

# REPRODUCIBILITY CRISIS AND OPEN SCIENCE

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Arnaud Legrand

Univ. Grenoble Alpes, CNRS, Inria, Grenoble INP

International Week, Grenoble, January 2020



# PUBLIC EVIDENCE FOR A LACK OF REPRODUCIBILITY

- J.P. Ioannidis. *Why Most Published Research Findings Are False* PLoS Med. 2005.
- *Lies, Damned Lies, and Medical Science*, The Atlantic. Nov, 2010
- *Reproducibility: A tragedy of errors*, Nature, Feb 2016.
- Steen RG, Retractions in the scientific literature: is the incidence of research fraud increasing?. J. Med. Ethics 37, 2011

## Los Angeles Times | BUSINESS

LOCAL U.S. WORLD BUSINESS SPORTS ENTERTAINMENT HEALTH STYLE TRAVEL

### Science has lost its way, at a big cost to humanity

Researchers are rewarded for splashy findings, not for double-checking accuracy. So many scientists looking for cures to diseases have been building on ideas that aren't even true.

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More > Science Magazine > 22 JUNE 2012 > MONDAY, 24 JUNE (1660) : 229

Article Views Science 17 January 2014;  
1 Save to My Folders Vol. 343 no. 6168 p. 229  
2 Download Citation DOI: 10.1126/science.1250475

Summary Full Text Full Text (PDF)

EDITORIAL Reproducibility Marcia McNutt

Science advances on a foundation of trusted data, but a new study finds that the scientific community is shaken by reports that a trend is not reproducible. Because confidence in results is shaken, we are calling for new measurement standards. For example, studies from the U.S. National Institute of Standards and Technology are recommending that authors will indicate handling (such as how to deal with outliers), whether a sufficient signal-to-noise ratio, whether the experimenter was blind to the conduct of the guidelines.

Related Content

Announcement: Reducing our irreproducibility: Nature News & Comment  
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NATURE | EDITORIAL

### Announcement: Reducing our irreproducibility

24 April 2013

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Over the past year, *Nature* has published a string of articles that highlight the reliability and reproducibility of published research (collected on the right).

nature International weekly journal of science

Menu archive > volume 483 - issue 7591 - editorials - article

NATURE | EDITORIAL

Must try harder

Nature 483, 509 (29 March 2012) doi:10.1038/483509a  
Published online: 28 March 2012

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Too many sloppy mistakes are creeping into scientific papers. Lab heads must look more rigorously at the data — and at themselves.

TheScientist EXPLORING LIFE. INSPIRING INNOVATION

NIH Tackles Irreproducibility

The federal agency speaks out about how to improve the quality of scientific research.

By Jef Akst | January 28, 2014

Courtesy V. Stodden, SC, 2015

The Economist

Washington's lawyer scruples  
How to do a nuclear deal with Iran  
Investment tips from Nobel economists  
Bond markets are back  
The meaning of Sechin Tendulkar

HOW SCIENCE GOES WRONG.

## CORRELATION AND CAUSATION

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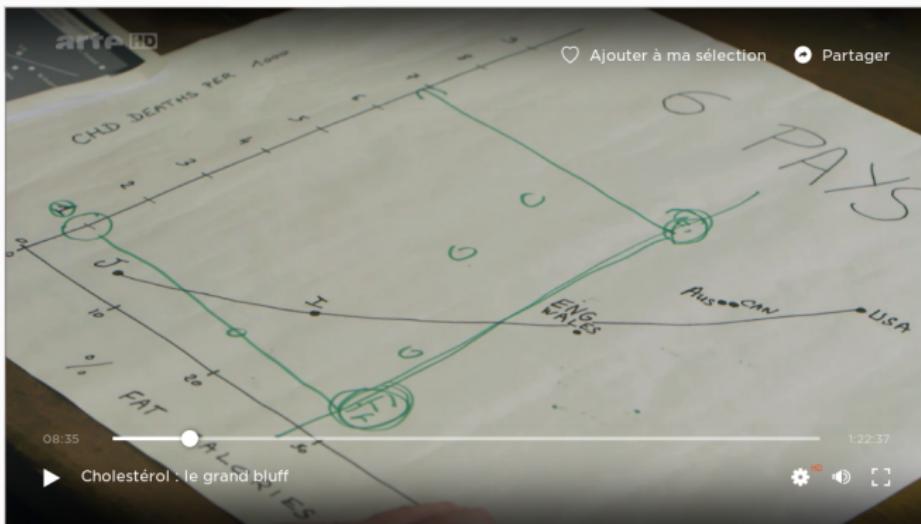
# A "VIVID" DEBATE: CHOLESTEROL AND STATINS

Cholesterol: le grand bluff (Arte, 18/10/2016 @ 20h50)



# A "VIVID" DEBATE: CHOLESTEROL AND STATINS

Cholesterol: le grand bluff (Arte, 18/10/2016 @ 20h50)



"Careful" selection of data and influence from the industry 😞

But that's not what I want to illustrate now... Even if data hadn't been removed, could we really conclude something from such data?

# INFERENCE: CORRELATION AND CAUSATION

It may be the case that two random variables  $X$  and  $Y$  are **dependent**

- E.g., Let's pick a student at random and measure its *DrinkingHabit* and its *TestScore*

In general, the more a student drinks the more his test goes down 😞

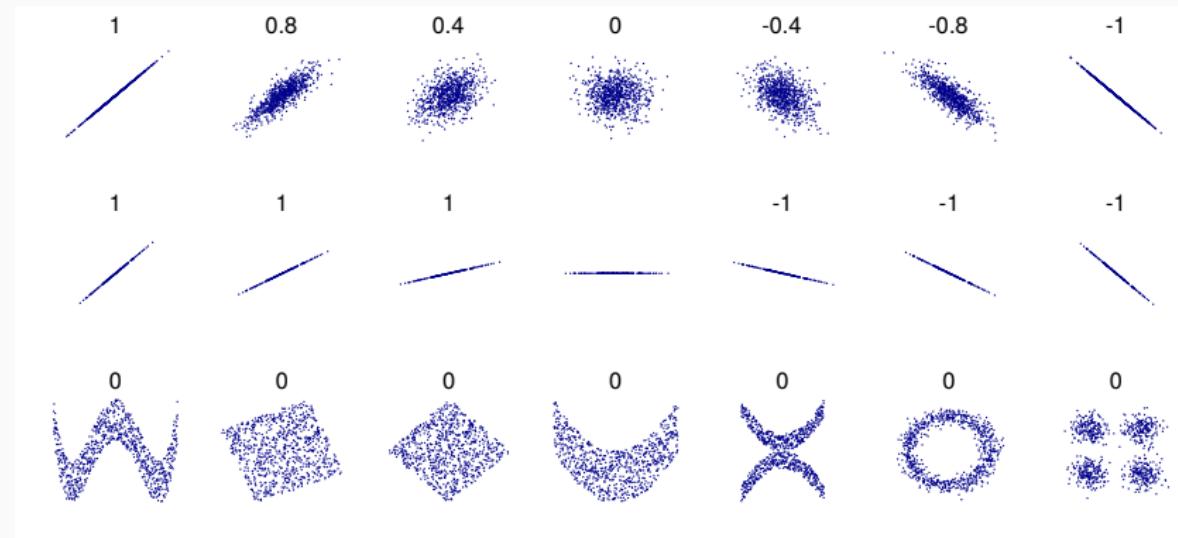
The **correlation** of two variables  $X$  and  $Y$  is defined as:

$$\text{corr}(X, Y) = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y} = \frac{\mathbb{E}[(X - \mu_X)(Y - \mu_Y)]}{\sigma_X \sigma_Y}$$

- The correlation is symmetrical ( $\text{corr}(X, Y) = \text{corr}(Y, X)$ )
- The correlation is in  $[-1, 1]$
- $\text{corr}(Y, X) = 1$  or  $-1 \Rightarrow$  perfectly linear relationship
- $X$  independent of  $Y \Rightarrow \text{corr}(X, Y) = 0$
- $Y$  grows when  $X$  grows  $\Rightarrow \text{corr}(X, Y) > 0$

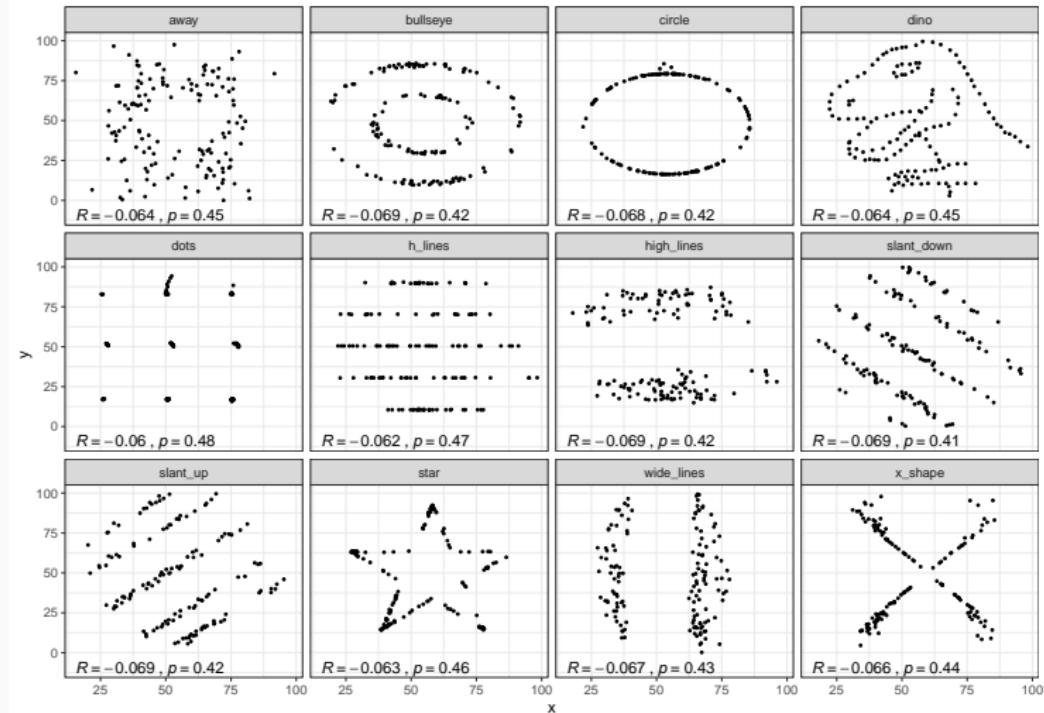
It is thus very tempting to use **sample correlation** as a way of knowing whether some variables are **dependant**

## SCATTER PLOT AND CORRELATION



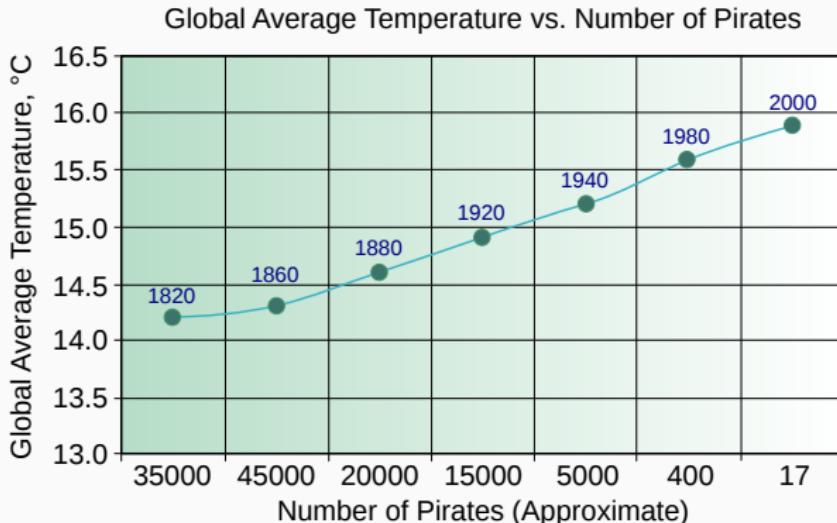
Non-linear relations or hidden variables are not well trapped by correlation

