EPS SCI C179 / 279
Search for Extraterrestrial Intelligence (SETI)
Spring 2024
WF 1:00–3:00 pm – Young 4232

Course Description:

Project-based course that addresses one of the most important scientific questions of our time: Are there other civilizations in the universe? Material from astronomy, computer science, signal processing, and statistics. Design of observational program, acquisition of telescopic data with the largest fully steerable telescope on Earth, development of algorithms to analyze data, and presentation of results. Introduction to the abundance and characteristics of extrasolar planetary systems; radio astronomy, including wave propagation and Doppler shift; signal processing, including sampling theory and Fourier transforms; random processes, including Gaussian and binomial statistics, and algorithm development. P/NP or letter grading. Students are invited to co-author a peer-reviewed publication that describes the search results.

Lectures (max. two hours/week) are supplemented with computer lab modules (min. two hours/week) that primarily rely on Python, Jupyter, and GitHub.

Instructor:

Professor Jean-Luc Margot (jlm@epss.ucla.edu)

Textbook:

There is no required textbook. Optional textbooks include:

Bracewell, R. The Fourier Transform and Its Applications, McGraw-Hill
Press, W. Numerical Recipes in C: The Art of Scientific Computing
Bevington, P. Data Reduction and Error Analysis for the Physical Sciences
Géron, A. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow
Condon, J. and Ransom, S. Essential Radio Astronomy

EPS SCI C179 / 279 website:

https://bruinlearn.ucla.edu/courses/184628

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Date	Lec.	Title	Lab.
W Apr. 03	L01	*Introduction, syllabus, radio astronomy fundamentals*	NB01 Python, Jupyter
F Apr. 05	L01	*Radio astronomy fundamentals (continued)*	Astropy
W Apr. 10	L02	*Celestial coordinates*	NB02 LST, Alt-Az
F Apr. 12		*Design of observing program*	Alt-Az general
W Apr. 17	L03	*Stars, planets, habitable zones*	NB03 Pandas
F Apr. 19	L04	*Select and order sources*	Travel. Salesp.
W Apr. 24	L05	*Fourier transform, sampling theorem*	NB04 FFT
F Apr. 26	L06	*Orbital elements, Doppler variations due to orbits/spins*	NB05 Time-Freq
W May 01	L07	*Integrated power (shift and add)*	Voyager 1
TBD	TBD	***Observing with Green Bank Telescope***	
F May 03	L08	*Noise statistics, relational databases*	NB06 Stats, NB07 SQL
W May 08	L09	*Application Programming Interface*	NB08 API
F May 10	L10	*Description of Final Projects*	
W May 15	L11	*Chirp waveforms*	Project
F May 17		*Telecommunication principles, interference*	Project
W May 22		*Dispersion in interstellar medium*	Project
F May 24		*Distributed and GPU computing*	Project
W May 29		*Machine learning techniques*	Project
F May 31		*Filtering techniques, natural vs. artificial signals*	Project
W Jun. 05		*Final project presentations*	
F Jun. 07		*Final project presentations*	

LEARNING OUTCOMES

Understand celestial coordinates and compute rise-transit-set times for sources
Understand radio astronomy fundamentals including sensitivity and Doppler shift
Understand abundance of planets and conditions for planetary habitability
Design and implement an observational program for a large radio telescope
Implement algorithms in Python to solve scientific problems
Perform spectral analysis of time-series data with the Fast Fourier Transform
Understand noise statistics and relevant probability distributions
Use Python-based graphical tools to present results of data analysis
Understand database concepts and access large database with Python
Complete a research project from conception to oral presentation of results

GRADING

Undergraduate students: grading is based on up to five problem sets (20%), course participation (25%), submitting a course evaluation (5%), and a final project (50%) that **need not** require implementation of machine learning, GPU computing, or other advanced CS techniques.

Graduate students: grading is based on up to five problem sets (20%), course participation (25%), submitting a course evaluation (5%), and a final project (50%) that **may** require implementation of machine learning, GPU computing, or other advanced CS techniques.

THE FINE PRINT

You are responsible for all material covered in lectures or reading. A PDF version of the lecture notes will be posted on the course web page.

Academic integrity is expected at all times. Collaboration between students is usually permitted, but the work that you submit for your homework and final presentation should be your own work. The careful use of large language models (e.g., ChatGPT) is tolerated as long as you independently validate the proposed solutions and acquire the skills that would allow you to independently produce similar solutions.

Title IX prohibits gender discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking. Students who have experienced sexual harassment or sexual violence can receive confidential support and advocacy at the CARE Advocacy Office for Sexual and Gender-Based Violence, 1st Floor Wooden Center West, CAREadvocate@caps.ucla.edu, (310) 206-2465. You can also report sexual violence or sexual harassment directly to the University's Title IX Coordinator, 2241 Murphy Hall, titleix@conet.ucla.edu, (310) 206-3417.