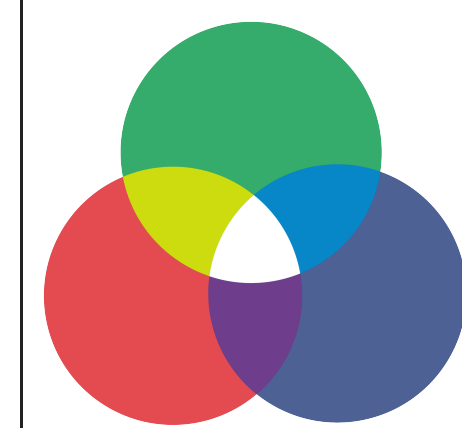




MICHIGAN STATE
UNIVERSITY



CMSE

AI FOR PROPOSAL

HANDLING AND SELECTION

Wolfgang Kerzendorf
SciOps 2022
18 May 2022
on behalf of the
DeepThought Initiative

AI – THE HYPE!

“WHEN YOU’RE FUNDRAISING, IT’S AI. WHEN YOU’RE HIRING, IT’S ML. WHEN YOU’RE IMPLEMENTING, IT’S LOGISTIC REGRESSION.”

everyone on Twitter ever



MICHIGAN STATE
UNIVERSITY



CMSE

ML FOR PROPOSAL

**HANDLING AND
SELECTION**

Always has been

Wait it's all about peer review



PEER REVIEW

~~THE OXFORD E~~ WIKIPEDIA ~~CTIONARY~~
DEFINES PEER REVIEW ...

PEER REVIEW IS THE EVALUATION OF SCHOLARLY WORK, RESEARCH, OR IDEAS BY ONE OR MORE PEOPLE WITH SIMILAR COMPETENCIES AS THE PRODUCERS.

c.f. Wikipedia

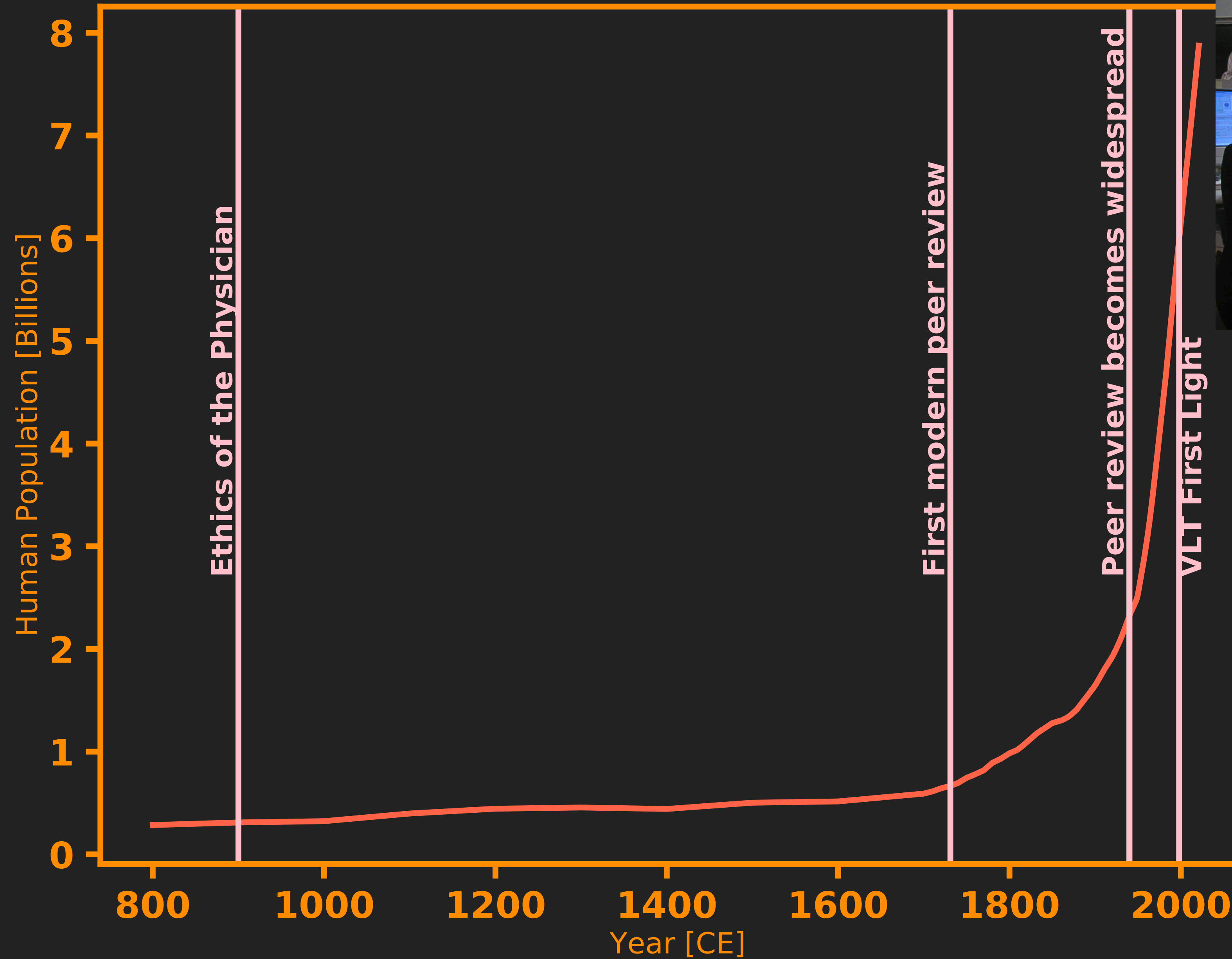
SOME HISTORY

- ▶ Credibility of science is most crucial in medical science
- ▶ *"Ethics of the Physician"* written by Alī al-Ruhāwī in ~900 CE
- ▶ Modern peer review Royal Society of Edinburgh in 1731
- ▶ Second half of 20th century more widespread (see e.g. Spier 2002)



