HUDK 4050: CORE METHODS IN EDM

11/7/17 10:56 AM

In the news

The New York Times Magazine

Not the Bots We Were Looking For

New Book: The Monsters of Education Technology 4
Audrey Watters on 31 Oct 2017

The MIT Press Journals
The Smartness Mandate:
Notes toward a Critique

PBS

ALGORITHMIC JUSTICE LEAGUE

JOY BUOLAMWINI
HOW I'M FIGHTING BIAS IN ALGORITHMS

BloombergTechnology

Silicon Valley Tried to Reinvent Schools. Now It's Rebooting

glassdoor 50 Best Jobs in America

Best-Ever Algorithm Found for Huge Streams of Data

Quantamagazine

WIRED
Big data meets Big Brother as China moves to rate its citizens

UNDARK Truth, Beauty, Science.
On Rewarding 'Bullshit': Why Algorithms Should Not Be Grading Essays

FAST COMPANY

Mark Cuban Talks About Funding Packback And The Future Of EdTech

Europe's Brighteye Ventures closes €50M fund to invest in edtech startups

Center for American Progress
New Data Reveal 250 Preschoolers Are Suspended or Expelled Every Day

INSIDE HIGHER ED A Data Paradox

E.U. Data-Protection Law Looms

That Ghostly, Glowing Light Above Canada? It's Just Steve

THE CHRONICLE OF HIGHER EDUCATION Seeking Integrity in EdTech Research – Again

The New York Times

Events

Event	Date	Time	Location	URL
The Provost's Conversation on Online Learning	November 8	4:00pm	Davis Auditorium, Schapiro CEPSR	https://columbia.us11.list-manage.com/track/click?u=8e1c6110b489f734b9985bec5&id=d0b52b0629&e=1cc15b53eb
Funny as Tech	November 7	7:00pm	The People's Improv Theater	https://thepit-nyc.com/event/2017-11-07-funny-as-tech-with-david-ryan-polgar-and-joe-leonardo
The People's Disruption: Platform Co-Ops for Global Challenges	November 10/11	all day	The New School	https://platform.coop/2017
KPMG Technology Career Forum	November 14	1:00pm	Online	https://app.brazenconnect.com/events/X1r8O?utm_medium=Marketing&utm_source=Data+Science+Association#!eventLanding;eventCode=X1r8O
The Role od Ed Research in EdTech	November 9	6:30pm	GDH 177/179	TCCS Link

Plans

- Next week: prediction

- Assignment 5

- November 30 last formal class

- Formative test: Dec 5

- Assignment 6: Group project Dec 7 & 12

- December 14: Everything due

Domain Structure Discovery
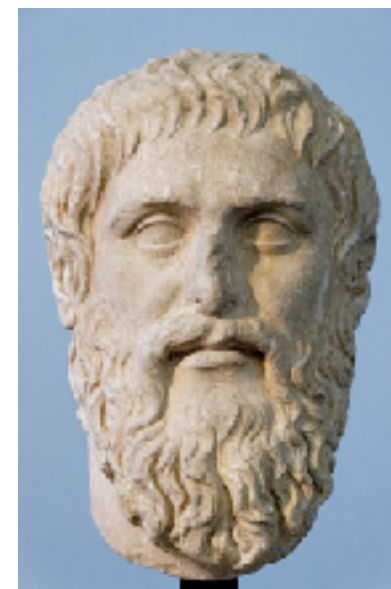
- Identifying the structure of knowledge in a(n) (educational) domain

- We've been at this a while

- Quantified epistemology

Samkhya, Yoga

सांख्य
~500BCE

Plato ~300BCE

孟轲 ~ 200BCE

Domain Structure Discovery

Perception (प्रत्यक्षाय) → Certain indivisible content

Inference (अनुमान) → Infer from perception
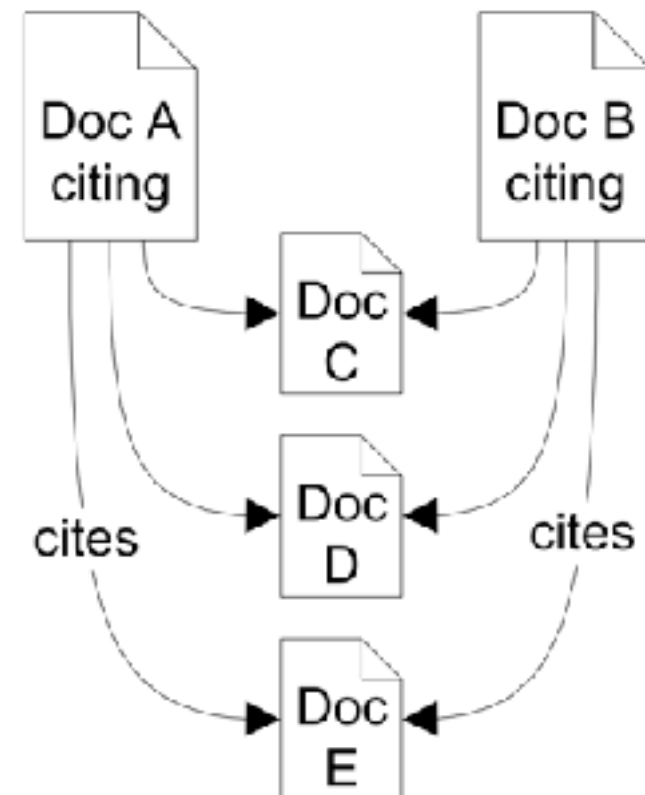
Word(शब्द) Reliable Source → Expert opinion

