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Where are We?

- Channel 1
  - Method Lectures
    1. Health information exchange
    2. Knowledge representation
    3. Information retrieval
    4. Imaging and image analysis
    5. Policy development and analysis
    6. Organization/management
    7. **Cognition (today)**
    8. Quality Measurement
    9. Evaluation
    10. Behavior Change
  - Followed by four “information resource” lectures

Cognition and Health Informatics

Prof. Charles P. Friedman

Introduction to Health Informatics

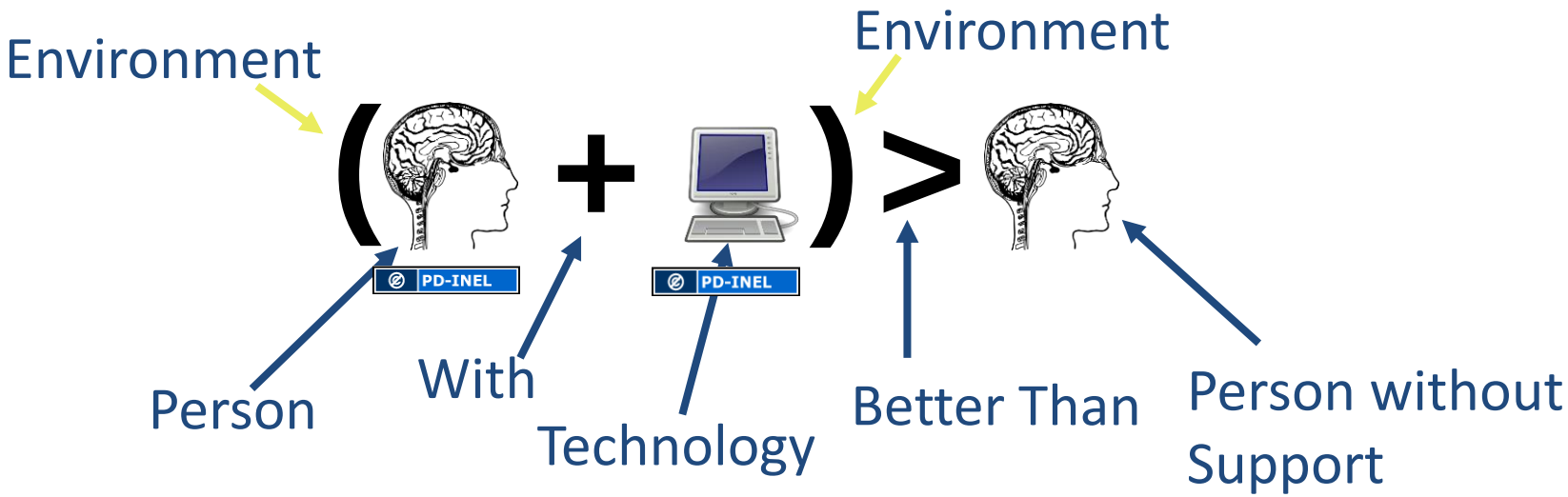
University of Michigan

November 12, 2013

Key Questions

1. Why is human cognition important?
2. How do people reason, solve problems and make decisions?
3. What are the implications for health informatics?

The "Fundamental Theorem": It's About People Reasoning & Making Decisions



Creating an environment of "supported practice"

