

USING SCIENCE TO RESTORE FAITH — IN SCIENCE

BY GREG DICK AND STEPHANIE KEATING



ONLINE REALITY

Memes — those pithy captioned images that fill our social feeds with humour, politics, and sometimes vitriol — simplify complex ideas into emotion-inducing caricatures of reality.

In his book “Thinking, Fast and Slow,” Nobel Prize-winning Professor of Psychology Daniel Kahneman described how our brains default to one of two processes when confronted with new situations.

The first process, which Kahneman calls “System 1,” is lightning fast. Information is taken in and immediately placed within a person’s existing mental constructs linked to emotions like danger, fear, happiness, or joy. System 1 thinking allows us to go efficiently about our day, making assumptions quickly, quietly re-enforcing our worldview, minimizing the need for profound alternations to our thought patterns, and reducing anxiety. It also comes in handy when you are confronted by a bear in the deep woods, or crossing the street against the lights.

The second process, “System 2,” is slow, methodical, and nuanced. System 2 is what allows us to make impactful decisions, like buying a house or planning out a healthy diet for the coming week. Using this process, we employ logic, weigh evidence, question inconsistencies, and dig deeper in search of a more complete picture. It’s a powerful process, one that consumes significantly more calories and is more mentally taxing than System 1, and is usually reserved for more intentional activities [2].

Combined, the two processes provide us with an effective means for getting through our days, instinctively reacting most of the time with little energy cost and reserving the more energy intensive mental efforts for those few activities that truly warrant.

A meme is the perfect tool to engage System 1, often triggering a laugh as your thumb continues to keep the scroll alive. The longer you scroll, the more ad revenue your favourite feed will generate.

Fear and anger seize your System 1 thinking with an even tighter grip — and this is where a problem begins to emerge. There is a strong financial incentive to keep you scrolling, so social media algorithms fill your feed with customized content that will trigger you most deeply — either emotionally reinforcing existing beliefs and biases or directly contradicting them. The result is a stream of questionable content being absorbed via System 1, repeatedly reinforcing your unconscious biases.

Most of us want to believe we are not affected by the stream of memes, but the evidence suggests we are [2]. Next time you are thumbing through your social feeds, engage System 2 by fact-checking each meme that would otherwise make you smile in agreement. But, before you start, predict how many memes you will get through before you abandon the task. My over-under was 3. I ended up down a deep rabbit hole on the first one, which is directly counter to the social network’s advertising strategy.

SUMMARY

The need for deep societal trust in science is now poignantly clear as COVID19 ravages the earth. This article, written before the onset of the pandemic looks to science as one means to regain this trust. The tension between humorous social memes and the torrent of misinformation they propagate are now in stark relief.

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AN EROSION OF TRUST IN SCIENCE

Another, and perhaps more insidious, result of having our biases consistently bolstered is the erosion of the role of the expert. Experts understand phenomena deeply, carefully teasing out nuance from the most complex relationships. Science, and scientists, are at an elevated risk in this environment.

Science is incredibly creative, powerful, and has shaped and re-shaped society for generations. Science is also slow, methodical, careful, risk averse, incredibly nuanced, and fallible. Scientists know that every interpretation of data comes with some amount of inherent error. Scientists are very careful to ring-fence what is within their study and what is not, what the results imply and what is not clear, lost in the experimental error. This naturally cautious approach, and recognition of error limits, is lost in a nuance-free, System 1-thinking, meme-filled world.

What's worse, the concept of error is often misunderstood. This, combined with a lack of mathematical literacy (think lottery tickets) and misunderstanding of scientific rigour, means that scientific findings are lowered to the same level as "opinion." When new evidence is discovered that renders a previous theory or hypothesis incorrect, too many see this as proof that science "doesn't really know." In fact, this is the process of science working exactly as it should, moving our understanding of the natural world forward one small step at time.

The challenge is significant. Economic incentives prejudice our online lives to swirl in a sea of bias-reinforcing, critical thought-undermining, emotional System 1 thinking. Exposure to this, day after day, week after week, and year after year is undermining scientific authority, which is not guaranteed to keep its place.

