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Certificate in Artificial Intelligence Design, Implementation and Application

Part-time

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1. Basic Principles of Artificial Intelligence

1.1. Market Demand for Artificial Intelligence

Figure 1 showing you that the worldwide artificial intelligence is projected to grow from USD 214,6 billion to 1339.1 billion in 2030 at a compound forecast rate 35.7% during the forecast period. You can find out that North America and Asia-Pacific are main artificial intelligence market.

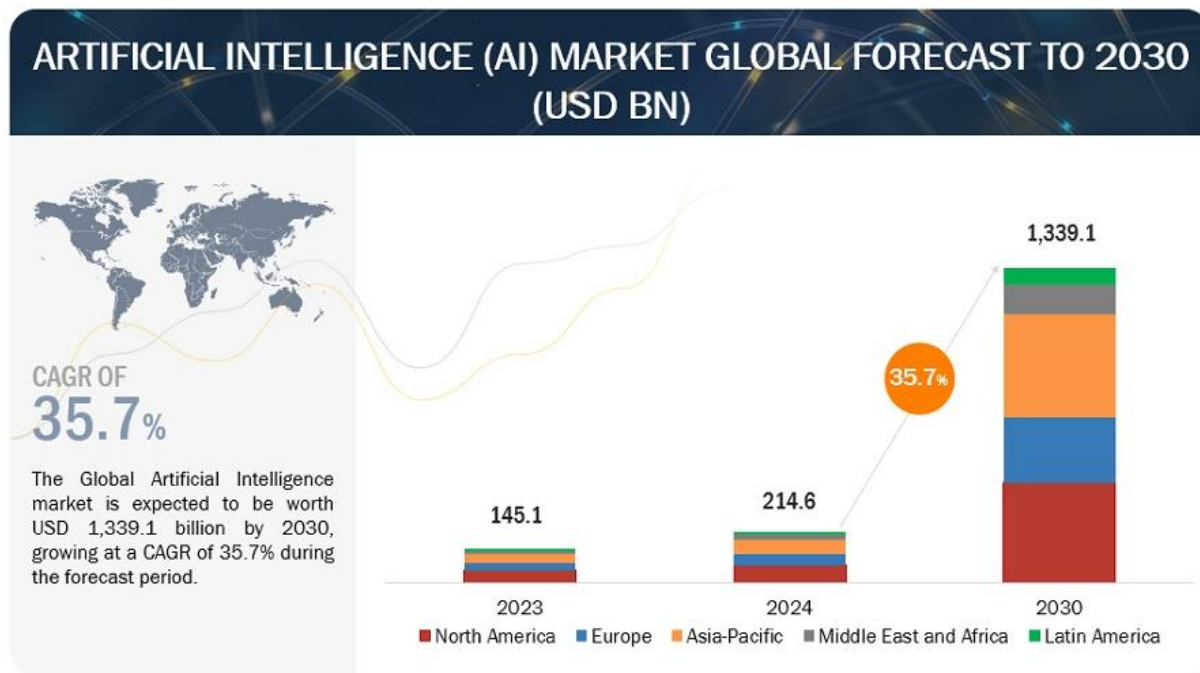


Figure 1 Artificial intelligence (AI) Market Global Forecast to 2030^[1]

1.1.1. Artificial intelligence market based on offering hardware, software and services

- Hardware
 - AI Accelerator
 - Processors
 - Central Processing Units (CPU)
 - Graphics Processing Units (GPU)
 - Field Programmable Gate Arrays (FPGA)
 - Other Processors
 - Memory
 - Networking Hardware
- Software
 - Classify by Discriminative AI and Generative AI
 - Discriminative AI
 - Classification Algorithms
 - Regression Algorithms

- Deep Learning Platforms
- Ensemble Methods
- Generative AI
 - Generative Adversarial Networks (Gans)
 - Autoencoders
 - Convolutional Neural Networks(Cnns)
 - Transformer Models
 - Bidirectional Encoding Representations from Transformers (BERT)
 - Generative Pre-trained Transformer 1(GPT-1)
 - Generative Pre-trained Transformer 2(GPT-2)
 - Generative Pre-trained Transformer 3(GPT-3)
 - Generative Pre-trained Transformer 4(GPT-4)
 - Language Model for Dialogue Applications (LaMDA)
 - Other Transformer Models
- Classify by Deployment Mode
 - Cloud/Off Premises
Scalability is the benefit of Cloud Solutions
 - On Premises
Physical control over the hardware is the benefit
- Classify by Coding Automation
 - No-code AI
 - Low-code AI
 - Pro-code AI
- Services
 - Professional Services
 - Training and consulting services
 - System Integration and Deployment Services
 - Support and Maintenance Services
 - Managed Services

1.1.2. Artificial intelligence market based on technology

- Machine Learning
 - Supervised Learning
 - Unsupervised Learning
 - Reinforcement Learning
- Natural Language Processing
 - Natural Language Understanding (NLU)
 - Text Classification
 - Named Entity Recognition (NER)
 - Intent Recognition

- Relationship Extraction
 - Others
- Natural Language Generation (NLG)
 - Text Summarization
 - Machine Translation
 - Language Modelling
 - Dialogue Generation
- Computer Vision
 - Object Detection
 - Image Classification
 - Semantic Segmentation
 - Facial recognition
 - Others
- Context-aware Artificial Intelligence (CAAI)
 - Context-Aware Recommendation System
 - Multi-Modal AI
 - Context-aware Virtual Assistants



Figure 2 Artificial Intelligence Market Ecosystem ^[1]

1.2. How artificial intelligence solves problems

1.2.1. AI Technology for Drone Delivery

Problem:

The middle section of Badaling Great Wall is. How can I receive takeaway there?



Figure 3 Meituan Drone Delivery Service

Solution:

The Meituan drone delivery service for the first time into Beijing landing on the Badaling Great Wall on August 2024. [2]

1.2.2. Flooding Warning System

Problem:

Flooding causing loss

Solution:

Using AI flooding warning system to minimize loss though generate flooding alert on specific water level.

1.2.3. Business Process Reengineering

Problems:

- Process inefficiencies lead to have high operating costs
- The inter-departmental cooperation is not smooth, and the phenomenon of information island is serious
- Unable to respond quickly to market changes and customer needs
- Lack of systematic process management and optimization methods

Solution:

Business Process Reengineering is used to make workflows more efficient by analyzing and redesigning processes from end to end.

1.3. Knowledge and Reasoning

1.3.1. Knowledge

1.3.1.1. 4 knowledge representation in AI

1. Logical Representation

Logical representation is a language with some concrete rules which deals with propositions and has no ambiguity in representation. Logical representation means drawing a conclusion based on various conditions. This representation lays down some important communication rules. It consists of precisely defined syntax and semantics which supports the sound inference. Each sentence can be translated into logics using syntax and semantics.

Syntax:

- Syntaxes are the rules which decide how we can construct legal sentences in the logic.
- It determines which symbol we can use in knowledge representation.
- How to write those symbols.

