

# IBM Watson and Medical Records Text Analytics HIMSS Presentation

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# The Next Grand Challenge



WATSON

Watson in Healthcare

JEOPARDY! The IBM Challenge

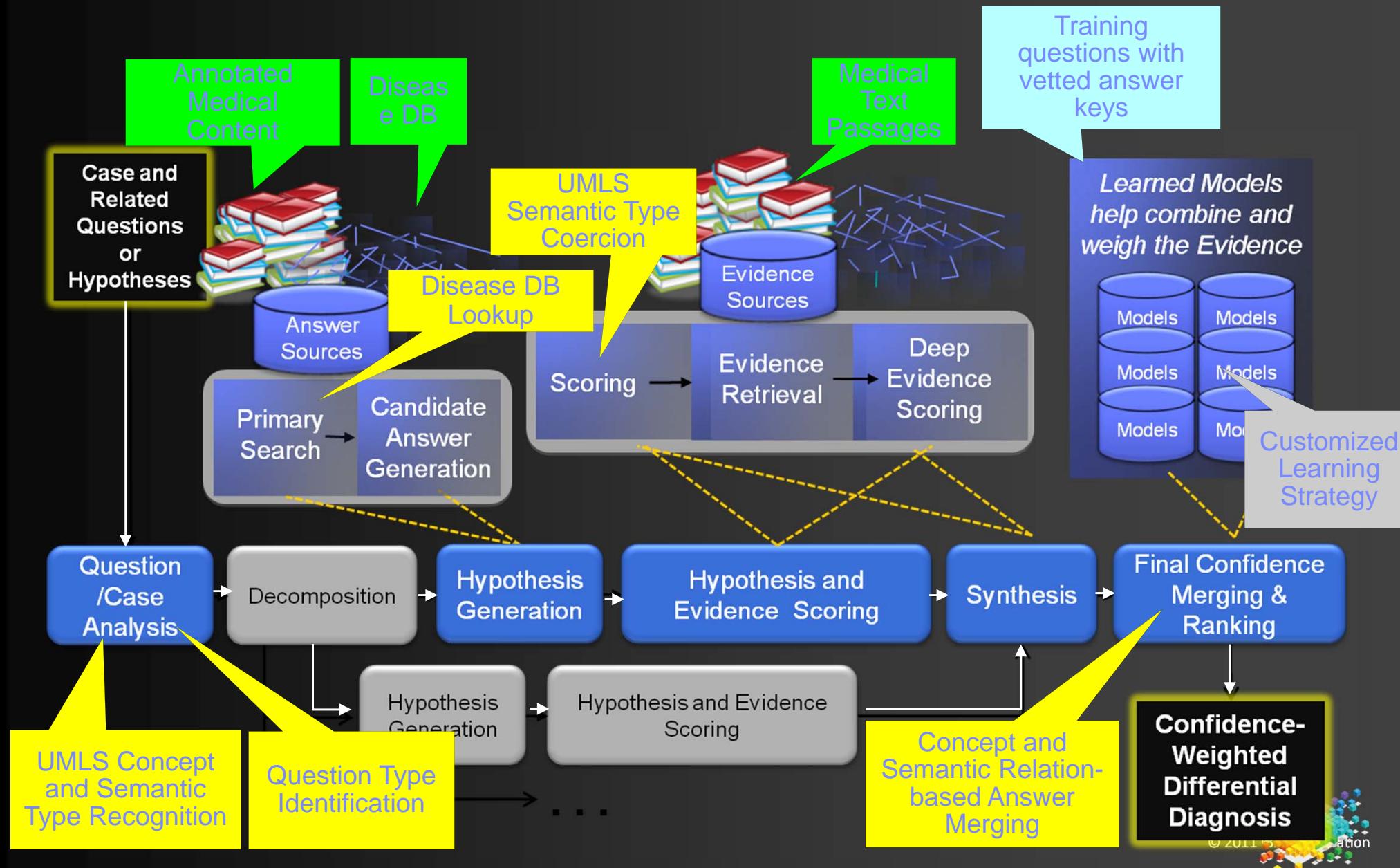


# Truly understanding natural language is the next great computing challenge

- Over **80%** of information today is unstructured and based on **natural language**
- The impact of **Systems of Engagement** both inside and outside the firewall is dramatic ... such masses of information **not easily understandable** by humans
- Legacy approaches have all failed; **“searching” not the right approach**
- A new approach is needed, leveraging **content analysis** and natural language processing

