Introduction to Machine Learning

Roberto Battiti

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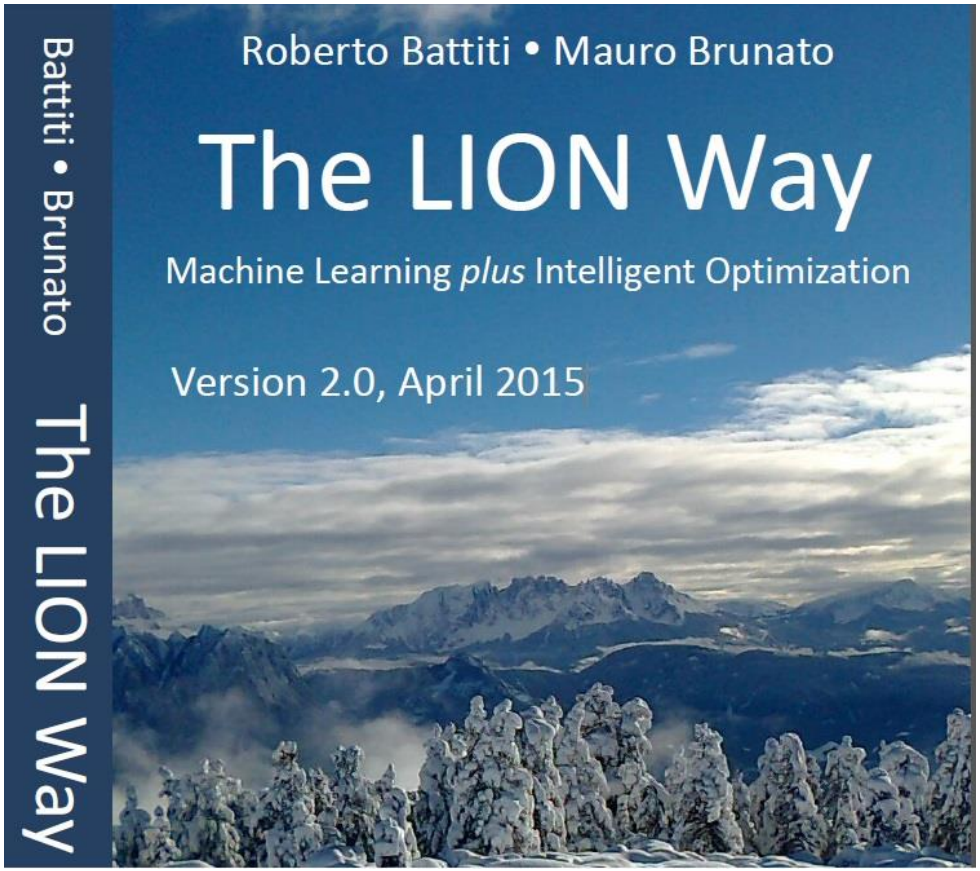
Subject: [ML]

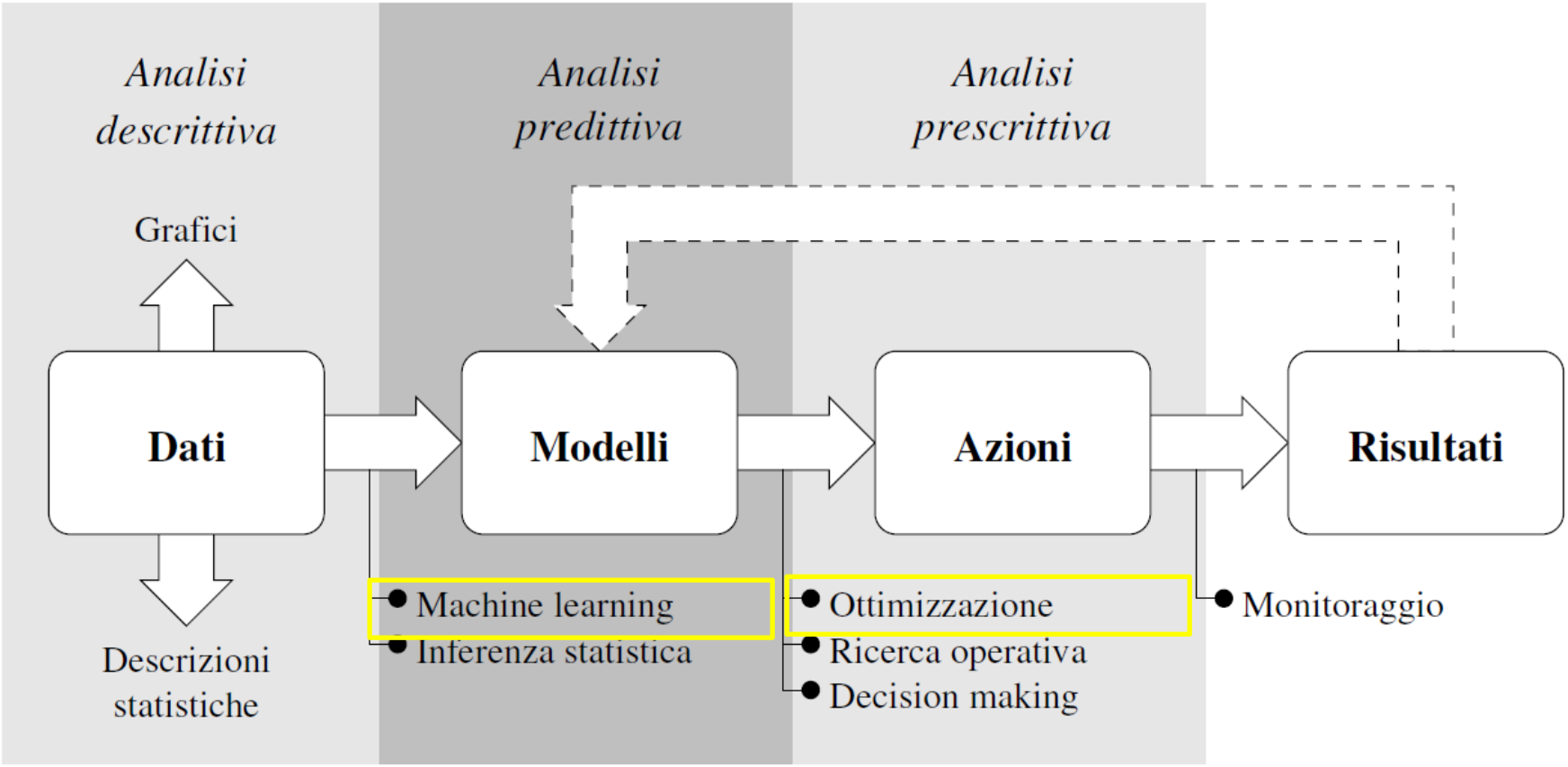
https://intelligent-optimization.org/courses/ML/