Semantics:

- Semantics are the rules by which we can interpret the sentence in the logic.
- Semantics also involves assigning a meaning to sentence.

Logical representation can be categorized into two logics:

1. Propositional Logics
2. Predicate logics

Advantages of logical representation:

1. Logical representation enables us to do logical reasoning.
2. Logical representation is the basis for the programming languages.

Disadvantages of logical Representation:

1. Logical representations have some restrictions and are challenging to work with.
2. Logical representation technique may not be very natural, and inference may not be so efficient.

2. Semantic Network Representation

Semantic networks are alternative of predicate logic for knowledge representation. In Semantic networks, we can represent our knowledge in the form of graphical networks. This network consists of nodes representing objects and arcs which describe the relationship between those objects. Semantic networks can categorize the object in different forms and can also link those objects. Semantic networks are easy to understand and can be easily extended.

This representation consists of mainly two types of relations:

1. IS-A relation (Inheritance)
2. Kind-of-relation

Example: Following are some statements which we need to represent in the form of nodes and arcs.

Statements:

- a. Pudding is a dog.
- b. Pudding is a mammal
- c. Pudding is owned by Tom.
- d. Pudding is yellow colored.
- e. All Mammals are animal.

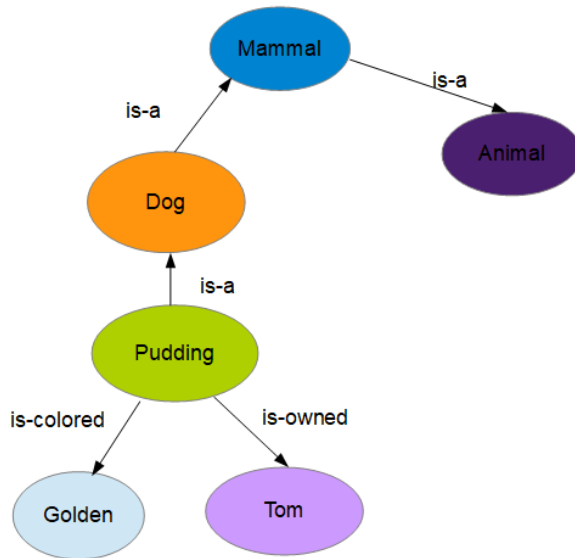


Figure 4 Different type of knowledge in the form of nodes and arc

Drawbacks in Semantic representation:

1. Semantic networks take more computational time at runtime as we need to traverse the complete network tree to answer some questions. It might be possible in the worst case scenario that after traversing the entire tree, we find that the solution does not exist in this network.
2. Semantic networks try to model human-like memory (Which has 1015 neurons and links) to store the information, but in practice, it is not possible to build such a vast semantic network.
3. These types of representations are inadequate as they do not have any equivalent quantifier, e.g., for all, for some, none, etc.
4. Semantic networks do not have any standard definition for the link names.
5. These networks are not intelligent and depend on the creator of the system.

Advantages of Semantic network:

1. Semantic networks are a natural representation of knowledge.
2. Semantic networks convey meaning in a transparent manner.
3. These networks are simple and easily understandable.

3. Frame Representation

A frame is a record like structure which consists of a collection of attributes and its values to describe an entity in the world. Frames are the AI data structure which divides knowledge into substructures by representing stereotypes situations. It consists of a collection of slots and slot values. These slots may be of any type and sizes. Slots have names and values which are called facets.

Facets: The various aspects of a slot is known as Facets. Facets are features of frames

which enable us to put constraints on the frames. Example: IF-NEEDED facts are called when data of any particular slot is needed. A frame may consist of any number of slots, and a slot may include any number of facets and facets may have any number of values. A frame is also known as slot-filter knowledge representation in artificial intelligence.

Frames are derived from semantic networks and later evolved into our modern-day classes and objects. A single frame is not much useful. Frames system consist of a collection of frames which are connected. In the frame, knowledge about an object or event can be stored together in the knowledge base. The frame is a type of technology which is widely used in various applications including Natural language processing and machine visions.

Example:

Tom is an engineer as a profession, and his age is 26.

Table 1 Data of Frame

Slot	Filters
Title	Tom
Profession	Doctor
Age	26
Marital Status	Single
Weight	68

4. Production Rules

Production Rule system consist of (condition, action) pairs, that means if satisfy condition then action.

It has mainly three parts

- A set of production rules
- Working memory
- Recognize-act-cycle

The agent checks for the condition and if the condition exists then production rule fires and corresponding action is carried out.

The condition part of the rule determines which rule may be applied to a problem. And the action part carries out the associated problem-solving steps. This complete process is called a recognize-act cycle.

The working memory contains the description of the current state of problems-solving and rule can write knowledge to the working memory. This knowledge match and may fire other rules.

If there is a new situation generates, then multiple production rules will be fired together, this is called conflict set. In this situation, the agent needs to select a rule from these sets, and it is called a conflict resolution.

Example:

If at MTR station and train arrive then get into the train.

If on the train and empty seat then sit down.

If train arrives at destination then get down from the bus.

1.3.1.2.Approaches to knowledge representation:

1. Simple relation knowledge

- It is the simplest way of storing facts which uses the relational method, and each fact about a set of the object is set out systematically in columns.
- This approach of knowledge representation is famous in database systems where the relationship between different entities is represented.
- This approach has little opportunity for inference.

Example: The following is the simple relational knowledge representation.

Table 2Example of the simple relational knowledge representation

Player	Weight	Age
Player1	45	18
Player2	42	21
Player3	42	22

2. Inheritable knowledge

- In the inheritable knowledge approach, all data must be stored into a hierarchy of classes.
- All classes should be arranged in a generalized form or a hierarchal manner.
- In this approach, we apply inheritance property.
- Elements inherit values from other members of a class.
- This approach contains inheritable knowledge which shows a relation between instance and class, and it is called instance relation.
- Every individual frame can represent the collection of attributes and its value.
- In this approach, objects and values are represented in Boxed nodes.
- We use Arrows which point from objects to their values.

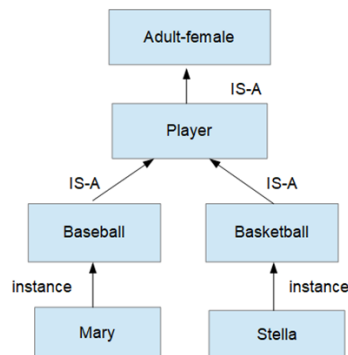


Figure 5 Example of inferential knowledge

3. Inferential knowledge

Inferential knowledge is acquired through the statistical procedures.

Example: Let's suppose there are two statements:

- Mary is a woman
 - All women are mortal
- Then it can represent as

woman(Mary)

$\forall x = \text{woman}(x) \text{ -----} \rightarrow \text{mortal}(x)$

4. Procedural knowledge

- Procedural knowledge approach uses small programs and codes which describes how to do specific things, and how to proceed.
- In this approach, one important rule is used which is **If-Then rule**.
- In this knowledge, we can use various coding languages such as **LISP language** and **Prolog language**.
- We can easily represent heuristic or domain-specific knowledge using this approach.
- But it is not necessary that we can represent all cases in this approach.

