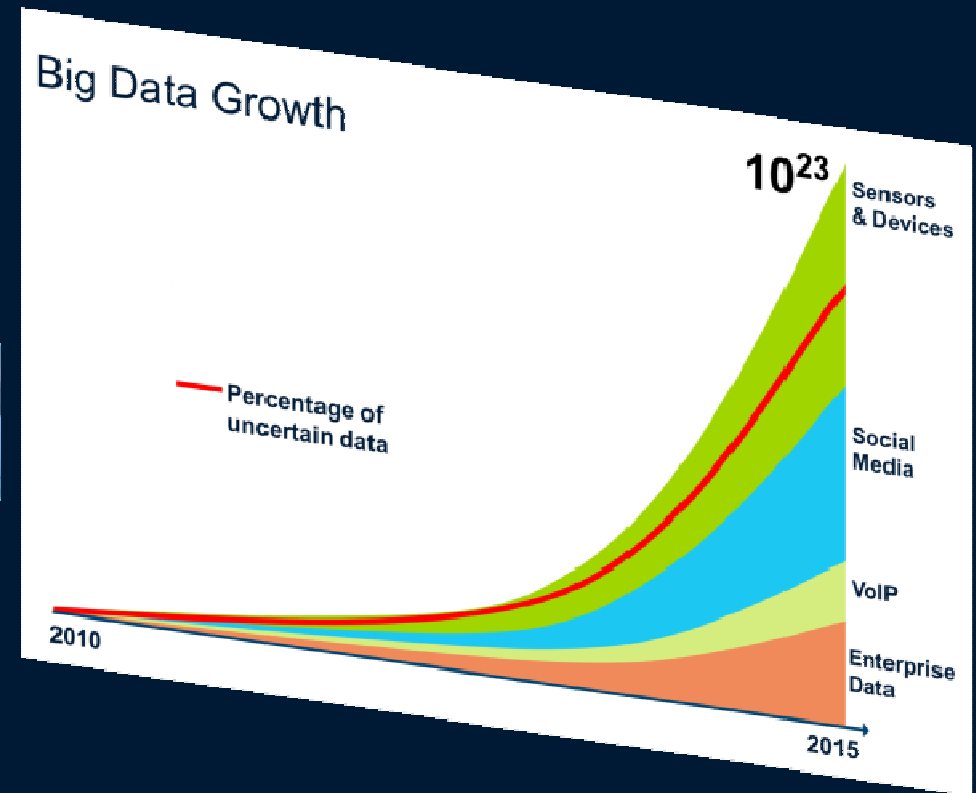


# Cognitive Systems - a New Era of Computing

Oded Cohn  
Vice President,  
Director of IBM Research – Haifa



# The Next 'Natural' Resource:



4-V's: Volume, Velocity, Variety, Veracity

Data/Information Overload

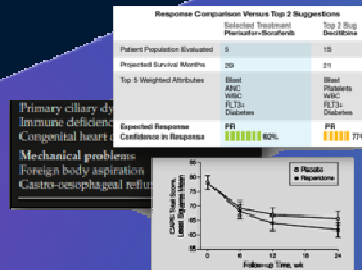
## Context Multiplier Effect

**>1,000x**

# 100x

# 10x

1x



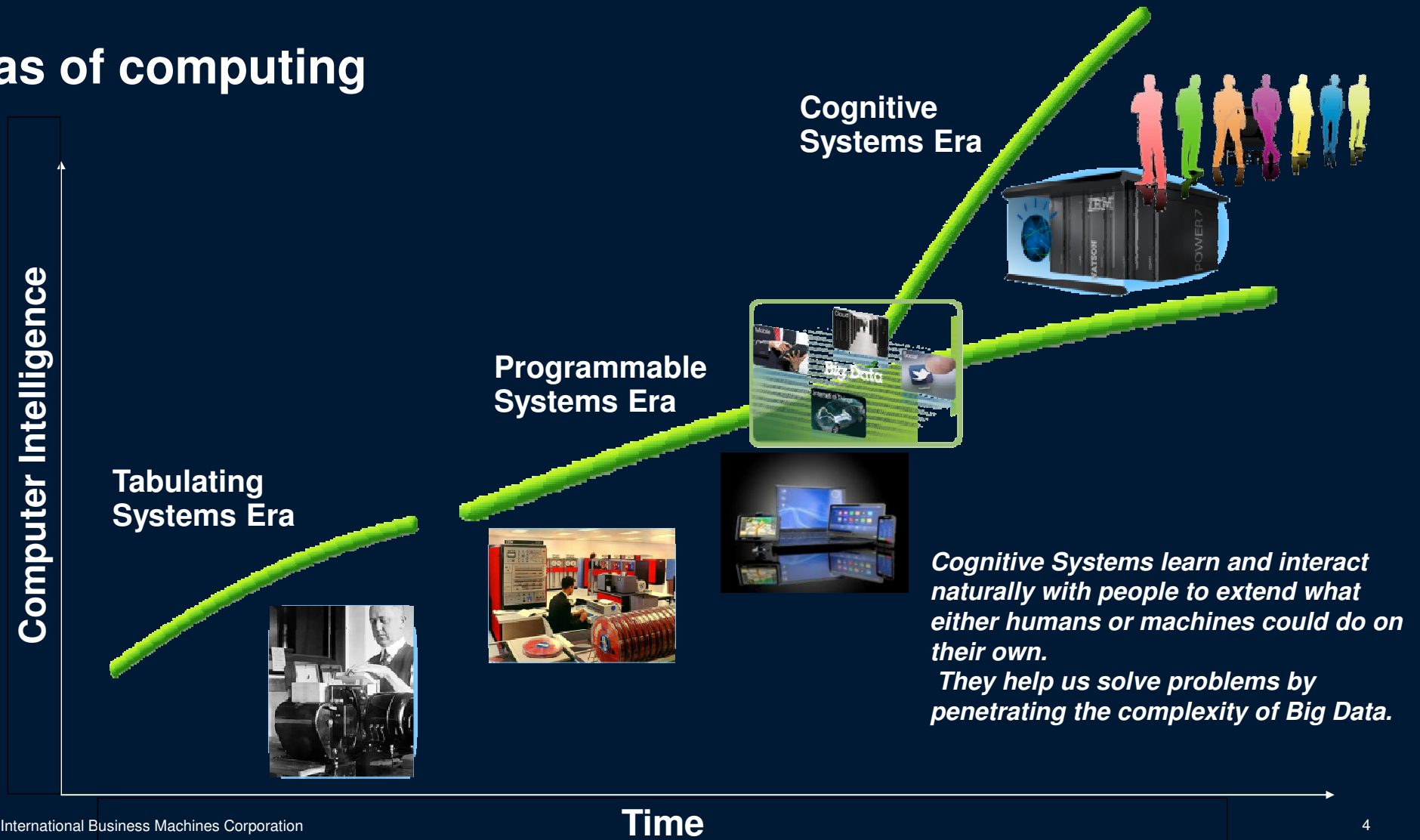
## Raw data

## Feature extraction metadata

## Domain linkages

## Full contextual analytics

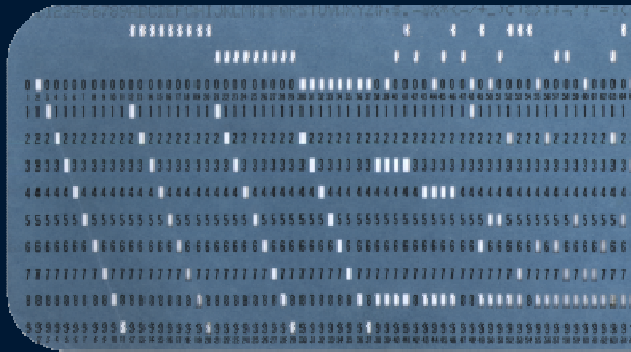
# Eras of computing





# Eras of computing

Tabulating  
Systems Era

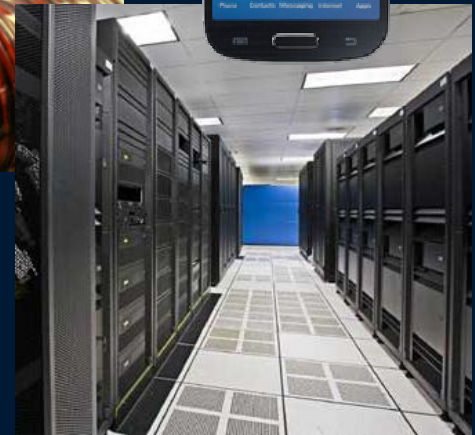
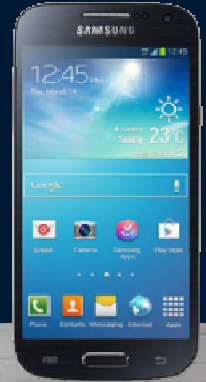


Automation of tasks

