

Academic Org: Div of Computer Science & Engg – Subject: Computer Science

Course: CSCI5660	Course ID: 013991	Eff Date: 2023-07-01	Crse Status: Active	Apprv. Status: Approved	[New Course]
Advanced Topics of AI for Life Sciences 生命科學中的人工智能進階					

This course introduces the advanced machine learning techniques for extending the boundary of life sciences. Topics to be covered include but are not limited to the recent successful stories of AI for life sciences study. We are going to cover reinforcement learning-based drug design (GENTRL), graph neural network-assisted antibiotics discovery, deep learning-enhanced super-resolution microscopy, ground-breaking molecular folding algorithm (AlphaFold), deep learning-based disease diagnosis and prediction, deep learning for single-cell and spatial transcriptomics, multi-modality/omics learning, model interpretability, privacy-preserving learning for life sciences. Along the course, we will further discuss the challenges and opportunities of AI in life sciences, such as foundation models with unlabeled data for solving data scarcity issue, out-of-distribution learning for drug design. This is a research-orientated course. By the end of the course, the students are expected to finish a substantial project, aiming at publication.

本科主要介紹高級機器學習技術在探索生命科學領域中的應用。涵蓋的主題包括但不限於最新的人工智能技術在生命科學研究中成功應用的各種案例。我們將學習基於強化學習的藥物設計 (GENTRL)、圖神經網絡輔助發掘抗生素的應用、基於深度學習增強的超分辨顯微成像、突破性的分子折疊算法 (AlphaFold)、基於深度學習的疾病診斷和預測，單細胞和空間轉錄組學結合的深度學習，多模態/多組學學習，模型可解釋性，生命科學的隱私保護學習等。在課程中，我們將進一步討論人工智能技術在生命科學中的挑戰和機遇，例如用未標記的數據訓練基石模型以解決數據稀缺的問題，將分佈外學習技術應用於藥物設計等。這是一門以研究為導向的課程。在課程結束時，學生將以發表學術論文為最終目的完成一個實質性項目。

Grade Descriptor: A

EXCELLENT – exceptionally good performance and far exceeding expectation in all or most of the course learning outcomes; demonstration of superior understanding of the subject matter, the ability to analyze problems and apply extensive knowledge, and skillful use of concepts and materials to derive proper solutions.

有關等級說明的資料，請參閱英文版本。

B

GOOD – good performance in all course learning outcomes and exceeding expectation in some of them; demonstration of good understanding of the subject matter and the ability to use proper concepts and materials to solve most of the problems encountered.

有關等級說明的資料，請參閱英文版本。

C

FAIR – adequate performance and meeting expectation in all course learning outcomes; demonstration of adequate understanding of the subject matter and the ability to solve simple problems.

有關等級說明的資料，請參閱英文版本。

D

MARGINAL – performance barely meets the expectation in the essential course learning outcomes; demonstration of partial understanding of the subject matter and the ability to solve simple problems.

有關等級說明的資料，請參閱英文版本。

F

FAILURE – performance does not meet the expectation in the essential course learning outcomes; demonstration of serious deficiencies and the need to retake the course.

有關等級說明的資料，請參閱英文版本。

Equivalent Offering:

Units: 3 (Min) / 3 (Max) / 3 (Acad Progress)

Grading Basis: Graded

Repeat for Credit: N

Multiple Enroll: N

Course Attributes: MSc Computer Science
MPhil-PhD Computer Sci & Erg

Topics:

COURSE OUTCOMES

Learning Outcomes:

- At the end of the course of studies, students will be able to:
1. know the different kinds of computational problems in life sciences.
 2. understand how to use the AI techniques to resolve the above computational problems.
 3. apply and develop AI techniques to resolve the above problems.
 4. analyze the performance of the machine learning method and understand their limitations.
 5. enhance problem-solving ability, communication and presentation skills by doing project.

Course Syllabus:

Week 1: The overview of ML and DL
Week 2: Molecular folding algorithm based on deep learning (AlphaFold)
Week 3: Reinforcement learning-based drug design
Week 4: Graph neural network-assisted antibiotics discovery
Week 5: Deep learning-enhanced super-resolution microscopy
Week 6: Deep learning-based disease diagnosis and prediction
Week 7: Deep learning for single-cell and spatial transcriptomics
Week 8: Multi-modality/omics learning
Week 9: Model interpretability in life sciences
Week 10: Privacy-preserving learning for life sciences
Week 11: Foundation models in life sciences
Week 12: Out-of-distribution learning for drug design
Week 13: Course project presentation

Assessment Type:

Homework or assignment	: 20%
Project	: 60%
Test or quiz	: 20%

Feedback for Evaluation:

1. Results of assignments and quiz
2. Course evaluation and questionnaire
3. Reflection of teachers
4. Question-and-answer sessions during class
5. Student consultation during office hours or online

Required Readings:

To be provided by course teacher.

Recommended Readings:

"Introduction to data mining" by Michael Steinbach, Pang-Ning Tan, and Vipin Kumar (ISBN: 9780321321367)
"Deep Learning " by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (ISBN: 9780262035613)

OFFERINGS

1. CSCI5660	Acad Organization=CSEGV; Acad Career=RPG
-------------	--

COMPONENTS

LEC : Size=40; Final Exam=N; Contact=3

TUT : Size=40; Final Exam=N; Contact=1

ENROLMENT REQUIREMENTS

1. CSCI5660

Enrollment Requirement Group:

For undergraduate students in Computer Science (CSCIN) or Computer Engineering (CENG) or Artificial Intelligence – Systems & Technologies (AISTN); or
For students in MSc Computer Science; or
For students in MPhil-PhD Computer Science & Engineering

New Enrollment Requirement(s):

Other Requirement = For undergraduate students in Computer Science (CSCIN) or Computer Engineering (CENG) or Artificial Intelligence – Systems & Technologies (AISTN); or
For students in MSc Computer Science; or
For students in MPhil-PhD Computer Science & Engineering

CAF

< E N D O F R E P O R T >