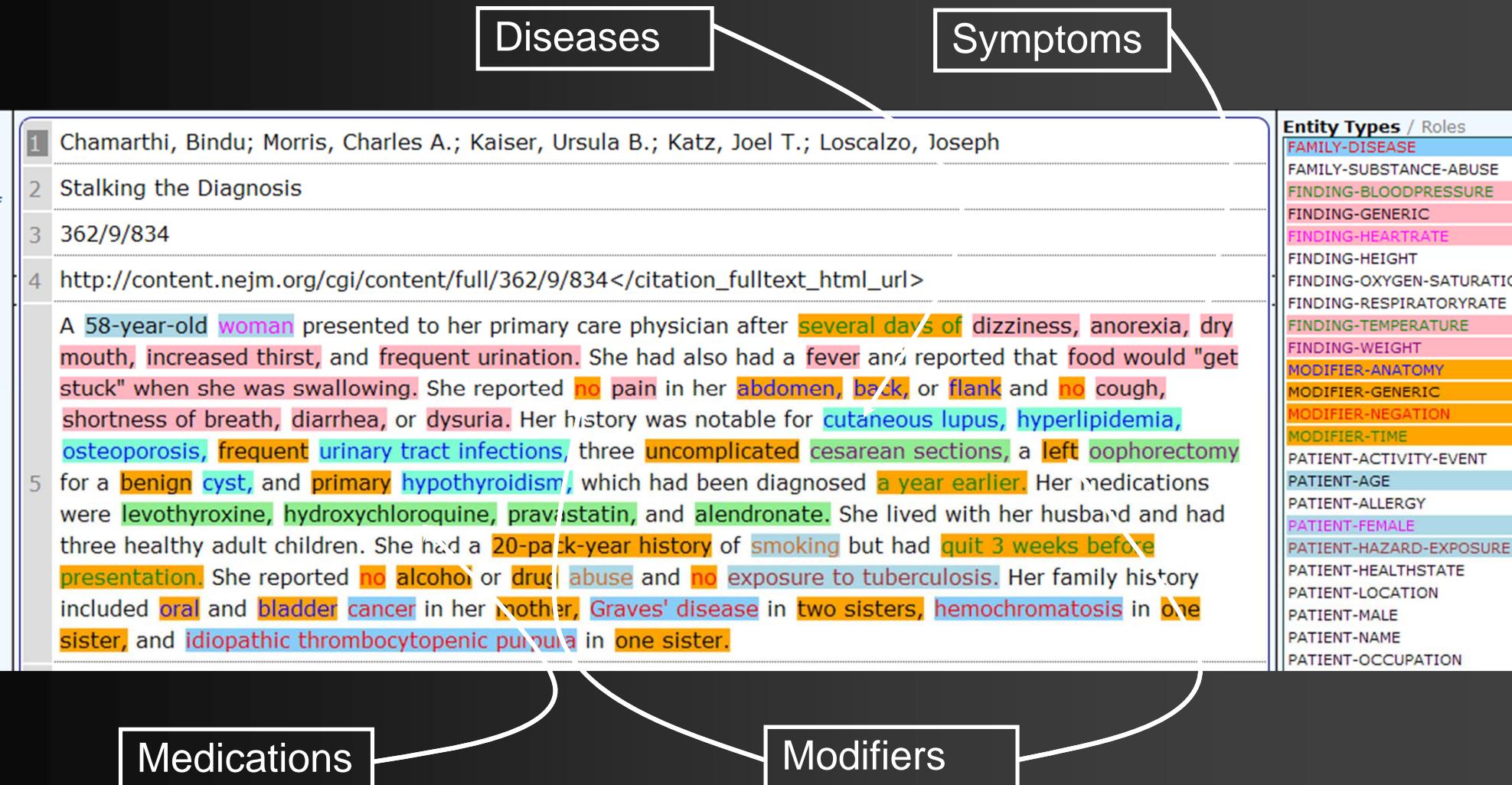


# IBM Watson for Healthcare Pipeline



# Applying Watson to the Real World

## Continuous Evidence-Based Diagnostic Analysis

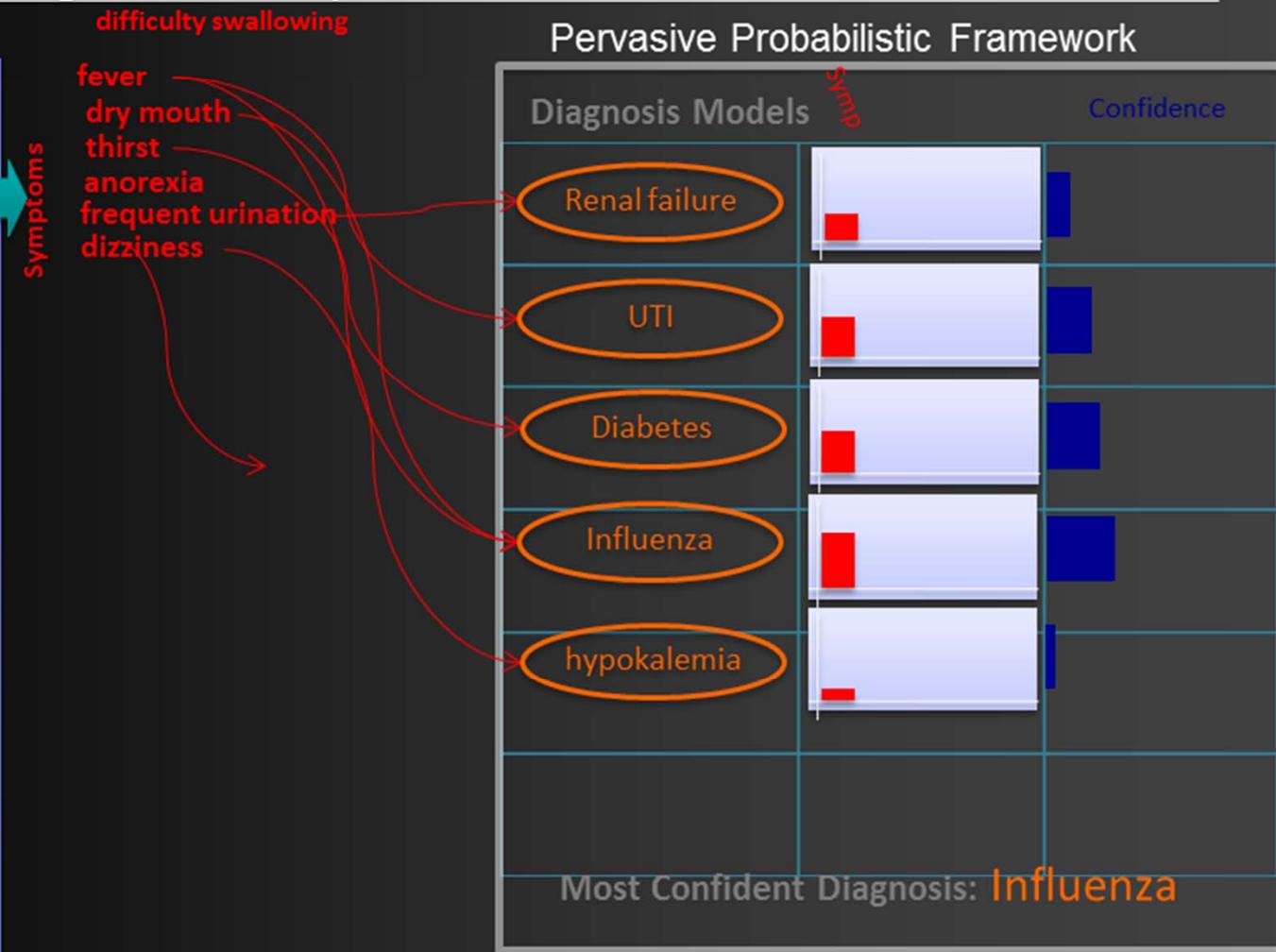




## Applying Watson to the Real World

## Continuous Evidence-Based Diagnostic Analysis

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



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difficulty swallowing

fever  
dry mouth  
thirst  
anorexia  
**frequent urination**  
dizziness  
no abdominal pain  
no back pain  
no cough  
no diarrhea

Symp

## Pervasive Probabilistic Framework

## Diagnosis Models

Renal failure

UTI

Diabetes

Influenza

hypokalemia

Confidence

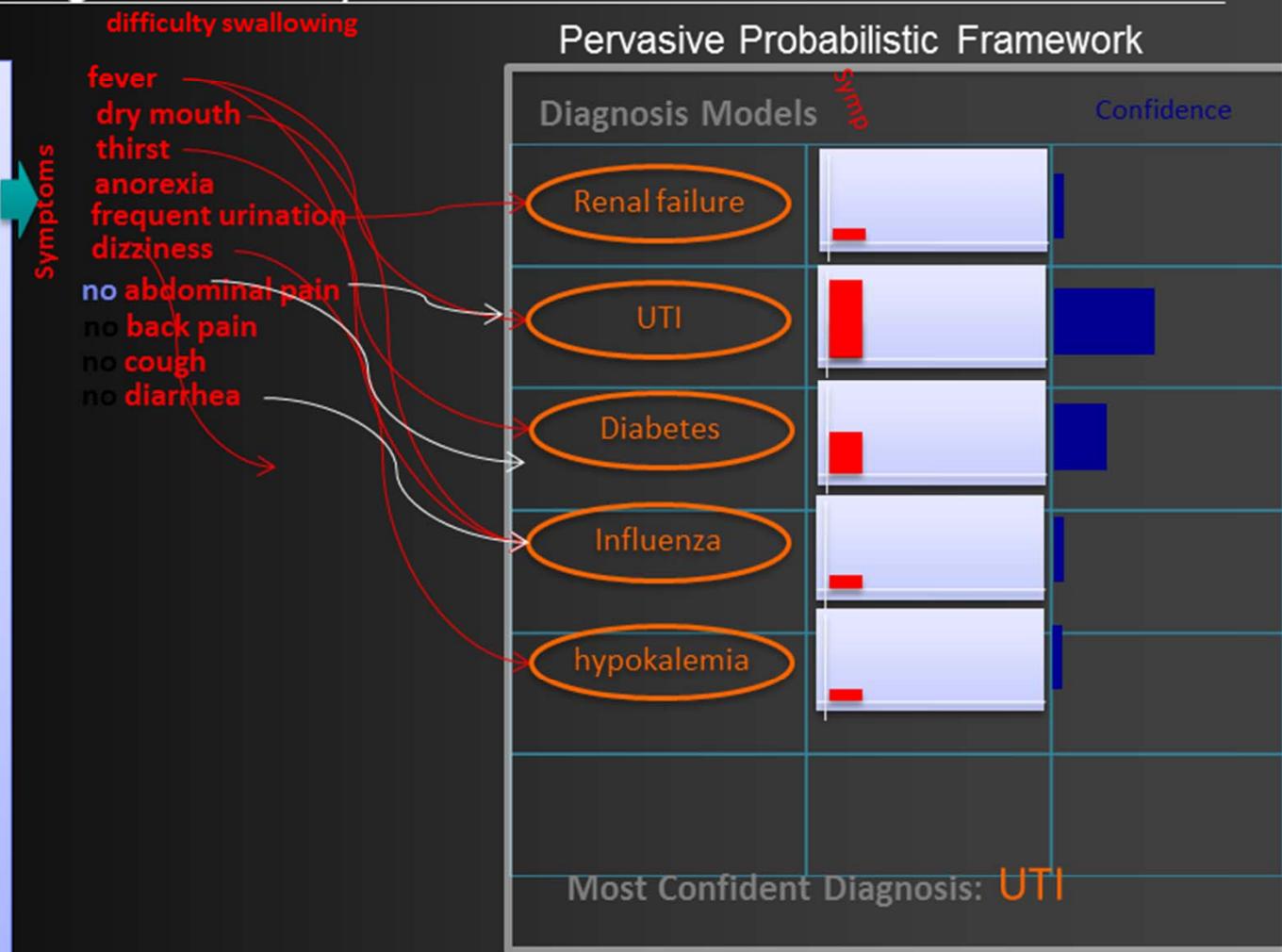
Most Confident Diagnosis: Diabetes

- Identify negative Symptoms

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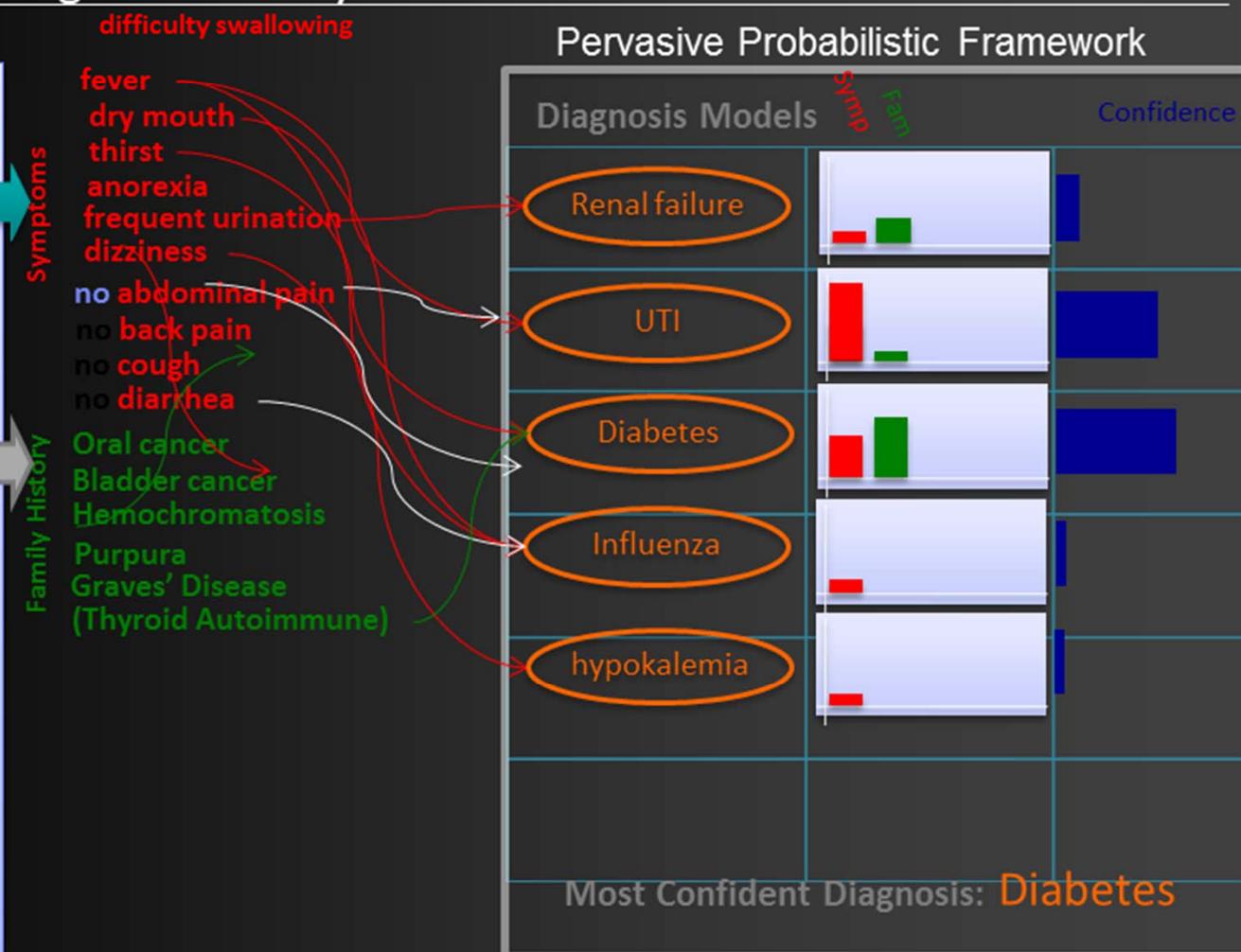


