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**2.1Introduction**

The field of **AI**, using the strongest tools available in computer science, works toward imitating intelligence in a human being. Such systems can perform various tasks usually attributed to human cognitive abilities, such as decision-making, pattern recognition, and problem-solving. AI has come a long way over the years, fueling innovations such as self-driving cars, intelligent virtual assistants, and highly advanced recommendation systems, hence revolutionizing industries and daily life.

In this chapter, basic machine-learning (ML) methodologies are looked into, a major subfield of AI. We will describe the three paradigms of learning: supervised learning, unsupervised learning, and reinforcement learning. Standard algorithms in machine learning will also be addressed followed by a transition into deep learning (DL), which is an enhanced version of ML that exploits multi-layer neural networks. The immediate goal in this instance is to firmly establish some of the fundamental concepts of these methods and their frameworks, in preparation for their application to real-world problems, including cybersecurity and SQL injection detection.

**FINIS**

2.2 ma**chine learning**

The field of machine learning is concerned with the question of how to construct computer programs that automatically improve with experience. In recent years many successful machine learning applications have been developed, ranging from data-mining programs that learn to detect fraudulent credit card transactions, to information-filtering systems that learn users' reading preferences, to autonomous vehicles that learn to drive on public highways. At the same time, there have been important advances in the theory and algorithms that form the foundations of this field.(1)

[1]( Mitchell, T. M, Machine Learning. McGraw-Hill, 1997.)

**Or wla**

Machine learning (ML) is a branch of artificial intelligence focused on developing algorithms and systems that can learn and improve from experience without being explicitly programmed. This field seeks to create computer programs capable of adapting to new data, identifying patterns, and making data-driven decisions. Over the years, machine learning has enabled groundbreaking applications across various domains, such as fraud detection systems that identify suspicious credit card transactions, personalized recommendation engines that adapt to user preferences, and self-driving cars that navigate complex environments. These advancements have been driven by significant progress in the theoretical foundations and algorithmic techniques that underpin machine learning(1) (2) mixed

* Mitchell, T. M. (1997). Machine Learning. McGraw-Hill.9(1)
* Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.(2)

**2.2.2 Machine Learning Types**

Whatever may be the nature and form of learning, machine learning always refers to a very wide-open field wherein computers learn from data to improve performance over time. **In machine learning, this kind of learning process is usually classed into three main parts which are supervised learning, unsupervised learning, and reinforcement learning**. Each type serves a certain distinct purpose and is used with certain types of problems. Besides those three types, hybrid approaches such as commodity inclusion and special techniques have also emerged to maintain and solve more complex issues.

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**2.2.1.1 Supervised Learning: Learning from Labeled Data**

Supervised learning is a fundamental paradigm in machine learning where labeled data is used to train models. Under this paradigm, the input data have known target outputs, thereby allowing the model to learn the relationship between input and output. By spotting patterns and correlations in data, supervised learning algorithms can then make predictions or determine classifications on fresh, never-before-seen data.

**Main Applications:**

Examples of supervised learning applications are:

**Classification:**

In a classification problem, the intention is to assign a set of data points to defined predefined categories or labels. Examples include classifying an email as spam or not spam with the model trained, or diagnosing different medical conditions based on patient data. The well-known algorithms used for classification are decision trees, support vector machines, and neural networks.

**Regression**:

The regression task is concerned with the prediction of a continuous quantity. This may include estimating house prices, stock market trends, and variations in temperature. Algorithms such as linear regression and polynomial regression are commonly used in this scenario.

