Reinventing Discovery: The New Era of Networked Science

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In *Reinventing Discovery*, Michael Nielsen argues that we are living at the dawn of the most dramatic change in science in more than 300 years. This change is being driven by powerful new cognitive tools, enabled by the internet, which are greatly accelerating scientific discovery. There are many books about how the internet is changing business or the workplace or government. But this is the first book about something much more fundamental: how the internet is transforming the nature of our collective intelligence and how we understand the world.

Reinventing Discovery tells the exciting story of an unprecedented new era of networked science. We learn, for example, how mathematicians in the Polymath Project are spontaneously coming together to collaborate online, tackling and rapidly demolishing previously unsolved problems. We learn how 250,000 amateur astronomers are working together in a project called Galaxy Zoo to understand the large-scale structure of the Universe, and how they are making astonishing discoveries, including an entirely new kind of galaxy. These efforts are just a small part of the larger story told in this book--the story of how scientists are using the internet to dramatically expand our problem-solving ability and increase our combined brainpower.

This is a book for anyone who wants to understand how the online world is revolutionizing scientific discovery today--and why the revolution is just beginning.

Reinventing Discovery: The New Era of Networked Science Details

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Matthewmartinmurray murray says

Lots of fun to read. I started off really enthusiastic about this. Then it got to be a little bit repetitive by repeating its themes and same 3-4 examples too many times. Its still very interesting to learn about collective intelligence. The thesis of the book is to encourage science to take on a new paradigm of open source data collection and shared results. Seems to be a little idealistic but it makes a pretty good point of how fast innovation could advance if everybody is directed in a similar path and gives free time and energy to put into a universal goal. I believe this would work only if it is formatted in an interesting way that would capture the imagination of the volunteers and there would need to be some un-named incentive that hasn't been presented yet. It is fun to think of a world that can advance as quickly as a potential collective of scientist working for one goal. Its powerful what a group of people can do when properly motivated and directed. If any of this is interesting to you, then you may like this book.

Lisa Kucharski says

Really enjoyed this, it covers the groundwork of science being practiced in a different manner than in the past... some examples are the FoldIt and Zooniverse efforts where data is analyzed by citizen scientists and data used by scientists... but also engages non-scientists to discuss the work as well.

He covers some great ground where open data, involvement of the public, and a forum that encourages use and discussion amongst both highly studied scientists and laymen. Of course there are only a few of these projects primarily as - scientists aren't rewarded to create these kinds of projects in general. So, the few that are there are unique in their area. Generally the data is shared via the internet and anyone can come and help, search and just peruse the information.

Nielsen also goes over the pitfalls of the use of information, the reality of how scientists work and of the influences to not share currently out weigh sharing.

But what is most interesting is that he talks about how this could be a new chapter in doing science... where data is openly shared, through a forum that allows discussion, helpful mentors and a focus on developing questions to discover new information.

He does seem to indicate that this type of work does better with sciences that don't involve "social sciences" since opinions of what is right or wrong tend to get in the way of clearly looking at data- without pre-conceived answers.

I find the ideas presented really interesting and could be a great way for humanity to solve some bigger problems that effect us all... but we collectively- humanity plus scientists must decide that we all need to move this way at the same time- in ways that benefit us all. Could be a great way to solve disease, but the money made by preventing knowledge of cures would certainly squash that idea.... sad but true.

Worth reading.

Amir-massoud says

This book is about how we can/should do science from now on. It promotes Open Science approach, which is based on the ideas of sharing data in an open source fashion, using the network to focus the attention of experts, benefiting from intelligent amplification tools, and etc.

I think it is a must-read book for professional scientists and a good book for science enthusiasts. It is generally written very well. The downside is that at points it becomes repetitive and loses its fast pace. Even though the book is already very short (the main body is less than 200), it could still be compressed a bit more. In general, I am happy that I read it and I will probably go back to it in the future.

Ana says

This is a great book - he talks about science and gives many excellent cases for the open science initiative. However, sometimes the author details too much about some things - he uses a whole page for some things that could be said in 2 sentences.
Anyway, would recommend!

Liam says

"In the most successful online collaborations this use of microexpertise approaches an ideal in which collaboration routinely locates ... people with just the right microexpertise for the occasion. In particular, as creative collaboration is scaled up, problems can be exposed to people with a greater and greater range of expertise... Instead of being an occasional fortuitous coincidence, serendipity becomes commonplace. The collaboration achieves a kind of designed serendipity..." (27)

"In this chapter we'll identify four powerful patterns that open source collaborations have used to scale. (1) a relentless commitment to working in a modular way, finding clever ways of splitting up the overall task into smaller subtasks; (2) encouraging small contributions, to reduce barriers to entry; (3) allowing easy reuse of earlier work by other people; and (4) using signaling mechanisms such as scores to help people decide where to direct their attention." (48-9)

"This points the way to a fundamental requirement that must be met if we're to amplify collective intelligence: participants must share a body of knowledge and techniques. It's that body of knowledge and techniques that they use to collaborate. When this shared body exists, we'll call it shared praxis..." (75)

"Citizen science can be a powerful way both to collect and also to analyze enormous data sets." (151)

"The problem today is that while it's now in the collective interest of scientists to adopt new technologies, their individual interest remain aligned with journal publication." (189)

Jani-Petri says

Decent discussion about the open science and how to approach it given the constraints, for example, faced by the career demands of the scientists. In times I had the feeling that the writing was a bit sloppy and repetitive, but this was easy enough book to read and a useful way to start discussion for real.

