Carnegie Mellon University
School of Computer Science

Master's Programs Overview and Comparison Data

Winter 2019–2020 (version of 9/15/2020)

School of Computer Science Master's Programs	Shortname & Handbook Link	Apply Link	Degree	Department	Partner Dept/College	Awards, Honors, Distinctions
Artificial Intelligence and Innovation	MSAII	Apply	Master of Science	Language Technologies Institute (LTI)		World’s first M.S. program combining AI with Innovation.
Automated Science - Biological Experimentation	MSAS	Apply	Master of Science	Computational Biology Dept (CBD)		World's first professional Master's Program in automated science.
Computational Biology	MSCB	Apply	Master of Science	Computational Biology Dept (CBD)	Mellon College of Science/Biology Department	MSCB student named a 2017 ACM SIGHPC/Intel Computational and Data Science Fellow
Computational Data Science	MCDS	Apply	Master of Computational Data Science	Language Technologies Institute (LTI)		Top honors in Automated Question-Answering Competition and Facebook global hackathon
Computer Science	MSCS	Apply	Master of Science	Computer Science Dept (CSD)		Carnegie Mellon and Tsinghua Universities Renew Dual-Degree Masters
Computer Vision	MSCV	Apply	Master of Science	Robotics Institute (RI)		First-of-its-kind Professional Masters Program in Computer Vision; industry sponsored capstone projects.
Educational Tech. and Applied Learning Science	METALS	Apply	Master of Educational Technology and Applied Learning Science	Human-Computer Interaction Institute (HCII)	Dietrich College of Humanities	100% career placement every year
Human-Computer Interaction	MHCI	Apply	Master of Human-Computer Interaction	Human-Computer Interaction Institute (HCII)		World's 1st professional program in human-computer interaction, user experience design & research.
Information Tech. Strategy	MITS	Apply	Master of Information Technology Strategy	Institute for Software Research (ISR)	Electrical and Computer Engineering/Institute for Politics & Strategy	Capstone project resulted in U.S. cyber operations research in the area of the Law of Armed Conflict.
Information Tech., Privacy Engineering	MSIT-PE	Apply	Master of Science	Institute for Software Research (ISR)		
Intelligent Information Systems	MIIS	Apply	Master of Science	Language Technologies Institute (LTI)		
Language Technologies	MLT	Apply		Language Technologies Institute (LTI)		MLT graduates win multiple paper awards, for example at ACL-2016
Machine Learning	MSML	Apply	Master of Science	Machine Learning Dept (MLD)		Master's degree from world's first PhD program in Machine Learning.
Product Management	MSPM	Apply	Master of Science	Human-Computer Interaction Institute (HCII)	Tepper School of Business	First Master of Science in Product Management Degree to blend Computer Science and Management
Robotic System Development	MRSD	Apply	Master of Science	Robotics Institute (RI)		Ranked #1 by Grad School Hub for Robotics masters programs
Robotics	MSR	Apply	Master of Science	Robotics Institute (RI)		
Software Engineering	MSE	Apply	Master of Software Engineering	Institute for Software Research (ISR)		A student team won the top prize at the Student IT Architecture Competition in 2020. Capstone projects have resulted in numerous significant deliverables for project sponsors including developing a framework for embedded space applications for NASA, and developing software to analyze data from a radiation sensor in collaboration with the CMU Robotics department for the Department of Energy.
Software Engineering - Embedded Systems	MSE-ES	Apply	Master of Science	Institute for Software Research (ISR)		Unique specialized program at the intersection of hardware and software engineering. MSE-ES students award national honors for a wearable opioid overdose detection device developed for a capstone project.
Software Engineering - Scalable Systems	MSE-SS	Apply	Master of Science	Institute for Software Research (ISR)		MSIT-SS team placed in Student IT Architecture Competition in 2019 and student won the National Center for Women & Information Technology Collegiate Aware in 2018.

