Why Experiments?

Experimental Research

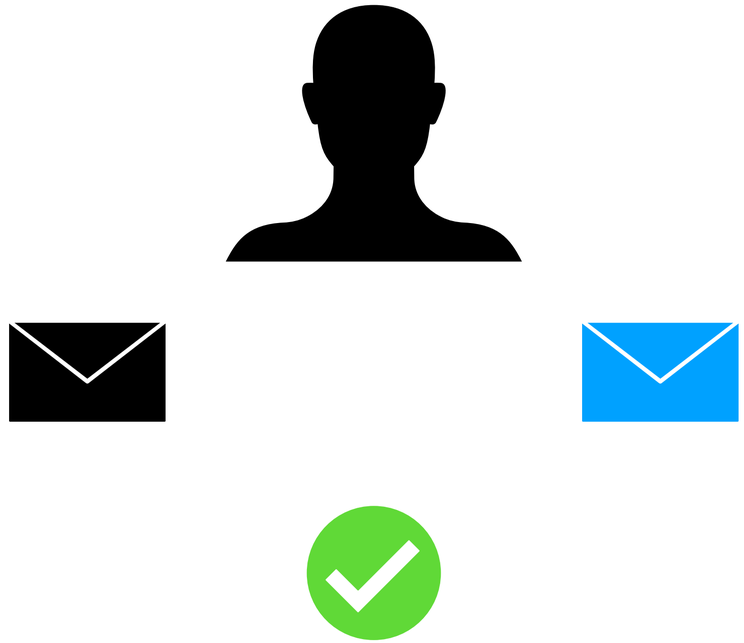
Prof. Yamil Velez (9/8/22)

Defining experiments

- Experimental research is a method of social scientific inquiry that stresses the importance of randomization in uncovering relationships between variables
- Most important concept: **random assignment**
  - By chance, units are assigned to different conditions or interventions and outcomes are measured
  - Units can be people, avocados, browser tabs
  - Chance: non-deterministic assignment
- Experiments can be used to study whether people are persuaded by certain kinds of messages, how communities respond to different programs, whether a new medication works, etc.

Defining experiments

- Two-arm experiment example
- Units: People
- Conditions: ~Reminder; Reminder
- Outcome: Turnout



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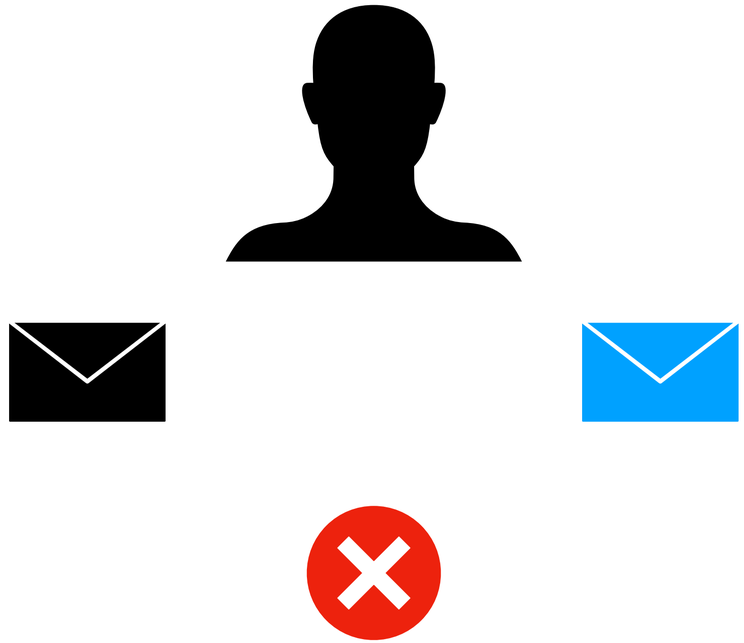

