阿拉伯土著 21:05
thought experiments

yuki 21:06
Touch wood

阿拉伯土著 21:07
knock on wood

Humble. 21:07
factor in

阿拉伯土著 21:07
factor in

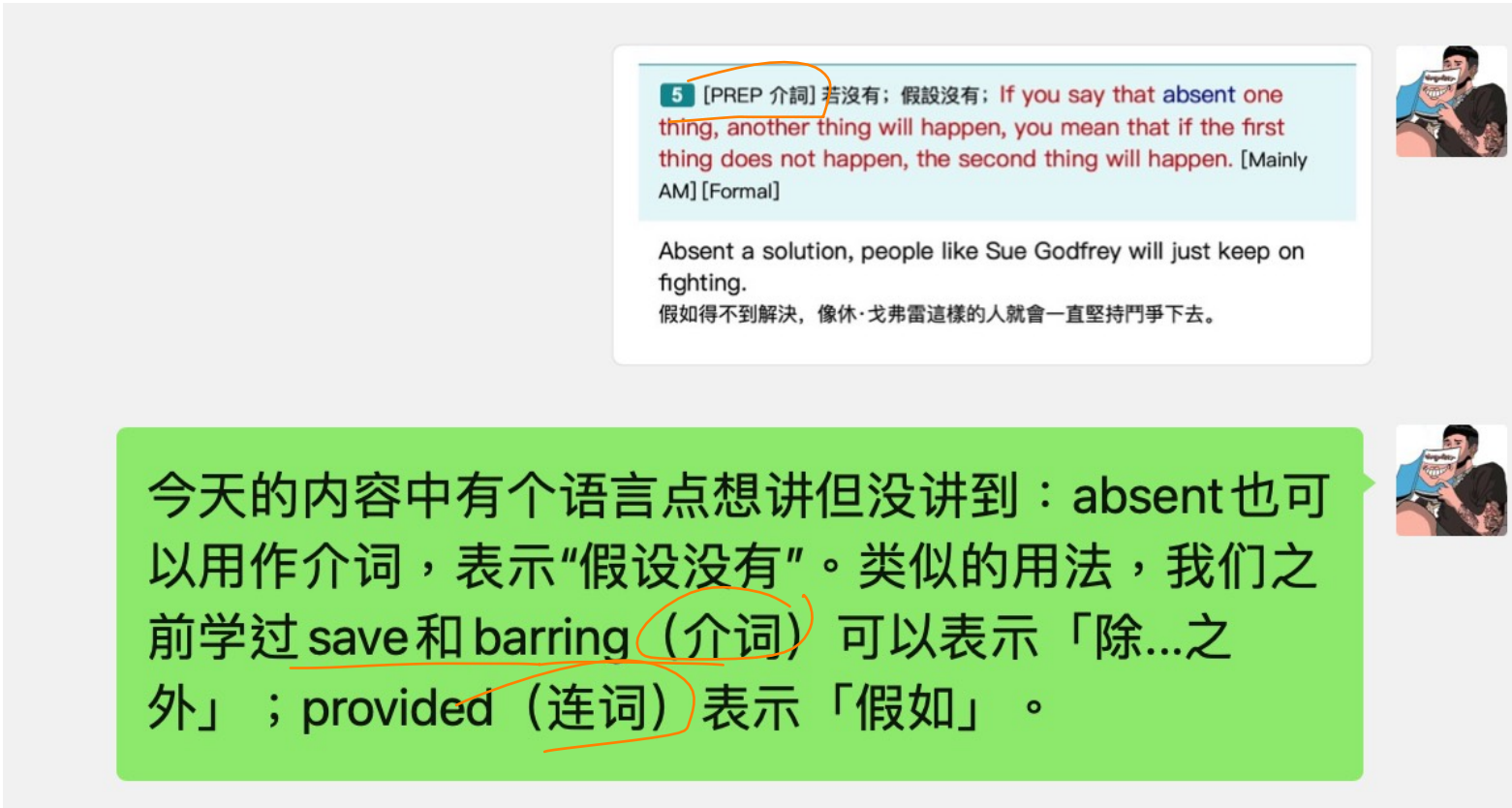
Jimmy.XL 20:55
不不 先把钱放桌面上再说...

阿拉伯土著 20:57
no brainer

Jing 20:57
no brainer vs tall order

jing 20:57
no brainer tall order

One of his notable thought experiments involved an elevator.[2] Imagine you were in a closed elevator, feet glued to the floor. Absent any other information, would you be able to know whether the elevator was in outer space with a string pulling the elevator upwards at an accelerating rate, or sitting on Earth, being pulled down by gravity? By running the thought experiment, Einstein concluded that you would not.



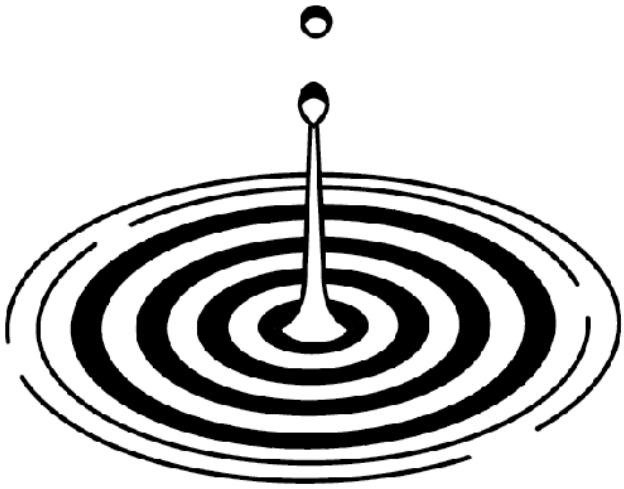

赌20刀这家伙是个超帅的黄金单身汉
20 bucks says this guy's like a hot, eligible bachelor.


Okay, okay, ten bucks says the man wins.
Who wants that action?


TEN BUCKS SAYS I NEVER SEE
THAT WOMAN AGAIN IN MY LIFE.


換一種
跑法
黃永玉
作於故鄉
時七庚
寅歲春

Second-Order Thinking



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What happens next?

Technology is fine, but the scientists and engineers only partially think through their problems. They solve certain aspects, but not the total, and as a consequence it is slapping us back in the face very hard.

Barbara McClintock [1]

The People Who Appear in this Chapter

Hardin, Garrett.
1915-2003 - American ecologist and philosopher. The common thread in his work was an interest in bioethics.

Cleopatra VII Philopator.
69-30 BCE - She was the last Ptolemy to rule Egypt and has been talked about ever since. The subject of numerous biographies, histories, plays, and movies, she is one of history's true legends.

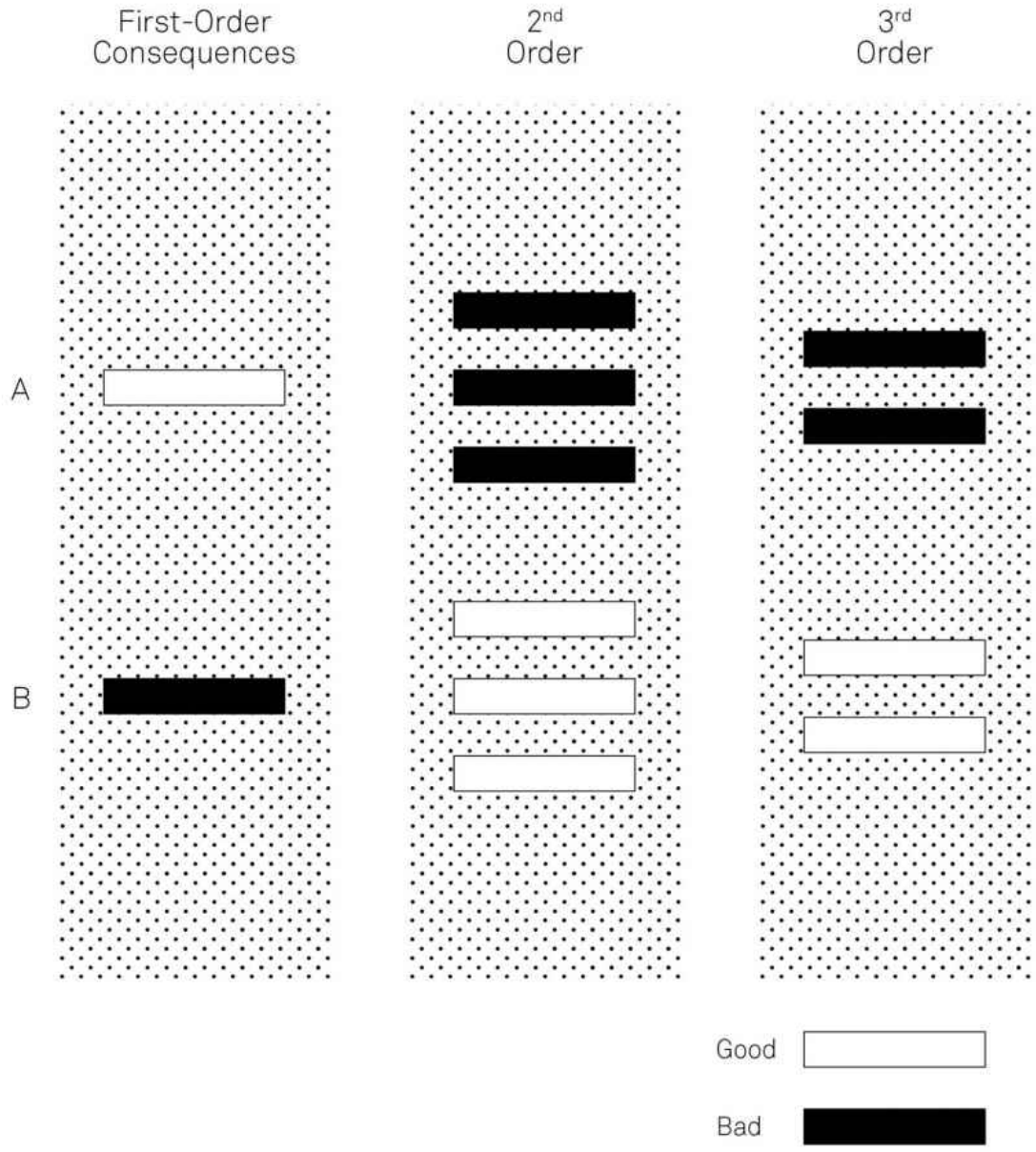
Wollstonecraft, Mary.
1759-1797 - English writer and philosopher. She wrote a huge variety of works, from novels and histories to philosophy and children's books. Her daughter Mary Shelley wrote Frankenstein.

Second-Order Thinking

Almost everyone can anticipate the immediate results of their actions. This type of first-order thinking is easy and safe but it's also a way to ensure you get the same results that everyone else gets. Second-order thinking is thinking farther ahead and thinking holistically. It requires us to not only consider our actions and their immediate consequences, but the subsequent effects of those actions as well. Failing to consider the second- and third-order effects can unleash disaster.

It is often easier to find examples of when second-order thinking didn't happen— when people did not consider the effects of the effects. When they tried to do something good, or even just benign, and instead brought calamity, we can safely assume the negative outcomes weren't factored into the original thinking. Very often, the second level of effects is not considered until it's too late. This concept is often referred to as the "Law of Unintended Consequences" for this very reason.

We see examples of this throughout history. During their colonial rule of India, the British government began to worry about the number of venomous cobras in Delhi. To reduce the numbers, they instituted a reward for every dead snake brought to officials. In response, Indian citizens dutifully complied and began breeding the snakes to slaughter and bring to officials. The snake problem was worse than when it started because the British officials didn't think at the second level. Second-order effects occur even with something simple like adding traction on tires: it seems like such a great idea because the more you have the less likely you are to slide, the faster you can stop, and thus the safer you are. However, the second-order effects are that your engine has to work harder to propel the car, you get worse gas mileage (releasing more detrimental carbon dioxide into the atmosphere), and you leave more rubber particles on the road.



This is why any comprehensive thought process considers the effects of the effects as seriously as possible. You are going to have to deal with them anyway. The genie never gets back in the bottle. You can never delete

consequences to arrive at the original starting conditions.

«Stupidity is the same as evil if you judge by the results.»

