Carnegie Mellon University
School of Computer Science

Master's Programs Overview and Comparison Data

Winter 2016–2017

School of Computer Science Master's Programs	Shortname & Handbook Link	Apply Link	Degree	Department	Partner Dept/Coll	Awards, Honors, Distinctions
Computational Biology	MSCB	Apply	Master of Science	Computational Biology Dept (CBD)	Biology	
Computer Science	MSCS	Apply	Master of Science	Computer Science Dept (CSD)		Carnegie Mellon and Tsinghua Universities Renew Dual-Degree Masters
Machine Learning	MSML	Apply	Master of Science	Machine Learning Dept (MLD)		New Master's degree from world's first PhD program in Machine Learning.
Human-Computer Interaction	MHCI	Apply	Master of Human-Computer Interaction	Human-Computer Interaction Institute (HCII)		World's first professional program for human-computer interaction, user experience design and user-centered research.
Educational Techn. and Applied Learning Science	METALS	Apply	Master of Educational Technology and Applied Learning Science	Human-Computer Interaction Institute (HCII)	Psychology	100% Career Placement Every Year
Robotics	RIMS	Apply	Master of Science	Robotics Institute (RI)		
Robotic System Development	MRSD	Apply	Master of Science	Robotics Institute (RI)	Tepper School of Business	Ranked #1 by Grad School Hub for Robotics masters programs
Computer Vision	MSCV	Apply	Master of Science	Robotics Institute (RI)		First-of-its-kind Professional Masters Program in Computer Vision; eighteen industry sponsored capstone projects in the first two cohorts.
Language Technologies	MLT	Apply	Master of Science	Language Technologies Institute (LTI)		MLT graduates win multiple paper awards, for example at ACL-2016
Biotechnology Innovation and Computation	MSBIC	Apply	Master of Science	Language Technologies Institute (LTI)	Computational Biology	MSBIC student named a James R. Swartz Entrepreneurial Fellow
Computational Data Science Analytics	MCDS	Apply	Master of Computational Data Science	Language Technologies Institute (LTI)		Top honors in Automated Question-Answering Competition and Facebook global hackathon
Computational Data Science Systems					Computer Science	
Human-Centered Computational Data Science					Human Computer Interaction	
Intelligent Information Systems	MIIS	Apply	Master of Science	Language Technologies Institute (LTI)		
Software Engineering	MSE	Apply	Master of Software Engineering	Institute for Software Research (ISR)	Tepper School of Business	MSE students are recipients of Siebel Scholarships and founders of numerous start-up companies.
Information Techn., Software Engineering	MSIT-SE	Apply	Master of Science	Institute for Software Research (ISR)		MSIT-SE students won top prize in 2015 Harvard Medical School sponsored hackathon.
Information Techn., Embedded Software Engineering	MSIT-ESE	Apply	Master of Science	Institute for Software Research (ISR)	Electrical and Computer Engineering	Unique specialized program at the intersection of hardware and software engineering
Information Techn. Strategy	MITS	Apply	Master of Information Technology Strategy	Institute for Software Research (ISR)	Electrical and Computer Engineering; Humanities and Social Sciences	Capstone project resulted in U.S. cyber operations research in the area of the Law of Armed Conflict.
Information Techn., eBusiness Technology	MSIT-EBIZ	Apply	Master of Science	Institute for Software Research (ISR)		2016 Practicum Competition awards $36,000 to winning student projects.
Information Techn., Privacy Engineering	MSIT-PE	Apply	Master of Science	Institute for Software Research (ISR)	College of Engineering	World's first-of-its kind program responding to the rapidly growing need for technical privacy expertise. Winner of a 2016 Top Privacy Paper for Policymakers.

