

Dr. Axel Koester – Storage Chief Technologist, European Storage Competence Center

IBM Watson technology at work

and the impact on BIG DATA

(or how to compress the English internet in 1TB)



Watson Grand Challenge

Current Watson Projects

How to deal with Massive Data

Lab Futures

```

3.141592653589793238462643383279
5028841971693993751058209749445923
07816406286208998628034825342117067
9821 48086 5132
823 06647 09384
46 09550 58223
17 25359 4081
2848 1117
4502 8410
2701 9385
21105 55964
46229 48954
9303 81964
4288 10975
66593 34461
284756 48233
78678 31652 71
2019091 456485 66
9234603 48610454326648
2133936 0726024914127
3724587 00660631558
817488 152092096

```

Records

Which one is more unbelievable?



Fabrice Bellard's home computer calculated pi to **2.7 trillion digits** (previous record held by a supercomputer)



Lu Chao successfully recited **67.890 digits** of pi from memory in 24 hours and 4 minutes Guinness book of records

Reciting π = Peanuts for a computer.

But how about

Reading & understanding unstructured documents

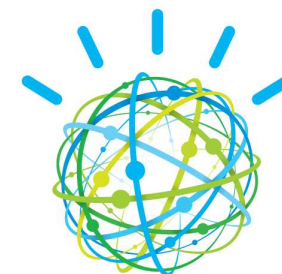
Understanding ambiguous human questions and pun

Responding in real time, before being 100% sure

Taking a 'good guess'



→ IBM Grand Challenge



 IBM WATSON

Jeopardy! all-time champions Ken Jennings & Brad Rutter

February 2011

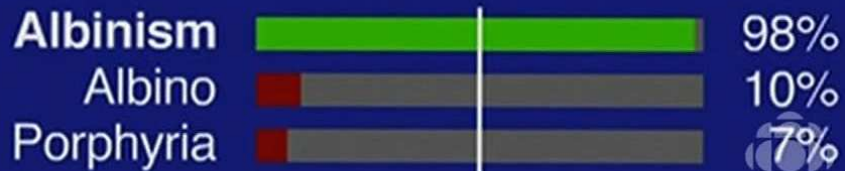
THINK

PIENSE
SINAOIIS
विए
ΣΚΕΨΟΥ
DENKE
PENSER

\$2,000
Ken

\$13,400
WATSON

\$5,000
BRAD



CBC

 accesses its knowledge* in parallel



(*) Multiple millions of complex matching searches per second, within a **knowledge base of the English WWW**.

10 km book stack

200 million memorized book pages,
with Wikipedia alone totaling **2,25 Mio.**

takes ~123 years to read

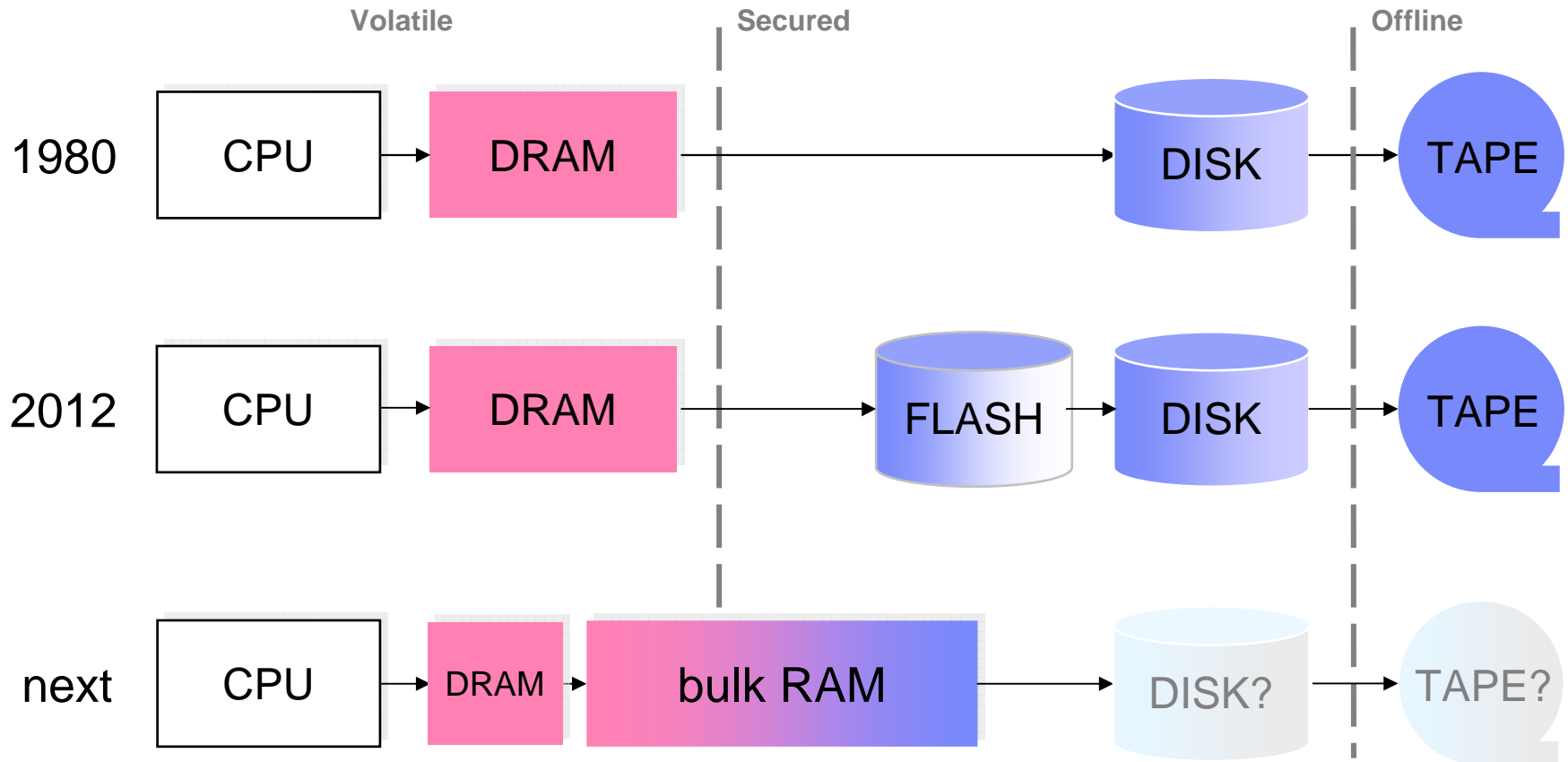
is an "information aggregator"