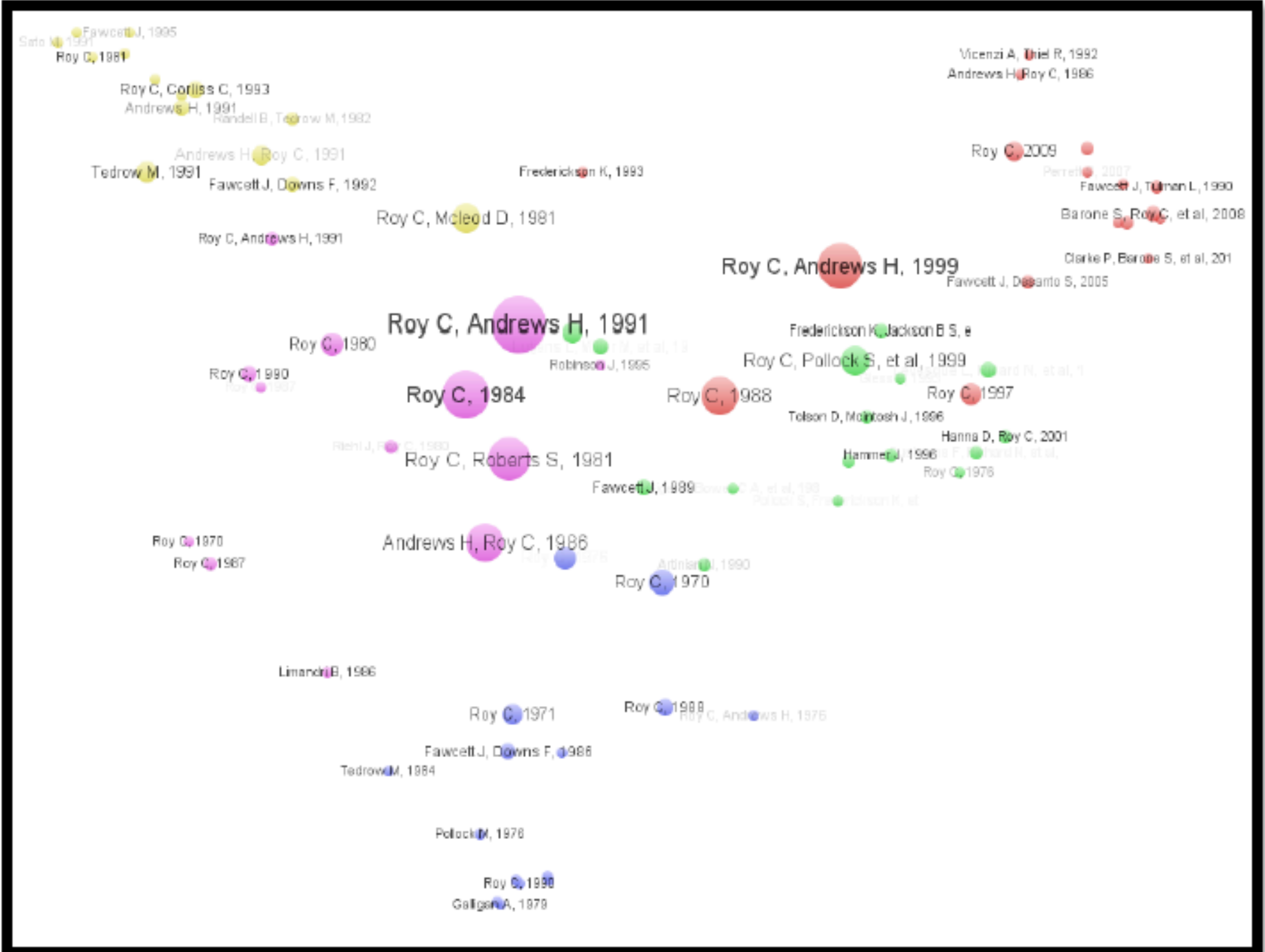Knowledge (ज्ञान)