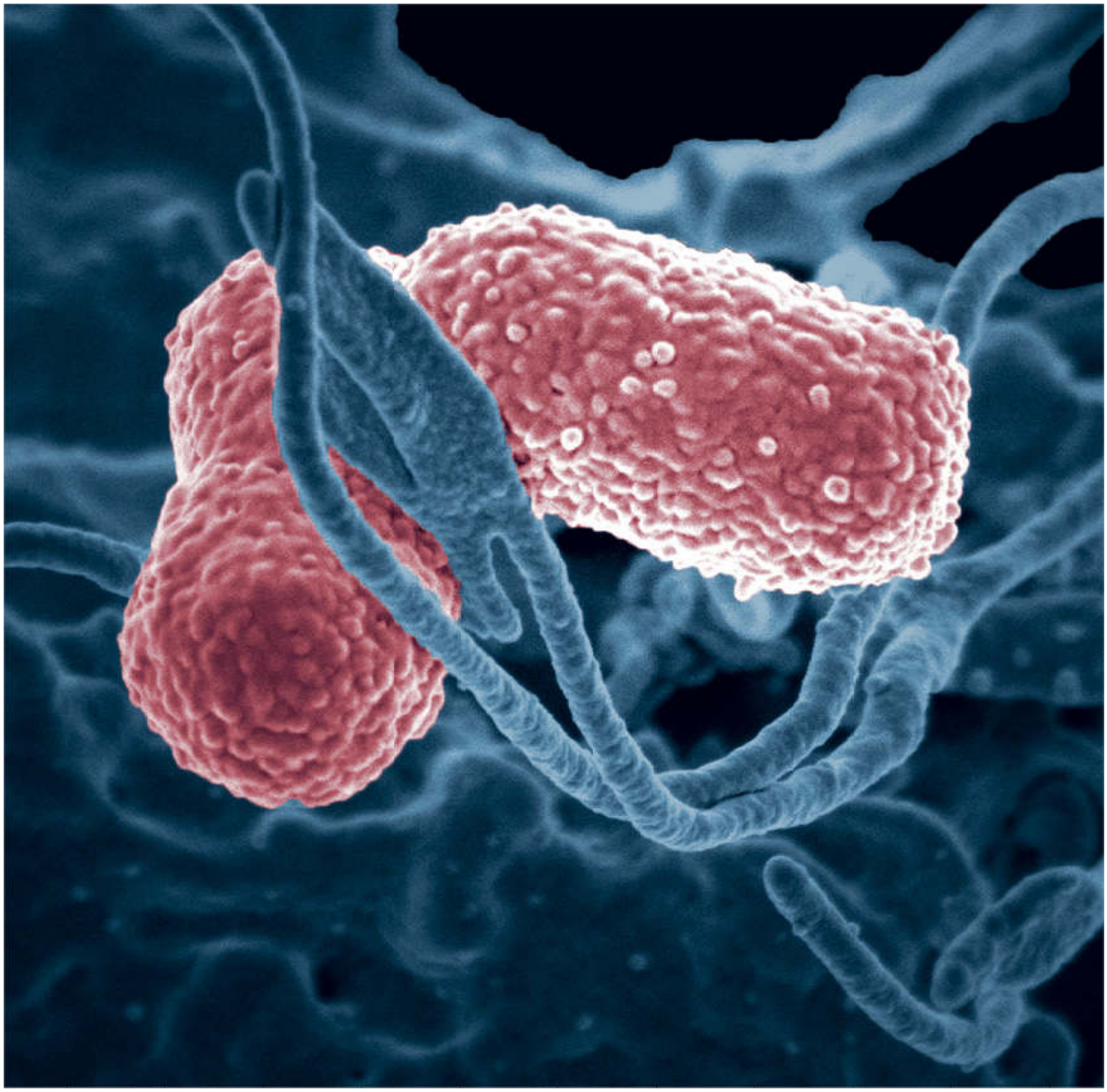
Margaret Atwood [2]

In an example of second-order thinking deficiency, we have been feeding antibiotics to livestock for decades to make the meat safer and cheaper. Only in recent years have we begun to realize that in doing so we have helped create bacteria that we cannot defend against.

In 1963, the UC Santa Barbara ecologist and economist Garrett Hardin proposed his First Law of Ecology: "You can never merely do one thing." [3] We operate in a world of multiple, overlapping connections, like a web, with many significant, yet obscure and unpredictable, relationships. He developed second-order thinking into a tool, showing that if you don't consider "the effects of the effects," you can't really claim to be doing any thinking at all.

When it comes to the overuse of antibiotics in meat, the first-order consequence is that the animals gain more weight per pound of food consumed, and thus there is profit for the farmer. Animals are sold by weight, so the less food you have to use to bulk them up, the more money you will make when you go to sell them.

The second-order effects, however, have many serious, negative consequences. The bacteria that survive this continued antibiotic exposure are antibiotic resistant. That means that the agricultural industry, when using these antibiotics as bulking agents, is allowing mass numbers of drug-resistant bacteria to become part of our food chain.



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Effect of effects: the original purpose of using antibiotics to increase cattle size led to the unintended negative consequence of creating an environment which lets drug-resistant bacteria thrive.

High degrees of connections make second-order thinking all the more critical, because denser webs of relationships make it easier for actions to have far-reaching consequences. You may be focused in one

direction, not recognizing that the consequences are rippling out all around you. Things are not produced and consumed in a vacuum.

> «When we try to pick out anything by itself, we find it hitched to everything else in the Universe.»
>
> John Muir[4]

Second-order thinking is not a way to predict the future. You are only able to think of the likely consequences based on the information available to you. However, this is not an excuse to power ahead and wait for post-facto scientific analysis.

Could these consequences of putting antibiotics in the feed of all animals have been anticipated? Likely, yes, by anyone with even a limited understanding of biology. We know that organisms evolve. They adapt based on environmental pressures, and those with shorter life cycles can do it quite quickly because they have more opportunities. Antibiotics, by definition, kill bacteria. Bacteria, just like all other living things, want to survive. The pressures put on them by continued exposure to antibiotics increase their pace of evolution. Over the course of many generations, eventually mutations will occur that allow certain bacteria to resist the effects of the antibiotics. These are the ones that will reproduce more rapidly, creating the situation we are now in. — *Sidebar: Second-Order Problem*

Second-order thinking teaches us two important concepts that underlie the use of this model. If we're interested in understanding how the world really works, we must include second and subsequent effects. We must be as observant and honest as we can about the web of connections we are operating in. How often is short-term gain worth protracted long-term pain?

Second-Order Problem

Warren Buffett used a very apt metaphor once to describe how the second-order problem is best described by a crowd at a parade: Once a few people decide to stand on their tip-toes, everyone has to stand on their tip-toes. No one can see any better, but they're all worse off.

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Buffett, Warren.
"Letter to Shareholders, 1985." BerkshireHathaway.com. Retrieved from:
http://www.berkshirehathaway.com/letters/1985.html

Let's look at two areas where second-order thinking can be used to great benefit:

1. Prioritizing long-term interests over immediate gains
2. Constructing effective arguments

Second-order thinking and realizing long-term interests:
This is a useful model for seeing past immediate gains to identify long-term effects we want. This is often a conflict for us, as when we choose to forgo the immediate pleasure of candy to improve our long-term health. The first-order effect is this amazing feeling triggered by pure sugar. But what are the second-order effects of regular candy consumption? Is this what I want my body or life to look like in ten years? Second-order thinking involves asking ourselves if what we are doing now is going to get us the results we want.

Finding historical examples of second-order thinking can be tricky because we don't want to evaluate based solely on the outcome: "It all

turned out well, so he must have thought through the consequences of his actions." Even if you can glimpse the long-term gain from your short-term pain, there is no guarantee you are going to get there.

In 48 BC, Cleopatra of Egypt was in a terrible position.[5] Technically co-regent with her brother, in a family famous for murdering siblings, she was encamped in a swampy desert, ousted from the palace, stuck with no solid plan for how to get back. She was Queen, but had made a series of unpopular decisions which left her with little support, and which gave her brother ample justification for trying to have her assassinated. What to do?

At the same time the great Roman general Caesar arrived in Egypt, chasing down his enemy Pompey and making sure the Egyptians knew who really was in charge on the Mediterranean. Egypt was an incredibly fertile, wealthy country, and as such was of great importance to the Romans. The way they inserted themselves in Egypt, however, made them extremely unpopular there.

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In order to meet Caesar and develop an alliance, yet barred from the palace, Cleopatra organized an elaborate plot to smuggle herself in wrapped in a cloth and stuffed in a basket.

In order to survive, Cleopatra had to make some decisions. Should she try to work things out with her brother? Should she try to marshal some support from another country? Or should she try to align herself with Caesar?

In *Cleopatra: A Life*, Stacy Schiff explains that even in 48 BC at the age of 21, Cleopatra would have had a superb political education, based on both historical knowledge and firsthand exposure to the tumultuous events of life on the Mediterranean. She would have observed actions taken by her father, Auletes, as well as various family members, that resulted in exile, bribery, and murder from either the family, the Romans, or the populace. She would have known that there were no easy answers. As Schiff explains, "What Auletes passed down to his daughter was a precarious balancing act. To please one constituency was to displease another. Failure to comply with Rome would lead to intervention. Failure to stand up to Rome would lead to riots."

In this situation it was thus imperative that Cleopatra consider the second-order effects of her actions. Short-term gain might easily lead to execution (as indeed it already had for many of her relatives). If she wanted to be around for a while, she needed to balance her immediate goals of survival and the throne, with the future need for support to stay on it.

In 48 BC Cleopatra chose to align herself with Caesar. It seems likely she would have known the first-order effects of this decision: Namely that it would anger her brother, who would increase his plotting to have her killed, and that it would anger the Egyptian people, who didn't want a Roman involved in their affairs. She probably anticipated that there would be short-term pain, and there was. Cleopatra effectively started a civil war, with a siege on the palace that left her and Caesar trapped there for months. In addition, she had to be constantly vigilant against the assassination schemes of her brother. So why did she do it?

Developing Trust for Future Success

Trust and trustworthiness are the results of multiple interactions. This is why second-order thinking is so useful and valuable. Going for the immediate payoff in our interactions with people, unless they are a win-win, almost always guarantees that interaction will be a one-off. Maximizing benefits is something that happens over time. Thus, considering the effects of the effects of our actions on others, or on our reputations, is critical to getting people to trust us, and to enjoy the benefits of cooperation that come with that.

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To learn more about how we build trust in relationships see:
Ostrom, Elinor and Walker, James, eds. *Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research*. New York: Russell Sage Foundation, 2003.

In reality we will never know for sure. We can only make an educated guess. But given that Cleopatra ruled Egypt quite successfully for many years after these events, her decision was based on seeing the effects of the effects. If she could somehow make it through the short-term pain, then her leadership had much greater chances of being successful with the support of Caesar and Rome than without it. As Schiff notes, "The Alexandrian War gave Cleopatra everything she wanted. It cost her little." In winning the civil war Caesar got rid of all major opposition to Cleopatra and firmly aligned himself with her reign.

Being aware of second-order consequences and using them to guide your decision-making may mean the short term is less spectacular, but the payoffs for the long term can be enormous. By delaying gratification now, you will save time in the future. You won't have to clean up the mess you made on account of not thinking through the effects of your short-term desires. — *Sidebar: Developing Trust for Future Success*

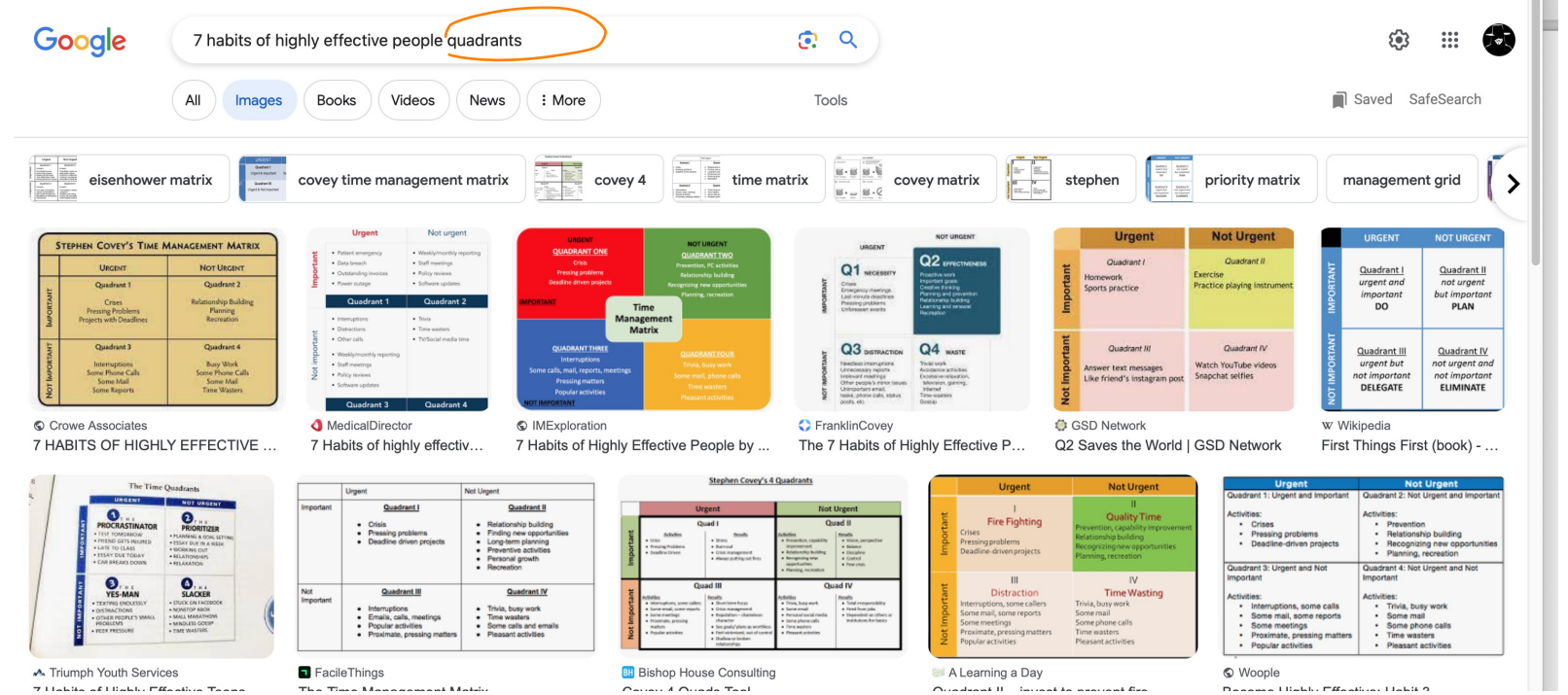
Constructing an effective argument: Second-order thinking can help you avert problems and anticipate challenges that you can then address in advance.

For example, most of us have to construct arguments every day. Convincing your boss to take a chance on a new form of outreach, convincing your spouse to try a new parenting technique. Life is filled with the need to be persuasive. Arguments are more effective when we demonstrate that we have considered the second-order effects and put effort into verifying that these are desirable as well.

