NUS Course Materials:
Ethical Behaviour and Respecting Copyright

All course participants (including permitted guest students) who have access to the course materials on Canvas or any approved platforms by NUS for delivery of NUS modules are not allowed to re-distribute the contents in any forms to third parties without the explicit consent from the module instructors or authorized NUS officials

Examples of Disallowed Actions

- No Posting on any websites (except for the materials explicitly allowed by your lecturer in the respective module)
- No selling of material
- No sharing of questions/answers which could lead to cheating/plagiarism
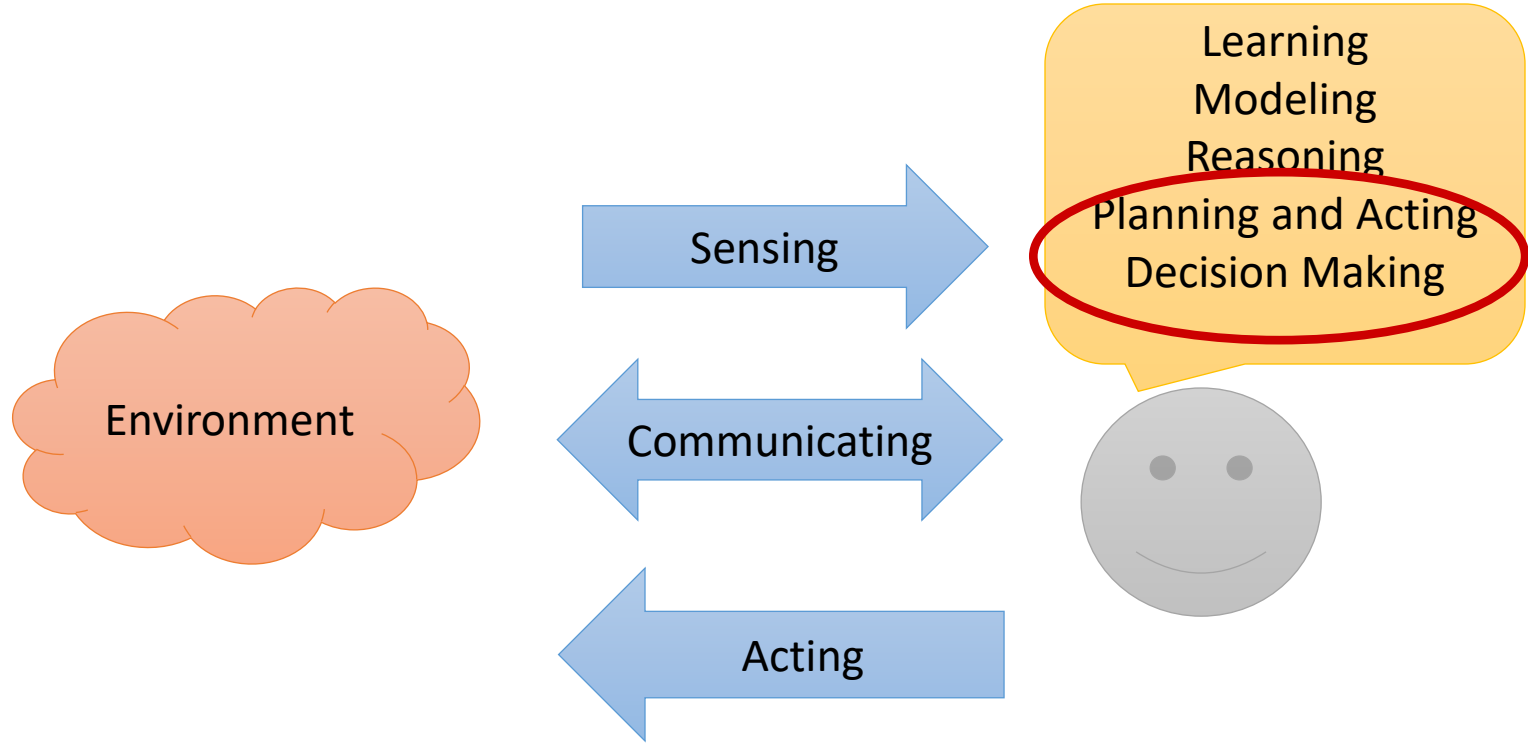
Hello!

