Introduction to Python

for Applications to Biomedical Industries

BME 6303

Fall 2020

Course Description

Introduction to Python with Applications to Biomedical Industries introduces students to coding through the Python programming language. The course aims to provide students with the ability to apply Python to analyze biological data and solve contemporary problems in the biosciences, bioengineering and biomedicine.

Overall Goal for Enrolling Quantu Project Volunteers:

Learning and education has been associated with greater cognitive reserve and protection from age-associated cognitive decline. A goal for our Quantu Project intervention studies is to understand what ways learning may help promote brain health for individuals. We are testing the hypothesis that learning a new language (including a computer programming language like Python) may (1) increase proteins in the blood that are indicative of neurogenesis, or the formation of new neurons; (2) improve cognitive performance in other tasks; and/or (3) improve cognitive health in other ways including optimizing sleep quality or improving performance on cognitive tests. The Python course is also meant to be fun and informative, and share a method we use in our daily lab research.

Overall Goal: This course will introduce students to coding in Python, and equip them with the foundation to apply Python programs to solve problems relevant to the biosciences, bioengineering, clinical medicine, and biomedical industries.

Specific Objective I: To gain knowledge of the basic concepts of computer programming by learning the structure, syntax and implementation of the Python language.

Specific Objective II: To gain familiarity with the methods, open-source programs, and other tools available for programming using Python.

Specific Objective III: To gain the programming skills needed to apply Python code to interpret large, complex, multimodal data (images, videos, protein-DNA interaction data, etc.) and be knowledgeable of the ways to optimize code.

Background on Python Course

Computing has revolutionized biology and bioengineering. Computer programs oversee medicine procedures, integrate data from fitness devices and phones, and guide health policy decisions worldwide. Biologists, bioengineers and medical students across all domains (e.g., molecular biology, regenerative medicine, infectious disease, fitness, health economics), would benefit from knowing how to program well. This course will introduce students to coding for biomedical applications using Python. Python is the most in-demand programming language by employers (Source: IEEE Spectrum, 2019). Python's utility across medical centers, the tech industry (e.g., Google, Amazon), and academia stems from its versatility, ease of use, and its open-source structure. Introduction to Python for the Biosciences and Bioengineering introduces the basics of Python's modules, functions, strings, lists, sorting and regular expressions.

Real-world, contemporary examples will be covered in class as students learn how to code in Python. Examples of programs that will be introduced include artificial intelligence methods to interpret images from brain scans and lab-grown tissues, bioinformatics programs to predict molecular biomarkers of infection, and time-dependent models to study daily exercise habits from wearable sensor data. Models that scrape public data from the web have been a key reference for health and political decisions, especially during the Covid-19 pandemic; and students will learn how to use Python to scrape publicly accessible data sources. After completing the course, students will have the foundational background to be able to design their own programs, mine public biomedical data sources, and tackle a range of problems in biology and bioengineering using Python.

Meeting Time & Location

Asynchronous, videos are posted online. The following dates will also provide virtual, live meetings, with optional attendance at 2:30 pm Central: **August 24, August 31, September 21, October 19, November 30, and Thursday December 3, 2020.**

Click here for URL to attend live session

All students should have access to the materials online at QutubLab.org/python.

Commitment from and to Quantu Project Volunteers: Volunteers are asked to complete as much of the Python course as they wish to. We hope you will enjoy the course and complete the whole course. At minimum, we request that volunteers complete 6 weeks (6 Modules). We will send emails with instructions on providing course feedback, and on other logistics for the Quantu Project research. **Please note:** we are not distinguishing volunteers from enrolled graduate students in the course other than no grades or credit are provided to volunteers, and course materials started 2 weeks later. Live course sessions and office hour periods on Mondays at 2:30 pm Central will be attended by up to 50 individuals from diverse backgrounds and skillsets. Should you need more instruction than provided from the online

videos and materials and the live office hour sessions, please do not hesitate to contact Quantu Project team members Jenny Brethen, Erin Pollet, Dr. Byron Long or Dr. Qutub. You can reach all of us at team@quantuproject.org.

