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Introduction to Artificial Intelligence (AI)

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Introduction to Artificial Intelligence (AI)

Shabib Md. Shadakatul Baree

Question01: Define machine learning and describe the main types of machine learning algorithms.

Machine Learning: Machine Learning is a branch of Artificial Intelligence that employs mathematical models in order to allow a computer to learn and improve on its own based on past experiences. In the last decade, great strides have been made in this field. Machine learning is the examination of computer programs that use algorithms, statistical; models and inference to learn, with no explicit programming.

Main types of Machine Learning algorithms: Certain machine learning algorithms are tailored for specific functions, yet there are four principal systems applied presently:

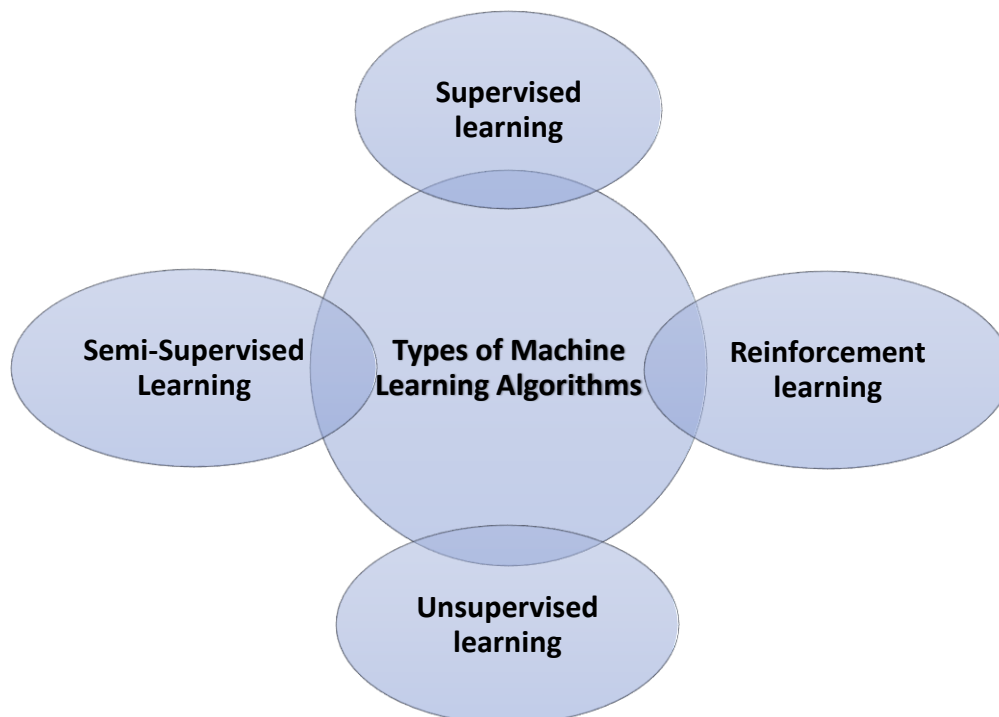


Figure: Types of Machine Learning algorithms

01. Supervised learning:



In supervised learning, the output of algorithm is transmitted back into the system so it is aware of the patterns before employing them. Alternatively, the algorithm is taught with data that has been given specific labels for a desired outcome. It is trained to the point where it can detect the associations and connections between the given input and the output labels, enabling it to provide accurate labeling results when exposed to previously unseen data. Let's see an example:

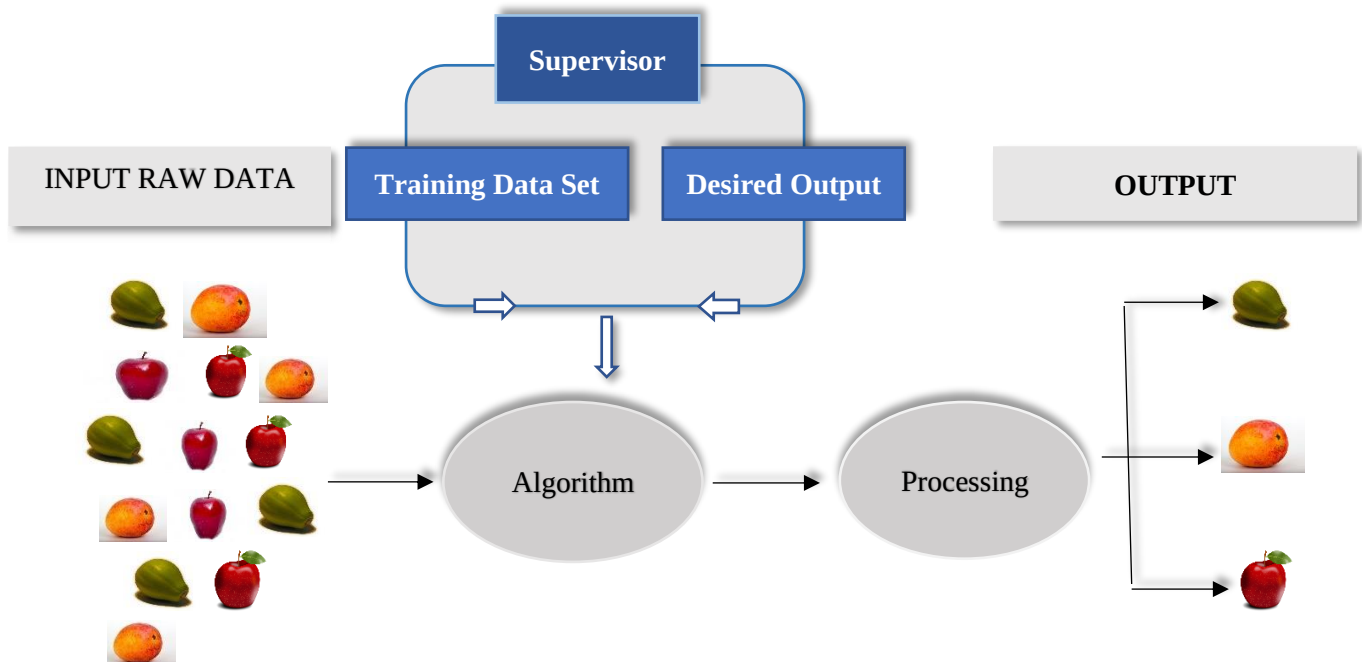


Figure: Supervised Learning

02. Unsupervised learning:



Machine learning algorithms that do not require labeled responses in order to draw conclusions from databases are referred to as unsupervised learning. This type of learning also goes by the name of self-organization and allows for the calculation of probabilities for the given inputs. Unsupervised learning algorithms are used to find patterns and correlations in data sets without the guidance of a known or predetermined outcome. Let's see an example:

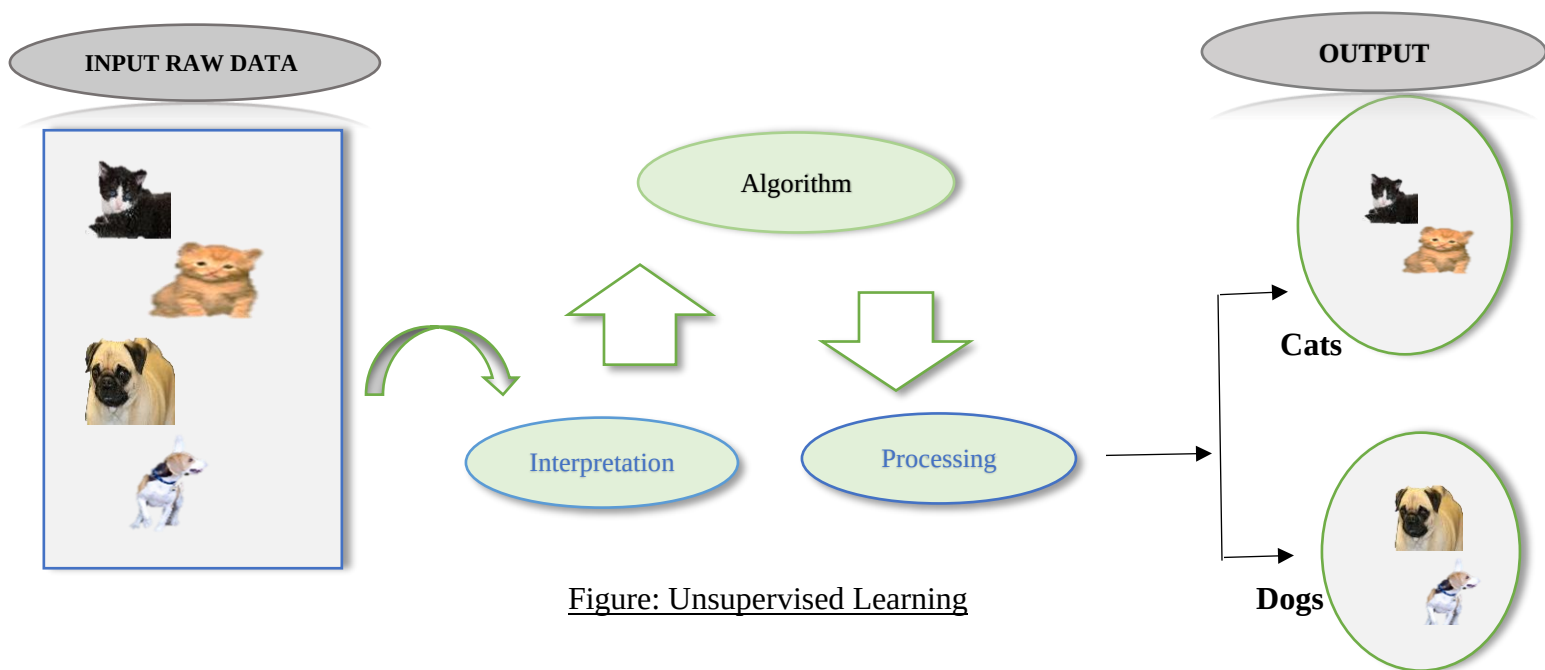
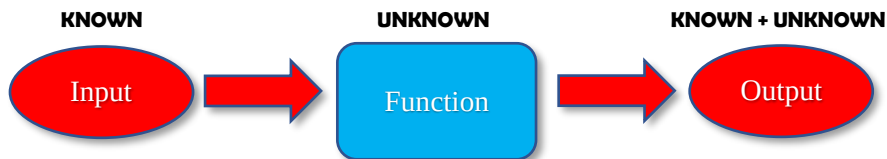


Figure: Unsupervised Learning

03. Semi-supervised learning:



Semi-supervised learning is a form of machine learning that combines both labeled and unlabeled data for training purposes. It lies between supervised and unsupervised learning, as it requires the use of labeled data to give the model guidance throughout the training process, but also requires the use of unlabeled data in order to assist the model in understanding the nature of data. The main objective behind semi-supervised learning is to learn from both labeled and unlabeled data in order to make more accurate predictions than if we only use labeled data. Let's see an example:

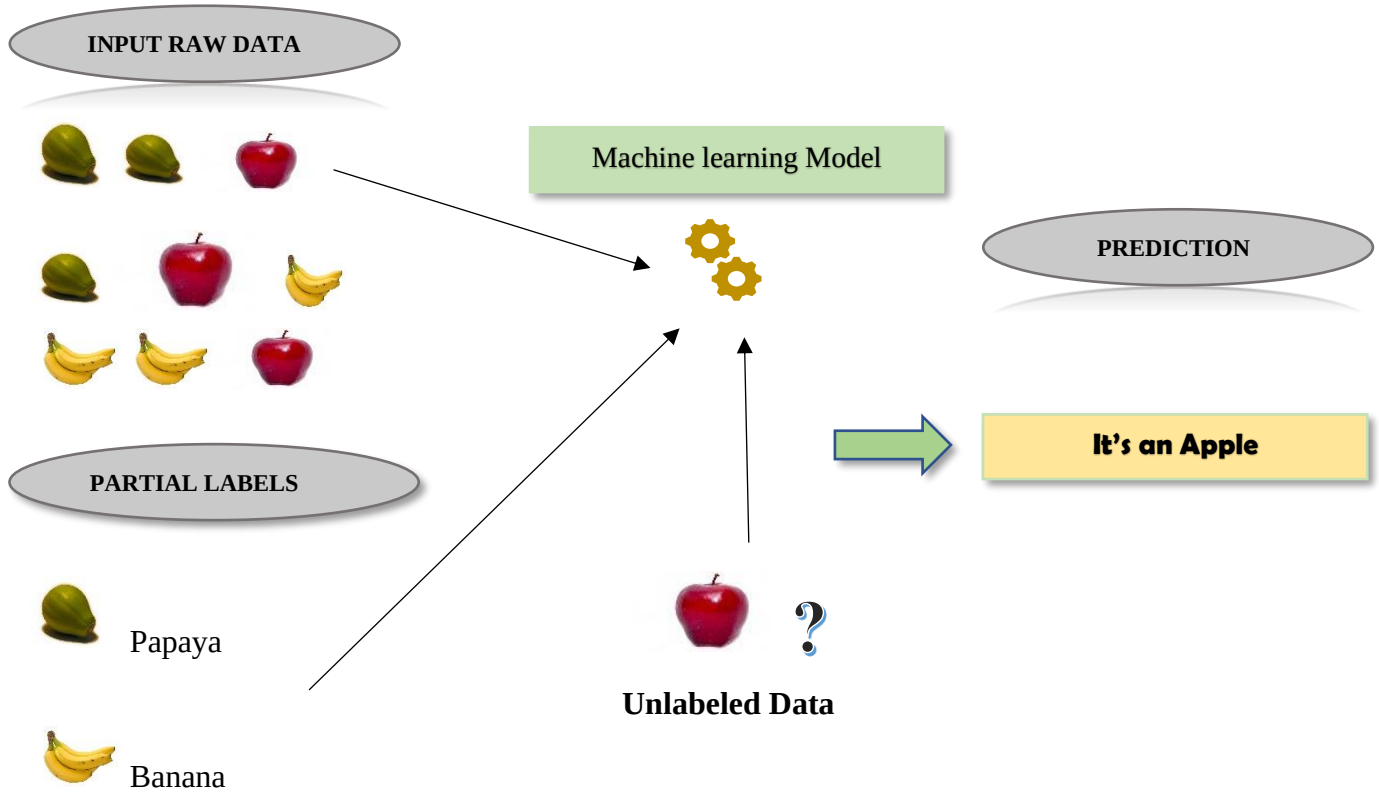


Figure: Semi-Supervised Learning

04. Reinforcement Learning:

Reinforcement learning is a method of machine learning focusing on how software agents should take actions in an environment in order to maximize some sort of reward. It is an area of machine learning that enables software agents to figure out the best way to behave in a given environment to maximize a certain kind of reward. It differs from Supervised learning in that it does not require labeled input data, Instead, the algorithm is able to learn the best action to take through trial and error, then using the resulting feedback to adjust its approach.

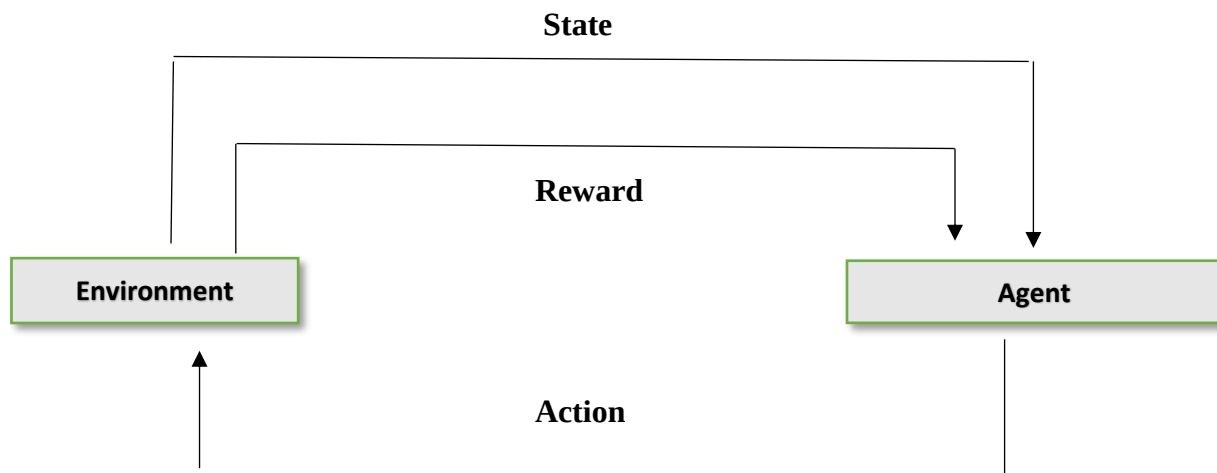


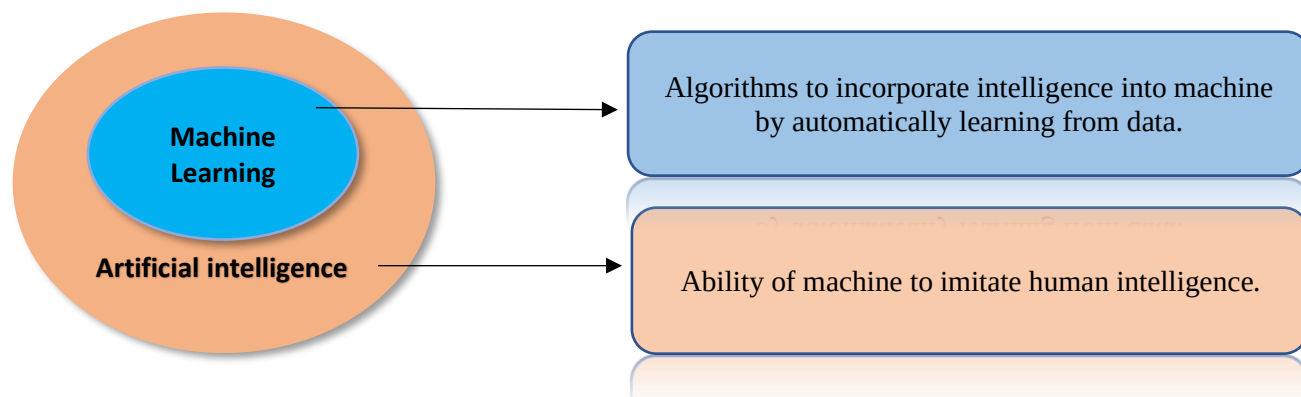
Figure: Reinforcement Learning

Question02: What is artificial intelligence and how is it different from machine learning?

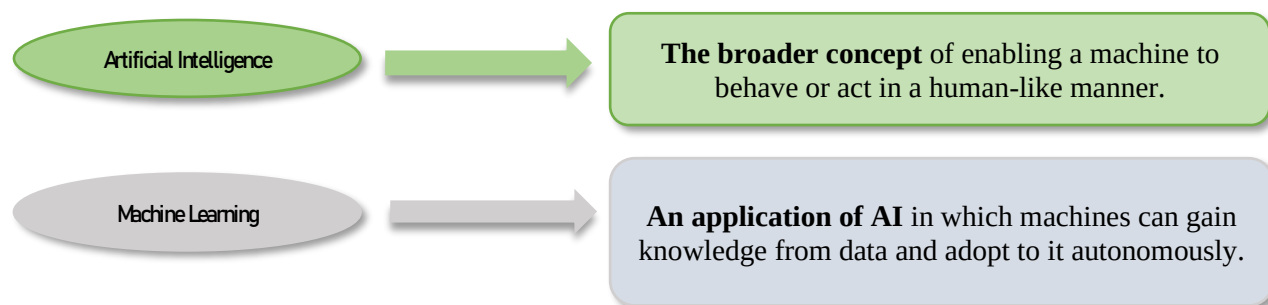
Artificial Intelligence: Artificial intelligence (AI) is a branch of computer science that studies the development of machines capable of performing tasks that require human intelligence and decision-making. The field of Artificial Intelligence is devoted to creating computer systems with the ability to think and act like humans. It does this by employing mathematical and logical

reasoning to comprehend new information and formulate decisions. AI is essentially designed to replicate the cognitive functions of people, such as learning and problem solving.

Artificial Intelligence vs. Machine Learning: Difference:



Machine learning and artificial intelligence are closely connected. Machine learning involves the use of algorithms to analyze data and create automated models to make predictions and decisions. Artificial intelligence encompasses the idea that machines can complete tasks in a smart manner, and ML is a type of AI where algorithms are used to learn from data and make predictions. The connection between these two concepts is that AI is the broader concept and ML is a specific type of AI.



Here are the differences between Artificial Intelligence and Machine Learning:

Artificial Intelligence	Machine Learning
AI facilitates a machine to imitate human cognitive ability to address problems.	ML is a system in which machine can learn independently from past experiences.
The objective is to craft an intelligent system capable of executing complex tasks.	The aim is to create machines which can self-improve from data to boost the precision of the result.
We construct systems that can complete complicated missions like a human being.	We train machines to execute certain tasks and produce precise outcomes by giving them data to learn.
Artificial Intelligence has a broad range of usages.	Machine Learning has a limited selection of utilizations.
AI applies technologies in an arrangement so that it replicates human decision-making.	ML applies self-learning algorithms to generate predictive models.
AI is capable of managing data of any structure, including Structured, Semi-Structured and Unstructured.	ML, on the other hand, is limited to Structured and Semi-Structured data only.
AI systems employ logic and decision trees to gain knowledge, rationalize and fix themselves.	ML systems depend on mathematical (statistical) models to increasing their understanding and can make changes when given new data or information.

Table: Machine Learning vs. Artificial Intelligence

Question03: Explain the concept of neutral networks and describe how they are used in machine learning.