Productivity and shift from menial work

# Eras of computing

Programmable  
Systems Era



Automation of processes and transactions

Enable global enterprise and empower the individual

# Eras of computing

## Cognitive Systems Era



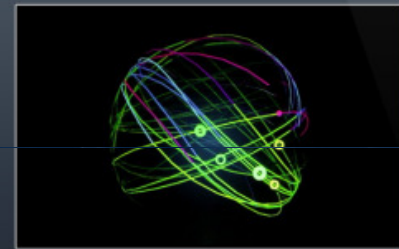
Penetrate complexity

Scale and magnify human capability

Unlock time value of insight

**Melissa:** How much will it cost to send my daughter to college?

**Watson:** Analyzing Options...



## Winning the Jeopardy! Challenge - a Milestone in Computing History

### Question Answering

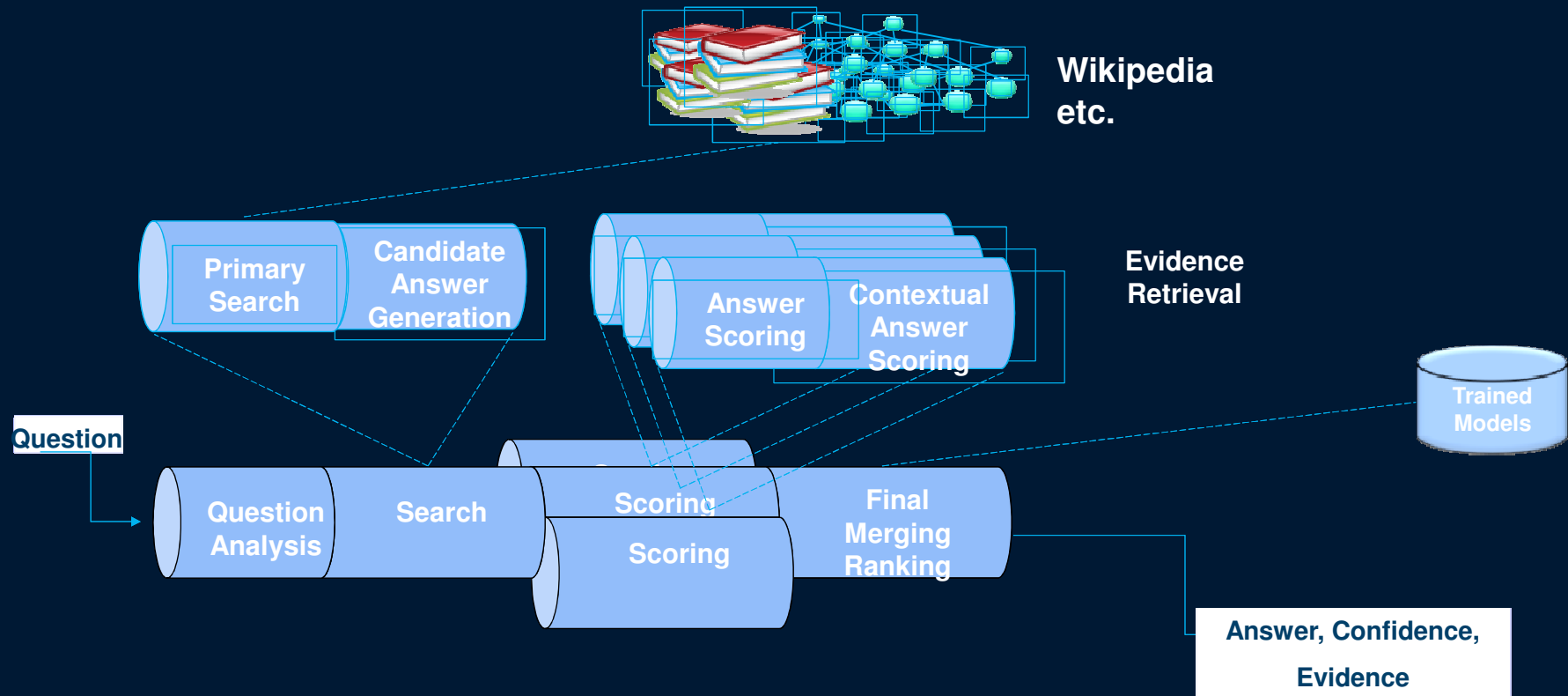
1. Broad/open domain
2. Complex language
3. High precision
4. Accurate confidence
5. High speed

