IBM

WATSON

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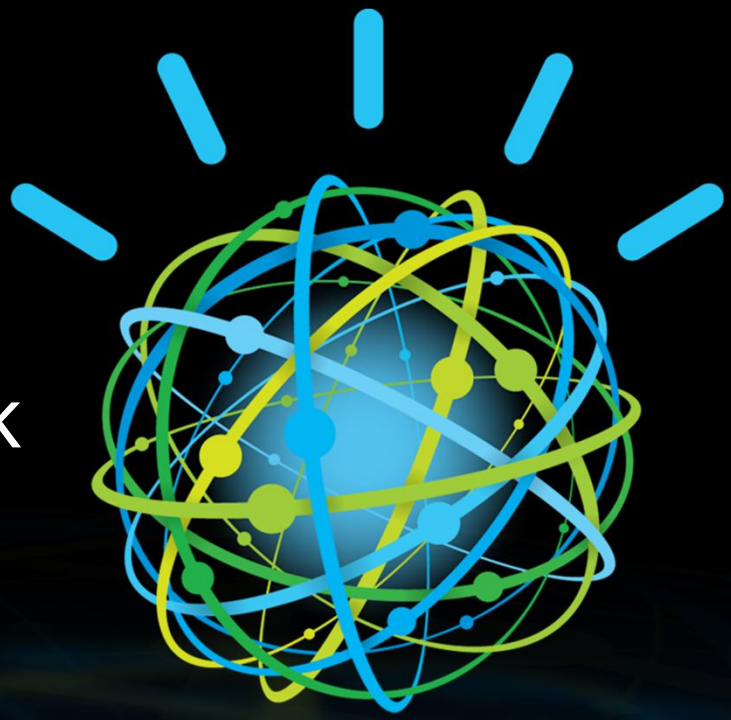
Putting IBM Watson to Work In Healthcare



Agenda

- What is IBM Watson and why is it important?
- How is IBM putting Watson to work?
- What can we expect in the future?

Data volume is expanding at an incredible rate

…data will grow 800% in the next five years

…Unstructured data grows 10-50X faster than structured

Data is getting more social. . .

…20M articles on Wikipedia

…30B pieces of Facebook content are shared monthly

…There are 156M public blogs

There are over 2.3B people on the Web today …

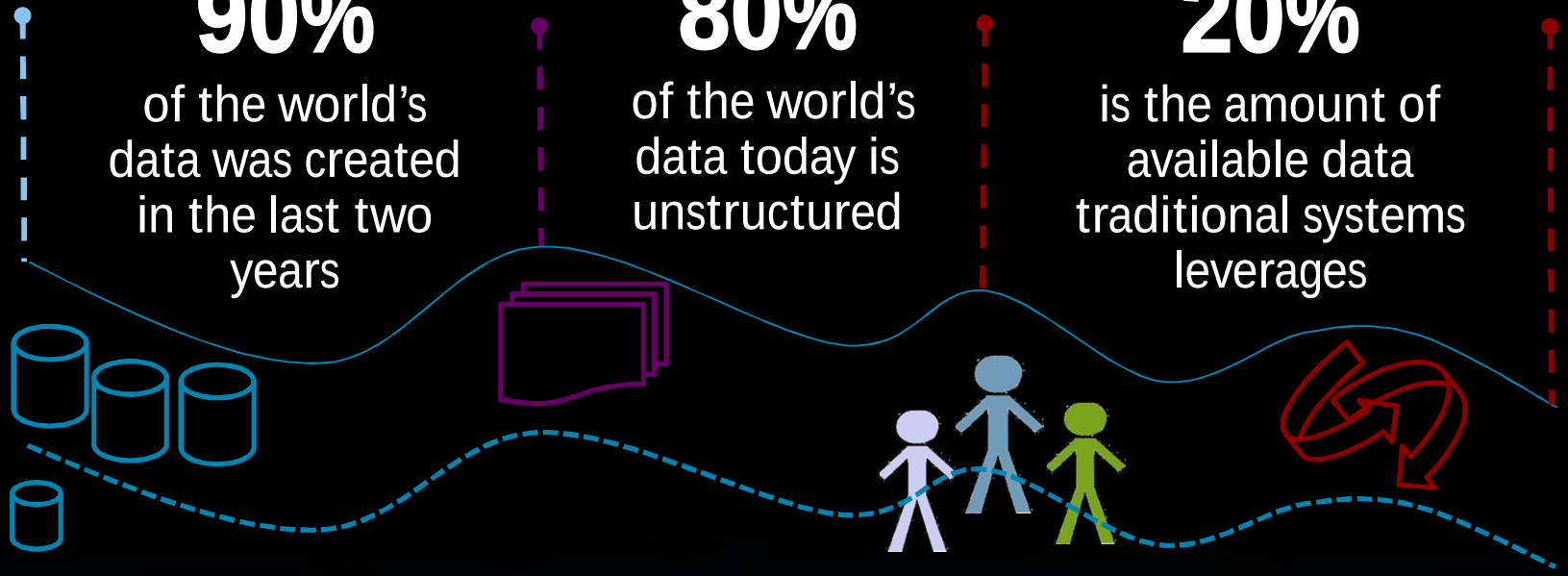
… and a trillion connected objects – cars, appliances, cameras, roadways, pipelines

Businesses on a Smarter Planet are "dying of thirst in an ocean of data"

