CASPEN Exit Report

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Host David Hogg, Flatiron CCA
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Purpose of visit

I reached out to David Hogg at the Flatiron CCA to collaborate on an area of interest that we both share: fast Bayesian inference. Both David Hogg and I had previously worked on projects that automatically marginalize over linear nuisance parameters [1, 2]. My idea was to extend this to all unimodal/convex nuisance parameters, using a Laplace approximation for the marginalization integral, and scale the approach into a more general method/software package. We were both interested in specific applications of this faster inference method and wanted to explore the connections to profile likelihoods. The purpose of the visit was to discuss the idea and put together a project outline and collaboration timeline.

Activities

During the visit I met David Hogg and his group in person and explored further connections at the Flatiron CCA. I discussed the project idea with two of David Hogg's close collaborators, Dan Foreman-Mackey and Adrian Price-Whelan, who helped shape the project direction by suggesting sanity checks and emphasis on measuring where the Laplace approximation breaks down. I put together a paper draft in a shared overleaf with a detailed outline of the project. We planned to present a general automatic marginalization method but to test it using a specific application example. David Hogg and I discussed the project daily and decided to expand his previous work on *The Joker* [3], a binary orbit detector, as our application example. I showed that the binary orbital model used in *The Joker* contains an additional linear parameter they had not previously noticed.

Unrelated to the project, I attended a Flatiron CCN seminar on symmetries in deep learning by Joan Bruna; I met with Joonas Nattila, Miles Cranmer, Sophie Koudmani, and

Nora Eisner. These informal meetings were helpful in shaping my ideas about pursuing a postdoc.

The visit allowed me to give a planned remote presentation at the Columbia high energy astrophysics group (THEA) in person on November 18th, and meet with Brian Metzger afterwards. We discussed the future of my work with NASA's X-ray polarimeter IXPE and what a postdoc at Columbia would look like.

Ongoing & Future Work

David Hogg and I agreed to meet regularly on Wednesday mornings to continue the project. The visit let us to clearly state our vision for the project and write down the math for our application example. Ongoing work will be programming a working example of automatic marginalization applied to binary detection, and comparing it to standard MCMC sampling methods and *The Joker* [3]. We aim to soon have a paper that showcases our general method, the application example, and a public Github repository with the code.

Acknowledgements

References

[1] Adrian M. Price-Whelan, David W. Hogg, Daniel Foreman-Mackey, and Hans-Walter Rix. The Joker: A Custom Monte Carlo Sampler for Binary-star and Exoplanet Radial Velocity Data. , 837(1):20, March 2017.

[2] A. L. Peirson, I. Liodakis, A. C. S. Readhead, and et al. New Tests of Milli-lensing in the Blazar PKS 1413 + 135. , 927(1):24, March 2022.

[3] Adrian M. Price-Whelan, David W. Hogg, Hans-Walter Rix, and et al. Close Binary Companions to APOGEE DR16 Stars: 20,000 Binary-star Systems Across the Color-Magnitude Diagram. , 895(1):2, May 2020.