ROBERTO BATTITI, MAURO BRUNATO.
The LION Way: Machine Learning plus *Intelligent Optimization*.
LIONlab, University of Trento, Italy, 2017

http://intelligent-optimization.org/LIONbook

Data Science



Presentiamoci/**interagiamo**

Corse objective

- **Master the main tools** of “Data Science” “Machine Learning”, “Learning from Data”, “Big Data”… “AI”

- Open the “black box”


NOW IN PRODUCTION
HENRY'S APPLETINI
Apple Juice
Are you up for a little recon? Meet me in the engine room...
Martini
Cosmopolitan
MAKR SHAKR

Middle Age…

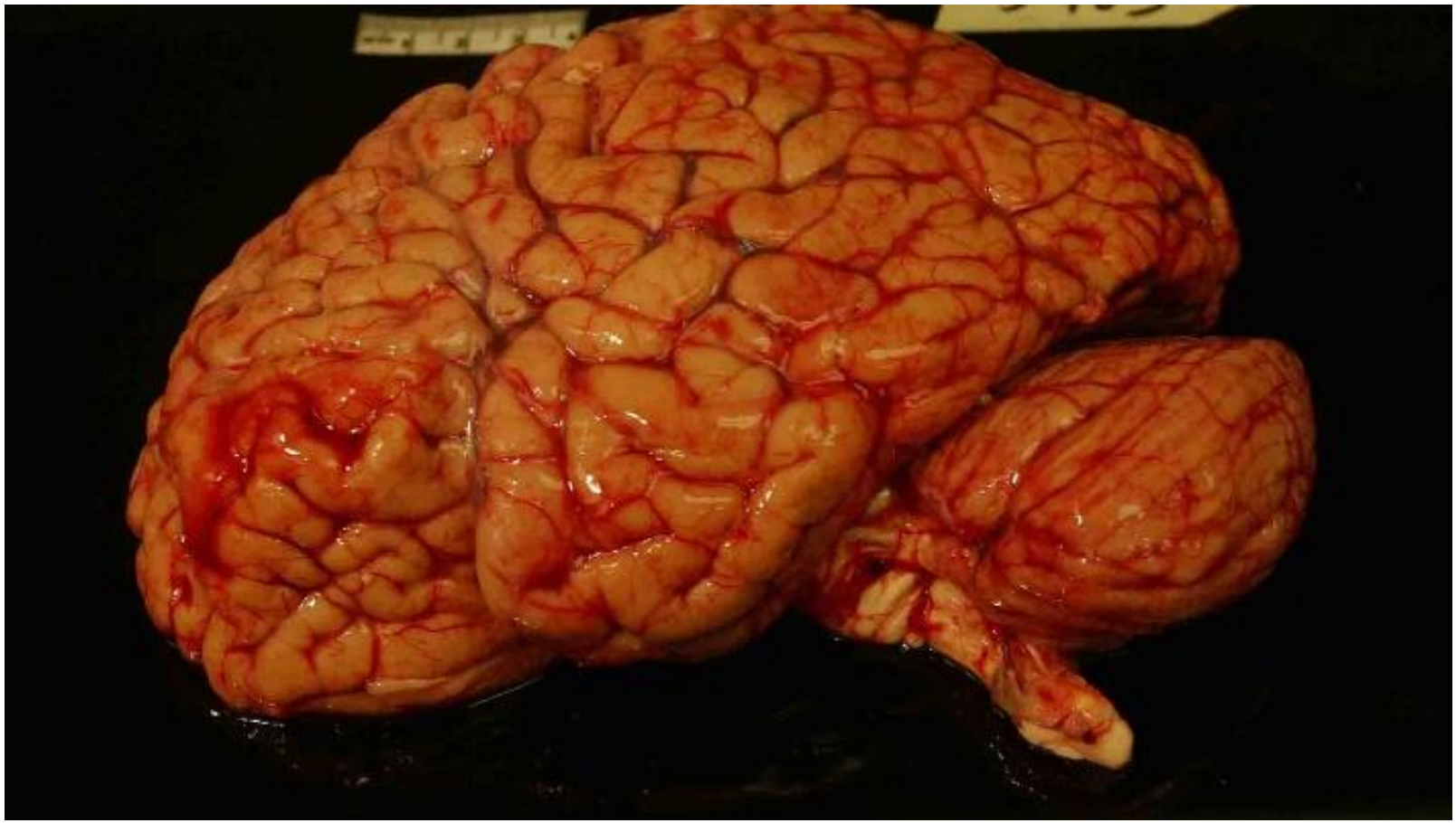
Masters attracted scholars through their reputation which led to students hiring them for instruction, thereby establishing a learning group known as a ***universitas*** **(learning community).**

A kind of *sharing economy*?

…Age of Cut-and-paste

Information at our finger tips

… only there??



2022

why are you here?