90%
of the world's data was created in the last two years

80%
of the world's data today is unstructured

20%
is the amount of available data traditional systems leverages



1 in 2
business leaders don't have access to data they need

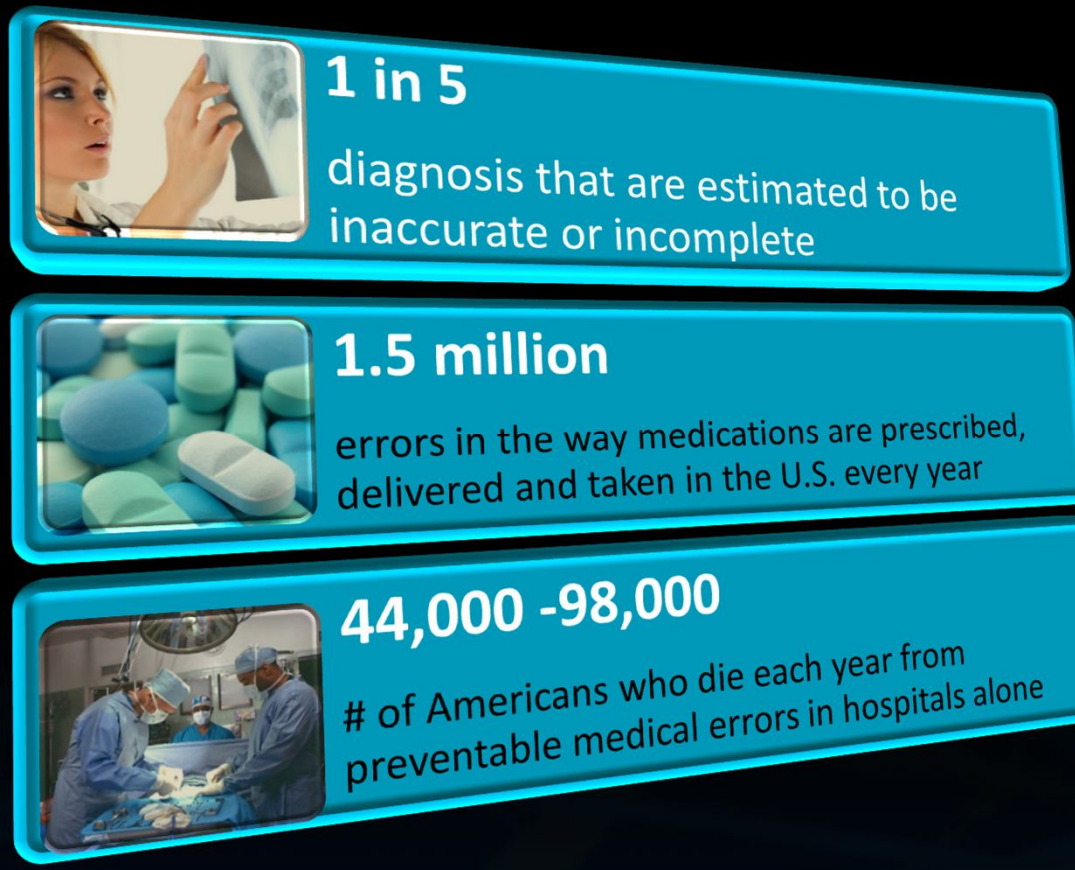
83%
of CIO's cited BI and analytics as part of their visionary plan

54%
of companies use analytics for competitive advantage

Source: GigaOM, Software Group, IBM Institute for Business Value"

Healthcare Industry is beset with some of the most complex information challenges we collectively face

- Medical information is doubling every 5 years, much of which is unstructured
- 81% of physicians report spending 5 hours or less per month reading medical journals



"Medicine has become too complex (and only) about 20% of the knowledge clinicians use today is evidence-based"

- Steven Shapiro Chief Medical and Scientific Officer, UPMC

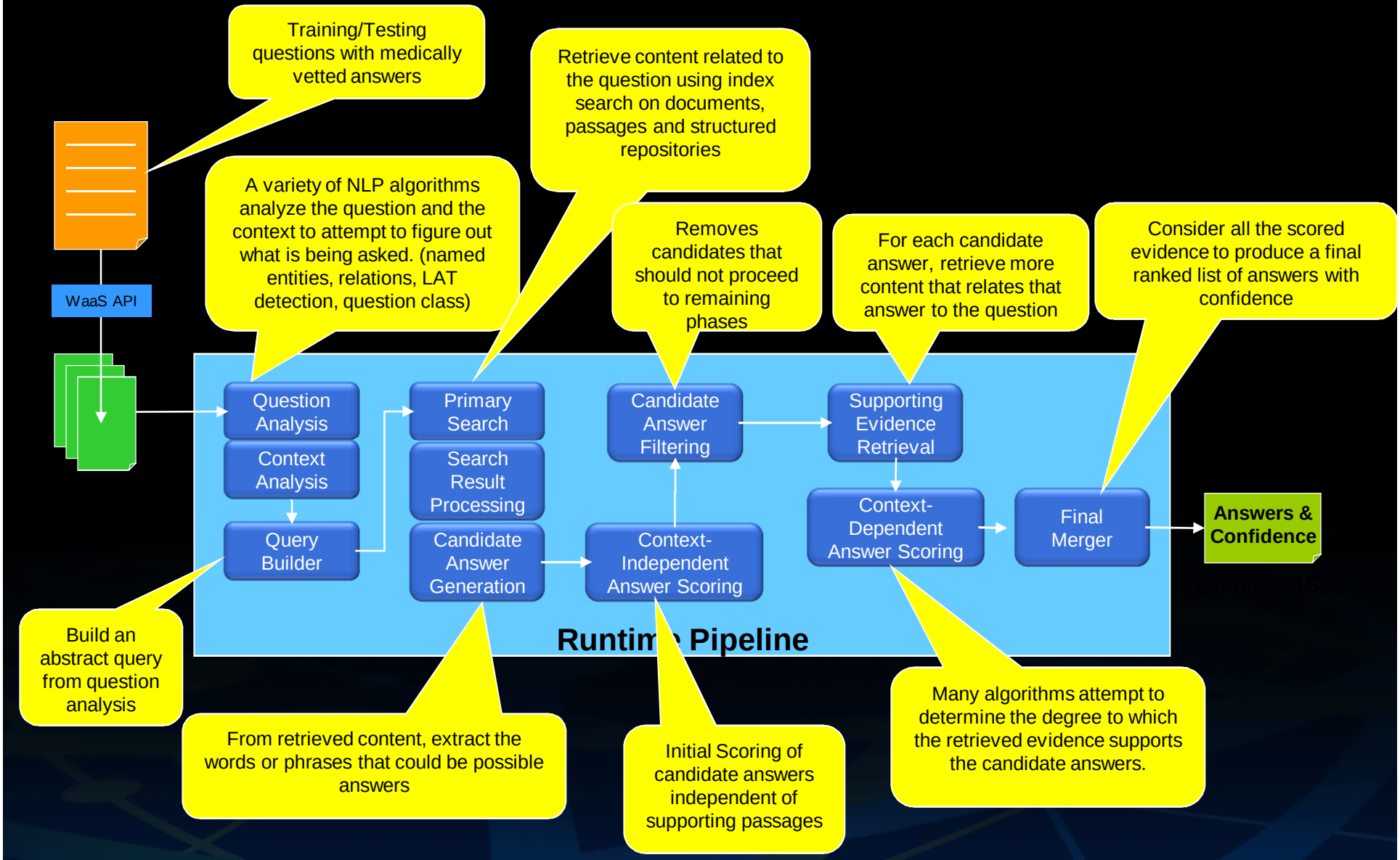
Source: International Journal of Circumpolar Health, DoctorDirectory.com, Institute for Medicine"

