From Population Health to Precision Health

IBM Watson Health™

William J, Kassler, MD, MPH

Deputy Chief Health Officer

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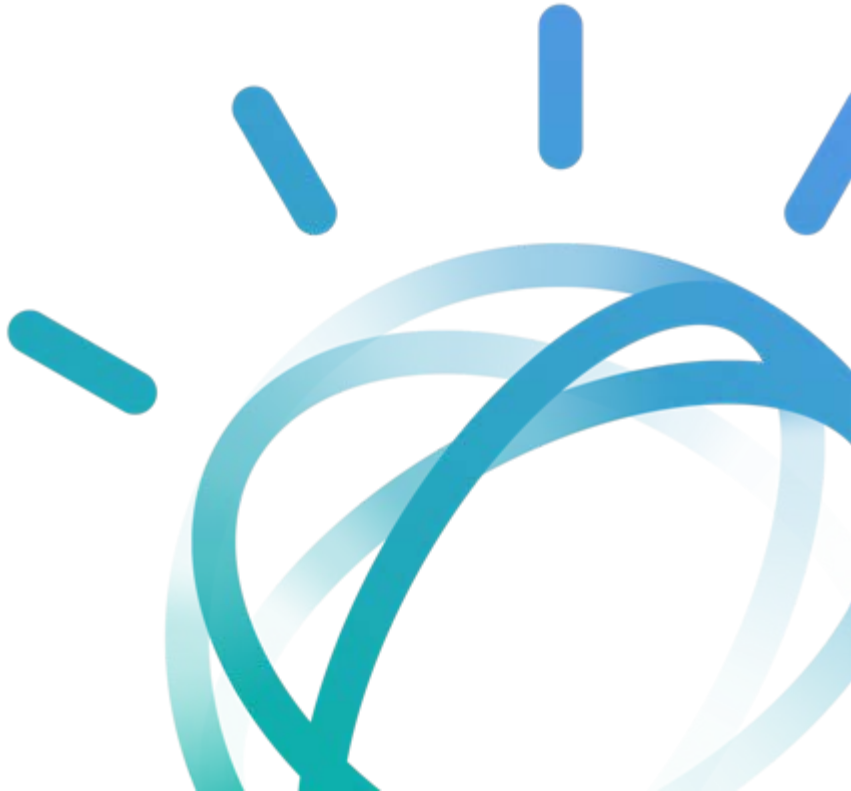
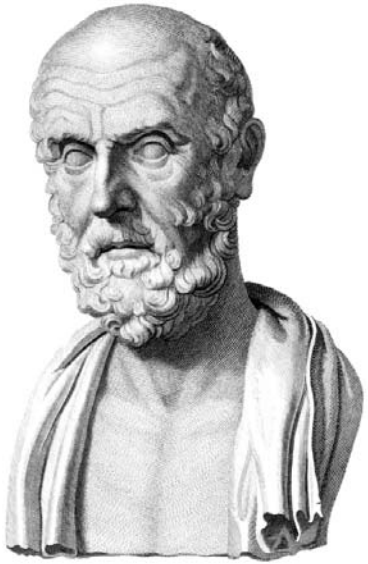
IBM





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The current health system faces serious challenges.

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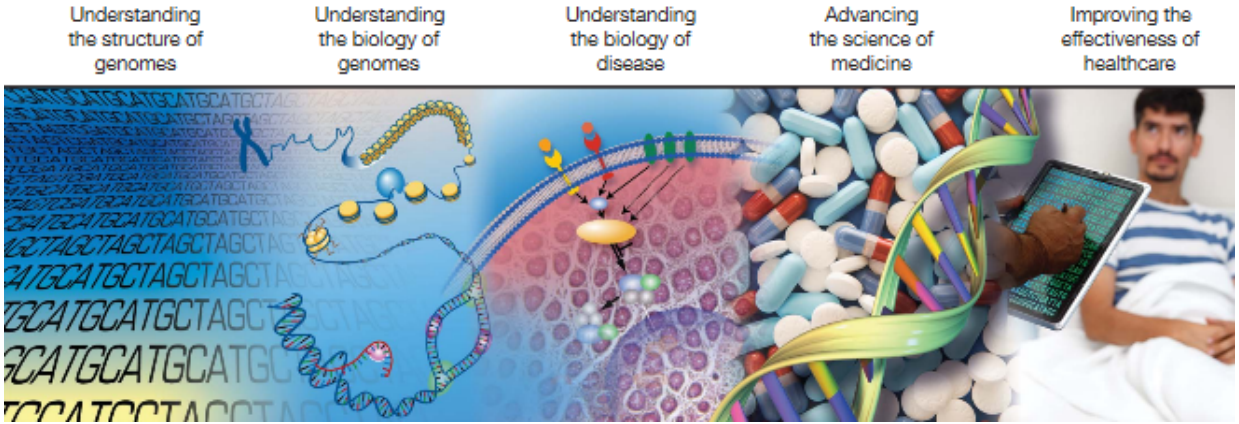
A New Era of Personalized Healthcare

