Artificial Intelligence and Business Analysis

Examining Practical Implementations of AI in the BI space.

Matthew R. Versaggi

- Senior Director of Artificial Intelligence and Cognitive Technology
- Distinguished Engineer

- United Healthcare / Optum Technology

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Matthew R. Versaggi – Background

Sr. Dir of AI, ML, & CT + DE

- Optum Technology

Artificial Intelligence Engineer

- Military Contractor

Philosopher

- Passion decades long
- Dozen+ formal courses

Entrepreneur

- CEO IT company
- Nearly 20 years

Education

- 4 University Degrees
  1. BA - Comp Science
  2. BS - Fin / MIS
  3. MS - CS (AI)
  4. MBA – (Int Biz/Econ)

- Professional Certificates
  - 2 in Security (Server/Network)
  - 1 Data Science / Machine Learning
  - 2 Artificial Intelligence
  - 4 Quantum Computing

AI Developer

- CNA Insurance

Adjunct Professor

- DePaul University
- Graduate School of Business
- 8 years
- Teaching Award

CIO

- Dental Insurance Co.

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Matthew R. Versaggi – Various Roles & Responsibilities

Technical SME (AI)

- Introduced **Intelligent Agents 2016**
  - ✓ Put into production solving VMWare problems
- Introduced **Cognitive Technology 2019**
  - ✓ Socialized via Dev Days
  - ✓ Standing up competencies via education Pgm
  - ✓ Plans to scale EDU pgm via College of AI
  - ✓ Creating a pipeline of CogTech projects
  - ✓ Project Work commencing in Q4 2019
- Introduced **Quantum Computing 2018**
  - ✓ Developing EDU Pedagogy
  - ✓ Establishing QC Business Case
  - ✓ Created a Optum QC Community

Education SME

- Created first AI Education Pilot Program – AI Engineers
- Helped create the College of Artificial Intelligence for the OTU
- Established Pedagogy for Technical SME's in the CoAI
- Helped establish the CMU/Optum Executive Ed AI / Biz Program
- Official Mentor for CMU/Optum Executive Ed AI / Biz Program

Thought Leader / Evangelist

- 46 Unique speaking engagements
- 14 Weeks of Travel w/Dev Days
- ✓ 1000's of Engineers Reached
- Founded MN AI Meetup Group
- Co-Organized MN Quantum Meetup Group
- Created Optum's AI day (Halicon Event)
- Preparing an Optum Quantum Event in 2020
- Curated AI Repository of resources

Senior Leader: Delivery

- 2.5 Years Leading Global AI / ML Team (**SD&SS / ATC**)
- Examined 260+ use Cases
- Delivered 74 projects in 2 years+
- Significant value delivered to enterprise

Strategist

- Actively engaged in A / Biz strategy formulation
  - ✓ Mentor for Optum / CMU Executive Ed AI / Biz Pgm
  - ✓ Altruistic: Mentor external enterprises in AI Strategy
  - ✓ Active speaker on AI Strategy

Mentor

- 3 Years – Next^3 AI Startup Mentor
- DSU Mentor
- CoAI Mentor
- Mentor to Engineers, Interns, TDPers and Executives.

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My Gift to You

Artificial Intelligence Repository

matt-versaggi.com/mit_open_courseware

This is the AI Repository compiling **years** of biz / tech AI materials in this one space.

Actively Maintained

Agenda

1. Goals for the Audience (*the value add of this presentation*)
2. Level Setting (*What is Artificial Intelligence, really?!*)
3. AI as a **GPT** (*General Purpose Technology)*

4. What is Data Science?
5. What is Machine Learning?
6. What is Deep Learning?
7. What are Intelligent Agents?
8. What are Graph Databases?

9. Getting started on an AI Project for BI Folks.
10. Who employs AI – a HC Example Driven Approach.
11. The Razors Edge (*Cognitive and Quantum Computing*)

12. Questions
13. References

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Level Setting

Terms and Definitions

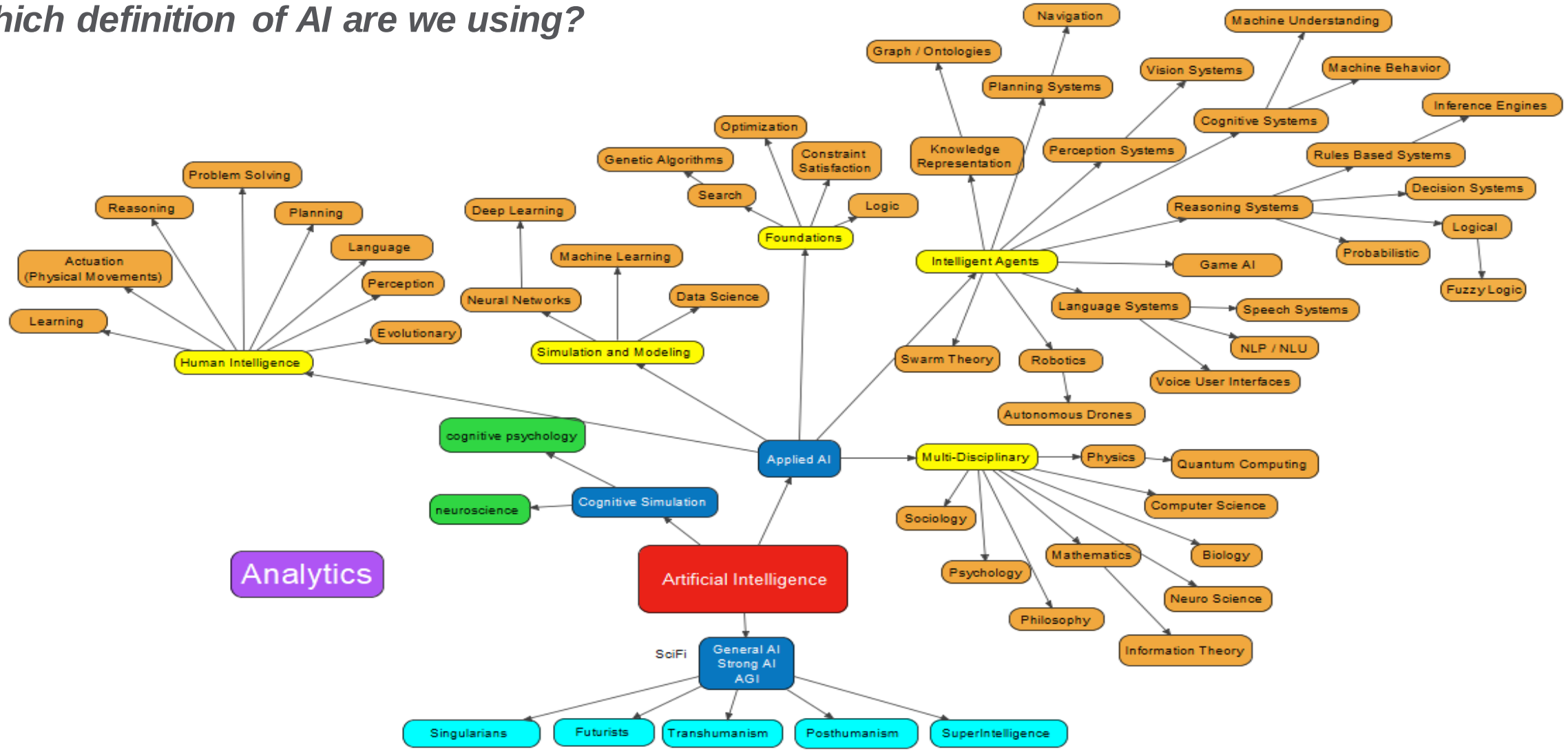
What is Artificial Intelligence?

The **essence** of **Artificial Intelligence** is about emulating the following human characteristics with the **hope** of actually creating them someday:

1. Learning
2. Reasoning
3. Problem Solving
4. Perception
5. Planning
6. Language
7. Actuation (movement)
8. *Evolutionary*

Level Setting

Which definition of AI are we using?



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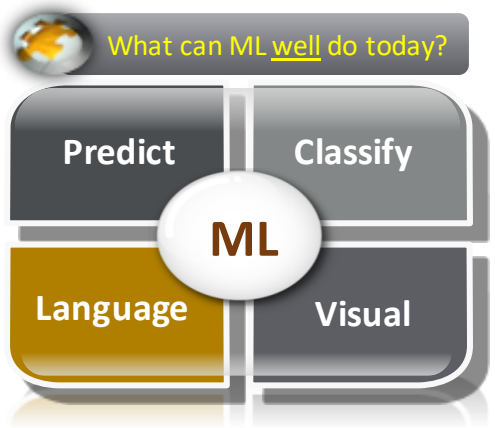
Machine Learning - & - Cognitive Technology

- Complementary (yet very different) Technologies.

Machine Learning: (ML)

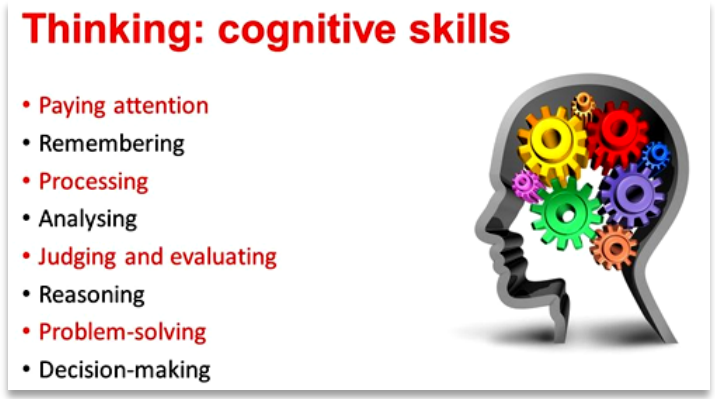
Machine Learning is made for tasks that require learning from data and then predicting, classifying or clustering information, images, or language elements.



Cognitive Technology: (CT)

What can CT do well today?

Cognitive Technology is made for tasks that require human cognitive skills, most particularly reasoning and problem solving skills. This type of AI "thinks" like humans do.



ML is not good at *augmenting* humans, *explaining* its decisions, and tasks requiring *reasoning*.

ML needs data to learn from.

Example Use-Cases:

- Emergency Room Predictions
- Provider Fraud Predictions
- Medical Coder Classification
- X-Ray / CT Scan Classification
- Automated Benefits Inquiry
- EOB language Translation
- Patient / Provider Matching
- Anti-Fraud Location Classification

Example Use-Cases:

- Clinical Decision Support Engine
- Automated Plan of Care Creation
- Augmented Medical Diagnostics
- Ambient Monitoring for Elderly Facilities
- Telemedicine Automated Triage
- Medical Digital Assistants

CT is not good at crunching *big data*, data *analytics*, or *business intelligence*.

CT needs situational context and experts to learn how to "**think**" from.

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Level Setting

Which definition of AI are we using?

AI Technologies:

[DS,ML,DL, RL]	Data Science ,Machine Learning, Deep Learning, Reinforcement Learning
[KR, GD, KG]	Knowledge Representation: (Graph Databases, Ontologies, and Knowledge Graphs)
[RPA]	Robotic Process Automation
[LS]	Language Systems : (NLP, NLU, Speech and Voice Systems)
[CB, IAS]	Chat Bots and Intelligent Assistants
[VS]	Vision Systems : (Image and Vision processing)
[IA, RL]	Intelligent Agents, Reinforcement Learning
[RS, ES, LS]	Reasoning Systems : (Expert Systems, Logic Systems)
[F]	Foundations : (Logic, Constraint Satisfaction, Search)
[CEP]	Complex Event Processing

Level Setting

Which definition of AI are we using?

AI Technologies:

Knowledge Representation: – method to structure knowledge in a way that supports automated reasoning capabilities.

Robotic Process Automation - software bots that are programmed and trained to replicate the actions of humans interacting with a desktop software applications.

Intelligent Assistants – akin to Halo's Cortana!

Intelligent Agents – akin to the swarming enemies in First Person Shooter games (eg. Halo).

Complex Event Processing – uses *temporal reasoning* (time based logic) to analyze real-time data streams looking for meaningful patterns.

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AI as a GPT

Artificial Intelligence as a
General Purpose Technology (GPT)

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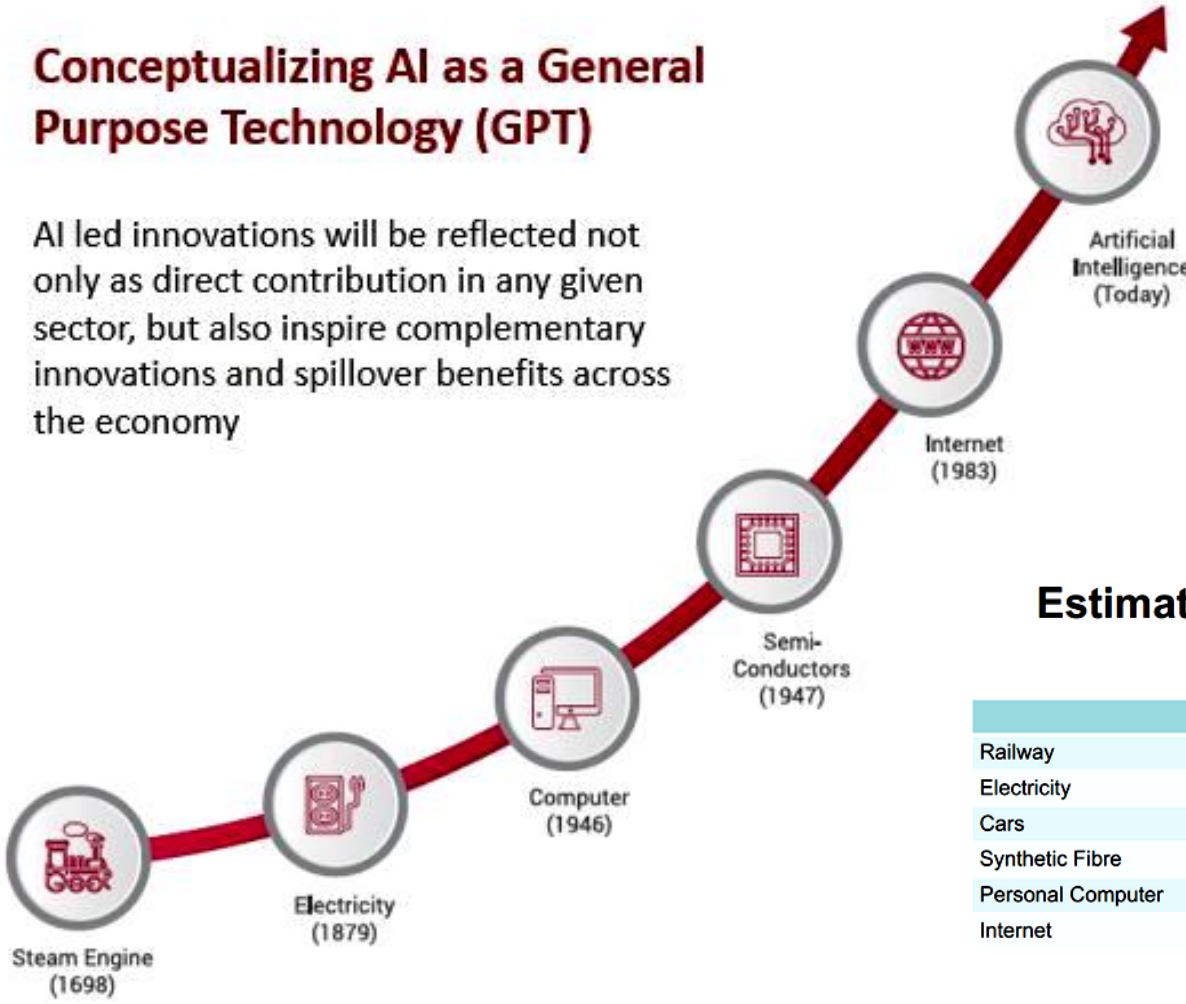
Artificial Intelligence as a *General Purpose Technology* (**GPT**)

General-purpose technologies (**GPTs**) are technologies that *can affect an entire economy* (usually at a **national** or **global** level).

