Course: AI
Fall term 2019

Koans for Group Projects 2019

LI Xiaoan (Dustin) 李孝安
MARS-lab
School of Computer Science and Engineering
Northwestern Polytechnical University

E-mail: dustinli@nwpu.edu.cn
QQ group: AI-2019
Cell phone: 18629662731

10:25

Outline

- ***Kōan***
- **Kōans for Group Projects**
- **Groups**
- **Student project timeline**
- Discussions
- **Group Presentations**

Kōan *(公案)*

- *What is* ***Kōan?***
  - *Wikipedia: "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."*
  - **公案**，禅宗术语，指禅宗祖师的一段言行，或是一个小故事，通常是与禅宗祖师开悟过程，或是教学片断相关。公案的原义为中国古代官府的判决文书，临济宗以**参公案**作为一种禅修方式，希望参禅者如法官一样，判断古代祖师的案例，以达到开悟，又称**公案禅**
- *General questions on group projects*:
  - Dr. Li Xiaoan: dustinli@nwpu.edu.cn
  - **Teaching Assistant**:

Kōans for Group Projects

- **Kōan 1: Wearable soft robotics**
- **Kōan 2: Embodied AlphaGo**
- **Kōan 3: Machine Reasoning based on Deep Learning**
- **Kōan 4: Energetically autonomous robots with "Microbial Fuel Cells"**
- **Kōan 5: Natural language understanding: Alana**
- **Kōan 6: Braitenberg Vehicles**
- **Kōan 7: Attractor States as the basis for Symbol Grounding**
- **Kōan 8: Learning how to swim like a fish**
- **Kōan 9: "Useful" robot collaboration from local rules**
- **Kōan 10: Softness and Stiffness of a swarm**
- **Kōan 11: Model (part) of a cell as a swarm**
- **Kōan 12: Passive walkers on Mars**
- **Kōan 13: Define your own kōan**

Kōan 1: 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 2: Embodied AlphaGo

- **AlphaGo** is a program made by Google's company DeepMind. It beat firstly the top player Lee Sedol.
- To understand the mechanism and approaches based in AlphaGo.
- Think about:
  - If AlphaGo is embodied with a human-like body (make up with its eyes, ears, limbs and mouth), will such an embodied AlphaGo win the world champion of game Go?
  - What are the challenging problems to be solved?

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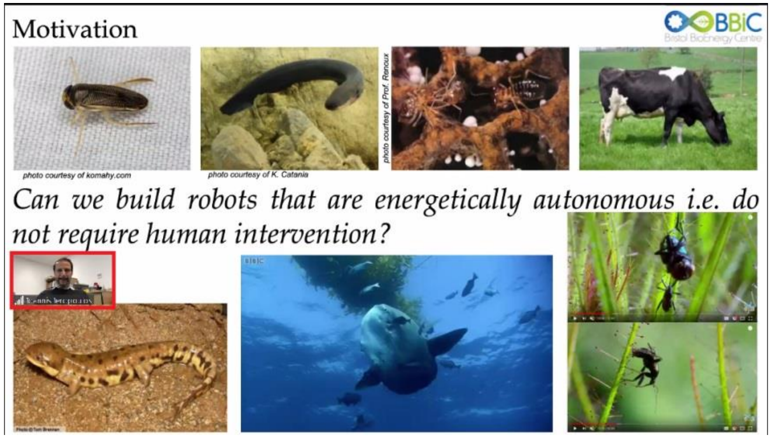
Kōan 3: Machine Reasoning based on Deep Learning

- Machine reasoning could be based on symbolic rules, or connectionism like neural networks. Deep learning provides great foundation for machine reasoning.
- Think about the challenging problems for embodied reasoning based on deep learning. What are the potentials and limitations for killer applications?

Kōan 4: Energetically autonomous robots with "Microbial Fuel Cells"

- **"Microbial Fuel Cells"** provides new way for energy of autonomous robots such as *EcoBot-III*
- Can the robots *EcoBot-III* live energetically autonomous?
- What are the limitations for **"Microbial Fuel Cells" ?**
- What is the challenging problem for the future?



