JAX London

Java futurity

Steve Wallin

Program Director

IBM Runtime Technologies

A new era in technology, a new era in business.

Java will evolve faster

predictable consistent cadence

easier migration

increased innovation

Java innovation is a journey

lambda
streams

modules
reactive streams

panama
valhalla
penrose
amber

Containers are a way of life

Cloud dynamics

Micro Services

Management

Everyone can engage in the future of Java development.

Why, and How ?

Every development team has both common and unique problems to solve.

Open source is key to fast innovation and adoption

OpenJDK
Eclipse OpenJ9
AdoptOpenJDK
Open Liberty
Eclipse MicroProfile
Java EE
IBM Cloud
Docker
Kubernetes

Where code goes, where data flows, cognition will follow.

CONSIDER:

Cognitive systems can understand the world through sensing and interaction, **reason** using hypotheses and arguments and **learn** from experts and through data. Watson is the most advanced such system.

Today, businesses in

36

countries across.

17

industries are applying cognitive technologies.

78%

of **business and IT executives** believe that successful business will **manage employees** alongside **intelligent machines.**

There are

350+

Watson ecosystem partner companies, with

100

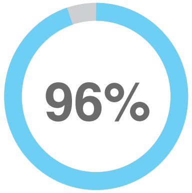
of those have taken their product to market.

On average there are

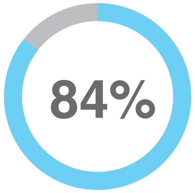
1.3B

Watson API calls a month and growing.

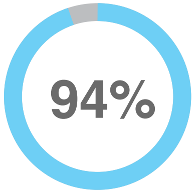
Among C-Suite executives familiar with cognitive computing:



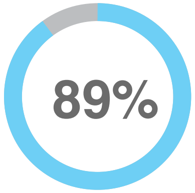
in **insurance** intend to invest in cognitive capabilities.



in **healthcare** believe it will play a disruptive role in the industry, and 60% believe they lack the skilled professionals and technical experience to achieve it.



in **retail** intend to invest in cognitive capabilities.



in **telecommunications** believe it will have a critical impact on the future of their business.

We can now confer on every digitized object, product, process and service a kind of thinking ability.

How, and why now?

Data is transforming industries and professions.

The world is being reinvented in code.

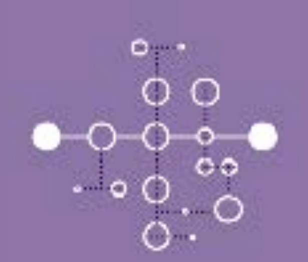
Computing is entering a new Cognitive Era.

Imagine the possibilities…

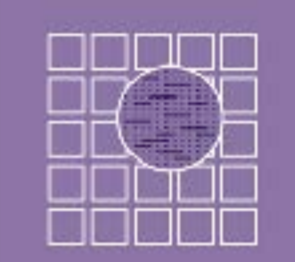
Tailoring responses to the personalities of your customers **without meeting a single one of them.**

Knowing the latest, most significant developments in your profession or industry **the moment they take place**

Products and services that improve themselves over time, **learning from and adapting to the world around them.**



Processes that identify their own inefficiencies-**and address them automatically-in real time.**



Uncovering patterns, resources, trends and other competitive advantages **invisible to competitors and their information systems.**

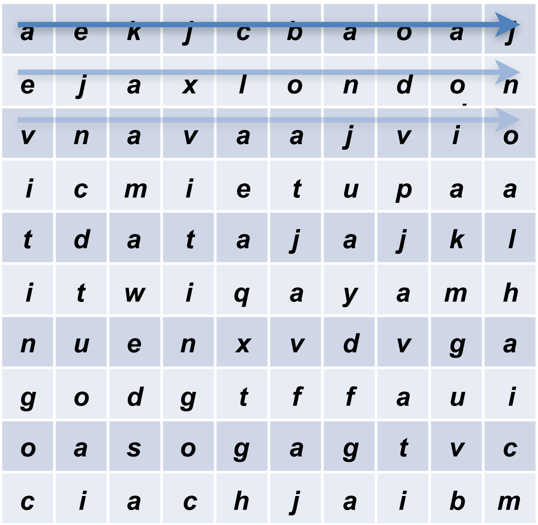
PROBLEM:

…so lets solve a word search

a	*e*	*k*	*j*	*c*	*b*	*a*	*o*	*a*	*j*
e	*j*	*a*	*x*	*l*	*o*	*n*	*d*	*o*	*n*
v	*n*	*a*	*v*	*a*	*a*	*j*	*v*	*i*	*o*
i	*c*	*m*	*i*	*e*	*t*	*u*	*p*	*a*	*a*
t	*d*	*a*	*t*	*a*	*j*	*a*	*j*	*k*	*l*
i	*t*	*w*	*i*	*q*	*a*	*y*	*a*	*m*	*h*
n	*u*	*e*	*n*	*x*	*v*	*d*	*v*	*g*	*a*
g	*o*	*d*	*g*	*t*	*f*	*f*	*a*	*u*	*i*
o	*a*	*s*	*o*	*g*	*a*	*g*	*t*	*v*	*c*
c	*i*	*a*	*c*	*h*	*j*	*a*	*i*	*b*	*m*

jaxlondon
java
ibm
cognitive

CLASSIC SOLUTION:



a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

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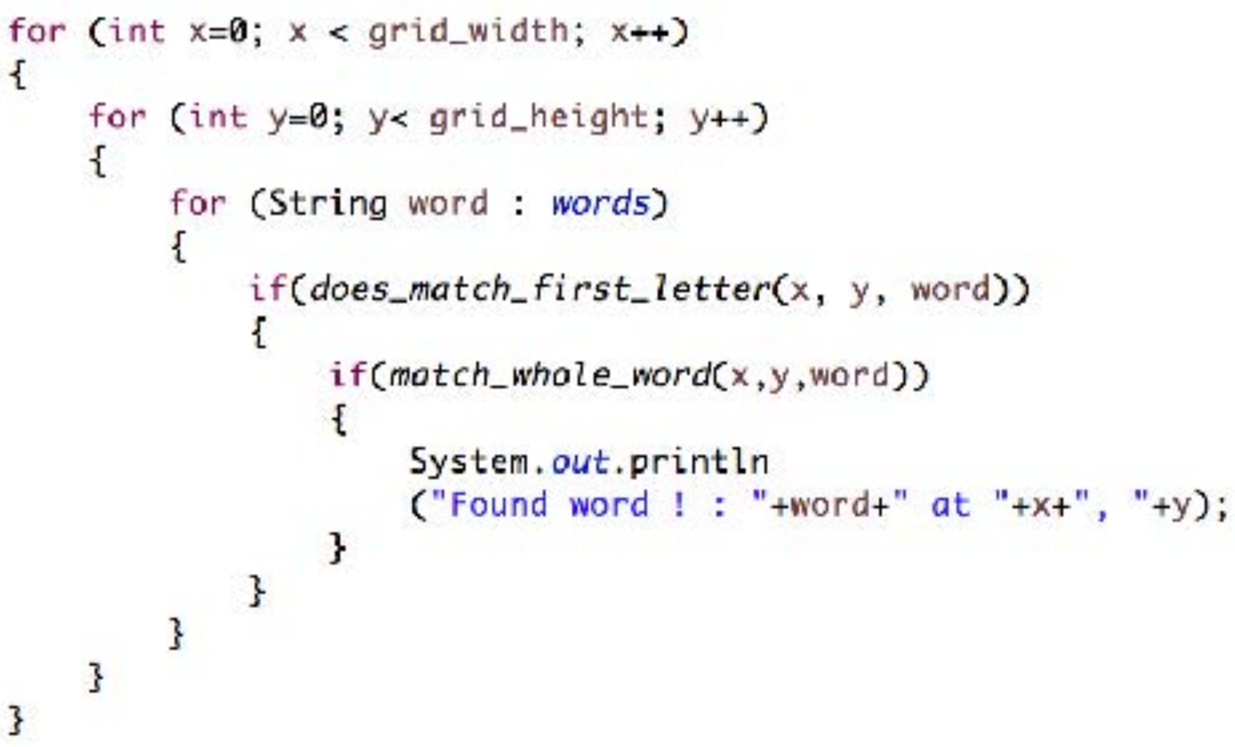
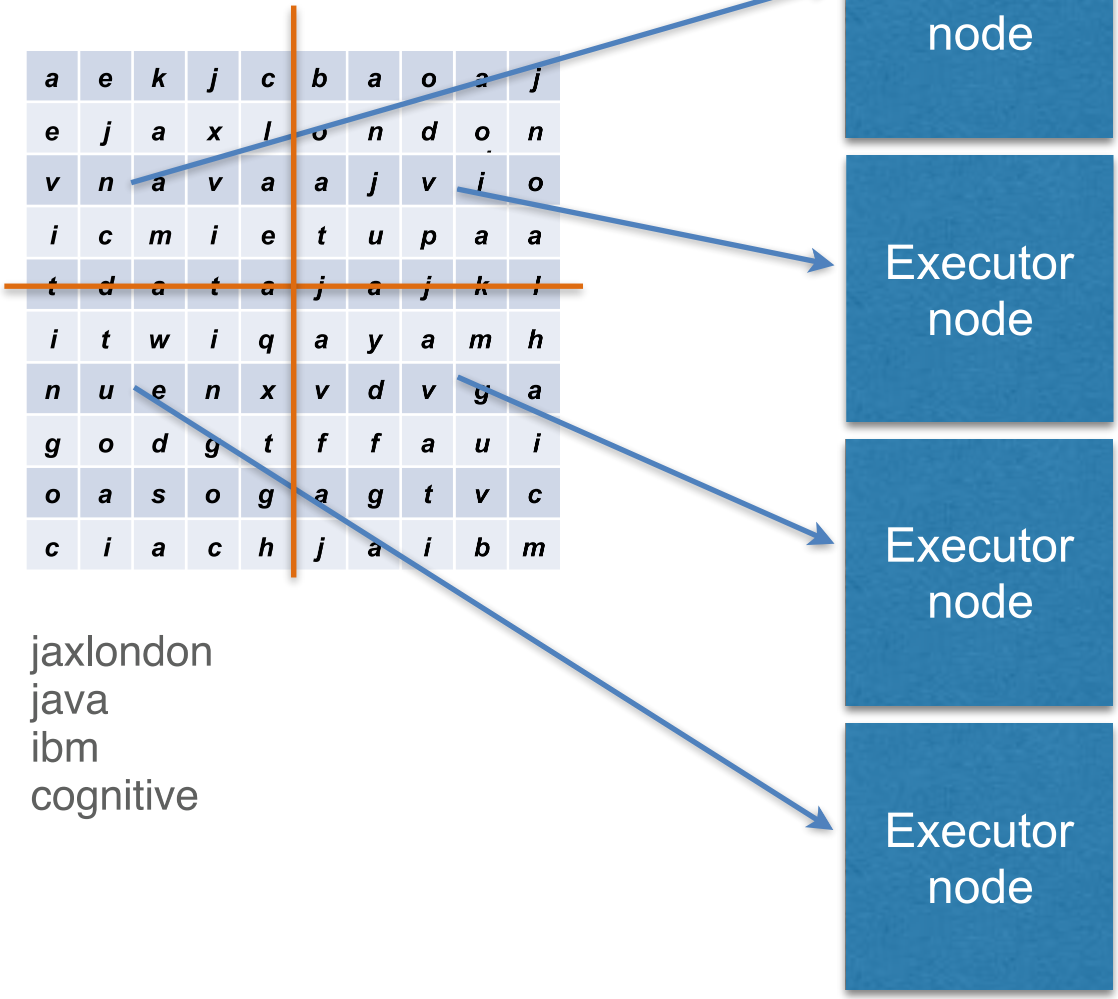


```
for (int x=0; x < grid_width; x++)
{
    for (int y=0; y< grid_height; y++)
    {
        for (String word : words)
        {
            if(does_match_first_letter(x, y, word))
            {
                if(match_whole_word(x,y,word))
                {
                    System.out.println
                    ("Found word ! : "+word+" at "+x+", "+y);
                }
            }
        }
    }
}
```

PARTITIONING:



a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

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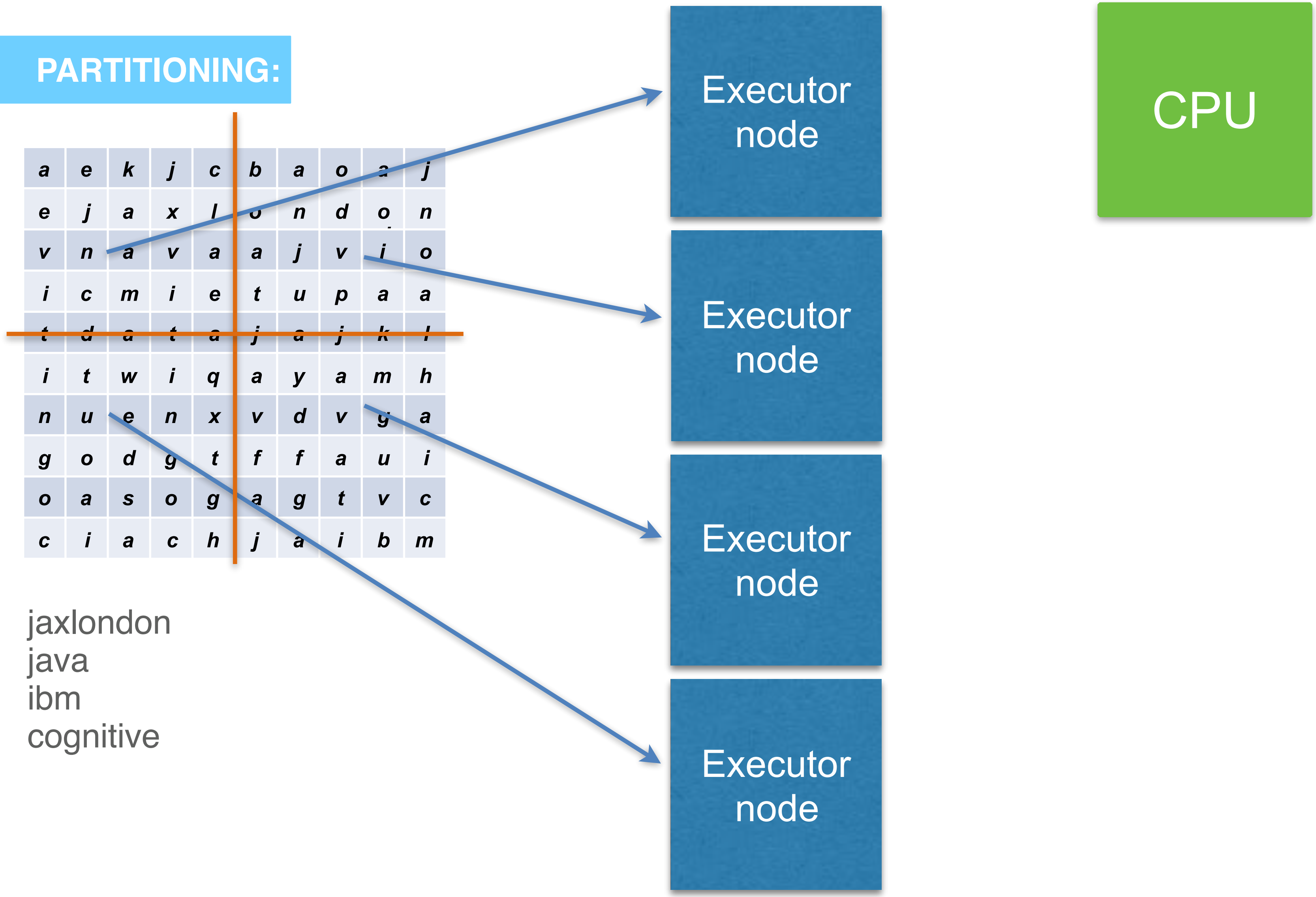

