

On the Responsible use of Pseudo-Random Number Generators in Scientific Research

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[REDACTED] LEVERHULME
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[REDACTED] FOR
DEMOGRAPHIC
SCIENCE



What is a PRNG?

**ChatGPT**

A pseudo-random number generator (PRNG) is a deterministic algorithm creating seemingly random number sequences using a specified seed. Unlike true random generators relying on unpredictable physical processes, PRNGs offer repeatability. This trait is beneficial in research, ensuring consistent results with the same seed, essential for reproducibility in various applications.



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 - Or, alternatively, use a subset of the seeds **we** provide.

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- An extremely important and scarcely researched problem.
- Pseudo-Random Number Generators occur everywhere!
- The variation in estimand can be huge (as we'll show).
- We bring attention to this through multiple types of replications.
 - Simulations, machine learning, NLP, and inferential research.
- Seed variation at times: i.) can be eliminated, ii.) is not a concern, iii.) cannot be eliminated (requires examination).

The General Premise

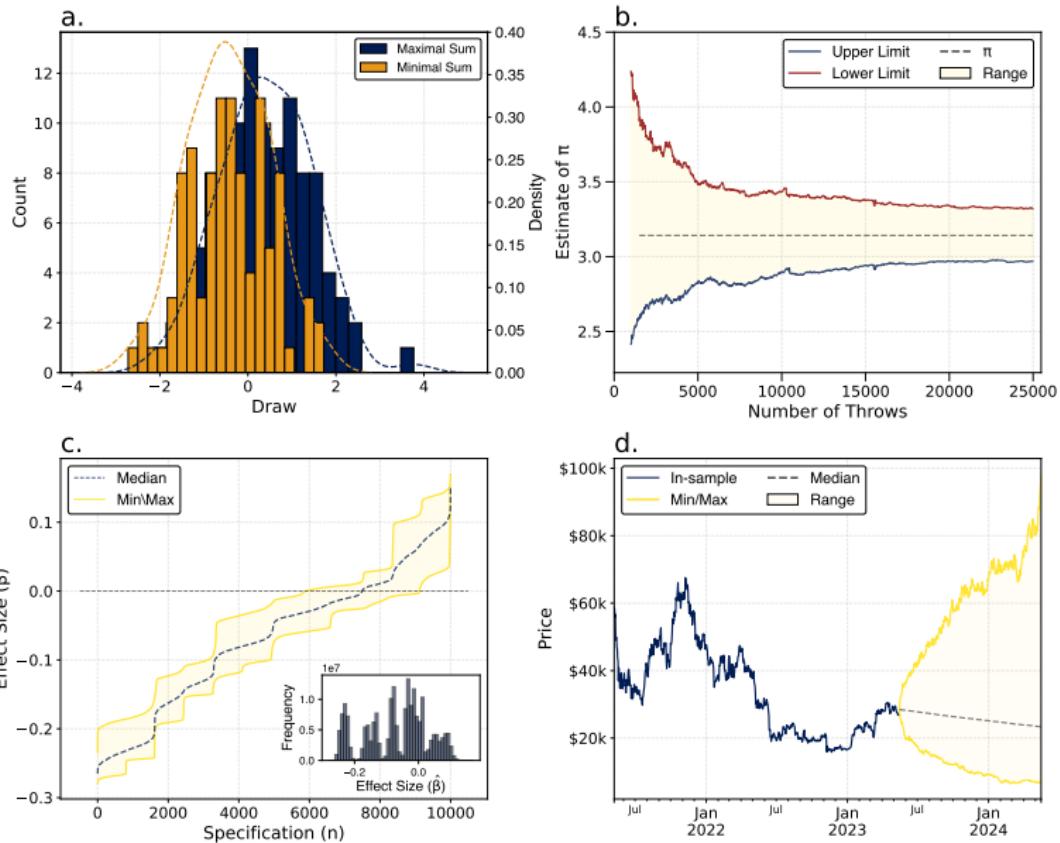
- **Problem Statement:** By setting **one** seed, we ignore the variation of our estimand as a function of how PRNGs were generated: computationally un-intensive, but scientifically dour.