School of Computer Science Master's Programs	Program Director	Program Administrator	Typical Semesters of Tuition	Typical Pattern of On-campus Semesters	Typical Internship Semesters	Typical Culminating Activity	Dept Providing Courses	Dept Providing Courses	Dept Providing Courses
Computational Biology	Christopher Langmead	Nicole Stenger	4	Fall, Spring, Fall, Spring	1	N/A			
Computer Science	Karl Crary	Tracy Farbacher	3	Fall, Spring, Fall	1	N/A	65% CSD	15% MLD	5% LTI
Machine Learning	William Cohen	Dorothy Holland-Minkley	3	Fall, Spring, Fall	1	Project	69% MLD	18% CSD	9% STATS
Human-Computer Interaction	Skip Shelley	Nicole Willis	3	Fall, Spring, Summer	0	Capstone	80% HCII	12% Design	1% CSD
Educational Techn. and Applied Learning Science	Ken Koedinger	Michael Bett	3	Fall, Spring, Summer	0	Capstone	81% HCII	14% Psych	3% Design
Robotics	George Kantor	BJ Fecich	4	Fall, Spring, Fall, Spring	0	Thesis	75% RI	12% MLD	5% CSD
Robotic System Development	John Dolan	Sarah Conte	3	Fall, Spring, Fall	1	Capstone	73% RI	9% TSB	7% HC
Computer Vision	Srinivasa Narasimhan	Sarah Conte	3	Fall, Spring, Fall	1	Capstone	67% RI	33% MLD	
Language Technologies	Robert Frederking	Kate Schaich	4	Fall, Spring, Summer, Fall, Spring, Summer	0	N/A	70% LTI	22% MLD	3% CSD
Biotechnology Innovation and Computation	John Vu	Charles Burger	4	Fall, Spring, Fall, Spring	1	Capstone	45% LTI	40% CBD	7% MLD
Computational Data Science Analytics Computational Data Science Systems Human-Centered Computational Data Science	Eric Nyberg	Jennifer Lucas	3	Fall, Spring, Fall	1	Capstone	50% CSD	30% LTI	16% MLD
Intelligent Information Systems	Teruko Mitamura	Kate Schaich	3	Fall, Spring, Fall	1	Capstone	63% LTI	24% MLD	7% CSD
Software Engineering	Anthony Lattanze	Lauren Martinko	4	Fall, Spring, Summer, Fall	0	Capstone	80% ISR	9% CSD	2% TSB
Information Techn., Software Engineering	Anthony Lattanze	Lauren Martinko	3	Fall, Spring, Summer	0	Capstone	76% ISR	7% CSD	7% IS
Information Techn., Embedded Software Engineering	Anthony Lattanze	Linda Smith	4	Fall, Spring, Summer, Fall	0	Capstone	44% ISR	34% ECE	10% CSD
Information Techn. Strategy	David Garlan	Linda Smith	3	Fall, Spring, Summer	0	Capstone	19% INI	17% ISR	13% CSD
Information Techn., eBusiness Technology	Michael Shamos	Amber Vivis	3	Fall, Spring, Summer	0	Capstone	95% ISR	2% CSD	1% HCII
Information Techn., Privacy Engineering	Norman Sadeh, Lorrie Cranor	Tiffany Todd	3	Fall, Spring, Summer	0	Capstone	85% ISR	5% CSD	3% HCII

School of Computer Science, Dean's Office	Garth Gibson	Angela Miller

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.
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), Information Networking Inst (INI)
Department providing courses data averaged over 2011-2015.

