HUDK 4050: CORE METHODS IN EDM

10/29/19 4:18 PM

In the news

A face-scanning algorithm increasingly decides whether you deserve the job

The Washington Post
Democracy Dies in Darkness

Ed Tech Tools Research Group Starts Work

THE JOURNAL

THE 74

After One City Experiments With Toddlers Wearing Recorders and Sees the Number of Words They Hear Grow 50%, 5 More Mayors Will Pilot Innovative 'Word Gap' Program

France Kicks Data Scientists Out of Its Courts

SLATE

Events

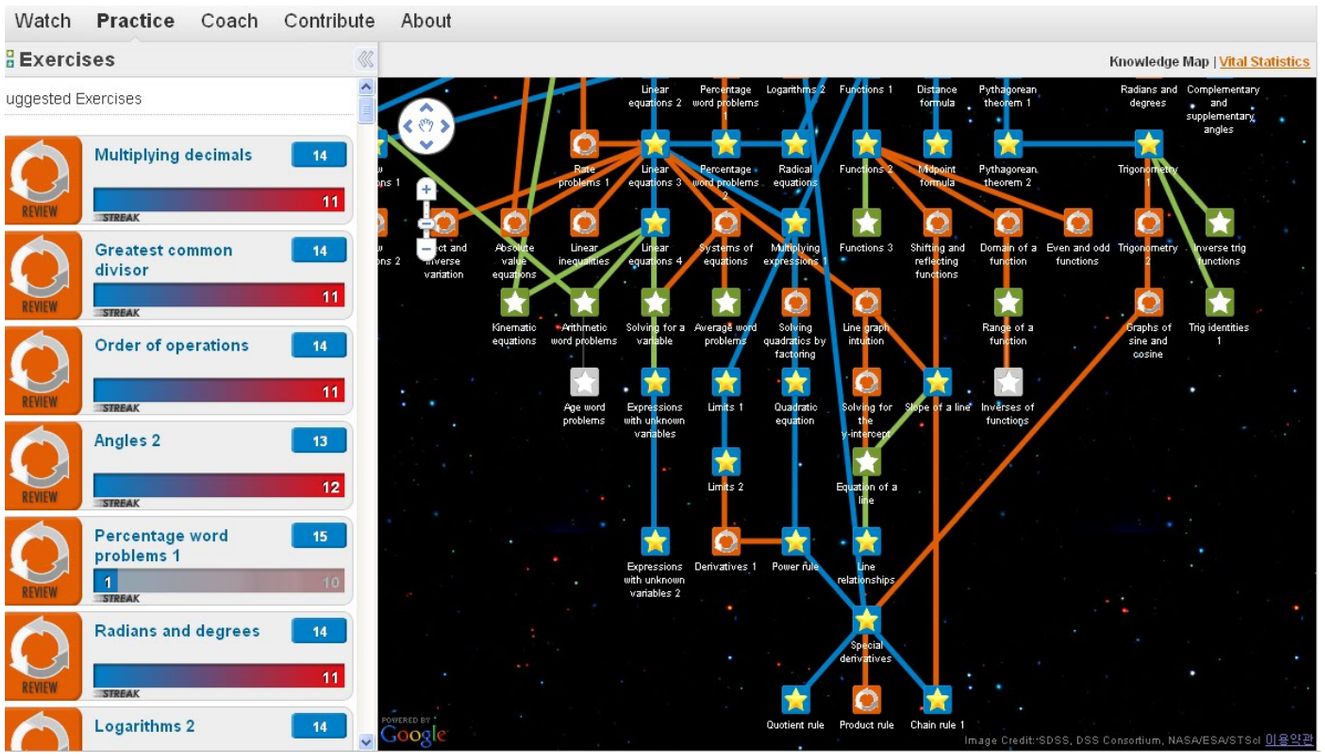
Title	Date - Time	Location
Academic Learning or Occupational Skills?	10/30 - 5:30	179 GDH
Race After Technology	10/30 - 6:00pm	Online
Robotics to Retrain & Restore Human Movements	11/1 - 12:00pm	NWB Rm 1406
AWS Machine Learning Day	11/6 - 12:00pm	Online
The Color of Surveillance	11/7	Georgetown University
All Tech is Human: NYC	11/9	ThoughtWorks
Xavier Ochoa: Multimodal Analytics	11/12 - 12:00pm	NYU
Science Communication Workshop	11/20 - 9:30am	Low Library
Citizens and Technology Summit	11/25	Ford Foundation