Self-Paced: Course material can be viewed anytime, and the course is self-paced. Suggested material and Python practice links are provided week by week. Modules are organized by 16 weeks. The three assignments (called Coding Challenges) are due at the indicated dates. Instructions to complete these three Coding Challenges will be sent via email to students who are participating as volunteers in the course.

Prerequisites: No prereqs required. This is an introductory graduate level course that is self-paced. Computer literacy, math skills and basic experience with coding are advantages. The course is meant to be challenging and fun for those who are learning computer programming for the first time.

Modules & Materials

All modules are posted online **QutubLab.org/pythonmaterials**. Follow along to perform the tasks associated with each week's modules. Each module describes three items to accomplish each week or biweekly: **Read. Watch. Do.**

Read. A link to suggested reading material will be provided.
Watch. A video will be posted for each Module. Please watch this.
Do. Practice for the week. These are Python practice problems to do each week. There will be one that you can follow along from the Module video and additional suggested exercises in W3Schools. You can also supplement this with work in zyBooks, however zyBooks work is completely optional.

Course Instructor & Additional Contacts

Dr. Amina Ann Qutub	QutubLab.org | amina.qutub@utsa.edu
Quantu Project Manager Jenny Brethen, Erin Pollet, Dr. Byron Long	team@quantuproject.org | quantuproject@gmail.com
Office Hours:	Mondays 2:30 pm Central online through Dec 7th, or by appointment Click here for URL to attend live session

Method of Instruction

This class will contain lectures, interactive coding, coding challenges, and a coding project. Course material can be found online at QutubLab.org/python.

Coding Challenges

There are three Coding Challenges during the class. For Quantu Project volunteers, assignments will be emailed to you the week before they are due. You are asked to do your best to complete them within a week through the requested survey form.

Final Coding Project

The final project code and short report is due **December 11**.

Course Readings

Course readings will be posted online (**QutubLab.org/pythonmaterials**). Direct links to the reading materials each week will be posted under each module.

There is one main online reference, W3Schools, and an optional online textbook, zyBooks. To access these:

Strongly suggested reading materials:

W3Schools https://www.w3schools.com/python/

Additional **optional** reference for problem sets:

zyBooks Sign up using your email at: https://www.zybooks.com/ and subscribe to the Python book by typing in UTSABME6303Fall2020. If you would like to use zyBooks as an additional supplement to your learning, and you are an enrolled volunteer in our project, please contact Jenny Brethen (Jennifer.brethen@utsa.edu). zyBooks costs $77 to subscribe. We will pay for this access for those volunteers who wish to make use of it. Students outside of research volunteers will need to purchase zyBooks on their own.

Introduction to Python for Applications to Biomedical Industries		
Module	**Topic**	**Suggested pace, HW & notes**
Module 1	Course Overview	Weeks 1-2
Module 2	Python Syntax (Data Types, Variables)	Weeks 2-3
Module 3	Python Operators	Weeks 3-4
Module 4	Python Logic Expressions	Weeks 4-5 Coding Challenge I sent via email
Module 5	Python Biomedical Application I *Omics and Biosensor Data Processing*	Weeks 5-6 Coding Challenge I due (9/21)
Module 6	Python Functions	Weeks 6-7; Note: Volunteer min. time commitment completed at 6 wks
Module 7	Python Classes, Objects & Inheritance	Weeks 7-8
Module 8	Python Modules	Weeks 8-9 Coding Challenge II sent via email
Module 9	Python Biomedical Application II *Biomedical Image and Video Analysis*	Weeks 9-10 Coding Challenge II due (10/19)
Module 10	Python File Handling	Weeks 10-11
Module 11	Machine Learning & AI in Python	Weeks 11-12 Coding Challenge III sent via email

Module 12	Python: Intro to Databases	Weeks 12-13 Coding Challenge III due (11/12)
Module 13	Python Special Topics: Web-scraping	Weeks 13-14
Module 14	Python Biomedical Application III *Working with Public Biomedical Data*	Weeks 14-15
Module 15	Final Coding Project Presentations	Weeks 15-16 Final Coding Project Presentations Due
12/3	Last Day of Classes	
Module 16	Final Coding Project Due	Week 16 Final Coding Project Due