Why is it so hard for computers to understand humans

	Structured Data	Unstructured Data
Where was Einstein born?	**Physicist** / **Birth Place** A. Einstein / Ulm N. Bohr / Copenhagen M. Curie / Warsaw Source: Excel File, Database, etc.	***"One day, from among his city views of Ulm, Otto chose a water color to send to Albert Einstein as a remembrance of Einstein´s birthplace"*** **Source: http://www.schaeffenacker-ulm.de/en/otto.html**
Welch ran this?	**Person** / **Organization** L. Gerstner / IBM J. Welch / GE W. Gates / Microsoft Source: Excel File, Database, etc.	***"If leadership is an art then surely Jack Welch has proved himself a master painter during his tenure at GE"*** **Source: *Jack Welch and the GE Way*, Robert Slater**

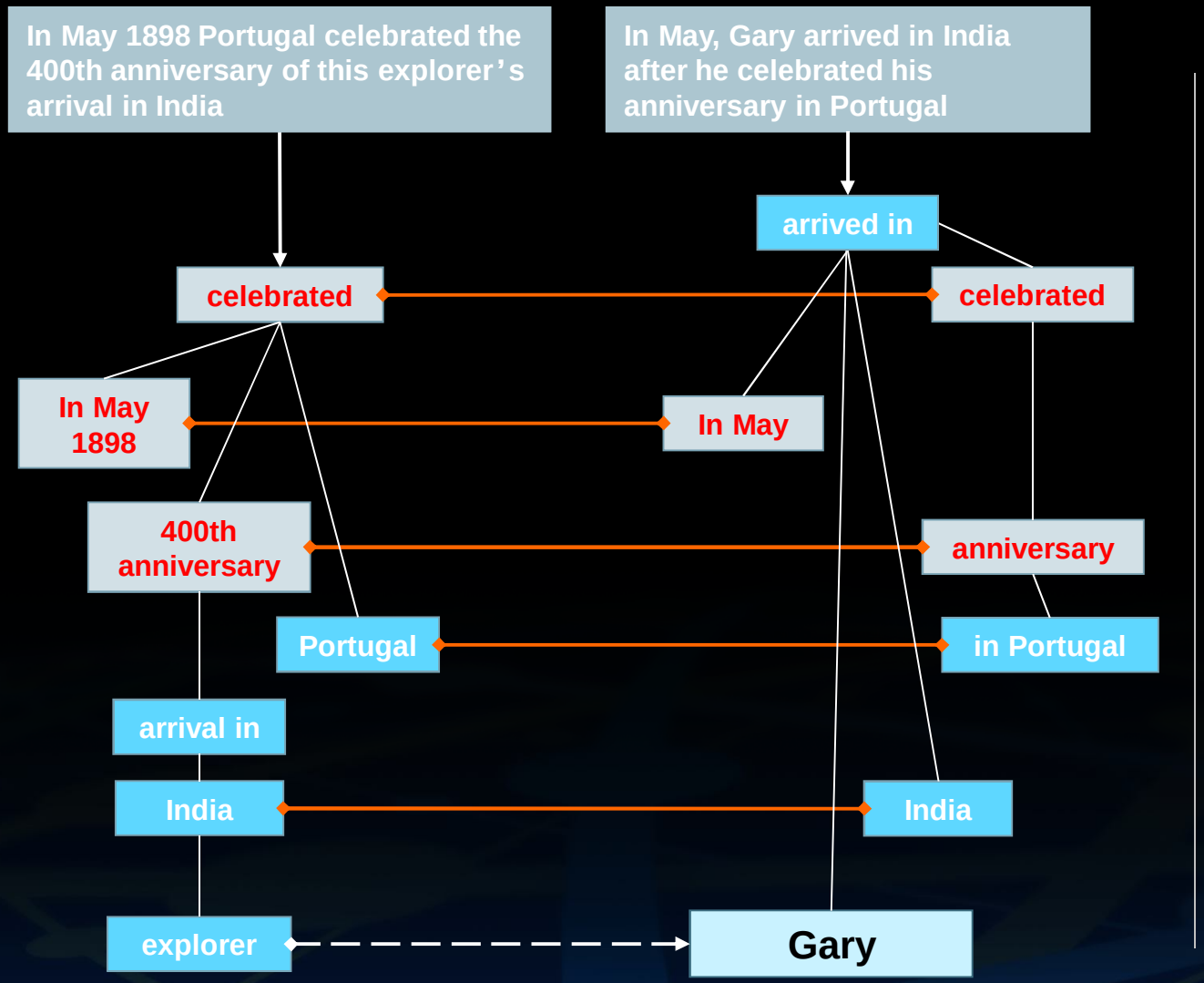
Source: IBM Research

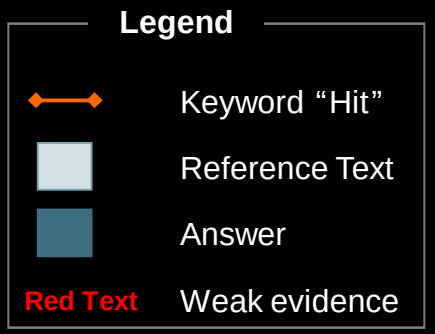
Watson: How It Works



Why is Jeopardy! so difficult?