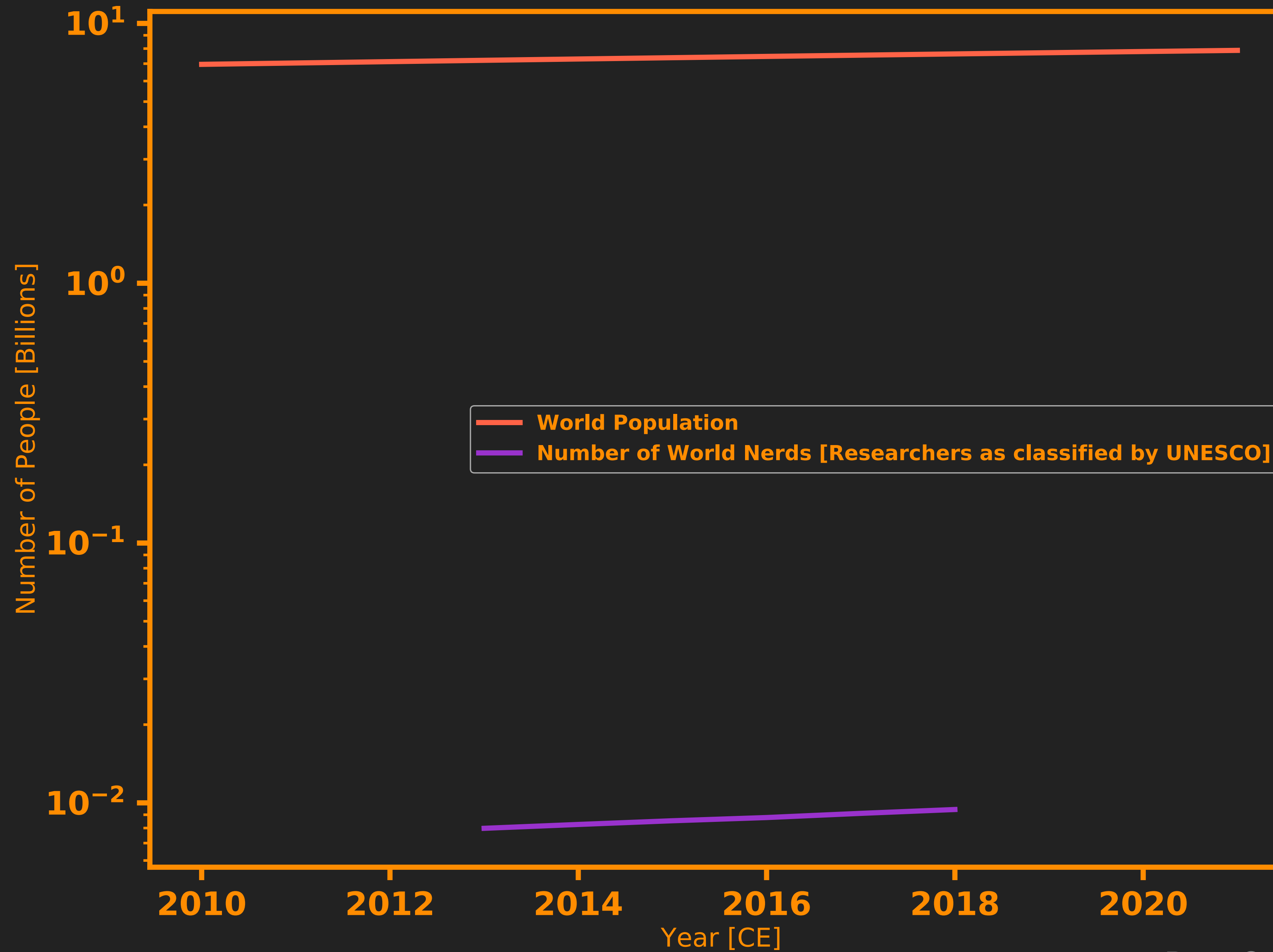
**THE CHALLENGE: A GROWING AND
GLOBAL SCIENTIFIC COMMUNITY**

A GROWING WORLD

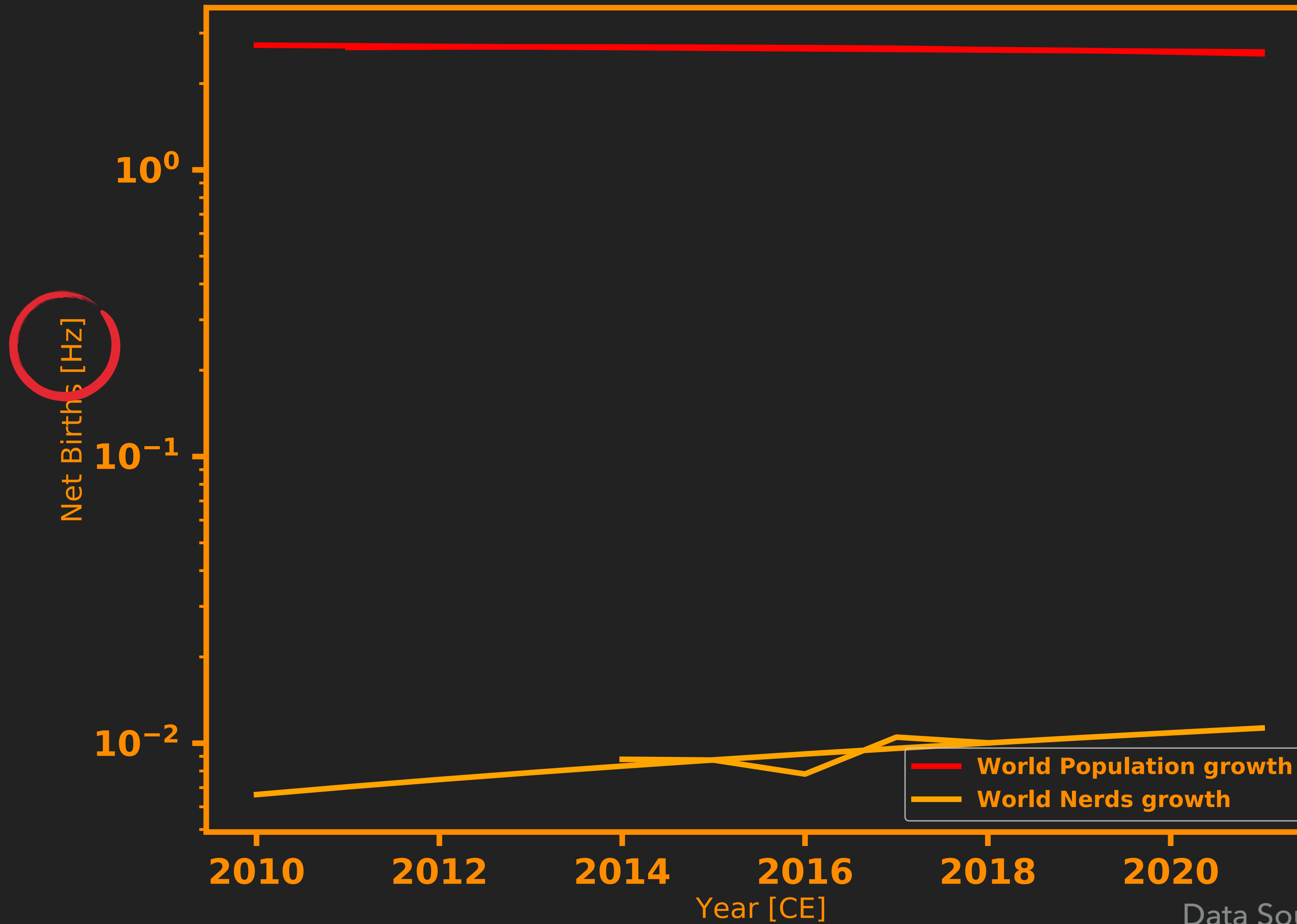


NERDS PER SECOND

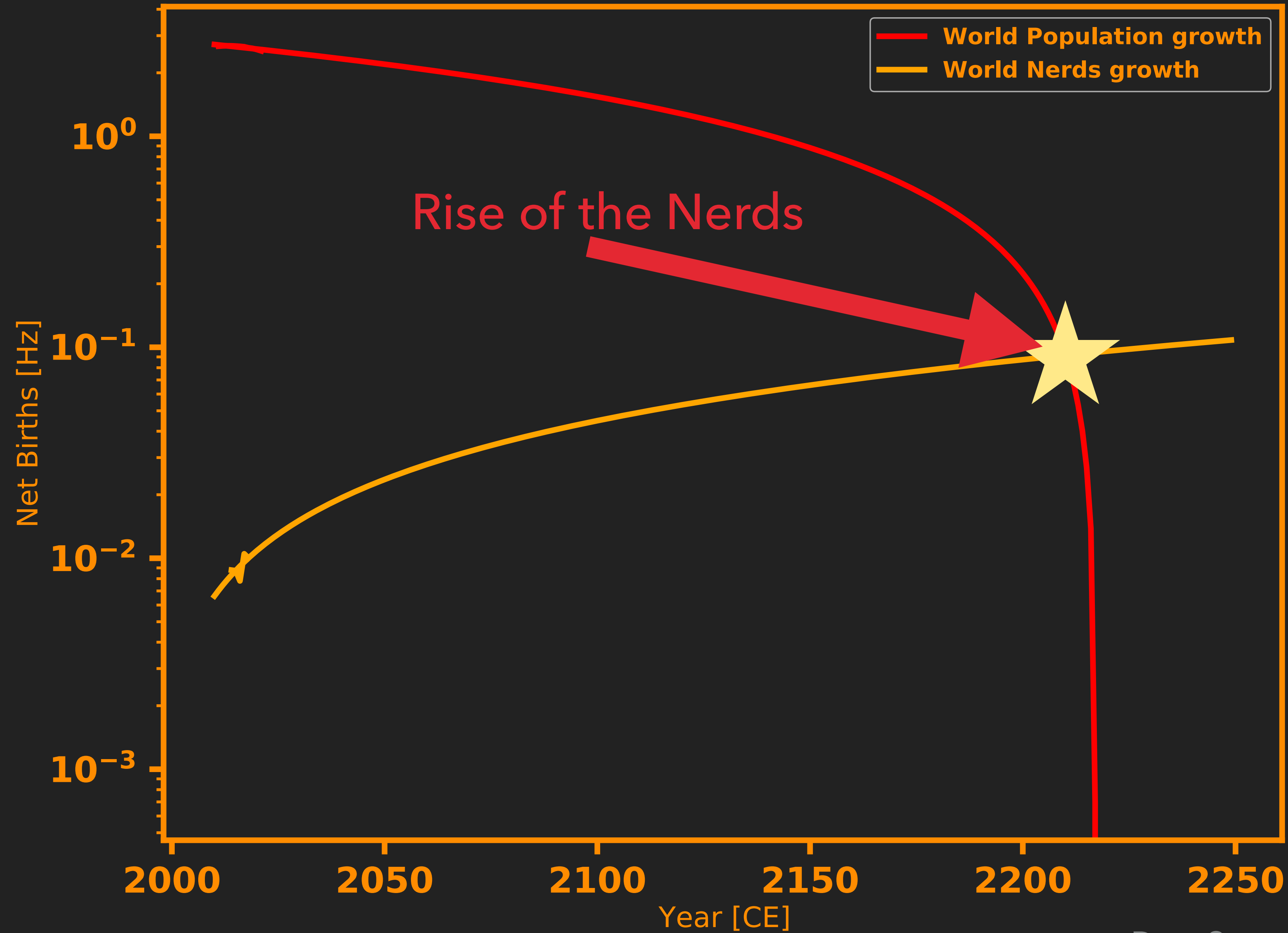
NERDS PER SECOND



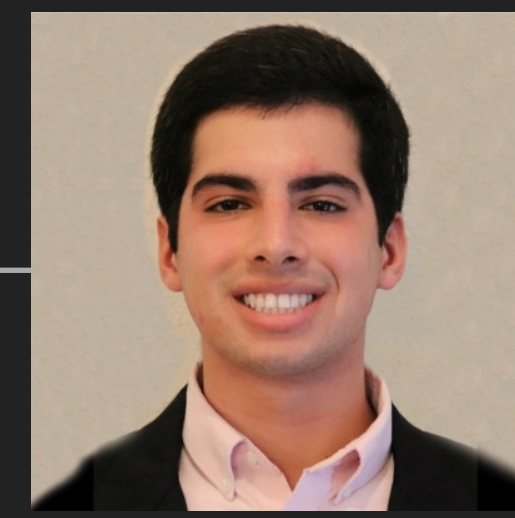
NERDS PER SECOND



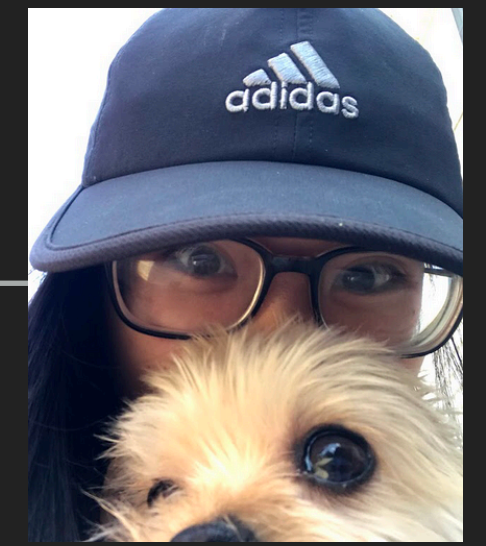
NERDS PER SECOND



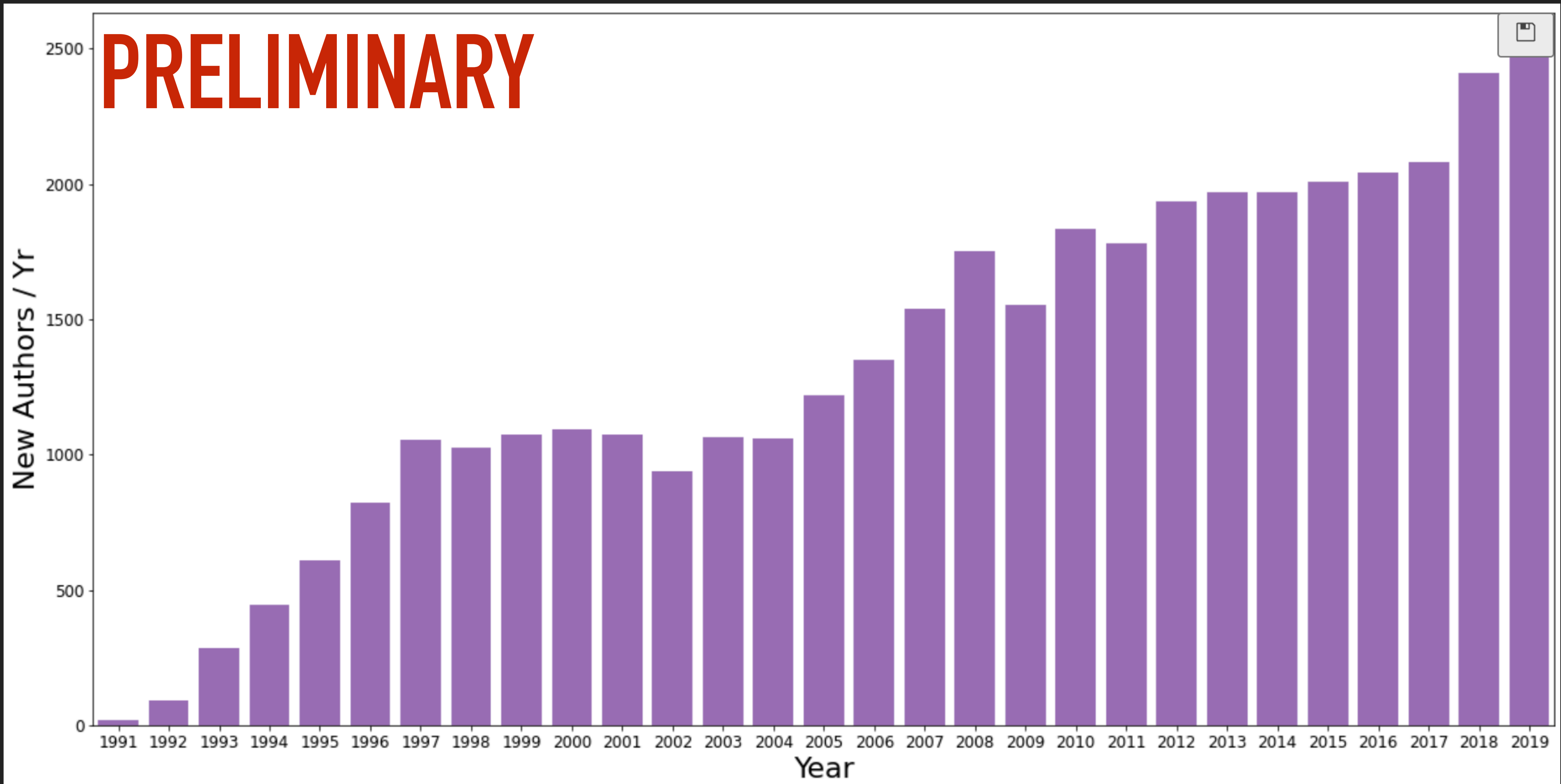
RISE OF THE ASTRONOMERS



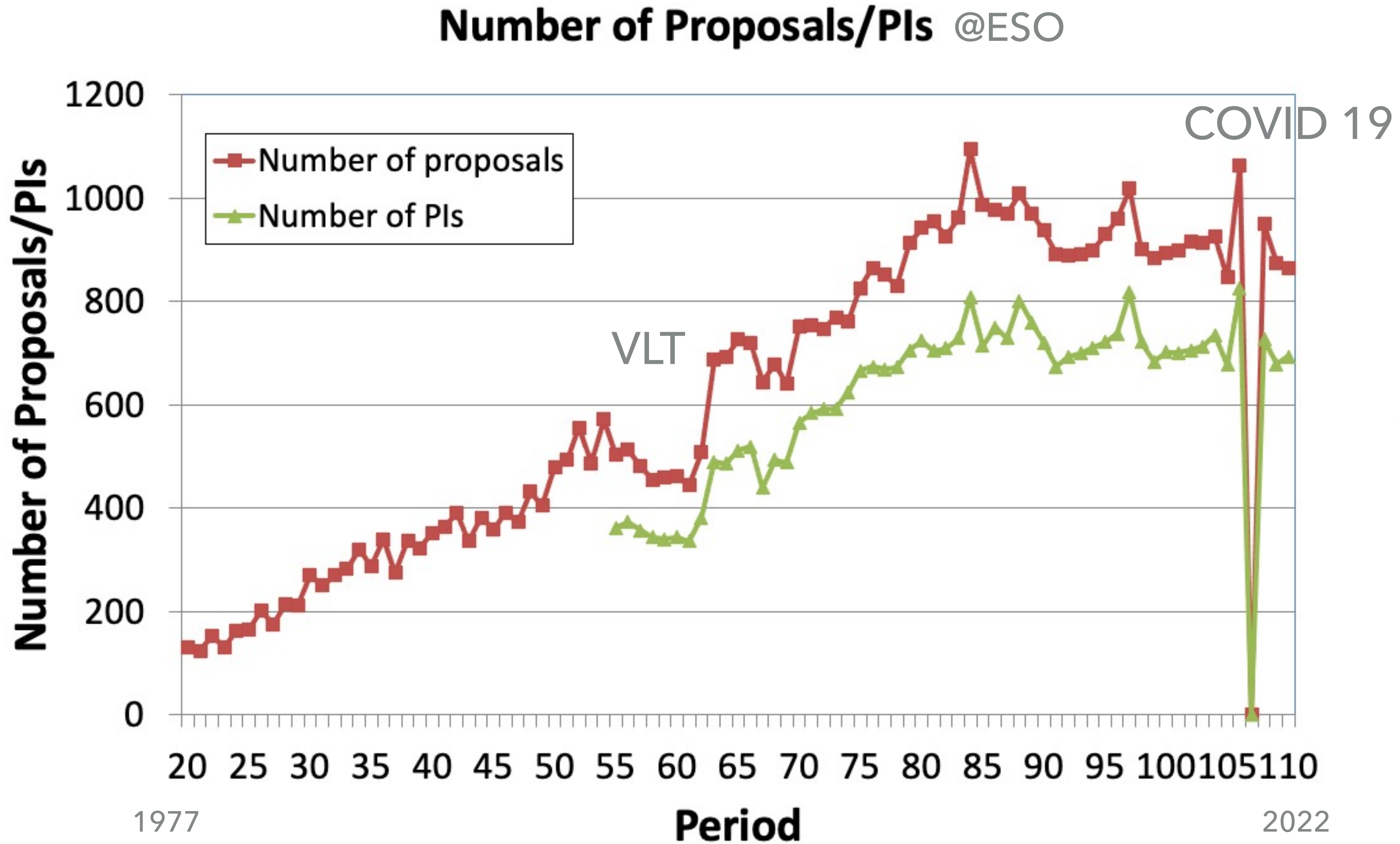
Vicente Amado



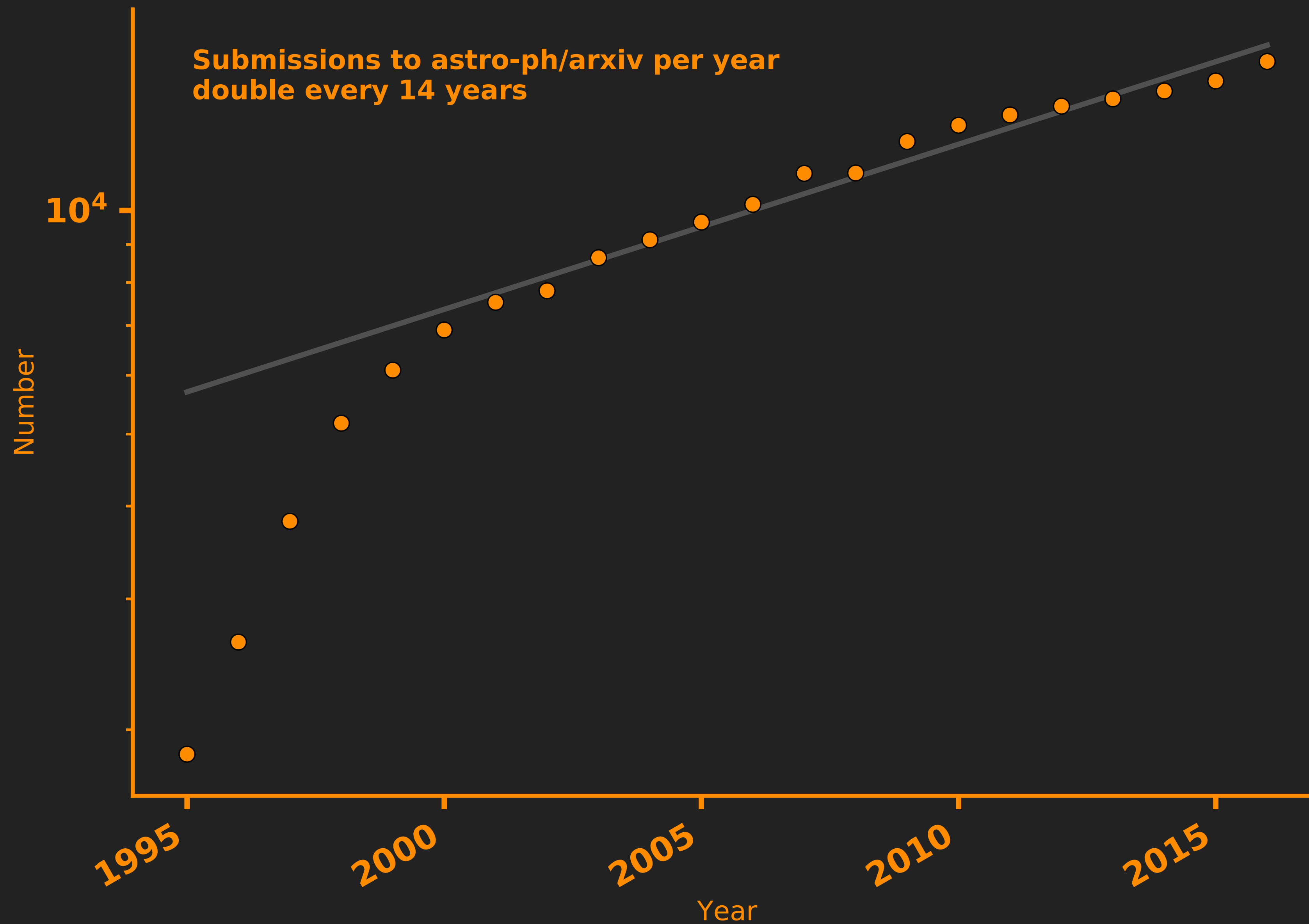
Bea Lu



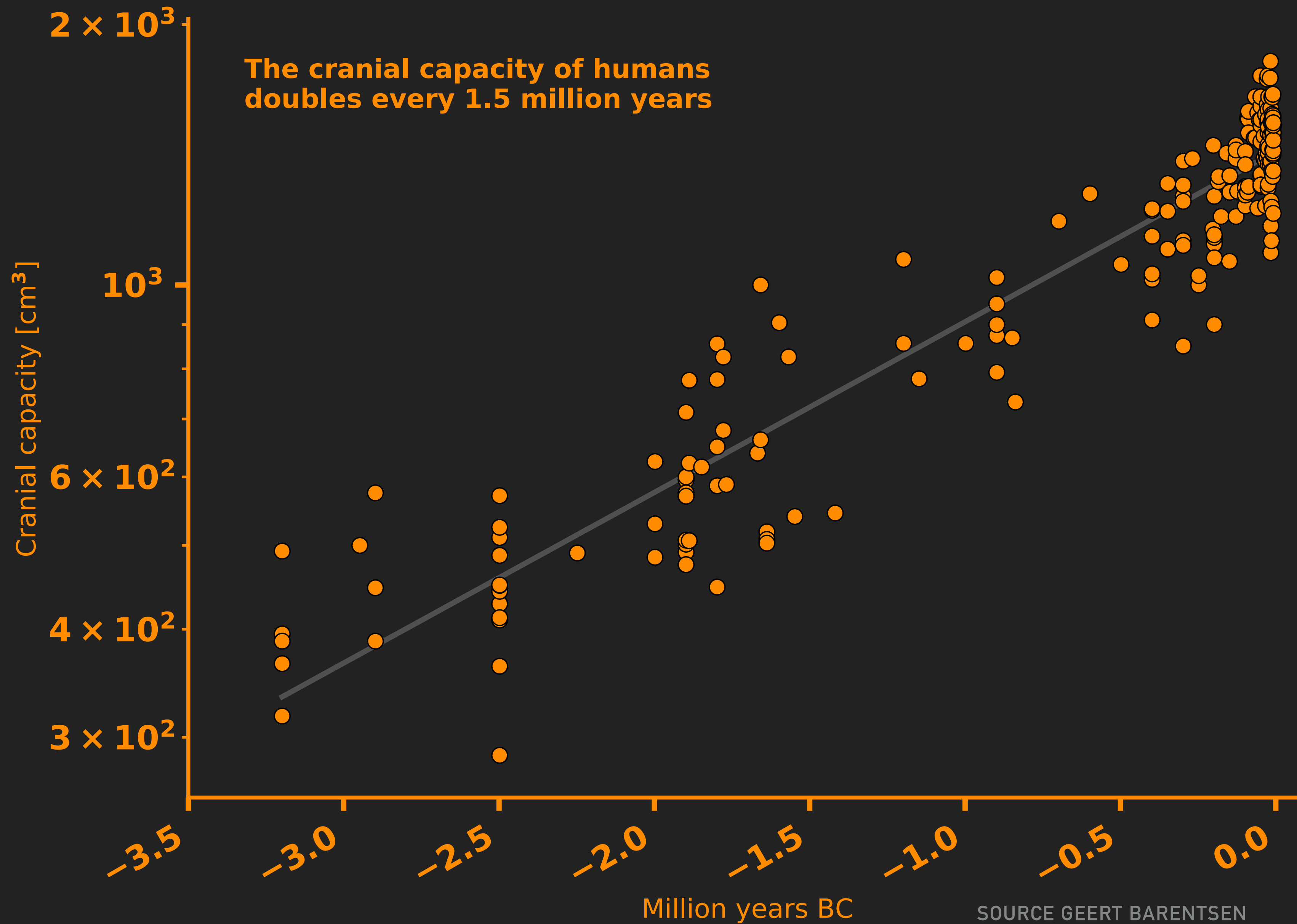
**MANY RESEARCHERS
MUCH OUTPUT**



MANY RESEARCHERS MANY PAPERS



HUMANS WON'T GET SMARTER ... FAST ENOUGH

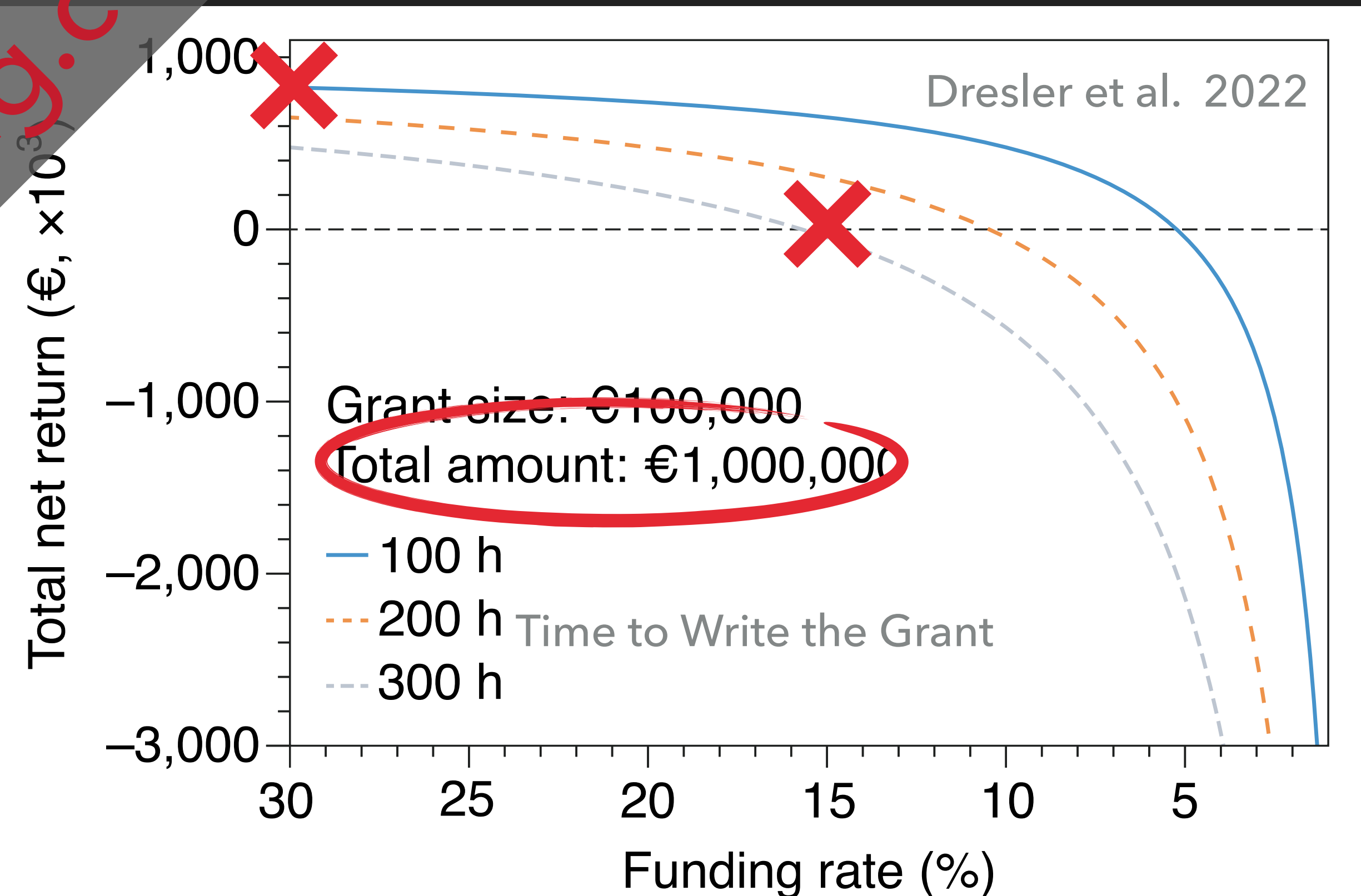


