How Usability and Reproducibility in Software Improves Teaching and Research

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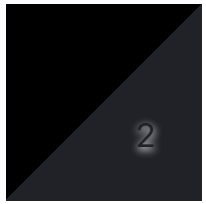
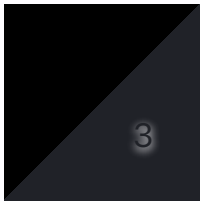
Reproducibility

Given the same raw data, can you follow the steps and understand the assumptions of how the authors arrived at their conclusion?



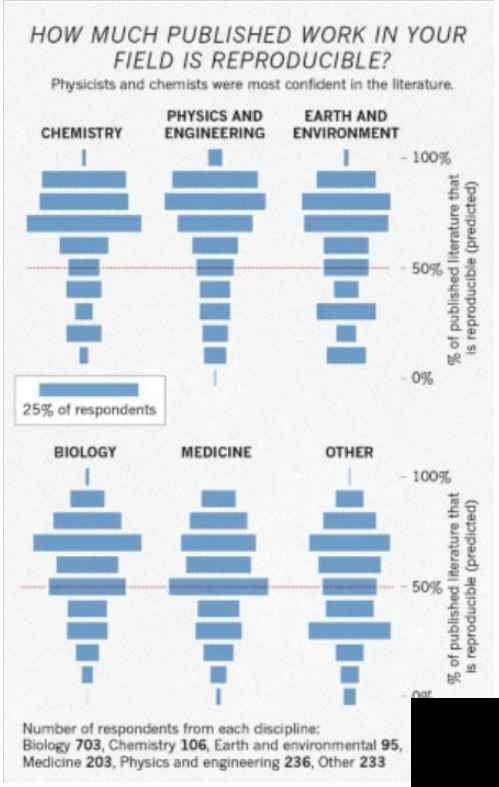
Why does it matter?

- Improves trust and transparency in science and beyond
- Promotes learning, habits, and building on others' work



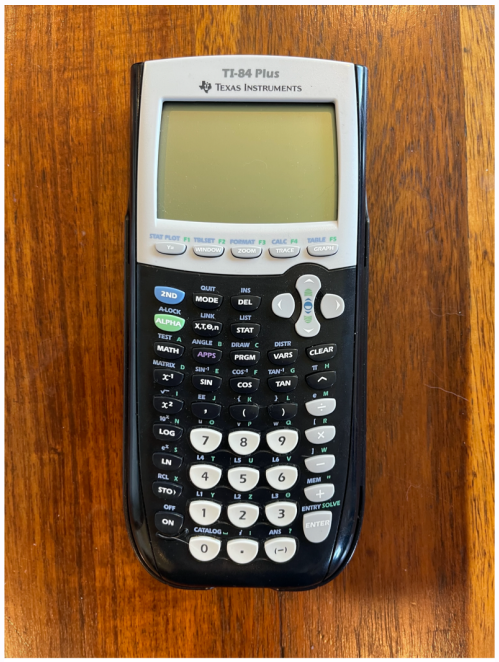
Trust in research

- Nature 2016 Survey 52% say there is crisis
- Nature 2021 Survey confidence in science leads to vaccination



Learning by doing

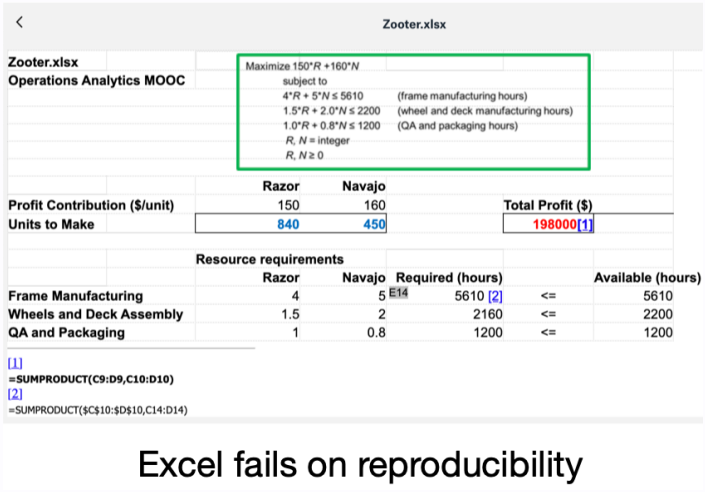
- Data used in all fields
- Computational sciences
- Larger models and big data
- Need to automate



In 2021, really?

Why is it hard?

