Monte Carlo and Markov Chains

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Opening Discussion

- Minute Essay comments
  - Are animations allowed for the test?
  - Length of final project presentations.
  - Sources of data for projects.

Building Models

- The type of model that you can build will depend a lot on the number of different values you try for each factor.

- With only two values, the model has to have no more than two parameters and will likely be linear. Larger numbers of data points can give you higher order fits.

- You want fits, not just interpolating of data.

Response Surfaces

- Another way to model data is to build a response surface.

- This is basically like what I showed you for my ring simulations.

- You vary 2 factors through a few values to form a surface of responses.

- If you had the right visualization software/hardware you might try to build a response space, but it can be harder to interpret.

Simulation Based Optimization

- Optimization is a field unto itself.

- The challenge with simulation is that evaluating new points in the parameter space can be costly.

- Unconstrained optimization basically uses Newton's method in a higher dimensional space. Derivatives typically taken numerically.

- Constrained optimization places bounds on where the solution can be. Linear programming.

Monte Carlo Method

- This is far more general than just simulations. We talked about using it for integrations.

- In simulations it works well for simulating uncorrelated, probabilistic events.

- Light scattering is a good example and I have two samples I have written that use that.

- You can apply Monte Carlo techniques to other simulations as well. I know people doing this to look at planet formation.

Markov Chains

- You have a system with multiple states and probabilistic transitions that have the Markov property:
  - The state at time n+1 depends on the state at n only.
- Each state can be seen as having a fractional probability or a population.
- Viewed as a directed graph, the edges are labeled with probabilities of transitions.
- One of my grad school advisors viewed all problems as Markov chains.

Minute Essay

- Any questions?
- Have a good weekend.