Big Data and Healthcare

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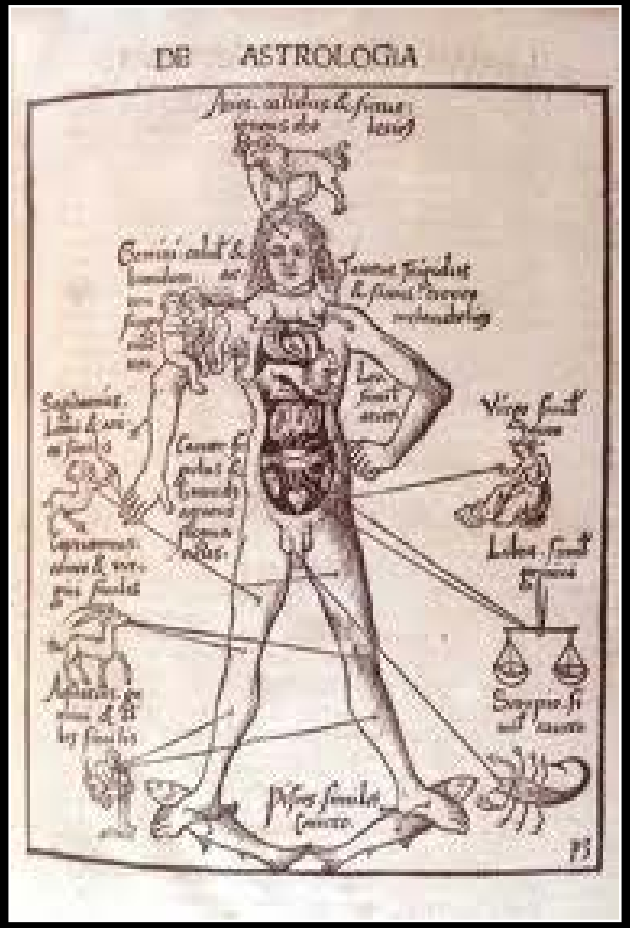
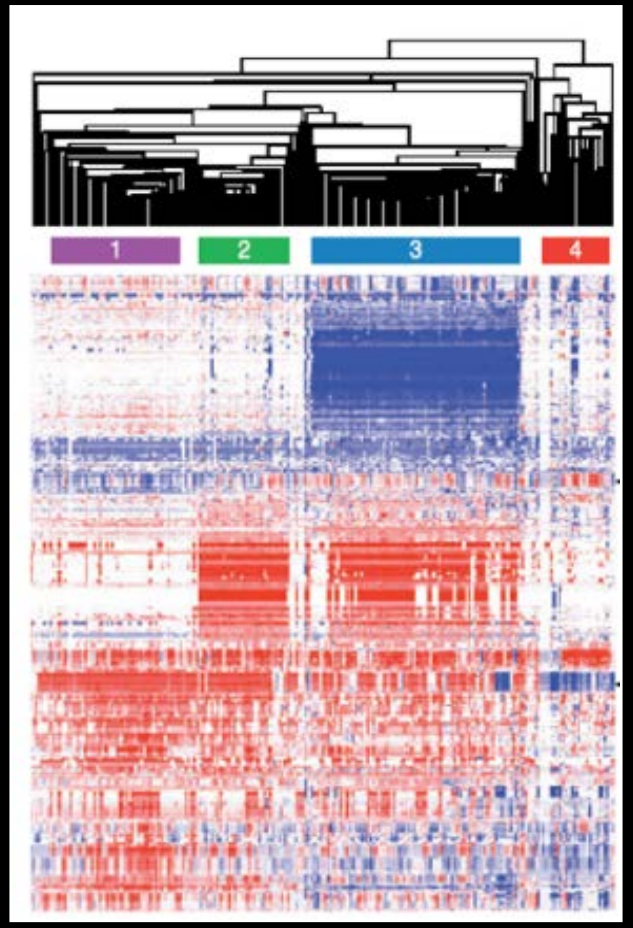
Fifth Annual Conference on
Governance of Emerging Technologies: Law, Policy and Ethics
Phoenix, AZ ● 18 May 2017

Challenges Facing U.S. Healthcare

- Balancing Infinite Demand versus Finite Resources
- From Volume-Based FFS Care to Value-Based Care
- From Reactive Interventions in Disease Episodes to Proactive Continuity of Care Services
- Improving Outcomes at Lower Cost and Realizing the Wellness Premium
- Technological Innovation and New Value Propositions in Healthcare

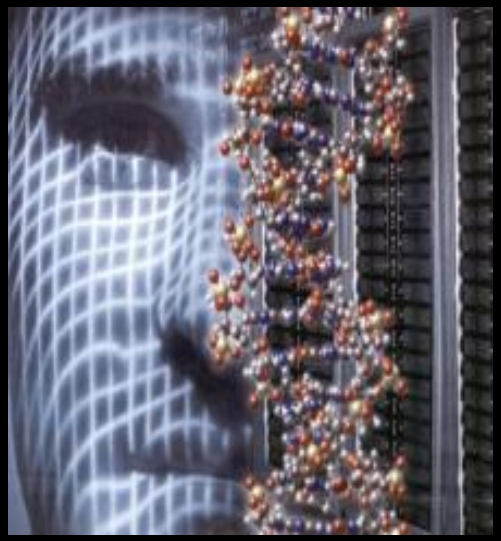
The Path to Precision Medicine: From Superstitions to Symptoms to Signatures