- Not WYSIWYG
- Hacker mindset
- Accessible data, code
- Replicate environment
- Cloud operations
- Trust chain for security



Zooter.xlsx

Zooter.xlsx
Operations Analytics MOOC

Maximize $150*R + 160*N$
subject to
$4*R + 5*N \le 5610$ (frame manufacturing hours)
$1.5*R + 2.0*N \le 2200$ (wheel and deck manufacturing hours)
$1.0*R + 0.8*N \le 1200$ (QA and packaging hours)
R, N = integer
$R, N \ge 0$

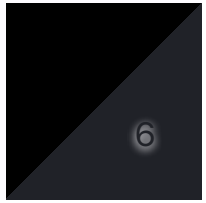
	Razor	Navajo		
Profit Contribution ($/unit)	150	160	**Total Profit ($)**	
Units to Make	840	450	198000[1]	

Resource requirements

	Razor	Navajo	Required (hours)		Available (hours)
Frame Manufacturing	4	5	E14 5610 [2]	<=	5610
Wheels and Deck Assembly	1.5	2	2160	<=	2200
QA and Packaging	1	0.8	1200	<=	1200

[1]
=SUMPRODUCT(C9:D9,C10:D10)
[2]
=SUMPRODUCT($C$10:$D$10,C14:D14)

Excel fails on reproducibility



Addressing Usability, Jim and team built

- RC^2 iOS and Mac Swift Client for Notebooks with remote computation, inspired by teaching at WVU
- RSpark a "Big Data" Docker-base compute environment with R, Spark, and other packages; used in short courses in Big Data with Spark

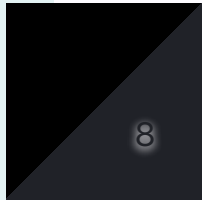
Late nights discussing

- R vs. Python
- R Markdown vs. Jupyter
- Spark vs. Apache Arrow
- Tensorflow vs. PyTorch
- Stan vs. PyMC3
- Mac vs Linux
- Functional programming

- Docker, Kubernetes, GPUs

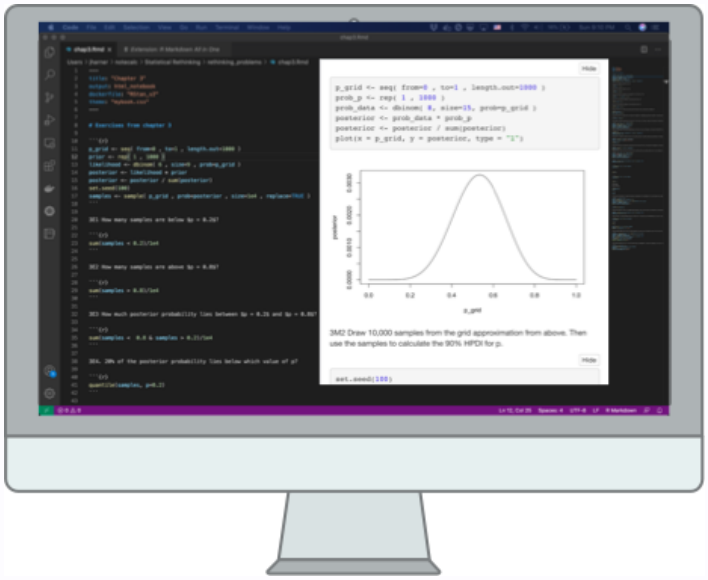
JIM HARNER

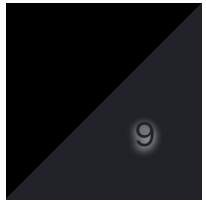
SOREN HARNER



Didact

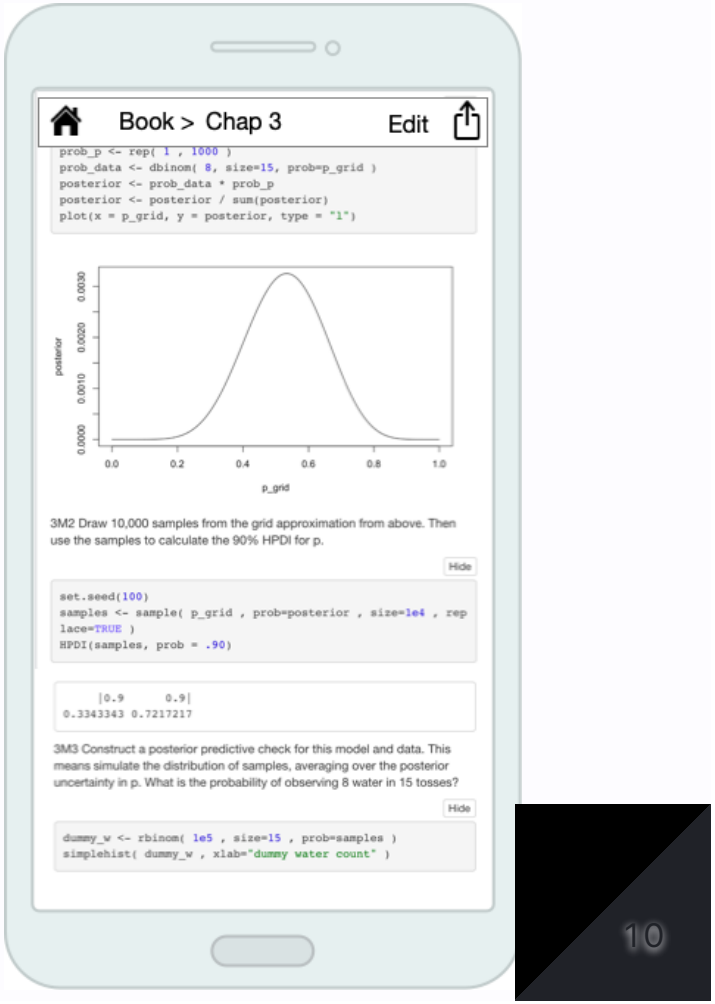
- Author in markdown
- Add code chunks
- VS Code ecosystem
- Language servers
- Javascript interactivity
- CSS formating
- Pull request to publish



