CTR FOR URBAN SCI AND PROGRESS (CUSP-GX)

CUSP-GX 900X Guided Studies (0-3 Credits)
Typically offered Spring and Summer
Students may engage in independent original research under the supervision of a CUSP or CUSP-affiliated faculty member. Students must come up with an original research topic under the direction of their faculty mentor and write a five-page research proposal that includes a description of and rationale for the study, and potential methodology, a brief literature review, and anticipated deliverables. The proposal must be submitted to the academic advisor for approval.
Grading: Grad Poly Graded
Repeatable for additional credit: Yes

CUSP-GX 5053 Geographic Information Systems (3 Credits)
Typically offered Spring
This course will provide an accessible introduction to the fundamental concepts and operations of Geographic Information Systems (GIS), focusing on urban applications. GIS is a powerful tool for analyzing spatial data and making data-driven decisions. This course will explore how geography is an interface for structured and unstructured data within complex systems. The course will introduce students to the central components of GIS as commonly deployed in enterprise software, free and open-source code libraries, and experimental systems. The course treats the methodology underlying GIS (particularly in spatial and computer science) and the software operations that collectively enable GIS functionality and applications (particularly data structures, spatial data access, and geometric operations). Hands-on lab sessions will walk students through GIS methods in popular software, including the ESRI ArcGIS (ArcGIS Pro and ArcGIS Online) and web-based visualization techniques using ArcGIS Storymaps and Dashboards. By the end of the course, students will be prepared for more advanced coursework at CUSP, particularly Urban Spatial Analytics and Advanced Spatial Analytics courses.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 6023 Introduction to Programming for Solving Urban Challenges (3 Credits)
Typically offered Fall
A variety of technical skills are needed to build analyses that can help us to solve urban challenges. This course is designed to develop programming skills and to gain familiarity with the techniques, concepts, and models of urban informatics computing. Students will learn to program in python through a series of online tutorials, and will be exposed to the leading thinking on urban challenges through readings and discussion. Weekly lectures will demonstrate how these skills can be used to construct analyses through detailed code reviews. Finally, students will have the opportunity to practice these skills as they build an analysis of an urban challenge using real data.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 6033 Urban Data Science (3 Credits)
Typically offered Spring
The course targets current and future urban practitioners looking to harness the power of data in urban practice and research. This course builds the practical skillset and tools necessary to address urban analytics problems with urban data. It starts with essential computational skills, statistical analysis, good practices for data curation and coding, and further introduces a machine learning paradigm and a variety of standard supervised and unsupervised learning tools used in urban data science, including regression analysis, clustering, and classification as well as time series analysis. After this class, you should be able to formulate a question relevant to Urban Data Science, locate and curate an appropriate data set, identify and apply analytic approaches to answer the question, obtain the answer and assess it with respect to its certainty level as well as the limitations of the approach and the data. The course will also contain project-oriented practice in urban data analytics, including relevant soft skills – verbal and written articulation of the problem statement, approach, achievements, limitations, and implications.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 6043 Civic Analytics, Urban Intelligence and Data-Informed Leadership (3 Credits)
Typically offered Fall
This course provides an overview of city government, operations, and management of information and communication technologies within cities and related policy domains. There will be an emphasis on new approaches to urban governance and data leadership ranging from performance management to innovation delivery units to smarter cities frameworks and public entrepreneurship. Throughout the course we will focus intently on the importance of data and how to collect it; and also how it should be presented from a policy, management, and political perspective to ensure impact. In addition, the role of civic engagement and community participation is explored. Case studies and best practice examples will be used extensively.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 7000 Data Governance, Ethics, and Privacy (0 Credits)
Typically offered Fall
For students working at the intersection of urban policy, planning, and applied data science, this course examines the ethical, legal, and governance challenges of using data and technology in complex urban systems. As cities increasingly rely on data to shape decisions in sectors like economic development, housing, mobility, public health, and resilience, new questions arise around how to make data practices ethical, equitable, accessible, and usable. Through frameworks in data ethics and governance, case studies in public interest technology and participatory science, and engagement with both traditional and non-traditional data, students will explore how to design and evaluate data policy and systems that serve the public good.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: No