In late 18th-century England, women had very few rights. Philosopher Mary Wollstonecraft was frustrated that this lack of rights limited a woman's ability to be independent and make choices on how to live her life. Instead of arguing, however, for why women should get rights, she recognized that she had to demonstrate the value that these rights would confer. She explained the benefits to society that would be realized as a result of those rights. She argued for the education of women because this would in turn make them better wives and mothers, more able to both support themselves and raise smart, conscientious children.

Her thoughts, from *A Vindication of the Rights of Woman*, are a demonstration of second-order thinking:

> *Asserting the rights which women in common with men ought to contend for, I have not attempted to extenuate their faults; but to prove them to be the natural consequence of their education and station in society. If so, it is reasonable to suppose that they will*



Stephen Covey's Time Management Matrix

	Urgent	Not Urgent
Important	**Quadrant 1** Crises Pressing Problems Projects with Deadlines	**Quadrant 2** Relationship Building Planning Recreation
Not Important	**Quadrant 3** Interruptions Some Phone Calls Some Mail Some Reports	**Quadrant 4** Busy Work Some Phone Calls Some Mail Time Wasters

change their character, and correct their vices and follies, when they are allowed to be free in a physical, moral, and civil sense.[6]

Empowering women was a first-order effect of recognizing that women had rights. But by discussing the logical consequences this would have on society, the second-order effects, she started a conversation that eventually resulted in what we now call feminism. Not only would women get freedoms they deserved, they would become better women, and better members of society.

A word of caution

Second-order thinking, as valuable as it is, must be tempered in one important way: You can't let it lead to the paralysis of the Slippery Slope Effect, the idea that if we start with action A, everything after is a slippery slope down to hell, with a chain of consequences B, C, D, E, and F.

Garrett Hardin smartly addresses this in *Filters Against Folly*:

Those who take the wedge (Slippery Slope) argument with the utmost seriousness act as though they think human beings are completely devoid of practical judgment. Countless examples from everyday life show the pessimists are wrong…If we took the wedge argument seriously, we would pass a law forbidding all vehicles to travel at any speed greater than zero. That would be an easy way out of the moral problem. But we pass no such law.[7]

In practical life, everything has limits. Even if we consider second and subsequent effects, we can only go so far. During waves of Prohibition fever in the United States and elsewhere, conservative abstainers have frequently made the case that even taking the *first* drink would be the first step towards a life of sin. They're right: It's true that drinking a beer *might* lead you to become an alcoholic. But not most of the time.

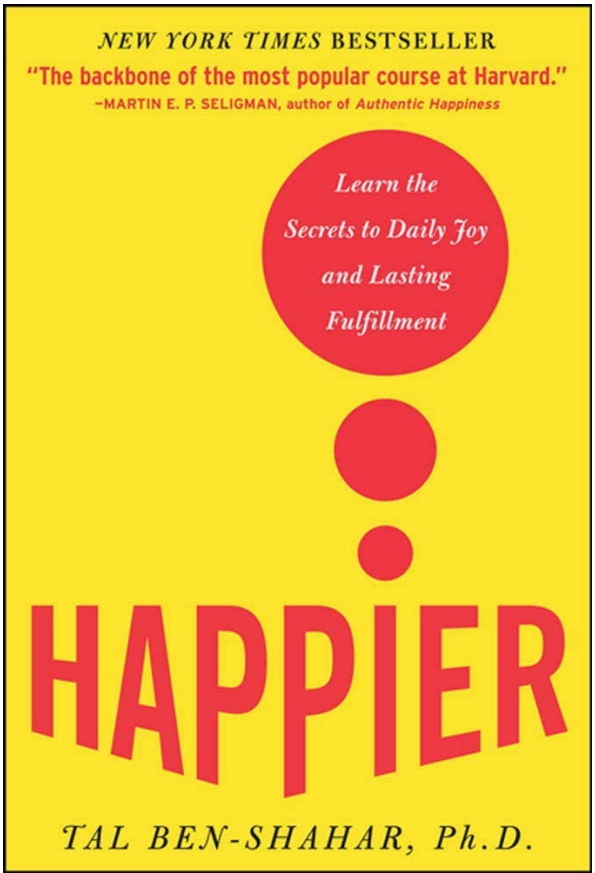
Thus we need to avoid the slippery slope and the analysis paralysis it can lead to. Second-order thinking needs to evaluate the most likely effects

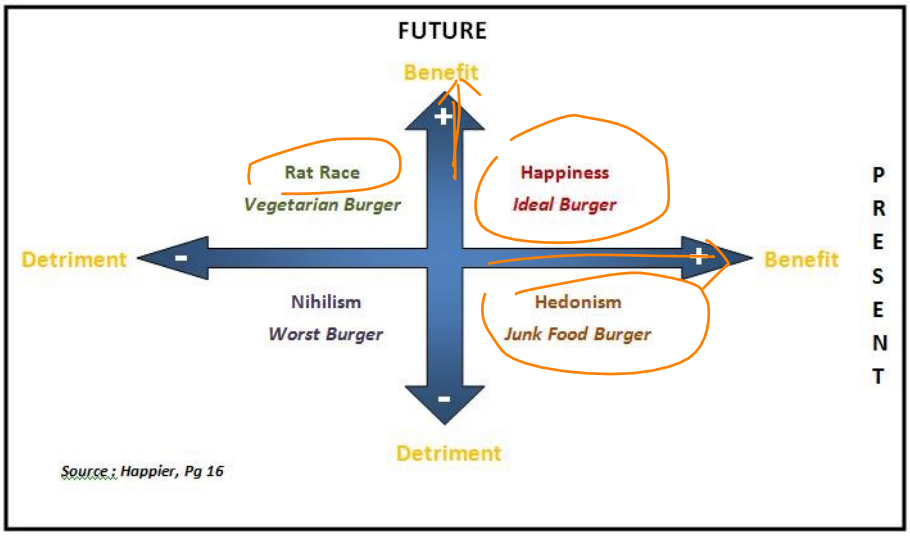
and their most likely consequences, checking our understanding of what the typical results of our actions will be. If we worried about all possible effects of effects of our actions, we would likely never do anything, and we'd be wrong. How you'll balance the need for higher-order thinking with practical, limiting judgment must be taken on a case-by-case basis.

Conclusion

We don't make decisions in a vacuum and we can't get something for nothing. When making choices, considering consequences can help us avoid future problems. We must ask ourselves the critical question: And then what?

Consequences come in many varieties, some more tangible than others. Thinking in terms of the system in which you are operating will allow you to see that your consequences have consequences. Thinking through a problem as far as you can with the information you have allows us to consider time, scale, thresholds, and more. And weighing different paths is what thinking is all about. A little time spent thinking ahead can save us massive amounts of time later.

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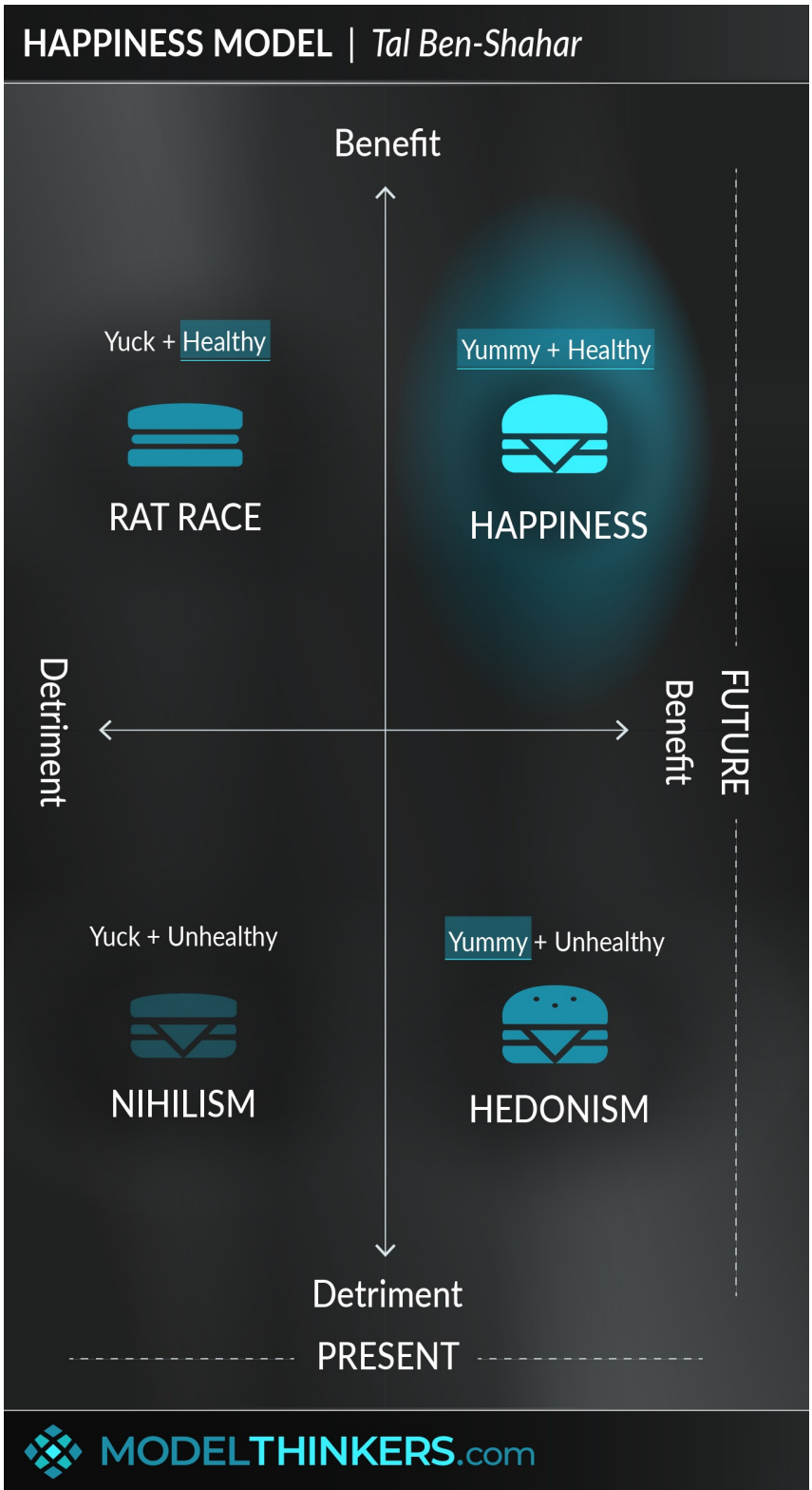
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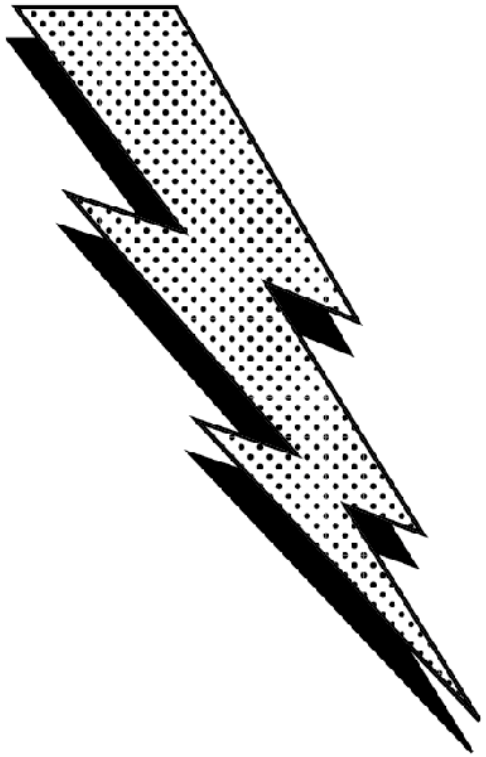
Probabilistic Thinking



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What are the chances?

The theory of probability is the only mathematical tool available to help map the unknown and the uncontrollable. It is fortunate that this tool, while tricky, is extraordinarily powerful and convenient.

Benoit Mandelbrot [1]

The People Who Appear in this Chapter

Bayes, Thomas.
1702-1761 - English statistician and minister. The theorem which bears his name is a critical part of probability mathematics. He never published it himself, and so we have to thank his friend Richard Price for not losing this work to history.

Atkins, Vera.
1908-2000 - Romanian-British intelligence officer. She received high honors from both the British and French governments for her work for the allies during World War II.

Probabilistic Thinking

Probabilistic thinking is essentially trying to estimate, using some tools of math and logic, the likelihood of any specific outcome coming to pass. It is one of the best tools we have to improve the accuracy of our decisions. In a world where each moment is determined by an infinitely complex set of factors, probabilistic thinking helps us identify the most likely outcomes. When we know these our decisions can be more precise and effective.

Are you going to get hit by lightning or not?
Why we need the concept of probabilities at all is worth thinking about. Things either are or are not, right? We either *will* get hit by lightning today or we *won't*. The problem is, we just don't know until we live out the day. Which doesn't help us at all when we make our decisions in the morning. The future is far from determined and we can better navigate it by understanding the likelihood of events that could impact us.

