Personalization

Goals

- Overall: Help us be more intentional about personalization systems we design
- Introduce a framework for creating automated personalization projects
- Work on a personalization project that you care about
- Practice these projects on a few data sets
- Work on a project using the LASI Dataset

Framework

- **Narrative Model**: Dinner party version of your personalization model or theory

- **Operational Model**: What you count and how you count it

- **Validation Model**: Convincing yourself you are right

Plan

<u>Day 1</u>

- Definitions…
- Narrative Models
- Operational Models
- Choose your own adventure

<u>Day 2</u>

- Validation Models
- Presentations

In the News

EDUCATION WEEK

Gates, Zuckerberg Philanthropies Team Up on Personalized Learning

TIME | U.S.

Why Mark Zuckerberg Wants to Spend on Personalized Learning

The Washington Post
Democracy Dies in Darkness

A primer for Mark Zuckerberg on personalized learning — by Harvard's Howard Gardner

Smithsonian.com

Is Artificial Intelligence the Key to Personalized Education?

USA TODAY

Is personalized learning the future? This high school thinks so.

Chalkbeat
Education news. In context.

As ed reformers urge a 'big bet' on personalized learning, research points to potential rewards — and risks

Forbes

Transforming Education, One Student At A Time

EdTech
Focus On K-12

IBM and Sesame Workshop Aim to Personalize Learning for Preschoolers

Exercise 1: Define These Terms (without Googling)

- Personalization:
- Differentiation:
- Individualization:
- Adaptivity:

Best Definition

Student

Magic

Better Student

Definitionally True

If we provide what the student needs, when they need it, they will learn better

The success of education depends on adapting teaching to individual differences among learners

329 BC, Xue Ji

"Uniformity is the curse of American schools...Individual instruction is the new ideal."

Charles Eliot, 1899

Vocabulary

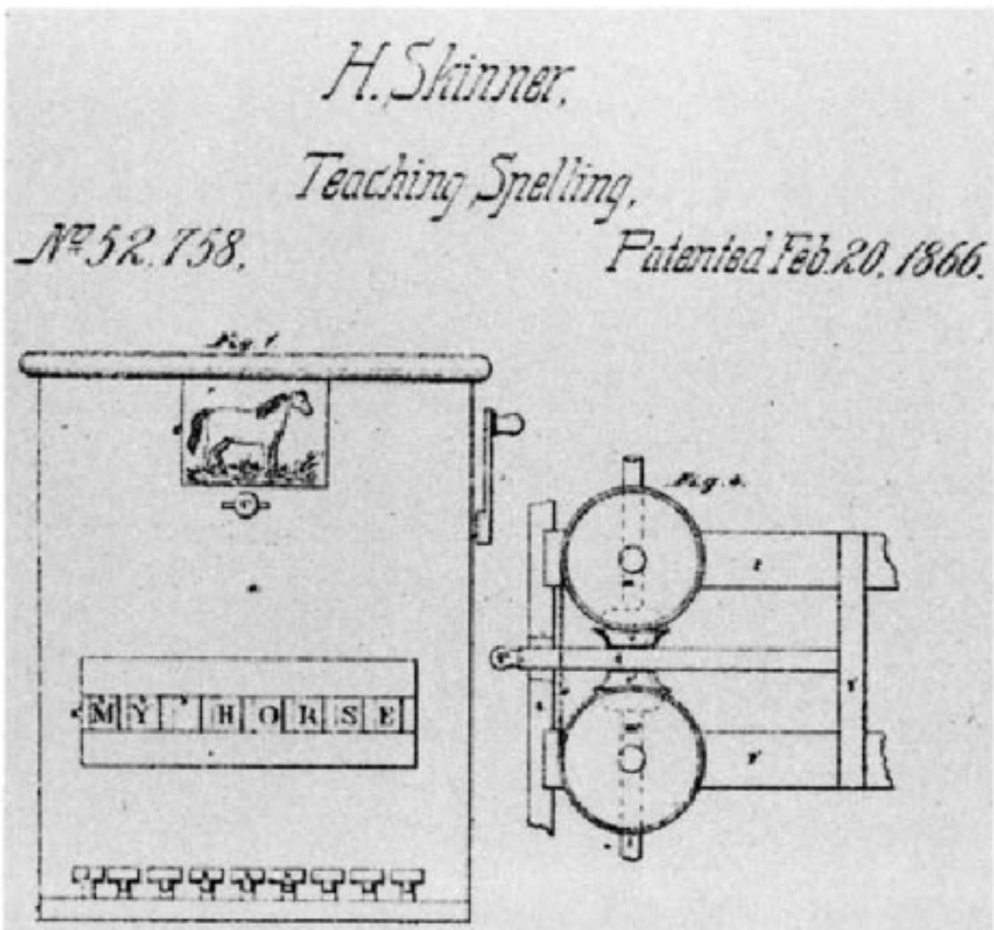
Individualization: learning goals are the same for all students, but students can progress through the material at different speeds

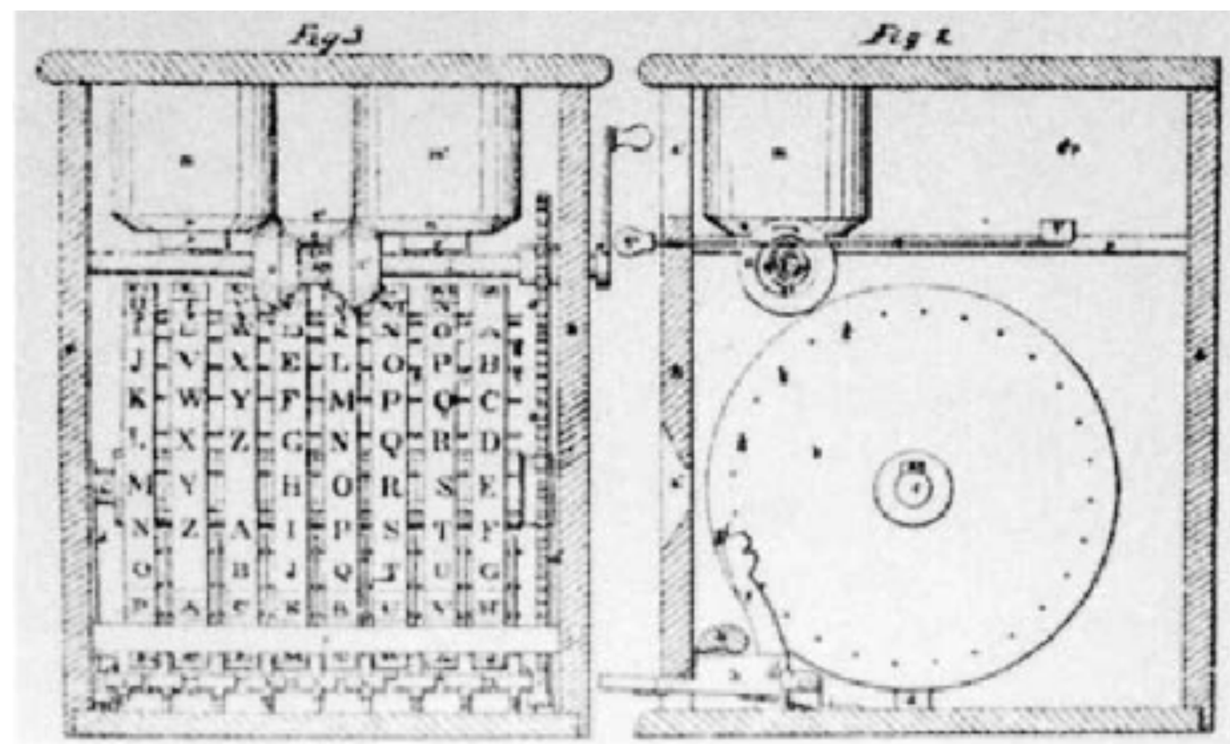
Differentiation: learning goals are the same for all students, but the method or approach of instruction varies according to the preferences of each student