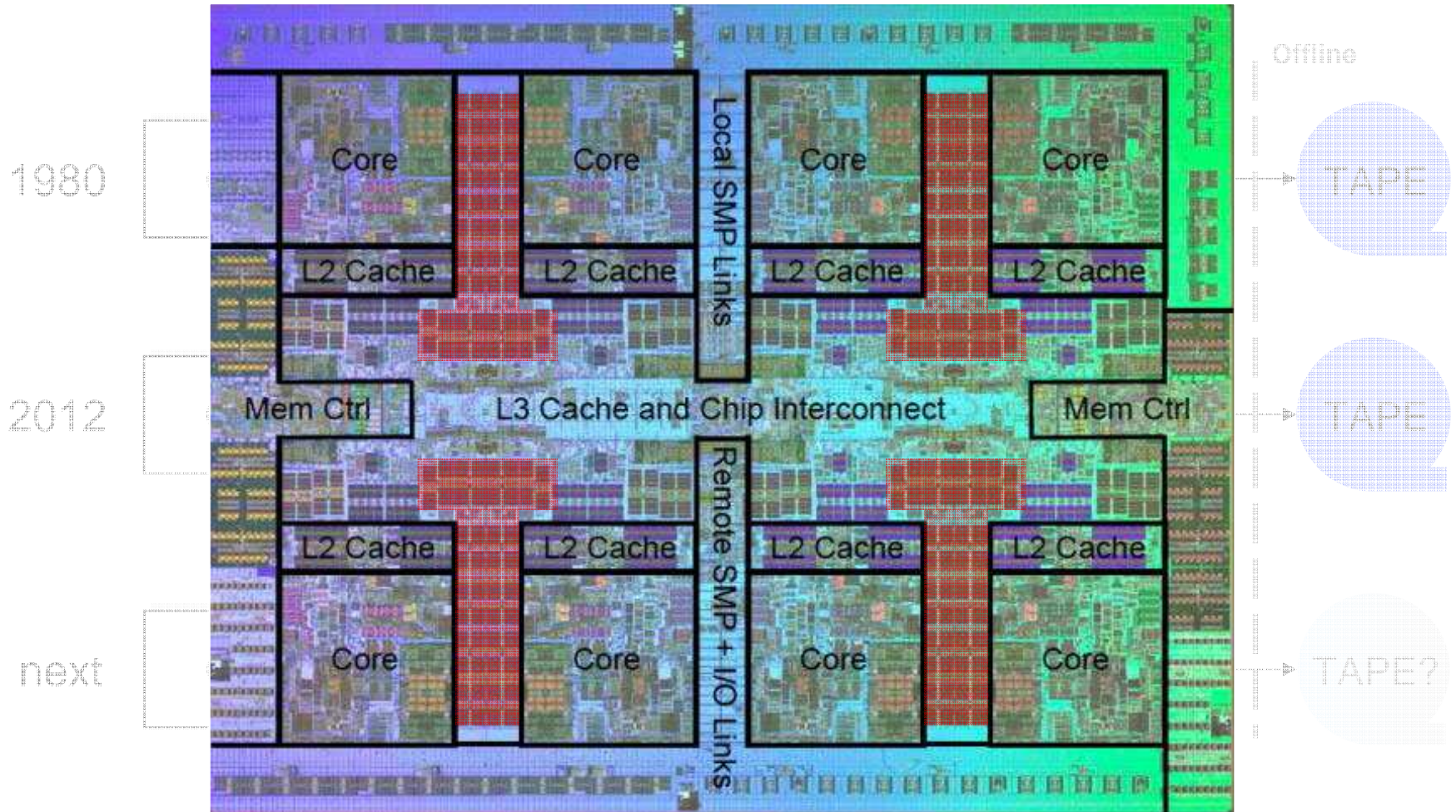
90 x 32 core IBM Power[®]750 / 16 TB RAM, 1TB disk content

***Parallel access to 100% of the data,
no Internet access during games**

How to achieve full parallel access to data

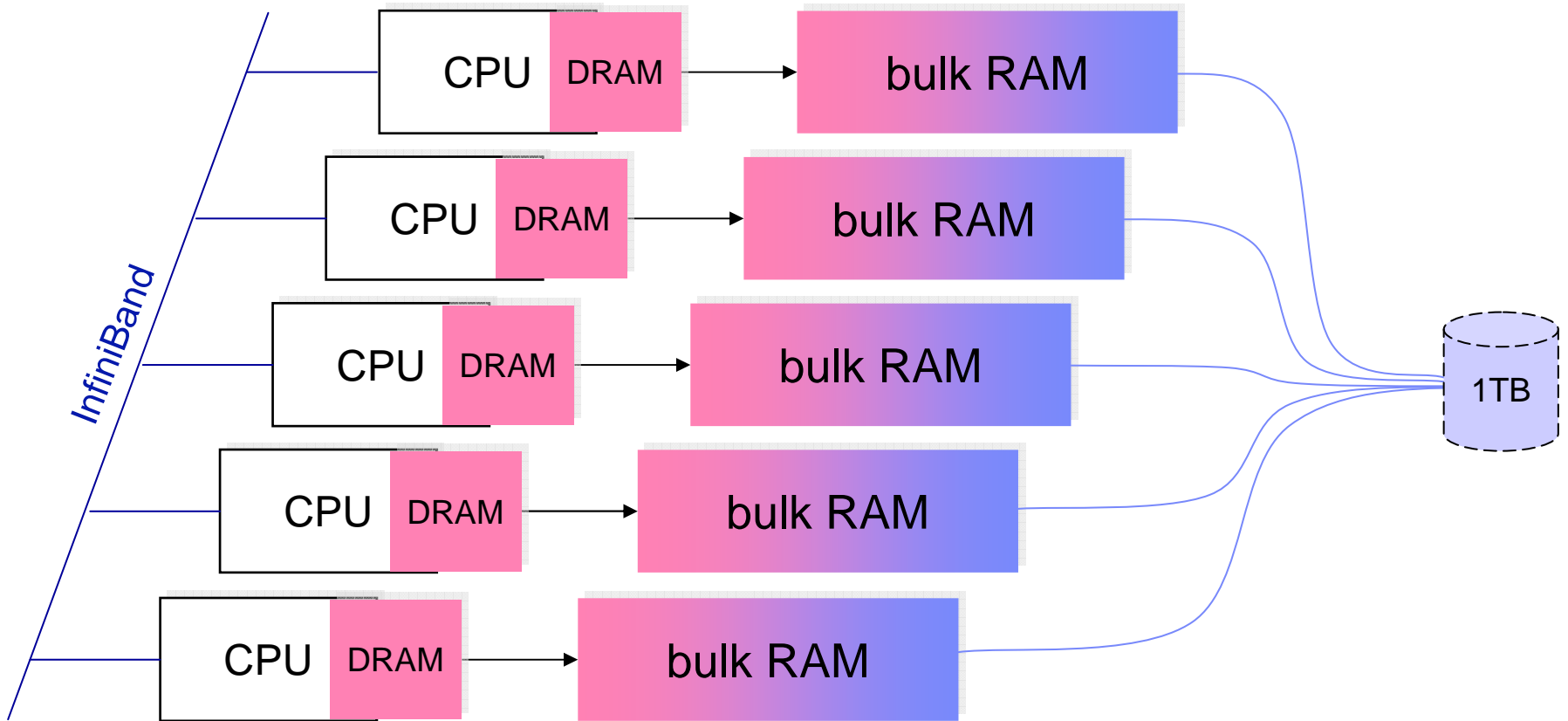


POWER7 with integrated DRAM 32MB



Challenge: CPU = Transistors, SRAM = Transistors, DRAM = Capacitors (denser!)