1.3.2. Reasoning

Three types of reasoning are as below:

1) **Deductive Reasoning**

If the original premises are true, then conclusions must also be true.

For example:

All human is mammal then all women are mammal.

2) **Abductive Reasoning**

Abductive reasoning typically begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the set. Abductive reasoning yields the kind of daily decision-making that does its best with the information at hand, which often is incomplete.

For example:

AI system is trying to identify a person in a photo.

If the AI System only has data on people of a certain race, it may be biased in its identification.

3) **Inductive Reasoning**

Inductive reasoning in AI typically involves making generalization based on specific observations or data.

For Example: Classify emails into categories such as “urgent,” “important,” “normal,” and “spam.”

Process:

a. Data Collection:

The AI starts by analyzing thousands of emails that are already labeled by users. It observed various features such as keywords, sender information, time of email, and user interactions (like whether emails are open quickly and replied to or marked as spam).

b. Pattern Recognition:

Through its analysis, the AI notices certain patterns.

- Emails contains word like “urgent” and sent from recognized contacts are often labeled as “urgent”.
- Emails from known commercial sources containing words like “sale” or “offer” are frequently marked as “spam”.
- Emails that are not from contacts but certain formal language and no promotional content are often classified as “important”.

c. Generalization:

Using these observations, the AI develops a general set of rules or a model to predict the category of new emails. For example, it might generalize that any email from a recognized contact that includes the word “urgent” should be classified as “urgent”.

d. Application:

When new emails arrive, the AI applies these generalized rules to classify them based on the learned patterns.

Outcome: The AI uses inductive reasoning to generalize from specific instances to broader rules, enabling it to perform email classification with a high degree of accuracy even on emails it has never seen before. ^[3]

1.4. Artificial Neural Network

1.4.1. What is Artificial Neural Network?

The term "**Artificial Neural Network**" is derived from Biological neural networks that develop the structure of a human brain. Similar to the human brain that has neurons interconnected to one another, artificial neural networks also have neurons that are interconnected to one another in various layers of the networks. These neurons are known as nodes.

Table 3 Biological Neural Network vs Artificial Neural Network

Biological Neural Network	Artificial Neural Network
Dendrites	Inputs
Cell nucleus	Node
Synapse	Weights
Axon	Output

1.4.2. Types of artificial neural network

There are various types of Artificial Neural Networks (ANN) depending upon the human brain neuron and network functions, an artificial neural network similarly performs tasks. The majority of the artificial neural networks will have some similarities with a more complex biological partner and are very effective at their expected tasks. For example, segmentation or classification.

1.4.2.1.Feedback ANN

The feedback networks feed information back into itself and are well suited to solve optimization issues. The Internal system error corrections utilize feedback ANNs.

Three main types:

1. Recurrent Neural Networks (RNNs):

Recurrent Neural Networks (RNNs) recognize patterns in sequences of data like time series or text. They use a hidden state to process variable-length sequences.

Key Features:

- Feedback Loop: Maintains a hidden state.
- Sequential Processing: Good for tasks needing context, like language modeling

2. Long Short-Term Memory (LSTM) Networks:

Long Short-Term Memory (LSTM) Networks handle long-term dependencies and solve the vanishing gradient problem. They have gates to control information flow.

Key Features:

- Forget Gate: Discards information from cell state.
- Input Gate: Stores new info in cell state.
- Output Gate: Decides what to output.

3. Gate Recurrent Unit (GRU) Networks:

Gated Recurrent Unit (GRU) Networks are simpler than LSTMs, combining forget and input gates into an update gate.

Key Features:

- Update Gate: Controls info flow to the hidden state.
- Reset Gate: Decides how much past info to forget.

1.4.2.2.Feed-Forward ANN

A feed-forward network is a basic neural network comprising of an input layer, an output layer, and at least one layer of a neuron. Through assessment of its output by reviewing its input, the intensity of the network can be noticed based on group behavior of the associated neurons, and the output is decided. The primary advantage of this network is that it figures out how to evaluate and recognize input patterns.

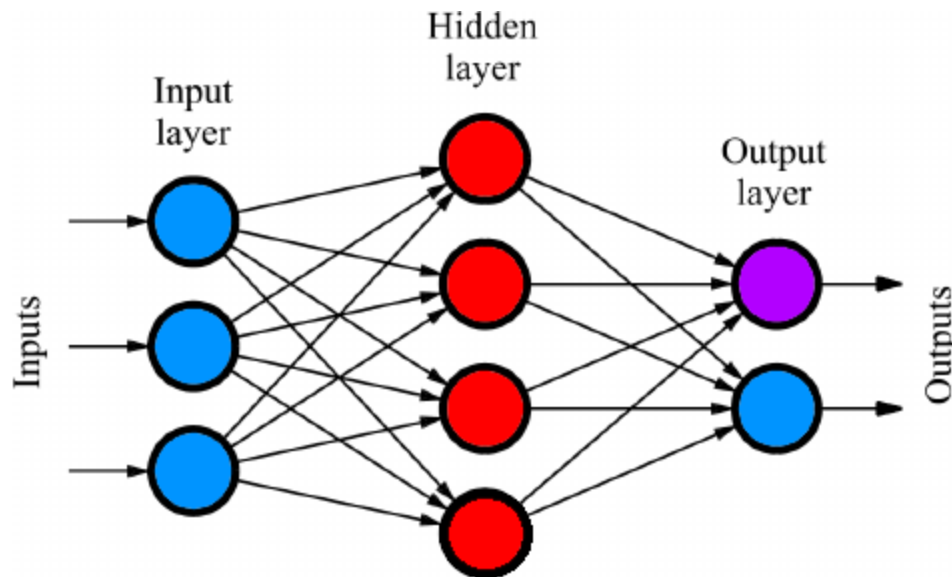


Figure 6 Architecture of Artificial Neural Network

The typical algorithm for feed-forward neural network is back-propagation. The algorithms responsible for updating network weights with the objective of reducing the network error.

1.5. Basic model of artificial intelligence learning

Machine learning System can obtain new knowledge by extracting patterns from raw data; without relying on hard-code knowledge system.

The appropriate steps of AI process are translated the problem into a machine learning problem, select appropriate data, build learning models, deploy the optimum models, assess the result.

The appropriate steps of a machine learning model training are:

1. Prepare data

Steps to prepare data

- **Input dataset**
- **Select columns**
- **Clean missing data**
- **Normalize data**

The goal of normalization is to change the values of numeric columns in the dataset to use a common scale, without distorting differences in the ranges of values of losing information.