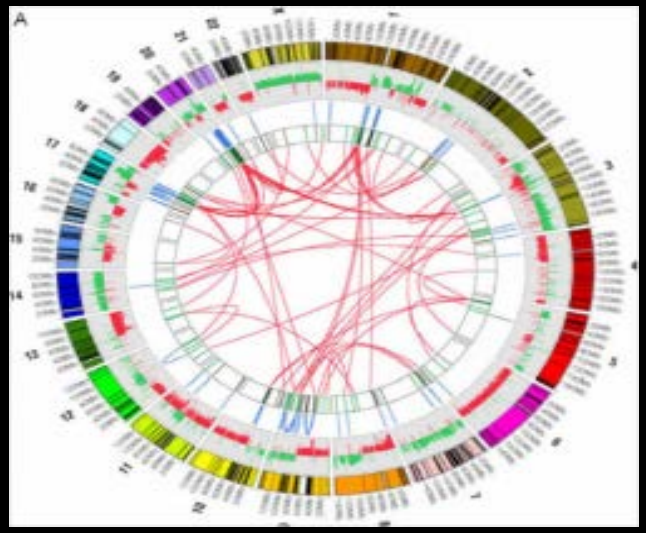


Precision Medicine

(Epi)Genomics



Causal Relationships Between Molecular Network Disruptions and Disease

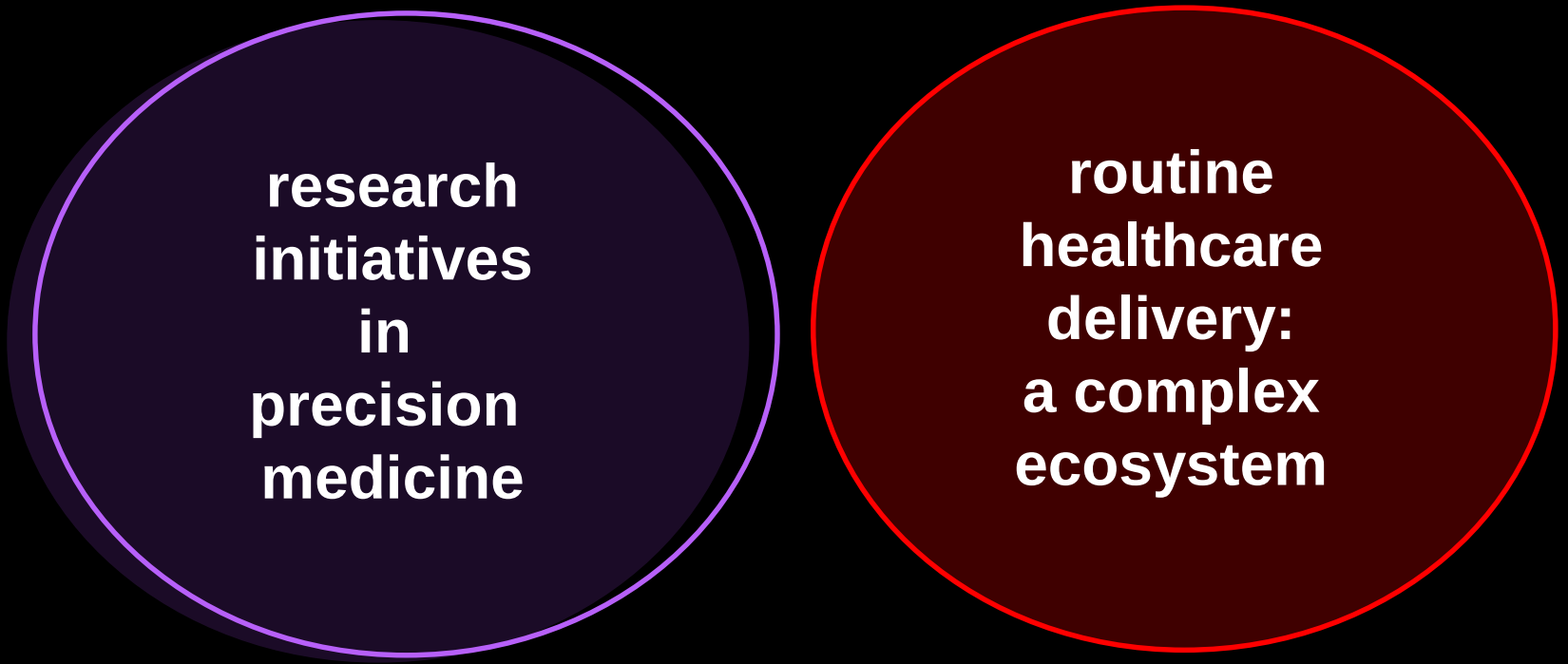


Patient-Specific Signatures of Disease or Predisposition to Disease

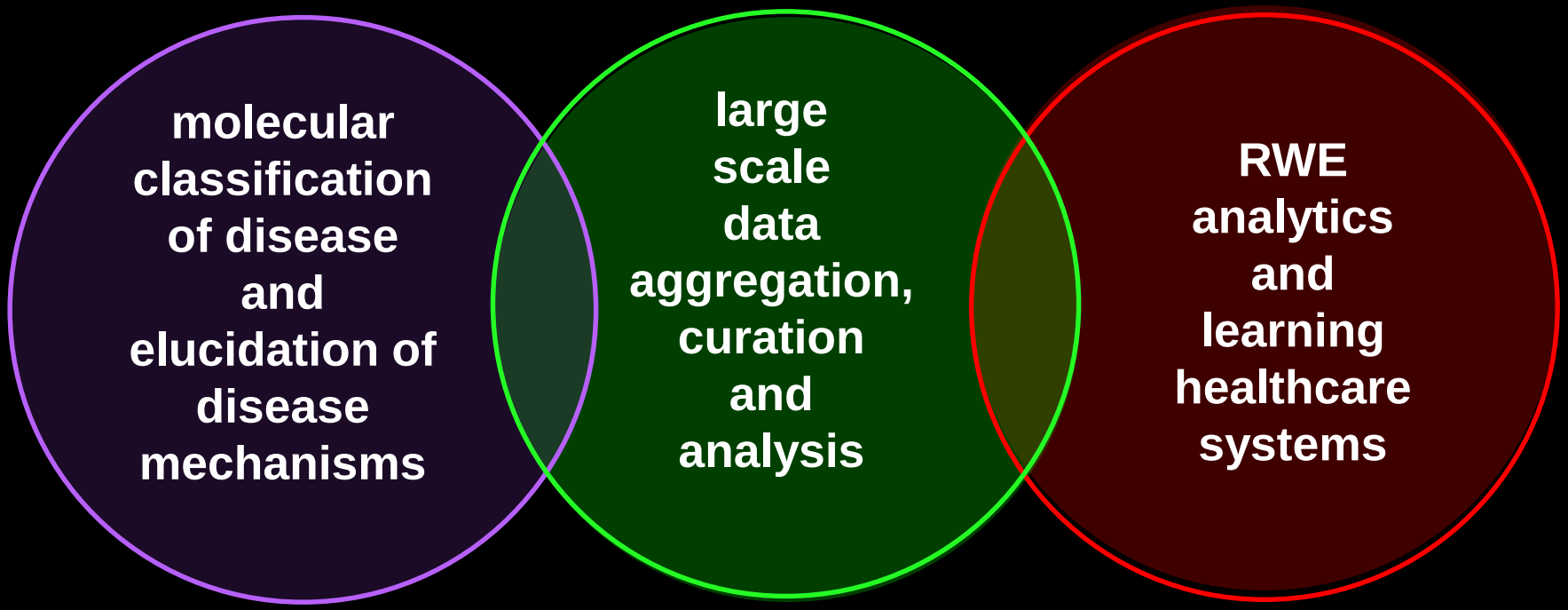
- **terabytes per individual**
- **zettabyte – yottabyte datasets for populations**

Big Data

Still Two Largely Separate Worlds



Precision Medicine and Data-Intensive Computational Medicine: Evolving Inter-Dependencies



Humana

“I don’t think of Humana so much as an insurance company as an IT company who is helping us with the data that we need in order to deal with our population health tools.”

Dr. Roy Beveridge, M.D.

CMO, Humana

Cited in Fierce Healthcare 9 May 2017