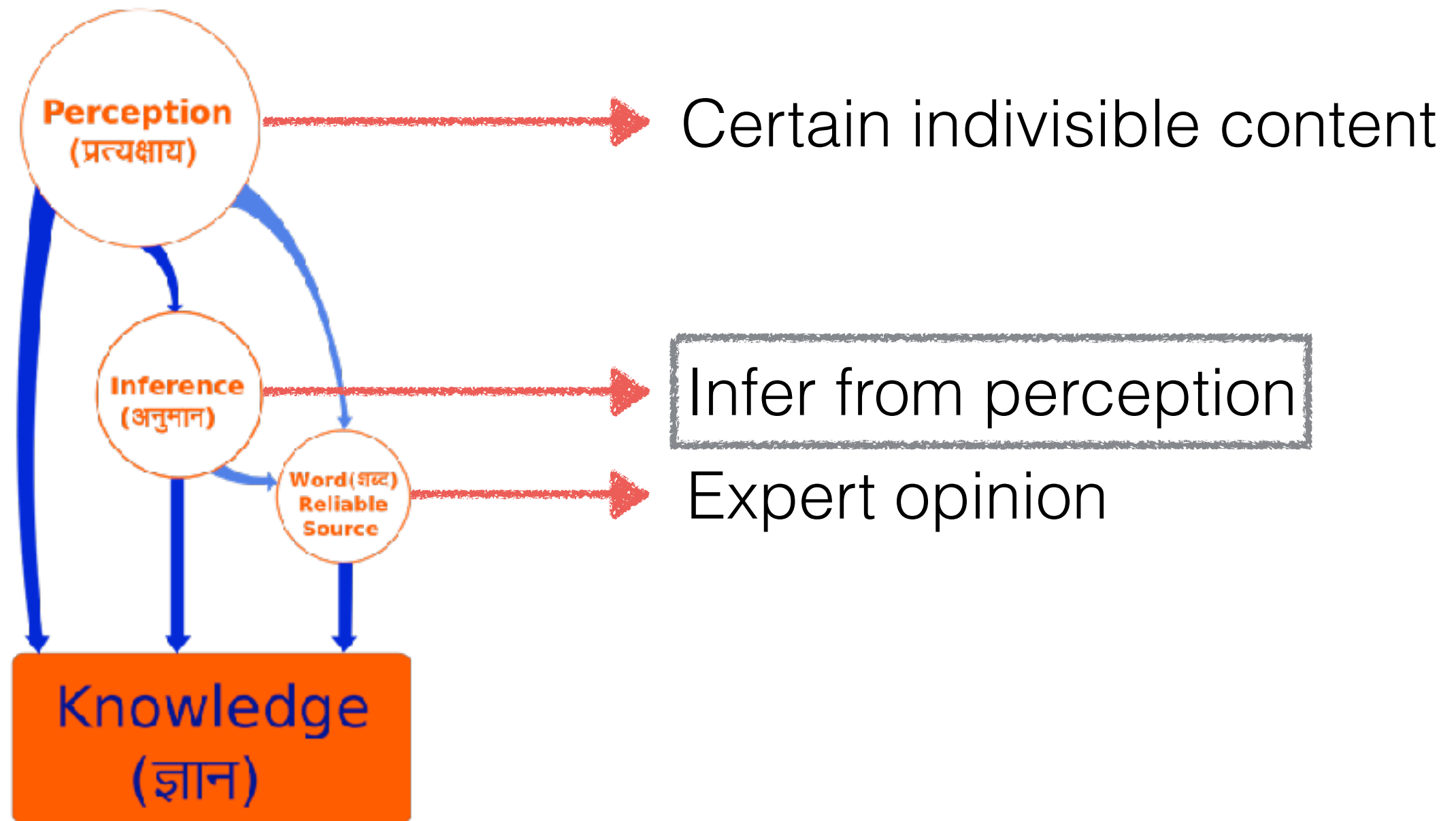
Bibliometrics