Neural networks are a form of artificial intelligence that emulates the neural pathways of the human brain to process data. This type of machine learning, known as deep learning, involves a layered structure of connected nodes or neurons like the brain. Artificial neural networks are designed to adapt and improve over time by learning from their mistakes. This technology utilizes interconnected artificial neurons in three layers to manage complicated tasks such as document summarization or facial recognition with greater accuracy:

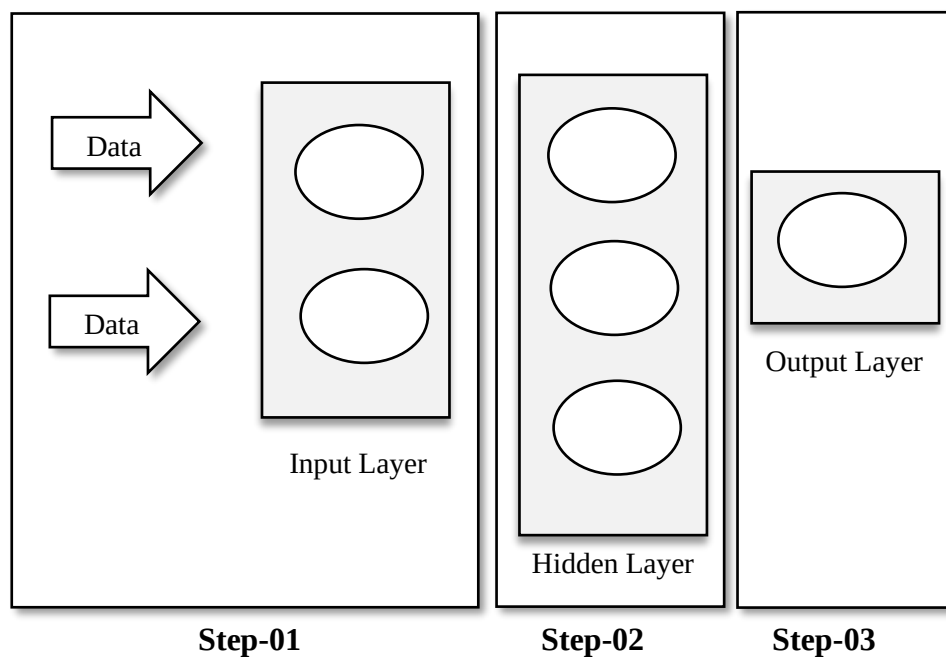
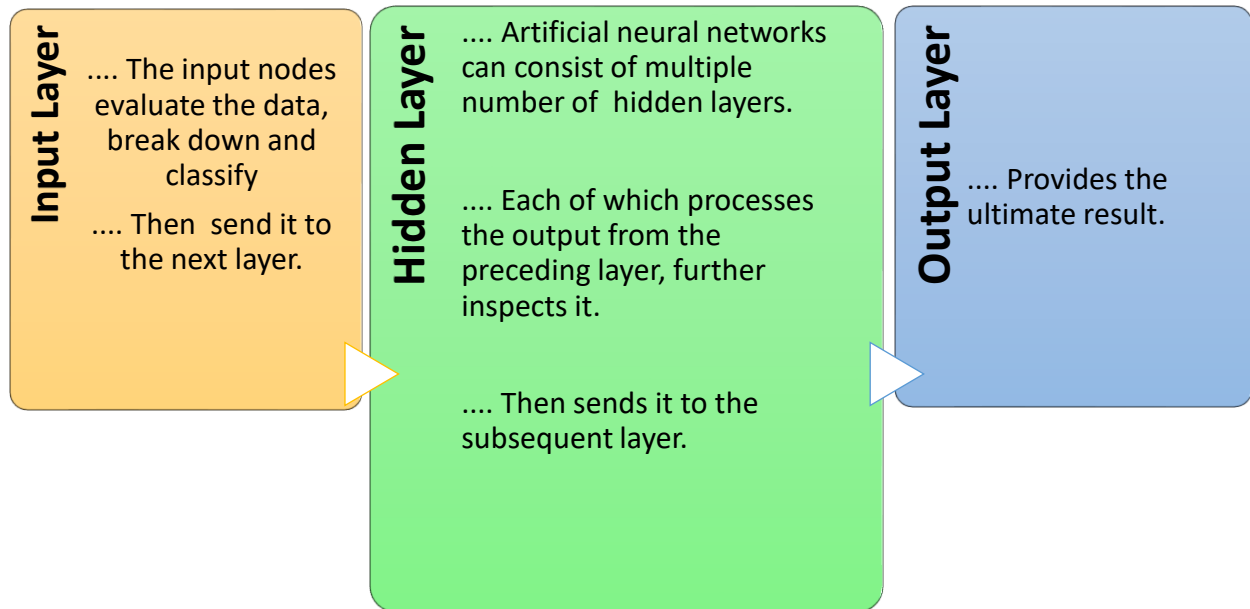
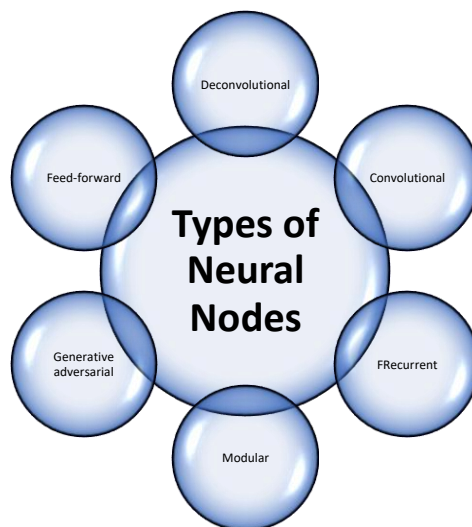


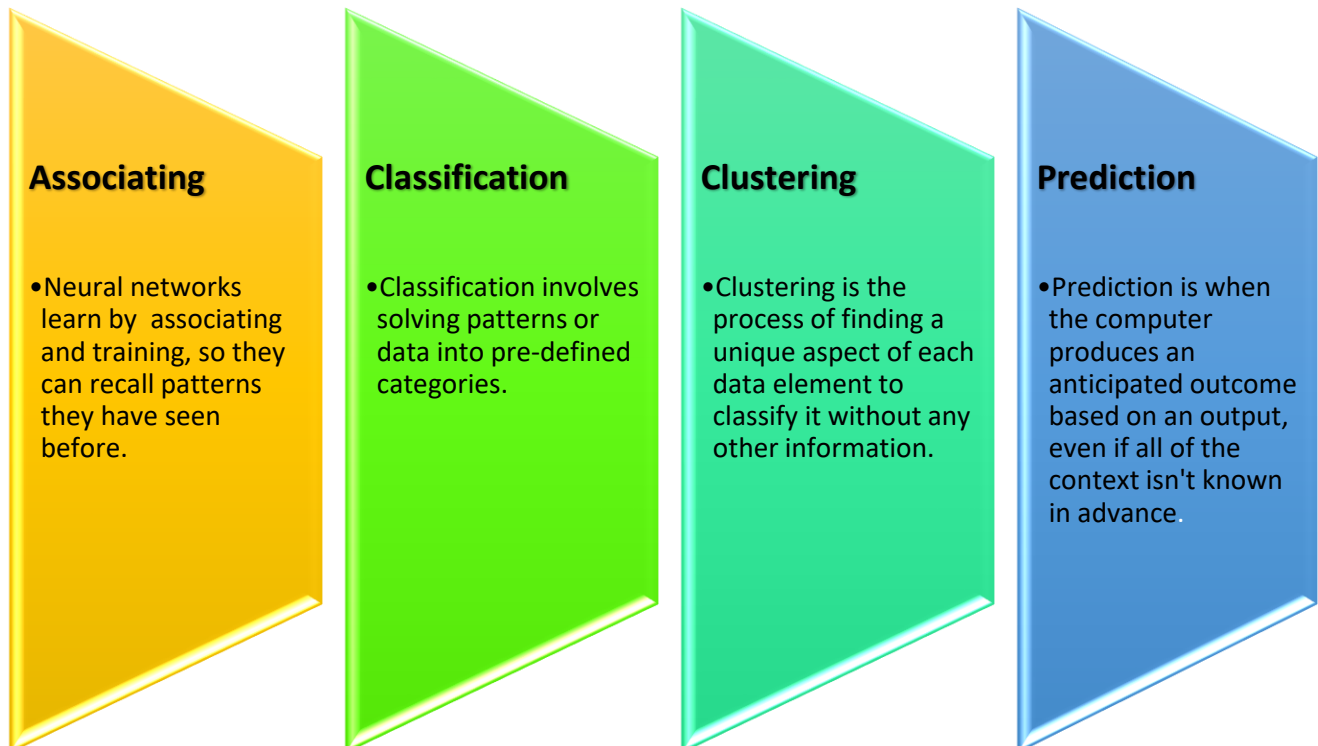
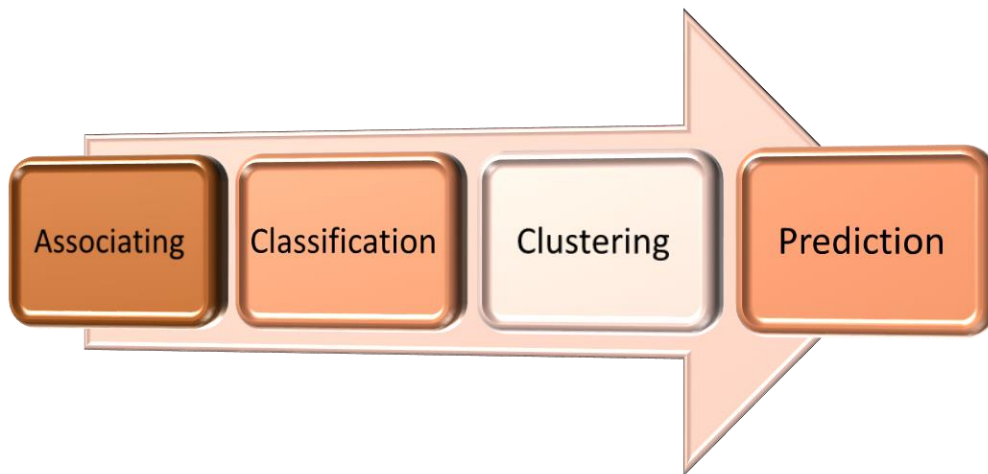
Figure: Three Layers of Neural Networks



Depending on the type of problem being solved, the number of output nodes may vary; for example, when dealing with a binary classification problem, one output node will be present, resulting in a 1 or 0 output. If the task is a multi-class classification one, the output layer would require multiple output nodes. Neural networks can be categorized according to various factors, such as the degree of their depth, the number of hidden layers in the network and the Input/Output capabilities of each node, as example :



Neural networks take four **critical steps** to operate effectively :



The following are some of the examples of applications built using different types of neural networks:

Prediction of Housing Price

- Predictions on the housing market can be made using Standard artificial neural network (ANN) .
- The inputs to the network could include various features of a home such as size, number of bedrooms etc., and the output would be a price estimate.

Whether user will click on advertisement

- Standard ANN may be employed to determine if a user will interact with an advertisement or not (click on ad or not).
- The input data includes user and advertisement information, with an output label such as click (1) or no click (0).

Weather Prediction

- Using Recurrent neural network (RNN) or Long Short-term Memory (LSTM) can help in predicting weather.

Image Classification

- Deep neural networks can be utilized for image recognition at pixel level.

Machine Translation

- For machine translation, RNNs can be used to process word meaning representations sequentially over time.
- To translate languages, deep neural networks can be used by learning semantic representation of words in one language and then map them into word-meaning representations in another language.

Speech Recognition

- Deep Feed-Forward NN, Deep Recurrent NN (RNN) and LSTM can be utilized to recognize speech.
- Here audio will work as input and text transcript as output.

Face Recognition

- For real world applications, Deep Convolutional Neural Network (DCNN) and Deep Belief Networks (DBN) can be applied to face recognition .

Autonomous Driving

- Constructing a custom or hybrid network architecture with CNN's, ANN's and other neural networks is necessary in order to generate models that can be utilized for autonomous driving.
- For example, input such as images and radar data will be needed in order to predict the position of other vehicles and objects to ultimately make decisions for safe driving.