2. Training

3. Score model

4. Evaluation

1.5.1. 4 Types of Machine Learning

4 Types of Machine Learning

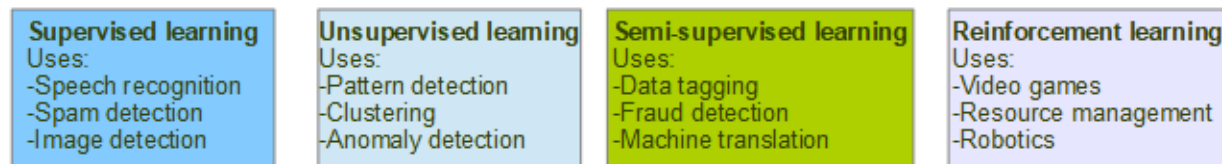


Figure 7 4 types of machine learning

1.5.1.1. Supervised Learning Models

Supervised learning is trained on a labeled dataset. Supervised learning learns patterns from the given training data with predefined input and output signals.

Supervised learning can be used in quality check in manufacturing. Images are labeled in “Pass” and “Fail” then used to train the model. The trained model is then used for classify the product is pass or fail the QC test.

Type of supervised machine learning

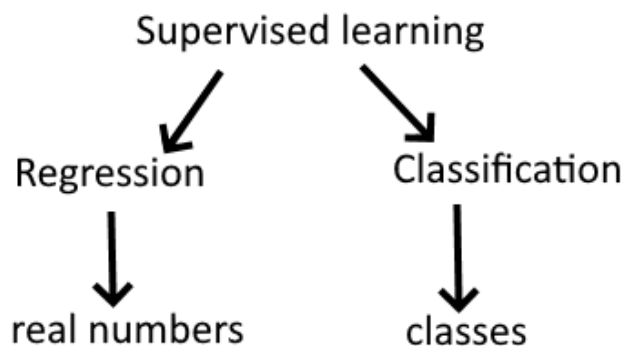


Figure 8 Type of supervised learning

1. Regression:

Regression machine learning model is used to predict the continuous values such as price, salary, age, etc.

Example of Regression model in a Business Context:

Price Optimization: E-commerce companies can employ regression models to optimize pricing strategies. By analyzing historical sales data, competitor pricing, customer behavior, and other factors, the model can estimate the optimal price for a product that maximize profitability or sales volume. This enables business to dynamically adjust prices based on market conditions and customer demand.

Linear Regression Algorithm

Fashion retailer used AI to analyze store receipts and returns to evaluate purchases at each store. The algorithm helps the store know what items to promote and stock more of in certain locations.

2. Classification:

Classification machine learning model is a process of finding a function which helps in dividing the dataset into classes based on different parameters.

Example of Classification Model in a Business Context.

Email Spam Filtering: In an email service provider, a classification model can be utilized for spam filtering. The model can be trained on a labeled dataset of emails, distinguishing between spam and non-spam emails. The trained model can then be used to automatically classify incoming emails as either spam or legitimate, ensuring a cleaner inbox for users and reducing the risk of phishing attacks.

Classification algorithms are used to predict/classify the discrete values such as Male or Female, True or False, Spam or Not Spam, etc.

Two-class classification (binary classification)

In a binary classification task, the goal is to classify the input data into two mutually exclusive categories. The training data in such a situation is labeled in a binary format: true and false; positive and negative; 0 and 1; spam and not spam, etc. depending on the problem being tackled. For instance, we might want to detect whether a given image is a cat or a dog.

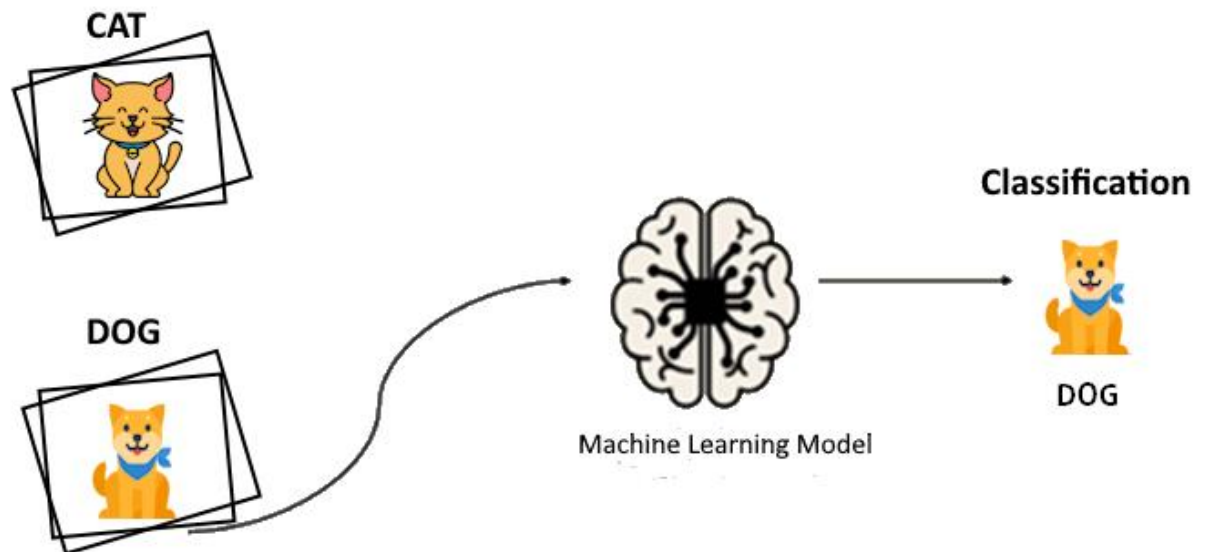


Figure 9 Classification

Logistic Regression and Support Vector Machines algorithms are natively designed for binary classifications. Other algorithms such as K-Nearest Neighbors and Decision Trees

can also be used for binary classification.

		Predicted class	
		P	N
Actual Class	P	True Positives (TP)	False Negatives (FN)
	N	False Positives (FP)	True Negatives (TN)

Figure 10 Predicted class

Useful statistic metrics for two-class classification problems.

- Accuracy: The proportion of all instances that are correctly predicted.
$$\text{Accuracy} = (\text{TP} + \text{TN}) / (\text{TP} + \text{TN} + \text{FP} + \text{FN})$$
- Precision: The proportion of all positive predictions that were correct (e.g. the percentage of people who were predicted to have the disease and actually had the disease).
$$\text{Precision} = (\text{TP} / (\text{TP} + \text{FP}))$$

ROC and AUC

- **Receiver-operating characteristic curve (ROC)**

The area under a receiver operating characteristic curve is a value that measures the overall performance of a two-class classification (binary classification).

The ROC curve is a visual representation of model performance across all thresholds.

The long version of the name, receiver operating characteristic, is a holdover from WWII radar detection.

The ROC curve is a graphical plot of the true positive rate (TPR) against the false positive rate (FPR) at various threshold settings.

