# SFI TRANSMISSION

## COMPLEXITY SCIENCE FOR COVID-19

**STRATEGIC INSIGHT:** **To make good decisions under uncertainty, decision-makers must act creatively to avoid paralysis, while recognizing the possibility of failure.**

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The current COVID-19 pandemic presents decision-makers with situations where the range of possible actions and the probabilities of possible outcomes are not known or even imagined.

Because data are unavailable or contestable, using them to make sense of exactly what is going on or how the pandemic will play out is unreliable. Actions are untested, their acceptance by populations is not guaranteed, and long-term societal and economic impacts are unclear. Should we aim to eradicate, to slow, or accept deaths of the vulnerable and minimize the collateral economic damage?

Given our data, we may want to extrapolate a curve to make a prediction. (fig. 1, below) It would be fantastic to have a perfect fit, but from limited statistical data, we cannot get that. Even worse, an optimal statistical fit (red line) is far inferior to a cone of

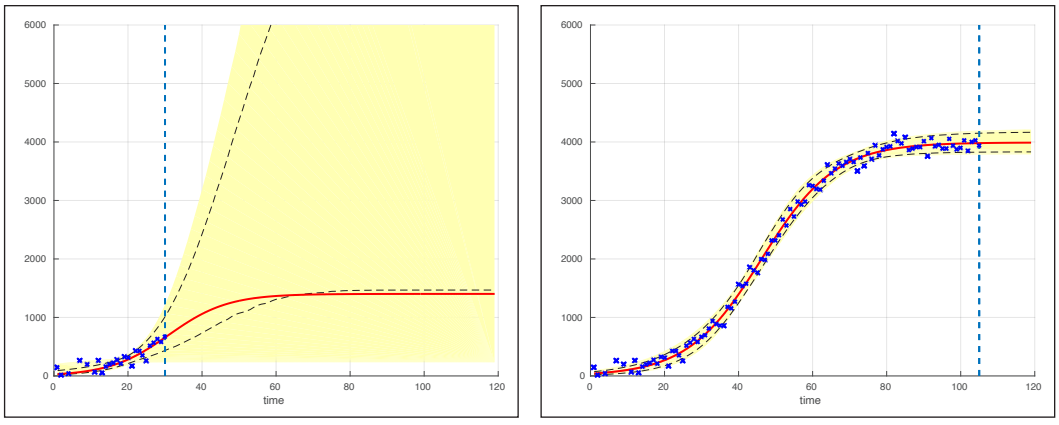


**Figure 1.** *Measuring (blue cross) and modeling (red line) the progress of an epidemic through time. At the start, our uncertainty of the future remains unavoidably large (yellow area) but nevertheless an accurate measure of our true state of ignorance and more deeply informative than the confidence from the poor model (red line). As time passes, new data allows us to significantly reduce this cone of uncertainty. The dashed blue vertical line is the time at which measurements are made. Credit: Leonard Smith (@lynyrdsmyth).*

possibilities conditioned on clearly stated assumptions. That is an important insight.

Radical Uncertainty (RU) is defined as a situation in which quantifying costs and consequences is contestable but we must choose. Current scientific decision theory, based mostly on a rationality paradigm that aims at optimal decisions in contexts of known outcomes and their probabilities, is silent on what to do. The financial crisis, the climate challenge, and now COVID-19 emphasize the need to fill this gap.

Our collaboration focuses on how to aid decision-makers in selecting data enquiringly from diverse sources, to recognize structural instabilities, and to imagine possible Big Surprises. It emphasizes systematic ways to reduce complexity and to identify essential variables which have the largest effect and which we can control. Can we understand the relations between them, for instance, by checking the effects of small perturbations and their propagation? Can we reduce general vulnerability? Which heuristics are good enough to cut through details, and what kinds of narratives make sense of complicated developments?

Crucially, optimization in RU is dangerous. Its premises are not satisfied. It blinds us to the need to embrace diversity and experiment. It installs a blame rather than a creative culture and causes fragility rather than resilience — whether designing medical facilities or supply chains, for instance.

Decisively, RU necessarily evokes ambivalence — reasons for and against choices and the accompanying emotions of doubt or excitement. To make good decisions under uncertainty, decision-makers must act creatively to avoid paralysis, while recognizing the possibility of failure and accompanying anxiety. Decisions can work if supported by and communicated with a conviction narrative (CN). A CN generates confidence and cooperation in the public. Good CNs are the product of inquiring into and facing doubt transparently in conversation. Bad CNs are the outcome of dictatorial assertion, attraction to phantastic object solutions, and groupthink, creating "certainty."

Progress requires novel cross-disciplinary research combining mathematics, machine-learning, and physics with economics, engineering, social science, and psychology.

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