- Identify negative Symptoms
- Reason with mined relations to explain away symptoms (thirst is consistent w/ UTI)

## Applying Watson to the Real World

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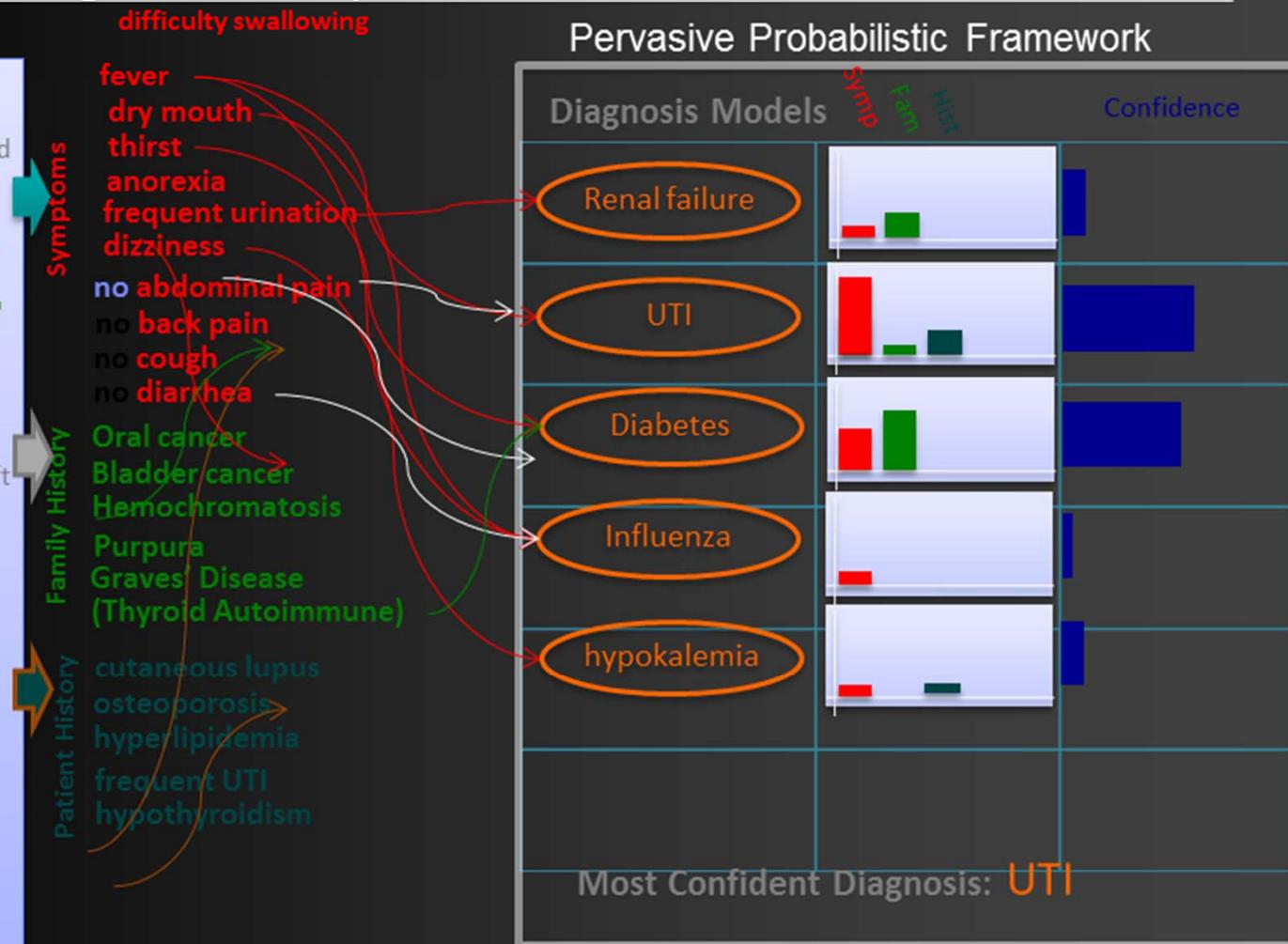


- Extract Family History
- Use Medical Taxonomies to generalize medical conditions to the granularity used by the models

## Applying Watson to the Real World

## Continuous Evidence-Based Diagnostic Analysis

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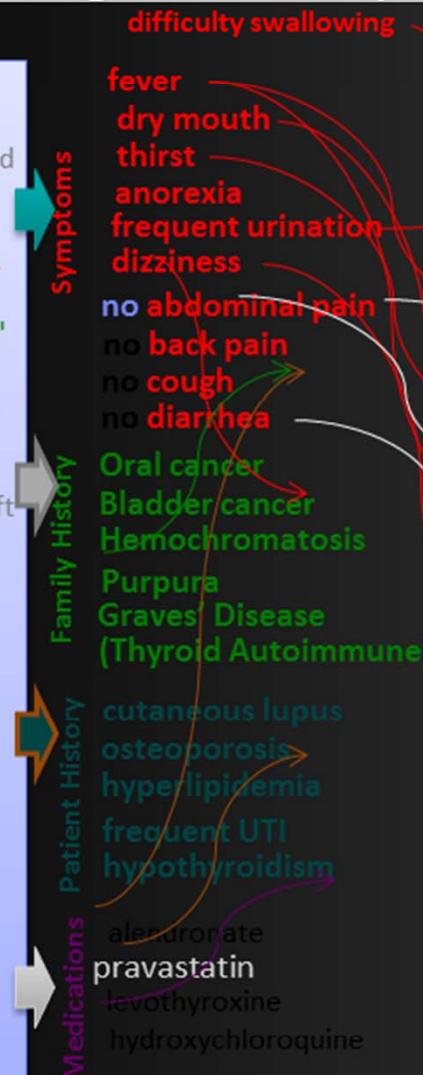
•Extract Patient History



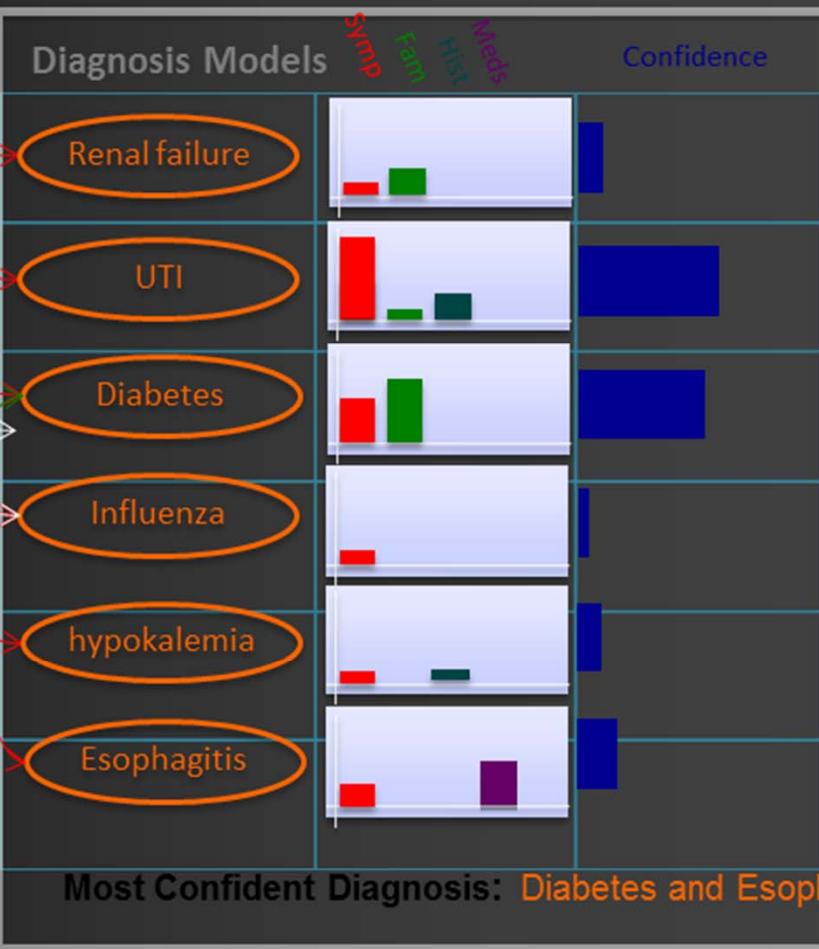
## Applying Watson to the Real World

## Continuous Evidence-Based Diagnostic Analysis

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## Pervasive Probabilistic Framework



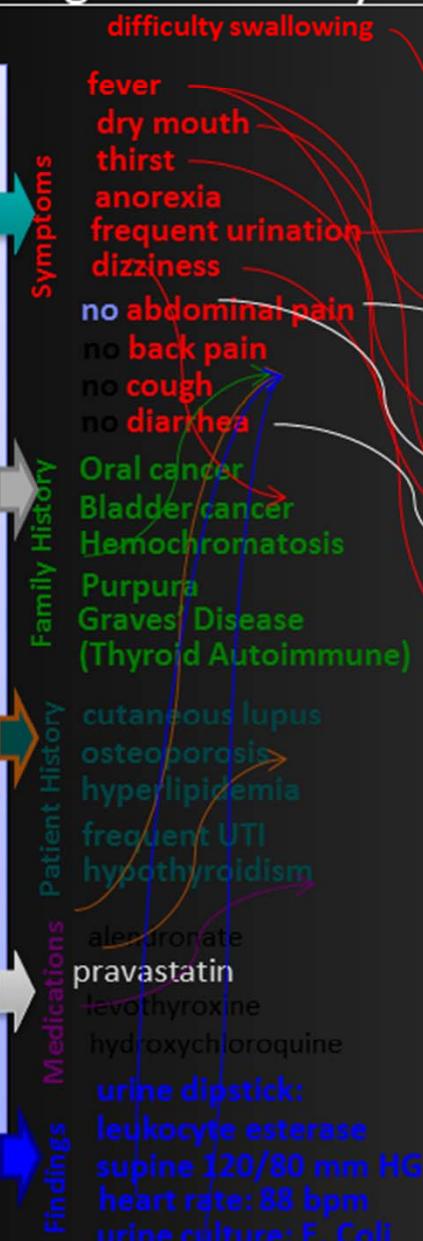
- Extract Patient History
- Extract Medications
- Use database of drug side-effects
- Together, multiple diagnoses may best explain symptoms



