Master of Science in Artificial Intelligence

Nurturing talents in artificial intelligence

2024-25 (September 2024 intake)
IS THE PROGRAMME FOR YOU

In today’s technologically advanced era, the indispensability of artificial intelligence (AI) in our daily lives is undeniable. With intelligent machines permeating every aspect of society, the advantages of enhanced efficiency and the augmentation of human capabilities have become apparent. One notable facet of AI is machine learning, enabling machines to observe, analyse, and even make mistakes, akin to the human brain, without explicit programming. As a result, AI has found its applications in diverse fields, including scientific research, transportation, and marketing. As we look ahead, the demand for AI professionals is expected to continue growing.

The Master of Science in Artificial Intelligence [MSc(AI)] is an interdisciplinary taught postgraduate programme jointly offered by the Department of Mathematics (host), the Department of Statistics & Actuarial Science, and the Department of Computer Science. This programme focuses on cultivating expertise in mathematics, statistics, and computer science, intending to leverage these disciplines to empower AI in decision-making and problem-solving across various private and public sector organisations and enterprises.

World-class Rankings of HKU

Quacquarelli Symonds (QS)

World Rankings 2024

#2 Asia Rankings 2024

Times Higher Education (THE)

#35 Asia Rankings 2024

US News Rankings

#55 Best Global Universities 2024

Why this Programme

Interdisciplinary and well-balanced curriculum

◊ Solid training in diverse techniques used in AI from the core courses
◊ Electives over related topics from mathematics, statistics and computer science
◊ A capstone project with real-life applications
◊ Guest lectures by distinguished scholars and industry experts
◊ Internship opportunities in the AI industry and academia

Learning within and beyond AI

◊ Students will learn the AI-related applications of mathematics, statistics and computer science to solve real-life problems
◊ The theoretical elements in the curriculum will help students develop essential intellectual capacity at large

Industry connections and career prospects

◊ Teaching team has strong connections with high-tech industries in the Greater Bay Area
◊ Our graduates are expected to be well prepared for careers such as software engineers, consultants and research scientists in AI and related fields such as big data and financial technology

Programme Information

Tuition fees

Composition fee: HK$330,000\(^\dagger\) (subject to approval)

Students are required to pay a tuition fee of HK$330,000, refundable on graduation subject to no claims being made and graduation fee (HK$150). All full-time students will be charged a student activity fee of HK$100 per annum to provide support for activities of student societies and campus-wide student events.

Programme duration

Full-time: 1.5 years

Medium of instruction

English

Study load

Credits: 72 credits

Learning hours: 1,440 – 2,160 hours (including 240-360 hours for project and contact hours of 264-396 hours)

Class schedule

Teaching takes place mainly on weekdays. Classes may also be arranged on Saturdays if needed.

Scholarships

◊ Master of Science in Artificial Intelligence Entrance Scholarship (HK$20,000)
◊ Master of Science in Artificial Intelligence Outstanding Performance Scholarship (HK$20,000 – HK$30,000)

Assessment

◊ Mainly written and programming coursework, and/or examinations
◊ A Capstone Project on a topic of student’s choice

* The fee shall generally be payable in 3 instalments over 1.5 years

Where will this Programme Lead You

Transferable skills

◊ Equip students with the solid foundation in both theory and practice in artificial intelligence and the underlying mathematical and statistical tools
◊ The practical elements in the courses help students develop essential intellectual capacity and skills, including but not limited to image processing, pattern recognition, financial technology, robotics and quantum computing and so on
◊ Students will learn the applications of mathematics, statistics and computer science to decision-making and problem-solving in organisations and enterprises within the private and public sectors
◊ Students will be able to apply the methodologies learnt ethically and effectively in different academic or professional disciplinary areas

Host

Department of Mathematics

Addressing the need for talents in the field of artificial intelligence, the Department of Mathematics, in collaboration with the Department of Statistics & Actuarial Science and the Department of Computer Science, launched the Master of Science in Artificial Intelligence Programme. We adopt an interdisciplinary academic focus to make our programme a comprehensive study in artificial intelligence.

