ARTIFICIAL INTELLIGENCE

In Clinical Research

Milan,
March 13th
Università Statale

Eng. Massimo Beccaria,
Alfa Technologies International

Agenda

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Definition

02 AI Potential

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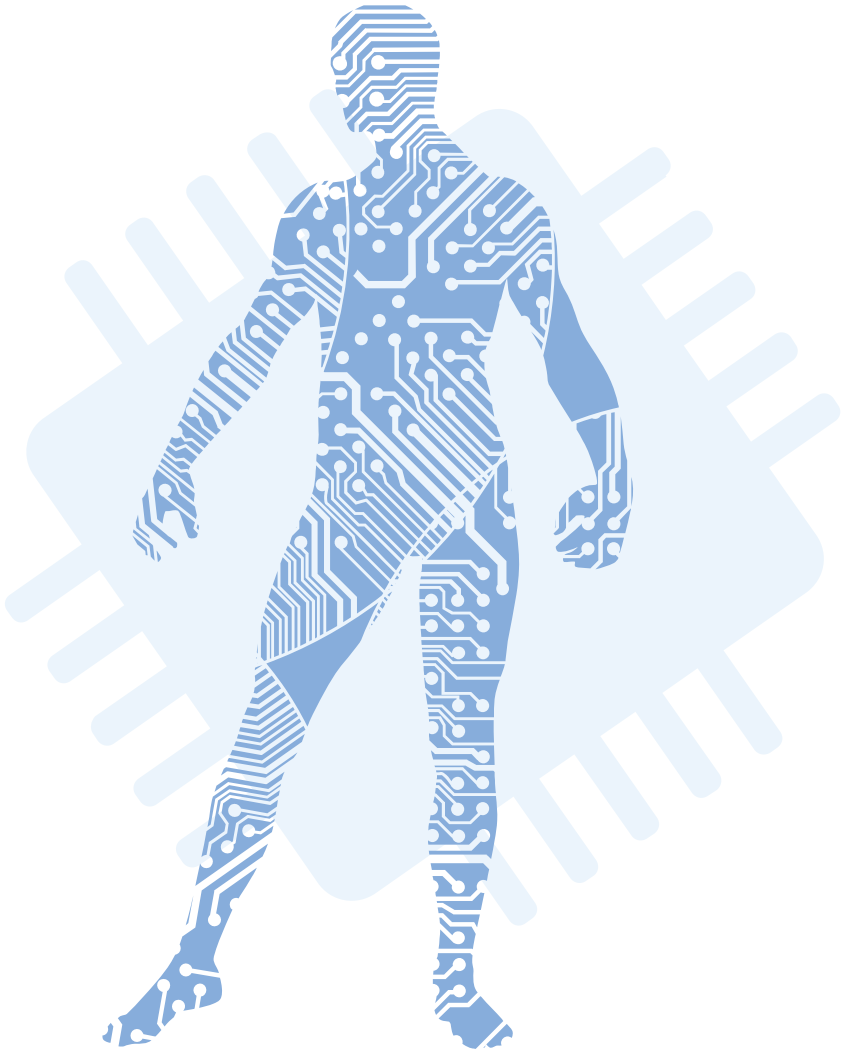
03 Where we could use AI in Healthcare cluster

Market and Actual state of the art of AI

04 Future

Where will lead this

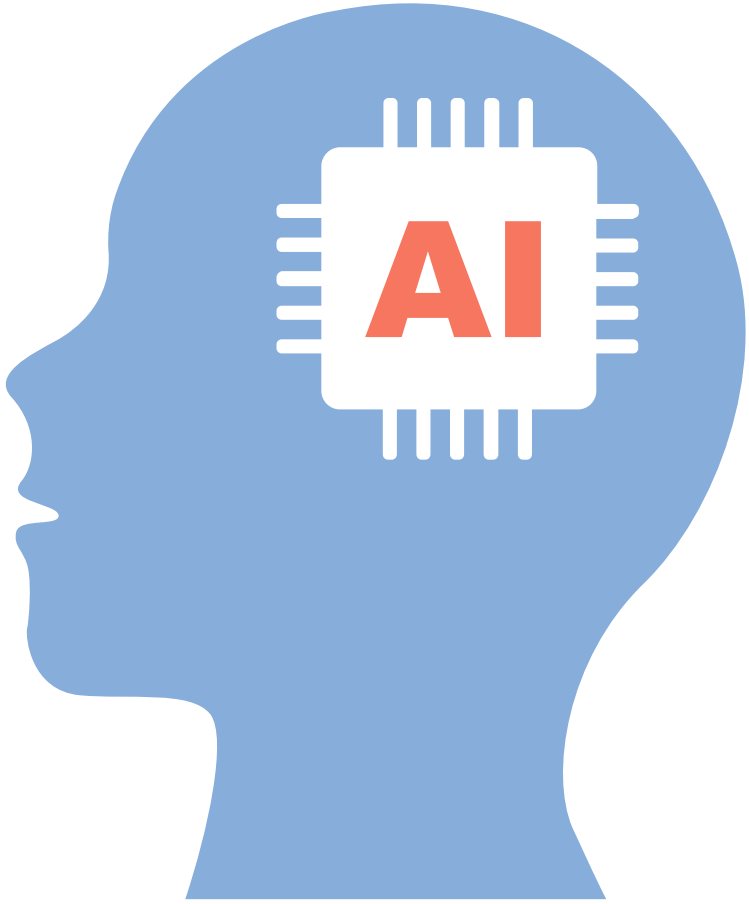


What is AI

Definition and History

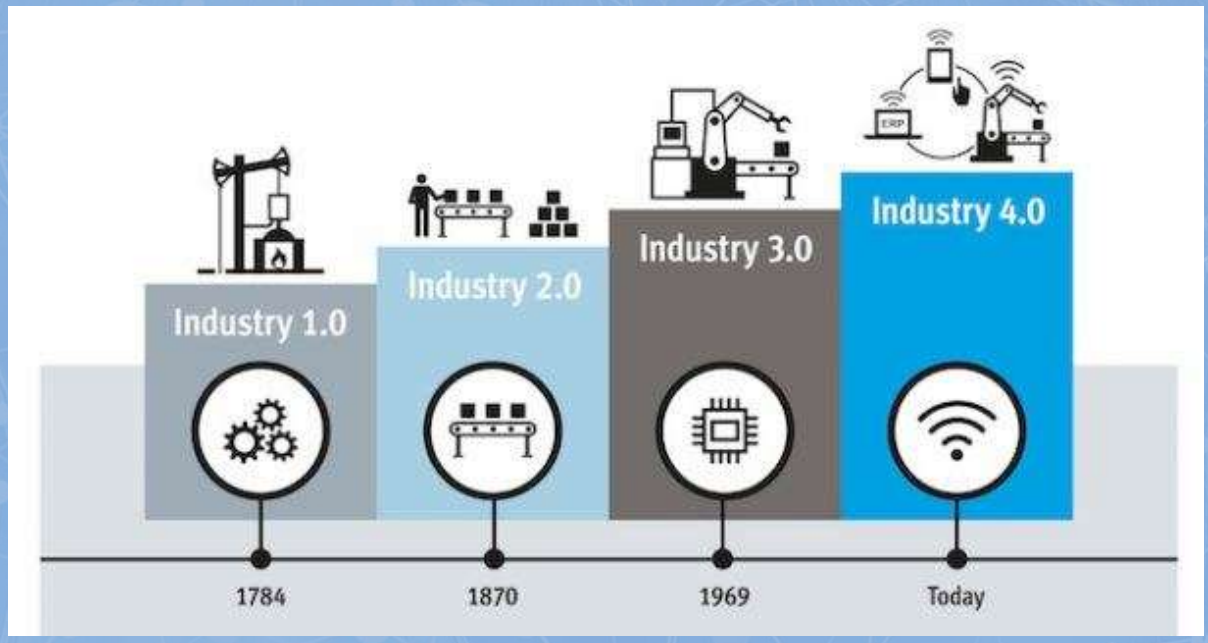
What is ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI), sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals. In computer science AI research is defined as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. Colloquially, the term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving".



