

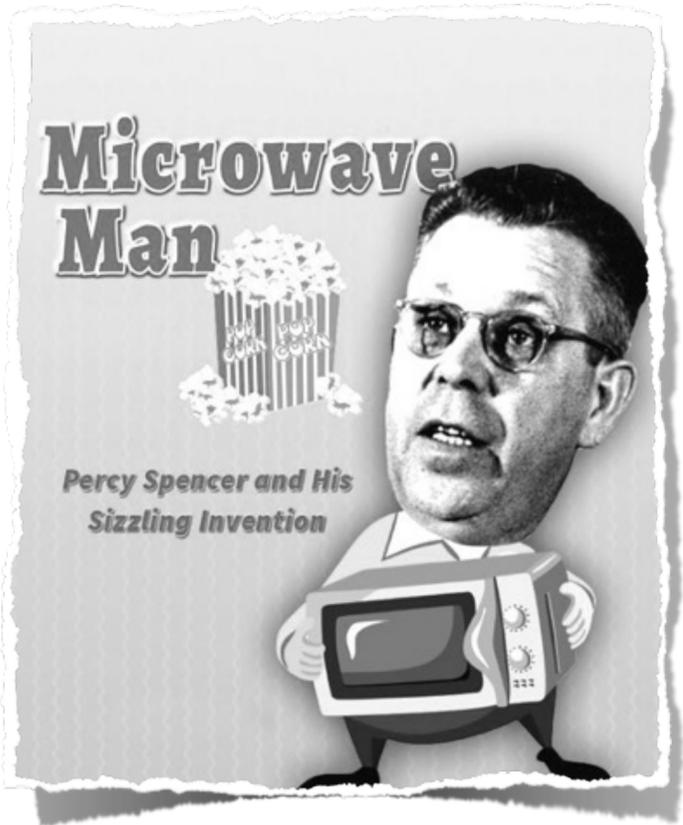
Quantifying the evolution
of individual scientific impact



Roberta Sinatra

 @robysinatra





Who will make an outstanding discovery,
and when?

Is a scientific career predictable?

We study scientific impact through publications



Physics

→ 500k over 110 years

→ 5M citations

Radicchi et al, Phys. Rev. E 80 (2009)

Petersen et al, PNAS, 108 (2011)

Deville, Wang, Sinatra, Song, Barabási, Sci. Rep. 4:4770, (2014)

Sinatra, Wang, Deville, Song, Barabási, Science, 354, 6312 (2016)

WEB OF KNOWLEDGESM



6 fields

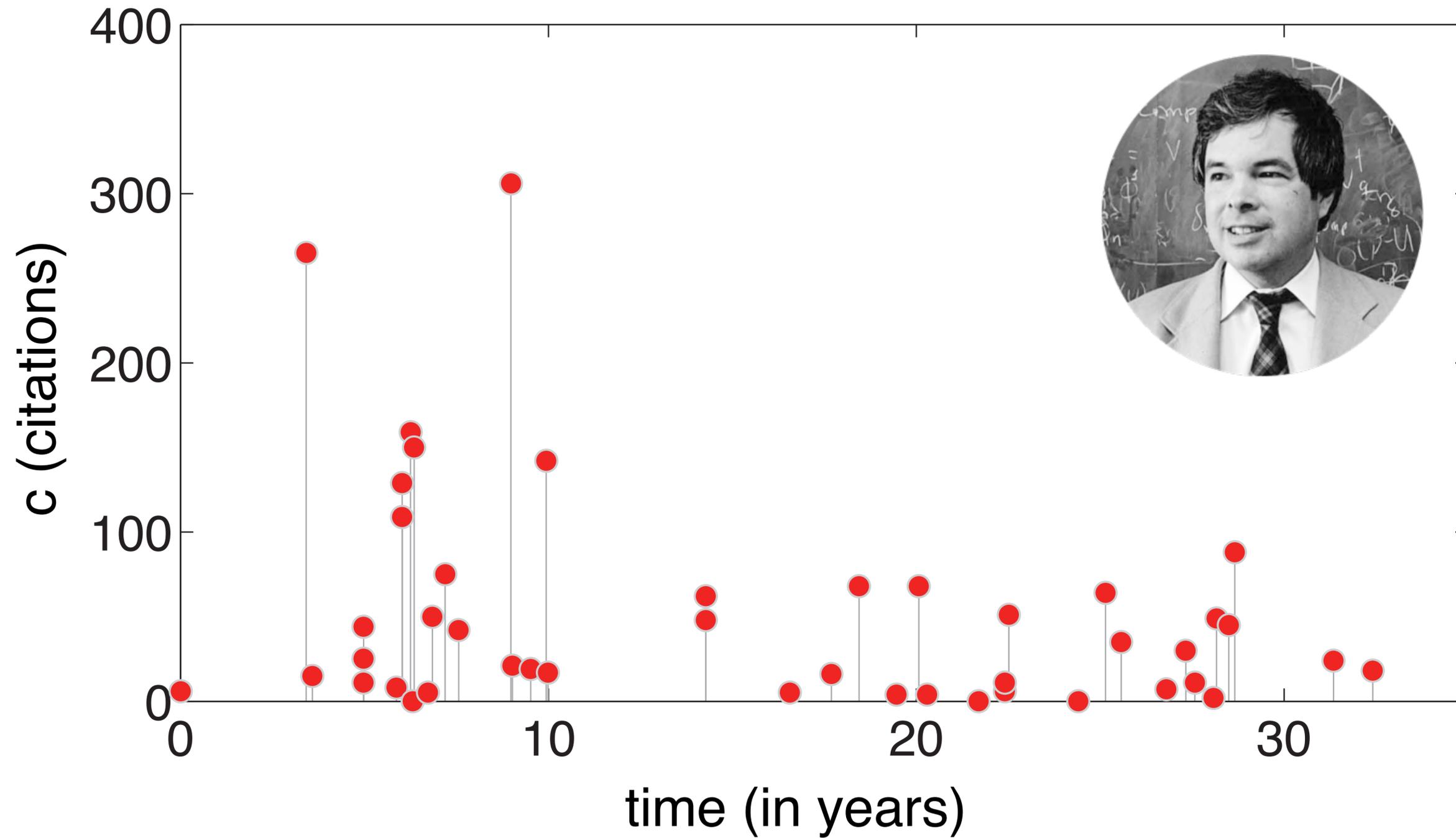
→ ~25,000 careers

→ ~500,000 papers

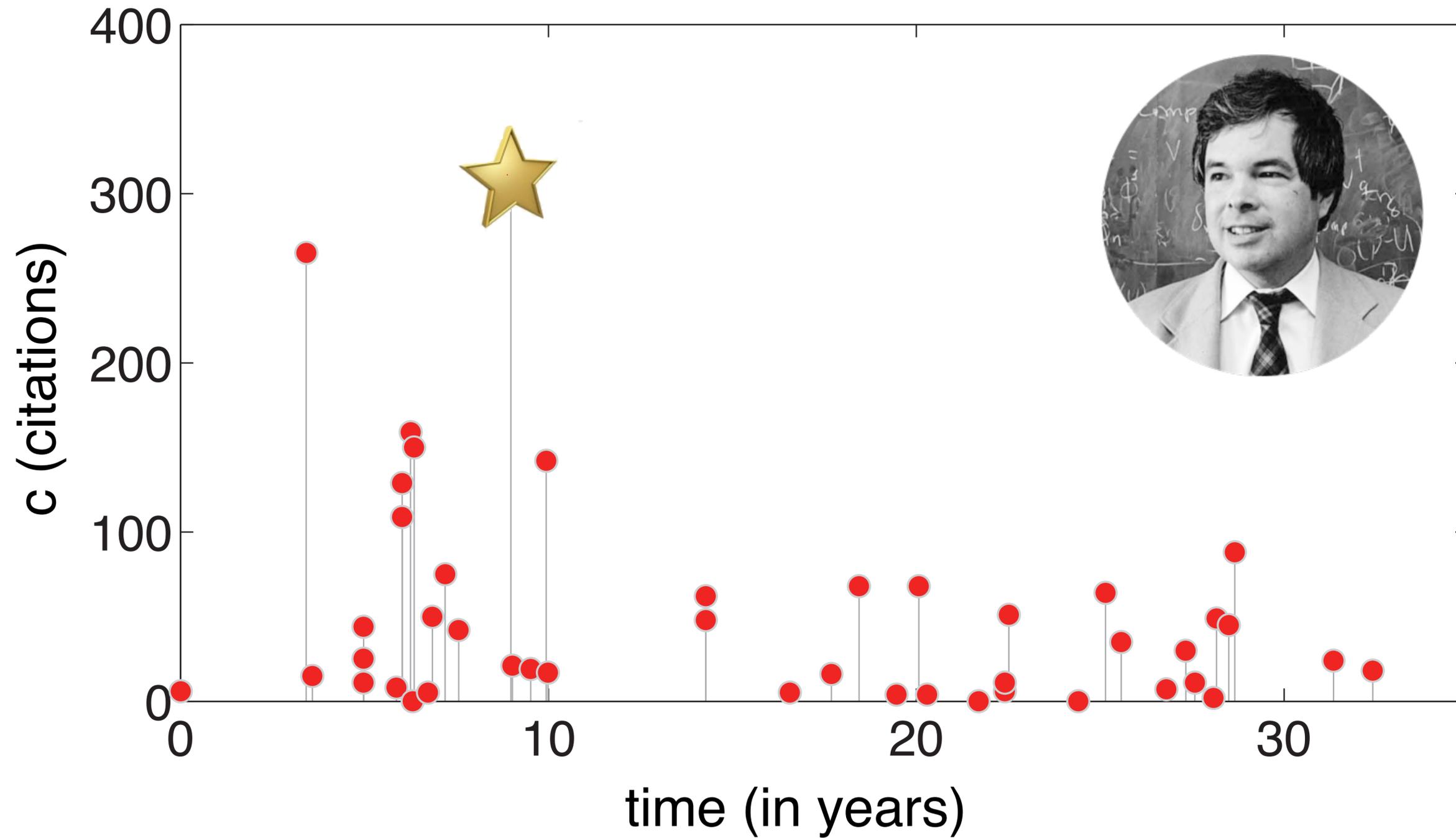


Sinatra, Wang, Deville, Song, Barabási, Science, 354, 6312 (2016)