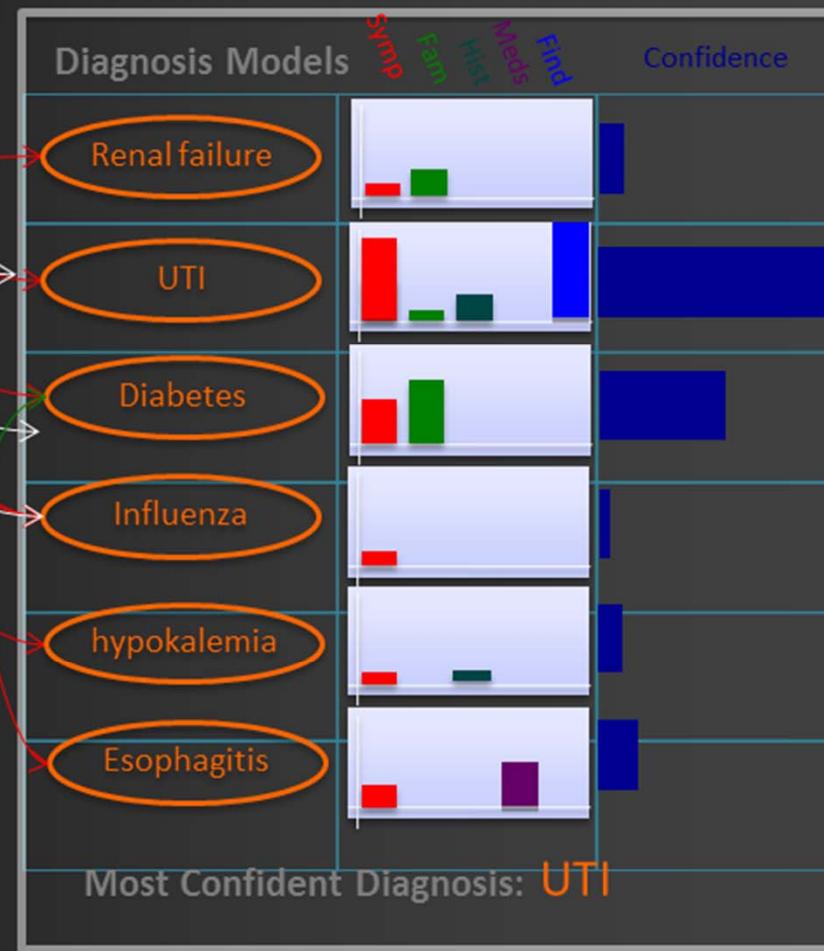
## Applying Watson to the Real World

## Continuous Evidence-Based Diagnostic Analysis

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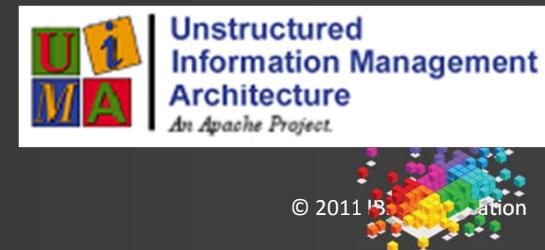
## Pervasive Probabilistic Framework



- Extract Patient History
- Extract Medications
- Use database of drug side-effects
- Together, multiple diagnoses may best explain symptoms
- Extract Findings: Confirms that UTI was present

# Watson and IBM Today

- **Natural Language Processing (NLP)** is the cornerstone to translate interactions between computers and human (natural) languages
  - Watson uses **IBM Content Analytics** to perform critical NLP functions
- **Unstructured Information Management Architecture (UIMA)** is an open framework for processing text and building analytic solutions
  - Several IBM ECM products leverage UIMA text analytics processing:
    - **IBM Content Analytics**
    - **OmniFind Enterprise Edition**
    - **IBM Classification Module**
    - **IBM eDiscovery Analyzer**



# IBM at 100: Innovation for Over 50 Years

Beginning in  
1957 ...

Searching and  
Classifying

## A Statistical Approach to Mechanized Encoding and Searching of Literary Information\*

H. P. Luhn

**Abstract:** Written communication of ideas is carried out on the basis of statistical probability in that a writer chooses that level of subject specificity and that combination of words which he feels will convey the most meaning. Since this process varies among individuals and since similar ideas are therefore relayed at different levels of specificity and by means of different words, the problem of literature searching by machines still presents major difficulties. A statistical approach to this problem will be outlined and the various steps of a system based on this approach will be described. Steps include the statistical analysis of a collection of documents in a field of interest, the establishment of a set of "notions" and the vocabulary by which they are expressed, the compilation of a thesaurus-type dictionary and index, the automatic encoding of documents by machine with the aid of such a dictionary, the encoding of topological notations (such as branched structures), the recording of the coded information, the establishment of a searching pattern for finding pertinent information, and the programming of appropriate machines to carry out a search.

### 1. Introduction

The essential purpose of literature searching is to find those documents within a collection which have a bearing on a given topic. Many of the systems and devices, such as classifications and subject-heading lists, that have been developed in the past to solve the problems encountered in this searching process are proving inadequate. The need for new solutions is at present being intensified by the rapid growth of literature and the demand for higher levels of searching efficiency.

Specialists in the literature searching field are optimistic about the future application of powerful electronic devices in obtaining more satisfactory results. A successful mechanical solution is unlikely, however, if such modern devices are to be viewed merely as agents for accelerating systems heretofore fitted to human capabilities. The ultimate benefits of mechanization will be realized only if the characteristics of machines are better understood and systems are developed which exploit these characteristics to the fullest. Rather than sublimate the artful classificatory schemes now in use, new systems would

base their mechanization on the principles of logic and justification.

be found in automation, there is a real danger that the demand for professional talent will become too great to fill. In view of the foreseeable strain, the most efficient use of talent will have to be made even by automatic systems. The operating requirements of these systems will, above all, have to be well adapted to the degree of education and experience of generally available personnel.

Language difficulties, too, will have to be met. The problems stemming from the mere volumes of literature to be searched are being continually aggravated by the increasing accession of foreign-language documents that rate consideration on an equal level with domestic material. To be of real value, future automatic systems will have to provide a workable means of overcoming the language barrier.

- Complexity levels of information systems

The general terms in which the problem of literature searching has been treated might indicate the possibility of a general, or universal, solution. It would be unreal-

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IBM JOURNAL • OCTOBER 1957

\*Presented at American Chemical Society meeting in Miami, April 8, 1957.

appropriately different techniques to their mechanization. The following list of six information systems in order of

# Medical Records Text Analytics

ICA Platform / Healthcare Annotators Accelerator / Health Language

- **IBM Content Analytics**

- **Natural Language Processing (NLP)**
  - **Unstructured Information Management Architecture (UIMA)**
  - Medical Concept Extraction Tooling

- **Health Language Medical Terminology Management**

- Standard Medical Terminologies Content  
(SNOMED, ICD-9, ICD-10, RxNorm, etc.)
  - Medical Terminology Management Tools