Society has advanced by utilizing science, but there are points in history where science was lost, like the European Dark Ages, where the science and medicine of the ancient Greeks was all but forgotten. In his latest book, philosopher Robert Crease [1] shares his view that a fall of scientific authority is a real threat, and offers thoughts on how it might be brought back.

Our climate crisis further raises the stakes: good science and popular trust in science will surely be needed as we enter what will be a fate-determining decade for the long-term survival of our species.

CHIMING IN WITH A SOLUTION

What if the solution to the steady erosion of scientific trust could come from science itself?

Imagine an algorithm that could sift through the continuous flow of data through Facebook, Instagram, and TikTok. What if, in real time, we could rank the veracity of content, fact-check memes, and link to original sources? Layer on blockchain technology to provide content with credible chain of custody

tracking, and a user could reliably see whether they are consuming science content generated by NASA or a misinformation troll farm.

An example can already be found in Canada's award-winning CHIME telescope, which uses algorithms to sift through a torrent of data in real-time to pick out the relevant signals. The CHIME collaboration is looking for peculiar astrophysical phenomena called "fast radio bursts," (FRBs) — ultrabrief blips of radio waves that can easily be lost amid the countless other signals traversing the night sky.

Prior to CHIME, only several dozen FRBs had been detected over the decade since their discovery. Thanks in large part to its sophisticated software, CHIME has discovered 13 new FRBs over a period of just two months during its pre-commissioning phase, running at a fraction of its full capacity.

USING ARTIFICIAL INTELLIGENCE TO BOLSTER HUMAN INTELLIGENCE

Another solution may lie in oft-touted realm of artificial intelligence (AI).

Headlines about AI breakthroughs seep into our news feeds with increasing frequency. Yet, according to neuroscientist Gary Marcus, these are so far only "microdiscoveries." They may broaden the potential applications of AI to more complex pattern-matching tasks, but will never move the field forward into the almost mythical promised land that the faithful believe artificial intelligence holds [4].

Since then, advances have been made in understanding how machine learning models, such as neural networks, "think" [3]. These results move machine learning and AI away from being simple "black box" tools and push them towards being "a true source of inspiration in science." Additionally, Judea Pearl and Dana Mackenzie offer insight on how AI can progress toward true reasoning via a three-rung "Ladder of Causation."

Rung one is *seeing*: sifting through masses of data in unique and creative ways in order to find hidden associations and correlations. Imagine an owl recognizing the movement of grass blades that reveal a well-camouflaged mouse scurrying through a field.

Rung two is *doing*: connecting disparate observations into an intervention. For example, a drug store might ask, "What will happen to our floss sales if we double the price of toothpaste?" Assume this change has never before been tried, so no data exists to draw from. An answer to this question would require connecting data that have never been considered together before.

Rung three is *imagining*: the act of wondering what if something was different than it currently is. "What if you didn't take that aspirin, would your headache still have gone away?" To answer

this, we must go back in time and consider a fictitious set of new “facts” that cannot ever be in the original data [5].

Pearl and Mackenzie place the current state of machine learning firmly on the first rung of the causation ladder, where they believe it will remain until the new science of *causal inference* is incorporated into the algorithms. A handful of scientists, including some at Perimeter Institute, are beginning to work at this new interface between artificial intelligence and causation, with optimistic early results.

Artificial intelligence empowered by the emerging science of causation may usher in the benevolent version of AI’s promise, enabling society to grapple with our unprecedented access to information of wildly varied veracity.

OPTIMISM FOR THE FUTURE

These are just two examples of where foundational physics could be laying the groundwork for answers to help get us back to a place where information can be trusted, experts are valued, and science can progress unhindered by the repercussions of a society that thinks it doesn’t work at all.

Do not mistake these futuristic musings, as accurate depictions of the current or even future state of AI, blockchain, or computer-centric astronomy. The intent is simply to illustrate some of the many sources of our unfailing optimism for humanity’s future by highlighting just a few of the current, cutting-edge science advances that may have the power to positively shape our world, if we have the continued courage to trust the rigour and process of science.

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