Personalization: learning goals and content as well as the method and pace may all vary (so personalization encompasses differentiation and individualization)

ed.gov (2010)

Teaching Machines





Teaching Machines

- Automatic or self-controlling device
- Presents a unit of information
- Provides some means for the learner to respond to the information
- Provides feedback about the correctness of the learner's responses

Skinner's Teaching Machines

(Benjamin, 1988)

Intelligent Tutoring Systems

- Simulate a human tutor
- Interpret complex behavior
- Respond differently to different students
- Offer hints
- (Learn from the student)

Adaptive

- Originally = assistive
- ~1990s = sequential estimate of aptitude (IRT)
- ~2012 = a system that adapts the educational environment according to students' learning needs
- Distinct from Cognitive Tutors in terms of methods employed
- A Cognitive Tutor built in San Francisco

Adaptive Systems

NETFLIX

amazon.com

PANDORA

last.fm

hulu

Linkedin

Adaptive Engines

KNEWTON

Grockit

prepme

KAPLAN

gymglish

adapt courseware

Recommender Systems

Collaborative filter: build a model from a user's past behavior + similar decisions made by other users

Content filter: utilize a series of discrete characteristics of an item in order to recommend additional items with similar properties

Definitions

- Must involve **time** (or at least two time points)
- Make inferences about **relevant groups** or **individuals**
- Requires a **defined goal/standard**
- Inherently **causal**
- **Automate**

Personalization/Differentiation/ Individualization

Underlying characteristic (for quant models):

Make probability statements about individual students

Underlying problem:

Students are bound by the arrow of time - they can only do any task once under the exact same conditions

Framework

- **Narrative Model**: Dinner party version of your personalization model or theory
- **Operational Model**: What you count and how you count it
- **Validation Model**: Convincing yourself there is a connection between your narrative and operational models

Narrative Model

If we alter the **environment by W**, for **subgroup X**, then **learner Y** will do **Z**

If learner X does Y in environment W, they get result Z (vs. Z’)

Exercise 2: Devise an Example

Take five minutes to invent a personalization example and write the narrative model

Narrative Model

Things **you cannot** change (or would be foolish to try)

Student history, demographics, contextual factors

Things **you could** change but **won't**

Admissions, game engine, UX

Things **you can** change

Content: Domain map
Approach: Compliance
Context: UX design

Action

Level up, email notification, content mode

Things **you want** to change

Target
Goals: critical thinking, understand algebra
Objectives: summarize pros and cons of school funding through land taxes, apply order of operations rules

Trigger: LMS logins, task completion, personality trait, assignment not submitted

Narrative Model

Cannot change	Can change	Want to change
	Action	Trigger/Target
incoming student study habits	email deadline reminders	student logins meet deadline
incoming student knowledge	content	understanding progress
student anxiety	content difficulty	correctness

Exercise 3: Categorize the aspects of your example into:

- Cannot change
- Can change
- Want to change

Narrative Model

Action Trigger

If we alter the **environment by W**, for **subgroup X**, then **student Y** will do **Z**

Target

If we **send email deadline reminders** to **students who do not login** then **those students** will **hand in their assignments on time**

Exercise 4: Convert your example into the following form:

If we alter the **environment by W**, for **subgroup X**, then **student Y** will do **Z**

Narrative Model

Part theory, part causal model, part guess

If you put “if” in front of it, this is the hypothesis that you are continuously testing

In what way does the narrative model matter?

Operational Model

Operational Model

What are you counting?

Cannot change	Can change	Want to change
	Action	Trigger/Target
incoming student study habits - student demographics - previous courses - previous LMS use	email deadline reminders - send/not send - time sent	student logins meet deadline - logins - submissions - timestamp - grades - completion

Exercise 5: Define what you are counting

Operational Model

What variation are you mining?

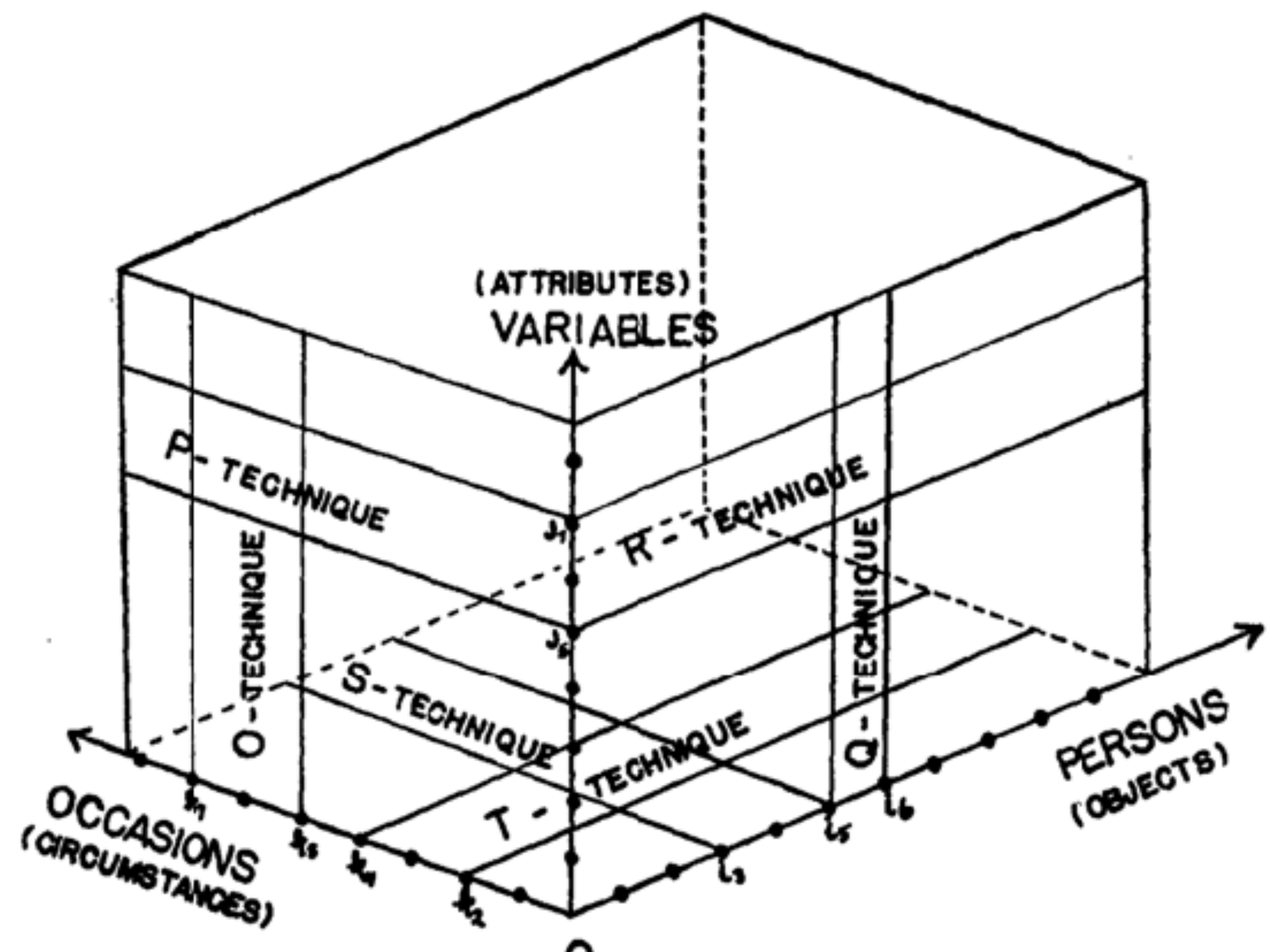


FIG. 1. THE COVARIATION CHART

Cattell, 1952

Exercise 6: Variation

Questions to ask:

- On what planes is the variation?
- What comparisons are available?
- What **relevant information** is available in that variation that we can draw **inferences** about **triggers** from?

