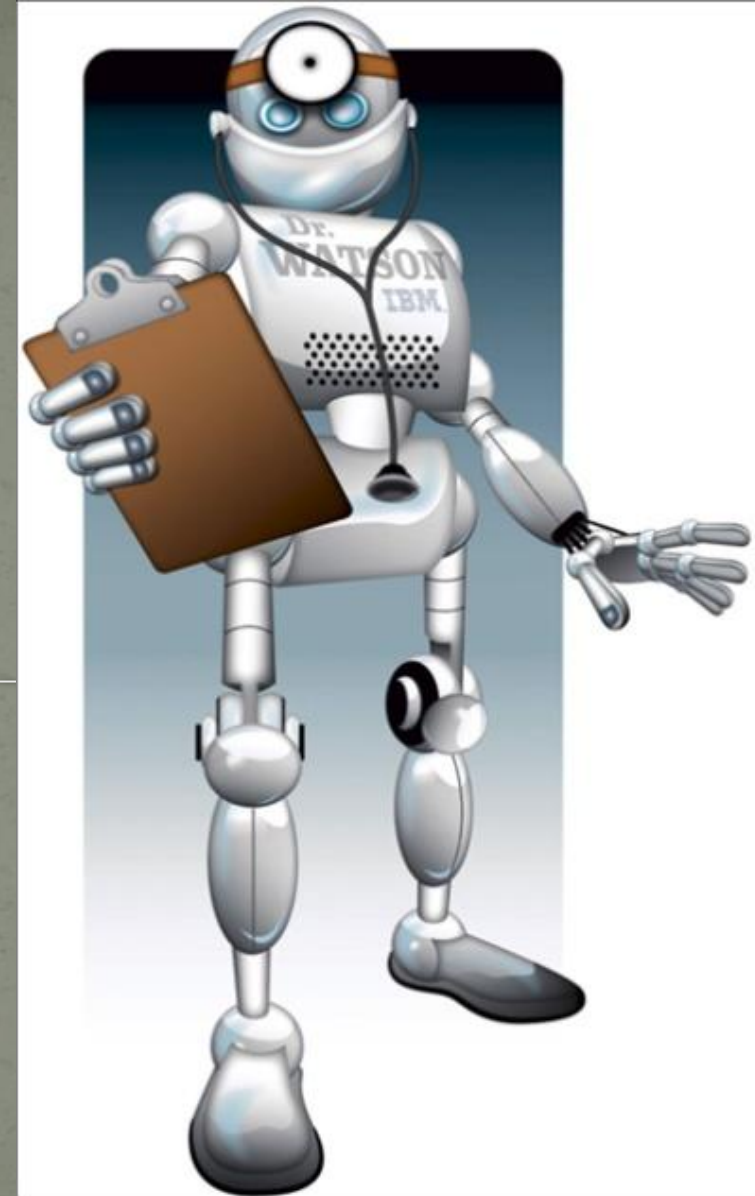Ontology Summit 2011 – Making The Case for Ontology

Grand Challenges:
The Dr. Watson Project:
Clinical Perspective

# Introduction

- Thanks for opportunity to participate in this session
- Cannot think of many "Grander" Challenges than the renaissance of research and applications of "artificial" or computational intelligence in medicine
  - Attempts in the past for a large scale system have met with very limited success and are not in use in medicine today
  - The potential for these systems if we can overcome the roadblocks and barriers are enormous

# Previous Attempts at Artificial Intelligence in Medicine

- Mycin- Stanford
  - Doctoral dissertation of Edward Shortliffe designed to identify bacterial etiology in patients with sepsis and meningitis and to recommend antibiotics
  - Had simple inference engine and knowledge base of 600 rules
  - Proposed acceptable therapy in 69% of cases which was better than most ID experts
  - Never actually used in practice largely due to lack of access and time for physician entry >30 minutes
- Caduceus – similar inference engine to Mycin and based on Harry Pope from U of Pittsburgh's interviews with Dr. Jack Myers with database of up to 1,000 diseases

# Previous Attempts at Artificial Intelligence in Medicine

- Internist I and II – Covered 70-80% of possible diagnoses in internal medicine, also based on Jack Myers' expertise

