

**NYU**Center for Urban
Science + Progress

Urban Computing Skills Lab: Introduction to Programming for Solving City Challenges

SUMMER 2020

- **Instructor:** Martina Balestra
- **Contact:** mbalestra@nyu.edu
- **Class Dates:** Wednesdays, 4-6 pm EST; June 10 - August 12, 2020
- **Location:** Online
- **Office Hours:** By appointment

Course Description:

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 help build a common skill set and familiarity with the techniques, concepts, and models for urban informatics computing. The online sessions will focus on building programming skills and using python to explore data and deploy statistical methods needed for urban analytics. These skills will be put to use in a series of challenges in which you will work with urban data. Finally, a series of talks by researchers at the institute will showcase some of the urban challenges that they are tackling in their work.

Plan for the Course:

This course will incorporate weekly online tutorials in programming methods with readings on urban challenges and presentations by faculty and researchers at the Center for Urban Science and Progress.

The programming instruction in this course will include a mix of lectures, tutorials, and exercises hosted in EdX as well as lab materials in jupyter notebooks. These notebooks are more of a “working area” and will not have all of the information that you’ll find in the EdX area. You will receive instructions for setting up the jupyter notebooks environments in the first session of the course. There will also be a number of graded programming exercises in EdX. We hope that you



will use these grades to measure your progress and understanding of the materials, however these grades will not count towards your final course grade. Questions about these assignments should be directed to the discussion board on the course website, or to self-created study groups. Office hours for outstanding questions will be by request.

In addition to the online lectures and exercises, the course will have weekly meetings via Zoom during the class time (above). Each week, you will be assigned readings (available on the EdX course website) centered around an urban challenge. Faculty whose research relates to this topic will discuss their work during the class time. If you are unable to attend the class in person, a recording of the talk will be posted on the course website.

Project & Course Evaluation:

Many of the weekly programming assignments are automatically graded through the course website, but will not count towards a course grade. However, you will have the option to receive three credits for this course upon completion of an additional project if you enroll in the fall semester. If you choose this option, you will be provided with a dataset related to an urban system. You will use the skills that you have developed throughout this course to complete an end-to-end analysis of this data. This will include loading into a jupyter notebook, processing (e.g. cleaning, transforming data), exploring (e.g. descriptive statistics), analyzing, and visualizing this data. The analysis will be guided by several predefined research questions, as well as a research question that you will propose and execute on. The project will be due in the second week of the fall semester: September 14, 2020. We will discuss this project in greater detail towards the end of the course.

Course Outline

Week 0.

This course will be hosted in the EdX platform with lab materials available as jupyter notebooks. Once you have registered for the course, you will receive an email with instructions for registering for an EdX account and linking you to the course page. Information for setting up a jupyter notebook instance on your computer is provided on the EdX course page.

To Do: Introduce yourself on the course website discussion board!

Week 1. June 10, 2020

Title: Introduction to 'Urban computing skills lab: Programming for solving city challenges'

Speaker: Martina Balestra

Due June 17: This week's reading materials will provide you with an introduction to the course and should provide you with some advice for using the various resources available to you through this course and how to get the most out of this experience:



1. **EdX Module 1:** Introduction
2. **Reading:** Alsina, Victòria, and José Luis Martí. “The birth of the CrowdLaw movement: Tech-based citizen participation, legitimacy and the quality of lawmaking.” *Analyse & Kritik* 40.2 (2018): 337-358.

Week 2. June 17, 2020

Title: The birth of the CrowdLaw movement: Tech-based citizen participation, legitimacy and the quality of lawmaking

Speaker: Victoria Alsina, Industry Assistant Professor & Academic Director at CUSP

Due June 24: The lectures, readings, and exercises that you will do in preparation for next week’s class will provide you with an overview of python’s syntax. At the end of this week, you should be able to define python variables, utilize and demonstrate python syntax, use (and understand) variables in python, perform simple numerical operations, use built-in data types, and alter the flow/ execution of the code using control flow statements.