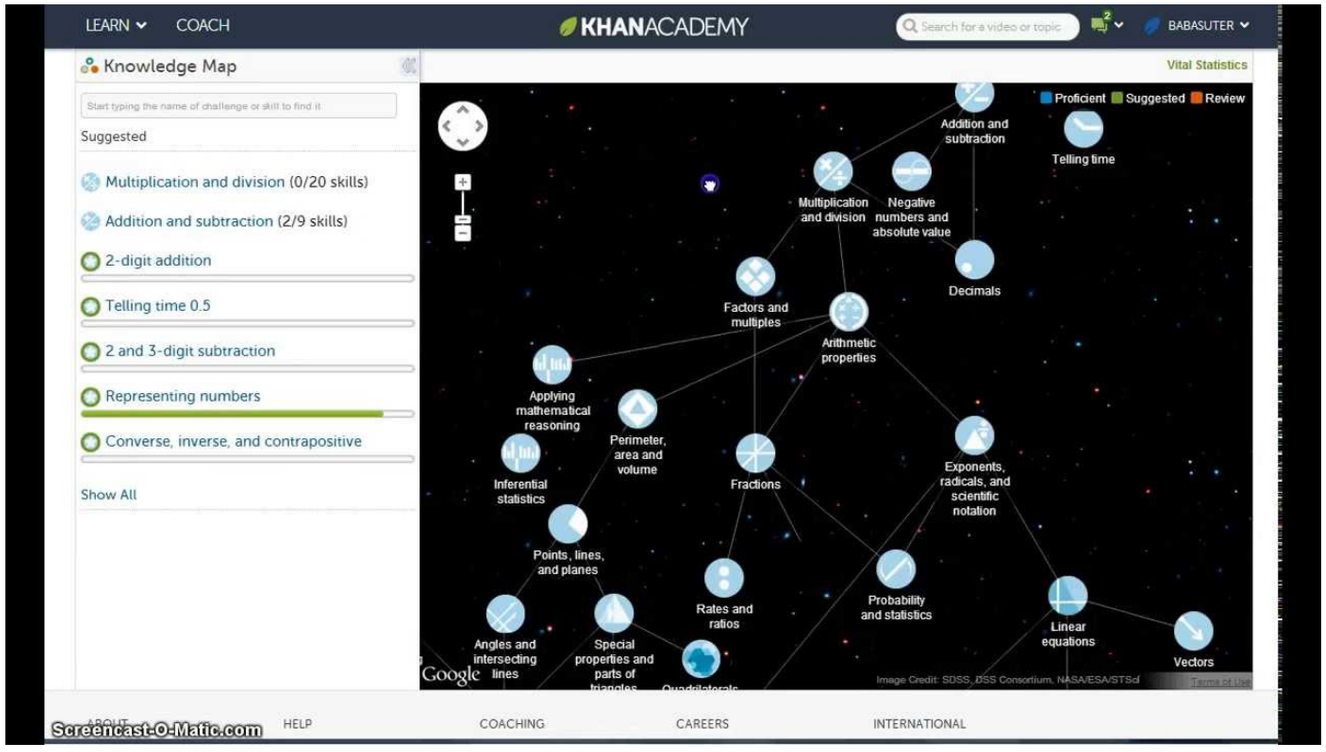
Plans

- 10/31: Assignment 4 Assigned
- 11/5: Assignment 3 Due
- 11/7: Assignment 5 Assigned
- 11/12: Assignment 4 Due
- 11/14: Assignment 6 Assigned
- 11/19 Assignment 5 Due
- 11/21 Assignment 7 Assigned
- 11/26 Assignment 6 Due
- 12/3 Assignment 7 Due
- 12/5: Assignment 8 Assigned
- 12/13: Assignment 8 Due
- 12/17: Assignment 8 Watch/ Rate

http://bit.ly/HUDK4050CAL

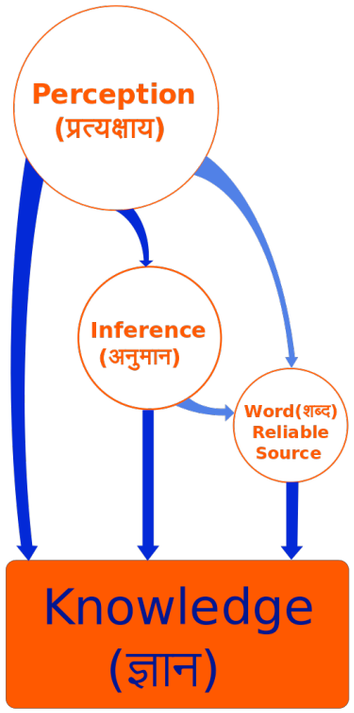
ALICE'S ESTIMATED PROFICIENCY
ON ALL LEARNING OBJECTIVES IN THE GRAPH





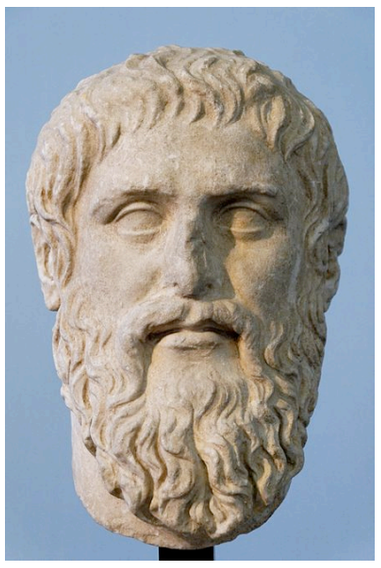
Domain Structure Discovery

- Identifying the structure of knowledge in a(n) (educational) domain
- We've been at this a while
- Quantified epistemology



