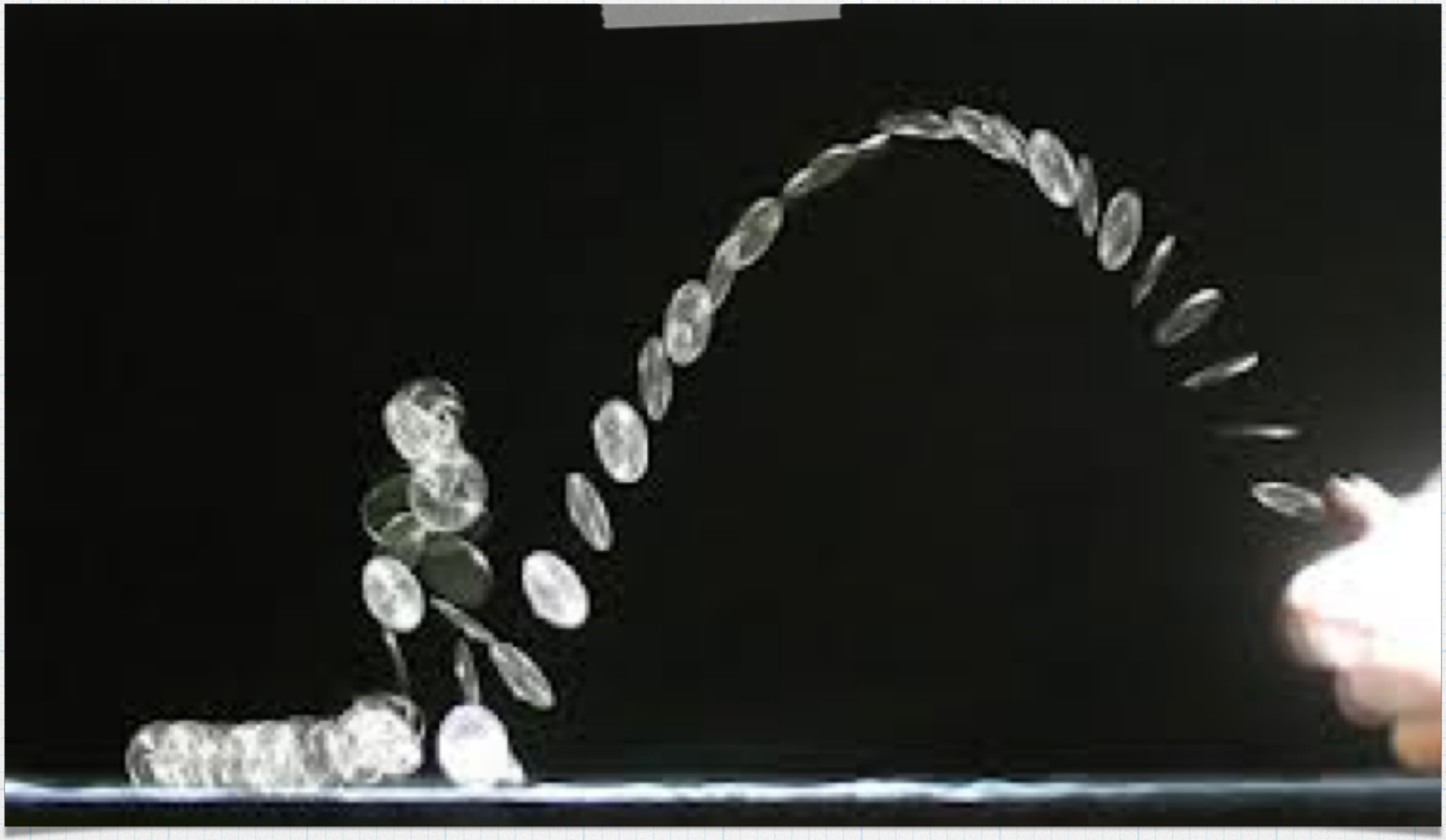
Randomness & Randomization

Randomization: lost in translation?

* Definition of random "azar" (according to the dictionary of the RAE):
  * Casualidad
  * Caso fortuito
  * Desgracia imprevista

Randomization: lost in translation?