- the majority of events that influence wellness/disease risk occur largely outside of formal interactions with the healthcare system

- daily decisions by individuals have greater effects on their health than decisions controlled by the healthcare system

Mapping Genotype-Phenotype Relationships and Disease Risk:

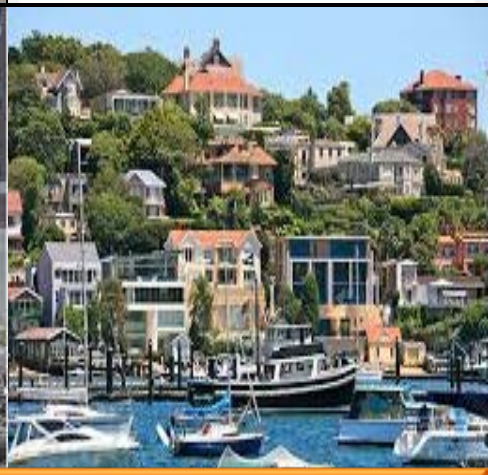
Systematic Integration of Diverse Data for Population Health Analytics

Continuity of Care Record: From Womb to Tomb







Behavior

Environment

Social Spaces Become Quantifiable

- who knows why people do what they do?
  - the fact is that they do!
- these actions can now be traced and measured with unprecedented precision
- with sufficient data, the numbers reveal increasingly predictable behavior and individual risk patterns
- new ethical and legal issues
  - consent, privacy, surveillance, security

