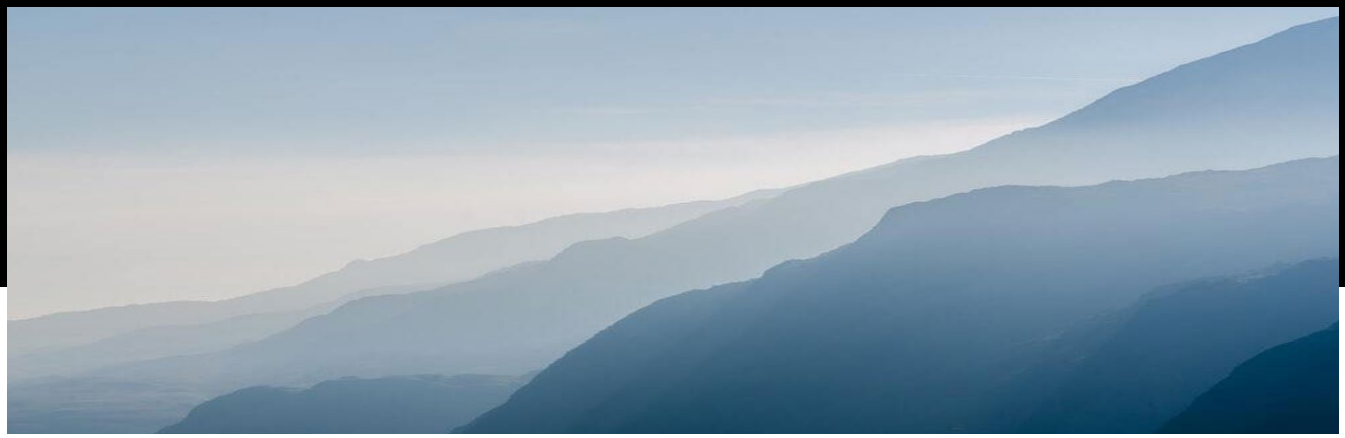
Transmission: Insights on COVID-19

WEEK THREE



Welcome back to the *Complexity of COVID-19* course from the Santa Fe Institute. For the past few weeks, we have been collecting ideas from Santa Fe Institute researchers about the COVID-19 pandemic. These provide a broad range of insights from a variety of scientific perspectives. COVID-19 has very quickly proven to be a terrifying demonstration of complex systems. We are all suddenly witnessing the consequences of deeply entangled systems, and moving beyond this epidemic will require equally new ideas that can span all walks of life.

All of the transmissions in this batch are about the space for innovation and adaptation after a crisis, when the landscape has shifted. Organisms adapt to the world around them, not perfectly, but optimally for their specific habitat. For these essays, the concept of a changing fitness landscape can be used, both literally and metaphorically, to think about how crises bring about new possibilities.

A fitness landscape is a model through which we can see the topography of a particular species' fitness with respect to its environment. Invented by Sewall Wright in the late 1930s, a fitness landscape shows us how well an organism's traits and behaviors are suited for survival and reproduction. Higher-fitness is shown as a peak, and lower-fitness is shown as a valley. In times of relative stasis, we seldom see drastic changes to the landscape. But when a catastrophe comes along and destroys life as we once knew it, there is room for creative and novel approaches to the future.

These essays demonstrate how we find ourselves in a unique position to recalibrate practices that we were locked into before COVID-19. It may be the case that when we've reached a sub-optimal peak, we ignore the prospect for improvement, because things seem to be going well enough, and changing our behavior comes at a cost of energy and resources. As painful as this epidemic has proven to be, the crisis that we now face may allow and/or require us to change our strategies as a result, especially if the risks for doing so are diminished.

Elena is a fundamental scientist who has been working on understanding how viruses evolve in order to model general complex systems. SARS-CoV-2 is an RNA virus, and RNA viruses display high levels of mutation. As such, they are very adaptable, and can mutate quickly so as to evade their host's immune system and continue to replicate. However, high mutation rates lead to increasing instability and fragility. As we learned last week, COVID-19 transferred from a bat host to a human host. When a virus is capable of infecting a wide variety of hosts, its fitness increases, and it fares better than viruses that can only replicate within particular host cells. In terms of viral fitness, generality beats specialty, and high rates of mutation allow for helpful adaptation, up to a point.

If a virus continues to mutate at increasing rates, it risks mutating itself out of existence. This is a concept that Elena and his team have been exploring in their research of "Defective Interfering Particles" (DIPs), the non-replicating, junk-bits of a virus that are, as their name suggests, "defective." As a result of mutation, DIPs can no longer reproduce, but they still compete with capable viruses for resources within a host cell, and thereby "interfere" with that virus's replication. Therefore, DIPs might prove to be an effective anti-viral. Further experimentation is needed.

