Physics 302
Scientific Computation and Machine Learning

Xiaosheng Huang

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E-mail: xhuang22@usfca.edu	Course Website: **https://usfca.instructure.com**
Class Room: LS 103 (Fall, 2020: remote)	Class Hours: TR 4:35 - 6 PM
Lab Room: LS 103 (Fall, 2020: remote)	Lab Hours: 6 - 7 PM
Office: Harney G42 (Fall, 2020: remote)	Office Hours: MW 3 - 4 PM
Teaching Assistant: TBA	E-mail: awesomeTA@dons.usfca.edu

Course Description

This course introduces to the students a selected set of state-of-the-art scientific computing and machine learning tools, applicable to nearly all scientific/engineering disciplines. It covers data fitting, Artificial Neural Networks, visualization and animation tools, numerical solutions to partial differential equations, and symbolic computation, with the emphasis on the first two topics.

Prerequisites

CS 110 with a minimum grade of C, and MATH 211 with a minimum grade of C; or PHYS 301; or instructor's consent.

Resources:

1. Effective Computation in Physics by Scopatz & Huff [ECP]
   (Amazon Kindle version: $18.35)
2. A Survey of Computational Physics by Rubin H. Landau et al. [SCP]
   (Amazon: used copy $\lesssim$ $20)
3. Data Reduction and Error Analysis for the Physical Sciences by Bevington & Robinson [DR]

4. Numerical Recipes 3rd Ed. by William H. Press et al. [NR]

5. The Elements of Statistical Learning by Trevor Hastie et al. [ESL]
(https://web.stanford.edu/~hastie/Papers/ESLII.pdf)

Program Learning Outcomes

https://catalog.usfca.edu/preview_program.php?catoid=4&poid=1530

Course Learning Outcomes:

Upon successful completion of this course, a student will be able to:

- Understand and use a selected set of state-of-the-art scientific computation and machine learning tools.
- Identify a computational approach to a complex "real life" problem.
- Develop effective and efficient algorithm for a moderately sophisticated computation problem.
- Improve and maintain programs through software carpentry and modern version control.
- Learn to use many other scientific computing tools not covered in the class on their own.

These learning outcomes will be met through attendance of lectures, participation during lab times, and visits during my office hours when you need help, and completion of homework sets and projects.

Class Attendance

Students are expected to attend all class meetings. This is a fast-paced course, and absences from class will have a negative impact on learning the material. If you need to be excused for a class, please inform me beforehand.

Homework Assignments and Projects

You will have programming homework assignments and a final project in this course. Each one of them will be at least a medium-sized project. Active participation during the lab times is essential — this is when you will practice on small scale computational problems that are related to the projects and when I will help you break down each of these projects into major components. I strongly encourage you to work with your peers, though you should hand in your own work. I of course will also be available during office hours to offer additional help. No late homework will be accepted.

Final project due (and tournament): **Friday December 11, 2020, at 4:35 PM.**

Grading Policy

Your term average will be computed with the following weighting factors:

Class and Lab Participation	25%
Homework	50%
Final Project	25%

Weekly Schedule

The following schedule is tentative and subject to change.

Week of (Monday)	Topics
08/17	Probabilities and Uncertainties [DR Ch 1, 2, 3]
08/24	Least squares and χ^2 Minimization [DR Ch 4, 6; SCP Ch 8]
08/31	Perceptrons and Artificial Neural Networks [ESL 11]
	Friday, September 4: Census Date (last day to drop classes with a refund)
09/07	Building a Neural Network from the Ground Up
09/14	ANN Regression and ANN Classification
09/21	Architecture and Hyperparamters: regularization and activation functions
09/28	Convolutional Neural Networks
10/05	Neural Network Tuning: training/validation/testing, batch Sizes, dihedral transformations, learning rate, etc.
10/12	Deep Learning, A.I., and Final Project Description
10/19	TensorFlow, Keras, PyTorch (GPU vs. CPU)
10/26	Other considerations in deep learning
11/02	Bayesian framework; uncertainties in x and y
11/09	Differential Equations [SCP Ch 9, 17; NR Ch 20; SCP Ch 17]
11/16	Symbolic Computation
	November 23-27: THANKSGIVING
11/30	Time permitting: more advanced topics

Academic Integrity

As a Jesuit institution committed to cura personalis - the care and education of the whole person — USF has an obligation to embody and foster the values of honesty and integrity. USF upholds the standards of honesty and integrity from all members of the academic community. All students are expected to know and adhere to the University's Honor Code. You can find the full text of the code online at www.usfca.edu/academic_integrity. The policy covers:

- Plagiarism - intentionally or unintentionally representing the words or ideas of another person as your own; failure to properly cite references; manufacturing references.
- Working with another person when independent work is required.
- Submission of the same paper in more than one course without the specific permission of each instructor.
- Submitting a paper written by another person or obtained from the internet.
- The penalties for violation of the policy may include a failing grade on the assignment, a failing grade in the course, and/or a referral to the Academic Integrity Committee.