***GPTs** have the potential to drastically alter societies through their impact on pre-existing economic and social structures.*

The historical record suggests that dismal prophecies about the economic and social impact of great technological advances **rarely** come to pass. Thus, with AI poised to emerge as the new GPT, we should **not** necessarily envision a future whereby humans will be rendered obsolete and mass unemployment will be the "new normal."

- The Economics of Artificial Intelligence: Artificial Intelligence as the Next GPT A Political-Economy Perspective



Historical Instantiations of GPTs

Estimates of Adoption Lags

(Comin & Mestieri 2018)

	Invention Year	Mean Lag (Years)
Railway	1825	71
Electricity	1882	47
Cars	1885	36
Synthetic Fibre	1931	29
Personal Computer	1973	14
Internet	1983	6

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Artificial Intelligence as a *General Purpose Technology* (**GPT**)

GPT	Spillover Effects	Date
Domestication of plants	Neolithic Agricultural Revolution	9000-8000 BC
Domestication of animals	Neolithic Agricultural Revolution, Working animals	8500-7500 BC
Smelting of ore	Early metal tools	8000-7000 BC
Wheel	Mechanization, Potter's wheel	4000–3000 BC
Writing	Trade, Record keeping	3400-3200 BC
Bronze	Tools & Weapons	2800 BC
Iron	Tools & Weapons	1200 BC
Water wheel	Inanimate power, Mechanical systems	Early Middle Ages
Three-Masted Sailing Ship	Discovery of the New World, Maritime trade, Colonialism	15th Century
Printing	Knowledge economy, Science education, Financial credit	16th Century
Factory system	Industrial Revolution, Interchangeable parts	Late 18th Century
Steam Engine	Industrial Revolution, Machine tools	Late 18th Century
Railways	Suburbs, Commuting, Flexible location of factories	Mid 19th Century
Iron Steamship	Global agricultural trade, International tourism, Dreadnought Battleship	Mid 19th Century
Internal Combustion Engine	Automobile, Airplane, Oil industry, Mobile warfare	Late 19th Century
Electricity	Centralized power generation, Factory electrification, Telegraphic communication	Late 19th Century
Automobile	Suburbs, Commuting, Shopping centres, Long-distance domestic tourism	20th Century
Airplane	International tourism, International sports leagues, Mobile warfare	20th Century
Mass Production	Consumerism, Growth of US economy, Industrial warfare	20th Century
Computer	Digital Revolution, Internet	20th Century
Lean Production	Growth of Japanese economy, Agile software development	20th Century
Internet	Electronic business, Crowdsourcing, Social networking, Information warfare	20th Century
Biotechnology	Genetically modified food, Bioengineering, Gene therapy	20th Century
Business Virtualization	Paperless office, Telecommuting, Software agents	21st Century
Nanotechnology	Nanomaterials, Nanomedicine, Quantum dot solar cell, Targeted cancer therapy	21st Century
Artificial Intelligence	Autonomous car, Inventory robot, Industrial robot	21st Century

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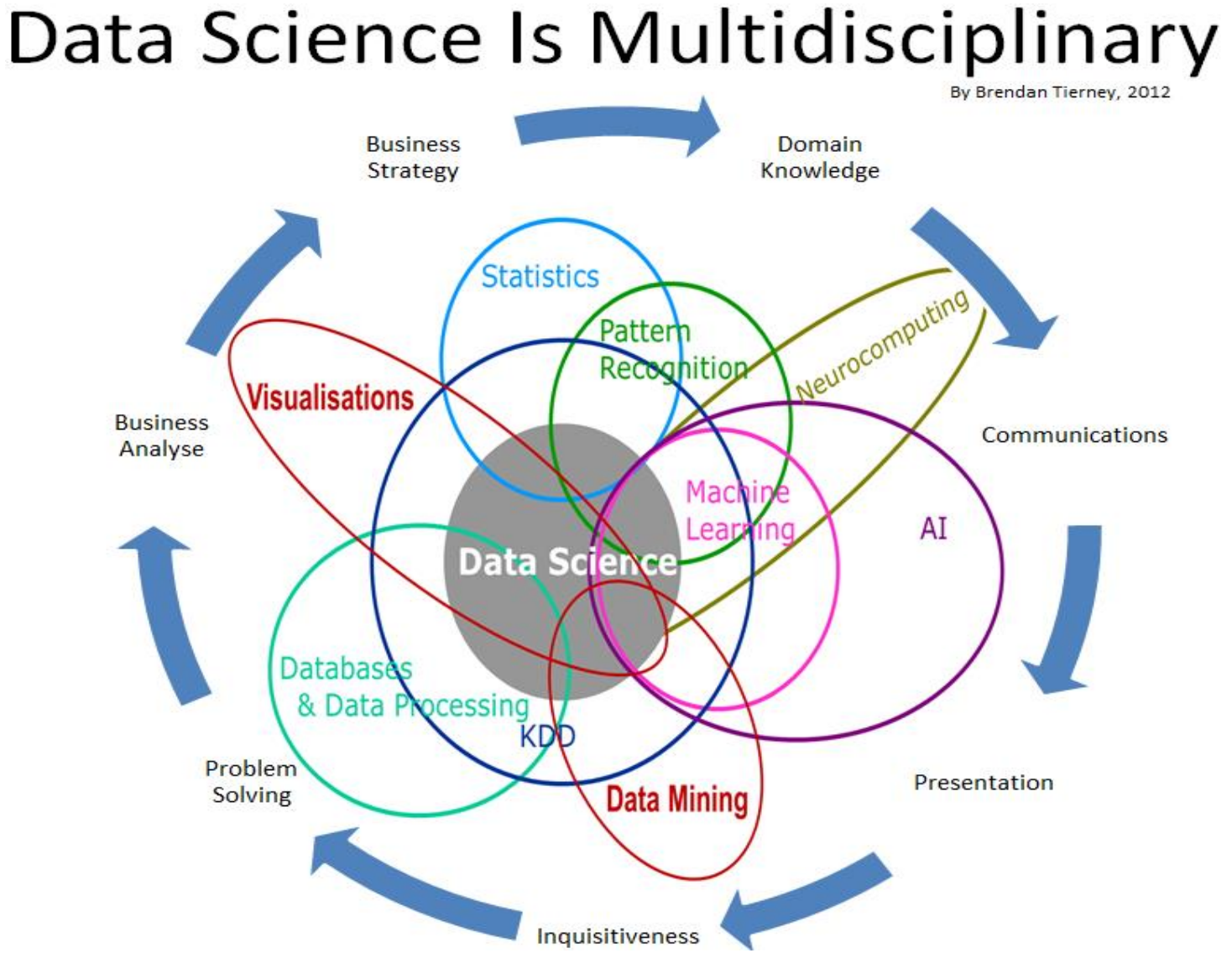
Data Science

What is Data Science?

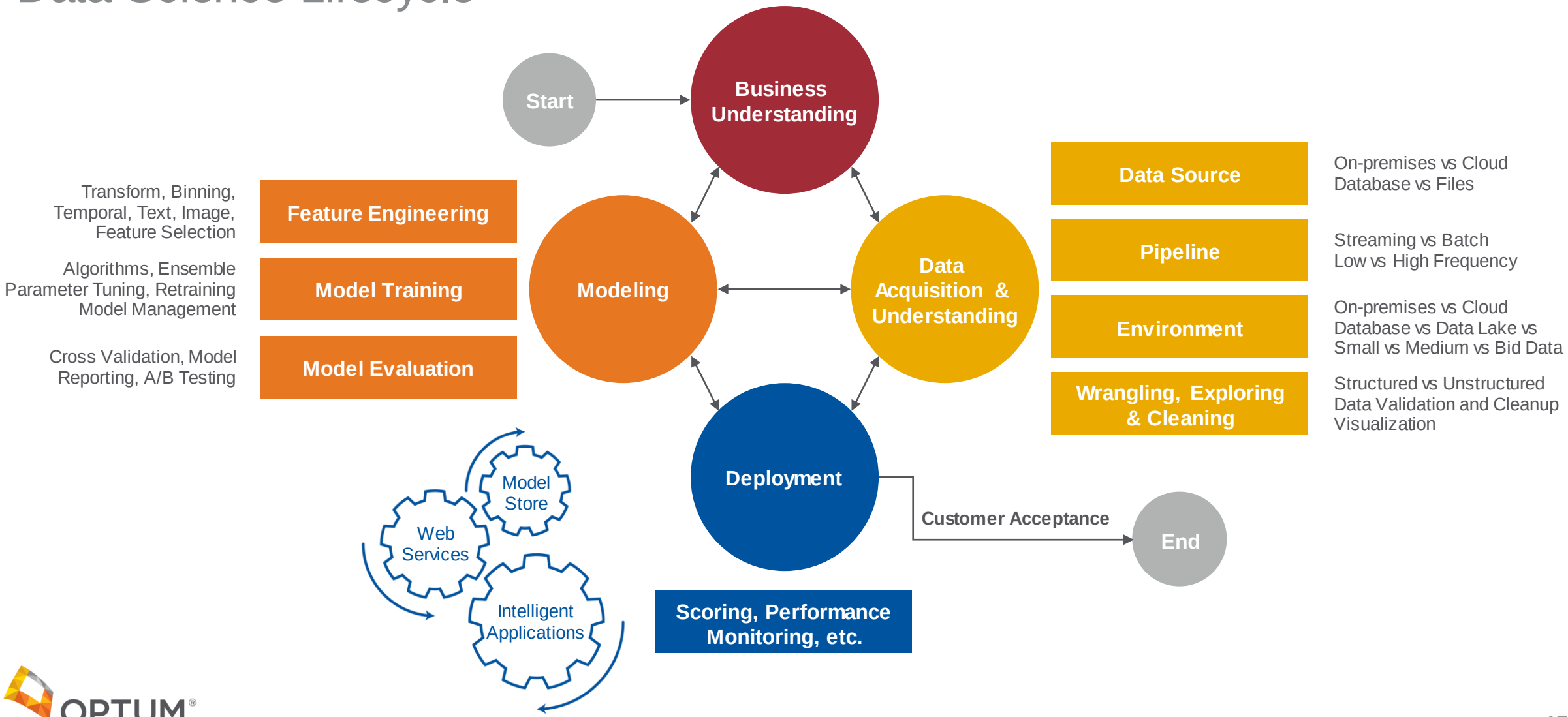
The **essence** of Data Science is the **extraction of knowledge and insights** from data (aka Data Mining).