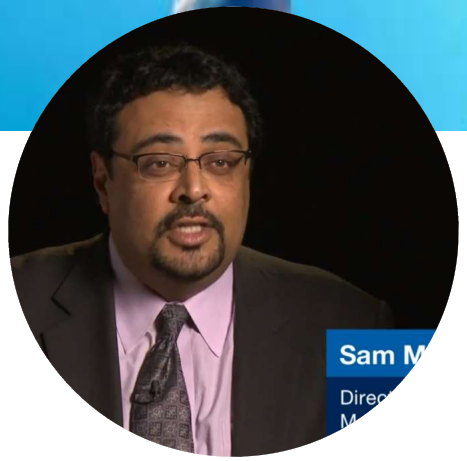
https://en.wikipedia.org/wiki/Artificial_intelligence

The Road for the Artificial Intelligence



4 Industrials Revolutions to came to our days.
The IR gives the possibility to all Humankind to leave the hard work. We substitute muscle with steam and machine.
In the last revolution (That is still ongoing) we are trying to re-create our cognitive process

Market value of Artificial Intelligence

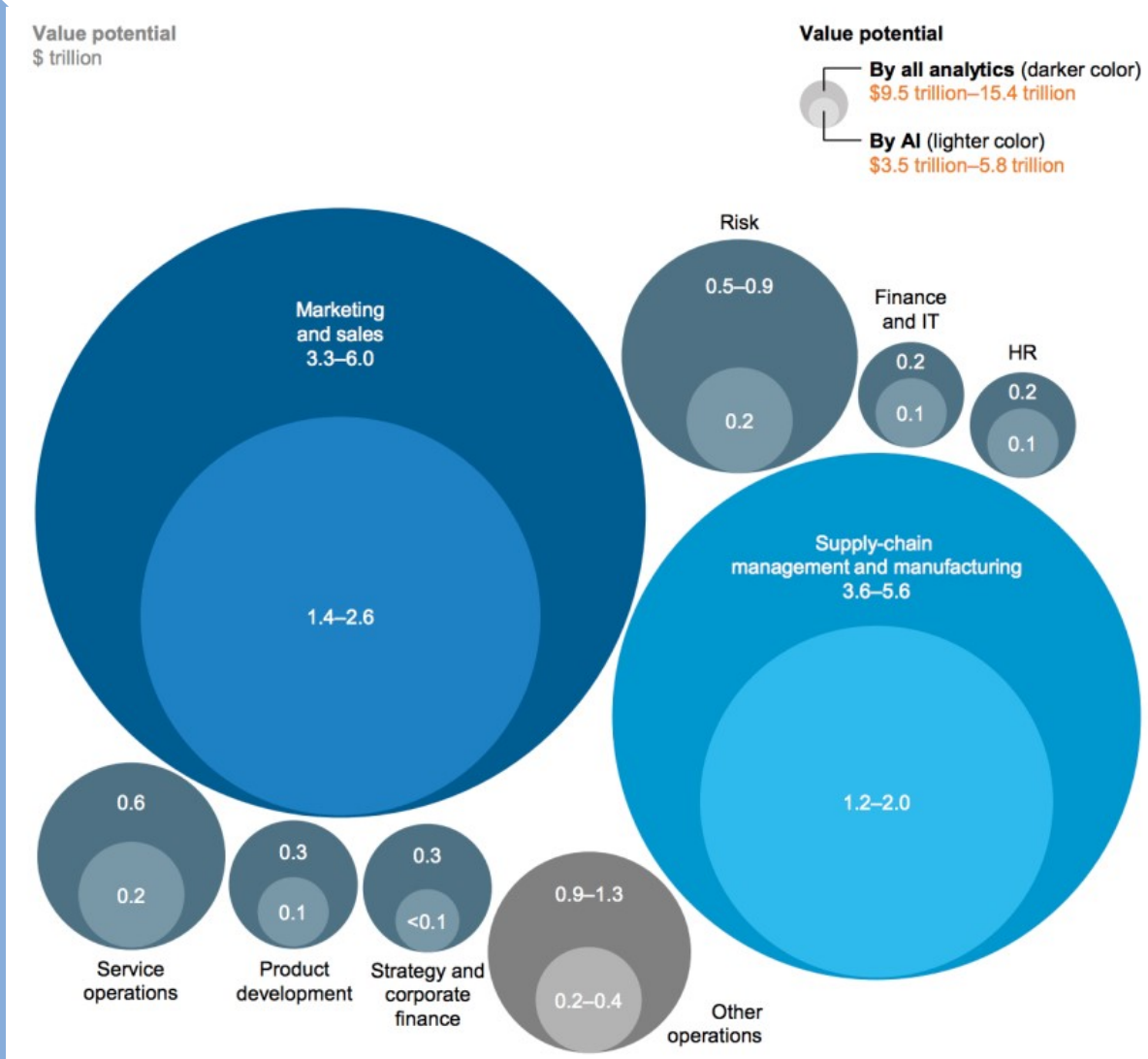


Sam Marwaha

McKinsey director

MICHAEL DOE

McKinsey estimates AI techniques have the potential to create between $3.5T and $5.8T in value annually across nine business functions in 19 industries.



AI can potentially create US$3.5–5.8 trillion in annual value

The report defines AI as deep learning techniques based on artificial neural networks, such as feed forward neural networks, recurrent neural networks (RNN), and convolutional neural networks (CNN). These algorithms have grown from fledgling research subjects to mature techniques in real world use. Advanced AI techniques such as generative-adversarial-networks (GANs) and reinforcement learning are not within the scope of the report.

In the 19 industries studied, AI's potential annual value was between US$3.5 trillion and US$5.8 trillion. Retail is the industry expected to be most impacted by AI at US$0.4–0.8 trillion, followed by travel (US$0.3–0.5 trillion), and transport & logistics (US$0.4–0.5 trillion). Marketing & sales, and supply-chain management & manufacturing are sectors where AI can help companies grow US$1.2–2.6 trillion in annual revenue.