School of Computer Science Master's Programs	Program Director	Program Administrator	Typical Semesters of Tuition	Typical Pattern of On-campus Semesters	Type	Typical Internship Semesters	Typical Culminating Activity	Dept Providing Courses	Dept Providing Courses	Dept Providing Courses
Computational Biology	Christopher Langmead	Samantha Mudrinich	4	Fall, Spring, Fall, Spring	Professional	1	N/A	CBD		
Automated Science - Biological Experimentation	Christopher Langmead	Janet Garrand	4	Fall, Spring, Fall, Spring	Professional	1	Capstone/ Research	CBD		
Computer Science	David Eckhardt, David O'Halloran	Angy Malloy	3 or 4	Fall, Spring, Fall (Spring)	Professional	1	N/A	65% CSD	15% MLD	5% LTI
Machine Learning	Katerina Fragkiadaki	Dorothy Holland-Minkley	3	Fall, Spring, Fall	Professional	1	N/A	69% MLD	18% CSD	9% STATS
Human-Computer Interaction	Skip Shelly	Nicole Willis	3	Fall, Spring, Summer	Professional	0	Capstone	80% HCII	12% Design	1% CSD
Educational Techn. and Applied Learning Science	Ken Koedinger	Michael Bett	3 or 4	Fall, Spring, Summer (Fall)	Professional	0	Capstone	81% HCII	14% Psych	3% Design
Product Management	Jason Hong, Greg Coticchia	Casey Walker	2	Spring, Summer, Fall	Professional	1	Capstone	50% HCII	50% TSB	
Robotics	George Kantor	BJ Fecich	4	Fall, Spring, Summer, Fall, Spring, Summer	Research	0	Thesis	75% RI	12% MLD	5% CSD
Robotic Systems Development	John Dolan	Sarah Conte	4	Fall, Spring, Fall, Spring	Professional	1	Capstone	73% RI	9% TSB	7% HC
Computer Vision	Kris Kitani	Sarah Conte	3	Fall, Spring, Fall	Professional	1	Capstone	67% RI	33% MLD	
Language Technologies	Robert Frederking	Kate Schaich	4	Fall, Spring, Summer, Fall, Spring, Summer	Research	0	N/A	70% LTI	22% MLD	3% CSD
Computational Data Science	Eric Nyberg	Jennifer Lucas	3	Fall, Spring, Fall	Professional	1	Capstone	37% LTI	20% HCII-CSD-MLD	3% STAT
Intelligent Information Systems	Teruko Mitamura	Alexandra Balobeshkina	3 or 4	Fall, Spring, Fall (Spring)	Professional	1	Capstone	75% LTI	18% MLD	7% CSD
Artificial Intelligence and Innovation	Michael Shamos	Amber Vivis	4	Fall, Spring, Fall, Spring	Professional	1	Capstone	65% LTI	15% MLD	20% Other
Software Engineering	Travis Breaux	Lauren Martinko	4	Fall, Spring, Summer, Fall	Professional	0	Capstone	80% ISR	9% CSD	2% TSB
Software Engineering - Scalable Systems	Travis Breaux	Lauren Martinko	3	Fall, Spring, Fall	Professional	1	Capstone	76% ISR	7% CSD	7% IS
Software Engineering - Embedded Systems	Travis Breaux	Lauren Martinko	3	Fall, Spring, Fall	Professional	1	Capstone	75% ISR	25% MLD	
Information Techn. & Strategy	Travis Breaux	Marlana Pawlak	3 or 4	Fall, Spring, Summer, Fall	Professional	0	Capstone	25% ISR	45% LTI-MLD-CSD	30% IPS
Information Techn., Privacy Engineering	Lorrie Cranor, Norman Sadeh	Tiffany Todd	3	Fall, Spring, Summer (Fall)	Professional	1	Capstone	85% ISR	5% CSD	3% HCII
School of Computer Science, Dean's Office	David Garlan	Tony Mareino								

Notes:
Individuals can be contacted using our Directory: http://www.cs.cmu.edu/directory
Internships are typically taken away from campus during the Summer semester; some programs feature on-campus summers without classes or tuition, typically involving research.
A culminating activity involves more work than most classes, draws on learning from the rest of the program, produces a document and presentation and satisfies a graduation requirement.
After completion **Professional** program students typically obtain jobs in industry; **Research** program students typically enter PhD programs.
Departments teaching courses include: Statistics (STATS), Design (Design), Psychology (Psych), Heinz College (HC), Tepper School of Business (TSB)
Departments teaching courses include: Information Systems (IS), Electrical and Computer Engineering (ECE), Institute for Politics and Strategy (IPS)
Department providing courses data averaged over 2015-2019.