EcoBot-III, Artificial Life'12, MIT Press, pp.733-740
IEEE int Robots & Sys (IROS), 2015, 3888-3893
Artificial neural networks simulating microbial fuel cells with different membrane materials and electrode configurations, 2019, Journal of Power Source, 436:226832

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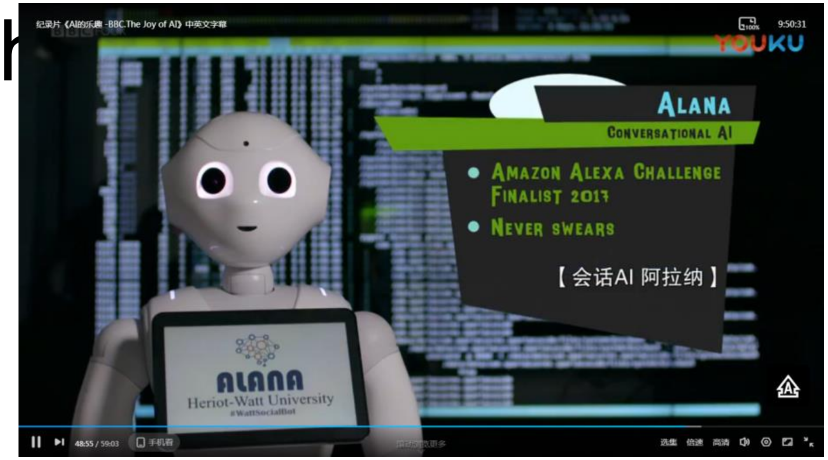
Kōan 5: Natural language understanding robots: *ALANA*

- autonomous robots such as ***Alana***
- Can the robots Alana really understand?
- What are the limitations for NLP?
- **What is the challenging problem for the future?**

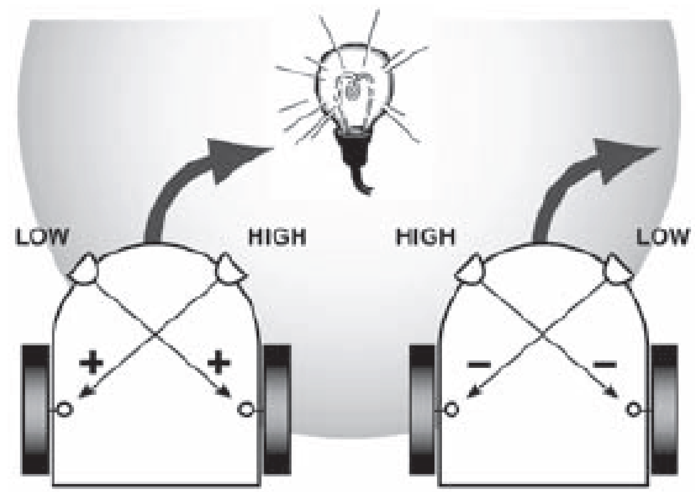


Starting from

- ***The joy of AI***, a documentary made by BBC, 2018
- Related papers published

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)...

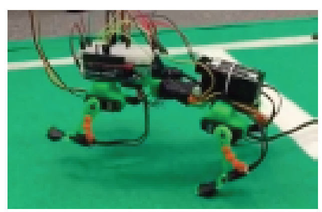


Page 80 in "How the body shapes the way we think"

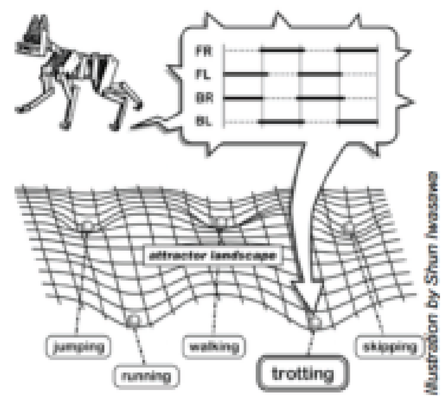
University of Zurich[UZH]

Kōan 7: Attractor States as the basis for Symbol Grounding

- Use the Puppy platform from Webots, or build your own
- Can Puppy categorize its gaits using its sensor input?
- What role do command data and proprioceptive data have?
- Why would Puppy need to change its gait? Environment and/or intrinsic motivation?



https://www.youtube.com/watch?v=dTAExarRs8w
https://www.youtube.com/watch?v=UEV5jJJWhFE
https://www.youtube.com/watch?v=iSr6adUvd_I



