**機器學習[Machine learning** (**ML**)**]**

**機器學習是一門人工智慧的科學，該領域的主要研究物件是如何在經驗學習中改善具體演算法的效能。**

**機器學習是對能通過 經驗 自動改進 的 電腦演算法 的研究。**

**機器學習是用 資料 或 以往的經驗，以此最佳化電腦程式的效能標準。**

**A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E**

**機器學習類型:**

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| --- | --- | --- |
| **類型** | **說明** | **代表性演算法** |
| **監督式學習**  **Supervised learning** | **由訓練資料中學到或建立一個模式(函數/learning model)，並依此模式推測新的實例。**  **訓練資料(labeled Training data)是由輸入物件（通常是向量）和預期輸出所組成。**  **函數的輸出可以是一個連續的值(迴歸分析regression)，或是預測一個分類標籤(分類classification)** | **迴歸分析regression**  **Linear regression**  **Logistic regression**  **分類演算法classification**  **決策樹Decision trees**  **支援向量機(SVM)**  **Support vector machine** |
| **非監督式學習**  **Unsupervised learning** | **機器研究輸入的資料，多數是未標記(no labeled)與非結構化的資料，並開始使用所有相關且可存取的資料來識別模式和關聯性。**  **非監督式學習是在模仿人類如何觀察世界。我們運用直覺和經驗將事情分類，而隨著經歷更多體驗，分類和識別的能力會越來越精確；對於機器而言，「經驗」則是輸入和可用的資料量。** | **Clustering叢集演算法**  **k-Means…..**  **維度縮減Dimensionality reduction**  **主成分分析PCA**  **自動編碼器Autoencoder**  **生成對抗網路(GAN)** |
| **半監督式學習**  **Semi-supervised learning** | **Combines a small amount of labeled data with a large amount of unlabeled data during training.**  **Semi-supervised learning falls between unsupervised learning (with no labeled training data) and supervised learning (with only labeled training data)** | **transductive support vector machine(TSVM)**  **部分特殊型Deep Learning演算法** |
| **Reinforcement learning** | **an area of machine learning concerned with how intelligent agents ought to take actions in an environment in order to maximize the notion of cumulative reward.** | **蒙特卡洛學習 Monte-Carlo Learning**  **Temporal-Difference Learning**  **SARSA**  **Q-Learning** |

**決策樹Decision trees**

**分類演算法效能評估指標;** **混淆矩陣(confusion matrix)**

**【資料來源】https://en.wikipedia.org/wiki/Confusion\_matrix**

如何辨別機器學習模型的好壞？==> Confusion Matrix

**TP(True Positive): 正確預測成功的正樣本 TN(True Negative): 正確預測成功的負樣本**

**FP(False Positive): 錯誤預測成正樣本(實際上為負樣本) 第一型錯誤 (Type 1 Error)**

**FN(False Negative): 錯誤預測成負樣本(或者說沒能預測出來的正樣本) 第二型錯誤(Type 2 Error)**

**在統計學上FP被還被稱為第一型錯誤(Type 1 Error)，FN被稱為第二型錯誤(Type 2 Error)**

|  |  |
| --- | --- |
|  | **全部樣本數 = P + N**  **condition positive (P) P = TP +FN**  **the number of real positive cases in the data**  **condition negative (N) N = FP +TN**  **the number of real negative cases in the data**  **正確預測 = TP + TN 錯誤預測 = FP + FN** |
|  |  |

**常見問題與解決方案: overfitting(過度擬合)問題**

**【資料來源】https://en.wikipedia.org/wiki/Overfitting**

**過度擬合訓練集卻無法預測更多的測試集**

**overfitting is "the production of an analysis that corresponds too closely or exactly to a particular set of data, and may therefore fail to fit to additional data or predict future observations reliably".To lessen the chance or amount of overfitting, several techniques are available (e.g., model comparison, cross-validation, regularization, early stopping, pruning, Bayesian priors, or dropout). The basis of some techniques is either (1) to explicitly penalize overly complex models or (2) to test the model's ability to generalize by evaluating its performance on a set of data not used for training, which is assumed to approximate the typical unseen data that a model will encounter.**

**解決方案:更多精彩詳述請參加課程**

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**The basis of some techniques is either (1) to explicitly penalize overly complex models or (2) to test the model's ability to generalize by evaluating its performance on a set of data not used for training, which is assumed to approximate the typical unseen data that a model will encounter.**

**人工智慧(Artificial intelligence)**

**【資料來源】https://en.wikipedia.org/wiki/Artificial\_intelligence**

**(1)Artificial intelligence (AI) is intelligence demonstrated by machines, as opposed to natural intelligence displayed by animals including humans.**

**(2)Leading AI textbooks define the field as the study of "intelligent agents": any system that perceives its environment and takes actions that maximize its chance of achieving its goals.**