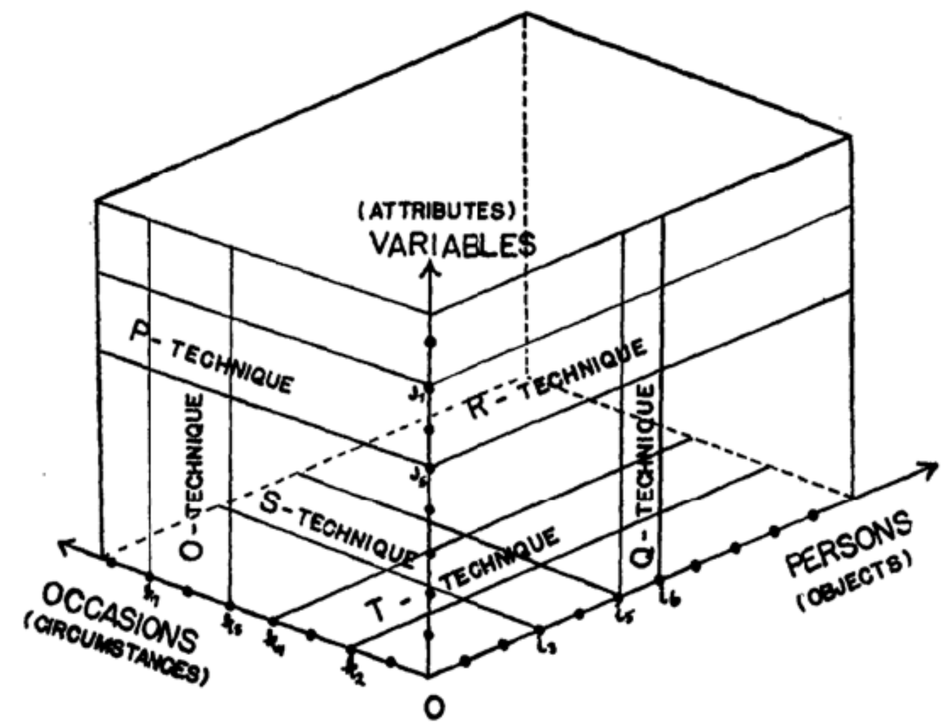


Fig. 1. The Covariation Chart

Operational Model

- How are you making meaning from that variation?
- What is the trigger?
- What is the action?