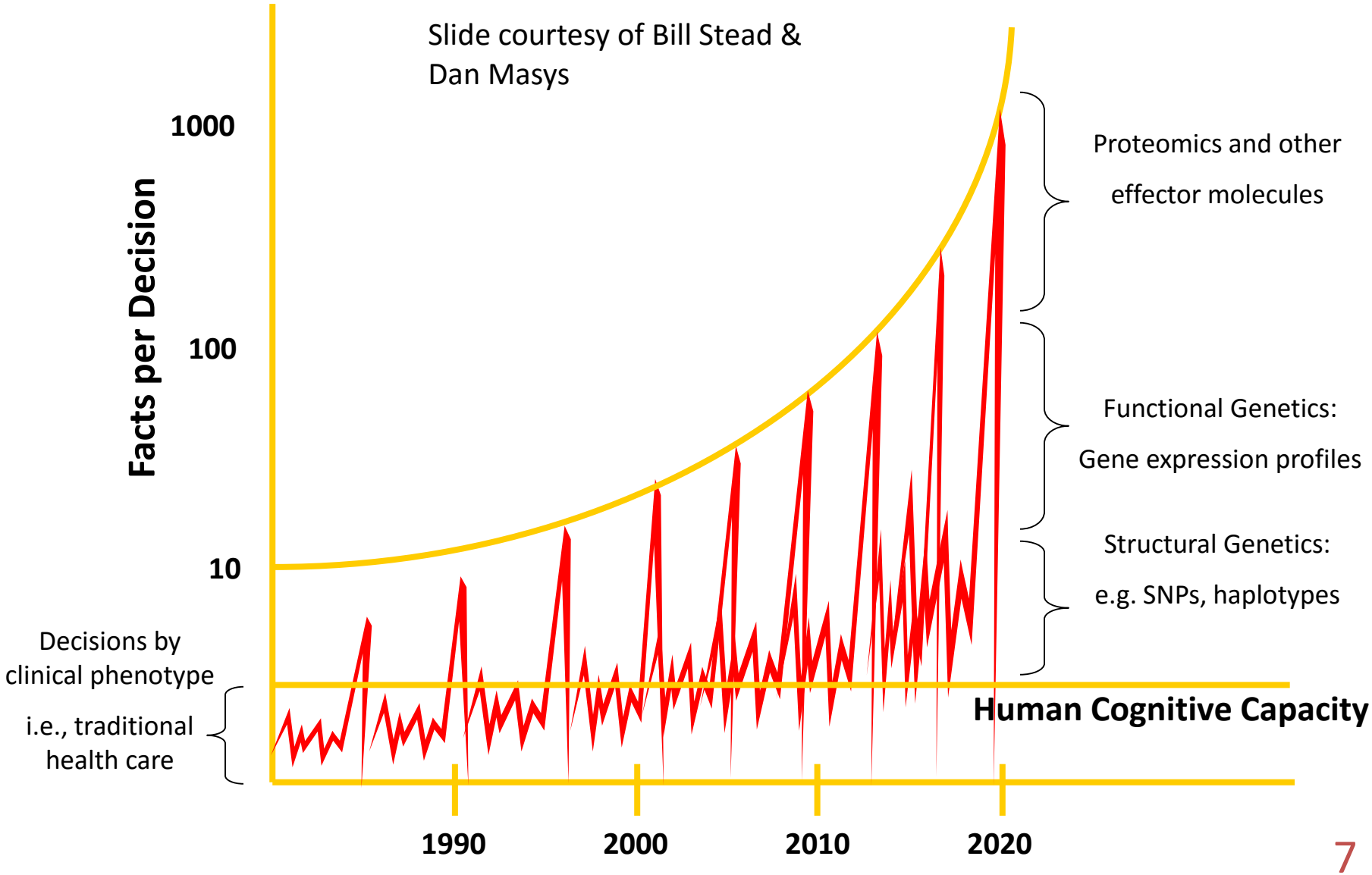
such that an intelligent person (practitioner, scientist, student)

working in combination with information resources/technology

is "better" than the person without such support,

and then demonstrating that we've done it.