a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

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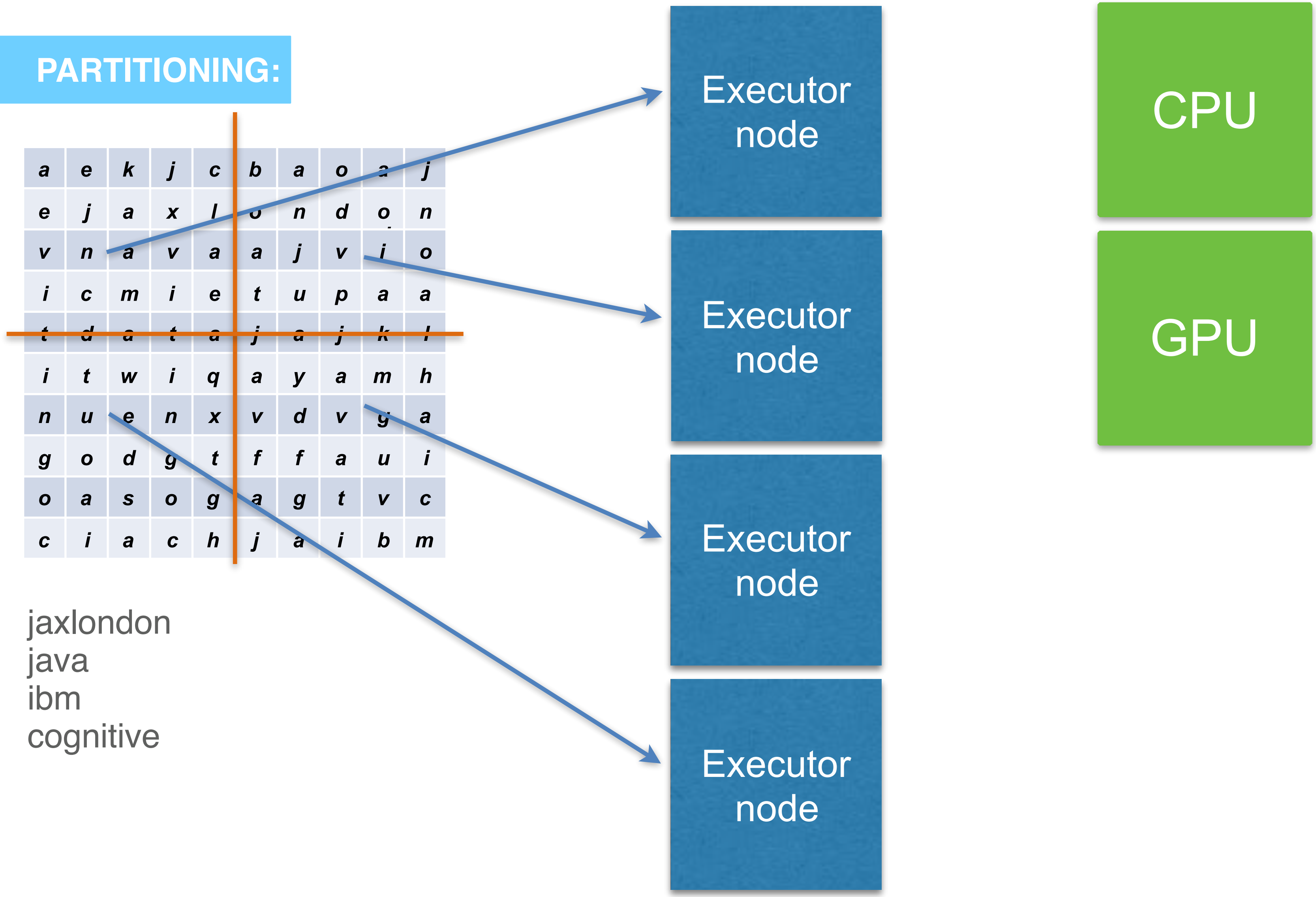
PARTITIONING:



a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

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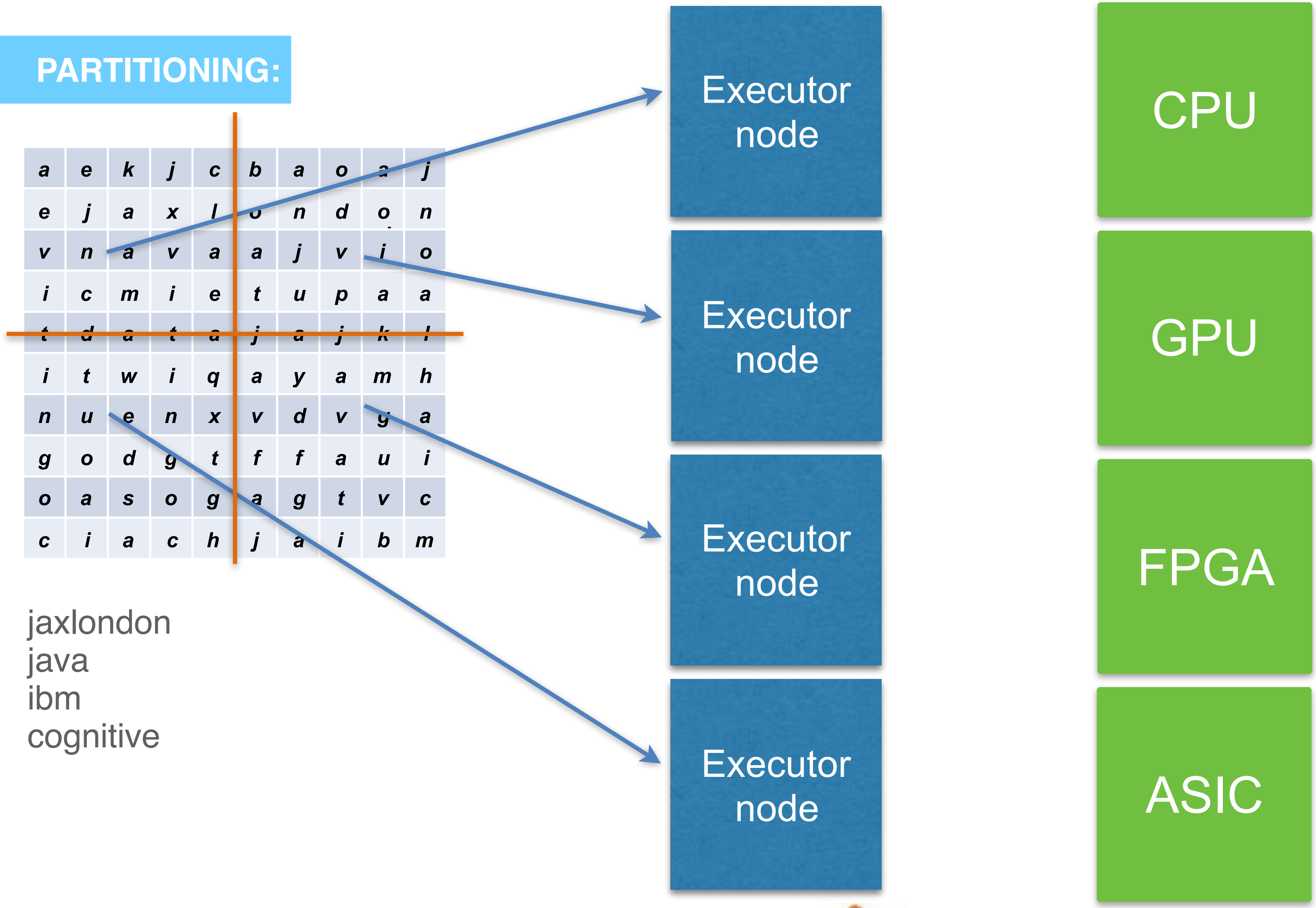
cognitive

hadoop APACHE Spark akka

PARTITIONING:



a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

Executor node

Executor node

Executor node

Executor node

CPU

GPU

FPGA

ASIC

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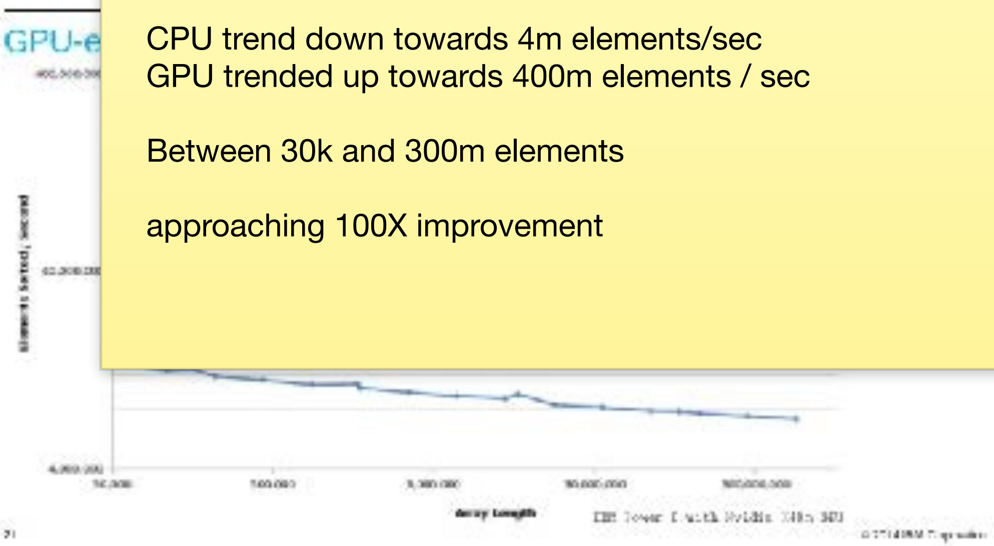
hadoop APACHE Spark akka

IBM + NVIDIA

Improving Java application performance with GPU exploitation is available in IBM SDK for Java 8 and OpenJDK 9 with Eclipse Open9

Standard SE API optimisation as well as CUDA4J API for explicit low level control

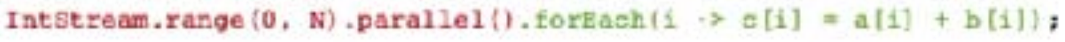


GPU Test
Sorting
30k elements - in order to see offload to GPU being of benefit

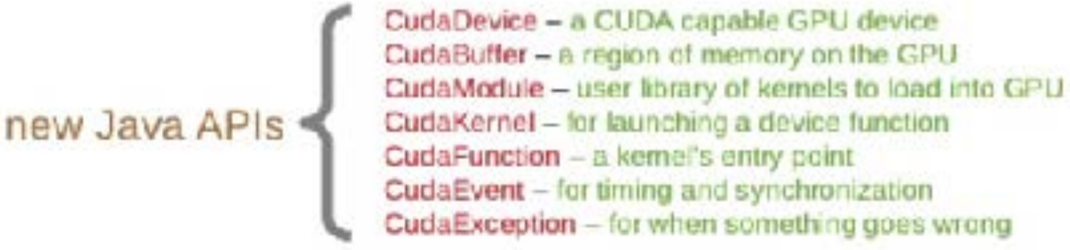
CPU trend down towards 4m elements/sec
GPU trended up towards 400m elements / sec

Between 30k and 300m elements

approaching 100X improvement



```
IntStream.range(0, N).parallel().forEach(i -> c[i] = a[i] + b[i]);
```



new Java APIs

- CudaDevice – a CUDA capable GPU device
- CudaBuffer – a region of memory on the GPU
- CudaModule – user library of kernels to load into GPU
- CudaKernel – for launching a device function
- CudaFunction – a kernel's entry point
- CudaEvent – for timing and synchronization
- CudaException – for when something goes wrong

PROBLEM:

…so lets solve a word search

a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

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How do you design for people when people constantly change?

Follow your users

Measure Success

Stay Curious

Follow
your users

Empathy can’t be outsourced!