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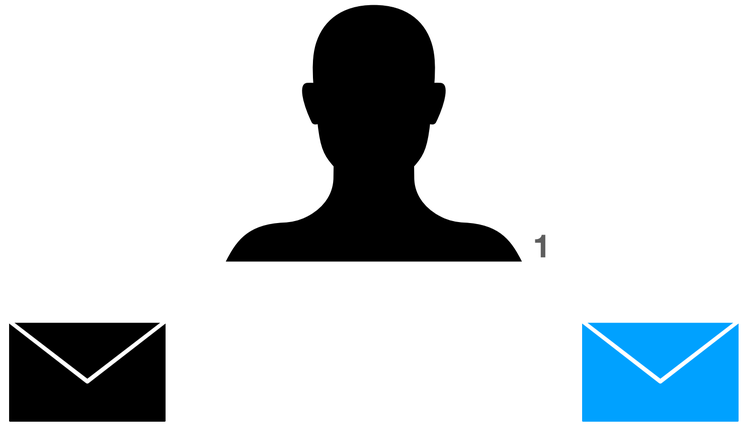

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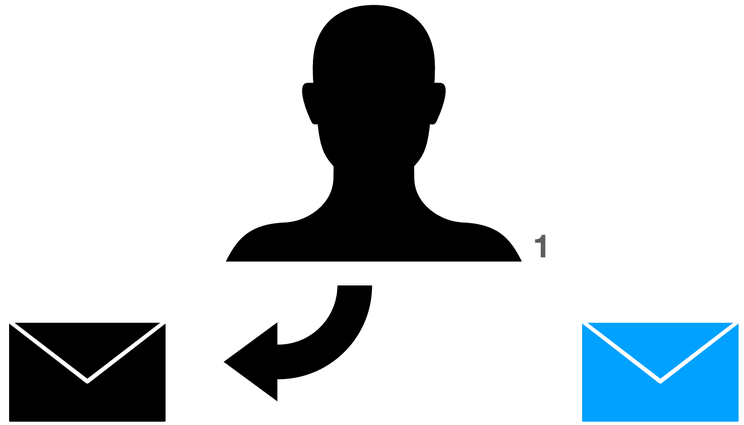

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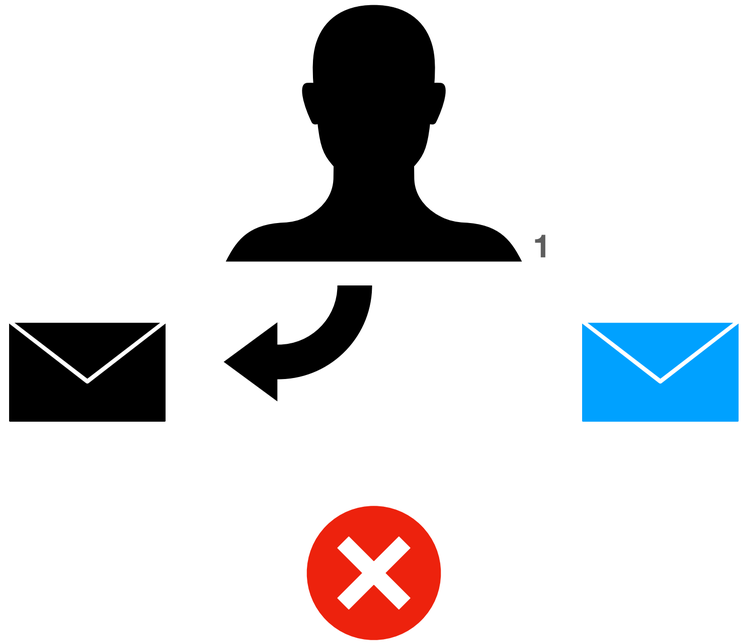