CUSP-GX 7013 Introduction to Applied Data Science (3 Credits)
Typically offered Fall
This course provides an introduction to Urban Data Science, focusing on the application of data analytics in urban contexts. The course will explore a range of data handling techniques, from data curation and collection to preprocessing and cleaning. Key topics include exploratory data analysis (EDA), hypothesis testing, and handling randomness in data. The course also covers essential statistical techniques like linear and logistic regression, covering topics including out-of-sample evaluation techniques and regularized regression. Practical case examples will illustrate the concepts, preparing students to tackle real-world urban data challenges.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 7020 Ph.D. Colloquium (0 Credits)
Typically offered Fall and Spring
A dynamic and interactive seminar course that promotes understanding the problems that city stakeholders face and identifying innovative urban solutions centered around them. This promotes communication and teamwork across disciplines in the Interdisciplinary doctoral Track in Urban Science: Complexity, Informatics, and Sensing at CUSP while building community in the student body. This seminar course will consist of a four-week rotation of activities. Twice a month, students will discuss the seminal papers on the emerging field of Urban Science (covering different theoretical and methodological perspectives from different disciplines at CUSP) with faculty. Once a month, there will be guest lecture workshops with professionals from the city and private sectors, and academics. Whenever possible, students will actively participate in lived-experience sessions, in which enrollees can gain hands-on experience on the issues faced by stakeholders. Finally, once a month, they will participate in internal presentations.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: Yes

CUSP-GX 7023 Applied Data Science (3 Credits)
Typically offered Spring
This course explores advanced topics in urban data science, including dimensionality reduction techniques, optimization methods, and Time Series Analysis. It also covers powerful tools for big data analytics, such as Dask, MapReduce, and Multiprocessing. Additionally, the course delves into network analysis, exploring methods for studying urban networks and their structures. Other key topics include feature engineering and selection, as well as Bayesian Networks and Bayesian Inference. An introduction to game theory will also help students understand strategic decision-making in urban contexts. Through hands-on examples, students will develop the skills needed to apply these techniques to real-world urban challenges. | Prerequisite: CUSP-GX 7013
Grading: Grad Poly Graded
Repeatable for additional credit: No
Prerequisites: CUSP-GX 7013.

CUSP-GX 7033 Machine Learning for Cities (3 Credits)
Typically offered Spring
The objective of this course is to familiarize students with advanced machine learning techniques and demonstrate how they can be applied to urban data. The course focuses on practice-oriented concepts and techniques, which are illustrated through applications to urban problems and datasets. For this reason, it includes a significant programming component, with Python as the primary language. Topics cover a variety of supervised and unsupervised learning methods, such as decision trees, support vector machines, clustering algorithms, text mining, and ensemble learning. Other key topics include an introduction to causal modeling, Gaussian processes, and anomaly detection. The course also explores strategies for effective machine earning and discusses the opportunities and limitations it brings.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 7043 Civic Analytics (3 Credits)
Typically offered occasionally
Cities are increasingly data-rich environments, and data-driven approaches to operations, policy, and planning are emerging as powerful tools to address localized global challenges that shape residents' daily lives. This course introduces the key actors, actions, impacts, and challenges of policy-based innovations. Students explore core urban systems—such as housing, mobility, open space, water, and sanitation—through both qualitative and quantitative policy analytics. Through lectures, discussions, applied exercises, and assessments (e.g., policy memos, business case analyses), students develop critical skills to evaluate urban policies, programs, and projects. The course prepares students for work in Policy Analytics, CUSP, and the broader application of urban data science to complex policy challenges.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 7053 Innovative City Governance (3 Credits)
Typically offered Fall
This course introduces students to cutting-edge approaches in urban innovation, focusing on how cities can leverage data and technology to address complex challenges in urban governance, urban development, public health, environmental sustainability, and risk management.
