

Latent Variable Modeling



Konstantina Sokratous



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Postdoctoral Fellow – University of Missouri

I focus on modeling decision-making
and higher order cognition

- Formal/computational methods to inform psych science
- MathPsych/CogSci tools to inform AI decision-making

01

Why latent variable modeling?

Why not study what we want
directly?

In psychology...

- We cannot measure directly things we care about
 - Intelligence
 - Depression
 - Impulsivity
 - Risk judgements and preferences



Process Based (cognitive) Models

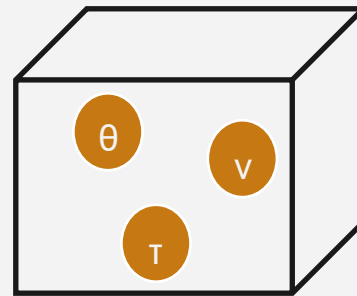
Mechanistic

Describe the process by which
observable behavior is generated

Latent parameters

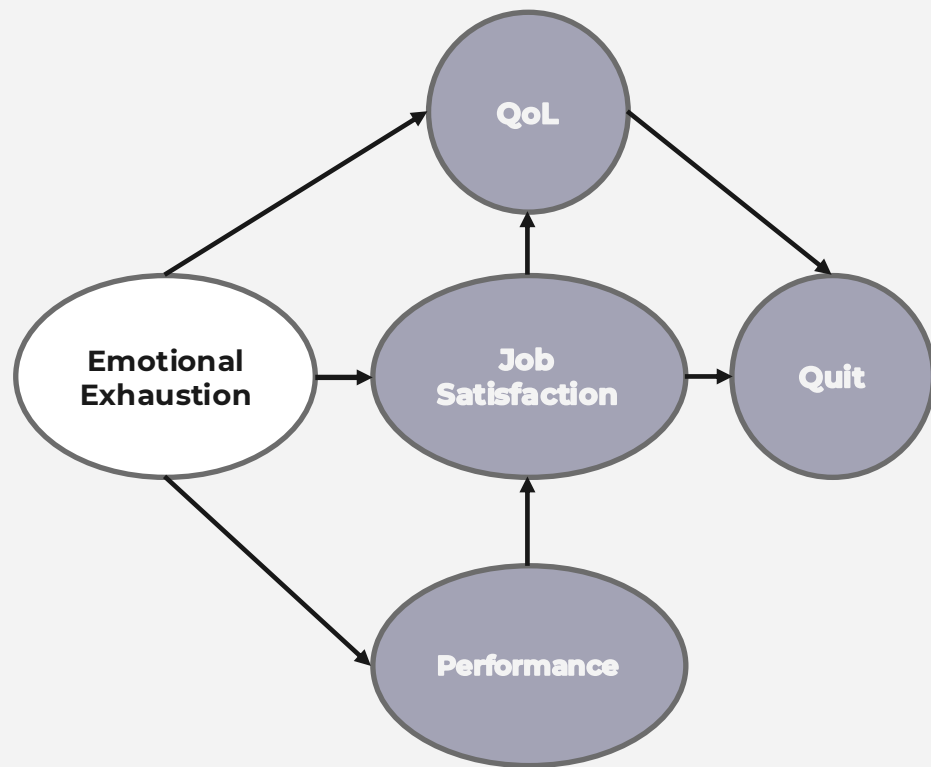
Unobserved, psychologically
interpretable quantities that have
a functional meaning

MECHANISTIC MODEL



From latent (hidden) to observed

- **Latent** is the thing we care about and the **observed** (accuracies, choices, RTs, variables) what we see
- You need to infer **1st** from the **2nd**
- Can we be explicit how the hidden thing produces the visible thing?
 - Can we establish a **relationship between the two?**

