Combating Health Challenges through Data and Cognitive Insights

Dusty Majumdar, PhD
VP and Chief Marketing Officer
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The official seal of MIT, depicting its motto “Mens et Manus,” which is Latin for mind and hand.

MIT and IBM: putting our “minds and hands” together to create the future of AI
RSNA 2017: AI has potential to match the hype

RSNA 2017 shows AI in healthcare, value-based imaging

Fujifilm to Introduce Artificial Intelligence Initiative for United States Market at RSNA 2017

Will the rise of the machines imperil radiologists?

General Electric (GE) Announces Collaboration with NVIDIA to Accelerate Artificial Intelligence Adoption in Healthcare

A 'Blowout Year' for AI in Radiology

Arterys Receives FDA clearance for Arterys MICA, its web-based medical imaging analytics platform

Zebra Medical Vision Enables Radiology Algorithms on Google Cloud With AI1 All-in-One Offering

Lunit Unveils "Lunit INSIGHT," A New Real-time Imaging AI Platform on the Web at RSNA 2017
Today’s Healthcare Challenges

**Every 73 days**
The rate medical data is expected to double by 2020

**51%**
Of physicians experienced at least one symptom of burnout in 2016, a 25% increase in the last 4 years

**2 billion**
The number of people over the age of 60 by 2050

**12.9 million**
Expected global shortage of health-care workers by 2035

**$47 trillion**
Cumulative estimated global economic impact of chronic disease between 2011 and 2030

In 2015, U.S. healthcare spending increased 5.8 percent to reach 3.2 trillion, or $9990 per person.

The amount of Medicare payments to alternative payment models by 2018.

Expected shortage of physicians by 2020.
The rate medical data is expected to double by 2020.

Healthcare data that comes from unstructured data sources.

The amount of healthcare data in 2011.
<table>
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<tr>
<th>Data Explosion</th>
<th>Dynamic Delivery</th>
<th>Value vs Volume</th>
<th>Efficient, Effective R&amp;D</th>
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<tbody>
<tr>
<td>150+ exabytes of healthcare data today&lt;sup&gt;1&lt;/sup&gt;</td>
<td>50% Expected alternative payments from Centers of Medicare &amp; Medicaid by 2018&lt;sup&gt;4&lt;/sup&gt;</td>
<td>$47 trillion Estimated global economic impact of chronic disease by 2030&lt;sup&gt;7&lt;/sup&gt;</td>
<td>1 in 10 clinical Trials in cancer are shut down from lack of participation&lt;sup&gt;10&lt;/sup&gt;</td>
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<tr>
<td>Over 230K active clinical trials&lt;sup&gt;2&lt;/sup&gt;</td>
<td>75%+ of patients expected to use digital health services&lt;sup&gt;5&lt;/sup&gt;</td>
<td>$3 trillion Estimated U.S. healthcare spending&lt;sup&gt;6&lt;/sup&gt;</td>
<td>$2B Average costs to develop a new pharma drug&lt;sup&gt;11&lt;/sup&gt;</td>
</tr>
<tr>
<td>80% of healthcare data coming from unstructured sources&lt;sup&gt;3&lt;/sup&gt;</td>
<td>60-90K Expected shortage of physicians by 2025&lt;sup&gt;6&lt;/sup&gt;</td>
<td>100’s Number of decisions a person with Type 1 Diabetes makes a day&lt;sup&gt;9&lt;/sup&gt;</td>
<td>&lt; 10% drugs currently in development that make it to market&lt;sup&gt;12&lt;/sup&gt;</td>
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Our Mission

We, Watson Health, aspire to improve lives and give hope by delivering innovation to address the world’s most pressing health challenges through data and cognitive insights.
IBM leadership in AI and Health is more than 10 years in the making
Tabulating Systems Era
1900 – 1940s

Programmable Systems Era
1950s – Present

Cognitive Computing Era
2011 –
Gerald Tesauro (1994) developed a self-teaching backgammon program called TD-Gammon.


Arthur Samuel demonstrated (1956) playing Checkers with the IBM 701 on Television.

Jeopardy! 2011 Games Provide a Laboratory for Reasoning
**Trend:** Approaching Human Accuracy

**Image Recognition - %Error Rate**

- 2010: 30%
- 2011: 25%
- 2012: 20%
- 2013: 15%
- 2014: 10%

**Speech Recognition - %Error Rate**

- 2000: 25%
- 2002: 20%
- 2004: 15%
- 2006: 10%
- 2008: 5%
- 2010: 0%
- 2012: 5%
Unstructured data—“dark data”—accounts for 80% of all data generated today.
Growing data volume and complexity demands a new approach.