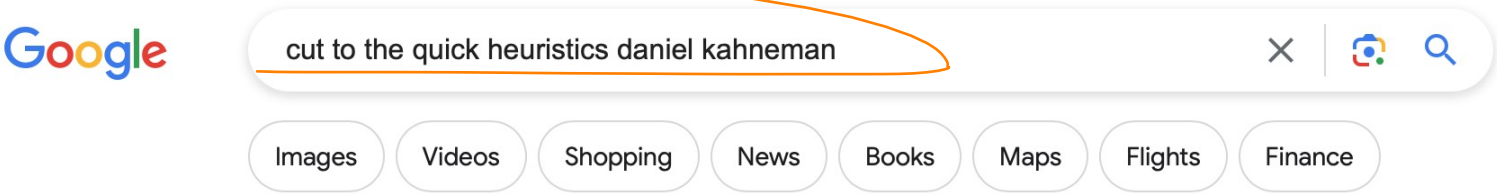
Our lack of perfect information about the world gives rise to all of probability theory, and its usefulness. We know now that the future is inherently unpredictable because not all variables can be known and even the smallest error imaginable in our data very quickly throws off our predictions. The best we can do is estimate the future by generating realistic, useful probabilities. So how do we do that?

Probability is everywhere, down to the very bones of the world. The probabilistic machinery in our minds— the cut-to-the-quick *heuristics* made so famous by the psychologists Daniel Kahneman and Amos Tversky— was evolved by the human species in a time before computers, factories, traffic, middle managers, and the stock market. It served us in a time when human life was about *survival*, and still serves us well in that capacity.[2]

But what about today— a time when, for most of us, survival is not so much

9 [PHRASE 短語] 觸及…痛處;極大傷害；令…傷透了心；If something cuts you to the quick, it makes you feel very upset. [V inflects] [LITERARY 文]

I once heard her weeping in her bedroom, which cut me to the quick.
有一次，我聽見她在臥室裡哭泣，這深深地刺痛了我的心。



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SUE | Behavioural Design
https://suebehaviouraldesign.com › kahneman-fast-slo...

Kahneman Fast and Slow thinking explained

Oct 17, 2561 BE — When making a decision, this heuristic provides us with a **mental short-cut that relies on immediate cases that come** to our mind. Or easier put: ...

what does cut-to-the-quick mean: Probability is everywhere, down to the very bones of the world. The probabilistic machinery in our minds—the cut-to-the-quick heuristics made so famous by the psychologists Daniel Kahneman and Amos Tversky—was evolved by the human species in a time before computers, factories, traffic, middle managers, and the stock market. It served us in a time when human life was about survival, and still serves us well in that capacity.

The phrase "cut-to-the-quick" is used metaphorically in this context and does not have a literal meaning. In the passage you provided, it refers to the deep, fundamental nature of the probabilistic machinery in our minds.

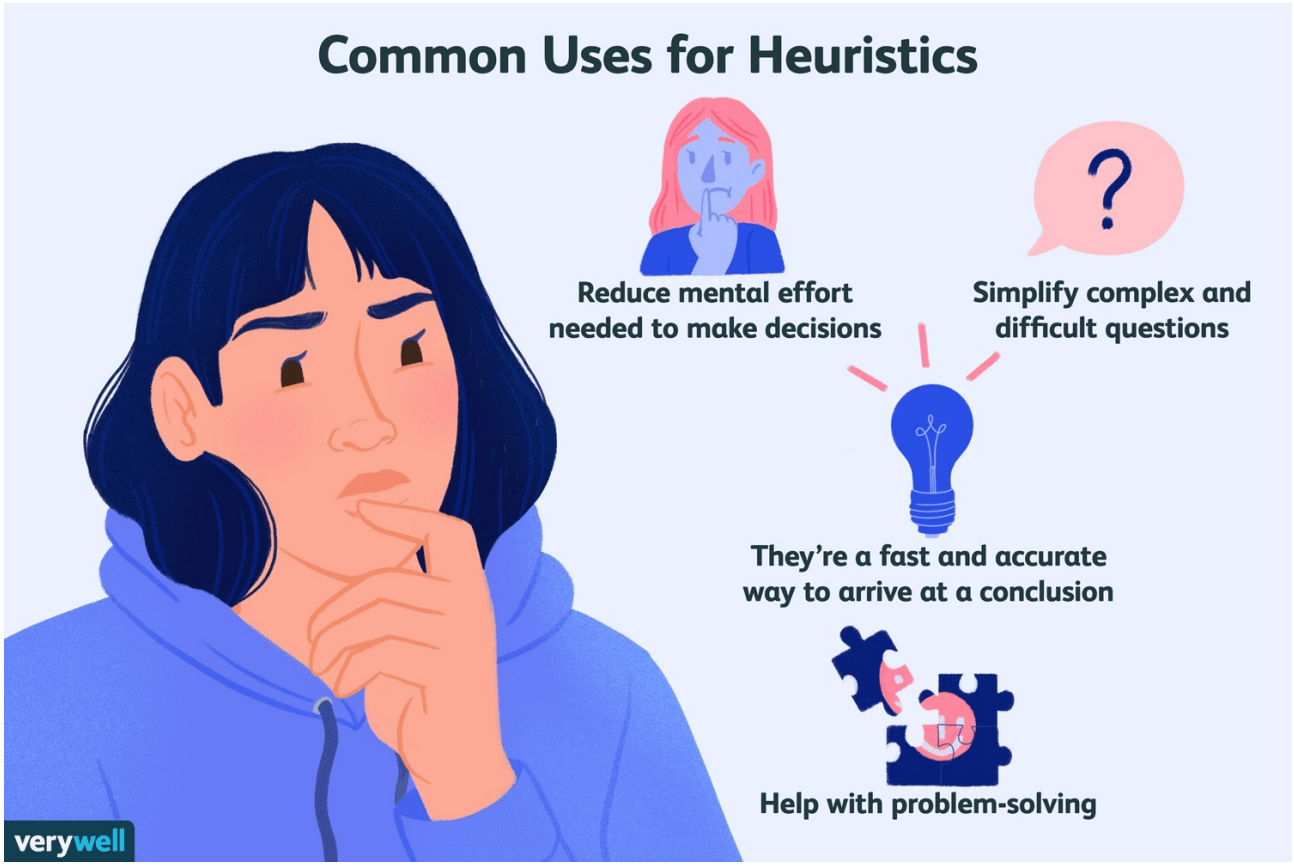
To understand the metaphor, let's break it down. The "quick" refers to the living tissue beneath the fingernail or toenail, which is highly sensitive. If you were to cut into the quick, it would cause intense pain. In this context, "cut-to-the-quick" signifies reaching the core or essence of something, exposing its most essential and sensitive parts.

By using the phrase "cut-to-the-quick heuristics," the author is emphasizing that the probabilistic mechanisms or mental shortcuts in our minds, as described by psychologists Daniel Kahneman and Amos Tversky, are deeply ingrained and fundamental to human cognition. These heuristics help us make quick judgments and decisions based on probabilities, which were developed through evolution in a time when survival was paramount.

The author suggests that despite [illegible] nology and the complexities of modern life, our probabilistic thinl [illegible] st as it did in the past. It is a

Regenerate response

Send a message


Common Uses for Heuristics
Reduce mental effort needed to make decisions
Simplify complex and difficult questions
They're a fast and accurate way to arrive at a conclusion
Help with problem-solving
verywell

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Heuristics and biases: The psychology of intuitive … - Gilovich - Cited by 4975

The contributions of **Daniel kahneman** and Amos … - Shefrin - Cited by 69

Judgment under Uncertainty: **Heuristics** and Biases: … - Tversky - Cited by 48855

Kahneman and Tversky define this heuristic as a mental shortcut for making frequency or probability judgments based on "the ease with which instances or occurrences can be brought to mind" (p. 1127). The availability heuristic occurs because we can call certain memories to mind more easily than others.

The Decision Lab
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Heuristics - The Decision Lab

THE DECISION LAB Case Studies How We Work Industries Resources About Us

BIAS Why do we take mental shortcuts? SAVE TO MY BRAIN BANK

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What are Heuristics?

Heuristics are mental shortcuts that can facilitate problem-solving and probability judgments. These strategies are generalizations, or rules-of-thumb, reduce cognitive load, and can be effective for making immediate judgments, however, they often result in irrational or inaccurate conclusions.

Where this bias occurs

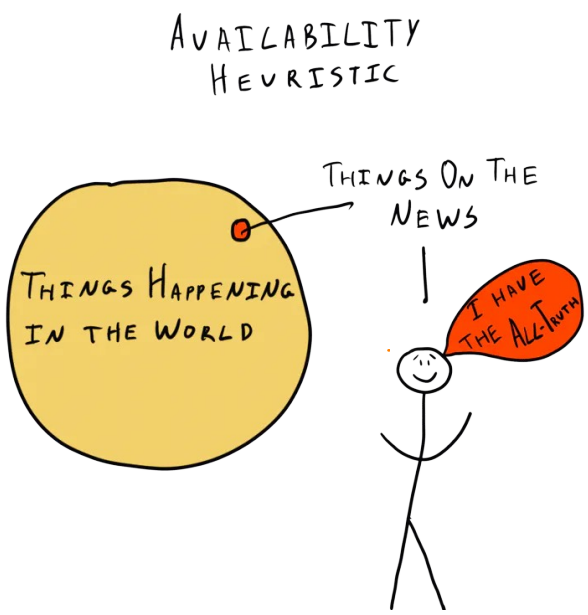
We use heuristics in all sorts of situations. One type of heuristic, the availability heuristic, often occurs when we're attempting to make judgments about the frequency with which a certain event occurs. Say, for example, someone asked you whether more tornadoes occur in Kansas or Nebraska. Most of us can easily call to mind an example of a tornado in Kansas: the tornado that whisked Dorothy Gale off to Oz in Frank L. Baum's The Wizard of Oz. Although it's fictional, this example comes to us easily. On the other hand, most people have a lot of trouble calling to mind an example of a tornado in Nebraska. This leads us to believe that tornadoes are more common in Kansas than Nebraska. However, the states actually report similar levels of tornadoes.[1]

Why it happens

In their paper "Judgment Under Uncertainty: Heuristics and Biases" (1974)[2], Daniel Kahneman and Amos Tversky identified three different kinds of heuristics: availability, representativeness, and anchoring and adjustment. Each type of heuristic is used for the purpose of reducing the mental effort needed to make a decision, but they occur in different contexts.

Availability heuristic

The first type of heuristic is the **availability heuristic**, which was touched upon in the example of judging the frequency with which tornadoes occur in Kansas relative to Nebraska. Kahneman and Tversky define this heuristic as a mental shortcut for making frequency or probability judgments based on "the ease with which instances or occurrences can be brought to mind" (p.1127).[3]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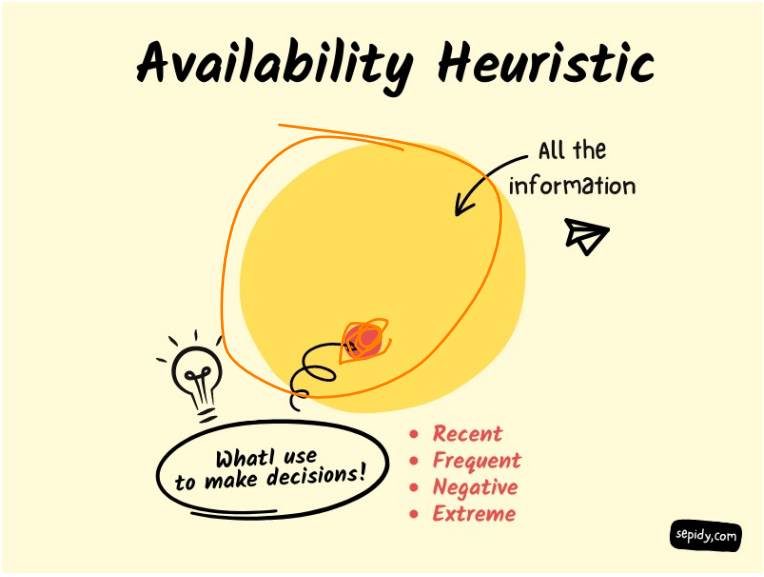
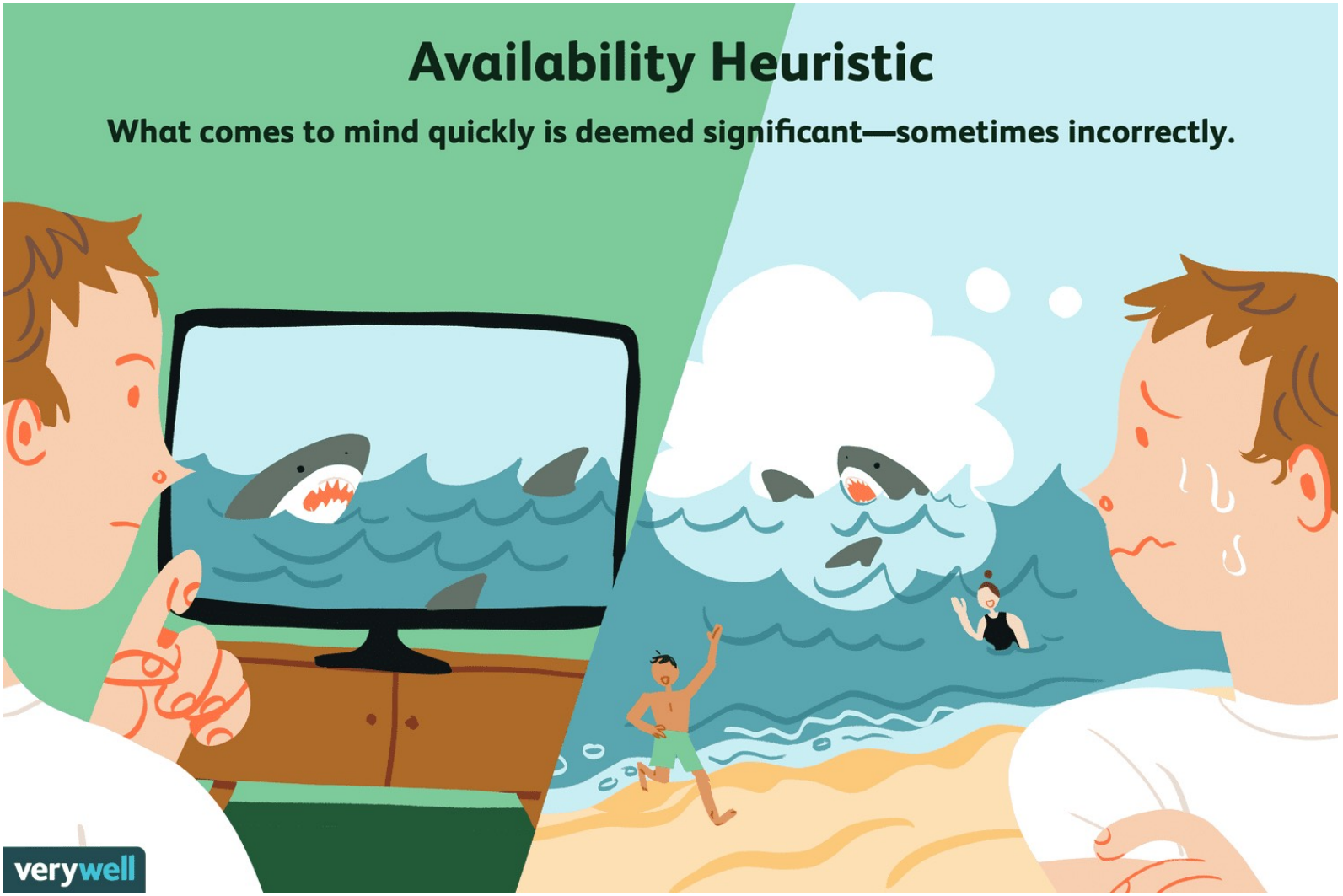
THINGS HAPPENING IN THE WORLD
I HAVE THE ALL-TRUTH