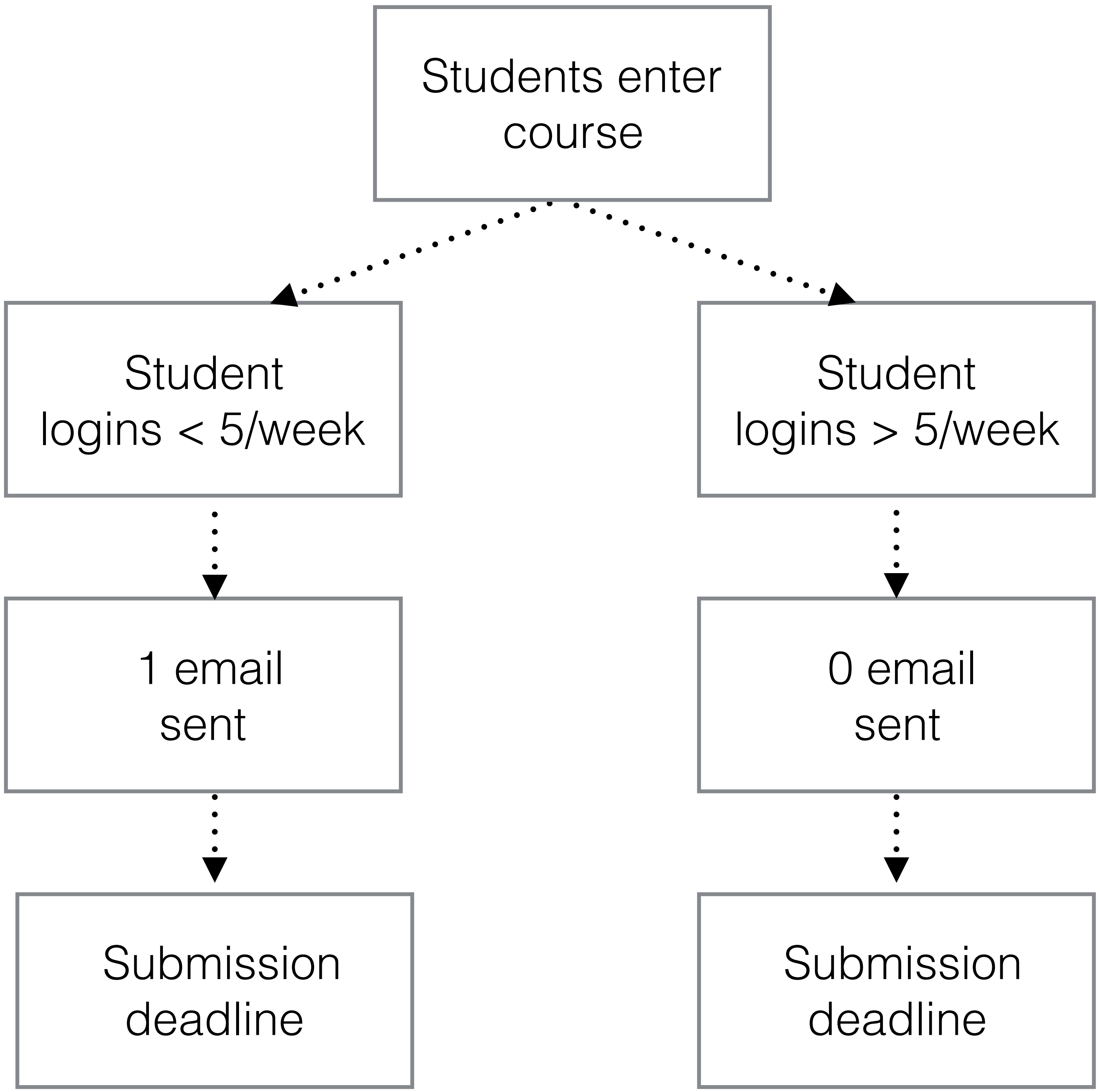
Exercise 7: Simulate Data

- Using R, simulate and visualize the variables for your example

Operational Model

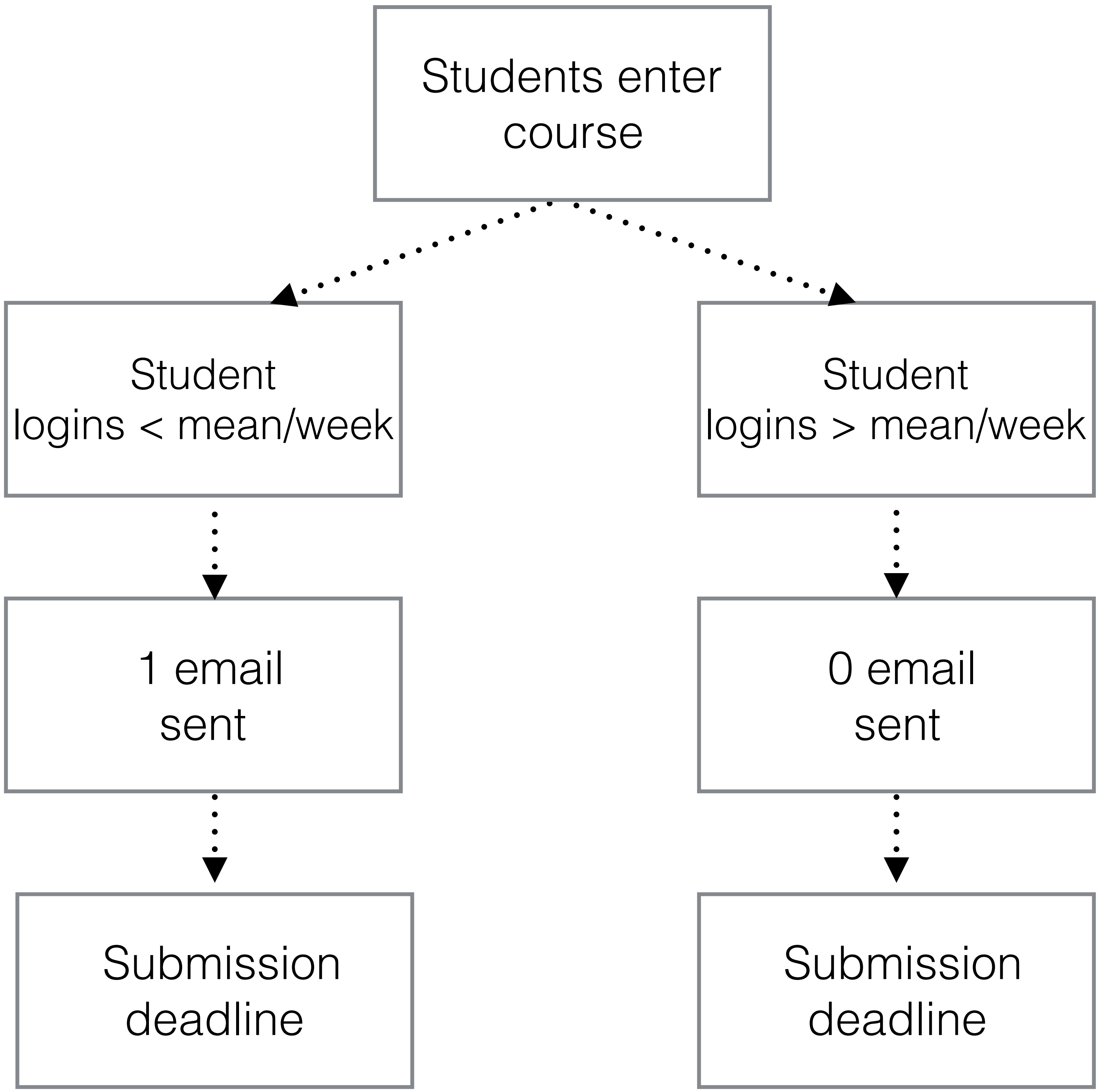
- How does the machine make decisions?

Example 1: Arbitrary Decision



Count: logins
Variation: theoretical/time
Information: priorities

Example 2: Mean Decision

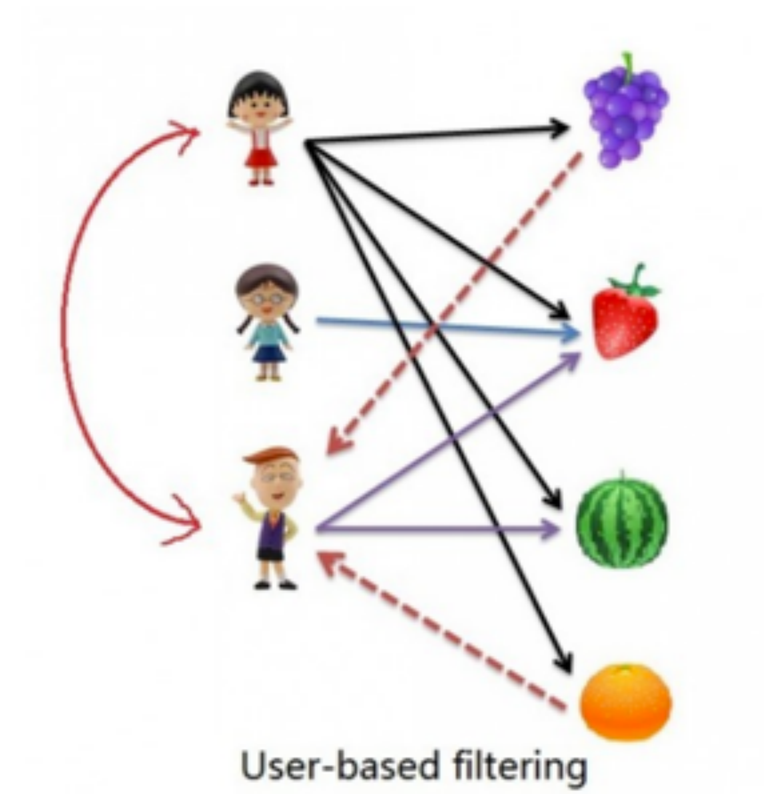


Count: logins
Variation: between-individual
Information: priorities

Example 3: User Based Collaborative Filter

	student A	student B	student C
podcast	score improved = yes	yes	no
game	yes	no	no
quiz	yes	yes	no

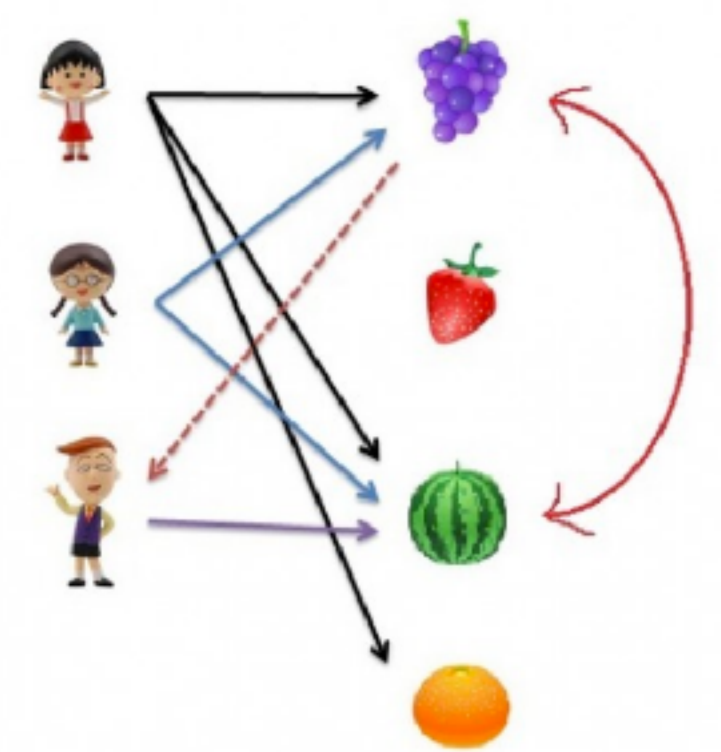
Count: score change, tasks, students
Variation: between-individual
Information: learning



Example 4: Item Based Collaborative Filter

	student A	student B	student C
podcast	score improved = yes	yes	no
game	yes	no	no
quiz	yes	yes	no