Students with Disabilities:

If you are a student with a disability or disabling condition, or if you think you may have a disability, please contact USF Student Disability Services (SDS) at 415 422-2613 within the first week of class, or immediately upon onset of disability, to speak with a disability specialist. If you are determined eligible for reasonable accommodations, please meet with your disability specialist so they can arrange to have your accommodation letter sent to me, and we will discuss your needs for this course. For more information, please visit:http://www.usfca.edu/sds or call (415) 422-2613.

Behavioral Expectations:

All students are expected to behave in accordance with the Student Conduct Code and other University policies (see http://www.usfca.edu/fogcutter/). Open discussion and disagreement is encouraged when done respectfully and in the spirit of academic discourse. There are also a variety of behaviors that, while not against a specific University policy, may create disruption in this course. Students whose behavior is disruptive or who fail to comply with the instructor may be dismissed from the class for the remainder of the class period and may need to meet with the instructor or Dean prior to returning to the next class period. If necessary, referrals may also be made to the Student Conduct process for violations of the Student Conduct Code.

Learning & Writing Center

Learning & Writing Center provides assistance to all USF students in pursuit of academic success. Peer tutors provide regular review and practice of course materials in the subjects of Math, Science, Business, Economics, Nursing and Languages. Other content areas can be made available by student request.To schedule an appointment, log on to TutorTrac at https://tutortrac.usfca.edu. Students may also take advantage of writing support provided by Rhetoric and Language Department instructors and academic study skills support provided by Learning Center professional staff. For more information about these services contact the Learning & Writing Center at(415) 422-6713, email:lwc@usfca.eduor stop by our office in Cowell 215. Information can also be found on our website atwww.usfca.edu/lwc.

Counseling and Psychological Services

Our diverse staff offers brief individual, couple, and group counseling to student members of our community.CAPS services are confidential and free of charge. Call 415-422-6352 for an initial consultation appointment. Having a crisis at 3 AM? We are still here for you. Telephone consultation through CAPS After Hours is available between the hours of 5:00 PM to 8:30 AM; call the above number and press 2.

Confidentiality, Mandatory Reporting, and Sexual Assault

As an instructor, one of my responsibilities is to help create a safe learning environment on our campus. I also have a mandatory reporting responsibility related to my role as a faculty member. I am required to share information regarding sexual misconduct or information about a crime that may have occurred on USF's campus with the University. Here are other resources:

- To report any sexual misconduct, students may visit Anna Bartkowski (UC 5th floor) or see many other options by visiting our website: www.usfca.edu/student_life/safer

- Students may speak to someone confidentially, or report a sexual assault confidentially by contacting Counseling and Psychological Services at 415-422-6352.
- To find out more about reporting a sexual assault at USF, visit USFs Callisto website at: www.usfca.callistocampus.org.
- For an off-campus resource, contact San Francisco Women Against Rape (SFWAR) (415) 647-7273 (www.sfwar.org).

Student Accounts — Last day to withdraw with tuition reversal

Students who wish to have the tuition charges reversed on their student account should withdraw from the course(s) by the end of the business day on the last day to withdraw with tuition credit (census date) for the applicable course(s) in which the student is enrolled. Please note that the last day to withdraw with tuition credit may vary by course. The last day to withdraw with tuition credit (census date) listed in the Academic Calendar is applicable only to courses which meet for the standard 15-week semester. To find what the last day to withdraw with tuition credit is for a specific course, please visit the Online Class Schedule at www.usfca.edu/schedules.

Financial Aid — FAFSA priority filing deadline (undergraduates only)

TBD - Priority filing deadline for FAFSA (The Free Application for Federal Student Aid -https://fafsa.ed.gov/) for continuing undergraduates.

The course policy and syllabus are subject to change as deemed necessary by the instructor.