Failure prognosis: Data science predicts which failures will ultimately succeed

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Oprah Winfrey was fired from her first job in television. Steven Spielberg was rejected from film school multiple times, and Michael Jordan didn't make his high school's varsity basketball team.

Stories like these fuel motivational mantras about learning from failure and coming out stronger on the other side. But little research has been done to support these anecdotes, and even less has examined the

mechanisms as to how failure leads to success, until now.

Data scientists from Northwestern University and the University of Chicago looked at the dynamics of failure in three different areas—science, entrepreneurship and terrorism—and found that the way one fails matters. The study, which will be published Oct. 30 in *Nature*, was led by a team at Northwestern's Center for the Science of Science and Innovation (CSSI), Kellogg School of Management and McCormick School of Engineering.

After an initial failure, paths diverge, the study found. Some individuals go on to achieve eventual success, and others continue to fail until they drop out. This divergence was evident as early as the second attempt. The factor that ultimately determined which path an individual took was the extent to which they learned from previous failures and how they applied that knowledge going forward, according to the study.

"If you only look at the attributes of successful attempts, you're missing half the story," said corresponding author Dashun Wang, CSSI director and associate professor of management and organizations at Kellogg. "This is where big data can help. Analyzing all cases in the data, both successes and failures, helps avoid bias."

According to the researchers, this model could help individuals and organizations make better use of their past failed experience to achieve success. It also could aid managers and policy makers in making decisions about promotions, project leadership roles and more.

Conventional explanations of success tend to center around luck or assumptions about the individual's work ethic, but the researchers found that it is not so simple. With each successive iteration, individuals and organizations may take past experiences into account in order to refine future attempts—a pattern that can help predict divergent outcomes.

The key insight, according to the researchers, is that there is a critical threshold for the number of past attempts that should be considered. If individuals incorporate more lessons beyond that threshold, the efficiency and quality of subsequent attempts improves, leading to eventual success. If individuals incorporate lessons from too few failed attempts, they will find themselves on the path to permanent failure.

Lead author Yian Yin explained that small variations near the threshold make a huge difference.

"It's similar to the transition between water and ice at 0 degrees Celsius," Yin said. "Increasing or decreasing the temperature by just a small amount near this threshold leads to fundamental changes."

"The findings fit with conventional wisdom that failure can teach you lessons," said co-author Yang Wang of Northwestern. "You learn from your mistakes and correct them in the next attempt, constantly iterating rather than starting each attempt from scratch. This helps you fail faster and smarter, improving with each attempt."

The researchers utilized data sets for three fields—scientific research, entrepreneurship and terrorism—and applied standard definitions of success for each field, such as entrepreneurs achieving an initial public offering or high-value merger and acquisition.

By tracing successive attempts by individuals, the researchers were able to assess the extent to which individuals incorporated previous learnings into their next iterations, and how many attempts it took for each individual to eventually achieve either success or permanent failure. They found the same pattern of results, with diverging paths to either success or failure, for each field, indicating the model may apply to other industries and topics as well.

"In a world of intense competition, failure is an essential ingredient for success," said co-author James Evans, professor of sociology at UChicago. "Our results provide some of the first evidence that how you fail matters."

The study is titled "Quantifying dynamics of failure across science, startups, and security."

More information: Quantifying the dynamics of failure across science, startups and security, *Nature* (2019). DOI: 10.1038/s41586-019-1725-y , nature.com/articles/s41586-019-1725-y

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