Samkhya, Yoga

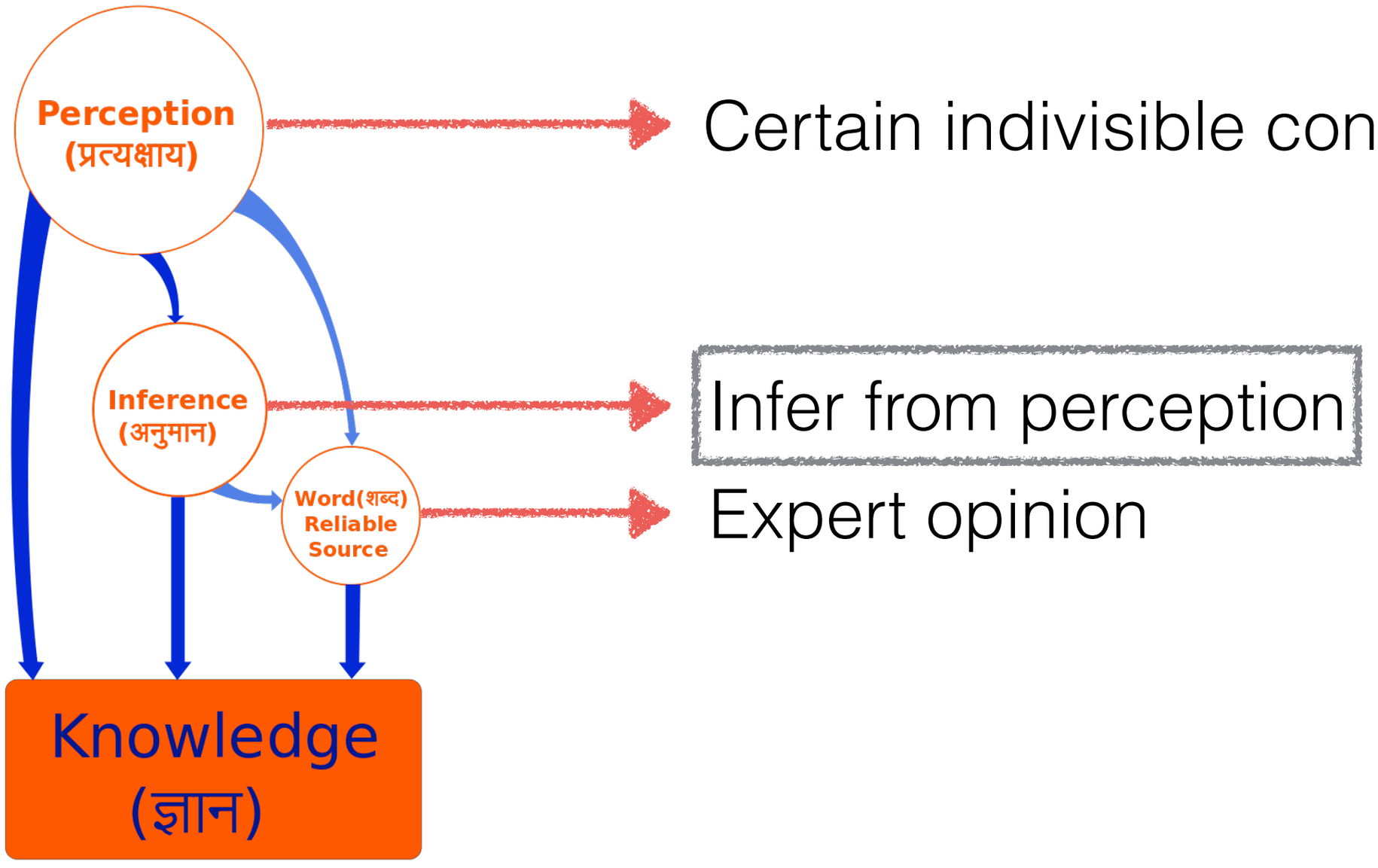
सांख्य
~500BCE



Plato ~300BCE

孟轲 ~ 200BCE

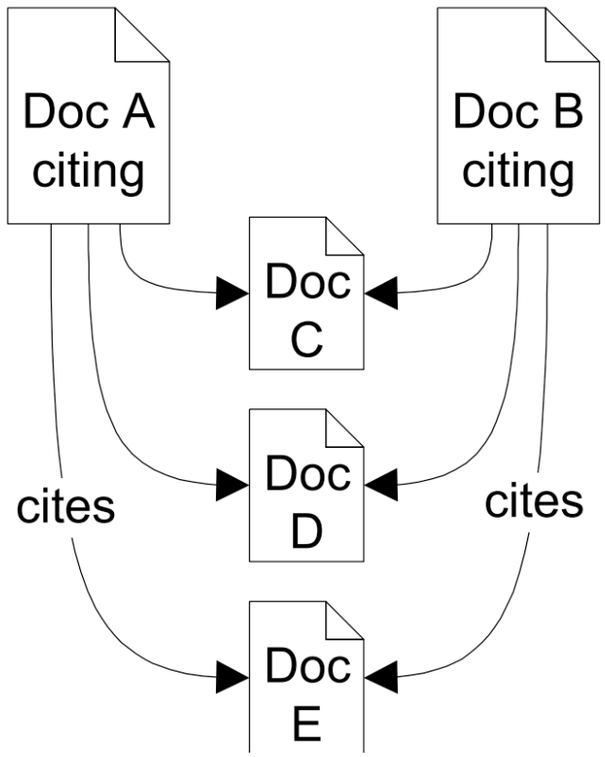
Domain Structure Discovery



Bibliometrics

