



CS3244 Machine Learning

Semester 2, 2021-2022

Outline

- Course administration
- Introduction to machine learning
- Concept learning

Course Administration

- Teaching staff
- Teaching resources
- Objective
- Syllabus
- Assessment overview

Teaching Staff

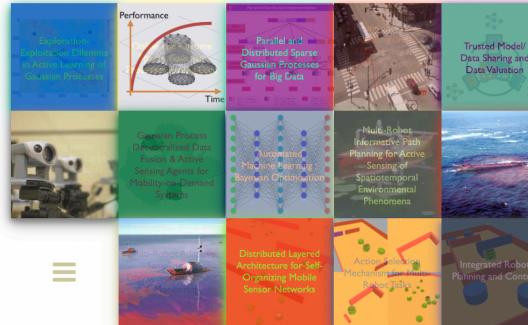
- Lecturers: Bryan Low & Daren Ler*

 - Email: {lowkh, dler}@comp.nus.edu.sg
 - Website:
<http://www.comp.nus.edu.sg/~lowkh>
<https://www.comp.nus.edu.sg/cs/bio/dler/>
 - Office: COM2-02-58 / AI SG I4.0-05-04
COM2-02-65*
 - Consultation hours: By appointment
 - Research interests: Machine learning (CS3244), planning under uncertainty (CS4246), AI (CS3243)

- Tutors: Sherman Yuen, Sng Weicong, Lucas Agussurja, Fan Xiaofeng, Sebastian Tay, Rachael Sim, Wu Zhaoxuan
 - Email: Check LumiNUS
 - Consultation hours: By appointment

Multi-Agent Planning, Learning, and Coordination Group (MapleCG) Towards bridging the gaps between planning, learning, and coordination

LOW, BRYAN KIAN HSIEH | 陳健錫 | G
Associate Professor (with tenure) > CS > NUS
Faculty Member > IESE > NUS Graduate School (NGS)
Faculty Affiliate > Inst. of Data Science > NUS
Ph.D. > ECE > UI > CHU



publications

RESEARCH SPOTLIGHTS “by articles for light reading”

Tweets by @bryanklow

Bryan Kian Hsiang Low
@bryanklow
The #AAA2022 paper of @inseblion
@michael_xinyi_chuan sheng @bryanklow
proposes a theoretically guaranteed fair
#SyntheticData reward mechanism for
collaborative #GenerativeModel
(#GAN, #GANS) based on maximum mean
discrepancy-based #DataValuation.

Incentivizing Collaboration in Machine Learning via Synthetic Data Rewards
To incentivize good participants, rewards are commensurate to contributions.

NUS School of Computing about 2 years ago

Is it possible for multiple #machinelearning models to work together? 🤔 NUSComputing Asst Prof Bryan Low and his collaborators designed a way for machine learning models to share information with each other while keep their data private.
<https://medium.com/.../sharing-without-oversharing-in-collect...>

MEDIUM.COM Sharing, without oversharing, in collect...
Researchers find a way to harness the power of c...

NUS School of Computing about 3 years ago

How can computer science be used to help Grandma find the best cookie recipe? 🍪 Read more: <https://nus.edu/YQj1Yy>

COMP.NUS.EDU.SG NUS Computing - What Bayesian Optim...
NUS Computing, School of Computing, National ...

Daren LER

Lecturer

PGDE (Education, National Institute of Education, Nanyang Technological University, Singapore)
Ph.D. (Computer Science, University of Sydney, Australia)
B.CST (Computer Science, First Class Honours, University of Sydney, Australia)

Daren Ler obtained his Ph.D. from the University of Sydney, Australia. He is currently a Lecturer in the Department of Computer Science, School of Computing, National University of Singapore (NUS).

Prior to his position at NUS, he served as a Computing Teacher as part of the Ministry of Education (MOE), Singapore, where he taught H2 Computing at National Junior College. In 2019, he was awarded the Outstanding Computing Teacher Award by MOE.

His current research interests are in the areas of meta-learning for automated machine learning, and computational thinking in mathematics education.

Teaching Resources: LumiNUS

<https://luminus.nus.edu.sg/>

- Lesson plan
- Lectures, tutorials, homeworks, diagnostic quizzes, projects, supplementary materials
- Announcements
- Homework and project submissions

Objective

Understand the fundamental concepts and theoretical foundations of *machine learning* (ML)

Who should take CS3244?

- Undergraduate students. Centered towards CS or by permission.
- This module is **THEORY-oriented**: ML uses and exploits considerable math, Bayesian statistics, and algorithms.
- **Prerequisites**
 - CS2010 or CS2020 or CS2040 Data structures & algorithms II/Accelerated
 - EE2012/A or MA2216 or ST2131 or ST2334 Probability and statistics
 - MA1102R or MA1505 or MA1507 or (MA1511 and MA1512) or MA1521 Calculus
 - MA1101R or MA1311 or MA1513 or MA1508E Linear algebra

Managing your Expectations

- White-box vs. black-box (e.g., deep learning) models



“Powerful you have become, the dark side I sense in you.”