Completion of Human Genome Project in 2003 led to expansion of research on the contributions of genomics in disease diagnosis, treatment, and prevention



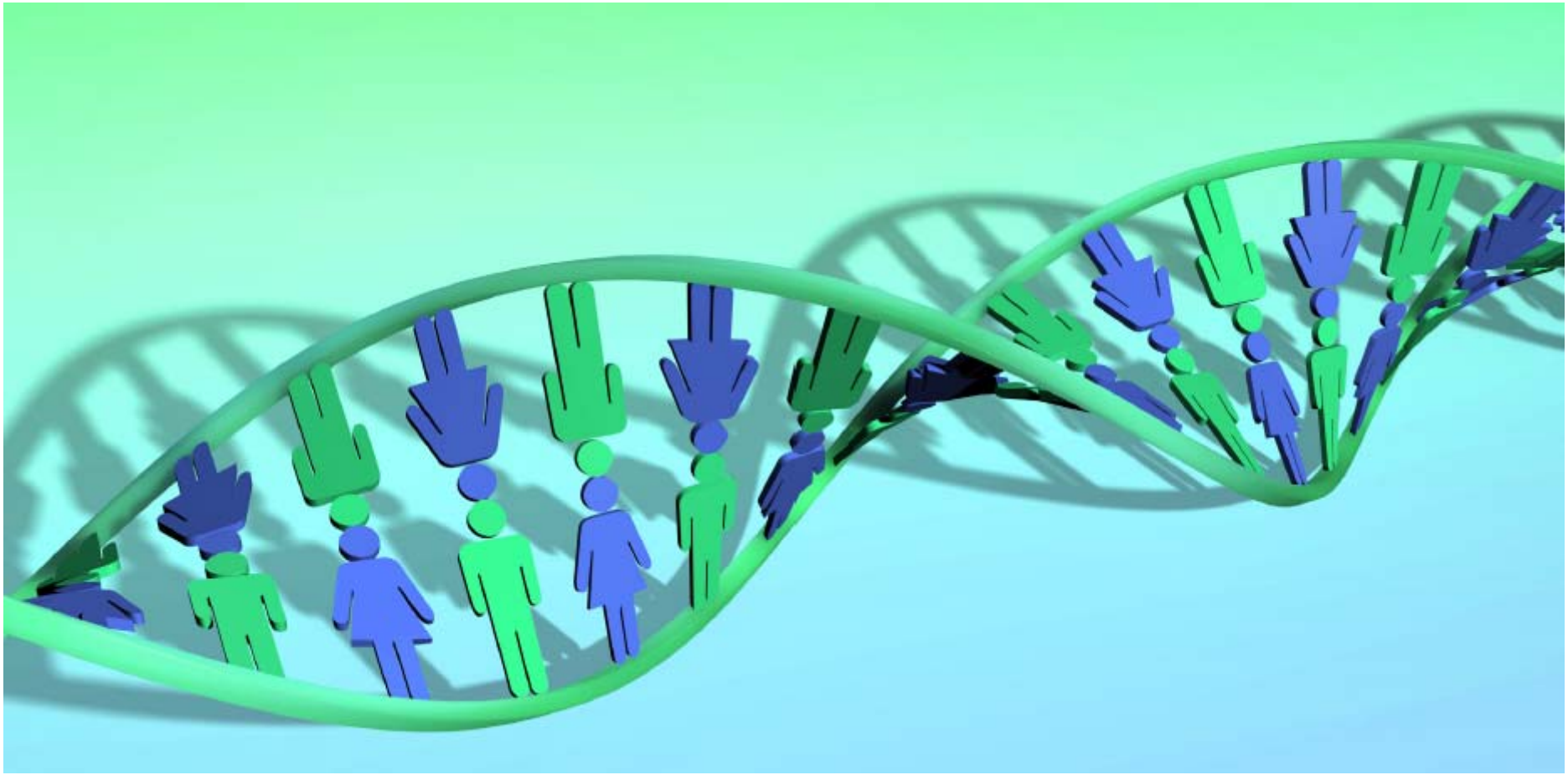
Green, ED et al (2011). Charting a course for genomic medicine from base pairs to bedside. *Nature* 470: 204-213

Early Discovery

What biological or environmental factors are causing disease? Can we design diagnostics and drugs to improve patient outcomes?

Clinical Genomics

What does my patient's genomic information tell me about the treatment I should select?



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The Challenges of Big Data

Keeping up

There are 100,000+ clinical trials running in parallel.

A patient will generate >12 TB of personal health data in a lifetime (300 million books).

Medline: 424 million published articles in 5600 journals

1.8 million new articles published annually

80% Unstructured

A typical high-need patient has a 100+ page electronic health record.