School of Computer Science Master's Programs	Program Goal	An Example Program Outcome (click for more program 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 biomedical fields	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.
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 Techn. and 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
Robotics (RIMS)	Preparing 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.	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 and image based rendering
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.
Biotechnology Innovation and Computation (MSBIC)	To develop successful entrepreneurs who can apply computing technology to disrupt the biotechnology and healthcare sectors and entering the market as professionals trained in the latest generation of computational and data engineering technology	Develop a business model and strategy for the product by integrate all of the acquired learning in the program towards the development of a formal Minimum Viable Product for demonstrations to Investors, Venture Capitalists, potential customers and prepare to launch their start up
Computational Data Science Analytics (MCDS-A)	To develop expertise and mastery over the large scale machine learning and data analysis techniques essential to computational data science analytics	Design, implement and evaluate the use of analytic algorithms on sample datasets
Computational Data Science Systems (MCDS-S)	To develop expertise and mastery over the large scale parallel and distributed systems essential to computational data science systems	Implement and evaluate complex, scalable data science systems, with emphasis on providing experimental evidence for design decisions
Human-Centered Computational Data Science (MCDS-H)	To develop expertise and mastery over the human-computer interactions and learning experience essential to computational data science interpretation	Design, implement and evaluate a user experience prototype for a given user need
Intelligent Information Systems (MIIS)	For students who want to rapidly master advanced content-analysis, mining, and intelligent information technologies prior to beginning or resuming 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
Software Engineering (MSE)	For software developers who have at least two years of experience and want 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.
Information Techn., Software Engineering (MSIT-SE)	For junior software professionals who have at least one year of experience (or equivalent internship/project experience) and want to enhance their software development and leadership skills	Apply formal modeling, analysis techniques, and tools to software requirements, design, implementation and validation to ensure quality in the software systems produced.
Information Techn., Embedded Software Engineering (MSIT-ESE)	Provides the foundations and skills in computer science, hardware and electrical engineering, and systems engineering necessary for effective embedded software engineering.	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 Techn. 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 Techn., eBusiness Technology (MSIT-EBIZ)	Prepares students to play a variety of mission critical roles leveraging the power of technology across the enterprise.	Electronic Negotiation) Apply basic game and auction theory to real-world markets, create a combinatorial auction for sourcing services, select a market-clearing technology to enable a particular market to function and determine tradeoffs behind different market designs.
Information Techn., 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

School of Computer Science Master's Programs	2016 Enrolled	2016 Accepted	2016 Applications	2016 Selectivity	25-75%tile Quant. GRE	25-75%tile Verbal GRE	25-75%tile Analytic GRE	% Female
Computational Biology	26	88	179	49%	167-170	159-167	4.0-5.0	41%
Computer Science	36	90	1707	5%	168-170	160-166	4.0-4.5	22%
Machine Learning	16	36	851	4%	169-170	154-164	3.5-4.5	19%
Human-Computer Interaction	65	122	438	28%	156-165	156-162	4.0-4.5	66%
Educational Techn. and Applied Learning Science	14	32	98	33%	162-168	157-163	3.5-5.0	72%
Robotics	34	88	559	16%	166-170	156-164	3.5-4.5	16%
Robotic System Development	43	72	230	31%	165-170	154-163	3.9-4.5	22%
Computer Vision	23	44	425	10%	168-170	153-160	3.0-4.0	16%
Language Technologies	26	82	126	65%	166-170	155-163	3.5-4.5	33%
Biotechnology Innovation and Computation	33	53	221	24%	166-170	152-160	3.0-4.0	30%
Computational Data Science Analytics	37	137	999	14%	168-170	154-160	3.0-4.0	28%
Computational Data Science Systems	18							
Human-Centered Computational Data Science	7							
Intelligent Information Systems	21	34	401	8%	167-170	156-160	3.5-4.0	29%
Software Engineering	10	22	77	29%	165-169	151-157	3.0-4.0	18%
Information Techn., Software Engineering	32	66	156	42%	161-170	151-156	3.0-3.9	29%
Information Techn., Embedded Software Engineering	7	15	56	27%	165-169	151-157	3.0-3.5	33%
Information Techn. Strategy	13	21	89	24%	168-170	153-156	3.5-4.0	43%
Information Techn., eBusiness Technology	61	124	425	29%	167-170	153-158	3.0-3.5	48%
Information Techn., Privacy Engineering	12	18	36	50%	167-170	153-156	3.0-3.5	39%
School of Computer Science Master's Overall	534	1144	7073	16%	165-170	154-161	3.5-4.5	35%

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.

2012-2015 worldwide GRE quantitative mean score: 152.5 (8.9 standard deviation); verbal mean score: 150.2 (8.5 standard deviation); analytical mean score: 3.5 (0.87 standard deviation).

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.

Combining all SCS master's programs, 4372 people applied and 1012 people were offered acceptance into at least one SCS master's program (23%).

Of the 1012 people that were offered acceptance into one or more SCS master's program, 230 had also applied to one or more SCS Ph.D. program (23%).