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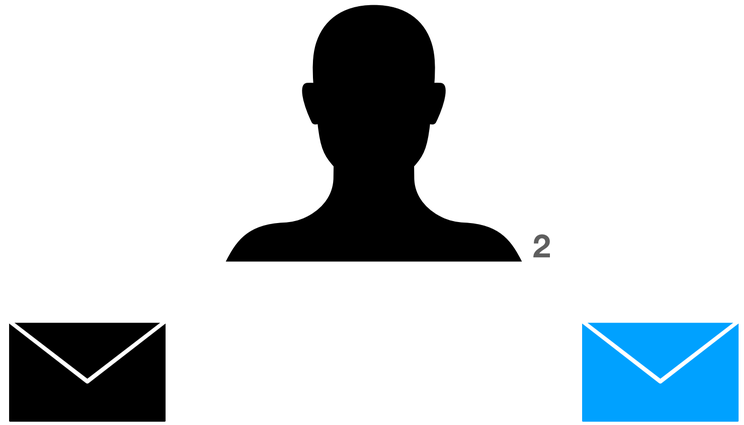

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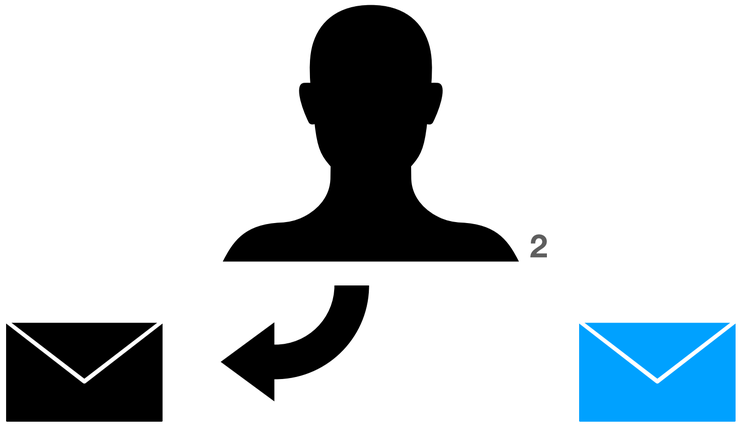

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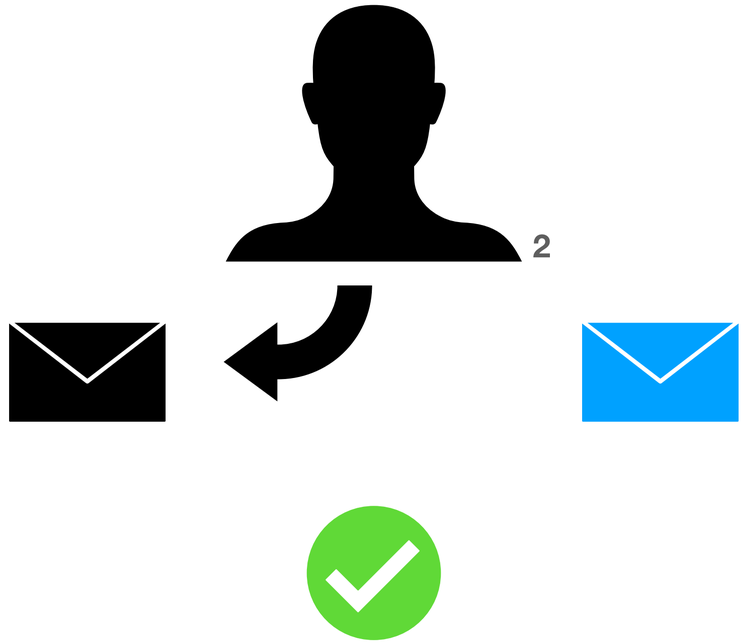

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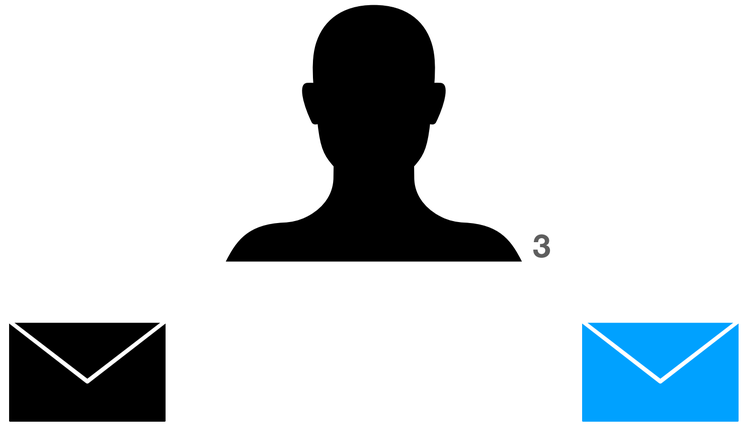