- **IBM Industry Solution Services Healthcare Annotators Assets**

- UIMA Annotator for Medical Entity and Relationship Extraction

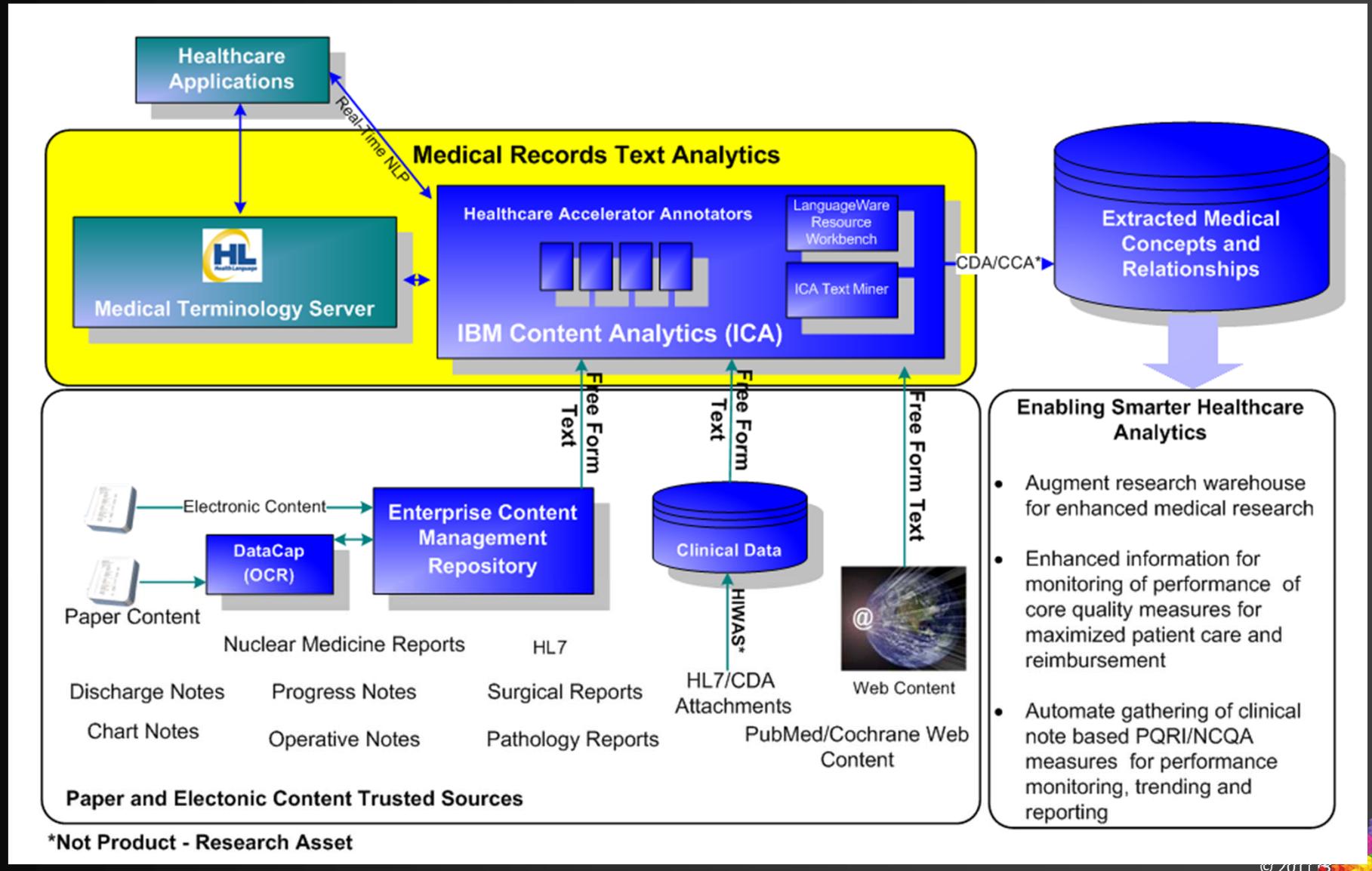
# Medical Records Text Analytics

## Healthcare Provider Use Case



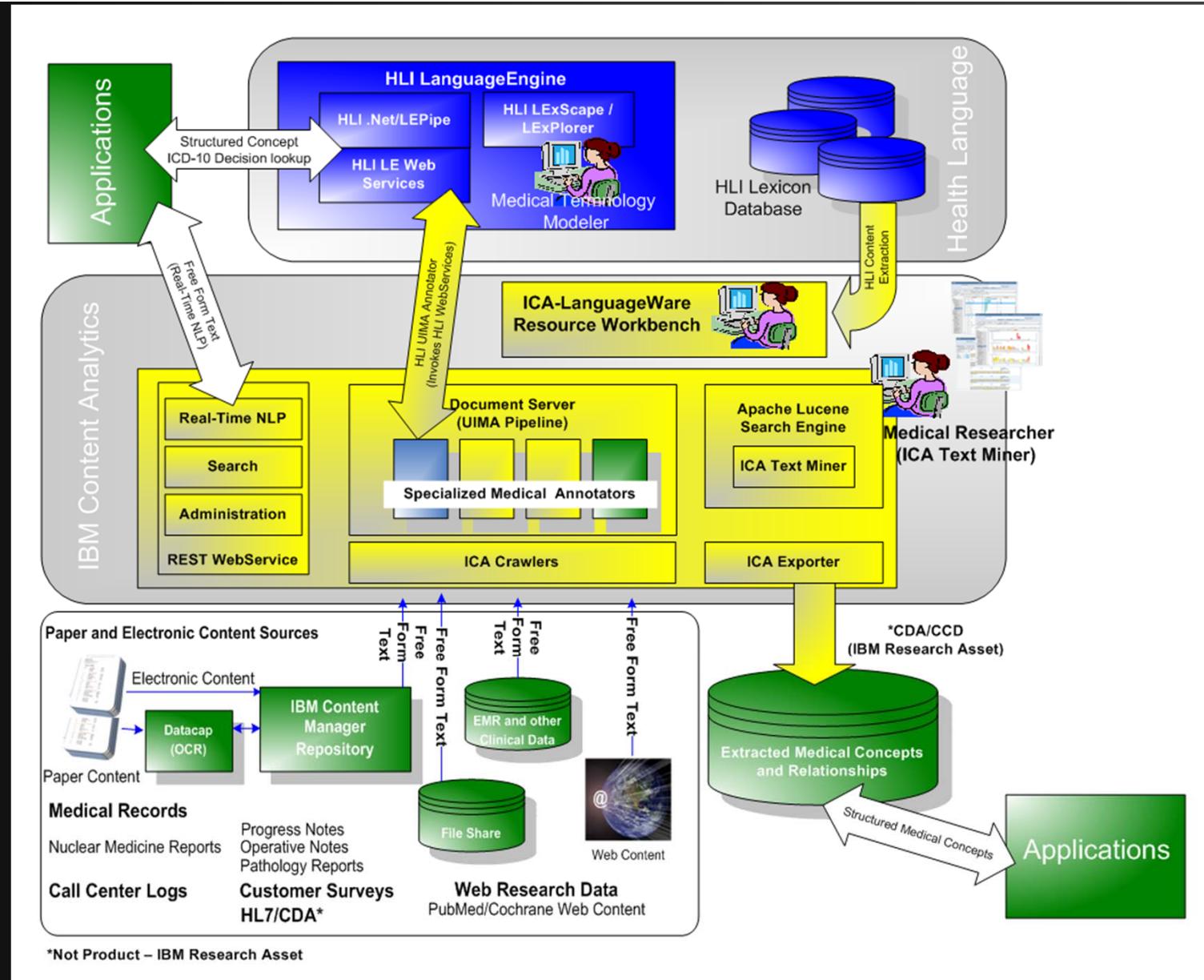
# Medical Records Text Analytics for Healthcare Providers

## ICA Platform / Healthcare Annotators Accelerator / Health Language



# Medical Records Text Analytics

## ICA Platform / Healthcare Annotators Accelerator / Health Language



# Medical Records Text Analytics

## Health Language Terminology Management Value

### Terminology Sets

- SNOMED CT / CA extensions
- ICD-9 P & CM
- ICD-10
- ICD-10-CM / PCS
- CPT-4
- HL7
- HCPCS
- APC, DRG, MS-DRG
- LOINC
- ICPC 1 & 2
- DSM IV
- MeSH
- Pharmacy (FDB, Multum)
- NDC
- RxNorm
- Nursing (NIC, NOC, NANDA)
- LCD / NCD / NCCI
- CDT
- Multiple Languages
- Local Codes – Nomenclature
- Consumer Friendly Terminology (CFT)

- ICD-10 (GM/AM/CA)
- ICD-O
- UK Admin Extension
- UK Gap Extension
- HRG
- OPCS-4
- CCI
- Read 2
- Read 4-byte
- SNOMED Facets
- Clinical Specialty Subsets

*HLI will evaluate and support additional code sets upon request.*

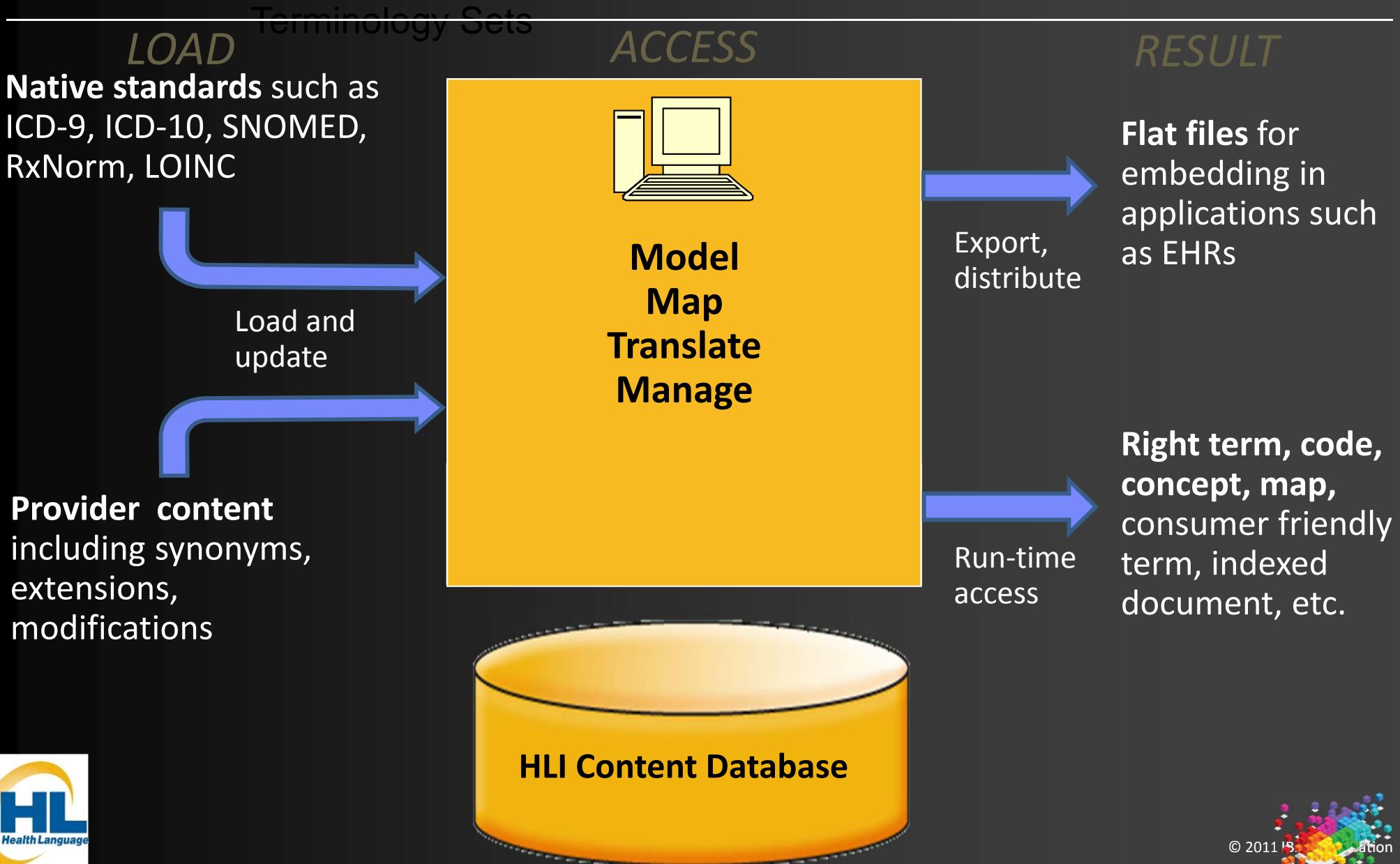


### Mappings

- SNOMED CT to ICD-9-CM
- SNOMED CT to ICD-10
- SNOMED CT to OPCS-4
- ICD-9-CM to SNOMED CT
- SNOMED CT to CPT
- CPT to SNOMED CT
- ICD-9-CM to ICD-10-CM/PCS
- ICD-10-CM/PCS to ICD-9-CM
- SNOMED to MeSH
- DSM IV to SNOMED
- ICD-9-CM Procedures to SNOMED
- HL7 to CHI
- Language to language (e.g., English to German)