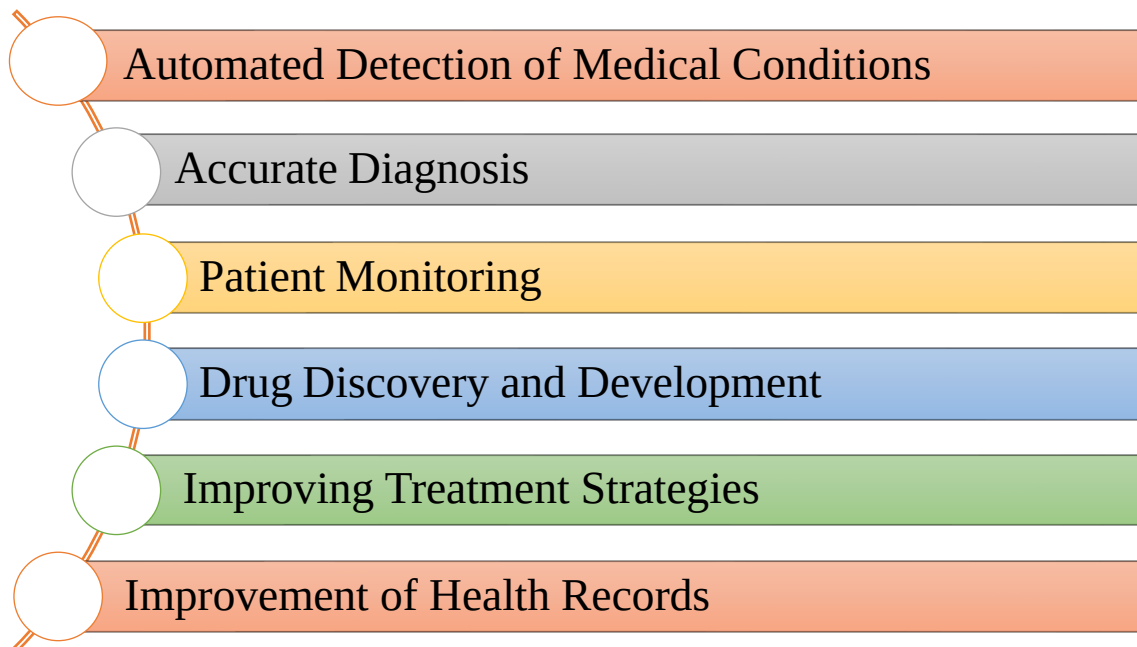
Recommendation Engines

- Neural networks can analyze user activity and provide personalized recommendations, such as Intelligent Product Tagging which uses neural networks to suggest products based off of the user's social media activity.

Question04: What are Some Common Applications of Machine Learning in Industries such as Healthcare, Finance, and Retail?

Machine learning has gained traction in various industries because of its capacity to process extensive data sets, recognize patterns, and generate forecasts or suggestions based on the data. Examples of such applications of machine learning in various industries are given below:

Applications of Machine Learning in Healthcare:

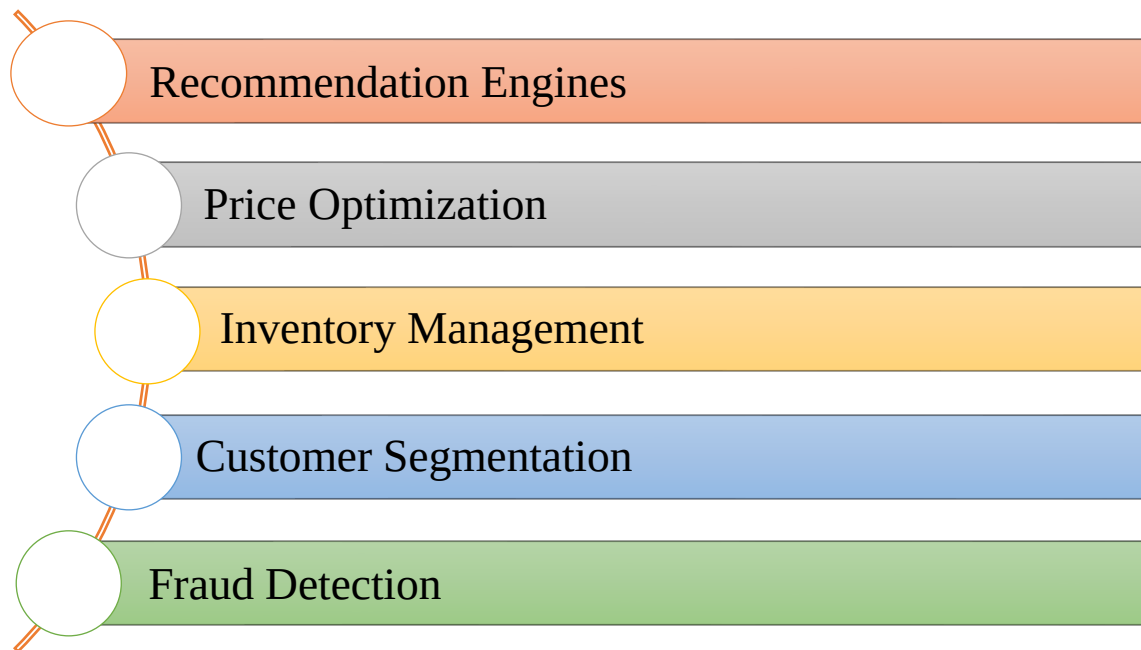


01. Automated Detection of Medical Conditions: Using machine learning algorithms, healthcare organizations are able to detect medical conditions from incoming patient data.

02. Accurate Diagnosis: Machine learning algorithms can help medical personnel to make accurate diagnoses for a given condition. As for example: IBM Watson Genomicsproje, a project of computing genome-based tumor sequencing and providing help in quick diagnosis.

- 03. Patient Monitoring:** Machine learning systems can be used to monitor patient health and detect potential changes in the patient's condition.
- 04. Drug Discovery and Development:** Machine learning can be used to accelerate the process of discovering new drugs and understanding how they interact with the body.
- 05. Improving Treatment Strategies:** Machine learning can be used to develop tailored treatments that are tailored to each individual patient. Example: IBM Watson Oncology, pioneer in this sector able to provide numerous treatment plans analyzing a patient's medical history firstly.
- 06. Improvement of Health Records:** Cloud Vision API from Google, ML handwriting recognition technology from MathWorks are leading examples

Applications of Machine Learning in Retail:



- 01. Recommendation Engines:** Machine learning algorithms can be used to provide product recommendations to customers. This helps to personalize their shopping experience, increase conversion rate and customer loyalty.

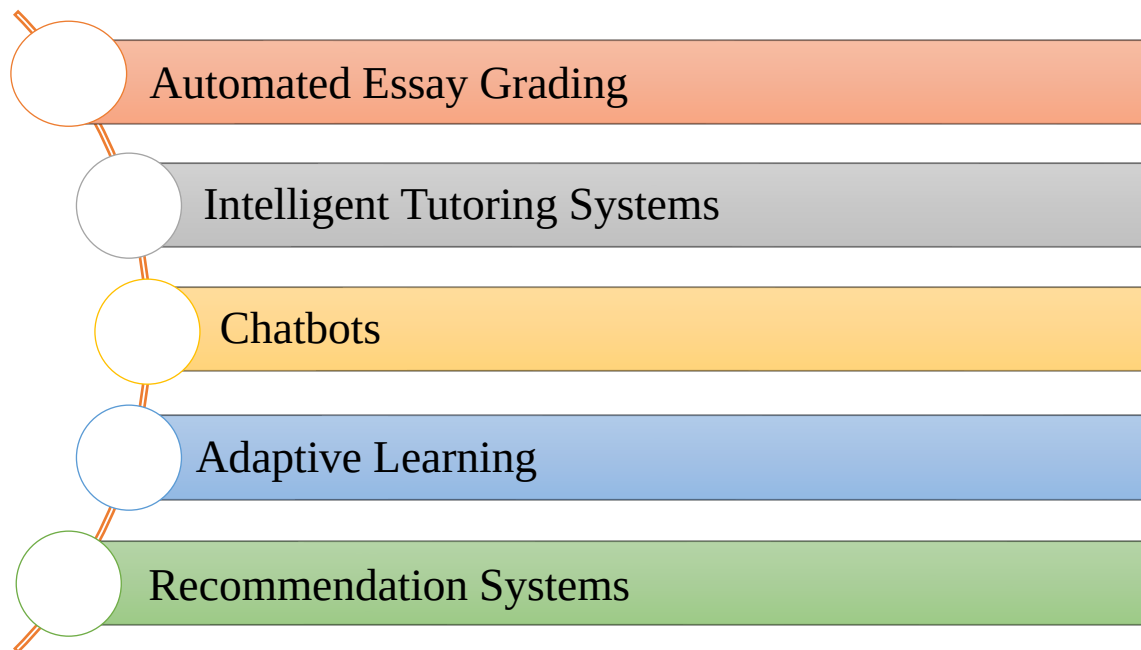
02. Price Optimization: Machine learning algorithms can be used to optimize prices for retail products. It can be used to find the optimal price for each item that maximizes profits.

03. Inventory Management: Machine learning algorithms can be used to predict demand for products based on historical data. This helps to anticipate upcoming demand and adjust inventory accordingly.

04. Customer Segmentation: Machine learning algorithms are used in segmenting customers into different groups, based on their purchase behaviors. This helps to target different customer segments with personalized offers.

05. Fraud Detection: ML algorithms are used to detect fraudulent transactions after analyzing patterns in data. This helps to reduce the chances of fraud and protect the company's assets.

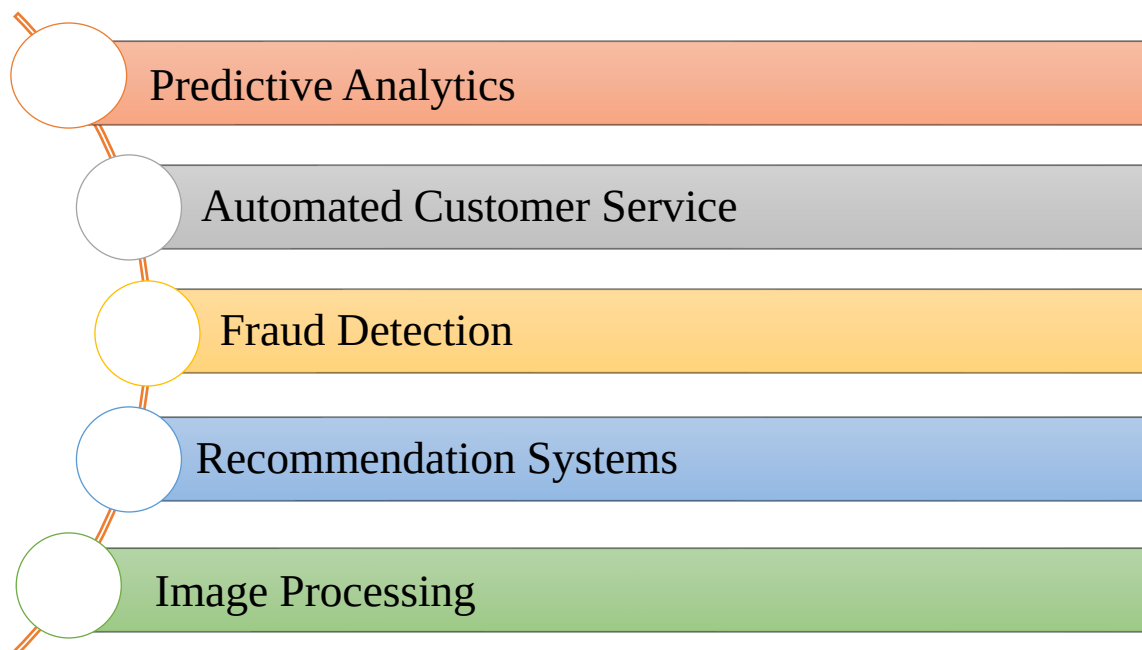
Applications of Machine Learning in Education:



01. Automated Essay Grading: Automated essay grading is when a computer program is used to grade student essays. This technology uses natural language processing and text analysis to grade essays.

