# AIML MODELS

**1. Statistical Models (Linear, Logistic Regression)**

Statistical models are lightweight, interpretable methods that assume a specific form (e.g. linear) relating features to the outcome. *Linear regression* models a continuous target as a weighted sum of inputs and fits coefficients by minimizing squared error. *Logistic regression* is used for classification (often binary): it models the log-odds of the class as a linear combination of input features, then applies a sigmoid to convert to probability. These models don't capture highly complex nonlinearity but are fast, robust, and good baselines.

**Real-life / interesting examples:**

- Predicting house or apartment prices based on features like size, number of rooms, age, location.
- Predicting whether a patient has a disease (yes/no) from clinical measurements (age, lab tests, vital signs).
- Estimating probability that an email is spam or not (binary classification).

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**2. Machine Learning Models (Decision Trees, Random Forests, SVM)**

These are more flexible, non-parametric or semi-parametric models. A *decision tree* splits data along feature thresholds (if/else) to partition inputs into homogeneous groups. *Random forest* builds an ensemble of many decision trees (trained on different subsets of data/features) and averages or votes the outputs to improve robustness. *Support Vector Machine (SVM)* tries to find a hyperplane that maximizes the margin between classes, and can use kernel functions to separate nonlinear classes in feature space.

**Real-life / interesting examples:**

- Credit scoring: classifying loan applications into "approve / reject" using random forests (to reduce risk).
- Medical diagnosis: decision trees used (or ensembles) to decide presence/absence of conditions based on symptoms and test results.
- Image classification on small datasets: SVM (with kernel) applied to extracted features (e.g. SIFT, HOG) to classify object categories.

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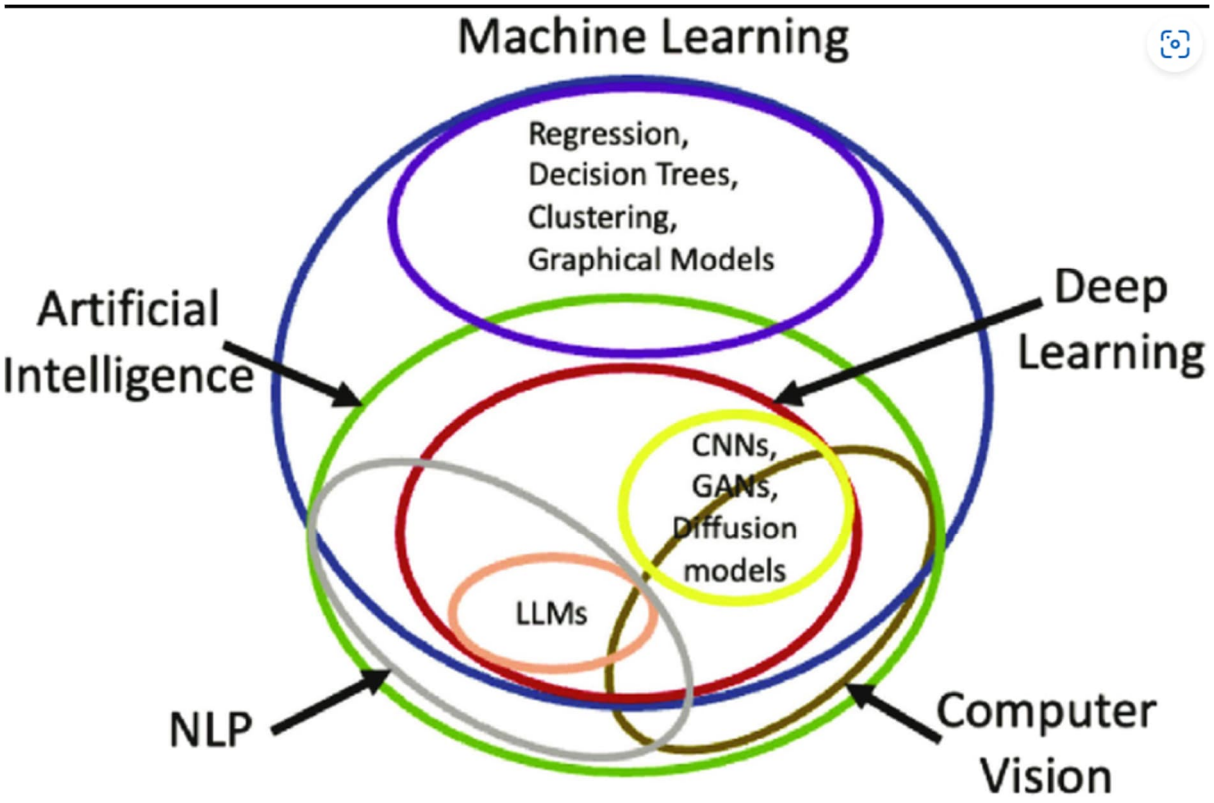


**3. Deep Learning Models: CNNs, RNNs, Transformers**

Deep learning models are neural networks with many layers that can automatically learn hierarchical feature representations. *Convolutional Neural Networks (CNNs)* are suited for spatial data (images, video) by applying convolution and pooling operations that capture local patterns. *Recurrent Neural Networks (RNNs)* (and variants like LSTM, GRU) are for sequential data (text, time series), maintaining hidden state across time steps. *Transformers* use attention mechanisms to capture relationships between all positions in a sequence in parallel, enabling more effective long-range context modeling; they are now the de facto standard for NLP and many multimodal tasks.

**Real-life / interesting examples:**

- CNNs: medical image diagnosis (detecting tumors in MRI/CT scans), object detection in self-driving cars.
- RNNs / LSTMs: language modeling, speech recognition, stock price time series forecasting.
- Transformers: large language models (e.g. GPT, BERT) for text generation / summarization / translation; vision transformers (ViT) for image classification; multimodal models combining vision & text.

**4. Generative Models: GANs, Diffusion Models, LLMs**

Generative models learn to **produce** new data samples resembling the training distribution. *GANs (Generative Adversarial Networks)* consist of a generator and a discriminator in adversarial training: generator tries to fool the discriminator, discriminator tries to detect fakes. *Diffusion models* gradually corrupt data (e.g. by adding noise) and then learn to reverse that corruption step by step, enabling generation by denoising. *LLMs (Large Language Models)* are sequence models trained to predict next token(s) in large corpora—once trained, they generate coherent, contextual text (and increasingly across modalities).

**Real-life / interesting examples:**

- GANs: *StyleGAN* for generating realistic human faces; generating fashion designs or artwork.
- Diffusion models: *Stable Diffusion*, *DALL·E*, *Midjourney* for high-quality text-to-image generation, inpainting, image editing.
- LLMs: ChatGPT, GPT-4 used for drafting content, answering questions, code generation; used in conversational agents, summarization, translation.

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