The Signal and the Noise

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Prediction

- Separate Signal from the Noise
- We're Mostly bad at this. Very Bad
- Information Overload Printing Press
- Productivity Paradox Information Age

Rating Agencies

- Forecasted the risk of CDOs at 0.12%
- Actual Default Rate at 28%
- Rating Quality had little effect on their profits
- Benefited almost solely from rating securities
- Simulated under assumptions and missed risk they were taking

Risk and Uncertainty

- Depending on the Dependence structure of the underlying assets, bundled securities can be much less or more risky than under assumptions such as independence.
- The Nature of the dependence is not known - Knightian Uncertainty
- Rating agencies claimed this uncertainty was risk - Moody's increased their estimate of default by 50%. Which did nothing to mollify.

Prediction in the Housing Bubble

- Homeowners assumed the prices would continue to rise -ignoring the bubble
- Banks and rating agencies did not understand the system risk present
- Economists did not understand how the leveraged bank sector was tied to the housing market
- Policy makers were overconfident in the rate of Recovery of the Economy - basing it falsely on recessions instead of financial crises.

Understanding Your Sample

- Should you Drunk Drive or Call Uber?
- Can we trust Rating Agencies to know how to rate new assets?
- You should always use your sample to avoid false confidence

McLaughlin Show

- Predictions occur at the final part of the episode
- Regardless of Political Affiliation, no guess is any better than 50%
- However the Predictions are structured with 75z% of them being completely false or Completely true

Political Scientists

- Almost nobody correctly predicted the Collapse of the Soviet Union
- Required piecing together structural problems with Soviet union and Gorbachev's motivations for reform.
- Poor estimates of Soviet GDP and its decline
- However this isn't unique to the Soviet Union - most political scientists are terrible at predicting anything.
- In fact, the ones that speak to the media do worse than ones that don't

Foxes vs Hedgehogs

- "The Fox knows many little things, but the hedgehog knows one big thing." - Archilochus
- Hedgehogs - Big ideas that govern all motion around us. Think Karl Marx
- Foxes - little ideas explain a little of an issue, but many of them combine to explain the picture. Usually multidisciplinary, cautious and empirical, as well as tolerant of complexity.
- Hedgehogs however make much better television guests, and receive the lion's share of publicity despite being worse at predictions.

Lessons from Hedgehogs

- Hedgehogs get worse at predicting as they get more experience
- They are letting their biases take over their prediction
- This occurs with television pundits and partisanship.
- Don't construct narratives, these become less like reality the more information you get, and become worse predictors.

How to Apply this to Prediction

- Think Probabilistically (Bayesian v Frequentist)
- Keep making forecasts and don't let the past affect today's prediction
- Consensus is a good sign, but not always
- There is no single data point that is sufficient for a complex system.
- Weigh Quantitative and Qualitative data together - Cook Political Report.

What makes baseball so easy to predict

- There is a lot of good data
- Play is largely independent. Players responsible for their own statistics
- Relatively few problems with complexity or dynamics
- We understand the processes underlying the data
- Easy to account for unobserved heterogeneity.

PECOTA isn't God's gift to scouting

- Outclassed by Professional scouting in predicting players' ability from minor to major league.
- A hybrid approach is the best predictive measure.
- Especially since there is interdependence between certain aspects (Pitchers in minor leagues aren't playing against great hitters).
- Bias can happen in statistical models - Billy Beane had bad defenses.

Don't Limit the Data

- Being able to combine qualitative information is important for prediction
- Baseball scouts exist to find out this information and bring to attention
- Beware of discounting something we can't categorize easily such as the tool kit of Dustin Pedroia

Predicting Weather

- Laplace's Demon - If you knew the exact state of the universe and all the laws of motion, we could predict perfectly.
- While this may be false, if we know the laws of motion and know the states of the universe, we're going to make pretty good predictions.
- Weather is something that we understand the underlying motion very well.
- We don't however know the state of every molecule in Earth's atmosphere

Predicting Weather

- We can however, discretize space and apply equations to data gathered. First attempted by Lewis Richardson
- However there is a lot of number crunching, so computers are pretty much required.
- However, as you become more precise in the discretization of the atmosphere, there is a computational cost. Doubling Precision increases the grid by 16 times as much.
- However this is a dynamic system, with one dimension being time, and we are not very good at predicting these.