AI Innovative start-up and VC

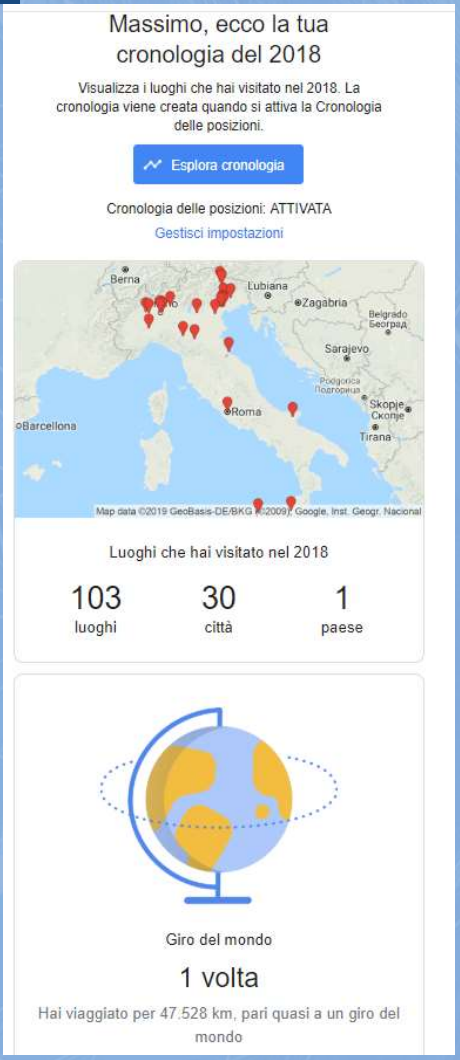
BenevolentAI	Atomwise	Insilico Medicine	Verge Genomics
115 M $	45 M $	20 M $	11 M $
has already made progress, in accelerating drug development	pioneered the use of deep neural Networks for structure based drug design	lead optimization and pre-clinical validation of drug-candidates	AI to develop Therapeutics against Alzheimer's and Parkinson's disease

Artificial Intelligence for Drug Discovery, Biomarker Development, and Generation of Novel Chemistry (https://www.biopharmatrend.com/post/72-2018-ai-is-surging-in-drug-discovery-market/)

Why is so important to us

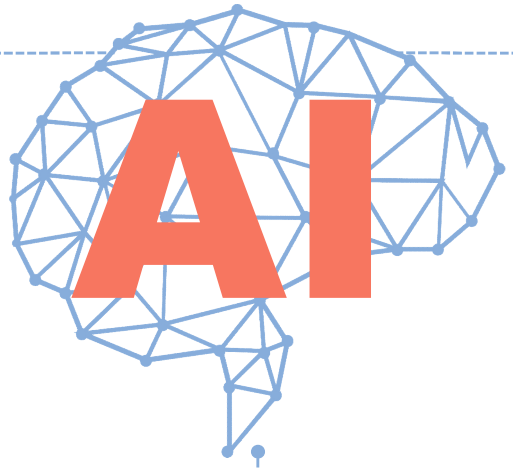
Definition and History

What is for us AI?



We are living in world where the technological creation anticipate our own imagination. Patients now are waiting for the next change.What that was imagination on a few years a go is now the present.

What AI can do for us now



TECHNOLOGY

Could reproduce limited cognitive pattern
Growing the computing power of devices
Growing the Robotic technologies
Growing the storage capacity
Growing battery technology

ENVIRONMENT

Everyone will be introduced in a new connected world
Presence of Big Data
Everyone has a PDA (i.e. smartphone)

VALUE CREATION FOR STAKEHOLDER

BIG PHARMA/BIOMEDICAL COMPANIES

May increase their own market value with AI;
More efficacy and efficiency on research and improvement on their products

PATIENTS

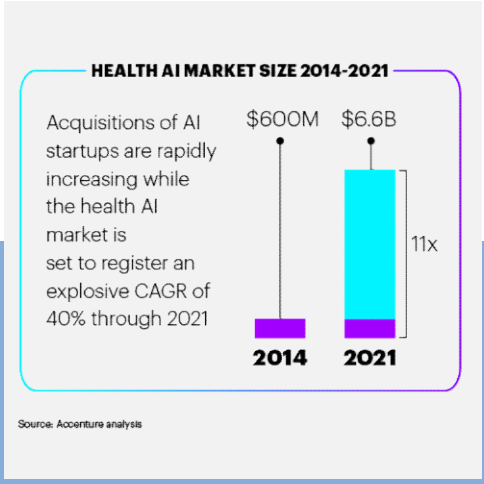
May have access to precision therapy
May save time and have a better qol
May have warning and research improvement

PHYSICIANS/RESEARCHER

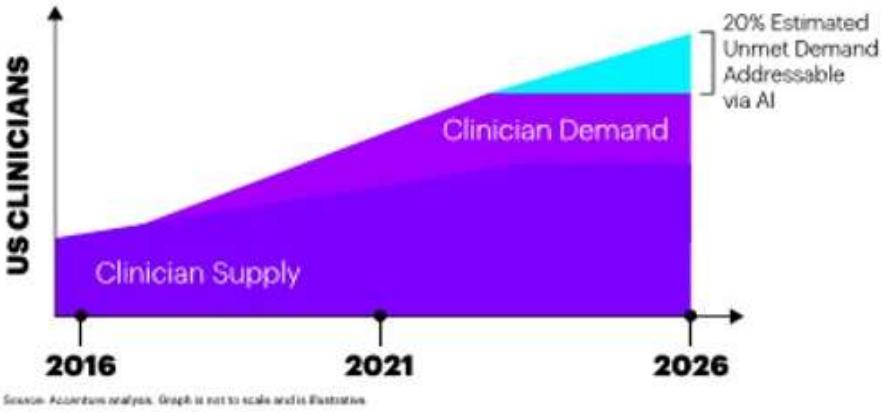
May Improve the research program
May analyze big data in no time
May support diagnosis

Growth opportunities in healthcare are hard to come by without significant investment, but artificial intelligence (AI) is a self-running engine for growth in healthcare.

According to Accenture analysis, when combined, key clinical health AI applications can potentially create $150 billion in annual savings for the US healthcare economy by 2026.



AI can address unmet clinical demand



As AI continues to become more prevalent and adoption flourishes, healthcare organizations must enhance their underlying structure to be positioned to take full advantage of new AI capabilities.

