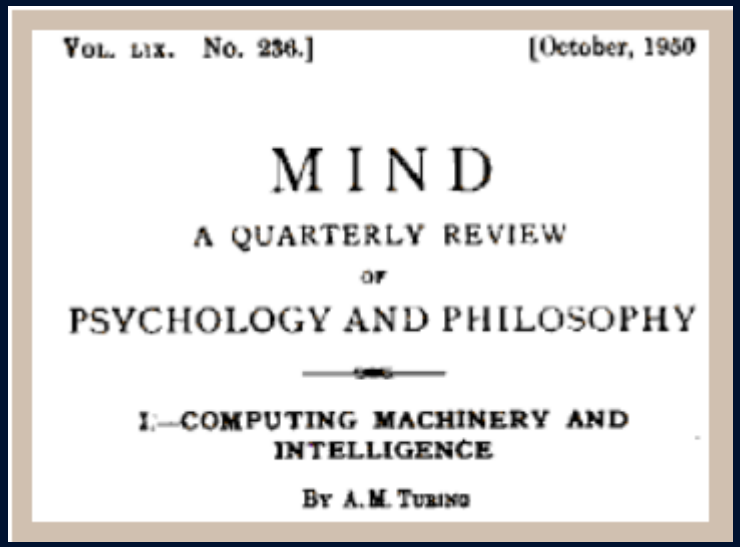
Technology and Evolution of Cognitive Systems

Alan Turing, 1950: „Can machines think?“



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MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

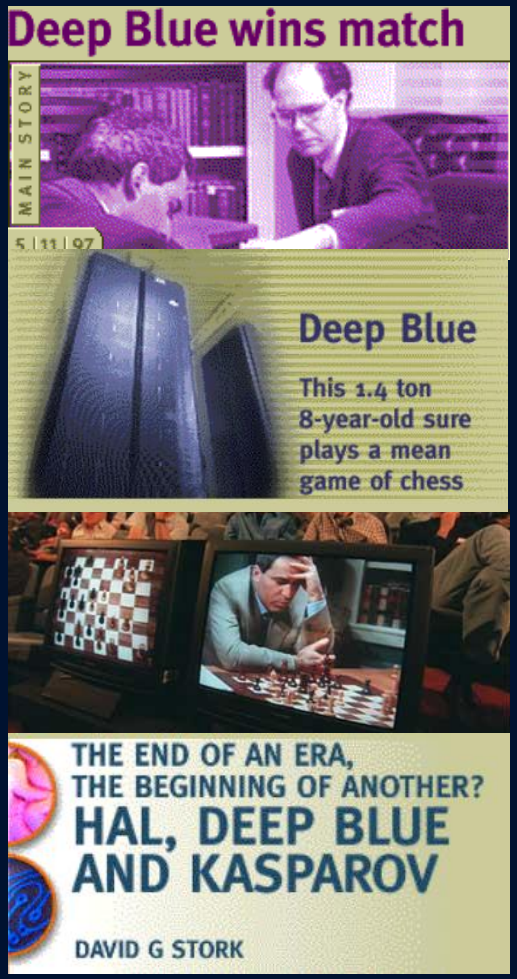
By A. M. Turing

1997: Can machines play chess?

On May 11, 1997, an IBM computer called IBM Deep Blue beat the world chess champion after a six-game match.

It was the classic plot line of man vs. machine.

Behind the contest, however, was important computer science, pushing forward the ability of computers to handle the kinds of complex calculations needed in many fields of science.