The strenuous effort of conceptual reflection

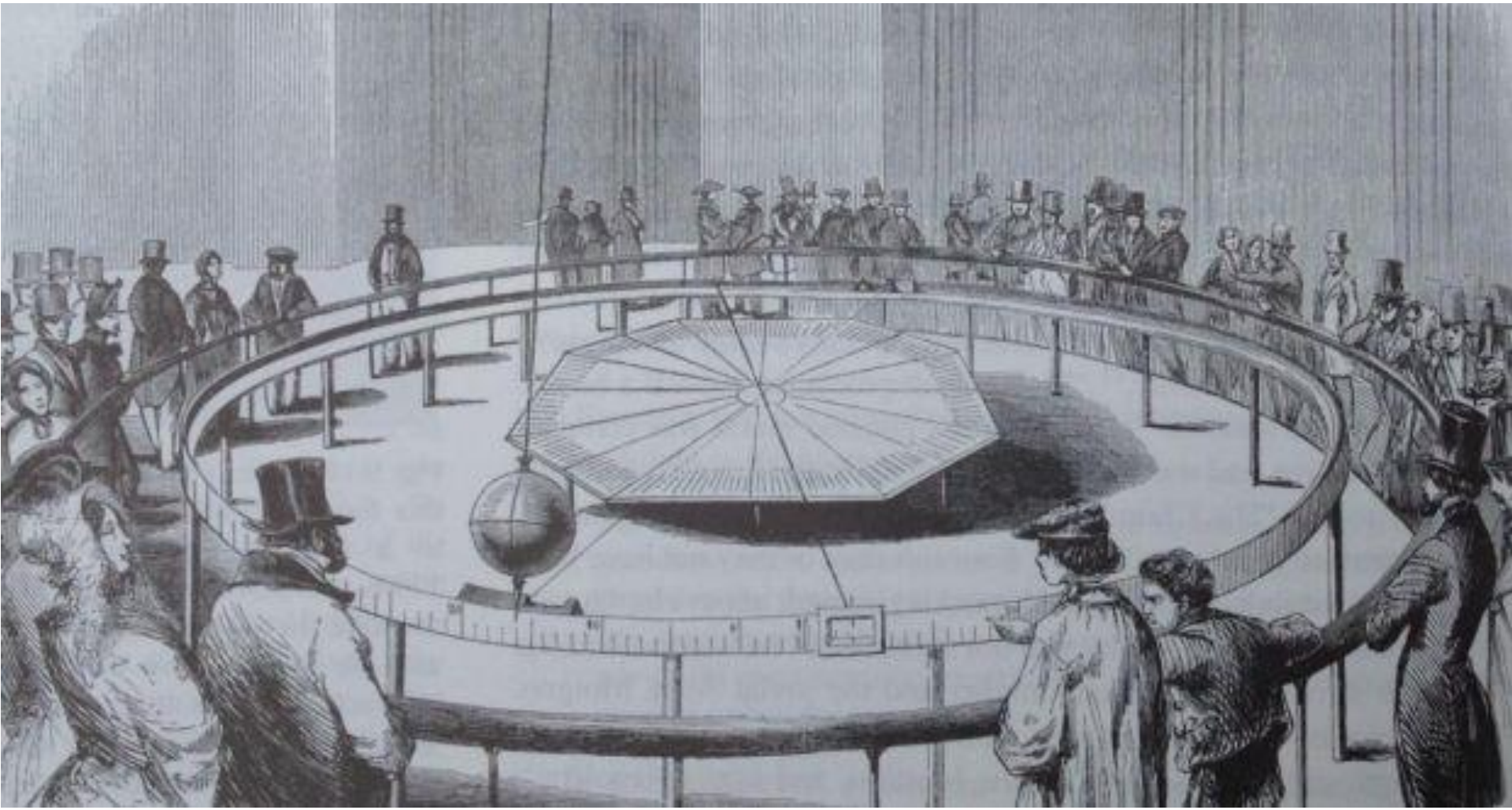
"die **Anstrengung des Begriffs**“ (Hegel)

Math does not happen naturally in humans


Science (incl. ML)
is a tool, but not
an easy one


BOSCH
GBH 5-36 D

A personal story…



Problem: determine if a coin is fair or rigged

Experiments: flip and count heads/tails

P-value in Statistical Hypothesis Testing

- A result could be obtained by chance
- **"Significant"** ←→ low probability of obtaining by chance (unlikely to occur by chance)
- Hypothesis : "coin is fair"

- If coin is fair, what is the probability of obtaining only heads? (or the result I measured)
- If too low, hypothesis that coin is fair is rejected
- "too low" needs a threshold value, the s.c. P-value

An interesting case: selling “100% sugar” pills without any compelling scientific evidence
https://en.wikipedia.org/wiki/Oscillococcinum

Coin flipping

- Ten flips only head, if fair coin p=…
- If all Italian people try, about 60,000 will conclude coin is “fake”…
- P-hacking

“if you torture the data long enough, it will confess to anything”

How to demonstrate you are an investment guru

- Predict next day evaluation (increase or decrease)
- Split customers in two…

Cut-paste scientific journalism?

- Slim by chocolate https://io9.gizmodo.com/i-fooled-millions-into-thinking-chocolate-helps-weight-1707251800


EXPRESS

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Blood pressure breakthrough: Jab every six months could

'Beautiful, brave and very, very talented' Jenny Eclair...

Chocolate accelerates weight loss: Research claims it lowers cholesterol and aids sleep

CAN you indulge your sweet tooth and lose weight? If it's chocolate that you crave than the answer seems to be yes.