Attractor states

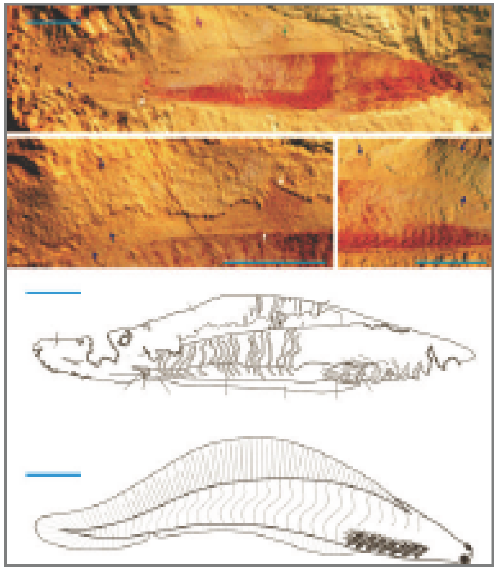
Pfeifer, R. and Bongard, J., 2006. *How the body shapes the way we think: a new view of intelligence*. MIT press.

demoPuppy repository (with CAD and printable files):
https://dermitza.github.io/demoPuppy/
Previous year's group repository:
https://bitbucket.org/koan12/shanghai-lectures-k-an-12

Kōan 8: Learning how to swim like a fish

- Fossil remains of extinct fish give 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
- 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 robot
- Can you gain insights on the way extinct fishes swam?
    - If yes, what can you tell about the fish from the obtained results?

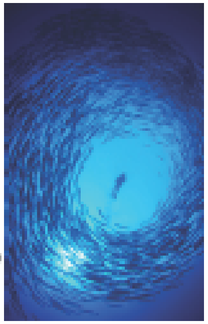
Haikouichthys* lived 525 million years ago



Zhang & Hou, 2004, p. 1163

[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 9: "Useful" robot collaboration from local rules



- 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?
- How may you control a swarm? How can you let it move from point A to point B?

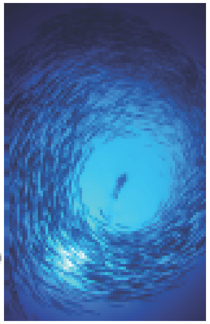
Do you have other ideas? Feel free to be creative!

* https://youtu.be/m9mn7EB1H6k https://en.wikipedia.org/wiki/Swarm_behaviour https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2234121/

Kōan 10: Softness and Stiffness of a swarm

- 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
- How to model these reactions?
- How may you control the perceived/measured stiffness of a swarm? How could you measure it?

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

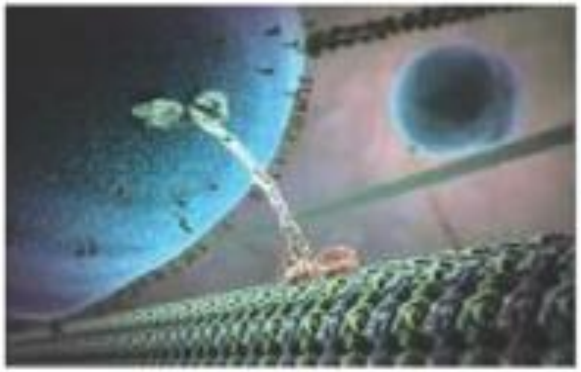


* https://youtu.be/m9mn7EB1H6k https://en.wikipedia.org/wiki/Swarm_behaviour https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2234121/

Kōan 11: Model (part) of a cell as a swarm

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

- Implement a swarm of simple agents of your choice in a large virtual environment mimicking a set of cellular process ideally a cell
- 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
- How to model these reactions?
- Why would a membrane help?



* https://youtu.be/m9mn7EB1H6k https://en.wikipedia.org/wiki/Swarm_behaviour https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2234121/

Kōan 12: Passive walkers on Mars

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

- Understand how passive wlakers walk down a slope
- Undestand how the Cornell Ranger walk
- What's the role of gravity?
- Design a passive walker for Mars surface and compare with terrestrilal ones
- What happens to human's brains on the ISS when moving???