The practical issue today: Information Overload and Complexity

80%
today is
unstructured

Automated Open-Domain Question Answering

A long-standing challenge of artificial intelligence to emulate human expertise

Given

Deliver

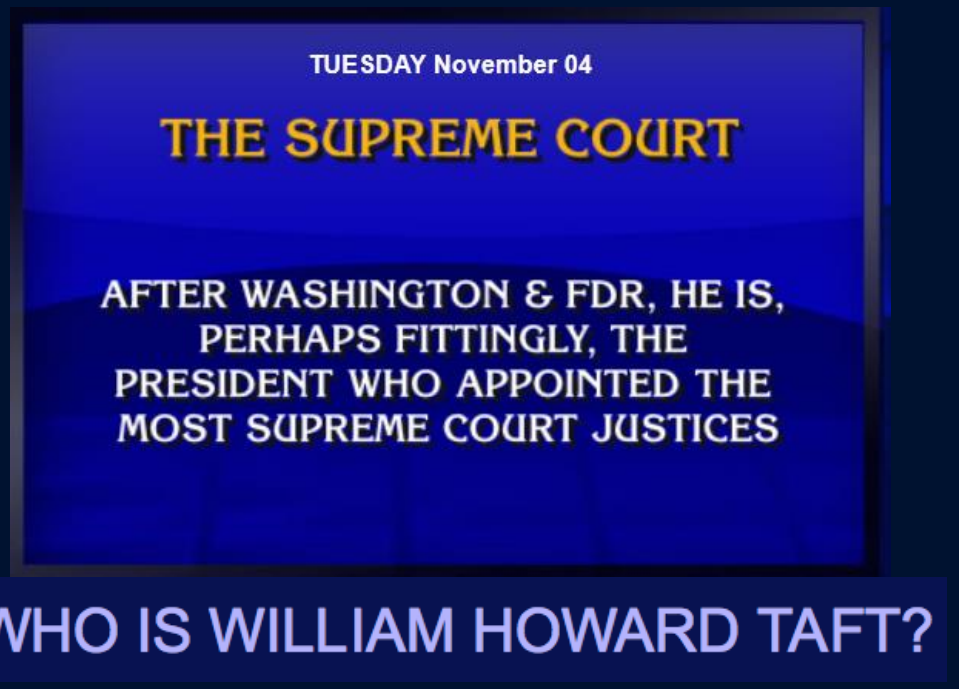
- ✓ **Precise Answers**
  Determine what is being asked & give precise respones
- ✓ **Accurate Confidence**
  Determine likelihood answer is correct
- ✓ **Consumable Justifications**
  Explain why the answer is right
- ✓ **Fast Response Time**
  Precision & Confidence < 3 seconds

Grand Challenge

Can we build a system that

- “digests” large amounts of unstructured information (especially text)
- and then answers open questions based on this data?

Proof point: Build a system that wins an open question game: Jeopardy!

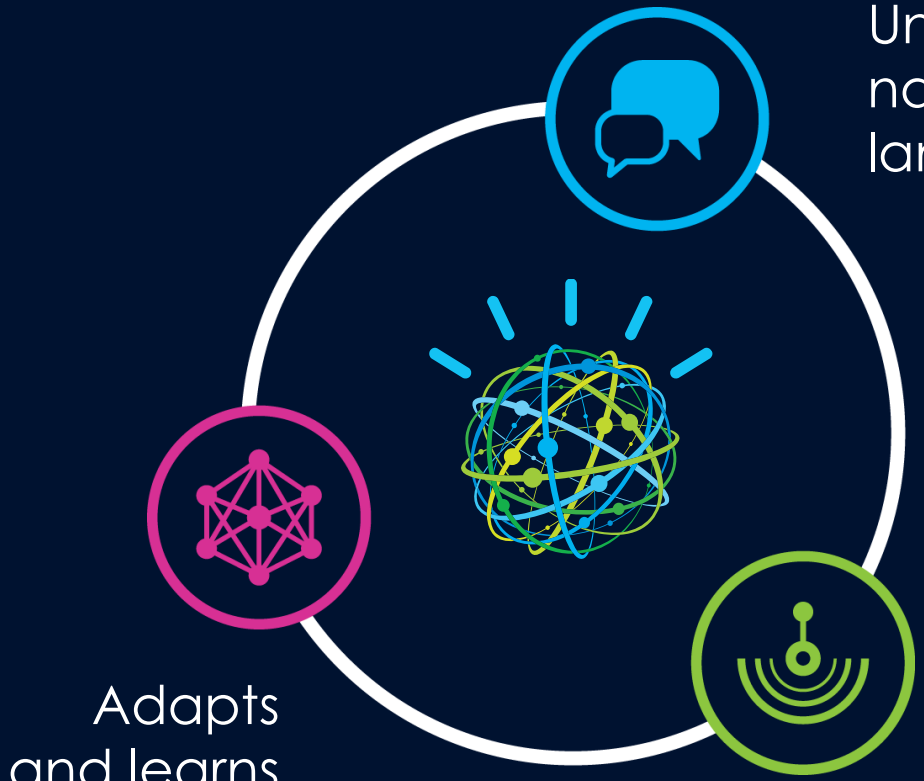


There is no way to program such a system in the traditional way.
It will have to learn!

Jeopardy!

In February 2011, an IBM computer called IBM Watson beat the two all-time Jeopardy! champions, Brad Rutter and Ken Jennings, after many months of training.

Key Features of Watson



Understands natural language

Generates and evaluates hypotheses

Adapts and learns

How does Watson learn?

1. Import selected bodies of literature.
2. Curate imported data.
3. Ingest all data to build a corpus of knowledge.
4. Train through prepared Q&A.

----- Go Live -----

5. Learn continuously from feedback.

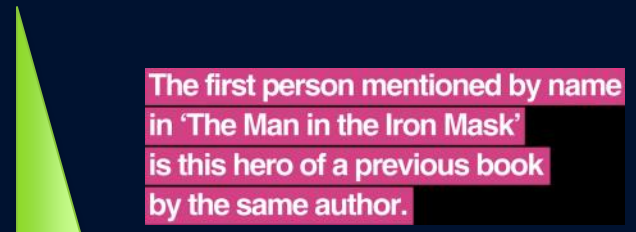
How does Watson answer questions?