(scientometrics, librametry, statistical bibliography)

- Citation patterns

- Raw number (impact score), Erdős Number

- Co-word analysis

- Network representation

Bibliographic Coupling

(Eigenvectors again!)

Fawcett J, 1995
Sato M, 1991
Roy C, 1981
Roy C, Corliss C, 1993
Andrews H, 1991
Randell B, Tedrow M, 1982
Andrews H, Roy C, 1991
Tedrow M, 1991
Fawcett J, Downs F, 1992
Frederickson K, 1993
Roy C, Mcleod D, 1981
Roy C, Andrews H, 1991
Vicenzi A, Thiel R, 1992
Andrews H, Roy C, 1986
Roy C, 2009
Perrett, 2007
Fawcett J, Tulman L, 1990
Barone S, Roy C, et al, 2008
Clarke P, Barone S, et al, 201
Roy C, Andrews H, 1999
Fawcett J, Desanto S, 2005
Roy C, Andrews H, 1991
Frederickson K, Jackson B S, e
Roy C, 1980
Robinson J, 1995
Roy C, Pollock S, et al, 1999
Roy C, 1990
Roy C, 1987
Roy C, 1984
Roy C, 1988
Roy C, 1997
Tolson D, Mcintosh J, 1996
Hanna D, Roy C, 2001
Riehl J, Roy C, 1980
Roy C, Roberts S, 1981
Hammer J, 1996
Roy C, 1976
Fawcett J, 1989
Pollock S, Frederickson K, et
Roy C, 1970
Roy C, 1987
Andrews H, Roy C, 1986
Roy C, 1976
Ardinan J, 1990
Roy C, 1970
Limandri B, 1986
Roy C, 1971
Roy C, 1988
Roy C, Andrews H, 1976
Fawcett J, Downs F, 1986
Tedrow M, 1984
Pollock M, 1976
Roy C, 1990
Galligan A, 1979

Alfonzo, Sakraida, Hastings-Tolsma (2014)

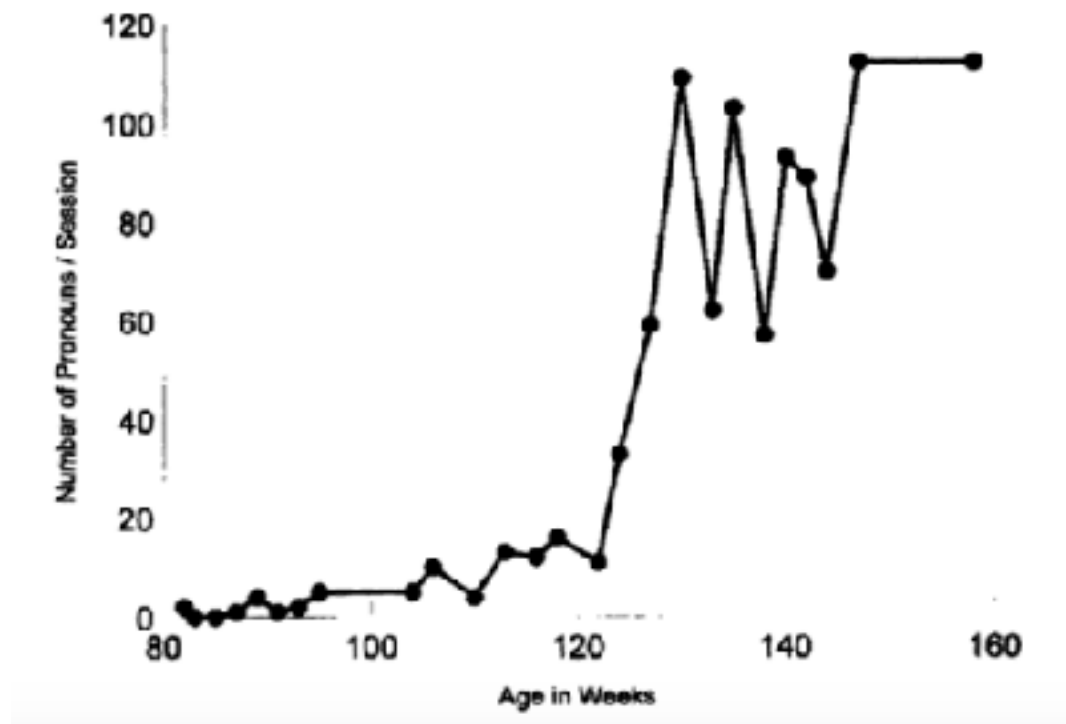Alfonzo, Sakraida,
Hastings-Tolsma (2014)

Latent Variable

Latent variables are variables that are not directly observed but are rather inferred from other variables that are observed and directly measured.
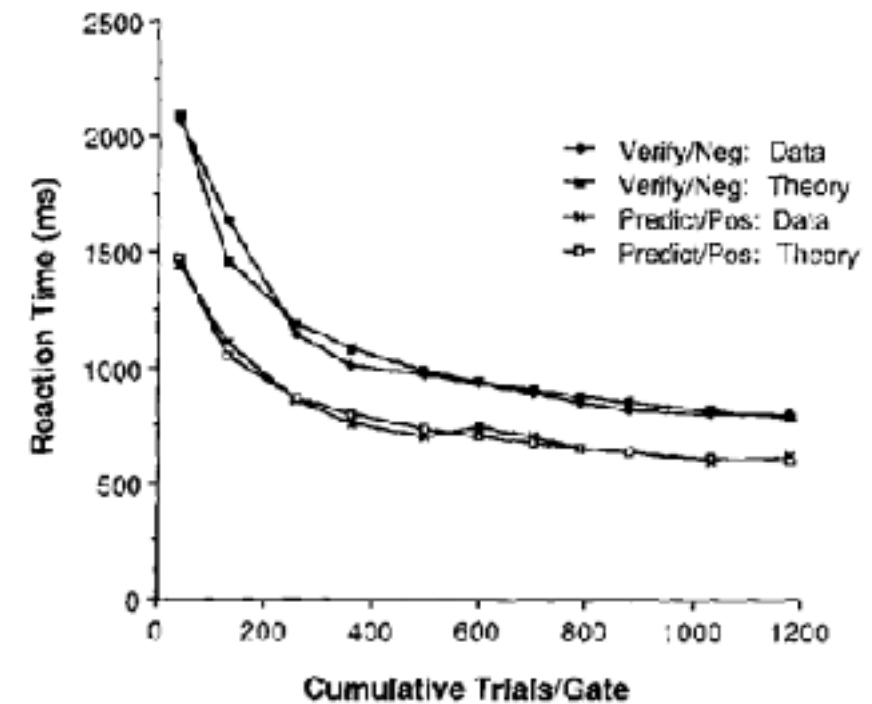
(What isn't a latent variable?)