School of Computer Science Master's Programs	Program Goal	An Example Program Outcome (see later page for complete learning outcomes)
Computational Biology (MSCB)	Produces elite Computational Biologists who understand how to use computation to model and analyze complex biological systems and who are prepared for doctoral degrees at top universities or industry jobs across the spectrum of pharmaceutical, biotechnology, and	Identify and formulate the algorithmic, analytic, and modeling problems associated with a wide range of research and engineering objectives in Biology by applying knowledge of Computer Science, Machine Learning and Mathematics.
Automated Science - Biological Experimentation (MSAS)	Trains practitioners in the design, implementation, and application of automation in scientific research.	Combine robotic scientific instruments, machine Learning, and artificial intelligence to iteratively build predictive models from experimental data and select new experiments to improve them.
Computer Science (MSCS)	To provide students a solid Computer Science core education plus access to a student-customized curriculum, thus supporting careers in industry, research labs, and/or further graduate study in Computer Science fields	Within one or more sub-fields of Computer Science, select, implement, deploy, and/or develop viable solutions to current and emerging problems
Machine Learning (MSML)	To provide students with a solid formal and practical understanding of machine learning, and to prepare them for careers in industry, research labs, or further graduate study.	Design and evaluate novel learning algorithms
Human-Computer Interaction (MHCI)	Integrates service and design thinking into a rigorous HCI curriculum that prepares our students to design and guide the future of human and technology interactions.	Envision how emerging technologies such as natural language processing, machine learning, big data and the IoT can be integrated to engage all human senses and contexts, and beyond visual presentation on a screen
Educational Tech. & Applied Learning Science (METALS)	Trains graduate students to apply evidence-based research in learning to create effective instruction and educational technologies within formal and informal settings.	Evaluate and improve instructional and assessment solutions using psychometric and educational data mining methods
Product Management (MSPM)	To develop successful product managers who can apply Computer Science and Management to disrupt software intensive industries.	Manage and work effectively with interdisciplinary product development teams to bring new products and services to market
Robotics (MSR)	Prepares students to take a leading role in the research and development of future generations of integrated robotics technologies and systems.	Formulate an approach to address an open robotics research problem, and develop a solution that matches or exceeds the current state-of-art.
Robotic System Development (MRSD)	To instill the fundamentals of robotics engineering and teach students the critical systems, technical, and business skills that robotics companies value in their employees	Design, implement and evaluate robotic systems including mechanical, sensing/electronics, and programming/control components
Computer Vision (MSCV)	Prepare students for careers in the field of computer vision and facilitate hands-on experience with real research and development projects addressing current applications of computer vision.	Analyze and evaluate fundamental methods in computer vision, experiment with sensing, mathematically analyze image projection, estimate features, analyze multi-view geometry, reconstruct 3D geometry of scenes, adapt physics of surface reflection, infer the objects shape and movement, and reason about and classify types of scenes
Language Technologies (MLT)	Prepare students to enter top-tier PhD programs in the area of Language Technologies, or start successful careers at the best industrial research labs	Interpret, select, and apply current theory, resources, and practice in language technology. This includes the application of computer technology to the analysis and/or production of human languages.
Computational Data Science (MCDS)	To develop expertise and mastery over techinques essential to computational data science systems in (a) large scale machine learning and data analysis, (b) large scale parallel and distributed systems, or (c) human-computer interactions and learning experience.	Design, implement and evaluate analytic algorithms on sample datasets; implement and evaluate complex, scalable data science systems, with emphasis on providing experimental evidence for design decisions; design, implement and evaluate a user experience prototype for a user need.
Intelligent Information Systems (MIIS)	To enable students to master advanced content-analysis, mining, and intelligent information technologies to assume leadership careers in industry and government.	Design, implement and evaluate a software system and machine-learning model on real world data sets at real world scale
Artificial Intelligence and Innovation (MSAII)	To prepare students to develop innovative AI applications in industry through the use of deep AI implementation skills, perception of market gaps of AI usage, the ability to persuade sponsors that a proposed AI system is worth supporting.	To prepare students to develop real-world AI applications in industry through the innovative use of a wide variety of AI tools, identify market gaps that can be filled using AI, develop personal skills needed for intrapreneurship and entrepreneurship.
Software Engineering (MSE)	Prepare software developers, who have at least two years of experience, through coursework and application in state of the art practices in software engineering and management to become technical and strategic leaders.	Apply formal modeling, analysis techniques, and tools to software requirements, design, implementation and validation to ensure quality in the software systems produced.
Software Engineering - Scalable Systems (MSE-SS)	Prepare entry-level software developers through coursework and application to specialize and prepare for careers in software engineering of scalable systems, including large-scale, intelligent systems.	Design, implement and evaluate a large-scale, real scalable system as part of a team.
Software Engineering - Embedded Systems (MSE-ES)	Prepare entry level sofware developers through coursework and application to specialize and prepare for careers in software engineering of embedded systems, including Internet of Things and cyber-physical systems.	Design software for embedded systems to include: selecting appropriate data structures and algorithms, software structures and patterns, to satisfy systemic functional and quality attribute requirements (e. g. safety, reliability, performance, etc.).
Information Tech. Strategy (MITS)	To produce leaders with the critical thinking skills and strategic perspective needed to solve challenges within the information and cyber domains.	Apply software architectural principles in the design and implementation of secure computer systems in light of the emerging realm of cyber warfare.
Information Tech., Privacy Engineering (MSIT-PE)	To prepare students for jobs as privacy engineers and technical privacy managers	Assess privacy-related risk and compliance, devise privacy incident responses, and integrate privacy into the software engineering lifecycle phases
Product Management (MSPM)	To develop successful product managers who can apply Computer Science and Management to disrupt software intensive industries	Manage and work effectively with interdisciplinary product development teams to bring new products and services to market