It aims to enhance students' sophistication in thinking about urban innovation and city governance together, while building practical skills for working across both the public and private sectors. The course emphasizes quantitative analysis, crosssector and community collaboration, emerging urban technologies, and applications of AI. Through a mix of lectures, class discussions, applied exercises, and a final project, students will critically assess existing cases of innovative city governance and develop their own projects to propose impactful urban solutions.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 7103 Capstone Urban Science Intensive I: Project Management (3 Credits)
Typically offered Spring
The Urban Science Intensive (USI I) is part of a two-semester capstone sequence that is the experiential learning focus of the program. USI I takes place over 14 weeks in the Spring semester and prepares students for delivering Capstone Projects in the summer. The core of the course is team-based work on a real-world urban problem, combining problem identification and evaluation, data collection and analysis, data visualization and communication, and finally, solution formulation and testing. This project-based course begins with the Social Impact Project, where students are introduced and immersed in problem definition and project delivery skills. The course also lays the foundation for the Capstone Projects, where students work on integrated teams with Agency and Industry Partners, immersed in the public aspects of the project. * *The Urban Science Intensive I course introduces students to their projects and the Agency and Industry mentors involved and develops team-building; students meet with various officials at the relevant agencies and industry partners, tour relevant projects and facilities, and begin to engage the community; student teams define the problem and craft a strategy to identify solutions, inventory available and needed datasets, and explore possibilities for new instrumentation and citizen engagement to support project objectives. This course involves a combination of lectures, student team project work, in-class group work, site visits, and guest speakers. | Prerequisite: CUSP-GX 7023
Grading: Grad Poly Graded
Repeatable for additional credit: No
Prerequisites: CUSP-GX 7023.

CUSP-GX 7113 Capstone Urban Science Intensive II: Data Analysis and Communications (3 Credits)
Typically offered Summer term
Student teams will engage in projects through the identification of urban challenges, integration and analysis of data, testing of solutions, and development of implementation strategies and final recommendations. They will apply urban informatics within the realworld constraints of city operations, accounting for political, policy, financial, and ethical considerations. Through lectures, in-class discussions, and project updates, students will receive feedback from instructors and peers, develop skills to translate technical findings for a variety of audiences, navigate the complexities of project planning, team collaboration, and stakeholder communication, and understand ethical and regulatory considerations. Final deliverables will reflect the integration of each student's disciplinary and domain expertise—spanning data science, policy, urban planning, and entrepreneurship. | Prerequisite: CUSP-GX 7103
Grading: Grad Poly Graded
Repeatable for additional credit: No
Prerequisites: CUSP-GX 7103.

CUSP-GX 8000 Foundations in Policy, Research, and Writing (0 Credits)
Typically offered Fall and Spring
Today's urban data scientists, engineers, and applied practitioners are increasingly called upon to do more than build models—they must also communicate insights, influence policy, and engage diverse audiences. This course is designed to strengthen the academic writing, public presentation, and policy communication skills essential for impactful, interdisciplinary work. Through a supportive, skills-based approach, students will develop practical competencies in writing for research and policy, presenting complex ideas clearly, and translating technical work into accessible narratives for decisionmakers, fellow scientists and engineers, and the public. Ideal for students seeking to enhance their voice and confidence in the broader civic and policy landscape of applied data science.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: No

CUSP-GX 8015 Large Scale Data Analysis with Machine Learning I (1.5 Credits)
Typically offered Spring
The past decade has seen the increasing availability of very large scale data sets, arising from the rapid growth of transformative technologies such as the Internet and cellular telephones, along with the development of new and powerful computational methods to analyze such datasets. Such methods, developed in the closely related fields of machine learning, data mining, and artificial intelligence, provide a powerful set of tools for intelligent problem-solving and data-driven policy analysis. These methods have the potential to dramatically improve the public welfare by guiding policy decisions and interventions, and their incorporation into intelligent information systems will improve public services in domains ranging from medicine and public health to law enforcement and security. The LSDA course series will provide a basic introduction to large scale data analysis methods, focusing on four main problem paradigms (prediction, clustering, modeling, and detection). The first course (LSDA I) will focus on prediction (both classification and regression) and clustering (identifying underlying group structure in data), while the second course (LSDA II) will focus on probabilistic modeling using Bayesian networks and on anomaly and pattern detection. LSDA I is a prerequisite for LSDA II, as a number of concepts from classification and clustering will be used in the Bayesian networks and anomaly detection modules, and students are expected to understand these without the need for extensive review.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8033 Urban Spatial Analytics (3 Credits)