* Definition of random "aleatorio" (according to the dictionary of the RAE):
  * Relativo al juego de azar
  * Que depende del azar

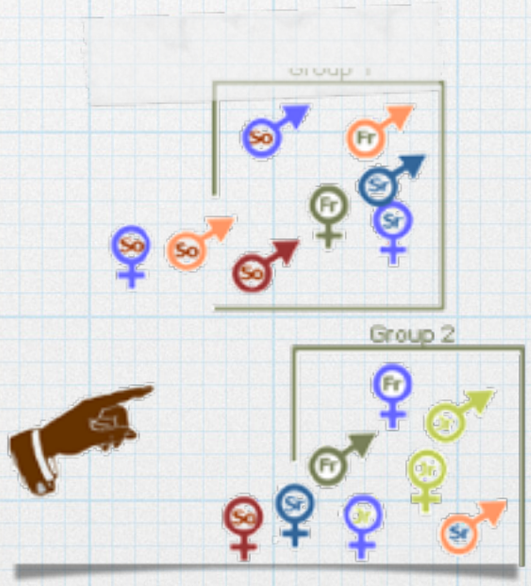


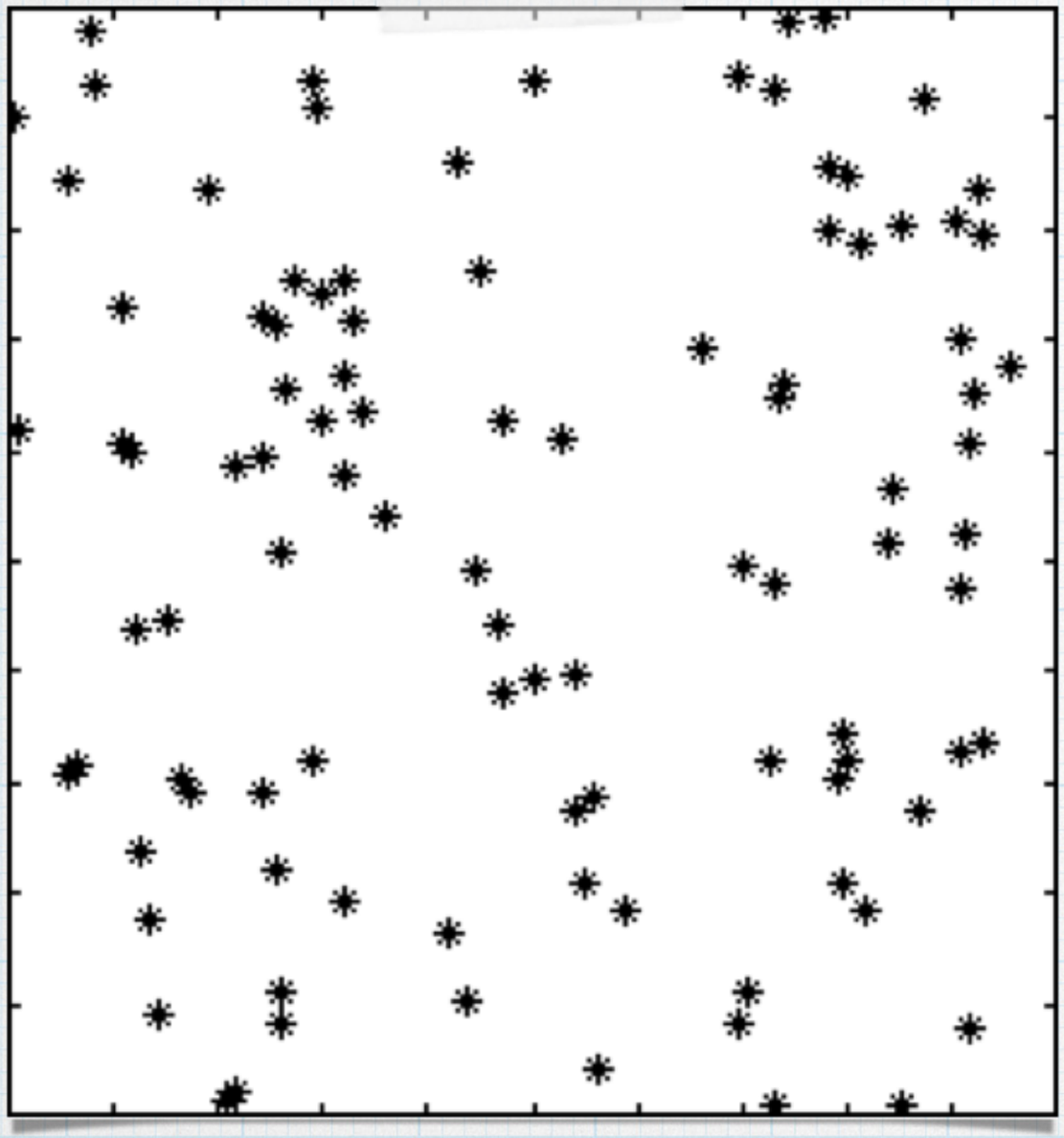
Flip a coin 10x

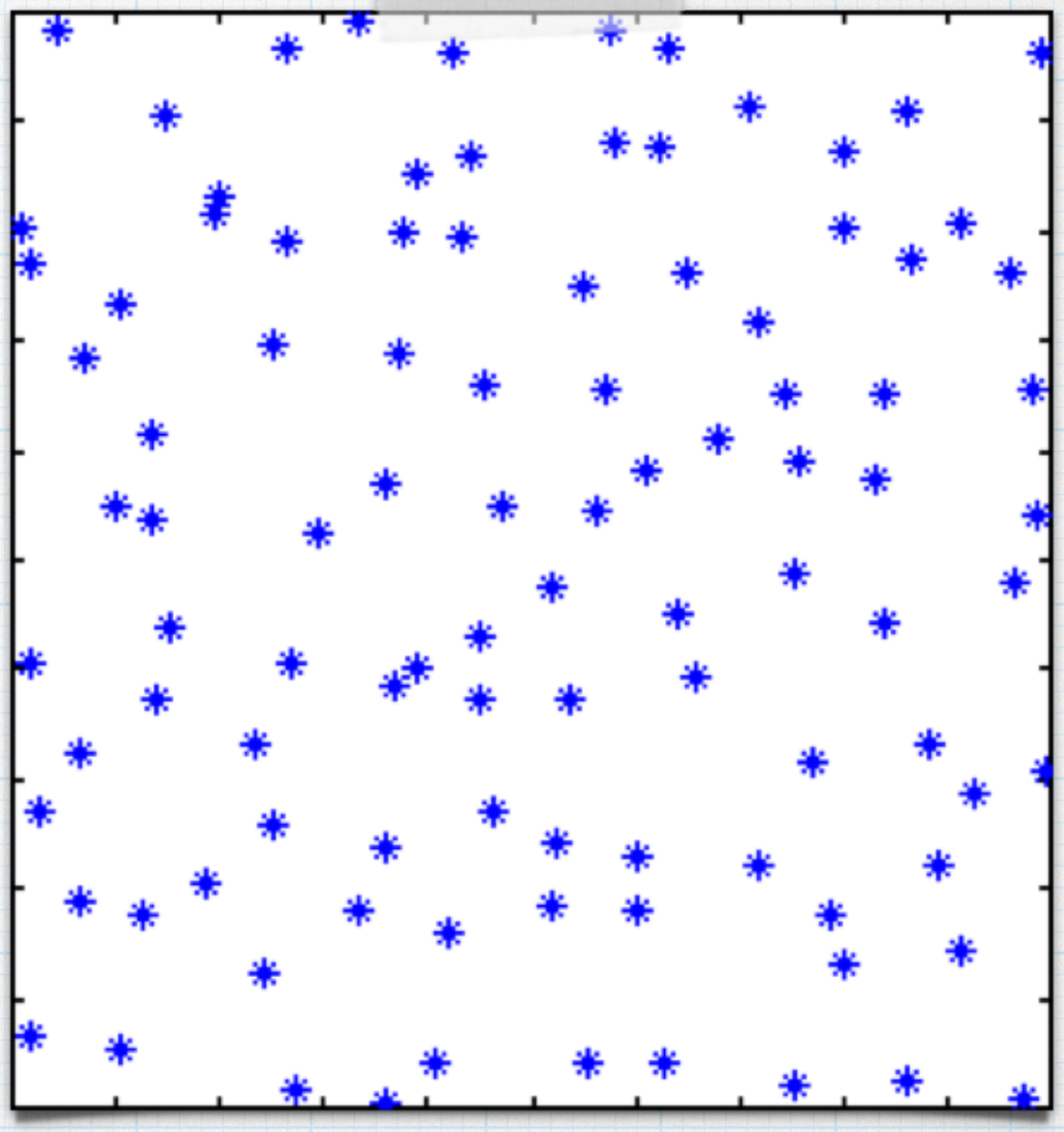
