

From Artificial Intelligence to
Quantum Computing
an IBM Journey in Physics, AI and Science

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Hello!

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[285727?s=460&v=4] | <https://avatars0.githubusercontent.com/u/285727?s=460&v=4>

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About the Technical Expert Council

The Technical Expert Council for Spain, Portugal, Greece and Israel is an affiliate of the IBM Academy of Technology.

[aotlogo 100x100] | https://researcher.watson.ibm.com/researcher/images/aotlogo_100x100.png

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To visualize the future of **IBM** you must know something of the past. — Thomas J. Watson, Sr.

IBM has a long relation with Physics.

...and Physics Engineering...

... *and Artificial Intelligence*...

...and Science in general.

Five IBM physicists have received the Nobel Prize in Physics

!

- Leo Esaki in 1973 for his work in semiconductors.
- Gerd Binnig and Heinrich Rohrer in 1986 for the scanning tunneling microscope.
- Georg Bednorz and Alex Mueller in 1987 for research in superconductivity.

And not just Nobel prizes

Many essential scientific breakthroughs were born from IBM Research through the decades.

Quantum tunneling

1958: Leo Esaki's discovery of the semiconductor junction, called the Esaki diode, finds wide use in electronics applications

Fractal Geometry

1967 - IBM, researcher **Benoît Mandelbrot**.

Nanotechnology

1981: Gerd Binnig and Heinrich Rohrer invent the scanning tunneling microscope, revolutionizing our ability to manipulate solid surfaces the size of atoms.

Quantum teleportation

1993: An international group of six scientists, including IBM Fellow Charles H. Bennett, confirmed the intuitions of the majority of science fiction writers by showing that perfect teleportation is indeed possible in principle, but only if the original is destroyed.

Deep Blue Chess

1997: First computer to defeat human World Chess Champion, Garry Kasparov.

IBM Blue Gene

2004: Supercomputer to observe protein folding and gene development.

... and many others

1947 Magnetic Core Memory **1957** Landauer Formalism - Conductance must come in Quantized Units **1958** Quantum Tunnelling **1960** Thin Film Heads **1966** Tunable Lasers **1966** Two-Dimensional Electron Gas (2DEG) **1967** Josephson Junctions **1968** DRAM - 1 Transistor RAM **1974** Dennard Scaling (aka Why Moore's Law also speeds up transistors in Lay Terms) **1978** Scanning Tunneling Microscope (1986 Nobel Prize Winner) **1982** Thermodynamics of Computation **1983** High Temperature Superconductors (1987 Nobel Prize Winner) **1990** Moving Atoms **1991** RFID **1993** Quantum Teleportation **1993** Seminal Contributions to the Theoretical Foundation of Quantum Information Processing **1994** High-Speed Silicon-Germanium Electronics **1997** GMR - Giant Magnetoresistive Heads **1998** Copper Interconnect **2002** SOI: Silicon on Insulator **2002** Theory of Nanoscale Material **2007** High-K Gate Dielectric **2008** Racetrack Memory **2008** Cooling 3D Chips **2011** Non-Planar Devices **2012** Holey Optochip - 1 Terabit per Second Optical Bus **2013** Millimeter Wave

more recently, and in the field of Artificial Intelligence

we had a well-known breakthrough

Watson Jeopardy! Challenge

!

► <https://www.youtube.com/watch?v=P18EdAKuC1U> (YouTube video)

!

- First computer to defeat TV game show Jeopardy! champions.
- Research teams are working to **adapt Watson to other information-intensive fields**, such as telecommunications, financial services and government.

Building on that we have built something special

a whole portfolio of Data Science, AI and Machine Learning solutions.

...integrated and working together and with researchers

(that's the vision)

Data → Information → Knowledge

Everything available on the cloud.

(... or almost everything)

... but not just in *any* cloud...

IBM Cloud

!

- APIs
- IoT
- Infrastructure
- AI ready
- Secure to the core

Watson Platform Services

Integrate Watson into existing applications or develop new ones through the use of comprehensive APIs.

some examples of available services

(plenty more on the IBM Cloud catalog!)

<https://www.ibm.com/cloud>

!

- Visual Recognition: <https://visual-recognition-demo.ng.bluemix.net/>
- Conversation: <https://conversation-demo.ng.bluemix.net/>
- Speech to text: <https://speech-to-text-demo.ng.bluemix.net/>
- Natural Language Classifier: <https://natural-language-classifier-demo.ng.bluemix.net/>

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- Natural Language Understanding: <https://natural-language-understanding-demo.ng.bluemix.net/>
- Personality Insights: <https://personality-insights-demo.ng.bluemix.net/>
- Tone Analyser: <https://tone-analyzer-demo.ng.bluemix.net/>

and ready-to-use *starter kits* that make it simple and fun

<https://console.bluemix.net/developer/watson/starter-kits>

!