By SARAH BARNS

PUBLISHED: 10:31, Mon, Mar 30, 2015 | UPDATED: 20:28, Sat, Apr 4, 2015

SHARE TWEET 2K

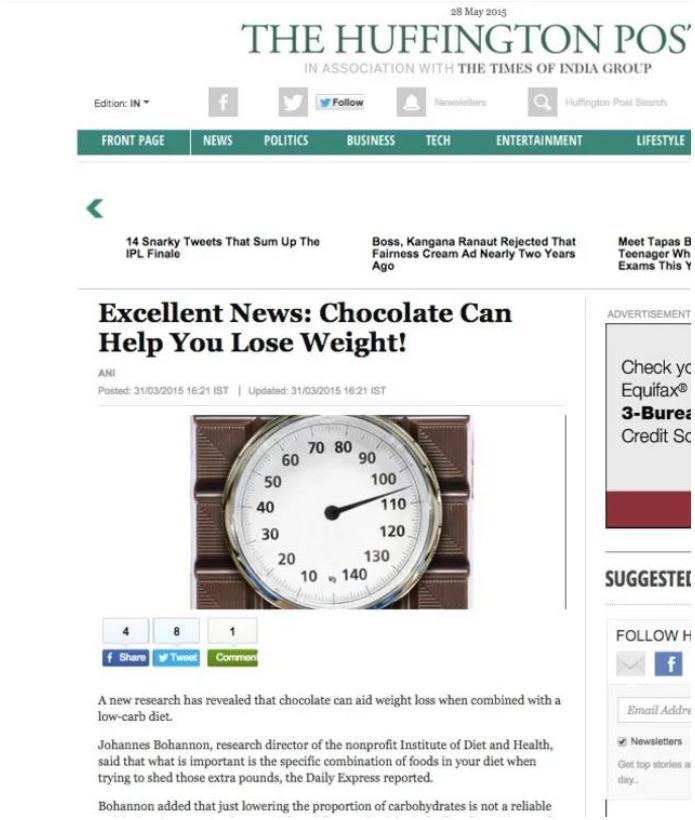
Chocolate can aid weight loss when combined with a low-carb diet, study claims


03.04 02:35 MIGnews.com

Шоколад - лучшая диета

Сотрудники немецкого Института питания и здоровья провели исследование, в результате которого пришли к выводу, что шоколад в сочетании с низкоуглеводной диетой помогает быстрее похудеть.

В ходе эксперимента его участники 19-67 лет были разделены на три группы. Первая группа соблюдала низкоуглеводную диету, вторая помимо диеты употребляла по 42 грамма темного шоколада в день, в


28 May 2015

THE HUFFINGTON POST

IN ASSOCIATION WITH THE TIMES OF INDIA GROUP

Edition: IN

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14 Snarky Tweets That Sum Up The IPL Finale

Boss, Kangana Ranaut Rejected That Fairness Cream Ad Nearly Two Years Ago

Excellent News: Chocolate Can Help You Lose Weight!

ANI

Posted: 31/03/2015 16:21 IST | Updated: 31/03/2015 16:21 IST

Share Tweet Comment

A new research has revealed that chocolate can aid weight loss when combined with a low-carb diet.

Johannes Bohannon, research director of the nonprofit Institute of Diet and Health, said that what is important is the specific combination of foods in your diet when trying to shed those extra pounds, the Daily Express reported.

Bohannon added that just lowering the proportion of carbohydrates is not a reliable