Random Sampling vs. Random Assignment

* Random sampling: selecting from a population with equal probability

* Random assignment: assigning subjects at random to experimental conditions







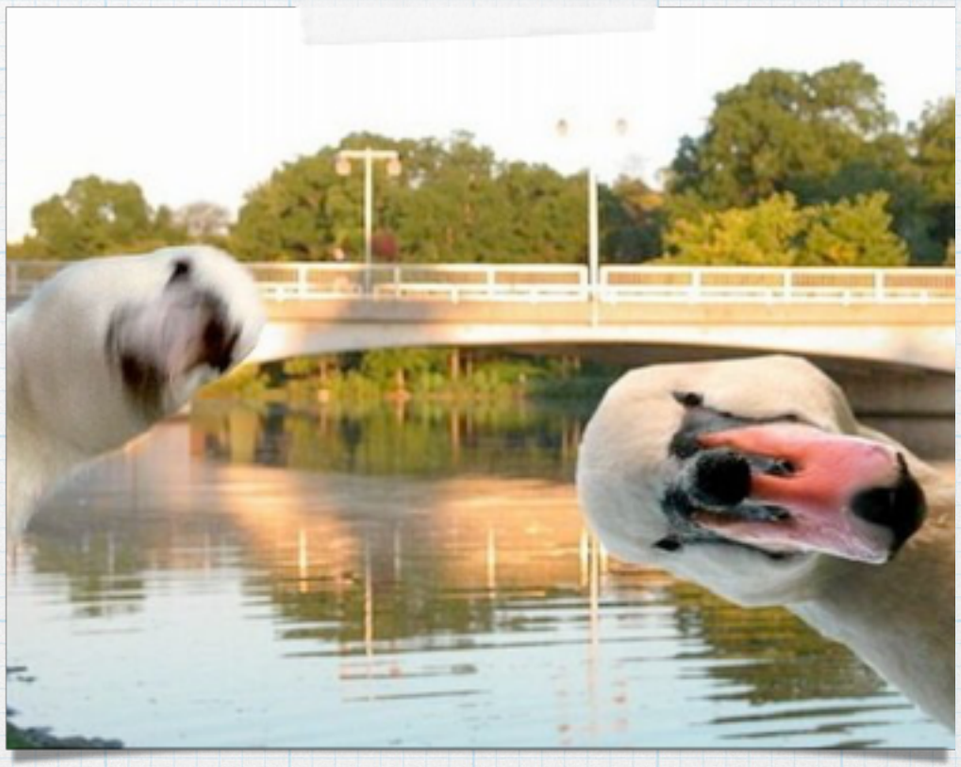
Which is Random?

> rbinom(100,size=1,p=.5)

1 0 1 0 1 0 1 0 0 0 1 0 0 0 1 1 0 0 0 1 0 0 0 0 1 0 1 1 0 1 0 1 0 1 1 0 1
0 0 0 0 1 0 1 0 0 0 1 0 0 0 1 0 1 0 **1 1 1 1 1 1 1 1 1 1** 0 0 1 0 1 0 0 0 1
0 0 0 1 1 1 0 1 0 0 1 0 0 0 1 1 0 0 1 1 1 1 0 0 0 0

How Can Randomization Reveal Causality?