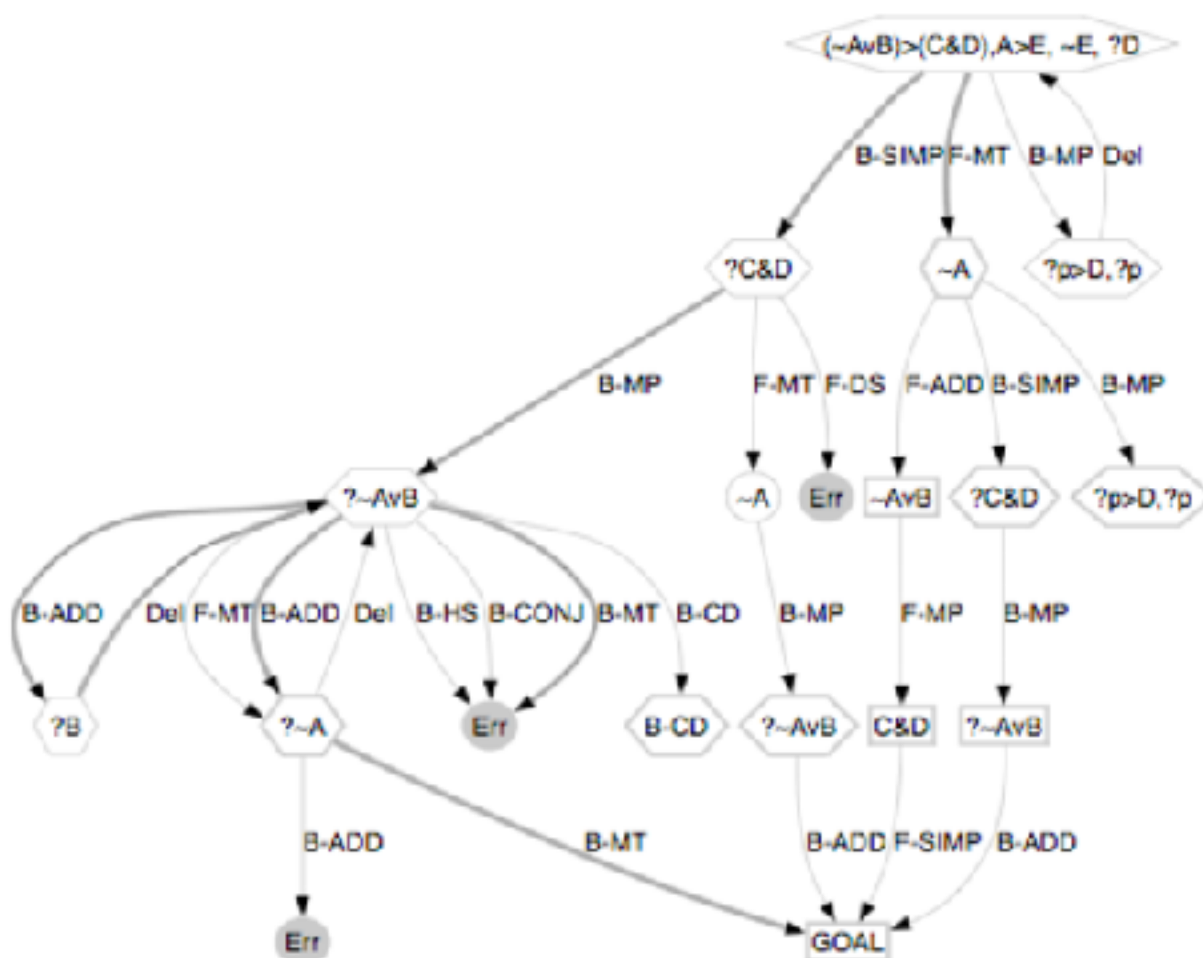
Count: score change, tasks, students
Variation: between-tasks
Information: learning



Item-based filtering

Example 5: Model Tracer

Compare models of **how** people **know**



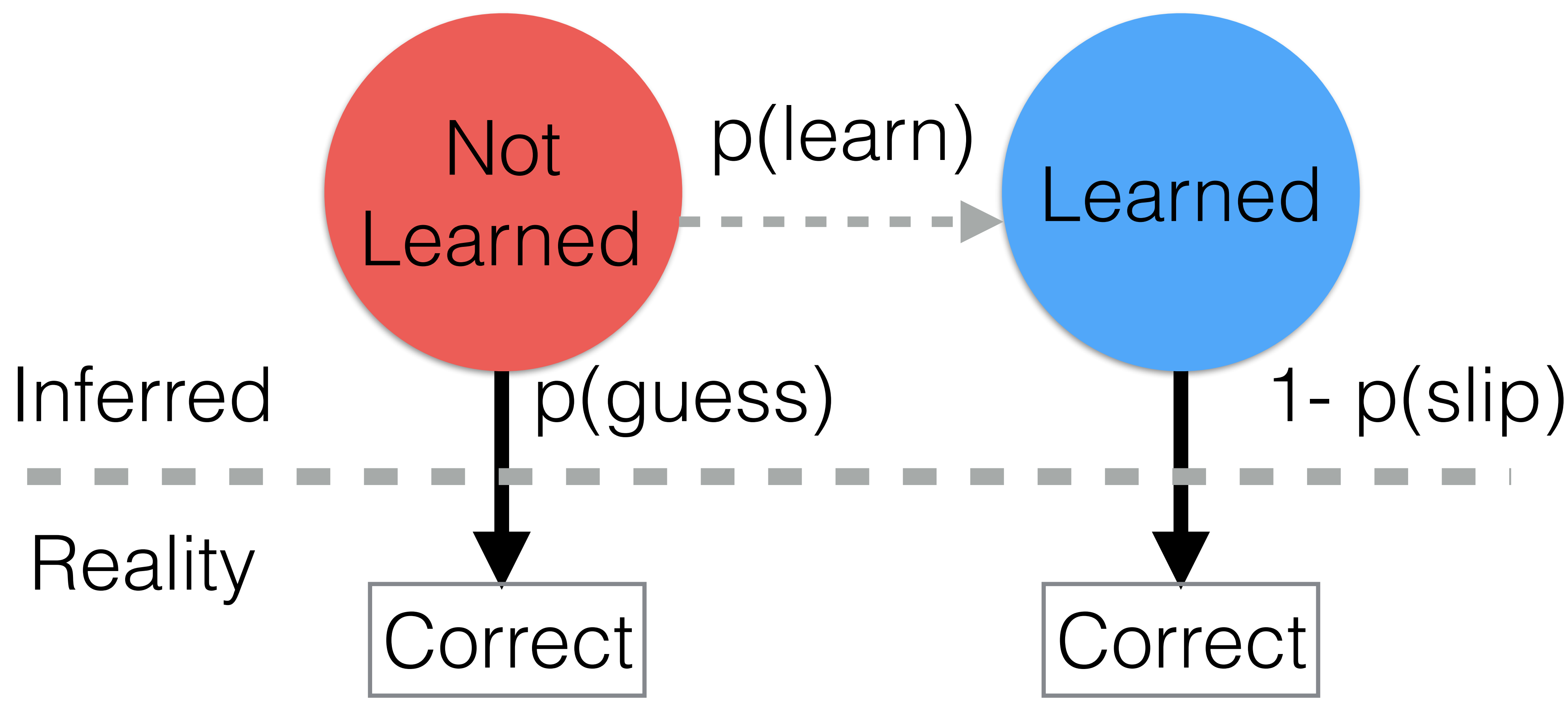
Count: decisions, pathway, success
Variation: between-students
Information: learning

M Croy, T Barnes, J Stamper

Example 6: Knowledge Tracer

- Operational model can be vey complex
- Can involve latent traits
- Can merge axes of variation

Count: correct/ incorrect, student
Variation: between-students, over-time
Information: latent trait model