Who should Take this Programme

◊ Candidates with a bachelor’s degree in subjects including but not limited to mathematics, statistics, computer science and engineering discipline
◊ University graduates and young professionals who aspire to pursue a career in this booming field
◊ Scholastically superior students to pursue further studies in the relevant fields
WHAT YOU WILL LEARN

Course Description

Master of Science in Artificial Intelligence

Programme structure

<table>
<thead>
<tr>
<th>Design of curriculum (72 credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compulsory courses (42 credits)</td>
</tr>
<tr>
<td>ARIN7001 Foundations of artificial intelligence (6 credits)</td>
</tr>
<tr>
<td>ARIN7011 Optimization in artificial intelligence (6 credits)</td>
</tr>
<tr>
<td>ARIN7012 Numerical methods in artificial intelligence (6 credits)</td>
</tr>
<tr>
<td>ARIN7013 Statistics in artificial intelligence (6 credits)</td>
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<tr>
<td>ARIN7002 Applied data mining and text analytics (6 credits)</td>
</tr>
<tr>
<td>COMP7604 Computational intelligence and machine learning (6 credits)</td>
</tr>
<tr>
<td>DASC7608 Deep learning (6 credits)</td>
</tr>
</tbody>
</table>

Disciplinary electives (18 credits)

List A:
- ARIN7014 Topics in advanced numerical analysis (6 credits)
- ARIN7015 Topics in artificial intelligence and machine learning (6 credits)
- MATH7223 Topics in advanced probability theory (6 credits)
- MATH7502 Topics in applied discrete mathematics (6 credits)
- MATH7503 Topics in advanced optimization (6 credits)

List B:
- STAT6001 Computational statistics and Bayesian learning (6 credits)
- STAT6008 Programming for data science (6 credits)
- STAT6029 Quantitative strategies and algorithmic trading (6 credits)
- STAT6021 Big data analytics (6 credits)

List C:
- COMP7308 Introduction to unmanned systems (6 credits)
- COMP7309 Quantum computing and artificial intelligence (6 credits)
- COMP7409 Machine learning in trading and finance (6 credits)
- COMP7502 Image processing and computer vision (6 credits)
- ARIN7007 Legal issues in artificial intelligence and data science (6 credits)

Capstone project (12 credits)

ARIN6700 Artificial intelligence project (12 credits)

Remarks:
1. Students who have completed the same or similar courses in their previous studies may, on submission of relevant transcripts, be permitted to select up to 18 credits of disciplinary electives from the other two lists if they are not able to find any untaken options from any one of the lists of disciplinary electives.
2. The programme structure will be reviewed from time to time and is subject to change.

Compulsory Courses

ARIN7001 Foundations of artificial intelligence

This course introduces foundational knowledge, methods and tools in mathematics, statistics and computer science for the purpose of studying and applying artificial intelligence.

ARIN7011 Optimization in artificial intelligence

This course introduces students to the topics in theory and algorithms of optimization that play important roles in artificial intelligence and machine learning. Topics include: 1) Fundamental optimization models in AI (linear programming models, integer programming models, network models, reinforcement learning and deep learning models, etc.); 2) Optimization theory in AI (optimality conditions, constraint qualification, global landscape analysis of deep neural networks, P- and NP-hard problems, approximation algorithms, preliminary graph theory, etc.); 3) Optimization algorithms in AI: (a) Classic algorithms (simplex method, interior point method, branch and bound method, cutting plane method, representative algorithms, gradient type methods, CG methods, projection methods, penalty method, Lagrange methods, quasi-Newton methods, Newton type methods), (b) Stochastic algorithms (stochastic gradient descent (SGD), stochastic coordinate descent methods, subsampled Newton, stochastic quasi-Newton), (c) Algorithms for large-scale optimization problems (Operator splitting algorithms (BCD type algorithms, ADMM, primal-dual type algorithms, etc.), centralized/decentralized algorithms, etc.). (d) Algorithms for nonconvex optimization and training deep neural networks.

ARIN7013 Numerical methods in artificial intelligence

This course introduces students to the numerical methods that are instrumental in artificial intelligence and machine learning. Topics include: 1) Notions and concepts in numerical analysis (convolution matrix (related to CNN), kernel methods, direct methods for sparse matrices), 2) Numerical method for solving linear systems (Jacobi Method, Gauss-Seidel method, Cholesky decomposition, singular value decomposition (SVD), low-rank matrix approximation with applications in artificial intelligence and machine learning), 3) Principal component analysis, tensor decomposition and their applications to computer vision, image processing and artificial intelligence and machine learning in general.

4) Compute eigenvalues and eigenvectors (Rayleigh quotient, with applications in artificial intelligence and machine learning).

5) Numerical methods for ordinary differential equations (stability, convergence analysis, relation between the SGD and Euler method, using DNN to compute ODEs).

ARIN7011 Optimization in artificial intelligence

The development of artificial intelligence has revolutionized the theory and practice of statistical learning, while novel statistical learning approaches are becoming an integral part of artificial intelligence.

ARIN7015 Topics in artificial intelligence and machine learning

By focusing on the interplay between statistical learning and artificial intelligence, this course reviews the main concepts underpinning classical statistical learning, studies computer-intensive methods for conducting statistical learning, and examines important issues concerning statistical learning drawn upon modern artificial intelligence technologies. Contents include classical frequentist and Bayesian inferences, resampling methods, large-scale hypothesis testing, regularization, and high-dimensional modelling.