The ROC curve is drawn by calculating the true positive rate (TPR) and false positive rate (FPR) at every possible threshold (in practice, at selected intervals), then graphing TPR over FPR. A perfect model, which at some threshold has a TPR of 1.0 and a FPR of 0.0, can be represented by either a point at (0, 1) if all other thresholds are ignored, or by the following:

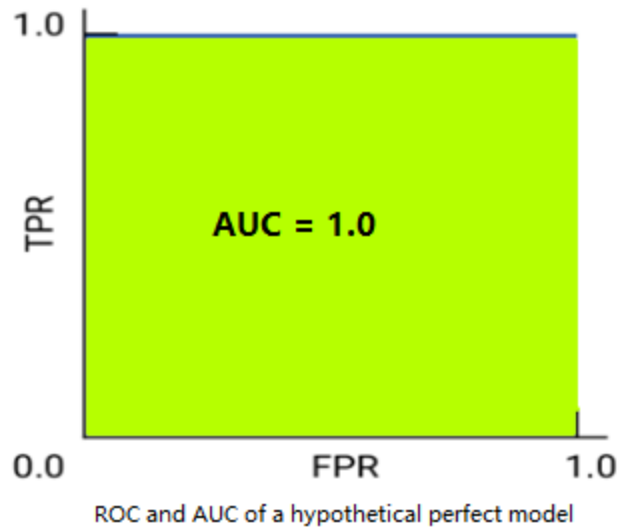


Figure 11 ROC and AUC of a hypothetical perfect model

AUC = 1 means prediction a 100% correct

- **Area under the ROC curve (AUC)**
AUC = 0.5 is a completely random classifier

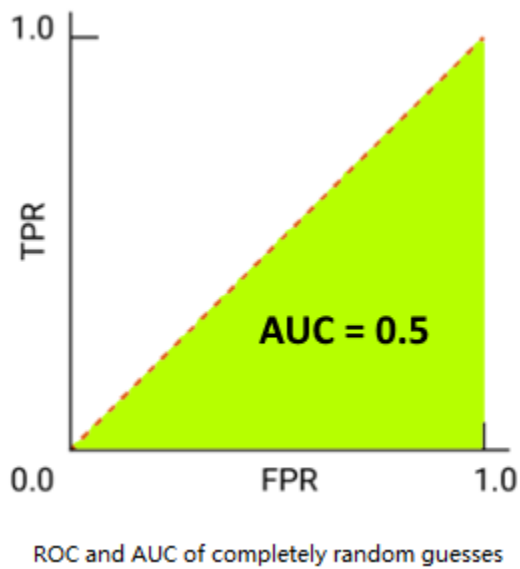


Figure 12 ROC and AUC of completely random guesses

1.5.1.2.Unsupervised Learning Models

Unsupervised Learning is trained on an unlabeled dataset.

Unsupervised learning explores data structures from a no artificially labeled dataset to extract meaningful information without the guidance of known outcome variables.

Unsupervised Learning can be used to group customers into different groups.

By selecting various criteria and characteristics, the algorithm can classify customers into a given number of smaller groups.

Unsupervised Learning Algorithms

K-means clustering algorithm searches for a predetermined number of clusters within a dataset.

DBSCAN algorithm is a density-based clustering algorithm that groups data points together based on their proximity to one another. It works by identifying core points (points with a minimum number of neighboring points within a specified radius) and expanding clusters around them.

1.5.1.3.Semi-supervised Learning Models

Semi-supervised anomaly detection methods combine the benefits of the previous two methods. Engineers can apply unsupervised learning methods to automate feature learning and work with unstructured data. However, by combining it with human supervision, they have an opportunity to monitor and control what kind of patterns the model learns. This usually helps to make the model's predictions more accurate.

Linear regression: This predictive machine learning tool uses both dependent and independent variables. The independent variable is used as a base to determine the value of the dependent variable through a series of statistical equations. These equations use labeled and unlabeled data to predict future outcomes when only some of the information is known.

1.5.1.4.Reinforcement Learning Models

Reinforcement Learning (RL) is a type of machine learning that involves an agent learning to take actions in an environment in order to maximize a reward. The agent receives feedback from the environment in the form of rewards or punishments based on its actions and uses this feedback to update its decision-making process.

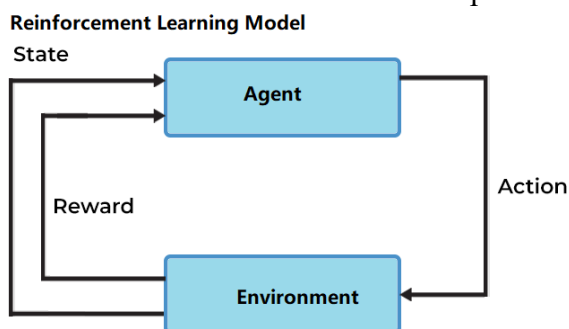


Figure 13 Reference Learning Model

1.5.2. Anomaly Detection

Anomaly Detection is any process that finds the outliers of a dataset. The use of supervised, unsupervised and semi-supervised learning algorithms will depend on the type of data being collected and the operational challenge being solved.

1.5.3. Fitting, overfitting, and underfitting

A model must make good predictions on new data. That is, you're aiming to create a model that "fits" new data.

As you've seen, an overfit model makes excellent predictions on the training set but poor predictions on new data. An underfit model doesn't even make good predictions on the training data. If an overfit model is like a product that performs well in the lab but poorly in the real world, then an underfit model is like a product that doesn't even do well in the lab.

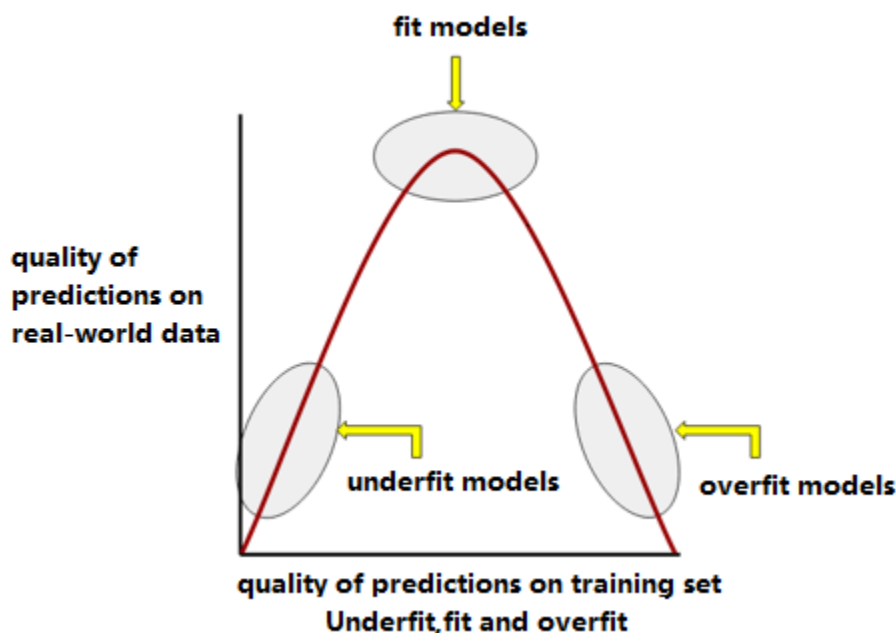


Figure 14 underfit, fit and overfit

2. Design and Implementation of Artificial Intelligence

2.1. Implementation of AI

2.1.1. Key steps for successful AI implementation in your business

Define Clear Goal and Objectives

Start by outlining specific goals and objectives you wish to achieve with AI. Whether it's improving operational efficiency, enhancing customer experience, driving sales, or optimizing processes, clear goals and objectives will guide the entire implementation strategy.