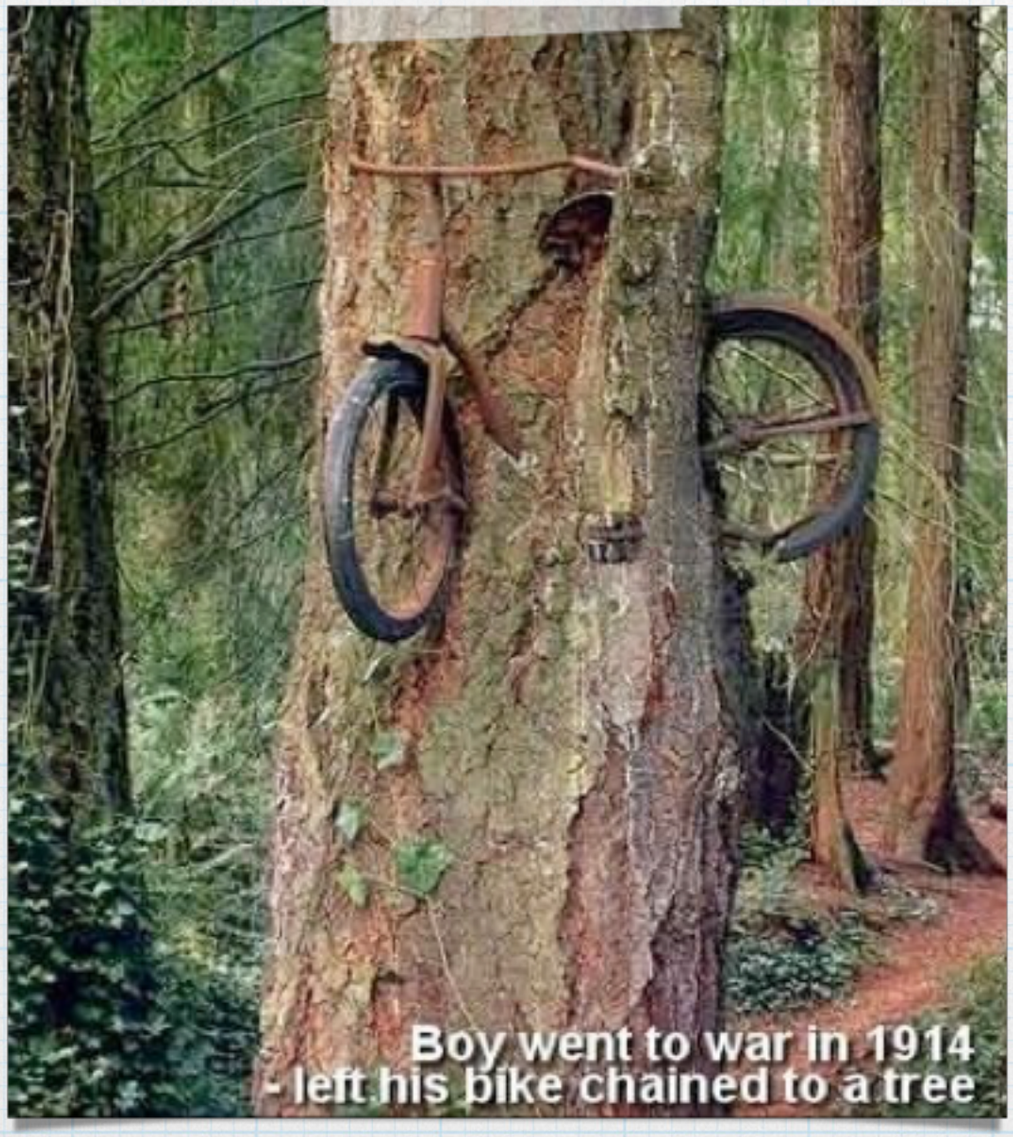
* Treatment & Control Groups are, in expectation, identical on average



Strict Definition of Random Assignment

* Every observation must have the same probability of being placed in the treatment group.

Random Assignment to Relevant Units



* Individuals, groups, institutions, periods of time...or many potential levels.

* Choice of analytic level determines what the study has the capacity to demonstrate.

* Example: randomize school vouchers at the level of the individual or at the level of the community? Do we want to know how students respond to new environment or how schools respond to competition?

* What kind of control group? Importance of placebo control groups in medicine.

Randomization

* Ways to do it:
  * Simple
  * Cluster
  * Block
  * Factorial
  * With a computer in advance

Basic Randomization

Gender	Random n	Rank	Select?
F	0.1011	7	1
F	0.3943	5	1
F	0.6757	3	0
F	0.0184	8	1
M	0.2660	6	1
M	0.9889	1	0
M	0.7971	2	0
M	0.5499	4	0
Average			0.5

Done by computer

Simply give a random number to each of *N* units

Then select the *T* units with the highest random number

Cluster Randomization

* Use if:
  * Intervention has to function at the cluster level, or
  * Outcome defined at the cluster level
* Disadvantage: loss of statistical power
* However: perfectly possible to assign SOME treatments at cluster level and then OTHER treatments at the individual level
* Principle: (unless you are worried about spillovers) generally make clusters as small as possible

Cluster Randomization

City	Cluster	Random n	Rank	Select?
A	1	0.1993	3	1
A	1			1
B	2	0.3836	2	0
B	2			0
C	3	0.1247	4	1
C	3			1
D	4	0.4267	1	0
D	4			0
Average				0.5

Done by computer

Simply give a random number to each of *N* CLUSTERS

Then select the *T* CLUSTERS with the highest random number

Blocking

* Randomization helps ensure good balance on all covariates (observed and unobserved) in expectation

* But balance may not be so great in realization

* Blocking can help ensure balance ex post on observables

* Ensures equal numbers of control and treatment units for each block

Blocking in Practice

Gender	Block	Random number	Rank	Select?
F	1	0.1378	4	1
F	1	0.4557	3	1
F	1	0.4660	2	0
F	1	0.7909	1	0
M	2	0.9317	1	0
M	2	0.2312	4	1
M	2	0.3993	3	1
M	2	0.9291	2	0
Average				0.5