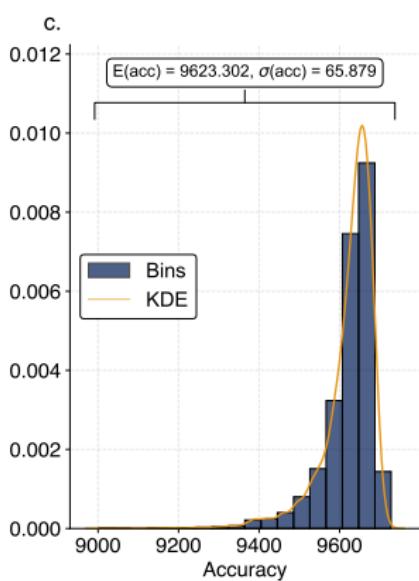
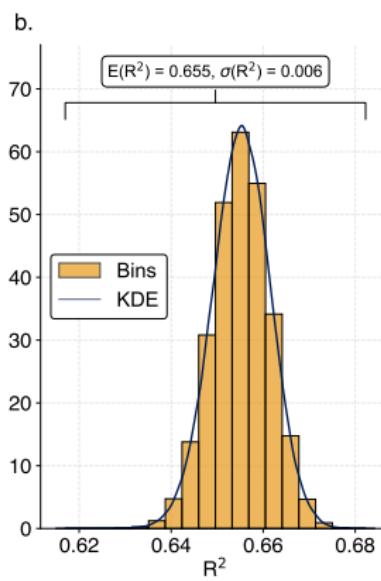
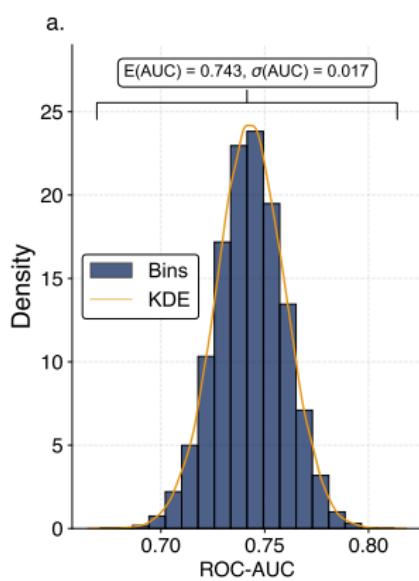
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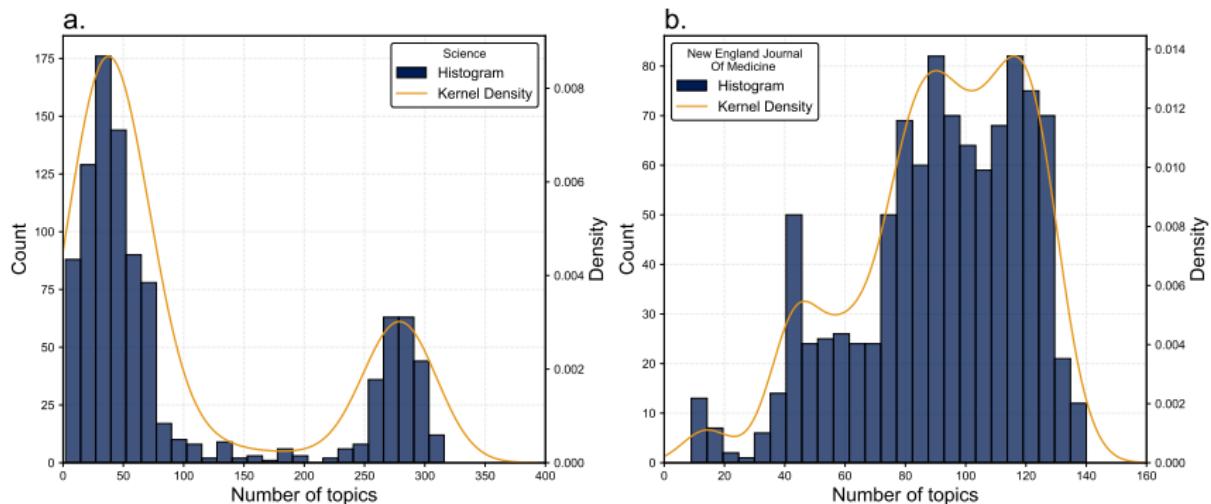
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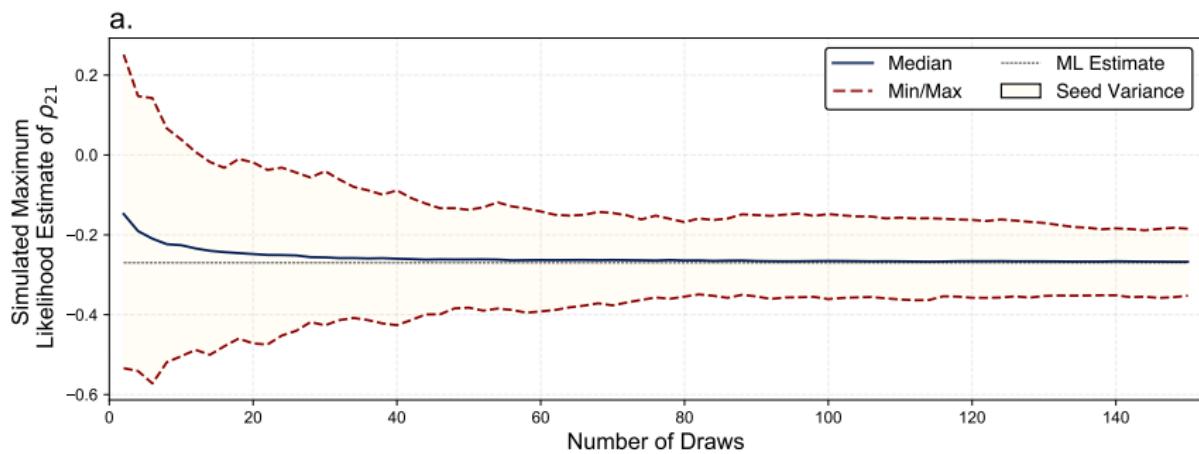