- 02. Intelligent Tutoring Systems:** Intelligent tutoring systems use artificial intelligence to give personalized feedback to students. It can be used to help students learn new concepts and improve their problem-solving skills.
- 03. Chatbots:** Chatbots use natural language processing to interact with students and provide them with educational advice. This technology can be used to help students with their studies, answer questions and provide personalized learning experiences.
- 04. Adaptive Learning:** Adaptive learning is when a computer program adapts to a student's learning preferences and goals. The program can adjust the complexity of the material, provide feedback and tailor the learning experience to each individual.
- 05. Recommendation Systems:** Recommendation systems use artificial intelligence to recommend online courses or other educational resources to students. The system looks at the student's interests, learning history and other data points to suggest courses that are tailored to their needs

Applications of Machine Learning in Business:



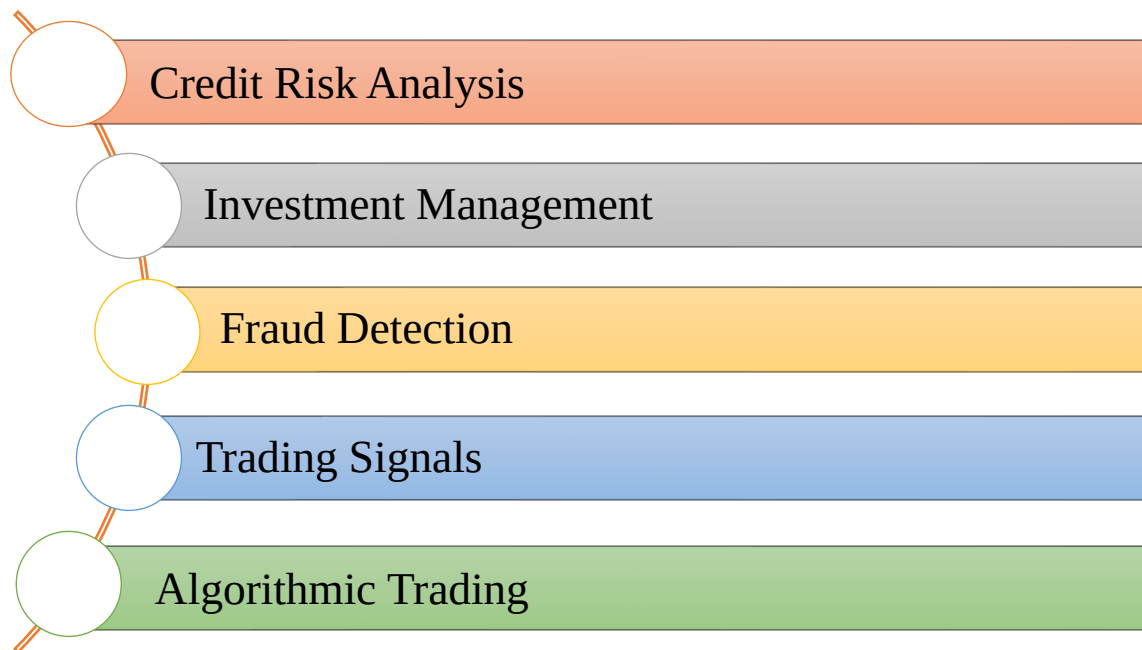
- 01. Predictive Analytics:** Predictive analytics is a powerful tool for businesses, as it uses data from the past to make more informed decisions about the future. It can be used to identify patterns, trends, and correlations in large datasets, allowing businesses to make more accurate predictions about customer behavior, the effectiveness of marketing campaigns, and the probability of certain outcomes.
- 02. Automated Customer Service:** Machine learning algorithms can be used to create automated customer service systems that are more efficient and accurate than traditional customer service systems. These systems can be programmed to answer simple questions, identify customer issues, and direct customers to the right resources.
- 03. Fraud Detection:** Machine learning algorithms can be used to detect and prevent fraud in businesses. By analyzing patterns in customer behavior and financial transactions, these algorithms can identify suspicious activities and alert businesses to potential threats.
- 04. Recommendation Systems:** Machine learning algorithms can be used to create recommendation systems that suggest products, services, or content to customers based on their past behavior. These systems can be used to increase customer engagement and drive sales.
- 05. Image Processing:** Machine learning algorithms can be used to analyze images and video for a variety of applications. This technology can be used for facial recognition, object detection, and video surveillance, making it a powerful tool for businesses.

Applications of Machine Learning in Finance:

- 01. Credit Risk Analysis:** Machine learning models can be used to analyze customer credit profiles and detect instances of fraud or default risk.
- 02. Investment Management:** Machine learning models can be used to identify profitable investments and build intelligent portfolios for investors.

03. Fraud Detection: Machine learning models can be used to detect instances of fraud such as credit card fraud, money laundering, and other financial crime.

04. Trading Signals: Machine learning models can be used to generate trading signals that alert traders to potential profit opportunities.



05. Algorithmic Trading: Machine learning models can be used to create automated trading strategies that execute trades based on market conditions.

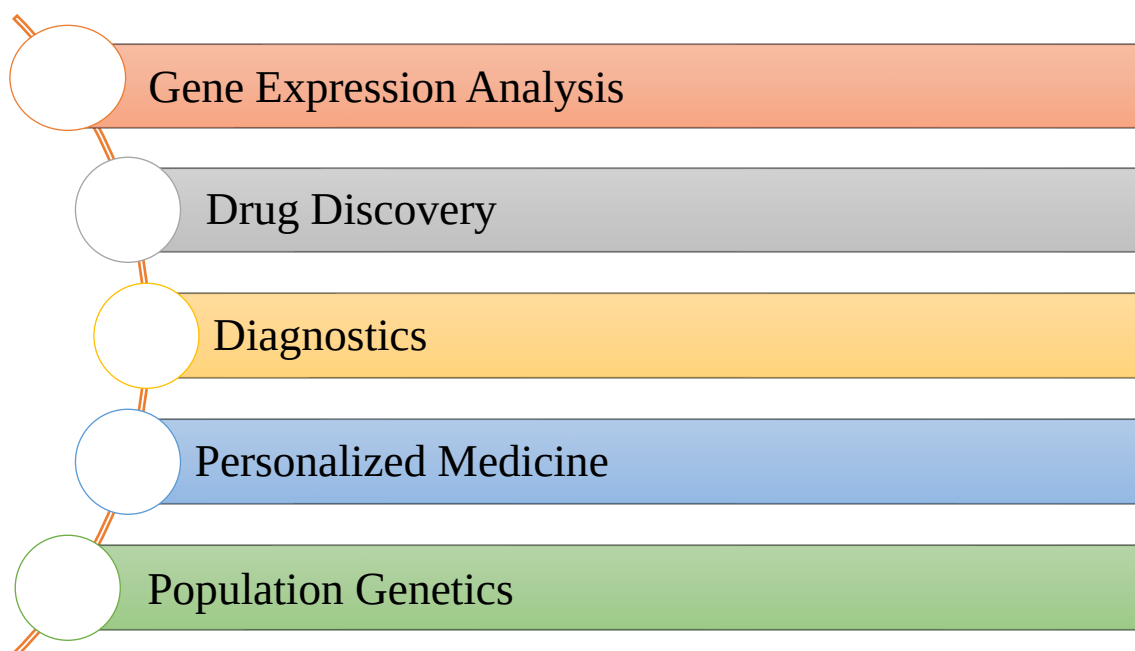
Applications of Machine Learning in Genetics and Genomics:

01. Gene Expression Analysis: Machine learning algorithms can be used to identify which gene expression patterns are associated with a particular phenotype or disease.

02. Drug Discovery: Machine learning models can be used to identify novel drug targets, predict drug response and toxicity, and develop drug repurposing strategies.

03. Diagnostics: Machine learning algorithms can be used to diagnose genetic diseases and detect biomarkers for predicting and monitoring disease progression.

04. Personalized Medicine: Machine learning algorithms can be used to identify personalized treatments for individual patients based on their genetic background.



05. Population Genetics: Machine learning algorithms can be used to detect population structure, trace human migration patterns, and identify genetic variants associated with diseases.

Question05 : How Does Unsupervised Learning Differ from Supervised Learning, and What are Some Examples of Each?

Supervised learning and unsupervised learning are two types of Machine Learning . The differences between these two types are outlined below :

Key Points	Supervised Learning	Unsupervised Learning
Input Data	Labeled	Unlabeled
Training Process	Model receives input data and ground-truth label during training	Model receives only input data without ground-truth label during training

General Purpose	Predict an outcome	Gain insight from the data
Computational Complexity	Less computationally demanding	More computationally demanding
Time Complexity	More time consuming	Less time consuming
Performance	More accurate	Less accurate
Number of Classes	Known in advance	Unknown, the result can be arbitrary
Feedback Mechanism	Has a feedback mechanism	Has no feedback mechanism

Examples of Supervised learning and Unsupervised learning: Here are some of the examples of both supervised and unsupervised learning:

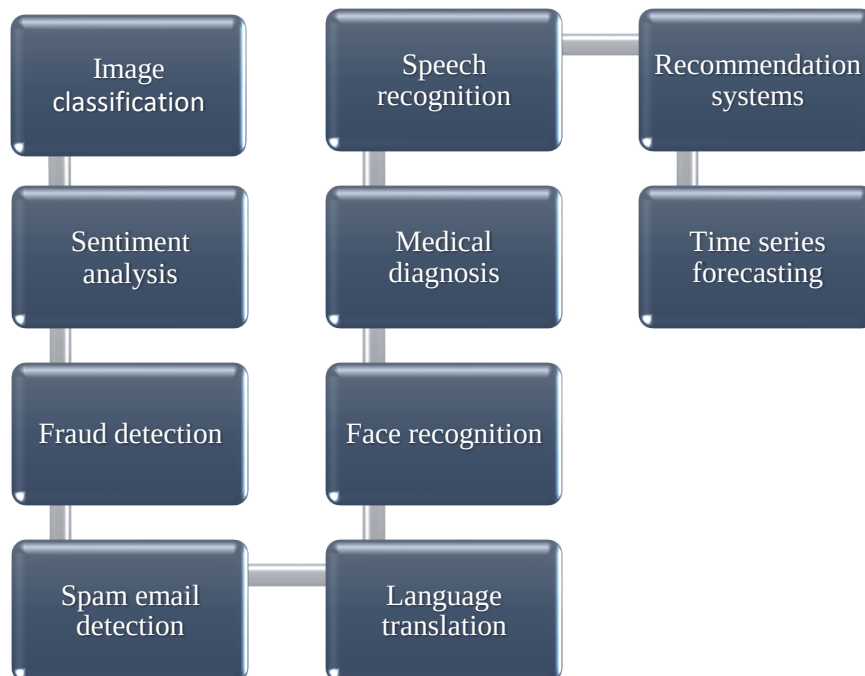


Chart: Examples of Supervised learning

Here are some example's of Supervised learning:

1. **Image classification:** A model is trained to recognize various objects in an image with labels indicating the object.
2. **Sentiment analysis:** A model is trained to predict the sentiment of a sentence or paragraph, indicating whether it is positive, negative, or neutral.
3. **Fraud detection:** A model is trained to differentiate between fraudulent and legitimate transactions, using labeled data.
4. **Spam email detection:** A model is trained to detect between spam and legitimate emails.
5. **Speech recognition:** A model is trained to recognize and transcribe speech, using labeled audio data.
6. **Medical diagnosis:** A model is trained to diagnose different medical conditions based on labeled patient data.
7. **Face recognition:** A model is trained to recognize faces from images with labeled names.
8. **Language translation:** A model is trained to translate language from one to another using labeled and translated sentence pairs.
9. **Recommendation systems:** Models are trained to personalize recommendations based on user behavior, preferences, and ratings.
10. **Time series forecasting:** A model is trained to predict future patterns and trends based on historical time series data.

