
Explore
Koan2 : How can actuation drive sensing
Final presentation
×4

Kōans YouTube channel: http://tinyurl.com/m9dpz56



Kōan 1: Soft catch

- Reliably catching objects is hard, but progress is being made (see videos)
- Can a ‘soft’ embodiment simplify the problem? If so, how?
- One source of inspiration could be the human body - what is the key to a successful catch?
- How does a passively compliant structure increase the time available to close the hand? How/why is the control simplified? Is it?
- Can a ‘soft’ embodiment also simplify the needed sensing?
- See for example the GummiArm*



Robot catches a variety of objects (w/ globally tracked markers): https://youtu.be/M413lLWvrbI

Soft octopus arm: https://youtu.be/vSRgO6GShTo

Passive “catch”: https://youtu.be/sBEPA2ymCbk

Do you have other ideas? Feel free to be creative!

* https://github.com/mstoelen/GummiArm

Kōan 2: From passive to actuated dynamic walking

Do you have other ideas?
Feel free to be creative!

- A passive dynamic walker exploits its own intrinsic dynamics to generate a “natural” and energy-efficient gait, but with several limitations:
    - It typically requires a downward slope for adding energy
    - It is typically limited to a very even and obstacle-free surface
- Could you add actuators? Where?
- What about sensors on the sole of the feet? Reflexes?
- How could you change the speed? (hint: check recommended reading!)
- Students could start by exploring the Webots passive walker example*
- What potential applications exist for very energy-efficient walking?

65 km on one charge - the Cornell Ranger:

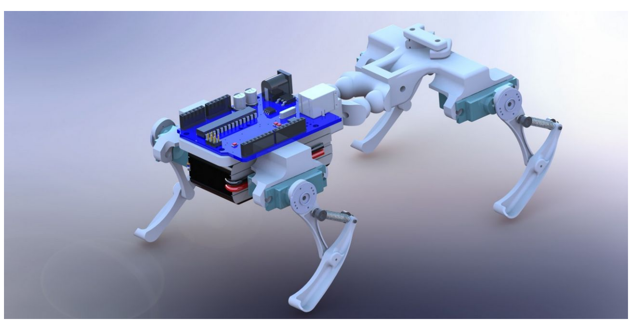
P. Bhounsule, et al., Low-bandwidth reflex-based control for lower power walking: 65 km on a single battery charge, International Journal of Robotics Research, vol. 33 no. 10, pp. 1305-1321, 2014. DOI: 10.1177/0278364914527485. http://ijr.sagepub.com/content/33/10/1305.refs.html

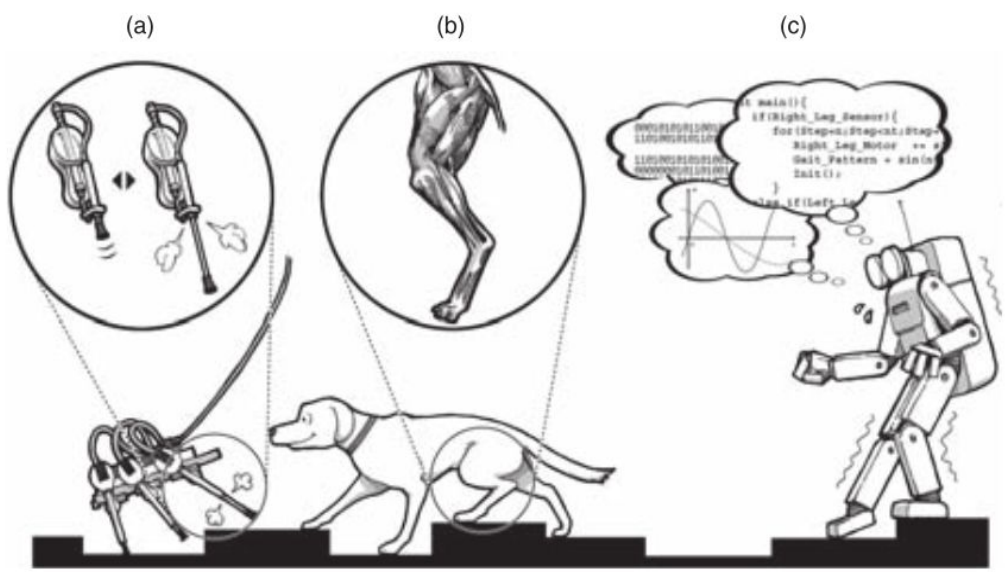
* http://shanghailectures.org/content/assignment-2-2012

Kōan 3: Take Puppy out for a walk

- We have seen that Puppy can move in a “natural” way with very simple actuation (e.g. one servo in each leg) and passive compliance (springs)
- But how well does the gait work in complex uneven terrains, and what factors contribute to the success/failure of the locomotion?
- The students can start from the Puppy example*, and put it in an uneven terrain. Explore performance and investigate improvements. Reflexes?