Invasion of the Body Trackers: Expanding the "Care Space" in Healthcare

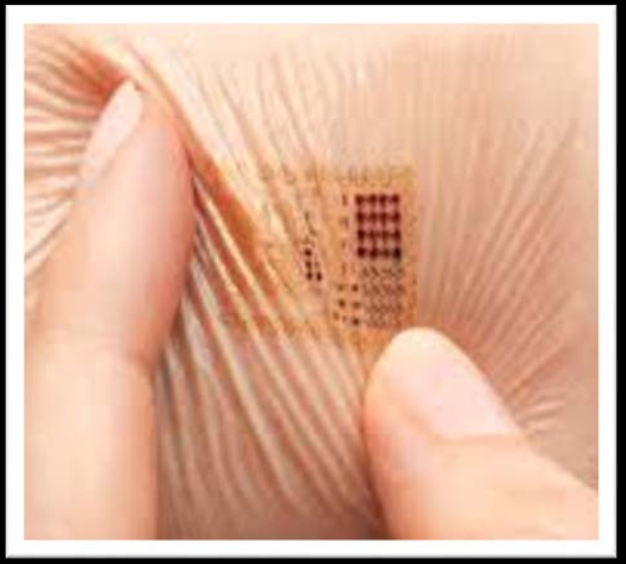
Healthcare Beyond The Clinic

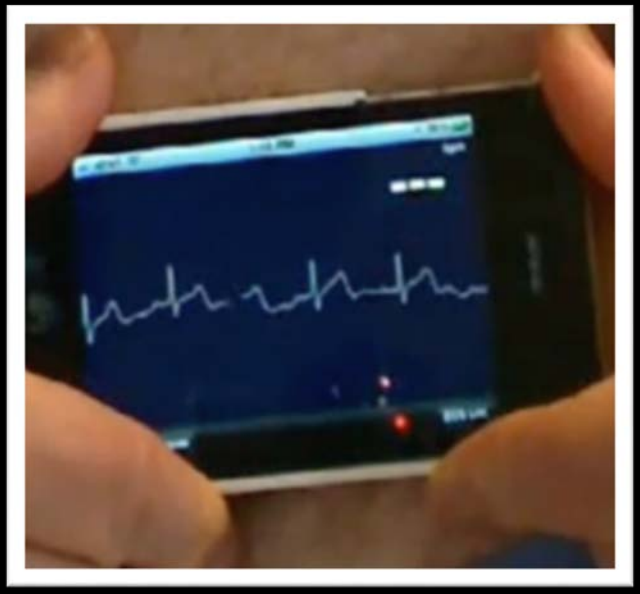
Remote Health Status Monitoring

Smartphones, Wearables, Devices and Digital Services

M4: Making Medicine More Mobile

Remote Health Status Monitoring





Gray Technologies and Aging in Place: Independent But Monitored Living for Aging Populations

Rx adherence

cognitive stimulation

in home support and reduced readmissions

reduced office visits

Digital Personal Assistants

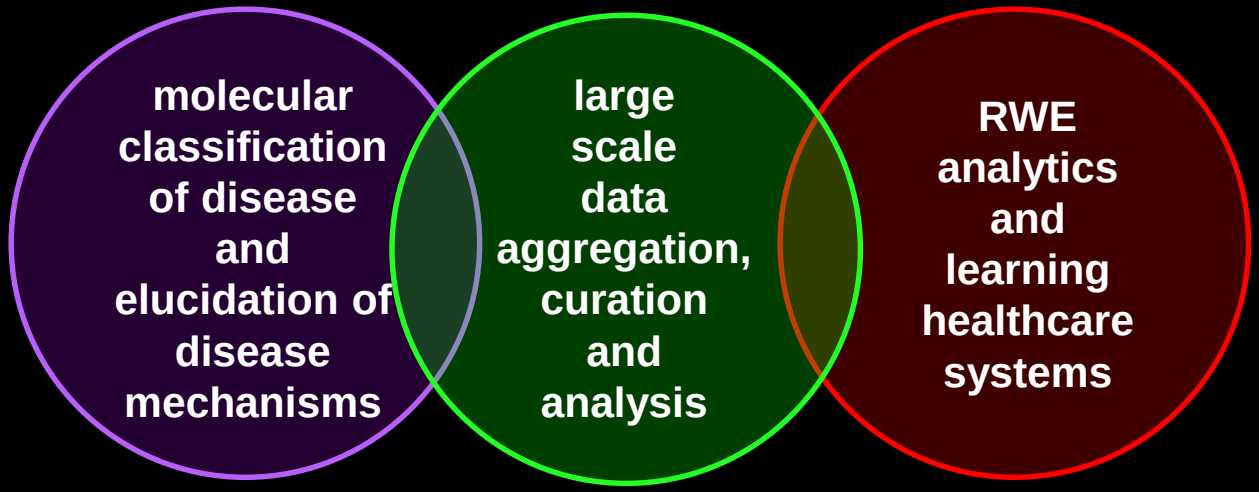
Population Health Research and Precision Medicine: Blurring the Boundaries Between Research and Clinical Care

- every encounter (clinical and non-clinical) is a data point
- every individual is a data node
- every individual is a research asset
- every individual is their own control

Mobile Apps, Wearables, Sensors and Continuous Health Status Monitoring

- who sets the standards?
- who integrates and interprets the data?
- who pays?
- who consents?
- who owns the data?

