Artificial Intelligence & GenAI

Overview on GenAI

General outline

- Introduction to AL/ML
- Machine Learning Techniques
- Deep Learning Techniques
- Demo of LLM
- Future of AL – thoughts
- Questions?

Introduction to AI, ML, & GenAI

- What is Artificial Intelligence?

  "ability to learn or understand"…..

  "to think abstractly" …. "ability to reason"

- How old is the concept of AI/ML?

  10 to 15 years? 30 years? ..

intelligence noun

in·tel·li·gence in-ˈte-lə-jən(t)s

Synonyms of *intelligence* >

1 **a** (1) : the ability to learn or understand or to deal with new or trying situations : REASON

also : the skilled use of reason

(2) : the ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria (such as tests)

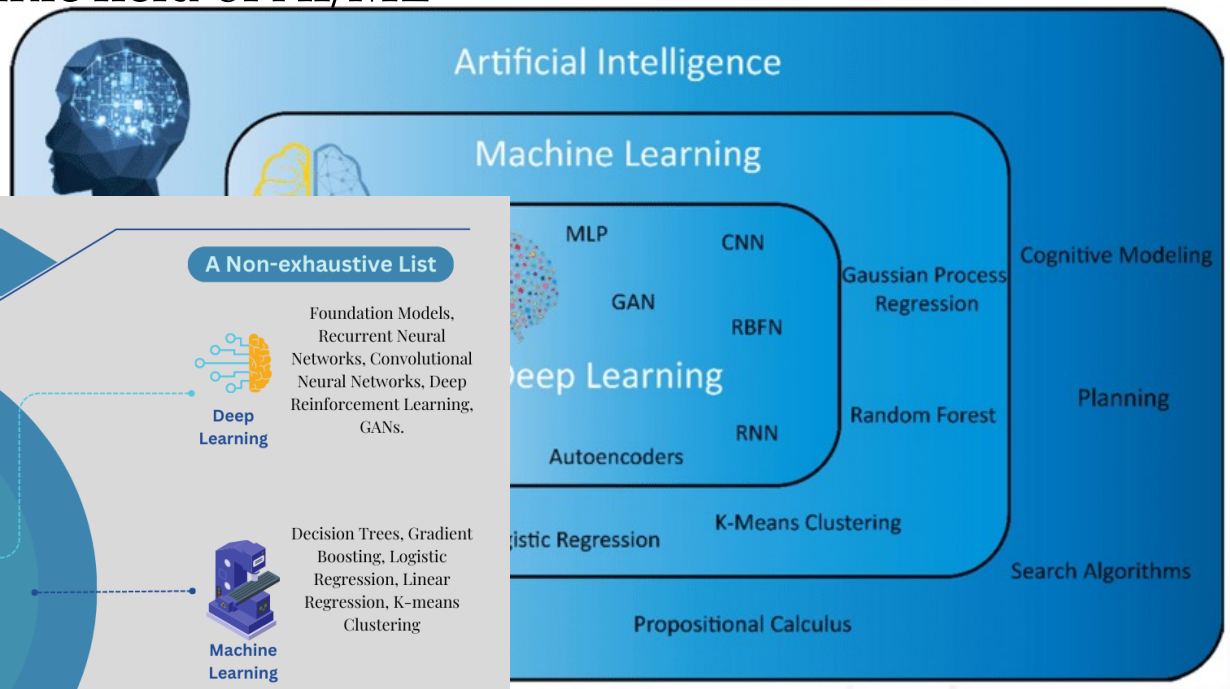
b : mental acuteness : SHREWDNESS

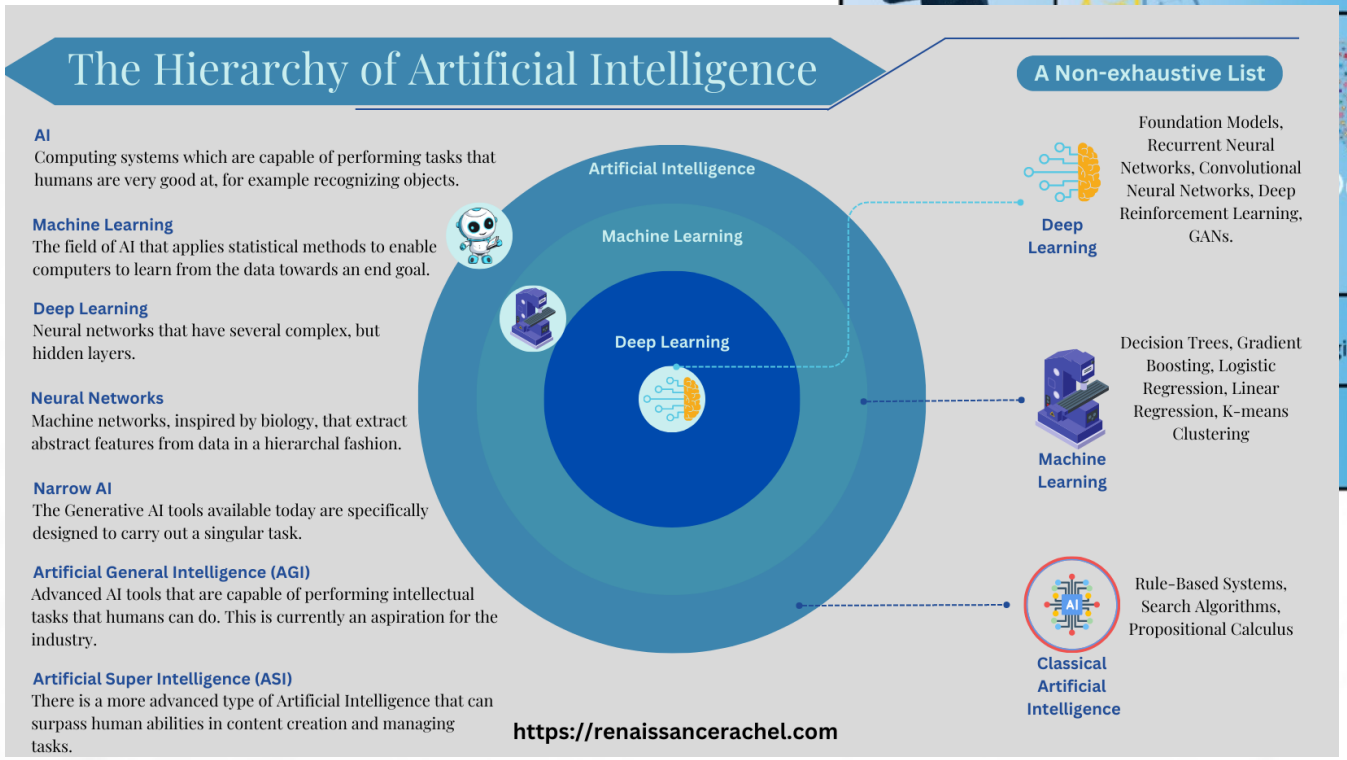
Source: https://www.merriam-webster.com/dictionary/intelligence