School of Computer Science Master's Programs	2016 Grads	2016 Con't Educ	2016 Grads Con't %	Schools by popularity	2016 Grads Empl'd	2016 Grads Empl %	Employers by polularity	Mean Salary	Median Salary	Max Salary	Min Salary	% Empl'd or Con't Educ	2016 No Info
Computational Biology	16	4	25%	Harvard, Johns Hopkins, U.Pitt	5	31%	Affymetrix, Emerald Therapeutics, U.Pitt					56%	5
Computer Science	61	9	15%	CMU, U.Wash	42	69%	Google, Airbnb, Microsoft	$ 110,293	$ 110,000	$ 152,500	$ 32,400	84%	10
Machine Learning	14	7	50%	CMU	7	50%	Twitter, Google, United Airlines	$ 131,000	$ 130,000			100%	
Human-Computer Interaction	81	3	4%	CMU	73	90%	Draper, Google, NASA	$ 94,965	$ 95,000	$ 135,000	$ 46,000	94%	2
Educational Techn. and Applied Learning Science													
Robotics	38	7	18%	CMU, MIT	27	71%	CMU, Mine Vision Systems, Tijee	$ 101,900	$ 100,000	$ 143,000	$ 65,000	89%	1
Robotic System Development	40		0%		39	98%	Apple, Uber, General Motors	$ 97,429	$ 100,000	$ 140,000	$ 50,000	98%	
Computer Vision													
Language Technologies	24	11	46%	CMU, GaTech, Johns Hopkins	11	46%	Amazon, Informatik Service, LendUp					92%	2
Biotechnology Innovation and Computation	41		0%		41	100%	Amazon, Boeing, IBM	$ 115,949	$ 115,000	$ 135,000	$ 80,000	100%	
Computational Data Science Analytics	63	2	3%	U.Michigan, U.Chicago	61	97%	Google, LinkedIn, Uber	$ 115,641	$ 115,000	$ 150,000	$ 80,000	100%	0
Computational Data Science Systems													
Human-Centered Computational Data Science													
Intelligent Information Systems	14		0%		12	86%	Google, Amazon, Twitter	$ 120,000	$ 115,000	$ 135,000	$ 100,000	86%	2
Software Engineering	66		0%		59	89%	Oracle, Innopolis Univ, AWS	$ 114,732	$ 119,000	$ 180,000	$ 70,000	89%	4
Information Techn., Software Engineering													
Information Techn., Embedded Software Engineering													
Information Techn. Strategy													
Information Techn., eBusiness Technology	77		0%		66	86%	Oracle, Amazon, Apple	$ 106,579	$ 110,000	$ 120,000	$ 50,000	86%	4
Information Techn., Privacy Engineering													
School of Computer Science Master's Programs	535	43	9%		443	88%		$ 109,300		$ 180,000	$ 32,400	96%	30

Notes:

The above data and more are available in these programs' placement docs: http://www.cmu.edu/career/salaries_and_destinations/

Data last updated September 2016

Con't Educ means some graduates continued in another educational program (Ph.D.).

Programs too small or too new to be reported: Master of Science in Computer Vision (Robotics Inst.), and Master of Science in Information Technology, Privacy Engineering (Inst of Software Research)

Programs closely related and merged to be reportable: Master of Human-Computer Interaction and Master of Educational Technology and Applied Learning Science (both Human-Computer Interaction Inst)

Programs closely related: Master of Software Engineering, Master of Information Technology Strategy, Master of Science in Information Technology, Software Engineering and Embedded Software Engineering (Inst of Software Res

Single program with multiple Majors: Master of Computational Data Science, majors in Analytics, Systems and Human-Centered (all Language Technologies Inst)

School of Computer Science, Sample of Master's Programs 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 objectives in Biology by applying knowledge of Computer Science, Machine Learning and Mathematics.
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

Computer Science (MSCS)

Analyze and prove the properties of algorithms, software, and/or computing systems using the theoretical underpinnings of Computer Science
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 problems
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)

Predict which kinds of existing machine learning algorithms will be most suitable for which sorts of tasks, based on formal properties and experimental results
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 engage all human senses and contexts, and beyond visual presentation on a screen
Rapidly prototype designs by selecting methods and tools to depict the preferred state at appropriate fidelity and functionality that can be experienced by clients and their customers
Evaluate responses to prototypes and select those that are likely to create strategic value by satisfying unmet and/or underserved customer needs
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 Techn. 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

Robotics (RIMS)

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-art.
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 problems
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 language and vision models
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 and image based rendering
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.