Chaos Theory

- Applies to non-linear dynamic systems.
- Tiny changes in the initial conditions can have huge consequences in the outcomes, even in a completely deterministic model.
- This means measurement error, and human error can have huge consequences in the predictions.
- This is handled by perturbation of the initial conditions and simulation.

The Human Touch

- It doesn't end there, there is still a human element to weather predictions.
- Humans attempt to account for mistakes that the computer may make, through their intuition about the machinations of the model.
- This is true because humans are much better still at visually identifying patterns and can correct for it much better than a computer can.
- This can lead to problems such as over fitting, but meteorologists improve predictions by about 25%, and predictions keep improving

Evaluating a Forecast

- Industry competition is not always seeking a more precise forecast, but a more useful one.
- The Economist's view on the Receiver Operating Curve.
- This can lead to dishonest predictions that are not necessarily bad, they simply are responding to other objectives.
- Be aware of goals other than strictly reporting truth.

Not such a success story - Earthquakes

- Officially "cannot be predicted" - Only Forecasted
- While we know the long-term rates at which earthquakes hit and the probabilities of earthquakes of different intensities, we can't really tell anything in the short-term.
- No real understanding of the mechanics that are working "under the hood"
- Data is relatively poor on anything but relatively powerful quakes in many places.

Purely Statistical Models Don't Work

- While aftershocks may be able to be predicted, especially involving movement down fault lines, we would like to predict the first shock.
- Without theory, you will simply be finding patterns in the noise.
- It is impossible to identify the signal in data that is this noisy without knowing what it is you are looking for.
- This is different from weather prediction, since we understand the laws of motion there.
- It is too easy to over fit because of the noise and large amount of data.

Why they aren't working (and may never)

- The Data is extremely noisy.
- "With four parameters I can fit an elephant, with five I can make him wiggle his trunk" - Von Veuman
- Making a model more complex often makes it worse.
- Non parametric fits that diverge from theory can be from over fitting and missing rare events
- Complex Process - Many simple actors combine for a very complicated process

Economics - Not so good with the predictions

- Economists are very bad at predicting, and often don't the uncertainty of their forecasts
- Often too overconfident - Despite there being readily available feedback
- Predictions fail to be accurate or precise
- "Nobody has a clue" - Jan Hatzius

Why do the predictions fail so badly

- The underlying processes are both dynamic and complex
- Cause and effect are extremely hard to determine
- The Data is horrible
- The Lucas Critique
- Goodhart's law - Targetting an indicator removes its predictive power

Structural Changes

- Since the economy is a complex dynamic system, it is changing over time.
- In particular becoming a global economy has shifted capital levels
- Baby boomers retiring, declining middle class and increased debt have all altered the way the American Economy works.
- Much of the recent growth during The Great Moderation was debt-fueled

Can these problems be handled?

- Don't throw out data - Silver claims the fed overvalued data from the Great Moderation to determine their forecasts
- To not throw out data is to assume there is no structural change over time, must make an assumption one way or another.
- How do we know when the economy has changed structurally?

Why have many of the Problems been resolved in weather and not economics?

- There is no hard science to turn back to.
- The structural approach which attempts this still has to make many unrealistic assumptions
- The system is far more complex
- Agents are all individually making decisions.

Computers don't help

- They just give you faster and bigger ways to mistake the signal for the noise.
- Models need to be about the economics going on behind the scenes, not the data that is produced by the economics.
- Stories about data are still just made by hedgehogs, and are unlikely to be anything but over fitting noise.

Incentives

- Forecasters who do not have their names attached to forecasts usually do better
- They aren't trying to make a name for themselves or trying to stay conservative to damage established reputation.
- Market for predictions or changing how we consume forecasts?

Predictions can influence behavior

- Predictions can undermine themselves - GPS diverts all traffic and creates a bigger jam
- Economic Predictors of recessions make actually cause them
- Flu predictions can increase vaccinations and reduce flu damage

A Solution to Complex Systems?