Text where meaning is often derived from context

Images: X-rays, sonograms, electrocardiograms, magnetic resonance images, and mass spectrometry results

Noisy

Problems of scale: finding the signal in the noise when its buried in millions of pages across multiple silos

Humans must collect, organize data and evaluate evidence

Introduces cognitive bias

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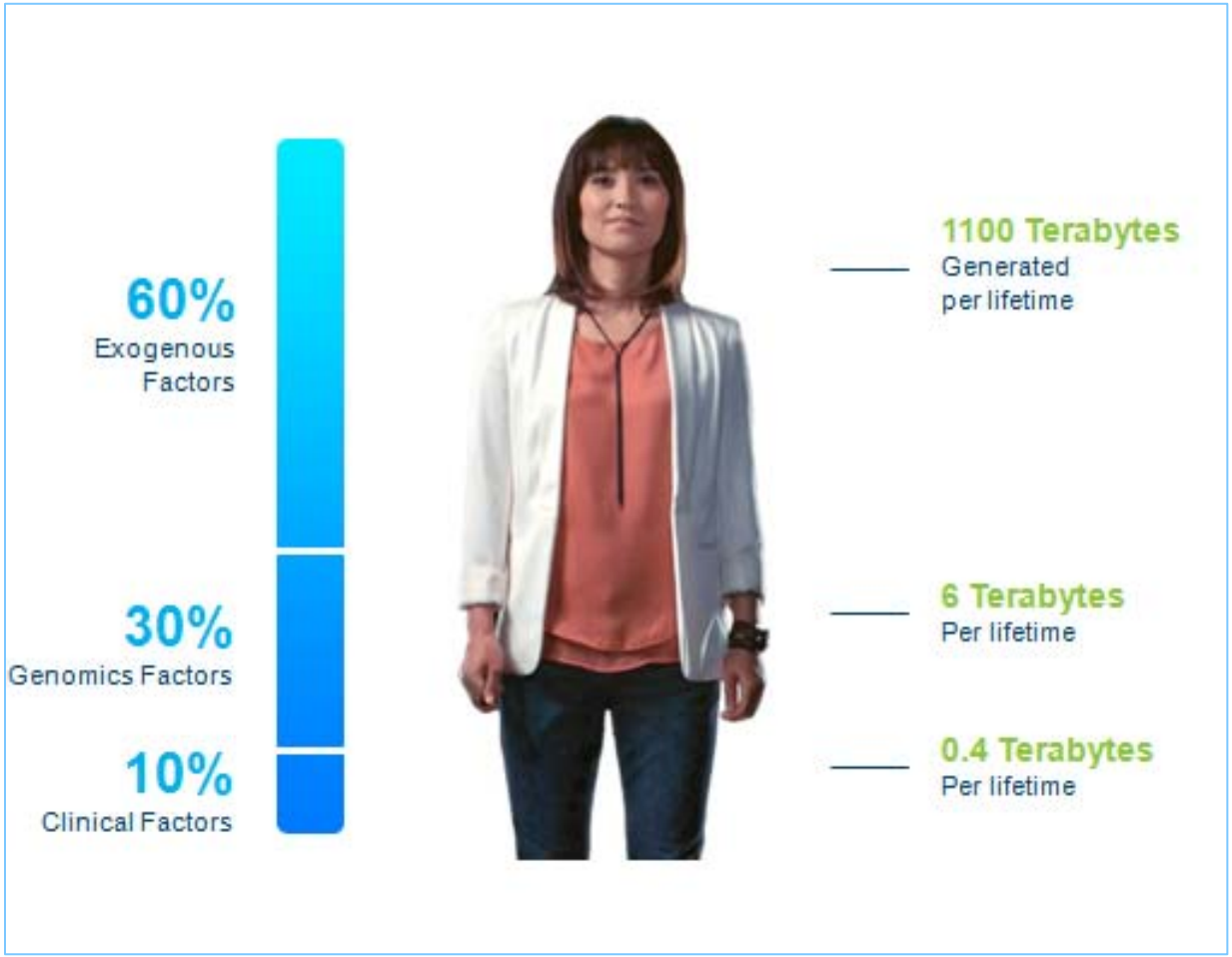