Availability Heuristic
All the information
What I use to make decisions!
Recent
Frequent
Negative
Extreme
sepidy.com

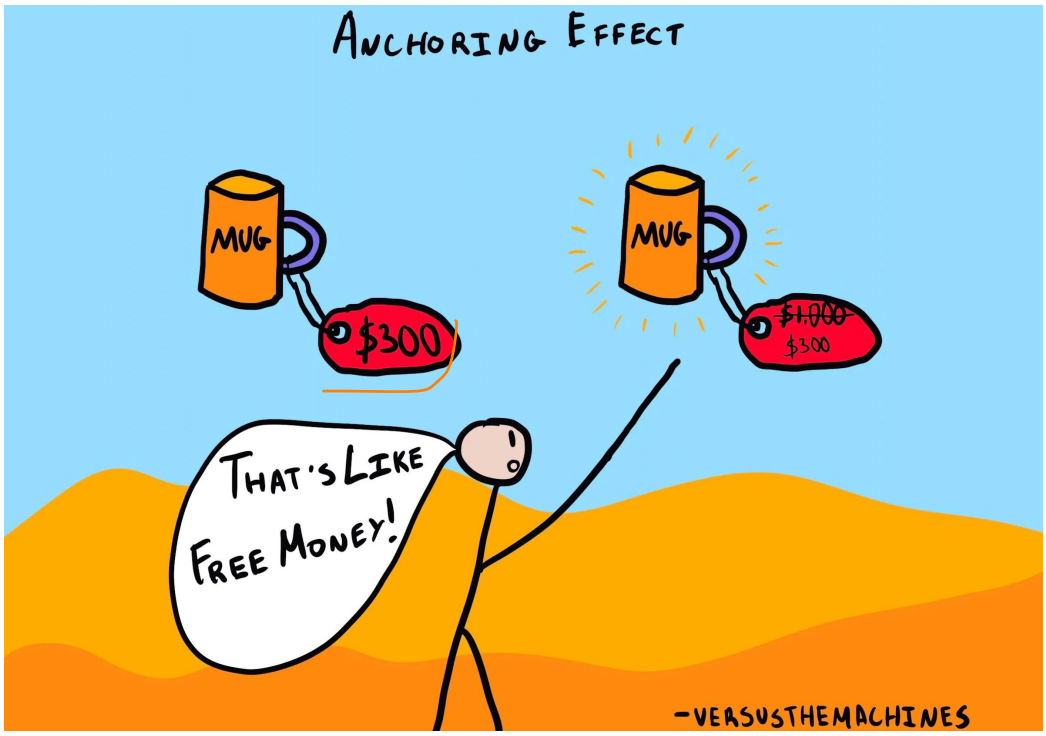

Availability Heuristic
What comes to mind quickly is deemed significant—sometimes incorrectly.
verywell

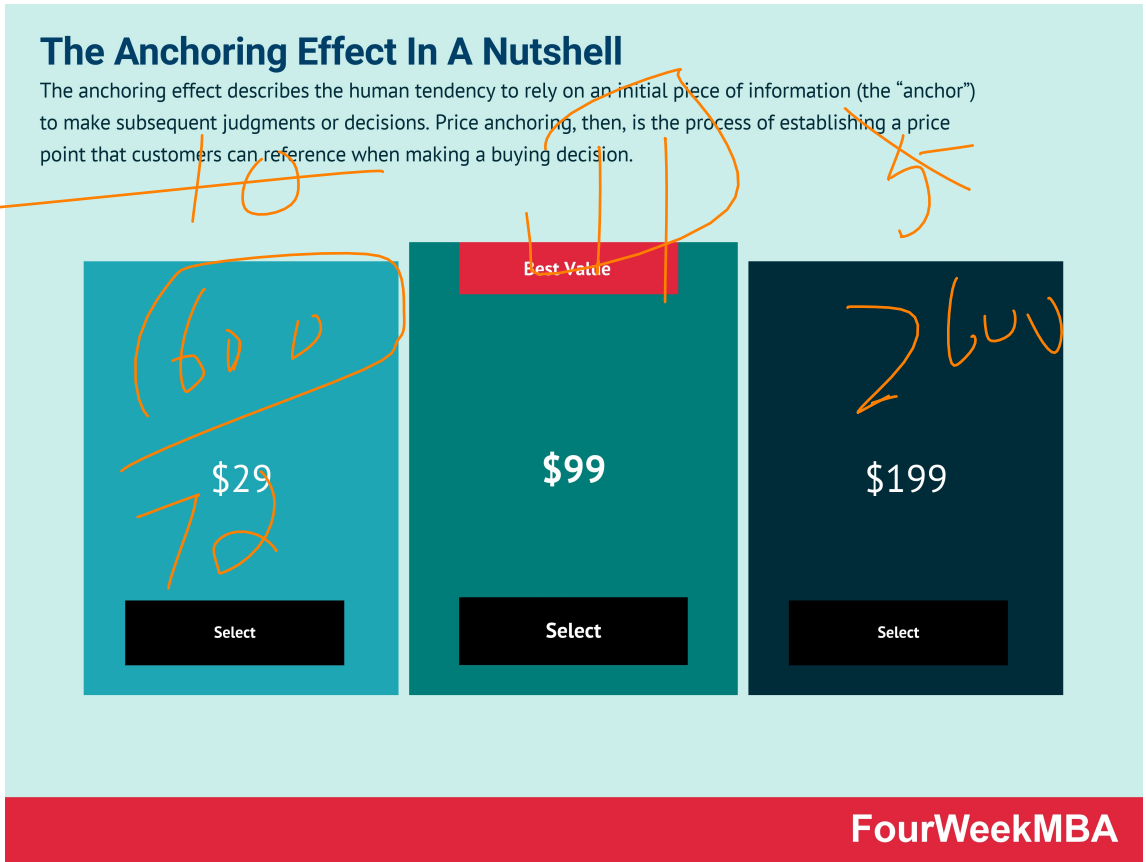
Representativeness heuristic

A second type of heuristic is the representativeness heuristic. We often rely on this heuristic when making probability judgments. We tend to classify events into categories, which, as illustrated by Kahneman and Tversky, can result in our use of this heuristic. When we use the representativeness heuristic, we make probability judgments about the likelihood that an object or event arises from some category based on the extent to which the object or event in question is similar to the prototypical example of that category.[5] For example, if someone we meet in one of our university lectures looks and acts like a stereotypical medical student, we may judge the probability that they are studying medicine as highly likely, even without any hard evidence to support that assumption.

Anchoring and adjustment heuristic

The third type of heuristic put forth by Kahneman and Tversky in their initial paper on the topic is the anchoring and adjustment heuristic.[7] This heuristic describes how, when estimating a certain value, we tend to give an initial value, then adjust it by increasing or decreasing our estimation. However, we often get stuck on that initial value – which is referred to as anchoring – which results in us making insufficient adjustments. Thus, our adjusted value is biased in favor of the initial value, which we have anchored on.





the issue? We want to *thrive*. We want to compete, and win. Mostly, we want to make good decisions in complex social systems that were not part of the world in which our brains evolved their (quite rational) heuristics.

For this, we need to consciously add in a needed layer of probability awareness. What is it and how can I use it to my advantage?

There are three important aspects of probability that we need to explain so you can integrate them into your thinking to get into the ballpark and improve your chances of catching the ball:

1. Bayesian thinking
2. Fat-tailed curves
3. Asymmetries

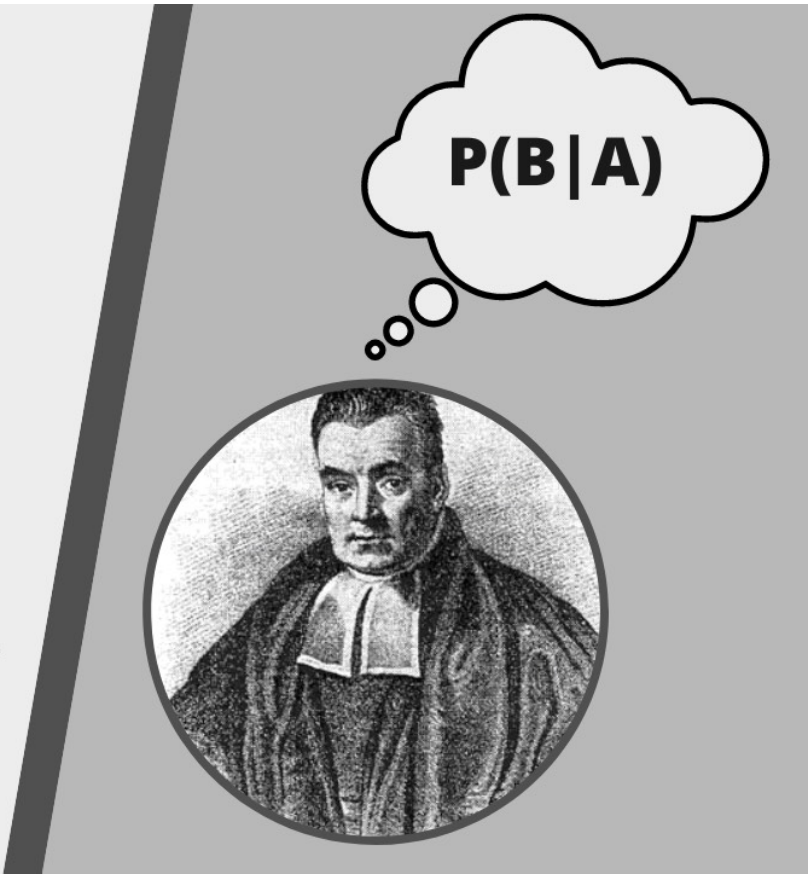
Thomas Bayes and Bayesian thinking: Bayes was an English minister in the first half of the 18th century, whose most famous work, "An Essay Toward Solving a Problem in the Doctrine of Chances", was brought to the attention of the Royal Society by his friend Richard Price in 1763— two years after his death. The essay concerned how we should adjust probabilities when we encounter new data, and provided the seeds for the great mathematician Pierre Simon Laplace to develop what we now call Bayes's Theorem.

The core of Bayesian thinking (or Bayesian updating, as it can be called) is this: given that we have limited but useful information about the world, and are constantly encountering new information, we should probably take into account what we already know when we learn something new. As much of it as possible. Bayesian thinking allows us to use all relevant prior information in making decisions. Statisticians might call it a *base rate*, taking in outside information about past situations like the one you're in.

Consider the headline "Violent Stabbings on the Rise." Without Bayesian thinking, you might become genuinely afraid because your chances of being a victim of assault or murder is higher than it was a few

BAYESIAN THINKING

Understanding the uncertainty



@MichalOleszak

LIKELIHOOD
The probability of "B" being True, given "A" is True

PRIOR
The probability "A" being True. This is the knowledge.

$$P(A|B) = \frac{P(B|A).P(A)}{P(B)}$$

POSTERIOR
The probability of "A" being True, given "B" is True

MARGINALIZATION
The probability "B" being True.

months ago. But a Bayesian approach will have you putting this information into the context of what you already know about violent crime.

You know that violent crime has been declining to its lowest rates in decades. Your city is safer now than it has been since this measurement started. Let's say your chance of being a victim of a stabbing last year was one in 10,000, or 0.01%. The article states, with accuracy, that violent crime has doubled. It is now two in 10,000, or 0.02%. Is that worth being terribly worried about? The prior information here is key. When we factor it in, we realize that our safety has not really been compromised.