**WHY IS IT A
CHALLENGE?**

COST OF PEER REVIEW

- ▶ Rising number of researchers and rising number of research products
- ▶ Funding does not increase as steeply
- ▶ Net-injection financial can be negative

<http://funding.com/>



**A PATCH – NOT A
SOLUTION**



Featuring Nando and many others here at ESO

ML ENHANCED

DISTRIBUTED PEER REVIEW



**DISTRIBUTED PEER
REVIEW**



**IDENTIFYING
EXPERTISE WITH ML**

DISTRIBUTED PEER REVIEW HISTORY

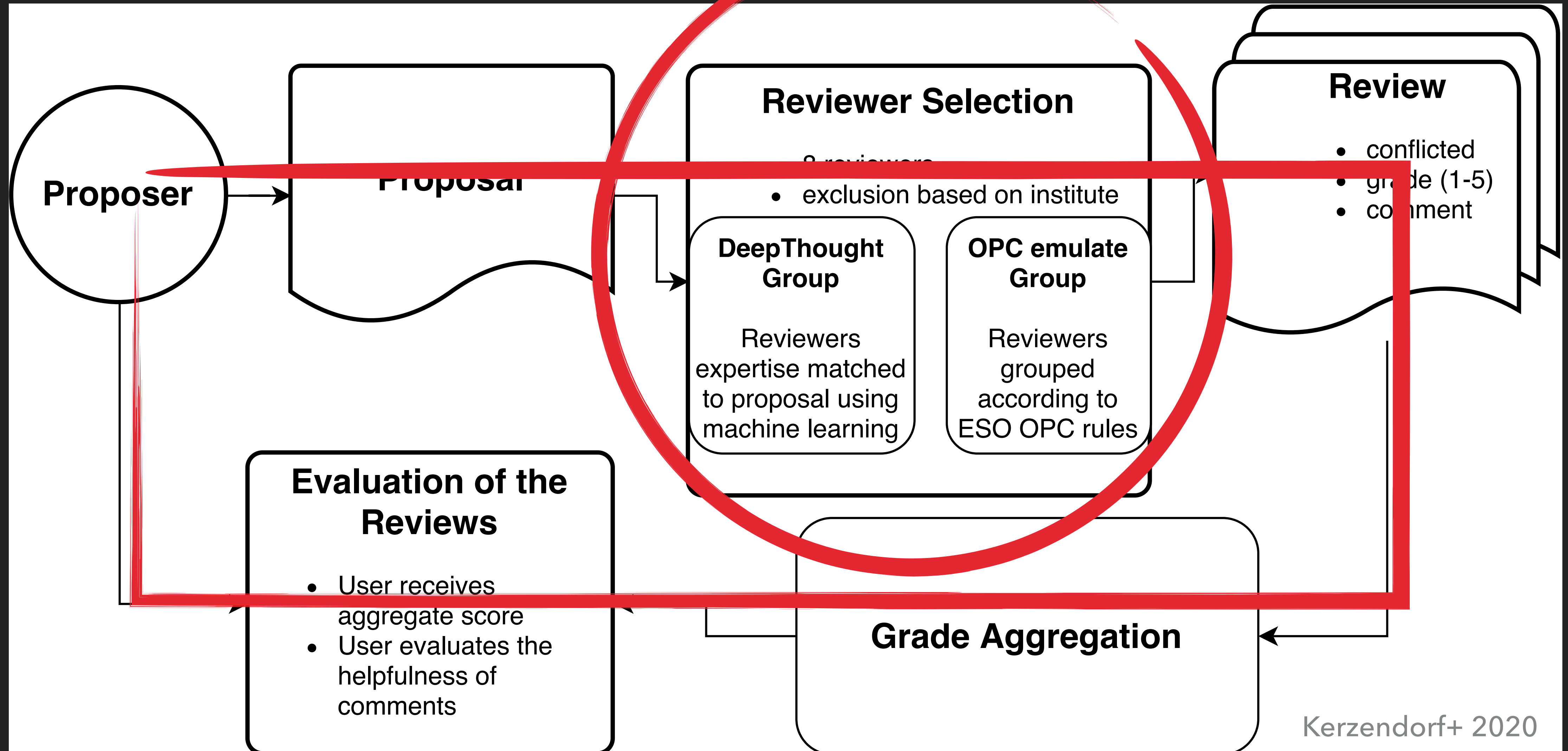
- ▶ Distributing the peer review task among the applicants as opposed to an invited panel
- ▶ Internet is changing things (Kohane & Altman 2000; The new peer review):
 - ▶ Recent proposals to start a life sciences online repository of preprints highlights the trend towards "publish first, review later" that seems to be emerging.
- ▶ For example - Wikipedia - a new form of peer review (March 9, 2000)
- ▶ Formalized Distributed Peer Review (Merrifield & Saari 2009)
- ▶ Gemini Fast Turnaround program (since 2015; Andersen+ 2019)
- ▶ Pilot at NSF in 2016 for Civil, Mechanical, and Manufacturing Innovation Division
 - ▶ Program Officer retired

EXPERIMENT OVERVIEW

- ▶ Period 103 (2018) a distributed peer review was run in **parallel** to normal ESO Time Allocation Committee operations.
- ▶ 172 proposals - 23% of PIs participated in this process
- ▶ Everyone who submits one proposal needs to review 8 proposals (each proposal has 8 reviews)

HOW DOES IT WORK?

