Sujay Nair

sujaynair03.github.io, sujaynr@ohs.stanford.edu, 1-530-400-1064

PROFILE

High school researcher passionate about astronomy and its intersection with computational/data science. Specifically interested in applications of machine learning and data analysis.

EDUCATION

Stanford Online High School (OHS) / California High School 2019-2022
Relevant Coursework:
10th: AP Computer Science, AP Calculus BC, Astrophysics/Astronomy Research Seminar, AP Statistics
11th: Linear Algebra, Differential Equations, AP Physics C Mechanics, AP Physics C Electricity & Magnetism, Data Structures & Algorithms in Java
12th: Multivariable Calculus, Light & Heat (Optics and Thermodynamics), Modern Physics (Relativity and Quantum Mechanics), Advanced Topics in Computer Systems, Data Science

RESEARCH EXPERIENCE

Freshening Exoplanet Transit Midpoints
Presented: 235th Meeting of the American Astronomical Society (AAS)
2020 CubeSat Workshop
In this study, we studied the effects of different comparison stars on the corresponding light curve and worked with 6 photometric functions.
Poster: `http://tiny.cc/oykfqz`

Utilizing Small Telescopes by Citizen Scientists for Transiting Exoplanet Follow-Up *Published: Publications of the Astronomical Society of the Pacific (PASP)*
`https://arxiv.org/abs/2003.09046`
From analyzing mid-transit times for many exoplanets, observations from small (<1m) telescopes can increase observational efficiency of large observatories.

Investigation of 14 Wide Common Proper Motion Doubles
Published: Journal of Double Star Observations (JDSO)
`http://www.jdso.org/volume16/number2/Caputo_173_182.pdf`
We investigated 14 physical systems from the Washington Double Star Catalogue. We used our measurements to assess the probability of gravitational relationships.

Analysis of HAT-P-23b, Qatar-1b, WASP-2b, and WASP-33b with an Optimized EXOplanet Transit Interpretation Code
Published and Presented: Society for Astronomical Sciences (SAS)
`http://www.socastrosci.org/images/2020_Proceedings_final.pdf` (155-165)
We analyzed 4 exoplanets and edited the Exoplanet Transit Interpretation Code to provide faster photometric analysis.

Analysis of Candidate Exoplanet TOI717.01 and Confirmed HAT-P-3b
Published and Presented: SAS
`http://www.socastrosci.org/images/2020_Proceedings_final.pdf` (177-183)
Analysis of transit properties of 2 exoplanets with 7 total image reduction methods.

Transit Analysis of Exoplanets TrES-5b and WASP-43b
Published: Research Notes of the AAS (RNAAS), Presented: 236th AAS
Oral Session - Extrasolar Planets III: Transits and Populations

https://iopscience.iop.org/article/10.3847/2515-5172/ab98f5
https://www.youtube.com/watch?v=pXhum_21gyY
We analyzed the transit properties of TrES-5b using many comparison stars and explored its extremely dim host star.

Mid-transit and Reference Star Analysis of HAT-P-37 b and Kepler-45 b
Presented: Exoplanet3 Heidelberg
https://iopscience.iop.org/article/10.3847/2515-5172/ab98f5
We analyzed the mid-transit times and comparison stars for the exoplanets HAT-P-37 b and Kepler-45 b. Poster list: https://hdconfsys.zah.uni-heidelberg.de/exoplanets3/poster_list.html

Transit Analysis of TOI 1780.01
Presented: ExoDem 2020 Caltech
(Poster not publically available)
We analyze the mid-transit times and comparison stars for the exoplanet TOI 1780.01.

Citizen Scientist Transit and Comparison Star Analysis of HATS-4 b with the East Bay Astronomical Society
Presented: IPoster for AAS 237
Link to Poster
6 members of the East Bay Astronomical Society will be introduced to the Exoplanet Transit Interpretation Code (EXOTIC) and will be guided through a complete transit and reference star analysis. Training Example: https://www.youtube.com/watch?v=KGdnoKfhMPw

Using Deep Learning with Phase Folded Light Curves to Detect Exoplanets
Presented: IPoster presentation for AAS 237
Link to Poster
We extend the work of transit detection by utilizing phase folded light curves to train a convolutional neural network to predict the existence of an exoplanet. We propose a scheme to generate synthetic data mimicking TESS observations from a single sector where the positive training samples are randomly generated transit data phase folded at the correct period, and the negative training samples are folded at a random incorrect period.

Sequence-based Encoding of Light Curves for Exoplanet Detection
Presented: IPoster presentation for AAS 238
Link to Poster
We explore the benefits of using recurrent neural networks for predicting the existence of an exoplanet. We tested LSTM layers in our Convolutional Neural Network (CNN) versus our standard CNN with synthetically generated light curves with varying amounts of noise.

Crowd-sourcing the Updating of Exoplanet Transit Timing Variations and Detecting Exoplanets using Deep Learning
First place at Washington State Science and Engineering Fair(WSSEF)
Wolfram Research Award
NASA Earth Systems Science Award
This summarizes my research in the area of updating exoplanet transits, crowd-sourcing the exoplanet transit effort, and deep learning for exoplanet detection.

Using Deep Learning to Predict Exoplanet Planetary Parameters based

on Generated Light Curves
In Progress
In this project we train a 1D Convolutional Neural Network to take as input artificially generated light curves mimicking TESS observations at a 2 min cadence and output a list with predicted planetary parameters-namely, Rp/Rs, Period, a/Rs, and T-mid. Comparing to the current state of the art algorithm, Transit Least Squares (TLS), which does not rely on machine learning, our Rp/Rs mean absolute error is roughly the same. We are still tuning the model to reach TLS performance for Period.

ADDITIONAL COURSEWORK

Data Science Specialization (10 Courses), Johns Hopkins University 2018-19

Deep Learning Specialization (5 Courses), deeplearning.ai 2019-20

XSeries Program in Astrophysics (4 Courses), ANU 2020-21

TECHNICAL SKILLS

Coding/Data Analysis: Deep Learning, Python (Tensorflow, Numpy), R, Java, C, Google Cloud Platform
Astronomy: Exoplanets, Double Stars, Astrophysics