Conversely, if we look at the diabetes statistics in the United States, our application of prior knowledge would lead us to a different conclusion. Here, a Bayesian analysis indicates you should be concerned. In 1958, 0.93% of the population was diagnosed with diabetes. In 2015 it was 7.4%. When you look at the intervening years, the climb in diabetes diagnosis is steady, not a spike. So the prior relevant data, or priors, indicate a trend that is worrisome.

It is important to remember that priors themselves are probability estimates. For each bit of prior knowledge, you are not putting it in a binary structure, saying it is true or not. You're assigning it a probability of being true. Therefore, you can't let your priors get in the way of processing new knowledge. In Bayesian terms, this is called the likelihood ratio or the Bayes factor. Any new information you encounter that challenges a prior simply means that the probability of that prior being true may be reduced. Eventually some priors are replaced completely. This is an ongoing cycle of challenging and validating what you believe you know. When making uncertain decisions, it's nearly always a mistake not to ask: What are the relevant priors? What might I already know that I can use to better understand the reality of the situation? — *Sidebar: Conditional Probability*

"One of the most important books I've ever read—an indispensable guide to thinking clearly about the world." —**Bill Gates**

FACTFULNESS

New York Times Bestseller

Ten Reasons We're Wrong About the World—and Why Things Are Better Than You Think

Hans Rosling with **Ola Rosling** and **Anna Rosling Rönnlund**

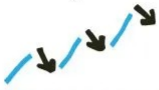
FACTFULNESS POSTER

Rules of Thumb

1 TO CONTROL THE GAP INSTINCT
Locate the majority

Is there really a gap?

2 TO CONTROL THE NEGATIVITY INSTINCT
Expect negative news



Would improvement get attention?

3 TO CONTROL THE STRAIGHT LINE INSTINCT
Imagine bending lines

Why would this line not bend?

4 TO CONTROL THE FEAR INSTINCT
Calculate the risk

Is it really dangerous?

5 TO CONTROL THE SIZE INSTINCT
Check the proportions

Is it big in comparison?

6 TO CONTROL THE GENERALIZATION INSTINCT
Question your categories

How are they different?

7 TO CONTROL THE DESTINY INSTINCT
Notice slow changes

Isn't it always changing slowly?

8 TO CONTROL THE SINGLE PERSPECTIVE INSTINCT
Use multiple tools

What other solutions exist?

9 TO CONTROL THE BLAME INSTINCT
Resist pointing finger

What system made this possible?

10 TO CONTROL THE URGENCY INSTINCT
Take small steps

Can we make decisions as we go?

Conditional Probability

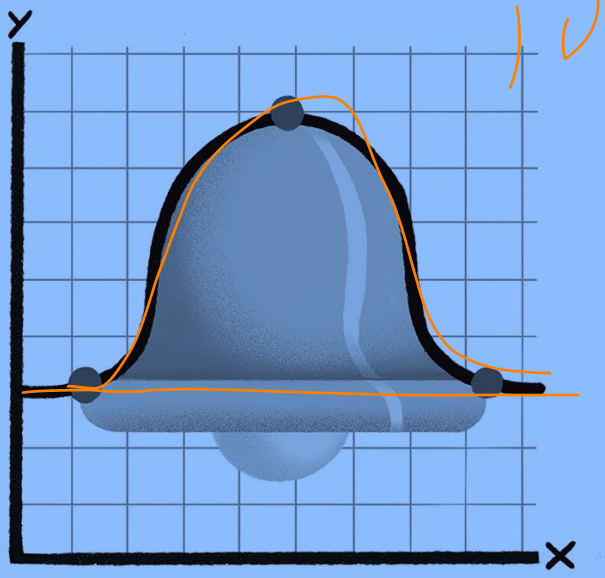
Conditional probability is similar to Bayesian thinking in practice, but comes at it from a different angle. When you use historical events to predict the future, you have to be mindful of the conditions that surrounded that event.

Events can be independent, like tossing a coin, or dependent. In the latter case, it means the outcomes of an event are conditional on what preceded them. Let's say the last three times I've hung out with you and we've gone for ice cream, I've picked vanilla. Do you conclude that vanilla is my favorite, and thus I will always choose it? You want to check first if my choosing vanilla is independent or dependent. Am I the first to choose from 100 flavors? Or am I further down the line, when chocolate is no longer available?

My ice cream choice is independent if all the flavors are available each time someone in my group makes a choice. It is dependent if the preceding choices of my friends reduce what is available to me. In this case, the probability of my choosing vanilla is conditional on what is left after my friends make their choices.

Thus, using conditional probability means being very careful to observe the conditions preceding an event you'd like to understand.

Now we need to look at fat-tailed curves: Many of us are familiar with the bell curve, that nice, symmetrical wave that captures the relative frequency of so many things from height to exam scores. The bell curve is great because it's easy to understand and easy to use. Its technical name is "normal distribution." If we know we are in a bell curve situation, we can quickly identify our parameters and plan for the most likely outcomes.



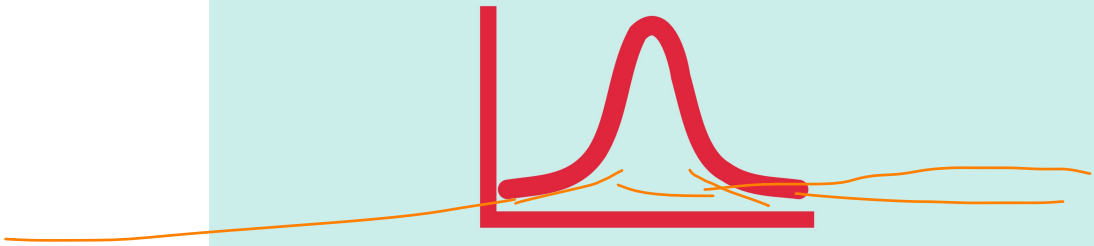
Bell Curve

['bel 'kərv]

A common type of distribution for a variable, also known as the normal distribution.

Fat-Tailed Distribution In A Nutshell

Fat-tailed distributions are graphical representations of the probability of extreme events being higher than normal. In many domains fat tails are significant, as those extreme events have a higher impact and make the whole normal distribution irrelevant. That is the case when it comes to power laws. Therefore, understanding the properties of those extreme events become critical to business survival and success.



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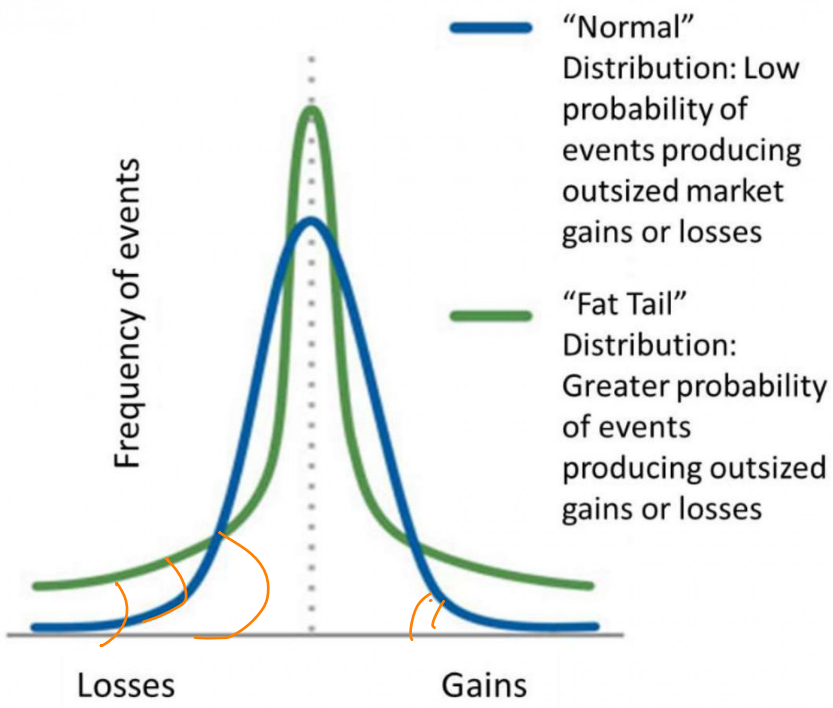


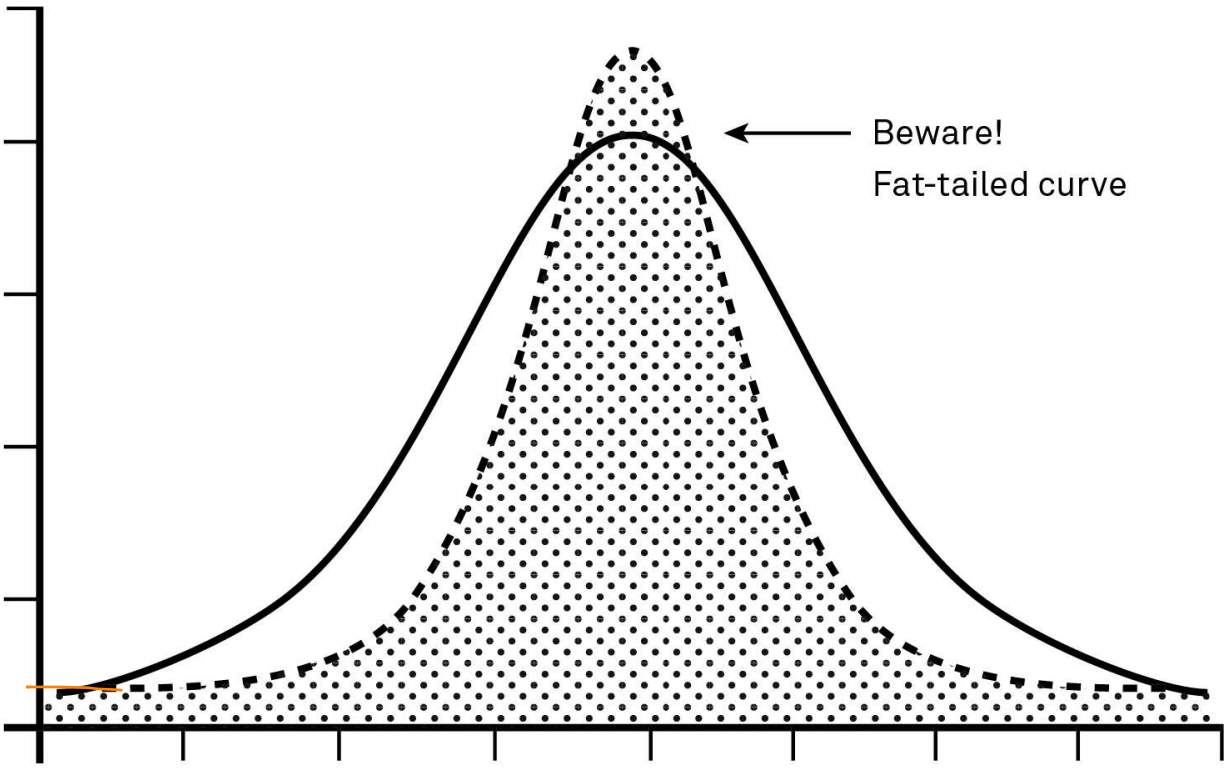
Fat-tailed curves are different. Take a look.

At first glance they seem similar enough. Common outcomes cluster together, creating a wave. The difference is in the tails. In a bell curve the extremes are predictable. There can only be so much deviation from the mean. In a fat-tailed curve there is no real cap on extreme events.

The more extreme events that are possible, the longer the tails of the curve get. Any one extreme event is still unlikely, but the sheer number of options means that we can't rely on the most common outcomes as representing the average. The more extreme events that are possible, the higher the probability that one of them will occur. Crazy things are definitely going to happen, and we have no way of identifying when. — *Sidebar: Orders of Magnitude*

Think of it this way. In a bell curve type of situation, like displaying the distribution of height or weight in a human population, there are outliers on the spectrum of possibility, but the outliers have a fairly well-defined scope. You'll never meet a man who is ten times the size of an average man. But in a curve with fat tails, like wealth, the central tendency does not work the same way. You may regularly meet people who are ten, 100, or 10,000 times wealthier than the average person. That is a very different type of world.

Let's re-approach the example of the risks of violence we discussed in relation to Bayesian thinking. Suppose you hear that you had a greater risk of slipping on the stairs and cracking your head open than being killed by a terrorist. The statistics, the priors, seem to back it up: 1,000 people slipped on the stairs and died last year in your country and only 500 died of terrorism. Should you be more worried about stairs or terror events?