Paganini “24 capricci” set the standard for etudes for this instrument

If leadership is an art then surely he has proven himself as a master painter at GE



# How Watson responds to a Question





# The New IBM Watson Group



TECH | 1/08/2014 @ 11:16PM | 10,623 views

## IBM Announces \$1B Watson Group, Moves Jeopardy Ace Computer To NYC

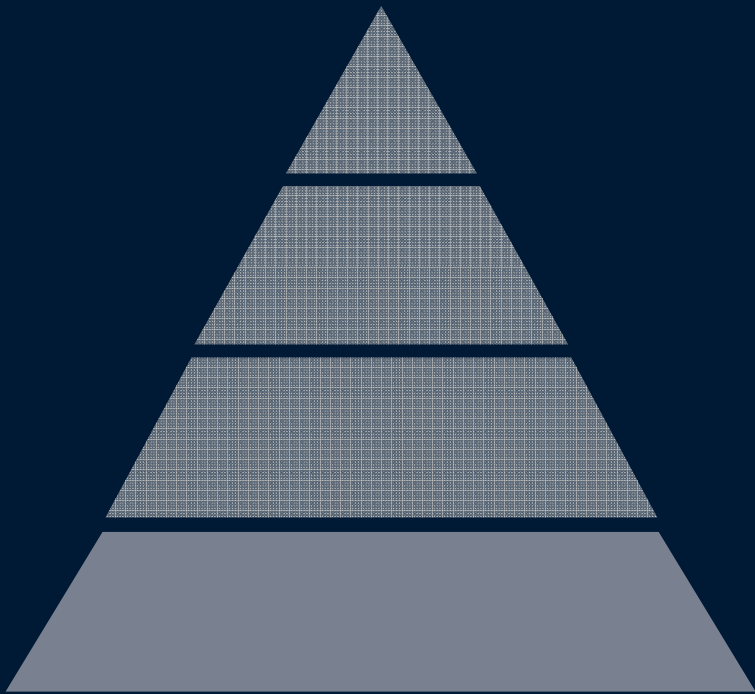
[+ Comment Now](#) [+ Follow Comments](#)

Three years after its splash appearance on Jeopardy, IBM is turning to the Watson computer system for inspiration again—this time as the centerpiece of a major new business unit in the Big Apple. The company will announce a major new business unit, at an event Thursday that it's created the IBM Watson Group to build out an ecosystem around Watson—and hopefully start making big-picture money off it—out of a major new office in New York City's East Village.



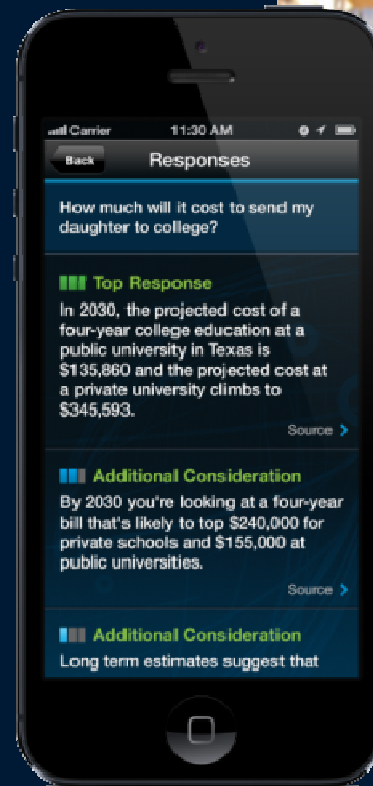
The new IBM Watson at work. (Credit: IBM)