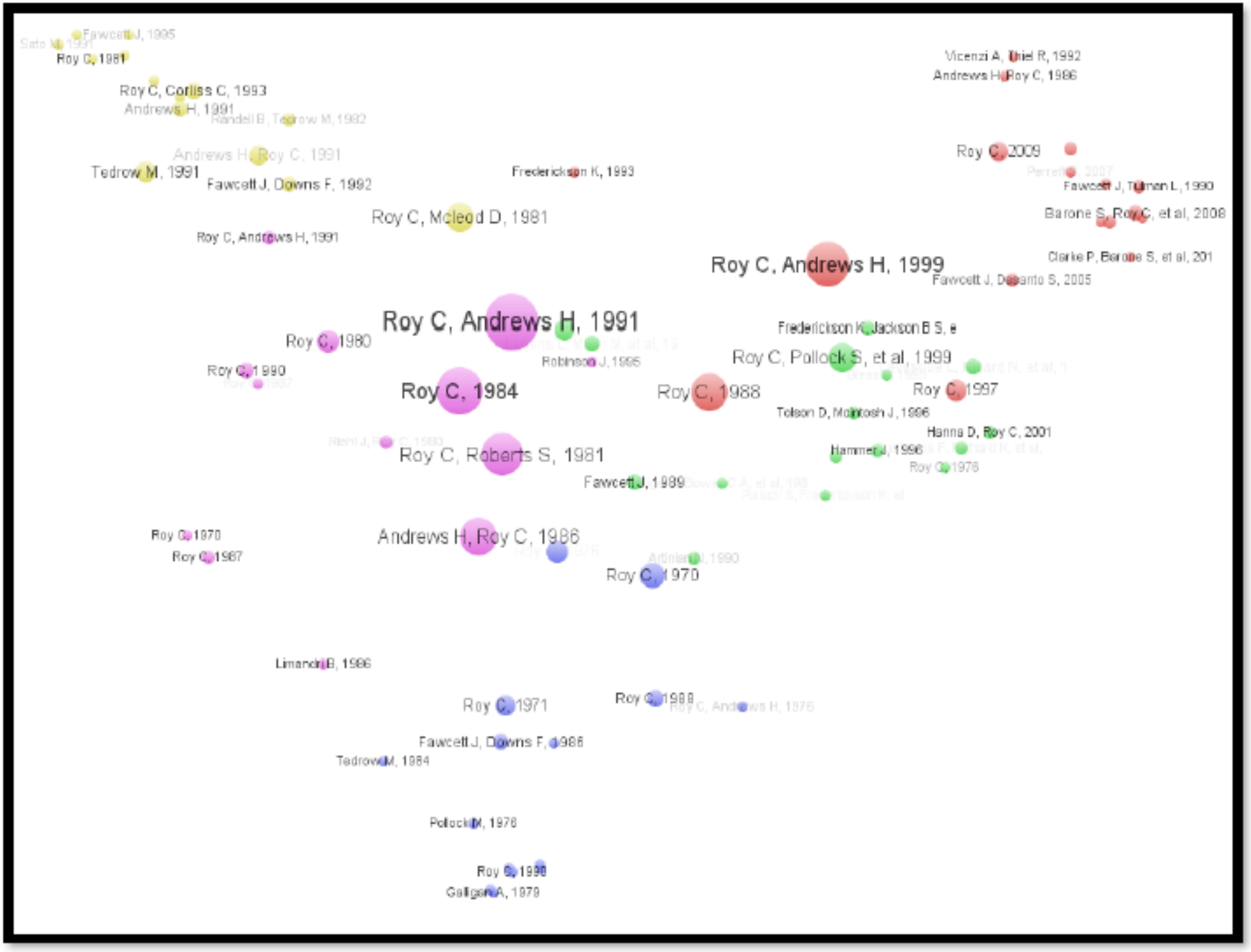
(scientometrics, librametry, statistical bibliography)

- Citation patterns
- Raw number (impact score), Erdős Number
- Co-word analysis
- Network representation