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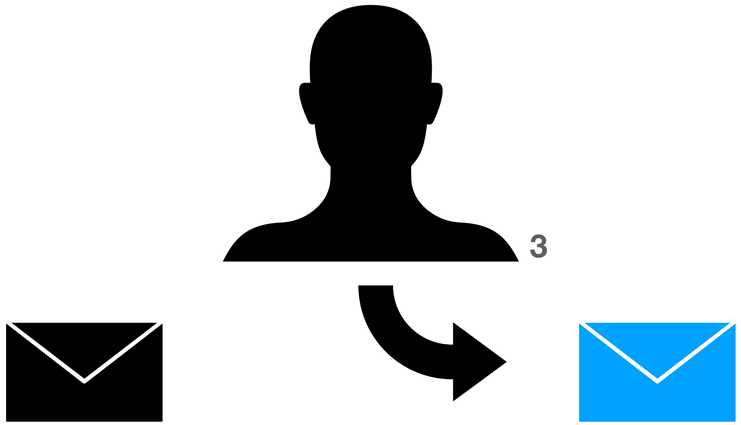

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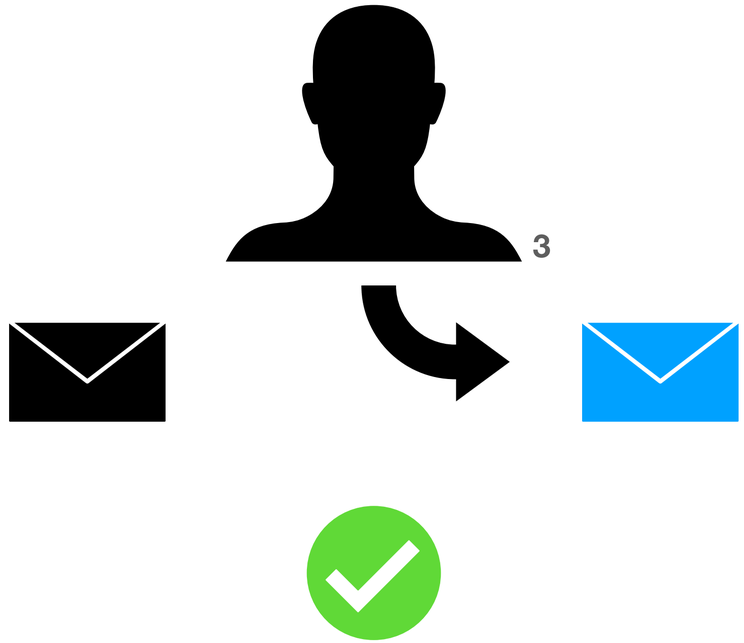

Why are we flipping coins to analyze political outcomes?

Primary goals of social science

- **Description**
  - Obtaining accurate counts of quantities
    - How many legislators in the New York State legislature?
    - What percentage of YouTube videos are political?
    - How many bills in Congress are about the environment?
- **Prediction**
  - Imputing unseen outcomes using observable data
    - Will Republicans or Democrats control the Senate?
    - Will Russia leave Ukraine?
- **Causation**
  - Understanding causal relationships between concepts
    - Does anger make people more likely to participate in politics?

