Analytics, Big Data and Automation in Health Care

Thomas H. Davenport
Babson/MIT/Deloitte/International Institute for Analytics

HSPH Leadership Strategies for IT in Health Care
February 3, 2017
Two Types of Data

<table>
<thead>
<tr>
<th>Name</th>
<th>Sex</th>
<th>Birth Date</th>
<th>Post Code</th>
<th>Complaint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter</td>
<td>Male</td>
<td>02/12/1954</td>
<td>SE24 6TY</td>
<td>Pain in left eye</td>
</tr>
<tr>
<td>Stewie</td>
<td>Male</td>
<td>05/01/1984</td>
<td>NW1 6XD</td>
<td>Chest pains</td>
</tr>
<tr>
<td>Chris</td>
<td>Female</td>
<td>04/08/1978</td>
<td>E17 7WE</td>
<td>Chest pains</td>
</tr>
<tr>
<td>Louis</td>
<td>Female</td>
<td>03/10/1960</td>
<td>WC1 7RA</td>
<td>Back pains</td>
</tr>
<tr>
<td>Meg</td>
<td>Male</td>
<td>09/09/1990</td>
<td>NW7 5LX</td>
<td>Headaches</td>
</tr>
</tbody>
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“Small data”
- Small volumes—< 100 TB
- Usually internal
- Structured in rows and columns of numbers
- Slow-moving enough to segregate
- Already suitable for analytics

“Big data”
- Large—in petabytes
- Often external
- Unstructured—text, voice, video, image, etc.
- Continually flowing
- Needs to be structured to be analyzed
Four Types of Analytics

Automated Analytics

Predictive/Prescriptive Analytics

Descriptive Analytics

Embedded analytics
- What if we take action?

Optimization
- What’s the best that can happen?

Randomized testing
- What if we try this?

Forecasting/Predictive models
- What happens next?

Statistical models
- What are the causes and effects?

Alerts
- What actions are needed now?

Query/drill down
- Where exactly is the problem?

Scorecards
- What information really matters?

Standard reports
- What happened?
What Should Health Care Organizations Do with Analytics?

Many organizations *use* analytics
- Optimizing aspects of operations
- Understanding what treatments are effective
- Allocating costs accurately and understanding what drives financial performance

A few organizations *compete on analytics*
- Making analytics and fact-based decisions key elements of their strategy and mission
Levels of Analytical Maturity

- Stage 1: Analytically Impaired
- Stage 2: Localized Analytics
- Stage 3: Analytical Aspirations
- Stage 4: Analytical Companies
- Stage 5: Analytical Competitors
Analytics and Data in Health Care—Where Are We?

Still mastering small data

- EMR
- Cost
- Operations

Big data’s already here

- Genomic
- Medical device
- Activity and behavior tracking
- Clinical notes

Mired in descriptive analytics, when we desperately need predictive and prescriptive
Some of What We Need

Predictive—analytics to predict the future

- Who’s going to contract diabetes?
- How will this drug work on patients with this genotype?
- Which physicians will prescribe this medication?

Prescriptive—analytics for the front line

- What care protocol should I use on this patient?
- How do I minimize the possibility of readmitting this patient?
- How can I lower the cost of this patient’s treatment?
The Analytical **DELTA**

\[ \Delta \text{DELTA} = \text{CHANGE} \]

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<thead>
<tr>
<th>D</th>
<th>DATA</th>
<th>BREADTH, INTEGRATION, QUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>ENTERPRISE</td>
<td>APPROACH TO MANAGING ANALYTICS</td>
</tr>
<tr>
<td>L</td>
<td>LEADERSHIP</td>
<td>PASSION AND COMMITMENT</td>
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<tr>
<td>T</td>
<td>TARGETS</td>
<td>FIRST DEEP THEN BROAD</td>
</tr>
<tr>
<td>A</td>
<td>ANALYSTS</td>
<td>PROFESSIONALS AND AMATEURS</td>
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Data

The prerequisite for everything analytical
Clean, common, integrated, boundary-spanning
Accessible in a warehouse (or Hadoop cluster)
Measuring something new and important
New Metrics / Data