# Cognitive computing – *Four Broad Capabilities*



# Cognitive computing – Assistance

*Leverage encyclopedic domain knowledge*

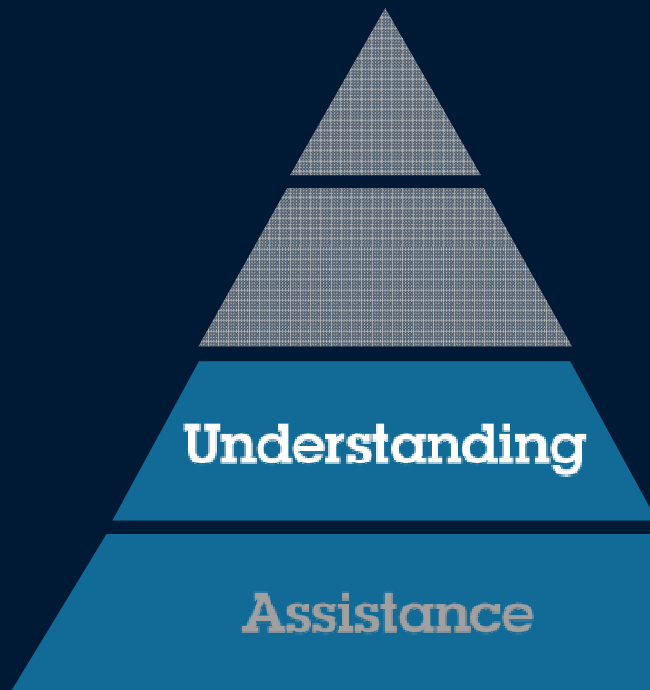


e.g. Watson Advisor

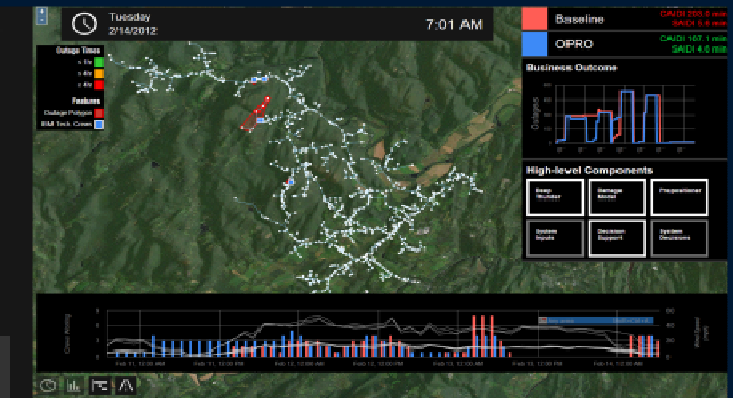


# Cognitive computing – Understanding

## *Map emergent patterns and connections*



OPRO

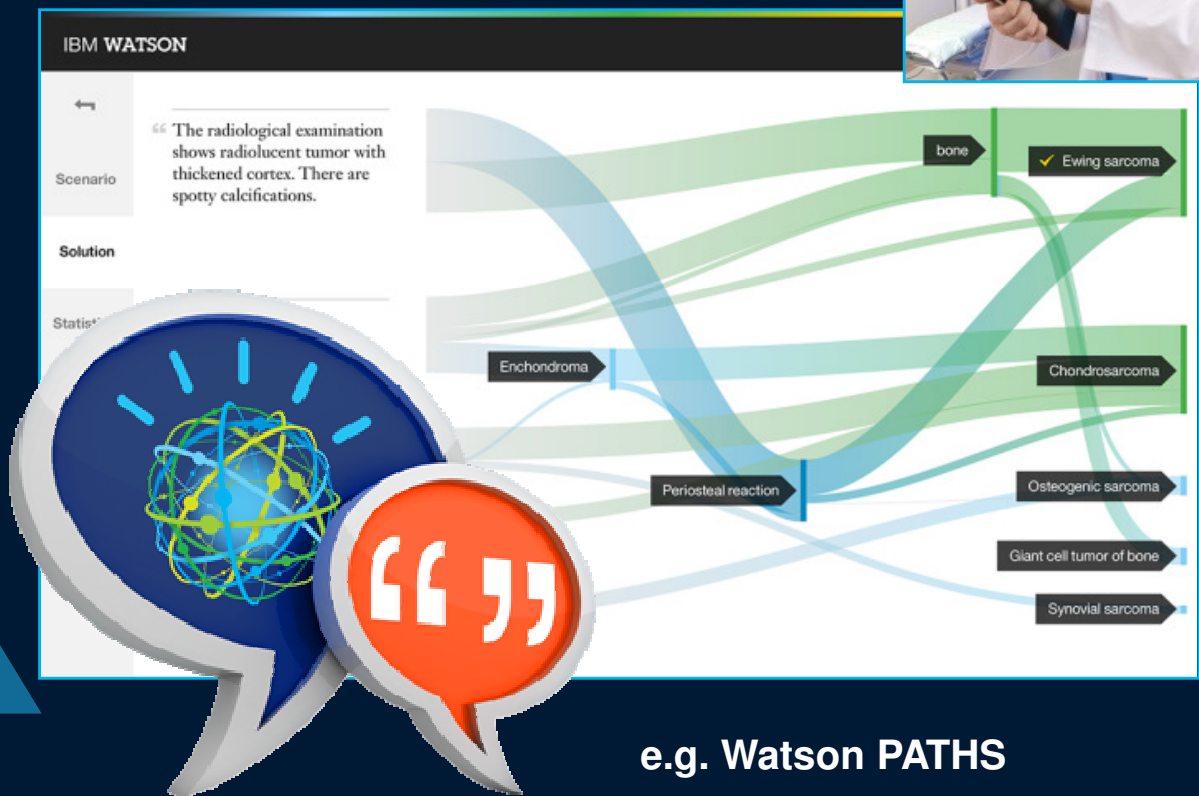


e.g. Using a weather forecast to understand the impact on infrastructure



# Cognitive computing – Decisions

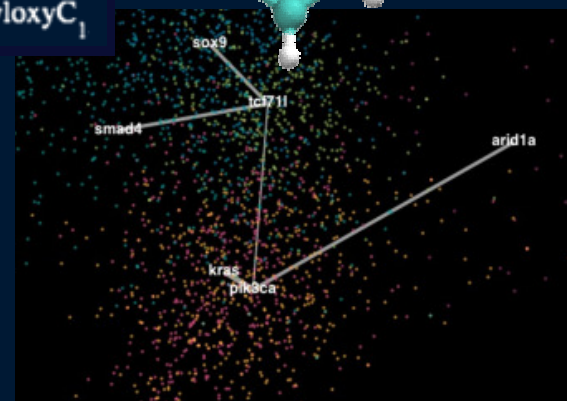
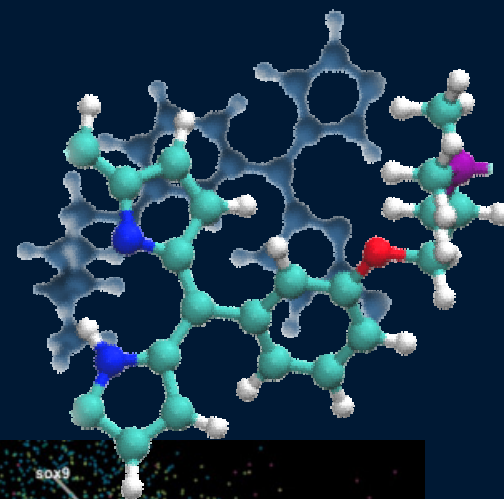
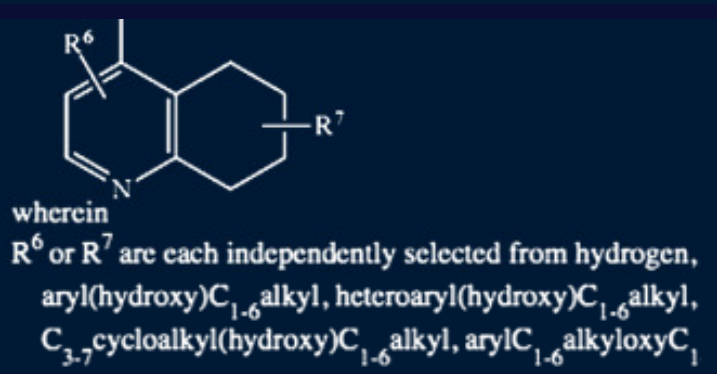
## *Analyzing conflicting points of view*



e.g. Watson PATHS

# Cognitive computing – Discovery

*Create new insights and find new value*



e.g. Food design,  
Cancer drug discovery

# The Human/Computer Partnership

People and computers collaborating  
with the goal of scaling and magnifying human cognition

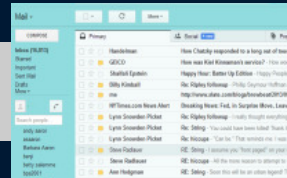
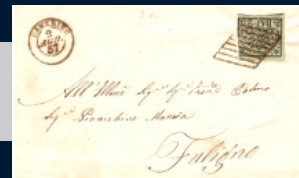


# Enhancing Human Capability

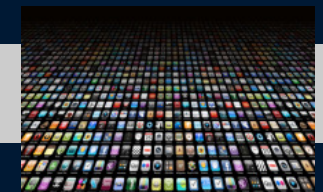
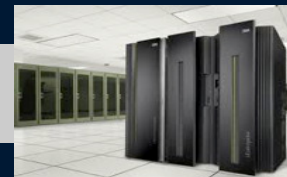
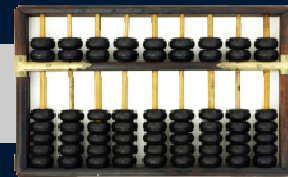
Physical limitations



Connectivity limitations



Productivity limitations



Complexity limitations



We need enhanced cognition.

