Scott E Page
University of Michigan
Santa Fe Institute

Diversity Bonuses:
How Are Differences Make Us Better At What We Do

Outline

Outline

Diversity Bonuses In Context

Problem Solving

Prediction

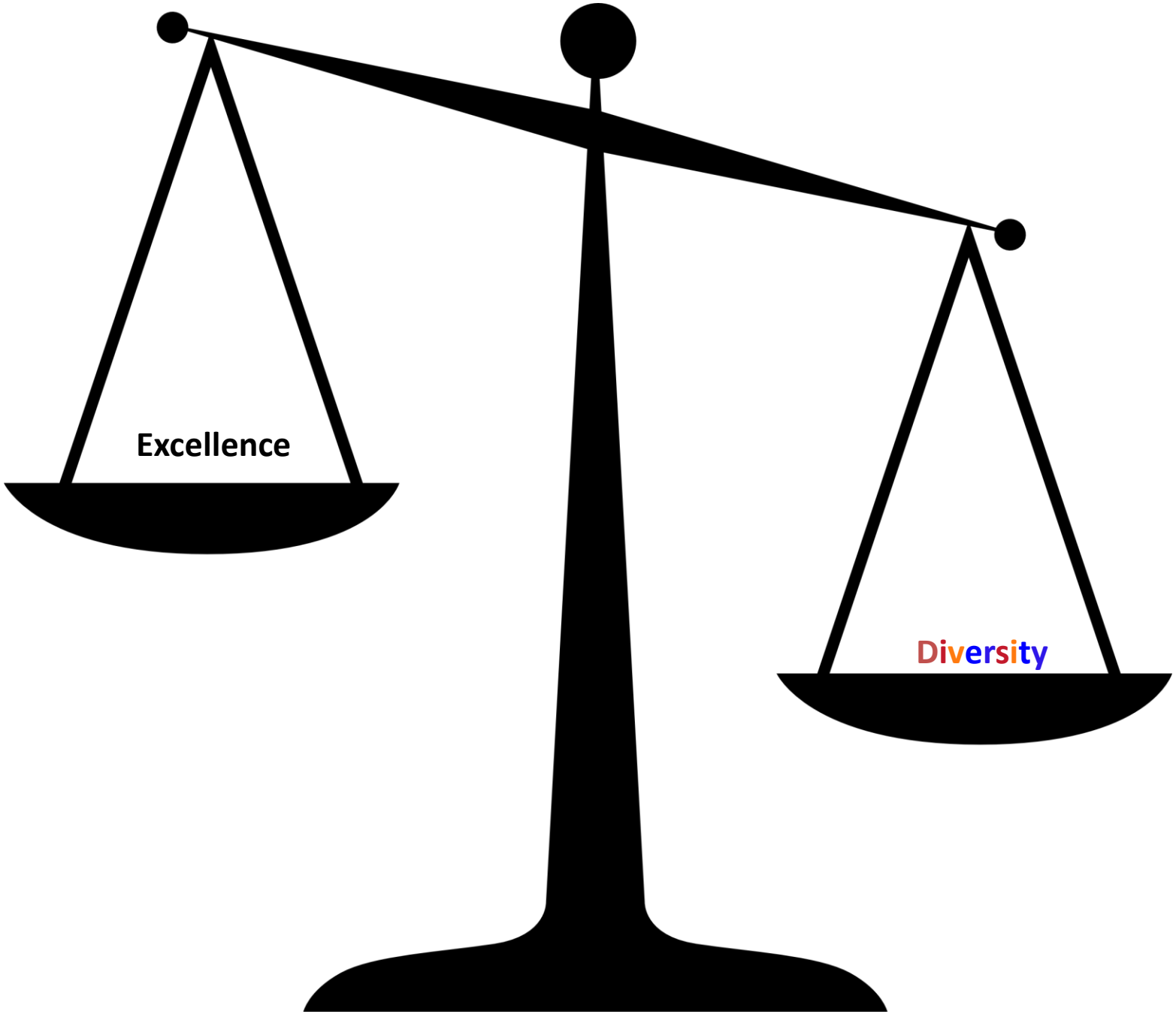
Aside: Identity Diversity

Practice

Diversity Bonuses In Context

Right Thing to Do

(Normative Ought)


Excellence
Diversity

Identity Based Knowledge

Diversity 3.0

Mark Nivet AAMC

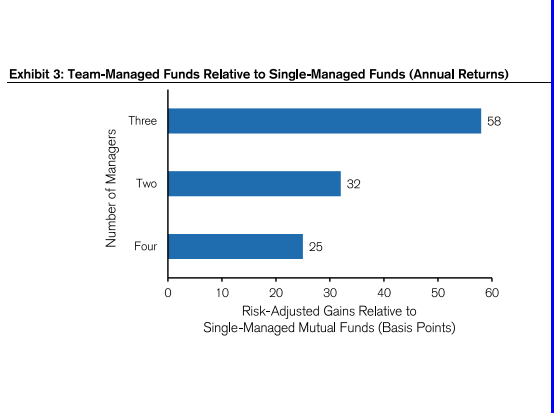
Diversity Bonuses: Cognitive Diversity Produces Better Outcomes on Difficult Tasks

Logic

Crowd Error = Average Error - Diversity

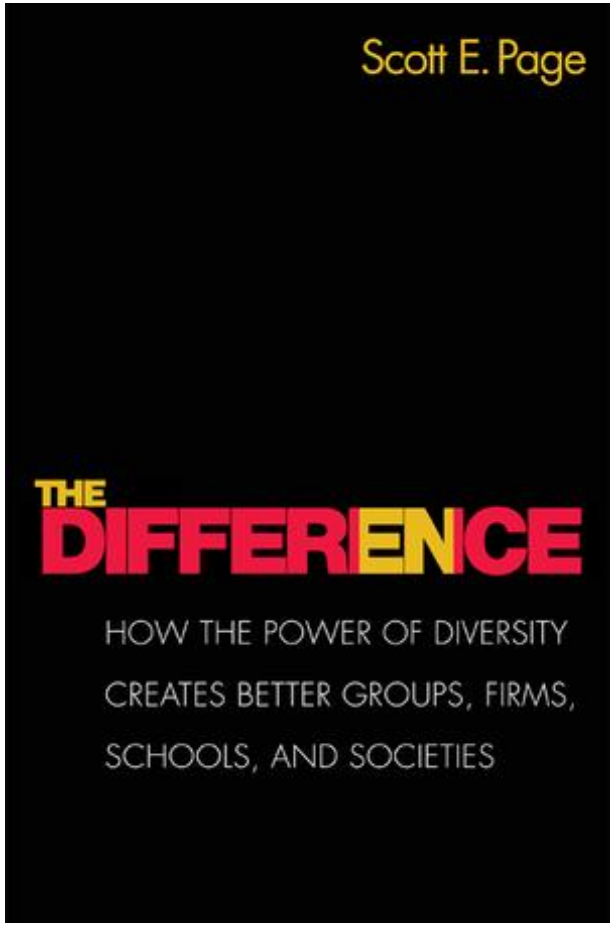
$$(c - \theta)^2 = \frac{1}{n}\sum_{i=1}^{n}(s_i - \theta)^2 - \frac{1}{n}\sum_{i=1}^{n}(s_i - c)^2$$