Skills

Fischer & Yan, 1980

Anderson, 1982

(There is also the whole world of construct validity)

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)

Instructional events

Explanation, lecture, text, rule, example, …

Assessment events

Teacher-student discussion, step in ITS, …

Exam, belief survey, …

KEY
Ovals – observable
Rectangles - inferred
Arrows – causal links

Learning events

Knowledge Components
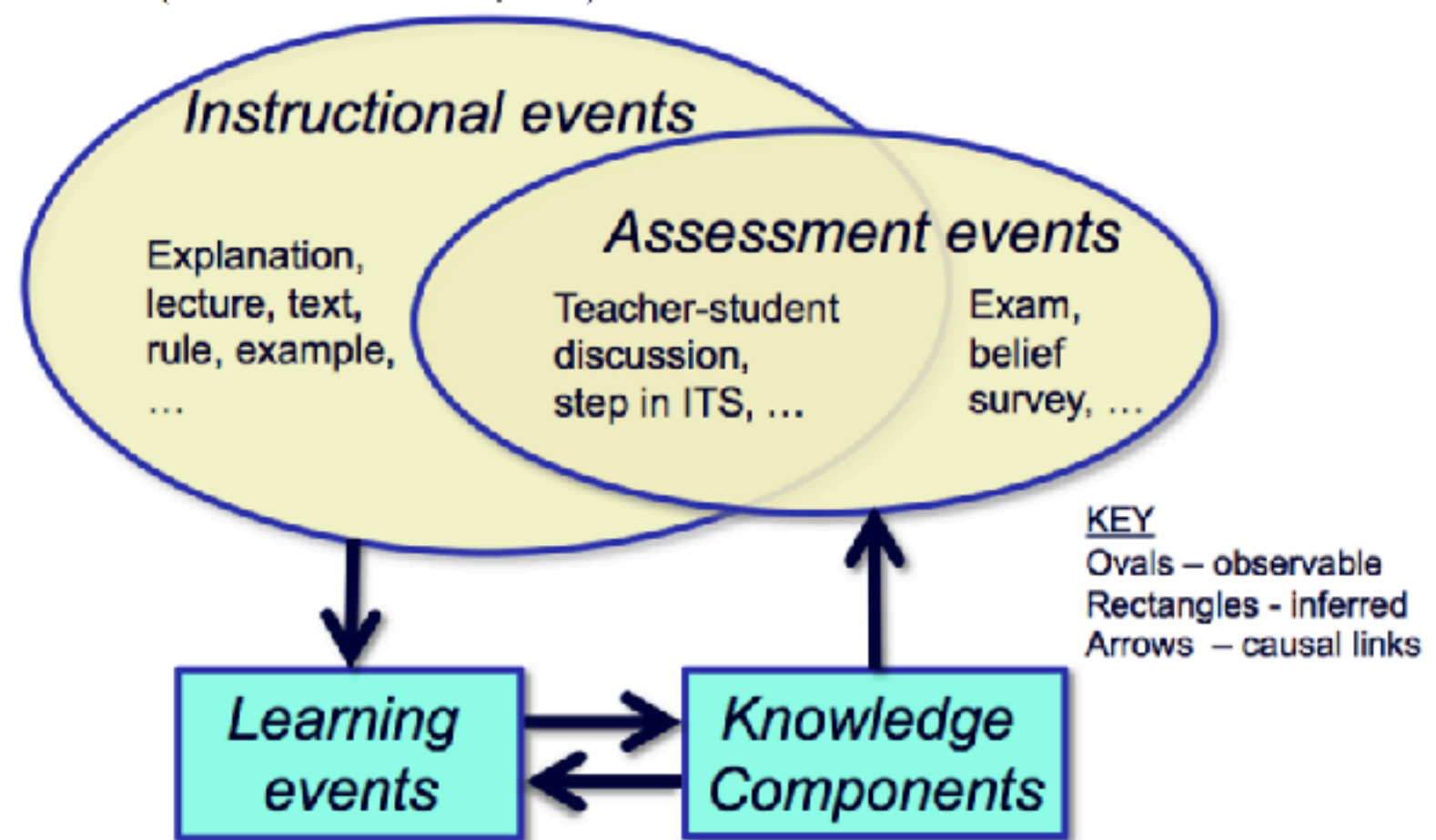
Q-Matrices

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

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

	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)