# Decisions Scenarios With a High Degree of Cognitive Complexity

## For the Enterprise...

Finance	Operations	Marketing & Sales	R&D and Design
Mergers, Acquisitions & Divestitures	Crisis and Emergency Management	Product Pricing & Launch	Brainstorming & Discovery
Investment Decisions	Project Planning	Selection of Markets & Geos	Innovation Portfolio Planning
Strategic Planning & Scenario Analysis	Discovery & Diagnosis	Competitive Analysis	Product Design

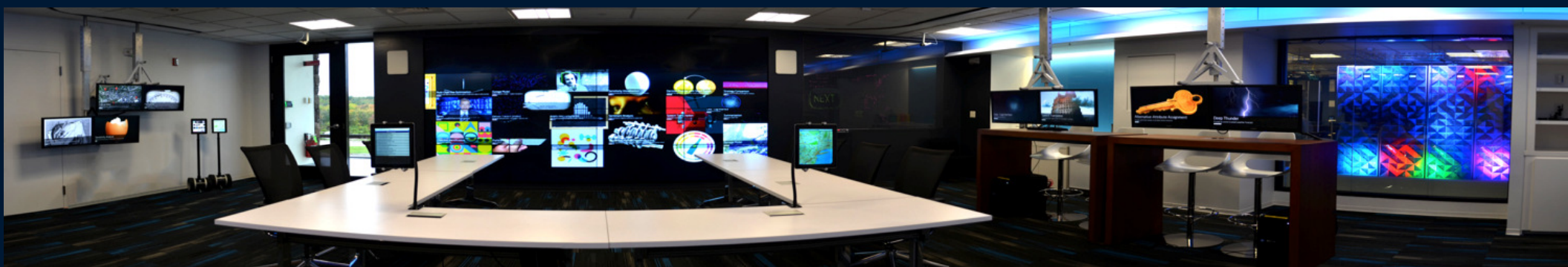
## For the Individual...

Education	Large Purchases	Financial Investments	Medical
Selecting a college	Purchasing a home	Retirement investment decisions	Selecting medical plans
Financing education	Purchasing a car	Stock market investments	Deciding on treatment options



# Cognitive Environments

An infrastructure inhabited by a society of cogs, humans and devices that enables them to behave as one shared integrated resource, enabling human-computer collaboration at the speed of thought



*The Cognitive Experience Lab @ T.J.Watson Research Center*

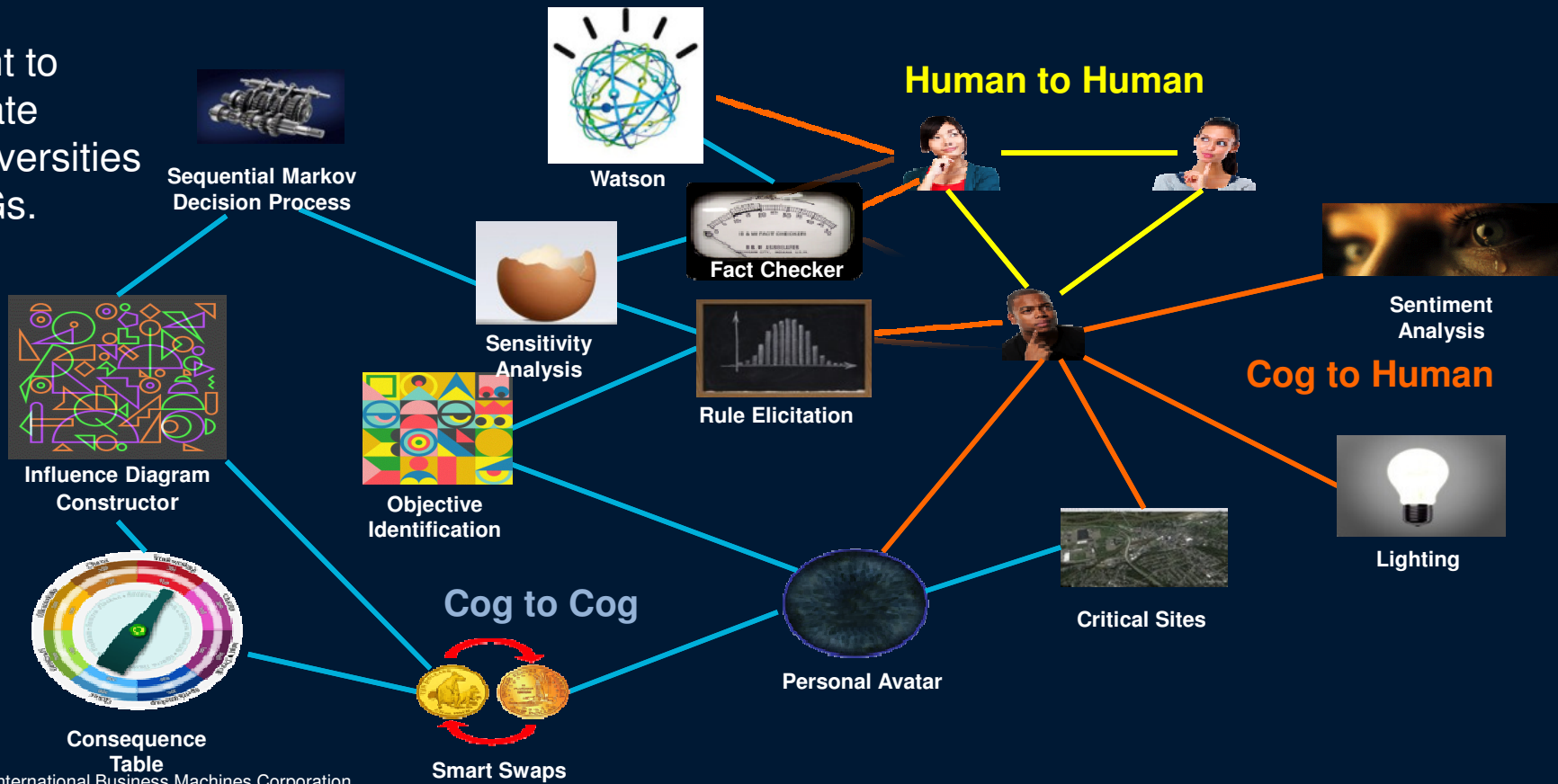
A cognitive room is just one possible instantiation of a customized cognitive environment.