School of Computer Science Master's Programs	2019 Enrolled	2019 Accepted	2019 Applications	2019 Selectivity	25-75 %tile Quant. GRE	25-75 %tile Verbal GRE	25-75 %tile Analytic GRE	% Female
Automated Science: Biological Experimentation	15	46	137	34%	165-168	154-157	3.0-4.0	39%
Computational Biology	32	112	365	31%	165-169	156-161	3.5-4.5	46%
Computer Science	35	111	1839	6%	168-170	158-165	4.0-4.5	23%
Human-Computer Interaction	62	97	443	22%	157-165	157-165	4.0-5.0	69%
Educational Tech. and Applied Learning Science	29	62	105	59%	164-170	155-164	3.5-4.5	76%
Product Management	21	27	53	51%	n/a	n/a	n/a	n/a
Information Tech. Strategy	26	51	110	46%	168-170	152-157	3.0-3.5	35%
Software Engineering	15	30	141	21%	160-169	153-160	4.0-4.5	21%
Software Engineering - Scalable Systems	29	80	170	47%	164-170	153-156	3.0-4.0	34%
Information Tech., Privacy Engineering	11	14	27	52%	169-170	152-154	3.5-4.0	21%
Computational Data Science	70	155	1566	10%	168-170	157-162	3.5-4.5	31%
Intelligent Information Systems	25	42	483	9%	167-170	155-161	3.5-4.0	38%
Language Technologies	25	76	657	12%	168-170	156-164	3.5-5.0	18%
Artificial Intelligence and Innovation	37	52	858	6%	167-169	157-163	3.5-4.5	31%
Machine Learning	27	98	1270	8%	168-170	158-165	4.0-4.5	18%
Computer Vision	28	79	672	12%	168-170	152-161	3.0-4.0	19%
Robotics	45	104	795	13%	166-170	155-164	3.5-4.5	13%
Robotic Systems Development	46	80	418	19%	166-170	155-162	3.5-4.5	25%
School of Computer Science Master's Overall	578	1316	10109	13%				

Notes:

Selectivity is the ratio of student applications offered acceptance over applications received; some programs requirements may diminish qualified candidates significantly.

GRE score ranges are 25th percentile to 75th precentile; for example, 25% of the students offered acceptance by CMU had a score below the 25th percentile.