ARIN7012 Applied data mining and text analytics

With the rapid developments in computer and data storage technologies, the fundamental paradigms of classical data analysis are mature for change. Data mining aims at automated discovery of underlying structure and patterns in large amounts of data, especially text data. This course takes a practical approach to acquaint students with the new generation of data mining tools and techniques, and show how to use them to make informed decisions. Topics include data preparation, feature selection, association rules, decision trees, bagging, random forests and gradient boosting, cluster analysis, neural networks, introduction to text mining.

COMP7404 Computational intelligence and machine learning

This course will teach a broad set of principles and tools that will provide the mathematical, algorithmic and philosophical framework for tackling problems using Artificial Intelligence (AI) and Machine Learning.
AI and ML are highly interdisciplinary fields with impact in different applications, such as biology, robotics, language, economics, and computer science. AI is the science and engineering of making intelligent machines, especially intelligent computer programmes, while ML refers to the changes in systems that perform tasks associated with AI. Ethical issues in advanced AI and how to prevent learning algorithms from acquiring morally undesirable biases will be covered. Topics may include a subset of the following: problem solving by search, heuristic (informed) search, constraint satisfaction, games, knowledge-based agents, supervised learning (e.g., regression and support vector machine), unsupervised learning (e.g., clustering), dimension reduction learning theory, reinforcement learning, transfer learning and adaptive control and ethical challenges of AI and ML.

Disciplinary Electives

**ARIN7014 Topics in advanced numerical analysis**
This course covers a selection of topics in advanced numerical analysis, which may include: 1) Krylov subspace, generalized minimal residual method (GMRES); 2) numerical (partial) differential equations; 3) stochastic methods and their applications to artificial intelligence and machine learning; 4) approximation theory, high-dimensional approximation (MCz, QMC, sparse grid method); 5) Fourier analysis, wavelet analysis; 6) robust PCA and dimensional reduction methods. The selected topics may vary from year to year.

**ARIN7015 Topics in artificial intelligence and machine learning**
Selected topics in artificial intelligence that are of current interest will be discussed in this course.

**MATH7224 Topics in advanced probability theory**
Selected topics in probability theory will be discussed in this course.

**MATH7502 Topics in applied discrete mathematics**
A study in greater depth of some special topics in mathematical programming or optimization. It is mainly intended for students in Operations Research or related subject areas. This course covers a selection of topics which may include convex programming, nonconvex programming, saddle point problems, variational inequalities, optimization theory and algorithms suitable for applications in various areas such as machine learning, artificial intelligence, imaging and computer vision. The selected topics may vary from year to year.

**STAT6011 Computational statistics and Bayesian learning**
This course aims to give undergraduate and postgraduate students an introduction on modern computationally intensive methods in statistics. It emphasizes the role of computation as a fundamental tool of discovery in data analysis and statistical inference, and for development of statistical theory and methods. Contents include: Bayesian statistics, Markov chain Monte Carlo methods such as Gibbs sampler, Metropolis-Hastings algorithm, and data augmentation; generation of random variables using the inversion methods, rejection sampling, the sampling/importance resampling method; optimization techniques including Newton’s method, expectation-maximization (EM) algorithm and its variants, and minorization-maximization (MM) algorithm; integration including Laplace approximation, Gaussian quadrature, the importance sampling method, Monte Carlo integration, and other topics such as hidden Markov models, and Bootstrap methods. More advanced Bayesian learning methods cover approximate Bayesian computation, the Hamiltonian Monte Carlo algorithm, hierarchical models and nonparametric Bayes.
Course Description

WHAT YOU WILL LEARN

Kelly formula, money and risk management. The second and corresponding performance measures, and (6) contrarian strategies, (5) back-testing methodologies or stationarity, (4) cross-sectional momentum and reverting instruments, (2) statistical arbitrage and pairs are: (1) techniques for trading trending and mean-reverting instruments. The first half of the course focuses on strategies and quantitative trading.

STAT8020 Quantitative strategies and algorithmic trading

Quantitative trading is a systematic investment approach that consists of identification of trading opportunities via statistical data analysis and implementation via computer algorithms. This course introduces various methodologies that are commonly employed in quantitative trading. The first half of the course discusses statistical models of high frequency data and related trading strategies. Topics that planned to be covered are: (7) introduction of market microstructure, (8) stylized features and models of high frequency transaction prices, (9) limit order book models, (10) optimal execution and smart order routing algorithms, and (11) regulation and compliance issues in algorithmic trading.