Checkout demoPuppy:
https://dermitza.github.io/demoPuppy/





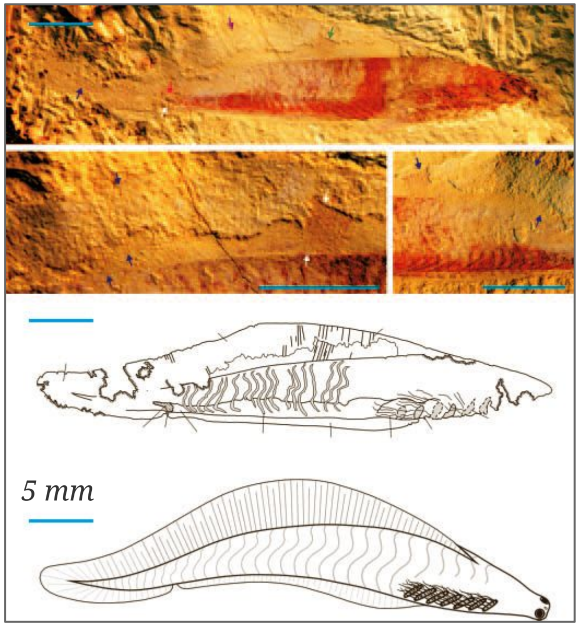
Page 97 in “How the body shapes the way we think”

* http://shanghailectures.org/content/assignment-3-2012

Kōan 4: Learning how to swim like a fish

- Once in a while, we discover fossil remains of extinct fish, giving us insights on the evolution of species.
- The way these species lived and moved can only be roughly estimated by looking at the features of the fossilized fishes.
- The students will design a robot-fish[1] and a machine learning algorithm[2] allowing the fish to efficiently learn how to "swim" either in simulation[3] or using a real robot.
- Can your method give insights on the way extinct fishes swam?
  - If yes, what can you tell about the fish from the obtained results?

Haikouichthys* lived 525 million years ago



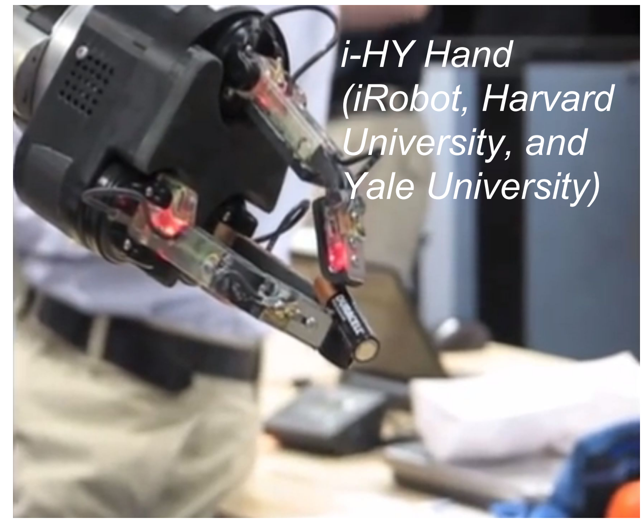
Zhang & Hou, 2004, p. 1163

Do you have other ideas? Feel free to be creative!

[1] *Software or hardware.*
[2] *The proposed method would be applicable to different fishes and validated with non-extinct species of fish.*
[3] *2D simulator here or 3D simulator here.*
* *https://en.wikipedia.org/wiki/Haikouichthys*

Kōan 5: A soft touch

- Explore designs of hands (and arms?) with different degrees of passive compliance.
  - E.g. rigid links connected by springs
  - Implement a physical design (3D print?) or in e.g. Webots or VoxCad
- What objects can be "grasped" when:
  - Hand falls on top by gravity?
  - One, two or more actuators are used? 2, 5 or more fingers?
- Discuss the impact on controller design and movement planning required.