Exercise 8: Choose a Methodology

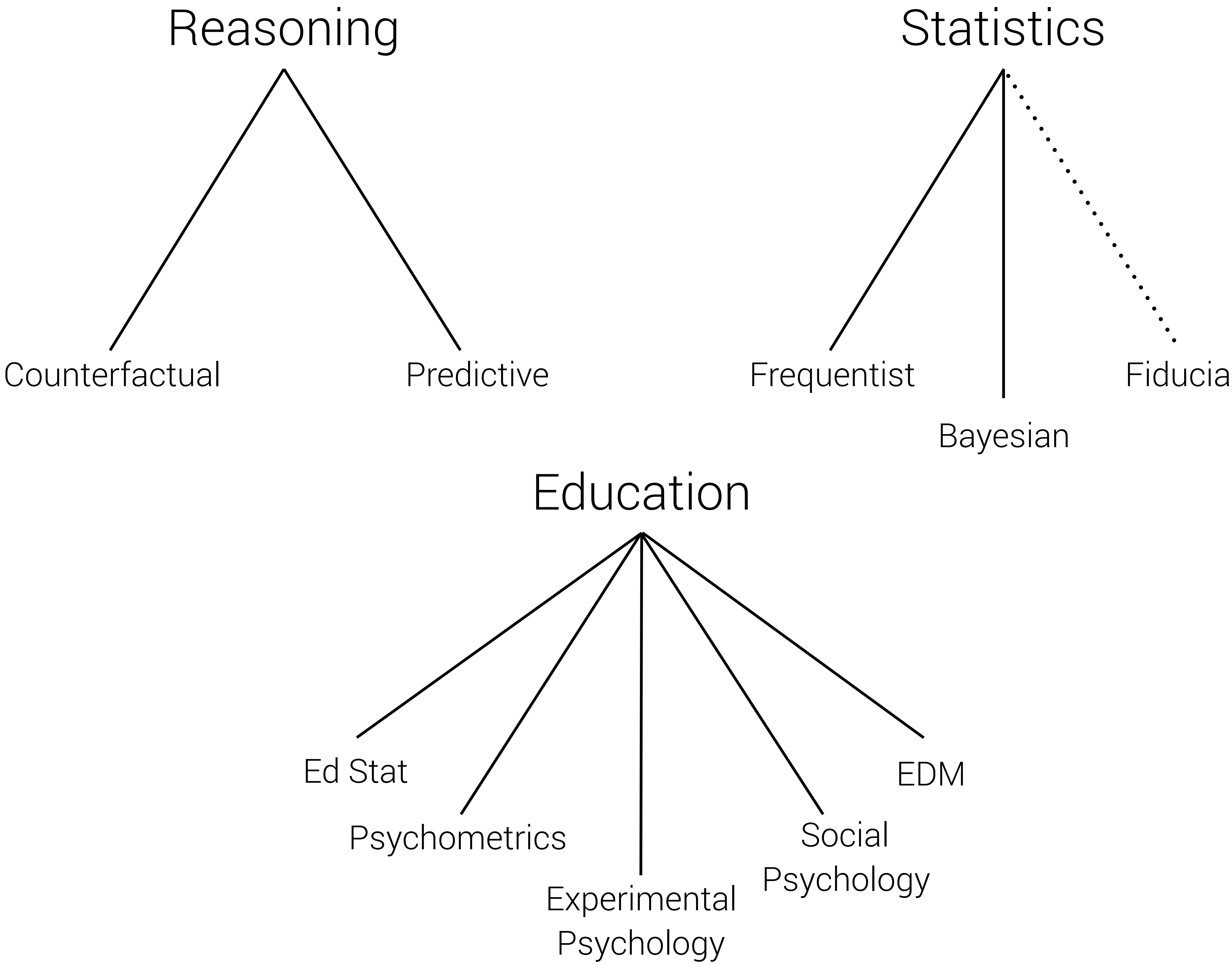
- Choose a methodology appropriate to the variation you have defined and the inference you believe you need to make for your trigger