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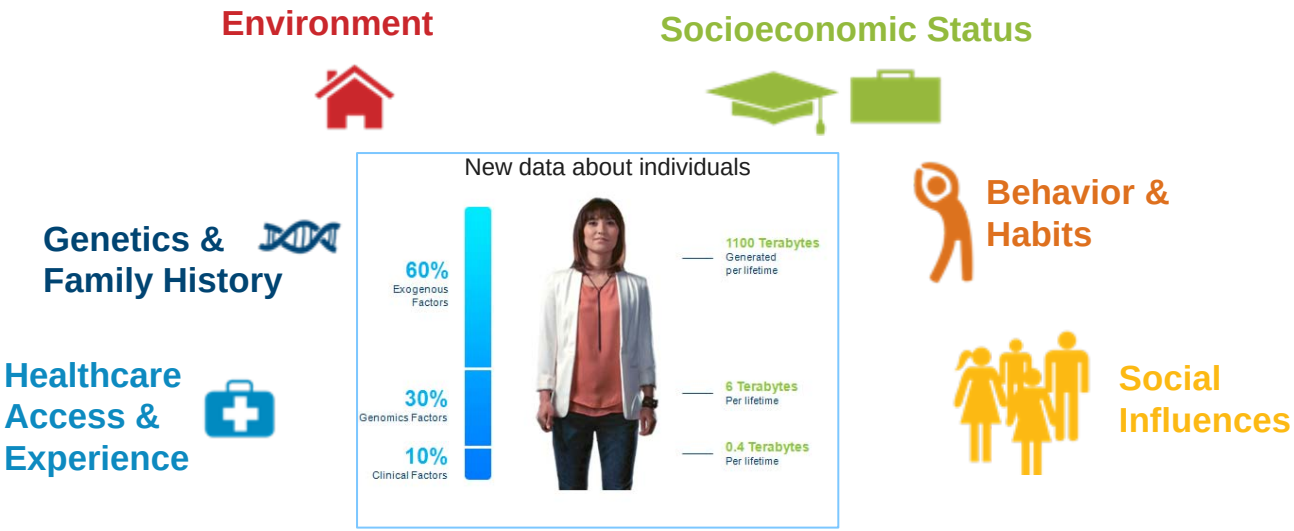
McGovern et al. The Relative Contribution of Multiple Determinants to Health Outcomes, Health Affairs, August 21, 2014.

Only 10% of health outcomes are related to healthcare



It’s critically important that we consider all influences and opportunities for positively affecting health choices.

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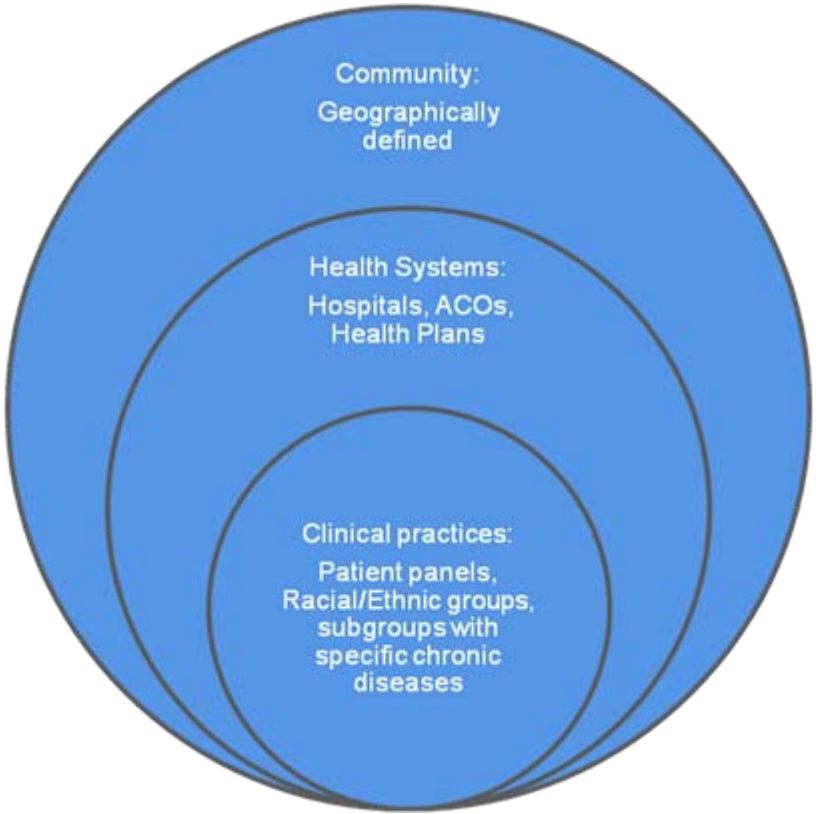
McGovern et al. The Relative Contribution of Multiple Determinants to Health Outcomes, Health Affairs, August 21, 2014.