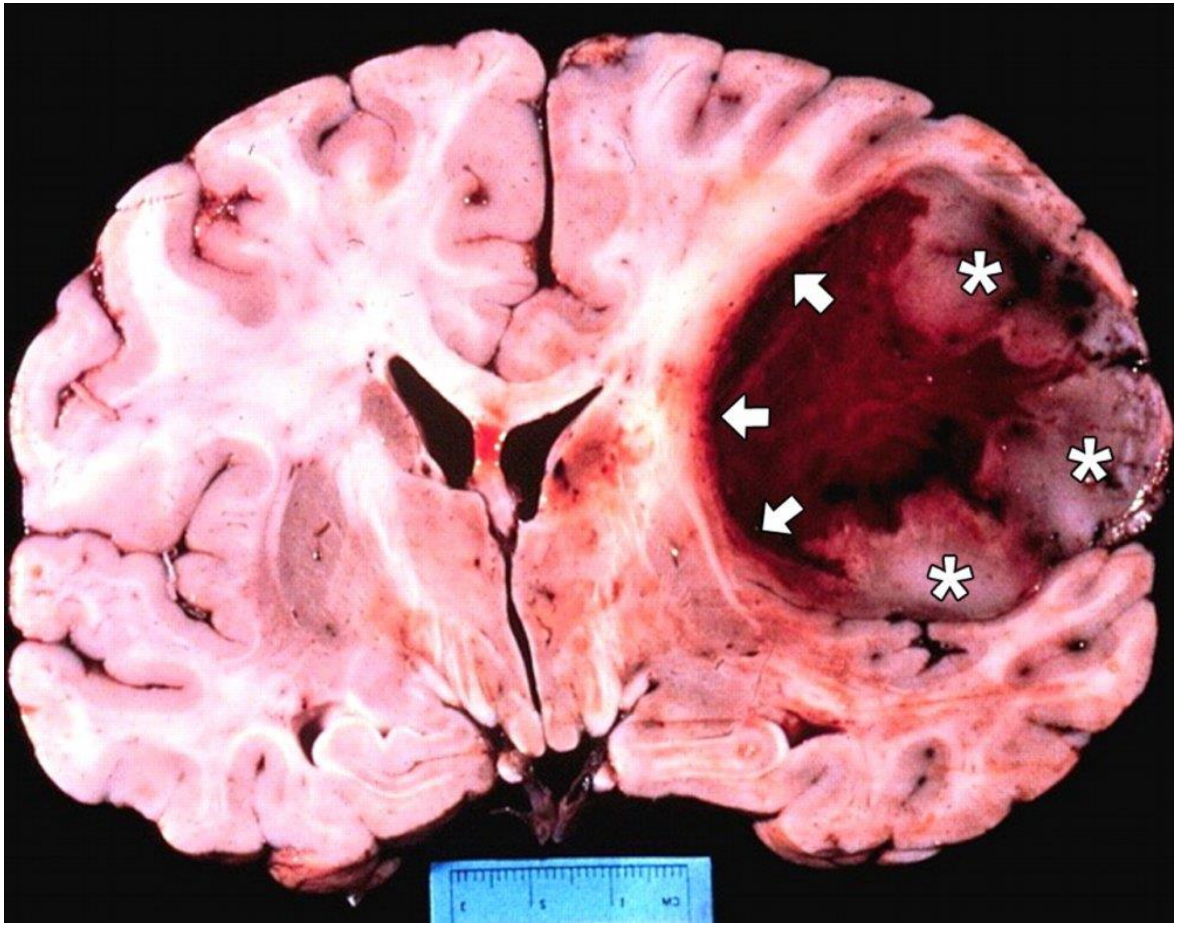
Data



The Checklist Manifesto

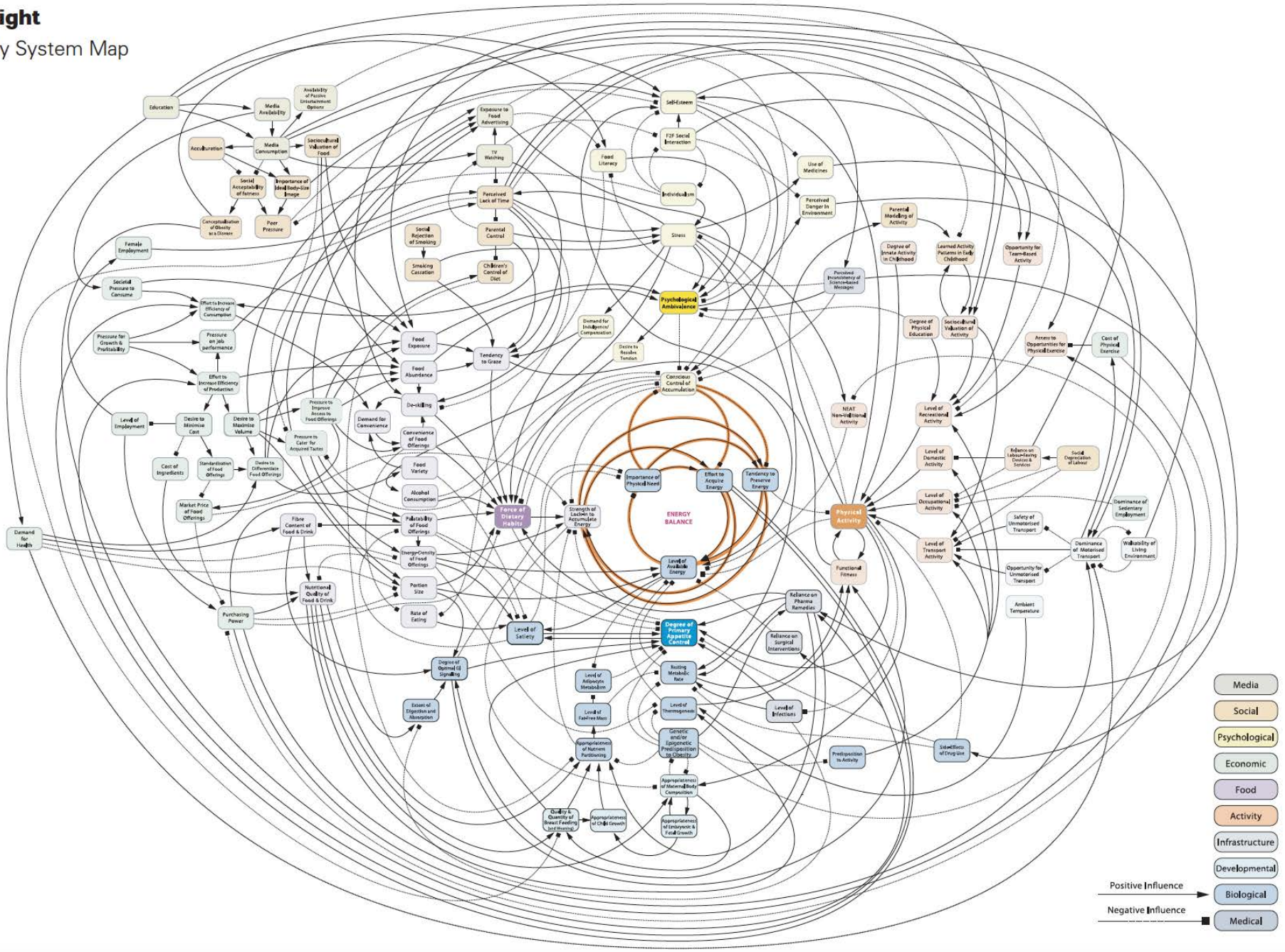
Author: Atul Gawande

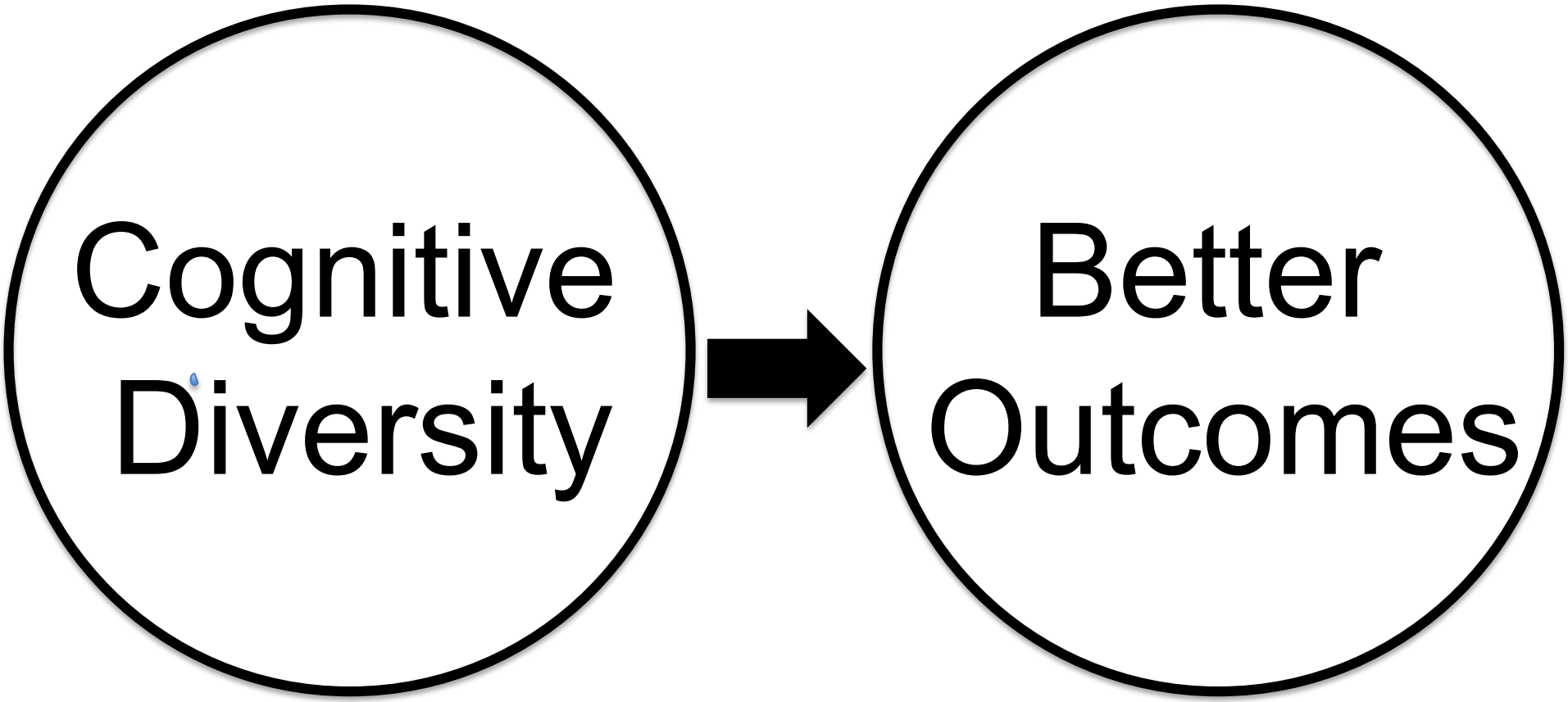

Scott E. Page
THE DIFFERENCE
HOW THE POWER OF DIVERSITY CREATES BETTER GROUPS, FIRMS, SCHOOLS, AND SOCIETIES

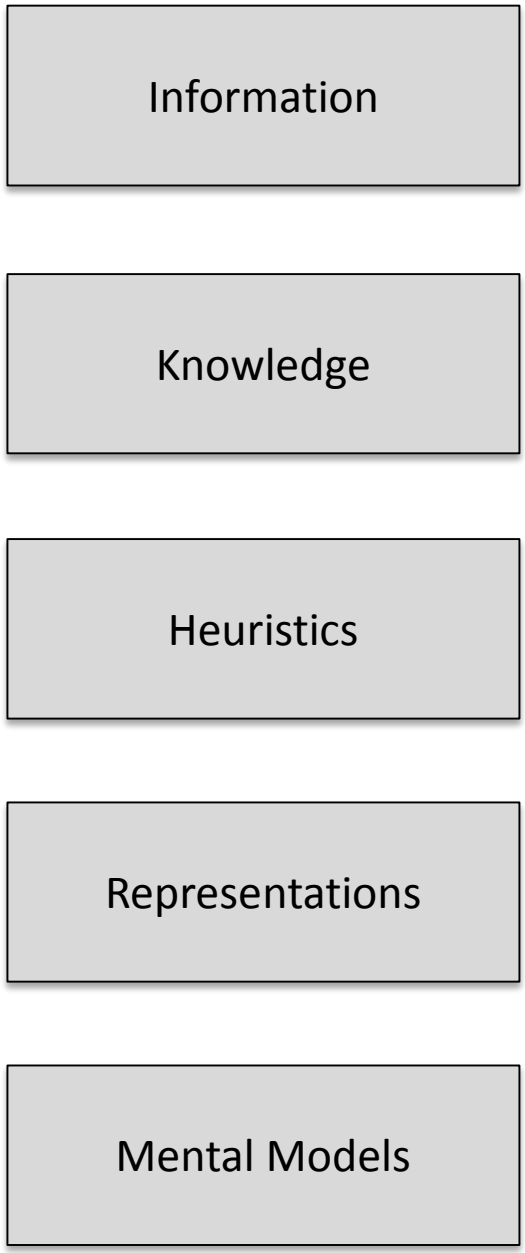


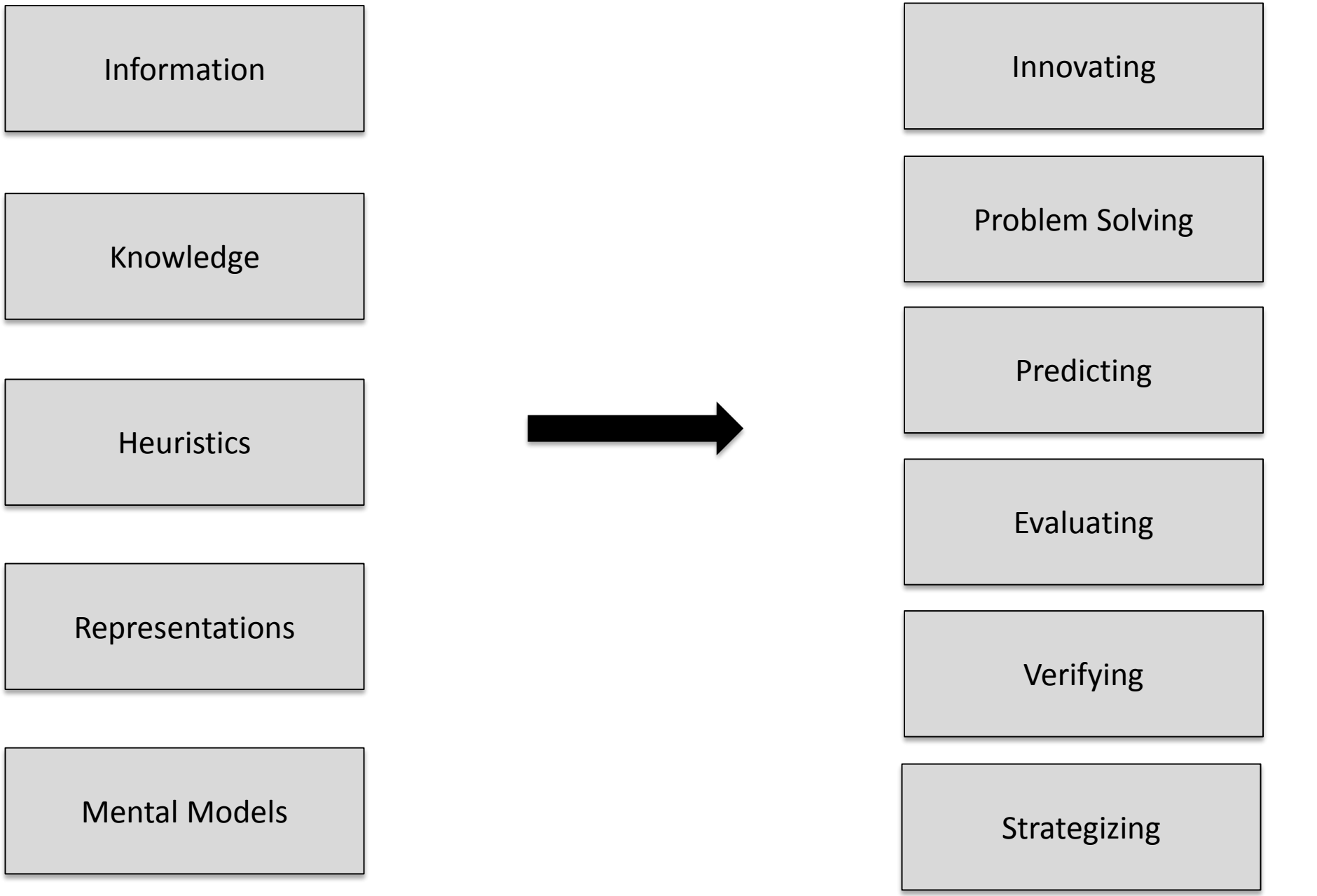
Foresight

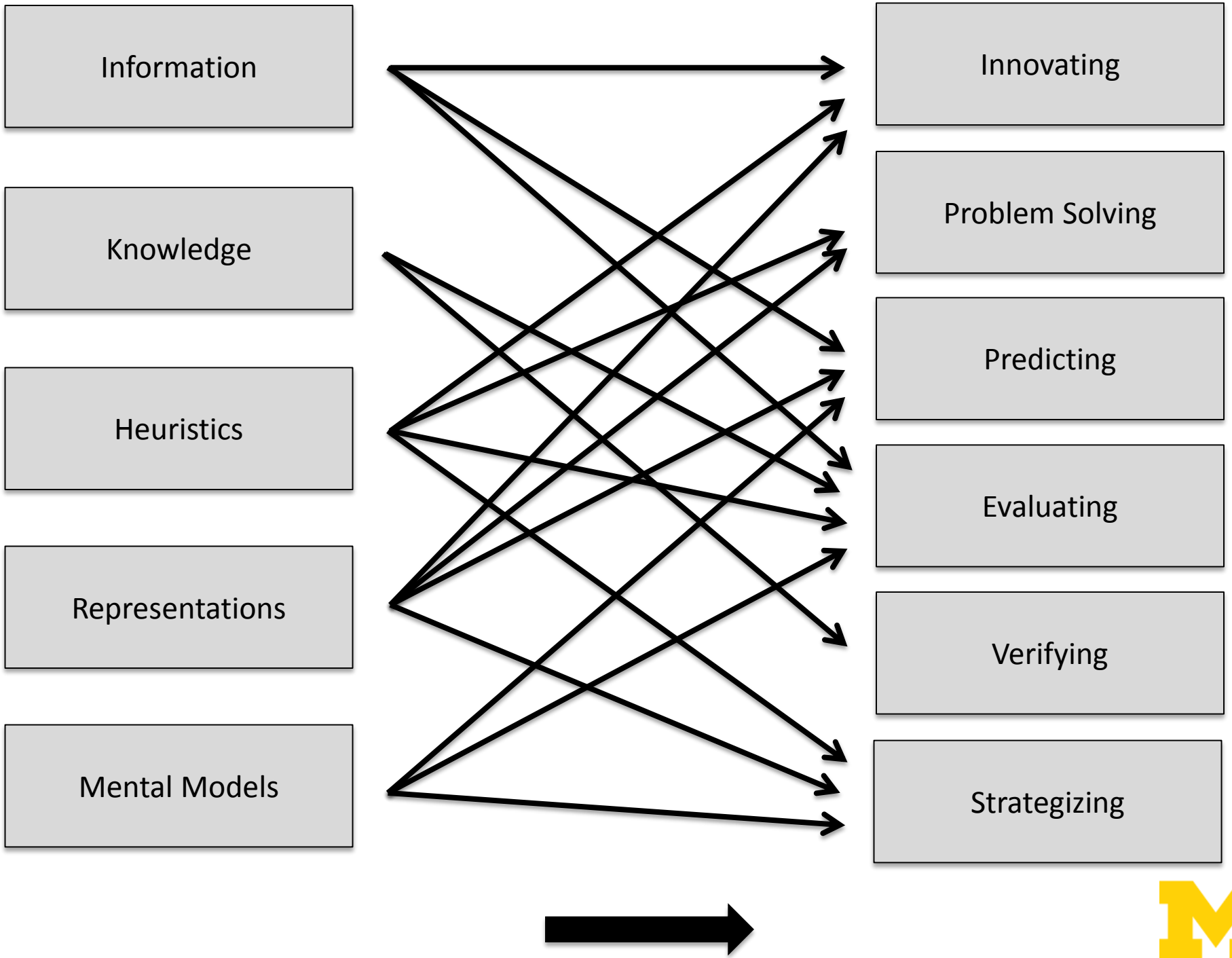
Obesity System Map




Cognitive Diversity
Better Outcomes


Information
Knowledge
Heuristics
Representations
Mental Models


Information
Knowledge
Heuristics
Representations
Mental Models
Innovating
Problem Solving
Predicting
Evaluating
Verifying
Strategizing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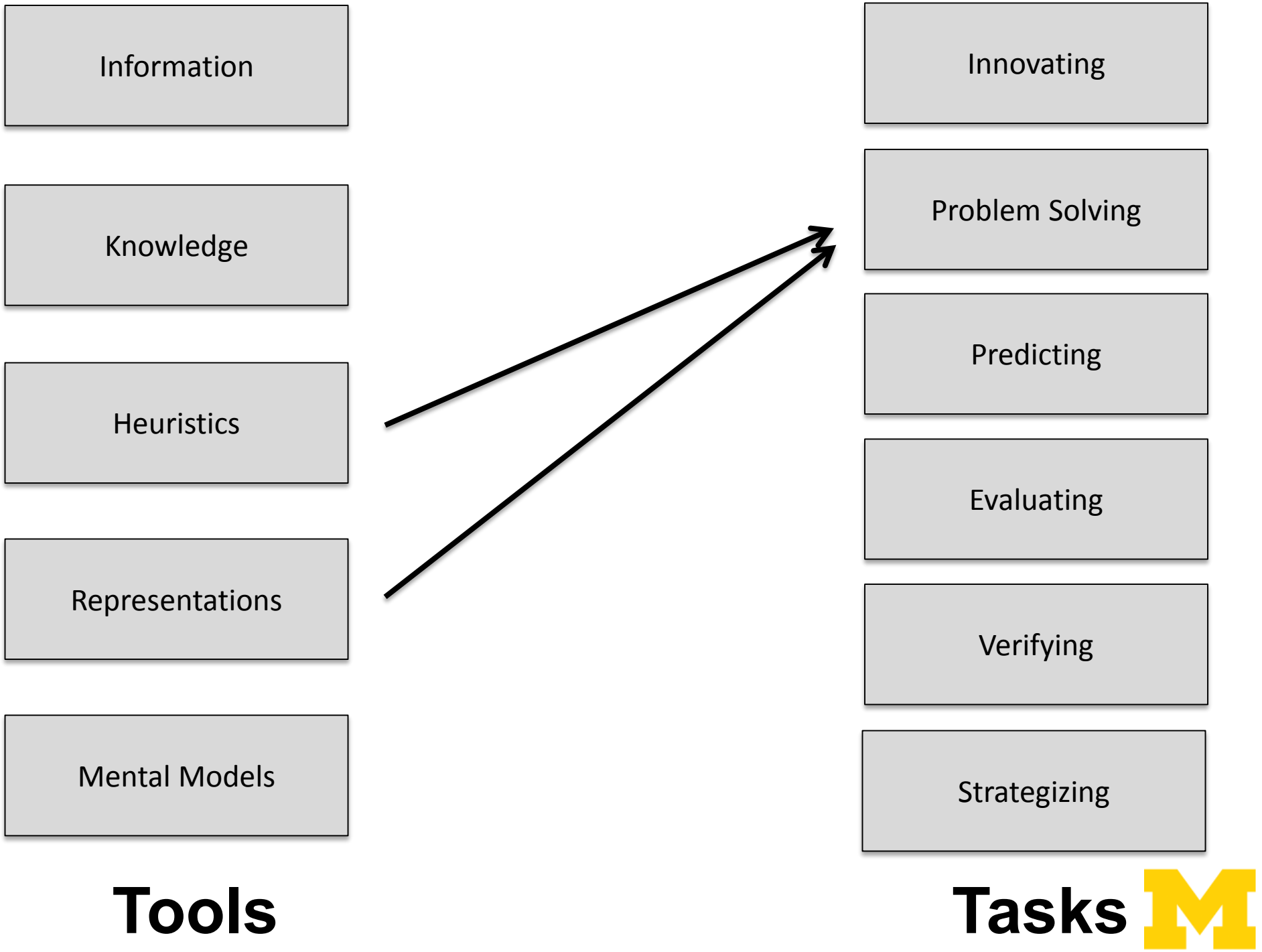
Problem Solving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Predicting
Evaluating
Verifying
Strategizing
Tools
Tasks

A Test

Create a collection of agents with diverse **perspectives** and **heuristics**

Rank them by their performance on a problem.

Note: all of the agents must be “smart”

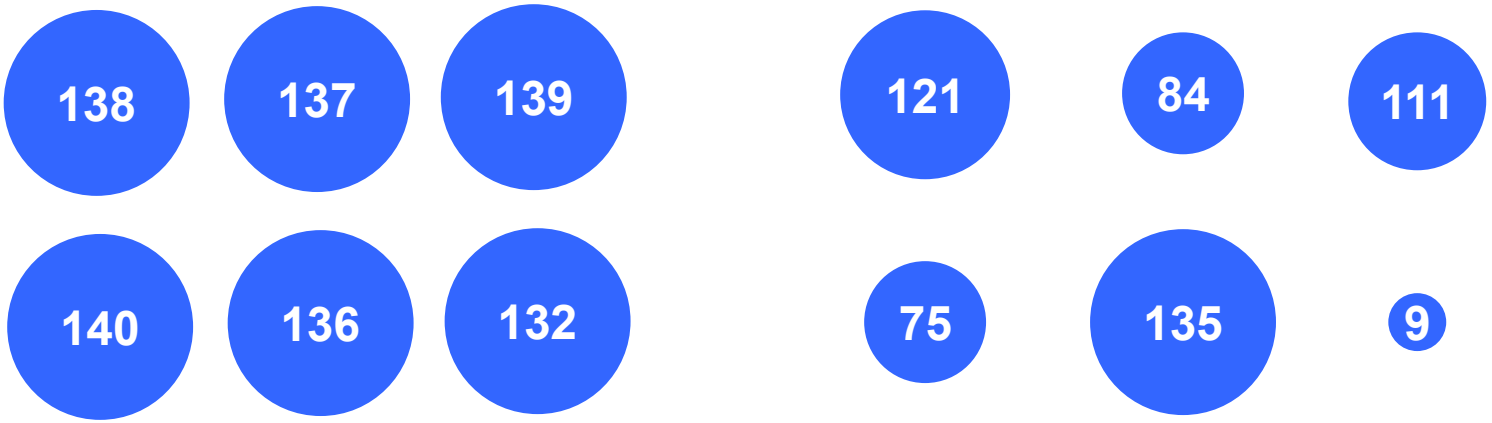
Experiment