- Learning fundamental concepts & theoretical foundations vs. improving your rank in Kaggle
- ~~Bryan Low~~ vs. ANDREW NG (Co-founder, Coursera; Adjunct Professor, Stanford University; former head of Baidu AI Group/Google Brain)
- Second time teaching such a massive ML class (> 3x)
- Let me in! If not, my future will be ruined!

References

- [CB] C. M. Bishop (2006). Pattern Recognition and Machine Learning.
- [TM] T. Mitchell (1997). Machine Learning.
- [DHS] R. O. Duda, P. E. Hart, and D. G. Stork (1997). Pattern Classification.
- [RN] S. Russell and P. Norvig (2010). Artificial Intelligence: A Modern Approach (3rd Edition).

Additional Resources

You will also find good tutorials, tools, & publications at

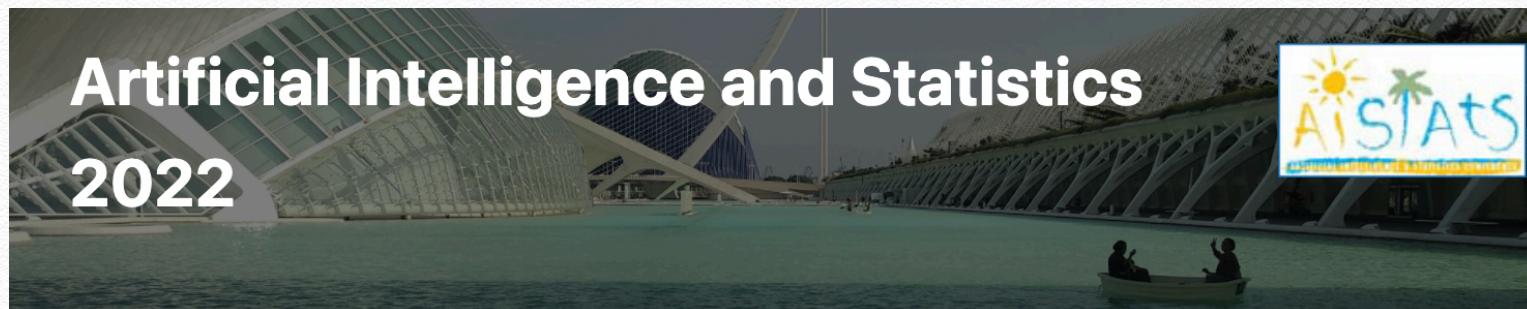
- Neural Information Processing Systems Conference (NeurIPS)
<http://neurips.cc>
- International Conference on Machine Learning (ICML) <http://icml.cc>
- International Conference on Artificial Intelligence and Statistics (AISTATS) <http://www.aistats.org>
- International Conference on Learning Representations (ICLR) <http://iclr.cc>
- Conference on Uncertainty in Artificial Intelligence (UAI)
<http://www.auai.org>
- AAAI Conference on Artificial Intelligence (AAAI) <http://www.aaai.org>
- International Joint Conference on Artificial Intelligence (IJCAI)
<http://ijcai.org>

Syllabus

- Concept learning
- Decision trees
- Neural networks
- Bayesian inference
- Computational learning theory
- Other ML topics...

Public Holidays

- NUS Calendar: “Please note that the official end time for classes on Chinese New Year eve is 2pm” > No lecture on 31 Jan
- 31 Jan - 2 Feb: Lunar New Year > No tutorials on week 4



Assessment Overview

- **Midterm assessment** (Week 8) 30%

 - ▶ **10 Mar 2022 (Thurs, 12noon-2pm)**: During lecture
 - ▶ NO make-up

- **Final assessment** (23 Apr 2022, 9-11am) 40%
- **Term project : ML Singapore!** 25%
- **Graded tutorials, class attendance, online quizzes** 5%

Freedom of Information Rule

- Collaboration is acceptable and encouraged.
- You must always write the name(s) of your collaborators on your assignment.
- You will be assessed for the parts for which you claim is your own contribution.

On Collaboration

- You are free to meet with fellow students(s) and discuss assignments with them.
- Writing on a board or shared piece of paper is acceptable during the meeting; however, you **may not take any written (electronic or otherwise) record away from the meeting.**
- After the meeting, do something else for at least a half-hour before working on the assignment.
- This will ensure that you are able to reconstruct what you learned from the meeting, **by yourself.**