Lens Customers

Health Behaviors

Smile Frequency
If you’re competing on analytics, it doesn’t make sense to manage them locally
No fiefdoms of data, technology, or people
Some level of centralized expertise desirable
Organizations may also need to upgrade hardware and infrastructure
What’s your enterprise?
Leadership

“At Caesars we’ll fire you for three things”
Gary Loveman, CEO
Caesars Entertainment

Toby Cosgrove at Cleveland Clinic
- “We measure everything”

Jim Mongan, John Glaser, and Gary Gottlieb at Partners Healthcare
- “High-performance medicine”

Brent James at Intermountain
- “Science projects”

Joe Jimenez at Novartis
- “Building bioinformatics capabilities”
Targets

Pick a major strategic target, with a minor or two

- Chicago = Radiology productivity
- Partners = Adverse drug events + care protocols
- Intermountain = Validation of care protocols
- Genentech = Genomic informatics

Can also have two primary user group targets

- United Healthcare = Patients + other insurers
- Owens & Minor = Supply chain managers + hospitals
Analysts

Analytical Champions
Lead analytical initiatives

Analytical Professionals/Data Scientists
Can create new algorithms

Analytical Semi-Professionals
Can use visual and basic statistical tools, create simple models

Analytical Amateurs
Can use spreadsheets, use analytical transactions

* percentages will vary based upon industry and strategy
Changing the Way We Do Analytics

1.0  
- Small, structured, static data
- Back-office analysts
- Slow, painstaking
- Internal decisions
- Descriptive analytics
- Human hypotheses

2.0  
- Big, unstructured, fast-moving data
- Rise of data scientists
- Data products in online firms
- Rise of Hadoop and open source
- Visual analytics
- "Agile is too slow"

3.0  
- Mix of all data
- Internal/external products/decisions
- Analytics a core capability
- Move at speed and scale
- Predictive and prescriptive analytics

4.0  
- Analytics embedded, invisible, automated
- Cognitive technologies
- "Robotic process automation" for digital tasks
- Augmentation, not automation

1975-? 2001-? 2013-? 2016-?
Analytics 1.0 | Artisanal Analytics

► Primarily descriptive analytics and reporting
► Internal, small, structured data
► “Back office” teams of analysts
► Internal decision support focus
► Predictive models based on human hypotheses
Analytics 2.0 | The Big Data Era

1.0 Artisanal Analytics

2.0 Big Data

- Complex, large, unstructured data
- New computational capabilities required
- “Data Scientists” emerge
- Online firms create “data products”
Analytics 3.0 | The Data Economy

1.0 Artisanal Analytics

2.0 Big Data

3.0 The Data Economy

- Seamless blend of traditional analytics and big data
- Analytics core to the business
- Data and analytics-based products in every business
- Industrialized decision-making at scale
$2B initiative in software and analytics, with $7B in digital revenues in 2016

Primary focus on data-based products and services from “things that spin”

Reshaping service agreements for locomotives, jet engines, turbines

Gas blade monitoring in turbines produces 588 gigabytes/day—7 times Twitter daily volume

Marketing new industrial data platforms and brands like “Predicity” and “Predix”
United Healthcare 3.0

- “Health in Numbers” ad campaign
- Converts call center speech to text and mines it for indications that Medicare patients might attrit
- Real-time fraud intervention stops claims payment before it happens
- Scoring of all UHC members in terms of predictive disease profiles, propensity to enroll and succeed in health management
- OptumHealth, a $67B business, sells healthcare data, analytics, and technology
Intermountain Healthcare 3.0

- From Brent James’ “science experiments” to “perfecting the clinical work process”
- Cost of treatment can be monitored by clinicians along with other variables
- 70 informatics researchers in Homer Warner Center for Informatics Research
- Intermountain offers software and services (with Deloitte) on health outcomes analysis based on 90 million EHR records over 40 years
- Using Hadoop to store and analyze clinical notes, machine and sensor data in ICUs, and other pressing issues
Partners Healthcare System 3.0?