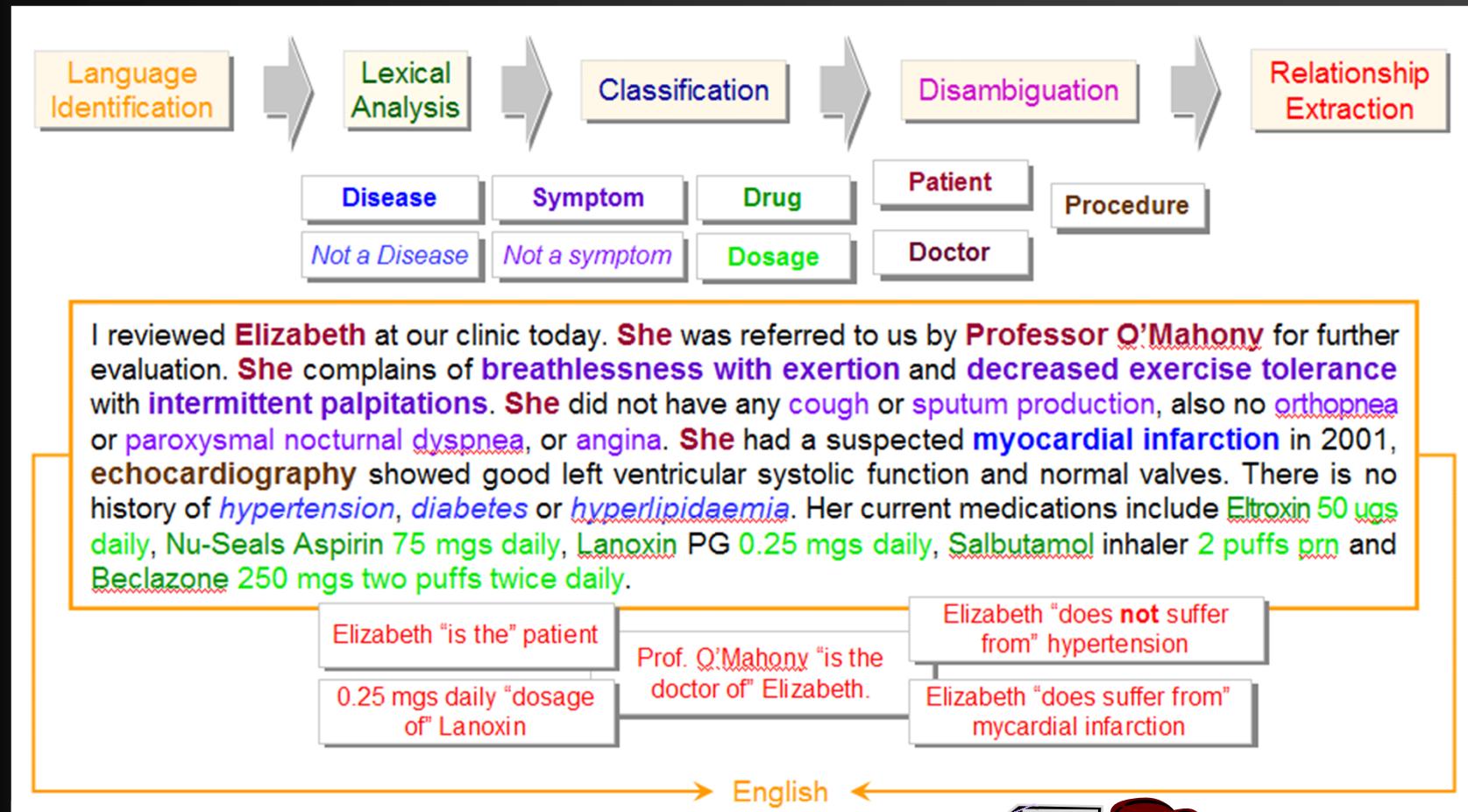
# Medical Records Text Analytics

HLI Language Engine Solution



# Medical Records Text Analytics

IBM Content Analytics LanguageWare Resource Workbench



Customizable  
Domain  
Resources



Resources

Resources

Rules &  
Seed list

Rules



LanguageWare Workbench  
(Medical Records Specialist)

<http://alphaworks.ibm.com/tech/lrw/download>



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# Medical Records Text Analytics

## IBM Content Analytics LanguageWare Resource Workbench

Annotations Index - Mozilla Firefox: IBM Edition

File Edit View History Bookmarks Tools Help

file:///C:/discovery/healthcare/Output/index.html

Annotations Index

CLIA # 3X13177744  
Patient: Sarah Doe  
PT. # 9833399  
Acc # B112235554  
Physician: Professor John Franks  
Acct # 3332-02

HISTORY AND PHYSICAL

DATE OF ADMISSION: 10/04/2008

This patient is being admitted for observation.

CHIEF COMPLAINT: Vertigo and possible syncope.

HISTORY OF PRESENT ILLNESS: The patient is a 70 year old woman visiting from Quebec who has been here for 3 weeks helping to take care of her son's 18-month-old child. She began having some pain in her right ear and some ringing for the last several days and then today had this episode where she said she kind of collapsed, maybe passed out, and found herself on the floor. She also has had some abdominal cramps for the last several days with some diarrhea earlier this week that has since resolved. No nausea. No vomiting. No chest pain. No palpitations. No swelling in the legs. No fever, but she has had episodes of shaking kind of chills.

PAST MEDICAL HISTORY: 1. Hypertension. 2. Hypothyroidism.

ALLERGIES: NO KNOWN DRUG ALLERGIES.

MEDICATIONS: 1. Synthroid 0.05 mcg. She actually takes 3/4 of a tab of this every day. 2. She takes a French medicine called Coversyl, which is some type of antihypertensive.

SOCIAL HISTORY: Occasional wine. No tobacco.

FAMILY HISTORY: No heart disease. History of cancer.

PHYSICAL EXAMINATION: VITAL SIGNS: Blood pressure 165/71. Temperature 36.8. Respiratory rate 20.

GENERAL: She is an elderly woman in no acute distress.

HEENT: Pupils are equal, round, and reactive to light. Extraocular movements are intact. Cranial nerves II-XII are intact. Tympanic membranes were both clear. The left side showed some more scarring than the right side, but no effusions.

NECK: No jugular venous distention (JVD). No adenopathy or bruits

LUNGS: Clear to auscultation.

CARDIAC: Regular rate and rhythm. No murmurs, gallops, or rubs.

ABDOMEN: Soft and nontender. No hepatosplenomegaly.

Annotations Index

H&P1

- + com.HLI.DictFinding (43)
- + com.HLI.DictGender (3)
- + com.HLI.DictProcedure (9)
- + com.IBM.Address (1)
- com.IBM.CessationEducation (0)
- + com.IBM.Date (1)
- + com.IBM.DictDrug (6)
- + com.IBM.DictDrugForm (1)
- com.IBM.DictDrugRoute (0)
- + com.IBM.Doctor (1)
- + com.IBM.Drug (3)
- + com.IBM.Finding (24)
- + com.IBM.FindingAbsent (19)
- com.IBM.FootExamFinding (0)
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- com.IBM.VISIT\_DATE (0)

Done



# Medical Records Text Analytics

## IBM Content Analytics LanguageWare Resource Workbench

Annotations Index - Mozilla Firefox: IBM Edition

File Edit View History Bookmarks Tools Help

file:///C:/discovery/healthcare/Output/index.html

Annotations Index Google

Annotations Index

CHIEF COMPLAINT: Abdominal pain.

HISTORY OF PRESENT ILLNESS: The patient is a 46-year-old woman who noted the onset of abdominal pain this morning of sharp and felt gassy-like. She tried to alleviate the pain with Gas-X and with an enema but these did not alleviate the pain and it became increasingly worse. She came into the emergency room. CT scan was performed and she was diagnosed with a ureteral stone. She has had some nausea and some vomiting but no diarrhea, no constipation. No fever, chills, no dysuria, no chest pain, no shortness of breath, no palpitations.

PAST MEDICAL HISTORY: For gastroesophageal reflux, bleeding ulcer several years ago, jerking legs, migraines.

PAST SURGICAL HISTORY: Hysterectomy, right ovary due to adhesions.

MEDICATIONS: 1. **Nexium**. 2. **Prozac 60 mg daily**. 3. **Lamictal one oral daily**. 4. Multivitamin.

SOCIAL HISTORY: No tobacco, occasional **alcohol**. She is from Texas.

FAMILY HISTORY: Unremarkable.

PHYSICAL EXAMINATION: VITAL SIGNS: Pulse 88, 96% on 2 liters. She is afebrile. Blood pressure 127/74.

GENERAL: This is a 43-year-old woman appearing in no acute distress. Pupils equal and reactive to light. Extraocular movements intact.

NEUROLOGICAL: Cranial nerves grossly intact.

LUNGS: Clear to auscultation.

CARDIAC: Regular rate and rhythm, no murmurs, gallops or rubs.

ABDOMEN: Soft, nontender, no hepatosplenomegaly, no rebound, guarding, no peritoneal signs. No CVA tenderness. She was examined by me after several doses of pain medications.