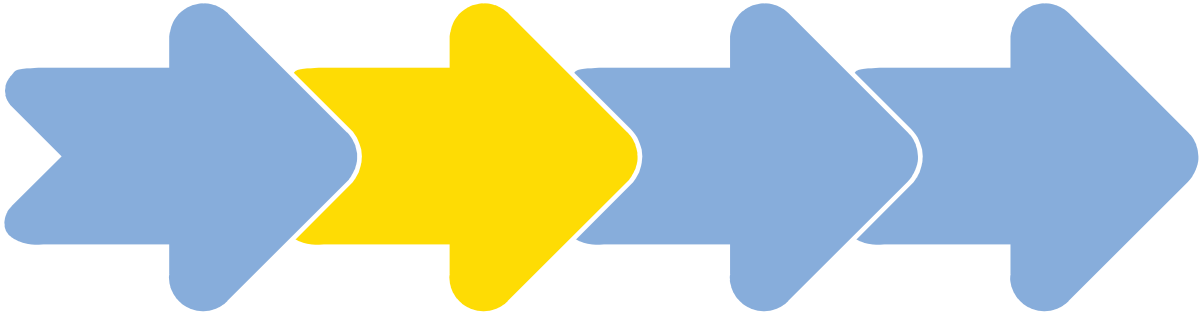
WORKFORCE. The nature of work and employment is rapidly changing and will continue to evolve to make the best use of both humans and AI talent. For example, AI ofers a way to fill in gaps amid the rising labor shortage in healthcare. According to Accenture analysis, the physician shortage alone is expected to double in the next nine years.

AI has the power to alleviate burden on clinicians and give workers tools to do their jobs better. For instance, AI voice-enabled symptom checkers triage patients to lower-cost retail or urgent care settings and direct patients to the emergency department only when emergency care is necessary. AI can address an estimated 20 percent of unmet clinical demand (see Figure).

Where we could use AI in the Healthcare cluster

Market and Actual state of the art of AI

What AI can do for us



01

Reduce Costs

Less time means less money. We could use AI such as a really quick tool to analyze large amount of data and simulate trials

02

Improve the research process with more efficiency and efficacy

Using AI we could save time and be more efficacy/efficiency. Creating a new machine learning models to anticipate issues and enhance research programs

03

Expand our knowledge

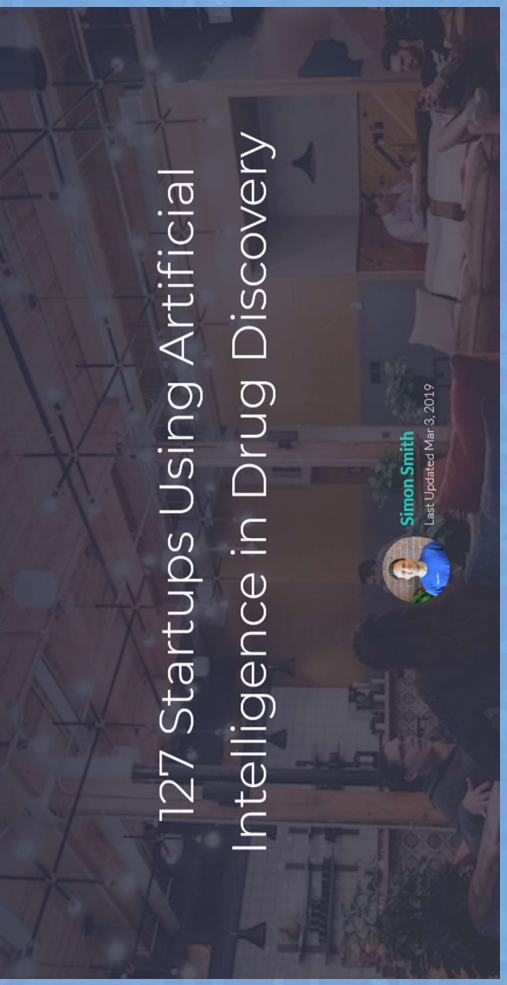
We can use Ai to discover relationship and reproduce a cognitive process to evaluate new drugs or use old drugs to a new thearapeutical indications

04

Faster access to therapy for patients

Patience can enjoy o new AI tools to be a part of the research program and be used in active way

Artificial Intelligence in Drug Discovery



1. Aggregate and Synthesize Information
2. Understand Mechanisms of Disease
3. Generate Data and Models
4. Repurpose Existing Drugs
5. Generate Novel Drug Candidates
6. Validate Drug Candidates
7. Design Drugs
8. Design Preclinical Experiments
9. Run Preclinical Experiments
10. Design Clinical Trials
11. Recruit for Clinical Trials
12. Optimize Clinical Trials
13. Publish Data

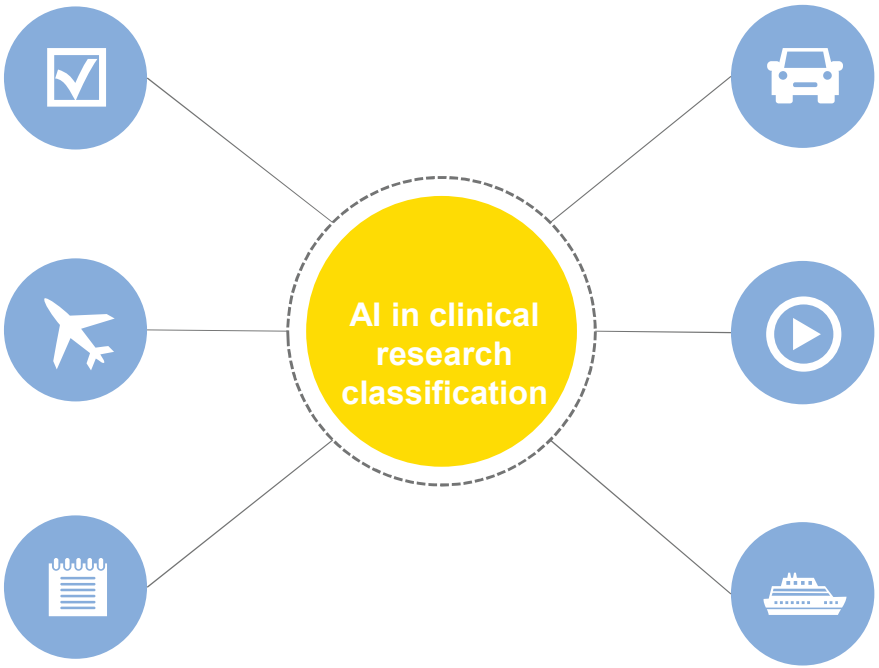
https://blog.benchsci.com/startups-using-artificial-intelligence-in-drug-discovery#step3

Clinical Research

Find and create big data to analyze:
I.A. that harvest between several databases and aggregate data, Use Ai to extract structural biological knowledge to power drug discovery application

Cognitive approach to discover relationship
Uses AI to: Analyze genomic data related to cancer and other diseases, Find applications for existing approved drugs or clinically validated candidates.

Optimize the process:
Uses Ai to:create a Chat bot or machine learning system to prevent issue on clinical trials, Optimize oncology drug development with a biomarker monitoring platform and millions of patient datapoints



Match the right patients to the right cure
Uses AI to Enroll more patients in appropriate trials, or uses AI to Analyze medical records to find patients for clinical trials

Simulate clinical trials and silico
Uses AI to Run experiments in a central lab from anywhere in the world, or use ai to Optimize, reproduce, automate, and scale experiment workflows.

Publish data;
Uses AI to Write a draft scientific manuscript based on provided data.