Reconciling the clinical perspective with a broader community perspective



Based on Kassler et al. N Engl J Med 372; 2015

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Tabulating Systems Era

1900 – 1940s

Programmable Systems Era

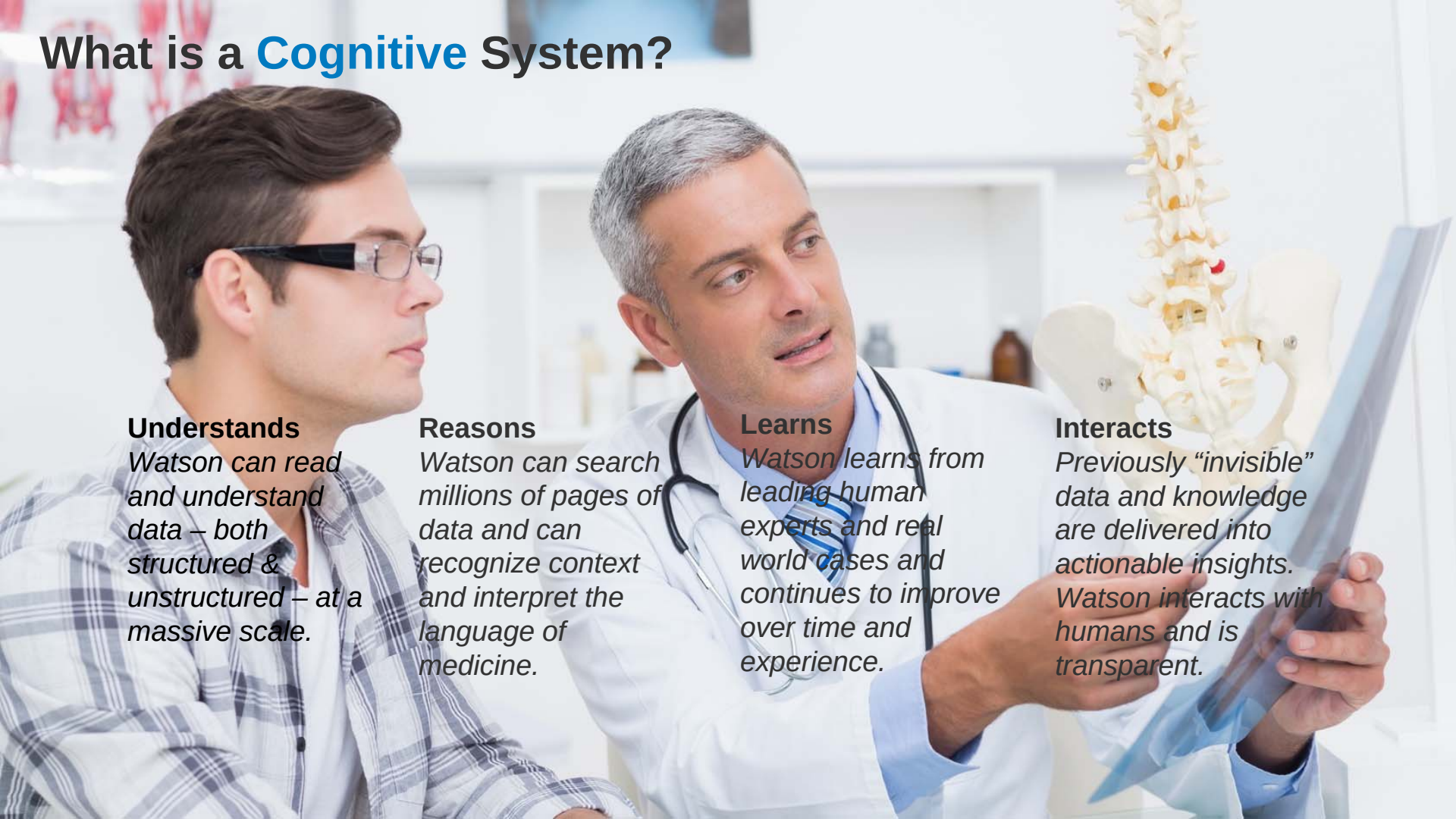
1950s – Present

Cognitive Computing Era

2011 –

© IBM 2016

What is a Cognitive System?



Understands
Watson can read and understand data – both structured & unstructured – at a massive scale.

Reasons
Watson can search millions of pages of data and can recognize context and interpret the language of medicine.

Learns
Watson learns from leading human experts and real world cases and continues to improve over time and experience.

Interacts
Previously "invisible" data and knowledge are delivered into actionable insights. Watson interacts with humans and is transparent.

Natural Language Processing

Reads unstructured documents, notes, patient history, lab reports …

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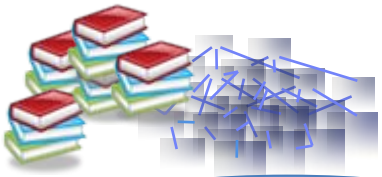
Combine Knowledge-driven and Data-driven Analytics to generate insights and identify potential outcomes