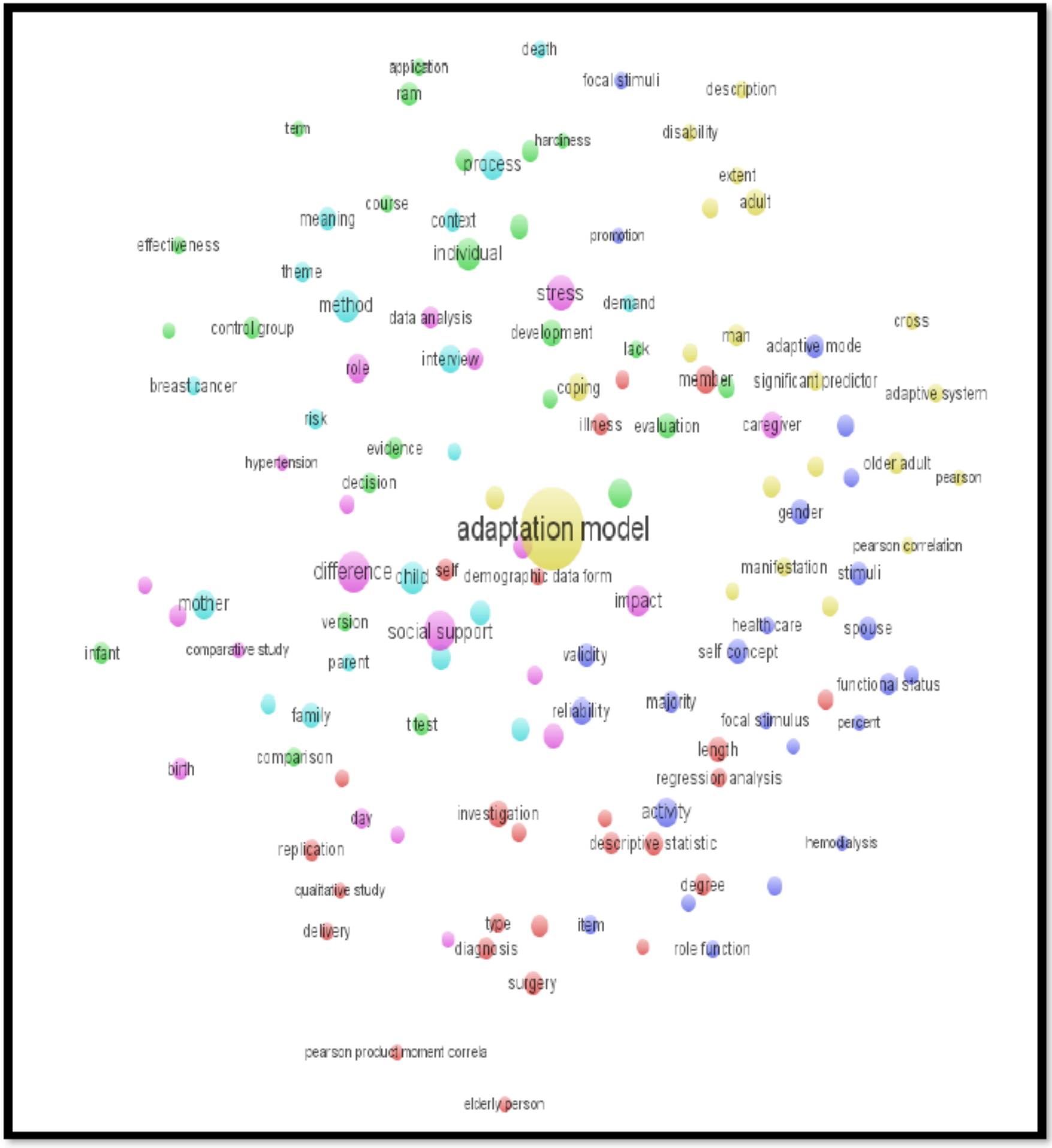


Bibliographic Coupling

(Eigenvectors again!)



Alfonzo, Sakraida, Hastings-Tolsma (2014)



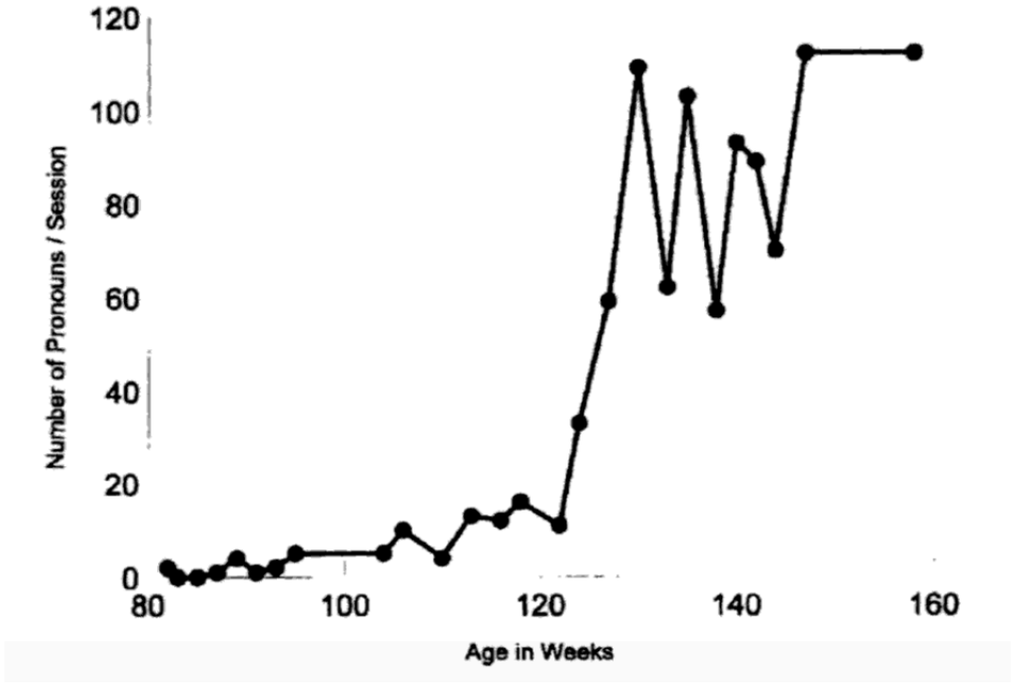
Alfonzo, Sakraida, Hastings-Tolsma (2014)

Latent Variable

Latent variables are variables that are not directly observed but are rather inferred from other variables that are observed and directly measured.