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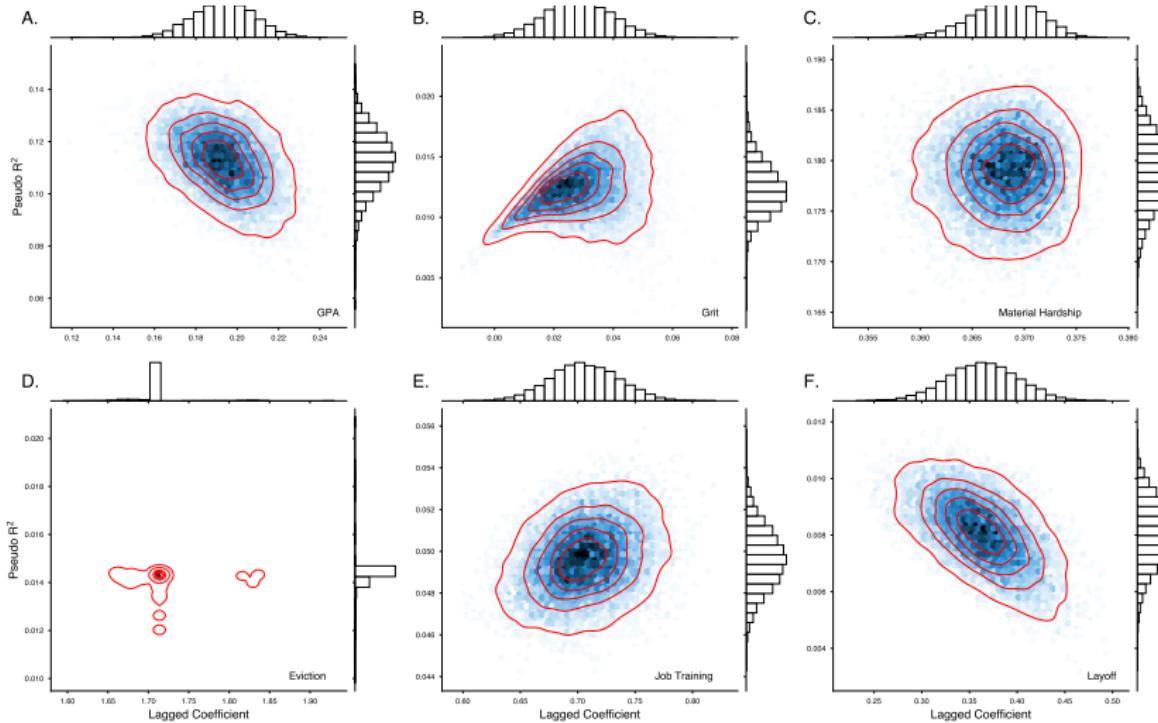
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- **Replication:** Similar to specification curves and p-hacking, we can consider whether an original result is in the tail/IQR of the distribution of possible outcome space.