Precision Medicine and Computational Medicine: Evolving Inter-dependencies



The Big Data Challenge

V6: volume, variety, velocity, veracity, virtualization, value

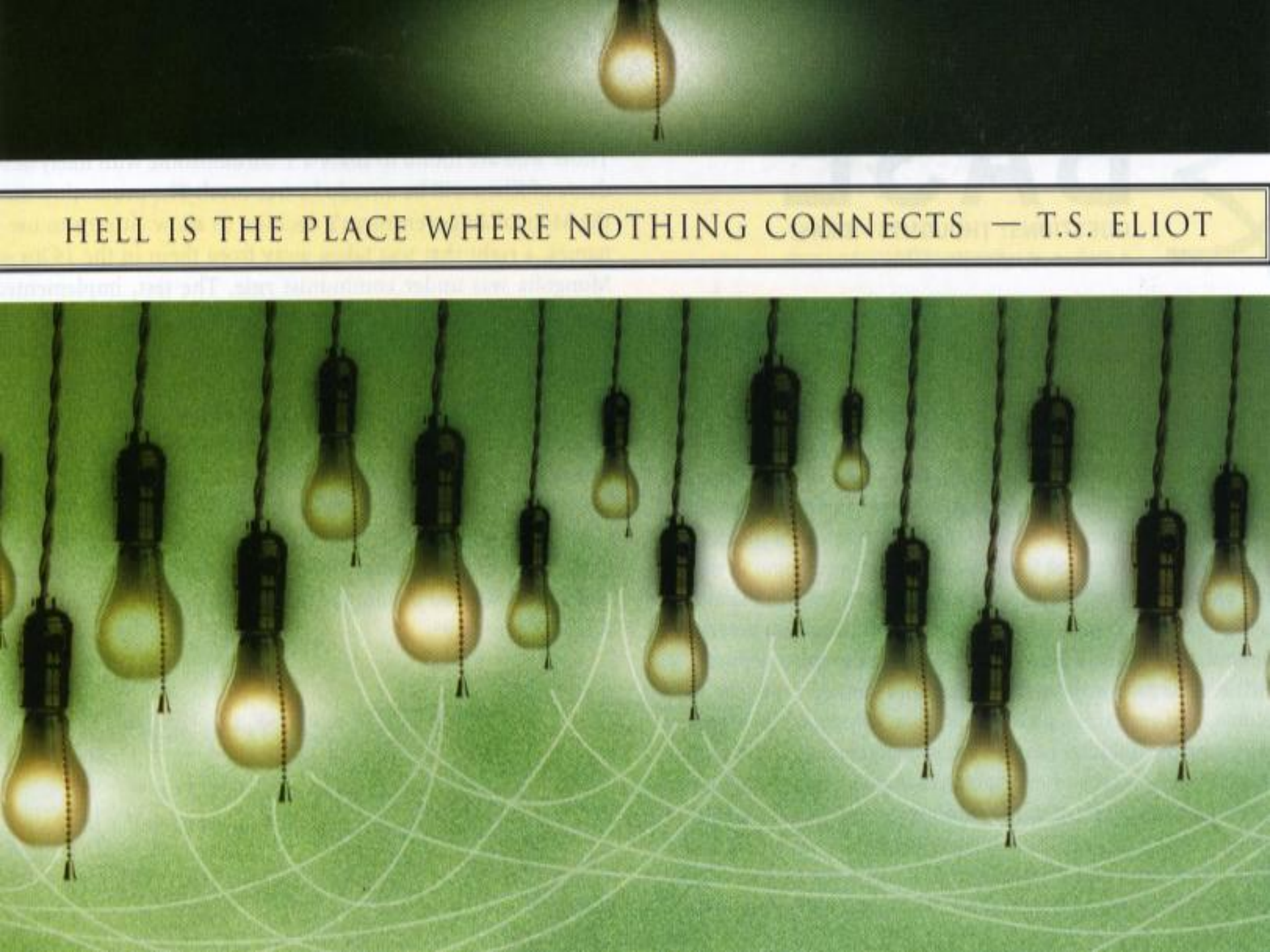
D3: distributed, dynamic, decision support

I3: infrastructure, investment, intelligent systems

Now Comes the Hard Part!