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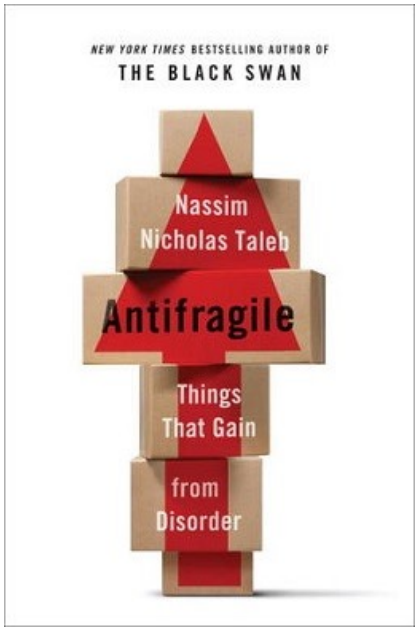
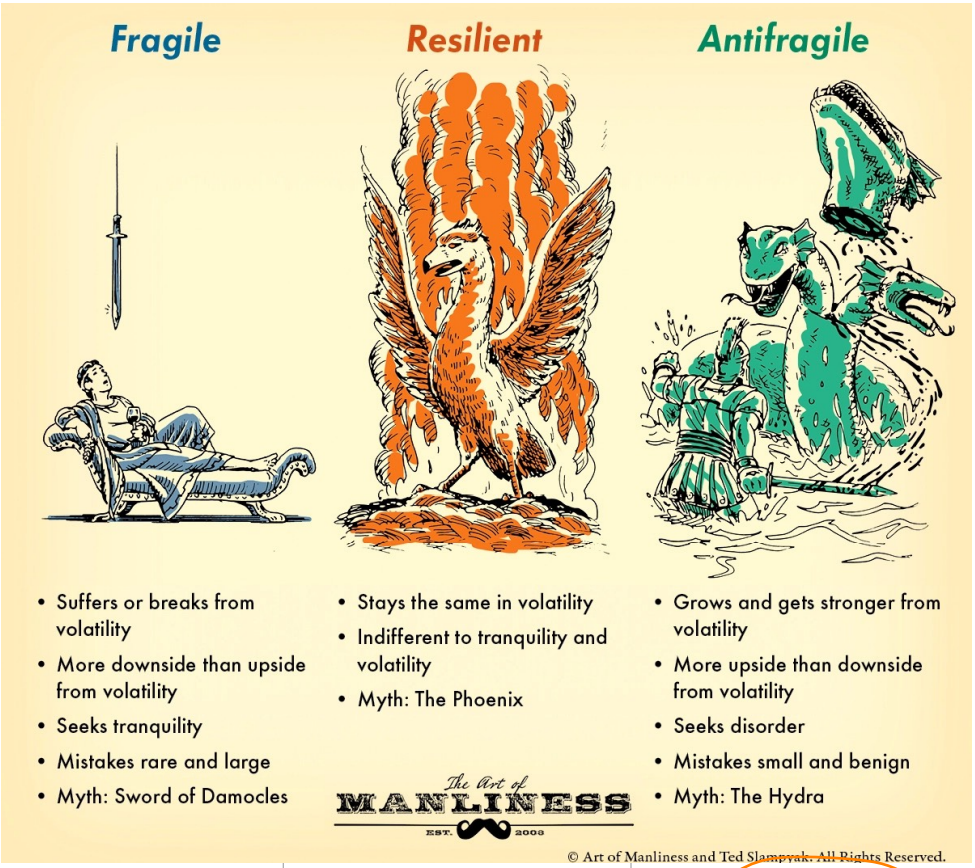
Always be extra mindful of the tails:
They might mean everything.

Some use examples like these to prove that terror risk is low— since the recent past shows very few deaths, why worry?[3] The problem is in the fat tails: The risk of terror violence is more like wealth, while stair-slipping deaths are more like height and weight. In the next ten years, how many events are possible? How fat is the tail?

The important thing is not to sit down and imagine every possible scenario in the tail (by definition, it is impossible) but to deal with fat-tailed domains in the correct way: by positioning ourselves to survive or even benefit from the wildly unpredictable future, by being the only ones thinking correctly and planning for a world we don't fully understand.

— *Sidebar: Anti-fragility*





FRAGILE

RESILIENT

ANTIFRAGILE

Anti-fragility

How do we benefit from the uncertainty of a world we don't understand, one dominated by "fat tails"? The answer to this was provided by Nassim Taleb in a book curiously titled *Antifragile*.

Here is the core of the idea. We can think about three categories of objects: Ones that are *harmed* by volatility and unpredictability, ones that are *neutral* to volatility and unpredictability, and finally, ones that *benefit* from it. The latter category is antifragile— like a package that wants to be mishandled. Up to a point, certain things benefit from volatility, and that's how we want to be. Why? Because the world is fundamentally unpredictable and volatile, and large events— panics, crashes, wars, bubbles, and so on— tend to have a disproportionate impact on outcomes.

There are two ways to handle such a world: try to predict, or try to prepare. Prediction is tempting. For all of human history, seers and soothsayers have turned a comfortable trade. The problem is that nearly all studies of "expert" predictions in such complex real-world realms as the stock market, geopolitics, and global finance have proven again and again that, for the rare and impactful events in our world, predicting is impossible! It's more efficient to prepare.

What are some ways we can prepare— arm ourselves with antifragility— so we can benefit from the volatility of the world?

The first one is what Wall Street traders would call "upside optionality", that is, seeking out situations that we expect have good odds of offering us opportunities. Take the example of attending a cocktail party where a lot of people you might like to know are in attendance. While nothing is *guaranteed* to happen— you may not meet those people, and if you do, it may not go well— you give

yourself the benefit of serendipity and randomness. The worst thing that can happen is...nothing. One thing you know for sure is that you'll never meet them sitting at home. By going to the party, you improve your odds of encountering opportunity.

The second thing we can do is to learn how to fail properly. Failing properly has two major components. First, never take a risk that will do you in completely. (Never get taken out of the game completely.) Second, develop the personal resilience to *learn* from your failures and start again. With these two rules, you can only fail temporarily.

No one likes to fail. It hurts. But failure carries with it one huge antifragile gift: learning. Those who are not afraid to fail (properly) have a huge advantage over the rest. What they learn makes them less vulnerable to the volatility of the world. They benefit from it, in true antifragile fashion.

Let's say you'd like to start a successful business, but you have no business experience. Do you attend business school or start a business that might fail? Business school has its benefits, but business itself—the rough, jagged real-world experience of it—teaches through rapid feedback loops of success and failure. In other words, trial and error carries the precious commodity of information.

The *Antifragile* mindset is a unique one. Whenever possible, try to create scenarios where randomness and uncertainty are your friends, not your enemies.

–

Taleb, Nassim.
Antifragile. New York: Random House, 2012.

Asymmetries: Finally, you need to think about something we might call "metaprobability"— the probability that your probability estimates themselves are any good.

This massively misunderstood concept has to do with asymmetries. If you look at nicely polished stock pitches made by professional investors, nearly every time an idea is presented, the investor looks their audience in the eye and states they think they're going to achieve a rate of return of 20% to 40% per annum, if not higher. Yet exceedingly few of them ever attain that mark, and it's not because they don't have any winners. It's because they get so many so wrong. They consistently overestimate their confidence in their probabilistic estimates. (For reference, the general stock market has returned no more than 7% to 8% per annum in the United States over a long period, before fees.)

Orders of Magnitude

Nassim Taleb puts his finger in the right place when he points out our *naive* use of probabilities. In *The Black Swan*, he argues that any small error in measuring the risk of an extreme event can mean we're not just slightly off, but way off— off by orders of magnitude, in fact. In other words, not just 10% wrong but ten times wrong, or 100 times wrong, or 1,000 times wrong. Something we thought could only happen every 1,000 years might be likely to happen in any given year! This is using false prior information and results in us underestimating the probability of the future distribution being different.

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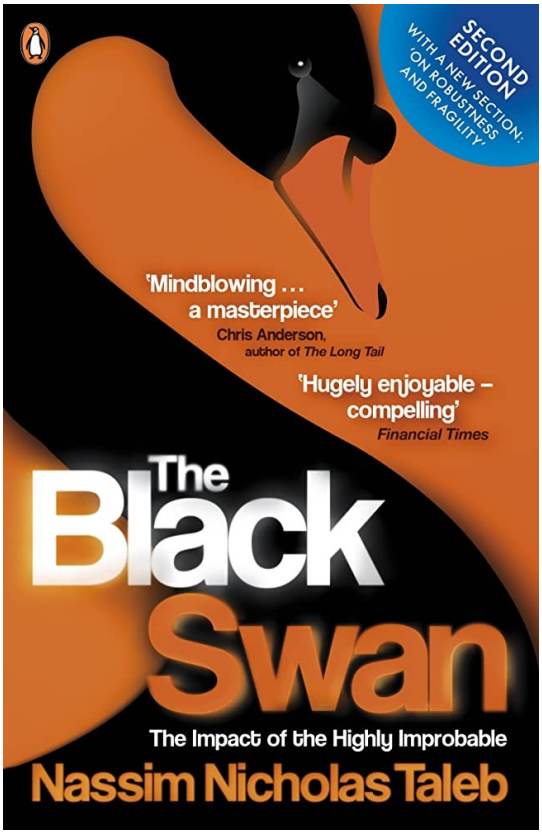
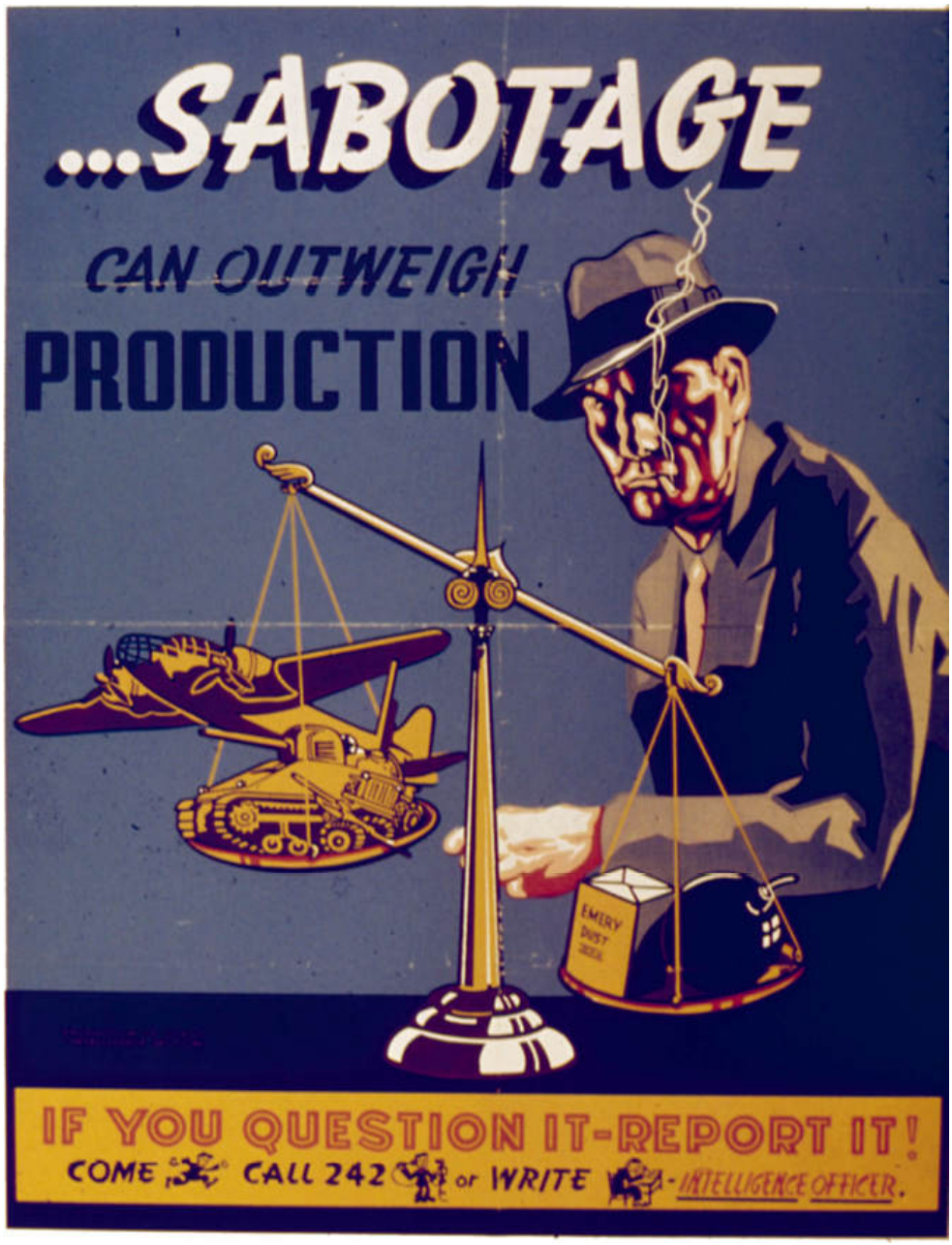
Taleb, Nassim. *The Black Swan: The Impact of the Highly Improbable*, 2nd edition. New York: Random House, 2010.





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The SOE's primary goal in France was to coordinate and initiate sabotage and other subversive activities against the Germans.

Another common asymmetry is people's ability to estimate the effect of traffic on travel time. How often do you leave "on time" and arrive 20%

early? Almost never? How often do you leave "on time" and arrive 20% late? All the time? Exactly. Your estimation errors are asymmetric, skewing in a single direction. This is often the case with probabilistic decision-making.

Far more probability estimates are wrong on the "over-optimistic" side than the "under-optimistic" side. You'll rarely read about an investor who aimed for 25% annual return rates who subsequently earned 40% over a long period of time. You can throw a dart at the Wall Street Journal and hit the names of lots of investors who aim for 25% per annum with each investment and end up closer to 10%.

The spy world

Successful spies are very good at probabilistic thinking. High-stakes survival situations tend to make us evaluate our environment with as little bias as possible.

When Vera Atkins was second in command of the French unit of the Special Operations Executive (SOE), a British intelligence organization reporting directly to Winston Churchill during World War II[4], she had to make hundreds of decisions by figuring out the probable accuracy of inherently unreliable information.

Atkins was responsible for the recruitment and deployment of British agents into occupied France. She had to decide who could do the job, and where the best sources of intelligence were. These were literal life-and-death decisions, and all were based in probabilistic thinking.

First, how do you choose a spy? Not everyone can go undercover in high stress situations and make the contacts necessary to gather intelligence. The result of failure in France in WWII was not getting fired; it was death. What factors of personality and experience show that a person is right for the job? Even today, with advancements in psychology, interrogation, and polygraphs, it's still a judgment call.

–

Many of the British Intelligence services worked with the French Resistance in WWII. It was a win-win. Expert knowledge of the territory for the British, weapons and financial support for the Resistance.