EXTREMITIES: No clubbing, cyanosis or edema.

LABORATORY STUDIES: CT scan: A 2 mm nonobstructing stone in the right kidney and 3 mm obstructing stone in the distal left ureter with considerable peripelvic and perinephric edema on the left suggesting some urine extravasation from the obstructing collecting system. White count 10.0, hematocrit 37, note MCV 100, sodium 138, potassium 3.5, chloride 103, bicarb 19, anion gap 20, creatinine 1.1, liver function tests are unremarkable. Calcium 9.9. A urinalysis 15 of ketones but otherwise, unremarkable.

ASSESSMENT AND PLAN: A 46-year-old woman with ureteral stone.

1. Ureteral stone. The emergency room physician spoke with the on call urologist who felt that there is a reasonable chance that the stone could pass on her own and that at this point will treat with IV hydration and pain control. Follow her exam clinically. At this point, there is no sign or symptoms of infection. We will treat her with some intravenous fluid and pain control through the night as an observation status.
2. Increased MCV. She has a family history of hypothyroidism. She has been checked before some time last year. I will recheck the TSH now but I have told her to have B12 levels checked when she returns to Texas. The case was discussed with the patient and the patient's family.
3. History of depression. We will continue her **Prozac** and her **Lamictal**.
4. Gastroesophageal reflux disease. Will continue her **Nexium**.

H&P2

- + com.HLI.DictFinding (37)
- + com.HLI.DictGender (3)
- + com.HLI.DictProcedure (9)
- + com.IBM.Address (1)
- + com.IBM.CessationEducation (0)
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- + com.IBM.DictDrugRoute (6)
- + com.IBM.Doctor (1)
- com.IBM.Drug (7)
  - + com.IBM.Nexium
  - + com.IBM.Prozac 60 mg daily
    - + com.IBM.measure
      - + com.IBM.en.MeasureAmount (1)
        - + com.IBM.60 mg
      - + com.IBM.drug
        - + com.IBM.DictDrug (1)
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# Medical Records Text Analytics

IBM Content Analytics LanguageWare Resource Workbench

CrossRiverOverview

Cognos Viewer - D06 NCQA Scorecard

NCQA Measure	Qualifying Patients	% of Patients	Target	Potential Points	Actual Points	Status
HbA1c Poor Control >9.0%	919	18%	15%	15	0	●
HbA1c Control < 7%	2,179	42%	40%	10	10	●
Blood Pressure Control >= 140/90 mm Hg	3,090	60%	35%	15	0	●
Blood Pressure Control <130/80 mm Hg	1,083	21%	25%	10	0	●
Smoking Status and Cessation Advice or Treatment	1,574	31%	80%	10	0	●
LDL Control <100 mg/dl	446	9%	36%	10	0	●
LDL Control >130 mg/dl	1,850	36%	37%	10	10	●
Foot Exam Completed	4,927	96%	80%	5	5	●
Retinal Exam Completed	4,826	94%	60%	10	10	●
Nephrology Assessment	5,138	100%	80%	5	5	●
Total			100	40	0	●

**HbA1c Control 7.0%**

Facility

Provider

Facility/Provider

Historical Compliance %

Provider Patient Totals

■ Patients Within Measure ■ Patients Outside Measure



# Medical Records Text Analytics

## IBM Content Analytics LanguageWare Resource Workbench

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file:///C:/discovery/healthcare/Output/index.html

Annotations Index

Most Visited Infosphere Clinical An... /manager Annotations Index1 Annotations Index2 IBM Business Transfor... IBM Internal Help Ho... IBM Standard Software... IT Help Central Join World Community... Windows Marketplace IBM

Annotations Index

Account#: 7X4553C  
MRN: 179-79-723  
OFFICE VISIT  
Exam Date: 07/20/09

Sex: F DOB: 7/13/61

HX: This 38 year diabetic is here for a follow-up evaluation following adjustment of her hypoglycemic medication. Glyburide was had been increased from 5mg to 10mg daily. She reports that her glucometer readings at home have improved, with first morning glucose around 100. Her hypertension and hyperlipidemia have been under reasonable control with medication. Ms. Doe has no specific complaints.

SH: Married, two children ages 12 and 14, A&W.  
Alcohol: occasional social drinker  
Tobacco: 1 ppd, wishes to stop

PHYS EX:  
HEENT: normocephalic, without masses, non-tender  
CN: II-XII intact and symm  
Fundii: minimal arteriolar nicking, without hemorrhages  
Neck: supple, full ROM, nontender, full ROM  
Chest: clear to P&A, nontender  
Cardiac: S1, S2, gr II/VI systolic ejection murmur PMI L4th ICS MCL  
Abd: soft, nontender, without masses, without organomegaly  
Pelvic: deferred  
Rectal: nl rectal tone, no masses, brown heme neg stool.  
Ext: full ROM, DTRs AJ, KJ, B, T 2+ bilat  
Radial pulses 2+ bilat, nl hand neuro exam  
Femoral and popliteal artery pulses 2+ bilat  
DP pulse: + R, 1+ L  
Without ulcers, wounds, erythema  
NL proprioception both halluces  
NL light touch on feet  
10g monofilament sensed 3/4 locations left plantar surface, 4/4 locations right plantar surface  
Neuro: F to N, RAMs intact  
Gait, tandem gait normal  
Rombergs normal  
LABS: reviewed  
IMPRESSION: Improved diabetic management  
No acute abnormalities  
PLAN: Continue current medication regimen, glucometer readings at home four times a day.  
Referred to Smoke-enders  
Follow-up two months

Annotations Index

PhysExam

- + com.HLI.DictFinding (11)
- com.HLI.DictGender (0)
- + com.HLI.DictProcedure (2)
- com.IBM.Address (0)
- + com.IBM.CessationEducation (1)
- + com.IBM.Date (2)
- + com.IBM.DictDrug (4)
- com.IBM.DictDrugForm (0)
- + com.IBM.DictDrugRoute (2)
- com.IBM.Doctor (0)
- com.IBM.Drug (3)
  - + Glyburide
  - glucose
  - drug
    - + com.IBM.DictDrug (1)
      - + glucose
  - Alcohol- + com.IBM.Finding (9)
- + com.IBM.FindingAbsent (1)
- com.IBM.FootExamFinding (1)
  - + com.IBM.FootExam\_FilamentTest (1)
  - + com.IBM.FootExam\_Structural (1)
  - + com.IBM.FootExam\_Touch (1)
  - + com.IBM.FootExam\_Vascular (1)
  - com.IBM.LOINC\_Date (1)
  - com.IBM.LOINC\_section (4)
  - com.IBM.PatientName (0)
  - com.IBM.PatientNumber (0)
  - + com.IBM.Person (2)
    - com.IBM.RELname2drug (0)
    - com.IBM.RELname2finding (0)
    - com.IBM.RELname2findingabsent (0)
    - com.IBM.RELname2number (0)
    - com.IBM.SmokingNegative (0)

# Medical Records Text Analytics

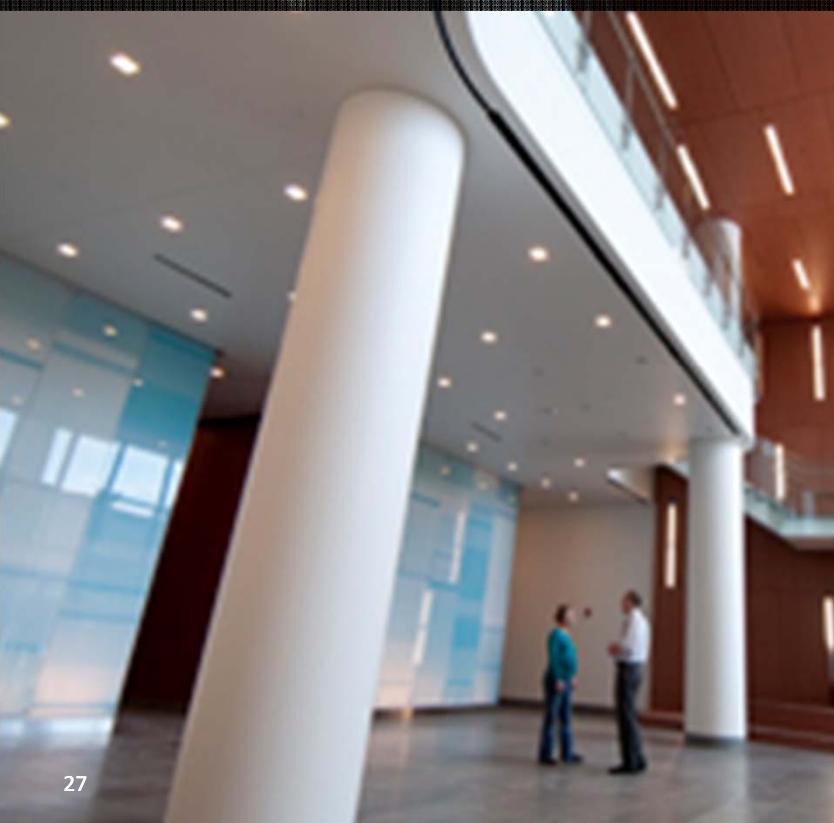
## IBM Content Analytics LanguageWare Resource Workbench

## BJC Healthcare and Washington University Partnership

# Smart is: unlocking biomedical informatics answers

*"We anticipate this solution to be a game changer in biomedical research and patient care. I believe that IBM Content Analytics will ultimately accelerate the pace of clinical and translational research through more rapid and accurate extraction of research relevant information from clinical documents"*

Dr. Rakesh Nagarajan, M.D., Ph.D., Associate Professor, Department of Pathology and Immunology, Washington University.



**Industry context: healthcare**

**Value driver:** access to biomedical trends, insight

**Solution onramp:** content analytics

### **Business Challenge**

Existing Biomedical Informatics (BMI) resources were disjointed and non-interoperable, available only to a small fraction of researchers, and frequently redundant. No capability to tap into the wealth of research information trapped in unstructured clinical notes, diagnostic reports, etc.