NEURAL:

a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

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NEURAL:

a	e	k	j	c	b	a	o	a	j
e	j	a	x	l	o	n	d	o	n
v	n	a	v	a	a	j	v	i	o
i	c	m	i	e	t	u	p	a	a
t	d	a	t	a	j	a	j	k	l
i	t	w	i	q	a	y	a	m	h
n	u	e	n	x	v	d	v	g	a
g	o	d	g	t	f	f	a	u	i
o	a	s	o	g	a	g	t	v	c
c	i	a	c	h	j	a	i	b	m

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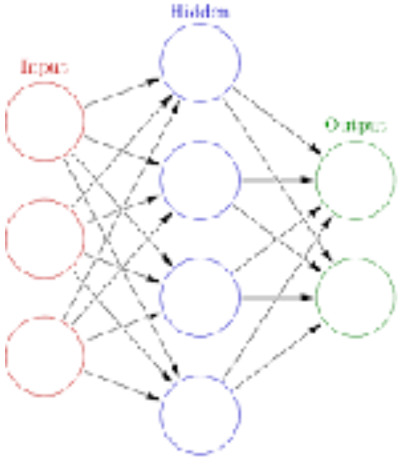


DL4J DEEPLEARNING4J

Neuroph Java Neural Network Framework

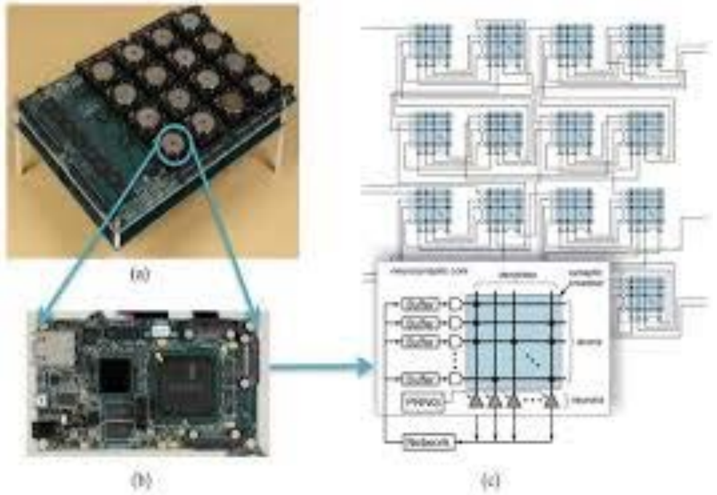
IBM Watson

TensorFlow

SYNAPSE:

A program to develop a neuromorphic processor that is a new kind of cognitive computer

Designed to simulate the neurones and dendrites of the brain for low power efficient operation



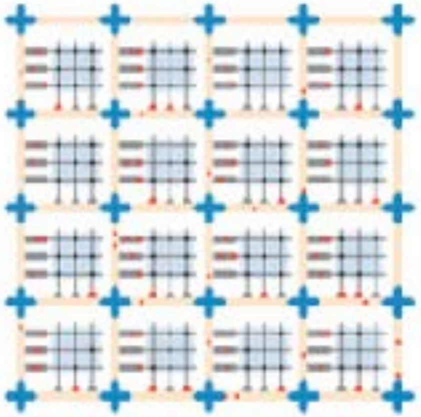
Different from a standard chip

Traditional chips run all of the time
This new neurosynaptic chip is event-driven and **operates only when it needs to**, resulting in a cooler operating environment and lower energy use.

The neurosynaptic chip veers from the traditional von Neumann architecture, which inherently creates a bottleneck limiting performance of the system.

New architecture

IBM's brain-inspired architecture consists of a network of neurosynaptic cores. Cores are distributed and operate in parallel. Cores operate—without a clock—in an event-driven fashion. Cores integrate memory, computation, and communication. Individual cores can fail and yet, like the brain, the architecture can still function. Cores on the same chip communicate with one another via an on-chip event-driven network. Chips communicate via an inter-chip interface leading to seamless scalability like the cortex, enabling creation of scalable neuromorphic systems.



Traditional computers focus on language and analytical thinking

(Left brain)

Neurosynaptic chips address the senses and pattern recognition

(Right brain)

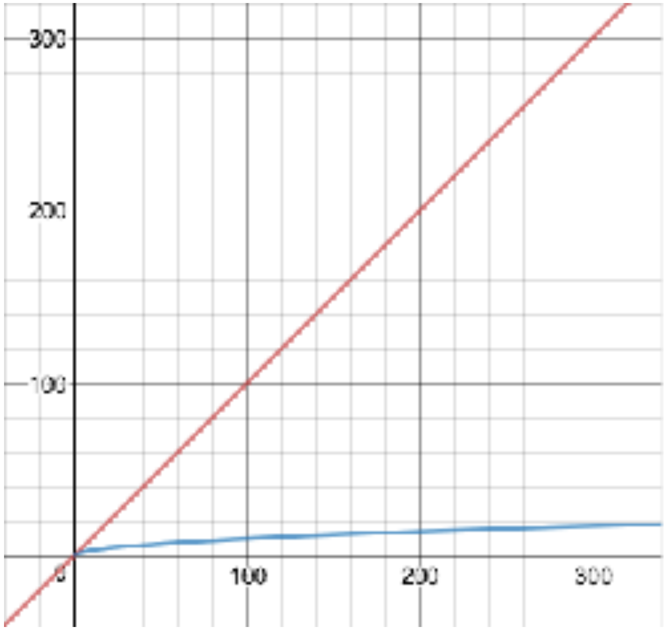
Over the coming years, IBM scientists hope to meld the two capabilities together to create a **holistic computing intelligence**

SEARCH

SEARCH

On a classical computer this search problem cannot be solved in fewer than O(N) evaluations

In 1996 a search algorithm was defined by Lov Grover. This algorithm can transform the problem into an O(√N) search.



At roughly the same time that Grover published his algorithm, Bennett, Bernstein, Brassard, and Vazirani proved that no quantum solution to the problem can evaluate the function

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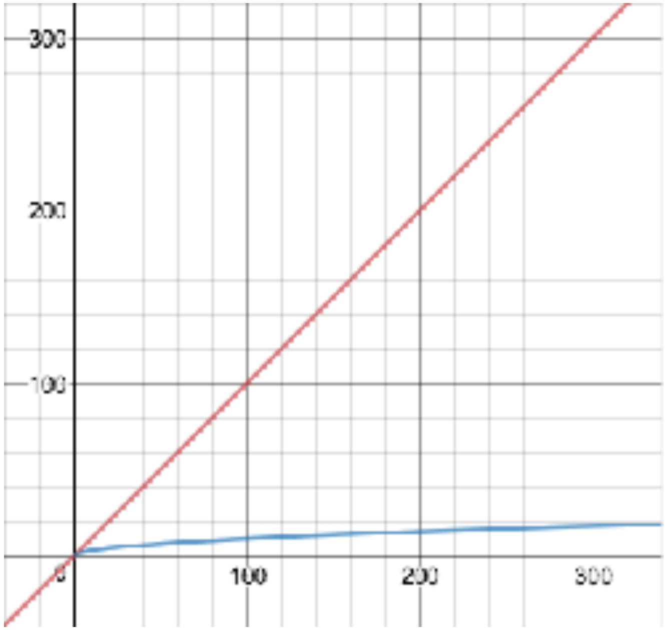
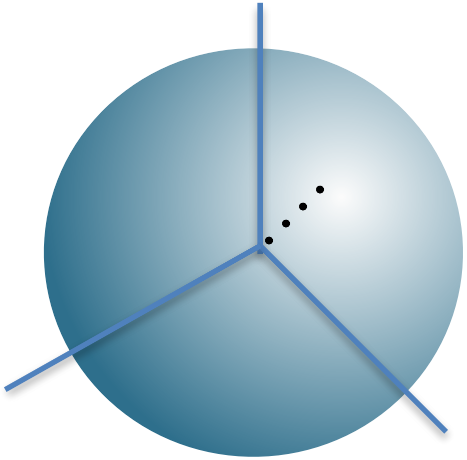