For now, in an exemplary demonstration of science's need to be adaptable, Elena and his team have completely repurposed their lab. They have taken equipment formerly used for theoretical investigation and are applying it to medical diagnostic procedures, in support of public health systems at this urgent time. Fundamental science can lead to future solutions when uninterrupted, but in the throes of a biomedical catastrophe like this one, the ability to shift and address the areas of most need may help us get through to the other side.

READ FULL TEXT

Image: Alchemist's Laboratory Showing Original Apparatus of the 16th and 17th Century. London. Courtesy Wellcome Trust.

Doug Erwin is a paleontologist. For a long time, he has been fascinated by what followed the end-Permian extinction, the greatest Mass Extinction of all time, which wiped out ~90% of all oceanic species, and ~70% of land organisms. Following that unprecedented crisis, an explosion of diversity emerged, and complex lifeforms like dinosaurs, mammals, insects, and flowering plants came onto the scene. This extinction is an example of destructive creativity. Once the majority of planetary life was wiped out, the surviving organisms constructed entirely different ecosystems from those that had existed before. Had this extinction not occurred, human beings would not exist.

This raises some important questions: What factors or characteristics favor survival during a crisis? How do those factors relate to the factors that favored survival before a crisis? This extinction episode demonstrates that factors that favored survival during “normal times” have little to do with what factors favor the life that emerges on the other side of catastrophe. When the board is wiped clean, we’re not limited to the same niches of our past: we can create novel and advantageous ventures for ourselves. In fact, it would be foolish to return to the way things were, having witnessed how fragile those strategies and systems turned out to be.

Many of us are experiencing a similar conundrum now. People who developed professional skills that allowed them to survive and succeed in the pre-COVID-world are now out of work. We can’t assume that when this is all over, things will return to the way they were. After a crisis, we should take account of the factors that carried us through to the other side: the things that proved robust and resilient, so as to bolster them in preparation for whatever comes next.
But we should also keep in mind that the environment changes dramatically in the aftermath of a crisis, providing a unique opportunity to reevaluate our understanding of the way things have to be.

READ FULL TEXT

Image: “Partridges in the Snow” by Józef Chełmónski. Oil. 1891.

Earlier in 2020, when the UN Climate Summit in Madrid fell apart, we witnessed how hard it is to implement global systemic change between multiple actors. Many constraints exist between entangled and entrenched systems. Organisms, social institutions, economies, etc., are the consequences of their own histories, their own trajectory of development, and are therefore very difficult to alter. Future actions are constrained by past actions, and the result is "canalized" complacency, where possibilities are limited by the conservation of proven pathways.

A good example of internal constraint is when an embryo grows from one cell into highly specialized collections of cells, and eventually into a complex lifeform by following a regulated path. Dogs have litters of puppies, not kittens. At no point during development will a puppy change into a kitten. But what about external constraints?

Consider the fitness landscape we just learned about. Natural selection depends upon a variety of phenotypes in a given environment. The phenotype that is most optimally equipped to thrive in that environment will be selected for, and so a population will reach a local optimum, a peak. But this can prevent other, even better, peaks from being reached, because that population would never descend into the valley. They're stuck, locally successful but not globally "fit." There are countless examples in the history of technology where "better" solutions did not win in the marketplace, because there was no viable path for them to overcome the constraints in their way. The iPhone was not successful because it was the best telephone, but because it competed as a completely new category of device: as a platform for an ecosystem of apps. It was disruptive. COVID-19 is disruptive, as well. In order to combat this crisis, we need to change existing external constraints and also rewire long-entrenched internal relations. This time of disruption is a time for experimentation. It's an opportunity for new ideas and strategies.

READ FULL TEXT

Image: "The Hussite King Jirí of Podebrady and Kunstat" by Alphonse Mucha. Oil on Canvas. 1923

Relying on our family, friends, and colleagues for answers to difficult questions is usually a good idea. Using the collective wisdom of people who are similar to us and who live in similar circumstances can be a quick shortcut to solving a variety of problems in our own daily lives. But our reliance on our social circles has an unfortunate corollary: it is difficult for people to change their minds while also keeping their social networks intact.

The consequences of disagreeing with your friends can be more cataclysmic than disagreeing with some talking head on the screen. This has long been a problem for scientists, who aren't part of most social circles. Significant sections of the US population have beliefs that do not align with the current scientific evidence. Lack of basic scientific knowledge is likely both a consequence and a cause of further distrust that prevents acceptance of science facts.