Identify the Right Data Sources

AI relies on data to make accurate predictions and decisions. Therefore, it's important to identify the right data sources for your AI system. This may include data from internal sources such as CRM systems, financial data, or supply chain data, as well as external data sources such as social

media or news feeds. It's also important to ensure that the data you use is accurate, relevant, and up-to-date.

Select the Right Tools and Technologies

Choose appropriate tools and technologies that fit your unique requirements is crucial. This may include machine learning algorithms, natural language processing tools, or predictive analytics platforms such as H2O.ai, Microsoft Azure AI, and TensorFlow. When selecting AI tools and technologies, it is crucial to consider various aspects, such as affordability, scalability, and user-friendliness.

Develop a Strong Data Strategy

For implementing AI for your business involves developing a comprehensive data strategy. AI algorithms often require a large amount of high-quality data to function effectively. This strategy should cover data collection, data cleaning, data storage, and data security... etc. Remember data is the fuel of AI.

- 1) Identify the data sources available
- 2) Establish a data mining process
- 3) Institute a robust data security and privacy framework
- 4) Determine analytics tools and methods for data interpretation

Invest in Training and Education

Implementing AI in your business requires not only the right tools and technologies but also the right skills and knowledge. It's important to invest in training and education for your employees to ensure they have the skills and knowledge needed to work with AI systems effectively. This may include training in data science, machine learning, or other AI-related skills.

Start Small and Scale Up

Implementing AI in your business can be a complex and time-consuming process. It's important to start small and scale up gradually as you gain experience and confidence. This may involve piloting AI projects in a specific department or business unit before rolling them out more broadly.

Monitor and Evaluate Performance

Set up metrics to track the performance of AI implementations against the defined objectives. Regularly analyze results, gather feedback, and make necessary adjustments to improve functionality and outcomes. ^[6]

2.1.2. Key processes involved in implementing AI

- 1) Problem Translation: Convert real-world issues into machine learning tasks.
- 2) Data Selection: Choose relevant and reliable data sources.
- 3) Data Understanding: Analyze data to uncover patterns and insights.
- 4) Dataset Creation: Format and prepare data for machine learning.
- 5) Model Building: Develop machine learning algorithm
- 6) Model Assessment: Evaluate model performance using metrics.
- 7) Model Deployment: Implement the best model in applications.
- 8) Result Evaluation: Continuously assess model performance overtime.

2.2. Design and Implementation of Deep Learning

A deep learning model can be trained for analyzing customer review to understand the customer satisfactory to the products.

The most common type of deep learning network used for NLP is RNN.

2.2.1. Steps for designing and implementing of deep learning model

Designing and implementing a deep learning model is a multi-step process that involves the following key phases:

Step 1: Problem Definition

1. **Identify the Problem:** Clearly define the problem you want to solve (e.g., classification, regression, segmentation, etc.).
2. **Select Metrics:** Choose appropriate evaluation metrics (accuracy, F1 score, mean squared error, etc.) relevant to the problem.

Step 2: Data Collection and Preprocessing

1. **Data Collection:** Gather the dataset needed for training. This could be images, text, time series, etc.
2. **Data Cleaning:** Handle missing values, remove duplicates, and filter out noisy data.
3. **Data Labeling:** Ensure that the data is labeled appropriately for supervised learning tasks.
4. **Data Augmentation:** Use techniques such as rotation, cropping, flipping, and color adjustments to increase the diversity of your training dataset, especially for image-based tasks.
5. **Normalization:** Scale features to a similar range (e.g., [0, 1] or [-1, 1]) to help models converge faster.

Step 3: Design the Model

1. **Choose a Model Architecture:**
 - For image data, you might choose Convolutional Neural Networks (CNNs).
 - For sequential data, consider Recurrent Neural Networks (RNNs) or Transformers.
 - For general tasks, Multi-Layer Perceptrons (MLPs) can be a good choice.
2. **Select the Hyperparameters:**
 - Number of layers and units per layer
 - Activation functions (ReLU, sigmoid, etc.)
 - Learning rate, batch size, dropout rate, and regularization methods.

Step 4: Implementation

1. **Framework Selection:** Choose a deep learning framework. Common choices include:
 - TensorFlow/Keras
 - PyTorch
 - MXNet
 - JAX
2. **Model Implementation:**
 - Initialize the model architecture.
 - Compile the model with an optimizer (e.g., Adam, SGD), loss function (e.g., categorical cross-entropy, mean squared error), and metrics for evaluation.

Step 5: Training the Model

1. **Train the Model:**

- Fit the model on the training dataset while validating on a separate validation set.
- Use callbacks for saving models, early stopping, and learning rate adjustments.

Step 6: Evaluation

1. **Evaluate the Model:** After training, assess the model's performance on a test set using the chosen metrics.

Step 7: Hyperparameter Tuning

1. **Optimize Hyperparameters:** Use techniques like grid search, random search, or Bayesian optimization to fine-tune model hyperparameters.

Step 8: Model Deployment

Save the Model: Export your model for inference.

1. **Deployment:** Deploy your model using various platforms (Flask/Django for web apps, TensorFlow Serving, or cloud services like AWS, Azure, GCP).
2. **Monitor and Maintain:** Post-deployment, continuously monitor the model's performance and retrain as necessary.

2.2.2. Practice building an OCR application

Azure OCR (Optical Character Recognition) is a service offered by Microsoft Azure as part of its Cognitive Services. The Azure AI Vision VisionV4.0 REST API provides the ability to extract printed or handwritten text from images in a unified performance-enhanced synchronous API that makes it easy to get all image insights including OCR results in a single API operation. The Read OCR engine is built on top of multiple deep learning models supported by universal script-based models for global language support. ^[8]