We envision people will create a huge variety of customized cognitive environments  
(offices, homes, cars, etc)

# The Society of Cogs

**Cognitive agents** that collectively learn and leverage sophisticated models of humans, engaging with them via adaptive multi-modal interfaces

We want to cooperate with universities on COGs.





# A sample of highly relevant disciplines

## Behavioral Science

Human Modeling  
Individual and Group Dynamics  
Bias Detection and Mitigation

## Learning & Reasoning Technologies

NLP & Deep Q&A  
Machine Learning  
Decision Theory

## Interactive Technologies

Speech and Gesture Recognition  
Conversational Systems  
Spatial Operating Environments

## Visualization Technologies

Spatially Aware Visualization  
Multi-modal Steering  
Big Data Visualization

Multi-agent systems; Distributed Systems; System of Systems

# Watson Academic Engagement



**SKILLS  
DEVELOPMENT**

**What Watson  
related skills do  
students need in  
the 21st century?**



**STUDENT  
ENGAGEMENT**

**How can  
individuals get  
involved with  
Watson?**



**RESEARCH**

**What role can  
universities play in  
Watson's  
development?**



**How will Watson  
technology redefine  
the future of  
computing?**

**Supporting an educational strategy that promotes:**

- **Research:** Collaborate on research with select institutions
- **Readiness:** Build a strong pipeline of skills
- **Recruiting:** Provide opportunities for graduates to secure and fill critical roles
- **Reputation:** Establish institution and IBM as thought leaders
- **Results:** Discover and drive opportunities today and tomorrow

# Examples of Watson healthcare client use cases

## MD Anderson's Oncology Expert Advisor powered by IBM Watson

### Business problem:

- Data overload from 100,000+ patients/year, thousands of clinical trials, and an ongoing flood of publications
- Lack of integration among researchers and clinicians

### Solution:

- Greater insights into effects of therapies can **help researchers accelerate new treatments for patients**
- Helps oncologists identify and **manage personalized treatments** for a patient throughout therapy cycle



## Watson Paths and Watson EMR Assistant Research Projects

### Business problem:

- Give medical students and doctors **easier insight into data to inform their diagnoses and decisions**

### Solution:

- Intuitive, new user interface to Watson's power revealing chains of evidence to support clinical reasoning
- Analysis of whole EMRs to extract and visually present summarized knowledge with semantic understanding of context



## IBM Watson Oncology built with Memorial Sloan Kettering

### Business problem:

- Need **better individualized cancer treatment plans**

### Solution:

- Suggestions to help inform oncologists' decisions based on 600K+ pieces of evidence and 2M pages of text from publications
- Analyzes patient data against thousands of historical cases and trained through 5000+ Memorial Sloan-Kettering MD and analyst hours
- Evolves with the fast-changing field



# MDACC Oncology Expert Advisor

THE UNIVERSITY OF TEXAS

MD Anderson Cancer Center

Oncology Expert Advisor, powered by IBM Watson

JSAllen - © - IBM.

Home

Patients

Cohorts

Therapy

Patient List > Raymond Svenson

Patient: Raymond Svenson

Summary

Timeline

Current Labs

Past Labs


Prognosis

Latest Therapy

Therapy History

Suggested Therapies

Patient Similarities





**Name** Raymond Svenson  
**Age** 73  
**Sex** Male  
**Race** White  
**Date of Birth** 12/24/1939  
**Last Followup Date** Alive as of 10/01/2013  
**Updated** 10/12/2013 3:41pm ETD

**Certified** ✓

Height	Weight	Temperature	BP	Pulse
163.5 cm	57.2 kg	36.7 °C	127 / 80	90 BPM

Last Update: Thu Oct 03 2013 10:18:07 PM

Important Developments 2 results [Clear Alerts](#)

-  Patient has neutropenia. See the [Timeline](#).
-  Patient has thrombocytopenia. See the [Timeline](#).

Patient Short Synopsis

Leukemia Service Date 08/21/2013

Current Diagnosis 06/15/2013 Acute Myelocytic Leukemia

Genetic Mutations 09/23/2013 FLT3-ITD, [View Full Report...](#)

Last Therapy 08/27/2013 2010-0374 - Azacitidine+PKC412

Last Therapy Response Pending

Zubrod Score 10/10/2013 [History](#)

Current Symptoms 10/01/2013 Nausea

Current Medications 09/11/2013 ..pkc-412, ..ondansetron (zofran) - New, Ambisome (liposomal Amphotericin B) - New, Bd Pre-filled Saline Blunt Can (sodium Chloride 0.9 %), Heparin Lockflush(porcine)(pf) (heparin, Porcine (pf)), Levofloxacin, Levothyroxine (synthroid), Potassium Chloride - New, Prilosec (omeprazole), Simvastatin (zocor), Tamsulosin (flomax), Valacyclovir (valtrex)

Comorbidities 09/19/2013 Blood Coagulation Disorder, Anemia, Leukopenia, Chronic Obstructive Lung Disease, Hypokalemia, Hypothyroidism, Inflammatory Disease Of Mucous Membrane, Mycosis, Pneumonia

Social History 09/19/2013 Quit Smoking

Family History of Cancer No Known Family History of Cancer

Surgeries No Known Surgeries

# MDACC Oncology Expert Advisor

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center Oncology Expert Advisor, powered by IBM Watson JSAllen ? IBM.

Home Patients Cohorts Therapy

Patient List > Raymond Svenson Patient: Raymond Svenson

Summary Timeline Current Labs Past Labs Prognosis Latest Therapy Therapy History Suggested Therapies Patient Similarities