*Check out the **Soft Robotics Toolkit** for inspiration:*

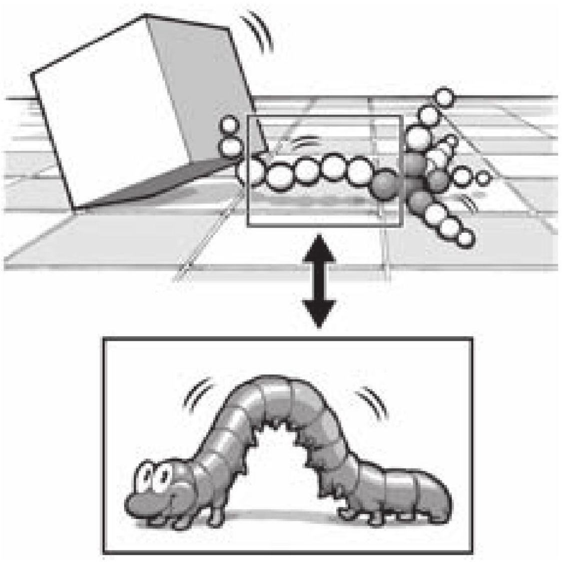
http://softroboticstoolkit.com

Do you have other ideas?
Feel free to be creative!

Kōan 6: Evolution of brain and body

Do you have other ideas? Feel free to be creative!

- In humans (and animals) the brain and the body (and the environment) have been evolved together over millions of years
- Explore the evolution of the brain (the control algorithms) and the body (the sensor, actuator and structure) of a robot
- And/or, what about the environment?
- The students can use Webots (e.g. the YAMOR modular robot), Ludobots*, or any other suitable simulation suite
- What benefits can you find for evolving the mind and body concurrently? How can it play a role in future robot designs?



Page 198 in "How the body shapes the way we think"

* http://www.uvm.edu/~ludobots/

Kōan 7: Wearable soft robotics

- Soft robotics provides tools for making safe and comfortable wearable devices ranging from power-assist and rehabilitation to shape-changing clothing.
- *Design a wearable soft device, and fabricate a prototype of it.* Use your imagination.
- Good places to start for ideas:
    - Soft Robotics Toolkit*
    - PneuFlex Tutorial**
    - JamSheets***
- How is the soft mechanism coupled with the human body? How is this related to the lecture topics?

Marty McFly with self-adjusting jacket, Back to the Future Part II

Do you have other ideas? Feel free to be creative!

*http://softroboticstoolkit.com/
**http://www.robotics.tu-berlin.de/index.php?id=pneuflex_tutorial
***https://vimeo.com/73164578

Kōan 8: "Useful" robot collaboration from local rules

Do you have other ideas?
Feel free to be creative!

- Implement a swarm of simple robots of your choice in a large virtual environment
- Use biological systems as inspiration, e.g. a flock of birds or school of fish.
- Under "normal" behavior individuals follow three rules
  - Move in the same direction as your neighbours
  - Remain close to your neighbours
  - Avoid collisions with your neighbours
- There are two main events that trigger a reaction:
  - Response to a predator attack* (escape)
  - Response to food (gather)
- How to model these reactions?

* https://youtu.be/m9mn7EB1H6k

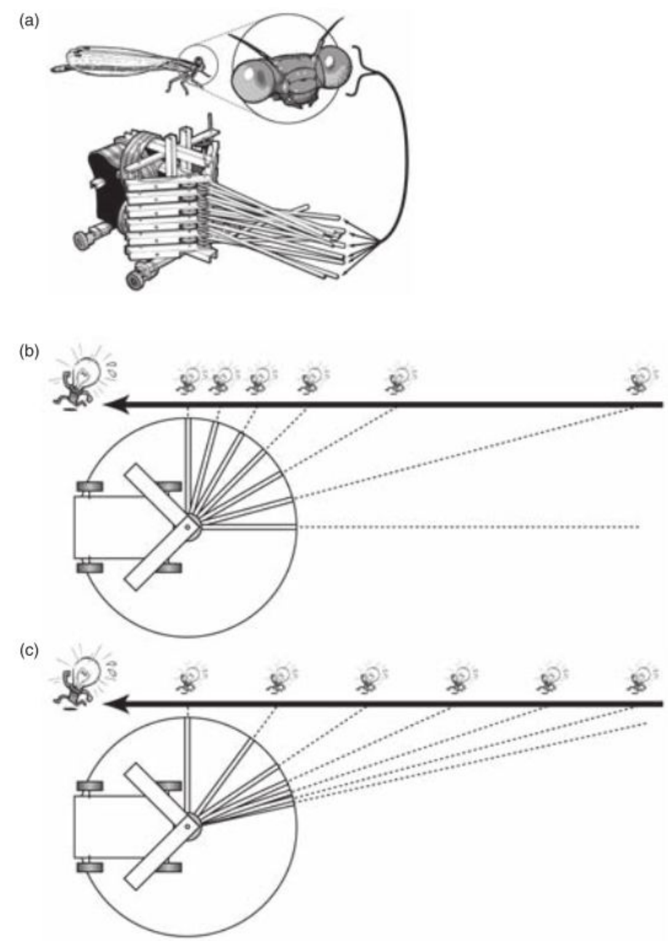
https://en.wikipedia.org/wiki/Swarm_behaviour
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2234121/

