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Role of Research in Industry
A View from Consulting

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Themes

Emerging Trends and Applications

Theory and Practice

Model Risk

Caveat (Do Think of an Elephant)

- "Research in Industry" is a multifaceted topic.

- I will talk mostly about predictive modeling (and related types of analytical activities) used in insurance and other industries.

- My perspective is not complete.

Emerging Trends

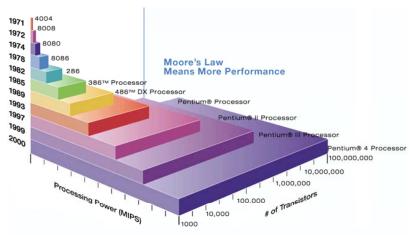The ubiquity of predictive modeling
Themes from behavioral economics

Moore, Moore, Moore

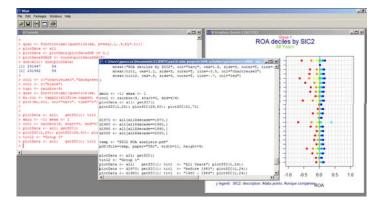**3 reasons why predictive modeling is now ubiquitous.**

- ## Technology
  - Cost of storage and computing power has decreased exponentially

- ## Data
  - Third-party data is becoming increasingly available
  - Companies are learning to do more with their internal data

- ## Software and algorithms
  - Great analytic ideas keep coming from statistics, economics, machine learning, marketing, …
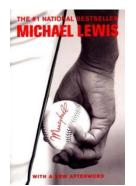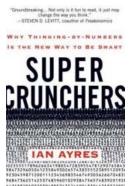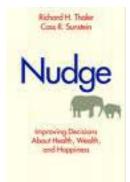 - Free tools like R
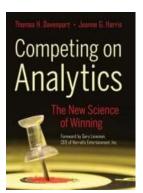

Moore's Law Means More Performance

Another Reason

- Businesspeople increasingly "get it".
- The business press is replete with stories about analytic-based improvements to business processes.
  - Amazon, Netflix recommendation algorithms
  - Progressive Insurance's innovations in pricing
  - Capital One uses of analytics for cross-sell, customer support, …
  - Harrah's Casino estimates "pain points" for individual gamblers
  - Oakland A's use of analytics to scout baseball players

- People in business (and government, medicine, education, …) are learning to value data and analytics as a corrective to limitations in human intuition.
  - "In God we trust; all others must bring data." – W. Edwards Deming

Aside: Analyzing Analytics

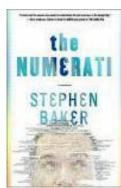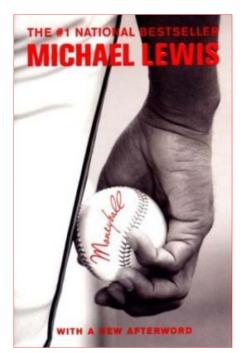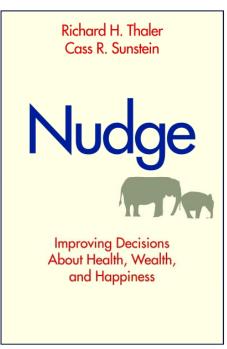- *Moneyball* is about baseball.
- *Nudge* is about economics.
- What's the connection?

- Billy Beane used analytics to identify talented baseball players *who had been under-valued in the market*.
- The market was not efficient.
- Why: it was dominated by a procession of baseball scouts who base decisions largely on "intuition" and "judgment".

- Can you think of other domains where this is the case?

Aside: Analyzing Analytics

"The problem is not that baseball professionals are stupid; it is that they are human. Like most people, including experts, they tend to rely on simple rules of thumb, on traditions, on habits, on what other experts seem to believe.

Even when the stakes are high, rational behavior does not always emerge. It takes time and effort to switch from simple intuitions to careful assessments of evidence."

> – Cass Sunstein & Richard Thaler review of *Moneyball*

"Human judges are not merely worse than optimal regression equations; they are worse than almost any regression equation."

-- Richard Nisbett and Lee Ross,
Human Inference: Strategies and shortcomings of Social Judgment

Summing Up

- Predictive Modeling is becoming ubiquitous because it is now possible for it to be ubiquitous
  - Diminishing cost of computing power
  - Increasing availability of data
  - Proliferation of analytical techniques and tools

- It is also becoming ubiquitous because there is a business reason for it to become ubiquitous
  - The human mind did not evolve to calculate Bayesian probabilities and make complex business decisions under uncertainty
  - We use heuristics, and our decisions can be biased
  - We are "predictably irrational" but we can also design algorithms to help us do a better job

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Emerging Applications

Deepening of Actuarial Work
Broadening of Actuarial Work

Deepening of Actuarial Work: Pricing

- GLM-based modeling has put insurance pricing on a firm statistical footing.

- We will likely see continual improvements in this area through the introduction of new data sources and analytic techniques.
  - Hierarchical modeling
  - Data mining, data visualization techniques
  - Geospatial analysis
  - Text mining
  - …

- **Commercial Insurance**: We have had success applying predictive modeling to all of the major lines of commercial insurance.

- As we refine our techniques we will continue to push out the boundaries.
  - Lines like D&O, E&O
  - Small books of commercial insurance policies

Deepening of Actuarial Work: Reserving

- Much of today's practice is still "pre-statistical".
  - No single, commonly accepted stochastic reserving framework comparable to GLM ratemaking.
  - Spreadsheet-based projection methods like chain-ladder, BF still common.