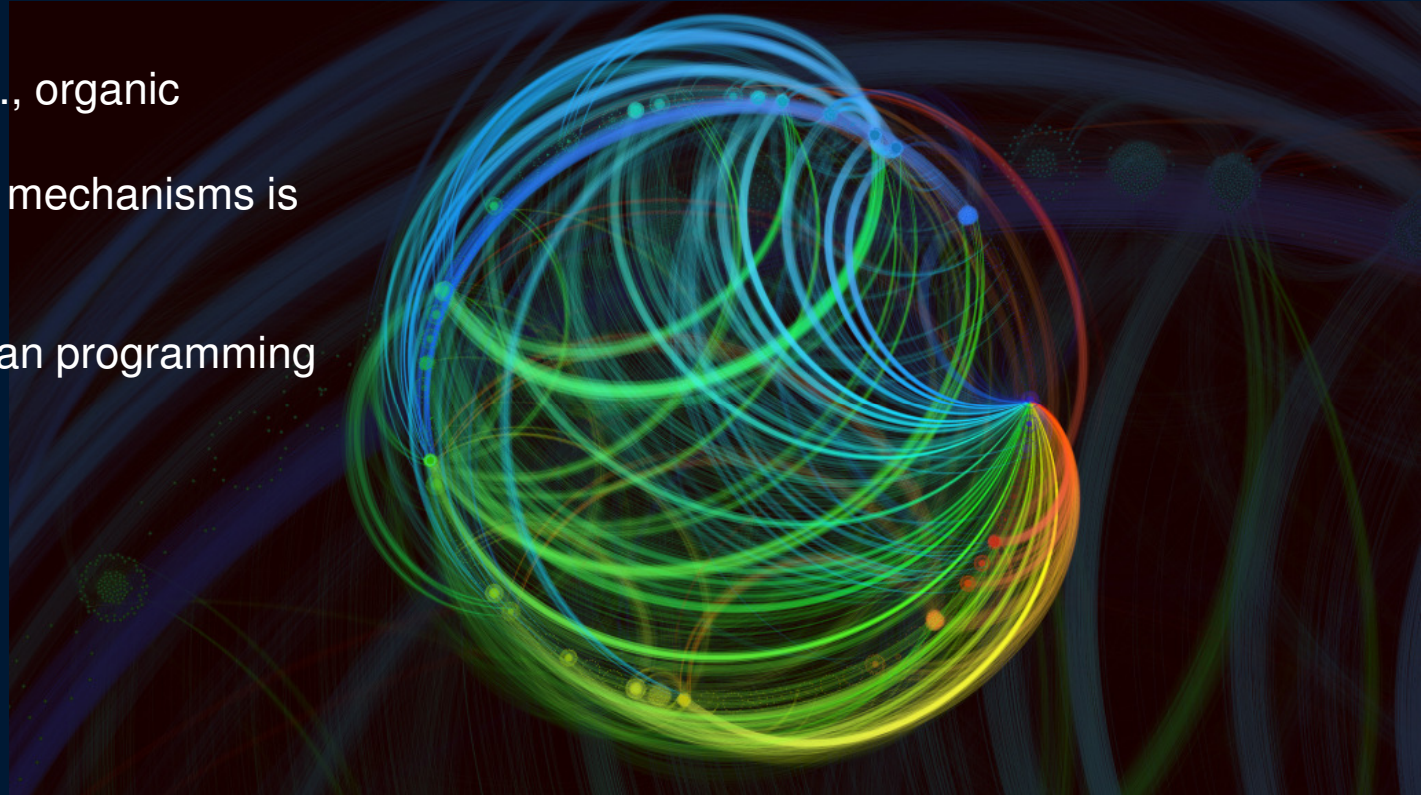
Azacitidine+PKC412 2010-0374 salvage-1 08/27/2013 Date Not Available

OEA Suggestions Approved Therapies Genomic Based Rx Clinical Trials

Therapy	Confidence	Audit	Rating
Salvage fludarabine + cytarabine + GCSF +/- idarubicin	Very High	Audit	( 0 comments )
Salvage clofarabine + cytarabine + GCSF	Medium	Audit	( 0 comments )
Subcutaneous Cytarabine, 5-azacytidine, Decitabine	Medium	Audit	( 0 comments )
Salvage cladribine + cytarabine + GCSF +/- mitoxantrone or idarubicin	Medium	Audit	( 0 comments )
Salvage HiDAC +/- anthracycline	Medium	Audit	( 0 comments )
Intermediate-intensity therapy (clofarabine)	Medium	Audit	( 0 comments )
Standard-dose Cytarabine 100-200, Idarubicin 12 or Daunorubicin 45-90 or Mitoxantrone 12	Medium	Audit	( 0 comments )
Salvage etoposide + cytarabine +/-	Low	Audit	( 0 comments )

# How do we take inspiration from the brain?

- **Post silicon technology** – e.g., organic superconductors
  - Our understanding of these mechanisms is still extremely limited
- **Architecture** - Non-Von Neuman programming models
  - SyNAPSE

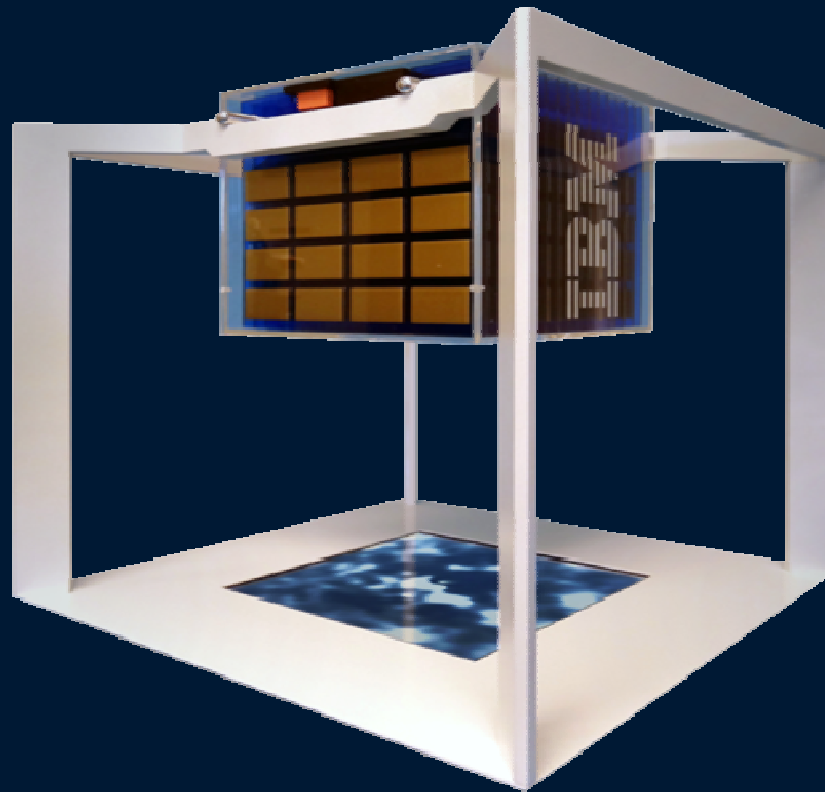
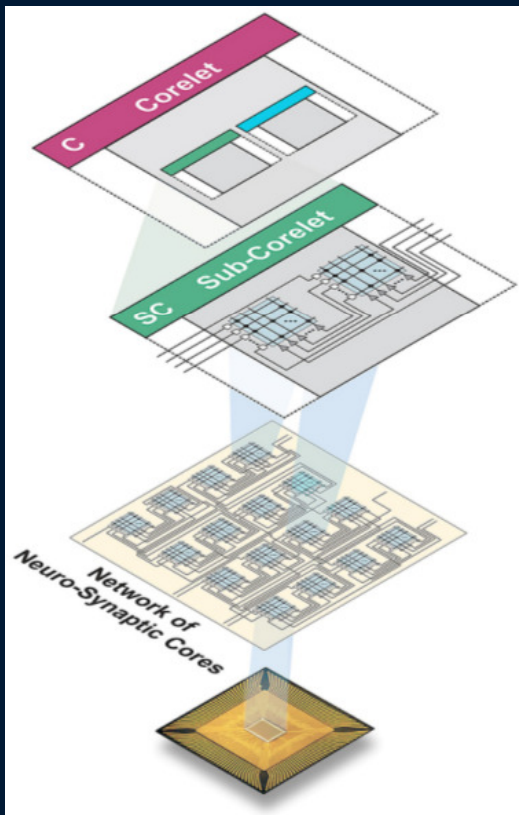


