

**Machine Learning for Exoplanet Detection:
Identifying Exoplanets in Light Curves**

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CS 4820: Artificial Intelligence

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Project Summary

This project explores the use of machine learning on exoplanet light curves for the detection of exoplanets. The primary objective is to identify potential exoplanets by finding dips in stellar brightness that indicate planetary transits. The milestones for this project include preprocessing and cleaning light curve data found from multiple large datasets, implementing three different machine learning approaches, evaluating model performance using metrics such as precision and recall, and providing a report and demonstration on our results. We will use light curve data from the Kepler/K2 and Transiting Exoplanet Survey Satellite (TESS) missions, as well as a synthetically generated dataset. The machine learning techniques we will experiment with are Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), and an Attention-based Transformer Network. The deliverables will include these three trained models, the experimental results, and the details will be presented and reported in an AAAI-format research paper.

Team Members

- Tristan Moffett – Undergraduate (CS 4820)
 - Role: Development and evaluation of a Convolutional Neural Network (CNN) for exoplanet detection from raw light curve data.
- Josh Manchester – Undergraduate (CS 4820)
 - Role: Development and evaluation of a Recurrent Neural Network (RNN) for exoplanet detection from Kepler and TESS light-curve data.
- Brianne Leatherman– Undergraduate (CS 4820)
 - Role: Development and evaluation of an Attention-based Transformer network for exoplanet detection from light curve data.

Literature Review Plan

Tristan Moffett (CNN)

1. Shallue, C. J., & Vanderburg, A. (2018). Identifying Exoplanets with Deep Learning: A *Five-planet Resonant Chain Around Kepler-80 and an Eighth Planet Around Kepler-90*. The Astronomical Journal, 155(2), 94. (AAS/IOP Publishing) (h5-index = 167)

2. Dattilo, A., Vanderburg, A., Shallue, C. J., Mayo, A. W., Berlind, P., Bieryla, A., Calkins, M. L., Esquerdo, G. A., Everett, M. E., Howell, S. B., Latham, D. W., Scott, N. J., & Yu, L. (2019). *Identifying Exoplanets with Deep Learning II: Two New Super-Earths Uncovered by a Neural Network in K2 Data*. *The Astronomical Journal*, 157(5), 169. (AAS/IOP Publishing) (h5-index 167)
3. LeCun, Y., Bengio, Y., & Hinton, G. (2015). *Deep learning*. *Nature*, 521(7553), 436–444. (Nature Publishing Group) (h5-index 490)

Josh (RNN)

1. Kügler, S. D., Polsterer, K. L., & Geißler, K. (2016). An explorative approach for inspecting Kepler data. *Monthly Notices of the Royal Astronomical Society*, 455(4), 4399–4410. (Oxford University Press, h5-index = 151)
2. Vida, K., Bódi, A., Szklenár, T., & Seli, B. (2021). Finding flares in Kepler and TESS data with recurrent deep neural networks. *Astronomy & Astrophysics*, 652, A107. (EDP Sciences, h5-index = 149)
3. Du, N., Dai, H., Trivedi, R., Upadhyay, U., Gomez-Rodriguez, M., & Song, L. (2016). Recurrent marked temporal point processes: Embedding event history to vector. In *Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 1555–1564). Association for Computing Machinery. (h5-index = 124)

Brianne Leatherman (Transformer)

- [1] Y.-C. Lin, “Machine learning revolution for exoplanet direct imaging detection: transformer architectures,” presented at the *SPIE Optics + Photonics 2025 Conference*, session: *Techniques and Instrumentation for Detection of Exoplanets XII*, San Diego, CA, USA, Aug. 2025. Available: <https://arxiv.org/abs/2508.14508>

(Proceedings of SPIE - The International Society for Optical Engineering, h5 index = 199)

- [2] H. Salinas, R. Brahm, G. Olmschenk, R. K. Barry, K. Pichara, S. I. Silva, and V. Araujo, “Exoplanet transit candidate identification in TESS full-frame images via a transformer-based algorithm,” *Monthly Notices of the Royal Astronomical Society*, vol. 538, no. 3, pp. 2031–2049, Apr. 2025. doi: 10.1093/mnras/staf347

(Monthly Notices of the Royal Astronomical Society, h5 index = 391)

- [3] H. Salinas, K. Pichara, R. Brahm, F. Pérez-Galarce, and D. Mery, “Distinguishing a planetary transit from false positives: a transformer-based classification for planetary transit signals,” *Monthly Notices of the Royal Astronomical Society*, vol. 522, no. 3, pp. 3201–3216, Jul. 2023. doi: 10.1093/mnras/stad1173

(Monthly Notices of the Royal Astronomical Society, h5 index = 391)