Form AR 140

The Hong Kong Polytechnic University

Subject Description Form

Subject Code	CMS6002
Subject Title	Frontiers of Artificial Intelligence
Credit Value	3
Level	6
Pre-requisite/ Co-requisite/ Exclusion	Expected to have undergraduate introductory background in Deep learning.
Objectives	This subject aims to provide students with a comprehensive and forward-looking understanding of the fast-evolving research frontiers in Artificial Intelligence (AI). It is designed to develop the students' ability to critically evaluate emerging methods, synthesize knowledge across subfields, and identify novel research directions that advance the state of AI.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Critically analyse and evaluate cutting-edge AI research across multiple domains. b. Identify open challenges and propose innovative research problems in AI. c. Integrate and apply knowledge from various AI paradigms (e.g., LLMs, graphs, multimodal learning, trustworthy AI). d. Communicate complex AI concepts effectively in both written and oral forms.
Subject Synopsis/ Indicative Syllabus	This subject covers advanced and rapidly evolving areas that define the current and future trajectory of AI. Topics include: **Large Language Models and AI Agents** • Large Language Models (LLMs) (fine-tuning, inference, scaling) • Reasoning & AI Agents (tool use, multi-agent systems, RAG) **Graph AI and Knowledge-Augmented Reasoning** • Graph neural network foundations • Applications (Anomaly detection, forecast) • Knowledge graphs & LLM Reasoning **Computer Vision and Generative Models** • Vision Transformers, diffusion models **Multimodal AI (Vision–Language–Speech Integration)** • Vision + Language + Speech (BLIP-2, GPT-4o) **AI for Time Series and Complex Systems** • Deep learning for time series (prediction, anomaly detection, classification). • Foundation Models for Time Series (TimeLLM, GPT4TS, universal models). **Recommender Systems**

<table>
<tr><td></td><td>AI for Science and Discovery
Trustworthy and Responsible AI</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>The course will be delivered through a combination of mini-lectures, critical readings, team presentations, and student-led discussions.
Mini-lectures: Introduce key frontier concepts and unify background knowledge.
Group discussions: Encourage peer learning and critical debate.
Research proposal presentations: Enable students to present and defend original research proposals.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="4">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td></tr>
<tr><td>1. Class Attendance & Participation</td><td>10%</td><td>✓</td><td></td><td></td><td>✓</td></tr>
<tr><td>2. Critical Paper Reviews (3 short reviews)</td><td>25%</td><td>✓</td><td></td><td>✓</td><td></td></tr>
<tr><td>3. Research Presentation</td><td>25%</td><td></td><td>✓</td><td></td><td>✓</td></tr>
<tr><td>4. Research Frontier Proposal (written)</td><td>40%</td><td></td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="4"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
Attendance & participation encourage active engagement, discussion, and in class activities.
Paper reviews assess critical evaluation skills.
Research presentations develop scholarly communication.
Written proposal demonstrates research originality and integration of knowledge.
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<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Mini-lectures, discussions, and presentations</td><td>30 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading and paper reviews</td><td>40 Hrs.</td></tr>
<tr><td>▪ Research proposal preparation and presentation</td><td>50 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>120 Hrs.</td></tr>
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Reading List and References	1. Zhao, W. et al (2023). A Survey of Large Language Models. arXiv:2303.18223 2. Yao, S. et al. (2023). ReAct: Synergizing Reasoning and Acting in Language Models. ICLR 2023. 3. Wu, Z. et al. (2021). A Comprehensive Survey on Graph Neural Networks. IEEE Transactions on Neural Networks and Learning Systems (TNNLS). 4. Liu, Y. et al. (2024). ARC: A Generalist Graph Anomaly Detector with In-Context Learning. NeurIPS 2024. 5. Radford, A. et al (2021). Learning Transferable Visual Models From Natural Language Supervision. ICML 2021 6. Luo, S. et al. (2024). Reasoning on Graphs: Faithful LLM Reasoning with Graph Structures. ICLR 2024. 7. Liang, Y. et al. (2023). Foundation Models for Time Series Analysis: A Survey. KDD 2024. 8. Jin, M. et al. (2024). Time-LLM: Reprogramming LLMs for Time Series Forecasting. ICLR 2024. 9. Liu, H. et al. (2022). Trustworthy AI: A Computational Perspective. ACM Transactions on Intelligent Systems and Technology. 10. Technical journals and Conference Proceedings, such as IEEE PAMI, IJCAI, NeurIPS, KDD, AAAI.