Monkey Brain wiring diagram



# Cognitive computing – SyNAPSE

## *Ultra-low power Neurosynaptic supercomputer*



### 2013 Milestones

- Non-Von Neuman “Corelet” programming model (August)
- First Silicon (September)

### 2014:

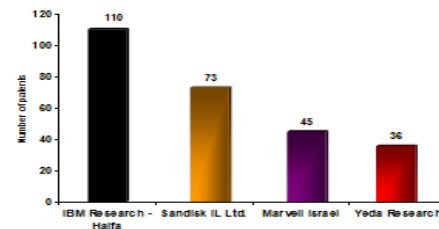
- enable developers to create and test uses for SyNAPSE

## IBM Research – Haifa

- Established in 1972
- Largest IBM Research facility outside the US
- Spanning all IBM Research strategy areas
- Working with IBM business units and IBM clients worldwide
- Collaborating with academia and industry
- About 100 patents / year



Top Israeli leaders for US patents





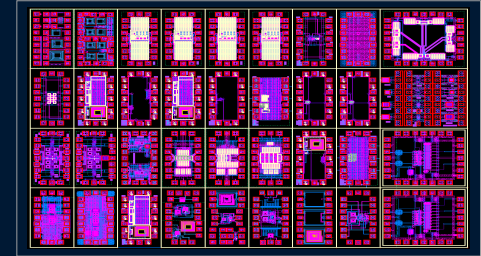
# Innovation from IBM Research – Haifa



**Cloud Computing**



**Storage**



**Quality**



**Big Data Analytics**



**Cognitive Computing**



**Social Analytics**



**Mobile**



**Healthcare**



**Retail**

# Mobile Shopping Advisor

Data: Product images and information.  
Shoppers use smartphone to pan  
products on store shelves

## Science and Technology used:

Augmented reality, image recognition,  
analytics

Value: More personalized experience for  
shoppers –  
recommendations and offerings based on  
preferences



*Merging the physical and  
the virtual worlds*

# Cognitive Analytics for Epilepsy Patients



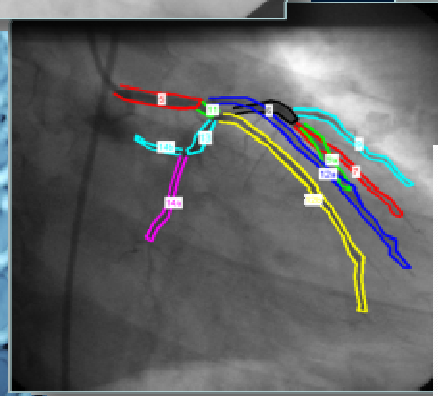
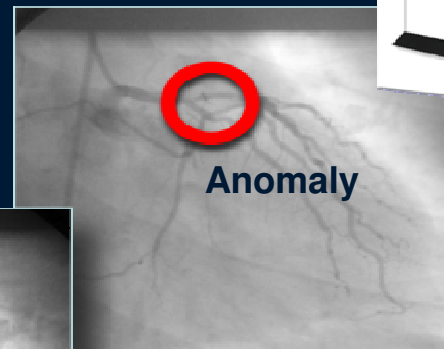
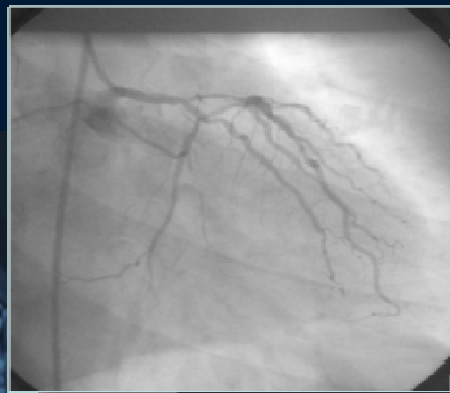
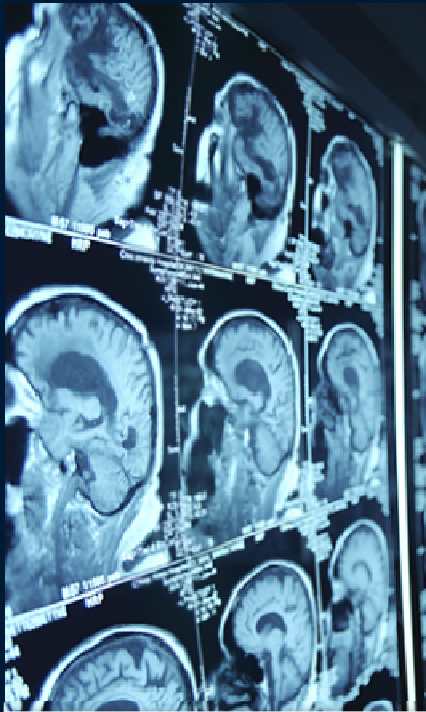
Data: Millions of records for patient data and scientific literature

**Science and Technology used:** Machine learning analytics and patient similarity analysis

Value: Support for decisions about which treatment will work best. More personalized care and improved outcomes.



# Medical Sieve



Data: medical images (multi-modalities) and healthcare records

**Science and Technology used:** image processing, computer vision, machine learning, analytics

Value: Reduced radiologists' workload and improved diagnostic quality

***Cognitive radiology assistant for the 21st century***

# IBM Research