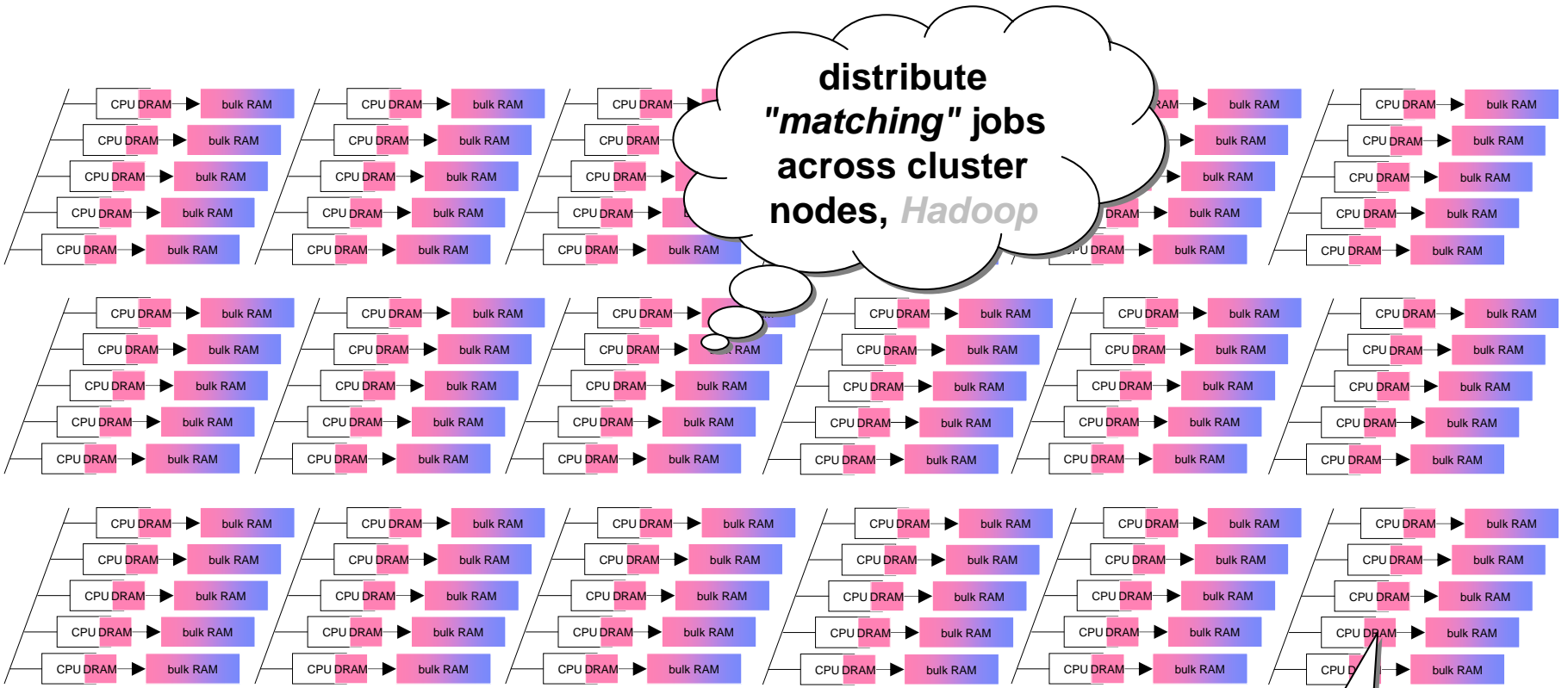
How to achieve full parallel access to data



:
 × 90 = 1 **IBM WATSON**
 each 4 sockets
 × 8 core
 × 4 threads

Application RAM
 Filesystem RAM

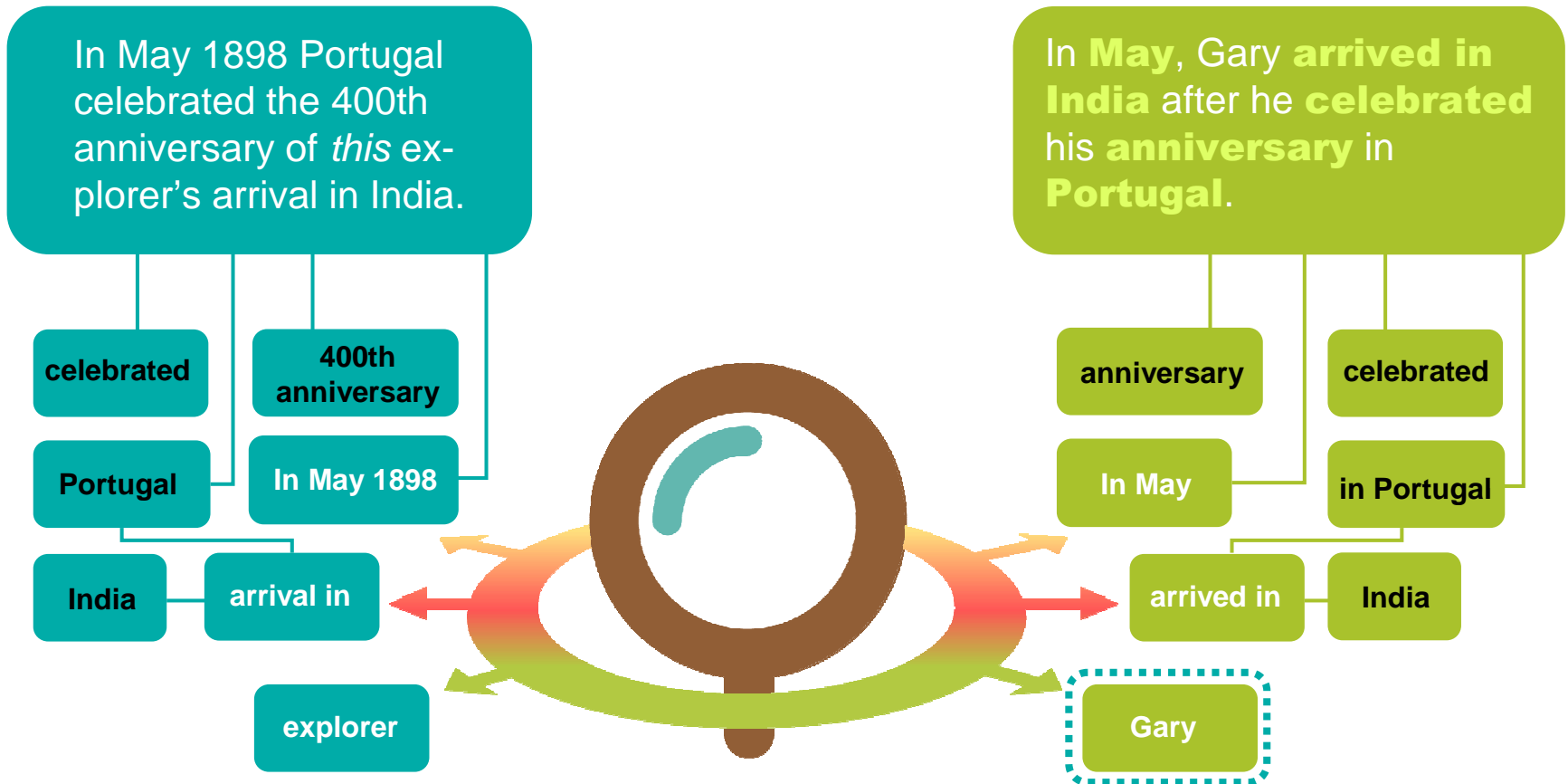
What is IBM Watson doing with these massive resources?



The correct answer could be somewhere here

How is Watson different from Google?