From population averages …



- Scientific papers
- Books
- Guidelines

Published Knowledge

Knowledge-Driven Approach

Age & Gender	45%
Adherence	32%
Martial Status	1%

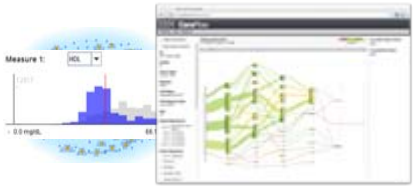
A 58-year-old woman presented to her primary care physician after several days of dizziness, anorexia, dry mouth, increased thirst, and frequent urination. She had also had a fever and reported that food would "get stuck" when she was swallowing. She reported no pain in her abdomen, back, or flank and no cough, shortness of breath, diarrhea, or dysuria. Her family history included oral and bladder cancer in her mother, Graves' disease in two sisters, hemochromatosis in one sister, and idiopathic thrombocytopenic purpura in one sister. Her history was notable for cutaneous lupus, hyperlipidemia, osteoporosis, frequent urinary tract infections, three uncomplicated cesarean sections, a left oophorectomy for a benign cyst, and primary hypothyroidism, which had been diagnosed a year earlier. Her medications were levothyroxine, hydroxychloroquine, pravastatin, and alendronate. A urine dipstick was positive for leukocyte esterase and nitrites. The patient was given a prescription for ciprofloxacin for a urinary tract infection and was advised to drink plenty of fluids. On a follow-up visit with her physician 3 days later, her fever had resolved, but she reported continued weakness and dizziness despite drinking a lot of fluids. She felt better when lying down. Her supine blood pressure was 120/80 mm Hg, and her pulse was 88 beats per minute; on standing, her systolic blood pressure was 84 mm Hg, and her pulse was 92 beats per minute. A urine specimen obtained at her initial presentation had been cultured and grew more than 100,000 colonies of *Escherichia coli*, which is sensitive to ciprofloxacin.

To insights for individual patient!

Observational Data

- Longitudinal records
- Claims, Rx, Labs
- Patient reported data

Data-Driven Approach



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Applications of Cognitive Analytic Techniques

Real World Evidence / Patient Similarity Analytics
Precision Cohorts: dynamic identification of “patients like mine”

Segmentation Analysis
Identifying & understanding the population: targeted care delivery and policies

Personalized Predictive Models
“Segment-of-one” predictive model

Data Visualization
Care pathways and associated outcomes

Trade-off Analytics
Personalized shared decision making

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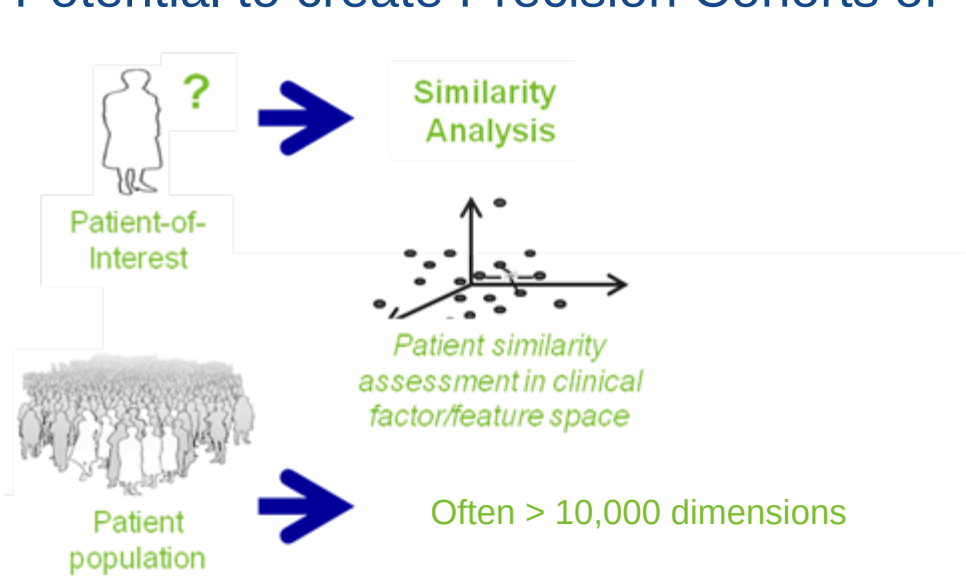
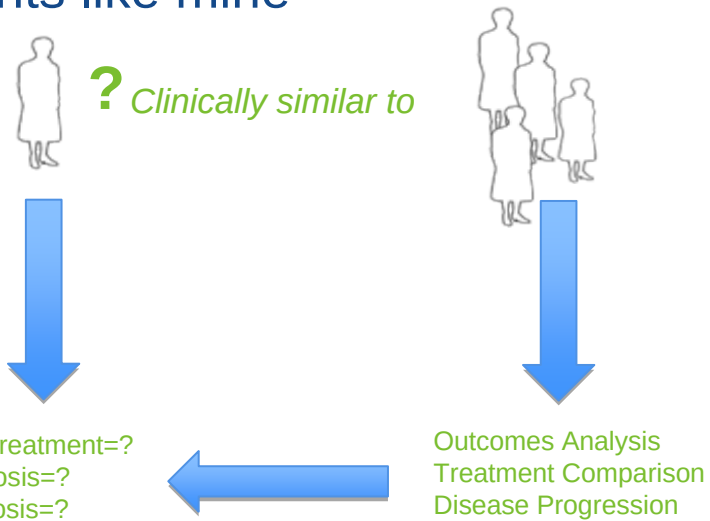
Patient Similarity Analytics

Potential to create Precision Cohorts of “patients like mine”





Machine Learning automatically learn the metric from observational data algorithms and labels provided by experts or derived from data