Group 1: Best 20 agents

Group 2: Random 20 agents

Have each group work collectively - when one agent gets stuck at a point, another agent tries to find a further improvement. Group stops when no one can find a better solution.

The IQ View



The diverse group almost always outperforms the group of the best by a substantial margin.

Lu Hong and Scott Page

Proceedings of the National Academy of Sciences (2002)

What Must be True?

Calculus Condition: *Problem solvers must all be smart-*
-we must be able to list their local optima

Diversity Condition: *Problem solvers must have*
diverse heuristics and perspectives

Hard Problem Condition: *Problem itself must be difficult*

Kleinberg Raghu Model:

Each person is a distribution over solutions.

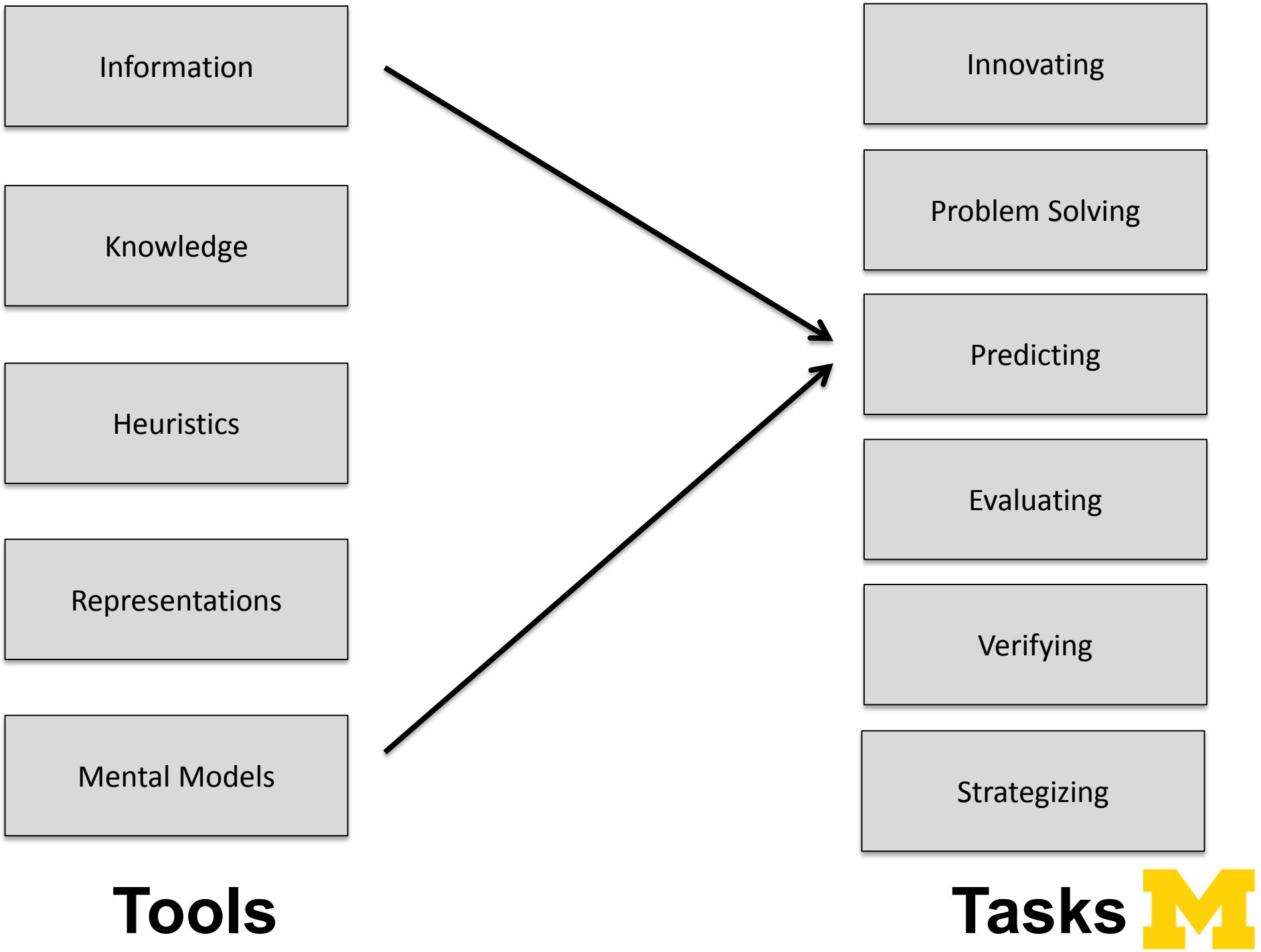
Team value equals function of solutions.

`` *We also show families of submodular and supermodular team performance functions for which no test applied to individuals can produce near-optimal teams.”*

*J*on Kleinberg, and Maithra Raghu, Cornell University, Ithaca NY

No Single Test Determines the Best Team If the Problem is Hard.