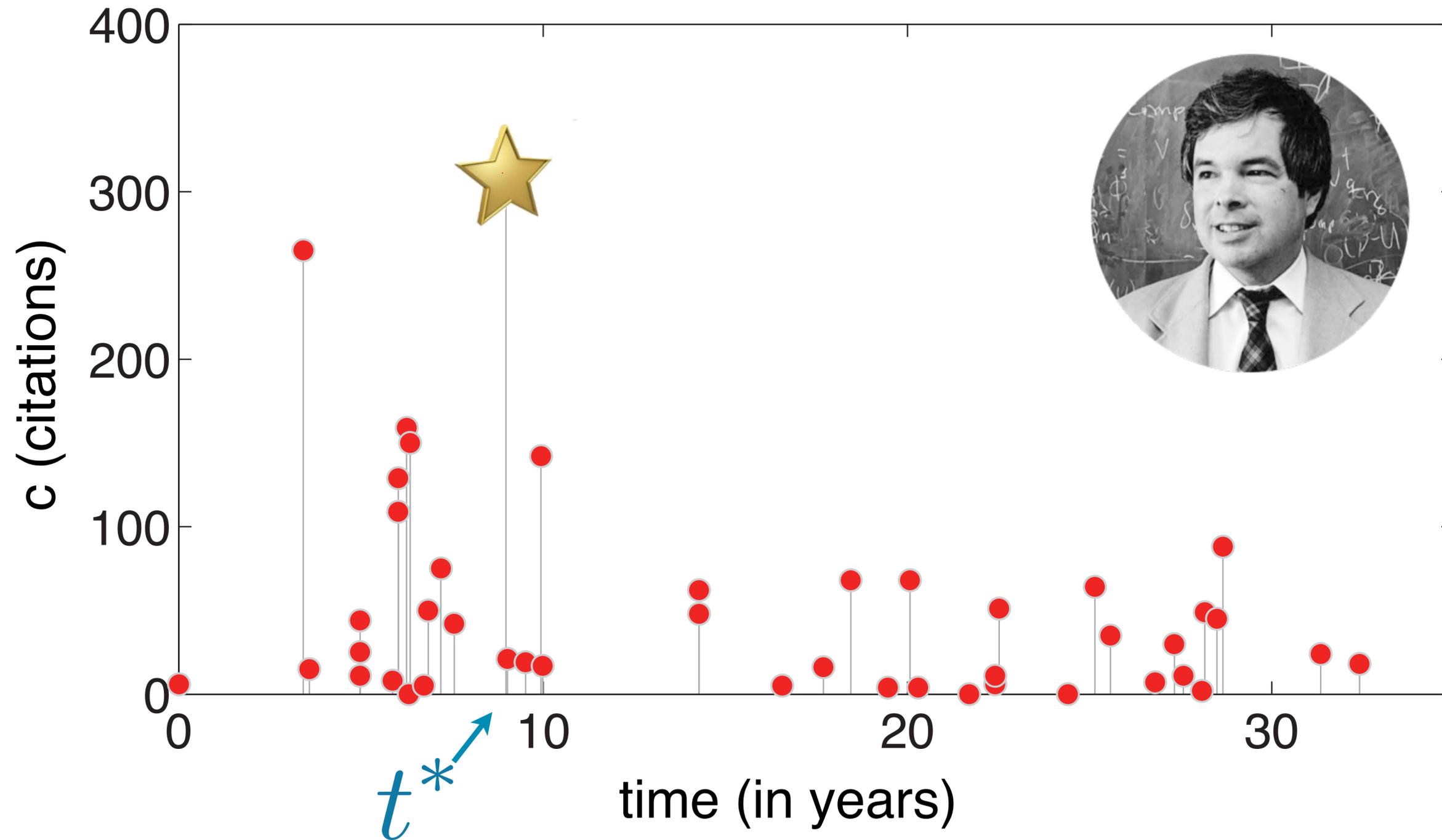
Career of K.G. Wilson (Nobel in Physics, 1982)



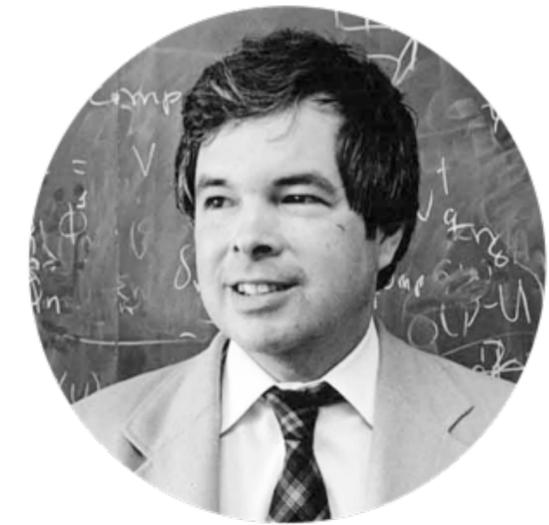
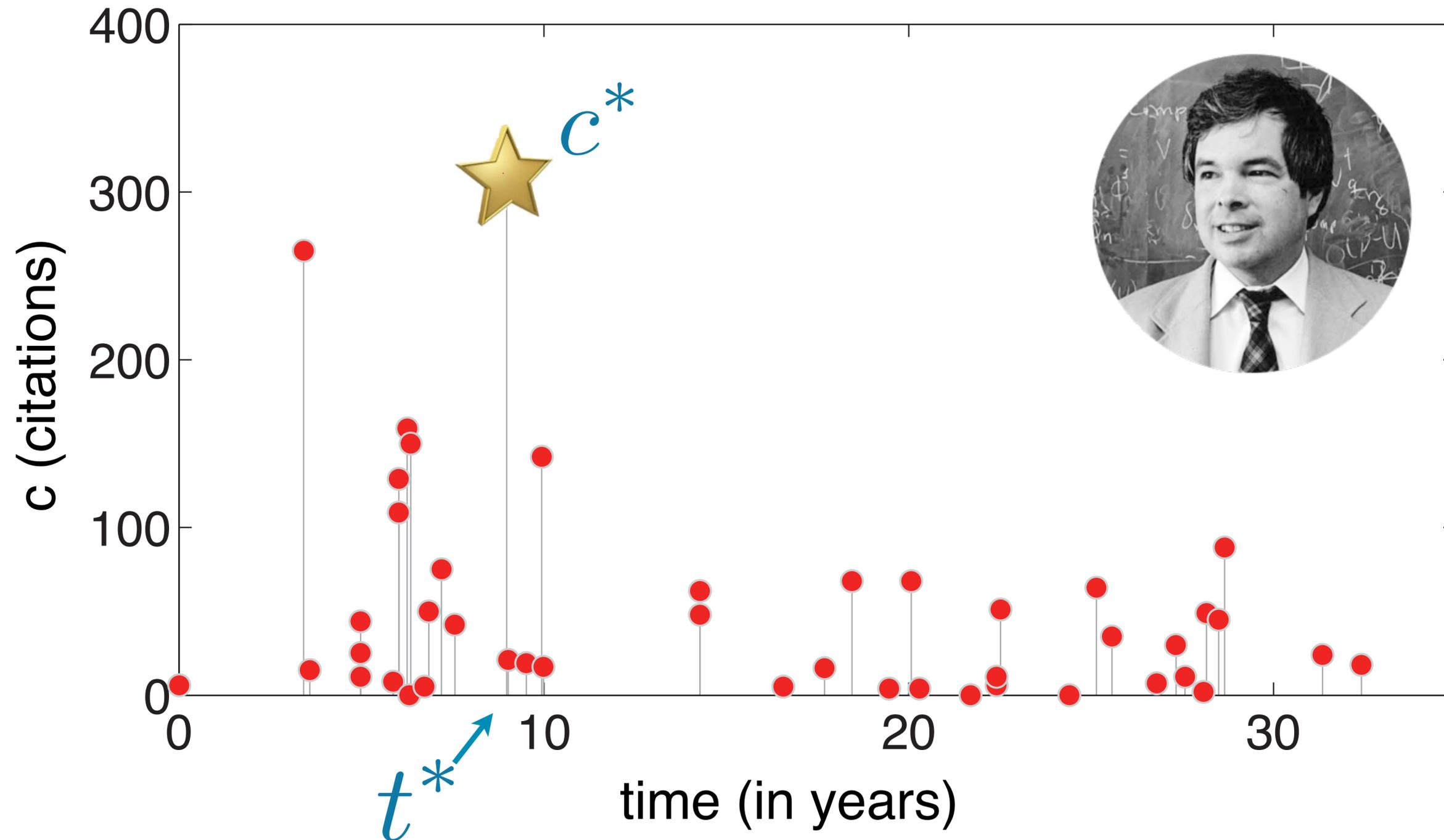
Career of K.G. Wilson (Nobel in Physics, 1982)