**2.2.1.2 Unsupervised Learning: Discovering Hidden Patterns**

Unsupervised learning is a type of machine learning ([ML](https://www.techtarget.com/searchenterpriseai/definition/machine-learning-ML)) technique that uses artificial intelligence ([AI](https://www.techtarget.com/searchenterpriseai/definition/AI-Artificial-Intelligence)) algorithms to identify patterns in data sets that are neither classified nor labeled. Unsupervised learning models don't need supervision or preexisting categories while training data sets, making them ideal for discovering patterns, groupings and differences in [unstructured data](https://www.techtarget.com/searchbusinessanalytics/definition/unstructured-data). It's well-suited for processes such as [customer segmentation](https://www.techtarget.com/searchcustomerexperience/definition/customer-segmentation), exploratory data analysis, [dimensionality reduction](https://www.techtarget.com/whatis/definition/dimensionality-reduction) and image recognition.

Unsupervised learning algorithms can classify, label and group the data points contained within data sets without requiring any external guidance to perform that task. In other words, unsupervised learning enables a system to identify patterns within data sets on its own.

In unsupervised learning, an AI system groups unsorted information according to similarities and differences even though no categories are provided.

AI systems capable of unsupervised learning are often associated with [generative learning models](https://www.techtarget.com/searchenterpriseai/definition/generative-modeling), although they might also use a retrieval-based approach, which is most often associated with [supervised learning](https://www.techtarget.com/searchenterpriseai/definition/supervised-learning). [Chatbots](https://www.techtarget.com/searchcustomerexperience/definition/chatbot), self-driving cars, [facial recognition](https://www.techtarget.com/searchenterpriseai/definition/facial-recognition) programs, [expert systems](https://www.techtarget.com/searchenterpriseai/definition/expert-system) and robots are among the systems that use supervised or unsupervised learning approaches. Unsupervised learning is also known as *unsupervised machine learning*. (3)

(3)( https://www.techtarget.com/searchenterpriseai/definition/unsupervised-learning)

**2.2.1.3 Reinforcement Learning: Learning Through Interaction**

Reinforcement learning problems involve learning how to map situations to actions to maximize a numerical reward signal. These problems are inherently closed-loop, as the system’s actions influence its future inputs. Unlike other forms of machine learning, the learner is not explicitly told which actions to take but must discover the best ones through trial and error. In more complex scenarios, actions impact not only immediate rewards but also future states and long-term rewards, making decision-making more challenging (4)

(4)( Reinforcement Learning: An Introduction Second edition, in progress Richard S. Sutton and Andrew G. Barto c 2014, 2015).

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**2.2.2 Machine learning algorithms**

**2.2.2.1** Logistic regression

Logistic regression is a supervised machine learning algorithm used for classification tasks, predicting the probability that an instance belongs to a specific class. It is a statistical method that analyzes the relationship between independent variables and a categorical outcome.

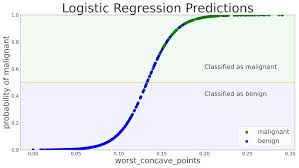
Unlike linear regression, logistic regression applies the sigmoid function to map input values to a probability ranging between 0 and 1. Instead of fitting a regression line, it models an "S"-shaped curve to distinguish between classes.

**Key Points:**

* Logistic regression predicts the output of a categorical dependent variable.
* The outcome is discrete (e.g., Yes/No, 0/1, True/False) but represented as a probability between 0 and 1 (5)

(5)( https://www.geeksforgeeks.org/understanding-logistic-regression/).