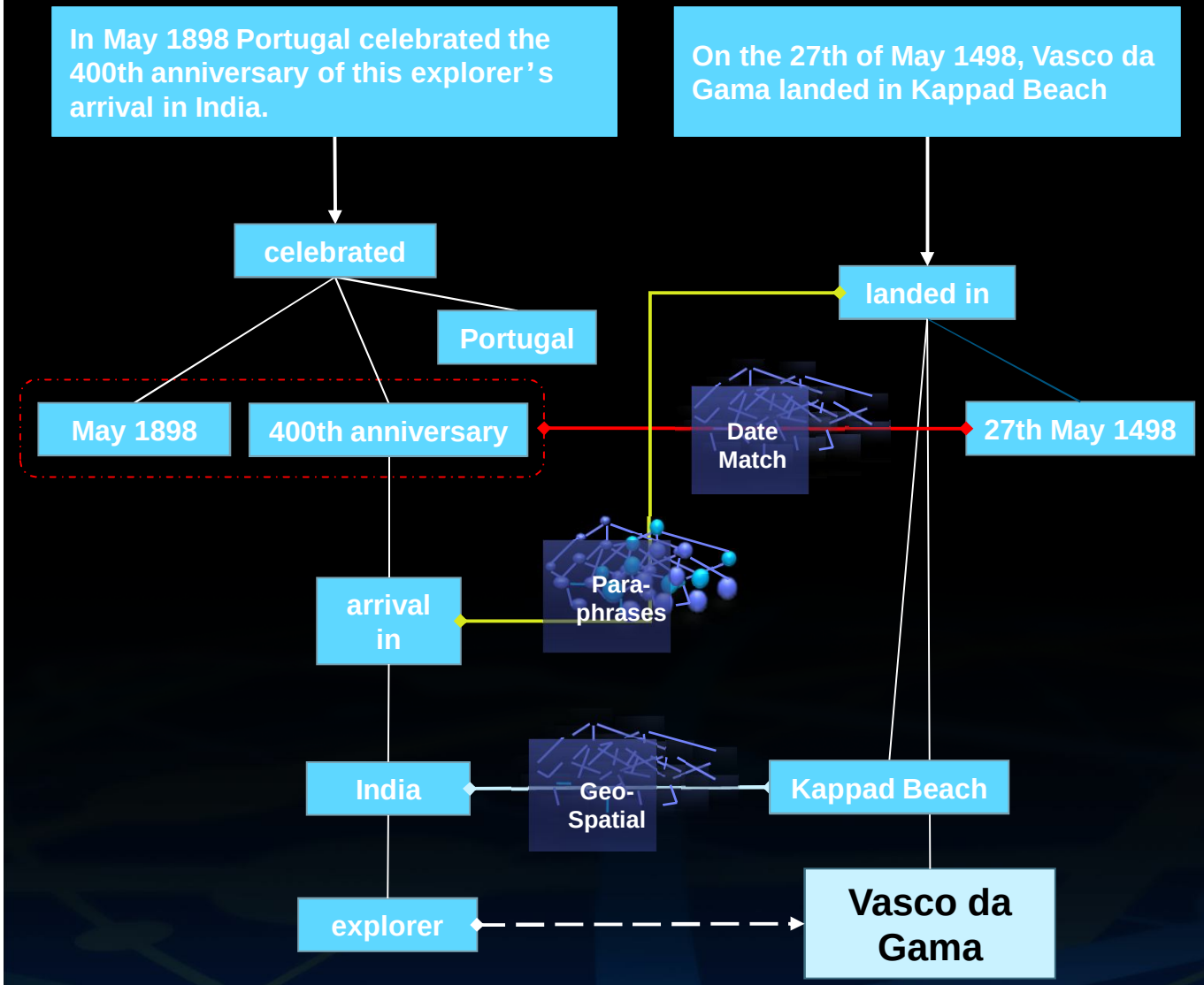
Answering complex natural language questions requires more than keyword evidence

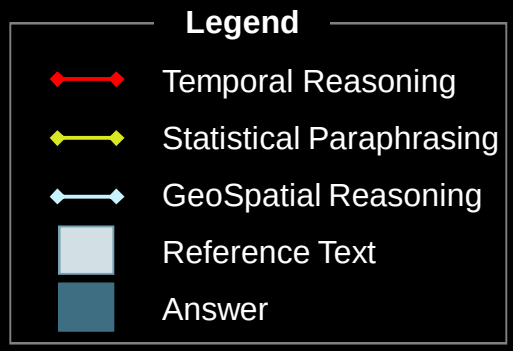




This evidence suggests "Gary" is the answer BUT the system must learn that keyword matching may be weak relative to other types of evidence

Watson leverages multiple algorithms to gather deeper evidence





Stronger evidence can be much harder to find and score…

- Search far and wide
- Explore many hypotheses
- Find judge evidence
- Many inference algorithms

…and the evidence is still not 100% certain

Evidence must be Evaluated for Different Forms

- Temporal Reasoning
  - Developed for Jeopardy! Has application in Healthcare as sequence or timing of symptoms may be relevant
- Geospatial Reasoning
  - Earth geography algorithms be reworked for human body *(the Pain started in my fingertips and progressed up my left arm)*
- Statistical Paraphrasing
  - New Algorithms required to, for example, Map between medical terminology and lay terms.