GRE quantitative and verbal are scored between 130 and 170 in 1 point increments; GRE analytical is scored between 0 and 6 in 0.5 increments.

July 2016-June 2019 worldwide GRE quantitative

For precentiles of all test takers, see http://www.ets.org/s/gre/pdf/gre_guide_table1a.pdf

The scope of % female is the fraction of students offered acceptance by CMU that are female.

School of Computer Science Master's Programs	2019 Grads	2019 Cont'd Educ	2019 Grads Cont'd	Schools by popularity	2019 Grads EMPL	2019 Grads EMPL	Employers by Popularity	Salaries Reported	Mean Salary	Median Salary	Max Salary	Min Salary	% EMPL or Cont'd	2019 Seeking	2019 No Info
Computational Biology	21	2	10%		15	71%		8	$ 77,500	$ 72,000	$120,000	$ 48,000	81%	1	3
Computer Science *	52	5	10%	MIT, CMU	42	81%	Google, Microsoft, Apple	23	$ 130,104	$125,000	$170,000	$100,000	90%	0	5
Machine Learning *	21	6	29%	MIT, CMU	14	67%	NVIDIA, Amazon	8	$ 132,125	$132,500	$155,000	$106,000	95%	0	1
Human-Computer Interaction	67	1	1%	CMU	62	93%	Google, Samsung, Wayfair	34	$ 111,059	$106,500	$170,000	$ 80,000	94%	2	2
Educational Techn. & Applied Learning Science	27	3	11%	CMU, U of Cal, U of Wis.	19	70%	CMU	9	$ 82,258	$ 75,000	$120,000	$ 60,000	81%	2	3
Robotics *	38	9	24%	CMU, MIT	22	58%	CMU, Facebook, Nuro	9	$ 120,111	$120,000	$160,000	$ 70,000	82%	1	6
Robotic System Development	41	1	2%	Stanford	37	90%	Cyngn, Blue River Technology	20	$ 128,450	$130,000	$160,000	$ 95,000	93%	2	1
Computer Vision	25	2	8%	CMU, Max Planck Inst.	22	88%	Google, Amazon, NVIDIA	11	$ 137,909	$140,000	$170,000	$115,000	96%	0	1
Language Technologies *	15	6	40%	CMU, Johns Hopkins	9	60%		5	$ 113,800	$115,000	$141,000	$ 90,000	100%	0	0
Computational Data Science **	62	1	2%	Univ. of Minnesota	54	87%	Google, Apple, Amazon	19	$ 130,000	$130,000	$150,000	$110,000	89%	0	7
Intelligent Information Systems	23	1	4%	CMU	20	87%	Apple, Microsoft	12	$ 135,085	$140,000	$160,000	$ 41,101	91%	1	1
Software Engineering	13	0	0%		13	100%	Google	11	$ 127,668	$120,000	$162,000	$108,000	100%	0	0
Software Engineering - Scalable Systems	34	1	3%		31	91%	Google, Amazon	11	$ 127,668	$120,000	$162,000	$108,000	94%	1	0
Software Engineering - Embedded Systems	8	0	0%		4	50%	Google, Amazon, Apple	0					50%	1	3
Information Techn. Strategy	13	0	0%		10	77%	Google, Amazon	6	$ 114,257	$120,000	$125,000	$100,800	77%	0	3
Information Techn., Privacy Engineering	8	0	0%		6	75%	Facebook, Amazon, NSA	4	$ 108,500	$108,500	$125,000	$ 86,000	75%	0	2
School of Computer Science Master's Programs	413	35	9%		334	81%	Google, Amazon, Apple	171	$ 123,079	$125,000	$170,000	$ 41,101	90%	9	35

Notes:
The above data and more are available in these programs' placement docs
Data for students graduating in August 2019, December 2019, or May 2019. No salary statistics are reported when fewer than 4 salaries are reported.
Cont'd Educ means some graduates continued in another educational program (Ph.D.). Seeking means still seeking a desired destination.
By popularity means in order of the destinations receiving the most students. Employers are only listed if they hired two or more students.
* Students that obtained a Master's degree while enrolled in a PhD program are omitted.
**Single program with multiple Majors: Master of Computational Data Science, majors in Analytics, Systems and Human-Centered (all Language Technologies Inst)
Data last updated July 31, 2020