Typically offered Fall
Urban Spatial Analytics focuses on developing spatial analysis skills specifically in an urban context, which cuts across various interdisciplinary fields like urban planning, socio-economic development, education, public health, real estate, criminal justice, environmental studies, transportation, and urban demography. This course will equip students with intermediate Geographic Information Systems (GIS) concepts to collect, understand, organize, store, analyze, and visualize complex urban geospatial data. Students will learn about combining and overlaying local urban datasets with regional and national datasets like the US Census to understand spatial relationships and foster critical thinking in addressing urban issues that inform urban and regional policies. Students will gain hands-on training on intermediate and advanced GIS techniques such as geospatial data management (vector and raster), advanced analyses (spatial statistics, proximity analysis, site suitability analysis, cluster analysis, network analysis), modeling techniques (machine learning, deep learning, and applications of geo-AI), visualization techniques, and other applications on solving real-world problems, using ESRI's product - ArcGIS Pro with advanced extensions as a primary software; however, students will be exposed to other tools/programming languages like ArcGIS Online, Python for GIS, and others.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8043 Advanced Spatial Analytics (3 Credits)
Typically offered Spring
In this course, students will learn about ongoing advances in the field of spatial analysis, particularly in current research and development contexts, including (1) process-based spatial modeling, (2) time-enabled spatial analysis, and (3) spatial analysis on new forms of spatial data. Although the class will explore several of these topics using software-based labs, the course is rooted in an exploration of the methodology underpinning spatial analysis and the derivation of analysis schemes. Students are expected to have prior coursework experience in Geographic Information Systems and spatial analysis. Example sets in the course will focus on urban analysis. | Prerequisites: CUSP-GX 7002
Grading: Grad Poly Graded
Repeatable for additional credit: No
Prerequisites: CUSP-GX 8033.

CUSP-GX 8053 Urban Decision Models (3 Credits)
Typically offered Fall
This course provides an introduction to computer-based optimization and simulation models for decision-making for government officials and policy makers. The emphasis is on models that are widely used in diverse functional areas, including every day operations such as waste collection, policing and transportation to policy making on environment/climate change to sheltering the homeless. Applications will include resource allocation, workforce planning, revenue management, asset-liability management (public sector finance models), environmental policy modeling, pension and bonding planning, and political campaign management, among others. The aim of the course is to help students become intelligent consumers of these methods. To this end, the course will cover the basic elements of modeling -- how to formulate a model and how to use and interpret the information a model produces. The course will attempt to instill a critical viewpoint towards decision models, recognizing that they are powerful but limited tools.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8063 Urban Sensing (3 Credits)
Typically offered Spring
Remote sensing technologies are becoming increasingly available at better resolution levels and lower costs. This course will provide an overview of some of the most common technologies in the areas of imagery, video, sound, and hyperspectral data that can be facilitated through smart phones or other readily accessible means. Students will be given a formal introduction to the aforementioned four areas and then be afforded an opportunity for hands on training in data collection and data analysis. In the course will have the opportunity to work in small groups to investigate an urban problem of interest to them at a site of their choosing. The teams will use these new learned technologies in tandem with other publicly accessible data (either formally available or also collected by the researchers) to investigate a working hypothesis about their chosen urban problem for their particular site.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8073 Big Data Analytics for Public Policy (3 Credits)
Typically offered Spring
The goal of the Big Data Analytics for Public Policy class is to develop the key computer science and data science skill sets necessary to harness the wealth of newly-available data. Its design offers hands-on training in the context of real microdata. The main learning objectives are to apply new techniques to analyze social problems using and combining large quantities of heterogeneous data from a variety of different sources. It is designed for graduate students who are seeking a stronger foundation in data analytics.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8083 Big Data Management & Analysis (3 Credits)
Typically offered Spring