TEMPORAL REASONING EXAMPLE

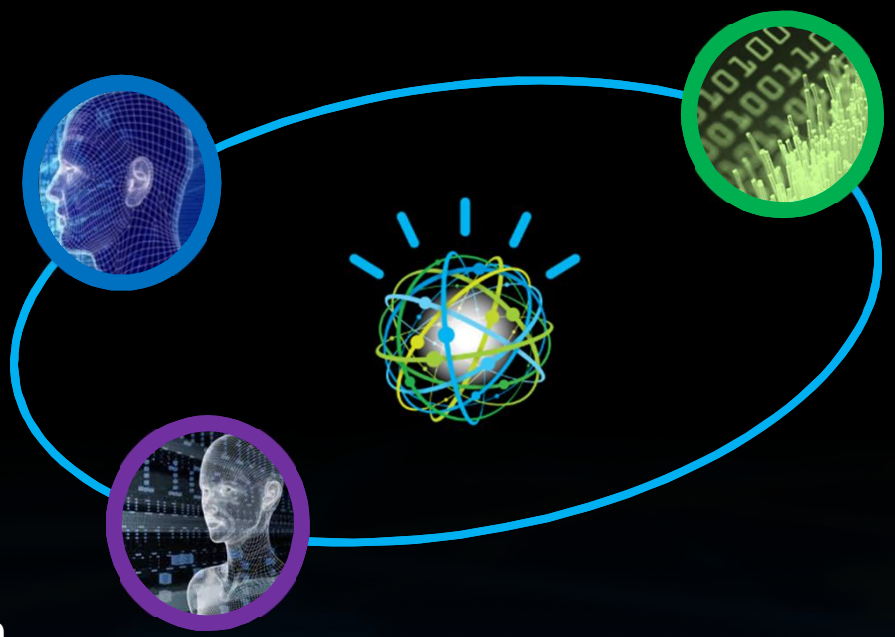
Typical influenza in adults is characterized by sudden onset of chills, fever, prostration, cough, and generalized aches and pains (especially in the back and legs). Headache is prominent, often with photophobia and retrobulbar aching. Respiratory symptoms may be mild at first, with scratchy sore throat, substernal burning, nonproductive cough, and sometimes coryza.

Later, lower respiratory tract illness becomes dominant; cough can be persistent, raspy, and productive. GI symptoms may occur and appear to be more common with the 2009 pandemic H1N1 strain. Children may have prominent nausea, vomiting, or abdominal pain, and infants may present with a sepsis-like syndrome.

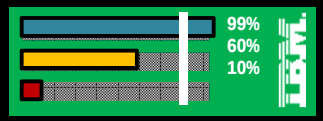
After 2 to 3 days, acute symptoms rapidly subside, although fever may last up to 5 days. Cough, weakness, sweating, and fatigue may persist for several days or occasionally for weeks.

IBM Watson brings together a set of transformational technologies to drive optimized outcomes

1 Understands natural language and human speech



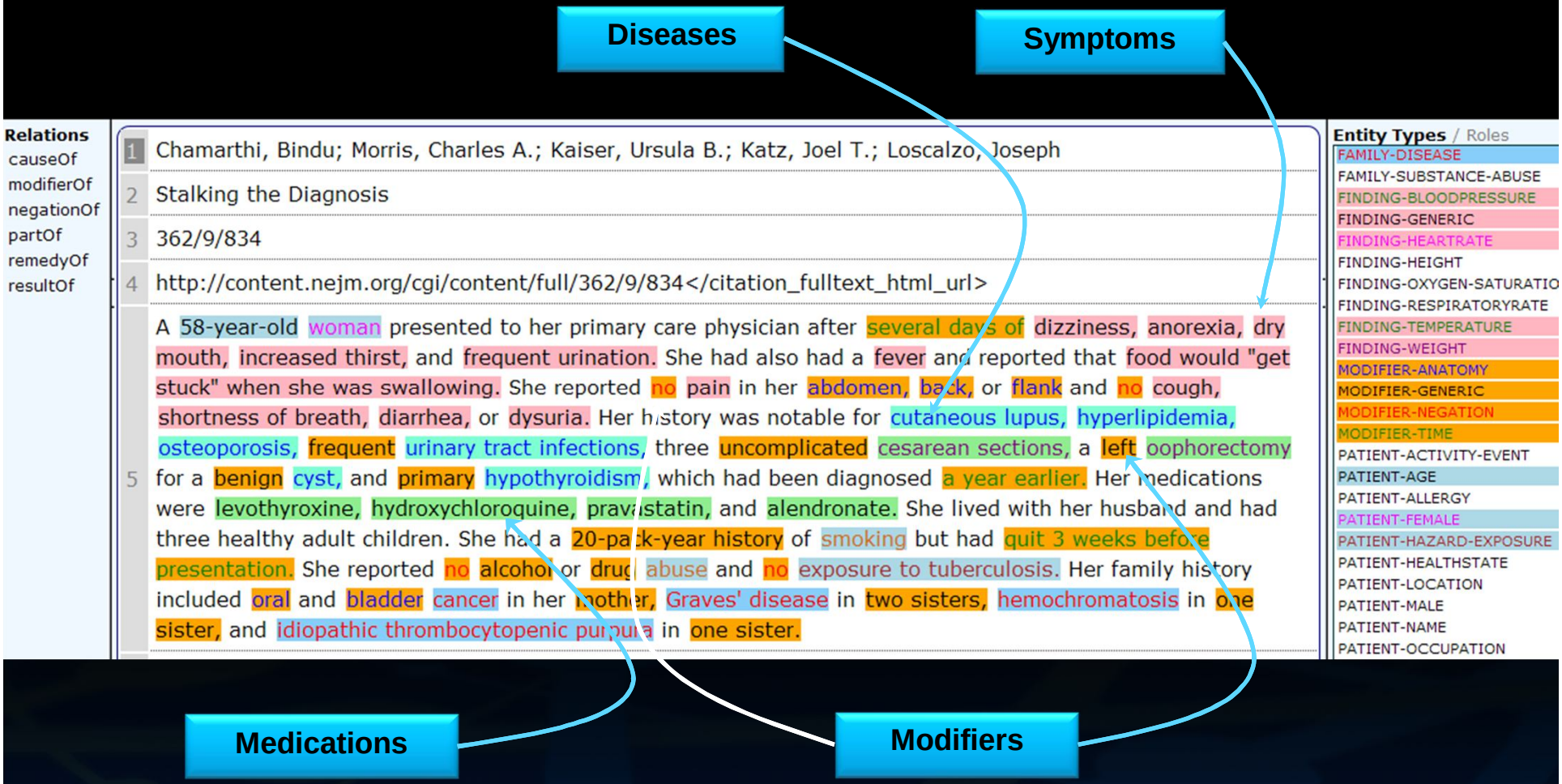
2 Generates and evaluates hypothesis for better outcomes



3 Adapts and Learns from user selections and responses

...built on a massively parallel probabilistic evidence-based architecture optimized for POWER7

NEJM Medical Concept Annotations



Matching Symptoms May Require Discovering Causal Chains

Observables: Patient Symptoms

Not directly explained by UTI

- Dysphagia (diff. swallowing)
- Xerostomia (dry mouth)
- Thirst
- Dizziness

?