Driving Precision Medicine and Data-Driven Healthcare Into Routine Clinical Practice

The Problem with Real World Data is the Real World


HELL IS THE PLACE WHERE NOTHING CONNECTS — T.S. ELIOT

Silos Subvert Solutions:
Protecting Turf and Sustaining the Status Quo

The Worst Supply Chain in Society: The Health Information Supply Chain

- fragmented, disconnected data
- incompatible data formats as barrier to data integration
- incomplete and inaccurate data
- slow transition from paper to electronic systems
- inadequate information on behavioral and environmental influences on health
- legislative barriers to data transfer based on well intentioned privacy protections
- organizational, economic and cultural barriers to open data sharing

Intrinsic Tensions in Open Data Policies and Data Sharing in Biomedicine

- privacy and security protections
- need for ‘large N’ datasets versus private/ proprietary data and analytical algorithms
- poor interoperabilities: the EMR vendor trap and deliberate information blocking
- incentives and rewards versus cultural resistance/economic burden to sharing in the research community
- data ownership

The Pending Era of Cognitive Computing and Decision-Support Systems: Overcoming the "Bandwidth" Limits of Human Individuals

- limits to individual expertise
- limits to our multi-dimensionality
- limits to our sensory systems
- limits to our experiences and perceptions
- limits to our objective decision-making

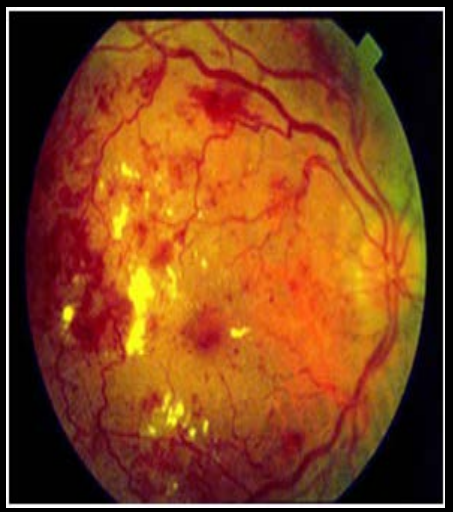
The Slow Brain and the Fast Machine

Cognitive Computing, Deep Learning and Machine Intelligence

The Future Workforce and the Future of Work

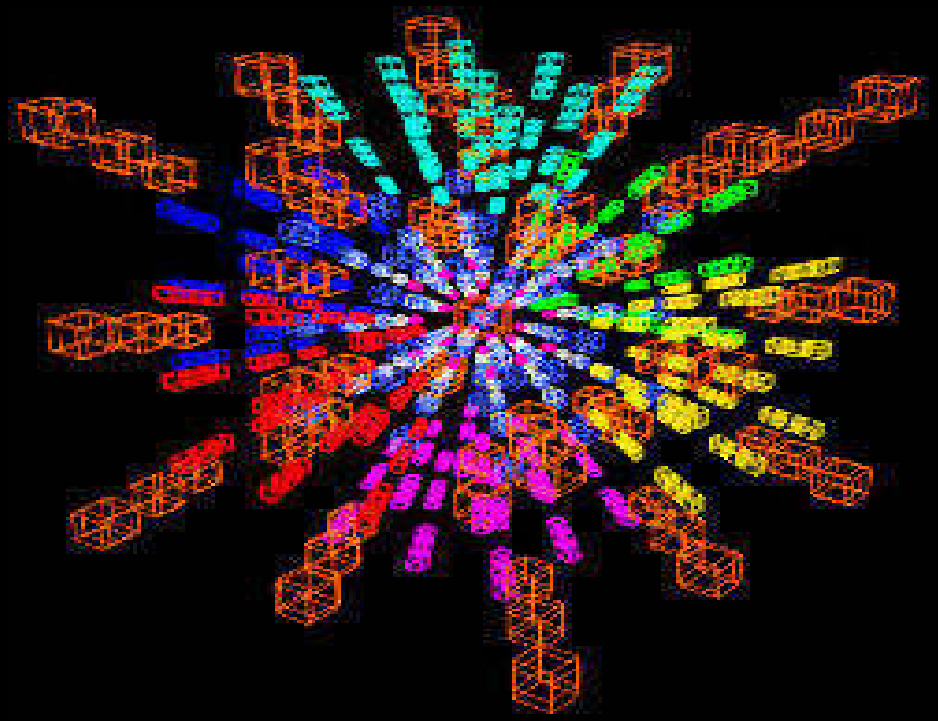
Machine Learning and Image Analysis in Clinical Medicine

