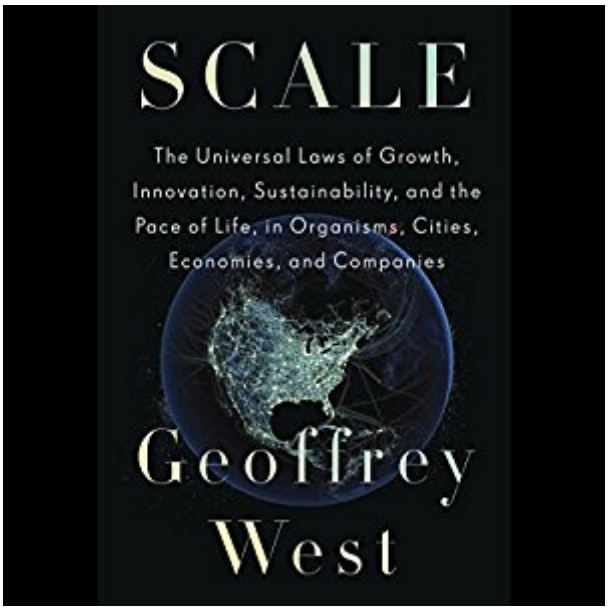
Scale: The Universal Laws Of Growth, Innovation, Sustainability, And The Pace Of Life, In Organisms, Cities, Economies, And Companies



Synopsis

From one of the most influential scientists of our time, a dazzling exploration of the hidden laws that govern the life cycle of everything from plants and animals to the cities we live in. Visionary physicist Geoffrey West is a pioneer in the field of complexity science, the science of emergent systems and networks. The term complexity can be misleading, however, because what makes West's discoveries so beautiful is that he has found an underlying simplicity that unites the seemingly complex and diverse phenomena of living systems, including our bodies, our cities, and our businesses. Fascinated by aging and mortality, West applied the rigor of a physicist to the biological question of why we live as long as we do and no longer. The result was astonishing and changed science: West found that despite the riotous diversity in mammals, they are all, to a large degree, scaled versions of each other. If you know the size of a mammal, you can use scaling laws to learn everything, including how much food it eats per day, what its heart rate is, how long it will take to mature, its life span, and so on. Furthermore, the efficiency of the mammal's circulatory systems scales up precisely based on weight: If you compare a mouse, a human, and an elephant on a logarithmic graph, you find with every doubling of average weight, a species gets 25 percent more efficient - and lives 2 percent longer. Fundamentally, he has proven, the issue has to do with the fractal geometry of the networks that supply energy and remove waste from the organism's body. West's work has been game changing for biologists, but then he made the even bolder move of exploring his work's applicability. Cities, too, are constellations of networks, and laws of scalability relate with eerie precision to them. Recently West has applied his revolutionary work to the business world. This investigation has led to powerful insights into why some companies thrive while others fail. The implications of these discoveries are far reaching and are just beginning to be explored. Scale is a thrilling scientific adventure story about the elemental natural laws that bind us together in simple but profound ways. Through the brilliant mind of Geoffrey West, we can envision how cities, companies, and biological life alike are dancing to the same simple, powerful tune.

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Customer Reviews

I had high hopes for this book, because the author is a great researcher and lecturer. However this book does not reflect his usual high standard.The beginning is terrible. He shows four graphs to illustrate scaling relationships, none of which have intelligible scales. I received an advance uncorrected copy, so perhaps some of the issues will be corrected in the final version, but the flaws run deeper than typographic.All the charts have log-log scales, although they are labeled in three different formats--scientific notation, exponent only or integer. There’s an old saying that everything looks linear in log-log plots. The reason that even a very large deviation in ratio of vertical to horizontal variable will look small if the range of the vertical variable is large. For example, the graph of "number of patents" versus "population" shows ratios that range from about 5 patents per capita to 200. No one would say that illustrates some universal law is in operation. But the vertical scale runs from population of 10,000 to 3.2 billion, 4.5 orders of magnitude, and that dwarfs the variation in patents per capita so things look linear. Standard statistical tests do not show linearity.Another problem with this chart is there is no explanation of how either variable is defined. You can’t talk about scale in isolation from what is being measured. It’s true there is a citation to the original work (although not a very helpful one). But it turns out that does not support the linearity the author of book claims, the whole point of the chart is to show that larger cities have more patents per capita than smaller ones, and says explicitly that the relation is non-linear. So the chart in the book is not only misleading by construction, it conveys the wrong idea.Another chart shows number of heartbeats per lifetime of "animals" versus weight. It looks constant, because the range seems to be about 30 million to 150 million, but the vertical scale runs from 100 to one trillion. "Animals" turns out to be a few selected mammals (whales are listed twice with different values). If you go to the paper, the author emphasizes that the interest is in the deviations from the typical relation shown by the animals on the chart; the chart only shows the typical animals. So far from a universal constant in nature, we find that a subset of mammals happen to have values within a factor of five, with other mammals and non-mammals outside that range, but missing from the chart even though the vertical

