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Computer Article – Introduction to AI and Machine Learning

Category	Details
Objective	To explain the fundamentals of Artificial Intelligence (AI) and Machine Learning (ML), including how machines learn from data and make decisions.
Context	AI and ML are widely used in modern technology such as recommendation systems, chatbots, healthcare diagnostics, and self-driving cars. The article targets beginners who want a foundational understanding
Evidence of Success	- Increased adoption of AI tools in industries (healthcare, finance, education) - Popular platforms using ML (e.g., recommendation engines) - Improved efficiency and automation in tasks - Growth in AI-related jobs and research
Challenging Issues	- Lack of high-quality training data - Ethical concerns (bias, privacy, fairness) - High computational costs - Difficulty in explaining AI decisions (black-box models)
Enclosure	Articles by Student

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Artificial Intelligence/Machine Learning– Explained

AI is a once-in-a lifetime commercial and defense game changer

Hundreds of billions in public and private capital is being invested in AI and Machine Learning companies. The number of patents filed in 2021 is more than 30 times higher than in 2015 as companies and countries across the world have realized that AI and Machine Learning will be a major disruptor and potentially change the balance of military power.

Until recently, the hype exceeded reality. Today, however, advances in AI in several important areas (here, here, here, here and here) equal and even surpass human capabilities.

If you haven't paid attention, now's the time.

AI and the DoD

The Department of Defense has thought that AI is such a foundational set of technologies that they started a dedicated organization- the JAIC - to enable and implement artificial intelligence across the Department. They provide the infrastructure, tools, and technical expertise for DoD users to successfully build and deploy their AI-accelerated projects.

Some specific defense related AI applications are listed later in this document.

We're in the Middle of a Revolution

Imagine it's 1950, and you're a visitor who traveled back in time from today. Your job is to explain the impact computers will have on business, defense and society to people who are using manual calculators and slide rules. You succeed in convincing one company and a government to adopt computers and learn to code much faster than their competitors /adversaries. And they figure out how they could digitally enable their business – supply chain, customer interactions, etc. Think about the competitive edge they'd have by today in business or as a nation. They'd steamroll everyone.

That's where we are today with Artificial Intelligence and Machine Learning. These technologies will transform businesses and government agencies. Today, 100s of billions of dollars in private capital have been invested in 1,000s of AI startups. The U.S. Department of Defense has created a dedicated organization to ensure its deployment.

But What Is It?

Compared to the classic computing we've had for the last 75 years, AI has led to new types of applications, e.g. facial recognition; new types of algorithms, e.g. machine learning; new types of computer architectures, e.g. neural nets; new hardware, e.g. GPUs; new types of software developers, e.g. data scientists; all under the overarching theme of artificial intelligence. The sum of these feels like buzzword bingo. But they herald a sea change in what computers are capable of doing, how they do it, and what hardware and software is needed to do it.

This brief will attempt to describe all of it.

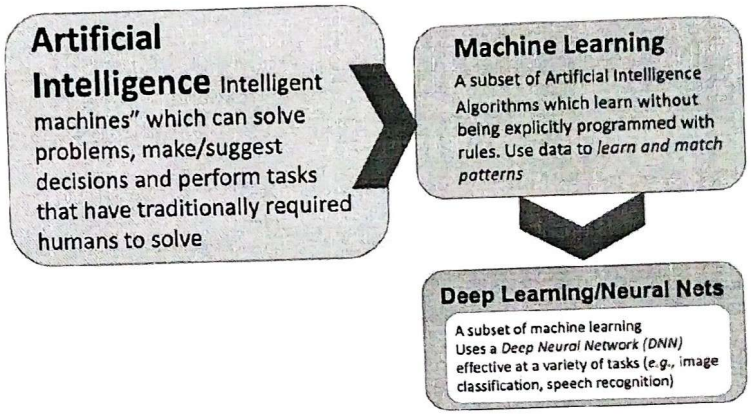
New Words to Define Old Things

One of the reasons the world of AI/ML is confusing is that it's created its own language and vocabulary. It uses new words to define programming steps, job descriptions, development tools, etc. But once you understand how the new world maps onto the classic computing world, it starts to make sense. So first a short list of some key definitions.