From Collins et al. 2001

You may start form here: http://ruina.tam.cornell.edu

Kōan 13: 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 conditions:
  - The Kōan must be related to the topics covered in class
  - The group mest be open to all students (max 5 in group)

– Contact us first, so we can help you organize:
  - Li Xiaoan (Dustin): dustinli@nwpu.edu.cn, QQ group: AI-2019

18629662731

Grading scheme

- Preliminary design report (25%)
  - Repository Wiki on e.g. GitHub/GitCafé (preferred) or 4 page (max) report
  - Ideas, plans and current progress
  - Graded by your tutor(s), send via email
- Group presentations (75%)
- Final score
  - Preliminary design report(25%)+Presentation(75%)

Kōans for Group Projects

- Resources
  - See the 2019 intro presentation “Group Project Kōans” PDF version
- **Group allocation**
  - Assigned according to kōan preference
    - Max 5 students per group
    - We aim to make groups as international as possible
- **Thinking outside of the box required!**
  - **No single “correct” answer to any of the Kōans**

Students’ TODOs

- 1. Read through details of the different kōans
  - This presentation will be available from website (kōans tab)
  - A living document, may be updated as we go along
- 2. Select a project from the kōans with your group members by December 17 23:59
  - Indicate your preferred one, and let me know in our QQ group
  - You will be assigned group and tutor

IS2019 Grouping result: 20191205

序号	姓名		题目	组类
1				
2				
3				
4				
5				
6				
7				

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Timeline

- 10 December: Kōans published
- 17 December: **Deadline**, register and select a Kōan
- 18 December: Student groups published
- 25 December: **Deadline**, preliminary design report
- *7* January*:* ***Group presentations***
  - ***9 January:*** **Deadline for Final Report submitted**

Discussions

- Experiment 1: Preparation of experiments
- Experiment 2
  - Presentation to the Koan selected for your group
    - Problem/ideas/questions
  - do experiment and interact
- Experiment 3
  - Presentation for preliminary design
- **Experiment 4**
  - **demonstration and improvement**

- **Group Presentation 20200109 14:00-16:00**

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Group Presentations

- **January 7**
- 10 minutes presentation, and 5 minutes answering questions for each group
- Slide for presentation required
- Submitted reports in PDF version
  - A preliminary design report for each group
  - **Project Report for each group** including the roles and contributions for each member

AII

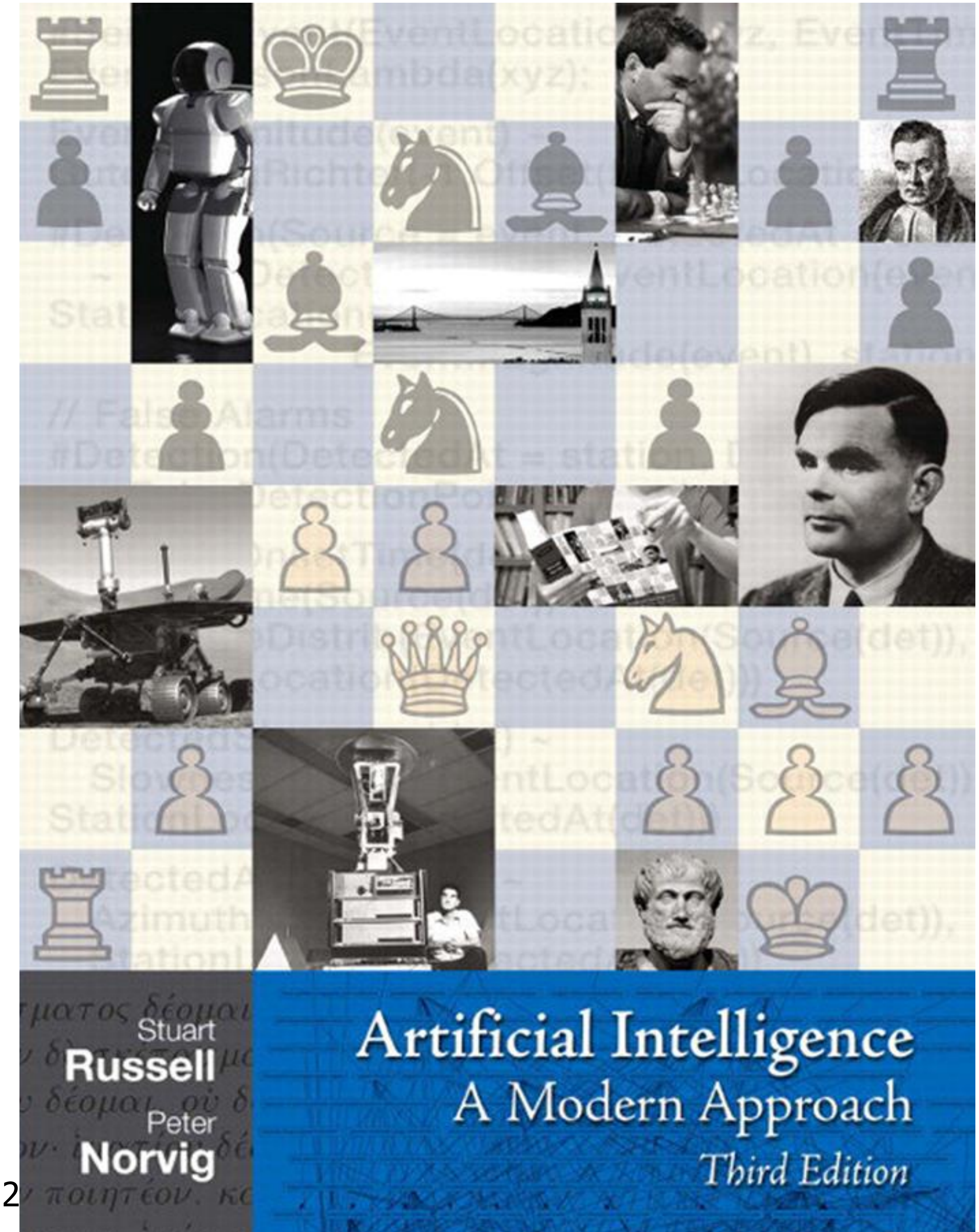
- Course home page: http://shanghailectures.org
- lecture notes, tutorials, assignment, grading, office hours, etc.
-
- Textbook: S. Russell and P. Norvig *Artificial Intelligence: A Modern Approach* Prentice Hall, 2006, Third Edition
- Lecturer: LI Xiaoan
-
- Grading: Class participation (20%), Project assignment (20%),
- Final exam (60%)
-
- Class participation includes participation in both lectures and tutorials (attendance, asking and answering questions, presenting solutions to tutorial questions).
- Note that attendance at every lecture and tutorial will be taken and constitutes part of the class participation grade.
-
- final exam (2 hrs) are open-book
-