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)

One Solution

- Create idealized patterns

- Compare the observed pattern to the idealized

- Use difference between them as an indicator of "model fit"

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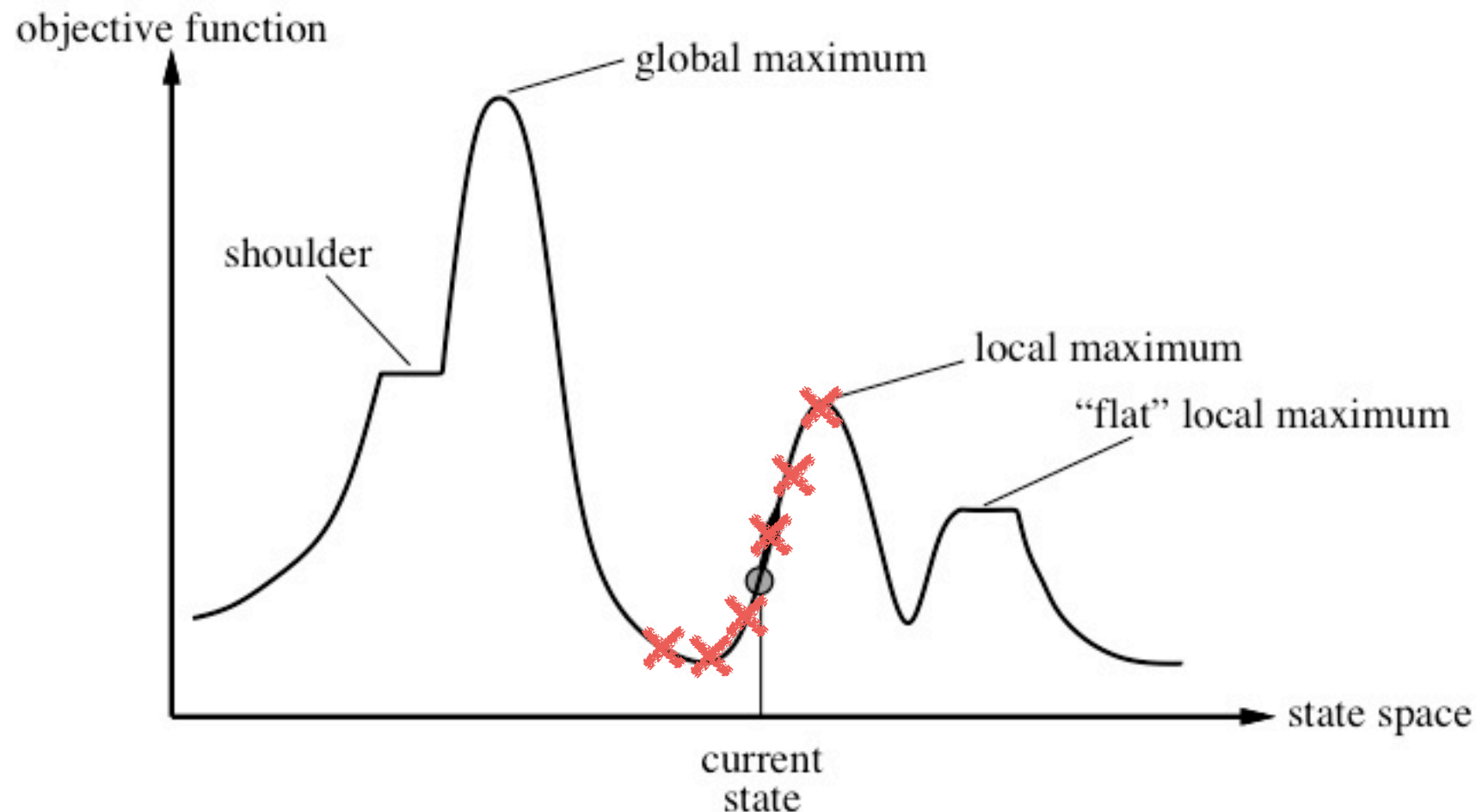
- If we stop too early might only capture a local maxima
- This is a "heuristic" algorithm - when problem is not algebraically solvable or would take too long
- State description contains all the information needed to find a solution

