Introduction to Python

for Applications to Biomedical Industries

BME 6303 | CRN 19454 | 3 credits

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.

Background: 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.

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.

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 attending for credit and/or auditing the class should have a UTSA ID and login in order to access UTSA's Blackboard links.

Prerequisites: No prereqs required. This is an introductory graduate level course. Strong math skills and basic experience with coding are an advantage.

Course Instructor

Dr. Amina Ann Qutub	QutubLab.org | amina.qutub@utsa.edu
Office Hours:	Mondays 2:30 pm Central Online, 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.

Coding Challenges: Coding challenges are due at midnight (11:59 pm on Blackboard) on the indicated due date. Students may work in groups on assignments; however, each student must complete the material and handle in / present independent copies of their assignment.

Final Coding Project: The final project code and short report is due **December 11**.

Course Readings

Required course readings will be described the first week of classes. They will be posted online (**QutubLab.org/python**) and on Blackboard.

Grading Criteria

Coding Challenges	36%
Course Participation	14%
Final Coding Project	50%
Total	100%

NOTES: If you believe that a mistake has been made in grading, you have ONE WEEK to request a regrade in writing. Course participation includes completing in-class coding challenges, contributing to in-class discussions and/or discussions with the instructor and TA outside of class.

Disabilities: If you have a documented disability that requires accommodation, please let the instructors know so that we can confidentially discuss your needs. You will also need to register with the Disability Support Services Office.

Disclosures & Computational Citations: Please note that many free computational tools, tutorials, editors, and algorithms are referenced throughout this course as useful resources (*e.g., PyCharm, scikit-learn, Biowheel, W3Schools, web blogs*). Dr. Qutub is the co-founder of DiBS, which produces the Biowheel tool. The academic version of Biowheel (academic.dibsvis.com) is provided as a reference and free tool to students and researchers (*Hill et al., Nature Methods 2016; bioRxiv 099739; Bioinformatics Peer Prize*). Dr. Qutub, Qutub lab members, and alumni have also designed algorithms and provided free, open source code packages for other machine learning programs mentioned in this course (*e.g., Shrinkage Clustering, cytoNet; Hu et al., BMC Bioinformatics, 2018; Nature Biomedical Engineering, 2019*). Credits and citations are provided for these and tools from other sources (*e.g., cBioPortal, silhouettes, pandas*).

Two commercial platforms are also cited as additional, optional resources: Matlab and an interactive Introduction to Python textbook from zyBooks. All tools, code, and tutorials with the exception of Python are optional. Reference to tools, platforms, 'Python cheat sheets', etc, are not endorsements beyond the instructional use intended for this course.

Assignment Dates: Assignment due dates may be extended, but will not be before, the listed key date on the syllabus schedule. Should you need an extension on an assignment due to extenuating circumstances, please provide a brief rationale for your request to the instructor.

Live Sessions: 2:30 pm Central

Monday, August 24
Monday, August 31
Monday, September 21
Monday, October 19
Monday, November 30
Other Mondays in Aug-Dec are dedicated to Q & A
Thursday December 3, 2020 (final group project presentations)

NOTE: Material covered in each module and/or timing may change slightly in order to accommodate course participants. Assignment due dates may be later – but will not be before – the listed key date.

Introduction to Python for Applications to Biomedical Industries			
Module	**Date**	**Topic**	**Key Dates & Notes**
Module 1	8/24	Course Overview	**Live Session I** 8/24
Module 2	8/31	Python Syntax (Data Types, Variables)	**Live Session II** 8/31
Module 3	9/7	Python Operators	
	9/7	***No Class, Labor Day***	
Module 4	9/14	Python Logic Expressions	**Coding Challenge I due** (9/15) *revised from 9/14
Module 5	9/21	Python Biomedical Application I *Omics and Biosensor Data Processing*	**Live Session III** 9/21
Module 6	9/28	Python Functions	
Module 7	10/5	Python Functions II	Classes, Objects & Inheritance will be covered in Module 8
Module 8	10/12	Python Classes, Objects & Inheritance	**Coding Challenge II due** (10/13) *revised from 10/12
Module 9	10/19	Python Biomedical Application II *Biomedical Image and Video Analysis*	**Live Session IV** 10/19

Module 10	10/26	Python Modules	
Module 11	11/2	Machine Learning & AI in Python	
Module 12	11/9	Python File Handling and Intro to Databases	**Coding Challenge III due** (11/12)
Module 13	11/16	Python Special Topics: Web-scraping	
	11/23	***No Class, Thanksgiving Break***	
Module 14	11/30	Python Biomedical Application III *Working with Public Biomedical Data*	**Live Session V** 11/30
Module 15	12/3	Final Coding Project Presentations	**Final Coding Project Presentations Due** **Live Session VI** 12/3
	12/3	Last Day of Classes	
Module 16	12/11	Final Coding Project Due	**Final Coding Project Due**