# THE DATASAURUS



<https://www.autodeskresearch.com/publications/samestats>

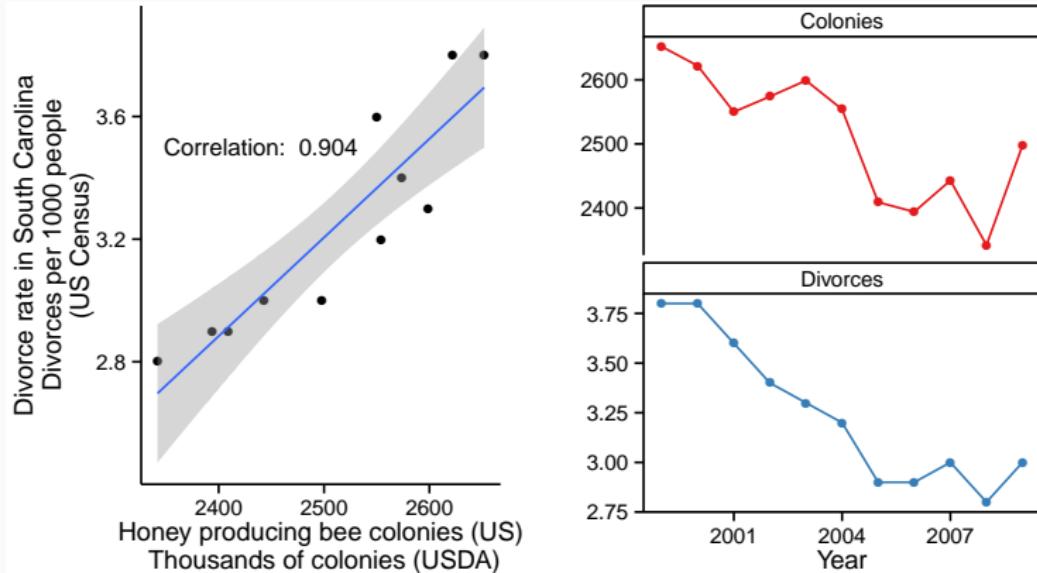
# CORRELATION DOES NOT IMPLY CAUSATION



Mikhail Ryazanov (talk) - PiratesVsTemp.svg.  
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- 2 variables can be strongly correlated to a third one (e.g., year)
- Btw, what is wrong with this figure? 😊

# OBSERVATIONAL VS. EXPERIMENTAL DATA ILLUSTRATION



Source: *Spurious correlations*. For the good of the US society, we should try to get rid of honey bees 😊

# THE DELUGE OF SPURIOUS CORRELATIONS IN BIG DATA

The Deluge of Spurious Correlations in Big Data, by C. Calude and G. Longo,  
Foundations of Science, March 2016)

## Is Data science is the end of science ?

- Powerful algorithms can now explore huge databases and find therein correlations and regularities.
- Properly defining "meaning" or "content" of such correlations is very difficult. But do we need to ?

## Ergodic Theory

- Almost every trajectory (even deterministic and chaotic) will eventually iterate in a similar way
- Regularity is expected but it does not mean that prediction can be done

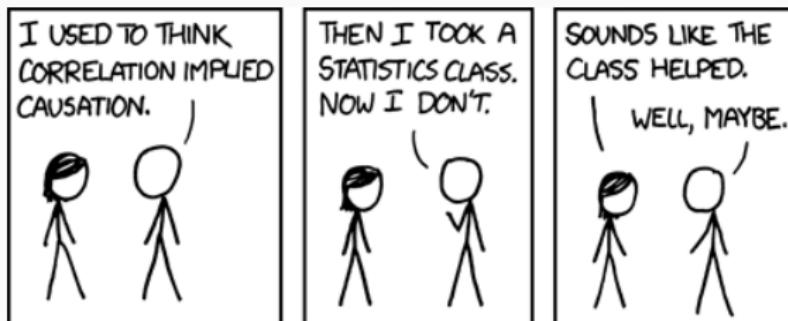
**Ramsey Theory:** Any sufficiently long string contains an arithmetic progression

- 0, 1, 1, 0, 0, 1, 1, 0, 0
- 0, 1, 1, 0, 0, 1, 1, 0, 1

# CORRELATION DOES NOT IMPLY CAUSATION

For any two correlated events, A and B, the following relationships are possible:

- A causes B (direct causation) 
- A causes B and B causes A (bidirectional or cyclic causation) 
- A causes C which causes B (indirect causation) 
- B causes A; (reverse causation) 
- A and B are consequences of a common cause, but do not cause each other 
- There is no connection between A and B; it is a "coincidence" 
  - But **designed experiments** can help you ruling this option out



# OPEN SCIENCE

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# SCIENTIFIC MISCONDUCT ? WHAT ARE THE CONSEQUENCES ?

## The Duke University scandal with scientific misconduct on lung cancer

- *Nature Medicine* - 12, (2006) Genomic signatures to guide the use of **chemotherapeutics**, by Anil Potti and 16 other researchers from Duke and USF
- Major commercial labs licensed it and were about to start using it before two statisticians discovered and publicized its faults

Dr. Baggerly and Dr. Coombes found errors almost immediately. Some seemed careless — moving a row or a column over by one in a giant spreadsheet — while others seemed inexplicable. The Duke team shrugged them off as “clerical errors.”

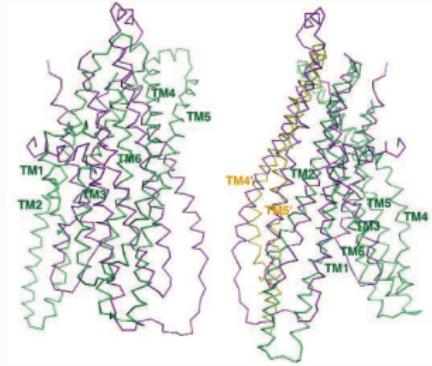
The Duke researchers continued to publish papers on their genomic signatures in prestigious journals. Meanwhile, they started three trials using the work to decide which drugs to give patients.

- Retractions: January 2011. Ten papers that Potti coauthored in prestigious journals were retracted for varying reasons

## Bad science is deleterious

- It is used to backup stupid politics, it affects people's life, ...
- It blurs the frontier between scientists and crooks

# UNFORTUNATE MISTAKES



Geoffrey Chang (Scripps, UCSD) works on crystallography and studies the structure of cell membrane proteins.

He specialized in structures of **multidrug resistant transporter proteins in bacteria**:  
MsbA de Escherichia Choli (Science, 2001),  
Vibrio cholera (Mol. Biology, 2003),  
Salmonella typhimurium (Science, 2005)

2006: Inconsistencies reveal a programming mistake

*a homemade data-analysis program had flipped two columns of data, inverting the electron-density map from which his team had derived the protein structure.*

5 retractions that motivate improved software engineering practices in computational biology