Defining causality

- **Definitions**
  - How would you define causation?
    - Perfect correlation
      - The presence of X is *always* associated with Y
      - Law-like behavior
    - Temporal ordering
      - Y is always preceded by X
  - What are some possible issues with these definitions?
- **Neyman-Rubin causal model definition**
  - Causality is the comparison of actual and counterfactual states of the world

Neyman-Rubin Causal Model

- Key concepts
  - Treatments
    - Interventions, independent variables, causes
  - Units
    - People, communities, avocados
  - Potential outcomes
    - Outcomes observed under different treatment assignments (or states of the world)
- Notation
  - i represents each unit (or observation)
  - T represents treatment (one value for each condition or level)
  - Y represents the outcome
  - Potential outcomes
    - Possible outcomes observed under different states of the world
  - τ represents the difference in potential outcomes between one state of the world and another state of the world

Neyman-Rubin Causal Model

$$\tau_i = Y_i(T_i = 1) - Y_i(T_i = 0)$$

Neyman-Rubin Causal Model

$$\tau_i = Y_i(1) - Y_i(0)$$

Neyman-Rubin Causal Model

$$\tau_i = Y_i(1) - Y_i(0)$$

outcome for unit *i* when assigned to treatment

outcome for unit *i* when assigned to control

Neyman-Rubin Causal Model

$$\tau_i = Y_i(1) - Y_i(0)$$

individual treatment effect

outcome for unit *i* when assigned to treatment

outcome for unit *i* when assigned to control

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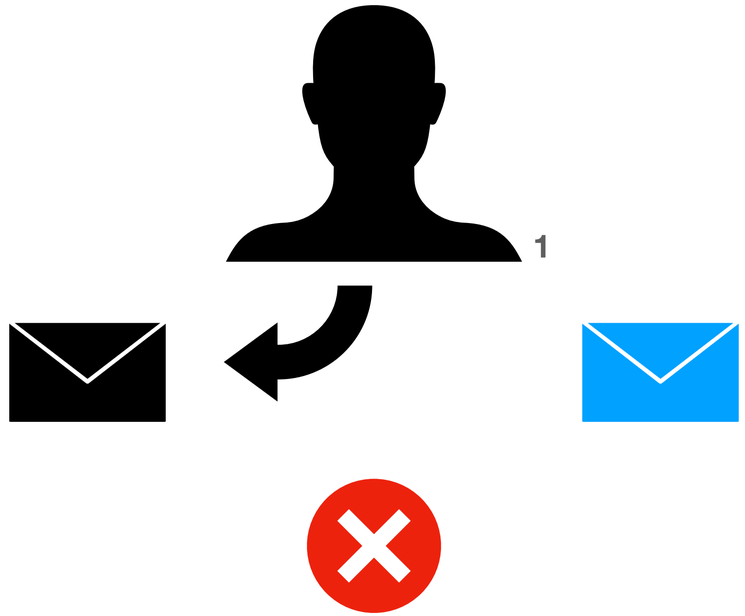

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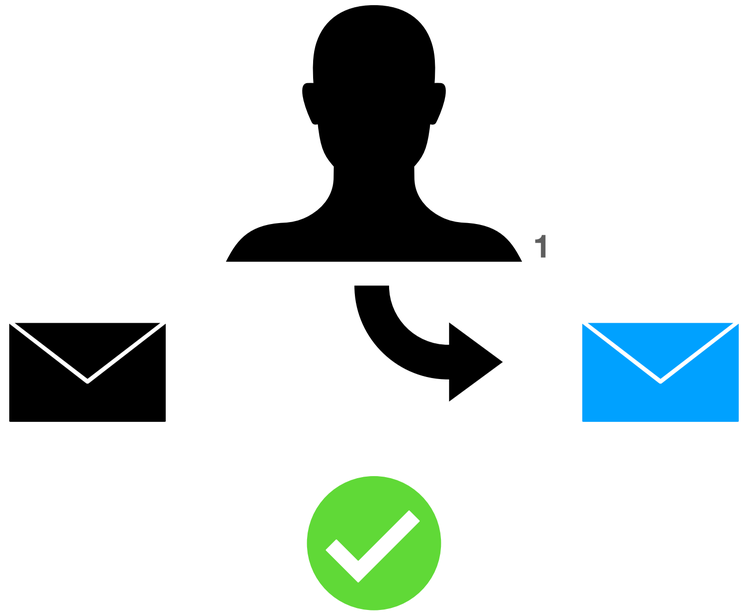