- Predictive modeling concepts will continue to be brought to bear ➔ the body of stochastic reserving theory will continue to develop.
  - Loss reserving will increasingly be seen as a type of statistical modeling.
  - Better point estimates
  - Reserve ranges – simulation, Bayesian techniques

- Predictive modeling will enable loss reserving with **claim-level data**.
  - Loss triangles are an artifact of paper-and-pencil statistics.
  - Use of claim-level data enables the use of **predictive variables**.
  - Can better analyze trends, books of business that have shifted over time.
  - (Is a loss triangle a "sufficient statistics" for estimating outstanding losses?)
  - More natural application of bootstrapping: with claim-level data, we can bootstrap the data rather than model residuals.

Broadening of Actuarial Work

- Predictive modeling is the ultimate "transferable skill".

- Many of the models be build are essentially the same as the models discussed in the marketing science literature.
  - Customer segmentation, profiling, "clustering"
  - Profitability modeling
  - Retention
  - Elasticity
  - Price optimization
  - Cross-sell
  - Customer lifetime value (CLTV)

- Certain actuaries will increasingly work as "marketing science" experts.
  - Increasing focus on modeling **market-based prices** in addition to **cost-based prices**.

- Marketing science: a consumer-centric rather than product centric view.

Modeling and Consumer Behavior

- Another aspect of the "marketing science" aspect of future insurance modeling work:

- Insurers will continue to find ways of modeling consumer *behavior*.

- Why is gender predictive?

- Why is credit predictive?

- What other behavioral data sources are out there?
  - Driving behavior
  - Bill payment behavior
  - Up-sell behavior
  - Web site activity
  - …

Other Emerging Applications for P&C Insurers

- Premium audit

- Claims analytics

- Premium audit models

- Agency analytics

- Target marketing

- Designing/evaluating ad/marketing campaigns

Theory and Practice

Moving from academia to industry

Theory and Practice

- In university we tend to learn, refine, and create theories.
- Work in industry tends to be practical.

- θεωρία: <u>contemplation</u>, perception
- πραξις: <u>process</u> (theory is used to guide action)

- Aristotle:
  - The goal of theoretical knowledge is truth
  - The goal of practical knowledge is action

- Theories help us "see" better so that we can take better actions.
  - Bounded rationality: human minds are "myopic".
  - Theories and models are corrective tools… analogous to eyeglasses.

Theory and Practice

- If one's ultimate goal is truth, it always makes sense to seek a better understanding

- If one's ultimate goal is action (as in industry) there will be a point of diminishing returns

- Theoretical knowledge is important… and in the age of "super crunchers" it is becoming ever more valuable…

- … but it's also important not to let it weigh you down

- Learn how to talk with business people and understand their needs

Simon Says

- Theory is the search for "ultimate" truth… we will always search for better theories.
  - A kind of optimization

- In industry the optimal solution isn't the best.

- Why: we need to account for the <u>cost</u> of an improved solution.

- "Satisficing" (Herbert Simon) = "satisfy" + "suffice"
  - We aim for adequacy rather than optimality.

Satisfising and Simplicity in Predictive Models

- There are theoretical reasons to seek simplicity when building predictive models:
    - The bias-variance tradeoff
    - Occam's razor: "Everything should be made as simple as possible, but not simpler" – Albert Einstein

- But there are practical reasons as well:
    - <u>Cost</u>: do we <u>really</u> need that variable in the model given its {cost / implementation difficulty / regulatory scrutiny / lack of intuitive appeal / disruptive effect}?
    - <u>Model risk</u>: models in industry are often intended to improve human decisions. But it is hard for people to make better decisions using models that they don't understand.

"We need models people can understand and a greater respect for risk… what high finance needs now are precisely the skills that actuaries have, a deep understanding of statistics, an historical perspective, and a willingness to work with data."
Paul Wilmott, *The Actuary* (UK), November 2008

Model Risk

Black Swan and Beyond

Varieties of Model Risk

- **Philosophical**: will the future reflect the past?
  - The problem of induction (David Hume)
  - Knightian Uncertainty (Frank Knight)
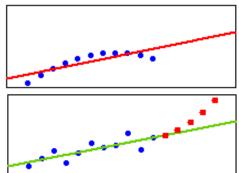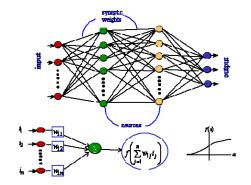 - Black Swans (John Stuart Mill, Nassim Taleb)

- **Theoretical**:
  - Model misspecification
  - Problems with extrapolating beyond the data
  - …

- **Practical**:
  - Quality control (Deming again)
  - Communication, misunderstanding
  - Willful misuse (gaming the system)
  - Documentation
  - Complexity
  - Unintended consequences

Emanuel Derman on Model Risk

Many of the types of model risks Derman identifies in finance apply equally to insurance and other domains.

- Often we model <u>behavior</u>, which is subject to change
  - e.g. relationship between credit and insurance claims

- Domain knowledge is critical
  - Analytics has enriched actuarial science… but actuarial domain expertise is still crucial

- Modeling is interdisciplinary
  - IT, project management, programming, statistics
  - Models are ultimately software – risks of programming bugs
  - QC, "human" design are important – risks due to misunderstanding, misuse of models

Goldman Sachs

Quantitative Strategies Research Notes

April 1996

Model Risk

Emanuel Derman