Look Before You Predict

Predicting the future is possible. In fact, we do it all the time with varying success. We're pretty sure that the sun will come up in the morning, and weather forecasts, at least for much of the coming week, are not too bad nowadays.

I rarely try to predict the future except as a form of amusement. If several outcomes are possible, then I might mention several "predictions" to different people. When the actual event occurs, someone might remember my prediction and think I have some special ability. Usually everyone else will have forgotten or ignored my bogus prognostications.

Predicting the future is a form of extrapolation, but I feel safer interpolating. If I have reasonably dense data on an interval, then it doesn't bother me too much to connect the points with line segments or curves and then imagine that the interpolated points are reasonable approximations. But I'm a lot more hesitant to extend those lines beyond the endpoints of the interval. I'm not sure these feelings are justified—I fear cliffs, but holes can be a danger as well.

One of the problems with assessing predictions is that we don't usually do it in a controlled manner. We take historical data sets and use part of the data for modeling and part of it for prediction. If the "prediction" accuracy looks good, we publish a paper. But, as far as I know, no journal requires us to predict the "real" future as a requirement for publication. If a prediction competition were set up, even under carefully controlled circumstances, then there will always be a best prediction and thus a winner, but I'm not sure that even the best prediction would be scientifically meaningful.

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Dennis, students, and friends hiking the Waterloo Trail in Southeastern Michigan.

Within the concepts and methods of systems and control, such as model predictive control, it may be useful to examine what makes prediction difficult. First, one of the keys to prediction is knowing as much as possible about the present, which makes extrapolation more reliable. Knowing the present requires having data about the past as well as models for interpreting the data—this is the problem of state estimation. But state estimation depends on the quantity and accuracy of the data, which may be limited and noisy, as well as the accuracy of the model, which is limited by all sorts of factors.

Miroslav Krstic and Dennis Bernstein.

Once we have our best estimate of the present, moving into the future can be a leap of faith. First, we don't know whether the accuracy of the model will hold up, especially due to unexpected changes, such as damage. But even if the model retains its accuracy, we may not be able to anticipate disturbances. Extreme disturbances such as 9/11 and Katrina are the most troublesome, but every gust of wind can affect the predicted motion. Statistical models and strategies can be used as a form of sophisticated gambling.

This is not to say that we can't know anything about the future. In all likelihood, the future will mimic the past—at least some elements of the past. The more we know about the past and the present, the better position we're in to predict the future. To the extent that the tools we develop help us know the past and present, our ability to predict the future can improve. Tools for prediction will perhaps always depend on a leap of faith, but I cannot say for sure.

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