Neyman-Rubin Causal Model

$$\tau_i = Y_i(1) - Y_i(0)$$

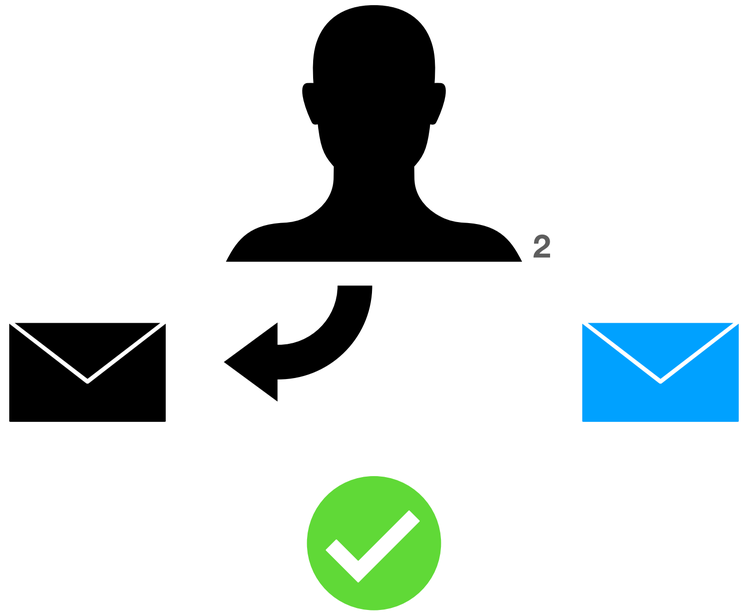
individual treatment effect

outcome for unit *i* when assigned to treatment

outcome for unit *i* when assigned to control

$$\tau_1 = 1 - 0$$

Neyman-Rubin Causal Model



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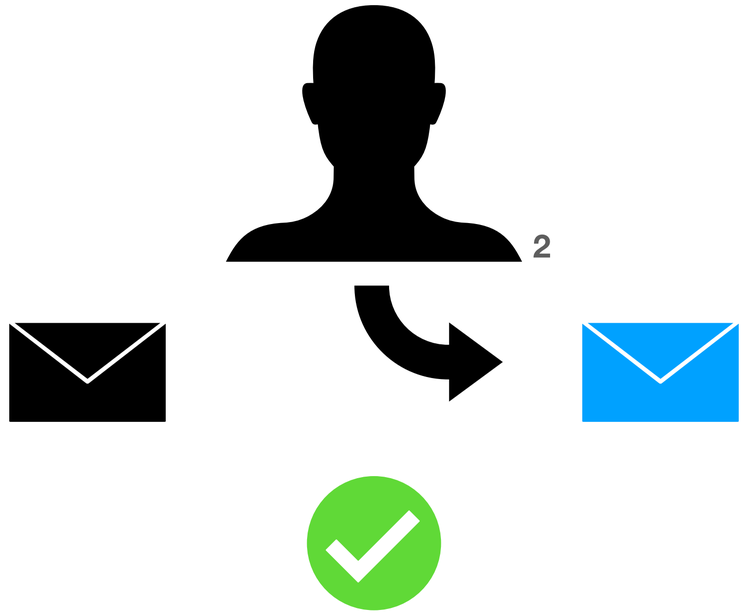


