SHAWN SPROUSE

INTRODUCING

LENNY SMITH

- Professor, Department of Statistics, The London School of Economics and Political Science, 2004-2020
- Senior Research Fellow (Mathematics), University of Oxford, UK, May 1992-2020
- Director, Centre for the Analysis of Time Series, 1992-2020
- Senior Research Fellow, Energy Policy Institute, University of Chicago, 2016-2020
- Research Associate, Mathematics Institute, University of Oxford, UK, May 1992-2020
- Postdoctoral associate, University of Warwick, 1990-1992
- Postdoctoral associate, University of Cambridge, 1987-1989
- Ph.D., Physics, Columbia University, 1987
- M.Phil., Physics, Columbia University, 1983
- M.A., Physics, Columbia University, 1982
- B.S., Physics, Mathematics & Computer Science, University of Florida, 1980

NEW FACULTY MEMBER

Top Model Toppler

In 1928, Sir Arthur Eddington predicted that a solar eclipse "would be visible" over Cornwall on August 11, 1999. Professor Leonard Smith wanted to see this one, and he had the advantage of being an expert in nonlinear dynamical systems and chaos, with a keen interest in climate and weather forecasting.

In the days leading up to the eclipse, Smith started checking the weather. He consulted an ensemble forecast model in which multiple simulations with different initial conditions are evolved over time and can be used to quantify the reliability of the forecast for each day.

"By running an ensemble forecast with the aim of tracking uncertainty, we had effective decision support," said Smith. Eddington's prediction did not come to fruition: it was cloudy in Cornwall. Smith managed to see the eclipse, but only by traveling to France.

MODEL-LAND

Smith, who joined ECE in August 2020, is interested in understanding the nature of predictions, especially when they're made by computer models developed in "model-land."

Model-land is a comfortable place, albeit a little dull—everything is well-defined, statistical methods are all valid, and we can prove and utilize theories, said Smith. But even when researchers compute probabilities in idyllic model-land, they are hamstrung by the uncertainties that lurk in every computation.

"It's a digital system, which means limited and chaotic," said Smith. "If you run a chaotic system forward on a digital computer, even if the model was perfect, uncertainties are going to grow."

Researchers like Smith try to use probabilities to reflect that uncertainty and follow it forward in time — like the ensemble forecast model — but there's another problem: "If the model itself is wrong, then model error will ruin probabilities the same way that chaos took down point forecasts," said Smith.

Handling these uncertainties, and their associated risks, is Smith's challenge.

Off the runway, into the real world

The real test comes, however, when the model is put to work in the real world. Smith is interested not only in what can go wrong in model-land, but also how models break when our theories of the world are too different from the world itself.

Models support decision making in almost every field, and Smith has worked with domain experts on problems that can be solved by (or caused by) models applied in offshore engineering, insurance, banking, professional sports, energy, plant pollination, meteorology, climate change, and more.

"You have your known-knowns, known-unknowns, and your unknown-unknowns, but many of the problems we encounter are due to 'known-neglecteds' —the things we know about, but we don't incorporate into our model," said Smith.

For instance, "we have a real problem

with the Andes," said Smith. In climate models, the Andes are about two kilometers too short.

When air runs into a mountain, it doesn't go straight through. Researchers know how to simulate rock, but the Andes are extremely narrow, said Smith. And if our models have high enough resolution, they run slower than real time.

"But when you're trying to make a decision, a model that runs slower than reality is not useful," explained Smith.

For now, they've sliced off the top of the range (in model-land) in order to actually get the model to achieve meaningful output.

MODEL BREAKER, PARTY POOPER

Smith juggles the human dynamic between trying to understand something at its most basic physics level, trying to simulate it with the world's most powerful computers, trying to interpret the model to get out of model-land back into the real world, accepting relevant dominant uncertainties, and the probability that something completely unexpected will occur.

"I look for the weakest link, what's going to break, what is going to cause this model to go wrong." said Smith. "Yes, this makes me very popular – I've been called a professional party pooper from four major podiums so far."