Factorial Design

* Factorial design enables testing of more than one treatment
* Does not reduce statistical power
* Can alter interpretation of results

	T2=0	T2=1
T1=0	25%	25%
T1=1	25%	25%

Factorial design in Practice

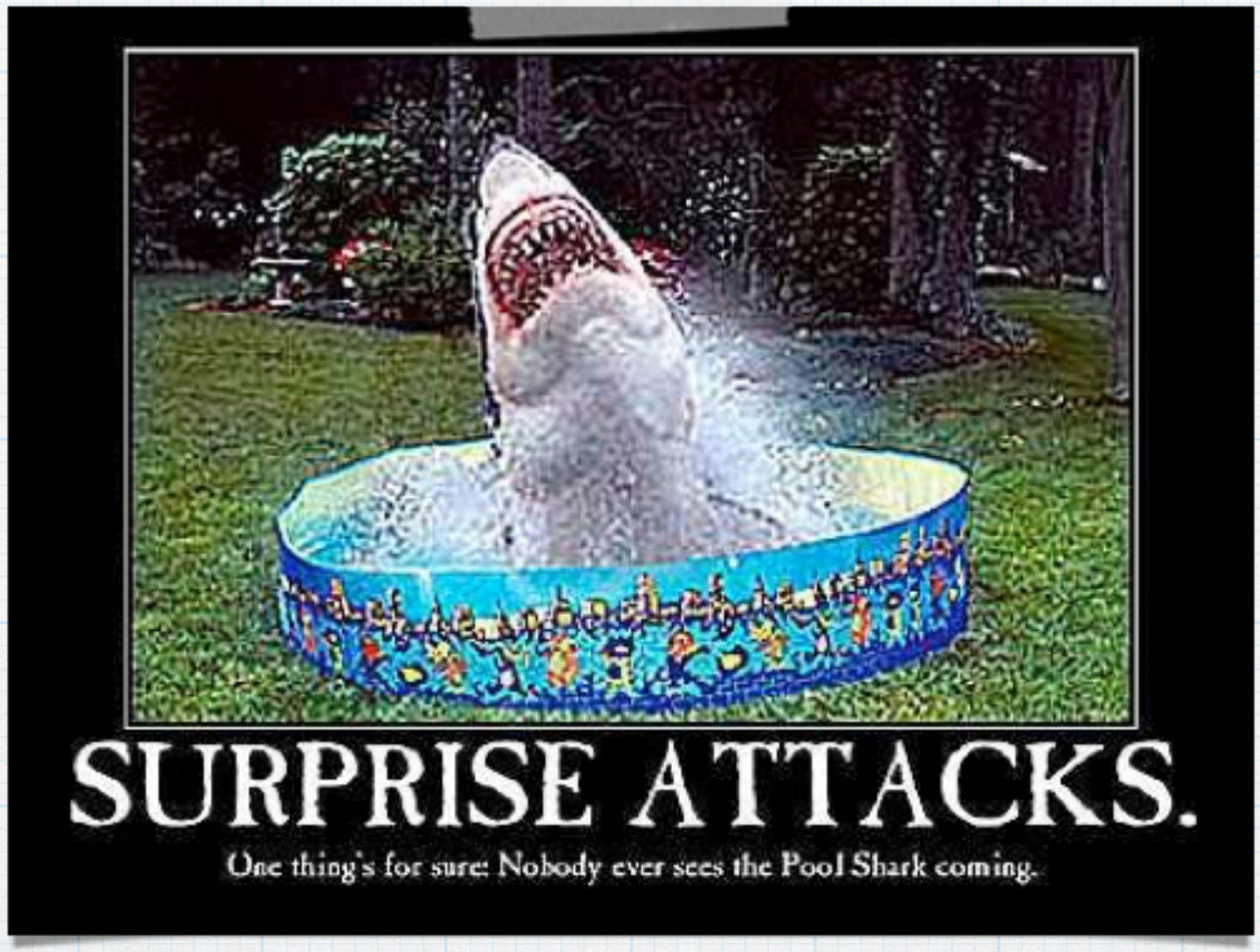
Gender	Block	Random n	Rank	T1	T2
F	1	0.0444	4	1	1
F	1	0.8061	2	0	1
F	1	0.0660	3	1	0
F	1	0.9680	1	0	0
M	2	0.5482	2	0	1
M	2	0.9003	1	0	0
M	2	0.0784	4	1	1
M	2	0.2565	3	1	0
Average				0.5	0.5