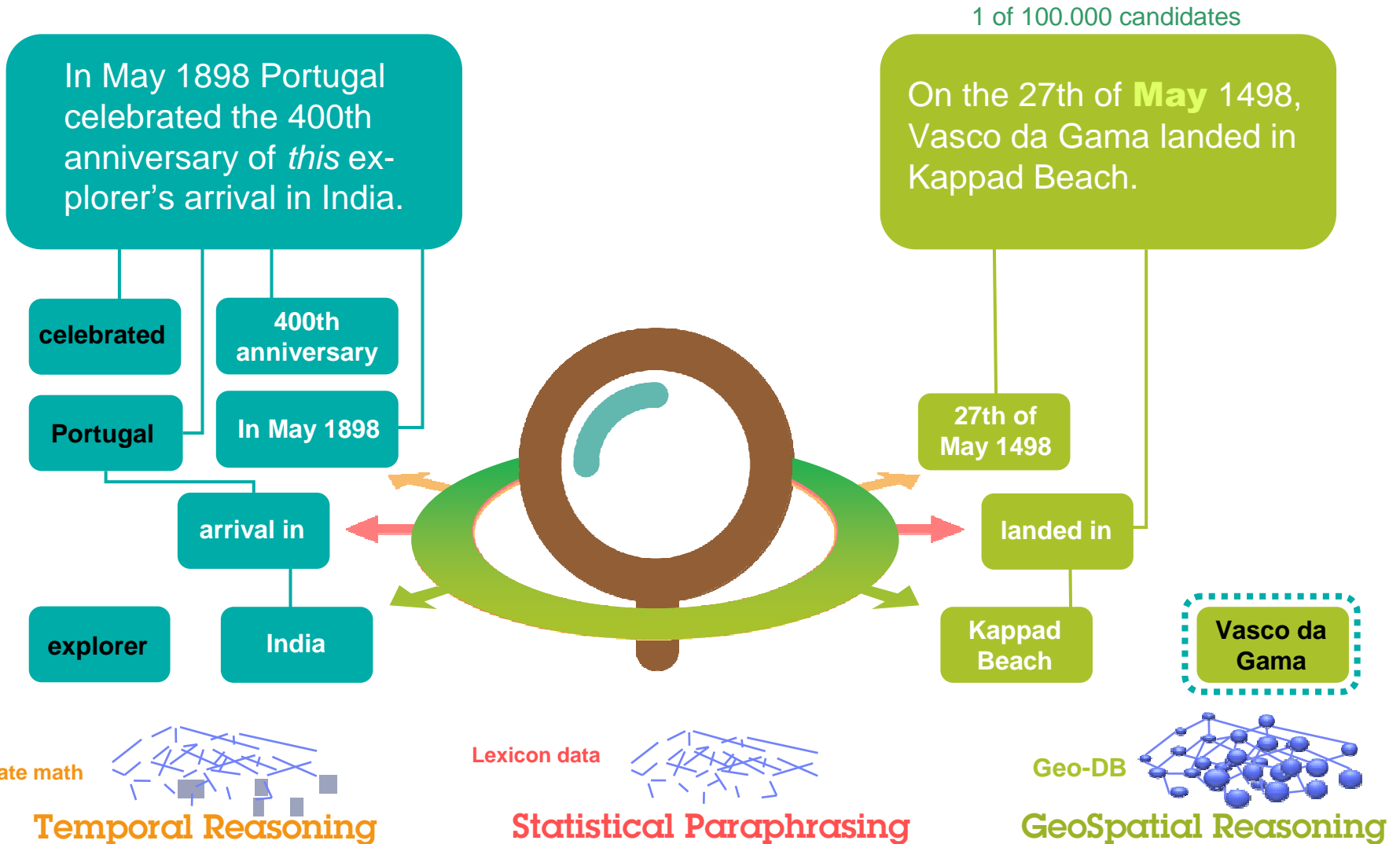
Here is **Google**:



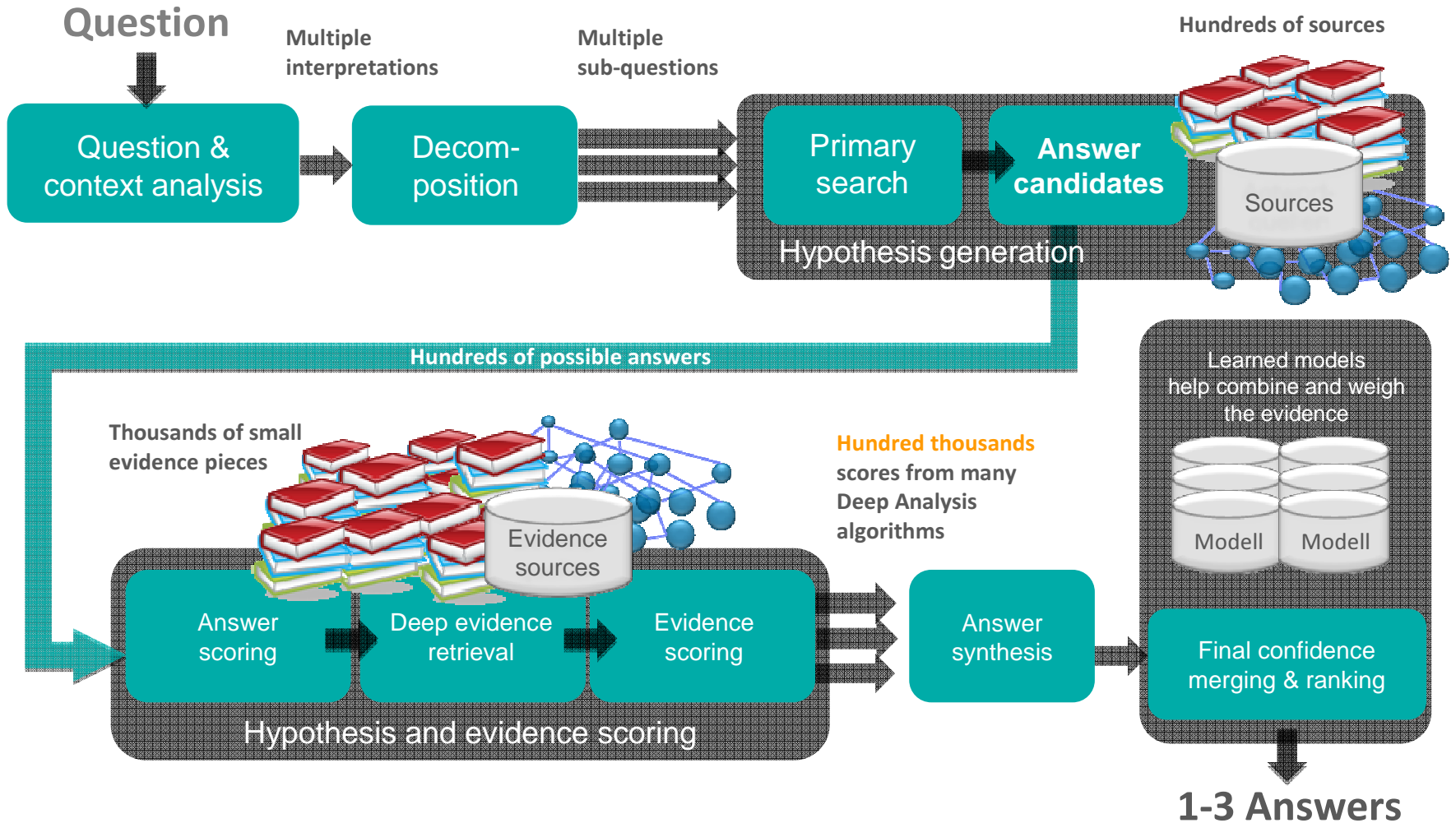
Keyword Matching
(+page ranking)

How is Watson different from Google?

Here is **Watson**:



Software Architecture



Watson's inventors surprised by amazing correct answers



Dr. Jennifer Chu-Carrol,
Watson algorithms

A precursor of new informatics – much less *deterministic*



Watson @ work

Recent Projects

In mid 2011, first **Watson** projects were started



Healthcare

Watson reads all medical publications, reports, journals using Nuance Clinical Language Understanding CLU and respond to nurse's questions with DeepQA®



80% of patient data is unstructured



Call center project

Reduced average call time from 5 to 4 min. by avoiding full traversal of yes/no questions tree: 20% reduced cost

More "Smarter Planet" ideas were born: fraud detection, justice antecedent case search, traffic flow ...

