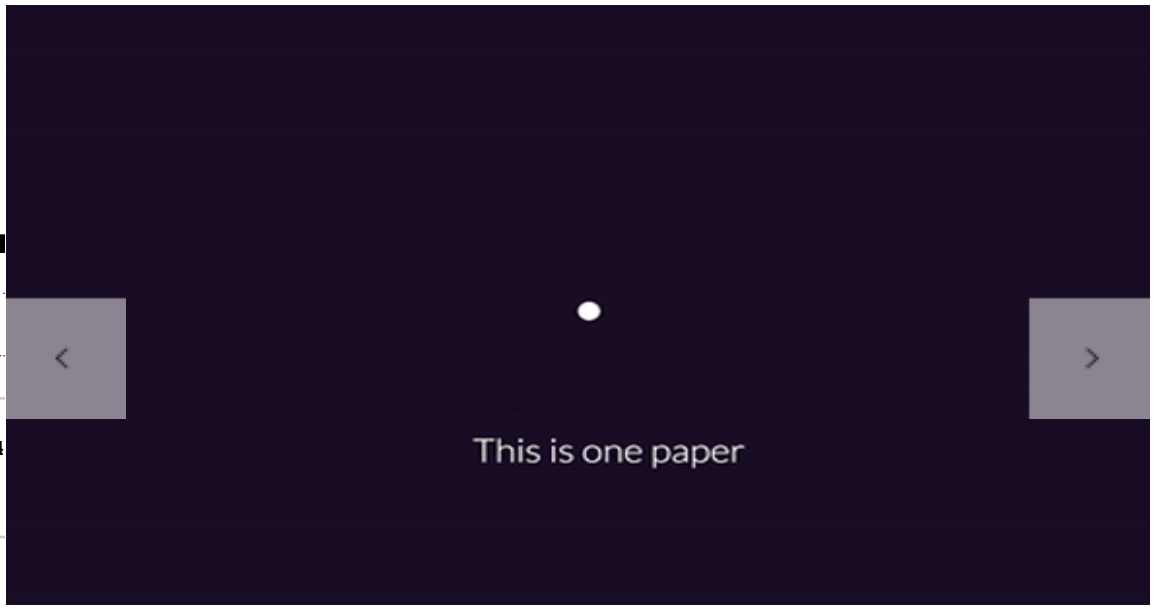
LIZ STINSON SCIENCE 11.03.16 2:00 PM

SEE HOW THE MOST INFLUENTIAL SCIENCE COMES IN WAVES



1 / 5 KIM ALBRECHT

TO ROBERTA SINATRA, careers are like ocean waves. Sometimes they soar high, sometimes they dip low, and every so often they appear to stagnate all together. “You really can’t predict when the big one will come,” she says. Sinatra is a network scientist at Budapest’s Central European University, and today, she has proof for her career-as-a-wave theory.

Sinatra and her fellow researchers make the case that career success, at least for scientists, is nearly impossible to predict. Despite previous research suggesting that most scientists make their biggest discoveries early in their career, Sinatra argues in a paper in *Science* today that a scientist’s most impactful publications—those with the largest numbers of citations, in this

instance—could happen at any point in your career.

Visualized, this phenomenon looks a lot like Sinatra's waves. Or the spikes and valleys of the lines on an electrocardiogram. "It's like a life line," says Kim Albrecht, a designer with Northeastern University's Barabasi Lab who created an interactive data visualization to explain Sinatra's findings. "One line represents the ups and downs of your career."

Albrecht's design reconstructs the publication record of more than 10,000 scientists who have at least 20 years of work and 10 publications under their belt. Each scientist is represented by a line—their highest impact papers the peaks, their lowest, the valleys. All of a scientist's published papers are plotted from left to right at equal intervals. By ignoring the exact publication date of the papers, Albrecht tried to illustrate the actual probability of when a scientist might publish her highest-impact work. "It shows that all papers have the likelihood to be the most successful one," Sinatra says.

Taken alone, any of these career lines wouldn't illustrate the randomness that Sinatra is talking about. It's only when these individual data points are viewed together, at the macro-scale, that the trend becomes visible. It's a lot of data to parse, but Albrecht breaks it down into

digestible pieces. You can explore careers in seven different scientific disciplines by clicking through them at the top of the page. You can also filter the results according to different parameters, including total number of papers written or the sustained impact a scientist has had over her career.

Albrecht explains that the visualization was inspired by Joy Division's Unknown Pleasures album cover, which features a stacked plot illustration from astronomer Harold D. Craft Jr's PhD dissertation "Radio Observations of the Pulse Profiles and Dispersion Measures of Twelve Pulsars." Albrecht repurposed the idea by making only the top 50 percent of cited papers visible; the rest fades away into a gradient. "If you looked at 500 lines at the same time, you wouldn't be able to see anything," he says.

As with most scientific visualizations, Albrecht left out some information for the sake of telling a clearer story. For instance, success isn't totally random: It's ultimately a confluence of productivity, luck, and ability. The reason most scientists find success early in their career is because they're simply more productive. Sinatra addresses these ideas in her paper, but it's hard to account for them in a legible visualization.

The end result is an interactive data

visualization that turns a complicated idea into a relatively simple narrative. Every discipline tells a different story. Chemistry shows the visualization biggest spike, thanks to Todd Miller's 1997 blockbuster paper "Gapped BLAST and PSI-BLAST: a new generation of protein database search programs," which garnered 7,809 citations. Meanwhile neuroscience's biggest spike is from Manuel Peitsch's 1,023 citations from his paper on comparative protein modeling. "Citations are like a currency," Sinatra says. They tend to be much higher in large fields like biology where people are writing many papers, and much lower in economics where the number of papers is much lower. "Peaks are systematically smaller or higher depending on how much this currency is inflated or deflated," she says.

Still, the story stays the same, no matter what discipline you're looking at. "You will always find the impact peaks occurring all over the place," Albrecht says. It's a comforting conclusion, at least if you're a scientist: If you're still waiting to produce your magnum opus, no need to worry—there's always tomorrow.