MUSA 500 Spatial Statistics and Data Analysis
This hands-on course will provide an introduction to statistical methods and will serve as a prequel to ESE502. Topics covered will include exploratory univariate analysis, correlation and Chi-square analysis, t-tests and ANOVA. Non-parametric alternatives to the standard tests will be discussed. OLS regression, including assumptions and diagnostics, will be covered in detail. Heavy emphasis will be placed on the application of each method covered. The course will conclude with an introduction to spatial statistical methods and a brief overview of linear algebra and matrix notation for OLS and spatial regression. Students will learn to use JMP-IN, ArcGIS and GeoDa for data analysis.
Taught by: Eugene Brusilovskiy
Course usually offered in fall term
Also Offered As: CPLN 671
Activity: Lecture
1.0 Course Unit

MUSA 501 Introduction to Applied Statistics
This hands-on course will provide an introduction to statistical methods and will serve as a prequel to ESE502. Topics covered will include exploratory univariate analysis, correlation and Chi-square analysis, t-tests and ANOVA. Non-parametric alternatives to the standard tests will be discussed. OLS regression, including assumptions and diagnostics, will be covered in detail. Heavy emphasis will be placed on the application of each method covered. The course will conclude with an introduction to spatial statistical methods and a brief overview of linear algebra and matrix notation for OLS and spatial regression. Students will learn to use JMP-IN, ArcGIS and GeoDa for data analysis.
Taught by: Eugene Brusilovskiy
Course usually offered in spring term
Activity: Lecture
1.0 Course Unit

MUSA 503 Modeling Geographical Objects
This course offers a broad and practical introduction to the acquisition, storage, retrieval, maintenance, use, and presentation of digital cartographic data with vector-oriented (i.e. drawing-based) geographic information systems (GIS) for a variety of environmental science, planning, and management applications. Previous experience in GIS is not required.
Taught by: Tomlin or O’Neill
Course usually offered in fall term
Also Offered As: CPLN 503
Activity: Lecture
1.0 Course Unit

MUSA 504 Business and Crime Geographics
In this hands-on course, students will learn how to use ESRI Business Analyst software and data to undertake real estate and social service market studies, business location studies, and consumer expenditure profiles. New this year, the course will also explore techniques and software for tracking and forecasting crime; and deploying police resources.
Taught by: Amos
Course usually offered in spring term
Activity: Seminar
1.0 Course Unit

MUSA 505 Web-based Mapping
This hands-on course will teach students how to develop and implement web-and internet-based mapping tools and applications using ESRI’s ArcGIS Server and ArcGIS Online products as well as the GoogleMaps Applications Programming Interface (API). Students will learn how to use web-based tools to build spatial databases, analyze and display spatial data at multiple scales, mix web-based vector and raster data with image data, conduct spatial analysis and develop urban and environmental planning applications.
Taught by: Landis and Dailey
Course usually offered in spring term
Prerequisite: CPLN 670 OR LARP 743
Activity: Laboratory
1.0 Course Unit

MUSA 508 Public Policy Analytics
Data scientists convert data into actionable intelligence. While most private sector data scientists optimize for profit, their public sector counterparts must address multiple complex bottom lines including economics, equity, politics, bureaucracy and social cohesion. This course teaches students how to wrangle government data; how to mine it for descriptive and predictive intelligence and how to communicate results to non-technical decision-makers. Broadly, coursework is focused on spatial analysis and geospatial machine learning and taught 70/30 in R and ArcGIS. Use cases include home price prediction, forecasting in criminal justice, land use modeling, transportation modeling and real estate site suitability. Prerequisites include vector and raster GIS and introductory statistics.
Taught by: Ken Steif
Course usually offered in fall term
Also Offered As: CPLN 592
Activity: Lecture
1.0 Course Unit

MUSA 509 Geospatial Cloud Computing & Visualization
This course teaches students how to collect, store, wrangle and display cartographic data in a cloud-based setting. Students will learn a reproducible approach for pulling spatial data from APIs with emphasis on PostGIS, Socrata and BigQuery; to wrangle these data in python; and visualize in various platforms including Seaborn and Carto. Students will build their own APIs and eventually develop their own introductory custom web applications. This course is the first in a progression and leads to the Spring course on Javascript Programming for Planning (a class on building comprehensive mapping applications.)
Taught by: Andy Eschbacher
Activity: Lecture
1.0 Course Unit
**MUSA 550 Geospatial Data Science in Python**
This course will provide students with the knowledge and tools to turn data into meaningful insights, with a focus on real-world case studies in the urban planning and public policy realm. Focusing on the latest Python software tools, the course will outline the "pipeline" approach to data science. It will teach students the tools to gather, visualize, and analyze datasets, providing the skills to effectively explore large datasets and transform results into understandable and compelling narratives. The course is organized into five main sections: Exploratory Data Science; Introduction to Geospatial Data Science; Data Ingestion & Big Data; Geospatial Machine Learning; Data Visualization & Storytelling.