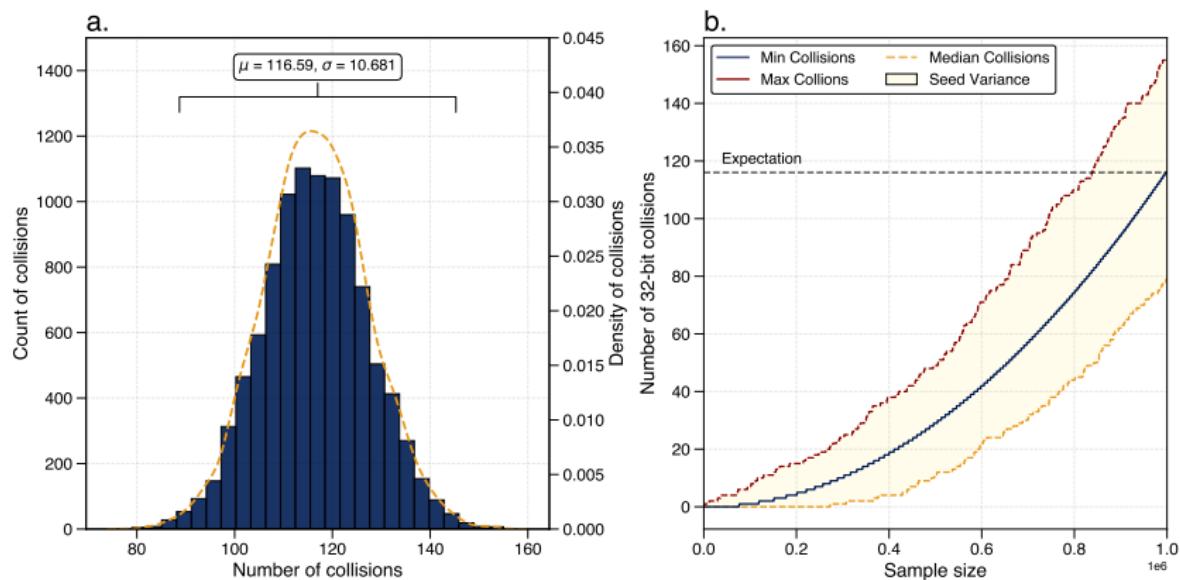


To make things more complicated...

- Hofert (2020): in *some* scenarios, **collisions** exist.
- Collisions: generation of duplicates b/c of insufficient complexity.
- An author of a leading LCDS publication recently stated to me:

"We wanted to run it [the model] with a 100k seeds, but in reality, it was only 99,905 or something, because we were seeing that our results weren't unique when they should have been."

- This *only* occurs in 32-bit Mersenne Twister implementations.
 - With 32-bit MT: $E(\text{collisions})$ is 116.
 - With 64-bit MT: $E(\text{collisions})$ is $2.71e-08$.
- The default implementation of MT in R is 32-bit. . . .



Concluding Thoughts

- Matt Salganik commented: 'That sounds great, but expensive!'
 - Expense no-longer prohibitive: everything here ran locally.
- Does anyone have ideas for other types of seed variability?
- Can this be corrective? Index historical seed variability?
- Prospectively: we make available a list of seeds (replication materials), encouraging their use as a pre-specified set.
- **TLDR:** when variation can't be eliminated, should be visualised.