The course aims to provide an understanding of big data and state-of-the-art technologies to manage and process them. General topics of this course include: big data ecosystems, parallel and streaming programming model, and spatial data processing. Hands-on labs and exercises in MapReduce, Hadoop, Spark, Hive, and Pig will be offered throughout the class to bolster the knowledge learned in each module.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8093 Data Visualization (3 Credits)
Typically offered Spring and Summer
Visualization and visual analytics systems help people explore and explain data by allowing the creation of both static and interactive visual representations. A basic premise of visualization is that visual information can be processed at a much higher rate than raw numbers and text. Well-designed visualizations substitute perception for cognition, freeing up limited cognitive/memory resources for higher-level problems. This course aims to provide a broad understanding of the principals and designs behind data visualization. General topics include state-of-the-art techniques in both information visualization and scientific visualization, and the design of interactive/web-based visualization systems. Hands on experience will be provided through popular frameworks such as matplotlib, VTK and D3.js.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8103 Data-Driven Methods for Policy Evaluation (3 Credits)
Typically offered occasionally
Data-Driven Methods for Policy Evaluation equips students with the tools to design, analyze, and assess public policies using data-driven approaches. Focusing on urban issues such as housing, economic development, environment, and climate, the course explores evidence-based methods for policy creation, monitoring, and evaluation. Students examine if/how data-centric technologies enable retrospective and prospective analysis, detect discriminatory practices, and audit algorithmic systems for fairness. While these innovations offer opportunities for greater efficiency, equity, and transparency, they also raise complex legal, ethical, and social questions. Students will research, design, and present a policy performance dashboard and participate in student led discussions and in-class scenario analyses to better understand the dynamic relationships between law, policy, and data in addressing today's urban challenges.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8113 Monitoring Cities (3 Credits)
Typically offered occasionally
The world's urban population is growing by nearly 60 million per year; equivalent to four cities like New York annually. Monitoring the chronological growth of key attributes of cities, as well as quantifying their current conditions presents a great potential for positive change. Through the acquisition of new data, there are immediate opportunities to influence the sustainable growth of small and medium size cities. There is also the potential for alleviating the extremes in Megacities, where conditions have reached a critical and unmanageable state. Looking at cities as interdependent networks of physical, natural and human systems, this course provides a perspective on how to monitor the function and wellness of these systems. Students obtain an understanding of needs assessment, planning, and technical approaches for instrumenting a city. This includes monitoring patterns of activity, mobility, energy, land use, physical and lifeline infrastructure, urban ecology, vegetation, atmosphere and air quality. The expected outcomes of this course is a comprehensive understanding of what can be instrumented and the monitoring architecture for acquiring and generating new data about cities.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8115 Large Scale Data Analysis with Machine Learning II (1.5 Credits)
Typically offered Spring
The past decade has seen the increasing availability of very large scale data sets, arising from the rapid growth of transformative technologies such as the Internet and cellular telephones, along with the development of new and powerful computational methods to analyze such datasets. Such methods, developed in the closely related fields of machine learning, data mining, and artificial intelligence, provide a powerful set of tools for intelligent problem-solving and data-driven policy analysis. These methods have the potential to dramatically improve the public welfare by guiding policy decisions and interventions, and their incorporation into intelligent information systems will improve public services in domains ranging from medicine and public health to law enforcement and security. The LSDA course series will provide a basic introduction to large scale data analysis methods, focusing on four main problem paradigms (prediction, clustering, modeling, and detection). The first course (LSDA I) will focus on prediction (both classification and regression) and clustering (identifying underlying group structure in data), while the second course (LSDA II) will focus on probabilistic modeling using Bayesian networks and on anomaly and pattern detection. LSDA I is a prerequisite for LSDA II, as a number of concepts from classification and clustering will be used in the Bayesian networks and anomaly detection modules, and students are expected to understand these without the need for extensive review. In both LSDA I and LSDA II, students will learn how to translate policy questions into these paradigms, choose and apply the appropriate machine learning and data mining tools, and correctly interpret, evaluate, and apply the results for policy analysis and decision making. We will emphasize tools that can "scale up" to real-world policy problems involving reasoning in complex and uncertain environments, discovering new and useful patterns, and drawing inferences from large amounts of structured, high-dimensional, and multivariate data. No previous knowledge of machine learning or data mining is required, and no knowledge of computer programming is required. We will be using Weka, a freely available and easy-to-use machine learning and data mining toolkit, to analyze data in this course.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8123 Climate Risk Analysis and Urban Sustainability (3 Credits)