### **What's Smart?**

Capitalizing on the untapped, unstructured information of clinical notes and reports by using IBM Content Analytics with IBM InfoSphere Warehouse.

### **Smarter Business Outcomes**

Researchers now able to answer key questions previously unavailable. Examples include *Does the patient smoke?, How often and for how long?, If smoke free, how long? What home medications is the patient taking? What is the patient sent home with? What was the diagnosis and what procedures performed on patient?*

# Medical Records Text Analytics

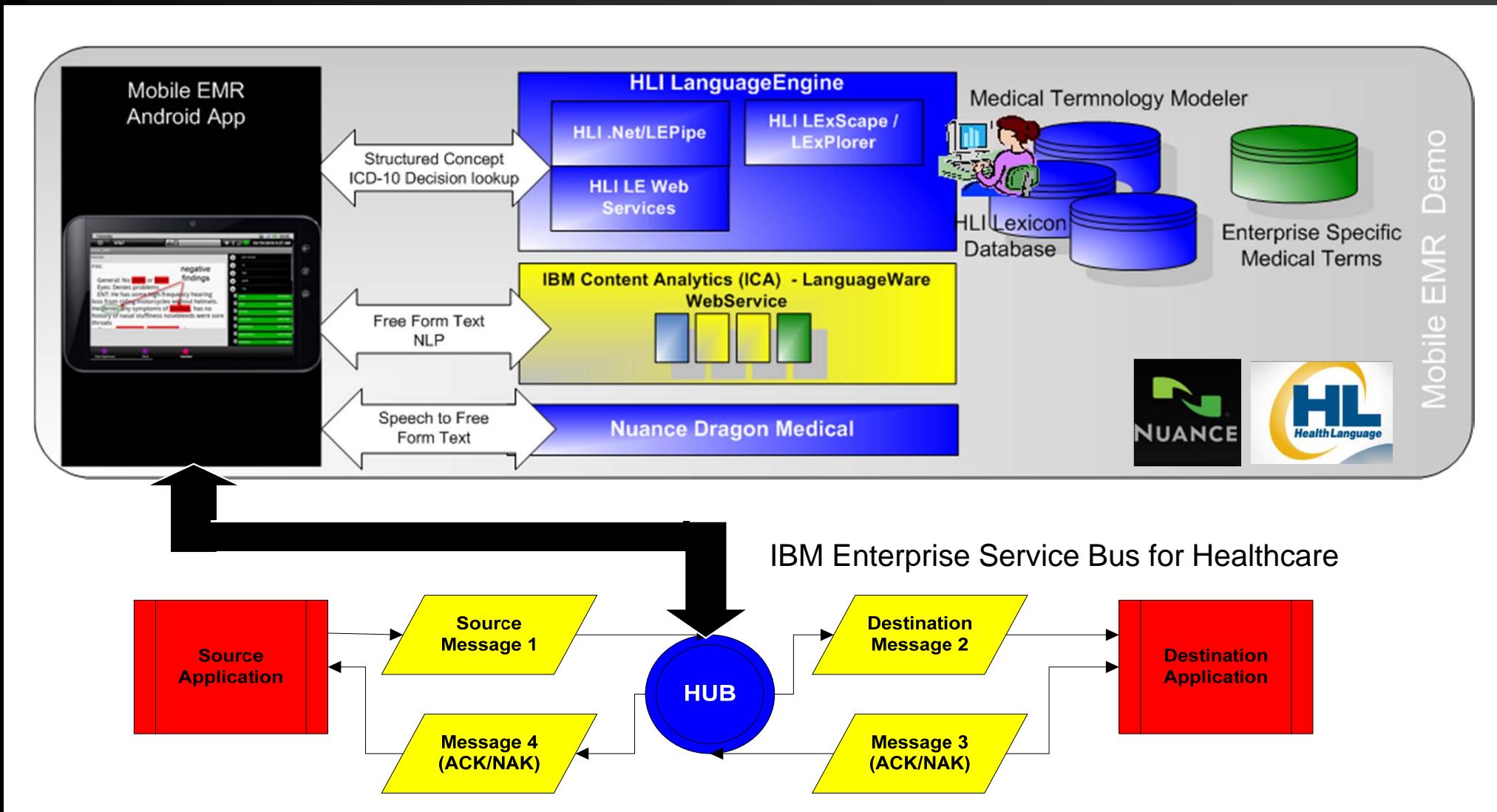
Mobile EMR Prototype



MobileEMR				
Jones, John	Asthma	2	10:15	Room 1
Doe, Mary	Asthma	3	10:20	Room 2
Baker, Joan	Asthma	2	10:25	Room 3

# Medical Records Text Analytics

## Mobile EMR Prototype



# Medical Records Text Analytics

Mobile EMR Prototype



The screenshot shows a mobile application interface for a medical record. At the top, it displays the carrier (AT&T) and the date and time (10/19/2010 9:37 AM). Below this, the patient's name is listed as "Jones, John". The interface includes a navigation bar with tabs for "Overview", "Final Impression" (selected), "Plans", and "Overview".  
  
The main content area contains the following text:  
ros:  
General: No chills or fever  
Eyes: Denies problems  
ENT: He has some high-frequency hearing loss from riding motorcycles without helmets.  
He denies any symptoms of tinnitus, has no history of nasal stuffiness nosebleeds were sore throats  
  
To the right of the text, there is a list of symptoms with checkboxes and their corresponding codes:

<input checked="" type="checkbox"/> chills	43724002
<input checked="" type="checkbox"/> fever	386661006
<input checked="" type="checkbox"/> tinnitus	60862001
<input checked="" type="checkbox"/> chest pain	29857009
<input checked="" type="checkbox"/> palpitations	80313002
<input checked="" type="checkbox"/> pedal edema	102576009
<input checked="" type="checkbox"/> heartburn	16331000

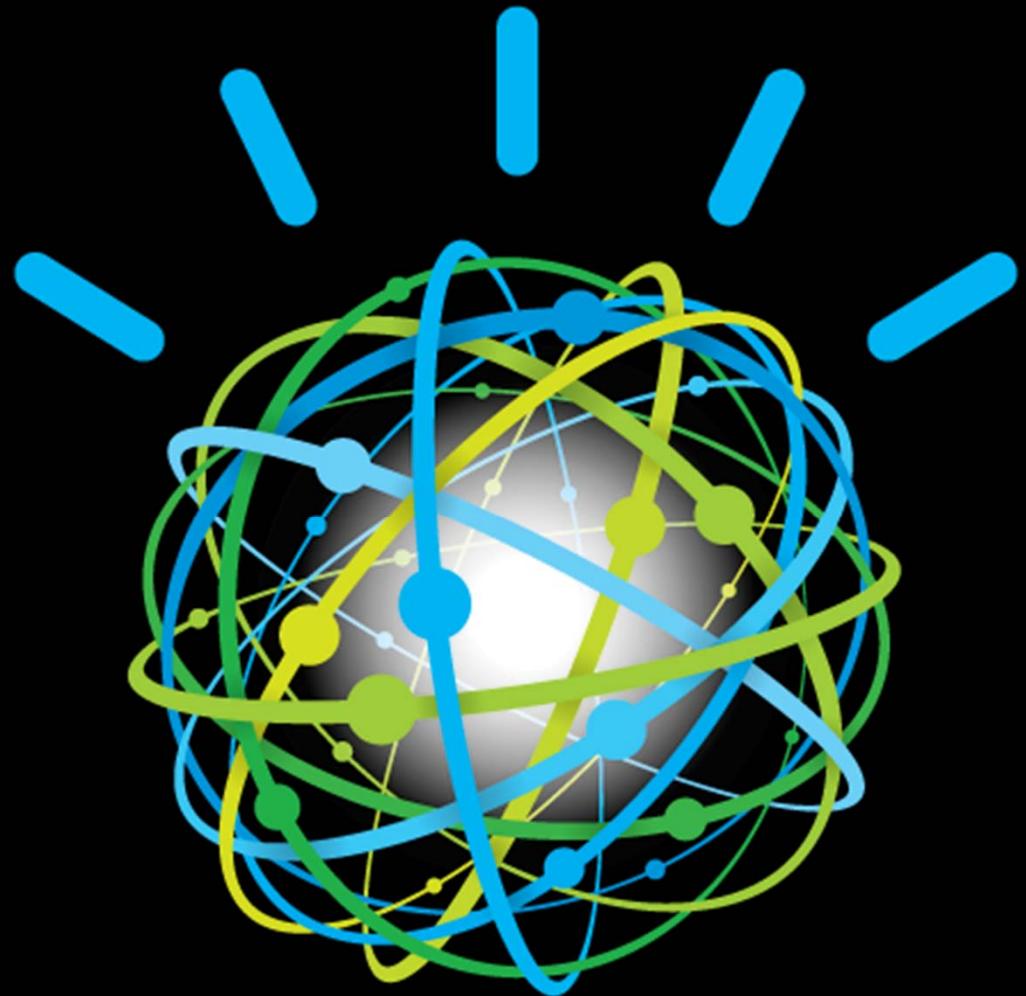
  
A red arrow points from the word "denies" in the text to the checkbox for "tinnitus". A green circle highlights the word "denies".



Thank you

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Randall Wilcox  
randywil@us.ibm.com



<http://www.ibm.com/software/ebusiness/jstart/textanalytics/>

# Early Mayo Clinic Text Analytics

MedTAS/P --- Evaluation on colon cancer pathology reports

	Precision	Recall	F-Score
<b>Primary Tumor</b>	0.80	0.84	0.82
<b>Metastatic Tumor</b>	0.60	0.43	0.50
<b>Lymph Nodes</b>	0.94	0.94	0.94
<b>Anatomical Site</b>	0.97	0.97	0.97
<b>Histological Diagnosis</b>	0.99	0.98	0.99
<b>Tumor Size</b>	1.00	1.00	1.00
<b>Grade</b>	0.99	0.97	0.98
<b>Date</b>	1.00	1.00	1.00
<b>Gross Description</b>	0.90	0.88	0.89