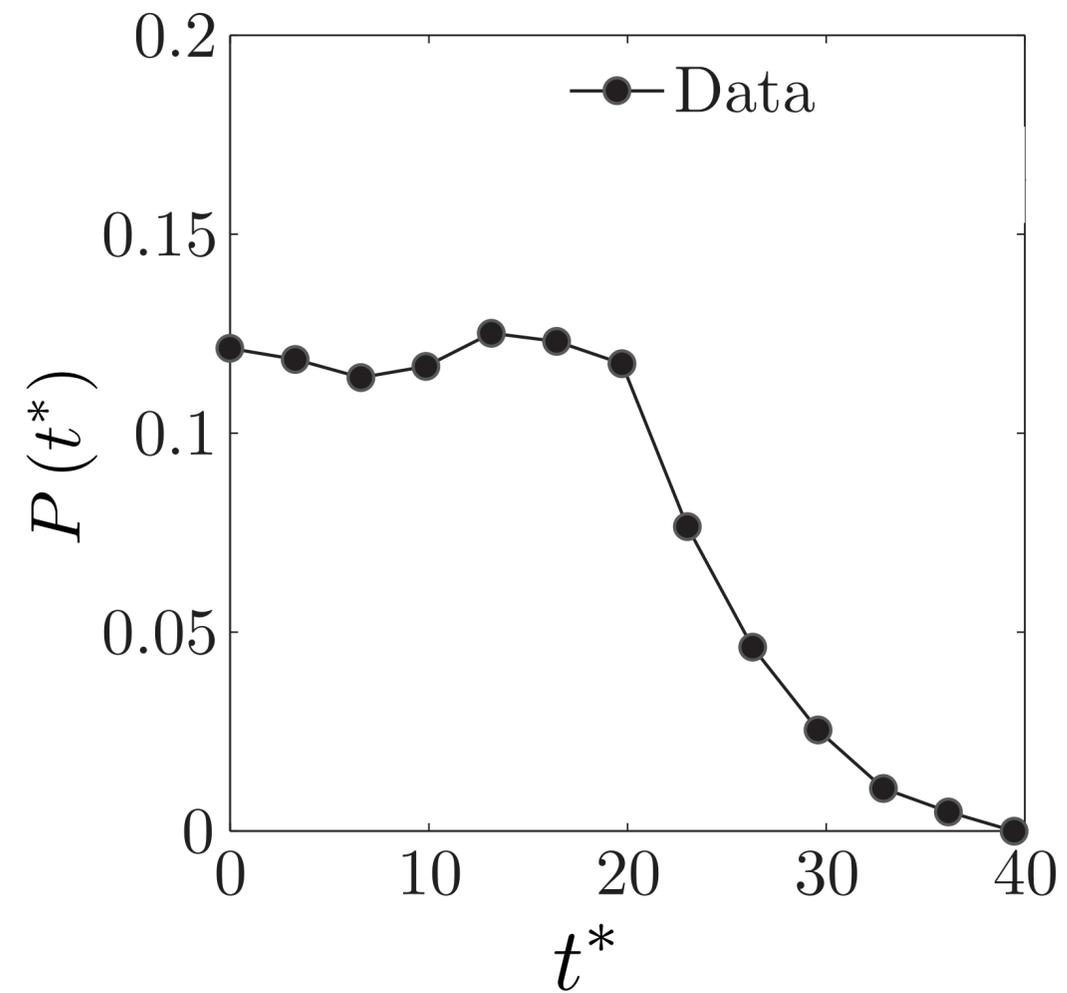
Career of K.G. Wilson (Nobel in Physics, 1982)



Career of K.G. Wilson (Nobel in Physics, 1982)



Timing of the hit

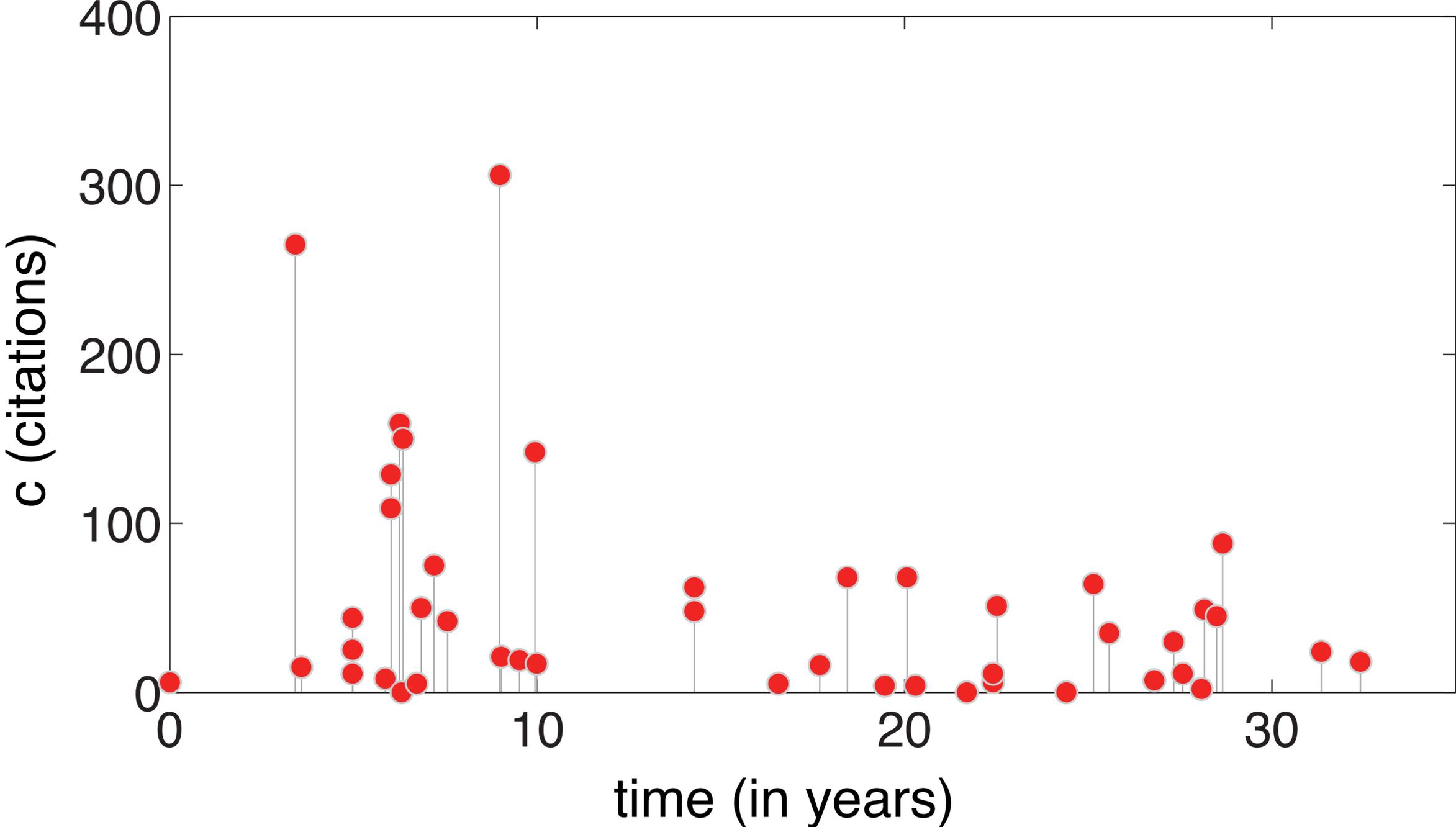


Jones, B. F., & Weinberg, B. A. (2011). PNAS, 108(47), 18910-18914.

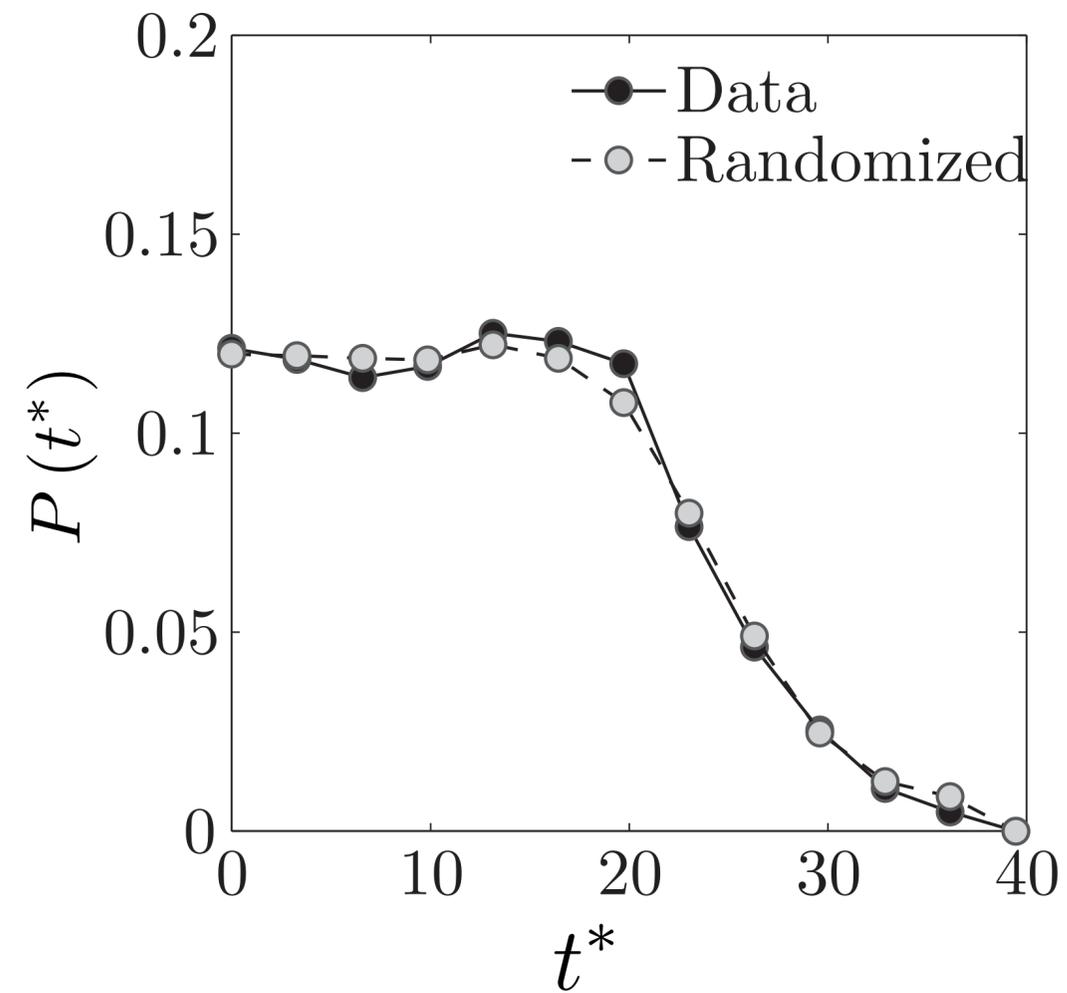
Simonton, D. F. (1997). Psychological Review 104, 66.