Prediction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The Wisdom of Crowds

Author: James Surowiecki

Diversity Prediction Theorem

Crowd Error = Average Error - Diversity

$$(c - q)^2 = \frac{1}{n}\sum_{i=1}^{n}(s_i - q)^2 - \frac{1}{n}\sum_{i=1}^{n}(s_i - c)^2$$

Crowd Error = Average Error – Diversity

$$0.6 = 2{,}956.0 - 2955.4$$

Six years of data
Half million users
17,700 movies

Data divided into (training, testing)
Testing Data dived into (probe, quiz, test)

Singular Value Decomposition

Each movie represented by a vector:

$(p_1,p_2,p_3,p_{4\ldots}p_n)$

Each person represented by a vector:

$(q_1,q_2,q_3,q_{4\ldots}q_n)$

BellKor

- 50 dimensions
- 107 models

Best Model: 6.8% Improvement

BellKor

- 50 dimensions
- 107 models

Best Model: 6.8% improvement

Combination of Models: 8.4%

BellKor's Pragmatic Chaos

Best Model 8.4%

Ensemble: 10.1%

Enter ``The Ensemble''

23 Teams

30 Countries

And the Winner is…

Ensemble	10.06%
Bellkor	10.06%

But, the Real Winner is…

Ensemble	10.06%
Bellkor	10.06%
50-50 Combination	**10.19%**

Economic Forecasts

1969-2009

28,000 forecasts by professional economists

6 economic indicators

Crowd mean 21% better than average person

Mannes, A. E., Soll, J. B., & Larrick, R. P. (2014). The wisdom of select crowds. Journal of Personality and Social Psychology, 107, 276-299.

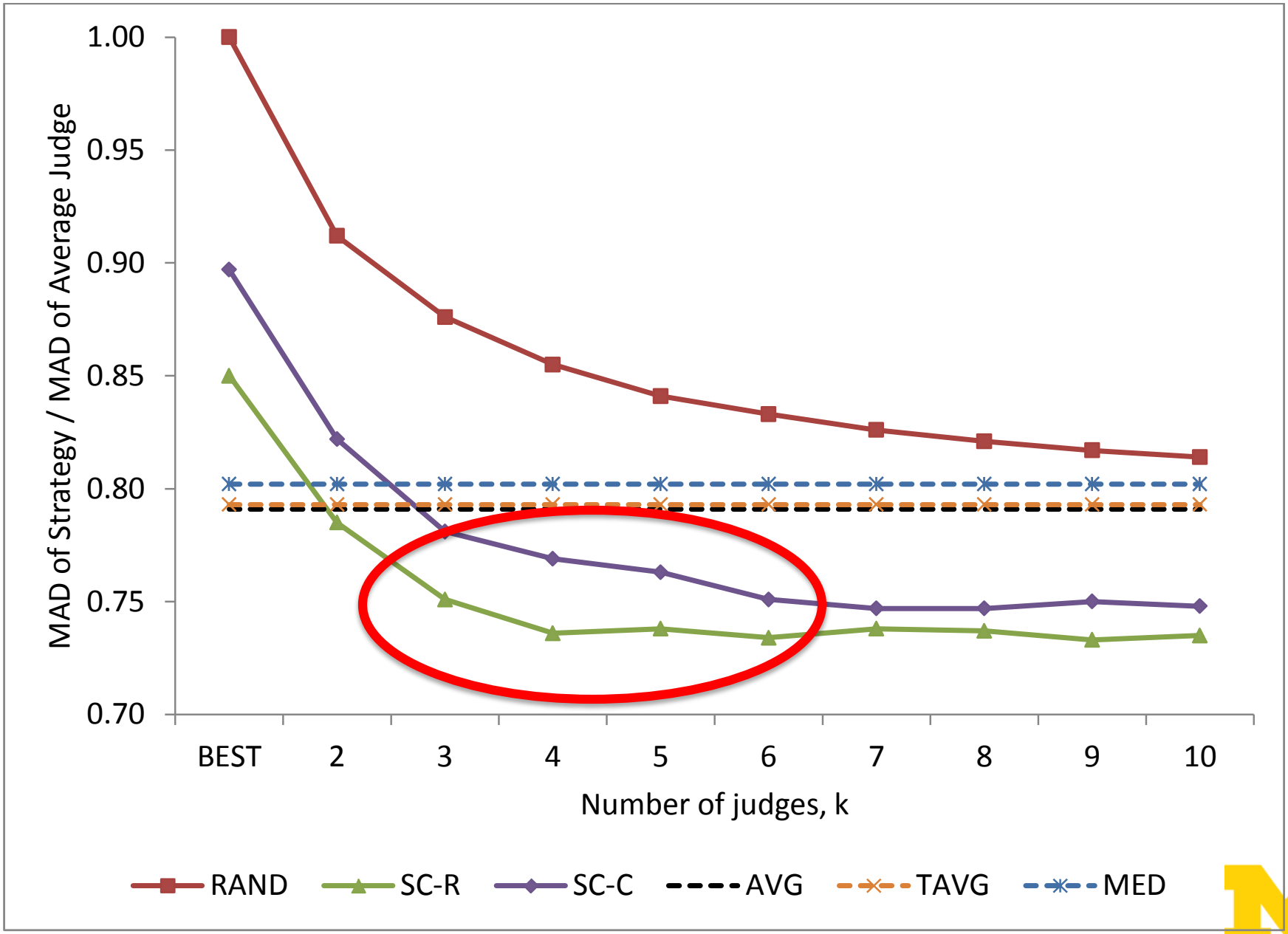
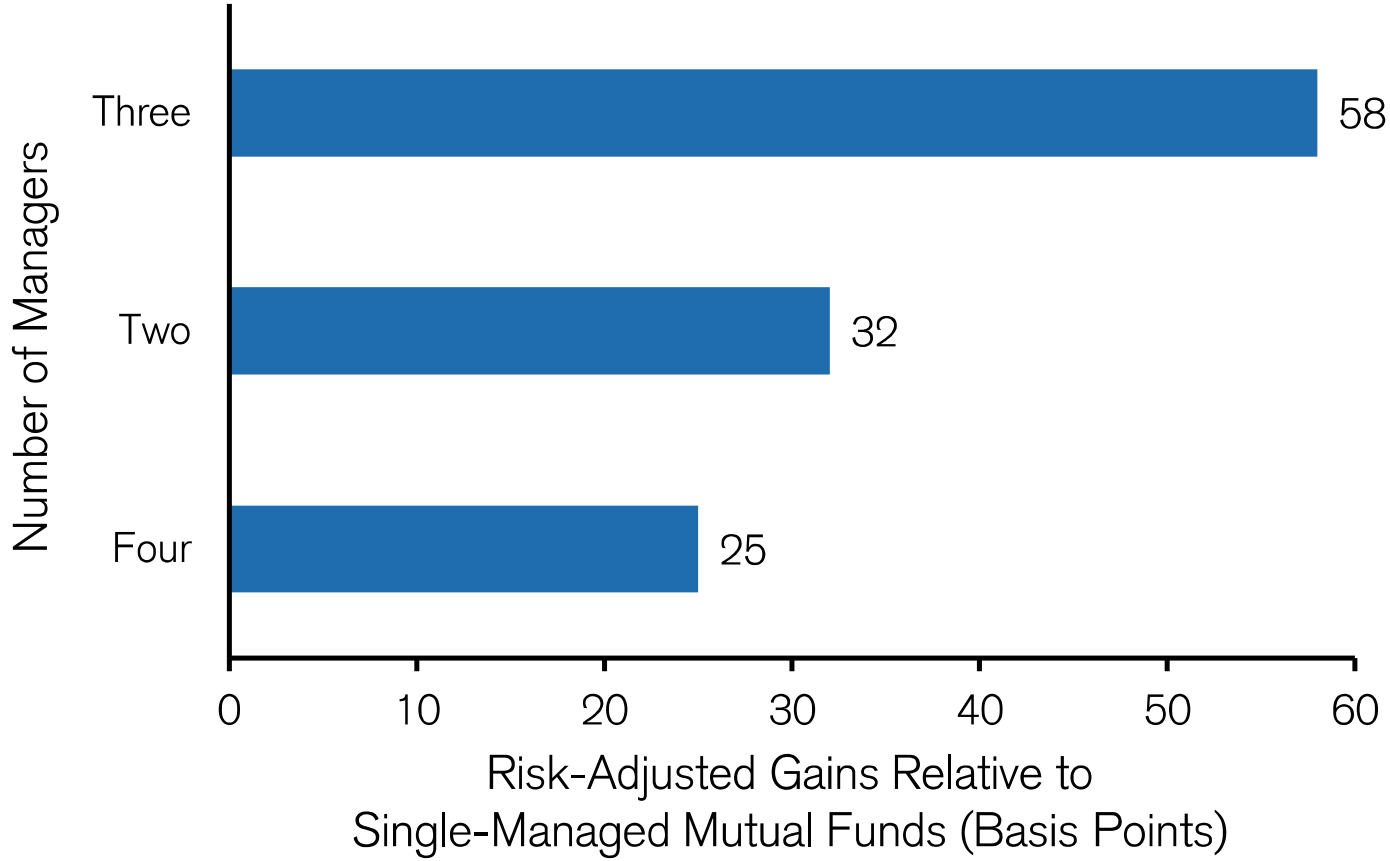
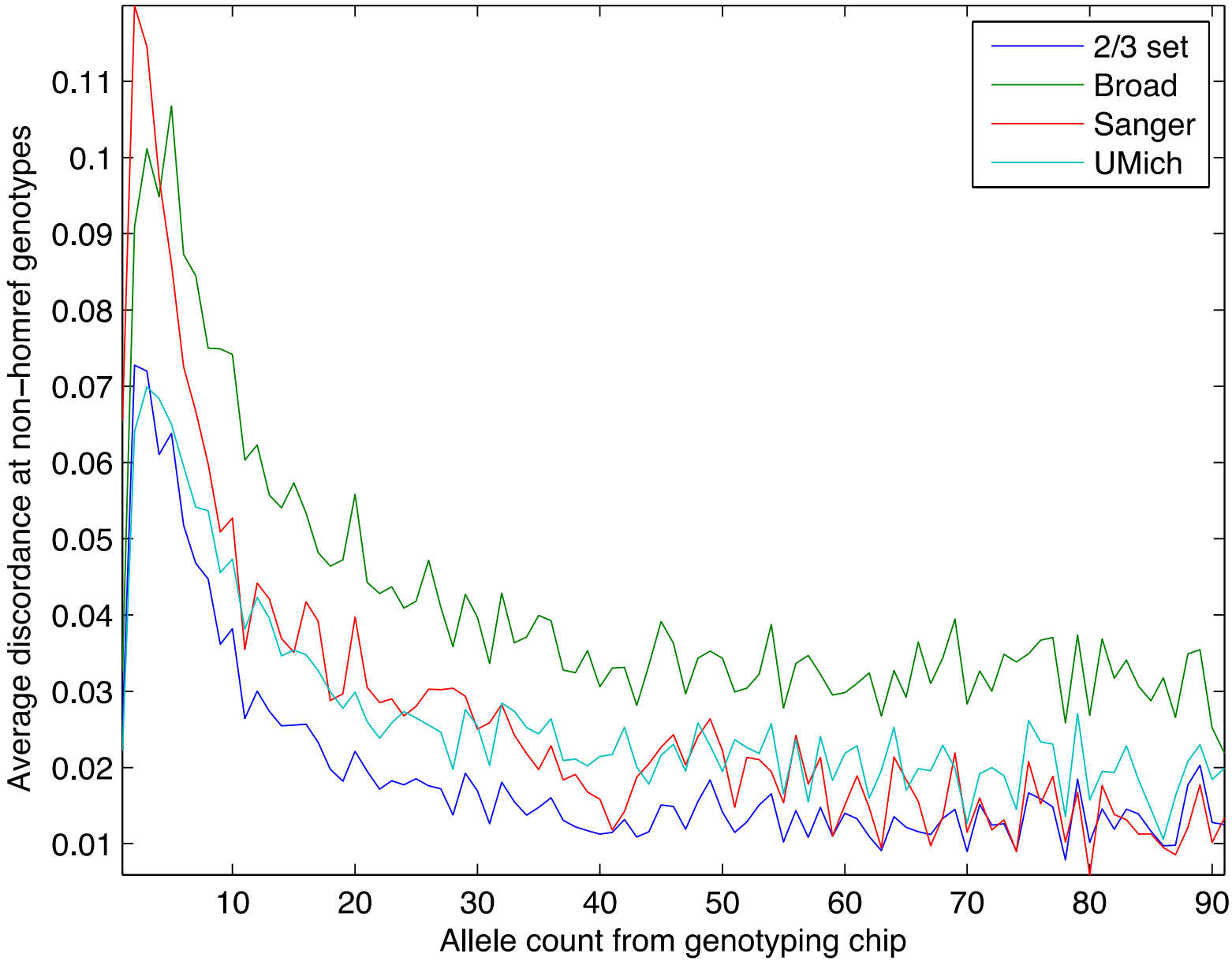

1.00
0.95
0.90
0.85
0.80
0.75
0.70
MAD of Strategy / MAD of Average Judge
BEST
2
3
4
5
6
7
8
9
10
Number of judges, k
RAND
SC-R
SC-C
AVG
TAVG
MED

Exhibit 3: Team-Managed Funds Relative to Single-Managed Funds (Annual Returns)