Hypothesis: UTI

UTI directly explains

- …
- Fever
- Anorexia
- Frequent urination
- …

(Others explained by UTI)

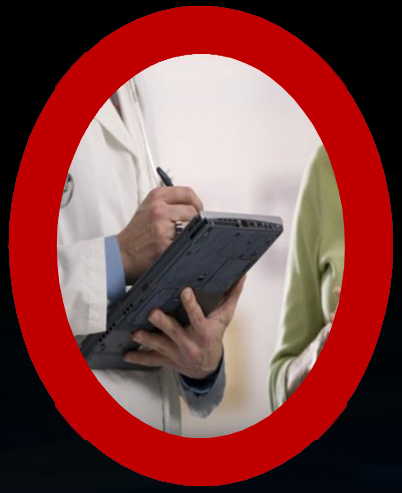
To gain confidence in UTI as the diagnosis, we have to see if it is possible to match what UTI does explain to what is observed but not directly explained.

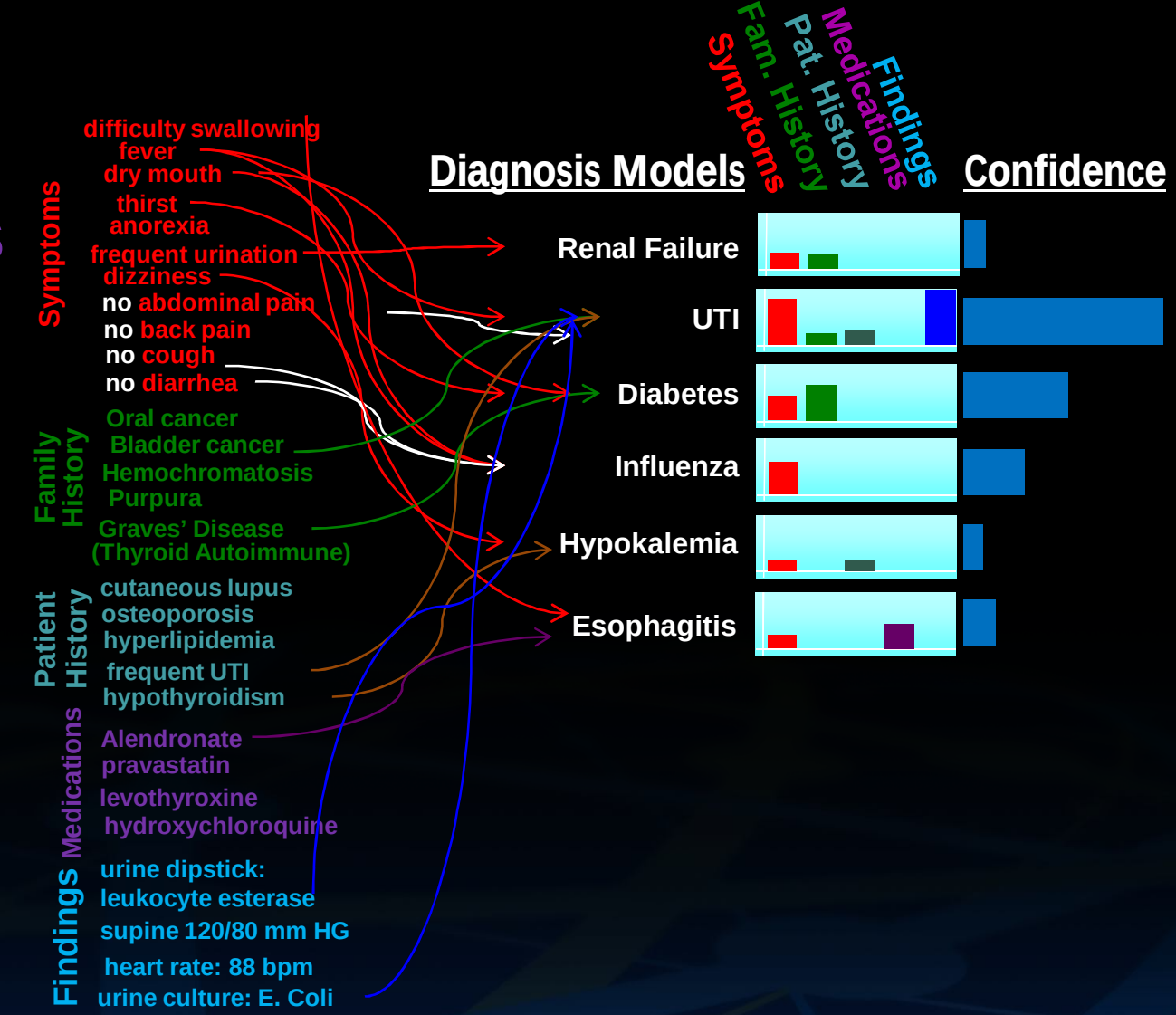
Are there "causal" or logical entailments that can be mined from text and knowledge bases that give some evidence that, for example,

fever can explain thirst and dry mouth?