Now, let's see some examples of Unsupervised learning:

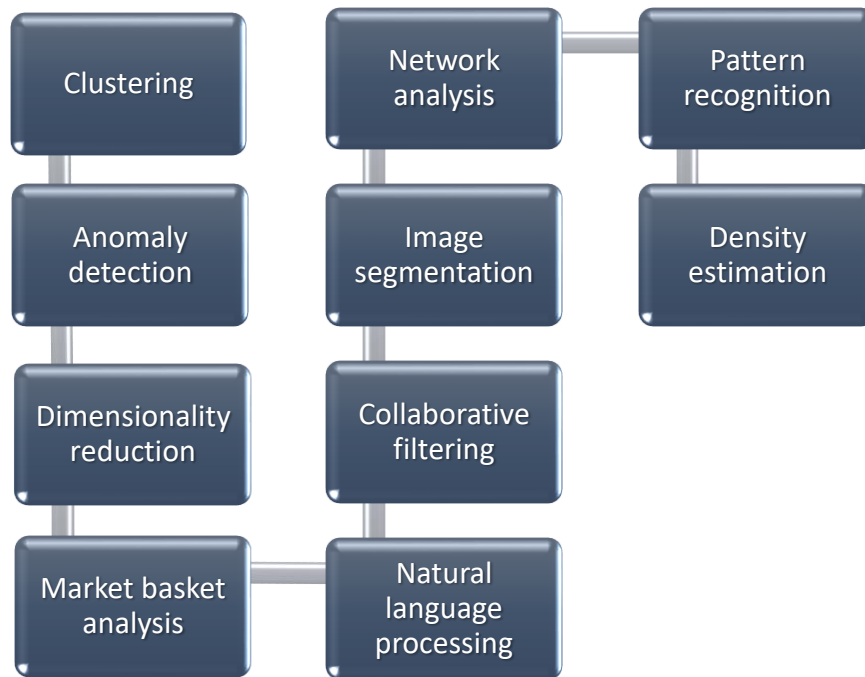


Chart: Examples of Unsupervised learning

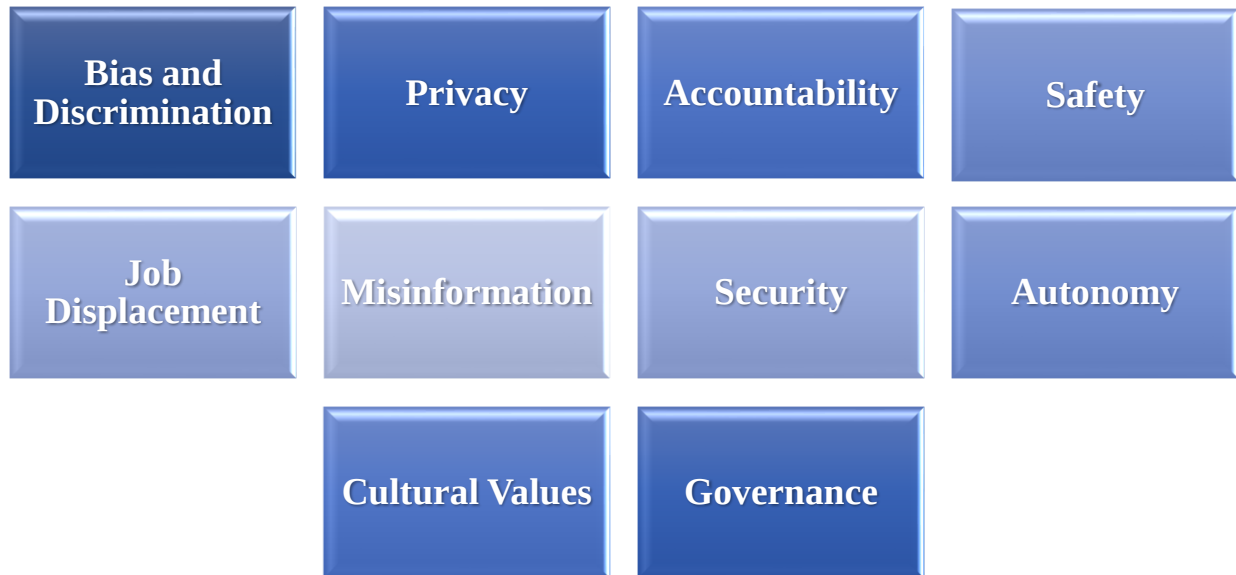
1. **Clustering:** Unsupervised learning is used to cluster data that shares similar characteristics, such as grouping customers based on their purchasing behaviors.
2. **Anomaly detection:** Unsupervised learning is used to detect outliers or anomalies in data that do not fit within a certain pattern.
3. **Dimensionality reduction:** Unsupervised learning is used to reduce the dimensionality of a large dataset, making it easier to analyze and visualize.
4. **Market basket analysis:** Unsupervised learning is used to analyze customer purchases and identify items that are frequently purchased together.
5. **Network analysis:** Unsupervised learning is used to analyze social networks and identify key influencers or communities within the network.

6. **Image segmentation:** Unsupervised learning is used to segment images into distinct regions based on their color, texture or other features.
7. **Collaborative filtering:** Unsupervised learning is used to recommend items or products based on the preferences and behavior of similar users.
8. **Natural language processing:** Unsupervised learning is used to extract key topics or themes from large textual data sets.
9. **Pattern recognition:** Unsupervised learning is used to detect patterns in data that may not be apparent to the human eye.
10. **Density estimation:** Unsupervised learning is used to estimate the probability density function of a dataset, which can be useful for statistical analysis and data modeling.

Question06: What are Some of the Ethical Concerns Associated with the Use of AI in Decision-Making and Automation, and How Can They be Addressed?

As Artificial Intelligence (AI) continues to advance, it is being increasingly integrated into decision-making and automation processes across various industries. While the benefits of AI are undeniable, there are also ethical concerns that come with its use. These concerns range from issues of bias and discrimination, to privacy, autonomy, and governance. In this context, it is essential to examine the ethical concerns associated with the use of AI in decision-making and automation, and how they can be addressed to ensure that AI is developed and utilized in a responsible and ethical manner.

The Ethical Concerns Associated with the Use of AI in Decision-Making and Automation are:



Keywords	Ethical Concerns	How to address
Bias and Discrimination	➤ The biases may be reflected by AI systems of their developers or the data used to train them, leading to unfair outcomes. ➤ As for example ,In 2018, AI recruiting	❖ AI systems need to be trained on diverse datasets and involve diverse teams of developers to mitigate the risk of bias and discrimination.

	tool of Amazon howed bias against women because it was trained on resumes from predominantly male candidates.	
Privacy	➤ AI systems collect and analyze data on individuals, which raises concerns about privacy violations. ➤ For example, in 2018, the Chinese government used facial recognition technology to track and monitor the Uighur minority population, leading to accusations of human rights violations.	❖ Regulations must be in place to ensure that AI systems are compliant with privacy laws and ethical principles.
Accountability	➤ With AI decision-making, it can be difficult to determine who is responsible for any harmful	❖ Clear mechanisms for accountability and transparency should be established to ensure that AI decision-making is

	outcomes. This raises concerns about accountability and transparency.	transparent and human oversight is in place.
Safety	➤ The use of AI in fields such as healthcare, transportation, and industrial automation raises concerns about safety. ➤ For example, an Uber self-driving car ,in 2018, killed a pedestrian in Arizona, which raised questions about the safety of autonomous vehicles.	❖ Regulations and safety standards must be established for AI use in fields such as healthcare and transportation.
Job Displacement	➤ The increasing use of AI automation may lead to job displacement for humans. ➤ A study by the World Economic Forum	❖ Programs should be established to retrain workers who are displaced by AI automation.

	estimated that 75 million jobs to be displaced by AI by 2022.	
Misinformation	➤ The use of AI to generate so-called "deep fake" videos and images raises concerns about the spread of misinformation and the erosion of trust in information. ➤ For example, in 2019, a deep fake of a political speech from Belgian Prime Minister Charles Michel went viral on social media.	❖ Efforts should be made to develop AI systems that can detect and combat fake news and deepfakes.

Security	➤ AI systems may be vulnerable to cyber attacks, leading to risks of data breaches and system failures. ➤ For example, In 2017, the WannaCry ransomware attack took advantage of a vulnerability in an outdated version of Windows, causing widespread disruption.	❖ AI systems must be designed to be secure and resilient to cyber attacks.
Autonomy	➤ The increasing use of AI raises questions about the autonomy of decision-making. As these systems become more advanced, they may make decisions without human control or oversight.	❖ AI decision-making should be subject to human oversight, and the use of AI should be guided by ethical principles.

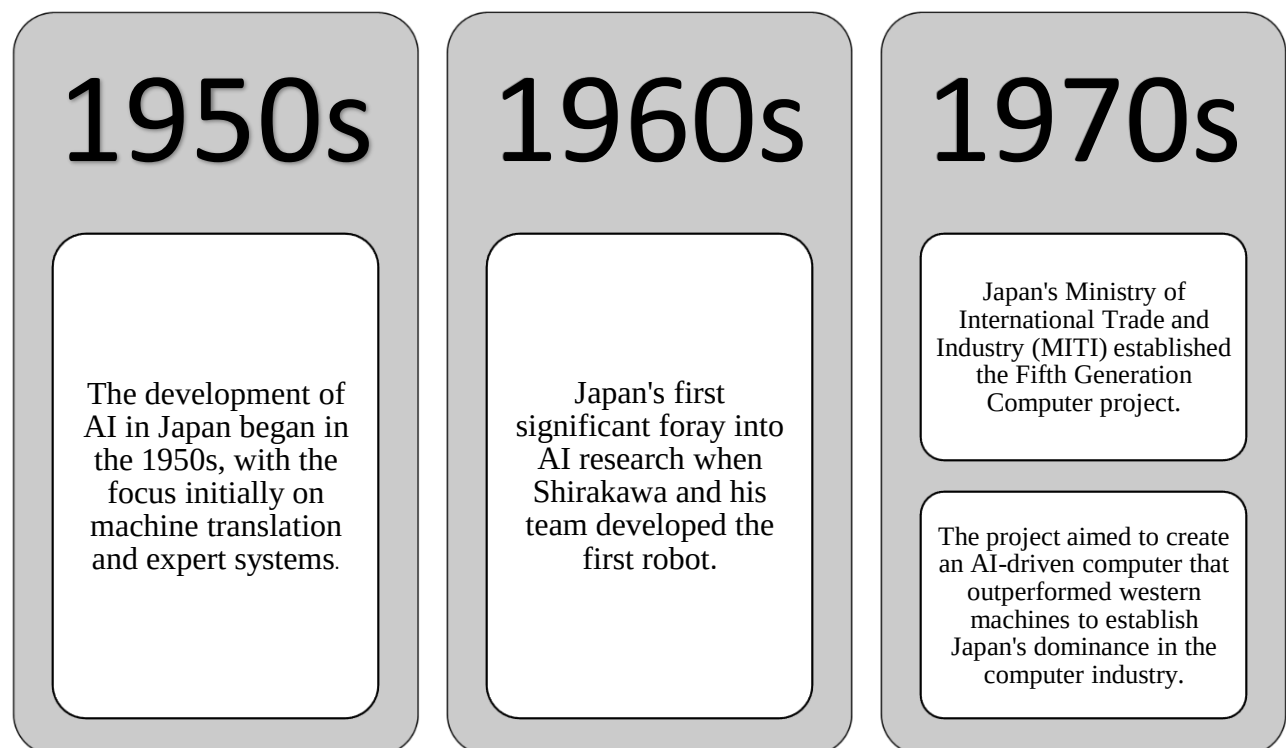
Cultural Values	➤ The use of AI may be influenced by cultural values, leading to challenges in cross-cultural adoption. ➤ For example, in Japan, there is a tendency to trust robots more than AI systems that are perceived to be impersonal.	❖ Cross-cultural training and collaboration can help ensure that AI systems are developed with an understanding of cultural values and norms.
Governance	➤ There are currently few regulations governing the development and use of AI which raises concern about the potential for misuse and the need for ethical guidelines to ensure responsible use. ➤ For example In 2020, the European Commission released	❖ Ethical guidelines and regulations should be established to ensure responsible use of AI and development .An international framework for AI governance should also be established.

	guidelines for the development and use of ethical AI.	
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Question 07: Discuss the History of AI Research and Development in Japan, and Identify Some of the Key Players and Innovations in the field.