Typically offered Spring
This course explores climate risks, focusing primarily on the analysis of physical risks, including hurricanes, floods, and heatwaves. Students will engage with statistical modeling and uncertainty quantification to assess both physical and transition risks to people, infrastructure, and the economy. Key topics include assessing vulnerabilities in the urban environment, the effects of extreme weather events, and the impacts of climate change. The class will utilize advanced statistical methods and risk modeling techniques, working with large datasets to inform analyses. Discussions will feature state-of-the-art quantitative concepts, supplemented by case studies that illustrate real-world challenges. Guest speakers from the climate risk field will share insights on effective risk mitigation strategies and modeling. This course is designed for graduate students interested in risk and climate for practice and research. Knowledge of undergraduate-level statistics and probability, as well as experience in data visualization using Python, is required. The class will meet regularly for lectures and discussions of reading assignments. Students will complete homework assignments and projects in the field of climate risk and resilience.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8133 The Citizen and The City (3 Credits)
Typically offered occasionally
Citizen and the City explores the application of urban data science through the lens of the third sector (non-governmental and community-based organizations) and how they address urban challenges through data, policy and technology. Emphasizing appreciative inquiry, design thinking, project management, and community science techniques, the course examines best practices through domestic and international case studies on how NGOs and CBOs work (or not work) collaboratively with private and public sector on urban challenges. In this project-centered class, students will collaborate with a NGO/CBO on the research, design and possible implementation of a project that integrates data and policy analysis, project management, and community science skills learned in the classroom. This course provides tools and experiences that help students understand urban challenges at multiple scales, across sectors, and from diverse perspectives. The hands-on approach prepares students to lead impactful, community centered initiatives that drive on-the-ground urban development.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8143 Internet-of-Things Security and Privacy: A Data-Driven Perspective (3 Credits)
Typically offered occasionally
Smart home IoT (Internet-of-Things) devices are gaining popularity in average consumer homes. These "smart" devices, such as cameras, plugs, TVs, dishwashers, etc, are also known to pose various security and privacy threats (e.g., your Alexa listening to you), but the opaque nature of these devices makes it difficult to discover security and privacy vulnerabilities. This course introduces basic and advanced topics on Internet-of-Things (IoT) security and privacy from a data-driven perspective. It starts with preliminaries on networking and Internet security, followed by security research based on a data-driven approach. Students will read peer-reviewed academic papers from multiple disciplines, ranging from computer science, psychology, and policy/law. Furthermore, students will engage in hands-on projects to independently investigate real-world security and privacy issues of IoT devices and/or propose solutions to fix these issues. Students for this class are expected to have networking knowledge, such as how TCP/IP works, how packets get forwarded, and how to run tcpdump. Otherwise, students are encouraged to take relevant Coursera courses on these topics before the semester begins and to seek the instructor's approval.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8153 Complex Urban Systems (3 Credits)
Typically offered Spring
This course offers an introduction to the broad field of complex urban systems, with a focus on project-based learning and computer coding. Using only basic concepts in probability and linear algebra, the course will introduce methods and principles of complex systems applied to urban systems, including geography laws, scaling principles, and mobility patterns.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8163 Structural Drivers of Inequitable Health in Urban Spaces (3 Credits)
Typically offered occasionally