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

Student Answer: 101110

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

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

$$L_1 = 1$$

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

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

Concept State	Students
000	A,D,X
001	B,M,N
010	C,E
011	F,G,H
100	I,J,K,L
101	O,W
110	P,Q,R,S
111	T,U,V,Z
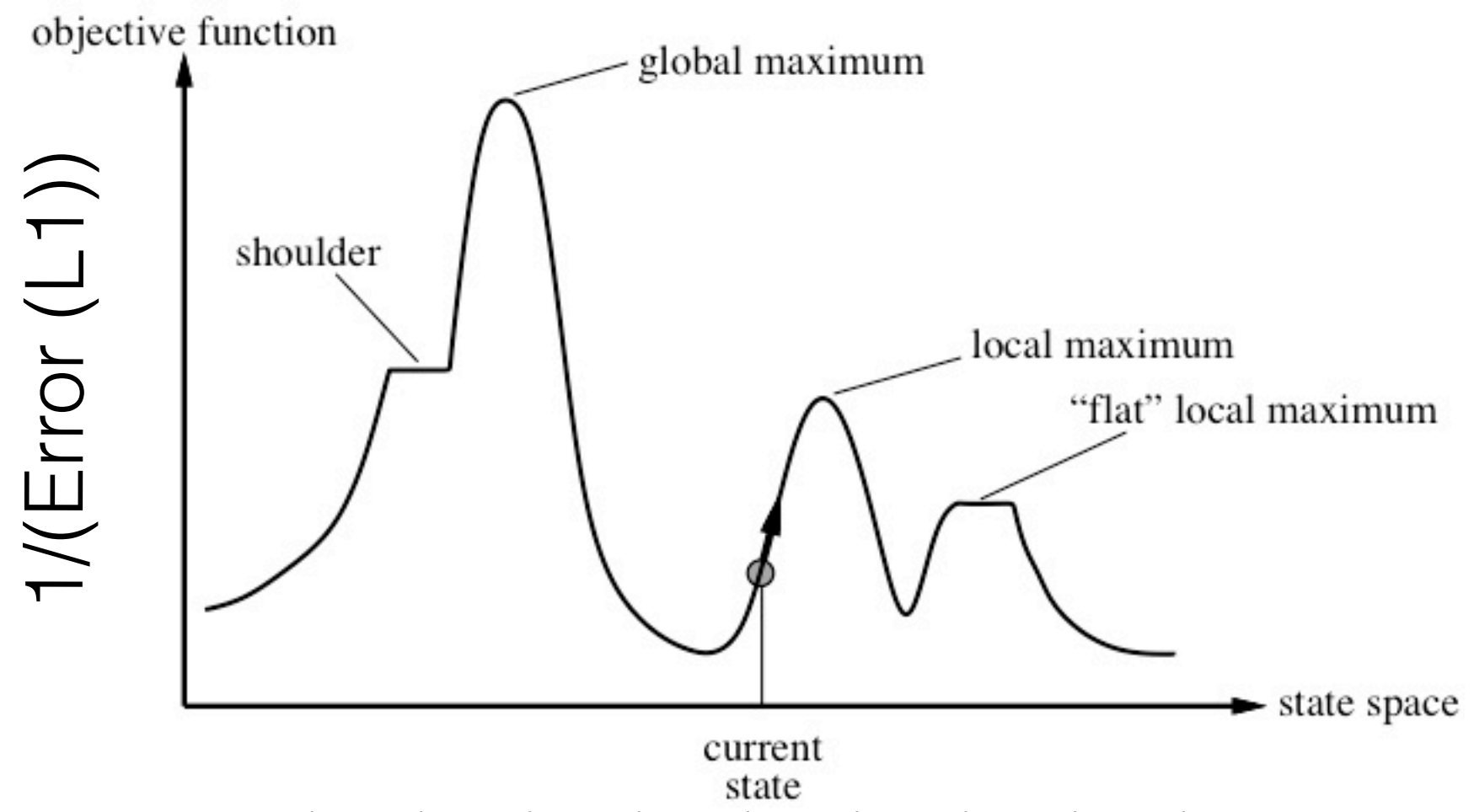
0	0	0	0	1	1	0	1	0	Q1
0	0	0	1	1	0	1	0	1	Q2
0	0	1	1	1	0	1	1	0	Q3
0	1	1	1	1	1	0	0	1	Q4

Answers

	Q1	Q2	Q3	Q4	Q5	Q8	Q9	Q8	Q9	Q10	Q11
Ans	2	4	3	4	2	4	2	2	3	3	4

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	

Concept State	IDR
00000	00000000000
00001	00000010000
00010	00010000000
00011	00010010000
10100	10100000101
10101	10100010111
10111	11110011111
11000	00101000000
11100	10101000101
11110	11111100101
01111	00010110111
01000	00000000000
01010	00000100000
01101	00010010111
01110	00010100101
11111	11111111111

- Find the IDR closest to your own
- There are two "all zero"
- Count how many digits are different to your answer

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 metal states" (constructs? knowledge states? skill definitions?)

