EPSS C179 / 279
Search for Extraterrestrial Intelligence: Theory and Applications
Spring 2019
WF 1:00–3:00 pm – Young 4232

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 and Poisson statistics, and algorithm development. The course is primarily based on a collaborative project: students design an observational program, acquire telescopic data, 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)
5642 Geology
310.206.8345

Teaching assistant (volunteer): Paul Pinchuk

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 and TensorFlow
Condon, J. and Ransom, S. Essential Radio Astronomy

EPSS C179 / 279 website:

https://ccle.ucla.edu/course/view/19S-EPSSCIC179-1

Earth, Planetary, and Space Sciences C179 / 279:
SETI - Spring 2018

Date	Lec	Title	Computer
W Apr. 03	L01	*Introduction, motivation, logistics* *Radio astronomy fundamentals*	
F Apr. 05	L02	*Computational techniques, Python, Jupyter* *Celestial coordinates*	LST
W Apr. 10	L03	*Stellar types, stellar evolution*	Alt-Az
F Apr. 12	L04	*Design of observing program (part 1)*	Alt-Az general
W Apr. 17	L05	*Design of observing program (part 2)*	Travel. Salesm.
F Apr. 19	L06	*Design of observing program (part 3)*	Travel. Salesm.
W Apr. 24	L07	*Exoplanets, Habitable Zone*	
F Apr. 26?	TBC	***Observing with Green Bank Telescope***	
F Apr. 26	L08	*Fourier transform, sampling theorem*	FFT
W May 1	L09	*Time-frequency diagrams*	Time-Freq
F May 3	L10	*Orbital dynamics, Doppler drift rate*	Shift & add
W May 8	L11	*Natural vs. artificial signals*	Voyager 1
F May 10	L12	*Dispersion in interstellar medium*	Tree algorithm
W May 15	L13	*Telecommunication principles, interference*	Excision
F May 17	L14	*Gaussian and Poisson Statistics*	Histograms
W May 22	L15	*Filtering techniques*	Pipeline
F May 24	L16	*Database techniques*	Pipeline
W May 29	L17	*Machine learning techniques*	Pipeline
F May 31	L18	*Distributed and GPU computing*	Pipeline
W Jun. 5	L19	*Final project*	
F Jun. 7	L20	*Final project*	
		Final exam	

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.