Do you have other ideas?
Feel free to be creative!

Kōan 9: EyebotSim

- Houseflies have a higher density of eye facets towards the front. This compensates for motion parallax - a “cheap” design
- Lichtensteiger and Eggenberger* developed the Eyebot, and demonstrated that such a solution could also be evolved in a robot
- Can you replicate the experiment on a robot of your choice in e.g. Webots?
- Can you find other examples of morpho-logical computation in nature? Other insects with similar sensor morphology?
- What is the potential for evolving the sensor morphology of robots in different real-world applications?

Page 131 in “How the body shapes the way we think”



* http://www.cs.cmu.edu/~motionplanning/papers/sbp_papers/integrated2/lichtensteiger_compound_eye.pdf

Do you have other ideas?
Feel free to be creative!

Kōan 10: Passive walking and hopping on a comet

- The comet 67P/Churyumov-Gerasimenko has very low gravity, and can be modeled as a rough block of ice
- The Philae lander 'weighs' about the equivalent of 1 gram there
- Moving it has proven very difficult

- Think of a passive walker and/or hopper able to move safely there
- Is it possible?
- You may draw inspiration from: Mirko Kovač, Manuel Schlegel, Jean-Christophe Zufferey, and Dario Floreano. 2009. A miniature jumping robot with self-recovery capabilities. In *Proceedings of the 2009 IEEE/RSJ international conference on Intelligent robots and systems* (IROS'09). IEEE Press, Piscataway, NJ, USA, 583-588. (the robot is in the picture)

Do you have other ideas?
Feel free to be creative!

Kōan 11: Evolving robot explorers

- There are nine oceans in the solar system, see http://www.jpl.nasa.gov/news/news.php?feature=4541
- The oceans of Europa and Enceladus are the best candidates so far for the search of ET life. They may have what's needed: liquid water, the chemical elements (C, N, O, P), and sources of energy (geothermal)
- They are beneath hundreds of Km-s thick crusts of ice (so we don't know what's down there)

  - How to plan a robot exploration of those distant worlds?
  - A solution might be provided by sending a self-evolving species of evolving intelligence robots
  - Think of a basic set of co-evolving morphology and intelligence robots

Kōan 12: Define your own kōan

- Have an idea for a kōan you would like to explore?
- Why not propose it, maybe other students are also interested!
- There are two main conditions:
    - The kōan must be related to the topics covered in class
    - The group must be open to all students (max 5 in group)
- Contact us first, so we can help you organize:
    - Martin F. Stoelen: martin.stoelen@plymouth.ac.uk
    - Tapio Tarvainen: tapio.tarvainen@chiba-u.jp
    - Jimmy Baraglia: jimmy.baraglia@gmail.com
    - José Carlos Castillo Montoya: jccmontoya@gmail.com

Student groups

- Assigned according to Koan preferences
  - Max 5 students per group
  - We aim to make groups as international as possible

- We encourage HW solutions
  - Local core of students ok for local HW (contact us)
  - But must remain open to students from other sites

- Thinking outside the box required!
  - No single “correct” answer to any of the Kōans

Student TODOs

1. Create a student account on the website

   http://shanghailectures.org/

2. Sign up for a Kōan:

   http://tinyurl.com/ohdzkdx

3. Install 30 day trial version of Webots Pro*:

   http://www.cyberbotics.com/

* Use same email registered on **ShanghAI Lectures website account** (let us know if not)