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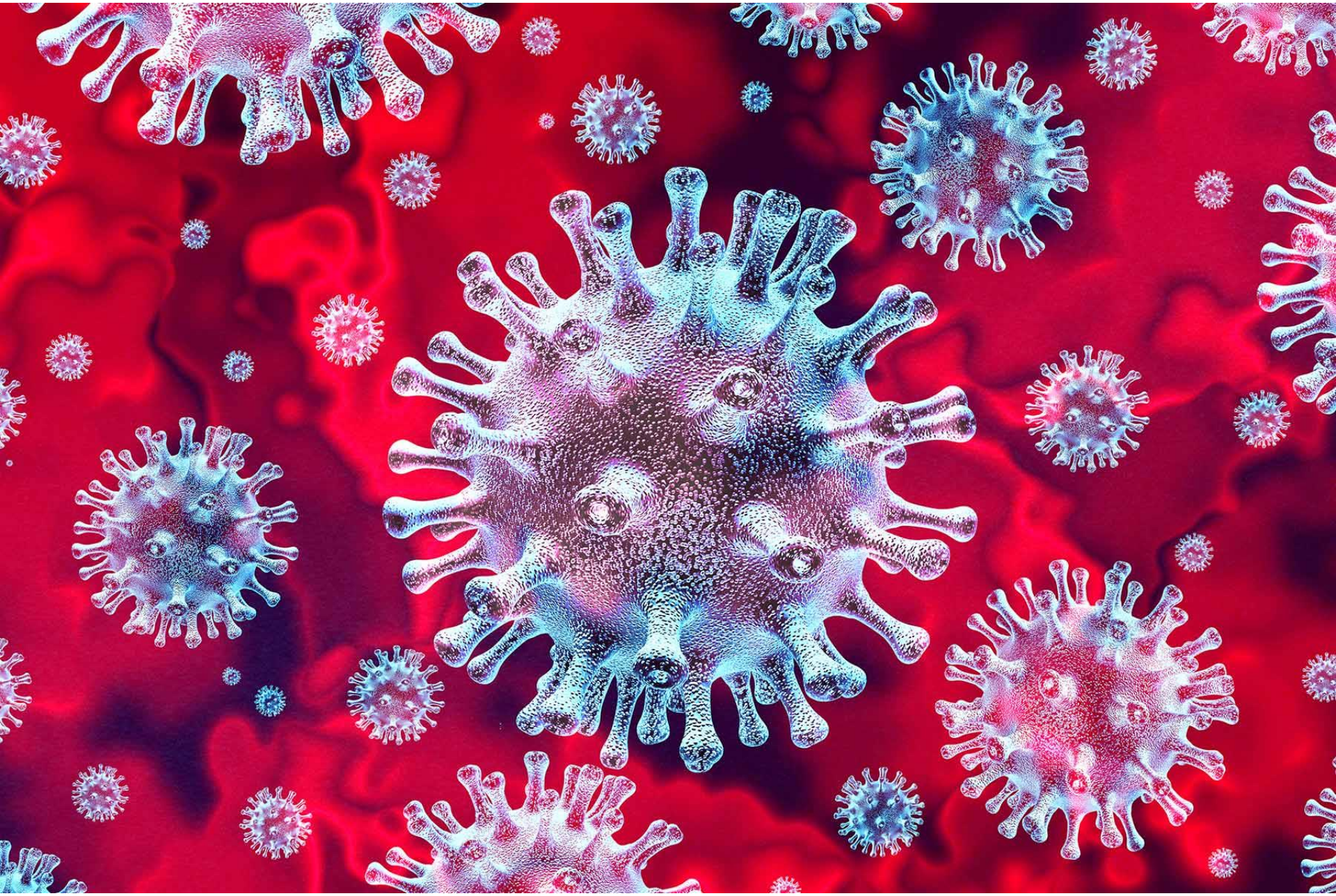
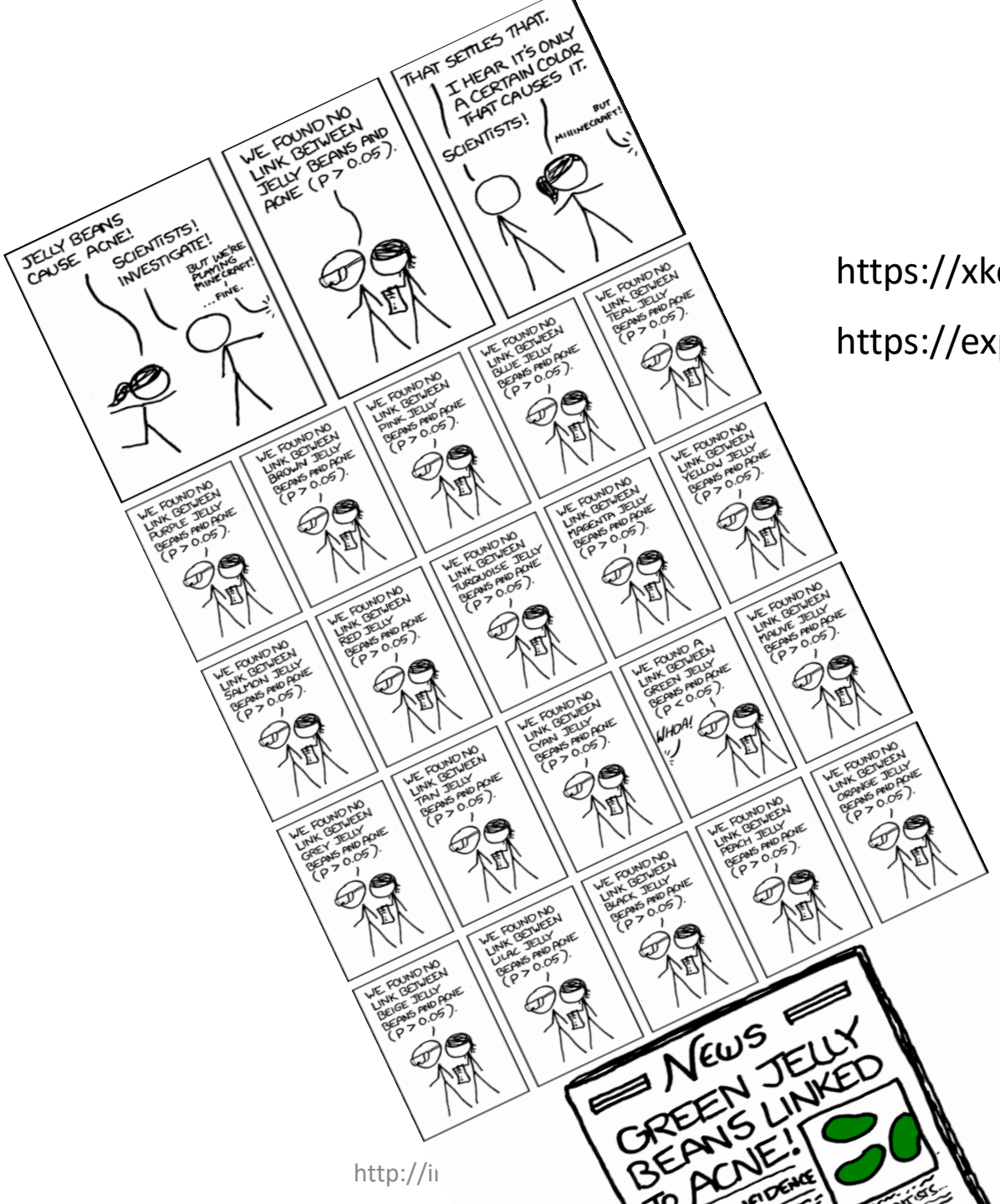
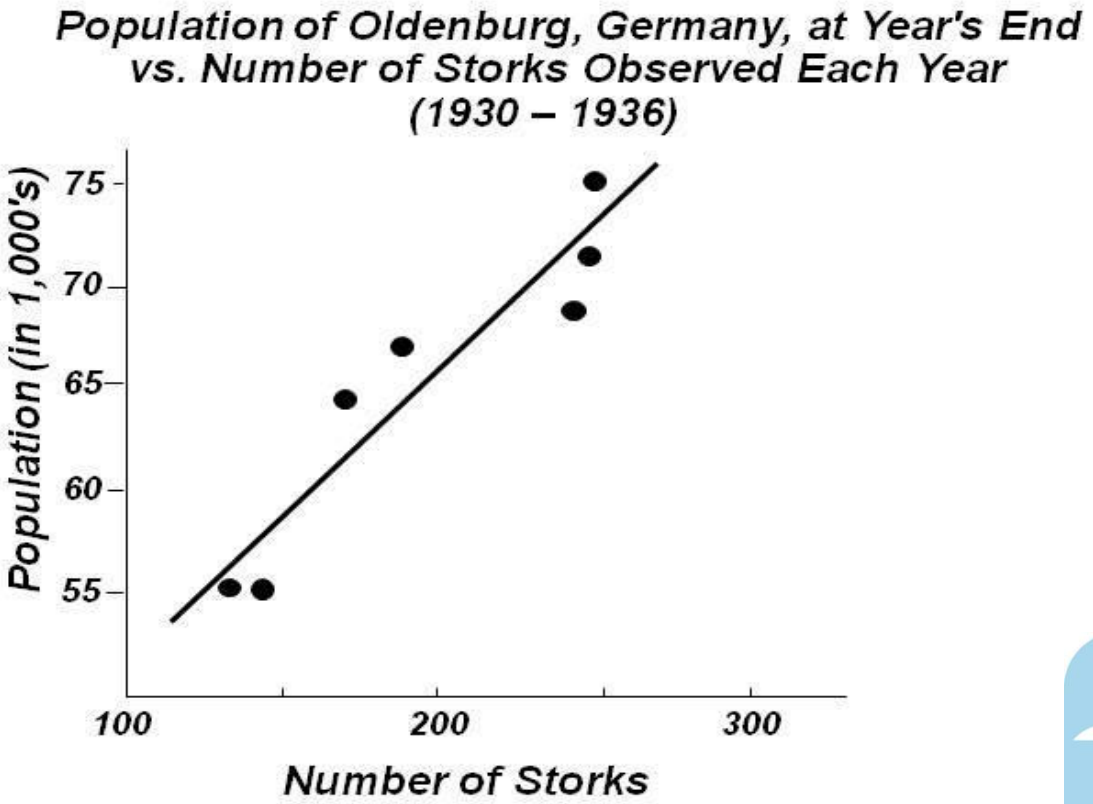