- Worked best on only single disease

- Long training and unwieldy interface took 30 to 90 minutes to interact with system

- Was succeeded by "Quick Medical Reference" which was discontinued ten years ago and evolved into more of a reference system than diagnostic system

# Dr. Watson Overview and History

- Initially had opportunity to visit IBM team about a year and a half ago

- Engaged Jeopardy team and discussed the potential for medical applications as next steps after Jeopardy Challenge

- Began initial research with IBM approximately one year ago

- Current grant with IBM for initial exploratory work with physician helping team to understand the medical domain and challenges

- Worked together on deeper understanding of the medical domain using multiple resources

- Visit to University of Maryland and the VA to see EMR and demonstration and discussion of the EMR
- Application for NIH Transformative Research Awards T-R01
  - NIH Common Fund for collaboration and exceptionally high impact, trans-NIH programs
  - Designed to pursue major opportunities and gaps in biomedical research that no single NIH institute could tackle alone

# Disclaimer

- Although we are collaborators and have been working together on the project, my vision and what IBM does may be very different

# Taking Watson to Medical School

University of Maryland, Baltimore
**SCHOOL OF MEDICINE**

- Want 3 components similar to medical students education
  - Book knowledge
  - Sim Human Model
  - Experiential learning from actual EMR

**UNIVERSITY OF MARYLAND**
**SCHOOL OF MEDICINE**

# Book Learning

- Textbook, journal, and Internet resource knowledge. Quiz materials. Like medical student this alone not enough don't want to make hypochondriac

# Advancing Deep Q/A's Medical Knowledge

- Continue to develop medical knowledge database
  - Harrison's
  - Merck
  - Current Medical Diagnosis and Treatment
  - American College of Physicians Medicine
  - Stein's Internal Medicine
  - medical Knowledge Self Assessment Program
  - NLM's Clinical Question Repository
- Use New England Journal of Medicine 130 CPC cases and quiz material
  - Additional CPC cases at U of Maryland
- Begin developing interactive capability to develop hypotheses and refine them depending on the answer to those questions
- Develop a tool that allows for physician feedback to the system for various hypotheses so community can interact and teach Watson

# SIM Human

- SIM Human model of physiology – work done at the University of Maryland School of Medicine and UMBC by Dr. Bruce Jarrell and colleagues
- Want to have understanding from model of physiology
- Work has been done to create simulations of disease processes and then observe how it affects other physiology in the body

# Clinical/Hospital "Experience"

- Consumption of electronic medical record which is largely just paper represented digitally, cannot search for "rash" for example

- Access to records at U of Maryland and VA but also larger repositories from the VA in de-identified manner

# Electronic Medical Record Challenges and Limitations

- Epic system at the University of Maryland
- VA's VISTA System
- University of Maryland EPIC system
  - EMR
    - Electronic version of paper records
    - Review large number of discharge summaries
    - Review progress notes and structured and unstructured additional information from EMR

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# IBM and VA Team Review of EMR

- Patient EMR such as VA's highly publicized and praised VISTA revealed numerous challenges
  - Despite the fact that virtually 100% of patient information is available in the electronic EMR with records going back more than 15 years
    - Not possible to search for a term within or among patient records such as "rash"
    - Majority of data is unstructured and in free text format
    - Much of the text in progress notes and other types of notes is highly redundant since interns and residents and attending physicians typically cut and paste information from lab and radiology and other studies and other notes
    - Information is entered with abbreviations that are not consistent and misspellings

# Patient Problem List

- Patient problem list has no "sheriff" and each physician is free to add "problems" but very few delete them for "problems" that are temporary
  - The problem lists themselves often have contradictory information

