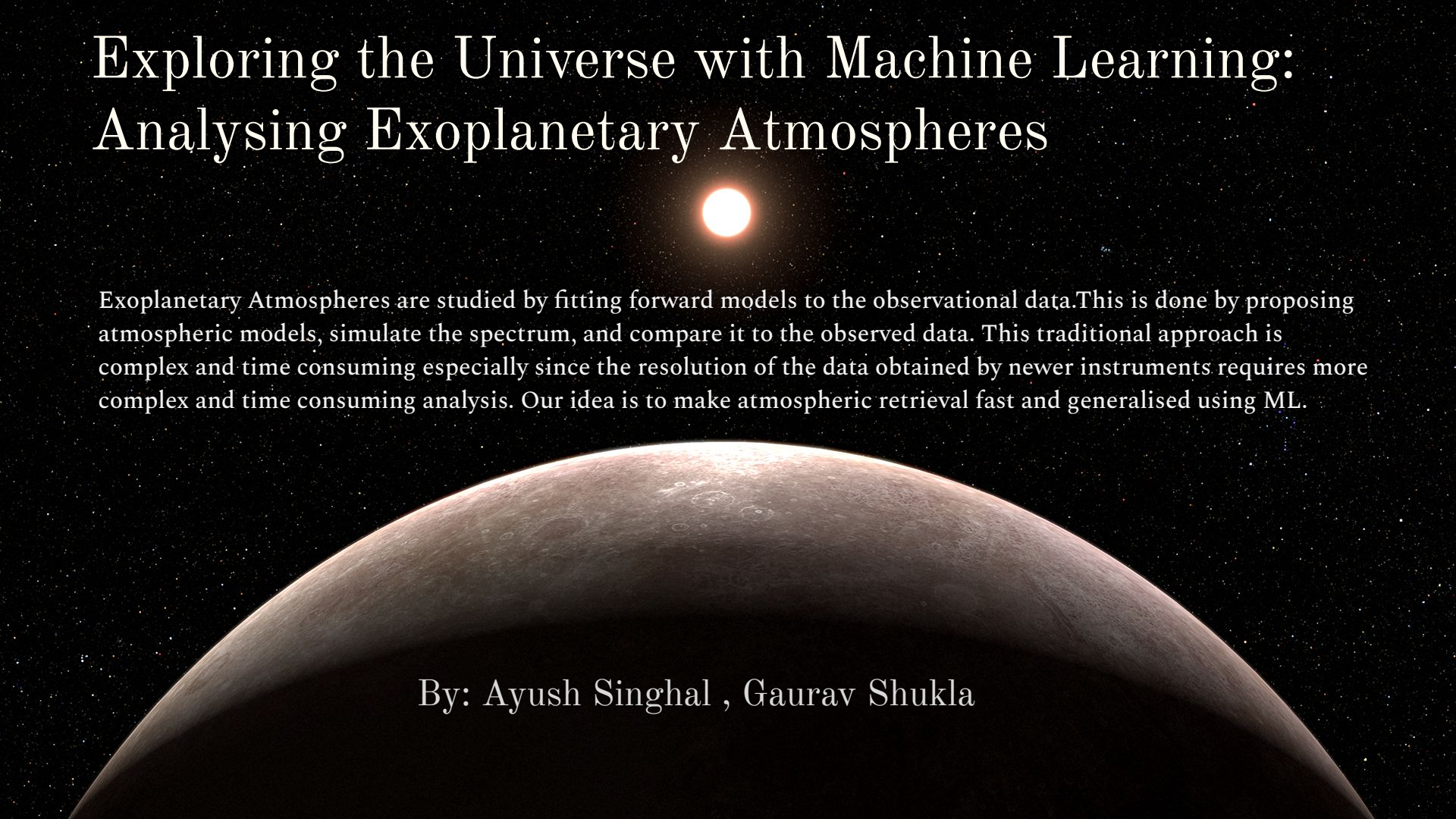
Exploring the Universe with Machine Learning: Analysing Exoplanetary Atmospheres

Exoplanetary Atmospheres are studied by fitting forward models to the observational data.This is done by proposing atmospheric models, simulate the spectrum, and compare it to the observed data. This traditional approach is complex and time consuming especially since the resolution of the data obtained by newer instruments requires more complex and time consuming analysis. Our idea is to make atmospheric retrieval fast and generalised using ML.



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Path

- Review the literature and learn about Random forest algorithm(mainly) and explore some other approaches like Bayesian Neural Networks, etc.
- Generate the synthetic spectra from the forward model with the specified parameters.
- Train the random forest on the simulated data and compare with the traditional retrievals.
- (Midway) Predict the planetary parameters(eg. Temperature, compositions of different molecules, etc) from the observed spectra of a planet.
- Extend the algorithm to accommodate for more exoplanetary parameters and higher resolution data.
- Implement other supervised algorithms like SVRs and compare them with random forest and the traditional approaches.
- Improve and train the Random forest algorithm for different types of exoplanets and classify them into specified categories.

Work Division

- Gaurav - Literature review, Data Processing and Binning ,Improvements and comparison with traditional methods.
- Ayush - Literature review, ML Algorithm Programming and Implementation, parameter and hyperparameter tuning.

References

- Márquez-Neila, Pablo et al. “Supervised machine learning for analysing spectra of exoplanetary atmospheres.” Nature Astronomy 2 (2018): 719-724.
- Nixon, Matthew C. and Nikku Madhusudhan. “Assessment of supervised machine learning for atmospheric retrieval of exoplanets.” Monthly Notices of the Royal Astronomical Society 496 (2020): 269-281.