For Vera Atkins in the 1940s, it was very much a process of assigning weight to the various factors and coming up with a probabilistic assessment of who had a decent chance of success. Who spoke French? Who had the confidence? Who was too tied to family? Who had the problem-solving capabilities? From recruitment to deployment, her development of each spy was a series of continually updated, educated estimates.

Getting an intelligence officer ready to go is only half the battle. Where do you send them? If your information was so great that you knew exactly where to go, you probably wouldn't need an intelligence mission. Choosing a target is another exercise in probabilistic thinking. You need to evaluate the reliability of the information you have and the networks you have set up. Intelligence is not evidence. There is no chain of command or guarantee of authenticity.

The stuff coming out of German-occupied France was at the level of grainy photographs, handwritten notes that passed through many hands on the way back to HQ, and unverifiable wireless messages sent quickly, sometimes sporadically, and with the operator under incredible stress. When deciding what to use, Atkins had to consider the relevancy, quality, and timeliness of the information she had.

She also had to make decisions based not only on what had happened, but what possibly could. Trying to prepare for every eventuality means that spies would never leave home, but they must somehow prepare for a good deal of the unexpected. After all, their jobs are often executed in highly volatile, dynamic environments. The women and men Atkins sent over to France worked in three primary occupations: organizers were responsible for recruiting locals, developing the network, and identifying sabotage targets; couriers moved information all around the country, connecting people and networks to coordinate activities; and wireless operators had to set up heavy communications equipment, disguise it, get

information out of the country, and be ready to move at a moment's notice. All of these jobs were dangerous. The full scope of the threats was never completely identifiable. There were so many things that could go wrong, so many possibilities for discovery or betrayal, that it was impossible to plan for them all. The average life expectancy in France for one of Atkins's wireless operators was six weeks.

Finally, the numbers suggest an asymmetry in the estimation of the probability of success of each individual agent. Of the 400 agents that Atkins sent over to France, 100 were captured and killed. This is not meant to pass judgment on her skills or smarts. Probabilistic thinking can only get you in the ballpark. It doesn't guarantee 100% success.

There is no doubt that Atkins relied heavily on probabilistic thinking to guide her decisions in the challenging quest to disrupt German operations in France during World War II. It is hard to evaluate the success of an espionage career, because it is a job that comes with a lot of loss. Atkins was extremely successful in that her network conducted valuable sabotage to support the Allied cause during the war, but the loss of life was significant.

Conclusion

Successfully thinking in shades of probability means roughly identifying what matters, coming up with a sense of the odds, doing a check on our assumptions, and then making a decision. We can act with a higher level of certainty in complex, unpredictable situations. We can never know the future with exact precision. Probabilistic thinking is an extremely useful tool to evaluate how the world will most likely look so that we can effectively strategize.

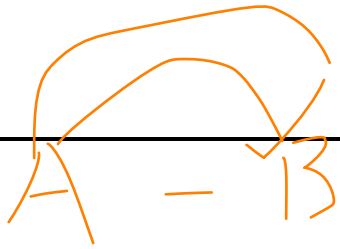
Insurance Companies

The most probability-acute businesses in the world are insurance companies— because they must be. When we think of insurance, we might think of life insurance (the probability of a policyholder dying at a certain age), or auto insurance (the probability of being in a car accident), or maybe home insurance (the probability of a tree falling on the house). With the statistics available to us, the probabilities of these things are easy to price and predict across a large enough population.

But insurance is deeply wide-ranging, and insurers will insure almost any event, for a price. Insurance policies have been taken out on Victoria's Secret models' legs, on baseball players' arms, on the Pepsi Challenge and the NCAA tournament, and even on a famous country singer's breasts!

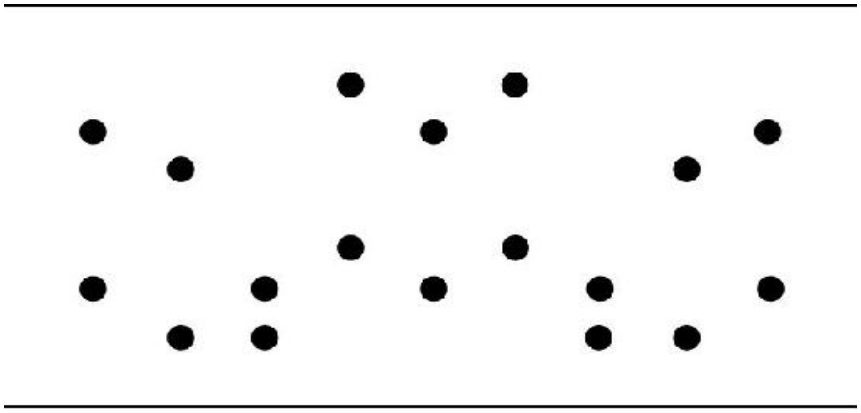
How is this possible? Only with a close attention to probability. What the great insurance companies in the world know how to do is pay attention to the important factors, even if they're not totally predictable, and price accordingly.

What is the probability of a Victoria's Secret model injuring her legs badly enough to end her career? One in 10,000? One in 100,000? Getting it right would mean evaluating her lifestyle, her habits, her health, her family history— and coming up with a price and a set of conditions that are good enough to provide a profit on average. It's not unlike handicapping a race at the horse tracks. You can always say yes to insuring, but the trick is to come up with the right price. And for that we need probability.



Supporting Idea:

Causation vs. Correlation



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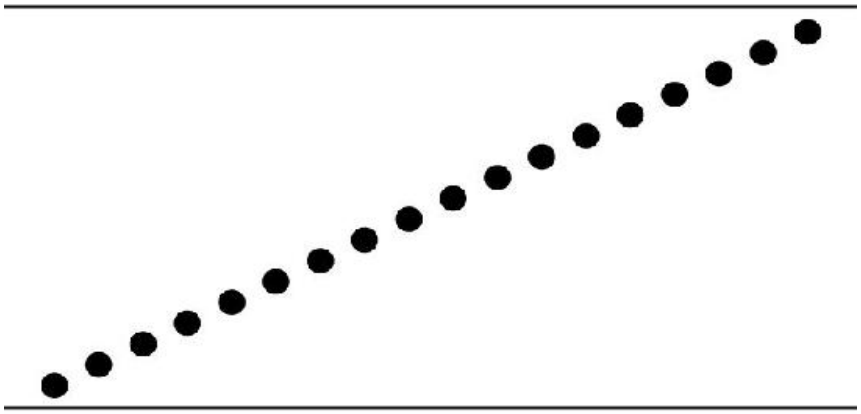
No Correlation



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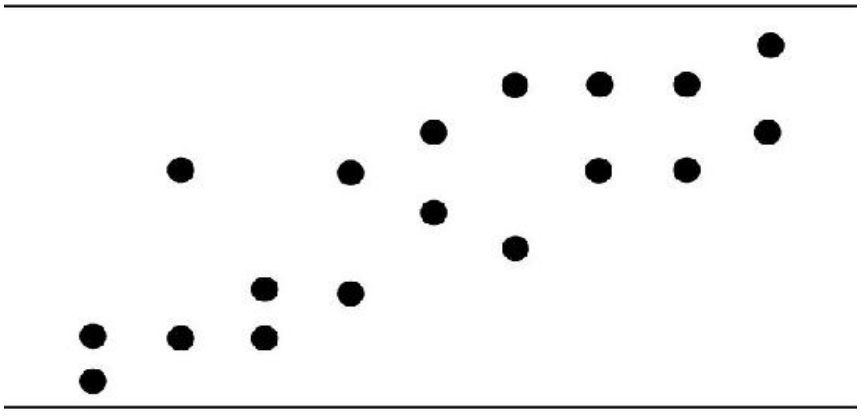
Perfect Correlation



Confusion between these two terms often leads to a lot of inaccurate assumptions about the way the world works. We notice two things happening at the same time (correlation) and mistakenly conclude that one causes the other (causation). We then often act upon that erroneous conclusion, making decisions that can have immense influence across our lives. The problem is, without a good understanding of what is meant by these terms, these decisions fail to capitalize on real dynamics in the world and instead are successful only by luck.

No Correlation

The correlation coefficient between two measures, which varies between -1 and 1, is a measure of the relative weight of the factors they share. For example, two phenomena with few factors shared, such as bottled water consumption versus suicide rate, should have a correlation coefficient of close to 0. That is to say, if we looked at all countries in the world and plotted suicide rates of a specific year against per capita consumption of bottled water, the plot would show no pattern at all.

Perfect Correlation

On the contrary, there are measures which are solely dependent on the same factor. A good example of this is temperature. The only factor governing temperature— velocity of molecules— is shared by all scales. Thus each degree in Celsius will have exactly one corresponding value in Fahrenheit. Therefore temperature in Celsius and Fahrenheit will have a correlation coefficient of 1 and the plot will be a straight line.

Weak to Moderate Correlation

There are few phenomena in human sciences that have a correlation

coefficient of 1. There are, however, plenty where the association is weak to moderate and there is some explanatory power between the two phenomena. Consider the correlation between height and weight, which would land somewhere between 0 and 1. While virtually every three-year-old will be lighter and shorter than every grown man, not all grown men or three-year-olds of the same height will weigh the same.

This variation and the corresponding lower degree of correlation implies that, while height is generally speaking a good predictor, there clearly are factors other than height at play.

In addition, correlation can sometimes work in reverse. Let's say you read a study that compares alcohol consumption rates in parents and their corresponding children's academic success. The study shows a relationship between high alcohol consumption and low academic success. Is this a causation or a correlation? It might be tempting to conclude a causation, such as the more parents drink, the worse their kids do in school.

However, this study has only demonstrated a relationship, not proved that one causes the other. The factors correlate— meaning that alcohol consumption in parents has an inverse relationship with academic success in children. It is entirely possible that having parents who consume a lot of alcohol leads to worse academic outcomes for their children. It is also possible, however, that the reverse is true, or even that having kids who do poorly in school causes parents to drink more. Trying to invert the relationship can help you sort through claims to determine if you are dealing with true causation or just correlation.

Causation

Whenever correlation is imperfect, extremes will soften over time. The best will always appear to get worse and the worst will appear to

get better, regardless of any additional action. This is called regression to the mean, and it means we have to be extra careful when diagnosing causation. This is something that the general media and sometimes even trained scientists fail to recognize.

Consider the example Daniel Kahneman gives in *Thinking Fast and Slow*:[5]

> *Depressed children treated with an energy drink improve significantly over a three-month period. I made up this newspaper headline, but the fact it reports is true: if you treated a group of depressed children for some time with an energy drink, they would show a clinically significant improvement. It is also the case that depressed children who spend some time standing on their head or hug a cat for twenty minutes a day will also show improvement.*

Whenever coming across such headlines it is very tempting to jump to the conclusion that energy drinks, standing on the head, or hugging cats are all perfectly viable cures for depression. These cases, however, once again embody the regression to the mean:

> *Depressed children are an extreme group, they are more depressed than most other children—and extreme groups regress to the mean over time. The correlation between depression scores on successive occasions of testing is less than perfect, so there will be regression to the mean: depressed children will get somewhat better over time even if they hug no cats and drink no Red Bull.*

We often mistakenly attribute a specific policy or treatment as the cause of an effect, when the change in the extreme groups would have happened anyway. This presents a fundamental problem: how can we know if the effects are real or simply due to variability?

Luckily there is a way to tell between a real improvement and

something that would have happened anyway. That is the introduction of the so-called control group, which is expected to improve by regression alone. The aim of the research is to determine whether the treated group improves more than regression can explain.

In real life situations with the performance of specific individuals or teams, where the only real benchmark is the past performance and no control group can be introduced, the effects of regression can be difficult if not impossible to disentangle. We can compare against industry average, peers in the cohort group or historical rates of improvement, but none of these are perfect measures.

Prologue

I. HOW TO LOVE THE WIND

Wind extinguishes a candle and energizes fire.

Likewise with randomness, uncertainty, chaos: you want to use them, not hide from them. You want to be the fire and wish for the wind. This summarizes this author's nonmeek attitude to randomness and uncertainty.

We just don't want to just survive uncertainty, to just about make it. We want to survive uncertainty and, in addition—like a certain class of aggressive Roman Stoics—have the last word. The mission is how to domesticate, even dominate, even conquer, the unseen, the opaque, and the inexplicable.

How?

II. THE ANTIFRAGILE

Some things benefit from shocks; they thrive and grow when exposed to volatility, randomness, disorder, and stressors and love adventure, risk, and uncertainty. Yet, in spite of the ubiquity of the phenomenon, there is no word for the exact opposite of fragile. Let us call it antifragile.

Antifragility is beyond resilience or robustness. The resilient resists shocks and stays the same; the antifragile gets better. This property is behind everything that has changed with time: evolution, culture, ideas, revolutions, political systems, technological innovation, cultural and economic success, corporate survival, good recipes (say, chicken soup or steak tartare with a drop of cognac), the rise of cities, cultures, legal systems, equatorial forests, bacterial resistance … even our own existence as a species on this planet. And antifragility determines the boundary between what is living and organic (or complex), say, the human body, and what is inert, say, a physical object like the stapler on your desk.

The antifragile loves randomness and uncertainty, which also means—crucially—a love of errors, a certain class of errors. Antifragility has a singular property of allowing us to deal with the unknown, to do things without understanding them—and do them well. Let me be more aggressive: we are largely better at doing than we are at thinking, thanks to antifragility. I'd rather be dumb and antifragile than extremely smart and fragile, any time.

It is easy to see things around us that like a measure of stressors and volatility: economic