# Next Steps for Dr. Watson After Medical School
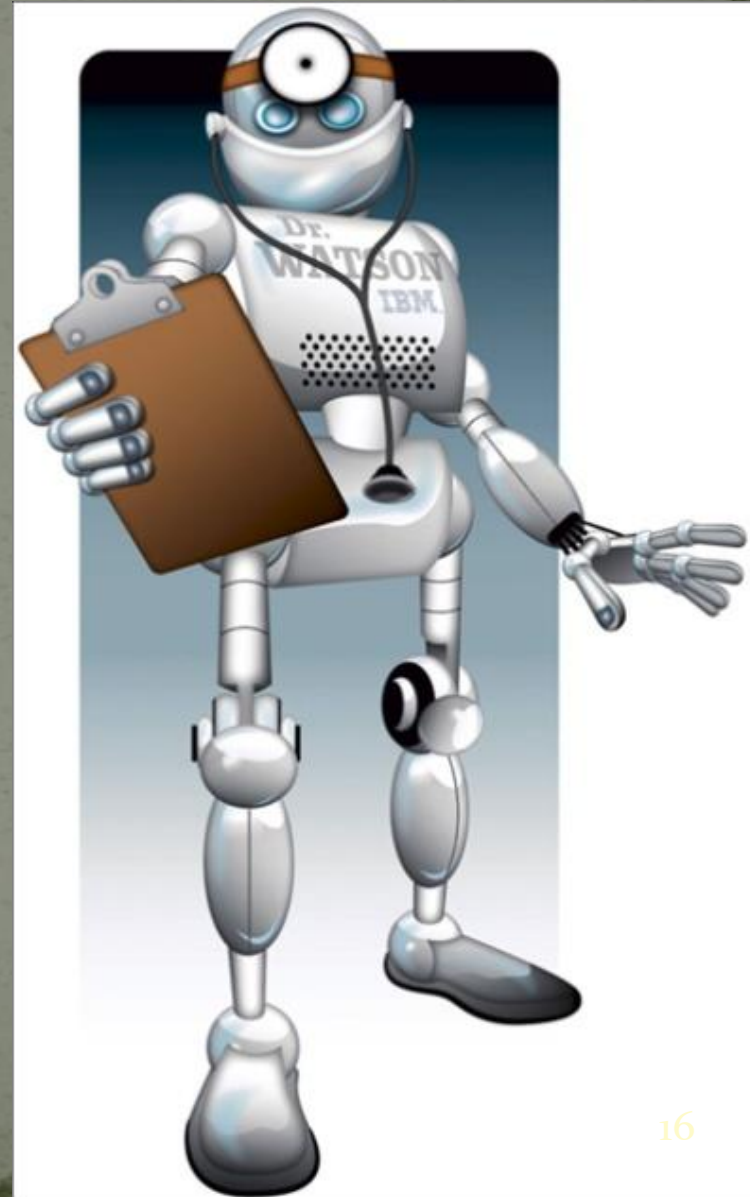
# Unsupervised or Semi-supervised Summary and Synthesis and Search of The Electronic Medical Record

- Ability to search through information in EMR
- Summarize EMR and provide view into what is most pertinent about the EMR – as resident might do that in presenting a case to me
- Create problem list
- Perform electronic "chart review" for patient to evaluate drug interactions, discrepancies with medications and diagnoses, and screen for recommended guidelines such as diabetic patient who has not had retinal exam

# Medical Diagnosis



- Interactive and chart review
- Chart Review
  - Watson software would take information from patient outpatient chart and/or hospital inpatient chart
  - May need to utilize a patient health record
    - Increasing trend in medicine toward patient owning their EMR so that patient information can be centralized and under patient control
  - Dr. Watson software would recognize and evaluate patient signs and symptoms and history and current symptoms and make one or more diagnoses in a supervised or semi-supervised fashion including assessment of probability of disease
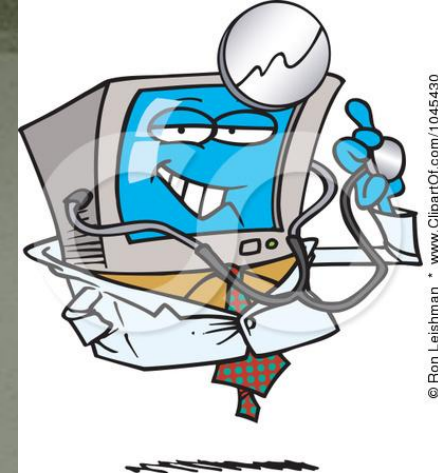
# Interactive