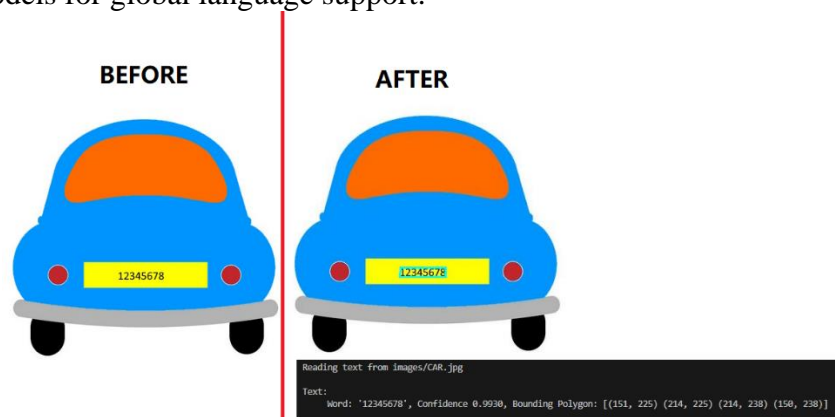


Figure 15 license plate recognition

2.3. Design and Implementation of Vision and Alert

2.3.1. Services for an Azure AI Vision Solution

Key services that revolve around imaging or visual content

Table 4 Services for an Azure AI vision solution

Services for an Azure AI vision solution	
Service Name	Descriptions
Azure AI Vision	Processes image and returns information
Face API	Detects and recognized face
Azure AI Custom Vision Service	Builds custom image classifiers
Document Intelligence	Extracts text, key-value pairs and tables from documents
Azure AI Video Indexer	Extract insights from video

2.3.1.1.About services for Azure AI Vision

Table 5 Services for Azure AI Vision

Services	Description
Optical Character Recognition (OCR)	The Optical Character Recognition (OCR) service extracts text from images. You can use the Read API to extract printed and handwritten text from photos and documents. It uses deep-learning-based models and works with text on various surfaces and backgrounds. These include business documents, invoices, receipts, posters, business cards, letters, and whiteboards. The OCR APIs support extracting printed text in several languages. Follow the OCR quick start to get started.
Image Analysis	The Image Analysis service extracts many visual features from images, such as objects, faces, adult content, and auto-generated text descriptions. Follow the Image Analysis quick start to get started.
Face	The Face service provides AI algorithms that detect, recognize, and analyze human faces in images. Facial recognition software is important in many different scenarios, such as identification, touchless access control, and face blurring for privacy. Follow the Face quick start to get started.
Video Analysis	Video Analysis includes video-related features like Spatial Analysis and Video Retrieval. Spatial Analysis analyzes the presence and movement of people on a video feed and produces events that other systems can respond to. Install the Spatial Analysis container to get started. Video Retrieval lets you create an index of videos that you can search with natural language.

2.3.1.2. Implement Azure AI vision solutions

1. Analyze images

- Select visual features to meet image processing requirements
The Azure AI Vision Image Analysis service can be used to extract several features from images
Features include:

- a. Retrieve image descriptions and tags
- b. Model customization
- c. Read text from image (OCR)
- d. Detect objects and people
- e. Generate image captions
- f. Identify and tag visual features in an image
- g. Smart crop
- h. Background Removal

- Detect objects in images and generate image tags
 - Include image analysis features in an image processing request
 - Extract text from images using Azure AI Vision
 - Convert handwritten text using Azure AI Vision
- #### 2. Implement custom Azure AI vision models by using Azure AI Vision
- Choose between image classification and object detection models
 - Label images
 - Train a custom image model, including image classification and object detection
 - Evaluate Azure AI custom vision model metrics
 - Publish an Azure AI custom vision model
 - Consume an Azure AI custom vision model
- #### 3. Analyze videos
- Use Azure AI Video Indexer to extract insights from a video or livestream
 - Use Azure AI Vision Spatial Analysis to detect the presence and movement of people in video ^[5]

2.3.2. Practice building vision and alert application

When detected dangerous animal then an alert will occur immediately.



Figure 16 Alert for dangerous animals

2.4. Design and Implementation of Natural Language Processing

NLP is a study concerned with giving computers the ability to understand human language, including text and spoken words.

2.4.1. Appropriate service for a natural language processing solution

Table 6 Service List for natural language processing solution

Service List for a natural language processing solution		
Custom text classification	Language Detection	Question answering
Custom-named entity recognition	Named Entity Recognition (NER)	Sentiment analysis
Conversation Language Understanding (CLU)	Orchestration workflow	Summarization
Entity Linking	Personally Identifiable Information (PII) detection	Text Analytics for health

2.4.2. Implementation on natural language processing solutions

1. Analyze text by using Azure AI language
 - Extract Key phrases
 - Extract entities
 - Determine the sentiment of the text
 - Detect the language used in the text
 - Detect Personally Identifiable Information (PII) in text
2. Process speech by using Azure AI Speech
 - Implement text-to-speech
 - Implement speech-to-text
 - Improve text to speech by using Speech Synthesis Markup Language (SSML)
 - Implement custom speech solutions
 - Implement intent recognition
 - Implement keyword recognition
3. Translate language
 - Translate text and documents by using Azure AI Translator service
 - Implement custom translation includes training, improving and publishing a custom model
 - Translate speech-to-speech by using Azure AI Speech service
 - Translate speech-text by using the Azure AI Speech service
 - Translate to multiple languages simultaneously
4. Implement and manage a language understanding model by using Azure AI Language
 - Create intents and add utterances

- Create entities
 - Train, evaluate, deploy and test a language understanding model
 - Optimize a language understanding model
 - Consume a language model from a client application
 - Import and export language understanding models
5. Implement and manage a language understanding model by using Azure AI Language
- Create a question answering project
 - Add question-and-answer pairs manually
 - Import sources
 - Train and test a knowledge base
 - Publish a knowledge base
 - Create a multi-turn conversation
 - Add alternate phrasing
 - Add chi-chat to a knowledge base
 - Export a knowledge base
 - Create a multi-language question answer solution ^[7]

2.4.3. Practice building translator

Create your translator base on Azure AI services.



Figure 17 Translator

2.5. Design and implementation of Chatbot

2.5.1. Design chatbot

1. Define the Purpose

Identify the Use Case:

- Customer support
- Appointment scheduling
- Ecommerce assistance
- FAQ handling
- Personal assistant tasks

Define User Personas:

- Who will use the chatbot?
- What are their needs and expectations?

2. Select Technology Stack

AI/NLP Engines:

- DeepAI API (GPT-4, ChatGPT)
- Dialogflow (Google)
- Microsoft Bot Framework
- Rasa
- IBM Watson Assistant

Back-end Framework:

- Node.js with Express
- Python with Flask or Django
- Ruby on Rails

Database:

- MongoDB (NoSQL)
- PostgreSQL or MySQL (SQL)

Front-end Framework:

- React
- Angular
- Vue.js

3. Design the Architecture

Basic Architecture:

1. Client/Front-End: User interface where users interact with the chatbot.
2. API Gateway: Routes requests from the front-end to the back-end.
3. Server/Back-End: Handles business logic, user authentication, and interactions with the AI engine.
4. AI/NLP Engine: Processes natural language inputs, generates responses.
5. Database: Stores user data, conversation history, and any other necessary information.

Communication Flow:

- User sends a message through the front-end.
- Message is sent to the API Gateway.
- API Gateway forwards the message to the back-end server.
- The back-end interacts with the AI engine, which generates a response.
- The back-end sends the response back to the API Gateway.
- API Gateway forwards the response to the front-end.