AI/ML - a shorthand for Artificial Intelligence/Machine Learning

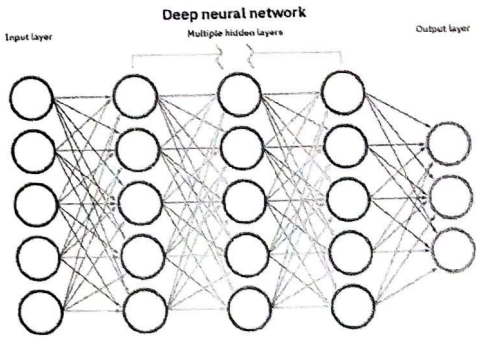
Artificial Intelligence (AI) - a catchall term used to describe "Intelligent machines" which can solve problems, make/suggest decisions and perform tasks that have traditionally required humans to do. AI is not a single thing, but a constellation of different technologies.

Machine Learning (ML) - a subfield of artificial intelligence. Humans combine data with algorithms (see here for a list) to *train a model* using that data. This trained model can then make predications on new data (is this picture a cat, a dog or a person?) or decision-making processes (like understanding text and images) without being explicitly programmed to do so.



Machine learning algorithms - computer programs that adjust themselves to perform better as they are exposed to more data. The "learning" part of machine learning means these programs change how they process data over time. In other words, a machine-learning algorithm can adjust its own settings, given feedback on its previous performance in making predictions about a collection of data (images, text, etc.).

Deep Learning/Neural Nets – a subfield of machine learning. Neural networks make up the backbone of deep learning. (The "deep" in deep learning refers to the depth of layers in a neural network.) Neural nets are effective at a variety of tasks (*e.g.*, image classification, speech recognition). A deep learning neural net algorithm is given massive volumes of data, and a task to perform - such as classification. The resulting model is capable of solving complex tasks such as recognizing objects within an image and translating speech in real time. In reality, the neural net is a logical concept that gets mapped onto a physical set of specialized processors. See here.)



Data Science – a new field of computer science. Broadly it encompasses data systems and processes aimed at maintaining data sets and deriving meaning out of them. In the context of AI, it's the practice of people who are doing machine learning.

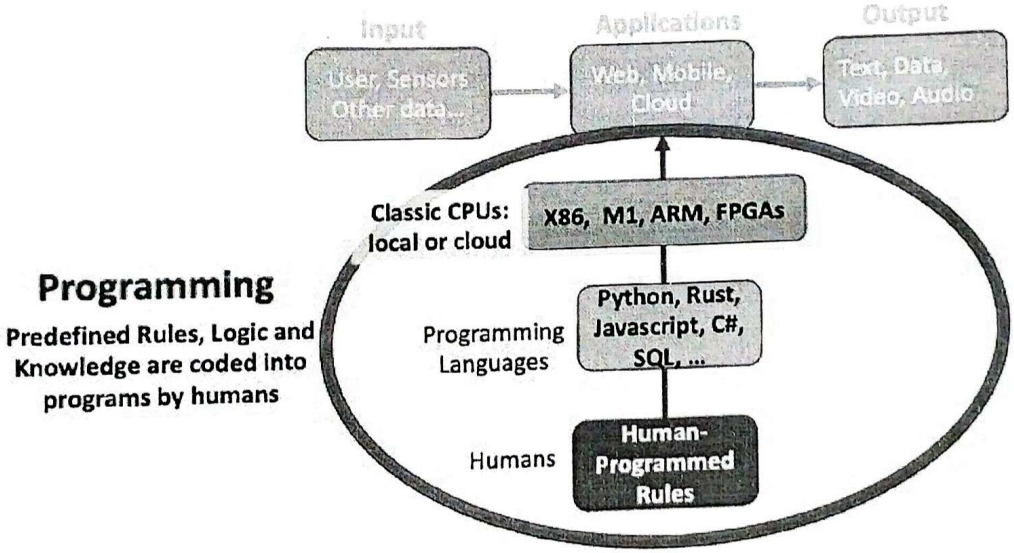
Data Scientists - responsible for extracting insights that help businesses make decisions. They explore and analyze data using machine learning platforms to create models about customers, processes, risks, or whatever they're trying to predict.

What's Different? Why is Machine Learning Possible Now?