Program Learning Outcomes

Computational Biology (MSCB)

Explain core concepts, theories, and experimental methods in Genomics, Molecular Biology, Cell Biology, and Systems Biology
Identify and formulate the algorithmic, analytic, and modeling problems associated with a wide range of research and engineering
Select, implement, justify, and apply computational methods to solve research and engineering problems in Biology
Evaluate and interpret the results of computational analyses of biological data and simulations of biological systems
Use professional and communication skills in order to be successful in the workplace

Automated Science - Biological Experimentation (MSAS)

Explain core concepts and experimental methods used in scientific research
Explain and operate a range of automated scientific instruments
Explain, implement, use, and justify computational methods for statistical and causal modeling
Explain, implement, use, and justify algorithmic methods for experiment selection and design
Design, implement, and evaluate an automated system for performing scientific experiments

Computer Science (MSCS)

Analyze and prove the properties of algorithms, software, and/or computing systems using the theoretical underpinnings of Computer
Analyze, design, and construct software which contributes to large, multi-layered/multi-machine systems
Analyze, design, and construct software which employs intelligence and learning to solve complex, open-ended, and/or noisy real-world
Within one or more sub-fields of Computer Science, select, implement, deploy, and/or develop viable solutions to current and emerging

Machine Learning (MSML)

Predict which kinds of existing machine learning algorithms will be most suitable for which sorts of tasks, based on formal properties and
Evaluate and analyze existing learning algorithms
Design and evaluate novel learning algorithms
Take real-world questions involving data and evaluate or develop appropriate methods to answer these questions
Present technical material clearly, in spoken or written form

Human-Computer Interaction (MHCI)

Collaborate on interdisciplinary teams to solve complex problems by applying human-centered research and design methods
Synthesize new understandings of complex and/or wicked problems that lead to new, innovative ideas
Envision how emerging technologies such as natural language processing, machine learning, big data and the IoT can be integrated to
Rapidly prototype designs by selecting methods and tools to depict the preferred state at appropriate fidelity and functionality that can be
Evaluate responses to prototypes and select those that are likely to create strategic value by satisfying unmet and/or underserved
Construct narratives that describe how HCI methods create business value and strategic significance
Communicate professionally within the context of an HCI team, with clients and all stakeholders

Educational Technology and Applied Learning Science (METALS)

Select and use state-of-the-art technologies as appropriate for a given problem including Artificial Intelligence, Machine Learning, Language Technologies, Intelligent Tutoring Systems, Educational Data Mining, and Tangible Interfaces
Design and implement innovative and effective educational solutions using advanced technologies
Evaluate and create evidenced based solutions to educational problems
Evaluate and create instructional designs using cognitive and social psychology principles of learning
Evaluate and improve instructional and assessment solutions using psychometric and educational data mining methods
Design educational solutions that are desirable as well as effective by employing interaction design skills and user experience methods

Develop continual improvement strategies that use cognitive task analysis, user experience methods, experiments, and educational data mining to reliably identify best practices and opportunities for change

Product Management (MSPM)

Identify, refine, and understand target markets
Define requirements, features, form, and delivery method for digital products
Critically analyze user interface evaluation techniques, including low-cost evaluation methods as well as formal summative user tests
Collect, organize, manipulate, and analyze data at scale to gain insights into products and services
Manage and work effectively with interdisciplinary product development teams to bring new products and services to market

Robotics (MSR)

Identify an open robotics-related research problem and describe the practical impact of solving it
Formulate an approach to address an open robotics research problem, and develop a solution that matches or exceeds the current state-of-
Summarize and critique the state-of-art in a contemporary robotics research field through a review of the recent research literature.
Thoughtfully and accurately depict research and collection experiences in a published written thesis and and a public oral presentation.
Perception Core: Identify and select available perception sensors; apply algorithms for processing sensor data; adapt techniques from research literature to solve problems in robotics.
Cognition Core: Identify and apply common algorithms for artificial intelligence and machine learning; extend algoritms to address challenges in robot knowledge representation, task scheduling, and planning.
Action Core: Anaylze physics or robotics systems, including actuators, mechanisms, and modes of locomotion; develop controllers to generate desired actions in robotic systems.
Math Foundations: Apply common tools in signal processing, optimal estimation, differential geometry, and operations research; synthesize multiple mathematical tools to address robotics research problems.