Sinatra, Wang, Deville, Song, Barabási, Science, 354, 6312 (2016)

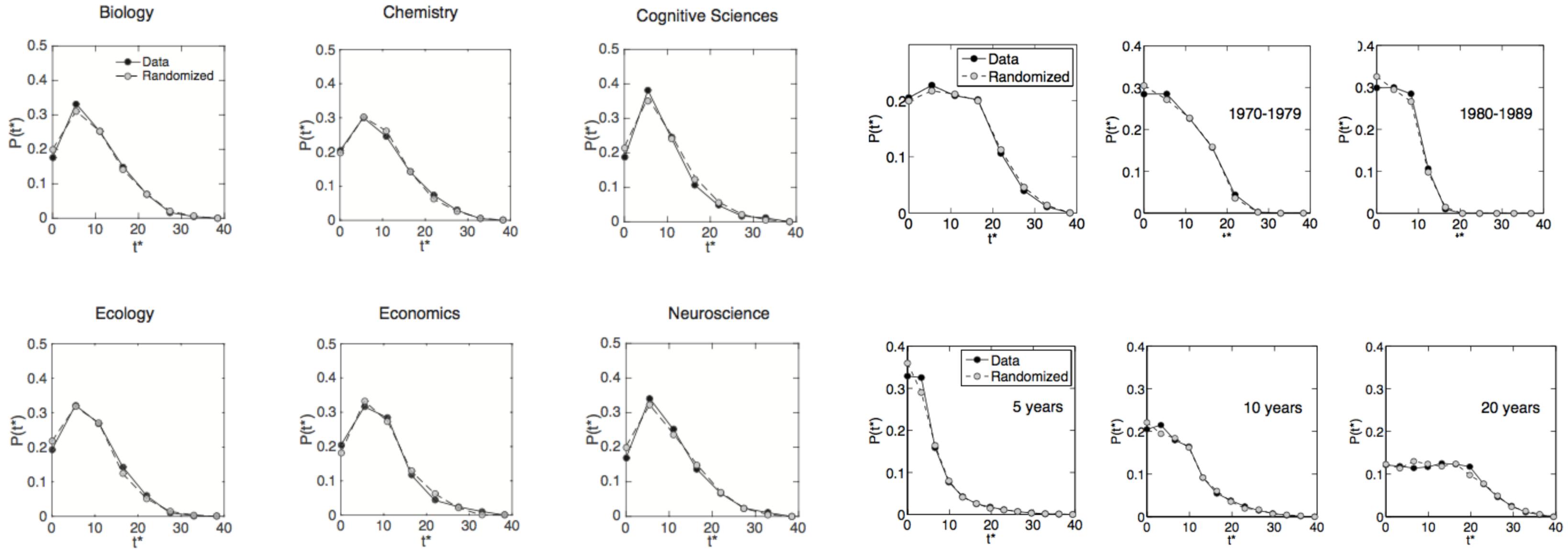
Randomization: we shuffle the impact of papers



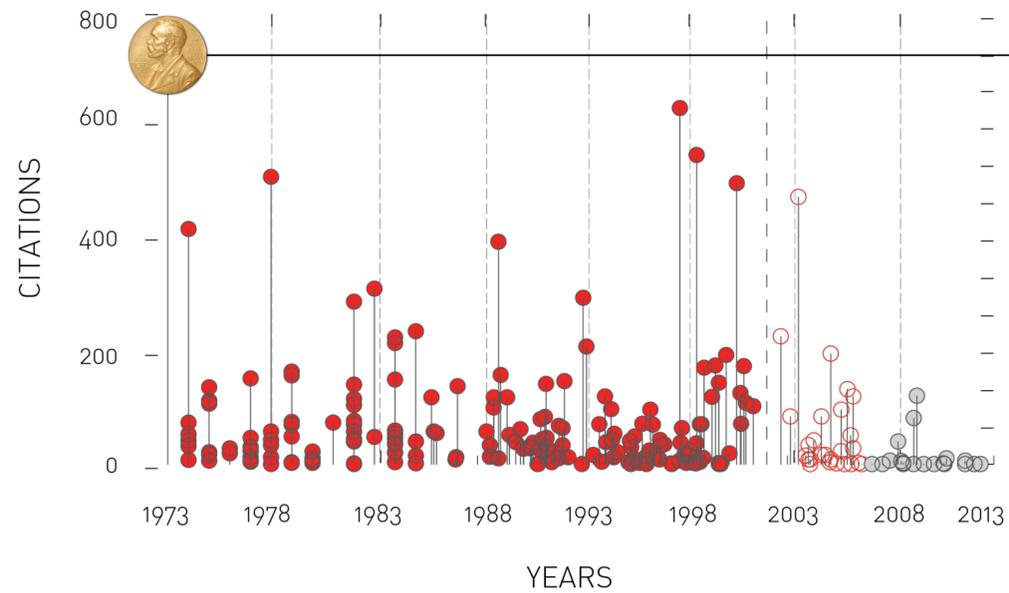
The hit is random in a scientist's sequence of publications



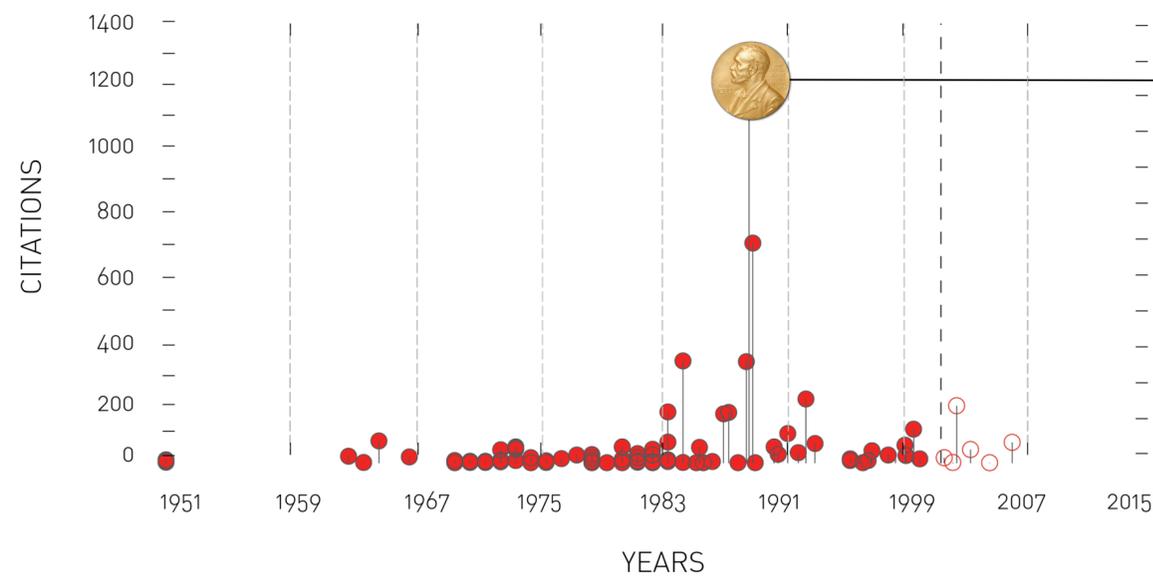
The hit is random in a scientist's sequence of publications



Impact is random within
a scientific career



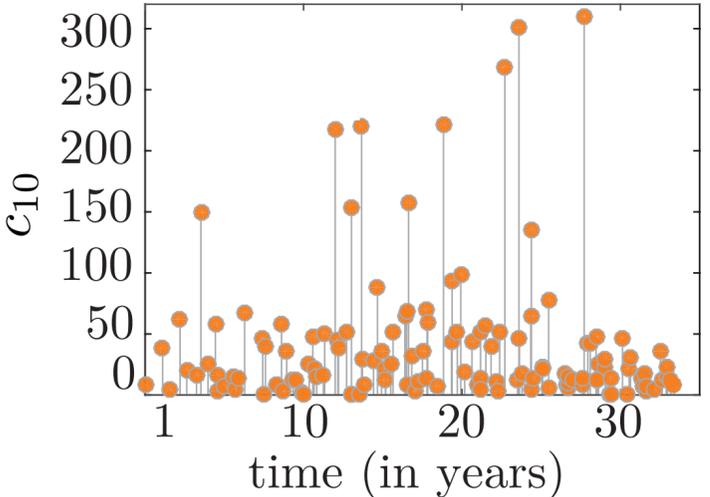
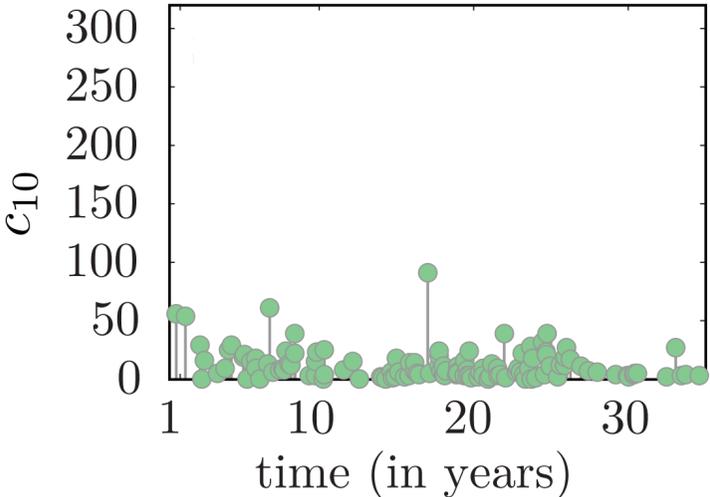
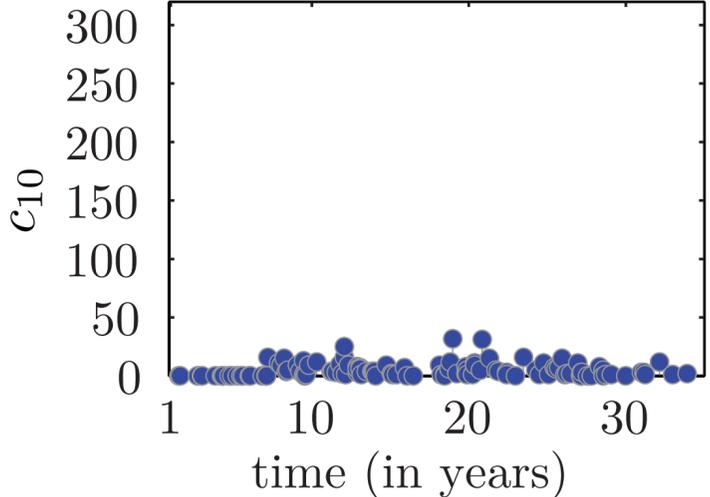
Frank G. Wilczek
Physics Nobel, 2004