Good Practice

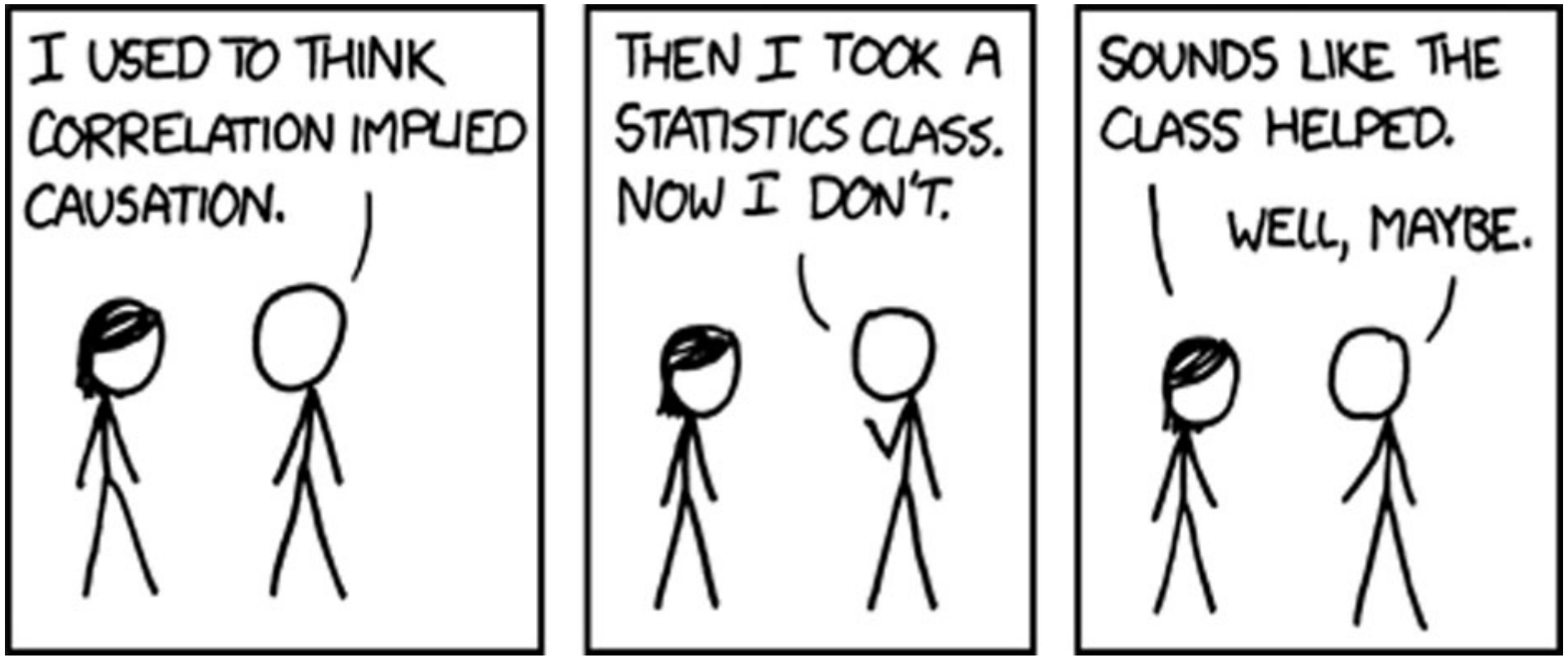
* Replicable - Set a seed!
* Preserve distributions
* Verify

Did Randomization Work?

* Common practice is to implement a set of t tests to see if there is balance
* But this makes no sense
* Randomization always works if implemented properly
* If you doubt whether it was implemented properly, do an F test
* If you worry about variance specify controls in advance as a function of relation with OUTCOME