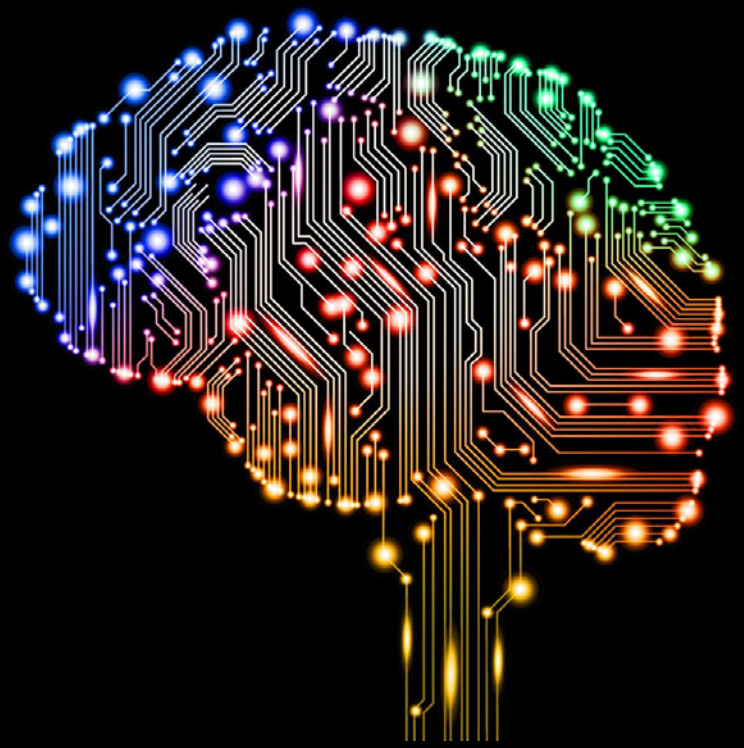
pathology	radiology	dermatology	ophthalmology



- large scale training sets and classification parameters
- standardized, reproducible and scalable
- 260 million images/day for $1000 GPU

Automated Context: Data Finding Data
"Intelligence at Ingestion"





Feature Extraction and Classification

Context Analysis

Persistent Context

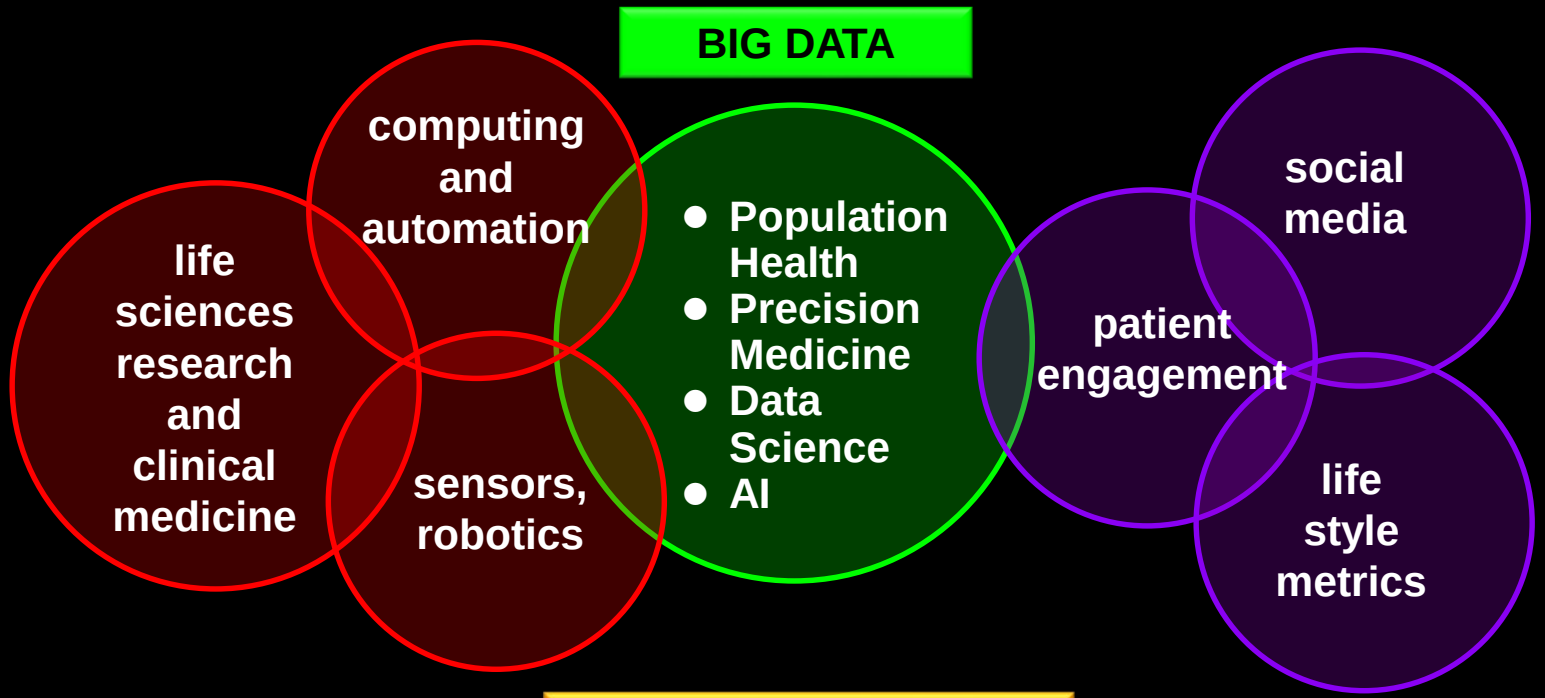
- **Relevance Detection**
- **Learning Systems**

- **Situational Awareness**
- **Rapid, Robust Decisions**

The Evolving Healthcare Information Ecosystem

technology

connectivity, continuity and consumerism



services integration (systems)

analytics for improved decisions and clinical outcomes (value)

the expanded care space (individuals)