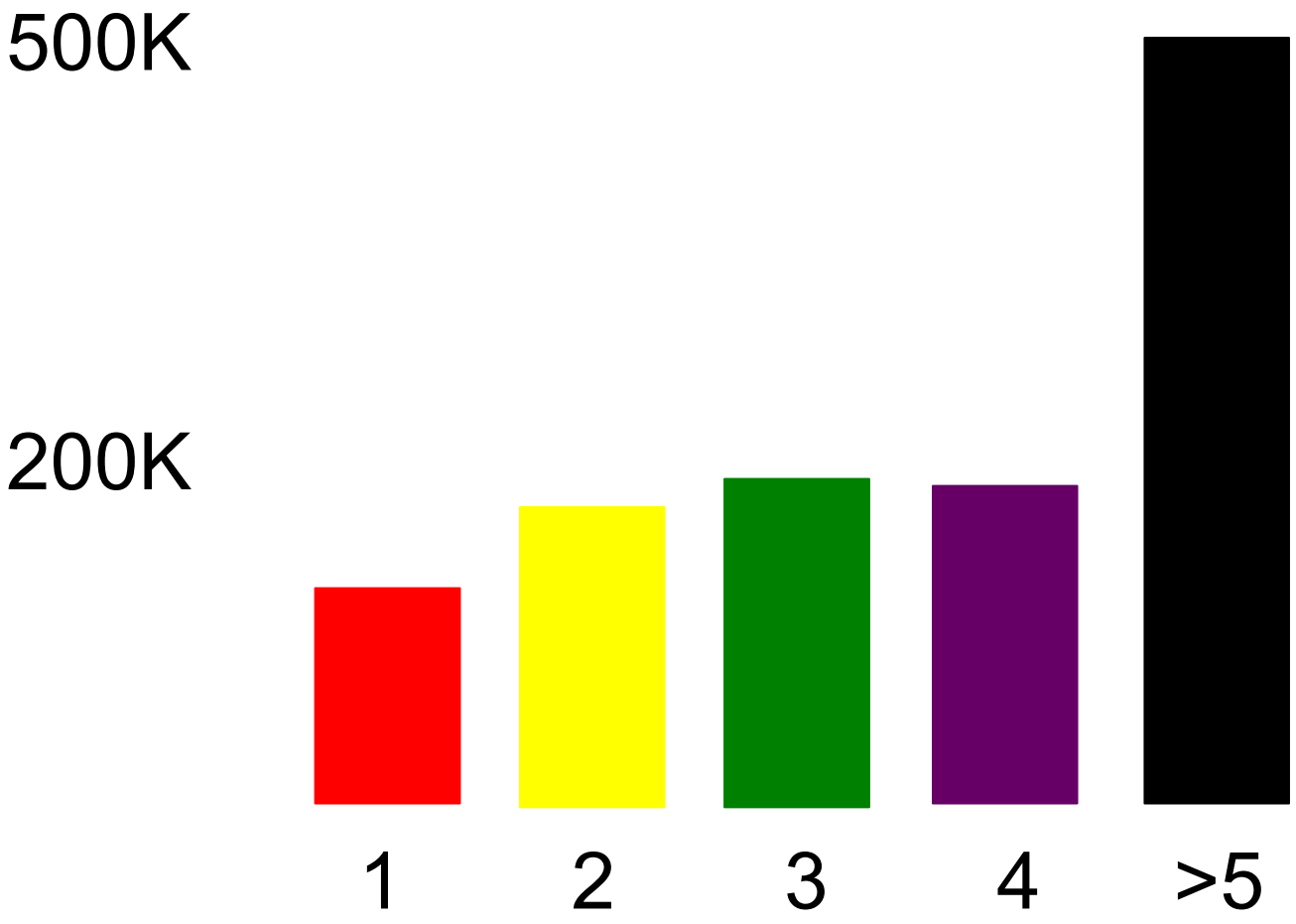



2/3 set
Broad
Sanger
UMich
Average discordance at non−homref genotypes
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
10
20
30
40
50
60
70
80
90
Allele count from genotyping chip

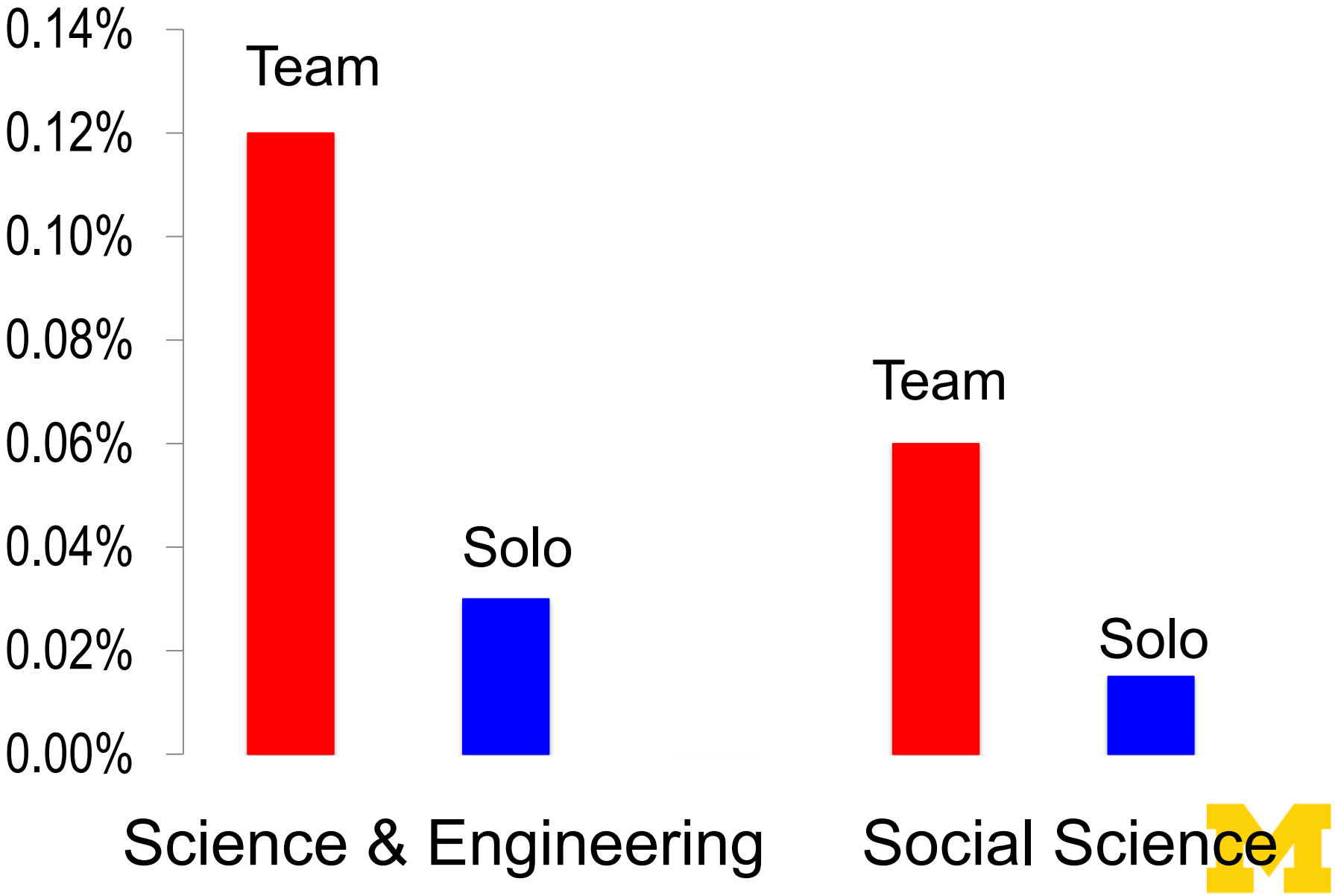
(Data)

Academic Research Papers 1960

Academic Research Papers 2016



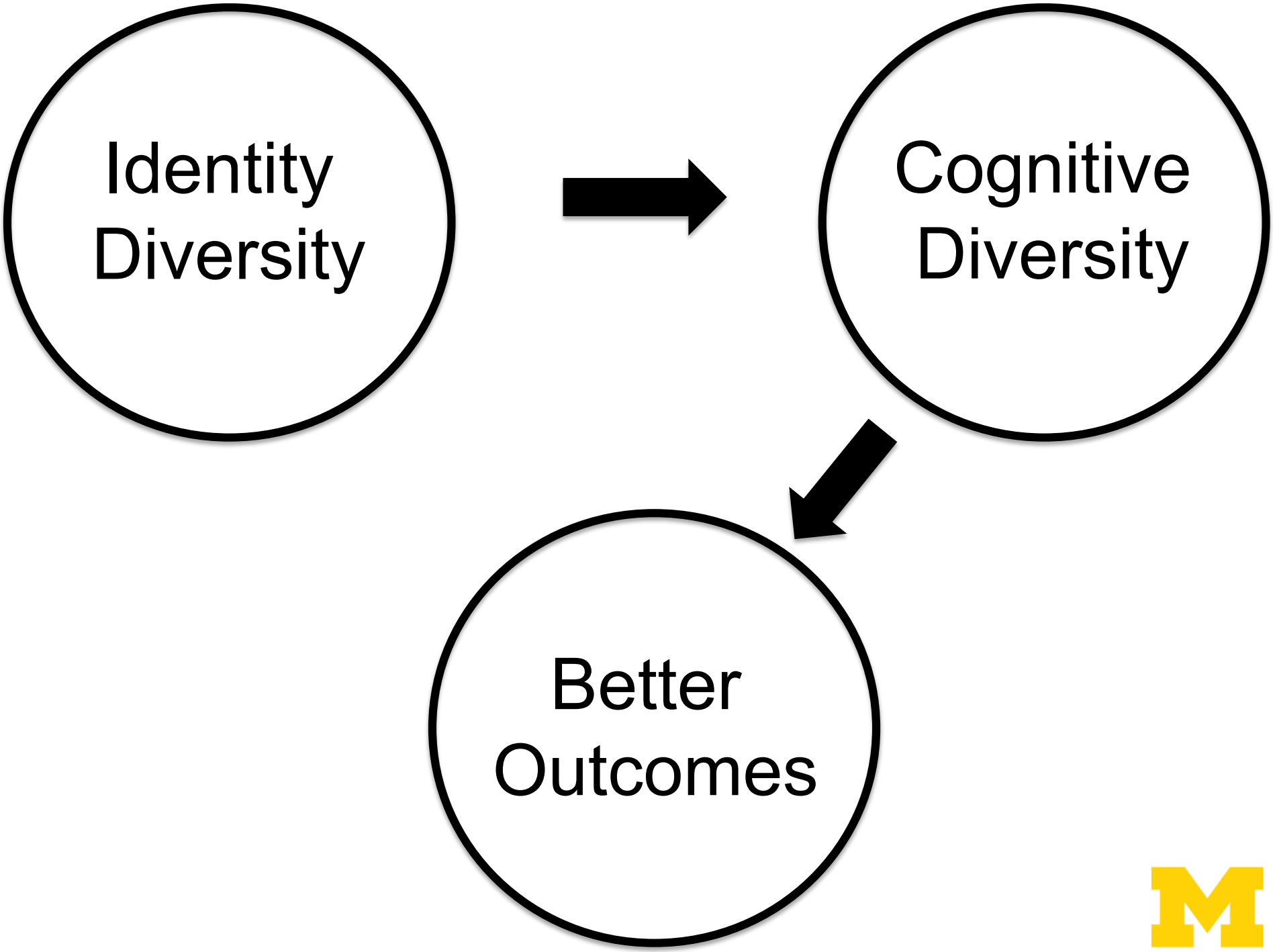
Papers > 100 Cites



Teams vs Solo Citations

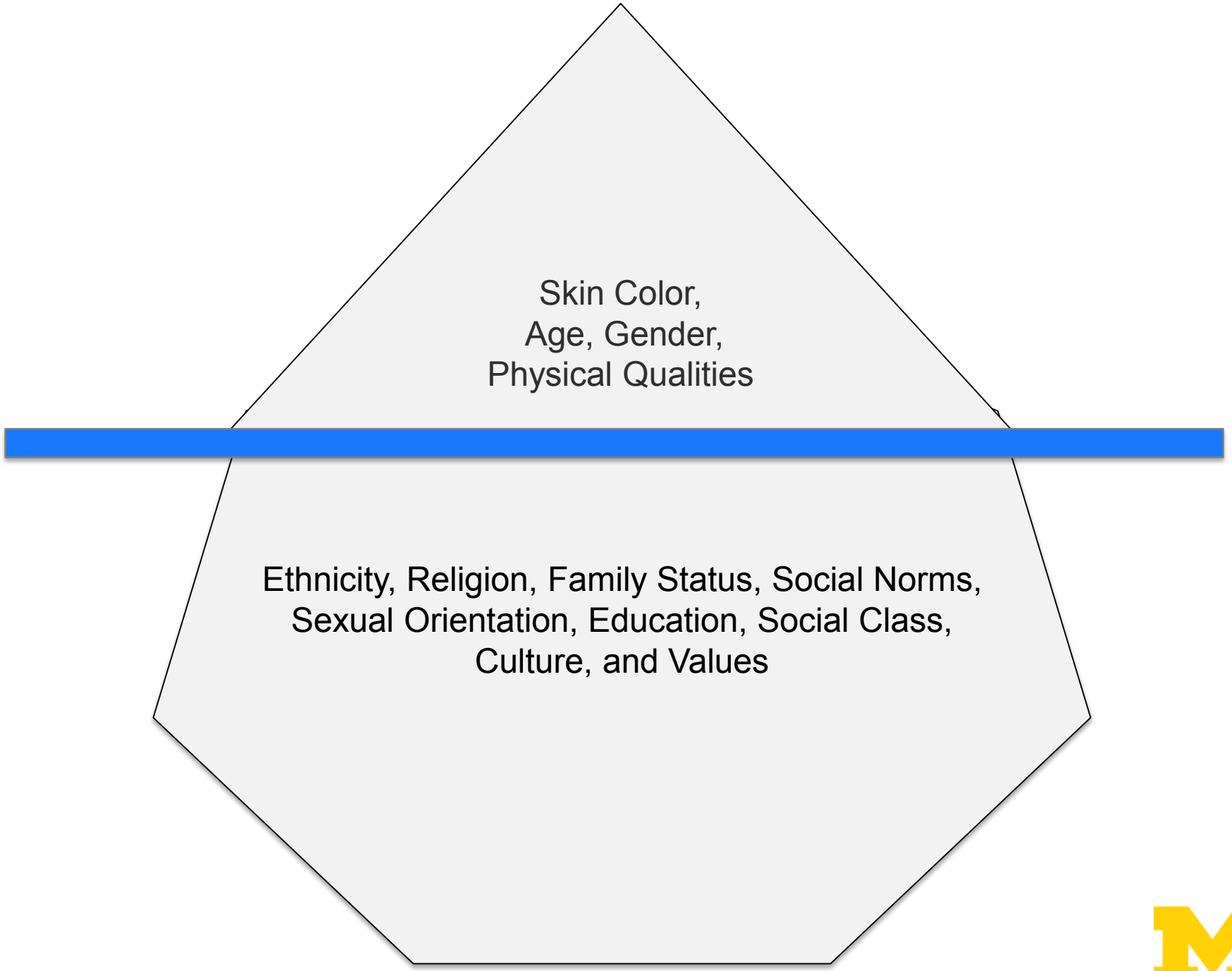
	# Subdisciplines	
	Teams Win	Solo Wins
Sciences	167	4
Social Science	54	0
Patents	32	4