- **Akshay** Narayan
  - Lecturer, SOC
  - Teaching: AI (CS4246/CS5446, CS3243) and
    SE (CS2113, CS3219, TIC3001, CS3203, CS2103)
  - Research: AI and Reinforcement learning
  - Before: TA 4 times; 3 yrs. Industry

- Contact
  - MSTeams: dcsaksh
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AI: Building A Rational Agent

Learning
Modeling
Reasoning
Planning and Acting
Decision Making

Sensing

Communicating

Acting

Environment

AI Planning and Decision Making

An intelligent agent needs to:

The Actor's View of Planning:
How to plan to act effectively in the real world?
How to act to plan effectively in the real world?

- make rational decisions
  - What does rational mean?
  - What are the decision objectives and guiding values?

- plan a sequence of actions to achieve some objective
  - How to learn to take actions optimally when there is uncertainty? Change?
  - How to scale it up to large problems?

- act appropriately when there are other agents around
  - How to act when the other agents are also "thinking" and optimizing for themselves?
  - How to function and behave in a responsible manner in a human society?

Course Objectives

- What is this course about?
  - To introduce foundational concepts and practical implications of AI planning and decision making
  - To survey some state-of-the-art advancements in theory and application of AI planning and decision-making technologies

- What will you learn from this course?
  - Understand the main concepts, capabilities, and limitations of AI planning and decision technologies
  - Apply the technologies in different applications
  - *Develop new technologies and applications

Syllabus

Week	Topics	Week	Topics
1	Introduction & Classical Planning	7	Reinforcement Learning | Test (?)
2	Real-world Planning and Acting	8	Real World Reinforcement Learning
3	Rational Decision Making	9	Partially Observable Markov Decision Process
4	Decision Analysis/Decision Theory	10	Game Theory and Multi-agent Decision Making
5	Markov Decision Process	11	Human Factors and Judgmental Decision Making & Responsible AI Decision Making
6	Reinforcement Learning	12	Test
R		13	*State-of-the-art Applications and Future Trends* AKA Project Presentations

Required Background for Enrollment

- **Discrete Structures**
  - Logic, Proofs, Functions, Relations, Recursion, Induction, Combinatorics, Graph Theory
- **Probability and Statistics**
  - Basic probability theory, random variables, Bayes' Theorem, probability models, information theory, experiment design, hypothesis testing, statistical inference
- **Artificial Intelligence**
  - Knowledge Representation, Reasoning, Learning, Search
- **Linear Algebra and Calculus**
  - Matrices, basic matrix operations, eigenvalues and eigenvectors, derivatives, maximization and minimization

Teaching Team

Name	Role	Contact
Akshay Narayan	Course Coordinator	dcsaksh@nus.edu.sg
Hannah Brown	Tutor	e0792519@u.nus.edu
Yue Junfeng	Tutor	e0555802@u.nus.edu
Ong Han Yang	Tutor	ong_han_yang@u.nus.edu
Samuel Lau Yi Ren	Tutor	e0544506@u.nus.edu
Zhao Peiduo	Tutor	e0389118@u.nus.edu
Shao Yurui	Tutor	shaoyurui@u.nus.edu
Bharath Shankar	Tutor	e0550582@u.nus.edu

Note: Please ask technical and course organization questions through the **FORUM** on **Canvas**!