Deep Learning, Machine Learning and Artificial Intelligence in Data Analytics and Decision Support

“I Can’t Let You Do That Dave”

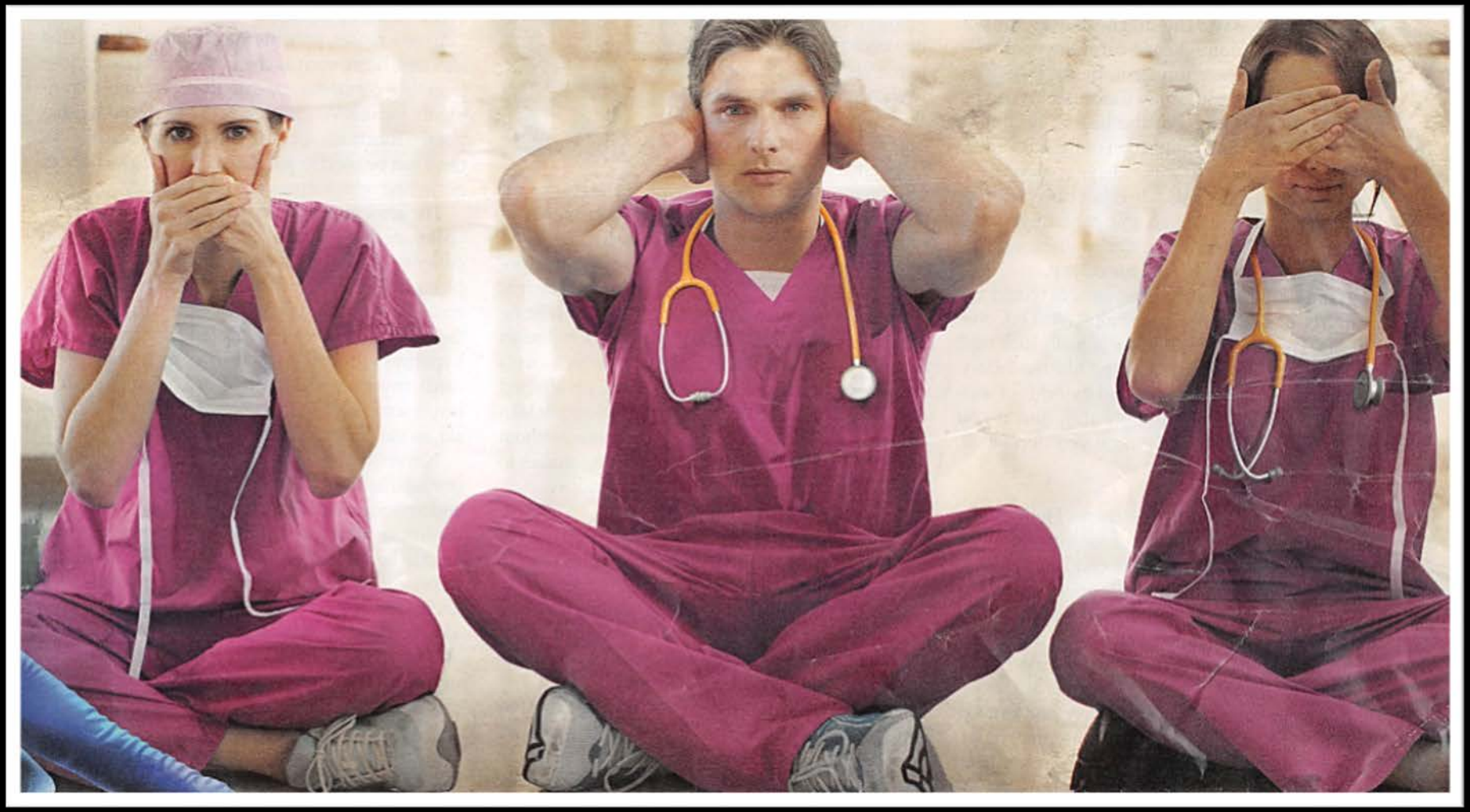
Automated Decision Support Tools and “Gated Autonomy” in the Management of Complex Systems

Living in a World Where the Data Analytics and Interpretation Algorithms Are Obscure to the End User

- ceding decision authority to computerized support systems
- culturally alien to professionals in their claimed expertise domain but they accept in all other aspects of their lives
- who will have the responsibility for validation and oversight of critical assumptions used in decision tree analytics for big data?
  - regulatory agencies and professional societies?
  - humans?
  - machines?


CHANGE
is good
you go first

DNR



Denial

Negativity

Resistance

The Rise of Data-Intensive Medicine and Digital Healthcare

The Intellectual Foundation for a New Era in Clinical Medicine and Public Health

From Reactive Responses to Illness Episodes to Proactive Continuity in Care to Optimize Wellness (Risk Reduction)

Profound Organizational Economic and Cultural Disruption in Healthcare Delivery and Professional Competencies

New Business Models and New Participants Previously Uninvolved in Healthcare

Slides available @ http://casi.asu.edu/