SYSTEM SETUP





**DISTRIBUTED PEER
REVIEW**



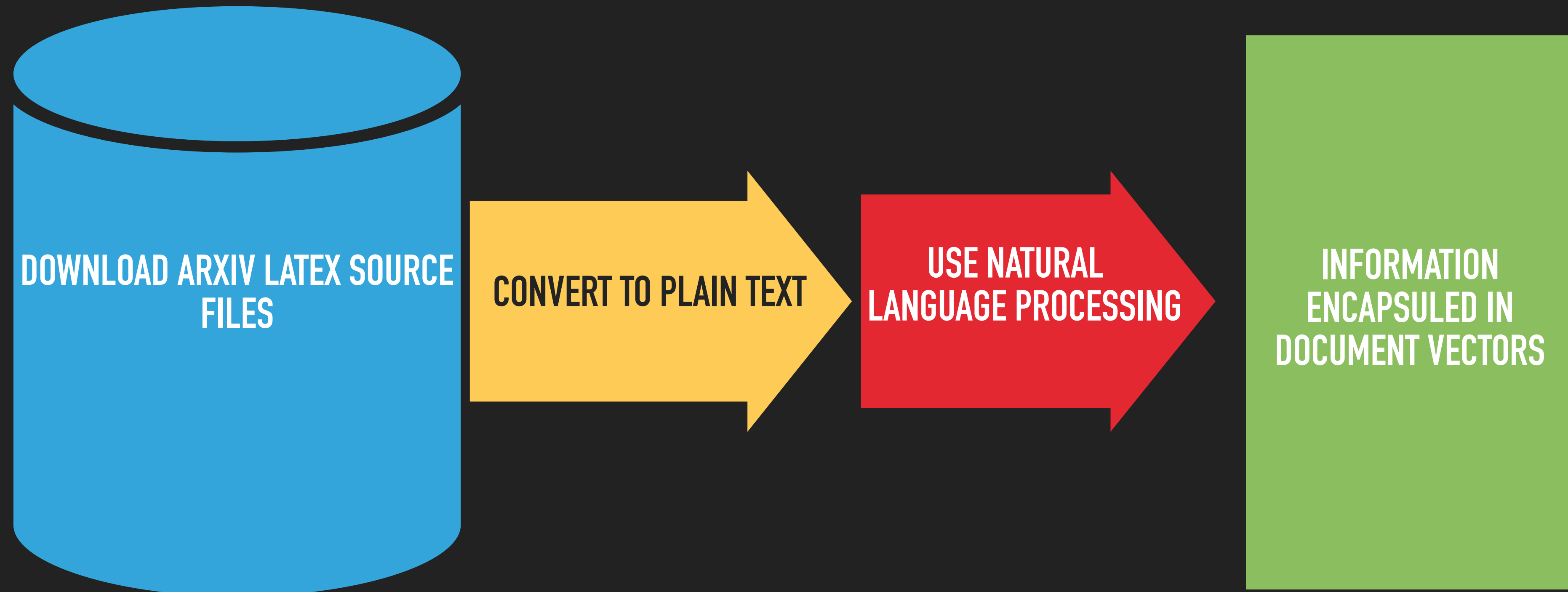
**IDENTIFYING
EXPERTISE WITH ML**

IDENTIFYING EXPERTISE

OBJECTIVELY

FINDING EXPERTS

- ▶ Panel expertise and proposal often matched by self-identified knowledge categories
- ▶ Distributed peer review also requires matching
- ▶ Should be automatic to lower impact on observatory
- ▶ Expertise is partially expressed in papers people write
- ▶ ... and they are easily accessible through Arxiv
- ▶ ... and Arxiv can be fully downloaded (~2 TB)



@ESO - thanks to Uta and team

LOTS OF JARGON!

WHAT DID WE DO?

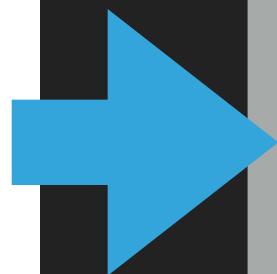
DETOUR TO

NATURAL LANGUAGE PROCESSING

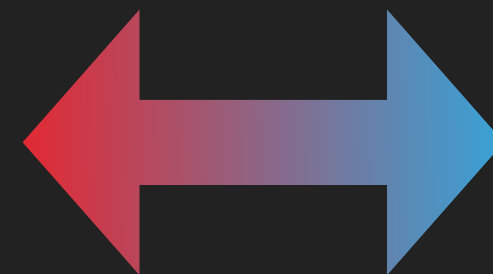
DOCUMENT WORD VECTORS (TFIDF – LUHN 1957; SPÄRCK JONES 1972)

$$\vec{\text{Document}} = \begin{matrix} \text{star} \\ \text{model} \\ \vdots \\ \text{galaxy} \end{matrix} \begin{pmatrix} 0.021 \\ 0.019 \\ \vdots \\ 0.1 \end{pmatrix}$$

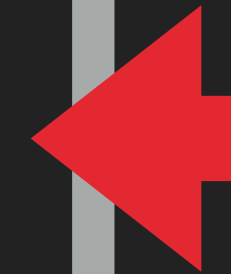
WHAT IF WE COULD KNOW WHAT EVERYONE KNOWS