A new drug in the market

$2.5B

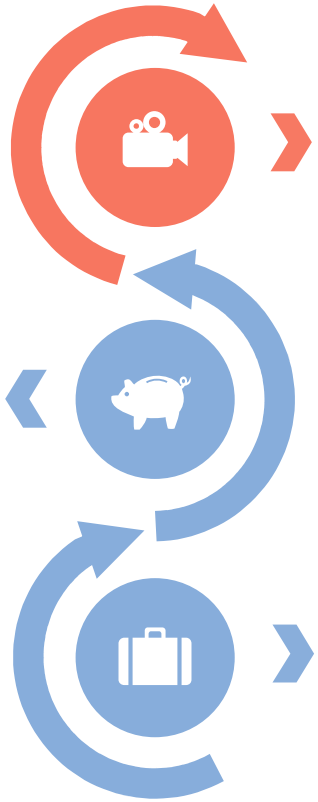
The cost of a typical drug to be introduced in the market

10 YEARS

Or more to identify new candidates - need all the help you can get?.

1/10 DRUGS

That enter phase 1 reach to patient - we need change



Mckinsey Report

About the use of AI In Healthcare cluster

Predictive modeling of biological processes and drugs becomes significantly more sophisticated and widespread

By leveraging the diversity of available molecular and clinical data, predictive modeling could help identify new potential-candidate molecules with a high probability of being successfully developed into drugs that act on biological targets safely and effectively

Trials are monitored in real time

Trials are monitored in real time to rapidly identify safety or operational signals requiring action to avoid significant and potentially costly issues such as adverse events2 and unnecessary delays

Patients are identified to enroll in clinical trials based on more sources—for example, social media—than doctors' visits

Furthermore, the criteria for including patients in a trial could take significantly more factors (for instance, genetic information) into account to target specific populations, thereby enabling trials that are smaller, shorter, less expensive, and more powerful

real-time and predictive analytics that generate business value.

Instead of rigid data silos that are difficult to exploit, data are captured electronically and flow easily between functions, for example, discovery and clinical development, as well as to external partners, for instance, physicians and contract research organizations (CROs). This easy flow is essential for powering the real-time and predictive analytics that generate business value.

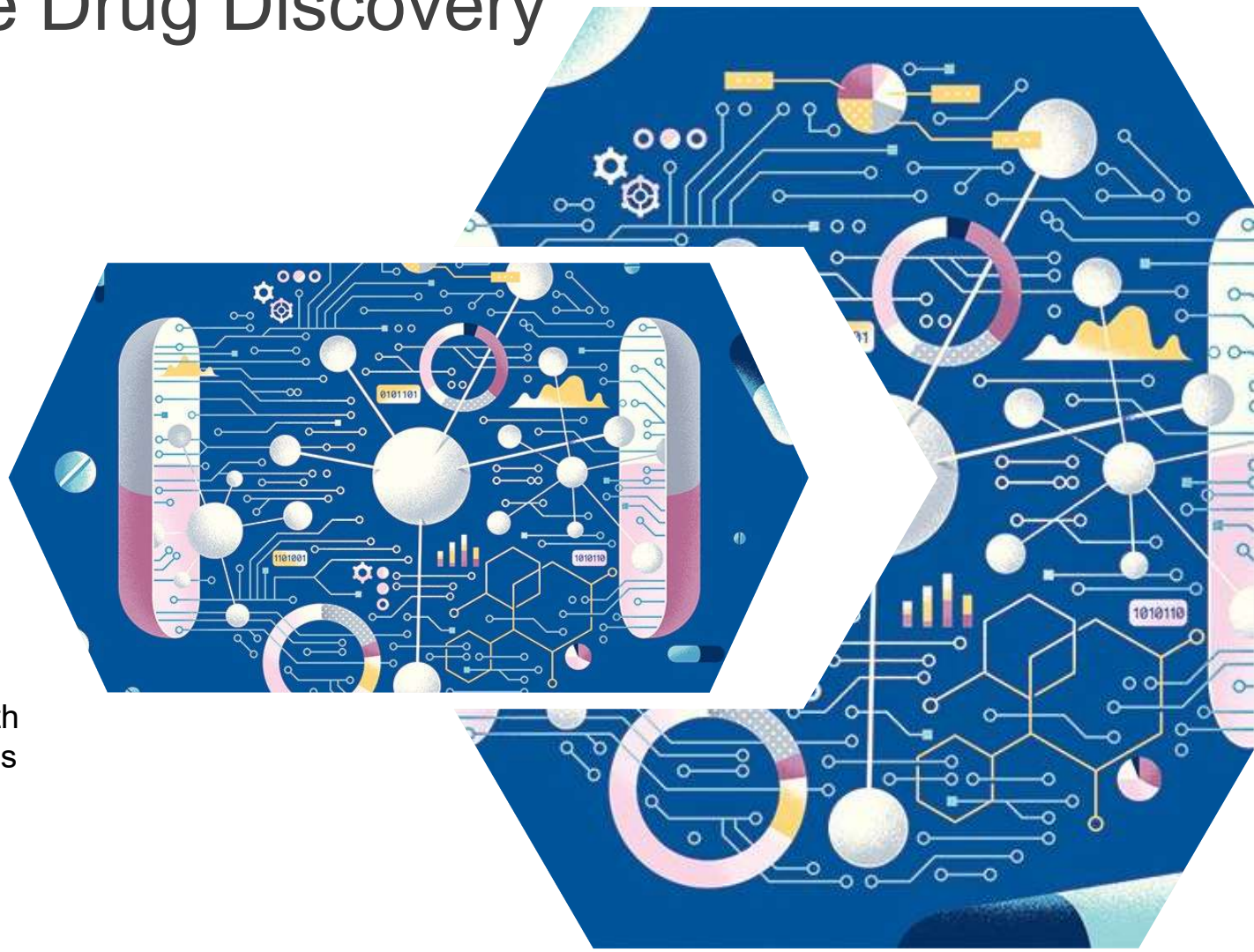
https://www.mckinsey.com/industries/pharmaceuticals-and-medical-products/our-insights/how-big-data-can-revolutionize-pharmaceutical-r-and-d

How AI could help the Drug Discovery

HERE COME THE ROBOTS

When the time comes for the history of artificial intelligence (AI) to be written, the algorithm that gets the job is likely to flag **12 June 2007** as worthy of note. That was the day that a robot called Adam ended humanity's monopoly on the discovery of scientific knowledge **— by identifying the function of a yeast gene**.

By searching public databases, Adam generated hypotheses about which genes code for key enzymes that catalyse reactions in the yeast *Saccharomyces cerevisiae*, and used robotics to physically test its predictions in a lab. Researchers at the UK universities of Aberystwyth and Cambridge then independently tested Adam's hypotheses about the functions of 19 genes; 9 were new and accurate, and only 1 was wrong.