To understand why AI/Machine Learning can do these things, let's compare them to computers before AI came on the scene. (Warning – *simplified* examples below.)

Classic Computers

For the last 75 years computers (we'll call these *classic computers)* have both shrunk to pocket size (iPhones) and grown to the size of warehouses (cloud data centers), yet they all continued to operate essentially the same way.



Classic Computers - Programming

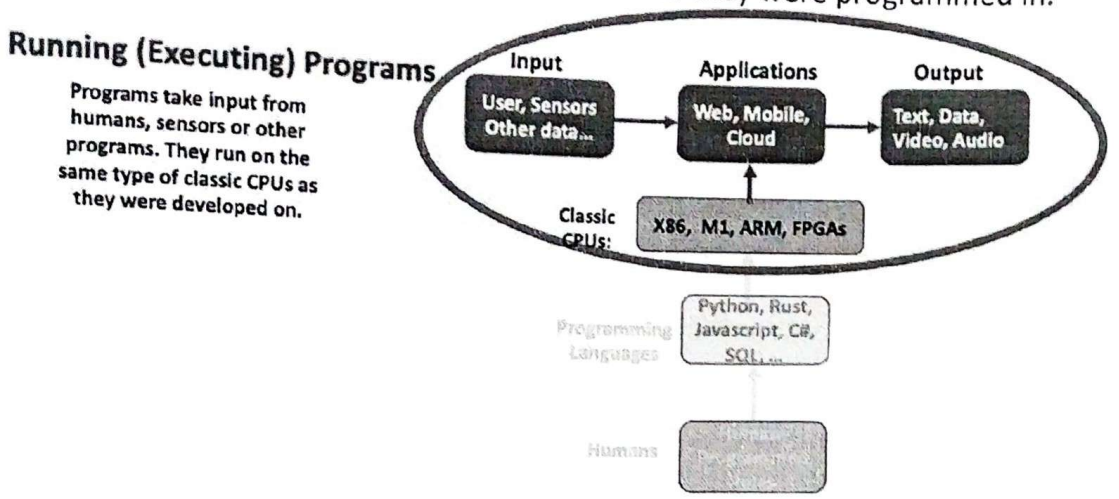
Classic computers are designed to do anything a human *explicitly tells them to do*. People (programmers) write software code (programming) to develop applications, thinking a priori about all the rules, logic and knowledge that need to be built in to an application so that it can deliver a specific result. These rules are explicitly coded into a program using a software language (Python, JavaScript, C#, Rust, ...).

Classic Computers - Compiling

The code is then *compiled* using software to translate the programmer's source code into a version that can be run on a target computer/browser/phone. For most of today's programs, the computer used to develop and compile the code does not have to be that much faster than the one that will run it.

Classic Computers - Running/Executing Programs

Once a program is coded and compiled, it can be deployed and run (executed) on a desktop computer, phone, in a browser window, a data center cluster, in special hardware, etc. Programs/applications can be games, social media, office applications, missile guidance systems, bitcoin mining, or even operating systems e.g. Linux, Windows, IOS. These programs run on the same type of classic computer architectures they were programmed in.



Classic Computers – Software Updates, New Features

For programs written for classic computers, software developers receive bug reports, monitor for security breaches, and send out regular software updates that fix bugs, increase performance and at times add new features.

Classic Computers- Hardware

The CPUs (Central Processing Units) that write and run these Classic Computer applications all have the same basic design (architecture). The CPUs are designed to handle a wide range of tasks quickly in a *serial* fashion. These CPUs range from Intel X86 chips, and the ARM cores on Apple M1 SoC, to the z15 in IBM mainframes.

Machine Learning

In contrast to programming on classic computing with fixed rules, machine learning is just like it sounds – we can train/teach a computer to "learn by example" by feeding it lots and lots of examples. (For images a rule of thumb is that a machine learning algorithm needs at least 5,000 labeled examples of each category in order to produce an AI model with decent performance.) Once it is trained, the computer runs on its own and can make predictions and/or complex decisions.

Just as traditional programming has three steps - first *coding* a program, next *compiling* it and then *running* it - machine learning also has three steps: *training* (teaching), *pruning* and *inference* (predicting by itself.)