Since late 2011, **Watson** projects are **multiplying**



Banking

a Micro-Watson reads all *minutes of consultation* and establishes trends and marketing directives based on written client requests. It also finds **omissions & inconsistencies**.

Insurance

a Micro-Watson reads relevant websites in order to quickly capture client opinion and competitive threats. Counselors can "ask Watson" for related information.



Airline

a Micro-Watson reads competitors' websites & publications in order to identify potential niches in flight plans / destinations.

Defense

Watson scans non-classified repositories for text with classified content / keywords.

German car makers started various **Watson** projects



Maintenance & Repair

"There's a rattling noise in the rear when I..."

Watson reads garage reports and helps identifying defects quickly.

More car makers' **Watson** projects

1. Help for complex problems with **ambiguous error codes** (or no codes)
2. Quick **decision support** for call centers on red warning light during journey
3. Car owners **chat forum scan**, public opinion, defect reports, ...
4. Traffic flow **prediction** for navigation systems
5. ...

What do Watson projects 'look like'?

Mini-Watson = IBM Content Analytics

The screenshot displays the IBM Content Analytics interface, which is divided into several functional areas:

- Top Navigation:** Includes document management, faceted navigation, time series, deviations, trends, facet pairs, connections, and reports. The current collection is 'NHTSA'.
- Faceted Navigation (Left Panel):** A sidebar with a filter and a list of facets such as Part of Speech, Phrase Constituent, Named entity, Troubles, Category for Auto, State, City, Vehicle/Equipment Corp, and Model. The 'Model' facet is currently selected.
- Key (Top Middle):** A network graph showing relationships between terms like 'unsafe', 'problem', 'wrong', 'lose', 'die', 'noise', 'break', 'fall', 'tear', 'wear', 'vibration', 'loose', 'wrap', 'vibrate', 'rough', 'hesitate', 'focus', 'intrepid', 'camry', 'grand cherokee', 'dakota', 'cherokee', 'dipango', and 'chili'. A key indicates that blue squares represent negative events and yellow lines represent correlations.
- Time Series (Right Panel):** A grid of charts showing trends for various entities over time (1984-2008). The entities include:
 - GENERAL MOTORS CORP. (147553)
 - FORD MOTOR COMPANY (135141)
 - DAIMLERCHRYSLER CORPORATION (103237)
 - TOYOTA MOTOR NORTH AMERICA, INC. (19424)
 - NISSAN NORTH AMERICA, INC. (18027)
 - HONDA (AMERICAN HONDA MOTOR CO.) (24196)
 - TOYOTA MOTOR CORPORATION (8290)
 - MAZDA NORTH AMERICAN OPERATIONS (7788)
- Dashboard (Bottom Panel):** A collection of smaller charts and tables:
 - City (Top10):** A pie chart showing the distribution of cities: San Diego, Washington, Baltimore, Miami, Jacksonville, Chicago, Houston, Dallas, San Antonio, and Los Angeles.
 - State (Top8):** A horizontal bar chart showing the top 8 states.
 - Part of Speech (Top6):** A bar chart showing the frequency of different parts of speech: Noun, Adjective, Conjunction, Verb, Adverb, and Numerical.
 - Maker/Year (Top3):** A bar chart showing the top 3 maker/year combinations.
 - Maker/TransType (Top5/2):** A table showing the top 5 maker/transmission type combinations.

First Column	AUTO	MAN
GENERAL MOT 147553	59781/1.1	4310/0.5
FORD MOTOR 135141	49260/1.0	5834/0.8
DAIMLERCHRY 103237	44614/1.2	3441/0.6
HONDA (AMER 24196)	8879/1.0	1858/1.4
TOYOTA MOTT 19424	8558/1.2	967/0.9
 - Maker/Year (Top4):** A line chart showing the top 4 maker/year combinations over time.
 - State/Flag (Top5/2):** A table showing the top 5 states/flags.

First Column	Important	Confidential
CA 70666		
NY 39102		
FL 36932	✓	
TX 34368		
PA 27217	✓	

Ambiguous language processing in Content Analytics

IBM Content Analytics change

Documents Facets Time Series Deviations Trends Facet Pairs Connections Dashboard

799/5086 results matched

Facet Navigation Default order

Facet 1 shows Keywords Node labels: Complete Correlation: 0-100

Facet 2 shows Keywords Highlight mode: No highlighting

Filter: Clear

- Part of Speech ²
 - Noun
 - Verb
 - Adjective
 - Adverb
 - Conjunction
 - Interjection
 - Numeral
- Phrase Constituent ²
- Named entity ²
- My Keywords
- complaint
- fg_text
 - st_text
 - technicalterms**
 - failure_codes
 - [redacted]

Search type: Facet search

Facet Path: \$.fg_text.st_text

Keyword:

New search Add to search Search

Key

- = st_text
- = technicalterms

Frequency

- = High
- = Low

Correlation Amount:

Low High

Wifi 11:28 AM

Diagnosis & Treatment

Panel

John Anderson

Age: 48

Reference ID: 2315-8875

Allergies: Peanuts, Penicillin, Ragweed

Vitals, Observations & Reports

Differential Diagnosis

Referral

Patient Goals

Treatment Options

Differential Diagnosis based on Current Information

Acute Coronary Syndrome (ACS)	<div style="width: 60%;"></div>	60%	<i>i</i>
Pneumonia	<div style="width: 50%;"></div>	50%	<i>i</i>
Pulmonary Embolism	<div style="width: 40%;"></div>	40%	<i>i</i>
Pneumothorax	<div style="width: 15%;"></div>	15%	<i>i</i>
Cholecystitis	<div style="width: 10%;"></div>	10%	<i>i</i>

Observations

Uncertain about whether he has had any fever. Did not feel it, but did not measure. Had occasional nausea, but denies vomiting; has not been coughing.

Next Steps

Electrocardiography (EKG)	Order >	<i>i</i>
Chest X-ray	Order >	<i>i</i>

Joanne Cameron | Sign out

Diagnosis & Treatment Authorizations Patient LPR

Wifi 11:28 AM

Diagnosis & Treatment

Panel

John Anderson
Age: 48

Reference ID: 2315-8875

Allergies: Peanuts, Penicillin, Ragweed

Vitals, Observations & Reports

Differential Diagnosis

Referral

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Treatment Options

Pulmonary Embolism

HPI and Symptoms	+ 0.56	—	<input type="range"/>	+	—
Chest pain	+ 0.67	—	<input type="range"/>	+	☰
Shortness of breath	+ 0.43	—	<input type="range"/>	+	☰
Sudden onset of symptoms	+ 0.28	—	<input type="range"/>	+	☰
Pain localization	+ 0.19	—	<input type="range"/>	+	☰
No Cough	- 0.66	—	<input type="range"/>	+	☰
Nausea	- 0.46	—	<input type="range"/>	+	☰
Muscle pains	- 0.32	—	<input type="range"/>	+	☰
Family History	+ 0.09	—	<input type="range"/>	+	+
Clinical Findings	+ 0.61	—	<input type="range"/>	+	+
Demographics	+ 0.47	—	<input type="range"/>	+	+

Joanne Cameron | Sign out

Diagnosis & Treatment Authorizations Patient LPR

The screenshot shows a mobile application interface for 'Diagnosis & Treatment'. At the top, there is a status bar with 'Wifi', '11:28 AM', and a battery icon. Below the status bar is a dark blue header with a 'Panel' button on the left and the title 'Diagnosis & Treatment' in the center. On the left side, there is a vertical navigation menu with a patient profile picture and several menu items: 'Reference ID: 2', 'Allergies: Peanu', 'Ragweed', 'Vitals, C & Repor', 'Differen', 'Referral', 'Patient', and 'Treatme'. The main content area is partially obscured by a white dialog box titled 'No Cough' with a 'Close' button in the top right corner. The dialog box contains the following text:

Reference:
"XYZ Principles of Internal Medicine", Textbook, 2005

Abstract:
Pulmonary embolism symptoms can vary greatly, depending on how much of your lung is involved, the size of the clot and your overall health — especially the presence or absence of underlying lung disease or heart disease. Common signs and symptoms include:

Shortness of breath. This symptom typically appears suddenly, and occurs whether you're active or at rest.