**Artificial neural networks(ANN類神經網路)**

**人工神經網路 簡稱神經網路（Neural Network，NN）或類神經網路，是一種模仿生物神經網路（動物的中樞神經系統，特別是大腦）的結構和功能的數學模型或計算模型**

**Deep Learning深度學習:**

**【資料來源】https://en.wikipedia.org/wiki/Deep\_learning**

**(1)Deep learning is part of a broader family of machine learning methods based on artificial neural networks.**

**(2)Learning can be supervised, semi-supervised or unsupervised.**

**(3)The adjective "deep" in deep learning refers to the use of multiple layers in the network.**

**(4)Early work showed that a linear perceptron cannot be a universal classifier, but that a network with a nonpolynomial activation function with one hidden layer of unbounded width can.**

**(5)Deep learning is a modern variation which is concerned with an unbounded number of layers of bounded size, which permits practical application and optimized implementation, while retaining theoretical universality under mild conditions.**

**Deep Learning深度學習架構與代表性模型:**

|  |  |  |
| --- | --- | --- |
| **架構** | **說明** | **代表性模型** |
| **CNN**  **Convolutional neural network**  **卷積神經網路** | **卷積神經網路（Convolutional Neural Network, CNN）是一種前饋神經網路，它的人工神經元可以回應一部分覆蓋範圍內的周圍單元，對於大型圖像辨識有出色表現**  **卷積神經網路由一個或多個卷積層和頂端的全連通層（對應經典的神經網路）組成，同時也包括關聯權重和池化層（pooling layer）。這一結構使得卷積神經網路能夠利用輸入資料的二維結構。與其他深度學習結構相比，卷積神經網路在圖像和語音辨識方面能夠給出更好的結果。這一模型也可以使用反向傳播演算法進行訓練。相比較其他深度、前饋神經網路，卷積神經網路需要考量的參數更少，使之成為一種頗具吸引力的深度學習結構** | **Alexnet**  **LeNet**  **VGG網路 …….** |
| **RNN**  **recurrent neural network**  **循環神經網路** | **A recurrent neural network (RNN) is a class of artificial neural networks where connections between nodes form a directed or undirected graph along a temporal sequence.**  **This allows it to exhibit temporal dynamic behavior.**  **RNNs can use their internal state (memory) to process variable length sequences of inputs** | **簡單的RNN模型(Vanilla RNN)**  **Long short-term memory (LSTM)**  **Gated recurrent unit(GRU)** |
| **GAN**  **Generative Adversarial Network**  **生成對抗網絡** | **GAN由一個生成網絡(generator network)與一個判別網絡(discriminative network)組成。**  **通過讓兩個神經網路相互博弈的方式進行學習。**  **生成網絡從潛在空間（latent space）中隨機取樣作為輸入，其輸出結果需要盡量模仿訓練集中的真實樣本。**  **判別網絡的輸入則為真實樣本或生成網絡的輸出，其目的是將生成網絡的輸出從真實樣本中盡可能分辨出來。生成網絡則要盡可能地欺騙判別網絡。兩個網絡相互對抗、不斷調整參數，最終目的是使判別網絡無法判斷生成網絡的輸出結果是否真實** | **有超多模型**  **DCGAN**  **CGAN**  **WGAN**  **CycleGAN**  **….** |
| **Deep Reinforcement learning**  **深度強化學習** | **Deep reinforcement learning (deep RL) is a subfield of machine learning that combines reinforcement learning (RL) and deep learning.**  **RL considers the problem of a computational agent learning to make decisions by trial and error. Deep RL incorporates deep learning into the solution, allowing agents to make decisions from unstructured input data without manual engineering of the state space.**  **Deep RL algorithms are able to take in very large inputs (e.g. every pixel rendered to the screen in a video game) and decide what actions to perform to optimize an objective (eg. maximizing the game score).**  **常見的應用:**  **robotics, video games, natural language processing, computer vision, education, transportation, finance and healthcare** | **Deep Q-Network (DQN)**  **策略梯度法(Policy gradient methods)**  **優勢值演員-評論家(Advantage Actor-Critic, A2C)**  **….** |

**【資料來源】**[**https://en.wikipedia.org/wiki/Deep\_reinforcement\_learning**](https://en.wikipedia.org/wiki/Deep_reinforcement_learning)

**梯度下降法gradient descent**

**【參考資料】 https://en.wikipedia.org/wiki/Gradient\_descent**

**梯度消失問題（Vanishing gradient problem）**

**[1]梯度消失問題是一種機器學習中的難題，出現在以梯度下降法和反向傳播訓練人工神經網路的時候。**

**[2]在每次訓練的迭代中，神經網絡權重的更新值與誤差函數的偏導數成比例，然而在某些情況下，梯度值會幾乎消失，使得權重無法得到有效更新，甚至神經網路可能完全無法繼續訓練。**

**參考資料:** [**https://en.wikipedia.org/wiki/Vanishing\_gradient\_problem**](https://en.wikipedia.org/wiki/Vanishing_gradient_problem)

**梯度消失問題的解決方案:有許多解法**

**[1]使用多級層次結構**

**[2]在RNN架構中使用LSTM(長短期記憶)**

**[3]使用更快的硬體**

**[4]採用不同的架構:如CNN中的殘差網絡（Residual Networks，ResNets）**

**[5]採用其他的激活函數:**

**- Rectifiers such as ReLU suffer less from the vanishing gradient problem, because they only saturate in one direction.**

**- Non-monotonic, non-saturating and oscillatory activation functions can alleviate the vanishing gradient problem and reduce training time**