Wuchty, Uzzi, and Jones 2007


Identity Diversity
Cognitive Diversity
Better Outcomes

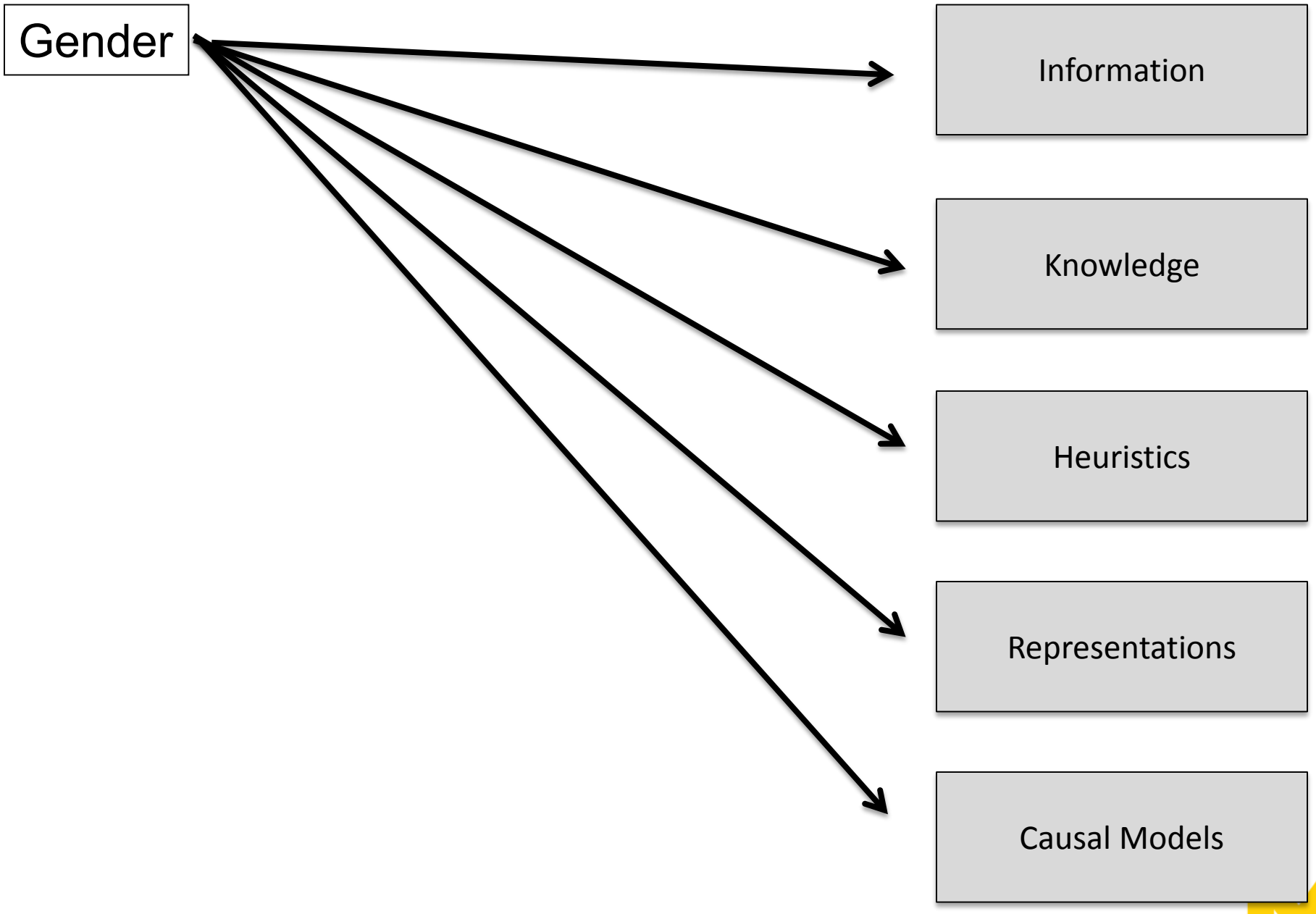
Three Metaphors

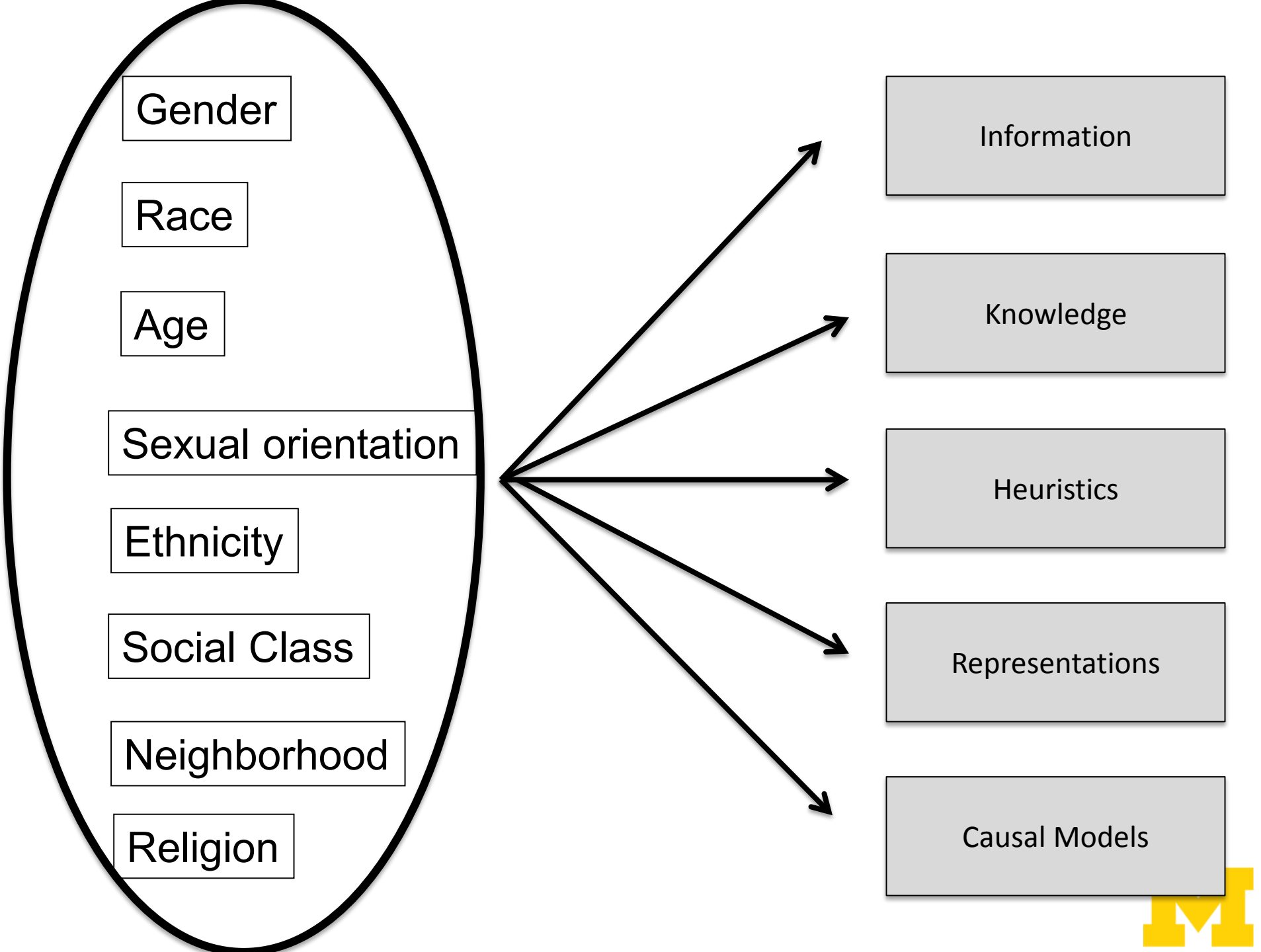
#1 The Iceberg


Skin Color,
Age, Gender,
Physical Qualities
Ethnicity, Religion, Family Status, Social Norms,
Sexual Orientation, Education, Social Class,
Culture, and Values

#2 The Bundle of Sticks

(Wasow and Sen 2014)


Gender
Information
Knowledge
Heuristics
Representations
Causal Models


Gender
Race
Age
Sexual orientation
Ethnicity
Social Class
Neighborhood
Religion
Information
Knowledge
Heuristics
Representations
Causal Models