Robotic System Development (MRSD)

Design, implement and evaluate robotic systems including mechanical, sensing/electronics, and programming/control components
Apply systems engineering principles to the creation of robotic systems throughout their life cycle from design to deployment
Apply business principles to robotic product development and strategic technology planning
Understand and apply fundamental robotics concepts in manipulation, mobility, control, computer vision, and autonomy
Function and lead effectively in team settings to create robotic technologies responsive to market demand
Cogently and actionably communicate the results of robotic product development work in verbal and written form

Computer Vision (MSCV)

Analyze and evaluate fundamental methods in computer vision, experiment with sensing, mathematically analyze image projection, estimate features, analyze multi-view geometry, reconstruct 3D geometry of scenes, adapt physics of surface reflection, infer the objects shape and movement, and reason about and classify types of scenes
Apply, analyze and evaluate mathematical concepts to computer vision problems - for instance, to apply, analyze, and evaluate methods for optimization, search, linear algebra, differential equations, functional approximation, calculus of variations on computer vision
Apply and evaluate core concepts in machine learning. For instance, apply, adapt and evaluate Bayesian learning, the Minimum Description Length principle, the Gibbs classifier, Naïve Bayes classifier, Bayes Nets & Graphical Models, the EM algorithm, Hidden Markov Models, K-Nearest-Neighbors and non-parametric learning, Maximum Margin classifiers (SVM) and kernel based methods, bagging, boosting and Deep Learning, reason about the appropriate methods for particular computer vision applications
Analyze advanced techniques in computer vision related to representation and reasoning for large amounts of data (images, videos and associated tags, text, GPS locations etc.) toward the ultimate goal of image understanding. Analyze theories of perception, identify mid-level vision (grouping, segmentation) cues, discriminate objects and scenes, reason about objects and scenes in 3D, recognize and characterize actions, reason about objects in the context of their backgrounds, parse images into components, jointly study and analyze
Deep analysis of advanced geometry and algebraic tools in computer vision such as affine and projective geometry, exterior algebras, fundamental matrix, trifocal tensors, and how to apply these tools for scene reconstruction tasks
Apply, adapt and analyze optical concepts of reflection, refraction, transmission, scattering, polarization, light fields and methods such as compressive sensing, computational imaging as applied to computer vision problems such as material understanding, geometry estimation

Read, understand, implement, analyze, evaluate and present advanced research papers in computer vision
Define and scope a capstone project and communicate with a external or internal customer and interact with customer and within a team over two semesters to implement, analyze, evaluate, iterate and present the project

Language Technologies (MLT)

Interpret, select, and apply current theory, resources, and practice in language technology. This includes the application of computer technology to the analysis and/or production of human languages.
Read, analyze, criticize and suggest improvements on current research publications in language technologies
Identify and develop an approach to address an open research problem in language technologies. Develop, analyze and report a solution that improves on the state-of-art.

Computational Data Science (MCDS)

Design, implement and evaluate the use of analytic algorithms on sample datasets
Apply and customize systems techniques to application specific data science conditions and objectives
Identify tradeoffs among systems techniques and contrast alternatives, within the context of specific data science application domains
Design, implement and evaluate a user experience prototype for a given user need
Explain how a machine learning model is applied and evaluated on real world datasets
Implement and evaluate complex, scalable data science systems, with emphasis on providing experimental evidence for design decisions

Intelligent Information Systems (MIIS)

Design, implement and evaluate the use of analytic algorithms on unstructured and semi- structured information
Explain how a machine-learning model is applied and evaluated on real world datasets
Design, implement and evaluate a software system and machine-learning model on real world data sets at real world scale
Analyze Intelligent Information systems in different application domains and survey as well as critique state of the art solutions for the
Organize, execute, report on, and present a real world Intelligent Information systems in collaboration with other

Artificial Intelligence and Innovation (MSAII)