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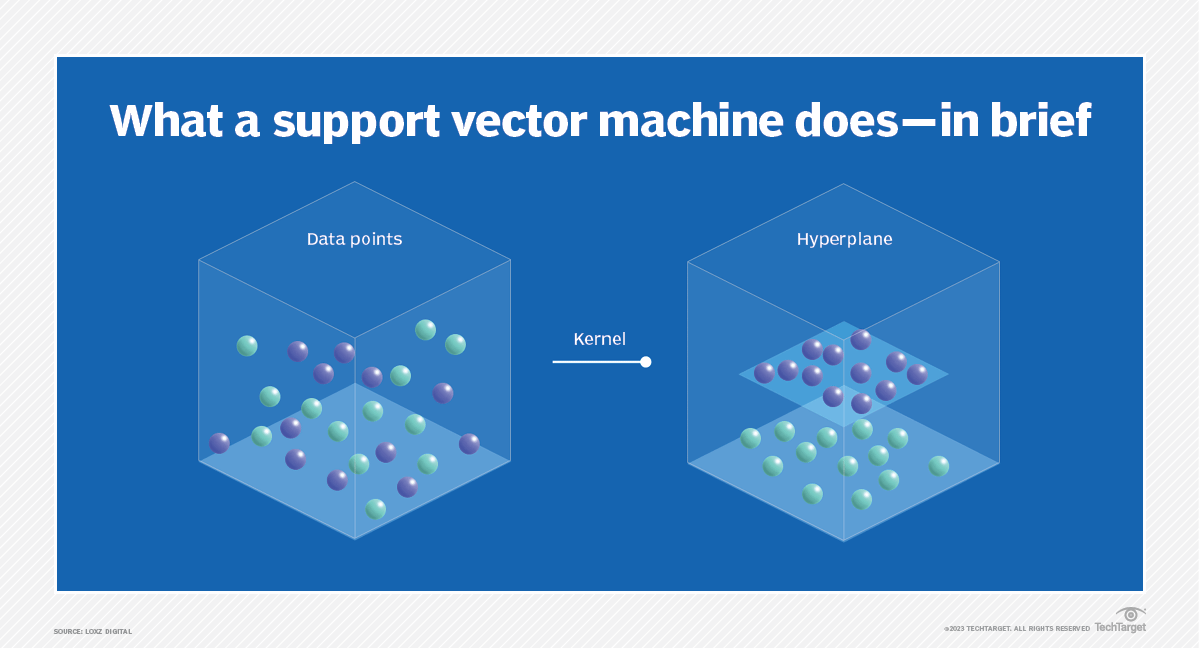


2.2.2.2 SVM

SVM (Support Vector Machine) is one of the supervised learning techniques employed for classification and regression tasks. The classification margin between various classes is maximized by finding the optimal hyperplane. Among the significant concepts are \*\*support vectors\*\* (data points that are critical in defining the margin), \*\*hyperplane\*\*, and \*\*kernel functions\*\* (which map the data into higher dimensions for separating it nonlinearly).

SVM uses three kernels-linear SVM, polynomial SVM, and artillery -to handle \*\*linearly separable\*\* and \*\*non-linearly separable\*\* data. It employs a soft margin to maximize the margin and add a penalty when data points are misclassified. The optimization problem is reduced to minimizing a loss function while ensuring that the classification is being done correctly. The \*\*dual problem\*\* allows efficient computation and non-linear classification by means of \*\*kernel trick\*\*. SVM is widely adopted in text classification, image recognition, and bioinformatics.(4)

(4)( https://www.geeksforgeeks.org/support-vector-machine-algorithm/)



Figure(<https://www.techtarget.com/whatis/definition/support-vector-machine-SVM#:~:text=A%20support%20vector%20machine%20(SVM)%20is%20a%20type%20of%20supervised,data%20set%20into%20two%20groups.)>

**2.2.3 Machine learning applications**

**Game Playing**- RL is being used to create systems that can contrast and even surpass human capabilities in playing games like chess, Go, and video games (AlphaGo, for example).

**Robotics**: Training robots to be able to perform complex tasks such as walking or grasping objects.

**Autonomous Systems**: To be able to move safely and efficiently by itself, self-driving cars require reinforcement learning.

The Most Famous Algorithms:

**Q-Learning**: A model-free algorithm which learns values for actions available in a certain state.

**Deep Q-Networks (DQNs**): Combines Q-learning with deep neural networks in order to high-dimensional state spaces (Sutton & Barto, 2018).

Reinforcement learning is the right approach for sequential decision making and long-term planning.

2.3 Deep Learnig