Lykken | Bors-boom | de la Torre | Xu | Cron-bach | Fischer | Adkins | Banaji | Steele
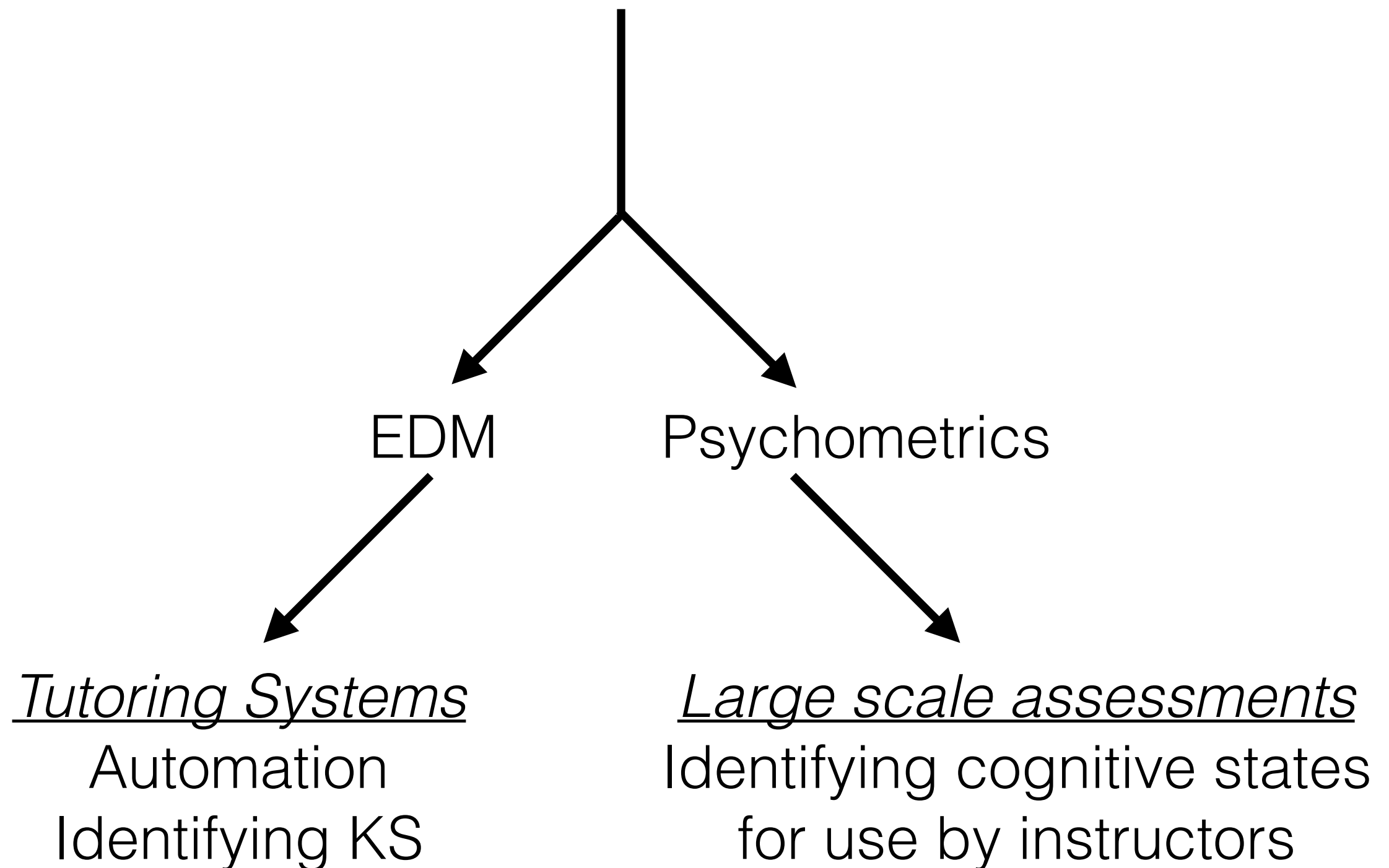
No — Can this problem be solved? — Yes

Divergence by Domain

EDM

Psychometrics

Tutoring Systems
Automation
Identifying KS

Large scale assessments
Identifying cognitive states
for use by instructors

Activity: Build Q-M

- Get into groups

- Agree on a topic

- Agree on concepts within that topic

- Devise some questions that relate to the concepts

- Map the concepts to those questions

- Email your answer to me with TEAM NAME

One Solution

- Create idealized patterns

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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

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

$L_1 = \ 1$

Student Answer:
101110

Concept State	Ideal Response Vector
000	000010
001	001010
010	000110
011	011110
100	000011
101	001110
110	000111
111	111111