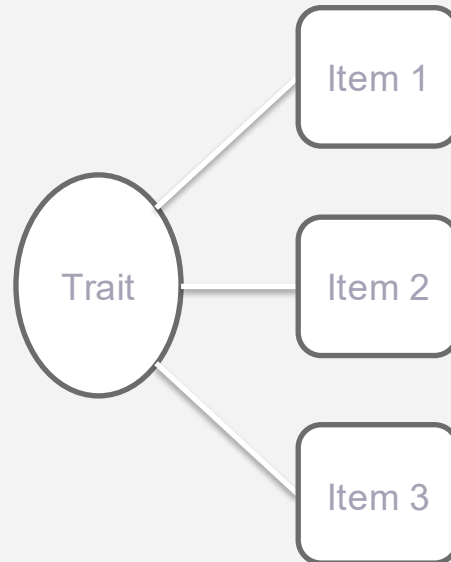


Latent variable modeling can support different goals

- One goal can be (psychometric) **measurement**:
 - How much of this thing (traits, abilities, constructs) does this one person have?
 - Which latent variables are there? How are each related to observed ones? How are they measured by different items?
- Another goal can be **exploratory**:
 - How many latent variables are there and what is the structure of the data?

Measurement: IRT, SEM, CFA

- What you learn:
 - Where a person sits (location on the construct, comparable across people)
 - How well an item works (which indicators carry more info about construct)
 - Does the construct hold together? (one vs multiple splits)
- **Caveats:**
 - Hardly invariant, construct is assumed real, no explanation on how ability produced a “4”



Exploration: EFA, LPA, LCA, MM

How many factors in my data?

What loads on each?

Is a 6 factor theory supported?

How do other factor theories compare?

Are there latent subgroups?

Are distinct types of people defined over continuous/categorical indicators?

Caveats

Different criteria routinely disagree, class solutions can be unstable, factor rotation is indeterminate