Sensors & Devices
Medical Images
Images/Multimedia
Natural Language
Enterprise Data

You are here

IDC, Digital Universe Study, 2014
Cognitive System Attributes

**Understanding**
Measured by the ability to interpret and derive actionable information and knowledge

**Reasoning**
Ability to link together data/information elements, draw connections from knowledge resources and solve problems using the information

**Learning**
Extent the system improves over time with exposure to new data

**Interacting**
Recognition of and leveraging available content to fit naturally in workflow and provide interactions that work best for users
Humans excel at:

- Common Sense
- Dilemma
- Morals
- Compassion
- Imagination
- Dreaming
- Abstraction
- Generalization

Cognitive systems excel at:

- Natural Language
- Pattern Identification
- Locating Knowledge
- Machine Learning
- Eliminate Bias
- Endless Capacity
What is Deep Learning?

Deep learning is a branch of machine learning that makes use of multiple processing layers and hierarchical representations to drive the learning process.
Deep Learning: A branch of Machine Learning

Deep learning is a branch of machine learning that makes use of multiple processing layers and hierarchical representations to drive the learning process.
Now comes the second machine age. Computers and other digital advances are doing for mental power—the ability to use our brains to understand and shape our environments—what the steam engine and its descendants did for muscle power.

ERIK BRYNJOLFSSON
Schorr Family Professor of Management Science
Professor, Information Technology
Director, The MIT Initiative on the Digital Economy
On September 7, 2017 we announced a 10 year, $240M investment to create the MIT-IBM Watson AI Lab in Cambridge, MA

- The lab will carry out fundamental AI research and seek to propel scientific breakthroughs that unlock the potential of AI
- It is one of the largest, long-term university-industry AI collaborations to date
- We are mobilizing the talent of more than 100 AI scientists, professors and students to pursue joint research
Purpose-Built Healthcare Cloud and Extensive Data Repository

- HIPAA and GxP compatible
- End-to-End Security
- Purpose-Built for Health Data
- Regular Updates
- Business Continuity/Resiliency

- 200M+ lives
- 100M+ patient records
- Billions images managed
- 1.2M medical abstracts
- 3B+ reference points
- 4M+ drug patents
- 40M+ research documents
## Innovative Cognitive Solutions with Watson APIs

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<tr>
<th>Oncology &amp; Genomics</th>
<th>Government</th>
<th>Life sciences</th>
<th>Value-Based Care</th>
<th>Imaging</th>
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<tr>
<td>Watson for Genomics</td>
<td>Social Program Management</td>
<td>Clinical trials</td>
<td>Next Generation Population Health Suite</td>
<td>“Cardiac Advisor”**</td>
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<td>Watson for Oncology</td>
<td>Health &amp; Human Services</td>
<td>Watson for Drug Discovery</td>
<td>Next Generation Payer Analytics</td>
<td>“Voice to Report or Cardiologists and Radiologists”**</td>
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<tr>
<td>Clinical Trial Matching for Oncology</td>
<td>Next Generation Program Integrity</td>
<td>Watson for Patient Safety</td>
<td>Next Generation Provider Portable Analytics</td>
<td>“Breast Advisor”**</td>
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- **Adaptable Cognitive API Services**
- **Deep Learning**
- **Sequence Learning**
- **Natural Language Processing**
- **Domain-specific Annotation, Curation**
Cognitive applications in health

Achieving high degree of concordance with global oncologists on cancer treatment recommendations using Watson for Oncology

Discovering new drug targets for amyotrophic lateral sclerosis with Watson for Drug Discovery

Predicting potential hypoglycemic events for patients with diabetes through Medtronic’s Sugar.IQ with Watson

Identifying symptoms and severity of schizophrenia through MRI analysis

Detecting onset of heart failure through electronic health records

Highly Adaptable Cognitive API Services

Deep Learning Technology

Sequence Learning Capabilities

Natural Language Processing Technology

Highly Domain-specific Annotation and Curation
Market Dynamics in Oncology and Genomics

42% How much the demand for cancer care will increase by 2025¹

$173B The projected total cost of cancer care by 2020³

1,500 The estimated shortage of oncologists in the U.S. in the coming decade²

only 3% of adults with cancer are enrolled in clinical trials⁴

1 in 4 deaths in the U.S. are due to cancer⁵

>70% of U.S. counties have no medical oncologist at all⁶

>100x more data produced by next-gen sequencing than by the most sophisticated Sanger sequencers⁷

50% of all treatments in early clinical development rely on biomarker data⁸
Watson in Oncology & Genomics is IBM’s ‘Moonshot’ Program
Key features of Watson for Oncology