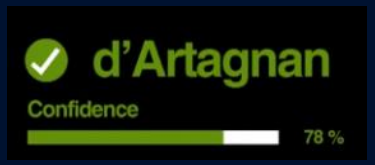
1. Question Analysis

1. Hypothesis Generation

1. Hypothesis & Evidence Scoring

2. Final Merging & Ranking





Watson for Jeopardy! System

- 2880 processors
- 80 TeraFLOPS/s
- 15 Terabyte RAM

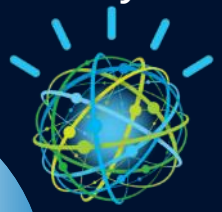
Beyond Jeopardy!

Watson 1.0: *Jeopardy!*

Specific questions

This poet wrote to a friend, "We are by September and yet my flowers are as bold as June. Amherst has gone to Eden."

Statistical analysis



Statistical ranking

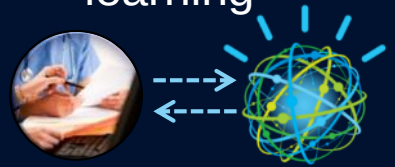
Batch training

Watson Evolution

Rich problem scenarios

Interactive & multimodal dialog

Continuos learning



Evidence profiles

Our Definition of Cognitive Computing

Cognitive computing systems learn and interact naturally with people to extend what either humans or machine could do on their own.

They help human experts make better decisions by penetrating the complexity of Big Data.

Cognitive systems expand the problems we can address

Programmatic Systems

- Leverage traditional data sources
- Follow pre-defined rules (programs)
- Provide the same output to all users

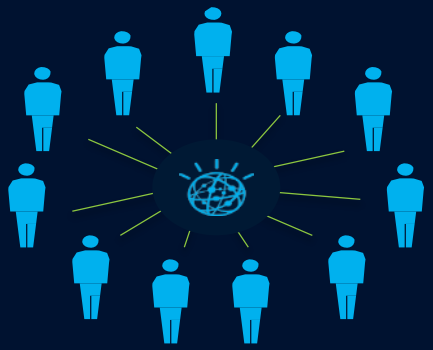
Cognitive Systems

- Are taught, not programmed.
- Learn and improve based on experience
- Interpret sensory and non-traditional data
- Relate to each of us as individuals
- Allow us to expand and scale our own thinking

A new partnership between humans and computers!

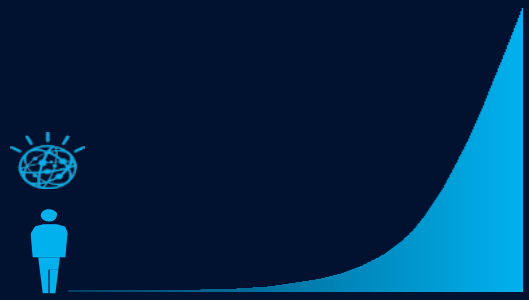
Enhance

the cognitive process of professionals to strengthen decision making in the moment



Scale

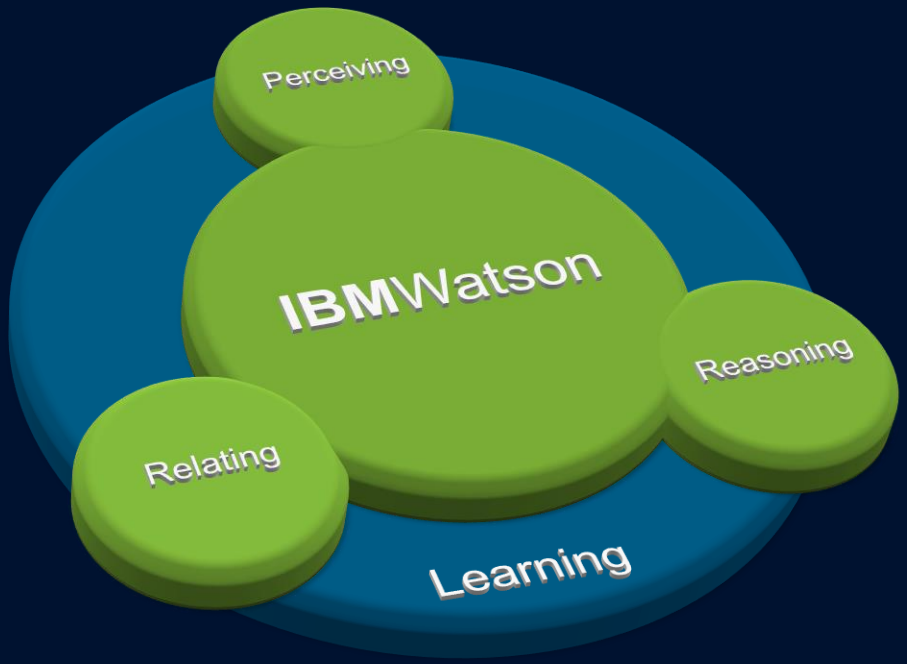
expertise by elevating the consistency and objectivity of decision making across an organization.