- Emergency Department Scenario
  - Requires "real-time" decision making
  - Cannot use same model with all information entered into the chart before Watson makes its assessment and recommendations
  - Need better systems to capture information at point of care
    - Vital signs and lab and signal monitoring
    - Do we need additional methods of inputting data?
    - Do we need to capture live conversations with providers and patients?
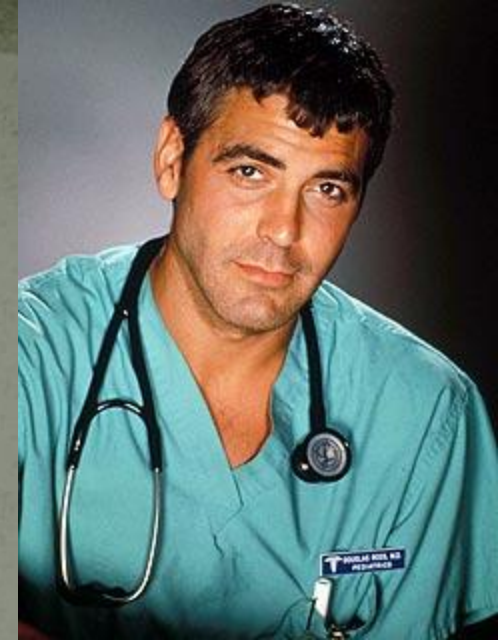
# Interactive Dynamic Diagnosis

- Need to give ability of physician to interact with Watson in dynamic fashion to allow refinements with ability of both software to ask additional questions and suggest diagnostic studies and ability of physician to refine diagnostic possibilities and to "educate" Watson about additional medical perspectives

# Ingestion of Databases

- Various databases disconnected and not easily accessible
  - Parkinson's Johns Hopkins
  - Leukemia MD Anderson
  - TCGA- NIH
- Unfortunately these are not made available publically and need to have method to discover them and then standard to understand what they contain and their format etc.
-

# Emergency Department Scenario

- Can't wait for note to be finished
- Need to acquire information structured and otherwise in real-time in order to help out with decisions unlike oncology scenario where there is more time to review findings

# Treatment Options

- Previous systems also included suggestions from "expert systems" for treatment options
- Given the proper databases it would be possible to tailor the treatment to specific patients to truly "personalize" medical treatment

# Teaching Dr. Watson Bedside Manners
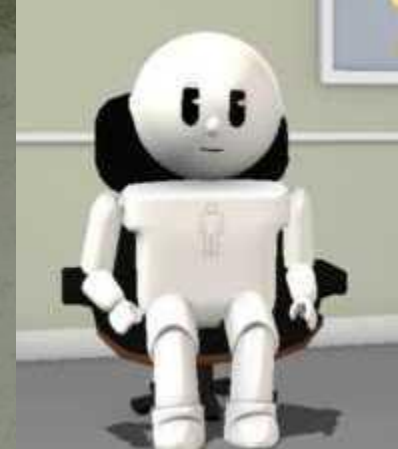
- Is it possible that machines will replace humans in the doctor-patient relationship? I doubt it. According to a study done by the Mayo Clinic in 2006, the most important characteristics patients feel a good doctor must possess are entirely human

- According to the study, the ideal physician is **confident, empathetic, humane, personal, forthright, respectful,** and **thorough**. Watson may have proved his cognitive superiority, but can a computer ever be taught these human attributes needed to negotiate through patient fear, anxiety, and confusion? Could such a computer ever come across as sincere?

# Conclusion

- Fundamental differences between challenge to Jeopardy Quiz team and medical applications include:
    - Information may be incorrect or ambiguous
    - May be more than one diagnosis
    - Need to take into strong consideration diseases that are serious and can cause serious harm despite relative probability of that disease as the most likely diagnosis
- The Watson Q/A technology and Jeopardy demonstration have captured the imagination of many people including those in healthcare and this may provide a critical springboard to revive many of the excellent initiatives on artificial intelligence applications in medicine
- The potential of these to revolutionize medicine is tremendous and exciting