Biotechnology Innovation and Computation (MSBIC)

Identify key market opportunity and key drivers behind disruptive technologies
Analyze and synthesize emerging technological trends to shape new or disrupt existing markets
Create a prototype that best captures the balance of the market opportunities and feasibility and distinguishing it from competitive alternatives
Develop a business model and strategy for the product by integrate all of the acquired learning in the program towards the development of a formal Minimum Viable Product for demonstrations to Investors, Venture Capitalists, potential customers and prepare to launch their start up
Implement an Industry-Sponsored Capstone project using data analytics tools with real word data for predicting trends

Computational Data Science Analytics (MCDS-A)

Design, implement and evaluate the use of analytic algorithms on sample datasets
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 and document data science requirements in different application domains and survey as well as critique state of the art solutions for those requirements
Organize, execute, report on, and present a real world data science project in collaboration with other researchers/programmers

Computational Data Science Systems (MCDS-S)

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
Develop and justify design decisions in the context of state of the art data science domains and problems
Anticipate and avert structural and/or implementation problems with systems design, especially with scaling and tail distributions
Implement and evaluate complex, scalable data science systems, with emphasis on providing experimental evidence for design decisions
Interpret and comparatively criticize state of the art research talks and papers, with emphasis on constructive improvements

Human-Centered Computational Data Science (MCDS-H)

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
Design, implement and evaluate a software system and machine learning model on real world data sets at real world scale
Survey, analyze and critique human centered data science problems in different application domains and their state of the art solutions
Organize, execute, report on, and present a real world data science project in collaboration with other researchers/programmers

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 program requirements
Organize, execute, report on, and present a real world Intelligent Information systems in collaboration with other researchers/programmers

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 development.
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 customer
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.

Information Techn., Software Engineering (MSIT-SE)

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, and documentation development.
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-world industrial customer
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.

Information Techn., Embedded Software Engineering (MSIT-ESE)

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 project controls.
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 Techn. 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 cyber law.
Apply software architectural principles in the design and implementation of secure computer systems in light of the emerging realm of cyber warfare.

Information Techn., eBusiness Technology (MSIT-EBIZ)

(Internet of Things) How to choose appropriate IOT technologies to support a specific business process and design a sensor-based IOT system to improve process efficiency
(Requirements Elicitation and Analysis) How to isolate project context and identify relevant stakeholders, produce Quality Attribute Scenarios, capture business processes and control flow using Interaction and/or Activity Diagrams and create requirements specifications
(Web Application Development) Design a three-tier web application using the MVC design pattern, install and configure appropriate J2EE tools and technologies to implement a web application
Electronic Negotiation) Apply basic game and auction theory to real-world markets, create a combinatorial auction for sourcing services, select a market-clearing technology to enable a particular market to function and determine tradeoffs behind different market designs.
(Team formation and management) Before every four tasks, and once again for the Practicum, new teams are formed by the faculty. This requires students to brief each other on their individual backgrounds and skills so the team can parcel out work to its members effectively, define a leadership structure, etc. Tasks last 2-3 weeks, during which 2.5 man-months of effort is expended. Teams must budget their time effectively to be able to produce all the deliverables necessary for each task. This involves careful management both of the team's time as a whole and the time of individual members.
(Triage) The skill of separating a massive collection of materials into three categories: (1) obviously relevant; (2) obviously irrelevant; and (3) material which will require more time for a relevancy determination.
(Presentation skills) Deliver a persuasive presentation explaining technical issues to business executives

Information Techn., 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 phases
Evaluate the usability and user acceptance of privacy-related features and processes
Act as an effective privacy subject-matter expert, working with interdisciplinary teams