# DIFFERENT REPRODUCIBILITY CONCERNS

**Social Sciences, Oncology, ...** methodology, statistics

**Genomics** software engineering, computational reproducibility, provenance, ...

**Computational fluid dynamics** numerical issues

Authors



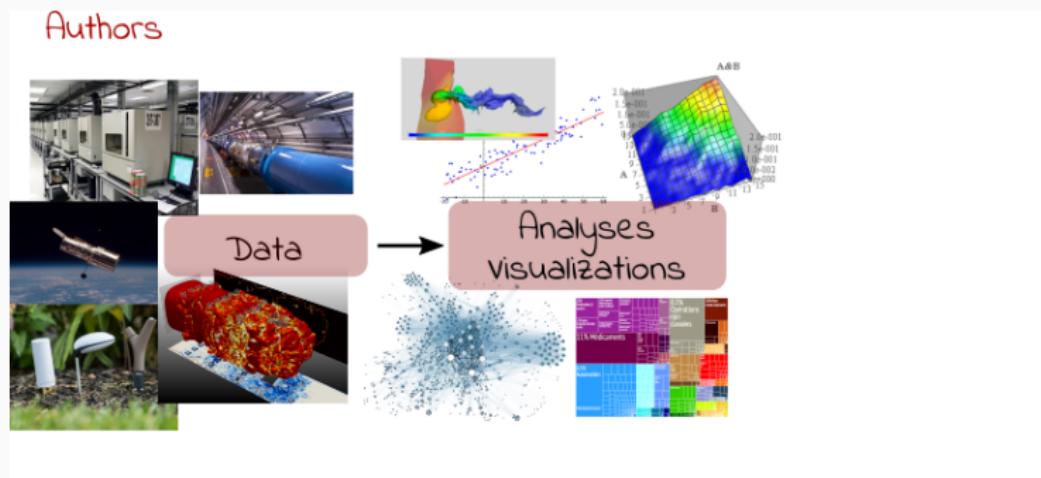
Data

# DIFFERENT REPRODUCIBILITY CONCERN

**Social Sciences, Oncology, ...** methodology, statistics

**Genomics** software engineering, computational reproducibility, provenance, ...

**Computational fluid dynamics** numerical issues

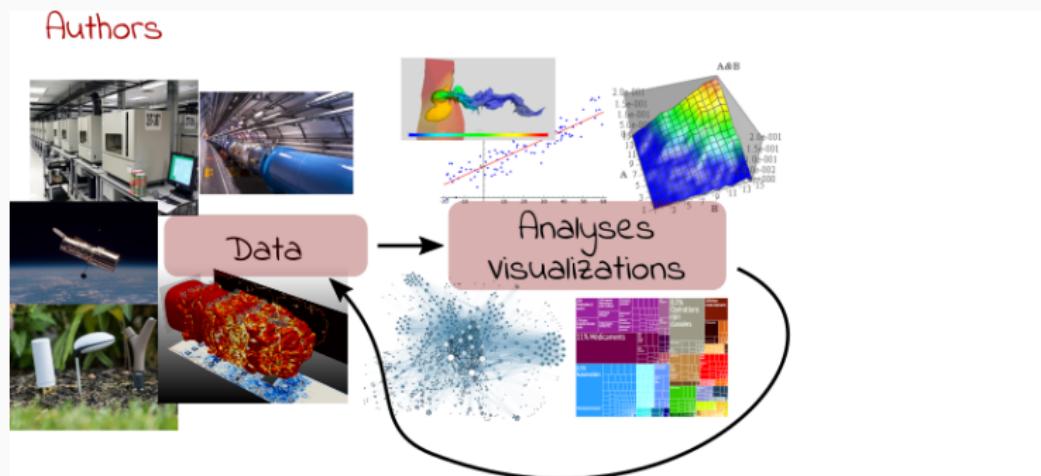


# DIFFERENT REPRODUCIBILITY CONCERN

Social Sciences, Oncology, ... methodology, statistics

Genomics software engineering, computational reproducibility, provenance, ...

Computational fluid dynamics numerical issues

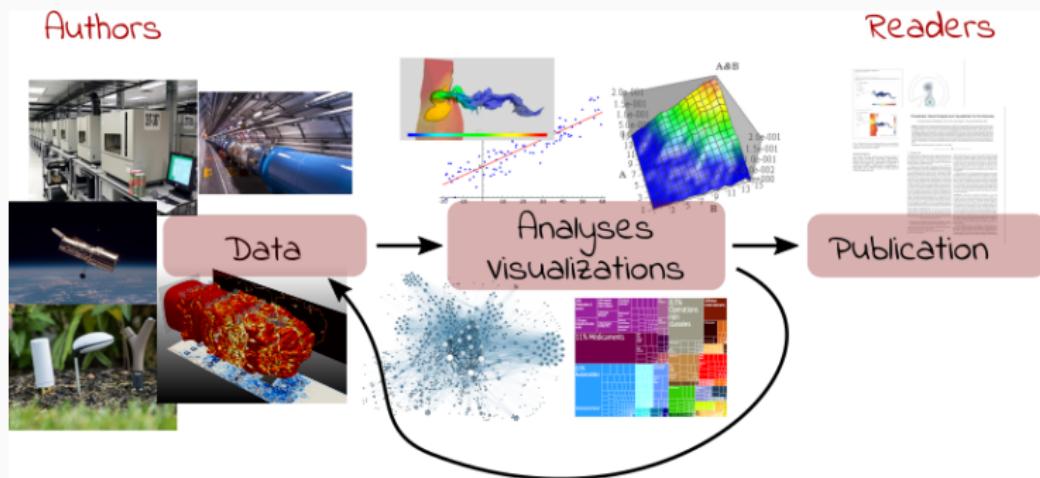


# DIFFERENT REPRODUCIBILITY CONCERN

Social Sciences, Oncology, ... methodology, statistics

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Computational fluid dynamics numerical issues

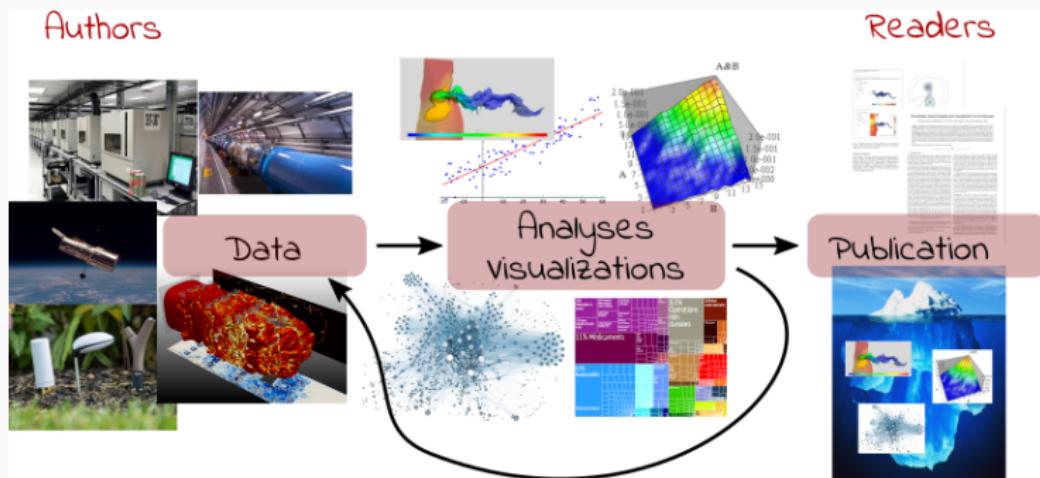


# DIFFERENT REPRODUCIBILITY CONCERN

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Computational fluid dynamics numerical issues

