EPSS C179 / 279
Search for Extraterrestrial Intelligence: Theory and Applications
Spring 2021
WF 1:00–3:00 pm – Remote Learning

Course Description:

The Search for Extraterrestrial Intelligence (SETI), also known as the search for technosignatures, is based on a number of astronomical, mathematical, statistical, and computational principles. This course covers fundamental concepts in these disciplines in the context of SETI: abundance and architecture of extrasolar planetary systems; radio astronomy, including wave propagation and dispersion; signal processing, including sampling theory and Fourier transforms; random processes, including Gaussian statistics, and algorithm development. The course is primarily based on a collaborative project: students design an observational program, acquire data with a large telescope, develop algorithms to analyze the data, and write a report/article on the 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)

Teaching assistant volunteers:

Paul Pinchuk (ppinchuk@physics.ucla.edu) and Robert Geil (rgeil@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

EPSS C179 / 279 website:

https://ccle.ucla.edu/course/view/21S-EPSSCIC179-1

Earth, Planetary, and Space Sciences C179 / 279:
SETI – Spring 2020

Date	Lec.	Title	Lab.
W Mar. 31		*Introduction, motivation, syllabus, remote learning guide*	NB01 Python, Jupyter
F Apr. 02	L01	*Radio astronomy fundamentals, recent results*	Astropy
W Apr. 07	L02	*Celestial coordinates*	NB02 LST, Alt-Az
F Apr. 09		*Design of observing program*	Alt-Az general
W Apr. 14	L03	*Stars, planets, habitable zones*	NB03 Pandas
F Apr. 16	L04	*Select and order sources*	Travel. Salesp.
W Apr. 21	L05	*Fourier transform, sampling theorem*	NB04 FFT
F Apr. 23	L06	*Orbital elements, Doppler variations due to orbits/spins*	NB05 Time-Freq
W Apr. 28	L07	*Integrated power (shift and add)*	Voyager 1
W Apr. 28	3-5 pm	***Observing with Green Bank Telescope***	
F Apr. 30	L08	*Noise statistics*	NB06 Statistics
W May 05	L09	*Relational databases*	NB07 SQL
F May 07	L10	*Filtering techniques*	NB08 API
W May 12		*Telecommunication principles, interference*	Pipeline
F May 14		*Dispersion in interstellar medium*	Pipeline
W May 19		*Natural vs. artificial signals*	Pipeline
F May 21		*Distributed and GPU computing*	Pipeline
W May 26		*Machine learning techniques*	Pipeline
F May 28			
W Jun. 2		*Final project*	
F Jun. 4		*Final project*	

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
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 five problem sets (25%) and a final project (75%) that **will not** necessarily require implementation of machine learning, GPU computing, or other advanced CS techniques.

Graduate students: grading is based on five problem sets (25%) and a final project (75%) that **will** 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 and violations will be reported to the Dean of students. Collaboration between students is never permitted except when explicitly allowed by the instructor.

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.