
Preface

Even though the twenty-first century is still young, it is already marred by the dot-com crash, terrorism, financial system collapse, war, unsettling climate change, rise of new viruses—both animal and cyber—and an evolving socio-political shift caused by lightening speed advances in technology. Compared with the twentieth century, the first decade of the twenty-first century was as eventful and significant as the last 50 years of the previous century. Why?

We live in an age of rapid-fire change because over the past 200 years the comparatively straightforward Industrial Revolution has morphed into an era of nonlinear change punctuated with tipping points. The machinery of the current century is a collection of interconnected complex, rather than smooth-running, systems. Gradual and linear change no longer happens. Instead, “progress” moves in bursts—fits-and-starts marked by waves of unimaginable flashes, sparks, booms, bubbles, shocks, extremes, bombs, and leaps. Half probabilistic and half nonlinear deterministic, the twenty-first century is defined by intersecting long-tailed distributions, rather than independent and isolated Normal distributions. Episodic phenomena behave erratically and have no average or expected values.

Social, economic, physical, and cyber systems operate near their tipping points—perched on the edge of chaos, because they are optimized for maximum utility. Modern society has wringed out all surge capacity and backup reserves. After 60 years of stretching resources and budgets, governments have reached their limits. Traditional problem solving methods no longer work. Old ways of understanding our world no longer explain the current observed reality. Systems at all levels are out of bounds most of the time and increasingly collapse.

We need a new way to think about this new open, transparent, disruptive, and long-tailed world. We need tools for understanding the complexity of everyday things. Unfortunately, few of us understand complexity theory and nonlinear cause-and-effect, and even fewer of us are able to comprehend the implications of collapses, transformations, and revolutions currently taking place. Why did the global economy collapse? What are the principles underlying punctuated complexity? How can we begin to understand the nonlinear dynamics of global climate change, political upheaval, economic extremes, and the inevitable collapse and disaster confronting our society?

This sequel to Bak's *Sand Pile*, the author's earlier book, continues to explore society at its boundaries. From bursts of waves at the Asilomar Beach, to economic collapses, globalization of a tilted globe, and flashmobs precipitated by the Internet, *Book of Extremes* examines society's nonlinear outer limits.

Finding answers to these questions was the task I set for myself when I wrote *Bak's Sand Pile* in 2011. *Bak's Sand Pile* borrowed ideas from complexity theory, while this book applies nonlinear mathematics, catastrophe theory, big data, social network analysis, and biology to go a step further. This book proposes theories to explain extremes—why punctuated reality is bursty; why systems that have worked for decades suddenly fail; and why the wellbeing of entire nations is no longer in the hands of their leaders.

I begin with a gentle introduction to “wave theory”—the basis of punctuated reality. The theory explains social movements like the Arab Spring as well as online social media movements like Occupy Wall Street. Then I show how networks enhance nonlinear bursts—everything is connected to everything else—and hence a relatively small perturbation in one part of the space-time continuum ripples through the ether and impacts other parts. Unlikely events are made more likely by connected events. And connected events lead to conditional probabilities and the Bayesian theory underlying predictive analytics. [How we can forecast the future].

I have borrowed many ideas from biology and applied them to other fields such as economics. One of the most powerful ideas is the *Paradox of Enrichment*, which explains bubbles, shocks, and disruptions in financial markets. When combined with network science and nonlinear chaos theory, the unexpected crashes and disruptions in the global economy begin to make sense. For example, in *Shocks*, I show how comparative advantage leads to a highly interconnected global supply chain, which in turn determines the fortunes of entire nations.

Is reality completely random and unpredictable? Are we perched on the edge of disaster? Our understanding of mega-events such as the formation of social-political movements online leading to political instability in the Middle East, collapse of supply chains following the Fukushima nuclear disaster, global meltdown due to the 2008 financial crisis, impending ecological disasters from climate change, and plain old risk from terrorism and pandemics begins to crystallize as these mathematical concepts are placed in the context of social, political, and economic reality. This is perhaps the main contribution of this book—the application of rigorous methods to explain seemingly unexplainable events.

Book of Extremes is a work-in-progress, but it is a beginning.

Book of Extremes

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