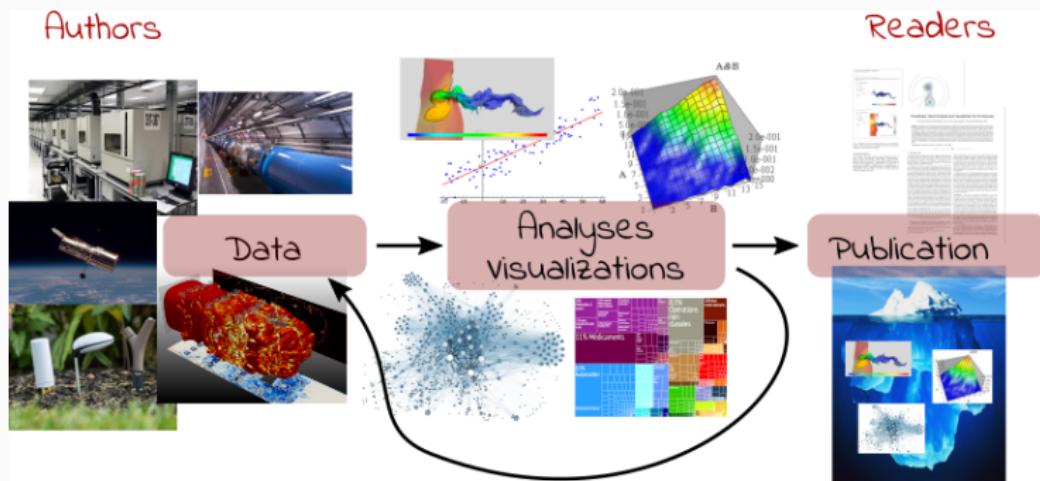


# DIFFERENT REPRODUCIBILITY CONCERN

Social Sciences, Oncology, ... methodology, statistics

Genomics software engineering, computational reproducibility, provenance, ...

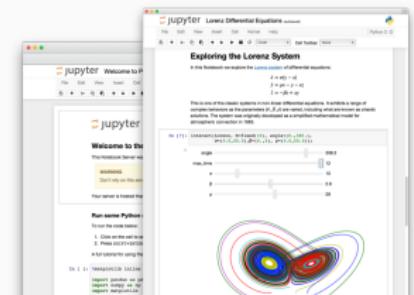
Computational fluid dynamics numerical issues



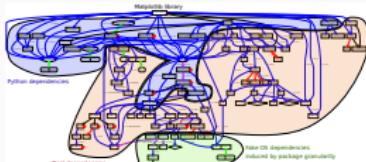
Reproducible Research = Bridging the Gap by working Transparently

# EXISTING TOOLS, EMERGING STANDARDS

## Notebooks and workflows



## Software environments



## Sharing platforms



# TOOL 1: COMPUTATIONAL NOTEBOOKS/LITTERATE PROGRAMMING

## Un document computationnel

Mon ordinateur m'indique que  $\pi$  vaut approximativement

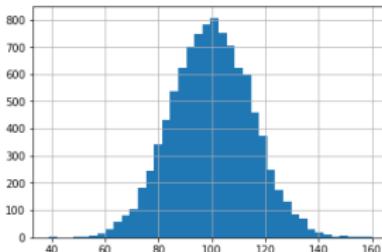
3.141592653589793

Mais calculé avec la méthode des [aiguilles de Buffon](#), on obtiendrait comme approximation :

```
import numpy as np
N = 1000000
x = np.random.uniform(size=N, low=0, high=1)
theta = np.random.uniform(size=N, low=0, high=pi/2)
2/(sum((x+np.sin(theta))>1)/N)
```

3.1437198694098765

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).



# TOOL 1: COMPUTATIONAL NOTEBOOKS/LITTERATE PROGRAMMING

Document initial dans son environnement

The screenshot shows a Jupyter Notebook window titled "example\_ip" (modified). It contains three code cells:

- In [1]:** A cell containing Python code to print pi.

```
from math import *  
print(pi)  
3.141592653589793
```

Output: Mais calculé avec la [méthode des aiguilles de Buffon](#) ([https://fr.wikipedia.org/wiki/Aiguille\\_de\\_Buffon](https://fr.wikipedia.org/wiki/Aiguille_de_Buffon)), on obtient d'abord comme approximation :
- In [2]:** A cell containing Python code to calculate theBuffon's needle problem.

```
import numpy as np  
N = 1000000  
x = np.random.uniform(size=N, low=0, high=1)  
theta = np.random.uniform(size=N, low=0, high=np.pi/2)  
2/(sum((x+np.sin(theta))>1))/N
```

Output: 3.14371986944998765
- In [3]:** A cell containing Python code to generate a histogram of random numbers.

```
%matplotlib inline  
import matplotlib.pyplot as plt  
  
mu, sigma = 100, 15  
x = mu + sigma*np.random.randn(10000)  
  
plt.hist(x,40)  
plt.grid(True)  
plt.show()
```

Output: A histogram showing a bell-shaped distribution centered around 100.

Document final

## Un document computationnel

Mon ordinateur m'indique que  $\pi$  vaut approximativement

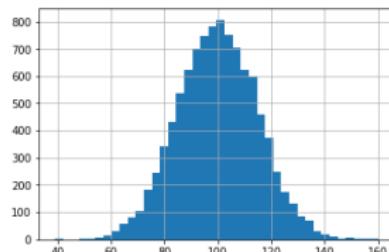
3.141592653589793

Mais calculé avec la [méthode des aiguilles de Buffon](#), on obtiendrait comme approximation :

```
import numpy as np  
N = 1000000  
x = np.random.uniform(size=N, low=0, high=1)  
theta = np.random.uniform(size=N, low=0, high=np.pi/2)  
2/(sum((x+np.sin(theta))>1))/N
```

3.14371986944998765

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).