Introduction

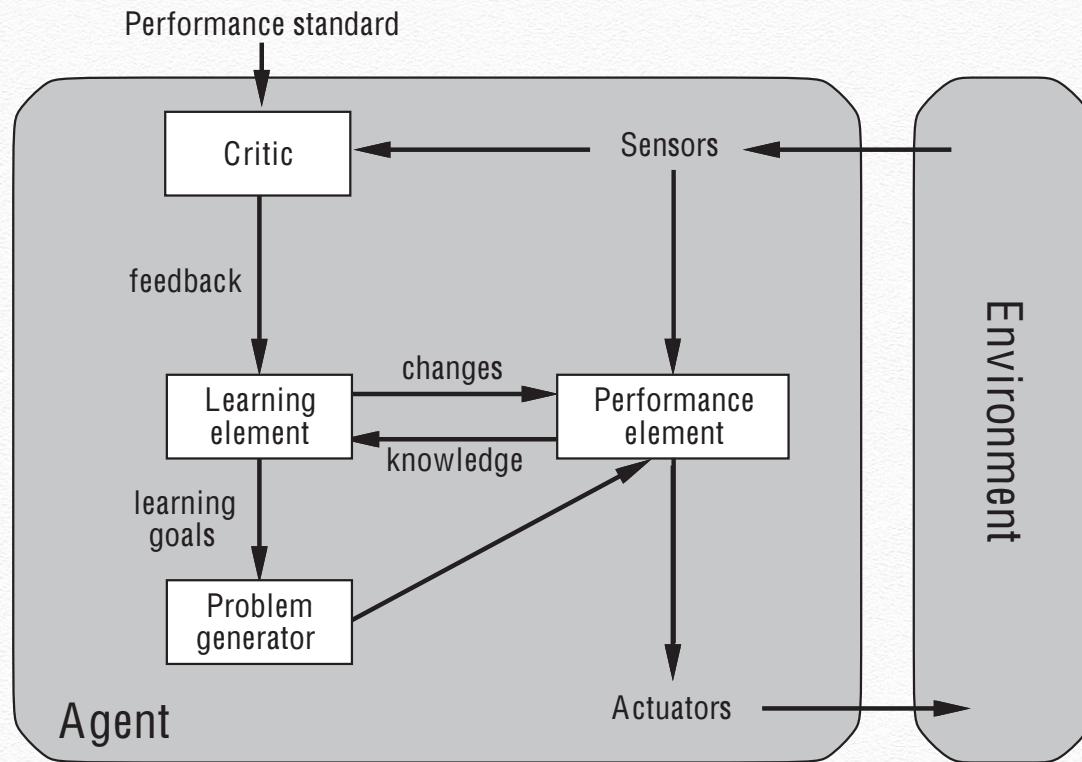
What is Learning? Why Learn?

- An agent is said to be *learning* if it improves its performance P on task T based on experience/observations/data E
 - T must be fixed, P must be measurable, E must exist
 - e.g., self-driving car

Reasons for learning:

- Hard to pre-program an agent's strategy to operate well in unknown, dynamically changing task environments
- Hard to encode all human knowledge (e.g., Go, Poker)
- Less to program if the agent can learn

Design of Learning Agent



- Performance element: selects the external actions
- Learning element: improves agent to perform better
- Critic: provides feedback on how well the agent is doing
- Problem generator: suggests explorative actions that will lead to new, informative (but not necessarily better) experiences

Learning Element

- Design of a learning element is affected by
 - Which components of the performance element are to be learned
 - What representation is used for data and the components
 - What feedback is available to learn these components
- Types of feedback:
 - **Supervised learning**: correct answer given for each example
 - **Unsupervised learning**: correct answers not given
 - **Reinforcement learning**: occasional rewards given

State of the Art : Collaborative ML & AutoML

N-CRIPT Public Seminar



**Trusted Data Sharing:
Incentivizing
Collaboration and
Rights to Be Forgotten
in Machine Learning**

Speaker: Assoc Prof Bryan Low
Tuesday 29 Dec
10.00am on Zoom



In this talk, Prof Low will present his preliminary research efforts in trusted data sharing. Specifically, he will discuss how we can perform data valuation, incentivize multiple parties with data to collaborate in building higher-quality models, and unlearn a trained machine learning model from data to be erased (e.g. personal data, malicious data) for compliance with regulations such as the Personal Data Protection Act, General Data Protection Regulation, and the future of personal data ownership.

bit.ly/4ncrpt
Please register here:



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NUS School of Computing
on Monday



Is it possible for multiple #machinelearning models to work together? 🤖🍪 #NUSComputing Asst Prof Bryan Low and his collaborators designed a way for machine learning models to share information with each other while keep their data private.

<https://medium.com/.../sharing-without-oversharing-in-collect...>

MEDIUM.COM
Sharing, without oversharing, in collective machine learning
Researchers find a way to harness the power of collective intelligence, wh...

39 Comment 18

NUS School of Computing
about 8 months ago



How can computer science be used to help Grandma find the best cookie recipe? 🍪💻

Read more: <https://nus.edu/2YQj1Yy>

COMP.NUS.EDU.SG
NUS Computing - What Bayesian Optimisation can teach us...
NUS Computing, School of Computing, National University of Singapore, ...

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<https://www.comp.nus.edu.sg/~lowkh/research.html>