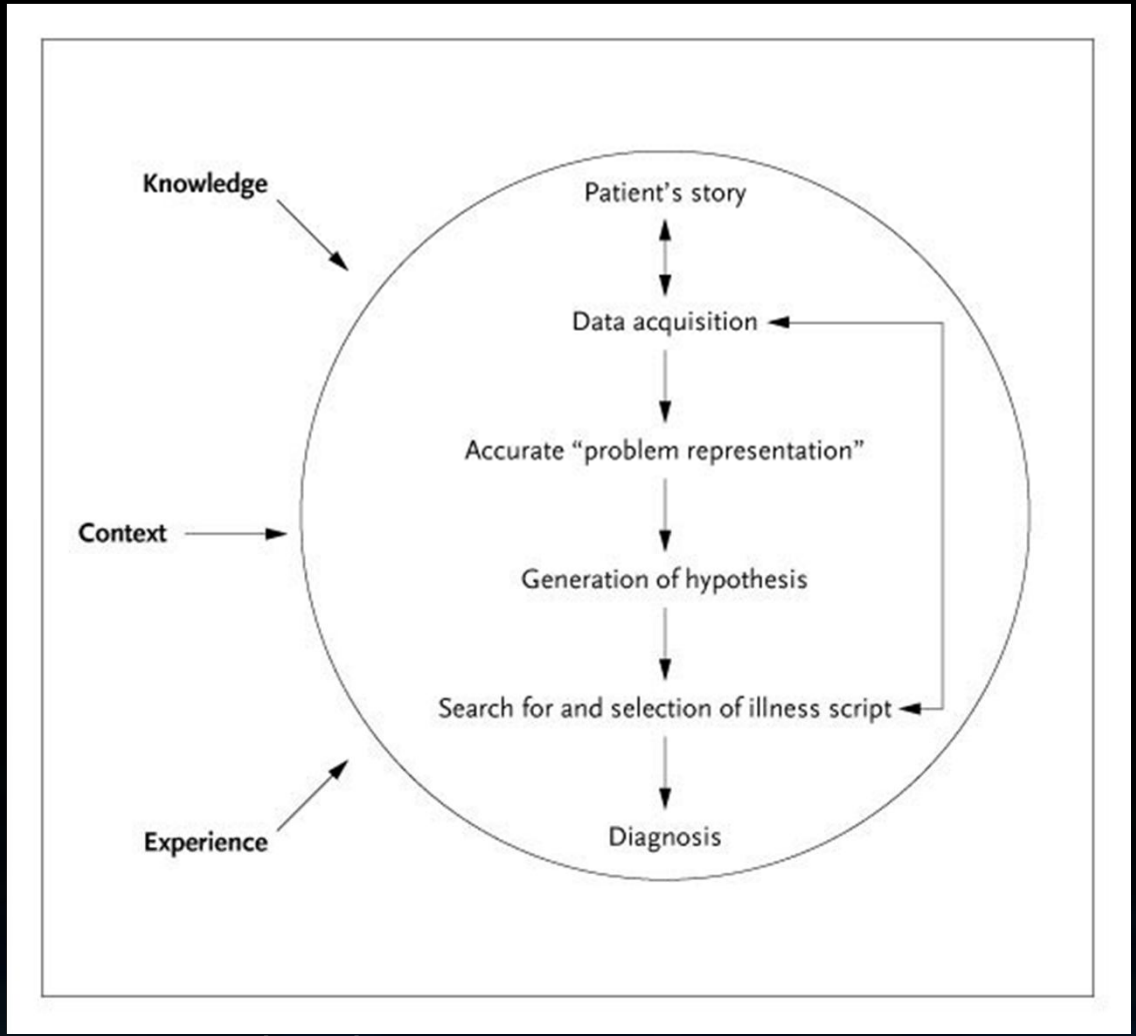
difficulty swallowing can explain dry mouth? ….

Putting the proper pieces together at the point of impact can be life changing





Key Elements of the Clinical Diagnostic Reasoning Process



Bowen J. N Engl J Med 2006;355:2217-2225

The NEW ENGLAND JOURNAL of MEDICINE

Role of Electronic Systems in Improving Diagnosis

- Filtering, organizing, and providing access to information … thoroughness in gathering the patient's history, findings from the physical examination, and other data. … The problem of having too much information is now surpassing that of having too little, and it will become increasingly difficult to review all the patient information that is electronically available.

- Serving as a place where clinicians, together with patients, document succinct evaluations, craft thoughtful differential diagnoses, and note unanswered questions. Free-text narrative will often be superior to point-and-click boilerplate …

Can Electronic Clinical Documentation Help Prevent Diagnostic Errors?
Gordon D. Schiff, M.D., and David W. Bates, M.D. N Engl J Med 2010; 362:1066-1069

Role of Electronic Systems in Improving Diagnosis

- A better approach to managing problem lists is needed. The failure to effectively integrate the creation, updating, reorganization, and inactivation of items on problem lists into the clinician's workflow has been one of the great failures of clinical informatics. …allowing specific providers (for instance, specialists or nonphysician staff members) to work selectively with a subset of problems are necessary features …
- Electronic systems should incorporate checklist prompts to make sure that key questions are asked and relevant diagnoses considered. … diagnostic checklists have so far been neither clinically helpful nor widely used. Yet, human memory alone cannot guarantee that key questions will be asked and important diagnoses considered and accurately weighed. Decision-support software and predictive models have also had limited use to date, but both could become important if their design were more practical and evidence-based — if, for example, they automatically generated differential diagnoses that facilitated both documentation and decision making.

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Leveraging Electronic Clinical Documentation to Decrease Diagnostic Error Rates

Role for Electronic Documentation

- Providing access to information
- Recording and sharing assessments
- Providing prompts
- Providing access to information sources

Goals and Features of Redesigned Systems

- Ensure ease, speed, and selectivity of information searches; aid cognition through aggregation, trending, contextual relevance, and minimizing of superfluous data
- Provide a space for recording thoughtful, succinct assessments, differential diagnoses, contingencies, and unanswered questions
- Provide checklists to minimize reliance on memory and directed questioning to aid in diagnostic thoroughness and problem solving
- Provide instant access to knowledge resources through context-specific "infobuttons" triggered by keywords in notes that link user to relevant textbooks and guidelines