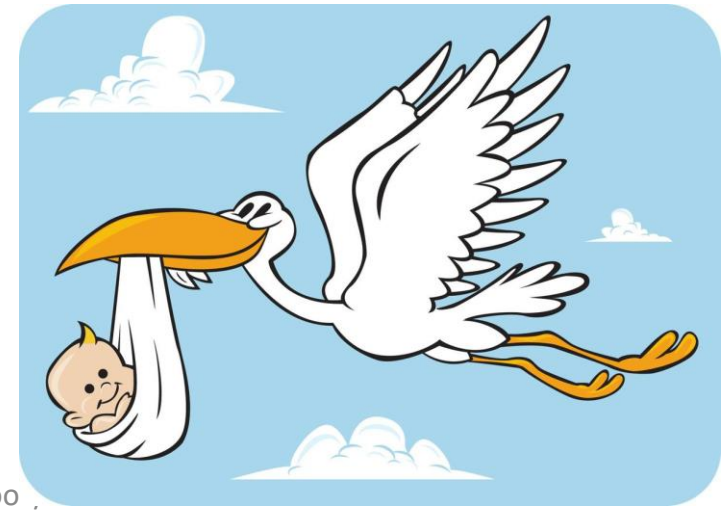
https://xkcd.com/882/

https://explainxkcd.com/882/

Correlation does not imply causation



Source: Statistics for Experimenters, by Box, Hunter & Hunter



Correlation is not causation

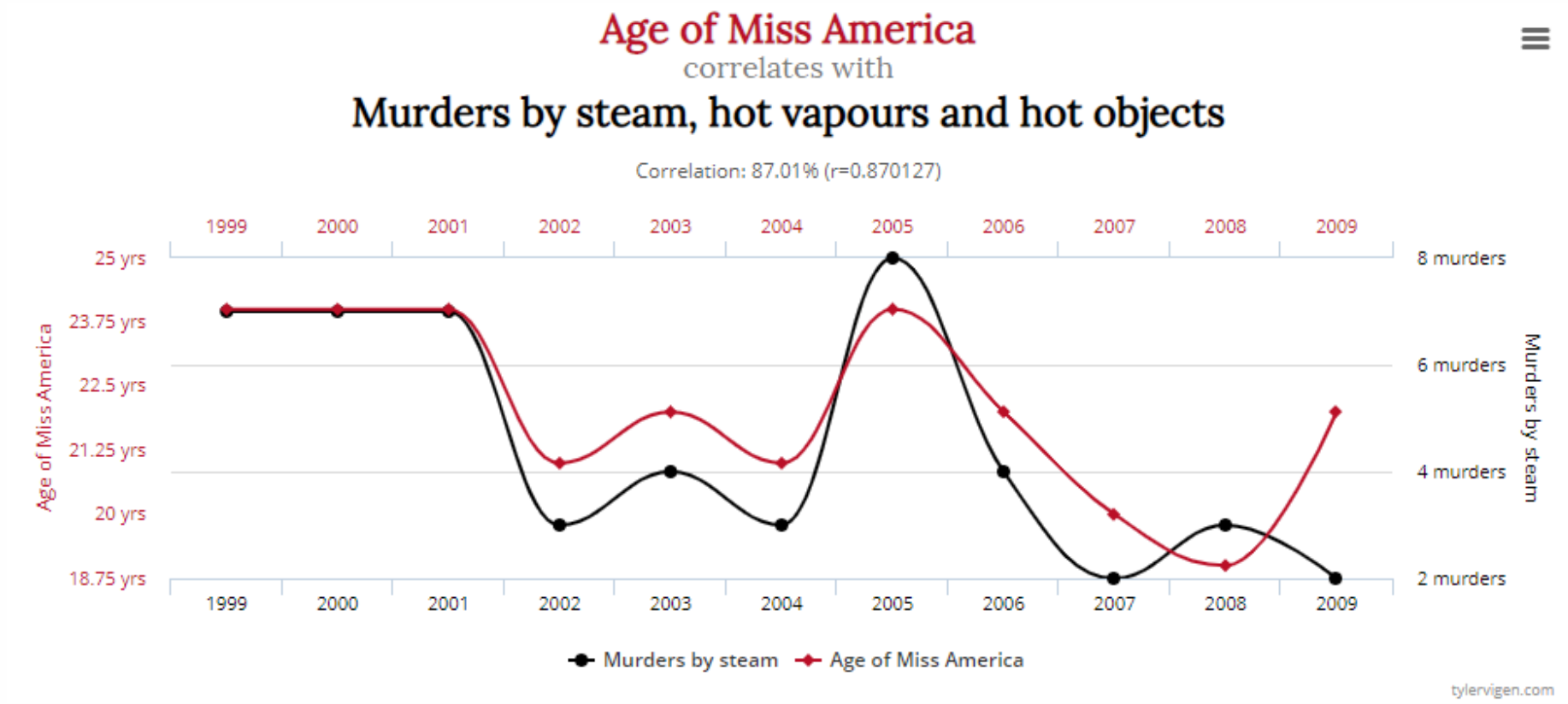
- Shoe number and height
- Going to the gym and being healthy
- …

“Post hoc” is not always “propter hoc”

- Event1 happens after Event0
- Does this mean that Event0 is causing Event1?
- Examples…

Correlation does not imply causation

http://www.tylervigen.com/spurious-correlations



UC Berkeley gender bias

	Men		Women	
	Applicants	Admitted	Applicants	Admitted
Total	8442	**44%**	4321	35%

UC Berkeley gender bias

Department	Men		Women	
	Applicants	Admitted	Applicants	Admitted
A	***825***	62%	108	**82%**
B	***560***	63%	25	**68%**
C	325	**37%**	***593***	34%
D	417	33%	375	**35%**
E	191	**28%**	***393***	24%
F	373	6%	341	**7%**

Hidden variable: department: **women tended to apply to competitive departments with low rates of admission** even among qualified applicants

Kidney stone treatment

Treatment A includes all open surgical procedures and Treatment B involves only a small puncture.