End Day I

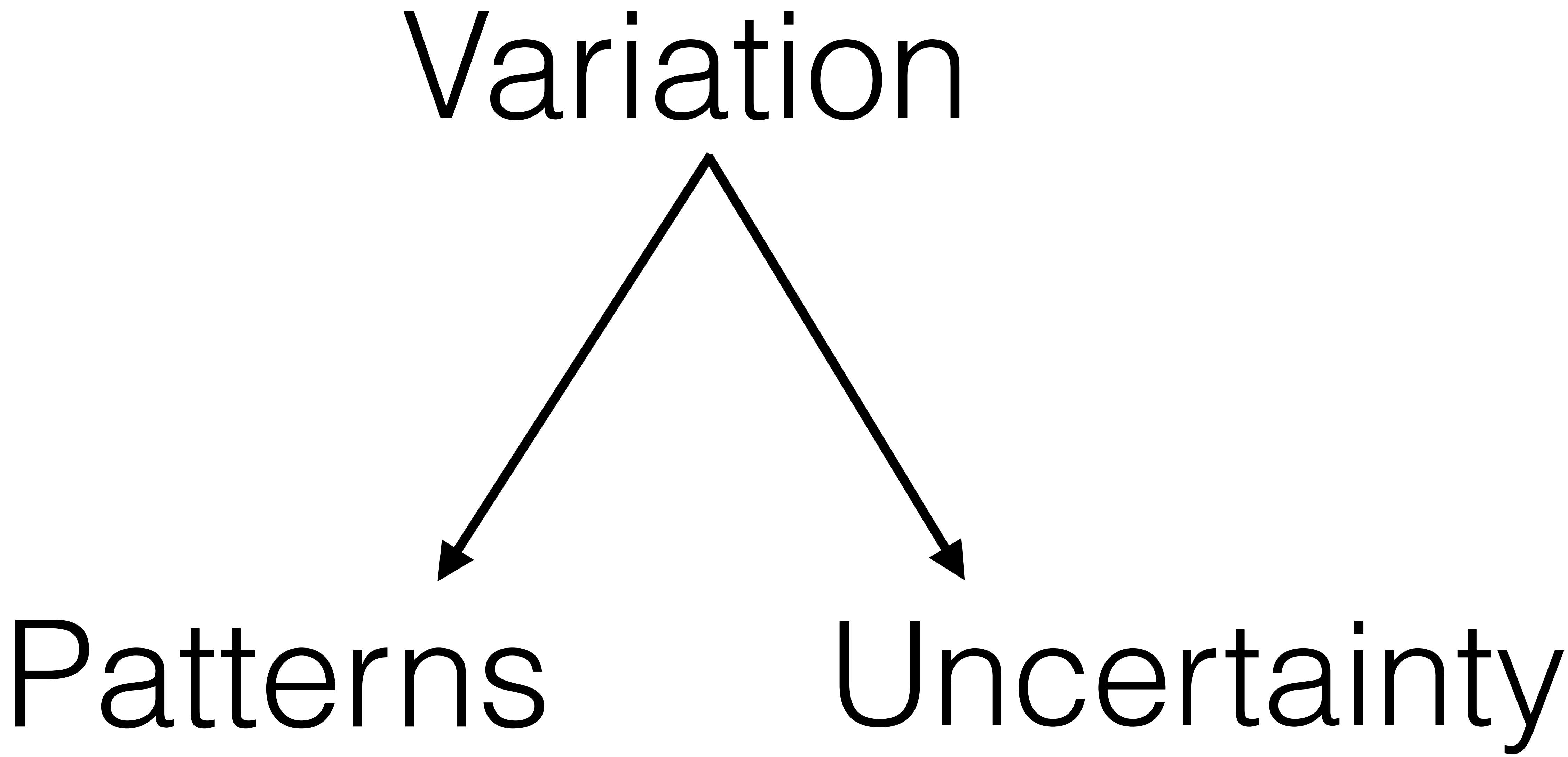
Operational Model

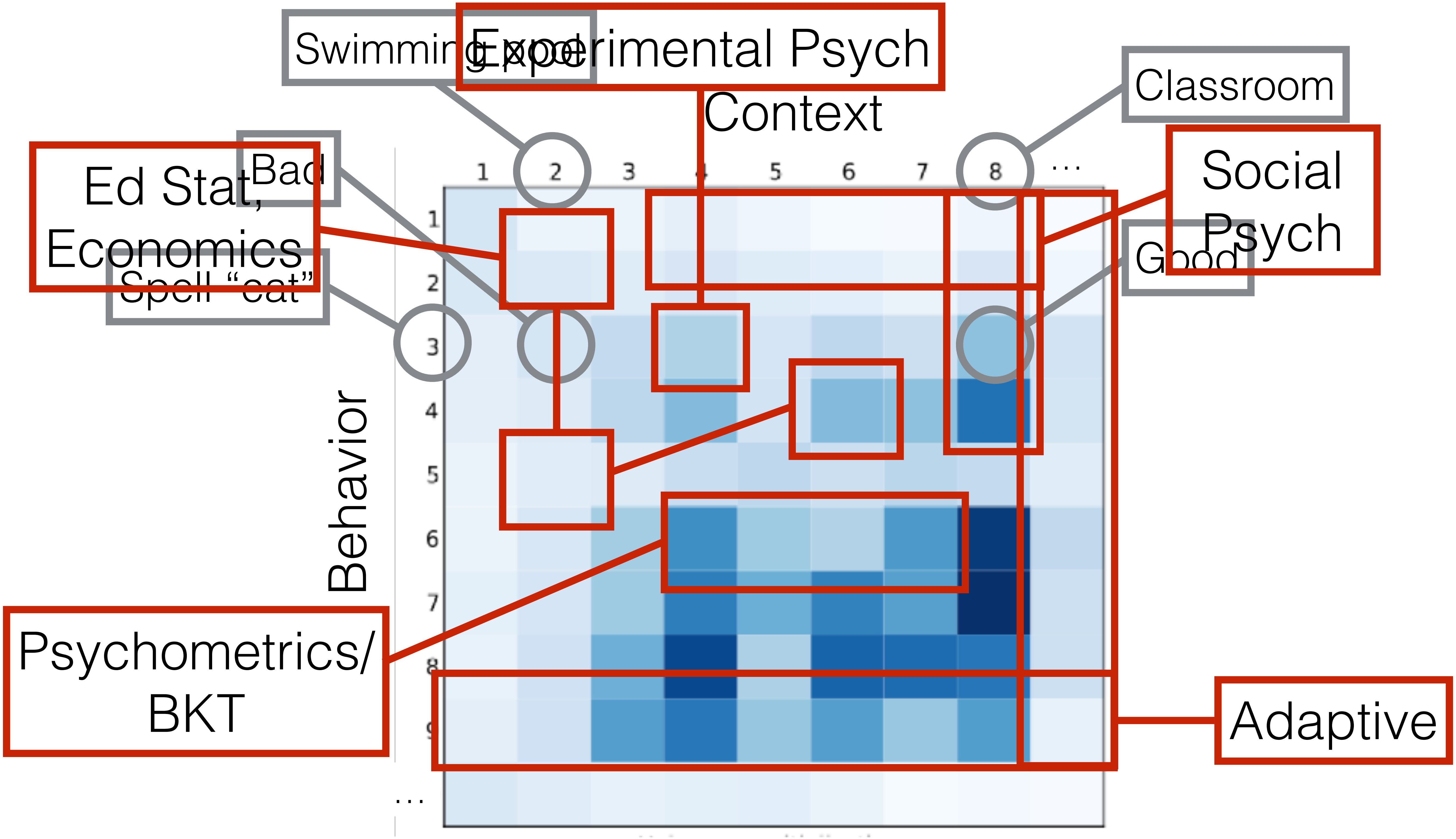
- What are you counting?
- What variation are you mining?
- What relevant information is available in that variation?
- How are you making meaning from that variation?
- What is the trigger?
- What is the action?
- How does the machine make decisions?