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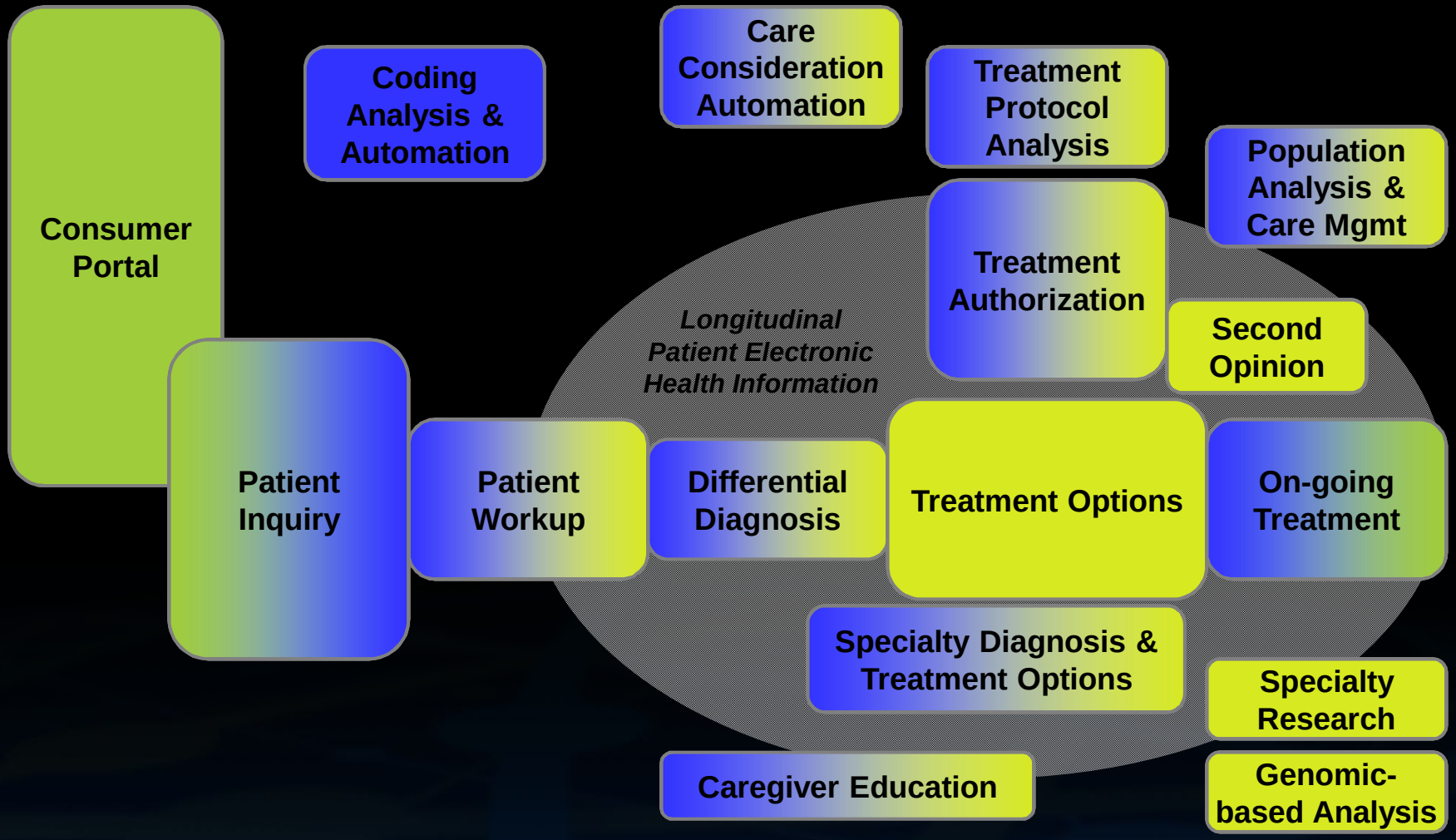
A Range of Watson-enabled Healthcare Solutions

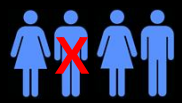


Patient ***Caregiver…Nurse…Physician Assistant*** ***Clinician***

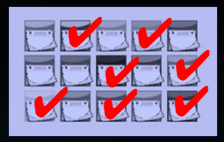
Working Together to Beat Cancer

Cancer is an insidious disease and the second highest cause of death

1 in 4
individuals will die from cancer



20%
of cancer cases receive the wrong diagnosis initially with some as high as 44%



3X
rate cancer cost climbs vs. std. health costs or 15-18% / yr.

.8B
s of cancer in the US in 2010

$$$$$$$$$
$$$$$$$$$
$$$$$$$$$

Cancer (US ONLY)	2011 New Cases (est.)	2011 Deaths	%
Respiratory	239320	161250	28%
Digestive	277570	139250	24%
Genital	338620	63980	11%
Breast	232620	39970	7%
Urinary	132900	28970	5%
Lymphoma	75190	20620	4%
Leukemia	44600	21780	4%
Oral	39400	7900	1%
Other	216450	88230	16%
TOTAL	1,596,670	571,950	100%

Source: American Cancer Society, National Health Institute

Working Together to Beat Cancer

IBM Watson and WellPoint putting Watson to work

What if …

healthcare could leverage the latest insights improving the quality of patient care while lowering costs?

WellPoint is doing it!

- First commercial applications of the IBM Watson technology
- Processing treatment requests faster and more efficiently
- Extended data assessment based on research, clinical, medical, market and patient data
- Applied learning based on action taken and outcome derived

Watson's Reasoning

- "Shallower" reasoning over large volumes of data and presenting alternatives to clinicians for the final decisions
- Casts a wide net
  - Considers a large amount of data
    - EMR
    - Literature
  - Unbiased
  - Learns
- Not limited by a database structure
- Watson defers judgment until it has considered many possibilities

Watson's Reasoning

- Hits sweet spot of human judgment
  - Problems with bias
  - Difficulty processing large arrays of evidence knows what additional case input information could have improved the confidence in the output analysis
- Health Care is inherently "uncertain." Watson does not make a diagnosis. It provides evidence-based information to help the clinician make an informed decision.
- Identifies missing information
- Watson's interactive process helps clinician vector in on the appropriate decisions

From battling humans on Jeopardy! to changing the way the world thinks, acts, and operates

Healthcare

Diagnostic/treatment assistance, evidenced-based insights, collaborative medicine

Financial Services

Investment and retirement planning, institutional trading and decision support

Contact Center

Call center and tech support services, enterprise knowledge management, consumer insight

Government

Public safety, improved information sharing, security, fraud and abuse prevention

IBM Watson and Smarter Analytics have the capabilities to address grand business and societal challenges

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