bit

1

0



qubit

SEARCH

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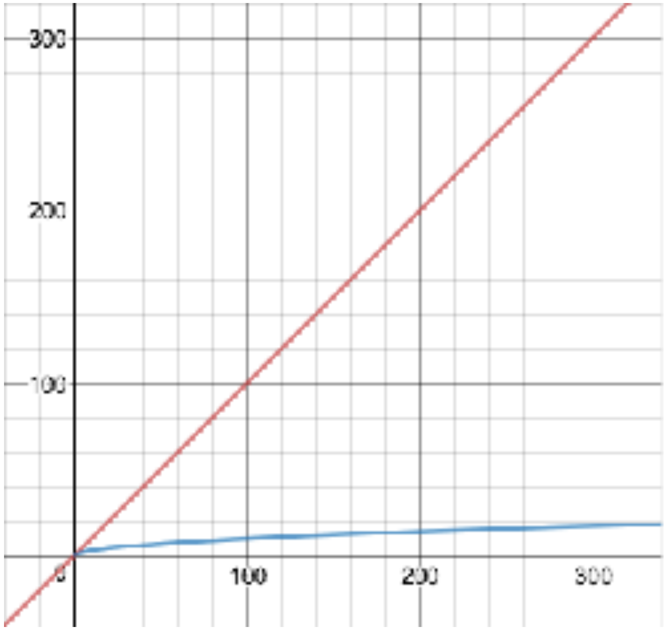

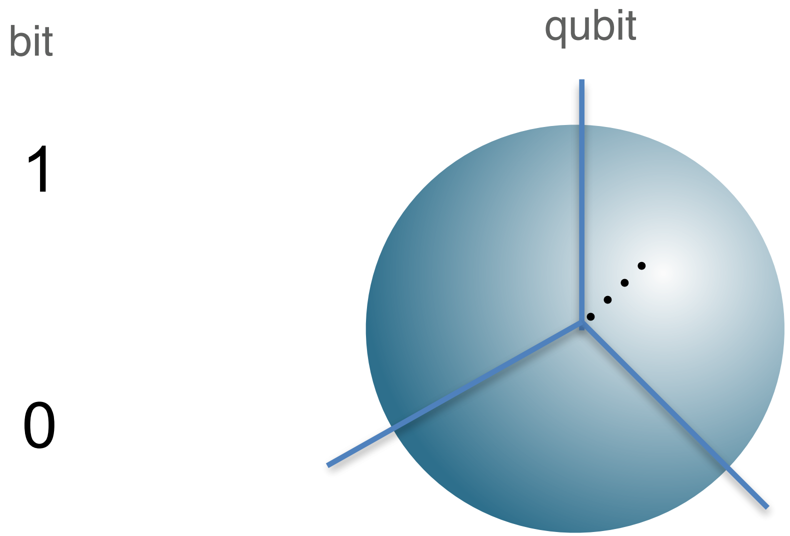

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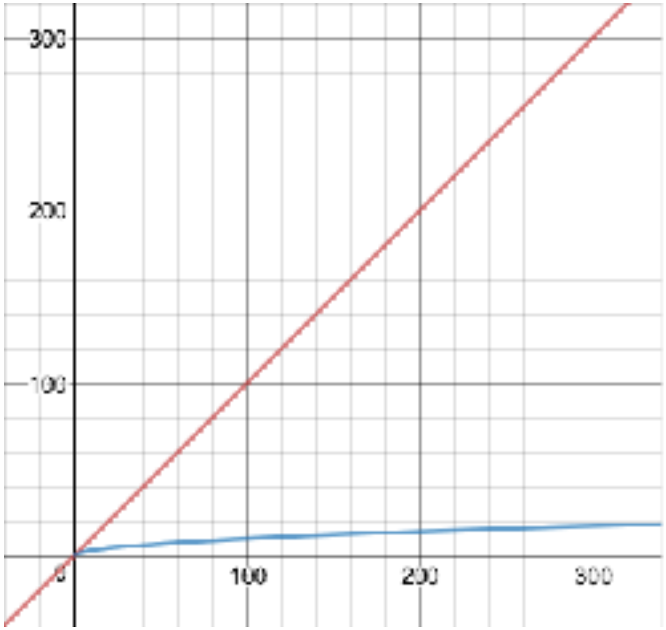

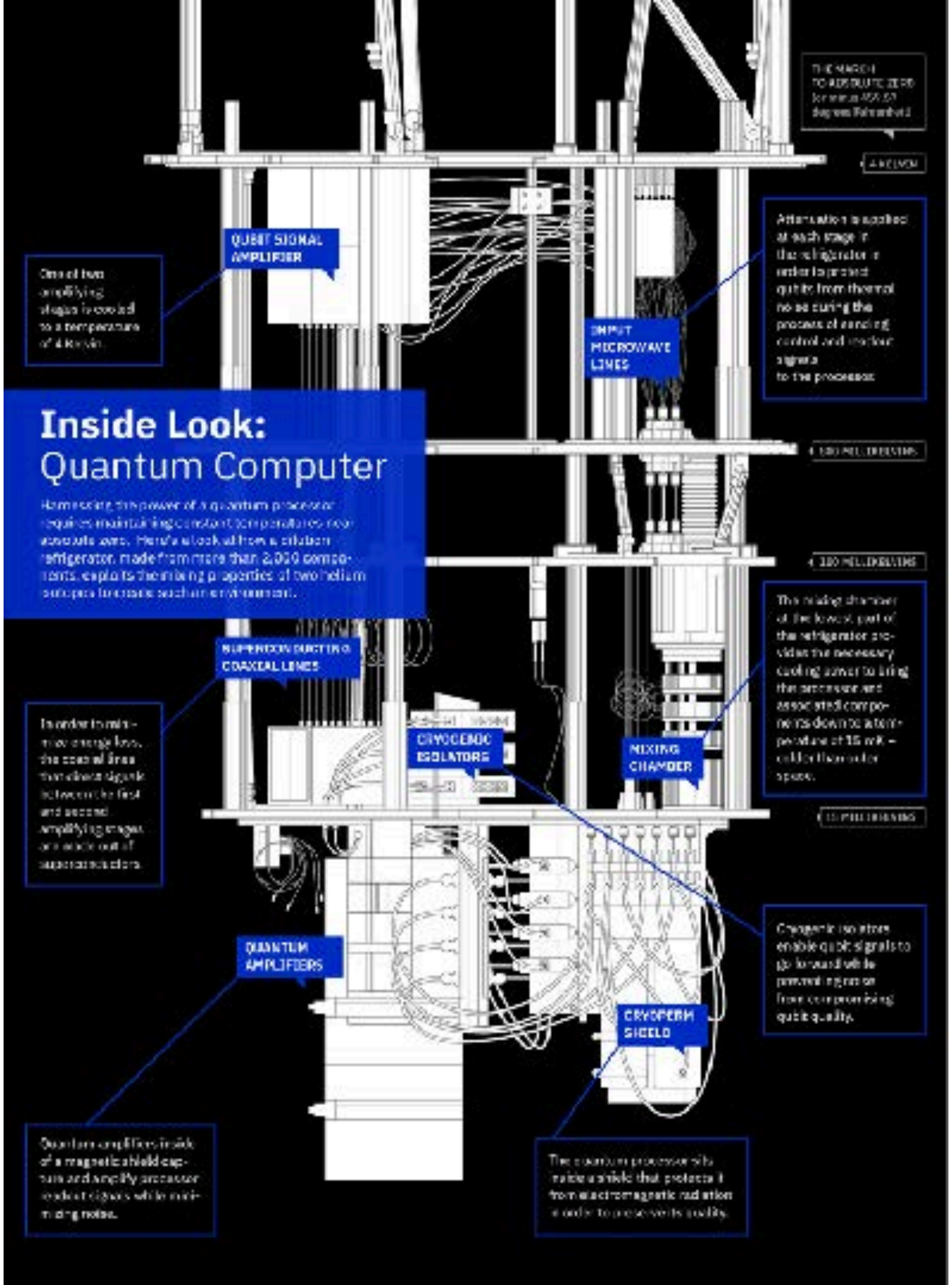

Inside Look: Quantum Computer

Harnessing the power of a quantum processor requires maintaining constant temperatures near absolute zero. Here's a look at how a dilution refrigerator, made from more than 2,000 components, exploits the mixing properties of two helium isotopes to create such an environment.

