Statistical Insights into Everyday Problems

By Sam Parl
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You know that the volatility of an investment matters as much as its overall return. But you may not know that research into this fundamental investment principle has been applied in many other disciplines to explain phenomena as unexpected as waiting times in lines at Disney World.

Kaiser Fung's new book *Numbers Rule Your World* uses nontechnical language to dissect many of the statistical challenges professionals and laypeople have confronted in recent decades. Fung's approach renders the book's concepts and anecdotes accessible, and provides a fun and informative read for professionals curious about the many hats statistics wears in today's society. From the successes of queuing theory at Disney World to the misapplication of lie detector tests in law enforcement and the military, Fung shows how statistical thinking has shaped our world.

Taken as a whole, the book offers an overview of applied statistics and teaches a valuable set of lessons about how to think statistically. Fung provides a great sampling of everyday accomplishments that make use of statistical thinking.

Each of Fung's five chapters describes two everyday situations where statistics clarify human misunderstanding in order to explain a fundamental point. Fung draws useful comparisons between the scenarios he discusses to help lead to each conclusion. In this way, *Numbers Rule Your World* is really a collection of short essays, and I recommend reading and digesting each chapter individually.

Here is a short recap of each chapter (highlighting its fundamental point):

Chapter 1: Fast Passes / Slow Merges
Lesson: "Always ask about the variability."

Fung's emphasis in this chapter is on the value of examining variability rather than commonly used averages. User satisfaction is the goal and users like control, Fung argues. Control sometimes can be won by managing variability. Even though average outcomes may worsen, that benefit of reduced variability means variance is usually a more important consideration than the average result.

The two queue-management examples he uses are not well related to this main point, although they are interesting case studies.

First, Fung discusses the implementation of on-ramp traffic lights in the 1970s to reduce highway congestion in the area around Minnesota's Twin Cities. He compares this innovation with the introduction of the "FastPass" at Disney World to allow park-goers to use their time more efficiently. FastPass is a new system whereby park-goers can reserve places in an electronic queue rather than standing in a physical line.

Although Fung seems to be setting up a dichotomy between controlling variability and optimizing average values, this problem never arises in his highway example, where controlling traffic variability decreases accidents and actually lowers commute times. While customers at Disney World face longer wait times with FastPass than if they stood in line waiting, they are free to explore the park in the meantime, leading to much higher satisfaction. In this case, time control emerges as the true king of customer satisfaction.

In neither case does the average time ever emerge as a serious problem that must be reconciled with variability, so Fung's lengthy discussion of this imaginary opposition and claims like "variable traffic conditions mess up our well-laid schedules, and that ought to upset us more than the average journey time" detract from the overall discussion. The true value of this chapter lies in its discussion of the success and failure of different attempts to control variability.

Chapter 2: Bagged Spinach / Bad Score
Lesson: "Pick useful over true"

The first thing any student of statistics learns is that "correlation is not causation." In his second chapter, Fung embraces causation's much-maligned counterpart and shows the ways correlation can be useful. The author applauds the use of correlation by epidemiologists working for the CDC to pinpoint the cause of a 2006 E. coli outbreak in spinach. While scientific analysis is still necessary to confirm suspicions before economically damaging steps are taken, Fung explains, looking for correlation is nonetheless a valuable timesaving tool. Fung reiterates the time benefits of using correlation in his defense of the credit scoring industry. Despite criticism of credit scores, Fung argues that they have opened the doors of credit to millions of people.

Fung is convincing in this chapter. While rallying to the defense of credit scoring, he excludes any discussion of the most important credit event in a half-century until the conclusion. There, he at last he explains that the problem was not with the nature of the practice, but with the unhealthy incentive structure regulators allowed at the time. For example, the housing bubble of the early 2000s resulted in economic growth that decreased borrowers' apparent risk of default. A much higher loan volume than was beneficial resulted, with a lot of money flowing to bad credit risks that were camouflaged by rising home prices. As long as regulators provide proper incentives, credit scoring can open the doors of finance to more people without driving swaths of borrowers into bankruptcy.

Chapter 3: Item Bank / Risk Pool
Lesson: "Compare like with like."

In Chapter 3, Fung shows how treating statistically dissimilar groups as though they were comparable can lead to analytical failure. Examining the efforts of Educational Testing Services (ETS) to minimize cultural bias in the SAT, he argues that it is not enough to merely compare the tests results of students from different ethnic backgrounds. A variety of other factors correlated with ethnic background (education level, for instance) can explain why students do poorly on the tests. Fung shows that black and white students of equivalent ability perform equally well, but that high-scoring students are a smaller portion of the black student population. This results in a worse average performance for black students and an illusion of bias, when it is more likely a question of education level. Fung maintains that a proper analysis should compare "like with like" in order to produce informative results. In this case, that means comparing high ability black students with similar white students in order to search for bias.