- Early adopters of EHR, CPOE, knowledge management
- Beginning to connect financial, operational, and clinical analytics
- Developed and spun out QPID for extracting intelligence from EHRs
- Finishing organization-wide EPIC transaction foundation and new data warehouse now—how to preserve emphasis on analytics?
Analytics 4.0 | The Cognitive Era

1.0 Artisanal Analytics
2.0 Big Data
3.0 The Data Economy
4.0 Cognitive

- Analytics used to make automated decisions
- Emergence of “cognitive technologies”
- Replacement of human tasks—digital/physical
- Augmentation is human focus
(Cumulative) Skills Across the Eras

1.0 Artisanal Analytics
► Data integration and curation
► Storytelling with data
► Business acumen
► Statistics
► Iterative exploration

2.0 Big Data
► Experimentation
► Data restructuring
► Open source coding
► Product development
► Visual analytics

3.0 Fast Business Impact for the Data Economy
► Machine learning
► Agile methods
► Change management

4.0 Cognitive
► Natural language processing
► Event stream processing
► Work design
► Neural networks/deep learning
Ten Automatable Jobs in Health Care

1. Radiologist—automated breast and colon cancer detection and treatment
2. Pathologist—automated Pap smears
3. Anesthesiologist—automated Propofol administration
4. Oncologist—automated cancer diagnosis and treatment recommendations
5. Surgeon—autonomous robotic surgery
6. Nurse—“robo-nurses” in Japan
7. Health insurance prior authorization—at Anthem and others
8. Clinical coder—automated medical coding
9. EMR system integrators—“robotic process automation” for data integration, conversion
10. Pharmaceutical scientist—cognitive computing for new drugs
Technologies Driving Knowledge Work Automation

- Embedded/operational analytics
- Machine learning
- Artificial intelligence/deep learning
- Rule engines
- Event stream/complex event processing
- Text-based “cognitive computing,” e.g., Watson
- Custom integrations and combinations of these
The Technology Is Great—But How About People and Processes?

► People
  ▶ We need an alternative to automation
  ▶ We need to begin preparing people for the impacts of these technologies

► Processes
  ▶ Identify those in need of more and better cognition
  ▶ Measure them, implement quickly, achieve value quickly
  ▶ Design what people and cognitive technologies do in them

(Pages and pages of similar graphics on Google Image, so all three must be necessary!)
People: Automation or Augmentation?

- Augmentation—smart humans helping smart machines, and vice-versa

- People do this by aiding automated systems that are better than humans at their particular tasks, or by focusing those tasks at which humans are still better

- The classic example: freestyle chess
  - Better than humans or automated chess systems acting alone
  - Humans can choose among multiple computer-recommended moves
  - Humans know strengths and weaknesses of different programs

- We’ve seen this before: textile machinery, spreadsheets
Five Steps to Surviving Automation

► **Step in**—humans master the details of the system, know its strengths and weaknesses, and when it needs to be modified

► **Step up**—humans examine the results of computer-driven decisions and decide whether to automate new decision domains

► **Step aside**—humans focus on areas that they do better than computers, at least for now

► **Step narrowly**—humans focus on knowledge domains that are too narrow to be worth automating

► **Step forward**—humans build the next generation of automated systems
Cognitive Processes—Criteria and Examples

- Knowledge bottleneck
  - Tertiary care diagnosis and treatment
- Need for decision quality and consistency
  - Health insurance preapprovals
- Too much data or content for humans to digest/analyze
  - Oncology
- Cognition currently too expensive for broad application
  - New drug development
Oncology, For Example

- Over 400 types of cancer
- Hundreds of oncogenes and tumor suppressor genes
- Biome probably implicated in cancer too
- Oncology information needs to be integrated with EMR data
- Over 75 different drugs for breast cancer alone
- Treatment options changing very quickly
- In short, too hard for humans, but machines don’t find it easy either—yet
Prescription for Surviving Technology Disruption

- Continue to evolve your capabilities for data management and analytics
- Make sure you and your management team understand the opportunities and threats
- Do pilots and proofs of concept
- Hire some great people
- Pay attention at this program!