John B. Fenn
Chemistry Nobel, 2002

There is always hope!

Careers look different



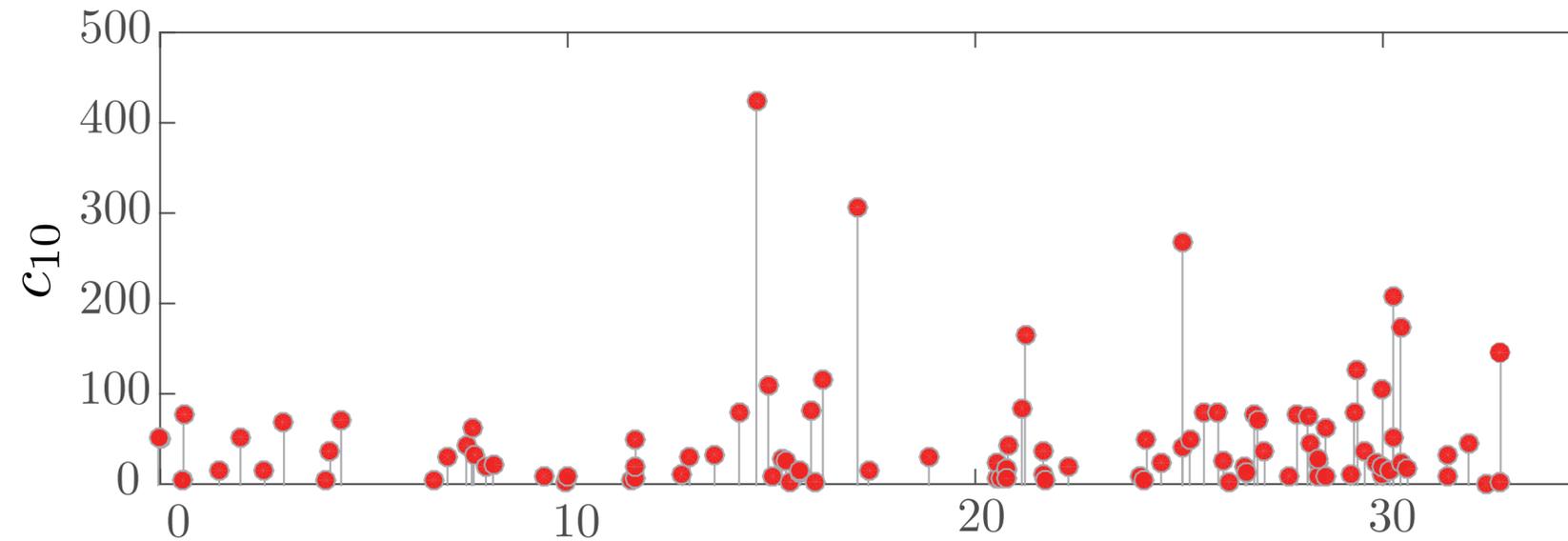
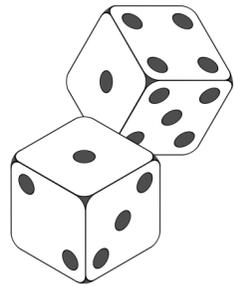
We want to untangle
productivity, individual ability, and luck

Modelling individual careers: Q-model

$$c_{j,\alpha} = p_{\alpha} Q_j$$

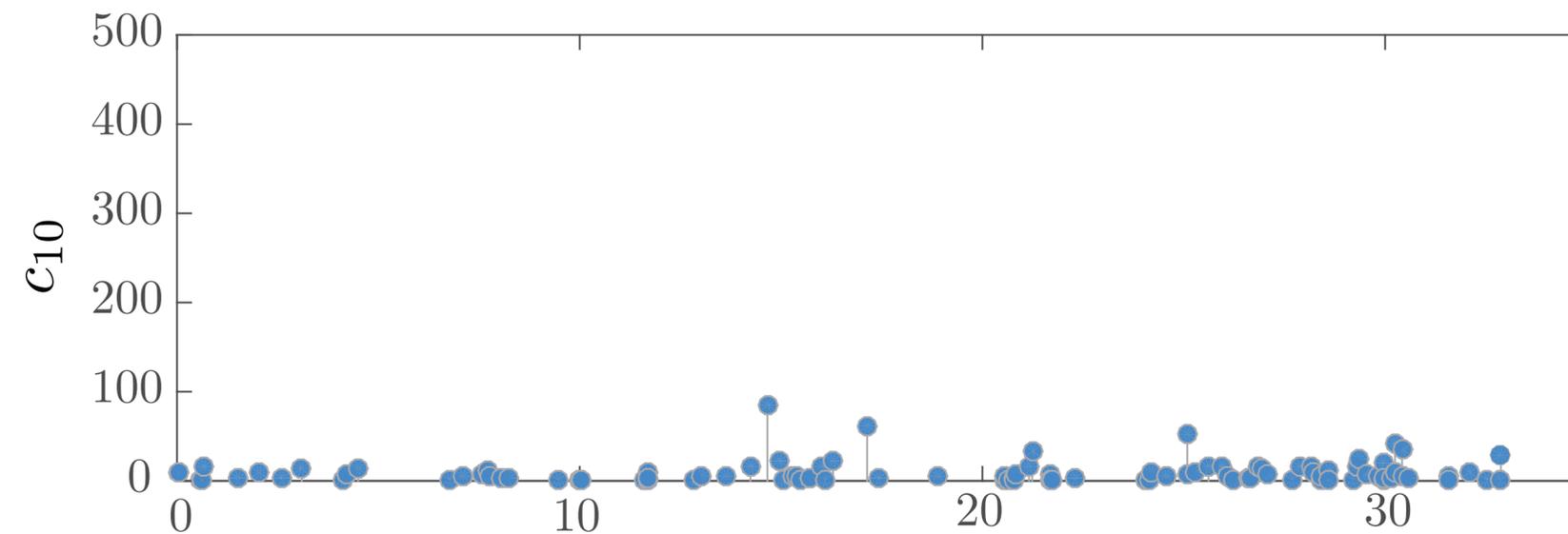
impact of j's paper = luck * researcher Q

Modelling individual careers: Q-model



$Q = 10$

$$c_{j,\alpha} = p_\alpha Q_j$$



$Q = 2$

Modelling individual careers: Q-model

$$c_{j,\alpha} = p_\alpha Q_j \quad \Sigma \equiv \begin{pmatrix} \sigma_p^2 & \sigma_{p,Q} & \sigma_{p,N} \\ \sigma_{p,Q} & \sigma_Q^2 & \sigma_{Q,N} \\ \sigma_{p,N} & \sigma_{Q,N} & \sigma_N^2 \end{pmatrix} = \begin{pmatrix} 0.93 & 0.00 & 0.00 \\ 0.00 & 0.21 & 0.09 \\ 0.00 & 0.09 & 0.33 \end{pmatrix}$$