STAT8021 Big data analytics

The recent explosion of social media and the computerization of every aspect of life resulted in the creation of volumes of mostly unstructured data (big data): web logs, e-mails, videos, speech recordings, photographs, tweets and others. This course aims to provide students with knowledge and skills of some advanced analytics and statistical modeling for solving big data problems. Topics include recommender system, deep learning: CNN, RNN, LSTM, GRU, natural language processing, sentiment analysis and topic modeling. Students are required to possess basic understanding of Python language.

COMP7308 Introduction to unmanned systems

To study the theory and algorithms in unmanned systems. Topics include vehicle modeling, vehicle control, state estimation, perception and mapping, motion planning, and deep learning related techniques.

COMP7309 Quantum computing and artificial intelligence

This course offers a theoretical overview of selected topics from the interdisciplinary fields of quantum computation and quantum AI. The scope of the lectures encompasses an accessible introduction to the fundamental concepts of quantum computation. Importantly, the introduction does not require preliminary knowledge of quantum theory. Detailed comparisons of computational principles and related phenomena in the classical and quantum domain outline the stark potential and challenges of quantum theory for fundamentally novel algorithms with enhanced processing power. Thereupon, the theoretical capability of quantum computers is illustrated by analyzing a selection of milestone algorithms of quantum computation, and their potential applications to artificial intelligence.

COMP7409 Machine learning in trading and finance

The course introduces students to the field of Machine Learning and help them develop skills of applying Machine Learning, or more precisely, applying supervised learning, unsupervised learning and reinforcement learning to solve problems in Trading and Finance. This course will cover the following topics. (1) Overview of Machine Learning and Artificial Intelligence, (2) Supervised Learning, Unsupervised Learning and Reinforcement Learning, (3) Major algorithms for Supervised Learning and Unsupervised Learning with applications to Trading and Finance, (4) Basic algorithms for Reinforcement Learning with applications to optimal trading, asset management, and portfolio optimization, (5) Advanced methods of Reinforcement Learning with applications to high-frequency trading, cryptocurrency trading and peer-to-peer lending.
WHAT YOU WILL LEARN

YOUR PROGRAMME EXPERTS

“Tapping into the AI expertise of our teaching team, we set out to nurture talents who will be geared up to meet the mounting demand for AI professionals both in Hong Kong and worldwide.”

Programme Director and Head of Department of Mathematics
Professor Xiaoming YUAN
BSc, MPhil Nanjing U; PhD City U

Academic staff

Department of Mathematics
Professor W K CHING
Professor G HAN
Dr B KANE
Dr Y LEI
Dr G LI
Professor T W NG
Professor X YUAN
Professor W ZANG
Dr B KANE

BSc, MPhil HK; PhD CUHK
BSc, MSc Peking U; PhD Notre Dame
BSc, MSc Carnegie Mellon, PhD Wisconsin
BSc, Hunan; PhD Wuhan
MS Fudan; PhD Texas A&M
BSc HK; MPhil, PhD HKUST
BSc, MPhil CUHK; PhD N CU
BSc, MPhil Nanjing U; PhD City U
BSc NUDT; MSc Academia Sinica; PhD Rutgers
BS, PhD Tsinghua

Department of Statistics and Actuarial Science
Dr Y CAO
Dr C W KWAN
Dr A S M LAU
Dr E A LI
Professor G D LI
Professor G S YIN

BS Fudan; MS, PhD Princeton
BSc, PhD HK
BEng City; MSc HK; PhD CUHK
BSc HK; MEcon, PhD Syd
BSc HK; MPhil CUHK; PhD HK
MA Temple; MSc, PhD N Carolina

Department of Computer Science
Professor F Y L CHIN
Dr K P CHOW
Professor T KOMURA
Dr I. KONG
Dr P LUO
Dr J PAN
Dr S SCHNIEDERS
Professor W WANG
Professor Y Z YU
Dr D F ZOU

BASc Toronto; MSc, MA, PhD Princeton
MA, PhD UC Santa Barbara
PhD Tokyo
PhD Carnegie Mellon University
PhD CUHK
PhD North Carolina, Chapel Hill
PhD HK
BSc, MEng Shandong; PhD Alberta
BEng CUHK; MPhil, PhD Cambridge
PhD USTC
PhD UC Berkeley
PhD UCLA

Admissions

Requirements

◊ A Bachelor’s degree or an equivalent qualification;
◊ Applicants should possess knowledge of linear algebra, calculus, probability theory, introductory statistics, and computer programming; and
◊ Fulfil the University Entrance Requirements.

How to apply

Application deadlines:
Main round: 12:00 noon (GMT +8), December 15, 2023
Clearing round: 12:00 noon (GMT +8), March 15, 2024

Online application:
admissions.hku.hk/tpg

Expected degree conferment will take place in
July 2026 (Summer Congregation)

Further Information

Programme details

Support for students

Enquiries

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