Knowledge Vector



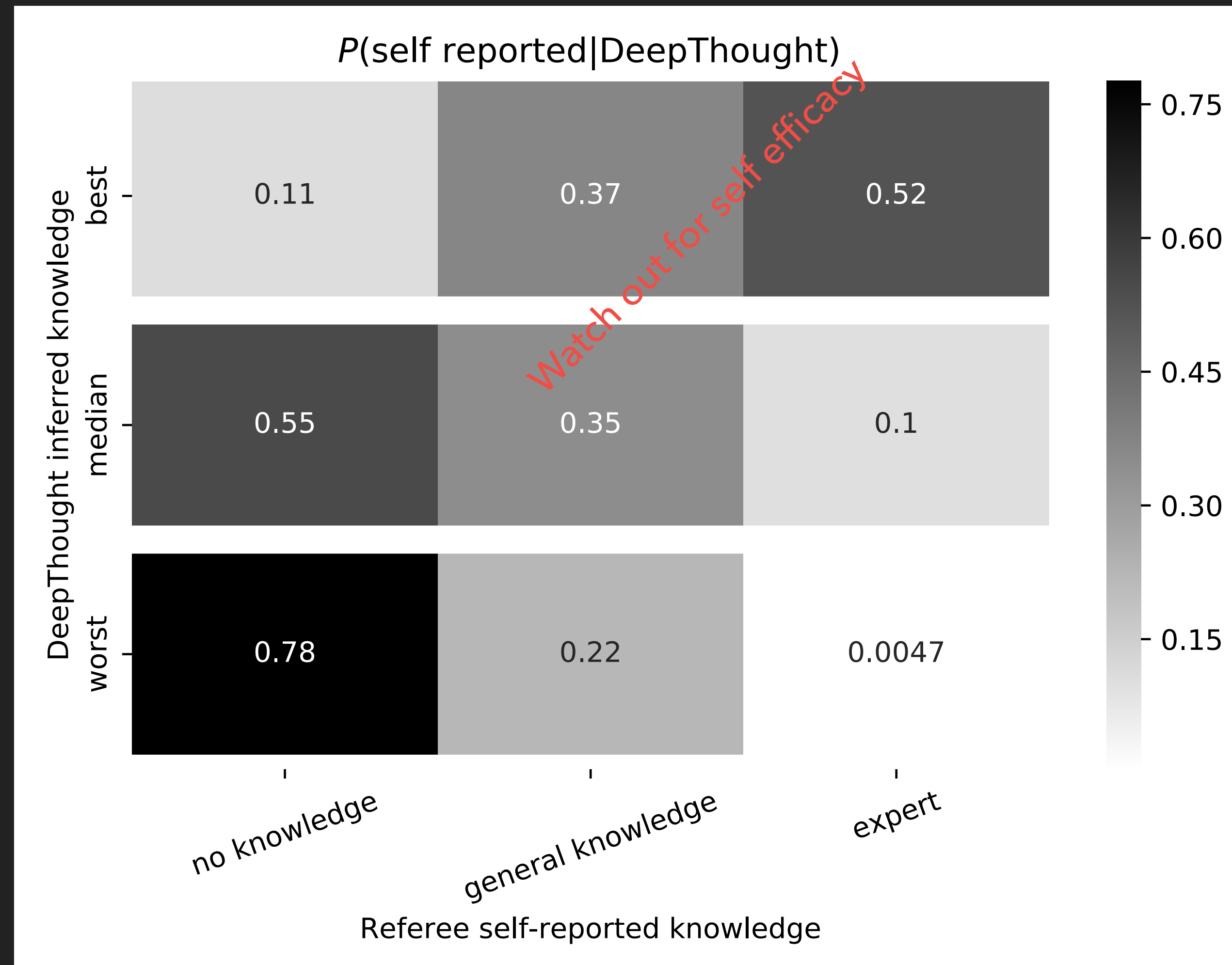
Proposal Vectors



Telescope Proposal

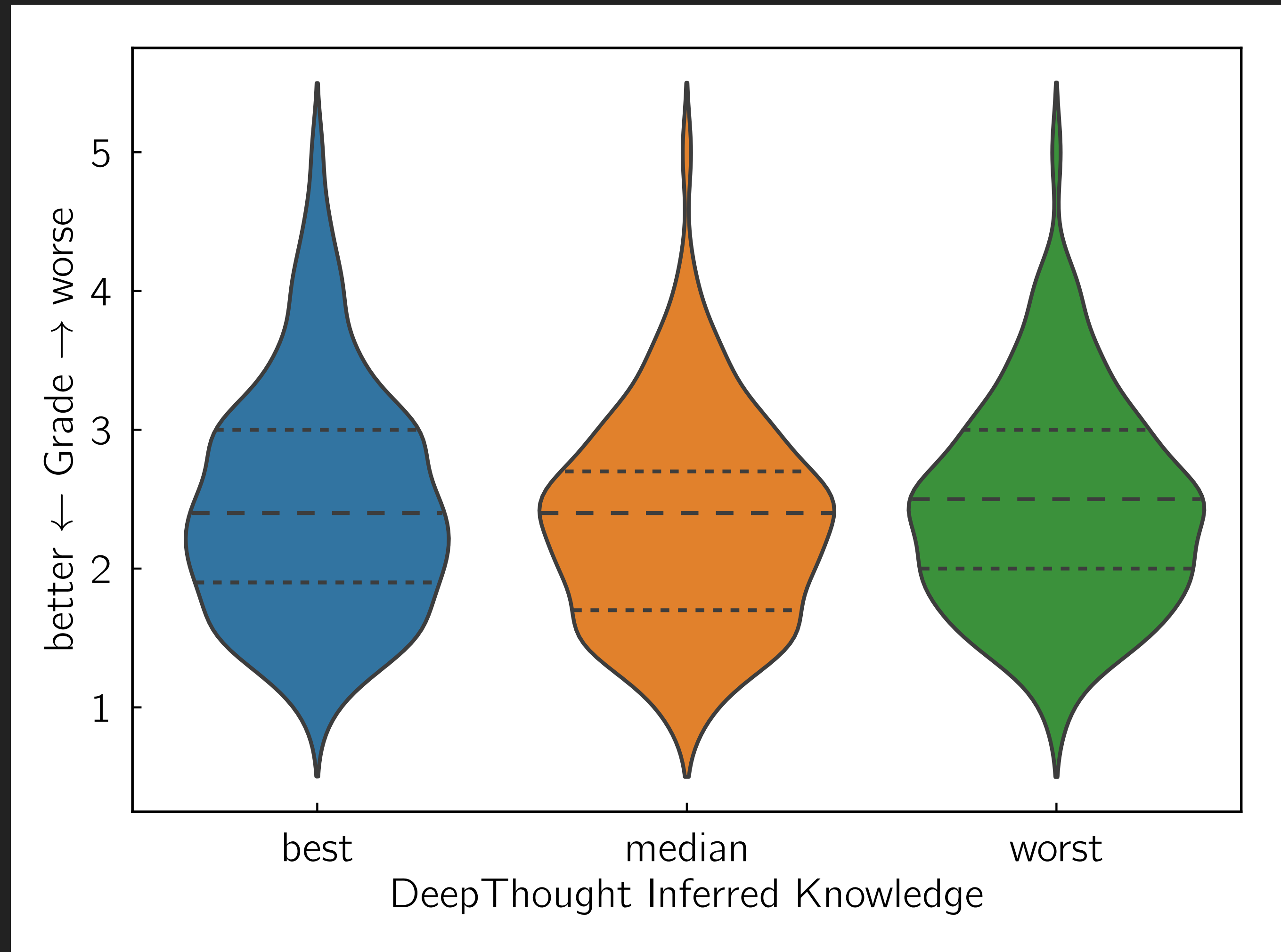
Sum of Scientist - published works
document vectors