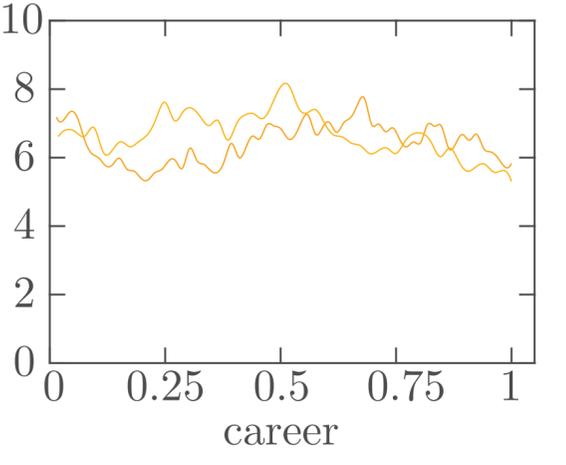
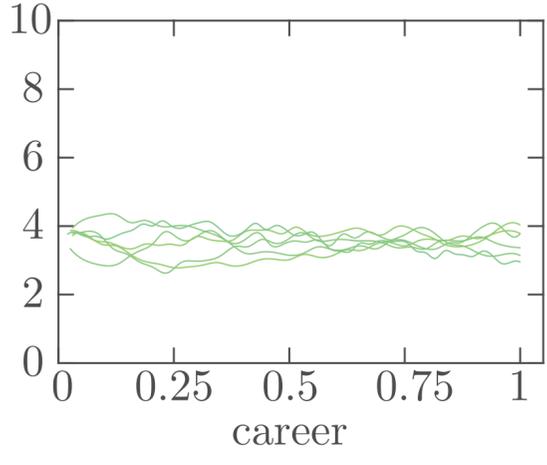
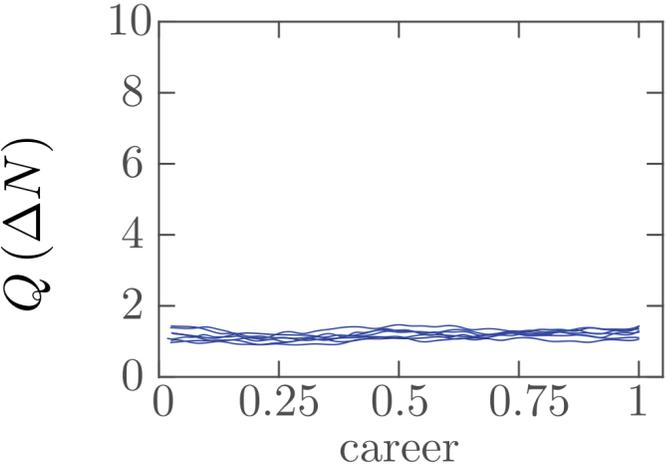
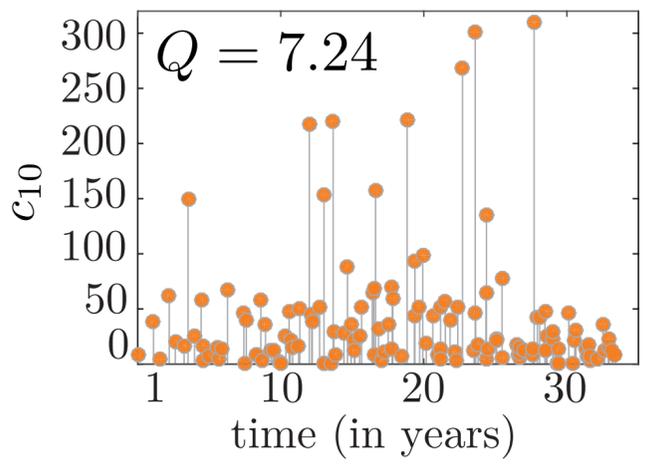
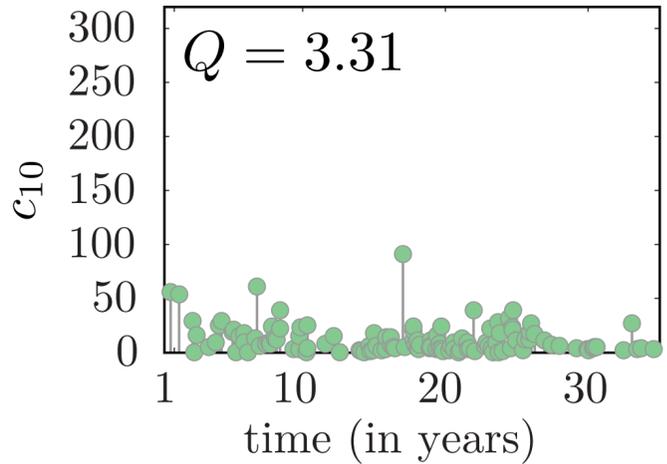
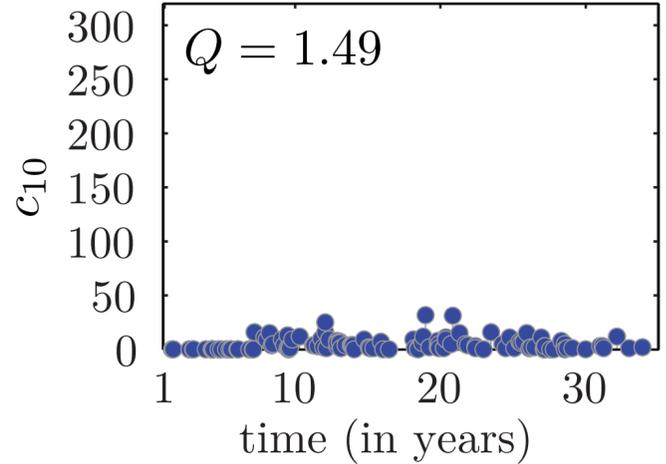
$P(p)$



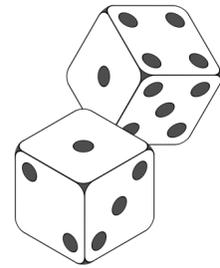
$P(Q)$

are decoupled

Prediction 1: the Q -parameter is stable throughout a career



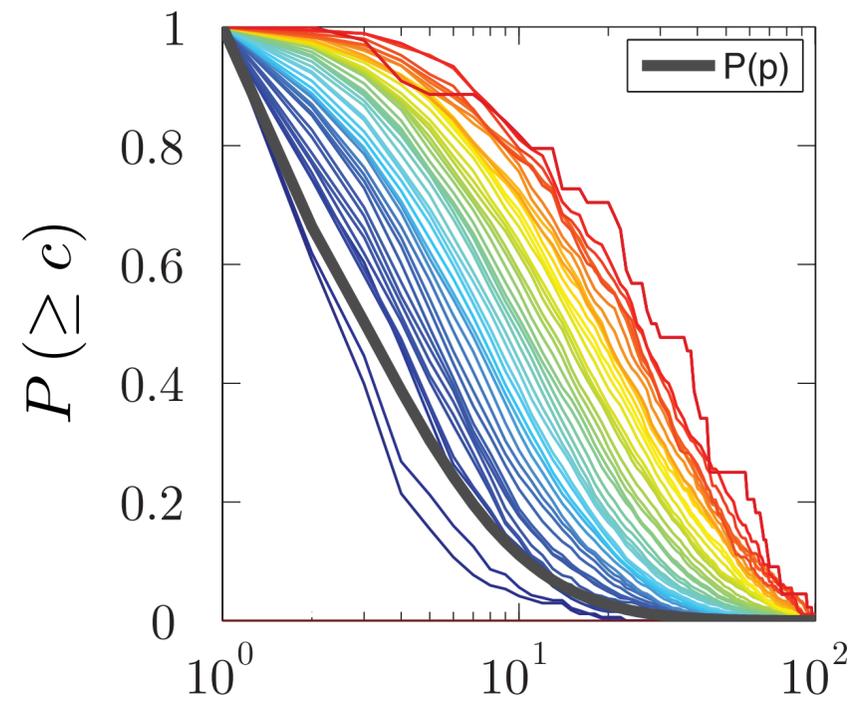
Prediction 2: the Q-model untangles luck and researcher Q



