Radboud University Nijmegen

Fundamental problems for main-stream Social & Life Sciences

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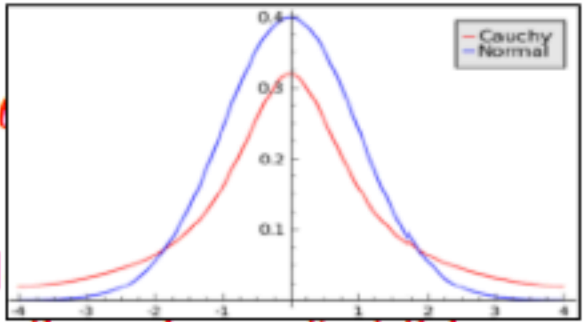
Press, W. H. (2014). Reproducibility Now at Risk? Paper presented at the Symposium on Evidence in the Natural Sciences New York, NY. https://www.simonsfoundation.org/event/symposium-on-evidence-in-the-natural-sciences/

Most of this talk is about human frailties, but some deeper foundational issues are also worth mentioning.

$$y = f(x)$$

"Discover" f by controlling x, measuring y



$$y = f(x;\theta)$$

But f also depends on unknown parameters
must be determined from the data.

$$y = f(x;\theta,R)$$

Of course the result also depends on rand an
arbitrarily nonlinear way – which we often linearize to "additive noise".

$$\langle y\rangle \approx \langle f(x;\theta,R)\rangle$$

So we are now measuring relations between expectations – if they exist (cf. Cauchy distribution).

$$\langle y(S)\rangle \approx \langle f(x;\theta,R,S)\rangle$$

Systematic errors are additional long-term random variables that don't average away.

$$P_{Y(S)}(y(S)) = \langle f(y,x;\theta,R,S)\rangle$$

Finally, y may itself be intrinsically probabilistic, as in quantum measurement or classical chaos (e.g., turbulence).

Gaussian graphical model (covmat/VAR)
1D Ising graphical model

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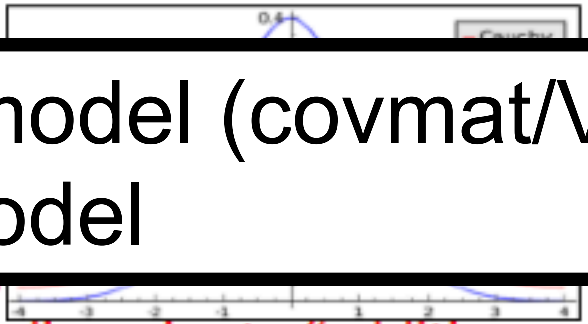

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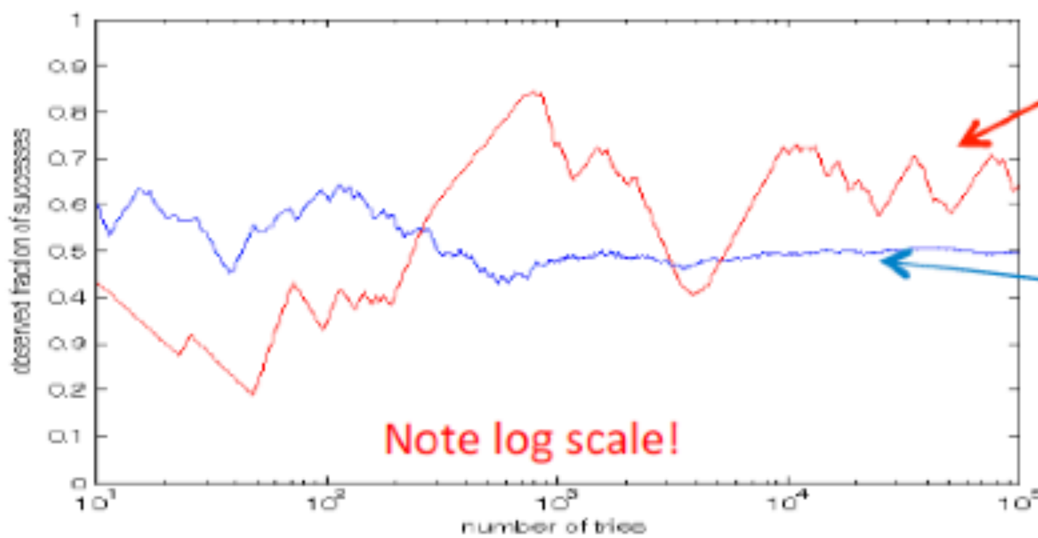
For complex adaptive systems (with internal state) the very notion of probability may not make sense.

Every time you click the button, either the Red or Green light goes on. By repeated clicks, estimate the probability P(Red).



Red fraction never converges!

By comparison, this is what a process converging as $t^{-1/2}$ would look like.

For those mathematically inclined: Would you be more surprised if I told you that the internal state of the machine is exactly statistically stationary, that is, P(state|*t*) does not depend on *t*?

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