Neyman-Rubin Causal Model

$$\tau_i = Y_i(1) - Y_i(0)$$

individual treatment effect

outcome for unit *i* when assigned to treatment

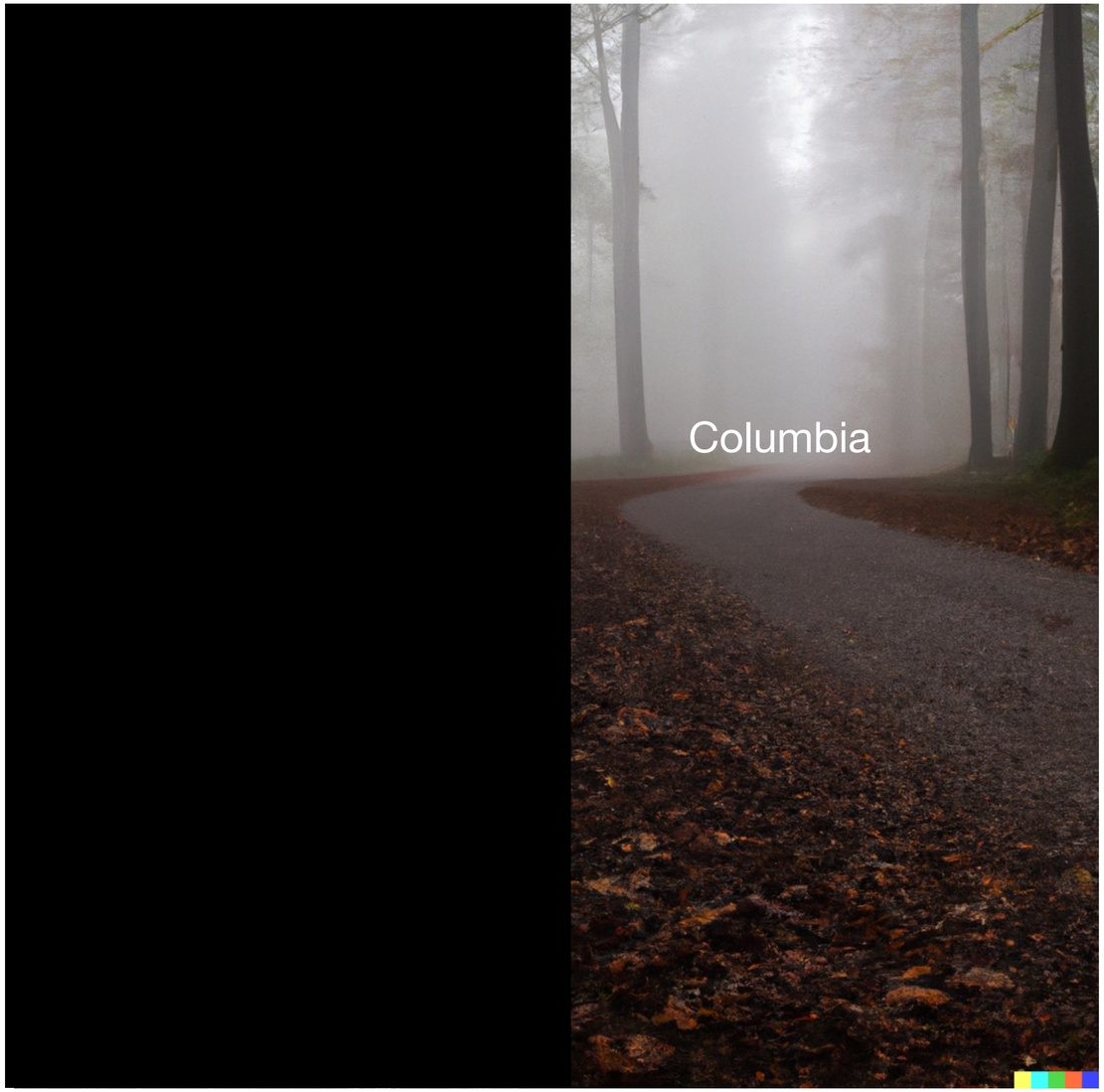
outcome for unit *i* when assigned to control

