Cognitive Computing in Healthcare:
Current Capabilities and Future Directions

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An **historic shift** in technology has occurred

1900  
Tabulating

1950  
Programmable

2011  
Cognitive
Cognitive Computing creates a new partnership between people and computers that enhances, scales and accelerates human expertise.
Cognitive computing machines learn and evaluate as we do

Study
Apprentice
Practice
Master

Ingest
Learn
Test
Experience

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Cognitive Computing enhances our abilities to perceive, reason and relate

**Perceiving:**
Understanding the world as we do: it interprets sensory input beyond traditional data

**Reasoning:**
Thinking through complex problems: it deepens our analysis and inspires creativity

**Relating:**
Understanding how we communicate, and personalizes its interactions with each of us

**Learning:**
Learning from every interaction, scaling our ability build experience
Why Cognitive Computing in Healthcare?

Combine Published Knowledge

Proliferation of medical literature

~700k new scientific articles / year

...with Individual Patient Data

Data Generated (per life)

Exogenous data (Behavior, Environment ...)

1,100 Terabytes

Genomics
6 Terabytes

Clinical data
0.4 Terabytes

Institutional Knowledge
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 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. She lived with her husband and had three healthy adult children. She had a 20-pack-year history of smoking but had quit 3 weeks before presentation. She reported no alcohol or drug abuse and no exposure to tuberculosis. Her family history included oral and bladder cancer in her mother; Graves' disease in two sisters, hemochromatosis in one sister, and idiopathic thrombocytophenic purpura in one sister.
## Cognitive Computing vs. Traditional Analytics

<table>
<thead>
<tr>
<th>Natural Language Processing</th>
<th>Cognitive Computing</th>
<th>Traditional Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understands imprecision of human language</td>
<td>Does not understand plain human language</td>
<td></td>
</tr>
<tr>
<td>Learns and improves based on experience</td>
<td>Follows simple if/then logic (rules-engine)</td>
<td></td>
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<tr>
<td>Understands NLP – extracts knowledge from comments and senses next steps (perception, reasoning, relating, learning)</td>
<td>Extracts structured data only – unable to process unstructured data</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Machine Learning</th>
<th>Cognitive Computing</th>
<th>Traditional Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probabilistic systems co-evolve with users</td>
<td>Decision-tree driven, deterministic applications</td>
<td></td>
</tr>
<tr>
<td>Taught &amp; not programmed</td>
<td>Re-programming is required for each modification</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Cognitive Computing</th>
<th>Traditional Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifies data from text and acts upon derived insights</td>
<td>Unable to process unstructured data</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Output</th>
<th>Cognitive Computing</th>
<th>Traditional Analytics</th>
</tr>
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<td>Provides a set of confidence ranked and evidence-based responses that can drive better outcomes</td>
<td>Provides key word based search function without confidence and evidence-based responses</td>
<td></td>
</tr>
</tbody>
</table>
Watson solutions address clinical and research needs

**Patient Insights**
- Watson Engagement Advisor (question & answer)
- Electronic Medical Record Advisor (EMRA)

**Evidence-based Insights**
- Watson for Oncology (Lung, Breast, Colon/Rectal Treatment Plans)
- Watson Clinical Trial Matching (Identify eligible trials for a patient)
- Watson Discovery Advisor (Insights from medical and research literature)

**Research Insights**
- Watson Genomics Advisor (insights into tumor DNA sequencing)
- Analysis of Medical Images (MRI, Mammogram, etc)

**Status**
- **Available today**
- **Development/Testing**
- **Research Phase**
Currently Available
Clinical challenge:
• Ability to assess quickly the best treatments for an individual patient based on latest evidence and clinical guidelines

Watson solution:
• A tool to assist physicians make personalized treatment decisions
  − Analyzes patient data against thousands of historical cases and trained through thousands of Memorial Sloan Kettering MD and analyst hours
  − Suggestions to help inform Oncologist’s decisions based on over 290 medical journals, over 200 textbooks, and 12M pages of text
  − Currently supports first line systemic treatment (Breast, Lung, Colorectal cancers)
Watson for Oncology – assessment and advice cycle

1. Extract key attributes from the patient’s case

2. Use key attributes to find candidate treatment options as determined by consulting NCCN Guidelines and MSK expertise

3. Search the corpus for supporting evidence for each option

4. Use Watson’s scoring algorithms to prioritize treatment options

Guidelines
- NCCN
- Memorial Sloan Kettering Cancer Center

Evidence
- Inclusion / exclusion criteria
- Comorbidities
- Contraindications
- MSK treatment preferences
- Drug information
- Published literature - studies, reports, opinions from Textbooks, Journals, Manuals, etc.

Patient Case
- 61 y/o woman s/p mastectomy is here to discuss treatment options for a recently diagnosed 4.2 cm grade 2 infiltrating ductal carcinoma...
Clinical Trial Matching

Business challenge:
• Clinicians have no easy way to search across eligibility criteria of relevant clinical trials for their patients
• Less than 10% of clinical studies are completed on time
• 30% of sites for clinical trials fail in enrolling even a single patient

Watson solution:
• Use patient data to instantly check eligibility across all relevant clinical trials

Initial focus is Oncology, Watson is trained in breast, lung and colorectal cancer, with other tumor types to follow
Empowers Consumer Engagement

By 2020, the customer will manage 85% of the relationship with an enterprise without interacting with a human.¹

How it works:

• Answers questions and guides users through processes with natural language dialogue

• Leverages natural language to interact with users and build knowledge and expertise

• Utilizes evidence evaluation and learning to provide informed and effective responses to users

¹ Gartner Predicts
Watson Engagement Advisor

Bupa Diabetes Coach Prototype
Future Directions
Cognitive Computing for Electronic Medical Records

- Watson applied to EMR produces an intelligent patient record summary
  - Identifies patient’s important medical problems
  - Meds, labs, and status of each problem
  - Provides ability to drill in to details

- Watson EMRA answers natural language questions on an EMR
  - Why was Januvia stopped?
  - Any history of heart murmurs?
Watson generates and groups Problems by clinical relevance

Watson groups medications by clinical relevance

Watson categorizes encounters

Illustrative Example - Patient Problem Oriented Summary
Patient Similarity

ID: 005-158-945-388

Gender: M

Date of Birth: June 2, 1933

Ethnicity: White

CHF Status: Diagnosed with CHF

CHF Diagnosis Date: July 3, 2012

Age: 79

Recent Medications:
- 6/26/12 Beta Blockers Cardi-o-selective
- 3/3/12 Ace inhibitors
- 3/3/12 Loop Diuretics
- 2/11/12 Loop Diuretics
- 12/29/11 Loop Diuretics

Recent Symptoms:
- 11/2/12 Arthritis/Intens
Watson Discovery Advisor sees

IBM Watson

transcription factor
growth factor
receptor
receptor kinase
generic
kinase
drug
GPCR

Information:
entity: p53
type: protein
family: generic
localization: nucleus

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Thank You