Efforts to improve life in urban spaces require making decisions regarding use of resources, targets for development, and priorities for financial and political investment. Each of these decisions is dynamic and builds off one another, but regardless of their intended target, these decisions all have consequences for health, a perspective embraced by the "Health in All Policies" framework. More specifically, each of these decisions (and their resulting policies) become structures that ultimately either serve to promote or prevent health equity in urban populations. The impacts of these structures extend beyond consequences for chronic disease (i.e., asthma, diabetes, cancer), as they lead to inequitable patterning of infectious disease risk as well, a phenomenon illustrated by the severe racial/ethnic disparities in disease and mortality risk that have been observed in New York City, throughout the COVID-19 Pandemic. This course is an introduction to structural thinking as it pertains to health in urban spaces. Throughout the course we will discuss items such as zoning, public transit, education, and policing, and think through their implications for health. Furthermore, we will discuss common practices regarding each of these domains and illustrate how these decisions have contributed towards health inequities across multiple axes, including race, ethnicity, gender, and social class. Lastly, we will walk through illustrative examples of policies that have positively influenced health outcomes for the overall population, but exacerbated inequity in doing so, and will discuss the ethics and utility of such trade-offs.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8813 Design for Innovation with AI & ML (3 Credits)
Typically offered Spring
Product and service innovations are increasingly delivered through digital platforms built on artificial intelligence (AI), and in particular machine learning (ML). The goal of this course is to expose students to methods for understanding the opportunities and challenges that designing with AI and ML foreground. The course adopts a human-centered perspective and systemic approach that considers the impact of these technologies on ethical concerns, sustainability and social innovation. Students will learn skills and techniques for conceptualizing digital platforms that use A.I. and ML to support innovative product-service systems, including design research and prototyping. This will enable students to explore how a diversity of stakeholders can benefit from and contribute to these emerging technologies. Throughout this process, students will reflect on the context in which the ML products and services they propose will be used, and their potential impact on diverse stakeholders.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8823 Digital Civics for Social Innovation (3 Credits)
Typically offered Fall
This course will equip students with an understanding of how digital technologies and government open data can be used to innovate democratic participation and improve government services, and help to create equitable smart cities. Case studies presented by guest speakers including public interest technology practitioners and researchers, and officers of NYC agencies, will provide a platform to support students in identifying opportunities for digital innovation and designing systems that help to support sustainability, democracy, resilience, and inclusion. Students will put their learning into practice by prototyping civic technology solutions. This course is suitable for all students, and does not require a specialist technical background or prior design experience.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8833 City Immersion (3 Credits)
Typically offered Fall
City immersion is an experiential learning course examining the strengths and challenges a city faces. Applying the Co-Cities Protocol and the CUSP Knowledge Tracks (AI, Complex Systems, GIS, Policy Analytics, Smart Infrastructure, Sustainability, Urban Technology Management) students engage with public authorities, civil society organizations, social innovators, businesses, and academic institutions to understand the city beyond what is presented in articles, text books and media. Students will collaborate with communities of the city to co-create informed, inclusive, and innovative strategies in response to identified pressing concerns and present their work to participating partners. | NOTE: Additional costs are associated with registering for this class (covering cost associated with primary grounded research immersion site trip: meals, housing, transportation).
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8843 Virtual and Augmented Reality (3 Credits)
Typically offered Fall
The course is a blend of theoretical and practical knowledge aimed at developing a well-rounded set of skills to ideate, design, implement, and evaluate sophisticated VR/AR projects. The course will proceed with 3 meta sections: 1) low-level real-time computer graphics, computer vision, and optics; 2) human perception, visual optics, and immersive user interface; 3) VR/AR application case studies. The theoretical part contains low-level optical and computational methods of how individual pixels are drawn on the screen, and how they are perceived by the human eyeball, the retina, and the brain. The practical part aims at teaching the skills needed to develop effective interactive VR/AR applications as a whole to assist real-world applications. The course also includes a series of small practical projects which enable students to gain experience with the development of fully-working interactive graphics and interface techniques. The final project, with the freedom to select among several topics, is organized in a way to simulate conditions happening in real-world (especially focusing on using VR/AR technologies to enhance daily human tasks) and includes activities to gain feedback from the instructor and the teaching assistants. Students are encouraged to have an understanding of linear algebra and programming prior to course. Please connect with instructor prior to enrollment if students have any questions.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8853 Understanding Urban Subsurfaces: Identifying, Integrating, & Operationalizing Relevant Data Streams (3 Credits)
Typically offered Spring
