Katz
Katz School
of Science and Health

Agile M.S. in Computer Science

Course Descriptions

AIM 5006 Artificial Intelligence

Prereqs: AIM 5002 and 5001 or COM 5000, 5001 and 5002

Artificial Intelligence (AI) is an interdisciplinary field, integrating knowledge and methods from computer science, mathematics, philosophy, psychology, economics, neuroscience, linguistics, and biology. Intelligent agents mimic cognitive functions to implement intelligent behaviors such as perception, reasoning, communication, and acting in symbolic and computational models. AI is used in a wide range of narrow applications, from medical diagnosis to speech recognition to bot control. The autonomous single, multiple, and adversarial agents that students build in this course will support fully observable and partially observable decisions in both deterministic and stochastic environments. Topics covered include search, constraint satisfaction, Markov decision processes, planning, knowledge representation, reasoning under uncertainty, graphical models, and reinforcement learning. The techniques and technologies mastered here will provide the foundational knowledge for the ongoing study and application of AI in other applications across practice areas.

AIM 5001 Data Acquisition and Management

Data Acquisition and Management focuses on the data structures, data design patterns, algorithms, methods, and best practices for the pre-modeling phases of data science workflows, including problem formulation, gather, analyze, explore, model, and communicate. This comprises the “data wrangling” work which is where most data scientists spend the majority of their time. Because data science is iterative, this preparatory work informs the modeling phase. Often, the creation and validation of new models requires going back for additional data, different data transformations, and exploration of data distributions. In short, every effective data scientist needs to master analytics programming. Course topics include basics of Python programming and required tools for data management and reading from or writing to databases, text files, and the web; shaping data into “tidy” data frames, exploratory data analysis, data imputations, feature engineering, and feature scaling.

AIM 5002 Computational Statistics and Probability

Arguably, most of data science is statistical learning, which requires strong foundational knowledge in probability and statistics. And applying computational methods such as direct simulation, shuffling, bootstrapping, and cross-validation to statistical problems is often more intuitive and can provide solutions where analytical methods would prove computationally intractable. This course introduces students to the statistical analysis of data using modern computational methods and software. Probability, descriptive statistics, inferential statistics and computation methods such as simulations sample distributions, shuffling, bootstrapping, and cross-validation will be covered.

AIM 5005 Machine Learning
Prereqs: AIM 5002 and 5001 or COM 5000, 5001 and 5002

In classical programming, answers are obtained from rules and data. In machine learning, rules are obtained from data and answers. The widespread availability and sharing of data, and improvements in computing capacity, processing methods, and algorithms have given machine learning the power to deliver game-changing systems and technologies to organizations that compete on predictive, prescriptive, and/or autonomous analytics. In this course, we'll look at methods for using, tuning, and comparing machine learning algorithms, based on measures of performance, accuracy, and explainability. We'll also look at recent advances and trends in automated machine learning.

AIM 5007 Neural Networks and Deep Learning
Prereq: AIM 5005

Data scientists have been able to leverage better algorithms on faster hardware optimized with graphical processing units to deliver improved performance and accuracy in whole classes of applications that had been previously commercially unviable. The biggest beneficiaries are applications that require unstructured data, such as audio and or video processing. Deep neural networks have also provided gains for other complex applications, from recommendation systems to natural language processing. This course builds on the concepts in machine learning to train multi-layered neural networks. Main topics covered in this course are generalization, convolutional neural network, recurrent neural network, long short-term memory, and autoencoder.

MAN 5580 Project Management

Big-Tech development and management is project-based, and successful researchers and technologists are effective at managing projects and collaborating in cross-functional, geographically distributed project teams. This course teaches the methodologies and tools for large-sized (PMI) and small-scale (Agile) projects as well as how to adapt management methods to organizational culture and project team members' background and experience

COM 5000 Introduction to Programming

Learning to write concise, effective, and well-documented computer programs is a prerequisite for any substantive study of computer science. This course introduces students to structured and object-oriented programming constucts, including data types, mathematical and logical operators, control flow constructs, basic data structures, functions, data input and ouput, objects, classes, methods, inheritance, and algorithmic problem solving. Students learn to effectively design, execute, and debug algorithms using an object-orientated approach.