$P(p)$

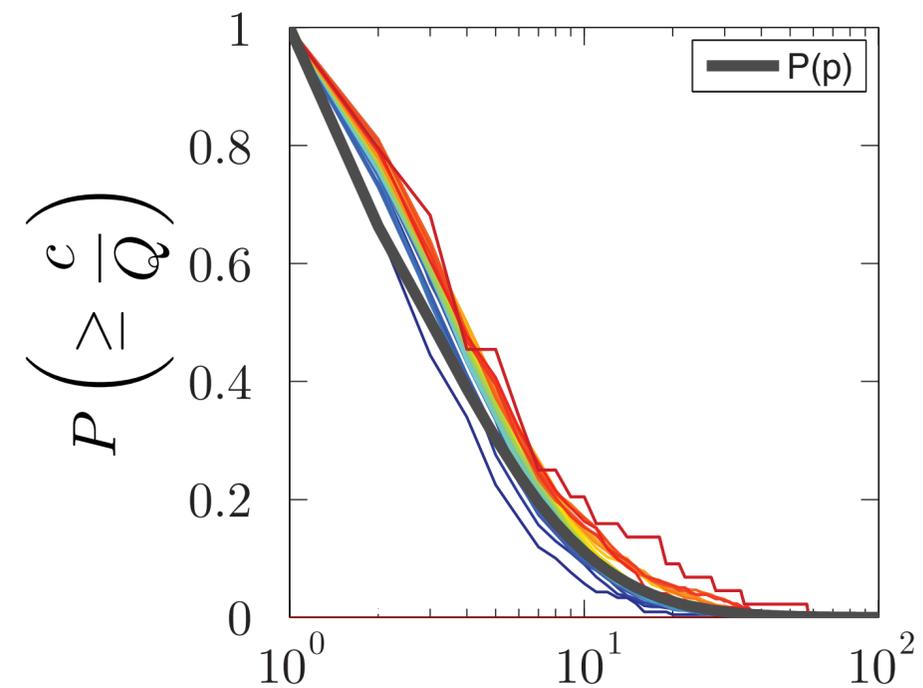
is universal

DATA

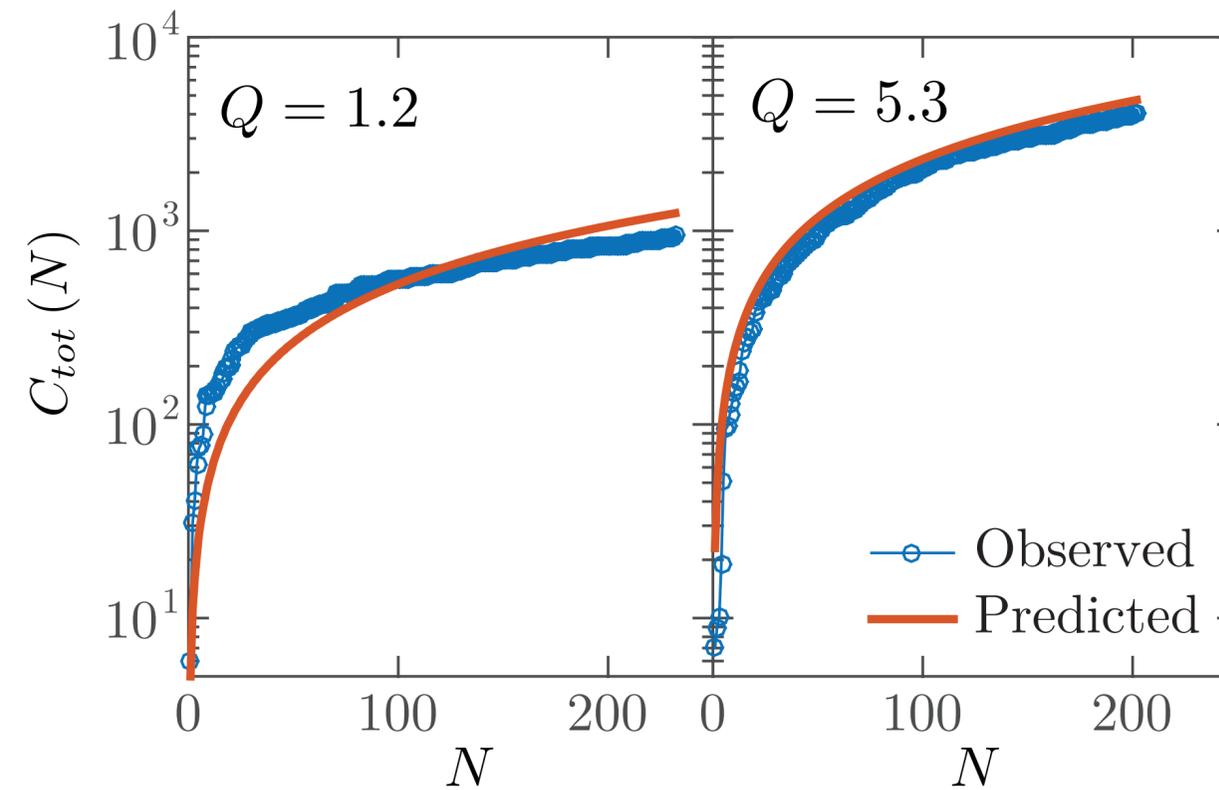
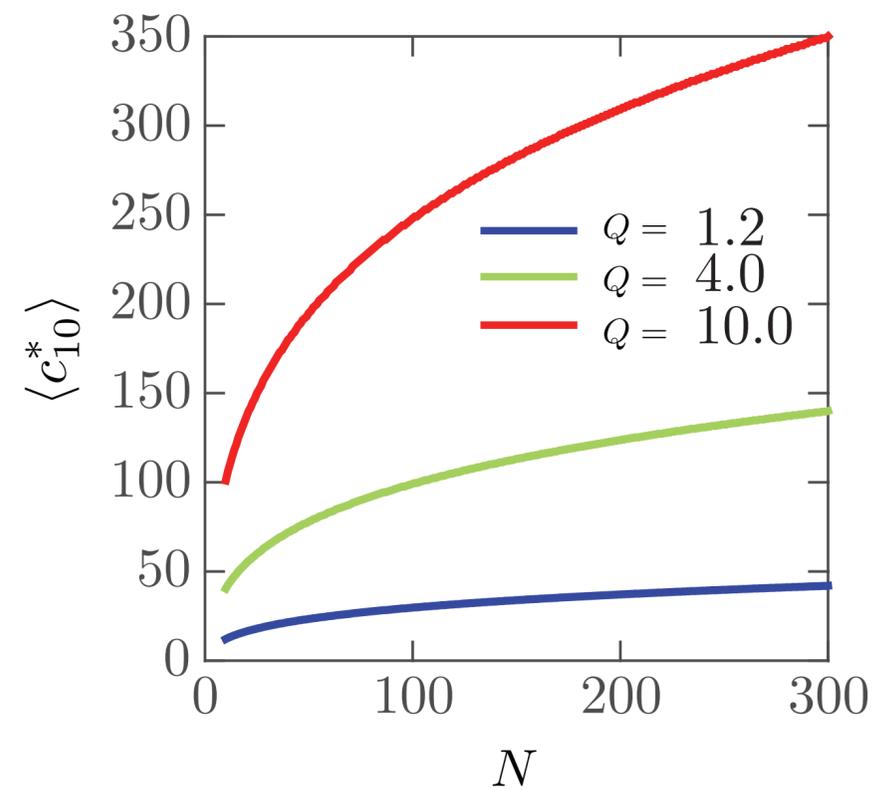


$Q|c$

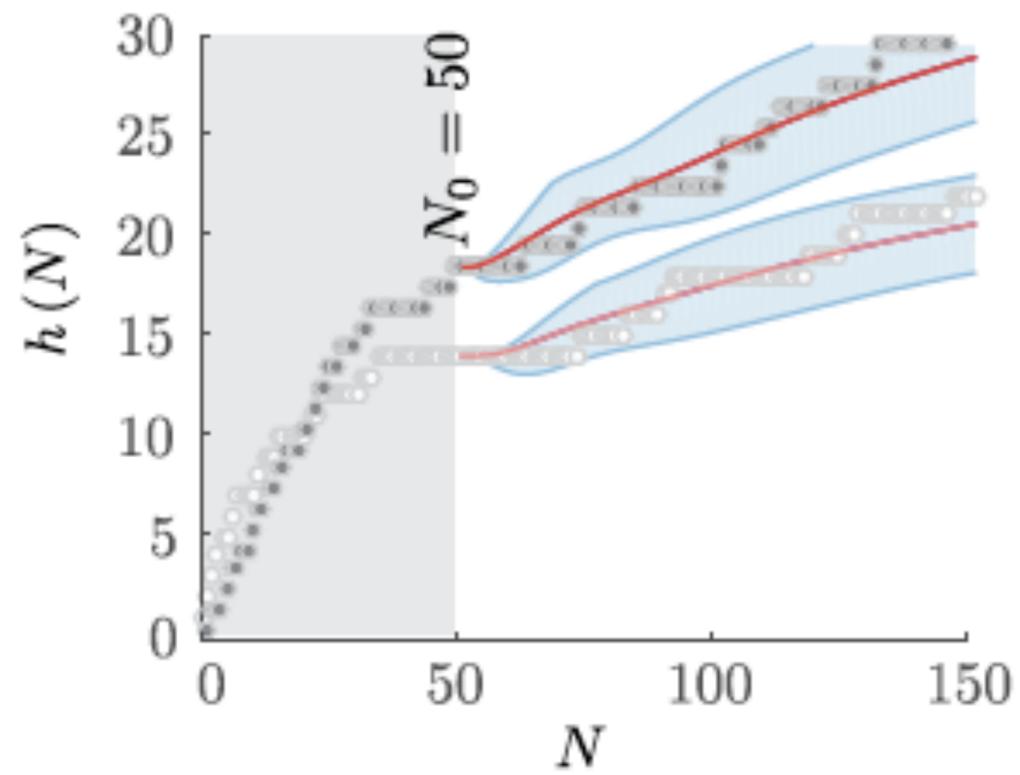
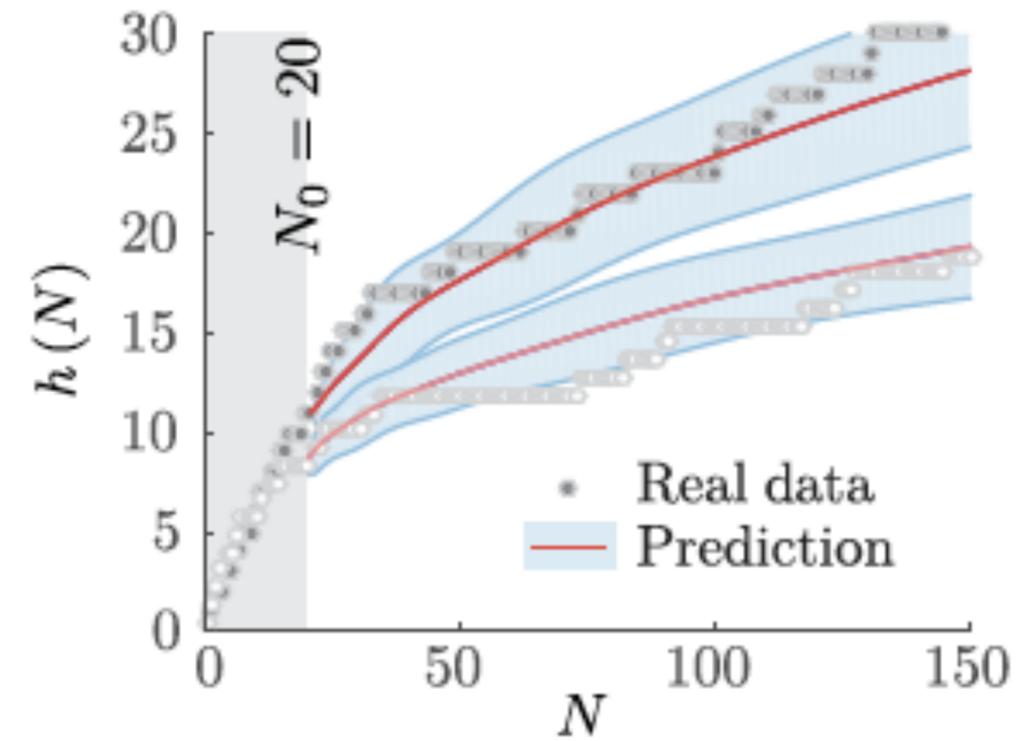
RESCALED DATA