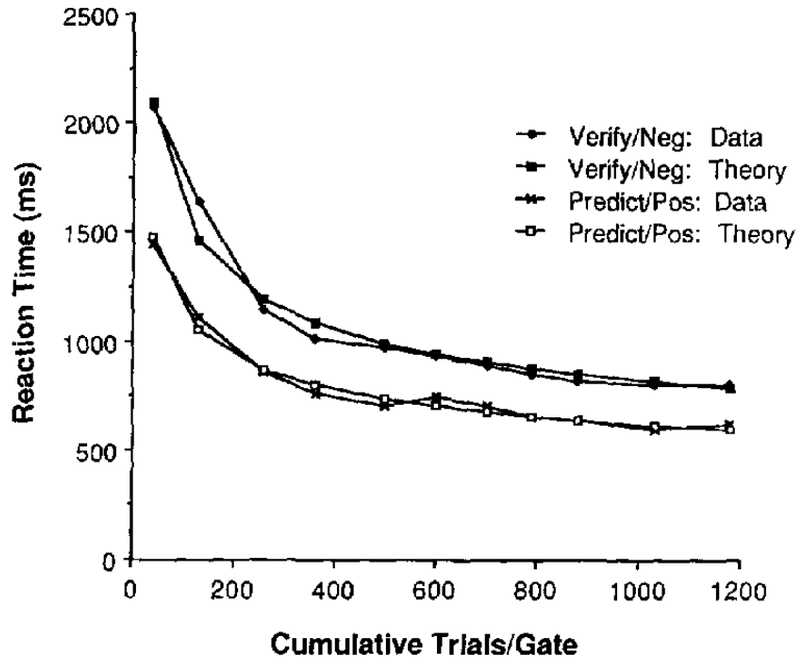
(What isn't a latent variable?)

Skills



Fischer & Yan, 1980

(There is also the whole world of construct validity)



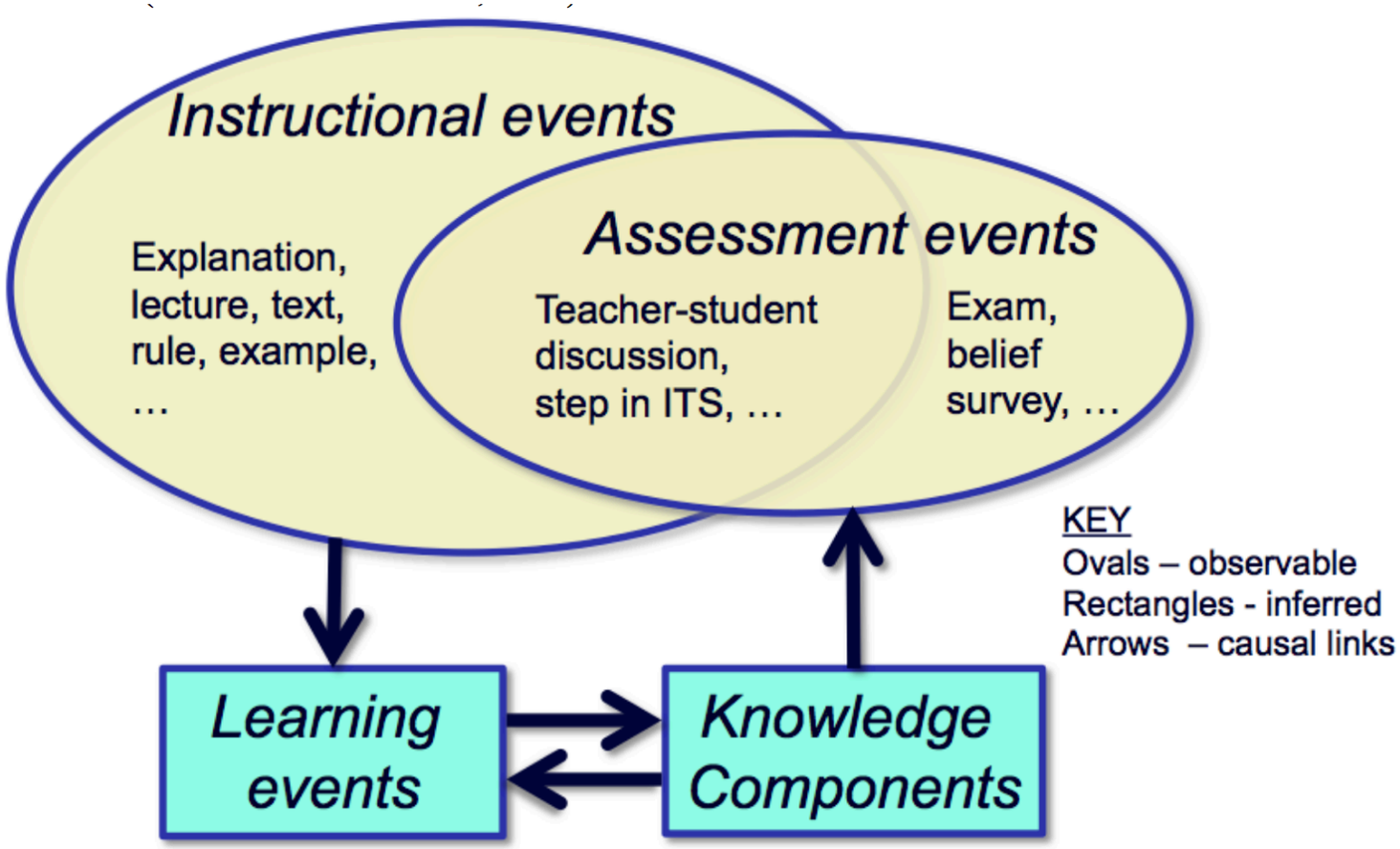
Anderson, 1982

Prolonged learning (memory) about a family of events

Mostly defined by experts/definitionally true

Knowledge Components

A description of a mental structure or process that a learner uses, alone or in combination with other knowledge components, to accomplish steps in a task or a problem (Koedinger & Nathan, 2004)