1. **EdX Module 2:** Introduction to python
2. **Reading:** TBD

Week 3. June 24, 2020

Title: Simulating Pedestrians

Speaker: Paul Torrens, Professor in the Department of Computer Science & Engineering

Due July 1: This week’s work will dive deeper into two primary data types, numerical data and strings, and related expressions and control flows. By the end of this week, you should be able to recognize and manipulate these different types of data effectively.

1. **EdX Module 3:** Numerical Data Types, Arithmetic Expressions, & Strings
2. **Reading:** TBD

Week 4. July 1, 2020

Title: The Power of Spatial

Speaker: Debra Laefer, Professor in Civil & Urban Engineering

Due July 8: This week’s work will cover different ways in which data can be organized in python so that it can be used (algorithmically) efficiently; for example, lists, tuples, and dictionaries. By the end of this week, you should be able to differentiate between python’s different data structures, create functions to make code more readable and reusable, and perform error handling.



1. **EdX Module 4:** Python in practice: lists
2. **Reading:** TBD

Week 5. July 8, 2020

Title: TBD

Speaker: Neil Kleiman, Clinical Assistant Professor of Urban Planning & Public Service, and Director at Wagner Innovation Labs

Due July 15: This week's work will provide an overview of data manipulation using boolean operators and iterative statements (e.g. for and while loops). These tools will enable you to effectively and efficiently process data.

1. **EdX Module 5:** Branching & Iterative Statements
2. **Reading:** TBD

Week 6. July 15, 2020

Title: A large-scale analysis of racial disparities in police stops across the United States

Speaker: Ravi Shroff, Assistant Professor of Applied Statistics, Assistant Professor of Urban Informatics

Due July 22: This week's work will teach students how to initialize and construct user-defined functions for reuse in analyses, reducing code duplications, and improving readability while reducing the complexity of the code.

1. **EdX Module 6:** Functions
2. **Reading:** TBD

Week 7. July 22, 2020

Title: Urban Complexity: Understanding complex urban systems through data analysis, machine learning and network science

Speaker: Stan Sobolevsky, Associate Professor of Practice And Director Of Urban Complexity Lab at CUSP

Due July 29, 2020: This week's work will provide you with an overview of data manipulation with NumPy - one of the most commonly used tools for computation in python. By the end of this week you should be able to construct, manipulate, and use numpy arrays in computation.

1. **EdX Module 7:** NumPy



2. **Reading:** Bello, Juan P., et al. "Sonyc: A system for monitoring, analyzing, and mitigating urban noise pollution." Communications of the ACM 62.2 (2019): 68-77.

Week 8. July 29, 2020

Title: SONYC: A System for Monitoring, Analyzing, and Mitigating Urban Noise Pollution

Speaker: Juan Bello, Director of CUSP, Professor of Music Technology and Computer Science & Engineering

Due August 5, 2020: This week's work will provide an overview of one of the other fundamental tools for doing practical, real world data analysis in python: the pandas package. By the end of this week, you should be able to define and use pandas series and dataframes, create dataframe from dictionary and .csv files, index and reindex dataframes, perform data alignment and arithmetic operations on dataframes, apply NumPy functions on dataframes, and design and build a sample exploratory data analysis.

1. **EdX Module 8:** Pandas
2. **Reading:** TBD

Week 9. August 5, 2020

Title: Machine Learning and Event Detection for Population Health

Speaker: Daniel Neill, Associate Professor of Urban Analytics; Associate Professor of Computer Science and Public Service; Director, Machine Learning for Good Laboratory

Due August 12, 2020: This week's work will provide an overview of data visualization using matplotlib, probably the single most used Python package for 2D-graphics. At the end of this week you will be able to prepare and plot simple lines and curves, beautify the output figures, summarize different types of plots and explain the elements that go into creating an output figure, discern where each type is suitable, compare and select the proper type of plot, and formulate publication quality figures.

1. **EdX Module 9:** Introduction to Matplotlib

Week 10. August 12, 2020

In the final class session we will discuss the final project. Students who complete this project and who enroll in the fall semester will be eligible to receive 3 credits for their participation.

Due September 14, 2020: Final project due for students who have enrolled in the fall semester and want to receive 3 credits for the summer course.