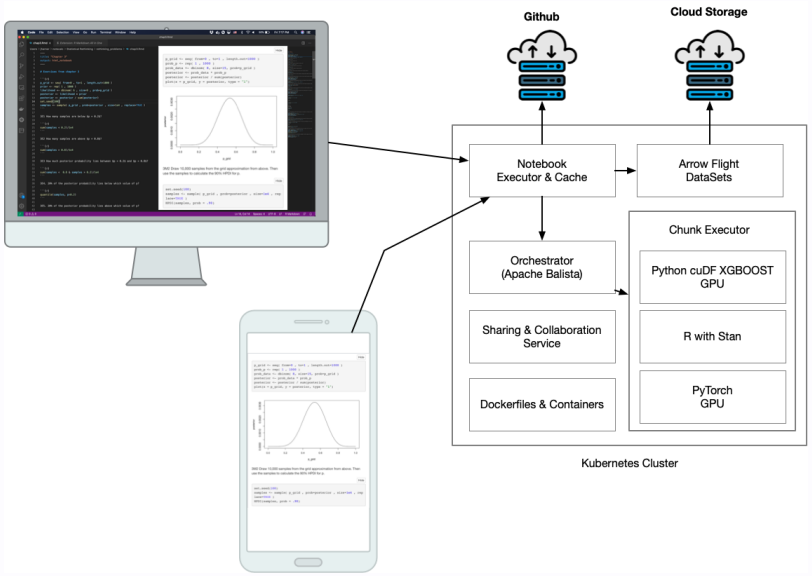


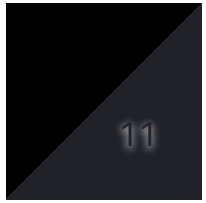
NoteCalc

- Read, share, re-use interactive notebooks
- Mobile and Web
- Obviate the calculator
- Better than static books and reports
- Verifiable, tamperproof



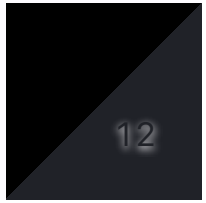
Remote computation and cloud services



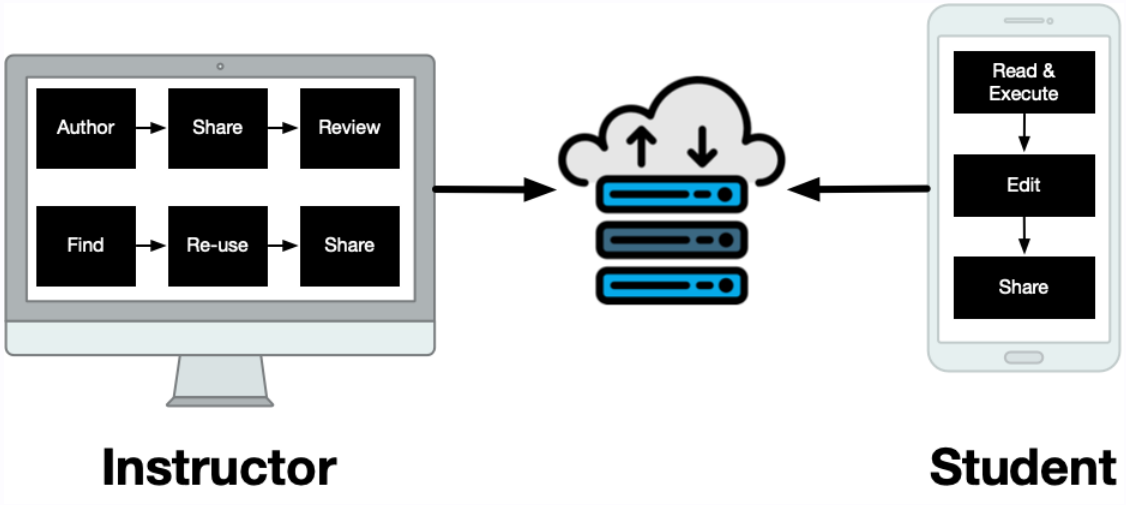


Reproducibility key to sharing

- Accessible code, e.g. Github
- Accessible, tamper-proof dataset vault, e.g. Arrow
- Accessible environment, e.g. Dockerfiles
- Notebook compiled into computational graph, i.e. shared random seed, externalized jobs
- Verifiable identity, auditable



Instructor, student collaboration



References

Introduction to Reproducible Science in R

1,500 scientists lift the lid on reproducibility

What does research reproducibility mean?

Trust in science, social consensus and vaccine confidence, Nature 2021 Survey