SELF-ASSESSED EXPERTISE VS DEEPTHOUGHT

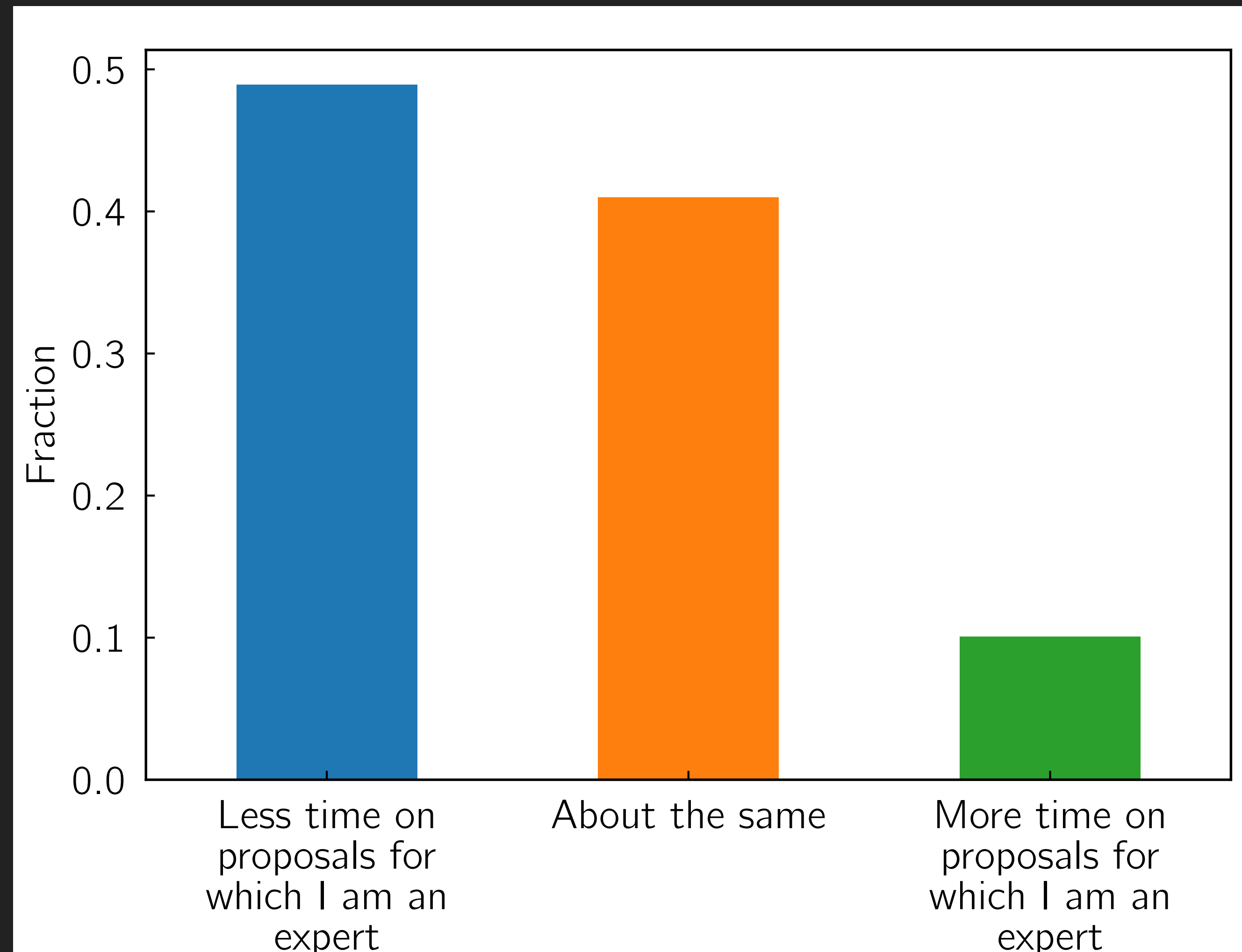


**DOES EXPERTISE
MATTER?**

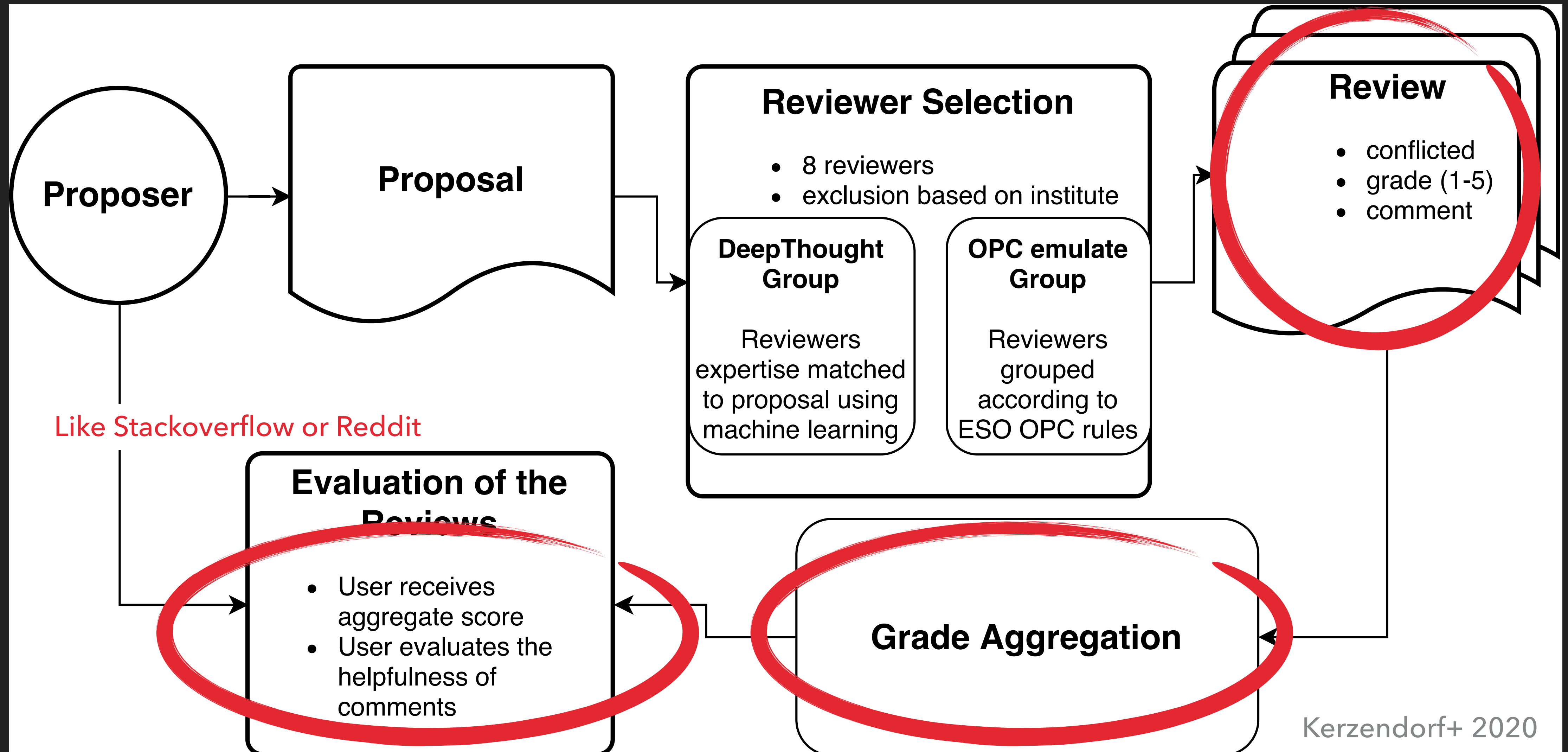
ARE EXPERTS BETTER AT PEER REVIEW



EXPERT REVIEWERS NOT NECESSARILY DIFFERENT ... BUT CHEAPER



SYSTEM SETUP

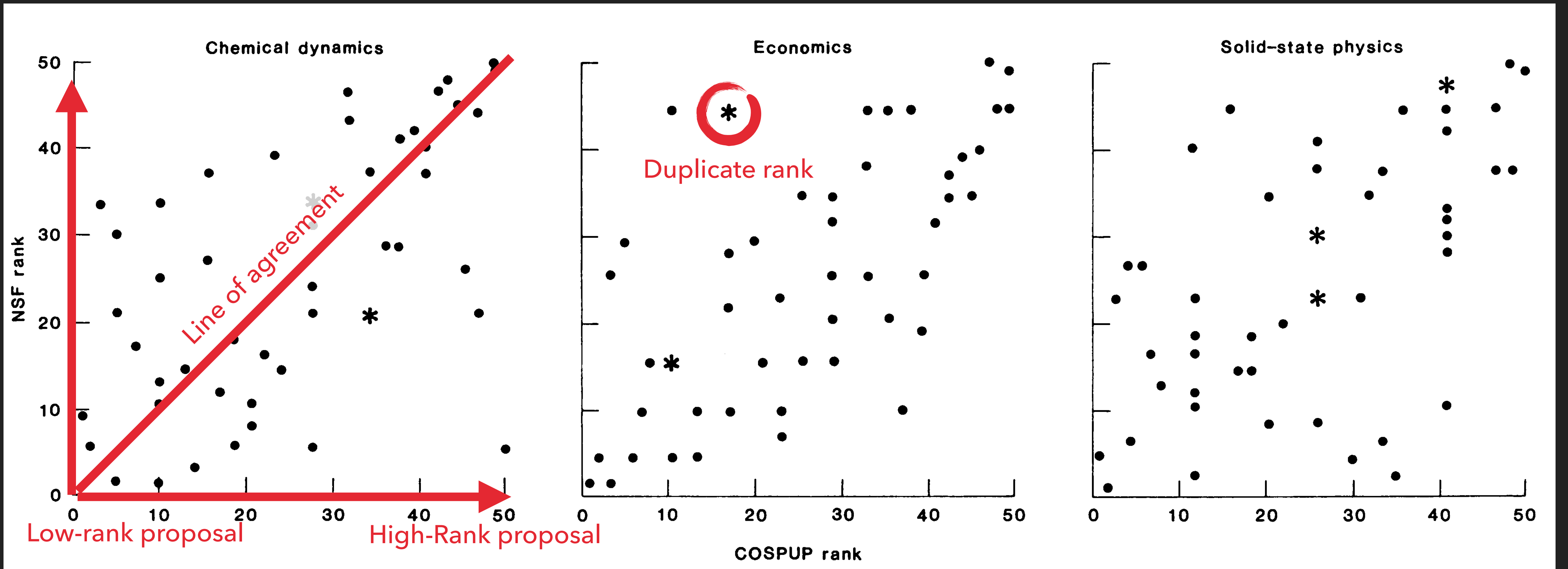


**COMPARING TO
TRADITIONAL TAC**

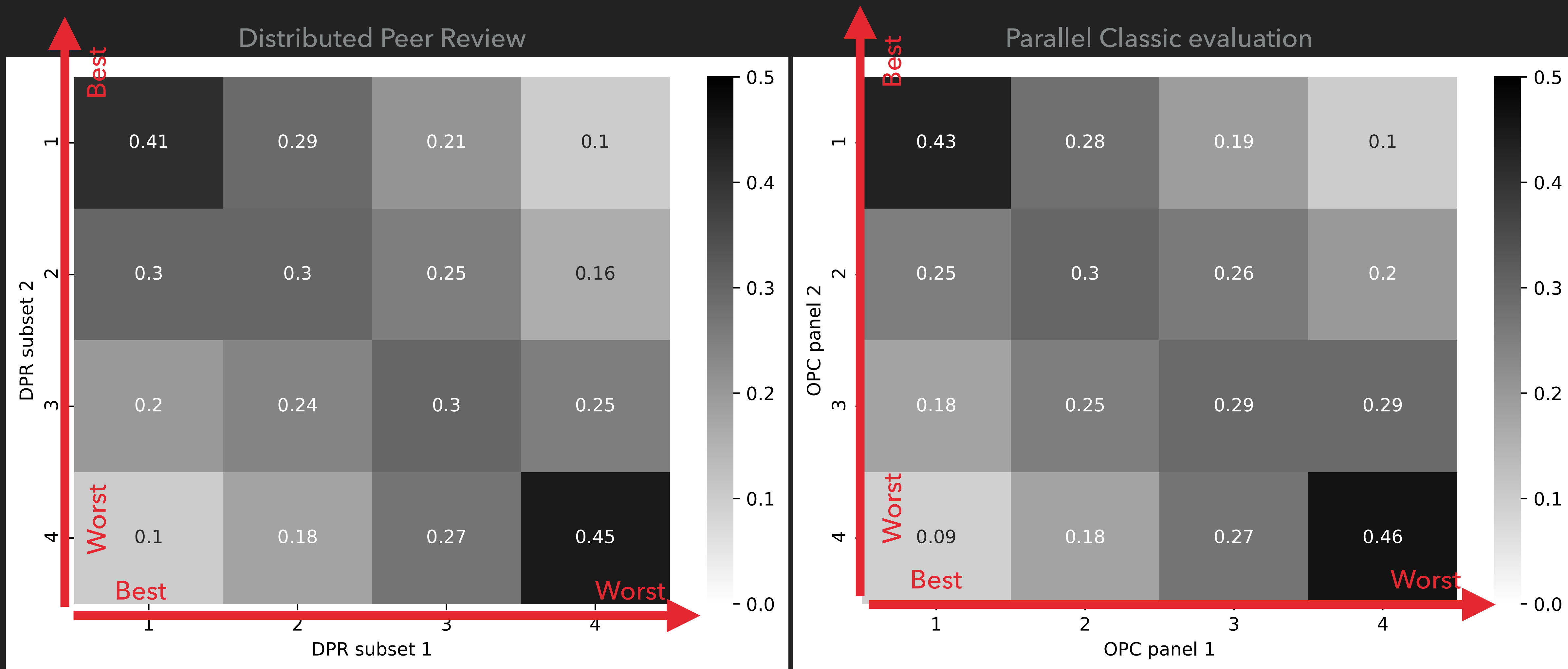
HARD COMPARISON

- ▶ People don't agree what is good - the problem with inter-reviewer reliability
- ▶ First experiment in the 1970s National Academy of Sciences Committee on Science and Public Policy (Cole, Cole & Simon 1981)
 - ▶ 150 NSF proposals from Chemical Dynamics, Economics, and solid-state physics
 - ▶ Half successful, half unsuccessful
 - ▶ Re-evaluated by scientists chosen by the National Academy of Science for each proposal

A KNOWN PROBLEM



OUR ATTEMPT AT COMPARISON



CONCLUSION

DISTRIBUTED PEER REVIEW – A NEW HOPE

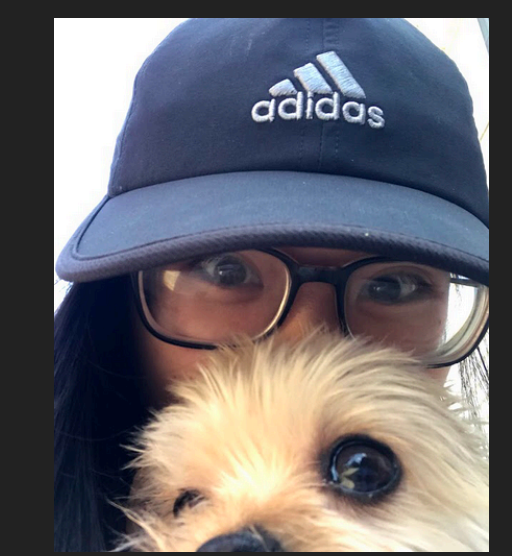
- ▶ Distributed Peer Review has several advantages
 - ▶ Spread the load
 - ▶ Train younger scientist quicker on review
 - ▶ With ML - faster matching of expertise to proposals
- ▶ and no clear disadvantages
- ▶ ESO Council has approved roll out after successful experiment for P110 (without the complex matching algorithm)
- ▶ Kerzendorf+ 2020 Very data rich experiment and loads more to learn
 - ▶ Anonymized open data at <https://zenodo.org/record/2634598>

PEER REVIEW - CONCLUSIONS

- ▶ Peer Review is a deeply flawed system
- ▶ ... but the best we have and likely better than alternatives
- ▶ Difficulty to ensure maintaining of quality standards, increase in performance, AND credibility to our benefactors
- ▶ Still lots to research and understand - bring in ML with caution
- ▶ A foundation of our trade and the trust that is placed in us
- ▶ A complex endeavor deserving of the same care than our astrophysics efforts