# TOOL 1: COMPUTATIONAL NOTEBOOKS/LITTERATE PROGRAMMING

Document initial dans son environnement

A screenshot of a Jupyter Notebook interface. The title cell contains the text '# Un document computationnel'. Below it, a cell (In [1]) contains Python code to print pi, followed by its numerical value. Another cell (In [2]) contains code to calculate pi using Buffon's needle method, with a note explaining the formula and its relation to pi. The final cell (In [3]) shows a histogram of random numbers.

```
# Un document computationnel
Mon ordinateur m'indique que $\pi$ vaut "approximativement"
3.141592653589793

Mais calculé avec la méthode des aiguilles de Buffon (https://fr.wikipedia.org/wiki/Aiguille\_de\_Buffon), on obtient aussi comme approximation : 3.1437198694998765

On peut inclure des formules mathématiques comme $ \frac{4}{\pi} \exp \left( -\frac{(x-\mu)^2}{2\sigma^2} \right) + \text{des dessins qui n'ont rien à voir avec } \pi $ (si ce n'est une constante de normalisation...).

3.1437198694998765
```

Document final

## Un document computationnel

Mon ordinateur m'indique que  $\pi$  vaut approximativement

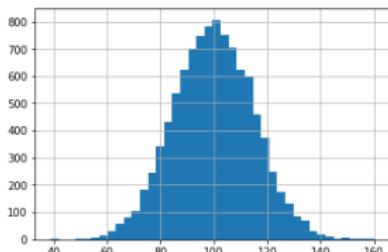
3.141592653589793

Mais calculé avec la [méthode des aiguilles de Buffon](#), on obtient comme approximation :

```
import numpy as np
N = 1000000
x = np.random.uniform(size=N, low=0, high=1)
theta = np.random.uniform(size=N, low=0, high=np.pi/2)
2/(sum((x+np.sin(theta))>1))/N
```

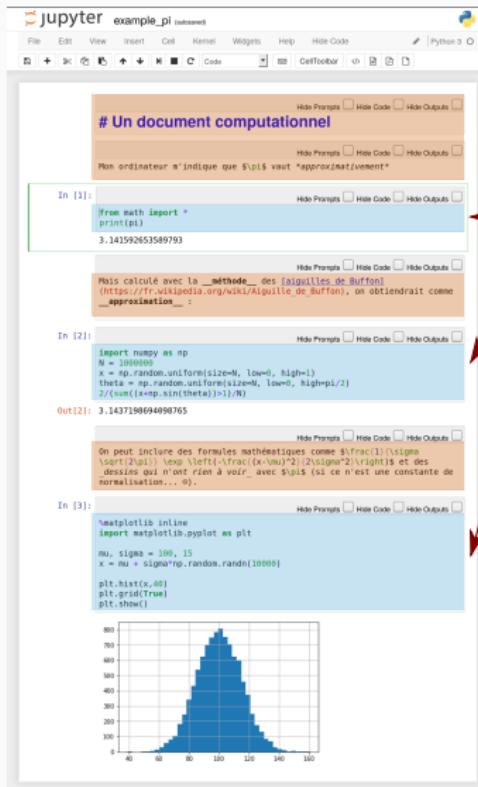
3.1437198694998765

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation...).



# TOOL 1: COMPUTATIONAL NOTEBOOKS/LITTERATE PROGRAMMING

Document initial dans son environnement



# Un document computationnel

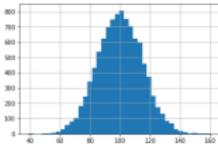
```
In [1]: from math import * print(pi) 3,141592653589793
```

Mais calculé avec la [méthode des aiguilles de Buffon](#) ([https://fr.wikipedia.org/wiki/Aiguille\\_de\\_Buffon](https://fr.wikipedia.org/wiki/Aiguille_de_Buffon)), on obtiendrait comme approximation :

```
In [2]: import numpy as np N = 1000000 x = np.random.uniform(size=N, low=0, high=1) theta = np.random.uniform(size=N, low=0, high=pi/2) 2*(sum((x*np.sin(theta))>1))/N Out[2]: 3,1437198694098765
```

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).

```
In [3]: %matplotlib inline import matplotlib.pyplot as plt mu, sigma = 100, 15 x = mu + sigma*np.random.randn(10000) plt.hist(x,60) plt.grid(True) plt.show()
```



Document final

## Un document computationnel

Mon ordinateur m'indique que  $\pi$  vaut approximativement

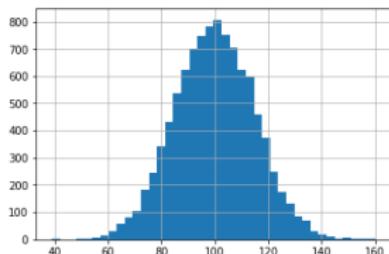
3.141592653589793

Mais calculé avec la [méthode des aiguilles de Buffon](#), on obtiendrait comme approximation :

```
import numpy as np N = 1000000 x = np.random.uniform(size=N, low=0, high=1) theta = np.random.uniform(size=N, low=0, high=pi/2) 2*(sum((x*np.sin(theta))>1))/N
```

3.1437198694098765

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).



# TOOL 1: COMPUTATIONAL NOTEBOOKS/LITTERATE PROGRAMMING

Document initial dans son environnement

# Un document computationnel

```
In [1]:  
from math import *  
print(pi)  
3,141592653589793
```

Mais calculé avec la `_methodes_ des éimpulles de Buffon` ([https://fr.wikipedia.org/wiki/Algille\\_de\\_Buffon](https://fr.wikipedia.org/wiki/Algille_de_Buffon)), on obtiendrait comme `approximation` :

```
In [2]:  
import numpy as np  
N = 1000000  
x = np.random.uniform(size=N, low=0, high=1)  
theta = np.random.uniform(size=N, low=0, high=pi/2)  
2/(sum((x+np.sin(theta))>1))/N  
Out[2]: 3,1437198694098765
```

On peut inclure des formules mathématiques comme `$\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$` et des dessins qui n'ont rien à voir avec `pi` (si ce n'est une constante de normalisation... ☺).

```
In [3]:  
%matplotlib inline  
import matplotlib.pyplot as plt  
  
mu, sigma = 100, 15  
x = mu + sigma*np.random.randn(10000)  
  
plt.hist(x, 99)  
plt.grid(True)  
plt.show()
```

Document final

## Un document computationnel

Mon ordinateur m'indique que  $\pi$  vaut approximativement

3.141592653589793

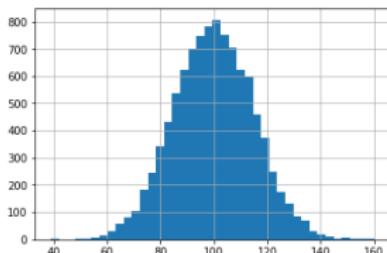
Mais calculé avec la **méthode des aiguilles de Buffon**, on obtiendrait comme approximation :

```
import numpy as np  
N = 1000000  
x = np.random.uniform(size=N, low=0, high=1)  
theta = np.random.uniform(size=N, low=0, high=pi/2)  
2/(sum((x+np.sin(theta))>1))/N
```

3.1437198694098765

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et

des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).