Data Science



Data Science

Data Science Lifecycle

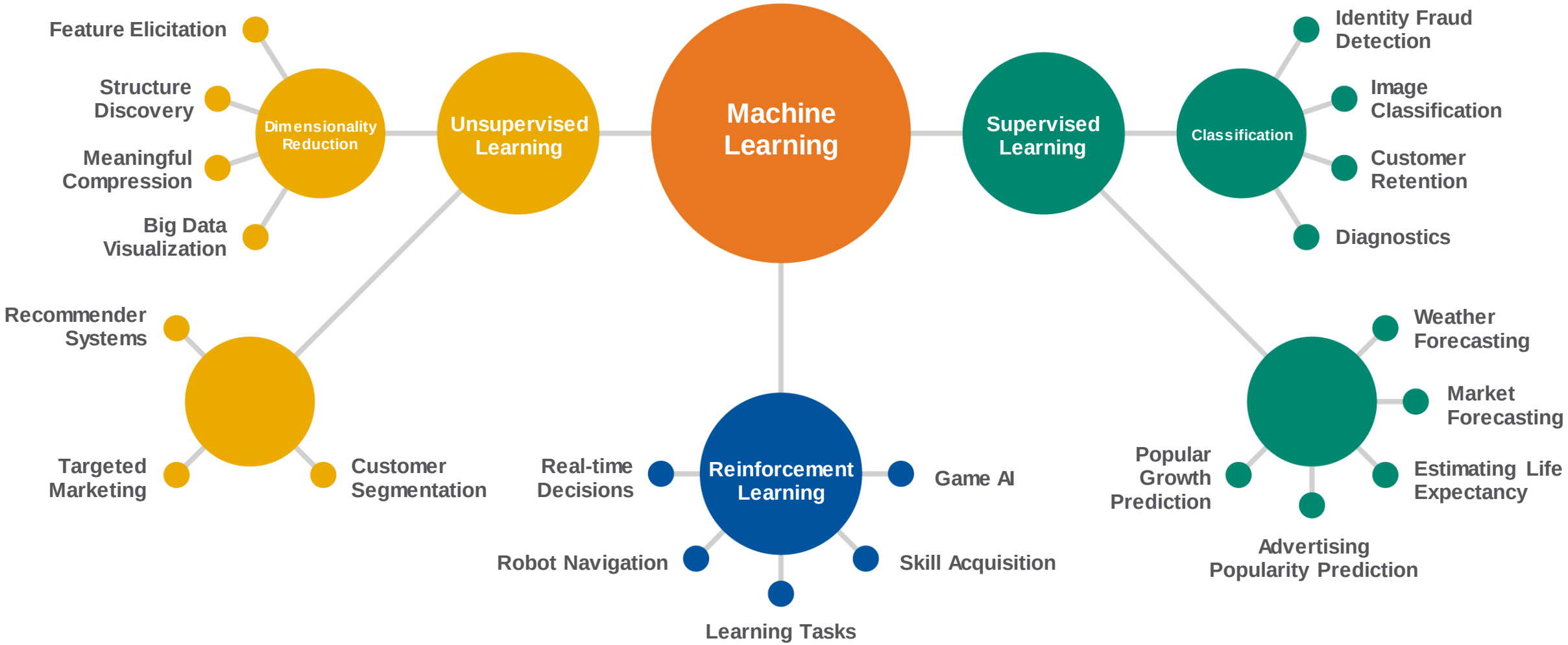


Machine Learning

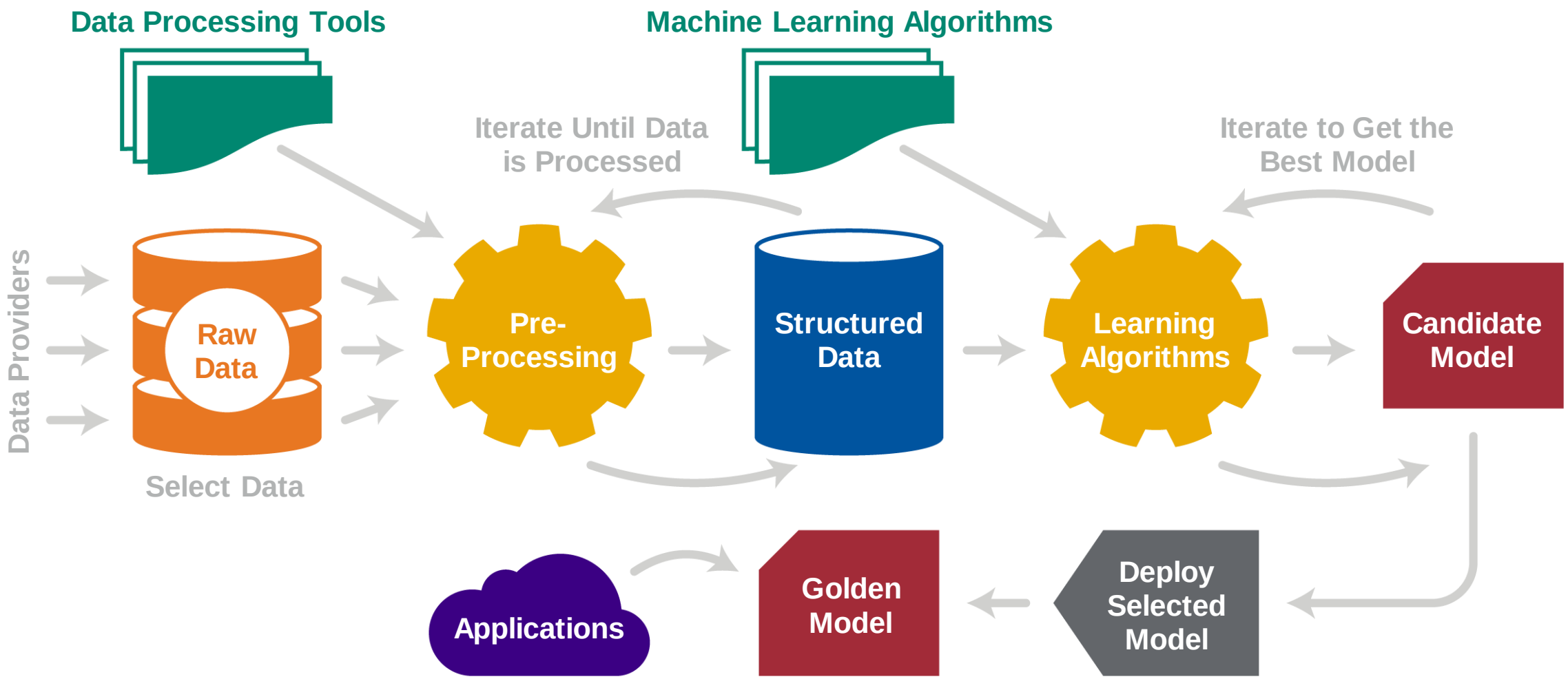
What is Machine Learning?

The **essence** of Machine Learning is **learning** from data with little (or no) human intervention.

Machine Learning



Machine Learning

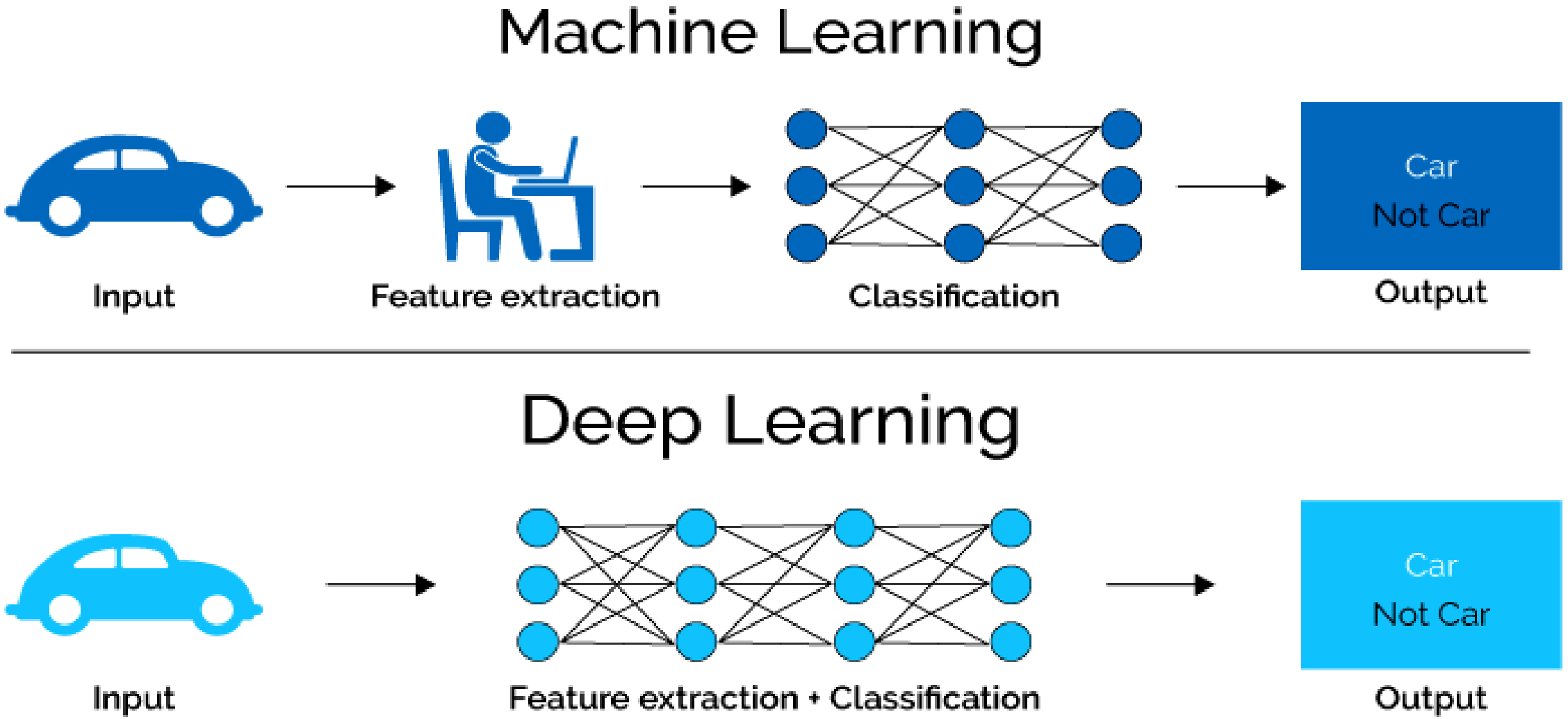


Deep Learning

What is Deep Learning?

The **essence** of Deep Learning is **automatic feature engineering** to facilitate *learning* in Neural Networks with *many* layers.

Deep Learning



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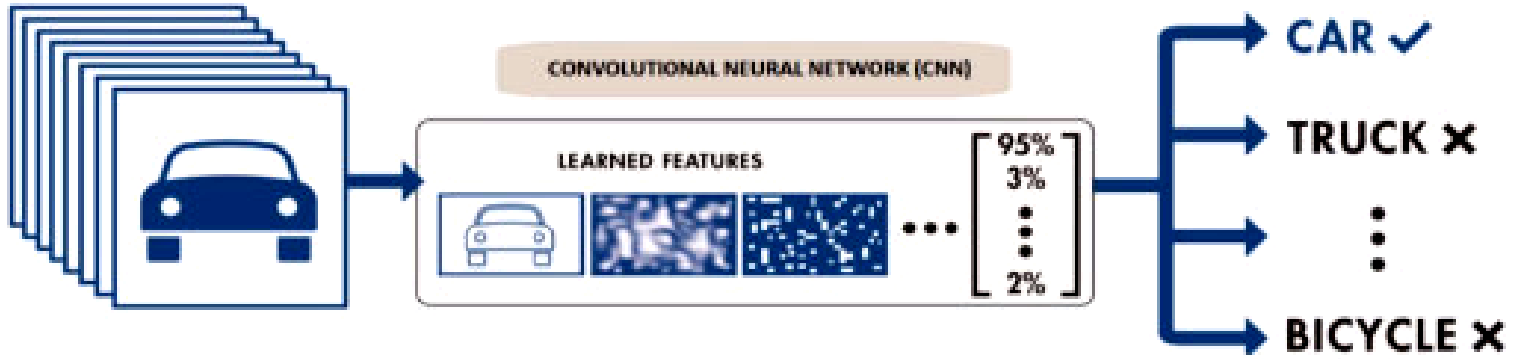
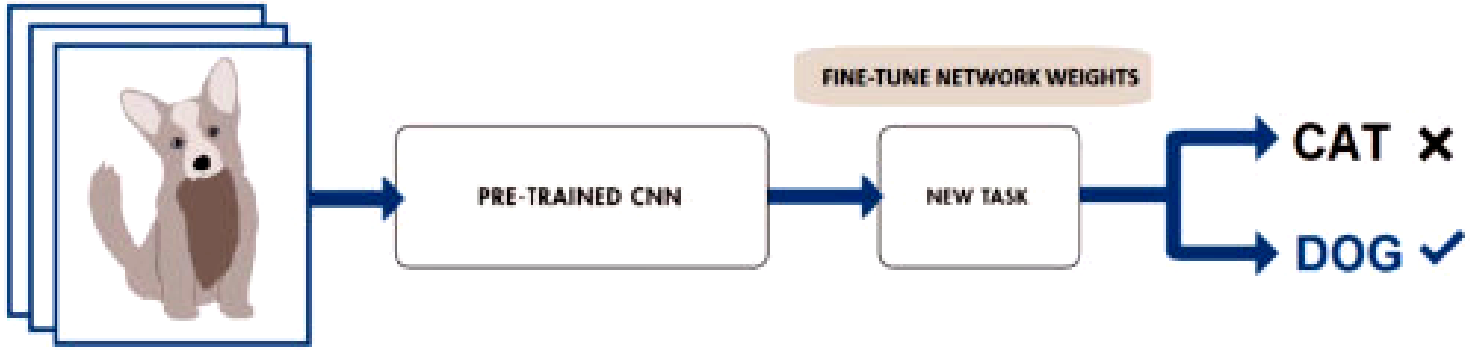
Deep Learning – Two Modalities

Two Approaches for Deep Learning

1. Train a Deep Neural Network from Scratch



2. Fine-tune a pre-trained model (transfer learning)



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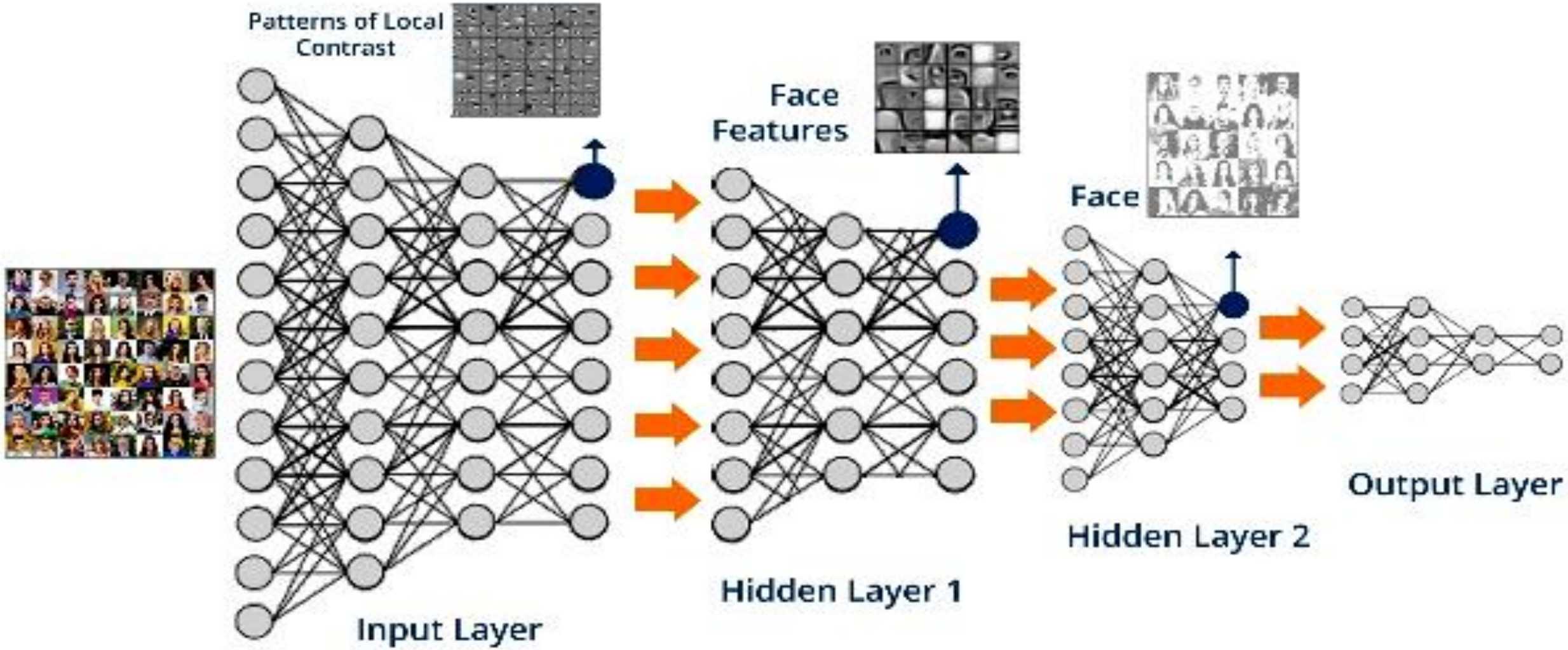
Deep Learning - Architecture