The Amount of Data Available is Exploding



If the Fundamental Theorem is Going to Hold: Information Resources Must…

- Address a problem where human cognition can benefit
- Be able to tell a person (or team):
  - something correct or at least plausible
  - that he/she doesn't already know
- Conform to:
  - the person's or team's cognitive state (thoughtflow)
  - the person's or team's context (workflow, culture)

How Human Cognition Can Benefit

An advice-giving resource can suggest:

- Plausible diagnoses
- Best drug and dosage
- Cheaper and equally effective alternative
- Patient is at risk for …
- I am/patient is due for this procedure
- A meal plan for today
- And others

The Challenge: Using this Architecture, Help People Make Better Decisions, Such That:

Data

Knowledge

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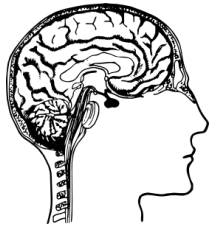
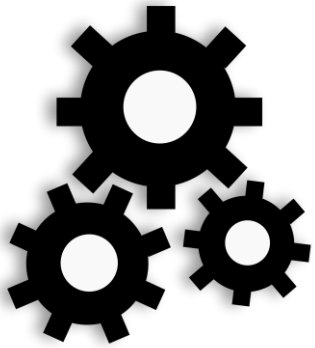
Human Decision-Maker



Reasoner



PD-SELF

Renderer

PD-SELF

Trigger

PD-SELF

Key Questions

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Key Principles of Human Cognition

What you know, and how that knowledge is organized is the primary determinant of what you can do or learn or do.

This unpacks into :

- Miller's Law and working memory
- Chunking: Our cognitive workaround
- Pattern Matching
- Forward reasoning and backward chaining
- The nature of expertise
- Biases and heuristics

Let's See How Good You Are (No Writing Allowed)

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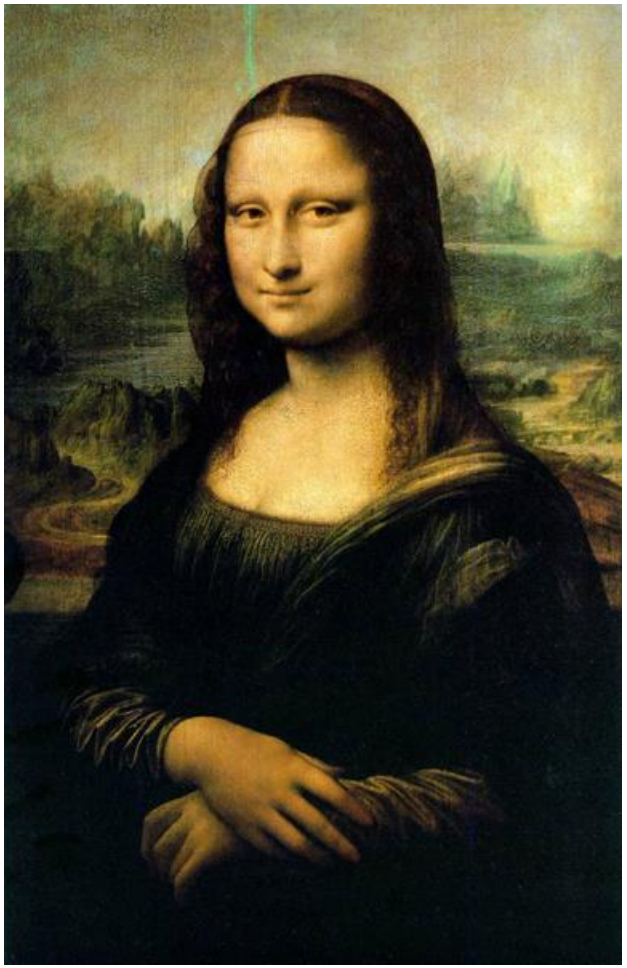
How About This?

12345123451234512345

Or This?



So What's Going On Here?

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Working Memory and Chunking

- Working memory

  George Miller: “7 plus or minus 2”
- “7 plus or minus 2” applies to unrelated elements in short term memory
- Our brains “chunk” related elements so they are processed as one → concept of a “syndrome” in health care
- Meta-chunking (chunks of chunks) creates elaborate knowledge structures that enable reasoning and problem solving

Pattern Matching and Image Recognition

- Warm and muggy
- Very dark sky
- Frequent bright lightning
- Gusty winds

Images and Patterns Have a Context

Patterns: Examples from Health

Person 1

- Sweating
- Fever
- Shaking/Chills
- Worsening cough with pain

Person 2

- Swelling in the eyes
- “Foamy” urine
- Weight gain

So Where Are We?