Course Logistics

- Classes (weekly)

  - Wednesday   1830 – 2030   In-person   Lecture (LT16)

  - Various   In-person   Tutorials

- Grading policy

  - Homework, participation*, and quizzes   45 %

  - Project (report due 22 Apr; presentation in week 13)   25 %

  - Test(s)   (*in-person, closed-book, using Examplify*)   30 %

Submission via Turnitin

* See slide 13

Course Logistics

- Core Contents
  - Main components are the same for CS4246 and CS5446
  - Common lectures
  - Tests and assignments may be differentiated between CS4246 and CS5446
  - Discussions on Canvas forum

- Tutorials and Assignments
  - Attempt tutorial questions before class; present and discuss in class
  - Homework (Pair): Written questions + Programming – Prerequisite: Python

- Project
  - Self-defined topic in teams of 4
  - 1-page proposal due after Recess Week (you can submit earlier too!)

Should be from the same cohort

Course Logistics

- SOC Unix Account
  - If you don't already have a SOC Unix account, please create one
  - Refer to the announcement made earlier

- Attendance
  - Lecture attendance is optional
    - In-lecture quizzes are used to boost participation marks if necessary
  - Tutorial attendance & participation are recorded
    - Counted towards participation

Course Resources

- Canvas
  - Course syllabus
  - Announcements
  - Lecture notes
  - Handouts
  - Assignments
  - Discussion Forum
  - Multimedia

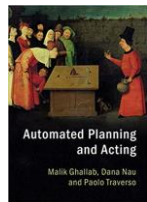Information on and web-links to other relevant materials will be made available throughout the course

Reference Books

- Main reference book:
  - (RN) Russell, S. and P. Norvig, Artificial intelligence: A modern approach. 4th ed. (Global ed.) 2021: Pearson. (Alternate: 3rd ed.)
    [Table of contents for 4th ed.: http://aima.cs.berkeley.edu/contents.html]
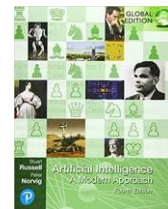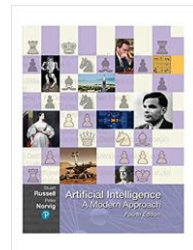
- Reference books:
  - (GNT) Ghallab, M., Nau, D. and Traverso, P. Automated Planning and Acting. Cambridge University Press, Cambridge, 2016.
    [Book website: http://projects.laas.fr/planning/]
    [e-Book for personal use: http://projects.laas.fr/planning/book.pdf]
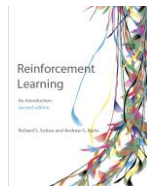
  - (SB) Sutton, R. S. and A. G. Barto. Reinforcement Learning: An introduction. 2nd ed. MIT Press, 2018, 2020
    [Book website: http://incompleteideas.net/book/the-book.html]
    [e-Book for personal use: http://incompleteideas.net/book/RLbook2020.pdf]

Additional Resources

- You will also find good tutorials, tools, publications at:
  - Conference in Uncertainty in Artificial Intelligence (UAI)
    - https://www.auai.org
  - American Association for Artificial Intelligence Conference (AAAI)
    - https://www.aaai.org
  - International Joint Conference on Artificial Intelligence (IJCAI)
    - https://www.ijcai.org
  - Neural Information Processing Systems Conference (NeurIPS)
    - https://nips.cc
  - International Conference on Automated Planning and Scheduling (ICAPS)
    - https://www.icaps-conference.org
  - International Conference on Autonomous Agents and Multiagent Systems (AAMAS)
    - https://www.ifaamas.org
  - International Conference on Artificial Intelligence and Statistics (AISTATS)
    - https://aistats.org
  - …

Honour Code

- NUS Code of Student Conduct:

  (A) Academic, Professional and Personal Integrity

  (B) Respect for People

  (C) Respect for and Compliance with the Law and with Campus Policies and Regulations

  (D) Responsibility towards Maintaining the Campus as a Place Conducive for Learning and Living

- This module will teach you how to apply and develop powerful Responsible AI technologies for the betterment of humankind

- If you are unable or unwilling to respect and abide by the Honour code, please **DO NOT** take this module!