**Treatment options for 7 cancers:** Breast  Lung  Colon  Rectal  Gastric  Cervical  Ovarian

Generates **ranked treatment plans and ranked treatment options within each treatment plan along** with all the supporting information for each of the treatment options:
- Overview (including outcome statistics and MSK curated publications)
- Additional publications (generated by Watson) [Experimental feature]
- Dosing reference
- Drug Information (adverse reactions, precautions, drug-drug interactions)

Provides a **timeline view of treatment plans** showing the duration of each component within the treatment plan (e.g. Chemotherapy for 4-6 weeks, Targeted therapy for 5 years, etc)

**Ability to compare two treatments side-by-side**

**Clinical trials searching** – pre-populated query to clinicaltrials.gov

**Initial support for displaying Dr. Evidence data as supporting rationale for some treatments**

**Print/Export capability including patient education material**
How it Works: Watson For Clinical Trial Matching

**Current Challenges**

- Searching across eligibility criteria of clinical trials is **time consuming** and **labor intensive**
- Fewer than 5% of adult cancer patients participate in clinical trials\(^1\)
- 37% of sites fail to meet minimum enrollment targets. 11% of sites fail to enroll a single patient \(^2\)

**The Watson solution**

- Uses structured and unstructured patient data to quickly check eligibility across relevant clinical trials
- Understanding of complex inclusion/exclusion trial criteria
- Increases speed to qualify patients
- Use at the point of care to identify potential clinical trials for an individual patient
- Use in the clinical trial office to identify potential patient candidates for an individual trial

**Point of Care: Patients to Trials**

Cognitive Clinician assistant to assess patient eligibility against all available trials.

**Tracker: Trials to Patients**

- Cognitive Clinical Trial Coordinator assistant to:
  - Continuously monitor and identify potential patients for trials
  - Identify changes in patient attributes impacting eligibility
  - Manage and share recruitment status of individual trials

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Watson Health © IBM Corporation 2017
Genome vs. genome analysis

- 95% Genotyping
- 5% Interpretation

2012

- 5% Genotyping
- 95% Interpretation

2020

Cost per genome
Number of genome sequenced

- 10 Mio
- 1

2007

2017
WATSON FOR GENOMICS

Solution Overview

Content Sources

VCF / MAF, Log2, Dge, Fusion Encryption

Content

20+ Content Sources Including:
- Medical Articles
- Drug Information
- Clinical Trial Information
- Genomic Information
- OncoKB by MSKCC

Service Analytics, Reports & Visualizations

Molecular Profile Analysis

Pathway Analysis

Drug Analysis
UNC compared the human tumor board and Watson in a case study and found that in 30% of the cases, Watson had found something new.

“These were things that by our own definition, we would’ve considered actionable had we known about it”

—Dr. Ned Sharpless, Director of the Lineberger Cancer Center, on 60 Minutes
In a recent study by the **New York Genome Center**, researchers using beta version of Watson to help scale the interpretation of whole genome sequencing found that for advanced glioblastoma, an aggressive brain cancer:

- *Published in Neurology, July 11th 2017*

10 minutes

Watson provided a report of potential clinically actionable genomic insights.

160 hours

Human analysis and curation arrived at similar conclusions for this patient.
Challenges in Imaging

- **Misdiagnoses have huge costs to organizations**
  - $4 billion is spent on false-positive mammograms in the US each year

- **Administrative tasks take up significant time**
  - 64% of radiologists’ time was spent on non-interpretive tasks

- **More physicians are experiencing burnout**
  - 51% of physicians experienced at least one symptom of burnout in 2016, a 25% increase in the last 4 years

- **Imaging is generating a huge volume of data**
  - 60 billion medical images were generated in 2015 across the US

- **Patient data is often unstructured**
  - 80% of patient data in organizations is unstructured, often lacking relevant context

**Sources:**
2. [http://content.healthaffairs.org/content/34/4/576.abstract](http://content.healthaffairs.org/content/34/4/576.abstract)
Rethinking Owner Mediated Health Records

Across the health ecosystem, blockchain solutions can:

**Save Time** - Business transactions automated and conducted in near real-time

**Remove Cost** - Business networks can eliminate intermediaries and scale easily

**Reduce Risk** - Business transactions become verifiable and auditable

**Increase Trust** - Through shared processes and recordkeeping
Case study: Submission of big data, such as genomics, to the FDA

*HIVE: High-Performance Integrated Virtual Environment, FDA’s cloud-based environment that comprises both a storage library of data and a powerful computing capacity.
Empowering Patients
That’s why we are dedicated to empowering heroes — both celebrated and unsung, expected and unexpected, those in headlines and on the frontlines — to transform health.

Empowering heroes, transforming health