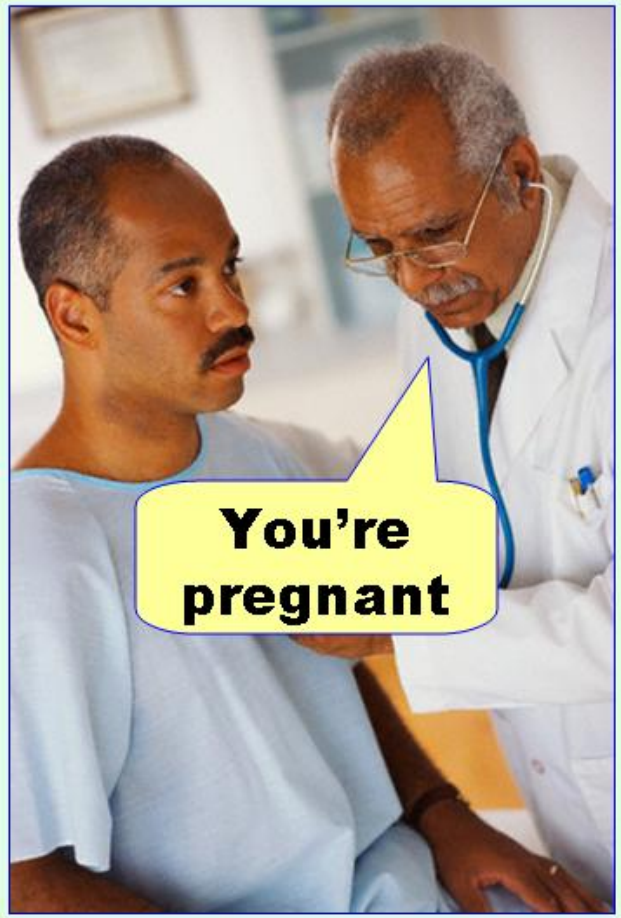


What Can Go Wrong with Randomization?


I USED TO THINK CORRELATION IMPLIED CAUSATION.
THEN I TOOK A STATISTICS CLASS. NOW I DON'T.
SOUNDS LIKE THE CLASS HELPED.
WELL, MAYBE.

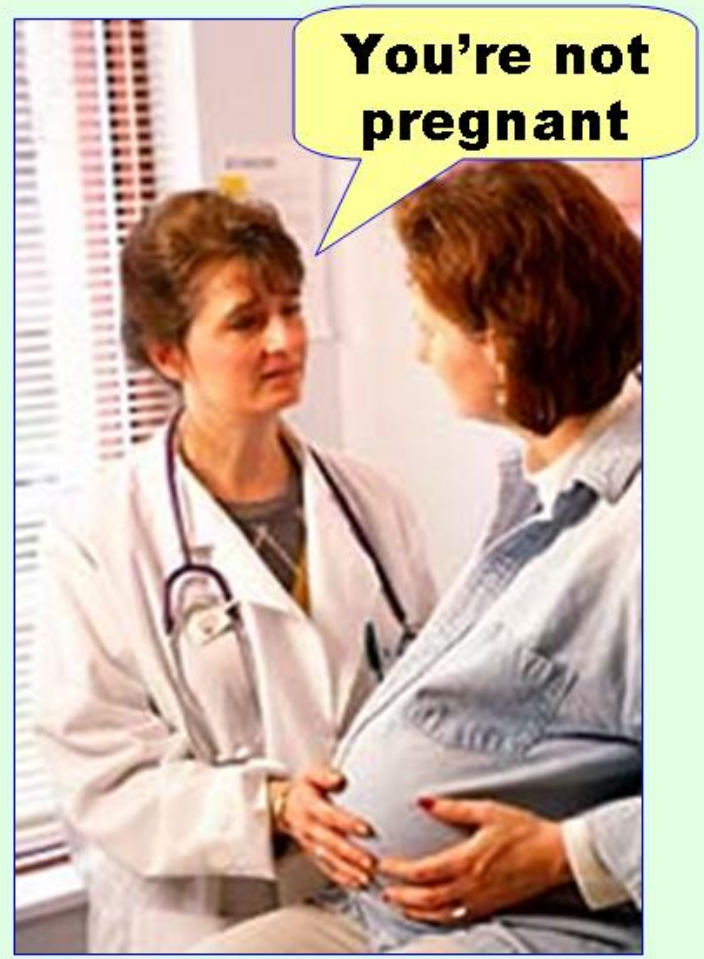
Type I error

(false positive)



Type II error

(false negative)



Nine Limitation of Randomization (?)

1. Ethics – is this sort of manipulation ethical? Sometimes not (parachutes)
2. The *real time* constraint. Sometimes to slow. Not much good to help understand history
3. History has happened
4. The problem of cost (sometimes; but possible very low)
5. The power constraint. You need a lot of units
   (actually: a problem for any statistical approaches)
6. External validity (problem for any evaluation)
7. The problem of spillovers, attrition, compliance, demand (problem for any evaluation)
8. The *variables as attributes* constraint (gender, ethnicity, problem for any evaluation)
9. The *assignment to treatment* constraint.
10. Reduced Flexibility for organization (problem for any prospective evaluation)