axis is scaled to accommodate them.A better chart shows metabolic rate versus weight (here labeled "mass" despite being the same scale as the previous graph). This includes selected mammals and birds, and does illustrate rough linearity in log-log space. But here the main interest is in the slope of the line rather than the linearity. Metabolic rate increases not linearly with mass but at about the 3/4 or perhaps 2/3 power. This is key, because a lot of things also go up with powers of mass and people disagree on which ones of them are important for setting the metabolic rate.Finally, there is a chart purporting to show that net income and assets of companies are linear in log-log space with number of employees. This is clearly nonsense. Technology companies often have hundreds of thousands of dollars of net income per employee, and few assets, while retailers have an order of magnitude lower profits per employee but much higher assets. There are companies that own and lease things with huge assets and few employees, and service companies that own nothing but a few desks and computers with many employees. It turns out if you read the notes at the back of the book that the 22 points are actually averages of over 30,000 companies (by the way, page, chapter and figure numbers are wrong in the notes, but I assume this will be corrected before publication). So all the chart tells us is when you average over large numbers of companies of different types but similar size, you get similar relations of employees to income and assets as the average for large numbers of companies of a different size.It’s not just the charts. Also in the first few pages, the author is hyperventilating about the "exponential rate of urbanization" that has increased the proportion of US residents who live in cities from 4% 200 years ago to 80% today and is an "impending tsunami with the potential to overwhelm us." A few seconds reflection shows the absurdity of that. If the urbanization rate is exponential, and has increased by a factor of 20 in 200 years, then in 15 years we’ll be at 100% and the "tsunami" will stall.Now I know most people think "exponential" means fast, but most theoretical physicists, and certainly the author, know better. It just means that the rate of increase is proportional to the level. Nothing in the physical universe is exponential and fast. Things can start out exponential, like a fire that spreads faster the larger it grows. But that fire eventually uses up available fuel and oxygen and goes out. Urbanization in the US since 1790 fits a near perfect Gompertz trend with an asymptote at about 83% (that doesn’t mean I predict urbanization will stabilize at 83%, drawing curves from the past is a dangerous way to predict the future, but at least a curve that fits the data is better than one that is clearly inconsistent with the data). Gompertz trends frequently give reasonable fits to data, exponential curves never do for very long.Another wildly false scare sentence is, "It is only relatively recently that we have become conscious of global warming, long-term environmental changes, limitations on energy, water, and other resources, health and pollution issues, stability of financial markets, and so