Courtney Johnston says

An important book, which lost its (tenuous from the start) grip on me on page 78.

Nielsen is an advocate for open science, and in this book he draws a picture of science standing at the threshold of its most important advance since the establishment of the Royal Society and the first norms of scientific publishing and data-sharing. The amplifying power of internet, he argues offers new opportunities for collaboration and sharing. The challenge is to move the bulk of the scientific community away from their closed and guarded approaches in order to take advantage of these opportunities.

Nielsen is clearly fired up:

> These tools are *cognitive* tools, actively amplifying our collective intelligence, making us smarter and so better able to solve the toughest scientific problems. To understand why all this matters, think back to the seventeenth century and the early days of modern science, the time of great discoveries, such as Galileo's observation of the moons of Jupiter, and Newton's formulation of the laws of gravitation. The greatest legacy of Galileo, Newton, and their contemporaries wasn't those one-off breakthroughs. It was the method of scientific discovery itself, a way of understanding how nature works. At the beginning of the seventeenth century extraordinary genius was required to make even the tiniest of scientific advances. By developing the method of scientific discovery, early scientists ensured that by the end of the seventeenth century such scientific advances were run-of-the-mill, the likely outcome of any competent scientific investigation. What previously required genius became routine, and science exploded.

> Such improvements to the way discoveries are made are more important than any single discovery. They extend the reach of the human mind into new realms of nature. Today, online tools offer us a fresh opportunity to improve the ways discoveries are made, an opportunity on a scale not seen since the early days of modern science. I believe that the process of science - how discoveries are made - will change more in the next twenty years than it has in the past 300 years.

The picture Nielsen draws is in many ways the opposite of that of Crick and Watson alternating between fervid bouts of creativity and languid cups of tea in the company of university popsies, stealing away with Franklin's x-rays and covering up their work as they rush for publication. He describes a number of projects that are models for the new kind of science he proposes, such as the Polymath Project (distributed mathematical problem-solving), open source software (the success of Linux, made possible through its modular nature, which allows a multitude of people to make innumerable small contributions), the Firefox

bugtracker (which allows any user of this open source browser to identify issues and submit enhancements), and Kasparov vs The World (the grandmaster takes on the international chess community, who use online tools to suggest, evaluate and select their moves, drawing on their distributed specialised expertise).

I agree with Nielsen's argument, but I'm not inspired by his rhetoric. His book is largely pragmatic, which is really a rather wonderful thing - polemic will only get you so far, and I can see this as a book that one scientist might press upon another as the open side tries to win over the closed.

But as a pure reading experience, the book is like a rather stodgy and dull boiled pudding, studded with the odd tasty bit of crystallised fruit. Overal, it is delivered more like a lengthy lecture to an undergrad class than a book. The pages are peppered with phrases like these:

> "Earlier in the book we discussed the open access policies that some of the scientific grant agencies are introducing...."
> "We'll now look at two strategies tan can be used to shift the culture of science...."
> "There are lots of ways of this is happening; so let me describe just a few snapshots..."
> "I won't make all the connections explicitly, since this isn't a textbook on political economy. If you're interested in exploring the connections further, please see 'Selected Sources and Suggestions for Further Reading', beginning on page 217."

Those are all from a single page (admittedly, from the finl chapter, which I flipped to this morning just to see whether I should be slogging through the intervening pages rather than kicking it in). They're harmless in themselves, but they accrete in this puddingish texture, where over all the book feels earnest rather than inspiring. And that's not a note I want to end on, as I genuinely think the book is important, Nielsen is very very smart and persuasive, and the possible future he outlines is one that makes moral and intellectual sense. I wish I could have enjoyed the book more.

Stephan Rasp says

Nielsen's book echoes my frustration with academia. He argues that the current state of academic science is untenable (it is!). An absolute must-read for any scientist.

Amanda says

After reading the review in *Science*, I'd like to take a peek at this book myself.
http://www.sciencemag.org/content/336...

Nikolay Theosom says

quite re-iterative and doesn't really offer anything beyond repeating mass media news

Adam Catto says

Simply wonderful. If you care at all about the progress of science, technology, or humanity, then read this book ASAP.

Gponym says

From browsing the clear and lively Reinventing Discovery you might not guess that Michael Nielsen is a physicist and well-known contributor to quantum computation theory. However, if you delve into the book, you'll soon detect the careful thinking patterns of a trained analyst or scientist. Nielsen put his scientific career on the back burner in 2008 to focus on bringing about a revolution in how science is carried out (https://en.wikipedia.org/wiki/Michael...). This book is one fruit of his new mission. It aims to sway scientists as well as to educate the public and appeals both to logic and emotion. Nielsen is pushing all of us toward what he hopes will be a leap in scientific progress built on an explosion of online collaboration and open data sharing among scientists and even the interested lay public.