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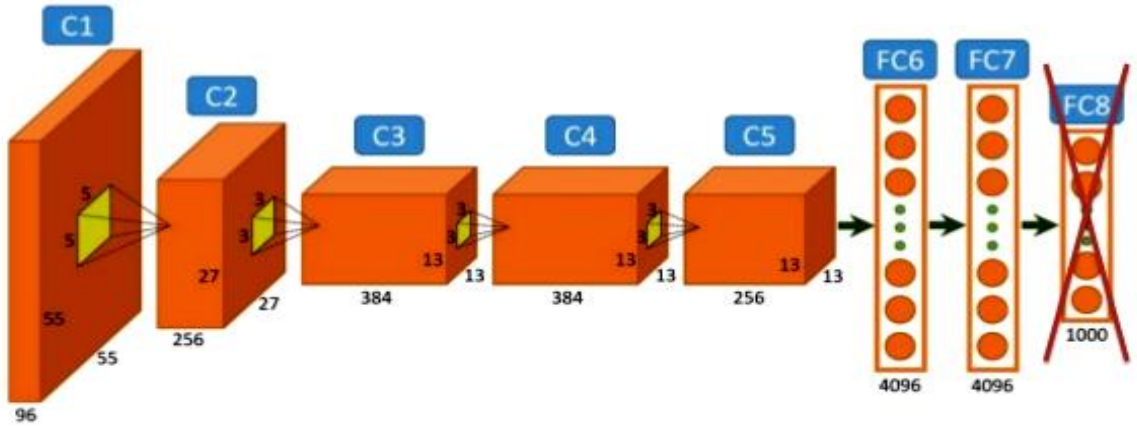
Deep Learning – Transfer Learning

Transfer Learning

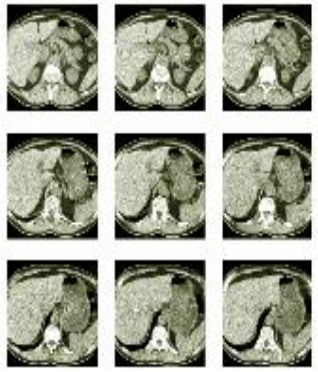


Transfer learning

ImageNet dataset

weight transference

Lung cancer dataset



1. Train on Imagenet ✓

2. Small dataset: **feature extractor**

Freeze these

Train this

Medical Imaging case

3. Medium dataset: **finetuning**

more data = retrain more of the network (or all of it)

Freeze these

Train this

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Intelligent Agents

What are Intelligent Agents?

The **essence** of Intelligent Agents is the creation of an entity(s) that embodies **intelligent characteristics**, **perceives** it's environment, and **autonomously takes action(s)** to achieve a particular goal - either as a **singleton** or self organizing as a **collective** (swarm).

Intelligent Agents Characteristics

Agent Attributes:

- ❑ Are Reactive
- ❑ Are Proactive
- ❑ Are Social
- ❑ Have Knowledge
- ❑ Have Beliefs
- ❑ Have Mental States
- ❑ Are Autonomous
- ❑ Dynamically Plan
- ❑ Communication and Collaborate

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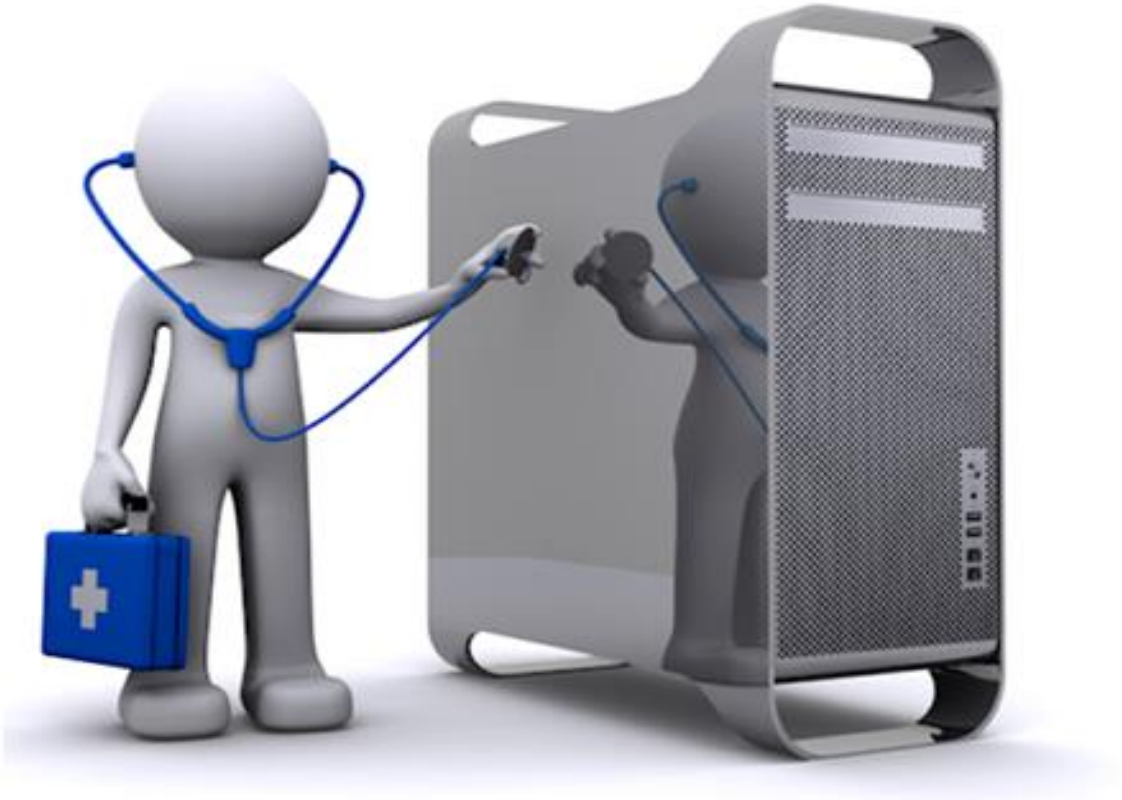
Intelligent Agents

Current Use Case

Autonomous health checking and healing of VMWare instances supporting UHG's infrastructure.



Autonomous:

1. VM **health checking**
2. Preemptive **server healing**
3. **Escalation** to humans
4. **Report** on Actions

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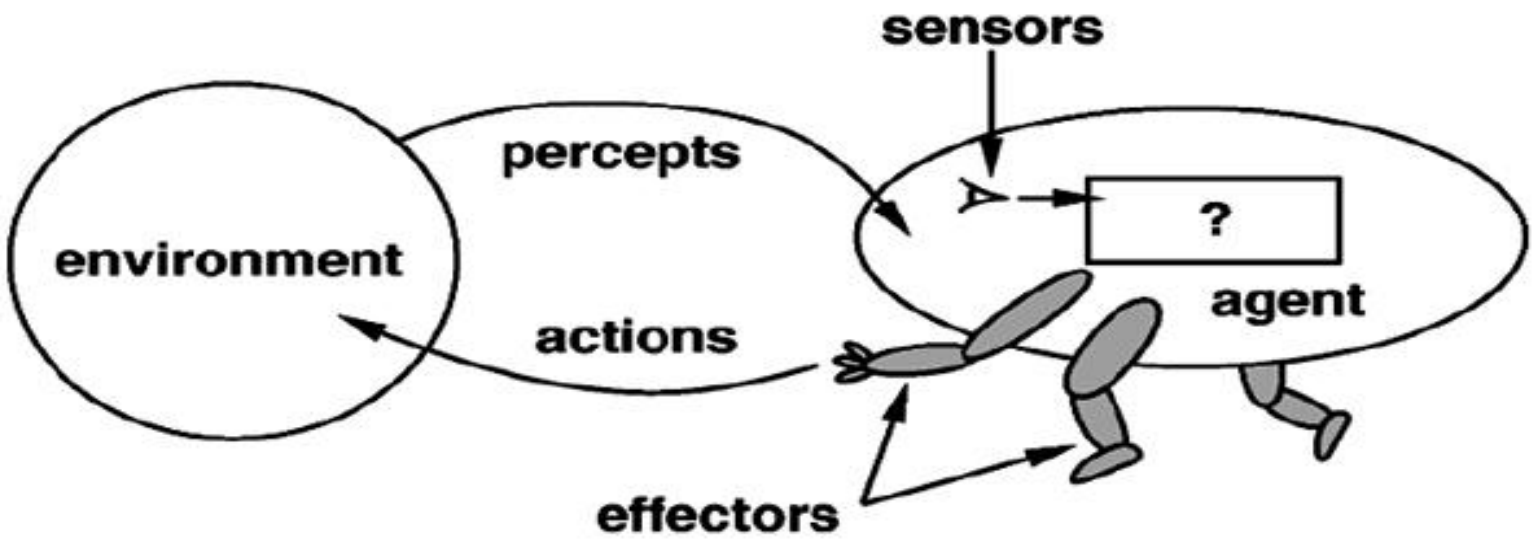
Intelligent Agents

(*) Definitions

- Agents **do** things, they **act**: that is why they are called **agents**

A Intelligent Agent is autonomous entity that can perceive its environment through sensors and act upon it using actuators.