Vicente Amado



Bea Lu

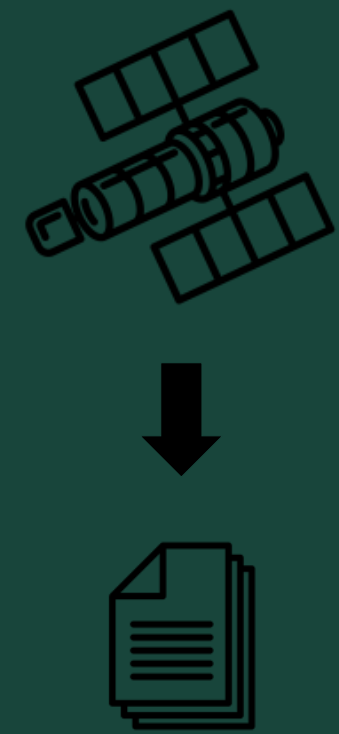
LITERATURE AS BIG DATA

DEEPTHOUGHT INITIATIVE

MEASURING IMPACT

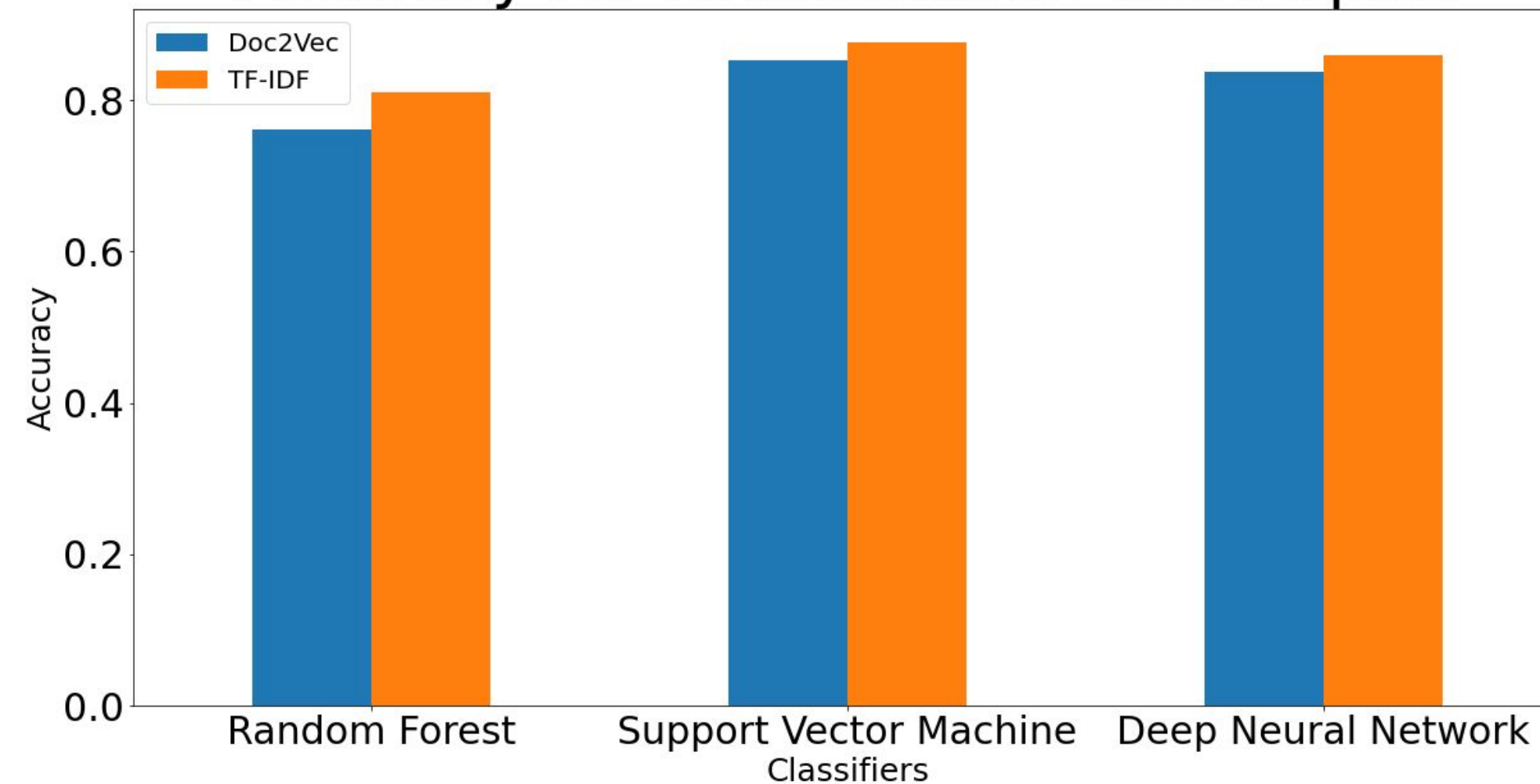


Vicente Amado



Using AI to identify the publications that used Hubble Space Telescope data for scientific gain.

Accuracy for Classification Techniques

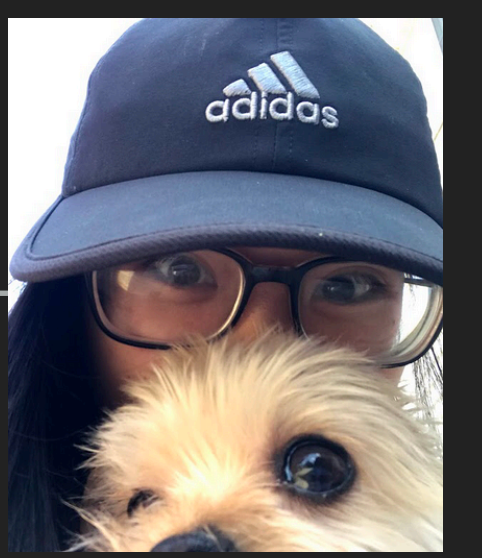


The success of an algorithm highly depends on the dataset and it is important to start with very simple algorithms before increasing the complexity. the best algorithm combination is TF-IDF with a Support Vector Machine classifier with an accuracy **0.87**.



Collaborators:
Wolfgang Kerzendorf, Michigan State University
Jack O'Brien, Michigan State University
Annie Didier, NASA Jet Propulsion Laboratory
Brian Cherinka, Space Telescope Science Institute
Katharina Kann, University of Colorado, Boulder

VIRTUAL JOURNALS



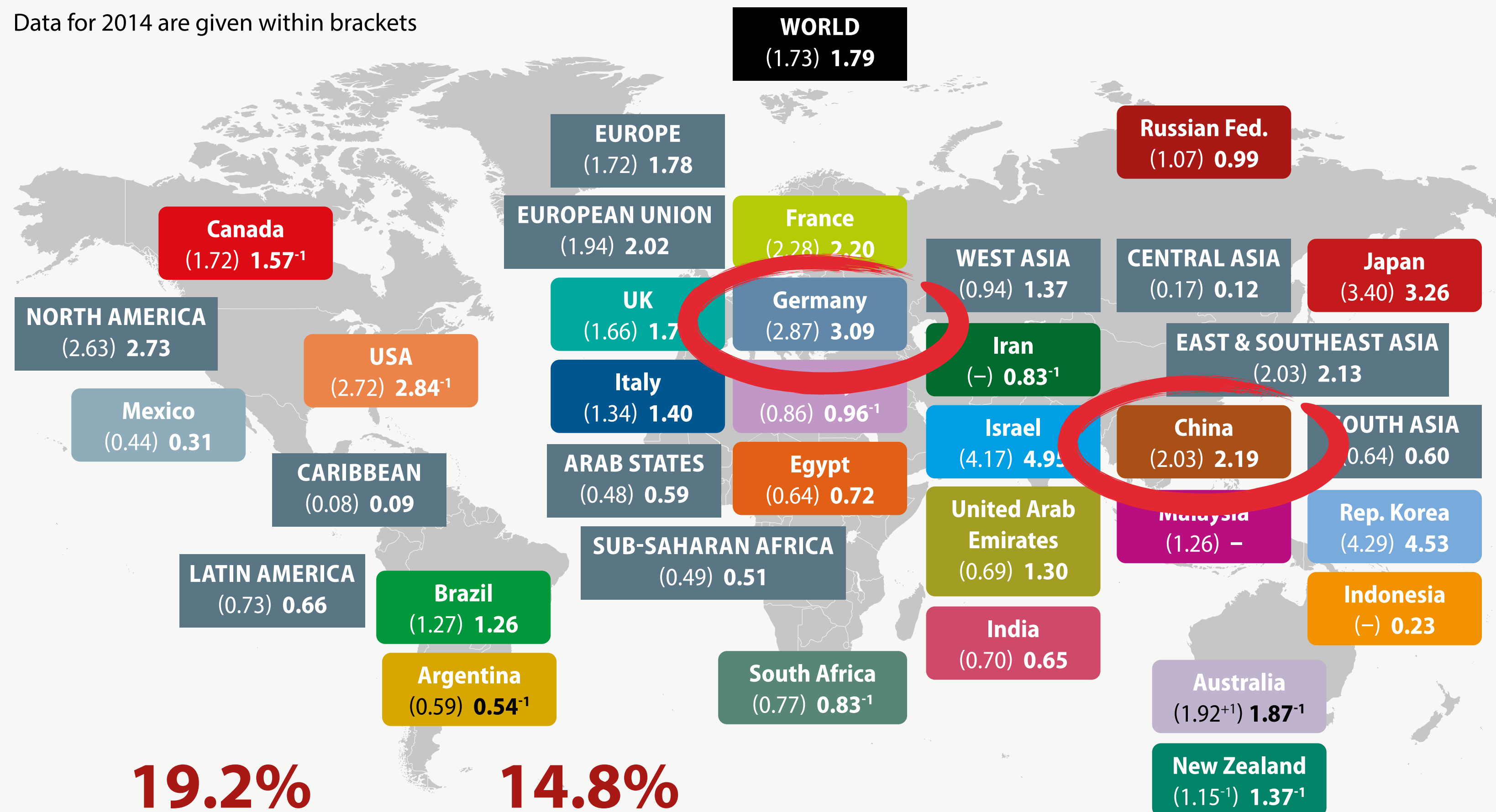
Bea Lu

- ▶ Many subfields do not have dedicated publication spaces
- ▶ Scattered publications across multiple journals
- ▶ Papers combining multiple subfields including the required one
- ▶ Organizations partially hand-curate such virtual journals
- ▶ Development and testing of algorithms to automate this process
- ▶ Work in progress for Nuclear Physics literature (for the Facility of the Rare Isotope Beam)
- ▶ Potential expansion to summarize and provide ML generated reviews

**AN OPPORTUNITY: A GROWING AND
GLOBAL SCIENTIFIC COMMUNITY**

Figure 1.2: Investment in research and development as a share of GDP, by region and selected country, 2014 and 2018 (%)

Data for 2014 are given within brackets



19.2%

Growth in global research spending
between 2014 and 2018*

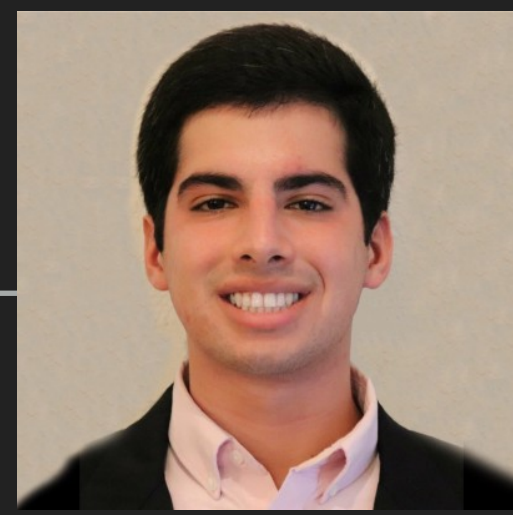
14.8%

Growth in global GDP
between 2014 and 2018*

*in constant 2017 PPP\$ trillions



Lou Strolger @ STScI



Vicente Amado

EXPERTISE IDENTIFICATION TOOL

- ▶ Large number of researchers separated by geography and communities
- ▶ Worldwide science collaboration building additional connections in addition to economics and politics
- ▶ Construct and maintain a list of unique authors and their publications
- ▶ Provide various algorithms for identifying expertise in researchers as reviewers or new collaborators
- ▶ Lower barriers for connections to under-represented communities
- ▶ Transparently constructed through open-science techniques
- ▶ ... work in the beginning - watch this space



A META-RESEARCH ENDEAVOR

- ▶ ML and NLP providing opportunities for new knowledge retrieval paradigms
- ▶ Growing and global community requires a rethink of our current processes
- ▶ Not unique to astronomy - Medical field is calling this meta research (see METRICS@Stanford with Ioannidis)
- ▶ Other efforts underway but very few with deep domain knowledge embedding
- ▶ Next steps, initial discussions with ArXiv, ESO, ESA, NASA underway
- ▶ Your input invaluable

THANK YOU

QUESTIONS?

Please contact me:

wkerzend@msu.edu

Twitter: @dtspace42

@wkerzendorf