Accelerate

development of expertise in others by capturing the expertise of top performers

Cognitive learning systems enhance our abilities to perceive, reason and relate



Perceiving:

Understand the world as we do: interpret sensory input beyond traditional data

Reasoning:

Think through complex problems: deepen our analysis and inspire creativity

Relating:

Understand how we communicate, and personalize interactions

Learning:

Learn from every interaction, scaling our ability to build experience

Research areas in Cognitive Computing

Visual sense,

Sound

Social graph based communication,

Empathy,

Arguing,

Humor,

Creativity,

Intuition

Moral compass,

…

Advanced algorithms,

Analytics acceleration,

Multi-objective decision support

More automated learning

Research on future cognitive systems

Traditional computers focus on language and analytical thinking

(Left brain)

(Right brain)

Neurosynaptic chips address the senses and pattern recognition

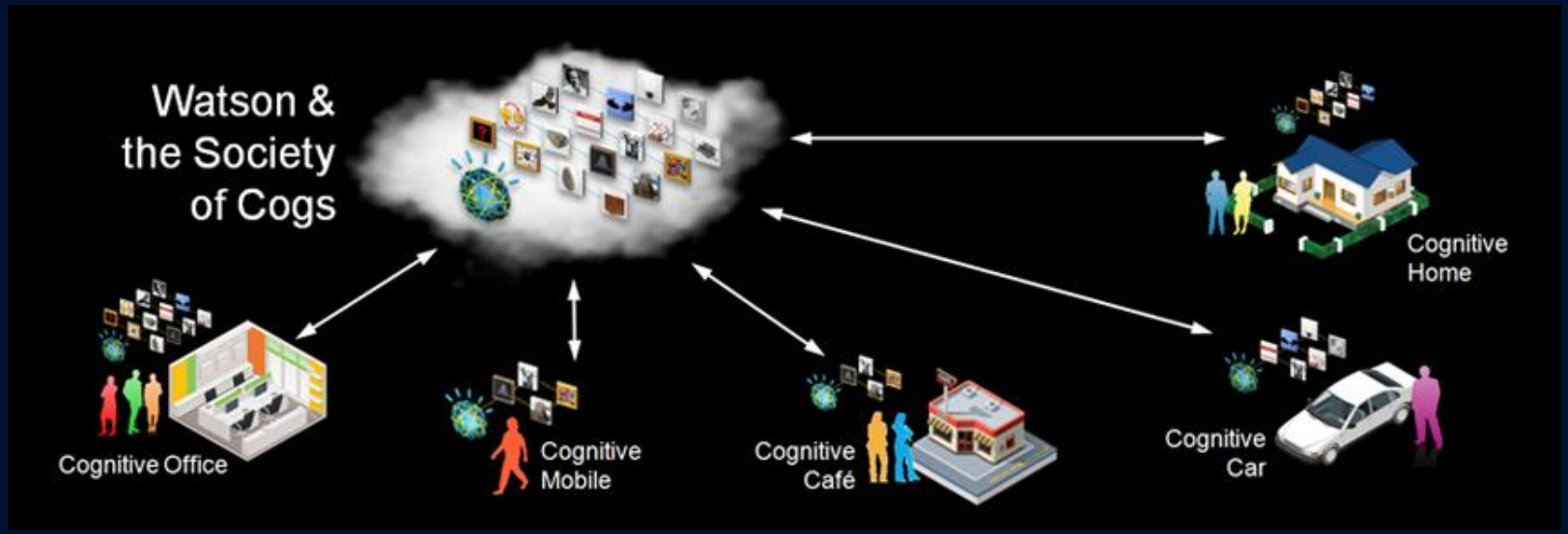
Over the coming years, IBM scientists hope to meld the two capabilities together to create a **holistic computing intelligence**

	2011	2014
Programmable neurons	256	1 million
Programmable synapses	262,144	256 million
Neurosynaptic cores	1	4,096

A society of cognitive systems interacting with humans

Various Cognitive Systems and Humans will interact and collaborate:

- Human to Cognitive System
- Cognitive System to Cognitive System
- Human to Human



Numerous applications

The new era of cognitive computing will transform our future

Tabulating Systems Era

Programmable Systems Era

Cognitive Systems Era

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Architecture for Big Data & Analytics