THE SEARCH TO ABSOLUTE ZERO (or minus 459.67 degrees Fahrenheit)

One of two amplifying stages is cooled to a temperature of 4 Kelvin.

Attenuation is applied at each stage in the refrigerator in order to protect qubits from thermal noise during the process of sending control and readout signals to the processor.

The mixing chamber at the lowest part of the refrigerator provides the necessary cooling power to bring the processor and associated components down to a temperature of 15 mK – colder than outer space.

In order to minimize energy loss, the coaxial lines that direct signals between the first and second amplifying stages are made out of superconductors.

Cryogenic isolators enable qubit signals to go forward while preventing noise from compromising qubit quality.

Quantum amplifiers inside of a magnetic shield capture and amplify processor readout signals while minimizing noise.

The quantum processor sits inside a shield that protects it from electromagnetic radiation in order to preserve its quality.

QUANTUM:

www.research.ibm.com/ibm-q/

a	e	k	j	c	b	a	o	a	j
l	g	m	e	e	t	u	p	a	p
l	n	a	v	a	a	j	v	i	o
p	c	m	i	e	t	u	p	a	a
r	d	a	t	a	j	a	j	k	l
u	t	w	i	q	a	y	a	m	h
d	u	e	n	x	v	d	v	g	a
j	o	d	g	t	f	f	a	u	i
a	a	s	o	g	a	g	t	v	c
z	i	a	c	h	j	a	i	b	m

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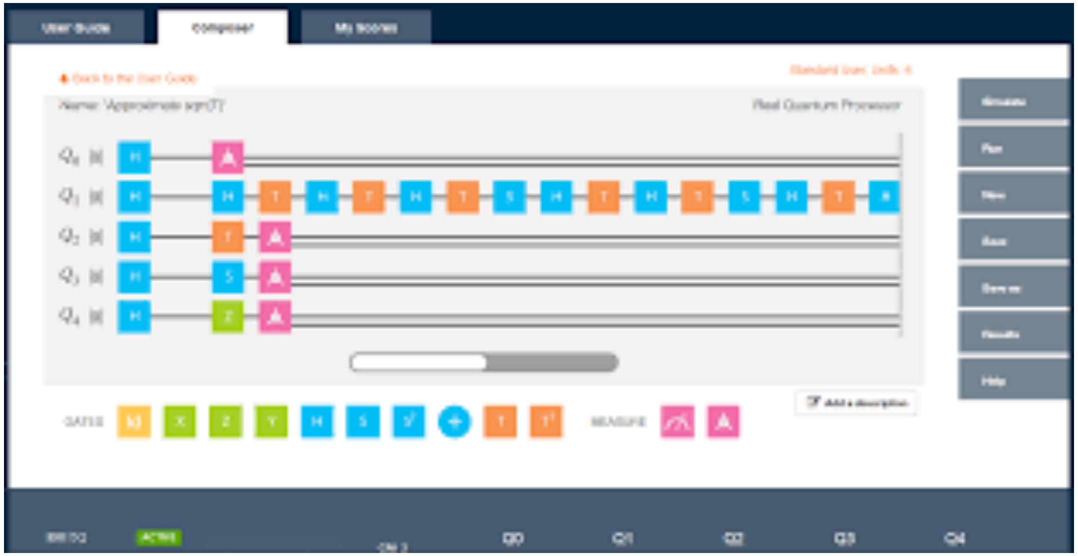
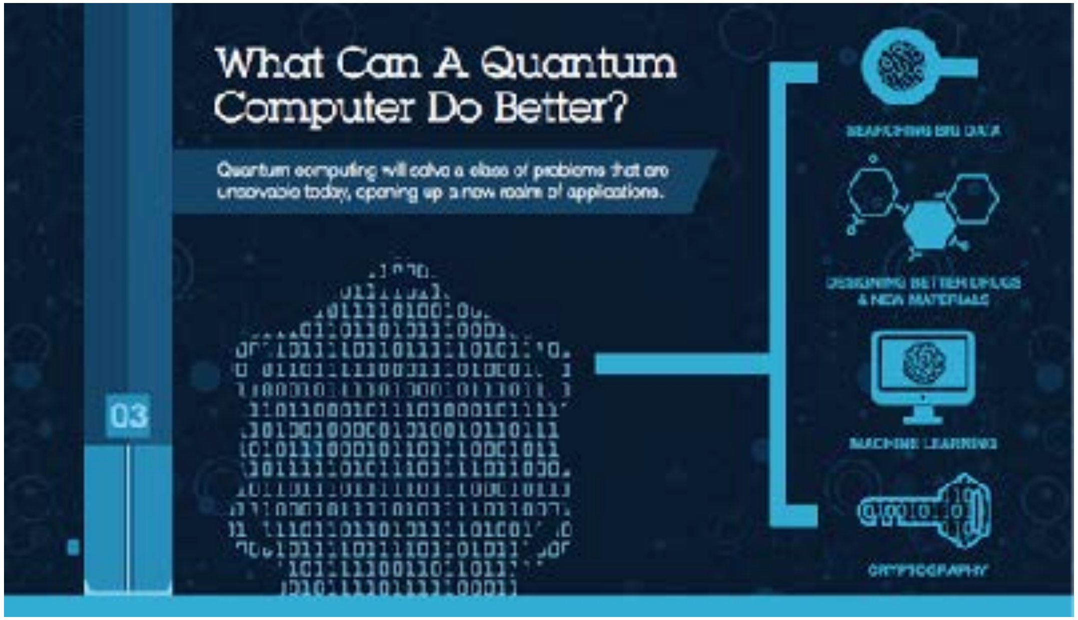




What Can A Quantum Computer Do Better?

Quantum computing will solve a class of problems that are unsolvable today, opening up a new realm of applications.

OPPORTUNITY:

Data flows from every device, replacing guessing and approximations with precise information. Yet 80% of this data is unstructured; therefore, invisible to computers and of limited use to business.

By 2020,

1.7 MB

of new information will be created **every second** for **every human being** on the planet.

HEALTHCARE DATA

99% growth by 2017

88% unstructured

Healthcare data comes from sources such as:

- Patient Sensors
- Electronic Medical Records
- Test Results

GOVERNMENT & EDUCATION DATA

94% growth by 2017

84% unstructured

Government & education data comes from sources such as:

- Vehicle Fleet Sensors
- Traffic Sensors
- Student Evaluations

UTILITIES DATA

93% growth by 2017

84% unstructured

Utilities data comes from sources such as:

- Utility Sensors
- Employee Sensors
- Location Data

MEDIA DATA

97% growth by 2017

82% unstructured

Media data comes from sources such as:

- Video and Film
- Images
- Audio

HOW, AND WHY NOW?