Treatment / Stone size	Treatment A	Treatment B
Small stones	*Group 1* **93% (81/87)**	*Group 2* 87% (234/270)
Large stones	*Group 3* **73% (192/263)**	*Group 4* 69% (55/80)
Both	78% (273/350)	**83% (289/350)**

the "lurking" variable (or confounding variable) is the severity of the case (represented by the doctors' treatment decision trend of favoring B for less severe cases),

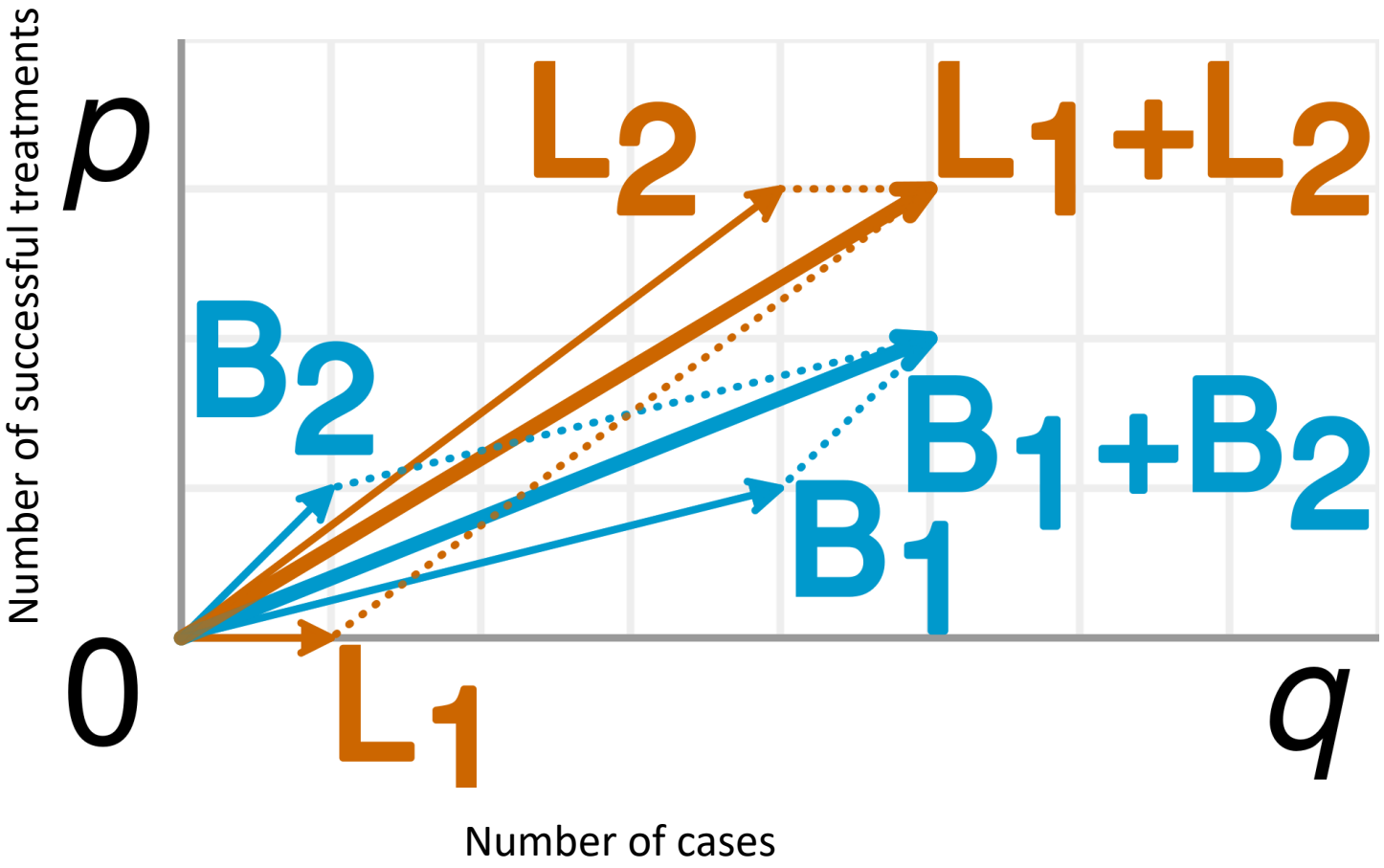
Simpson's paradox is a phenomenon in probability and statistics, in which a trend appears in several different groups of data but disappears or reverses when these groups are combined.

Which treatment is considered better is determined by an inequality between two ratios (successes/total). The reversal of the inequality between the ratios, which creates Simpson's paradox, happens because two effects occur together:

- The **sizes of the groups**, which are combined when the lurking variable is ignored, are very different. Doctors tend to give the **severe cases (large stones) the better treatment (A), and the milder cases (small stones) the inferior treatment (B).** Therefore, the totals are dominated by groups 3 and 2, and not by the two much smaller groups 1 and 4.
- The **lurking variable has a large effect on the ratios**; i.e., the **success rate is more strongly influenced by the severity of the case than by the choice of treatment**. Therefore, the group of patients with large stones using treatment A (group 3) does worse than the group with small stones (groups 1 and 2), even if the latter used the inferior treatment B (group 2).