Taxonomy

OBSERVED: CONTINUOUS

OBSERVED: DISCRETE

LATENT:
CONTINUOUS

Factor Analysis

SEM · CFA · EFA

continuous latent, continuous observed

IRT

Item Response Theory

continuous ability, categorical responses

LATENT:
DISCRETE

LPA

Latent Profile Analysis

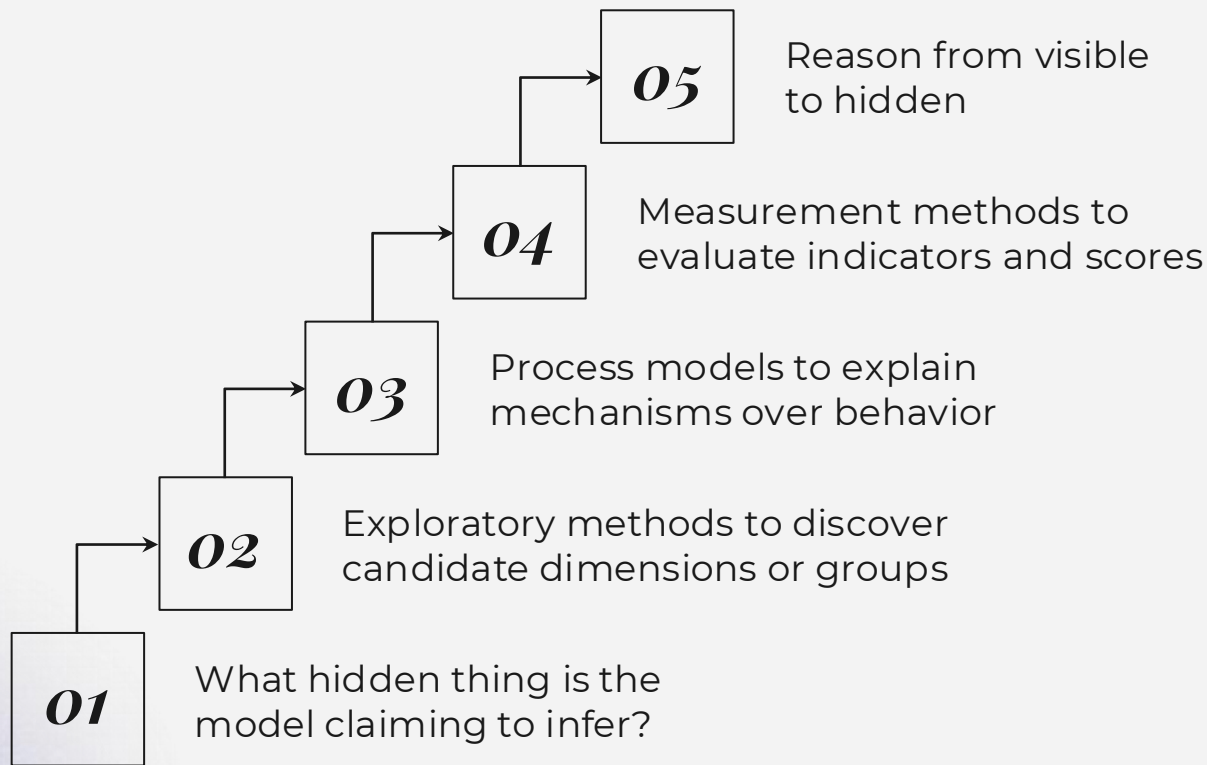
discrete classes, continuous indicators

LCA

Latent Class Analysis

discrete classes, categorical indicators

Take Aways

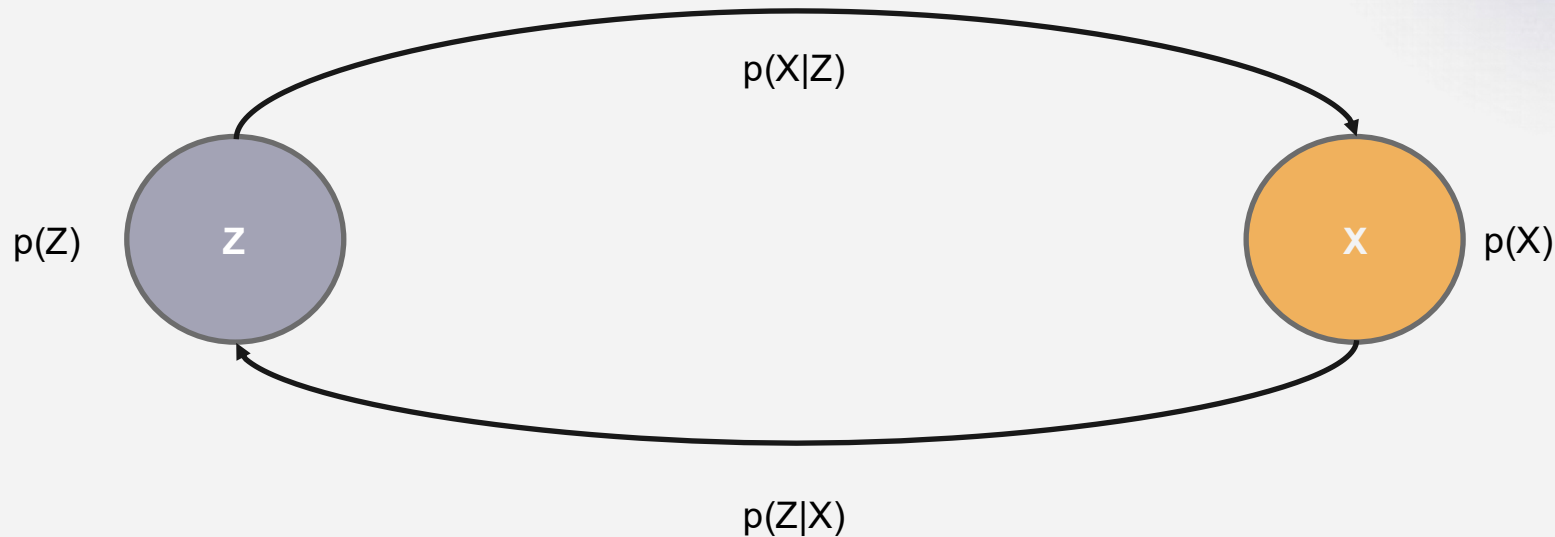


**Observed
Data**

**Model
Assumptions**

**Latent
Inference**

Every latent variable comes with assumptions



Next: What happens when we replace classical methods with NNs?

“There’s probably a way to machine learn the way out of it.”

—Someone Famous

Thanks!

Do you have any questions?

ksokratous@missouri.edu

lazyneuron.com