Chest pain. You may feel like you're having a heart attack. The pain may become worse when you breathe deeply, cough, eat, bend or stoop. The pain will get worse with exertion but won't go away when you rest.

Cough. The cough may produce bloody or blood-streaked sputum.

At the bottom of the application, there is a dark blue footer with a user profile for 'Joanne Cameron' and a 'Sign out' button. To the right of the profile are three icons representing 'Diagnosis & Treatment', 'Authorizations', and 'Patient LPR'. The IBM WATSON logo is in the bottom right corner.

Financial rating: Automatic evaluation of related news ("optimism" ranking)

Aktueller Nachrichtenenspiegel zu Volkswagen.

-  **Milliarden-Investition in sächsische Werke**
Bis zum Jahr 2016 will Volkswagen rund 2,5 Milliarden Euro in seine sächsischen Werke investieren (06.11.2011)
-  **Volkswagen darf Mehrheit an MAN übernehmen**
Volkswagen hat die Genehmigung der chinesischen Wettbewerbsbehörde erhalten und wird voraussichtlich am 9. November die Mehrheit am Nutzfahrzeugsteller MAN übernehmen. (03.11.2011)
-  **Anklage gegen Volkswagen und Telekom**
Ermittlungen der Staatsanwaltschaft Korruptionsverdacht gegen Telekom und VW (06.11.2011)
-  **Carsharing-Geschäft Auch Volkswagen steigt ein**
Wolfsburger wollen beim Carsharing den Vorsprung von Daimler, BMW und Peugeot einholen. Sechs Euro für eine halbe Stunde (03.11.2011)
-  **VW-Fusion beschert Porsche SE rote Zahlen**
Ohne bilanziellen Sondereffekt hätte Porsche nach drei Quartalen Milliardengewinn eingefahren - Fusion noch nicht absehbar (04.11.2011)
-  **Volkswagen beginnt Testprogramm für die WRC 2012**
Testfahrten mit dem neuen Polo R WRC erfolgreich begonnen (04.11.2011)
-  **Volkswagen CC künftig als eigenständiges Modell**
VW präsentiert den neuen CC: Künftig als eigenständiges Modell soll er die Lücke zwischen Passat und dem Oberklassemodell Phaeton schließen (04.11.2011)
-  **Die Lieblings-Automarken der Deutschen sind BMW, Volkswagen und...**
Das ist das Ergebnis einer repräsentativen Umfrage der GMK Markenberatung, für die im Juni 2011... Volkswagen ist die Lieblingsmarke der Besserverdienenden (03.11.2011)

Wind turbine planning at *Vestas* (InfoSphere BigInsights)



→ Analyze **petabytes of data** including weather reports, tidal phases, geospatial and sensor data, satellite images and deforestation maps to find the ideal placement of wind turbines.



1.222 node "SuperWatson"
at Vestas Wind Systems (DK)

What "normal" Watsons look like (IBM pre-packaged)

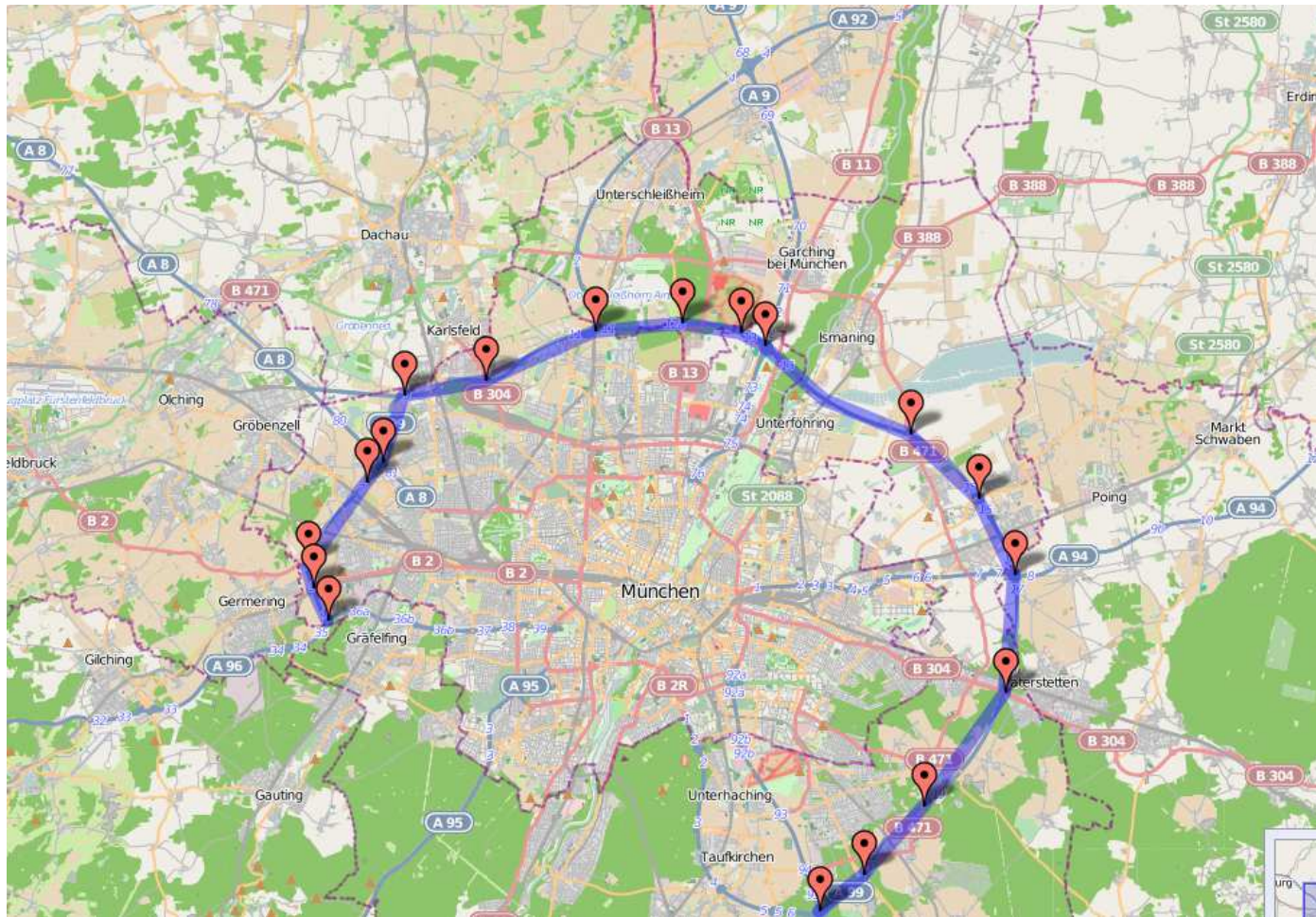


Based on System x3630:
Ultra-dense, storage-rich
server for *BigInsights*



Configuration	Starter	Half Rack	1 st Thru 4 th Full Rack	Additional Full Racks
Usable Storage	Up to 108TB	Up to 324TB	Up to 684TB per rack	Up to 720TB per rack
User space	Up to 36TB	Up to 108TB	Up to 228TB per rack	Up to 240TB per rack