Fung also exposes the unfair risk shouldered by inland Floridians because regulations prohibit hurricane insurance companies from raising premiums on their much riskier coastal counterparts. He specifically follows the rise and fall of Poe Financial, which exposed itself by buying up tens of thousands of discounted at-risk coastal insurance policies from the government. At the time the company was founded, insurers were becoming aware of Florida's increasing exposure to severe weather systems and either pulling out or (ineffectively) lobbying to raise premiums on risky coastal customers. In this environment, Bill Poe, the company's founder, actually lowered rates to drum up new business.

While Fung's point is valid and the topic is interesting, the example of Poe Financial is confusing. The eventual bankruptcy of his business had less to do with statistical failure than with illogical business decisions that left the company completely illiquid when a powerful series of storms struck. The real statistical story lies with Poe's inland customers, who in the end were forced to shoulder the burden of insuring the more exposed coastal regions.

Chapter 4: Timid Testers / Magic Lassos
Lesson: "Heed the give-and-take of two errors."

With the clearest focus of any chapter in the book, Fung's fourth section details how asymmetric incentives sway the results of statistical analysis. This is the most important theme in the book, and it can be reapplied to any of the other chapters. The two phenomena under the microscope in this chapter are professional drug tests and lie detectors.

In the first example, the author exposes the frightening numbers of false negatives that likely result from drug testers' reluctance to challenge athletes without absolute certainty of their test results. Fung humorously handles the outrageous hypocrisy of professional athletes as they preach from their bully pulpits and cow testers into submission by loudly decrying any vulnerability in the testing process.

Incentive structures can have devastating real world impacts that extend beyond athletics, and in his second example Fung explores the serious ramifications of asymmetric incentives for lie detectors used by the military and law enforcement. When the military screens applicants for on-base jobs, they subject them to a lie detector test. Unfortunately, when doing so testers are forced to choose between lax thresholds that are totally useless for reliably catching falsehood and a level of precision that would snare hundreds or thousands of innocents for every real security risk. For this reason, the National Academy of Sciences rejected the use of polygraph tests for national-security screening. Fung explains the statistics behind that decision.

He also shows that systems such as lie detector tests often do more damage than good when used by law enforcement. Jeffrey Deskavic was a teenager when, having aroused police suspicion for cooperating too thoroughly with their investigation into the brutal murder of a classmate, he was convicted and sent to prison. The evidence against him? A confession pressured out of him by investigators who told him he failed a polygraph test, after he spent months protesting his innocence. Deskavic spent 16 years in prison before another murderer's DNA was matched to the crime, and when he was finally released, he could not properly function in society. This catastrophe, and others like it, emerged from law enforcement's use of polygraphs to obtain confessions from suspects. With an easy-to-follow statistical number-crunch and examples like this, Fung reveals the moral dilemmas behind practical statistics and how risk and reward shape the results.

Chapter 5: Jet Crashes / Jackpots
Lesson: "Don't believe what is too rare to be true."

In his fifth and final chapter, Fung makes a statistical appeal to dispel subconscious myths that lead us to illogical decisions. He chooses to present us with two outlandish situations roughly equal in probability: a fatal plane crash and winning Canada's national lottery.

In the first of two fascinating anecdotes, he explains away the rumor that foreign airlines are more susceptible to crashes. In fact, on international routes they are just as safe as domestic carriers. Although flying is actually safer than driving and cheaper foreign airlines provide an equally safe experience, many people illogically reject foreign airlines out of hand or even forego air travel altogether, especially in the wake of well publicized flight disasters.

The second anecdote follows an investigation of rampant fraud beginning in 2006 in the Canadian lottery system, where store clerks and owners stole winning tickets from

customers. Statistics showed that there was a one in quintillion (forty zeros) chance that "insiders" such as store clerks could win as often as they do. Outsiders almost never win the prize and, as Fung argues, it is crazy of them to think that they could in a fair world.

In his last chapter, Fung urges us to use statistics in everyday decision-making. We make small, illogical choices everyday, whether they involve purchasing a lottery ticket or cultivating prejudices against perfectly safe airlines.

In the end…

Fung's book helps us to see beyond a narrow viewpoint and recognize the statistical truths around us. He challenges the way we look at statistics when he advocates variability as a more important parameter than averages. While his book sometimes veers off on tangents, they are always entertaining and usually offer informative context for the issue he is addressing. *Numbers Rule Your World* is enlightening, while avoiding heavily technical language, and generally fun to read. It is a wakeup call to all of us when we forget the data underlying our lives and decisions.

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