Q-Matrices

History

- Interested in student misconceptions

- Devised the “Rule Space Method”

- RSM converts item response patterns into probabilities of mastering particular “skills” or concepts

Kikumi Tatsuoka

Q-Matrix

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	
c1	1	1	1	0	1	0	0	1	0	0	0	
c2	0	0	0	0	1	1	0	0	0	0	0	
c3	1	0	0	0	0	0	0	0	1	1	1	
c4	0	1	0	1	0	1	0	0	0	0	0	
c5	0	0	0	0	0	0	1	1	0	1	0	

Concepts are defined by experts. Very time consuming & domain specific

Q-Matrix

	q1	q2	q3	q4	q5	q6
con1	1	0	0	0	0	1
con2	1	1	0	1	0	0
con3	1	1	1	0	0	0

(Tatsuoka, 1983;1996)

Probability a student is correct given mastery of a given concept

Q-Matrix

	q1	q2	q3	q4	q5	q6
con1	1	0.01	0.6	0	0.7	1
con2	0.8	0.7	0.8	0.76	0.5	0.42
con3	0.5	0.6	1	0.55	0.5	0.67

(Brewer , 1996)

Activity: Build Q-M

- Get into groups of 4
- Agree on a topic
- Agree on 3 concepts within that topic
- Devise 6 questions that relate to the concepts
- Map the concepts to those questions

Activity: Build Q-M

- Now, find another group and have them answer your questions
- Note which ones they get correct/incorrect
- Do the scores map onto your concepts?

Problem

Correspondence between expert-derived Q-matrices and student responses is not 100%

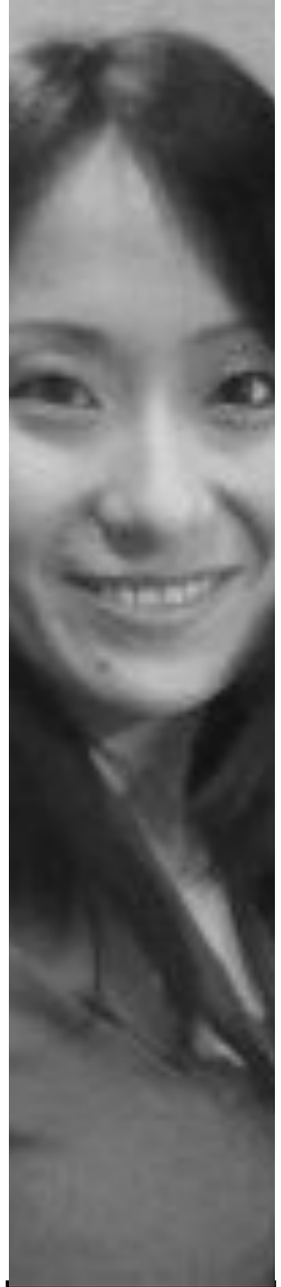
(Hubal, 1992)

Question: Can we use the Q-matrix method to derive valid “student mental states” (constructs? knowledge states? skill definitions?)

Lykken

Bors-boom

de la Torre



Xu

Cron-bach

Fischer

Adkins

Banaji

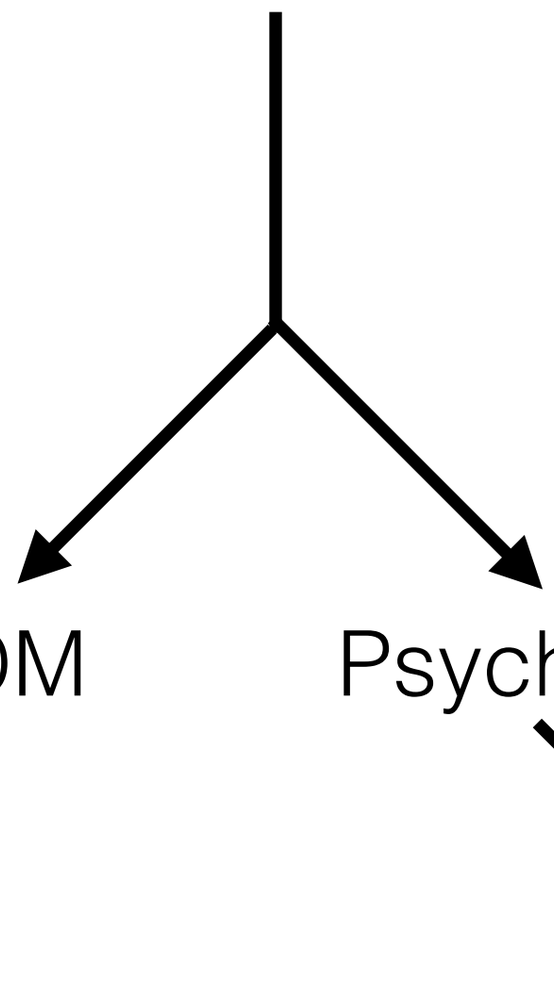
Steele

No

Can this problem be solved?