4. Develop the Front-End

Create UI Components:

- Chat window
- Message input box
- Send button
- Display message history
- User authentication forms (if needed)

2.5.2. Case Study

2.5.2.1.ChatGPT

ChatGPT is an Artificial intelligence chatbot, serves a variety of functions that make it useful for users in different contexts. Here are some key functions:

1. Information Retrieval: ChatGPT can answer questions and provide information on a wide range of topics, from general knowledge to specialized subjects.
2. Customer Support: It can assist with customer service inquiries, helping users troubleshoot issues, find information about products, or navigate services.
3. Educational Assistance: Learners can use ChatGPT for tutoring, getting explanations on concepts, or help with homework and study materials.
4. Language Translation: It can assist with translating text between different languages, aiding in communication for non-native speakers.
5. Writing Assistance: Users can get help with drafting emails, creating content, brainstorming ideas, or even editing text.
6. Personal Assistant: ChatGPT can help schedule tasks, set reminders, or manage to-do lists by providing organizational assistance.
7. Conversational Engagement: It can engage in casual conversations, providing entertainment, companionship, or even practicing language skills with users.
8. Creative Writing: Users can collaborate with ChatGPT on stories, poems, and other creative writing projects, generating ideas and content together.
9. Programming Help: For developers, it can provide coding assistance, debugging help, or explain programming concepts.
10. Mental Health Support: While not a substitute for professional therapy, it can offer general advice, coping strategies, and a listening ear for those in need of emotional support.
11. Decision Making: ChatGPT can help users weigh pros and cons of various choices, providing a second opinion on decisions.
12. Game Interaction: Engaging users in text-based games or interactive storytelling can be an entertaining function of the chatbot.

Try free ChatGPT: <https://deepai.org/chat/free-chatgpt>

2.5.2.2.Ernie Bot(文心一言)

Enhanced Representation through knowledge Integration (Ernie Bot) is an AI chatbot service product of Baidu, released in 2023. It is built on a large language model called ERNIE, which has been in development since 2019.The latest version, ERNIE 4.0 was announced on 17 Oct

2023. It is said to be the Chinese version of ChatGPT. Provides API interface for developers to carry out integration and secondary development.

Link to try Ernie Bot: <https://yiyan.baidu.com>



Figure 18 create chatbot images through Ernie Bot

3. Application and Development of Artificial Intelligence

3.1. Benefits of AI

Automation

AI enables automation of repetitive and mundane tasks, freeing up human resources to focus on more complex and creative endeavors. This leads to increased productivity, efficiency, and cost savings for businesses.

Data Analysis and Insights

AI can process and analyze vast amounts of data at a rapid pace, identifying patterns, trends and correlations that may be challenging for humans to uncover. This enables businesses to make data-driven decisions, gain valuable insights, and identify new opportunities for growth and optimization.

Predict what a particular customer is likely to buy is an example of gaining insight through data analysis.

Personalization

AI algorithms can analyze and understand individual customer preferences, behaviors, and needs, allowing business to deliver personalized experiences and recommendations. This personalized approach enhances customer satisfaction, engagement, and loyalty, leading to increased sales and customer retention.

3.2. Application areas and examples of artificial intelligence

3.2.1. AI in retail

Case Study: Retail Robot

Multinational retail corporation is testing shelf-scanning robots in dozens of its stores. The robots scan shelves for mission items, things that need to be restocked or price tags that need to be changed. The technique used on robot is image classification.

3.2.2. AI in healthcare

AI is also playing an increasingly important role in healthcare. AI-powered tools can help doctors diagnose diseases, develop new treatments, and provide personalized care to patients. For example:

- **Disease diagnosis:** AI can be used to analyze patient data and identify patterns that may indicate a disease. This can help doctors diagnose diseases earlier and more accurately.
- **Treatment development:** By analyzing large datasets of patient data, AI can identify new patterns and relationships that can be used to develop new drugs and therapies.
- **Personalized care:** By analyzing a patient's data, AI can help doctors develop treatment plans that are tailored to the patient's specific needs.

3.2.3. AI in education

AI could be used in education to personalize learning, improve student engagement, and automate administrative tasks for schools and other organizations.

For personalized learning:

AI can be used to create personalized learning experiences for students. By tracking each student's progress, AI can identify areas where the student needs additional support and provide targeted instruction.

For improved student engagement:

AI can be used to improve student engagement by providing interactive and engaging learning experiences. For example, AI-powered applications can provide students with real-time feedback and support.

For automated administrative tasks:

Administrative tasks, such as grading papers and scheduling classes can be assisted by AI models, which will help free up teachers' time to focus on teaching.

3.2.4. AI in finance

AI can help financial services institutions in five general areas: personalize services and products, create opportunities, manage risk and fraud, enable transparency and compliance, and automate operations and reduce costs. For example:

- **Risk and fraud detection:** Detect suspicious, potential money laundering activity faster and more precisely with AI.
- **Personalized recommendations:** Deliver highly personalized recommendations for financial products and services, such as investment advice or banking offers, based on customer journeys, peer interactions, risk preferences, and financial goals.
- **Document processing:** Extract structured and unstructured data from documents and analyze, search and store this data for document-extensive processes, such as loan servicing, and investment opportunity discovery.

3.2.5. AI in manufacturing

The benefits for using AI in manufacturing.

- **Improved efficiency:** Automating tasks, such as assembly and inspection
- **Increased productivity:** Optimizing production processes
- **Improved quality:** AI can be used to detect defects and improve quality control

3.3. The development of artificial intelligence

3.3.1. The future development of AI in different industrial fields

Healthcare

AI will help diagnose diseases, personalize treatment plans, monitor patients remotely, reduce dosage errors, and more. For instance, 70% of insulin users currently don't follow their prescriptions. Detecting such errors can help improve healthcare.

Education

AI will revolutionize education by enabling personalized and tailored learning experiences for students based on their abilities. Customized learning will provide opportunities for both high-performing and struggling students.

Finance

AI algorithms are already applicable to stock trading and investment fund management. Because they can analyze massive amounts of data, AI systems may outperform humans in financial decision-making. The finance industry will benefit from risk and compliance management as AI helps prevent financial disasters.

Military and Cybersecurity

AI will enable the development of autonomous weapon systems and robots for military purposes. It will also help strengthen cybersecurity through technologies like predictive threat analysis and prevention systems.

Transportation

Self-driving vehicles are one of the wildest technological realizations. AI will also help manage traffic and predict congestion to optimize travel time, monitor vehicle performance, and ensure timely repair and maintenance.

Advertising

AI will enable personalized ads tailored to individual users based on their specific interests, behaviors, locations, and profiles, improving targeting and effectiveness. It's no wonder that over 80% of businesses are testing AI in their marketing channels.^[4]

4. Terms

BOT

A bot is an automated software application that performs repetitive tasks over a network. It follows specific instructions to imitate human behavior but is faster and more accurate. A bot can also run independently without human intervention.

The bot solves the user problem better/easier/faster than any of the options is a key success factor that influences bot's success.

Epoch

Epoch refers to the number of times the entire training dataset is passed through the machine learning algorithm during training.

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