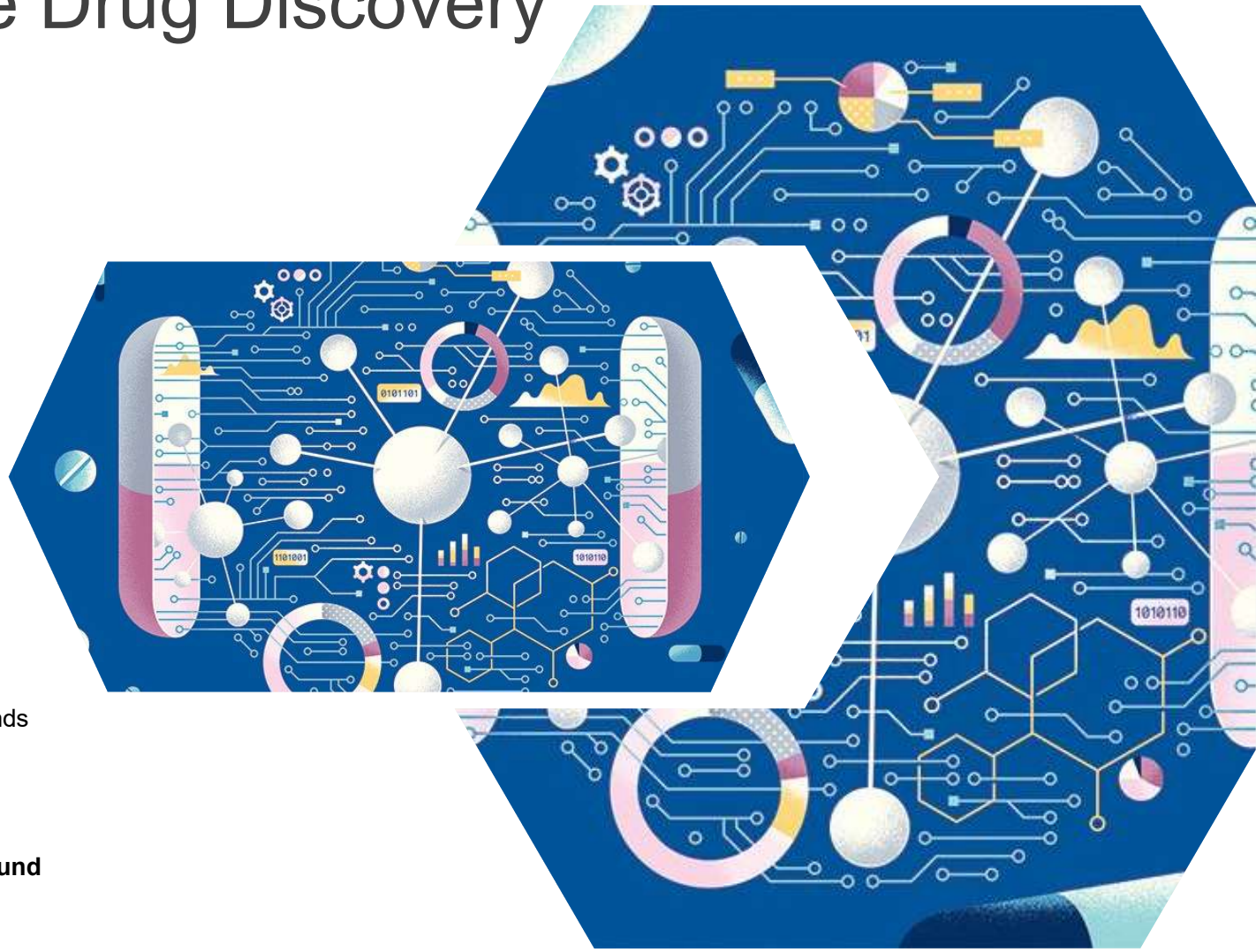


https://www.nature.com/articles/d41586-018-05267-x

How AI could help the Drug Discovery

London-based start-up firm **BenevolentBio (subsidiary of benevoltAI)** has its own AI platform, into which it feeds data from sources such as research papers, patents, clinical trials and patient records. This forms a representation, based in the cloud, of more than one billion known and inferred relationships between biological entities such as genes, symptoms, diseases, proteins, tissues, species and candidate drugs. This can be queried rather like a search engine, to produce ‘knowledge graphs’ of, for example, a medical condition and the genes that are associated with it, or the compounds that have been shown to affect it. Most of the data that the platform crunches are not annotated, so it uses natural-language processing to recognize entities and understand their links to other things. “AI can put all this data in context and surface the most salient information for drug-discovery scientists,” says Jackie Hunter, chief executive of BenevolentBio.

When the company asked this system to suggest new ways to treat amyotrophic lateral sclerosis (ALS), also known as motor neuron disease (MND), it flagged around 100 existing compounds as having potential. From these, scientists at BenevolentBio selected five to undergo tests using patient-derived cells at the Sheffield Institute of Translational Neuroscience, UK. **The research, presented at the International Symposium on ALS/MND in Boston, Massachusetts, in December 2017, found that four of these compounds had promise, and one was shown to delay neurological symptoms in mice**.



https://www.nature.com/articles/d41586-018-05267-x

Some Italian projects that uses AI

DIH-HERO

Project of Robotic and AI integration for Horizon 2020 (politecnico di Milano, Scuola Sant'anna di Pisa and Istituto Italiano di Tecnologia.