$$\tau_2 = 1 - 1$$

Neyman-Rubin Causal Model

	$Y_i(1)$	$Y_i(0)$	T_i	τ_i
1	1	0	1	1
2	1	1	0	0
3	0	0	0	0
4	0	1	1	-1


~Columbia
Columbia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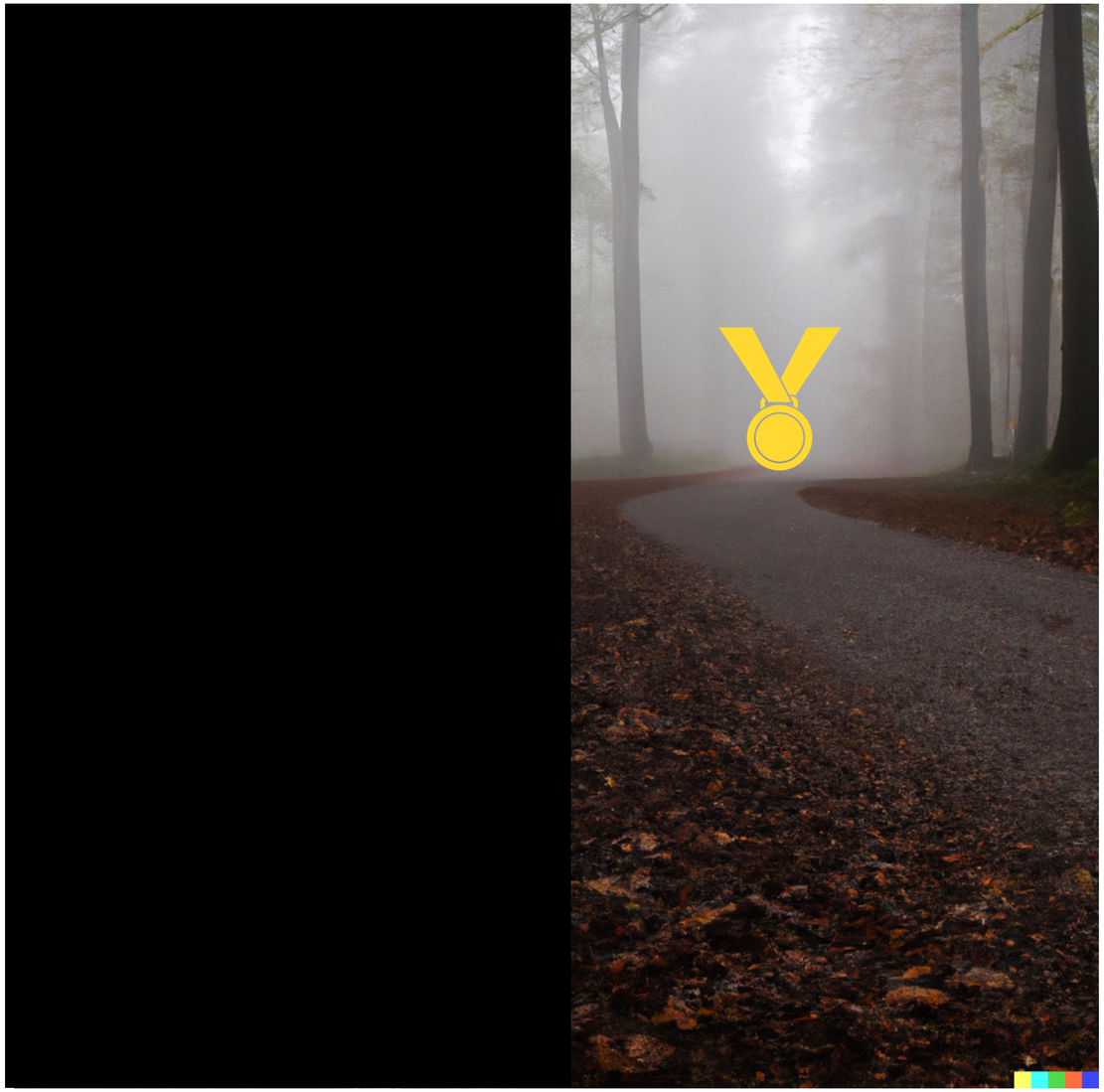

Fundamental problem of causal inference

Neyman-Rubin Causal Model

	$Y_i(1)$	$Y_i(0)$	T_i	τ_i
1	1	?	1	?
2	?	1	0	?
3	?	0	0	?
4	0	?	1	?

Assignment

- Submit a hypothetical experiment (on any topic)
- What are the units?
- What is the treatment? (Two conditions)
- What is the outcome?
- Create two potential outcomes tables for 4 units
  - Potential outcomes
  - Observable outcomes
    - Randomly assign the “units” to different conditions
    - Erase the potential outcomes for non-assigned condition