# TOOL 1: COMPUTATIONAL NOTEBOOKS/LITTERATE PROGRAMMING

Document initial dans son environnement

```
# Un document computationnel

In [1]: from math import * print(pi) 3,141592653589793

Mais calculé avec la __methodes__ des émouilles de Buffon (https://fr.wikipedia.org/wiki/Algouille_de_Buffon), on obtiendrait comme __approximation__ : 3.141592653589793

In [2]: import numpy as np N = 1000000 x = np.random.uniform(size=N, low=0, high=1) theta = np.random.uniform(size=N, low=0, high=pi/2) 2/(sum((x*np.sin(theta))>1))/N Out[2]: 3.1437198694098765

On peut inclure des formules mathématiques comme $\\frac{1}{\\sigma\\sqrt{2\\pi}}\\exp\\left(-\\frac{(x-\\mu)^2}{2\\sigma^2}\\right)$ et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).

In [3]: %matplotlib inline import matplotlib.pyplot as plt mu, sigma = 100, 15 x = mu + sigma*np.random.randn(10000) plt.hist(x,99) plt.grid(True) plt.show()
```

Document final

## Un document computationnel

Mon ordinateur m'indique que  $\pi$  vaut approximativement

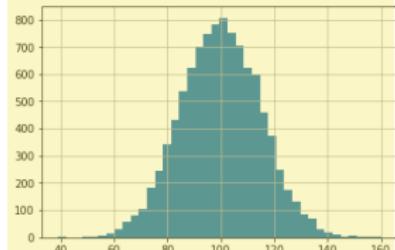
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Mais calculé avec la **méthode des aiguilles de Buffon**, on obtiendrait comme approximation :

```
import numpy as np
N = 1000000
x = np.random.uniform(size=N, low=0, high=1)
theta = np.random.uniform(size=N, low=0, high=pi/2)
2/(sum((x*np.sin(theta))>1))/N
```

3.1437198694098765

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}}\exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).



# TOOL 1: COMPUTATIONAL NOTEBOOKS/LITTERATE PROGRAMMING

Document initial dans son environnement

The screenshot shows a Jupyter Notebook interface with three code cells:

- In [1]:** Prints the value of pi (3.141592653589793) and includes a note about calculating pi with Buffon's needle method.
- In [2]:** Generates random points (x, theta) and calculates an approximation of pi based on the ratio of points where sin(theta) >= x.
- In [3]:** Plots a histogram of x values, showing a bell-shaped distribution centered around 100.

Document final

## Un document computationnel

Mon ordinateur m'indique que  $\pi$  vaut approximativement

3.141592653589793

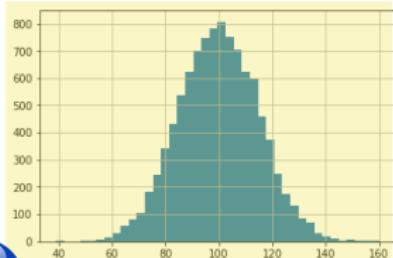
Mais calculé avec la **méthode des aiguilles de Buffon**, on obtiendrait comme approximation :

```
import numpy as np
N = 1000000
x = np.random.uniform(size=N, low=0, high=1)
theta = np.random.uniform(size=N, low=0, high=pi/2)
2/(sum((x+np.sin(theta))>1))/N
```

3.1437198694098765

Export

On peut inclure des formules mathématiques comme  $\frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$  et des dessins qui n'ont rien à voir avec  $\pi$  (si ce n'est une constante de normalisation... ☺).



## TOOL 2: FIGHTING SOFTWARE ENVIRONMENTS NIGHTMARE

What is hiding behind a simple

```
import matplotlib
```

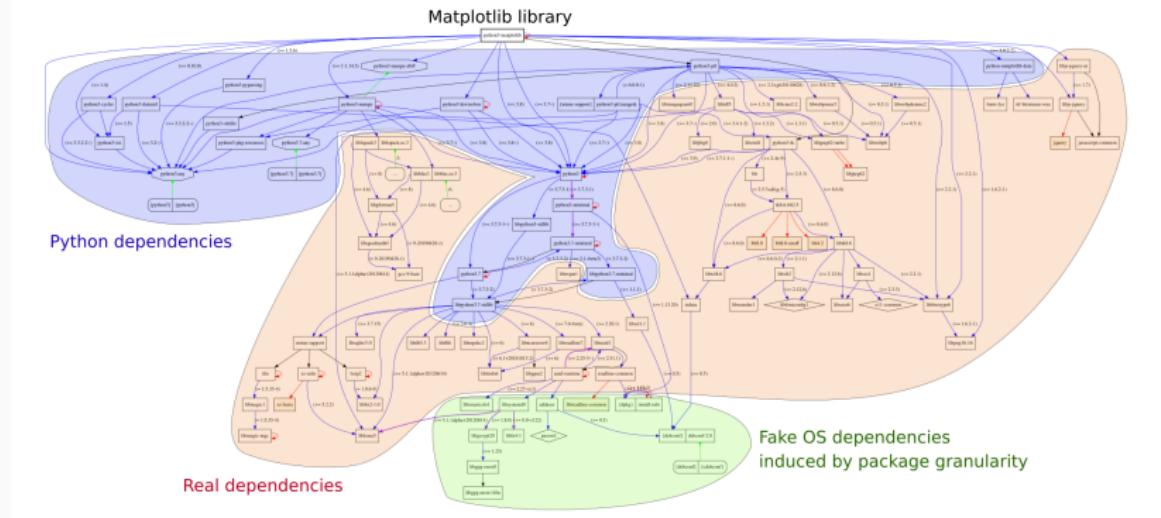
Package: python3-matplotlib  
Version: 2.1.1-2  
Depends: python3-dateutil, python-matplotlib-data (>= 2.1.1-2),  
python3-pyparsing (>= 1.5.6), python3-six (>= 1.10), python3-tz,  
libjs-jquery, libjs-jquery-ui, python3-numpy (>= 1:1.13.1),  
python3-numpy-abi9, python3 (<< 3.7), python3 (>= 3.6~),  
python3-cycler (>= 0.10.0), python3:any (>= 3.3.2-2~), libc6 (>= 2.14), libfreetype6 (>= 2.2.1), libgcc1 (>= 1:3.0), libpng16-16 (>= 1.6.2-1), libstdc++6 (>= 5.2), zlib1g (>= 1:1.1.4)