Opportunity Project

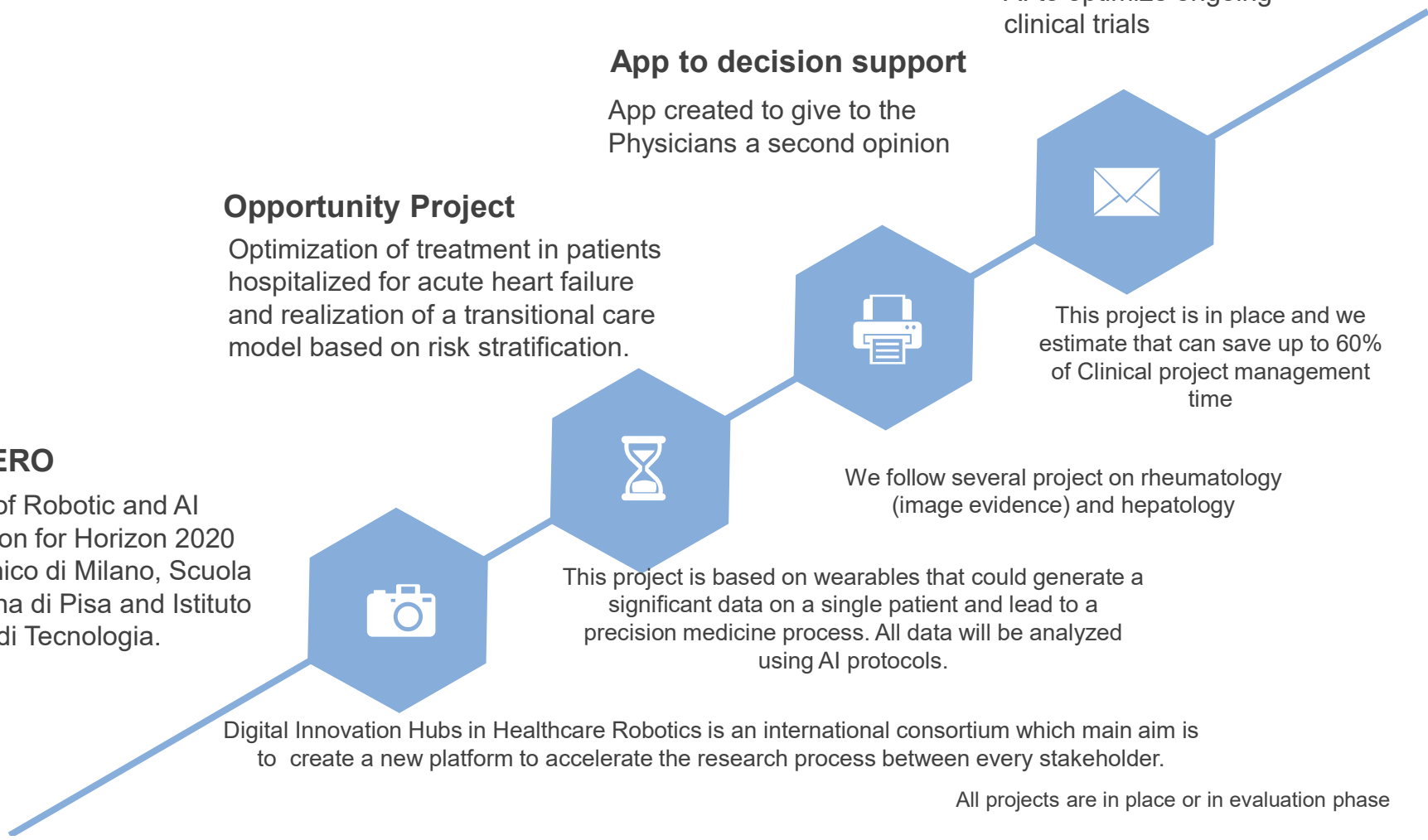
Optimization of treatment in patients hospitalized for acute heart failure and realization of a transitional care model based on risk stratification.

App to decision support

App created to give to the Physicians a second opinion

Optimization of CT

A Virtual avatar based on AI to optimize ongoing clinical trials



Digital Innovation Hubs in Healthcare Robotics is an international consortium which main aim is to create a new platform to accelerate the research process between every stakeholder.

This project is based on wearables that could generate a significant data on a single patient and lead to a precision medicine process. All data will be analyzed using AI protocols.

We follow several project on rheumatology (image evidence) and hepatology

This project is in place and we estimate that can save up to 60% of Clinical project management time

All projects are in place or in evaluation phase

Future

Where this will lead

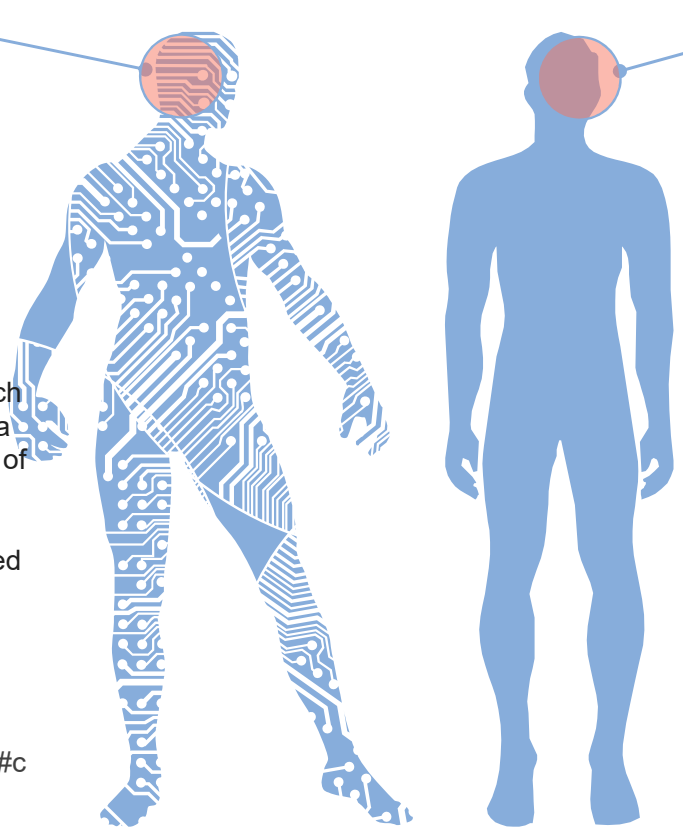
Hardware used

AI

- Energy needs:for Summit (SC) is 13 Mw
- Structure:2d
- Storage: about 10 petabyte= 10^{16} byte*
- Computing power: for Summit (SC) is 200 petaflops
- Composition: about 75% is silicon

- Summit occupies the size of two tennis courts and each hosts over 9216 22-core CPUs and over 27,648 Nvidia Tesla. In total the system has more than 10 petabytes of memory. Cooling the system requires 4000 gallons of water per minute and uses enough energy to power 8100 homes. 185 miles of fiber-optic cables are needed to connect the whole thing

- https://en.wikipedia.org/wiki/Summit_(supercomputer)#cite_note-tomssummit-2



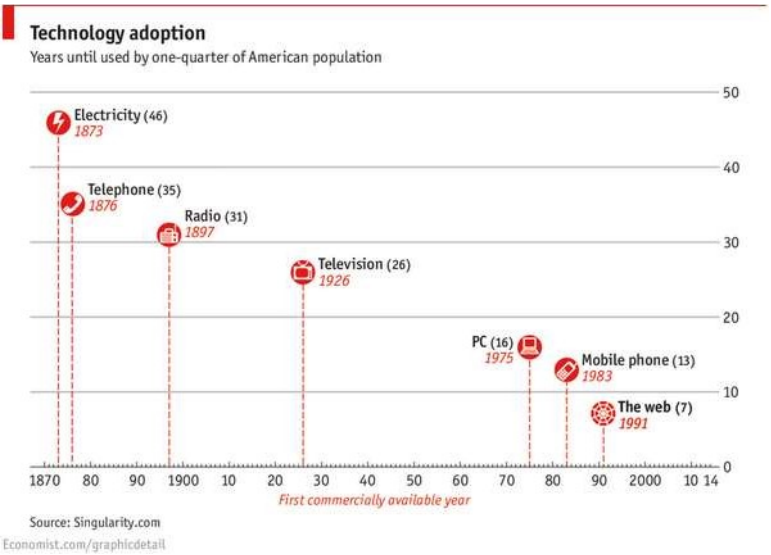
Human brain

- Energy needs:About 20-40w
- Structure:3d
- Storage: generally unknow, but recent research estimate in about 1 petabyte= 10^{15} byte*
- Computing power: generally unknow, for Dharmendra Modha, chief scientist of IBM, is low than 38 petaFLOPS
- Composition: about 75% is water

*https://www.repubblica.it/scienze/2016/01/24/news/capienza_dati_cervello_umano-131950767/?refresh_ce

Be Aware! Brain and Ai works differently…this is only a simulation

Technological Adoption



Past:

Changes were inter generational and society, people, productive systems could adapt

Past:

Positive workforces could balance in the long term

Today

Changes are Intra generational and society, people, productive systems have no time to adapt

Today

Negative workforces in the short term, no proof to be balanced in the long term

Why AI is so important for us

Artificial Intelligence FAQ

Machine no human

Today che cost for operation is huge. AI could use to send humans to mars not to cooking eggs

No pain No gain

Humans are the products of a survival selection. They try to adapt to the environment and for that reason the nature used tricks such as death or reproduction in order to give the best chance to survive to the humankind. Machines have no these nees…

Does AI will replace Humans?