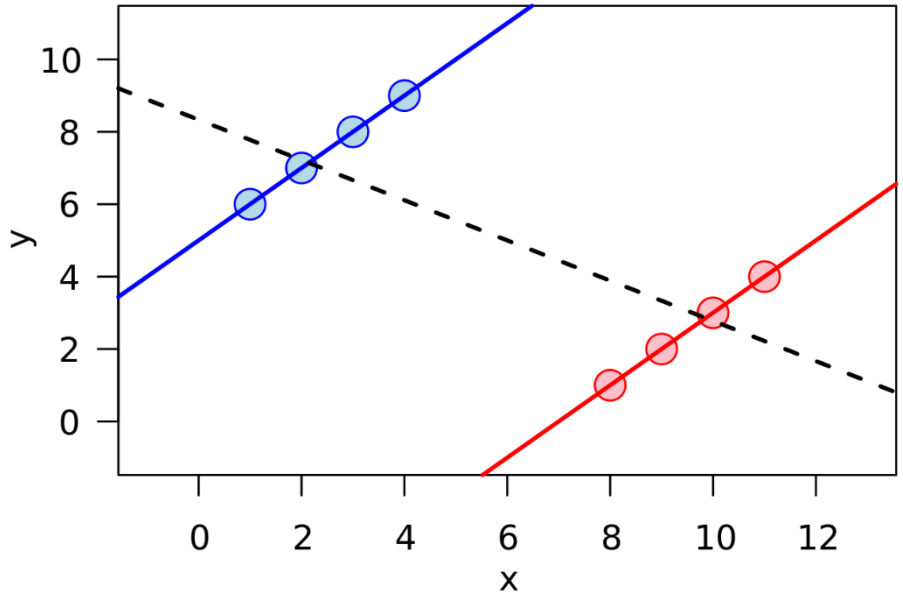
Based on these effects, the paradoxical result is seen to arise by suppression of the causal effect of the severity of the case on successful treatment. The paradoxical result can be rephrased more accurately as follows: **When the less effective treatment (B) is applied more frequently to less severe cases, it can appear to be a more effective treatment** *(omeopatia?)*

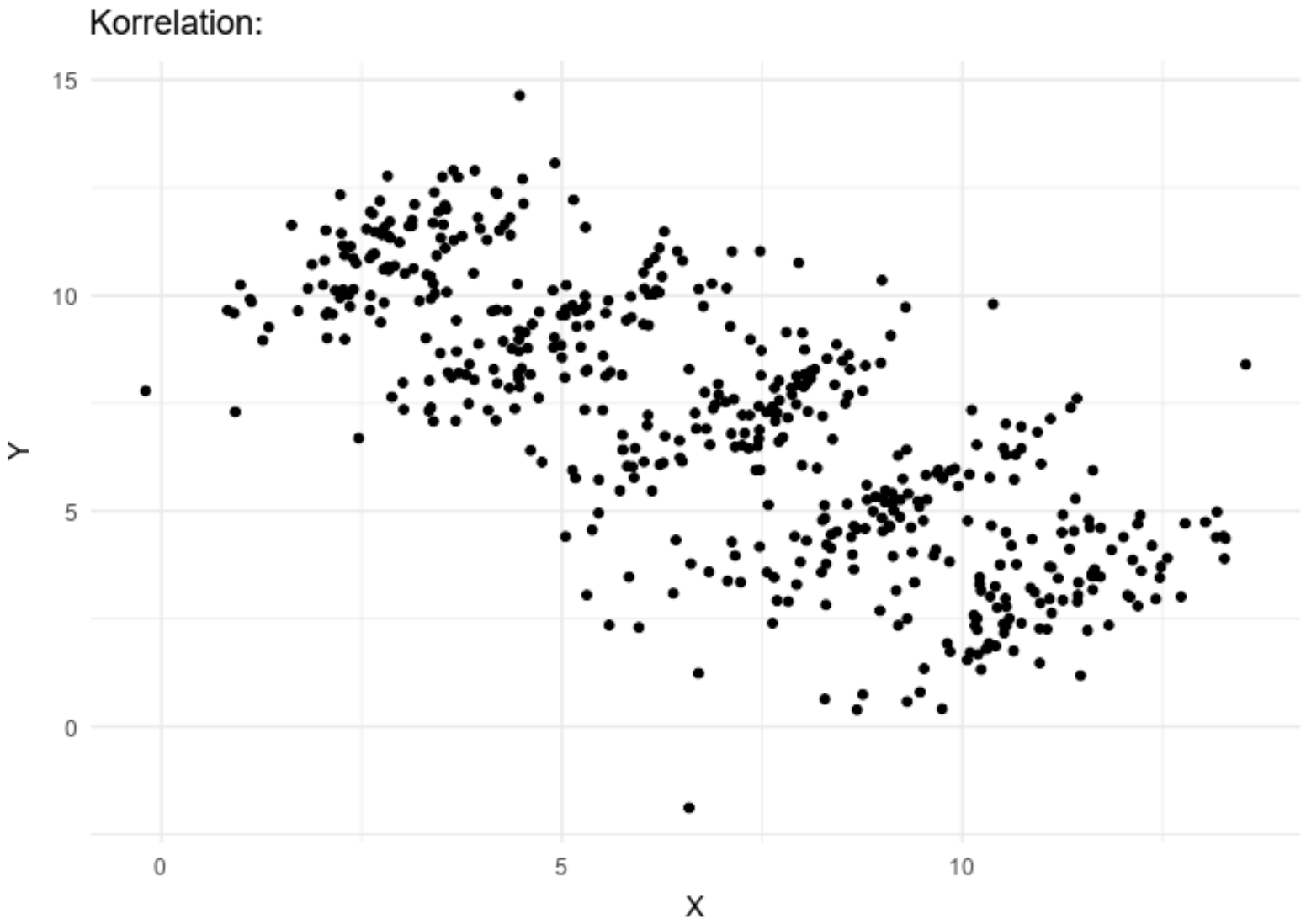
Simpson: vector interpretation



Simpson paradox

a trend appears in several different groups of data but disappears or reverses when these groups are combined




Korrelation:
15
10
5
0
Y
0
5
10
X