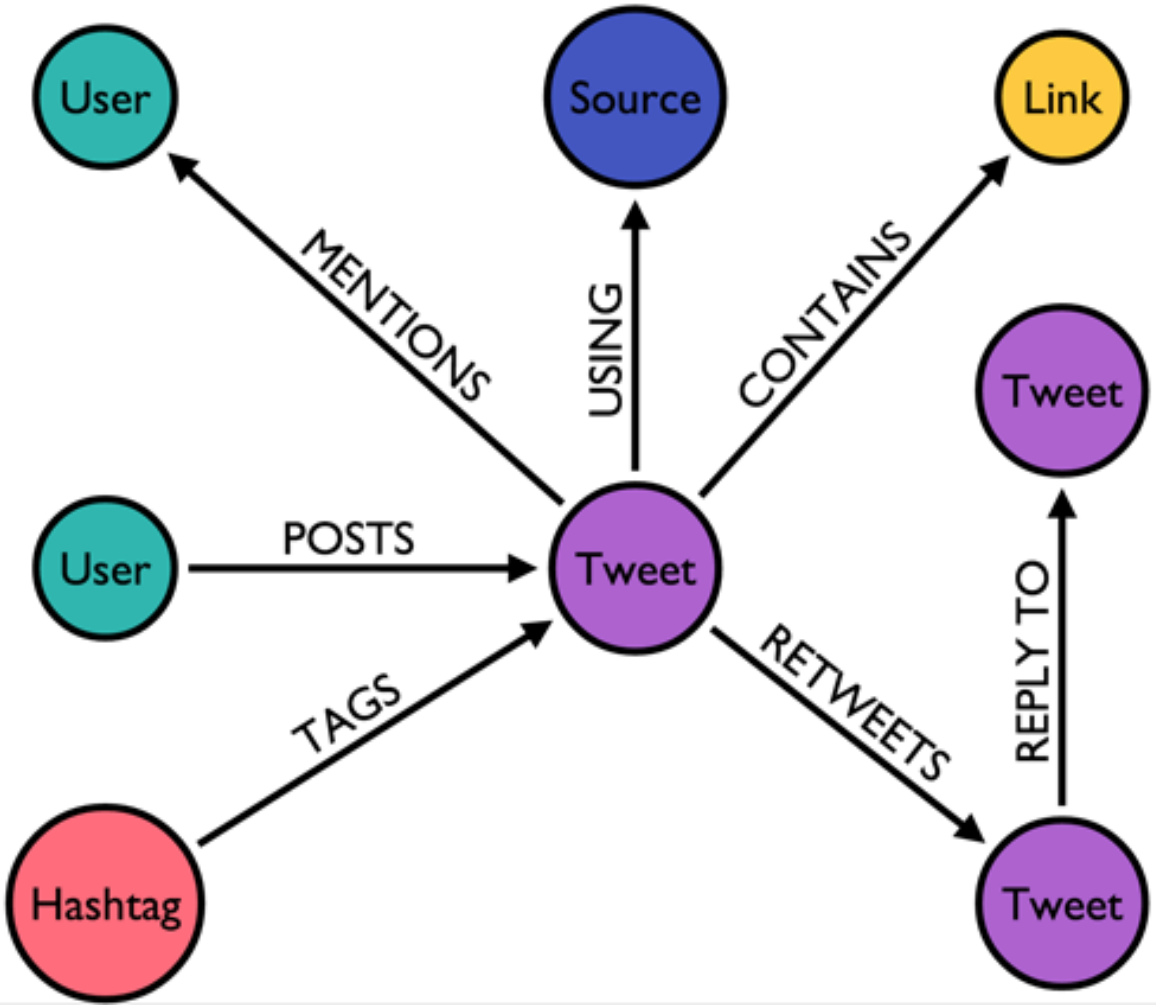
Agents

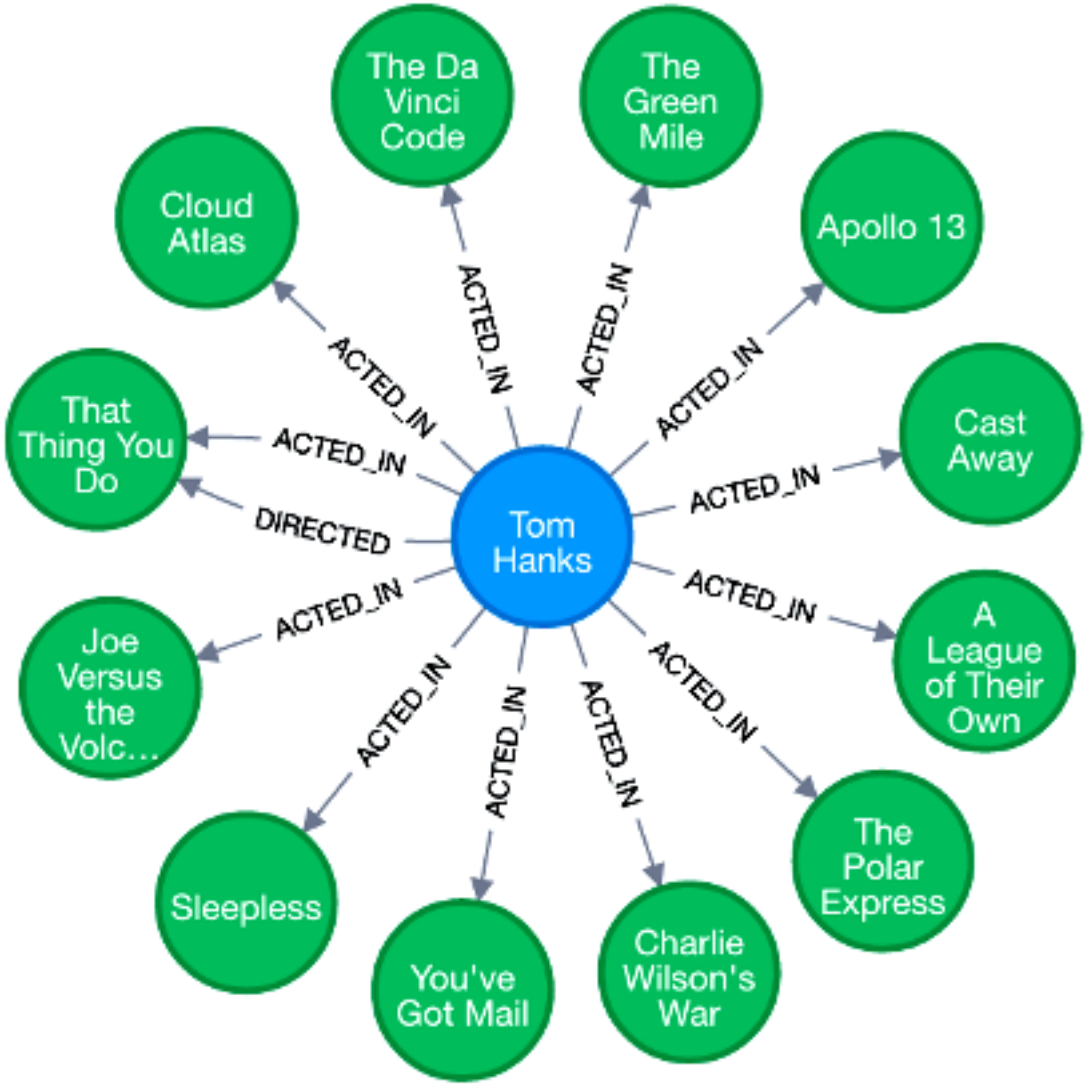
Graph Databases

What are Graph Databases?

The **essence** of Graph Databases is the **capture** and **treatment** of **relationships** between the data as vital information. Graph Databases are excellent for use cases which leverage **many-to-many relationships** and/or place a **premium on the relationships** between data elements.

Graph Databases : Examples





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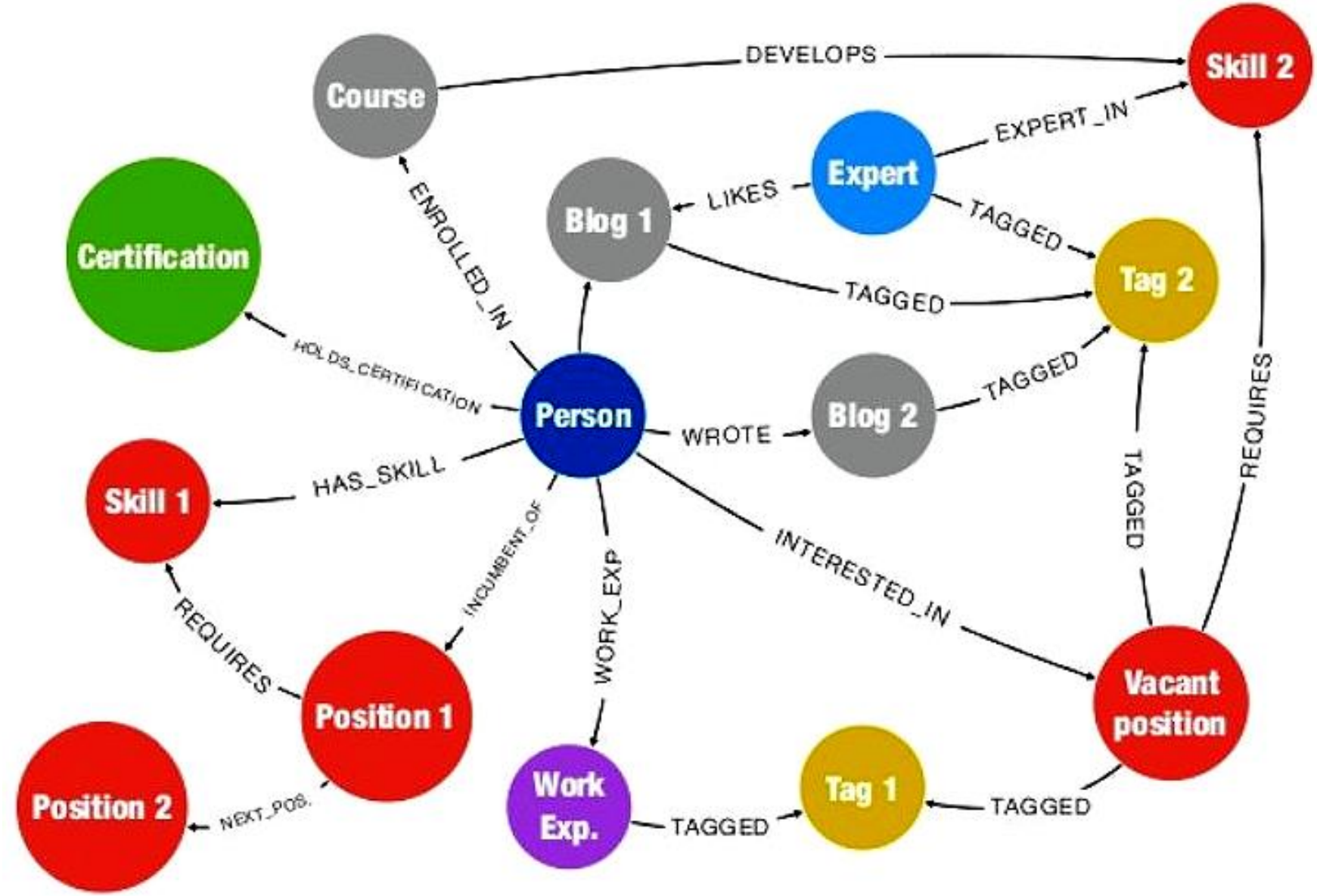
Graph Databases : Finding Hidden Potential



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Graph Databases

Use Cases

1. Fraud Detection
2. Knowledge Graph
3. Network Infrastructure Monitoring
4. Recommendation Engines
5. Master Data Management
6. Social Media
7. Identity & Access Management
8. Privacy, Risk, and Compliance

Getting Started in AI

-- High Level Check List --

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Getting Started in AI

Context - what does a BI person do when tossed onto an AI project cold?
Assumptions: It's an ML project and not a CT or some other stripe of AI project.

Understand Problem

- Business
- Technical / Tactical
- Strategic

Get the Data

- Little Data - easy
- Big Data - harder

Do EDA on data

- **Develop Tactical Hypothesis** to answer questions of business strategic value
- **Construct an Experiment Plan** to develop evidence based answers to the questions undergirded by the rigor of the data and it's analysis of that specific line of questioning.
- Extract Insights from the results of that experiment plan.
- Develop a dashboard or some other vehicle to present those results.
- Create a ML model – Prediction / Classification / Clustering if necessary
    - Stand alone
    - Integrate it within a system

Who Employs AI?

-- Using Healthcare as an example --

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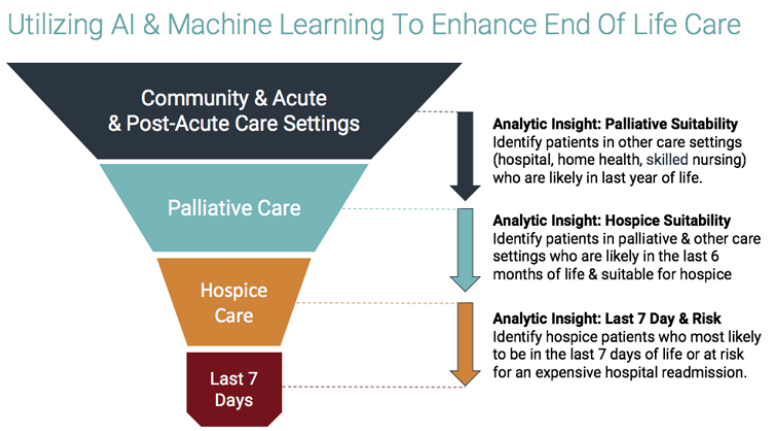
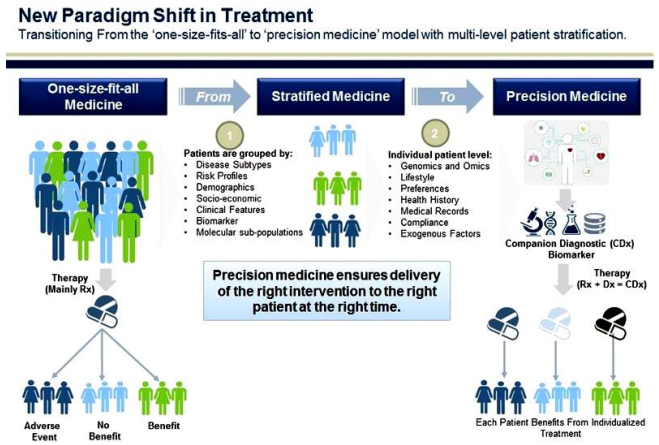
Richness of Healthcare. (HC QC Use-Cases Domains)

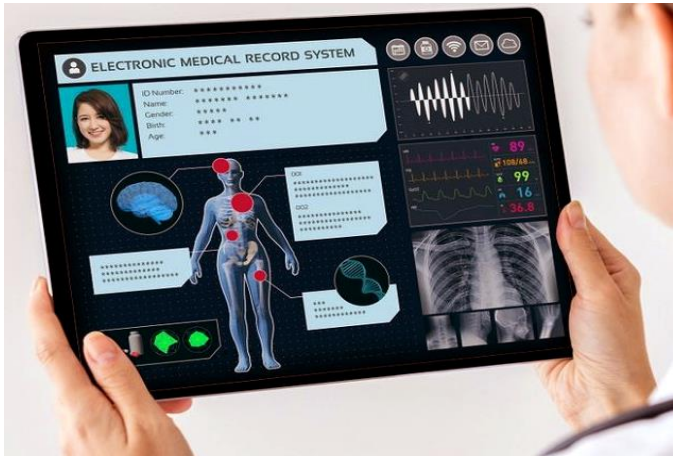
Aging, Chronic and End of Life Care



Patient Personalization and Precision Medicine

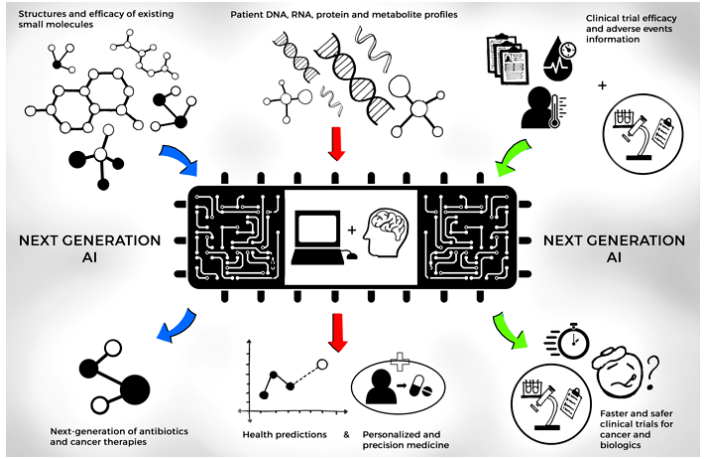


Electronic Medical Records



Everywhere Care (Virtual Physician, Telemedicine

Drug Development, Clinical Trials



Fraud, Waste, and Abuse

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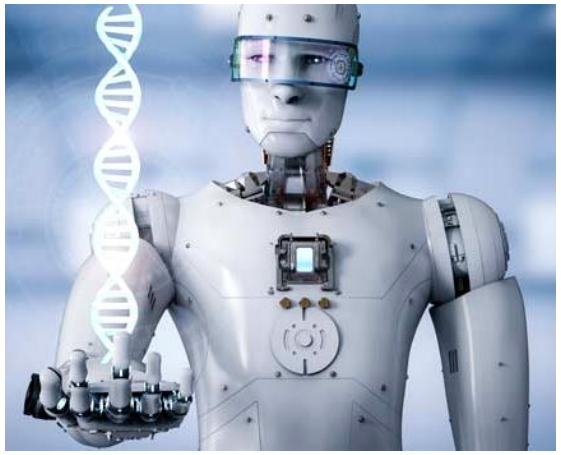
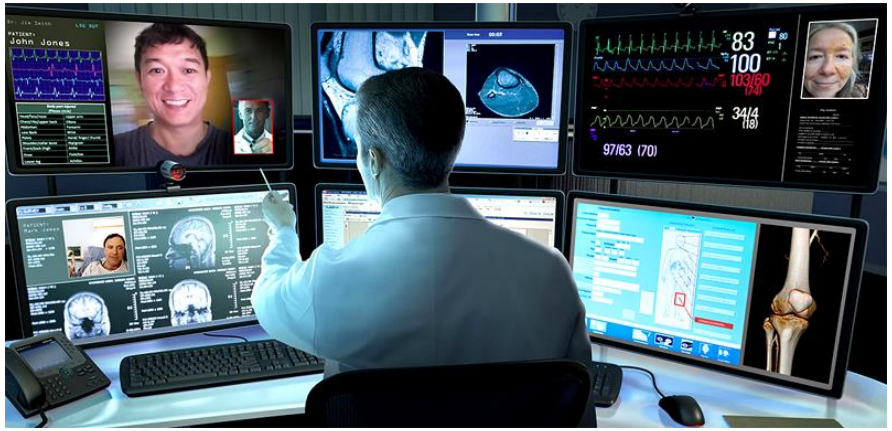
Richness of Healthcare. (HC QC Use-Cases Domains)

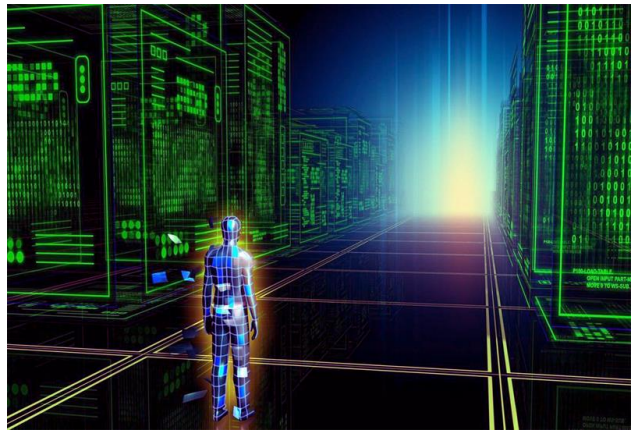
Genetics and Genomics



Augmented Decision Making



Simulation: Pandemics & Molecules



Preventative Care & Wellness

WELLNESS-ENHANCED CITIES, SMART HOMES, & HOSPITALS

Wellness real estate industry opportunities

Smart Cities & Mobility

- Development of **wellness-focused smart cities** – focus on community, mental health, etc.
- Connecting wellness real estate to adjacent urban areas via **autonomous vehicle systems, smart transport,** etc.