Course overview

- AI
  - Introduction to AI(chapters 1)
  - Agents (chapters 2, Embodied Agents)
- Problem-solving by searching
  - Search (chapters 3,4,*6*)
- Knowledge-based Reasoning
  - Logic (chapters 7,8,9), FOL inference, UI/EI, Reasoning(chap 12)'
- Uncertainty-oriented Reasoning
  - Quantifying Uncertainty (chap 13,14)
  - Probabilistic Reasoning (Chapter 14: 14.1-14.4)

Course overview

- Learning
  - Learning from Examples (chapters 18: 18.1-18.7, 18.12)
  - Chapter 20: 20.1, 20.2
- Robotics: Embodied Intelligence (chap 25, How…)
- Conclusions
  - Philosophical Foundations(chapter 26)
  - Perspectives(Chapter 27)



TURING MACHINE

Deep Blue

ASIMO

WATSON

AlphaGO

……

Main topics

- AI
  - Conceptions: Weak AI vs Strong AI/Embodied AI/open problems in AI
- Inference based on Bayes rules
- Decision Tree Learning
- Neural Networks
  - Perceptrons/Multi-layer Perceptrons/Learning Algorithms
- Evolutionary Computation
  - Genetic Algorithm

Main topics

- Exercises
  - Exercise 1, 2, 3
  - assignments
- Projects
  - Define a project
  - Grouping results
  - Requirement
  - Report for a project
  - Presentation issues

Project

- Define a project
  - Embodied robots
  - Deep learning
  - Detailed problem-solving strategies or algorithms
- Grouping results
  - G1: 范+秦+何
  - G2：向+黎+曹
  - G3：张+艾+冯
  - G4：
  - G5：

Presentation for project

- Slide for presenting
  - 7-miu presentation+6-miu Q&A for each group
- Report for project
  - Introduction of your project (Problem+Task+Questions)
  - Ideas or brain-storm
  - A scheme for your ideas
  - Improvement
  - A summary (conclusions, questions, contribution for each one)
- When &Where: **2019-1-09 Wed 10:30-12:30 JB-207**

Final Exam

- Overview
  I. **Check whether the statements are true or false and make your choice (30pts)**
  II. **Short Questions (25~30pts)**
  III. **Calculation based questions (25~30pts)**
  IV. **General questions(15pts)**
- Final score
  - Assignments and presents: 20%
  - Project: 20%
  - Final Exam(Closed/Open): 60%
- Closed exam!