While aboveground urban areas are extensively zoned, examined, and explored, equivalent conditions are rarely found in urban subsurface spaces. The lack of knowledge about what lies below ground and its location (1) poses significant obstacles to the cost-effective management of cities, (2) aggravates existing challenges to improve resilience, and (3) risks the loss of irreplaceable heritage. This course utilizes New York City as an evolving testbed to examine how historical perspectives, domain expertise, modern mapping, and advanced data analysis can help bridge critical knowledge gaps. It also explores how having more interoperable datasets can lead to reduced utility and construction costs, fewer service interruptions, and a fundamental rethinking of how subsurface space is utilized and regulated. This assignment-based course will challenge students to uncover and operationalize datasets and demonstrate their added value in addressing urban asset issues management.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8863 From Correlation to Causation: Data Science for Decision Making (3 Credits)
Typically offered Fall
While machine learning models are capable of exploiting correlations within high-dimensional data to perform predictions, uncovering the causal mechanisms — understanding if and how an intervention X causes an outcome Y — is vital for informed decision-making in business and policy. This course builds upon a foundation of basic statistics and programming to explore the essential principles of causal inference within data science. It provides practical training in applying causal inference techniques. First, the course will introduce tools for understanding causal structures, including graphical causal models. The course will then cover key methodologies in causal inference, such as propensity score matching, difference-in-differences, synthetic control methods, and more advanced techniques like instrumental variable (IV) estimations and causal machine learning models. This course serves as an introduction to the cutting-edge field of causal inference, with a focus on project-based and hands-on learning approach. | Knowledge of Python and basic statistics are preferred.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8873 Urban Computing and Artificial Intelligence (3 Credits)
Typically offered Spring
The course aims to equip students with the technical and analytical capacity to use state-of-the-art AI techniques for urban data science. It also seeks to foster thought leadership by encouraging critical thinking about the societal implications of urban computing and AI applications. This course begins with a recap of deep learning methods for spatial-temporal data and its practical applications in urban management. The course then delves into generative AI, providing an overview of models such as GPT and Large Language Models (LLMs), with a focus on practical applications for urban governance and modeling. The course concludes by introducing limitations and open questions including fairness and bias issues, techniques for causal inference and decision-making, and modeling urban complexity. This comprehensive course aims to not only provide technical skills but also to nurture a deep understanding of the broader implications and potentials of urban computing and AI in shaping future cities.
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 8883 Urban Transportation & Logistics Systems (3 Credits)
Typically offered Fall
This course provides graduate students with operations research methods to solve logistics problems faced by decision-makers for congested urban infrastructure. Optimization and evaluation methods covered include linear programming, network flow, integer programming, vehicle routing, facility location, functions of random variables, Markov processes, (point, spatial, and Jackson) queueing, and queue tolling. Students will design and analyze a toy system related to one of the following applications: public transport, shared mobility, ITS applications, freight deliveries, traffic operations. | Prerequisites: Graduate Standing or Department Permission
Grading: Grad Poly Graded
Repeatable for additional credit: No

CUSP-GX 9010 Urban Computing Skills Lab: Introduction to Programming for Solving City Challenges (0 Credits)
Typically offered not typically offered
The Masters program in Applied Urban Science and Informatics is a unique program that brings together people from diverse backgrounds and career paths who have found a passion for applying analytical skills to problem-solving in an urban context. Because of this wide variety of backgrounds, you may be entering into this program with little computer science background, or have less familiarity with urban challenges. This course is designed to develop programming skills and to gain familiarity with the techniques, concepts, and models of urban informatics computing. Students will learn to program in python through a series of online tutorials, and will be exposed to the leading thinking on urban challenges through readings and discussion. Weekly lectures will demonstrate how these skills can be used to construct analyses through detailed code reviews. Finally, students will have the opportunity to practice these skills as they build an analysis of an urban challenge using real data.
Grading: Grad Poly Pass/Fail
Repeatable for additional credit: No

CUSP-GX 9113 Special Topics in Urban Science & Informatics (3 Credits)
Typically offered occasionally
This special topic explores a specific perspective and research in urban science and informatics. Students are expected to participate actively through sessions.
Grading: Grad Poly Graded
Repeatable for additional credit: Yes