Published @ AMIA 2010

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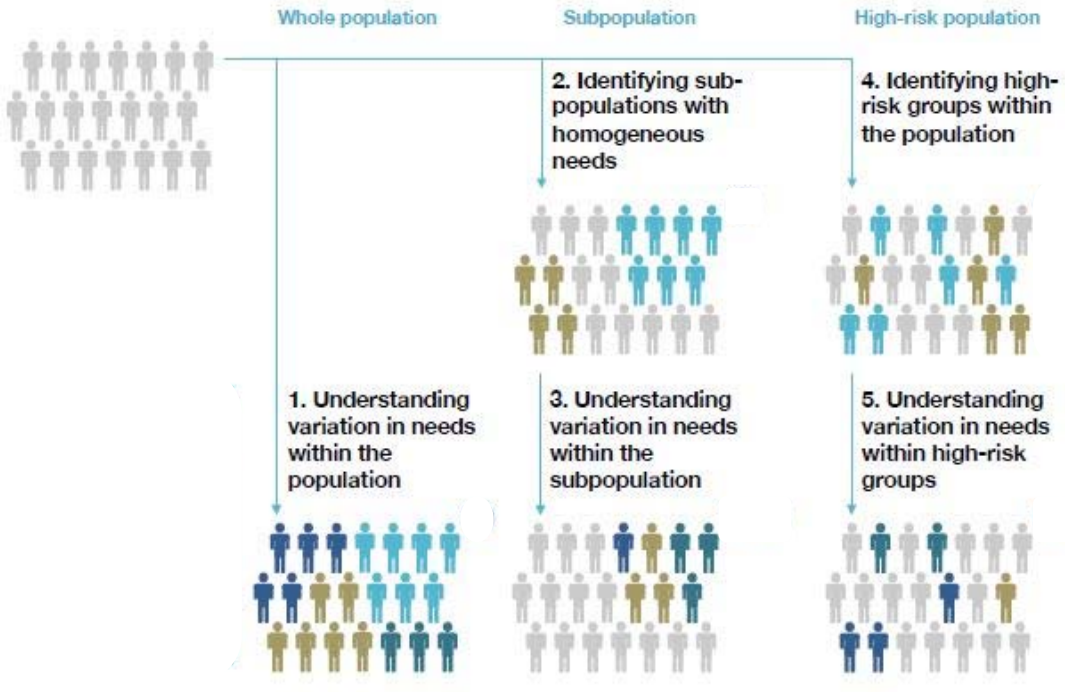
Segmentation Analysis



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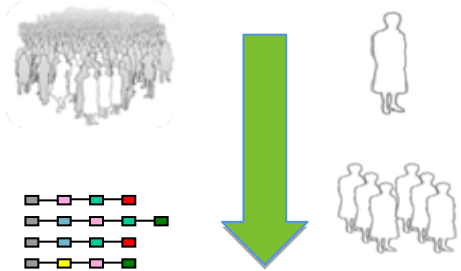
Adapted from: Vuik et al, Health Affairs 35, No 5 (2016) appendix

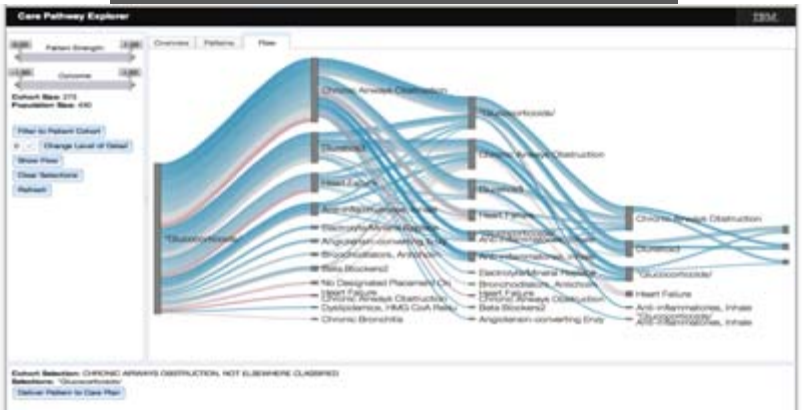
Care Path Flow

Potential to Visualize Care Pathways and Associated Outcomes

- **Patient Similarity Analytics** to find clinically similar patients
- Extract **historical event trails** and relevant patient characteristics
- **Visual Summary** of clinical pathways of similar patients, connected to relevant events
- **Outcomes related to pathways** - help inform clinical decisions with most-desirable vs most-problematic pathway



Care Path Visualization



Published @ AMIA 2011 & CHI 2013

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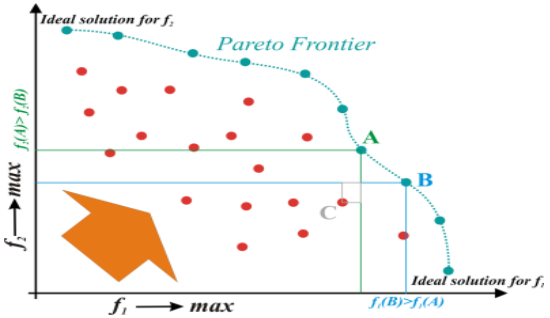
Tradeoff Analytics:

Optimize provider selection on service quality, proximity, license held, cost of service, and preferences



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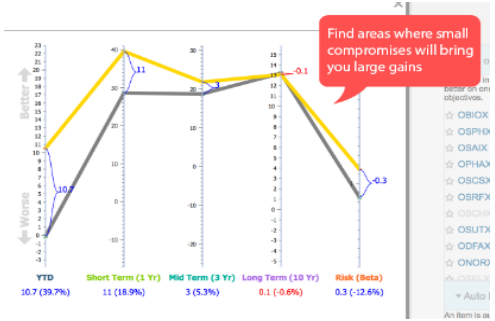

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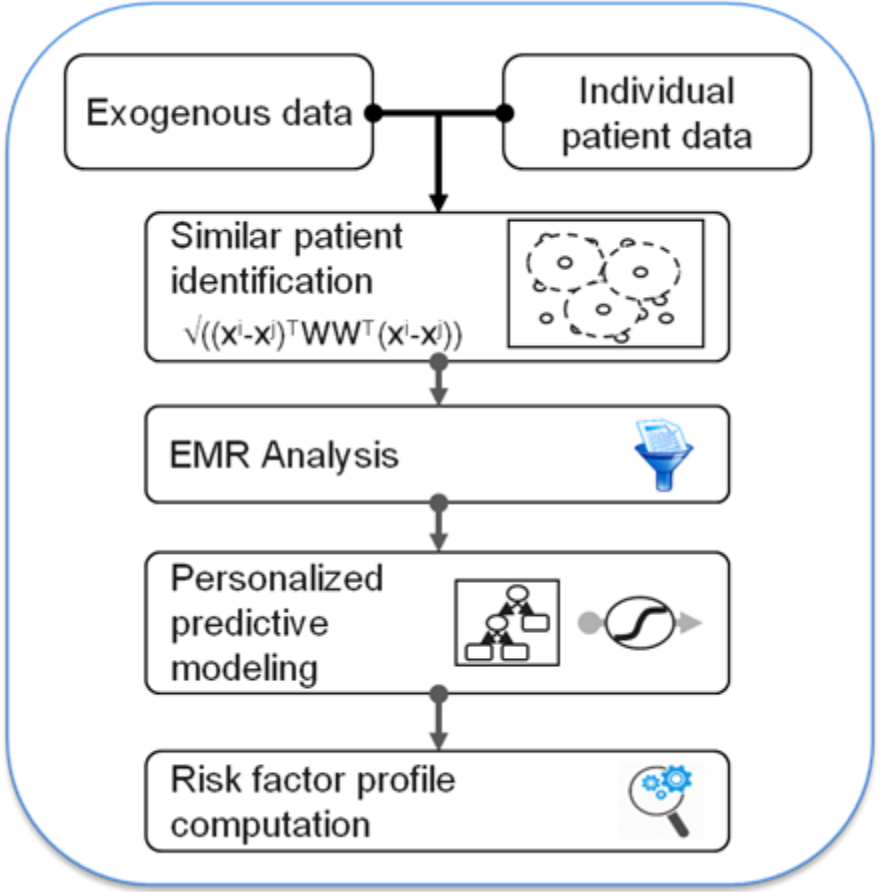
Personalized Predictive Models

Potential to:

- Predict
- Personalize
- Prevent
- Promote



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Humans + Cognitive = “AI” or Augmented Intelligence

People excel at:


Common sense


Dilemmas


Morals


Compassion


Imagination


Dreaming


Abstraction


Generalization

Cognitive systems excel at:


Natural Language


Pattern Identification


Locating Knowledge


Machine Learning


Eliminate Bias


Endless Capacity

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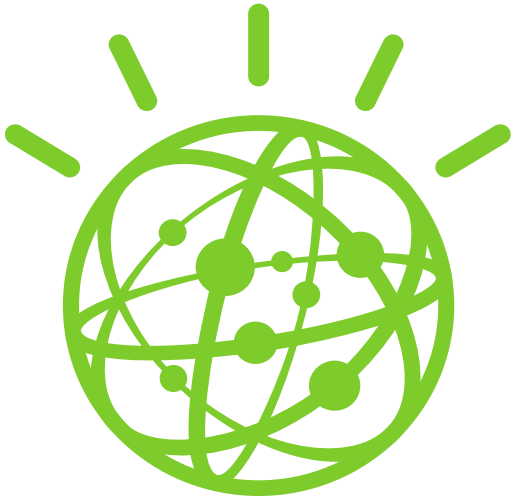
This is one of Laennec's original
stethoscopes, and it was presented by him
to Dr Bégin a French Army surgeon,
whose widow gave it to me in

Let’s Work Together



w.kassler@ibm.com

@KasslerMD
@IBMWatsonHealth

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