COM 5001 Computer Science Math I

Many concepts and theories in modern computer science are built on discrete mathematics, linear algebra, and calculus. This course introduces students to fundamental mathematics for computer science, including topics such as number theory, combinatorics, graph theory, differential, integral and vector calculus for functions of more than one variable as well as basics of linear algebra.

COM 5002 Algorithms and Data Structures

Most accomplished software designers recognize that a thorough knowledge of data structures and algorithmic analysis can significantly improve application design and performance. This course introduces students to a variety of data structures and algorithmic design paradigms. Students learn to assess the effectiveness of these structures and algorithms, considering factors such as computational complexity, storage space requirements, ease of use, and maintainability. They also design, develop, implement, and analyze a variety of software applications using data structures and algorithmic design paradigms.

COM 5003 Systems Analysis and Design

Effective analysis and design of computing systems and applications requires a variety of business, technological, and methodological considerations. In this course, students explore analytical approaches to the definition of business problems, requirements gathering, process modeling, data modeling, system design, system testing/quality assurance, and system implementation using full system development life cycle. They also explore traditional and emerging project management and application design and development paradigms.

COM 5010 Computer Systems

Understanding the internal behavior of computing devices enables the design of more efficient and scalable software systems. This course introduces students to the fundamental principles and components of computer system architecture. Students learn to describe, compare, and contrast different computing architectures and gain a deeper understanding of the relationship between hardware and software. Topics include the evolution of computing systems, digital logic, processor design, instruction sets, x86, x64, ARM, and RISC-V architectures, embedded systems, processor virtualization, graphics processing units (GPU’s), and smartphone architecture.

COM 5100 Advanced Algorithms

Designing efficient algorithms is one of the most important tools computers scientists use to solve difficult problems. This course covers techniques for designing efficient algorithms, as well as advanced topics such as self-adjusting search trees, network flows, linear programming, approximation algorithms, and randomization algorithms. Students apply these tools and techniques to real-world problems, such as airline scheduling, image segmentation, social networking, genomic sequencing, and survey design.

COM 5101 Theoretical Computer Science and its Application

The course provides students with a comprehensive understanding of the mathematical aspects of computer science as well as their application. Throughout the course, students will learn the theoretical foundations of computer science and gain knowledge with various topics including algorithms, computational models, and the fundamental principles underlying computation.

COM 5102 Emerging Paradigms in Programming

This advanced-level course explores innovative and cutting-edge programming concepts, languages, and methodologies. The course is designed for students who already possess a strong foundation in traditional programming paradigms and are eager to explore the latest trends and advancements in the field. Throughout the course, students will be exposed to various programming languages, frameworks, and tools to understand how they enable developers to tackle modern-day challenges effectively.

COM 5110 Operating Systems

An operating system (OS) is a resource manager that provides an environment for users and applications to cooperate and share computer system resources. Understanding how operating systems function allows engineers to develop more effective applications, better utilize system functionality, and improve performance. In this course, students learn how operating systems manage resources, including CPU, memory, and devices. The course also covers the objects and functions performed by operating systems, including process, thread, memory management, system calls, file system management, and interprocess communications.

COM 5120 Human-Computer Interaction

The rapid expansion of ubiquitous computing means that humans interact with computer technologies in all aspects of their lives. This presents numerous opportunities—and pitfalls—with regards to computer design. This course introduces students to the quantitative and qualitative study of Human Computer Interaction (HCI). We survey various approaches to studying HCI, including Interaction Design, Graphical Design, Educational Design, Human Robot Interaction, and Games. We also consider how the study of HCI influences the design of effective computer technologies.