Real time traffic jam prediction in Munich (InfoSphere Streams)



95% reliable prediction of traffic jams near Munich from scanning induction sensors on A8, A9 and A99

85% reliability for 2 hours future jam prognosis

"Learned" patterns

<http://www.bild.de/auto/auto-news/cebit/ibm-computer-watson-stau-vorhersagen-prognose-23004292.bild.html>

<http://www.computerwoche.de/hardware/data-center-server/2506319/>

Lab Research Cognitive Computing

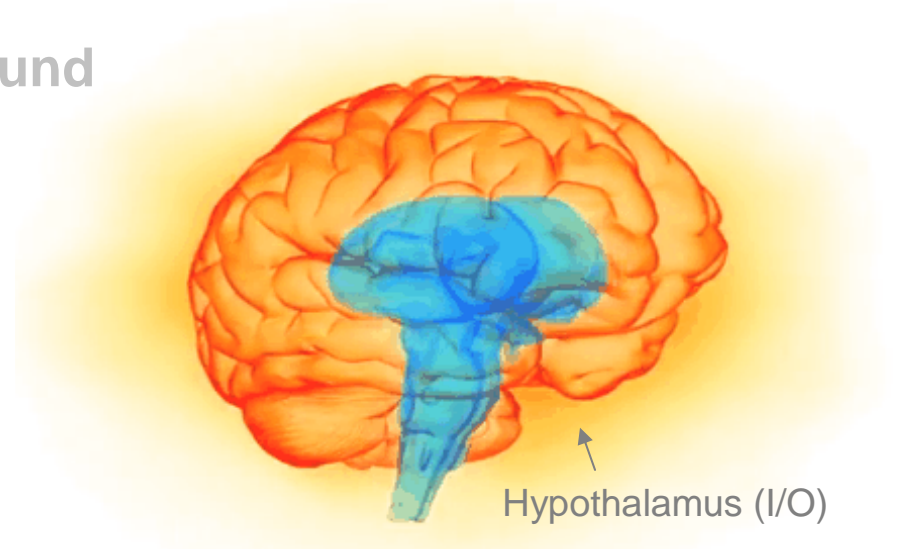
Human brains are incredibly good at "low power"

Recognize a face in a crowd – efficiently

Distinguish own from outside sound

Combine unrelated facts

Filter & distill information



20 Watt

How?

Brains are not 100% accurate.

"Lower power" from abandoning the 100% accurate IT

Unreliable input data

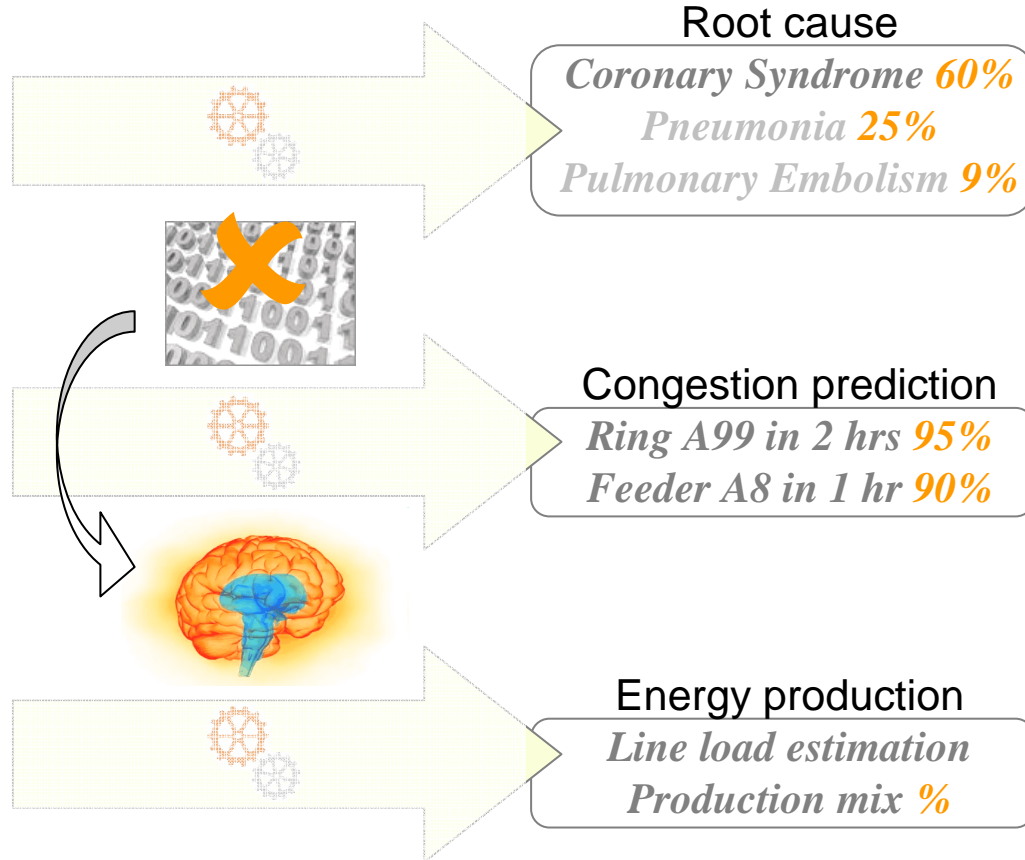
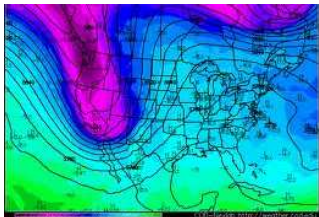
Patient symptoms



Road traffic sensors



Wind & sun forecast

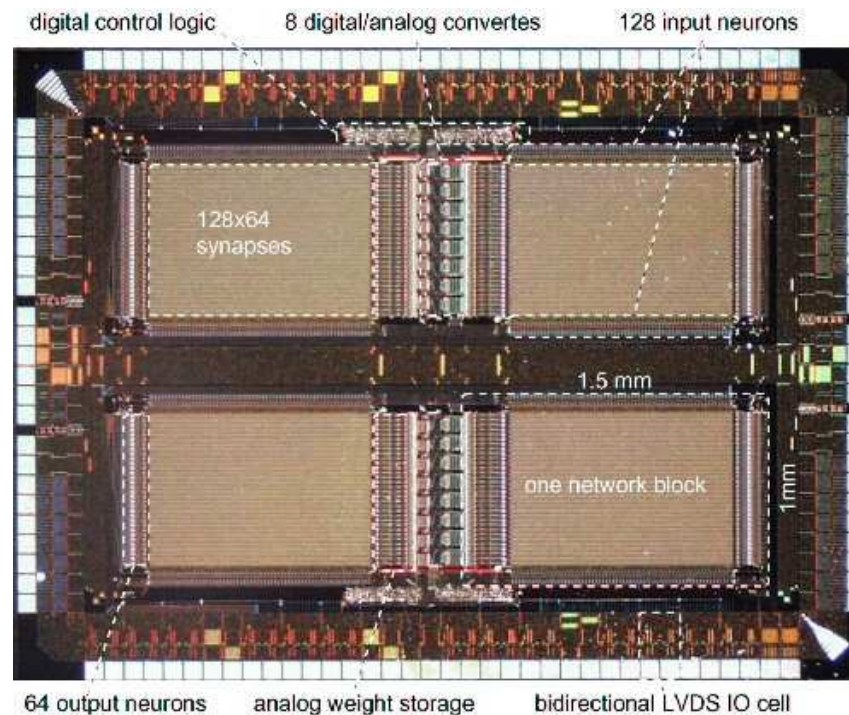


Approximation

Approximations based on unreliable data should not require bit-accurate processing !