(we also use them ourselves)

We also have specific solutions for getting the most of unstructured data

Watson Explorer

Mine and explore all your unstructured data

- Cognitive exploration
- Powerful text analytics
- Machine learning

<https://www.ibm.com/products/watson-explorer>

Watson Knowledge Studio

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To become an expert in a given industry or domain, Watson must be trained. The Knowledge Studio helps with the training.

<https://www.ibm.com/watson/services/knowledge-studio/>

!

- Easy-to-use tools for annotating unstructured domain literature.
- Uses those annotations to create a custom machine learning model that understands the language of the domain.
- Create rule-based models that finds entities in documents based on rules that you define.

!

and to easily get insights from data

Watson Analytics

!

- Smart data analysis and visualization
- Quick to use
- Guided and automatic predictive analytics
- Natural Language dialogue.

<https://watson.analytics.ibmcloud.com/>

but the focal point of all

and a huge part of IBM's vision

IBM Watson Data Platform

collaboration

integration

discovery

openness

full lifecycle

(from getting the data to showing it)

in IBM Cloud

of course

!

- Data governance
- Data preparation
- Data analysis
- Model creation
- Building apps

Some key components

IBM Data Catalog

!

Discover and manage data sources

<https://www.ibm.com/cloud/data-catalog>

Data Science Experience

!

!

Interactive and collaborative platform for the different roles

!

- Data Scientists
- Data Engineers
- Analysts
- Machine Learning Engineers

<https://datascience.ibm.com/>

now that we know a bit more about what we have

let's talk about how we have been using this to bring real results and tackle real challenges

globally and in Portugal

Some examples

Fraud detection

!

- Project with SIBS.
- Real-time fraud detection.
- Rule-based, predictive-based and AI-driven "best fit" model.

- Applies machine learning to go beyond "black box" models.

Healthcare, Pharmaceuticals & Life Science

!

Several projects, including an innovative project with Mundipharma focused on public awareness and information through a bot with domain knowledge.

Some additional ongoing projects:

- Adding cognitive support for patients with limited mobility.
- Improve accessibility using real-time AI-driven assistance.

Chatbots

In different industry segments we have active projects around *chatbots*.

- Automate first-line assistance.
- Provide an expert assistance with the ability to understand ambiguous queries.
- Add a natural-language interface to an existing solution.

Automation

Using Watson APIs we have active projects around

- Automation using visual recognition.
- Autonomous identification of equipment degradation.

Classification

For a major industrial company:

- Automatic classification of documents using a taxonomic tree and natural language processing.
- Streamline classification of documents by suggesting classes based on three analyses of the documents (which are *unstructured data*).

We have many active projects in these and other fields

in fact, we have a Cognite Asset Factory

θ

right next to you

We've been here for a while

**and helped to achieve some rather
important things**

some (extremely) big

some (extremely) small

but always shaping the future

Quantum Computing

!

In the summer of 1981, IBM and MIT organized a landmark event called the First Conference on the Physics of Computation.

It took place at Endicott House, a French-style mansion not far from the MIT campus.

!

Bennett and others realized that some kinds of computations that are exponentially time consuming, or even impossible, could be efficiently performed with the help of quantum phenomena. A quantum computer would store information in quantum bits, or qubits.

!

Nature is quantum, goddamn it! So if we want to simulate it, we need a quantum computer!

— Richard Feynman

!

► <https://www.youtube.com/watch?v=o-FyH2A7Ed0> (YouTube video)

IBM Q

An industry-first initiative to build commercially available universal quantum computers for business and science.

!

- 20 qubit available, 50 qubit developed
- QISkit: open to **anyone** for development.
- IBM Q Network: advancing quantum computing together

These are all reasons behind IBM's motto

THINK

Thank you!

Some final links

Community

Tools, algorithms and approaches are increasingly more open and social.

- Cognitive Class: Build Data Science and Cognitive Computing skills *for free* today
<https://cognitiveclass.ai>
- Data Scientist Workbench: virtual lab with Data Science tools ready to explore and put to use
<https://datascientistworkbench.com/>

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- Data Science Experience: Learn, create and collaborate <https://datascience.ibm.com/>
- IBM Code: Code patterns, tech talks, open source projects, developer advocates, dynamic communities, upcoming events. <https://developer.ibm.com/code/>
- IBM Cloud: integrate all IBM services with your solution, including Watson & Analytics services
<https://console.bluemix.net/catalog/>

References

- Fractal animation by Alexandre Tavernier (<http://coolfractalanimations.blogspot.pt/2014/05/mandelbrot-set-animation-color-changes.html>)
- IBM AI Research: https://researcher.watson.ibm.com/researcher/view_page.php?id=6813
- Neurons image by Michelle Kuykendal and Gareth Givanasen (Georgia Tech's NeuroLab): <https://www.youtube.com/watch?v=yy994HpFudc>
- Spring cloud time lapse by Harrison Rowntree (<https://www.youtube.com/watch?v=Qu7mcKZgqv0>)