COM 5210 Mobile Computing and Apps Development

Rapid developments in mobile technologies and systems—like low-cost and energy-efficient CPUs, new applications, increased internet speed, and advances in human-computer interfaces—have made mobile computing an indispensable part of human life. This course provides a broad introduction to the field of mobile computing and mobile application development. Topics include networking, operating systems, database, mobile security, and app development. Students also gain hands-on experience using mobile simulators and apps.

COM 5222 Fundamentals of Software Engineering

The course provides students with a deep understanding of the principles, techniques, and processes involved in software engineering. The course covers the foundational concepts and methodologies necessary for the development of high-quality software systems. It emphasizes the systematic approach to software development and project management, focusing on the entire software lifecycle from requirements gathering to deployment and maintenance.

COM 5323 Computer Graphics

The course provides students with a comprehensive understanding of the fundamental principles and techniques used in computer graphics. It explores the creation, manipulation, and rendering of digital images and visual content using software and hardware technologies. Throughout the course, students will learn the theoretical foundations of computer graphics and gain hands-on experience with various tools and software used in the field. The course covers both 2D and 3D graphics, enabling students to develop skills in both domains.

COM 5421 DevOps

The course is designed to provide participants with a comprehensive understanding of DevOps principles, practices, and tools. During this course, students will explore the fundamental concepts, methodologies, and technologies that drive the DevOps culture. They will learn how to bridge the gap between development and operations teams, enabling faster and more reliable software releases. The course will cover various aspects of the DevOps lifecycle, including continuous integration, continuous delivery, infrastructure automation, and monitoring. Through the course, the students are expected to have a solid understanding of DevOps concepts, tools, and practices, allowing them to contribute effectively to DevOps initiatives within their organizations.

COM 5440 Software System Security

The course provides students with a deep understanding of the principles, techniques, and processes involved in software system security. The course covers the measures and practices put in place to protect software applications and systems from potential threats and vulnerabilities. It emphasizes multiple layers of protection, each addressing different aspects of security, as software systems are often targeted by malicious actors seeking to exploit weaknesses and gain unauthorized access or control.

COM 5441 Hardware Security

The course provides students with a deep understanding of hardware security that focuses on protecting the physical components and integrated circuits of electronic devices from threats and attacks. This course provides a comprehensive overview of hardware security principles, techniques, and best practices to ensure the confidentiality, integrity, and availability of digital systems. Students will gain a deep understanding of hardware vulnerabilities, attacks, and mitigation strategies.

COM 6000 Capstone in Computer Science 1

The Capstone in Computer Science integrates students' prior coursework, research, colloquia, and professional experiences. It offers a unique opportunity to synthesize computer science theory with real-world practice through an applied project, thesis, approved internship, or equivalent activity. Students will work with their supervising faculty to identify deliverables for both Part 1 and Part 2 of the Capstone.

COM 6001 Capstone in Computer Science 2

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equivalent activity. Students will work with their supervising faculty to identify deliverables for both Part 1 and Part 2 of the Capstone.

COM 5500 Internship in Computer Science

This course allows students to participate in an off-campus internship supervised by a staff person at the internship site and overseen by a faculty advisor. The internship site must be approved by the program director and the overall duration of student work must be no less than 150 hours (based on a 3-credit course). At the start of the internship, the student and faculty advisor will jointly develop specific learning objectives tailored to the nature of the internship. Over the course of the internship, students will be required to submit weekly reflections, and at the end of the internship, students write a final paper that represents the culmination of the work.

COM 5999 Independent Study in Computer Science

The course provides the student with the flexibility to learn more about a topic of interest outside of the formal course setting. The subject should be chosen in consultation with a faculty advisor who acts as the student's supervisor, and with the permission of the program director. The student is required to submit a course contract describing the course of study and its specific learning objectives. Course credit is determined in advance by the instructor with the approval of the program director.

COM 5014 Special Topics in Computer Science

This course provides the opportunity to offer special interest courses on emerging theory, phenomena, and technologies in computer science, in areas such as systems, human-computer interaction, machine learning, and artificial intelligence. This will be an advanced class, whether seminar style or project based. Students are required to complete an appropriate project or other deliverable in line with the number of credits awarded for the course.