However, the current moment of COVID-19 might help break that cycle. Because of the medical nature of this particular threat, scientists are appearing in the media regularly to brief the public about the disease's progress. Because COVID-19 has infiltrated all parts of the world, it's threat is felt locally. Community stores are closed, friends are out of work, neighbors are infected. COVID's proximity has shifted authority back to science in ways that other threats have failed to do. What can we learn about the way that scientific information is being trusted during COVID-19, and how can we employ that in the future? While the general public is more receptive to science, now is the time for scientists to reach out to those beyond their own circles to create a dialogue about the scientific process and its value to society.

READ FULL TEXT

Image: "Robert Hooke Dining with Friends at Gresham College" by Rita Greer, 2012

Bill Miller is a successful investor operating under long timescales, a patient thrill seeker. Whereas the bulk of many other portfolios are bolstered by bonds and index funds that offer consistent, low returns, Bill has a love for high-beta (high-volatility) stocks that are riskier, but provide higher return potential. Last year, while most hedge funds returned an average of 9% investment, and when the S&P Index returned about 30%, Miller's fund capped the year at a 120% gain. How? By doing "nothing," as he puts it.

Miller garnered praise on Wall Street by beating the S&P Index for 15 years in a row, until the 2008 financial crisis hit. And even then, Miller laid low. He remained fully invested while others pulled out of the market in a panic. Today he is enjoying the fruits of his *non*-labor.

For Miller, this moment in history might be one of the greatest buying opportunities of a lifetime. Stocks at record highs declined almost 30% in the shortest time in history. As is often the case, when the market takes a downward turn, people sell in an effort to recoup what they can. At times like these, Miller takes to heart what John Maynard Keynes once said: "It is the duty of every serious investor to suffer grievous losses with great equanimity." For Keynes, it was better to be at the very bottom of the market than out of the game when things recover.

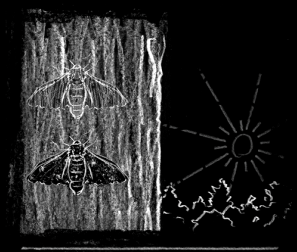
And that is Bill Miller's point: things will recover. If you can invest, do so now. If you are invested, stay still, relax. Stocks that are underperforming could excel in the changing context of the post-COVID market. The financial landscape has shifted. The peaks look like valleys now. On the one hand, this makes it easier to strategize and find a new position. Those who do so and get comfortable in these new valleys might find themselves on higher peaks when this is over.

READ FULL TEXT

Image: Detail: "The Tulip Folly" by Jean-Léon Gérôme. 1882

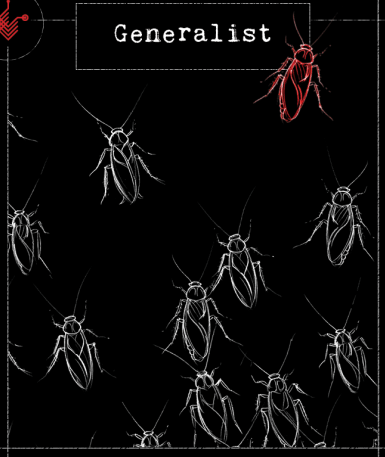
COMPLEXITY CARDS

Adaptation



A change in structure or behavior which results in being better fitted to a particular environment.

Generalist



A species that is able to thrive in a wide variety of environmental conditions and can make use of a variety of different resources.

Specialist

Is only able to thrive in a narrow range of environmental conditions, and/or on a unique set of resources.

Path Dependence

The current and future state, action, or strategy for any given circumstance is limited by the states, actions, and strategies of the past.

Life Support Systems Legend

- Architecture, Cities, & Scale
- Astrobiology & Life Detection
- Intelligent Systems & Cognitive Design
- Motion & Energy Technology
- Time Design
- Autonomous Ecosystems
- Social & Economic Engineering
- Planetary Policy, Law & Regulation
- All Complex Systems

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Complexity Podcast: Transmission Series Ep. 3

"Coronavirus, Crisis, and Creative Opportunity"

In the third episode of this special supplementary mini-series with SFI President David Krakauer, we discuss the history of change following a mass impact event, and the tools (such as natural selection, fitness landscape, adaptation) that allow species to thrive in the aftermath.

Transmission: Insights on COVID-19 Quiz 3

This weekly quiz will cover topics and details from this week's batch of articles so you can test your knowledge. Included in the quiz are more long-form discussion questions, which we hope will instigate interesting conversations between everyone in your household.

Related Recommendation: Book

After Man: A Zoology of the Future

by Dougal Dixon

InterPlanetary has always loved speculative fiction for its capacity to think through unknown futures. Here, Dixon imagines how animals evolved 50 million years after a mass extinction that humans did not survive. Beware the Flooer and Night Stalker.