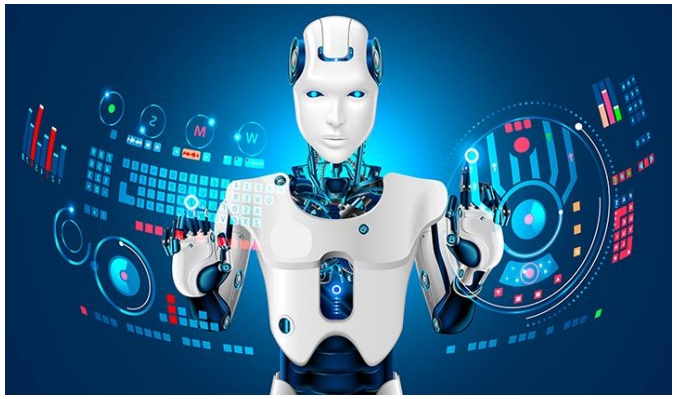
Smart Homes

- **Tech-enabled smart homes** with wellness features – automation, smart kitchens, sleep tech, lighting, etc.
- **Voice assistants** focusing on health and wellness services

Healthcare

- **Preventative and alternative healthcare services** – telemedicine, medical spas, homeopathic medicine, etc.
- **Redesigning hospitals and clinics** with wellness features to increase patient satisfaction

Intelligent Assistants



Mobile Healthcare

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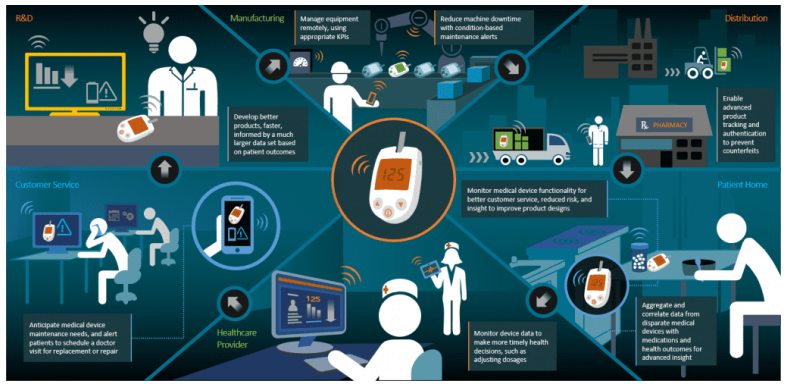
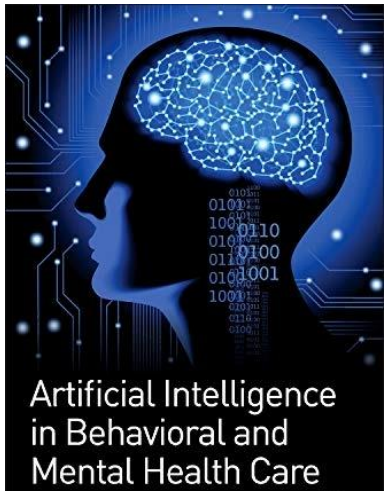
Richness of Healthcare. (HC QC Use-Cases Domains)

Healthcare Operations

Internet of Medical Things / Ambient Computing

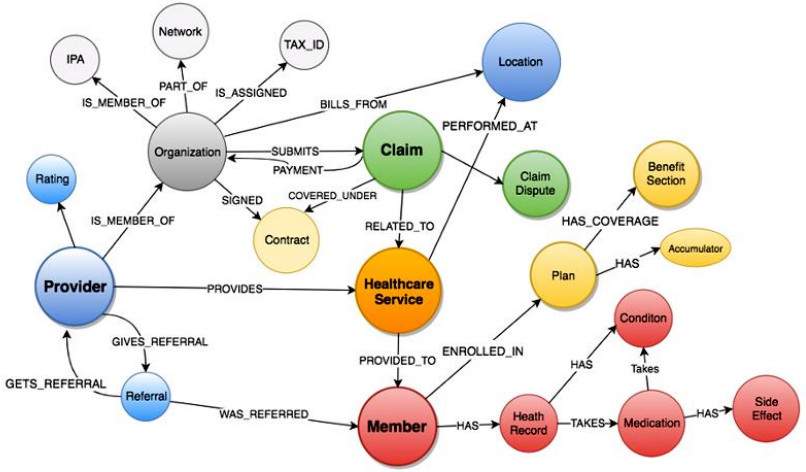


Behavioral / Mental Health



Smart Buildings: Environment is part of care team.

Graph Technology



Smart Hospitals

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The Razors Edge

- Cognitive Technology
- Quantum Computing

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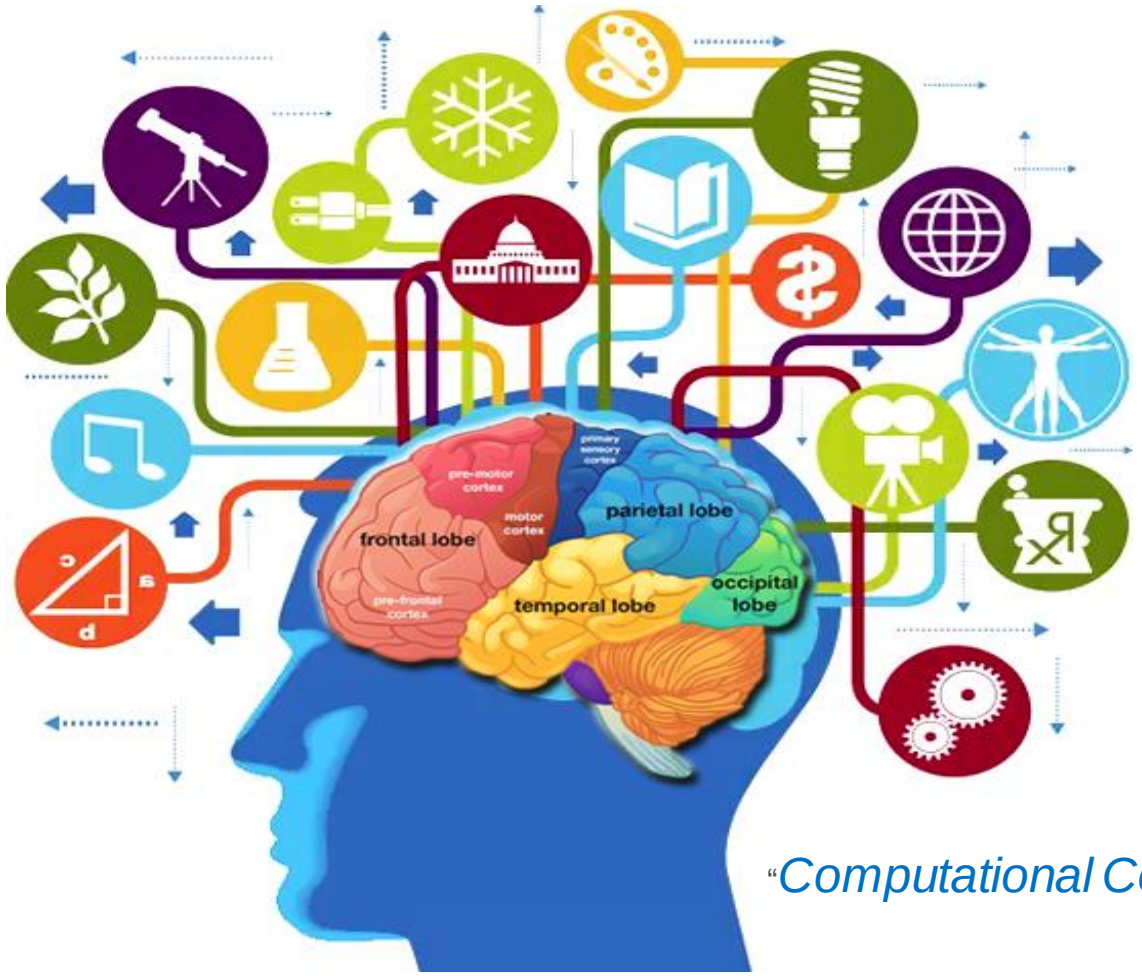
Cognitive Technology

The Razors Edge

Cognitive Technology



"*Computational Cognition*"

The Value Proposition

- The human mind is **a general-purpose problem-solving structure** – it's able to learn ***many, many*** subjects and solve problems in ***all*** of them using ***one single structure***.
- **Unlike conventional AI** (which only handles narrowly defined problems), Cognitive Technology(CT) provides a **general problem-solving capability not** found in other forms of narrow AI.
- This provides the **promise of solving a large set of Healthcare related problems** that have been *resistant* to other narrow AI approaches - it does this **because** CT can model human cognition.
- This is referred to as "*Computational Cognition*" – and is based in **Cognitive Sciences**.

Key Attributes of Cognition

- Attention
- Knowledge
- Memory
- Judgment
- Reasoning
- Problem Solving
- Decision Making
- Comprehension
- Language
- Learning

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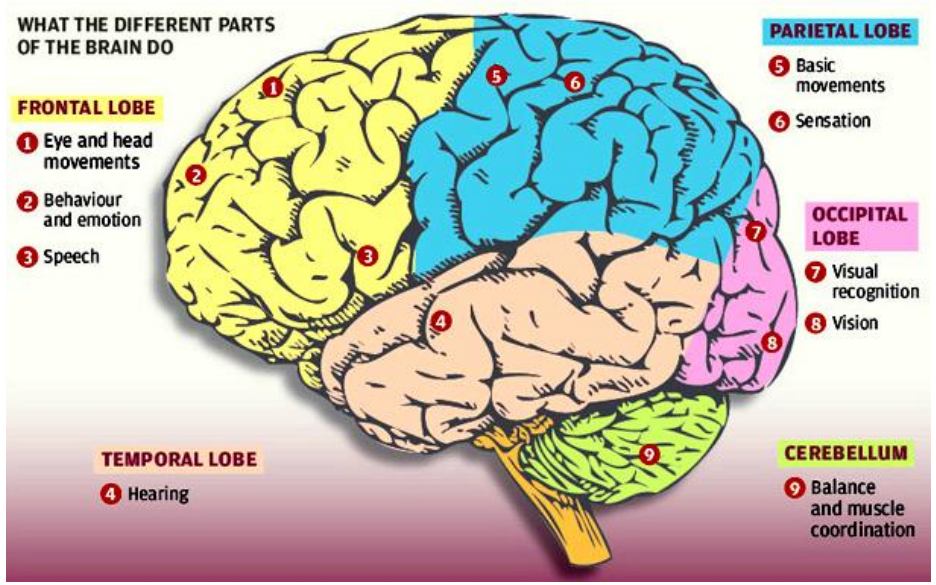
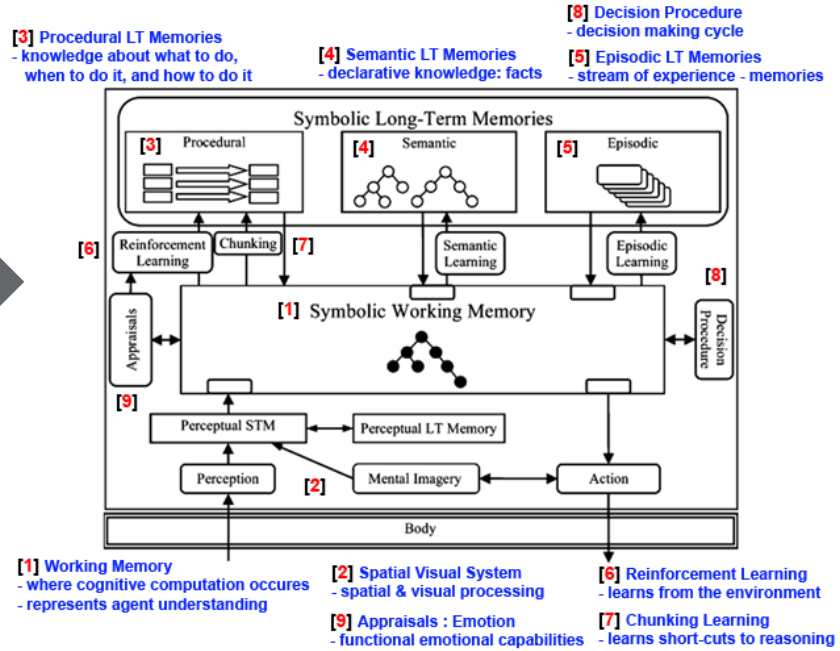
Computational Cognition: Brain *Inspired* Software Architecture





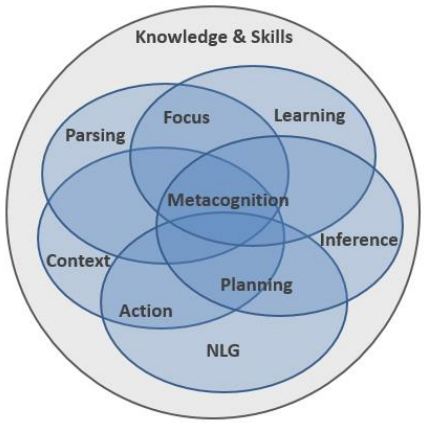
Definition:- Human Cognition

"The mental action or process of *acquiring knowledge and understanding* through **thought**, **experience**, and the **senses.**"

Key Aspects:

- Attention
- Knowledge
- Memory
- Judgment
- **Reasoning**
- Problem Solving
- Decision making
- Comprehension
- Language

Highly Integrated Cognitive Architectures



Definition:- Cognitive Architecture

1. Cognitive architecture is a **hypothesis** *inspired by the* ***human mind*** in which ***systems work together*** along with the necessary resources to *attain intelligent behavior in any complex environment*.
2. Cognitive architecture's **aim** is *the development of artificial agents that support the same capabilities as that of the human mind*.
3. Cognitive architectures are ***a lot like computer architectures***, except they *manipulate knowledge capabilities* instead of bits.