The title expresses Nielsen's belief that we are poised on the cutting edge of a fundamental reshaping of how most science gets done. Using some fascinating case studies he illustrates how this new era has already crept onto the scene. He cites the Polymath Project as successfully demonstrating the power of online collaboration. In this case an important mathematical challenge was solved entirely in the public eye over the course of a few weeks in 2009. Over 20 mathematicians contributed jointly to a web blog devoted to the problem that was hosted by Tim Gowers, a highly renowned mathematician. It was a heady time: Gowers later said that the Polymath process was "to normal research as driving is to pushing a car" (p 2).

Nielsen reviews the legacy process of scientific discovery which, he notes, has worked well yet whose essence has changed little since the advent of the first scientific journal in 1665 in England. He goes on to show the power of new resources and mechanisms that can support shared discovery (as in Polymath) but whose adoption by the broad scientific community lags. He asserts that the solution of many important scientific questions now and in future would benefit by the deliberate, thoughtful harnessing of the collective mind, and by openly sharing data, both research results as well as tips and informal knowledge about how to organize and carry out research. Nielsen foresees the need for creative and relentless design and redesign of collaborative platforms, for careful structuring of data and query mechanisms to facilitate automated access, and for open sharing of scientific data on a scale that dwarfs even current efforts like the Human Genome project or the Sloan Digital Sky Survey (SDSS) (p 98).

Nielsen lucidly presents many samples of these new ways of doing science, from Polymath to the Hap(lotype) Map to Galaxy Zoo (a website where anyone can help classify celestial objects) to the astounding Kasparov versus the World chess match in 1999. He draws on appropriate arenas outside science, including the software Open Source movement, to discuss advanced practices for enabling rapid and efficient online collaboration. "Architecture of attention" (p 32) and "designed serendipity" (p 27) are two memorable phrases he employs to tag the essence of these new practices. He contrasts all too briefly the new to some established ways of collaborating: conventional (hierarchical) organizations; the marketplace; offline small groups. He launches the effort to distil some principles that could guide pioneers who wish to implement online collaboration in a new problem-solving arena; it's but a tantalizing glimpse into what must become a

well-explored domain if the new collaboration style is to catch fire. He sketches a dream of one day having an open data web that can machines can query on their own. He notes that with such a large trove of accessible data, our notion of "explanation" may need to change: no longer will Occam's Razor be as sure a guide to what is a good explanation, since machines can develop explanations that no human can. Without digging deeply into it, he notes that inevitably new types of questions can be asked and answered when large troves of machine-accessible data begin to jostle shoulders in the public domain.

The book, then, is a survey of the landscape and some possible ways forward. It feels like just an opening manifesto in a campaign that is in tune with large societal shifts such as social networking and putting online just about everything. It is supported by sections of notes, references, suggestions for further reading and an index. As noted, it is studded with compelling real-world examples. Scientific culture change is no minor matter and Nielsen deals with some obstacles. More inspiration than howto, despite the many examples, it does not address details on how to implement solutions in particular disciplines. Also, I suspect that much more fine-grained attention than Nielsen has given will be needed to pick apart and tackle the significant personal and money-related resistances that hamper adoption of his proposals. The large amount of for-profit science is hardly mentioned here; as an outside observer, I wonder if that is so trivial an omission in this age dominated by large, rich corporations.

No book can do it all; Reinventing Discovery makes a good initial exploration of possibilities to enhance the process of discovery. This book should appeal to anyone interested in how science "happens" (or doesn't happen!), in how to potentially accelerate progress without huge financial investments, in novel ways to tackle many classes of problems.

Charlene says

If you were one of the many people who excitedly picked up a copy of "wisdom of crowds" only to be disappointed when you realized that the passion with which the author wrote was matched only by the confirmation bias that accompanied it, then you will be extremely happy about this book. It's too looks at the role of collaboration in generating a finished product, but unlike wisdom of crowds, it is a solidly researched contribution to the field of network research.

The author looks at both the value and challenges of sharing data in the scientific community.

Great arguments, solid writing. I really enjoyed this book quite a bit and highly recommend it.

Goran says

http://www.ted.com/talks/michael_niel...

Atila Iamarino says

Me recomendaram muito este livro por conta de uma apresentação sobre ciência cidadã que fiz (ciência feita por não cientistas). Li e gostei bastante, mas ele falou exatamente o que eu já estava apresentando, não me

acrescentou muito.

Michael Nielsen discute como colaboramos muito mais hoje em dia graças a internet e o tipo de produção científica que é possibilitada. A descrição do Galaxy Zoo e de como as pessoas estão fazendo descobertas astronômicas de casa, classificando as imagens, foi especialmente marcante.

Vale para cientistas se interessarem por acesso aberto e pela importância de comunicar melhor o que fazemos. Mas ele bate no ponto mais forte, enquanto o sistema de incentivos não mudar e não passarmos a valorizar esse tipo de atitude, nada vai mudar.

Ah, a descrição de Galileu contando o que havia descoberto por códigos foi especialmente marcante. A explicação fica para quem ler ;)