AI has a long historical background of research and development in Japan, dating back to the 1950s. In this part, we will discuss the history of AI research and development in Japan and identify some of the key players and innovations in the field.

History of AI Research in Japan:



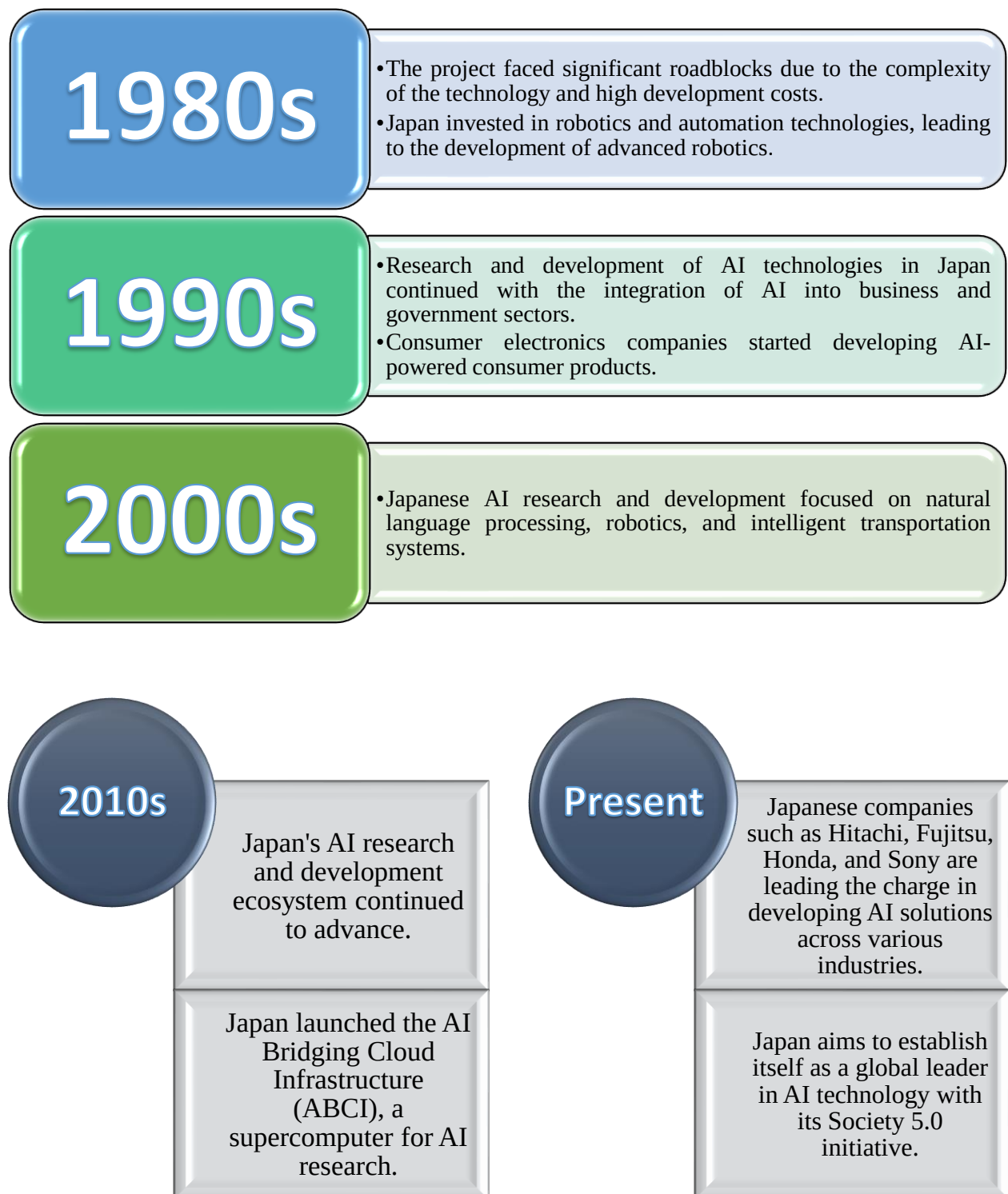


Figure: History of AI in Japan (1950-Present)

Key Players in AI Field in Japan:

› Hiroshi Ishiguro

- a robotics engineer who developed humanoid robots that can mimic human expressions and gestures.

› Yann LeCun

- a French computer scientist who works as a professor at New York University and leads Facebook's Artificial Intelligence Research division in Tokyo.

› Masahiro Mori

- a Japanese roboticist and professor who developed the concept of "uncanny valley" which refers to the discomfort humans feel towards robots that look and act almost like humans.

› Naonori Ueda

- a researcher at the National Institute of Advanced Industrial Science and Technology (AIST) who develops intelligent robotics technologies that can enhance human functions.

› Noriko Arai

- a computer scientist who founded the Todai Robot Project that aims to create an AI system capable of passing the entrance exam for the University of Tokyo.

› Takahiro Kawaguchi

- a researcher at Sony who works on developing AI systems that can understand human emotions and provide personalized experiences.

› Yoshua Bengio

- a Canadian computer scientist who works as a professor at the University of Montreal and leads the Montreal Institute for Learning Algorithms (MILA) whose research primarily focuses on deep learning.

› Kazuhiro Nakamura

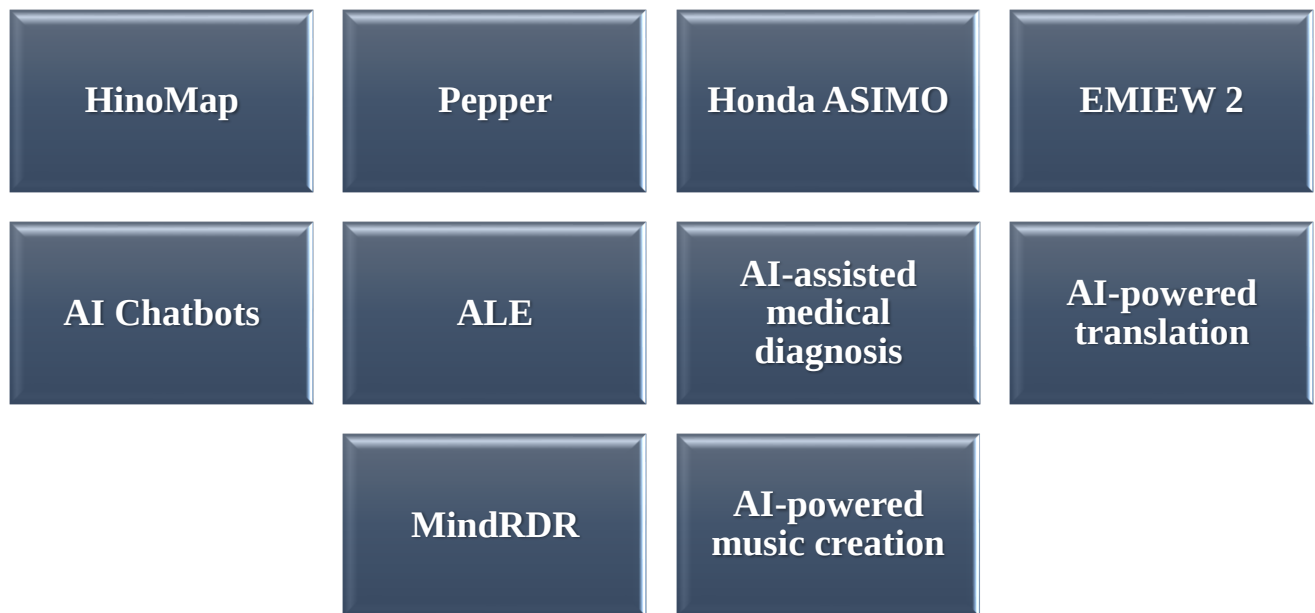
- a researcher at the NTT Communication Science Laboratories who focuses on developing AI systems that can recognize and interpret human speech.

› Tomohiro Shibata

- a researcher at the National Institute of Information and Communications Technology who develops AI technologies that can assist people with disabilities.

› Ryosuke Shibasaki

- a researcher at the University of Tokyo who works on developing AI systems that can analyze data from satellite imagery and maps.

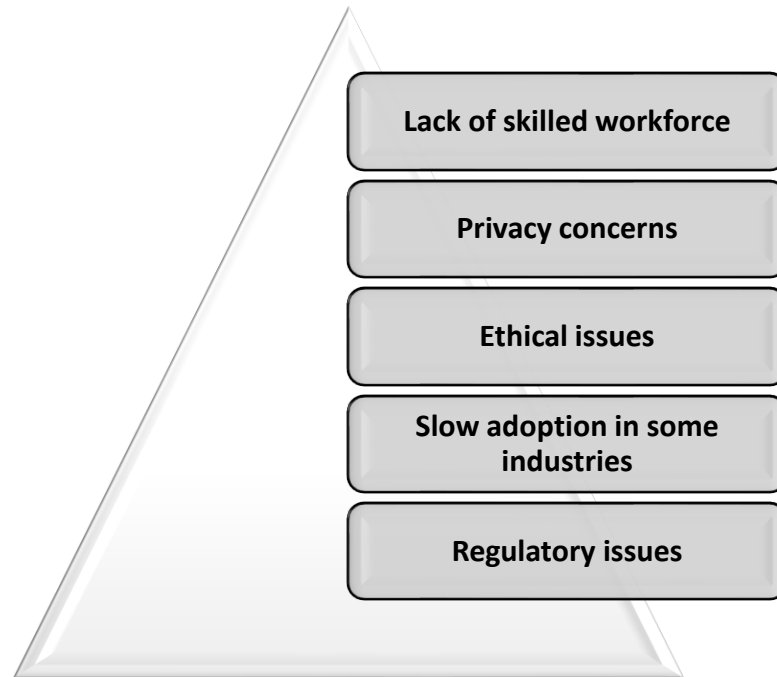
Innovations in AI Field in Japan:

1. **HinoMap** - an AI technology developed by Hitachi that uses data from cameras and sensors to create 3D maps of environments.
2. **Pepper** - a humanoid robot developed by Softbank Robotics that can recognize human emotions and interact with people.
3. **Honda ASIMO** - a humanoid robot developed by Honda that can walk on two legs, climb stairs, and recognize human voices and gestures.
4. **EMIEW 2** - a humanoid robot developed by Hitachi that can interact with humans and navigate in dynamic environments.