## TOOL 2: FIGHTING SOFTWARE ENVIRONMENTS NIGHTMARE

## What is hiding behind a simple

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import matplotlib
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## Package: python3-matplotlib



## TOOL 2: FIGHTING SOFTWARE ENVIRONMENTS NIGHTMARE

Python and its rapidly evolving environment

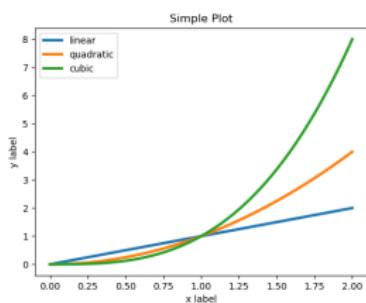
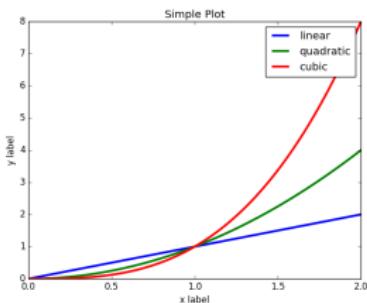
```
python2 -c "print(10/3)"  
python3 -c "print(10/3)"
```

3  
3.333333333333335

## TOOL 2: FIGHTING SOFTWARE ENVIRONMENTS NIGHTMARE

Python and its rapidly evolving environment

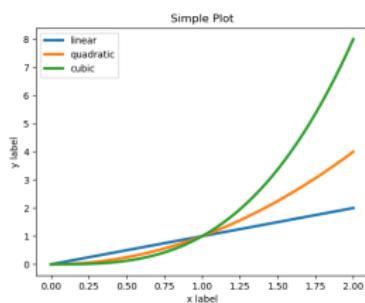
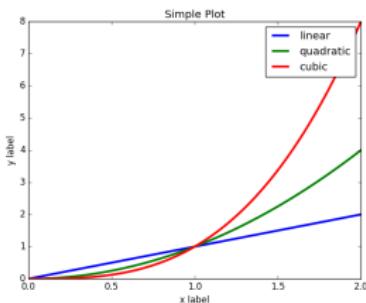
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## TOOL 2: FIGHTING SOFTWARE ENVIRONMENTS NIGHTMARE

Python and its rapidly evolving environment

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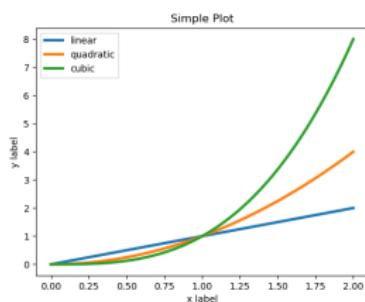
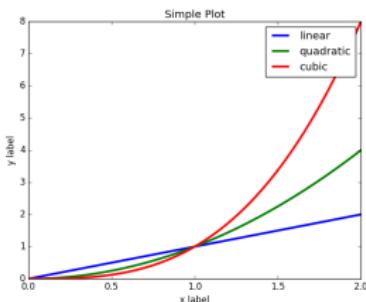


Cortical Thickness Measurements (PLOS ONE, June 2012): *FreeSurfer: differences were found between the Mac and HP workstations and between Mac OSX 10.5 and OSX 10.6.*

## TOOL 2: FIGHTING SOFTWARE ENVIRONMENTS NIGHTMARE

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## TOOL 3: FIGHTING INFORMATION LOSS WITH ARCHIVES

D. Spinellis. The Decay and Failures of URL References. CACM, 46(1), Jan 2003.

*The half-life of a referenced URL is approximately 4 years from its publication date.*

P. Habibzadeh. Decay of References to Web sites in Articles Published in General Medical Journals: Mainstream vs Small Journals". Applied Clinical Informatics. 4 (4), 2013

*half life ranged from 2.2 years in EMHJ to 5.3 years in BMJ*

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Article archives arXiv.org HAL  
archives-ouvertes.fr

Data archives figshare zenodo

Software Archive Software Heritage



or



= awesome collaborations ≠ archive

# CHANGING RESEARCH PRACTICES

## Soft. Engineering, Statistics, and Reproducible Research in the curricula



- Book on RR *Vers une recherche  
reproductible: Faire évoluer ses pratiques*
- MOOC on RR (3rd edition Feb. 2020)
- A new "Advanced RR" MOOC (Oct. 2020)
  - Software environment control (Docker)
  - Scientific workflow (snakemake)
  - Managing data (HDF5, archiving)

## **Manifesto: "I solemnly pledge" (WSSSPE, Lorena Barba, FAIR)**

1. I will teach my graduate students about reproducibility
2. All our research code (and writing) is under version control
3. We will always carry out verification and validation
4. We will share data, plotting script & figure under CC-BY
5. We will upload the preprint to arXiv at the time of submission of a paper
6. We will release code at the time of submission of a paper
7. We will add a "Reproducibility" declaration at the end of each paper
8. I will keep an up-to-date web presence

# CHANGING PUBLISHING PRACTICES

## Artifact evaluation and ACM badges



## Major conferences

- Supercomputing: Artifact Description (AD) **mandatory**, Artifact Evaluation (AE) still **optional**, Double blind vs. RR
- NeurIPS, ICLR: **open reviews**, reproducibility challenge



Joelle Pineau @ NeurIPS'18

- ACM SIGMOD 2015-2019, Most Reproducible Paper Award...

Mentalities are evolving people care, make stuff available, errors are found and fixed

# REPRODUCIBLE RESEARCH = RIGOR AND TRANSPARENCY

To err is human.

Good research requires time and resources

1. **Train yourself and your students:** RR, statistics, experiments
  - Beware of checklists and norms
  - Understand what's at stake
2. **Change the norm:** make publication practices evolve
3. **Incentive:** consider RR/open science when hiring/promoting



# SOME ADVERTISING

**TEN YEARS REPRODUCIBILITY CHALLENGE**

RESCIENCE SPECIAL ISSUE  
FREE TO READ - FREE TO PUBLISH



Would you dare to run the code from your past self?  
(the one that does not answer mail)

SUBMISSION DEADLINE 01/04/2020  
<http://rescience.github.io/ten-years>  
In association with Inria, CQRS, Software Heritage, Rescience, Comité pour la Science Ouverte, URFIST Bordeaux & Mission de la pédagogie et du numérique pour l'enseignement supérieur.

<http://rescience.github.io/ten-years/>



3rd Edition: ≈ March 2020

A new MOOC: "Advanced R"

- Software environment control (Docker)
- Scientific workflow (snakemake)
- Managing data (HDF5, archiving)

October 2020 ?