Yes

Divergence by Domain



Tutoring Systems
Automation
Identifying KS

Large scale assessments
Identifying cognitive states
for use by instructors

One Solution

- Create idealized patterns
- Compare the observed pattern to the idealized
- Use difference between them as an indicator of “model fit”

Idealized Pattern

	q1	q2	q3	q4	q5	q6
c1	1	0	0	0	0	1
c2	1	1	0	1	0	0
c3	1	1	1	0	0	0

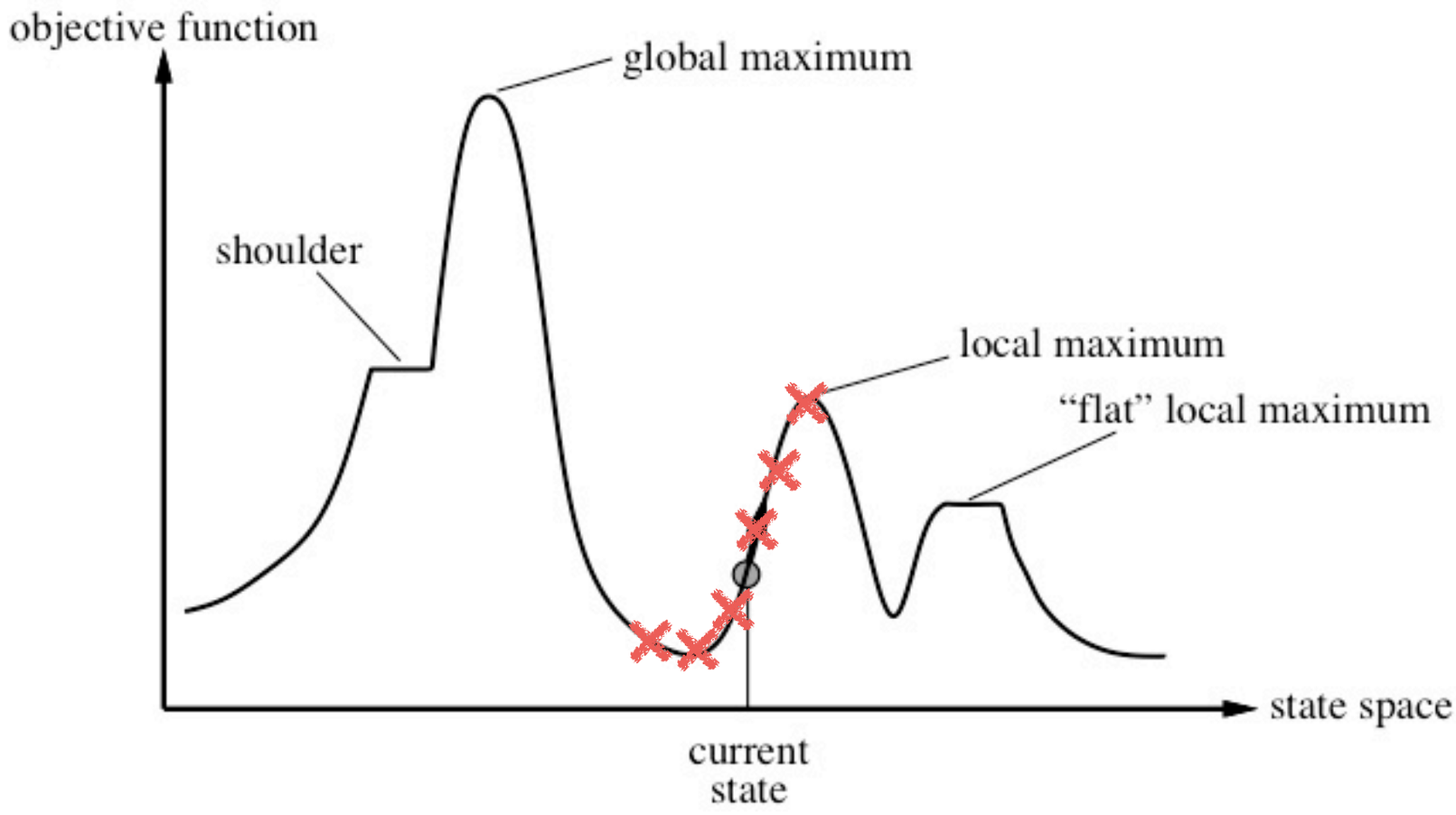
$$L_1 = \quad d(p,IDR) = \sum_q |p(q) - IDR(q)|$$

$$L_1 = \ 1$$

Student Answer: 101110

Concept State	Ideal Response Vector
000	000010
001	001010
010	000110
011	011110
100	000011
101	001011
110	000111
111	111111

Hill Climbing Algorithm



- If we stop too early might only capture a local maxima
- This is a "heuristic" algorithm - when problem is not algebraically solvable or would take too long
- State description contains all the information needed to find a solution