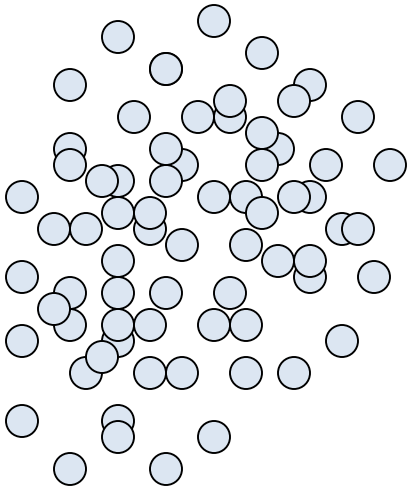
#3 The Great Blue Herons

Great Blue Heron

- 

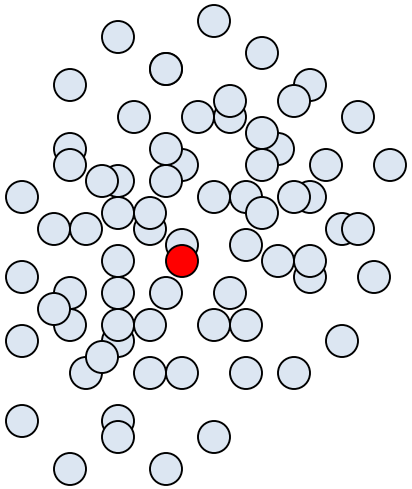
Great Blue Herons

- 

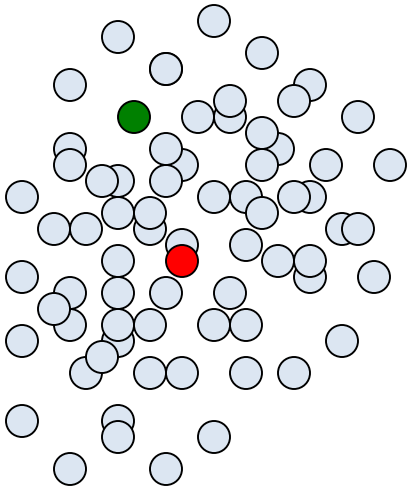


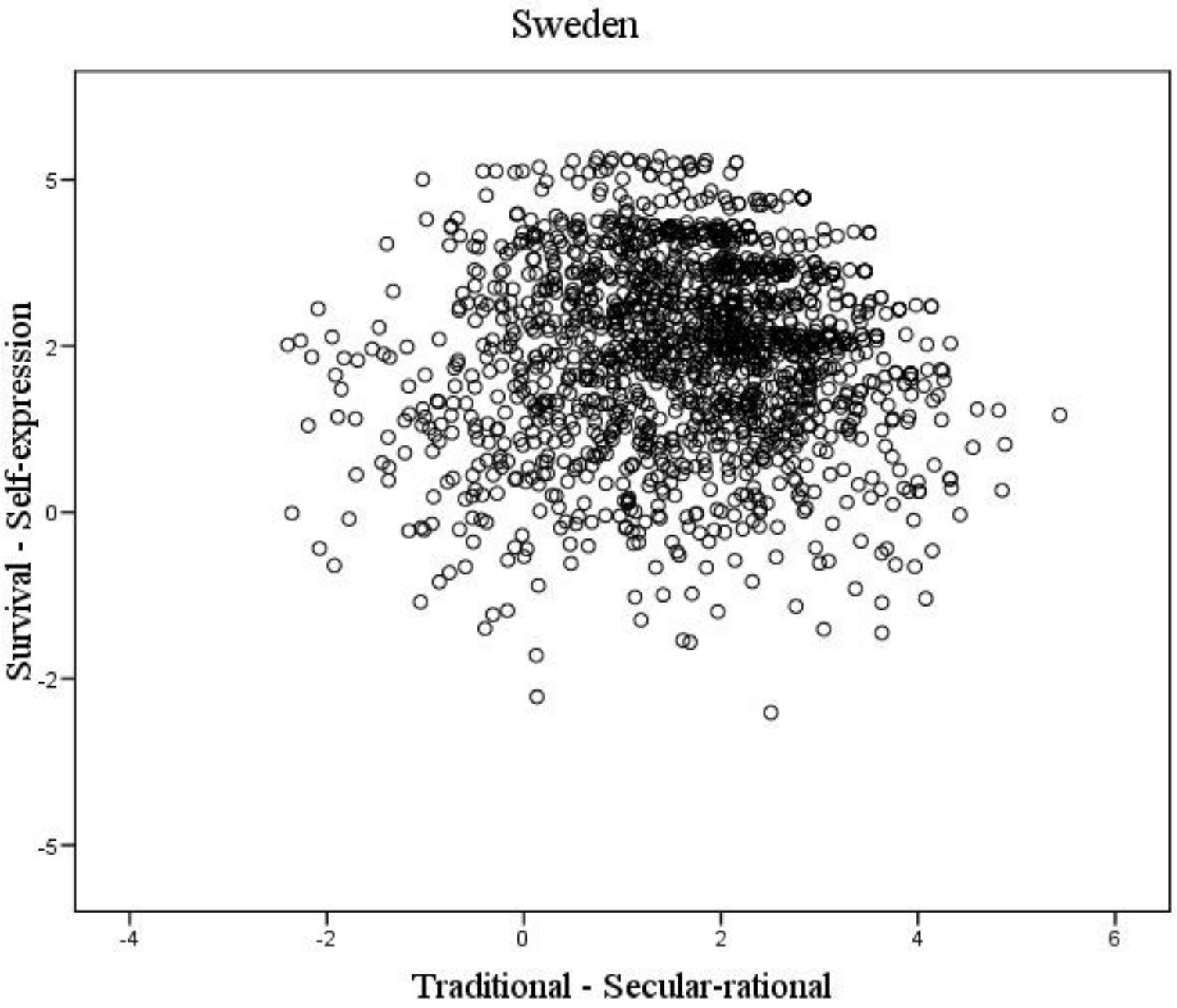
Great Blue Herons

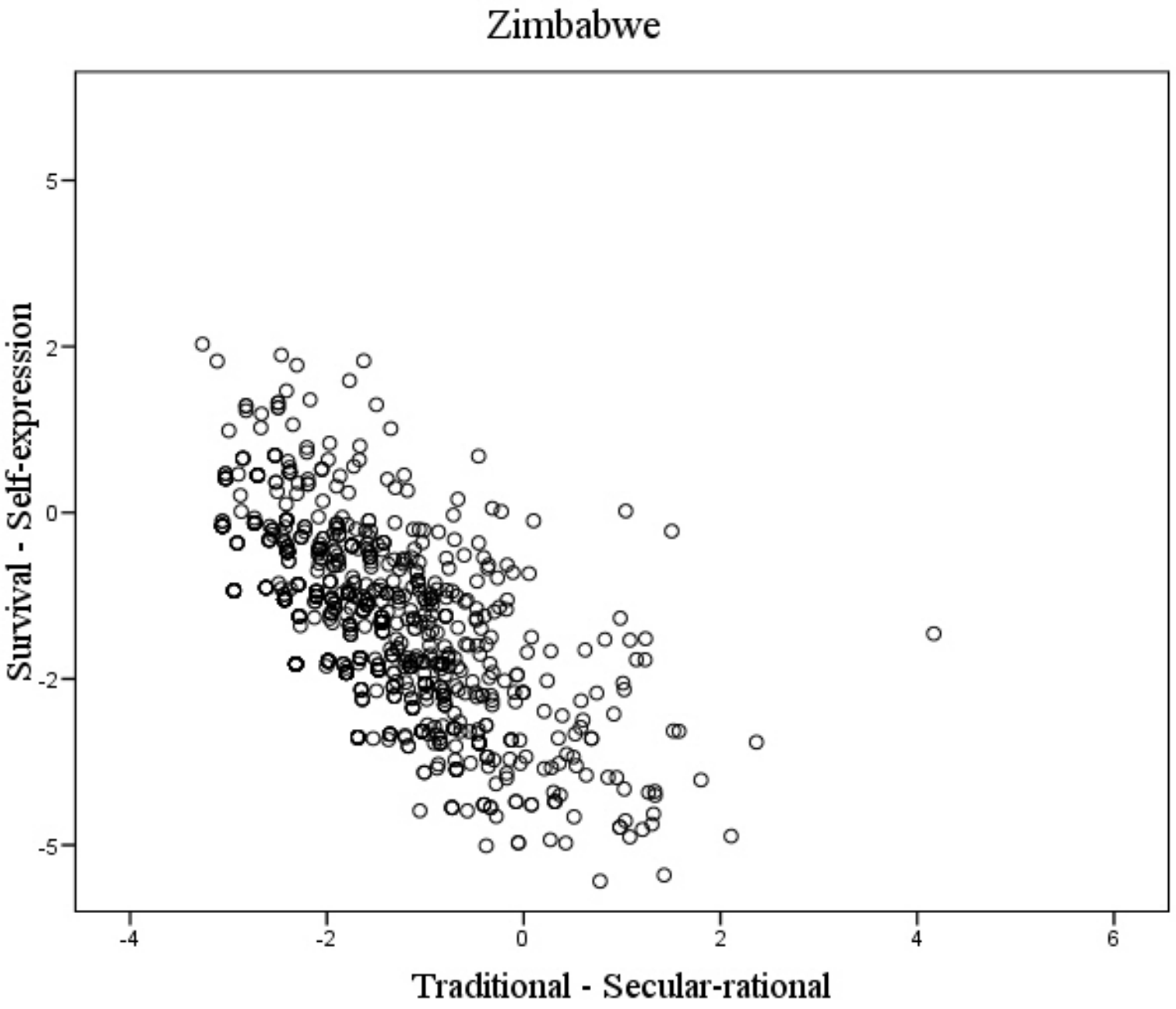
- 



Great Blue Herons




Sweden
Survival - Self-expression
5
2
0
-2
-5
-4
-2
0
2
4
6
Traditional - Secular-rational


Zimbabwe
Survival - Self-expression
5
2
0
-2
-5
-4
-2
0
2
4
6
Traditional - Secular-rational

Each person brings a unique repertoire of information, knowledge, experiences, heuristics, representations, and mental models.

Practice

The Water

"Morning, boys. How's the water?”

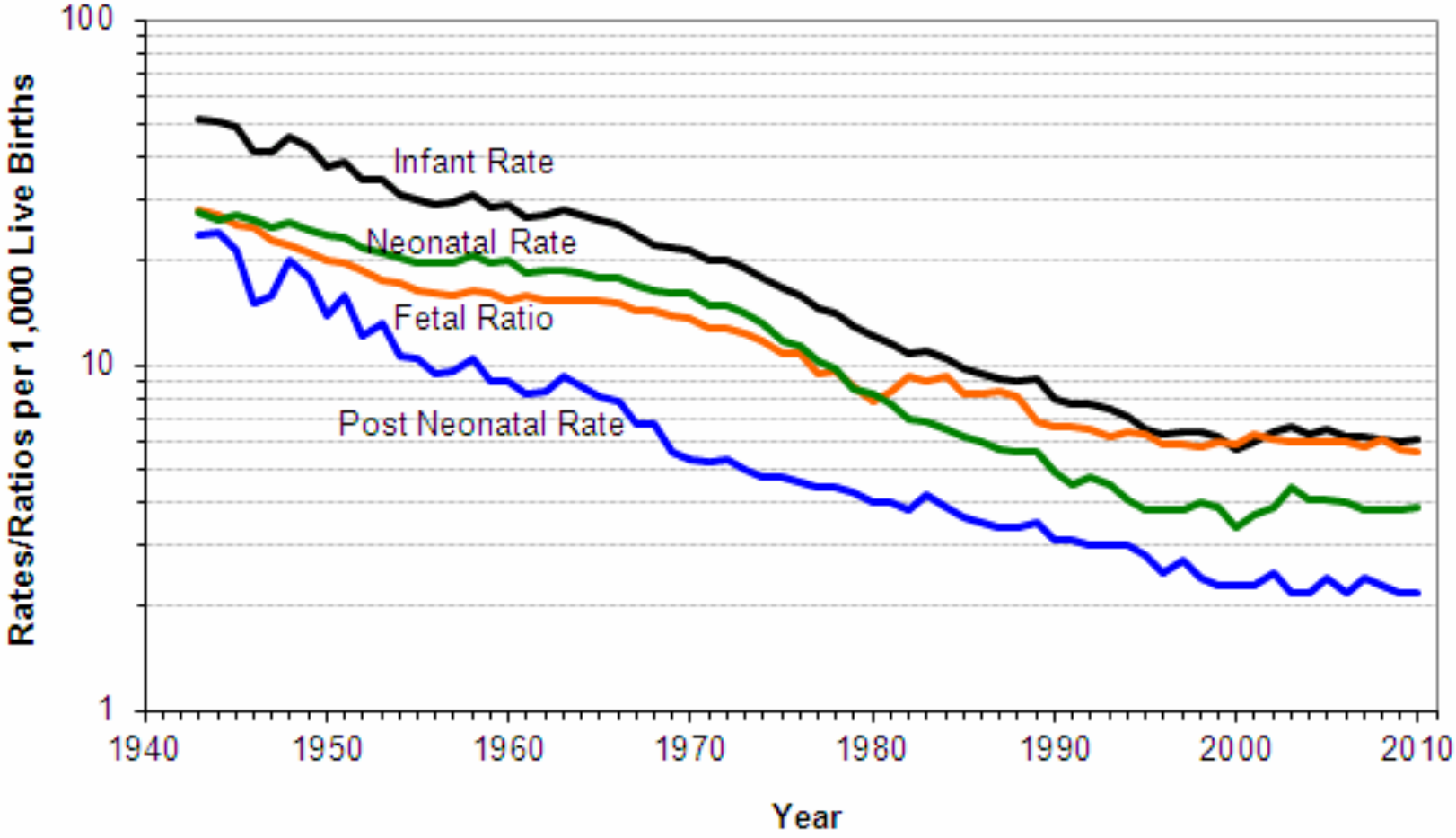
David Foster Wallace

"What the hell is water?”

