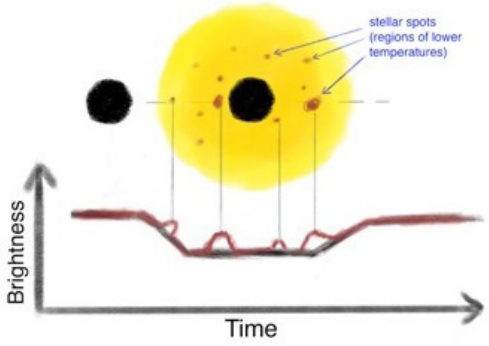
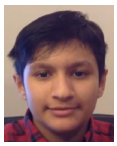
Using Machine Learning to Improve Prediction of Chemical Composition of Exoplanetary Atmospheres



USING MACHINE LEARNING TO IMPROVE PREDICTION OF CHEMICAL COMPOSITION OF EXOPLANETARY ATMOSPHERES



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Humankind does not currently possess instruments to detect life on exoplanets – planets outside the solar system. But efforts are ongoing to come up with newer ground and space-based telescopes that could help us learn more about atmos-pheres of these exoplanets.

When an exoplanet transits in front of its parent star, its main body blocks out some light of the star. This causes a dip in the light received from the star. If the exoplanet has an atmosphere around it, then the atmosphere will also absorb some of this light. How much light is absorbed by the atmosphere depends on its thickness and gases present.

Different gases absorb different wavelengths of light to different degrees. If we plot the transit of an exoplanet in different wavelengths, we will get light curves of different depths. Studying transit light curves of exoplanets in different wave-lengths could help us predict the chemical composition of their atmospheres.

However, the parent star of the exoplanet may have stellar spots that are cooler than the surrounding surface. This adds noise in the data. We must isolate depth in light curves caused by the exoplanetary atmosphere from those caused by the stellar spots. The current approach is to remove this noise manually which is time consuming and prone to errors.

Applying machine learning to exoplanetary data may help remove the noise of star-spots in data on transiting exoplanets' atmospheres received by space tele-scopes. I created a Hybrid Machine Learning model using Long-Short Term Memory (LSTM) - a form of Recurrent Neural Network (RNN) to reduce this noise. My model was able to accurately predict the exoplanet-star radius ratio in 55 wavelengths with a mean square error of 0.001. The Algorithm leads to elimination of noise and may lead to improved and accu-rate prediction of chemical composition of exoplanetary atmospheres.

The simulated dataset I used for my project can be accessed from the ARIEL Space Telescope Machine Learning Challenge website at: https://ariel-datachallenge.azurewebsites.net/ML