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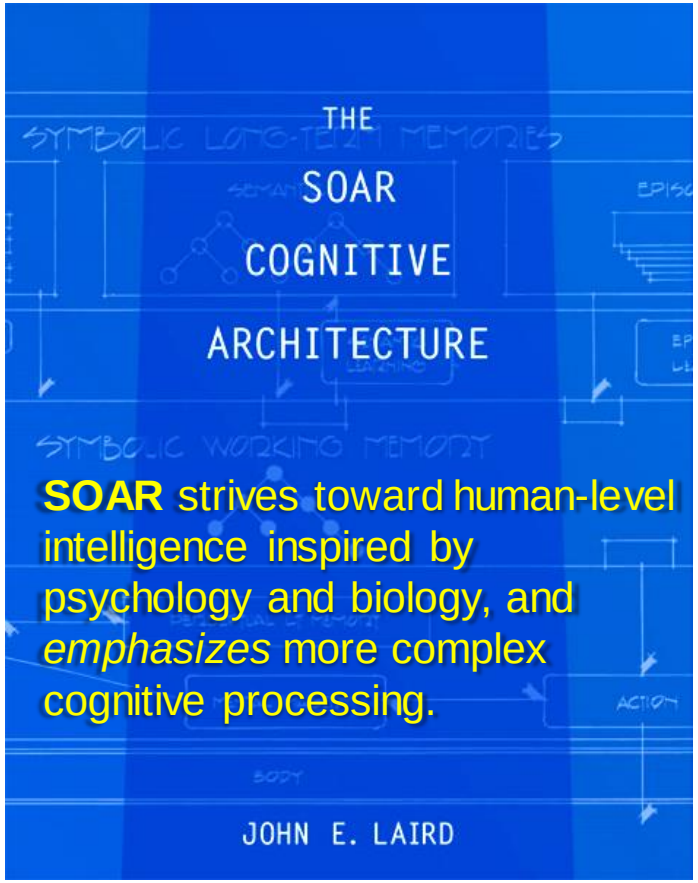
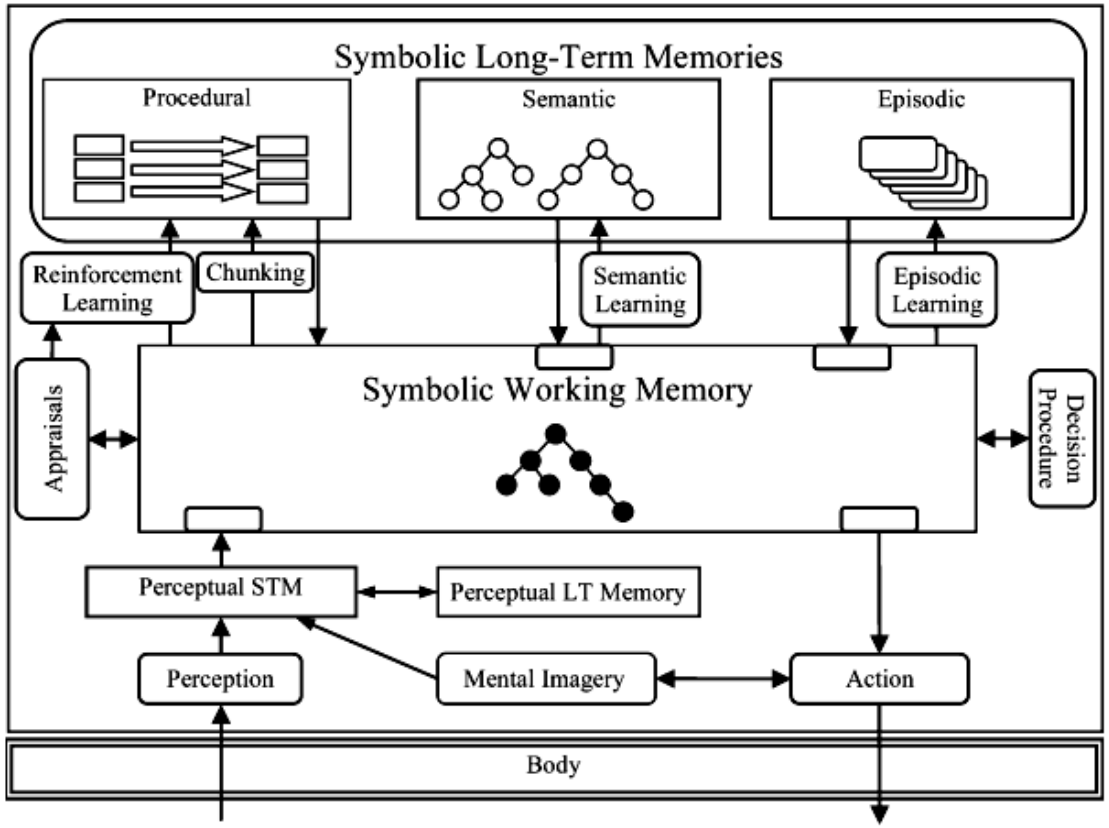
Cognitive Architecture - SOAR



State, **O**perator, **A**nd **R**esult.



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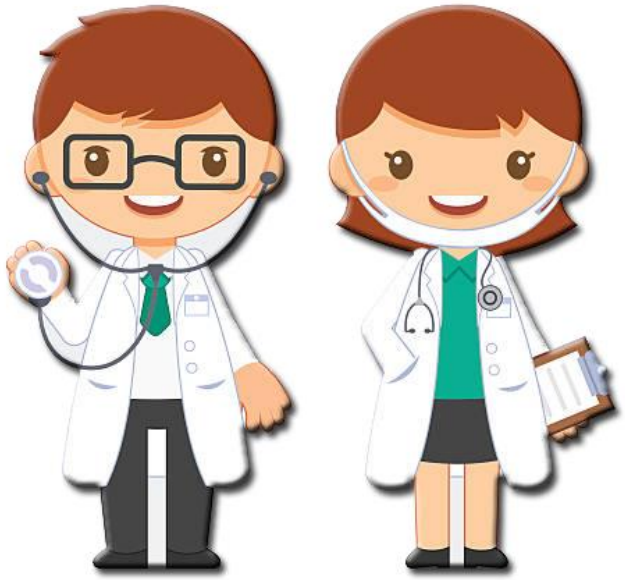
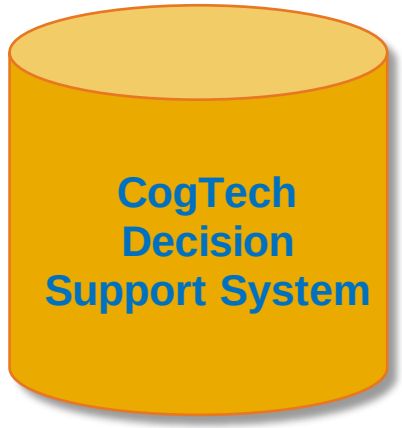
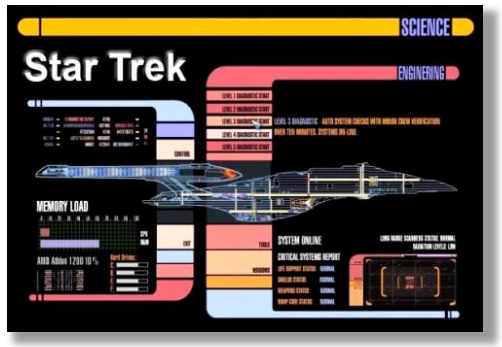
Augmentative Artificial Intelligence

(**CogTech**: an assisting technology, **does not replace** human decision making.)



Happy Med Staff !



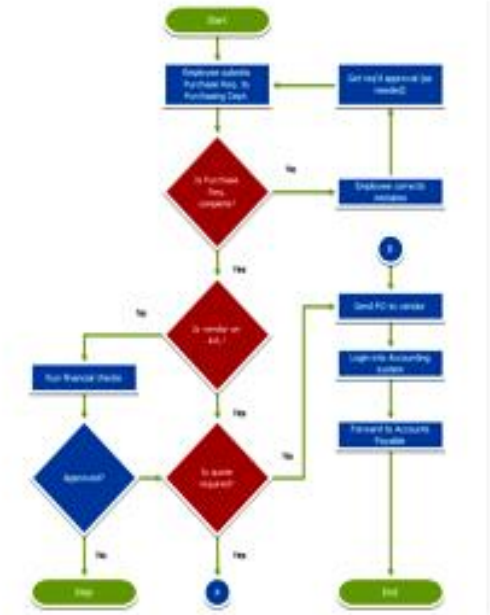


The Razors Edge

(CogTech: 3rd Wave AI Technology)

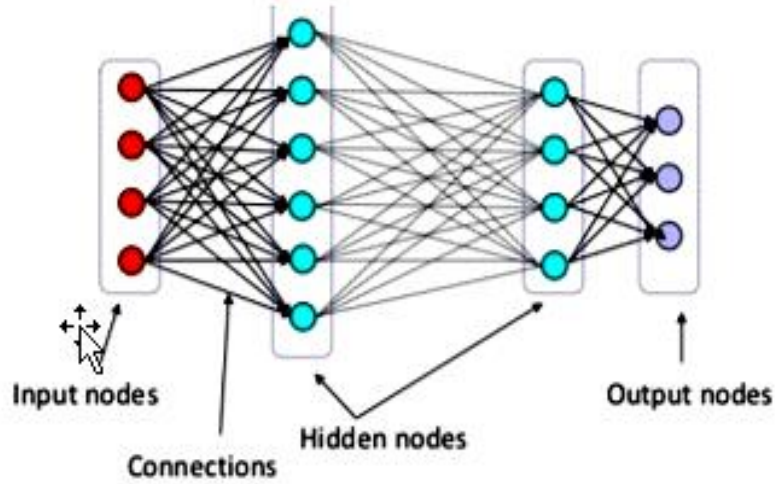
First Wave

Traditional Programming



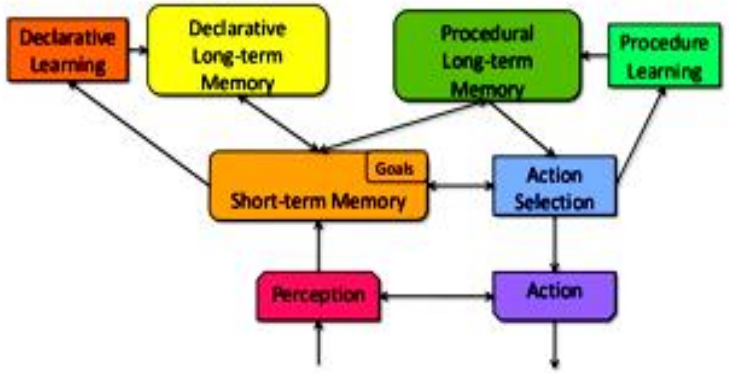
Second Wave

Neural Nets – Deep Learning



The Third Wave

Cognitive Architectures



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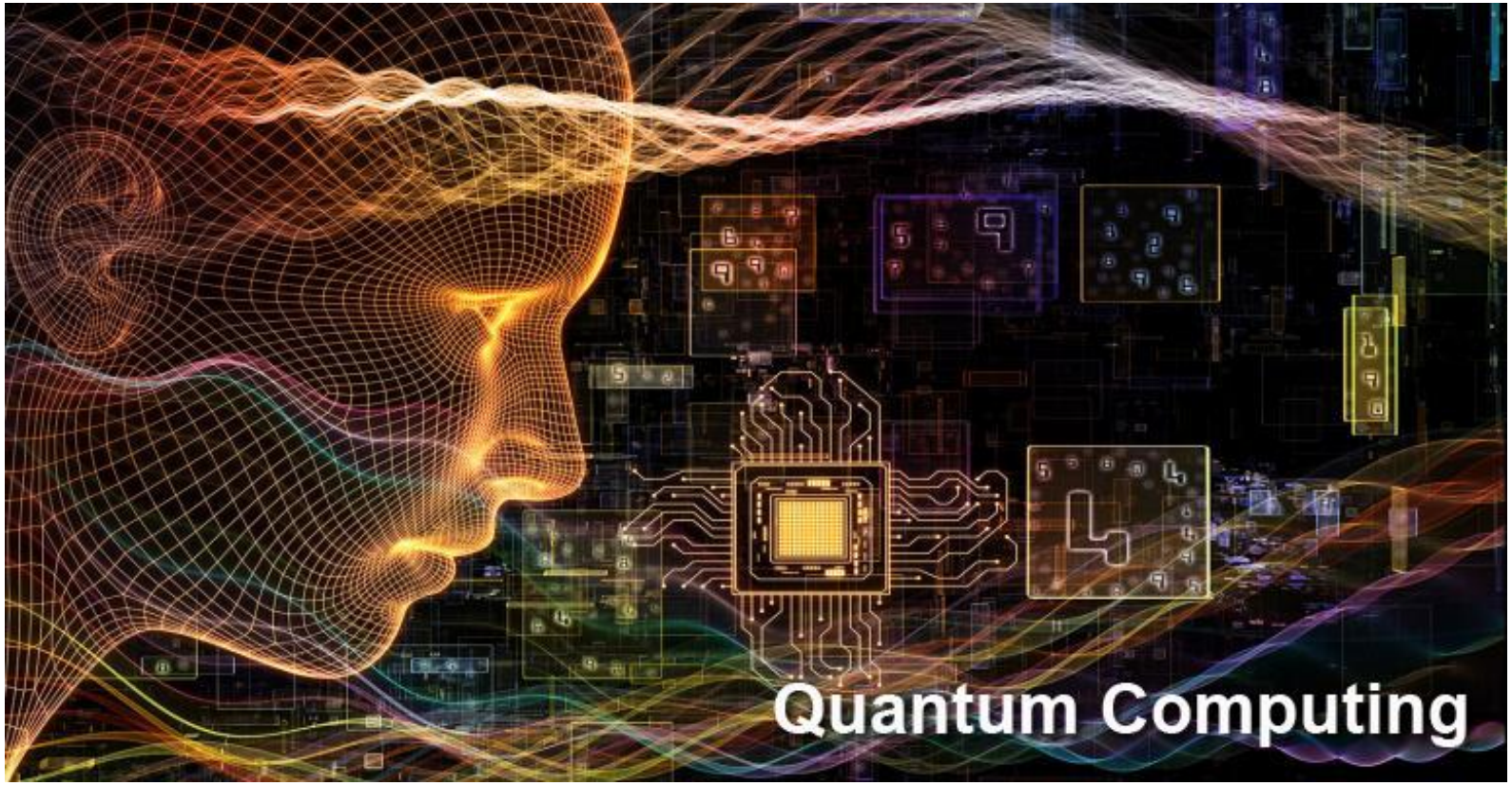
Quantum Computing