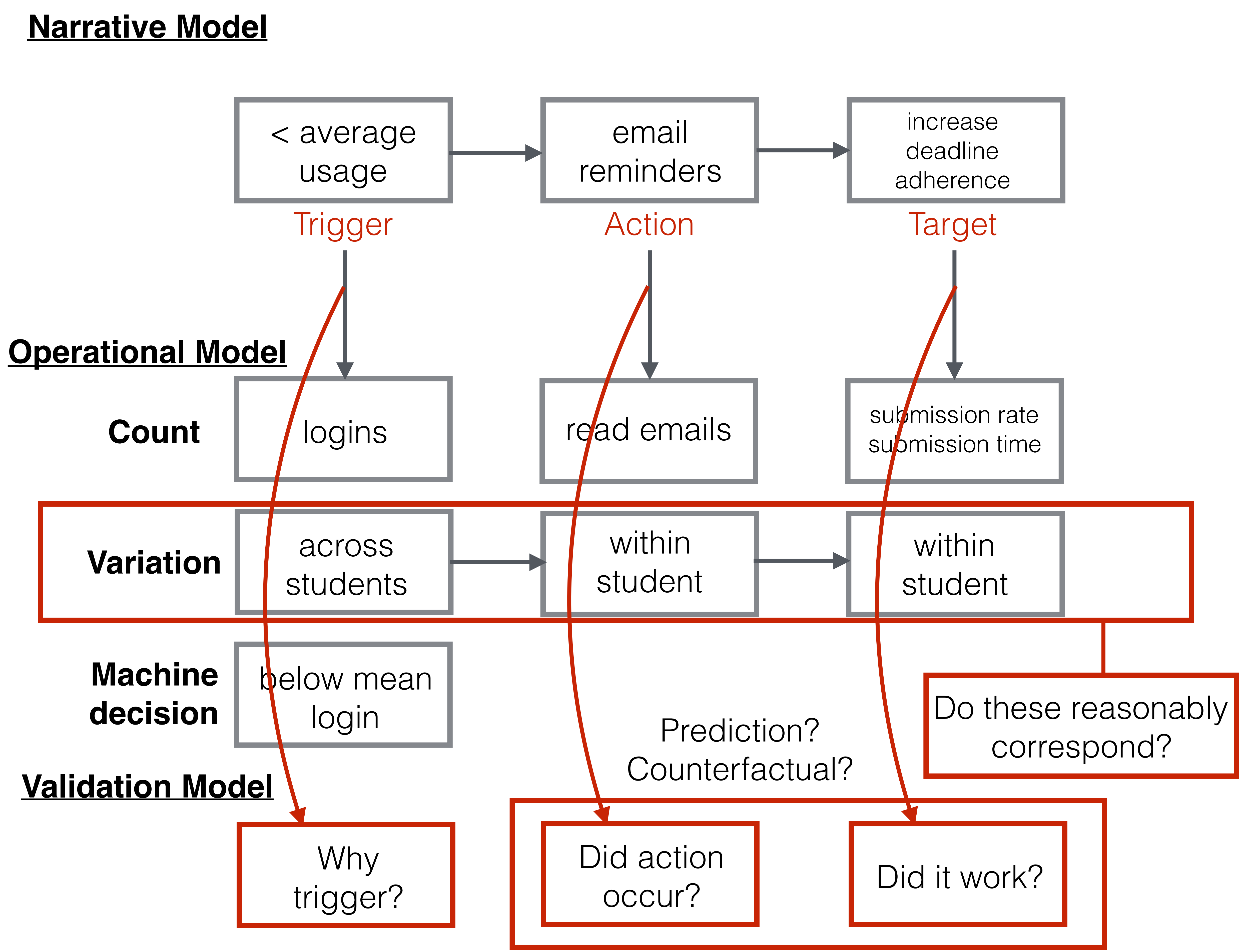
Validation Model

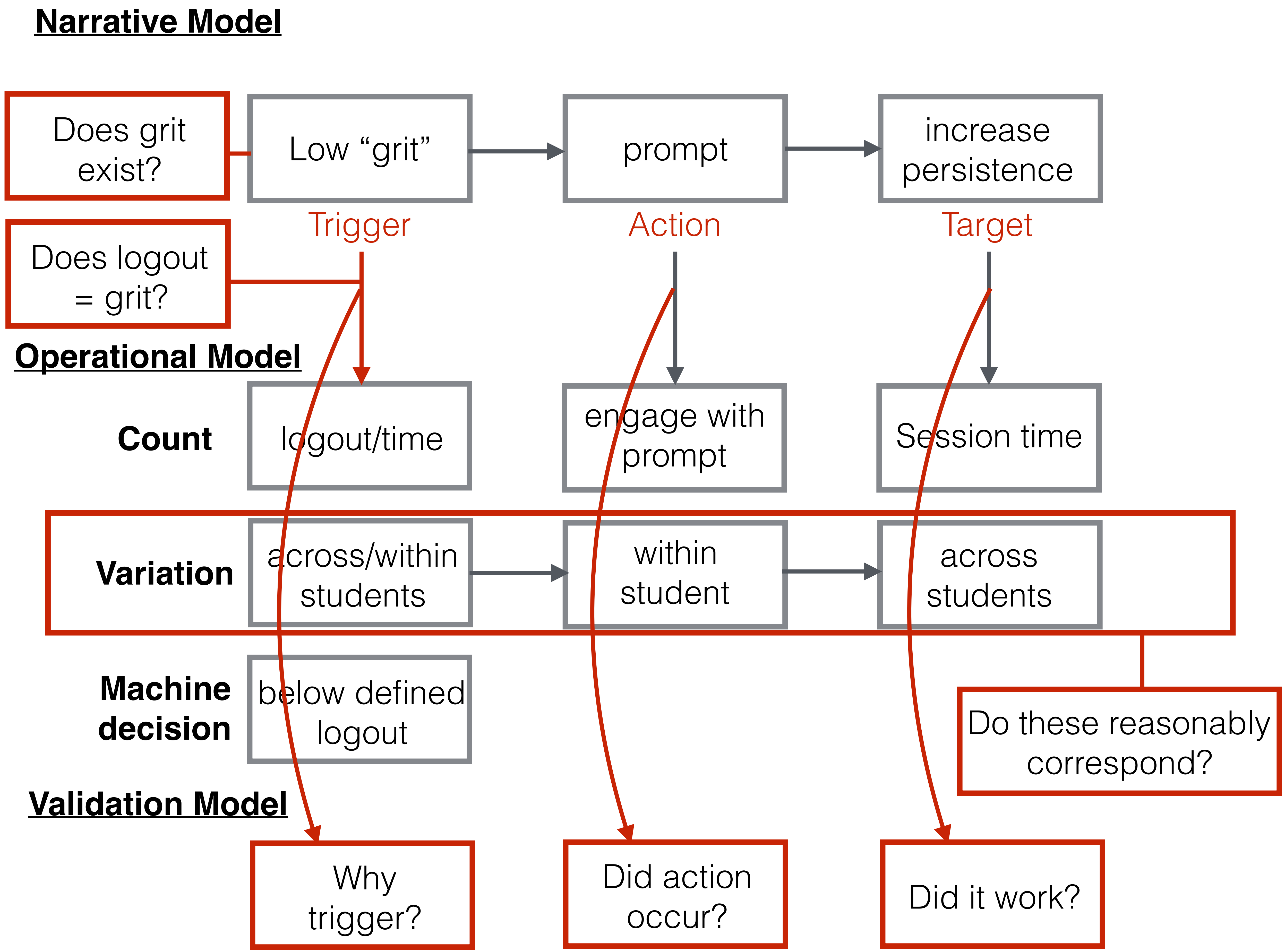


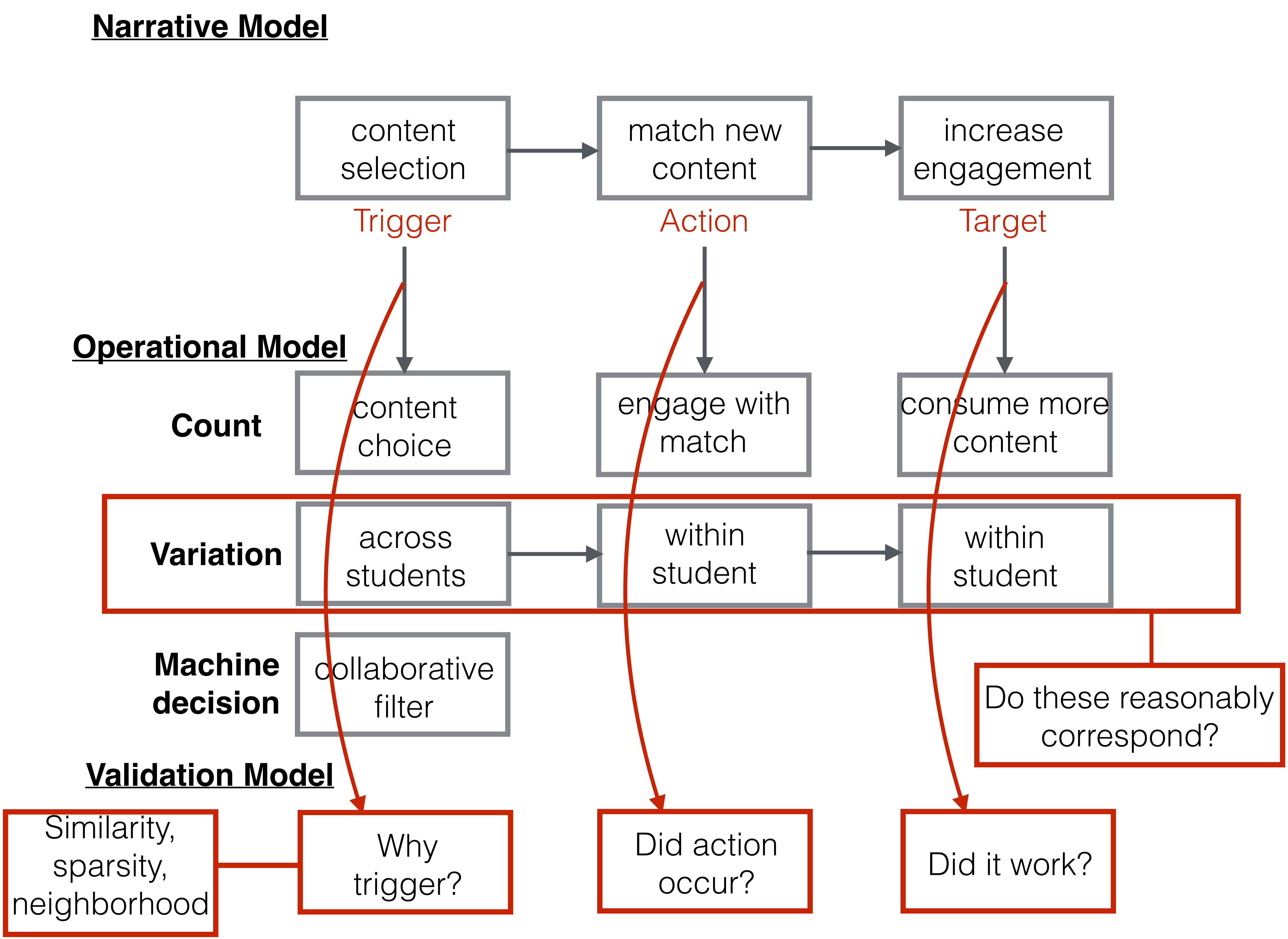
Reasoning
Counterfactual
Predictive
Statistics
Frequentist
Bayesian
Fiducial
Education
Ed Stat
Psychometrics
Experimental Psychology
Social Psychology
EDM


Variation
Patterns
Uncertainty


Swimming pool
Experimental Psych
Context
Classroom
Ed Stat, Economics
Bad
Social Psych
Good
Spell "cat"
Behavior
1
2
3
4
5
6
7
8
...
Psychometrics/ BKT
Adaptive


Narrative Model
< average usage
email reminders
increase deadline adherence
Trigger
Action
Target
Operational Model
Count
logins
read emails
submission rate
submission time
Variation
across students
within student
within student
Machine decision
below mean login
Do these reasonably correspond?
Prediction?
Counterfactual?
Validation Model
Why trigger?
Did action occur?
Did it work?


Narrative Model
Does grit exist?
Low "grit"
prompt
increase persistence
Trigger
Action
Target
Does logout = grit?
Operational Model
Count
logout/time
engage with prompt
Session time
Variation
across/within students
within student
across students
Machine decision
below defined logout
Do these reasonably correspond?
Validation Model
Why trigger?
Did action occur?
Did it work?


Narrative Model
content selection
match new content
increase engagement
Trigger
Action
Target
Operational Model
Count
content choice
engage with match
consume more content
Variation
across students
within student
within student
Machine decision
collaborative filter
Do these reasonably correspond?
Validation Model
Similarity, sparsity, neighborhood
Why trigger?
Did action occur?
Did it work?