Facility with a range of AI tools and implementation platforms
Appreciation for the dynamics of intrapreneurship and entrepreneurship
Ability to work in teams, including the skills of team organization and management and accommodating team diversity
Soft skills, such as speaking, presentation time management
Familiarity with the social and legal issues raised by the growth of AI
Ability to define, design and build an AI product
Hands-on implementation of a large-scale AI system for a commercial sponsor

Software Engineering (MSE)

Select appropriate methods for organizing and executing a full life-cycle project including scoping, business and requirements analysis, system design and tradeoffs, principled architecture construction, implementation testing and quality assurance, and documentation
Apply formal modeling, analysis techniques, and tools to software requirements, design, implementation and validation to ensure quality in the software systems produced.
Manage a complex software engineering project including gathering, analyzing, and prioritizing requirements from a real-world industrial
Demonstrate leadership skills.in managing a software development team including meeting management, project planning and tracking, setting technical direction, communication with customers and project technical leads, and problem solving/remediation.
Communicate effectively with team members and external stakeholders by listening actively, organizing and reporting clearly, and presenting orally in a clear, convincing manner.
Make individual presentations and produce written documentation that effectively explains to relevant stakeholders the rationale behind requirements identification and prioritization, architectural design decisions, project management approaches, and implementation plans.

Software Engineering - Scalable Systems (MSE-SS)
Select appropriate methods for organizing and executing a smaller, appropriately-scoped life-cycle project including scoping, business and requirements analysis, system design and tradeoffs, principled architecture construction, implementation testing and quality assurance, Apply formal modeling, analysis techniques, and tools to software requirements, design, implementation and validation to ensure quality in the software systems produced. Manage an appropriately-scoped software engineering project including gathering, analyzing, and prioritizing requirements from a real- Show leadership capability in organizing a software development team including meeting management, project planning and tracking, informing technical direction, interaction with customers and project technical leads, and problem identification / corrective action. Communicate effectively with team members and external stakeholders by listening actively, organizing and reporting clearly, and presenting orally in a clear, convincing manner. Make presentations and produce written documentation that effectively explains to relevant stakeholders the rationale behind requirements identification and prioritization, architectural design decisions, project management approaches, and implementation plans.
Software Engineering - Embedded Systems (MSE-ES)
Produce embedded system designs to include: identifying suitable microcontrollers, peripheral hardware, operating systems, and utilize disciplined analysis techniques to perform engineering tradeoffs and determine the fitness of their designs. Design software for embedded systems to include: selecting appropriate data structures and algorithms, software structures and patterns, to satisfy systemic functional and quality attribute requirements (e. g. safety, reliability, performance, etc.). Design and develop embedded continuous and event driven control systems and software. Select the appropriate development lifecycles and processes for an embedded systems project in a given organizational and business context, and manage small project development teams to include: developing project plans, tracking progress, and utilizing data driven Assure systems hardware and software quality with respect to functional correctness and key system qualities (e g. safety, reliability, performance, and so forth) using disciplined testing, analysis, verification and validation methodologies and technologies. Interact with customers to perform systems requirements engineering (elicitation, analysis, and change management) for an embedded systems project in a given organizational and business context. Create clear and concise technical and project documentation (e g. requirements, design, planning, and so forth) and effectively communicate such information to managerial, customer, and technical stakeholders.
Information Technology and Strategy (MITS)
Analyze, design, debug and implement large information systems that have security as a key systemic property. Build, analyze, and apply computer learning algorithms to problems of data extraction from large data sets. Reason about and apply basic principles of decision science to improve security decision making relevant to national and international Apply software architectural principles in the design and implementation of secure computer systems in light of the emerging realm of
Information Technology - Privacy Engineering (MSIT-PE)
Design cutting-edge products and services that leverage big data while preserving privacy Propose and evaluate solutions to mitigate privacy risks Explain how privacy-enhancing technologies can be used to reduce privacy risks Use techniques to aggregate and de-identify data, and understand the limits of de-identification Explain, compare and contrast current privacy regulatory and self-regulatory frameworks Explain and reason about current technology-related privacy issues Assess privacy-related risk and compliance, devise privacy incident responses, and integrate privacy into the software engineering lifecycle Evaluate the usability and user acceptance of privacy-related features and processes Act as an effective privacy subject-matter expert, working with interdisciplinary teams