on." Take those one at a time. Global warming started in the mid-1970s, before that the Earth was cooling (you could push it back to the 1950s, but the 1950s were cooler than the 1940s; note that I’m not saying that greenhouse emissions were not affecting the global temperature before 1970, just that the Earth was not warming overall). It was not only noticed immediately, before clear statistical evidence of the trend emerged, it had been predicted long before.People have always been aware of "limitations on energy, water and other resources," and our supply of resources is far greater than at any time in the past. Health? People didn’t know about sickness and death until recently? Pollution? The ancient Romans griped and sued about gravioris caeli and infamis aer, and Seneca wrote ÃƒÂ¢Ã â ¬Ã Å“No sooner had I left behind the oppressive atmosphere of. . .[Rome] and that reek of smoking cookers which pour out, along with clouds of ashes, all the poisonous fumes theyÃƒÂ¢Ã â ¬Ã â„¢ve accumulated in their interiors whenever theyÃƒÂ¢Ã â ¬Ã â„¢re started up, that I noticed the change in my condition.ÃƒÂ¢Ã â ¬Ã Â• Pollution has been a major political issue in Europe for nearly 1,000 years. People have known about instability in financial markets as long as there have been financial markets, and every expansion of markets since has been accompanied by periods of instability and crisis.After all this, only my respect for the author kept me going. The book gets quite a bit better when it leaves off the foolishness of the beginning and discusses specific topics with precision and insight. Nevertheless, I was overall disappointed by the book. It is repetitious and bloated. It tries to cover too many topics and relate them all to each other, often in strained ways. It mixes solid research with press release studies and outdated speculations. The notes are not as helpful as they should be, few of them have any explanation, many are just names of authors or books with no clue about how to find the specific support for the cited claim. There is not a clear distinction between patterns that occur for mathematical reasons--things like Fibonacci numbers, inverse square laws, Gompertz trends, fractal scaling and power laws--versus mathematical patterns that result from top down constraints. There is a lot of first-rate material as well, but it’s not packaged well.Overall, I would recommend this book to people who are well versed in these subjects, with the patience to wade through on overlong and repetitious book for the good parts. The author is the undeniable world expert some of these things, and they are very important things to understand. Readers who are new to these ideas are likely to be misinformed, although probably entertained. Readers who are not patient should look for a better exposition.

great and fast

Excellent book! A physicist account of biology, city planning, and economics. Great account of logarithmic functions.

West’s analysis can be a great basis for conversation and his insights are valuable for anyone looking to understand the factors affecting growth (and atrophy) within their company.

This is a very important book!

This is a very intriguing book. My own interests relate to the efforts at understanding the longevity and mortality of companies and non-profit enterprises. Surprisingly little good work has been done in this area. Compared with the multitude of research in business and finance, the study of company or industry "demographics" is negligible.I believe there may be discoverable general principles, including mathematical ones, underlying the rise and fall of companies and industries. But I found little real insight here.In looking at companies, the author claims they "die" when liquidated, bankrupt, acquired, or merged. But of course many enterprises continue to grow and prosper after a merger. The vast majority of US railroads no longer exist, having consolidated from thousands to about 5 majors. Some like the Milwaukee Road and Rock Island indeed died, but the mainlines of most of the big roads of 60 years ago are busier than ever today.....with a fraction of the employees.The author also limits the study to public companies, which are somewhat less important than even 20 years ago. LBO’s, Private Equity, and Sarbanes-Oxley have conspired to reduce the number of public companies. We have more private giants than ever, joined by those who have always been private like Publix, Mars, and Cargill.The book claims that the odds of a company lasting 200 years are zero, and that the few exceptions are tiny companies. Yet some US banks (e.g., Citigroup) and insurance companies have made it. Procter & Gamble and John Deere are just 20 years shy of 200, both having been founded in 1837. And what of our large non-profit corporations? What about Harvard is different? It has metabolism and maintenance like any other economic organism, to use the language of the book.I think trying to understand companies from massive averaged datasets, without looking at the actual facts, is a slippery slope. Sometimes companies (like Sears) change names, sometimes they reincorporate, sometimes they are acquired but are in effect the surviving corporations. Did AT&T die when SBC, its own child, bought it? Is CSX the continuation of The Chessie System or The Family Lines? Did BNSF die when Berkshire Hathaway bought it? Was Agilent born when HP spun it out? You have to really look at the specifics. The same applies to any survival studies of the Fortune 500, which I have been following

since 1963.I imagine the book's approach might be much more successful (and insightful) had the author studied products or industries rather than companies. Data on the production of commodities (from steel to education to rail freight) are readily available. They include the production of all enterprises, including private companies. Time series are often available for much longer than the 59 years used on public companies in this book. And ultimately all companies (and the economy at large) are built on the rise and fall of buggy whips and smartphones.The book makes you think. I am glad I bought it. But take at least parts of it with a big grain of salt.