Conclusions/Takeaways (Hyperstats 2023)
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I had the opportunity this summer to learn about and work on the application of Gaussian Process Regression to a Thermal Protection System problem. I was able to get a basic understanding of GPR's strengths but also potential weaknesses.

GPR:

- GPR is a great ML model and fairly easy to use.
- It's very flexible, with various options for kernels (which can fit anything, it seems) and hyperparameters.
- It can't ignore noise columns entirely, and suffers at > 20 dimensions.
- I want to learn more about modeling risk with its built-in uncertainty measurements.
- I am curious just how wide-ranging its applications can be, especially in engineering and finance.

Thermal Protection System problem:

- TPS data tends to be very linear.
- I am curious just how many of the 14 given parameters are uncertain IRL, and to what extent.
- The titanium's properties are so much less important than the exterior tile's. Engineers should hone in on reducing uncertainty in the tile's properties (height, density, etc.) rather than the titanium underneath.
- I wonder if the problem is dynamic, or if we could have a model with initial environment equations.

Overarching lessons from the summer:

- "You are the easiest person to fool": we must constantly ask ourselves how we might be wrong.
- Visuals are key: for presentations, people want to see pretty pictures
- It matters what you're comparing something to. Is there ever a 'fair' comparison?
- Cargo cult science: be aware of evidence favoring an assumed hypothesis.
- How to lie with statistics: ask "What is being hidden?"
- Surrogate modeling is fascinating. I wonder how ML will revolutionize research, and how much time it can save teams in the engineering process.
- Lastly, Williamsburg isn't too bad after all.

Overall, it was a great honor to be a part of the first Hyperstats program. It was my first time being fully absorbed in research, and diving into a specific problem. I feel that I've learned a lot about ML, GPR, and surrogates, but also about research and statistics as a field. I've also seen a huge leap in my coding skills and knowledge gained both through practice and 'osmosis' of being surrounded by great work partners.

Thank you to Dr. Hunt for this amazing opportunity and guidance, and to my lab partner Nick for his ingenuity and enthusiasm. This was a great experience and I hope the program continues next summer!