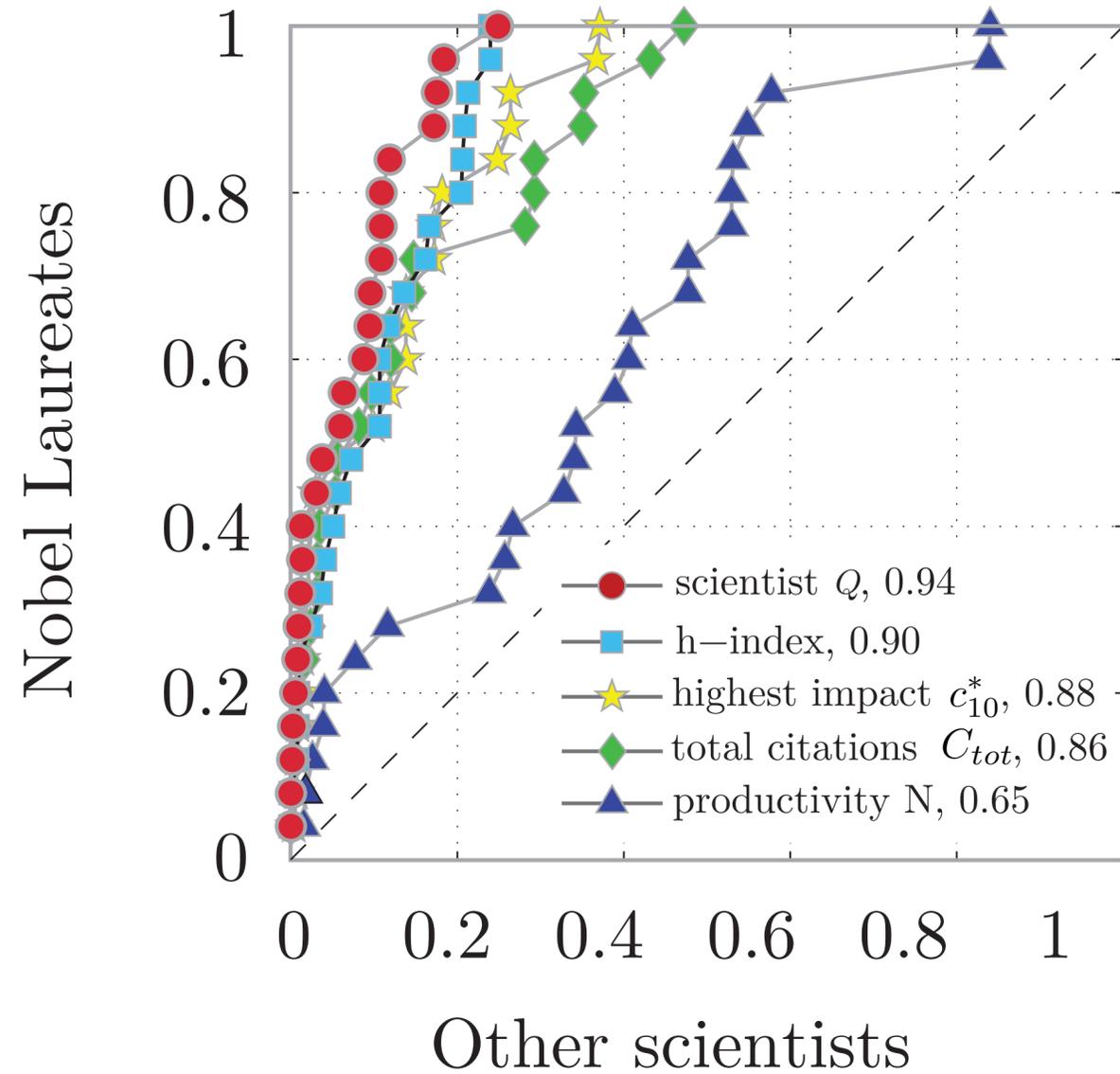
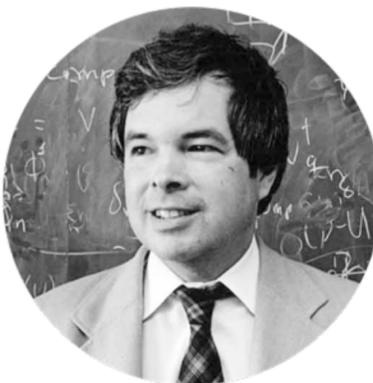
Prediction 3: the Q-model analytically predicts the dynamic of impact indicators



Prediction 4: the Q-parameter has early predictive power



Prediction 5: the Q-parameter detects nobel laureates better than other metrics



Who will make an outstanding discovery,
and when?

Is a scientific career predictable?

Who will make an outstanding discovery,
and when?

Lucky scientists with high Q ,
randomly in their career

Is a scientific career predictable?

Who will make an outstanding discovery,
and when?

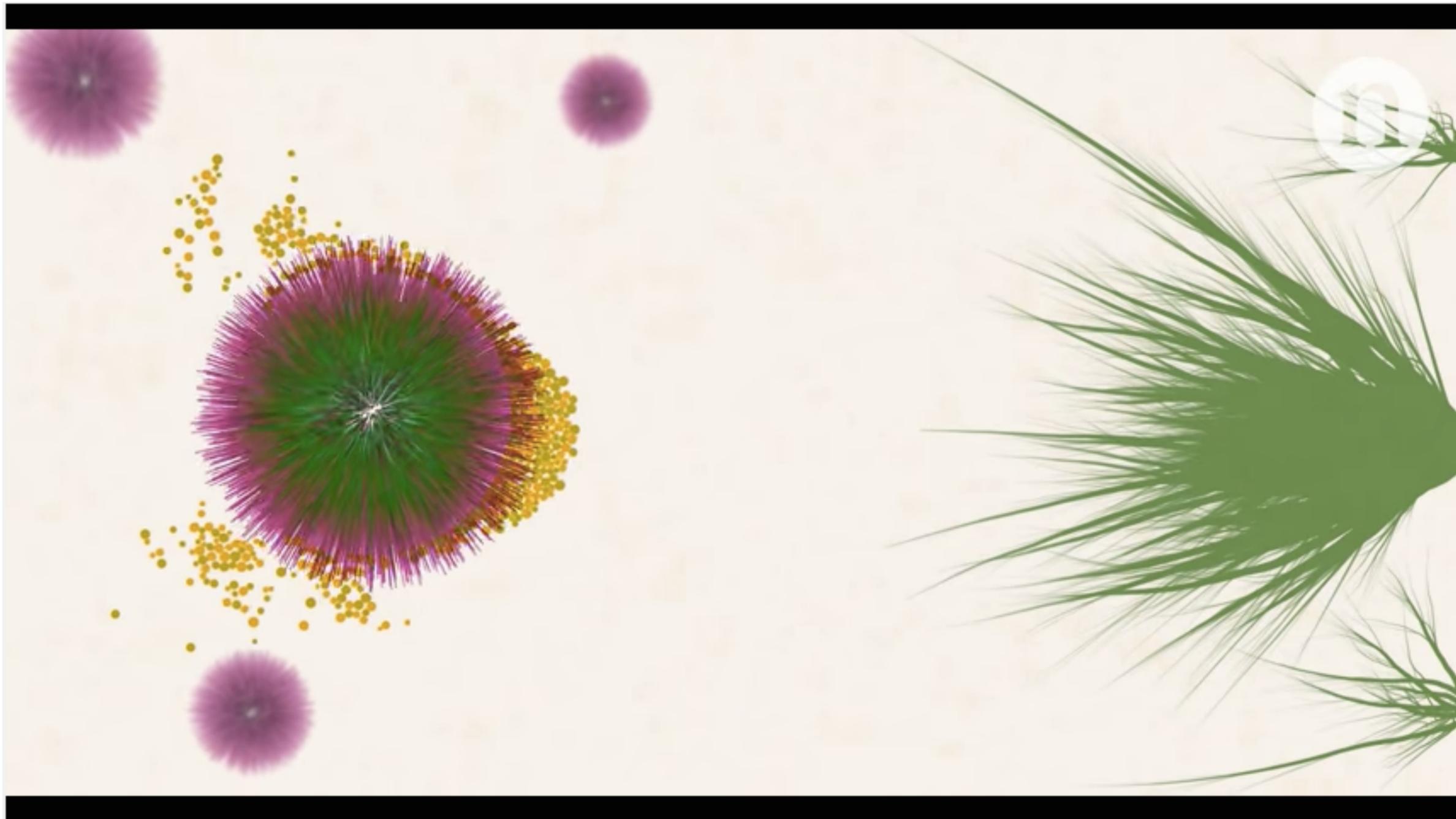
Lucky scientists with high Q ,
randomly in their career

Is a scientific career predictable?

Yes, after we quantify the luck component



<https://www.youtube.com/watch?v=qlnxM-Id4BU>



Is a scientific career predictable?



nature video

✓ Subscribed



155,677

15,539 views

Acknowledgements

with

Albert-László Barabási

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Chaoming Song

Michael Szell

Dashun Wang

Kim Albrecht

Mauro Martino

thanks to

JAMES S. McDONNELL FOUNDATION



Northeastern

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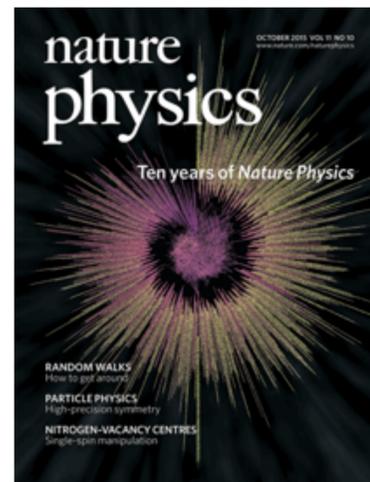
Sinatra, et. al, Science, 354, 6312 (2016)

Wang, et al. Science 342, 6154 (2013)

Deville et al. Sci. Rep. 4:4770, (2014)

Sinatra et al. Nature Physics 11, 791-796 (2015)

Szell and Sinatra, PNAS 112:48, 14749-14750 (2015)



Shameless plug

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Thank you!

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