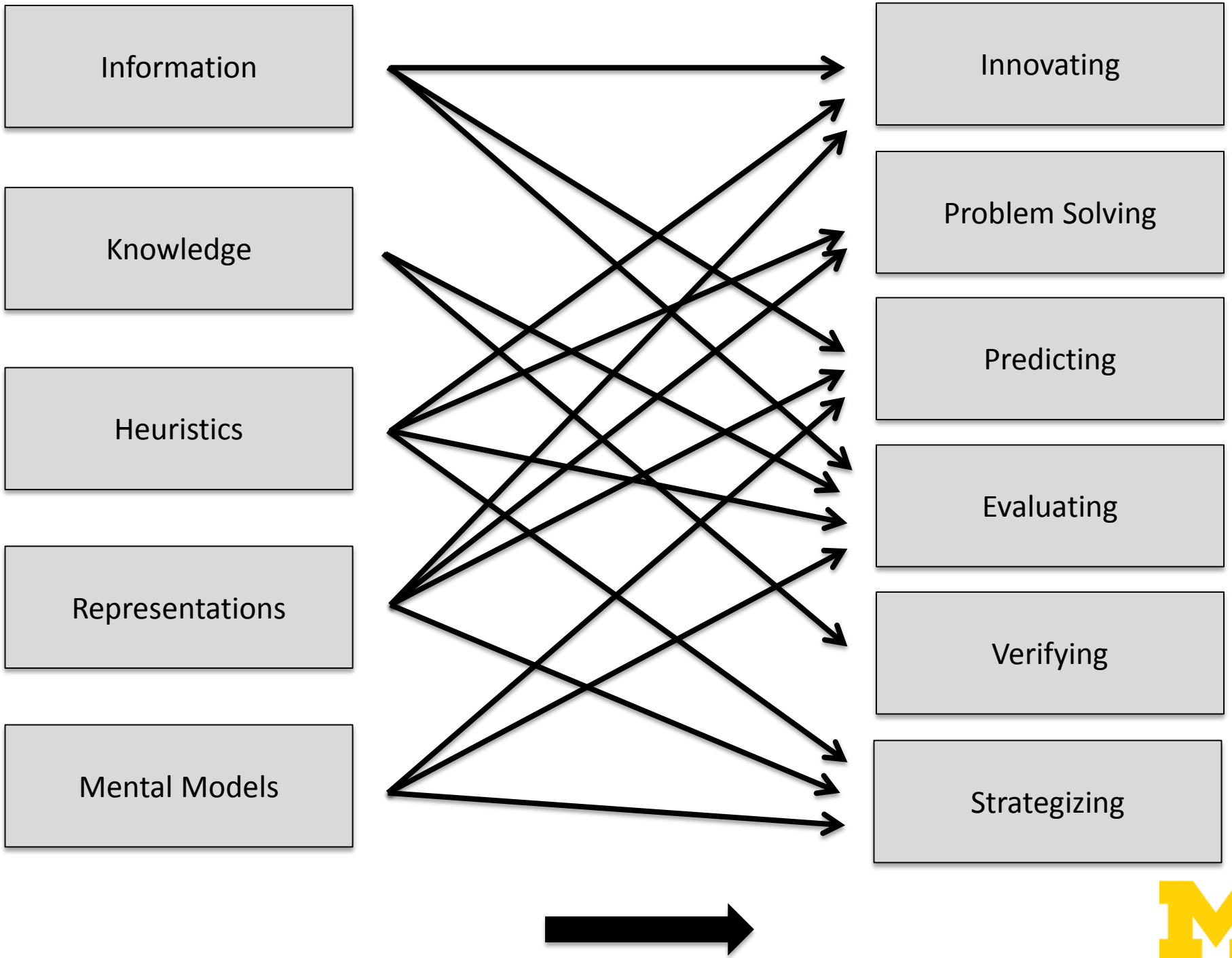
David Foster Wallace

Share Information, Knowledge, and Practices

Figure 12
Infant Death Rates and Fetal Death Ratios
1943-2010



Cast Wide Nets


Information
Knowledge
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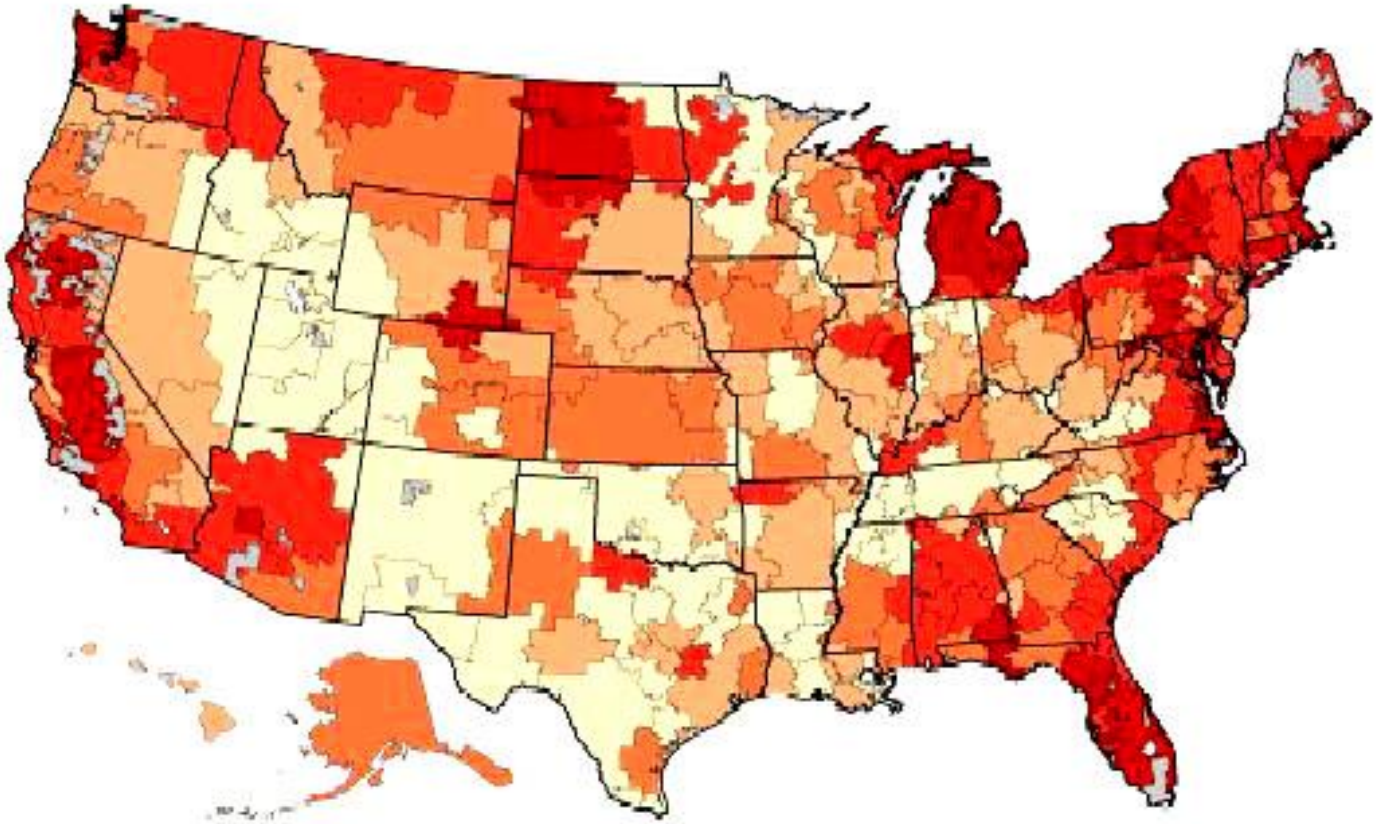
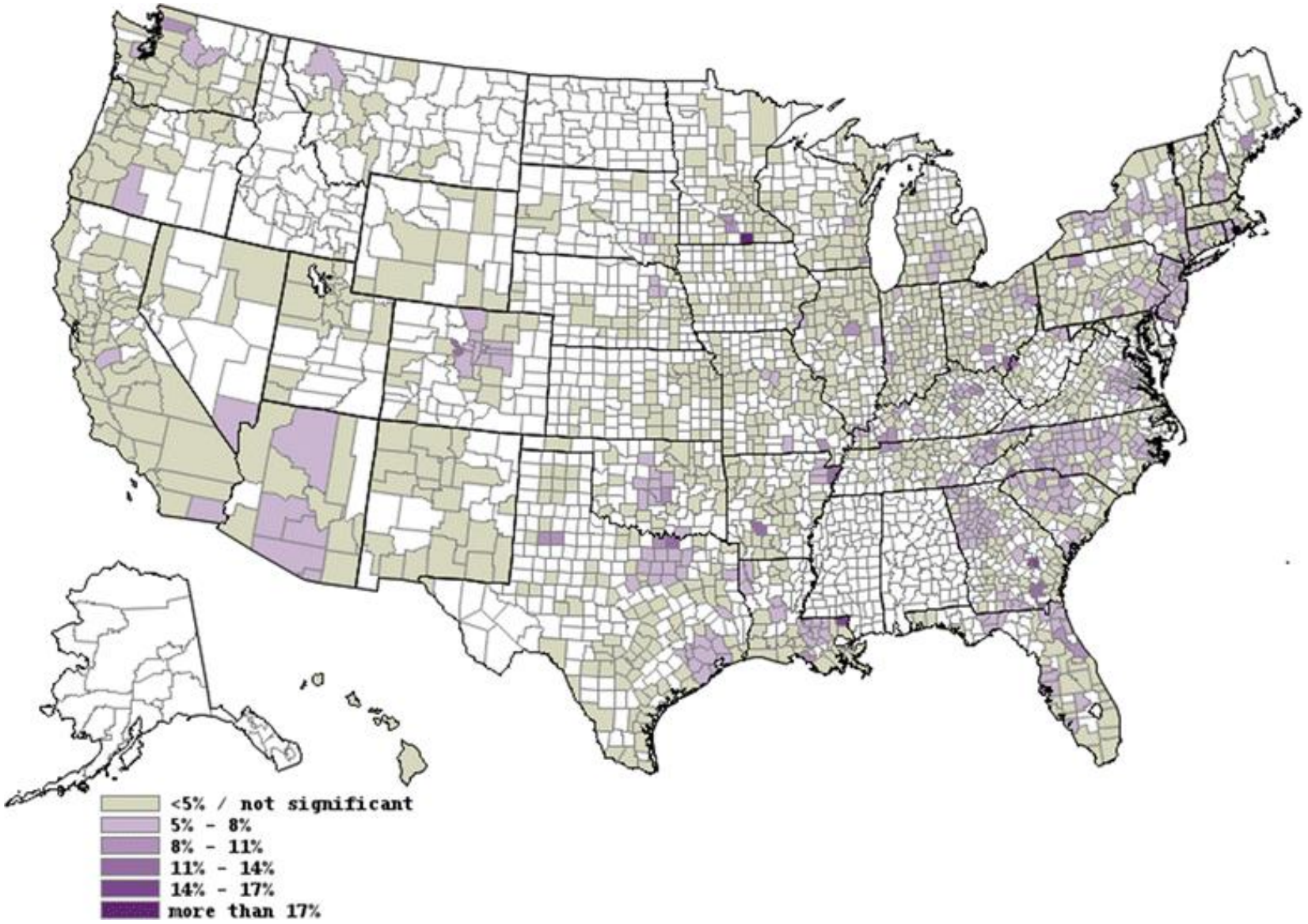
Mammograms



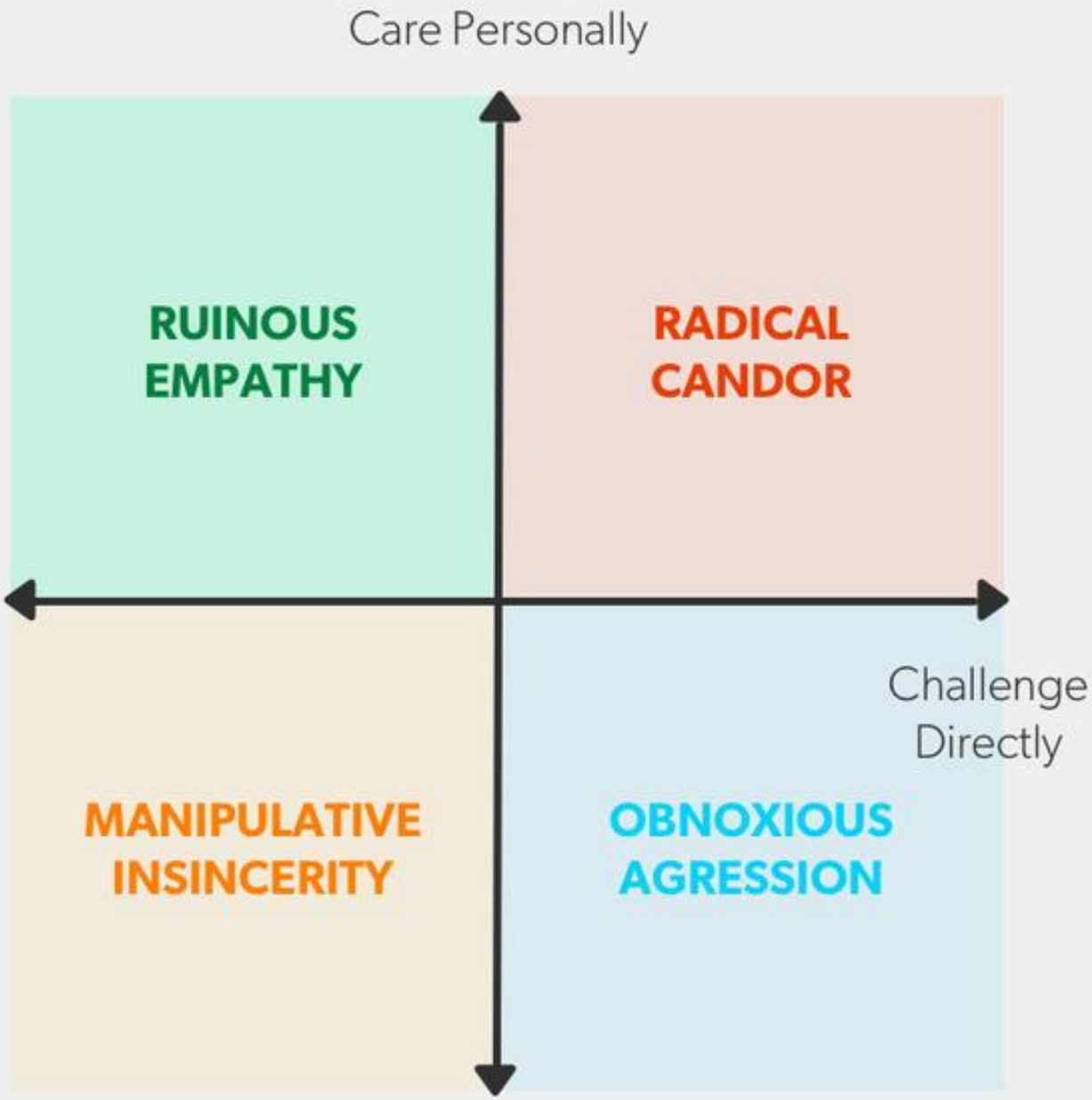
Map 6.4. Mammography

In 1993, the percentage of women undergoing one or more mammograms was high in the Northeast – notably New York State – and in Florida, Michigan, and most of California. North and South Dakota were remarkably split between high and low rate areas, as were Illinois, Colorado, and Wyoming.

Ceasarians



Radical Candor


Care Personally
RUINOUS EMPATHY
RADICAL CANDOR
Challenge Directly
MANIPULATIVE INSINCERITY
OBNOXIOUS AGRESSION

Thank You