- Limited capacity in working memory
- But we can “chunk”
- And we can learn patterns
- And we can instantly recognize and interpret images

Expertise

People become experts by:

- Practice, practice, practice—leading to learning of patterns
- Encountering many similar instances
- Coaching, feedback

- Accumulating expertise = developing rich scripts (schemata) for solving problems
- Expertise is highly domain specific
- Experts develop *automaticity*
- Some experts cannot explain how they do what they do (Ted Williams)

Problem Solving

- When confronted with problems, there are two modes of reasoning:
  - Forward: Apply a schema or script, based on known patterns, to the situation
  - Backward: Hypothesize a solution then collect data to confirm or reject hypothesis
- Forward reasoning is rapid and efficient
- Backward chaining is slow and inefficient
  - Often requires multiple cycles of “hypothesize and test”

Did you Reason Forward or Backward?

Situation 1

- Warm and muggy
- Very dark sky
- Frequent bright lightning
- Gusty winds

Situation 2

- Swelling in the eyes
- “Foamy” urine
- Weight gain

Expert-Novice Studies on the Nature of Expertise

- De Groot (chess): Chess masters can remember an entire chess board if the pattern results from a real game; if not, they are indistinguishable from novices
- Chi, Feltovich, Glaser (physics): Experts instantly recognize a problem "type" and how to solve it
- Patel, Bordage, others (medicine): Experts reason forward using "illness scripts"

Varying Expertise in Health Domains

- Patients/Consumers are typically novices
  - (Until many of them, with chronic diseases, become experts…)
- Professionals are experts
  - But only in their own domains
- Trainees are in an uncertain progression to becoming experts.

Heuristics and Biases

Systematic flaws in reasoning, that affect all human decision makers. A few examples…

- Anchoring (confirmation bias)
- Availability (recency)
- Framing

Absent feedback, people are not aware of these biases.

Also, decision analyses must take risk aversiveness into account. People will not always choose maximum utility.

Key Principles of Human Cognition Revisited

In a nutshell, this is how we solve problems and make decisions:

- Very limited working memory
- But we can "chunk" (create scripts)
- And we can match patterns really well
- We can reason forward (when we have well developed scripts) or backward (when we don't)
- Experts reason forward most of the time
- We're all susceptible to errors in judgment

Key Questions

This is the complement to the lectures on advice giving systems and CDS/CPOE:

1. Why is human cognition important?
2. How do people reason, solve problems and make decisions?
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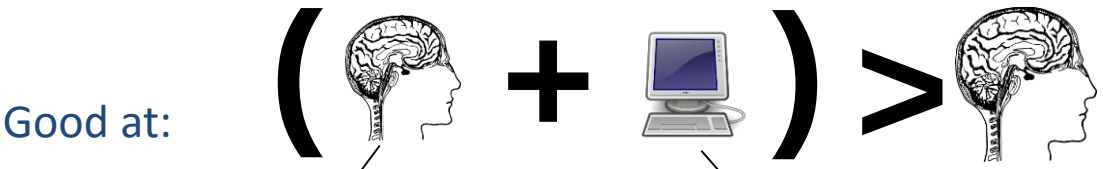
Why We Expect the Theorem to Hold

- The Principle of Complementarity
  - Persons do well things that machines do poorly
  - And vice versa
  - Vannevar Bush recognized this in 1945

Why Decision Support Has Largely Underperformed So Far

- Complementarity goes beyond putting the person and machine in the same place at the same time
- We have to meld them



Good at:

Good at:

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Decision Support from a Cognitive Perspective

To enable interactive "thinking together", we must:

- Address a problem where human cognition can benefit
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Summary: Key Questions

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