The Razors Edge

AI: Quantum Computing



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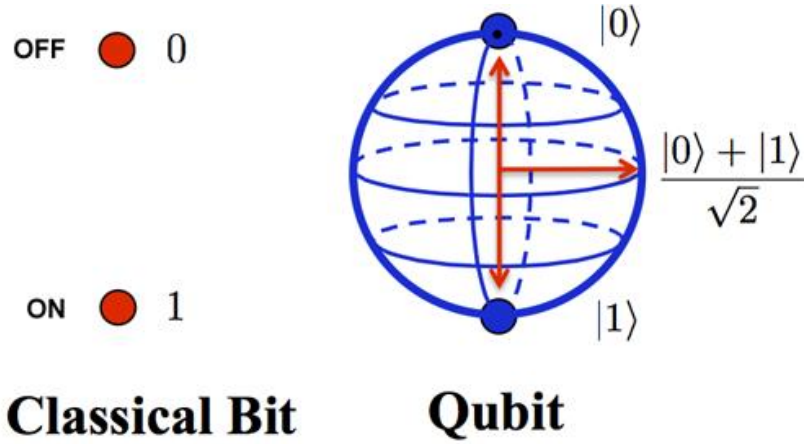
AI: Quantum Computing

What is Quantum Computing?

The **essence** of Quantum Computing is the creation of a computational system that uses **quantum mechanics** instead of **binary logic** to manifest its underlying computational circuitry.
-**(*Source of Power**: Subatomic particles behave differently – aim to exploit that difference.)*

Major Differences: (*Quantum* vs *Classical* Computing)

- Binary theory (**Bit**) only uses values of **ones or zeros** in its implementation.
- Quantum theory (**Qubit**) uses values of **ones, zeros and everything in between**.



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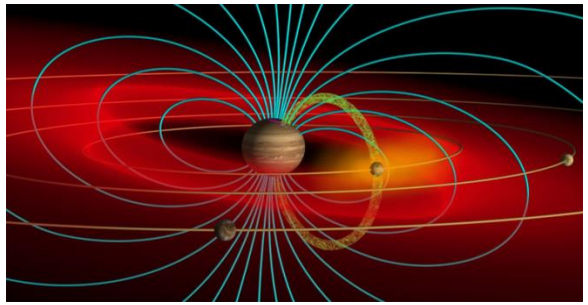
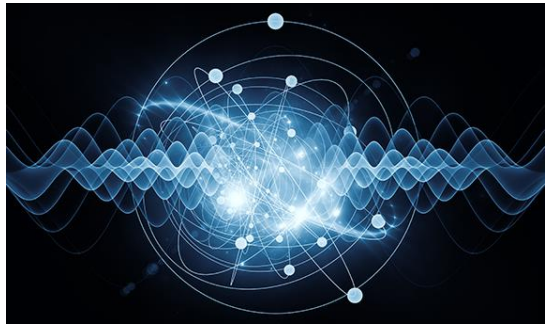
What makes QC special? (Promoters)

Subatomic Particles



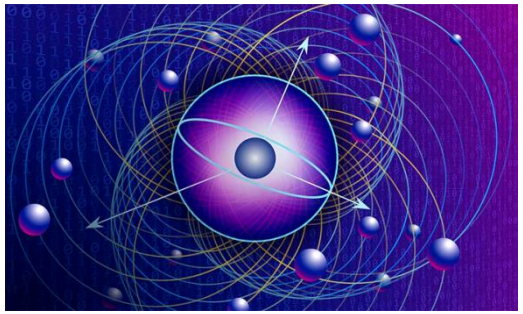
Accessing the power of Quantum Mechanics

Quantum Waves



Wave Function creates Superposition

Qubits



Foundation to all Quantum Circuitry

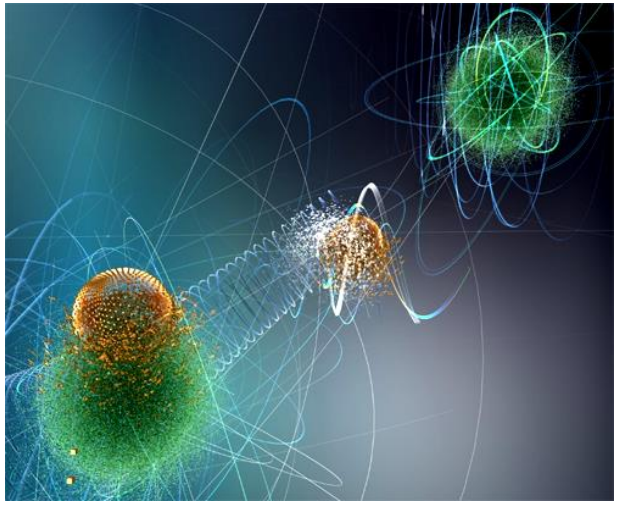
Superposition

Enables power of Quantum Algorithms

Quantum Interference

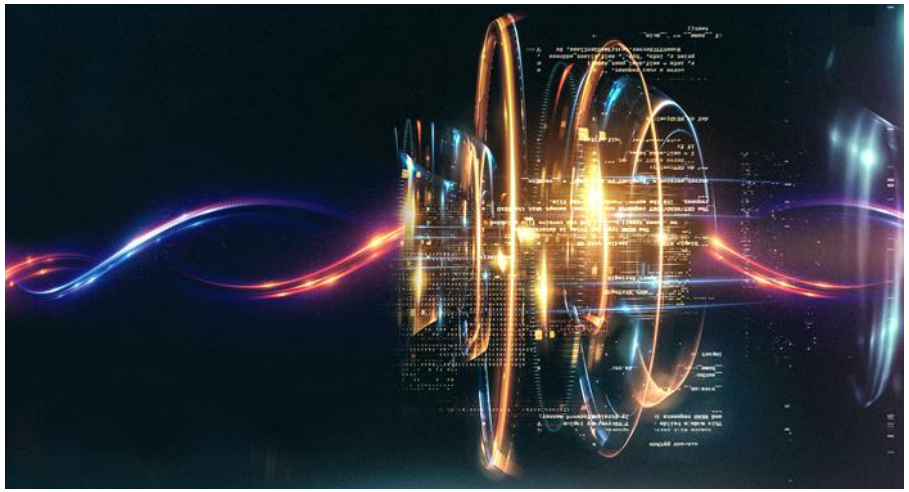
The core of Quantum Advantages

Quantum Entanglement



Fundamental Property of Quantum Mechanics

Quantum Teleportation



Important capability based upon Quantum Entanglement

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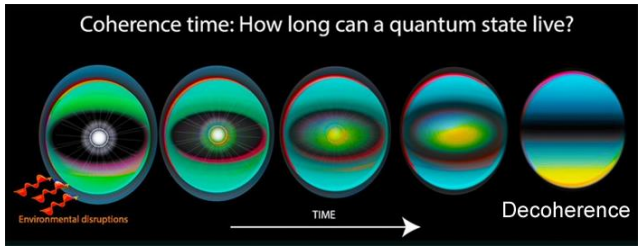
What makes QC special? (Detractors)

Unstable Wave Function



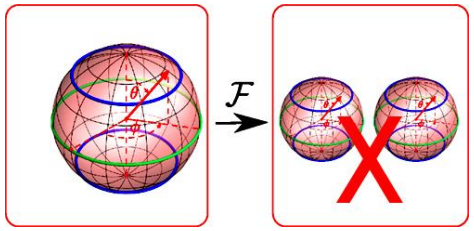
Quantum States are fragile

Reversible Functions

Gate	Input — Z — Output
Matrix	$Z = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$
Reversibility	$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = I$
Example	$Let\ \|0\rangle = \begin{bmatrix} 1 \\ 0 \end{bmatrix}\ and\ \|1\rangle = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \times \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

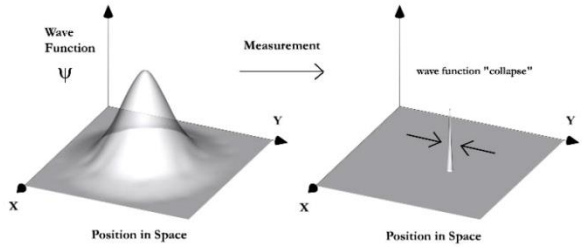
Information loss heat causes Decoherence

No Cloning Rule



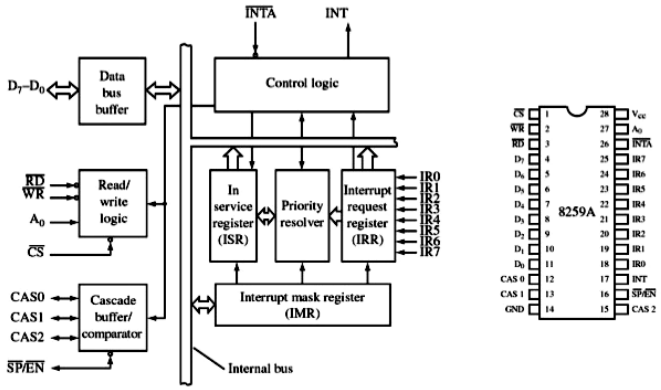
Can't copy Qubits like variables

Destructive Reads



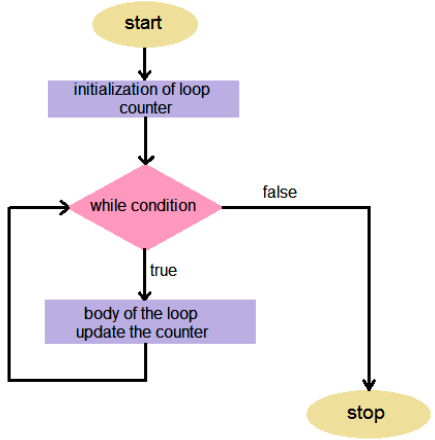
Reading Qubit's kills the Wave Function

Assembler Programming



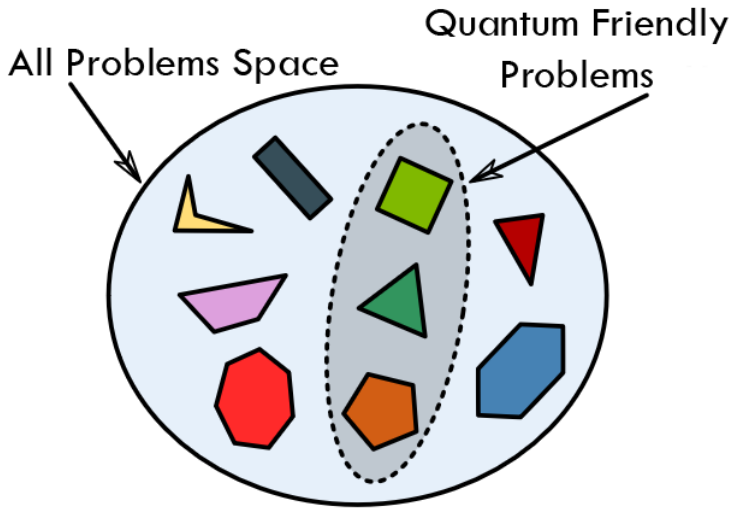
Quantum Computing is like Assembler Programming

No Loops



No Abstract Programming Constructs

Means: Restricted Problem Space



Only "Quantum Friendly" (or "Forced" friendly) can be addressed

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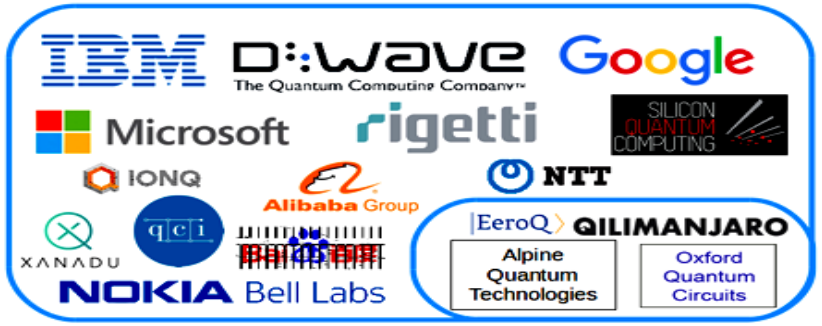
What makes QC special? (For Healthcare)

Producers



Those "**Creating**" the technology

The educational needs of *developers* in the **QC** "**Producers**" space ***Quantum Physics, Materials Science, and Opaque Mathematics.***

> 99%

Of the Educational Materials are produced for this producers group

Consumers

Those "**Using**" the technology

The educational needs of *developers* in the **QC** "**Consumers**" space are more closely aligned to ***Software Engineering*** than *quantum physics, materials science,* and *mathematics*.

< 1%

Of the Educational Materials are produced for this consumers group

Problem: No established way to standup competencies for *QC Software Engineers* in the **Healthcare space**.

We have developed a solution for that !

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Questions

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