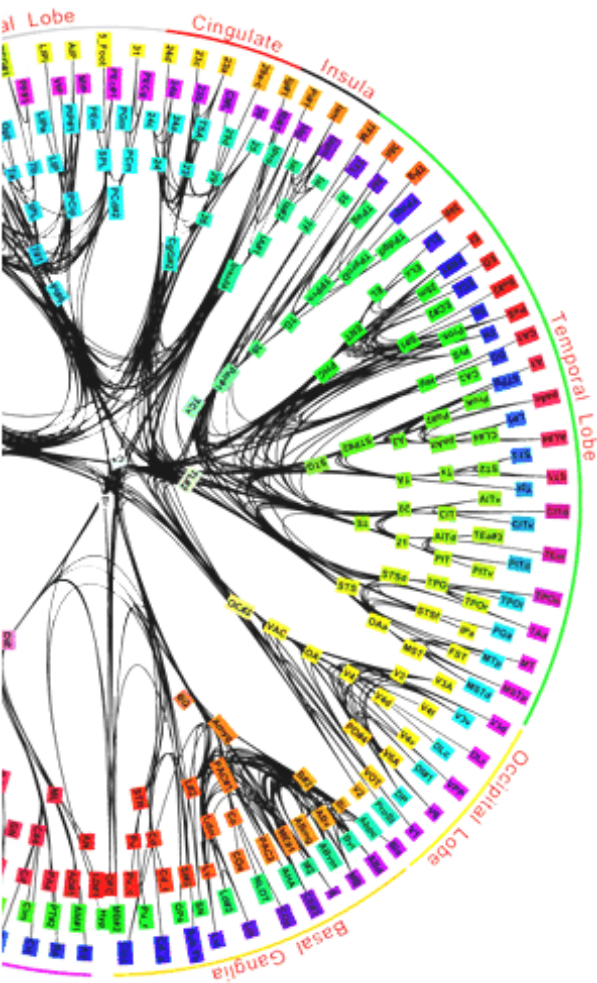
Future Microchips = analog technology?

- Digital = **low power**: 0 (no current) or 1 (no resistance)
- **no more true** at ultrahigh speeds, constantly *between* 0 and 1



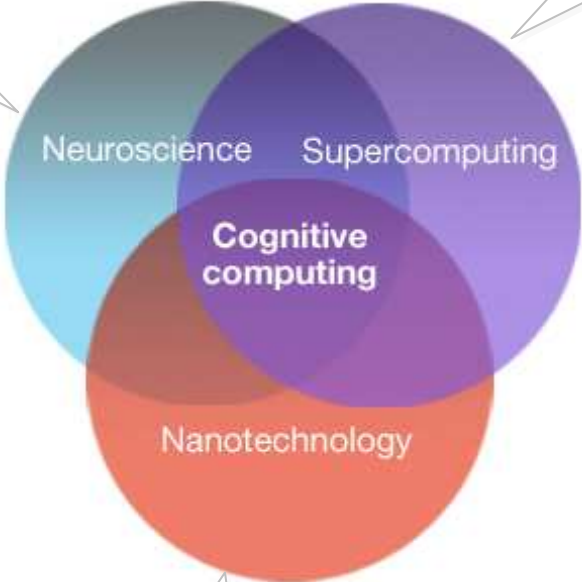
Source: University Heidelberg AnalOG Evolvable Neural Network

SyNAPSE and BlueBrain: Simulating the brain



understand *learning* down to synapses

explore large-scale brain simulations



design a chip that "learns" at molecular level

"Cognitive Computing Research" at IBM

SyNAPSE – Systems of Neuromorphic Adaptive Plastic Scalable Electronics



Dharmendra Modha, IBM
SyNAPSE program leader

"...simulating the entire human cortex, about 25 billion neurons, at full speed? To do that, you'll need to find 1000 times more computing power (than today's supercomputers)."

A SyNAPSE chip could do that at a fraction of the required energy.

"I'll have it ready for you within the next decade."

The initial phase of the SyNAPSE program developed nanometer scale electronic synaptic components capable of adapting the connection strength between two artificial neurons in a manner analogous to that seen in biological systems (Hebbian learning), and simulated the utility of these synaptic components in core microcircuits that support the overall system architecture. *(Wikipedia)*

Research VP

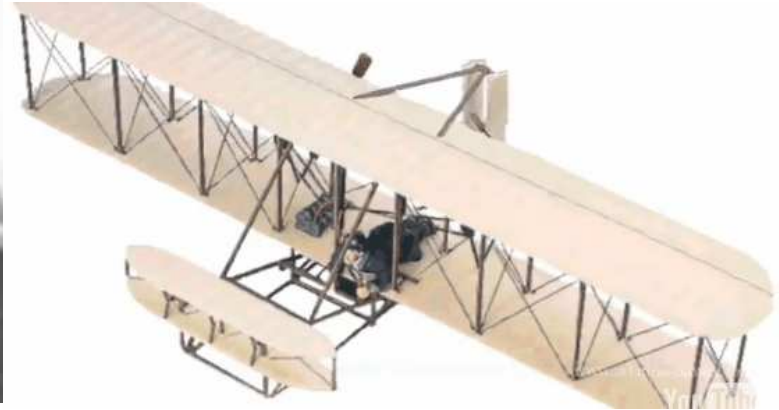


Bruce Hillsberg
blh@us.ibm.com
Director, Storage Systems

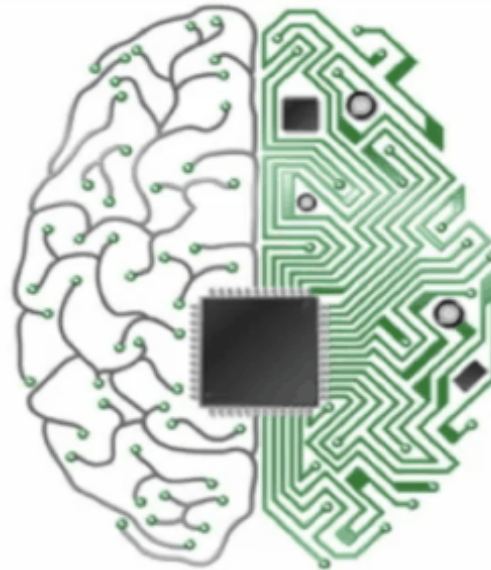


Dharmendra Modha
dmodha@almaden.ibm.com
Manager, Cognitive Computing

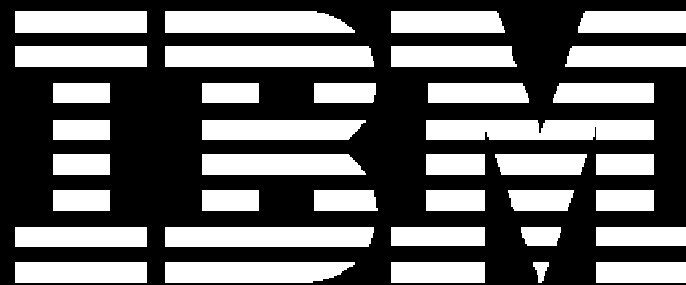
Truth is in the middle



copied nature «



» optimized engineering



axel.koester@de.ibm.com