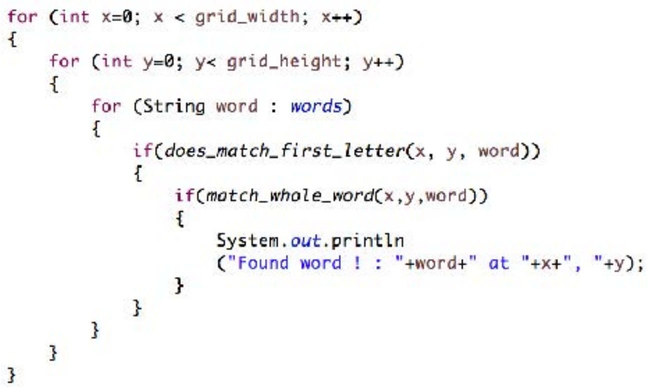
The world is being reinvented in code. Java code.

HOW, AND WHY NOW?

Computing is entering a new cognitive era.

What do you Think when you solve a problem?

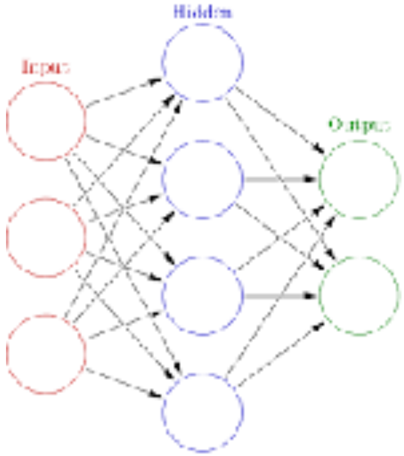
HOW DO YOU THINK?

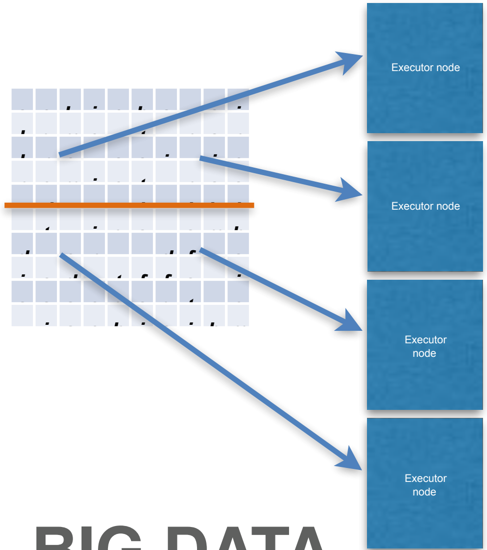


```
for (int x=0; x < grid_width; x++)
{
    for (int y=0; y< grid_height; y++)
    {
        for (String word : words)
        {
            if(does_match_first_letter(x, y, word))
            {
                if(match_whole_word(x,y,word))
                {
                    System.out.println
                    ("Found word ! : "+word+" at "+x+", "+y);
                }
            }
        }
    }
}
```

CLASSIC

NEURAL

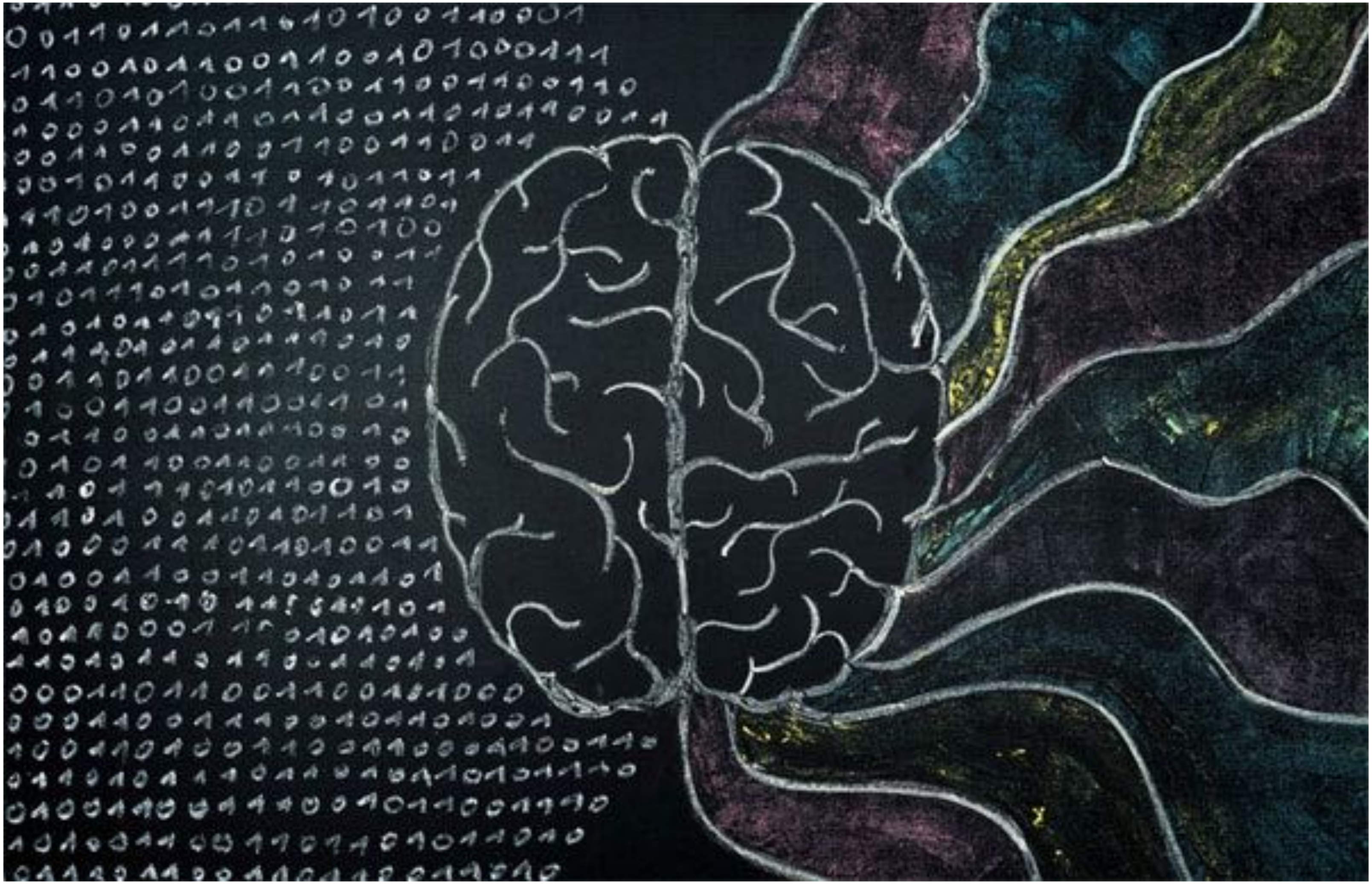




BIG DATA

QUANTUM

THINK TOGETHER



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