- When systems are complex because of actors - they can be simulated
- However these simulations need all the actions of the actors predicted, often by models that are unreliable.
- Worse they can come from psychology, or just be made up by the creators.
- For now have relatively little predictive power and are very hard to test

False Positives

- Bayes theorem tells us that if the underlying probability of something is very low then false positives can dominate the results.
- Tests that are 95% accurate for rare diseases can only be 10-30% sure that you have the disease.
- Research is especially affected by this because of the bias for results and the "publish or die" mentality.

Fisherian vs Bayesians

- Frequentists take a strong stance on the structure of the problem
- This eliminates the prior, but also eliminates sources of error besides the sampling error
- Requires a sample and many other assumptions that give it computational tractability at the cost of rigidity.
- Since the prior is eliminated it eliminates context which takes the form of a Bayesian Prior.

Gambling

- Bob Voulgaris - Bayesian approach to betting - everything is looked at in the context of probabilities.
- No notion of statistical significance, so there is no arbitrary cutoff levels at 95%.
- When rewards are occurring at the margin, as is the case in almost all competitive predictive markets, this is the approach that is needed.
- Hypothesis are still tested and examined in the context of some theory, but not tested in the Null hypothesis framework.

Less structure means more work

- Since there is much less structure placed on the model, our beliefs weigh stronger into the prediction.
- But no matter what our prior beliefs are, with enough data we should still see our beliefs converge.
- The literature is also on the path towards Bayesian approaches and is "converging" there.

Understand the underlying processes

- Computers have drastically helped weather prediction, where we understand the fluid dynamics that explain their machinations.
- Relatively useless at predicting things in Economics and Earthquakes where we don't understand the underlying process.

Computers work better with good data

- Computers are very likely to mistake the signal for the noise
- They lack the sight to see the big picture, and compensate by brute force and look-ahead algorithms with pruning.
- However they are still victims of the assumptions that their programmers have put on them.

Poker

- Pareto Principle - Diminishing returns to skill in poker
- Very noisy output - randomness plays a large role in returns
- Feeding on overconfidence of the fish.

Tilting

- Tilting results from the fact that skill matters, but the game is still extremely noisy, and this can effect how we play.
- In all things avoid entitlement tilting - thinking that because you acted optimally, that you deserved to win.
- Don't be seduced by noisy positive results meaning that you are doing better
- Cannot evaluate predictions in noisy areas solely by right and wrong, have to evaluate the process.

The Wisdom of Crowds

- Aggregation is incredibly powerful in certain situations
- However when people are reacting to other bets made, as is the case in a market, the dynamics are not as simple.
- The aggregate is only sometimes better than the best individual prediction.

Climate Prediction

- We understand the fundamental process that is heating the earth - The Greenhouse effect.
- However the primary cause for heating the earth isn't $C0_2$, its the water vapor stored in the air that becomes possible when the earth heats.
- While we understand the root cause very well, we are not very good at predicting temperatures.

Problems

- Fancy models in the time from 1995-2012 were outperformed by a linear regression on $C0_2$ only.
- Complex systems that are influenced by lots of noise and cyclical trends like El Niño rarely perform well.
- Scott Armstrong bet Al Gore in 2007 that temperatures would not increase each month over the next Decade and won.
- Large structural uncertainty and initial condition uncertainty.
- From 2001 to 2011 temperatures declined (though not by much)

A Bayessian Explanation

- Based on some prior belief of temperatures increasing, we can look at how our beliefs in global warming can change with a decade of temperatures decreasing.
- The more certain you are in your prior, the more hurt you are going to get by being wrong.
- 95% sure of Global warming updates to 85%
- 99% sure of Global warming updates to 28%.
- Overconfidence in something can reduce public faith when you are incorrect.

Uncertainty is back

- When we are unfamiliar with a possibility, we don't even think about it happening.
- "there are also unknown unknowns . . . things we do not know we don't know" - Donald Rumsfeld
- It can be very hard to sort and build theories of what we should be looking for when there isn't a solid theory to lean back on
- Failures of predicting 9/11 and Pearl Harbor.

In Summary

- Try to understand the theory underlying a process
- Think probabilistically and Bayesian
- Stay simple, but don't make so many assumptions that you lose predictive power
- Keep your incentives on getting predictions right, and do not trust those without the same incentives.