Taught by: Nick Hand  
Course usually offered in fall term  
Also Offered As: CPLN 691  
Activity: Seminar  
1.0 Course Unit

**MUSA 611 Java Script Programming for Planners and Designers**
This course will introduce City Planning, MUSA and design graduate students to Javascript. Students will learn the logic and syntax of the Java programming language for use in a simple web application (weeks 1 to 7), as well as how to program database and map-oriented web and desktop applications using Javascript (weeks 8 to 14). The "hands-on" uses of Javascript in urban planning applications will be emphasized. Students will hone their programming and applications development skills through a series of bi-weekly assignments.

Taught by: Faculty  
Course usually offered in fall term  
Also Offered As: CPLN 692  
Activity: Lecture  
1.0 Course Unit

**MUSA 620 Data Wrangling and Visualization**
The purpose of this course is to familiarize students with the "pipeline" approach to data science. This involves the process of gathering data; sorting the data; analyzing the data and visualizing the data such that non-technical managers can make use of it for decision making. The first part of the course teaches students how to gather data by way of scraping, APIs, Google Big Query, Twitter and other unstructured sources. The second part of this course, teaches students how to store and retrieve these data in a database. The third part of the class teaches some more esoteric machine driven analytics. The fourth and final component of the class is data visualization both in state and dynamic (web-based) form. The students will be expected to replicate this pipelines on a data set of their own choosing for their final project. 

Prerequisite: Working knowledge of R and ArcGIS.

Taught by: Hand, Nicholas  
Course usually offered in spring term  
Also Offered As: CPLN 691  
Activity: Seminar  
1.0 Course Unit

**MUSA 650 Geospatial Machine Learning in Remote Sensing**
Satellite remote sensing is the science of converting raw aerial imagery into actionable intelligence about the built and natural environment. This course will provide students the foundation necessary for the application of machine learning algorithms on satellite imagery. Use cases include building footprint detection, multi-class object detection in cities and land cover/land use classification. The students will learn basic concepts of machine learning, including unsupervised and supervised learning, model selection, feature elimination, cross-validation and performance evaluation. After learning traditional methods and algorithms, the course will focus on recent deep learning methods using convolutional neural networks and their application on semantic image segmentation. Prerequisites include MUSA 508, Geospatial Data Science in Python or equivalent.

Taught by: Dr. Guray Erus  
Course usually offered in spring term  
Activity: Lecture  
1.0 Course Unit

**MUSA 795 MUSA SUMMER: INTRODUCTION TO GIS & STATISTICS**
The summer GIS Bootcamp prepare students for the intermediate GIS classes that begin in the fall semester. It begins with a discussion of GIS in planning and the social sciences and then moves on to topics related to spatial data, geocoding, projection, vector and raster-based geoprocessing, 3D visualization and more. Each class includes a brief lecture and a walk through involving actual planning related data. Course enrollment is by permit only. Please contact Roslynne Carter (CPLN Dept.) at roslynne@design.upenn.edu.

Taught by: Faculty  
Course usually offered summer term only  
Activity: Lecture  
0.0 Course Units

**MUSA 800 MUSA Capstone Project**
One-term course offered either term  
Activity: Seminar  
1.0 Course Unit

**MUSA 801 MUSA/Smart Cities Practicum**
The purpose of this course is for students to work with city and non-profit clients on data science that convert government data into actionable public policy intelligence. Groups of 2-3 students will work with the client to understand the business process, wrangle data, develop spatial and aspatial analytics and serve these outputs to non-technical decision makers through the medium of data visualization. Students will be mentored by MUSA Faculty and advised by someone from the partnering agency. Prerequisites: students must have a working knowledge of R and experience building both spatial and statistical models including machine-learning models. Prerequisites include MUSA-507/CPLN-590 and either CPLN-505 or MUSA-500. Students must have taken or be enrolled concurrently in MUSA-601 or MUSA-800. Students without these specific prerequisites are asked to contact the instructor. Please contact the instructor for full admission details, no later than November 15, 2018. Interested students are asked to contact the instructor to learn about specific projects and how to apply for the course.

Taught by: Ken Steif  
Course usually offered in spring term  
Also Offered As: CPLN 790  
Prerequisite: (MUSA 507 OR CPLN 590) AND (CPLN 505 OR MUSA 500)  
Activity: Seminar  
1.0 Course Unit