Our most detailed information of Babbage's Analytical Engine comes from a memoir by Lady Lovelace (1842). In it she states, "The Analytical Engine has no pretensions to *originate* anything. It can do *whatever we know how to order it* to perform" (her italics). This statement is quoted by Hartree (1949) who adds: "This does not imply that it may not be possible to construct electronic equipment which will 'think for itself,' or in which, in biological terms, one could set up a conditioned reflex, which would serve as a basis

AI, ML, Deep learning, Neural networks… how are they related?

Many ways to organize the dynamic field of AI/ML





Key terminology

Vocabulary

Attention, Reasoning, Comprehension, Perception, Learning, -- Cognitive computing

Cognition - The mental action or process of *acquiring knowledge and understanding through thought, experience, and the senses*. [Oxford Dictionary]

Machine learning:

Parametric learning vs. Non-parametric learning

Gradient descent: iterative optimization algorithm used to minimize the loss function

Loss function: quantifies the difference between predictions and ground truth

Backpropagation: algorithm for computing gradients of the loss function with respect to network parameters

Learning rate: hyperparameter controlling the step size of gradient descent updates

ML: Parametric learning

Consider the equation for a straight line ($Ax + By + C = 0$).

There are two parameters that define the boundary for a given scenario (Yes/No).

When we use a Llama 2 trained on 7B, 13B, or 70B… it gives us the idea why it is expensive to train and build a good model.

Machine learning is an *optimization exercise*.

Gradient descent (and its variants) is the most common optimization algorithm used in ML.

.. cost function, loss function, etc. Then we have regularization, etc. Minima/Maxima, etc.

The best examples are linear regression, logistic regression, etc.

Fundamentally, the model tries to guess (predict) the output based on the input.

ML: Non-Parametric learning

In a non-parametric model, there is no equation with parameters is supplied.

The model is learned as part of the machine learning process. The algorithm needs to determine the model based on the training data.

Classification of Data

1. Structured data: Table, list of stock prices, monitoring data from IOT device, etc.
2. Unstructured data: text, audio, video, images, etc.
3. Semi-structured data: With a structure, but the structure contains Unstructured data. example: XML, JSON, etc.

Or as…

- Labeled data .. data with output.
- Unlabeled data .. data without output.

Can someone guess what these are?

Machine Learning Algorithms
(reference material)

Supervised – Regression
- Simple & multiple linear regression

Supervised - Classification
- Naïve Bayes
- Support Vector Machines (SVM)
- Logistic Regression

Supervised - Both
- Decision trees
- Random forest
- Neural Networks
- K Nearest Neighbors (KNN)
- ExtraTrees
- Generalized Linear/Additive Models (GLM/GAM)

Unsupervised
- K-Mean
- Principle Component Analysis (PCA)
- Hidden Markov Models
- Gaussian Mixture Model

Deep Learning Algorithms
(reference material)

- **Convolutional Neural Networks (CNNs)**
- Long Short Term Memory Networks (LSTMs)
- Recurrent Neural Networks (RNNs)
- Generative Adversarial Networks (GANs)
- Radial Basis Function Networks (RBFNs)
- Multilayer Perceptrons (MLPs)
- Self Organizing Maps (SOMs)

Deep learning – RNN & CNN

RNN

- Neural networks designed for processing sequences of data
- Maintain internal hidden states to capture temporal dependencies
- Variants of RNNs:
  a. Long Short-Term Memory (LSTM)
  b. Gated Recurrent Unit (GRU)
- Applications: text classification, language modeling, sequence-to-sequence learning

CNN

- Specialized neural networks for processing grid-like data (e.g., images)
- Convolutional layers: *learn local features in input data* (context)
- Pooling layers: *reduce spatial dimensions* and enhance feature representations
- Fully connected layers: perform classification based on learned features

Demo time…

Let us look at a simple LLM to understand some of the internals

Thoughts on future….

Questions