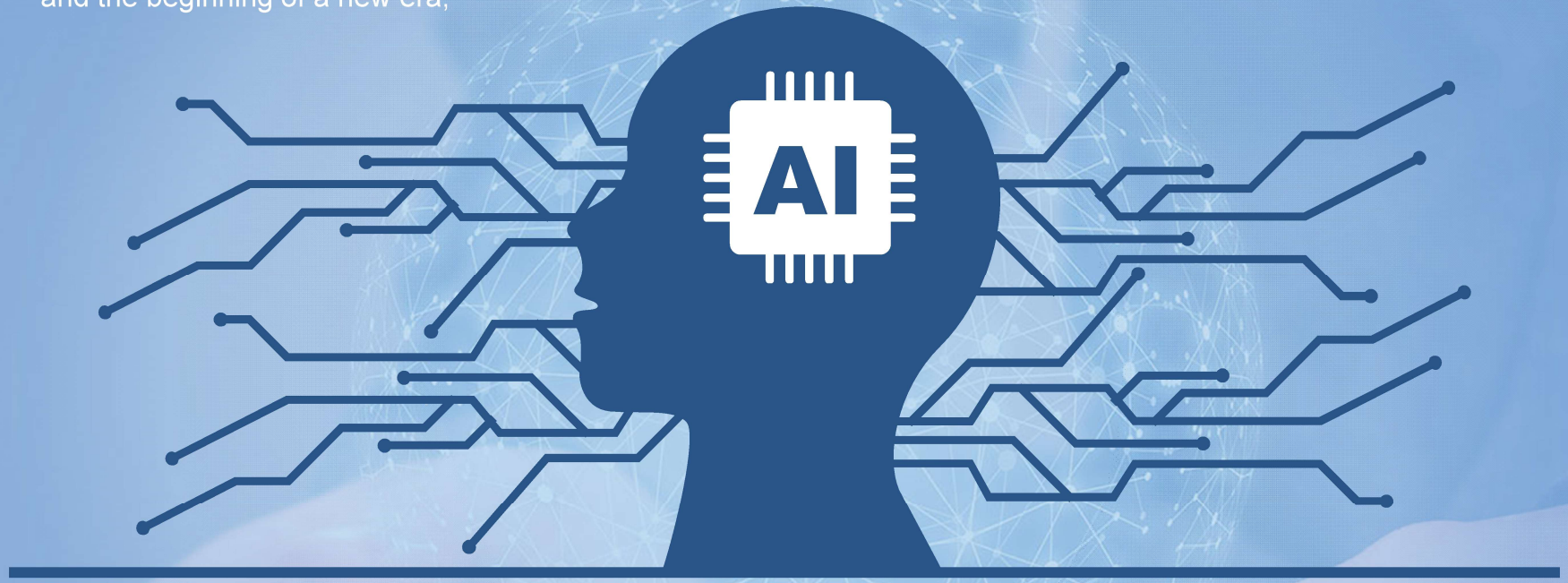
Yes, but only those one that are making work for Robot. Humans could have time to empower themselves and start new job filled of new skills

A.I. treats or opportunity?

Opportunity if we invest in continuous learning and create a social awareness and we could metabolize the innovation .

POSITIVE
SINGULARITY
mathematical singularity; that is, the point where a mathematical function tends to infinity. advantages are expected for humanity and the beginning of a new era,

NEGATIVE
SINGULARITY:
gravitational singularity; or in astrophysics the point in space-time where gravity tends to infinity and everything can happen



Singularity

Thanks to the new connective technology, one future possibility is to create a centralized intelligence where we connect robots and devices. This is a new species and is no equivalent to the biological species

I.A.

Discorso di Papa Francesco ai partecipanti all'assemblea plenaria della Pontificia accademia per la vita sul tema “Roboetica. Persone, macchine e salute”, durante l'udienza privata tenuta in Sala Clementina lunedì 25 febbraio

Conosciamo le difficoltà in cui il nostro mondo si dibatte. Il tessuto delle relazioni familiari e sociali sembra logorarsi sempre più e si diffonde una tendenza a chiudersi su di sé e sui propri interessi individuali, con gravi conseguenze sulla «grande e decisiva questione dell’ unità della famiglia umana e del suo futuro» (Lett. *Humana communitas*, 2). Si delinea così un drammatico paradosso: proprio **quando l’ umanità possiede le capacità scientifiche e tecniche per ottenere un benessere equamente diffuso, secondo la consegna di Dio, osserviamo invece un inasprimento dei conflitti e una crescita delle disuguaglianze**.

Il mito illuminista del progresso declina e l’ accumularsi delle potenzialità che la scienza e la tecnica ci hanno fornito non sempre ottiene i risultati sperati. Infatti, da un lato lo sviluppo tecnologico ci ha permesso di risolvere problemi fino a pochi anni fa insormontabili, e ne siamo grati ai ricercatori che hanno conseguito tali risultati; d’ altro lato sono emerse difficoltà e minacce talvolta più insidiose delle precedenti. **Il “poter fare” rischia di oscurare il *chi* fa e il *per chi* si fa.** Il sistema tecnocratico basato sul criterio dell’ efficienza non risponde ai più profondi interrogativi che l’ uomo si pone; e se da una parte non è possibile fare a meno delle sue risorse, dall’ altra esso impone la sua logica a chi le usa.

Eppure la tecnica è caratteristica dell’ essere umano. Non va compresa come una forza che gli è estranea e ostile, ma come un prodotto del suo ingegno attraverso cui provvede alle esigenze del vivere per sé e per gli altri. **È quindi una modalità specificamente umana di abitare il mondo.** Tuttavia, l’ odierna evoluzione della capacità tecnica produce un incantamento pericoloso: **invece di consegnare alla vita umana gli strumenti che ne migliorano la cura, si corre il rischio di consegnare la vita alla logica dei dispositivi che ne decidono il valore.** Questo rovesciamento è destinato a produrre esiti nefasti: la macchina non si limita a guidarsi da sola, ma finisce per guidare l’ uomo. La ragione umana viene così ridotta a una razionalità alienata degli effetti, che non può essere considerata degna dell’ uomo.


Thank You
Massimo Beccaria
Alfa Technologies International
Polihub Milano