5. **AI Chatbots** - chatbots developed by LINE, a popular messaging app in Japan, that uses AI to respond to user inquiries.
6. **ALE** - a startup that uses satellites to create artificial meteor showers that can be viewed from the ground.
7. **AI-assisted medical diagnosis** - AI systems developed by Fujitsu and other companies that can diagnose diseases and suggest treatments based on medical data.
8. **AI-powered translation** - translation systems developed by NTT and other companies that can translate languages in real-time.
9. **MindRDR** - an AI technology developed by a British startup that allows users to control a drone using their thoughts.
10. **AI-powered music creation** - music creation systems developed by Yamaha and other companies that can compose music based on user inputs.

Question 08: What are some of the challenges and opportunities facing AI in Japan today, and how might they impact the country's economy and society in the future?

Artificial intelligence (AI) has rapidly grown to become one of the most significant forces shaping the future of economies and societies worldwide. Japan, a country renowned for its technological innovations, is not exempt from the widespread adoption of AI technologies. This article explores some of the challenges and opportunities facing AI in Japan and how they could impact the country's economy and society in the future.

Challenges facing AI in Japan:**❖ Lack of skilled workforce:**

- Shortage of skilled professionals in the AI industry.
- Only 1 in 10 Japanese firms currently employ AI specialists, creating a significant talent gap.

❖ Privacy concerns:

- Risk of privacy breaches and misuse of data as AI systems collect personal data.
- The majority of Japanese citizens worry about the use of personal data by AI systems, with trust in the technology being relatively low.

❖ Ethical issues:

- Concerns about the impact of AI on jobs, social inequality, and making ethical decisions.
- Japan is grappling with the implications of AI for social inequality, job displacement, and ethical decision-making.

❖ **Slow adoption in some industries:**

- Cultural and structural barriers impeding the adoption of AI technologies in traditional industries.
- Traditional industries such as agriculture and construction remain relatively slow in adopting AI technologies.

❖ **Regulatory issues:**

- Legal and regulatory framework for AI still developing, creating uncertainty for businesses and investors.
- Japan's regulatory framework for AI is still nascent, and there is significant uncertainty around how to regulate the technology.

Opportunities for AI in Japan:

Demographic challenges

- AI has the potential to transform eldercare services in Japan, where an aging population is leading to increased demand for healthcare.

Innovation in traditional industries

- AI could increase the productivity and competitiveness of traditional industries like manufacturing, which still contribute significantly to Japan's economy.

International collaboration

- Collaboration with overseas companies and researchers can help Japanese firms stay at the forefront of AI innovation.

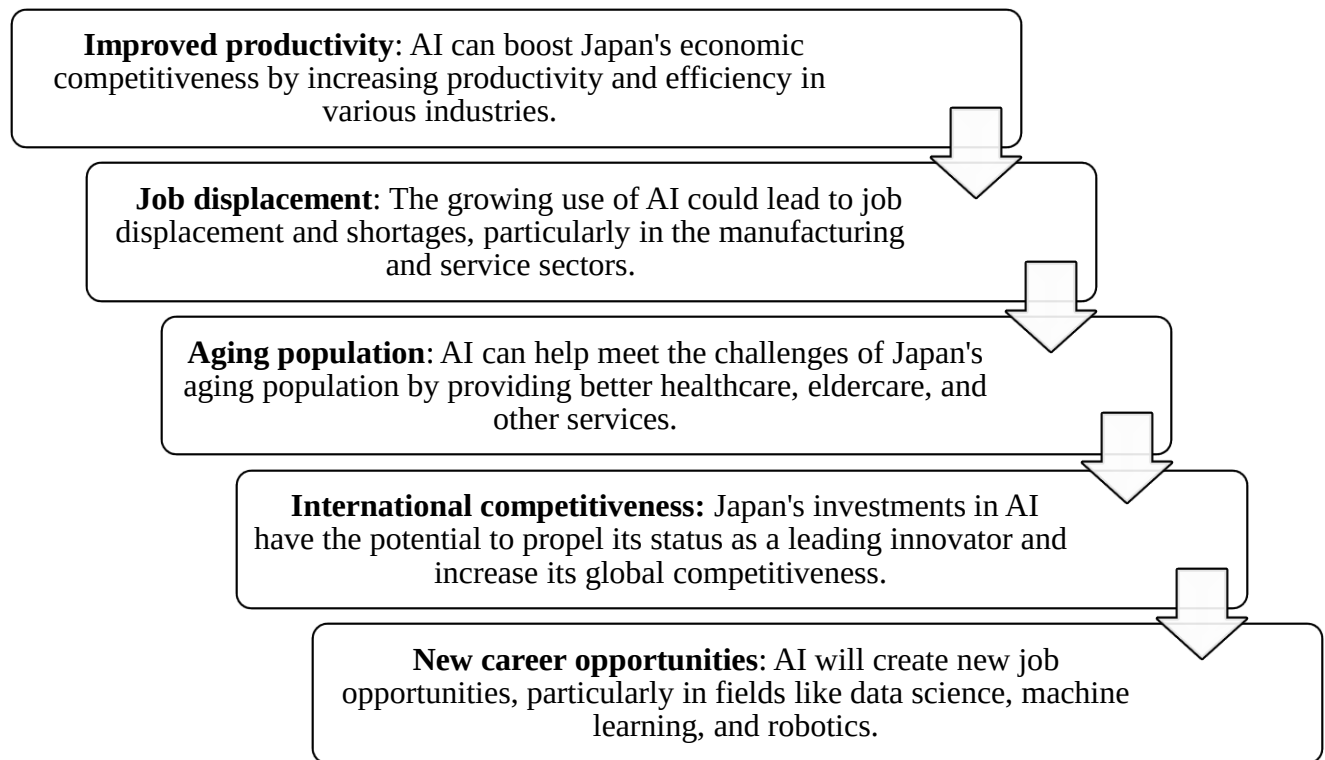
Smart cities

- The Japanese government sees AI as a crucial technology for realizing smart and sustainable urban development.

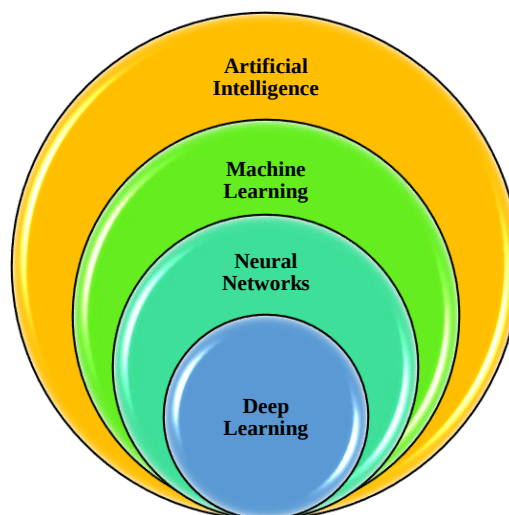
New business models

- Japanese firms are looking to AI to create new revenue streams, with particular attention to personalized products, predictive maintenance, and subscription services.

Impact on Japan's economy and society:



Question09: Explain the concept of Deep Learning and describe some of the most significant breakthroughs and applications of this technology in recent years.



Deep learning is a subset of machine learning that involves creating and training artificial neural networks to recognize patterns and make predictions. It works by using multiple layers of nodes in a neural network to identify and categorize data.

Some of the most significant breakthroughs and applications of deep learning in recent years include:



❖ **Image recognition:**

- Deep learning systems can recognise images with 97% accuracy, surpassing human performance.
- In 2015, Google's deep learning programme Inception surpassed humans in kitten identification.

❖ **Natural language processing:**

- Deep learning allows language models like GPT-3 to comprehend and create human-like answers.
- Google's BERT model improves language comprehension by over 10%.

❖ **Healthcare:**

- Deep learning systems can predict cancer outcomes with over 93% accuracy, stroke diagnoses by 30%, and heart attacks by 90%.

❖ **Fraud detection:**

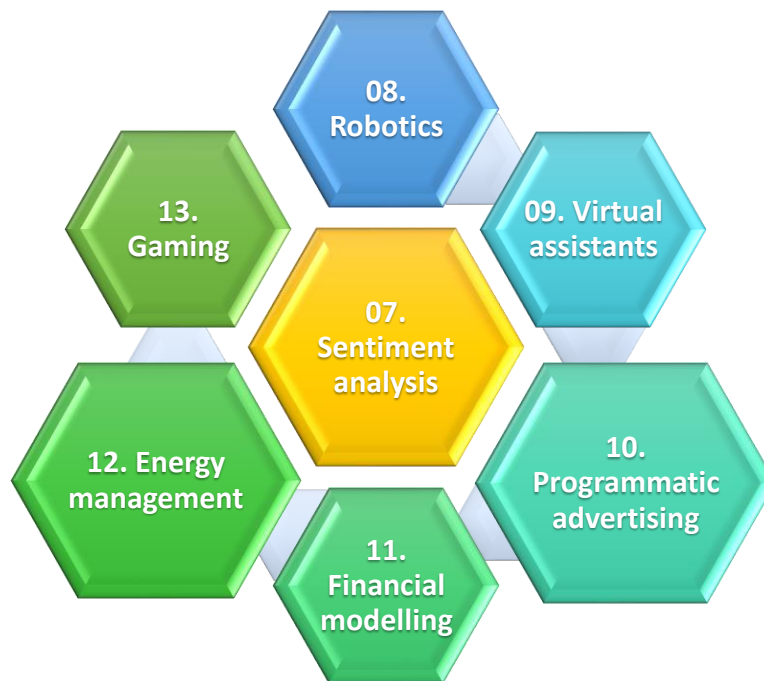
- Deep learning algorithms enhance fraud detection by 80%.
- PayPal detects questionable financial transactions using deep learning.

❖ **Autonomous vehicles:**

- Deep learning algorithms recognise things and navigate highways, boosting safety and efficiency.
- Tesla's Autopilot technology employs deep learning algorithms to recognise traffic patterns and estimate the optimum route.

❖ **Predictive maintenance:**

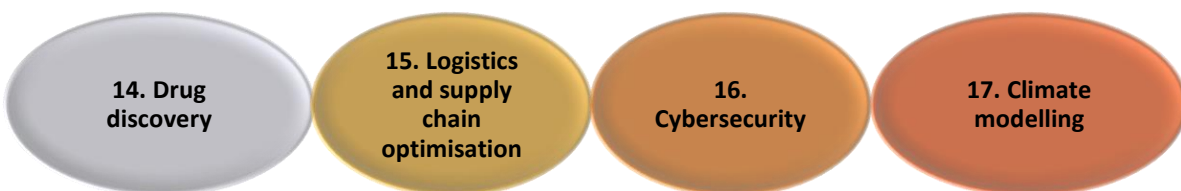
- In manufacturing, energy, and transportation, deep learning predicts equipment breakdowns and reduces downtime.
- Airbus predicts aeroplane component problems using deep learning.



❖ **Sentiment analysis:**

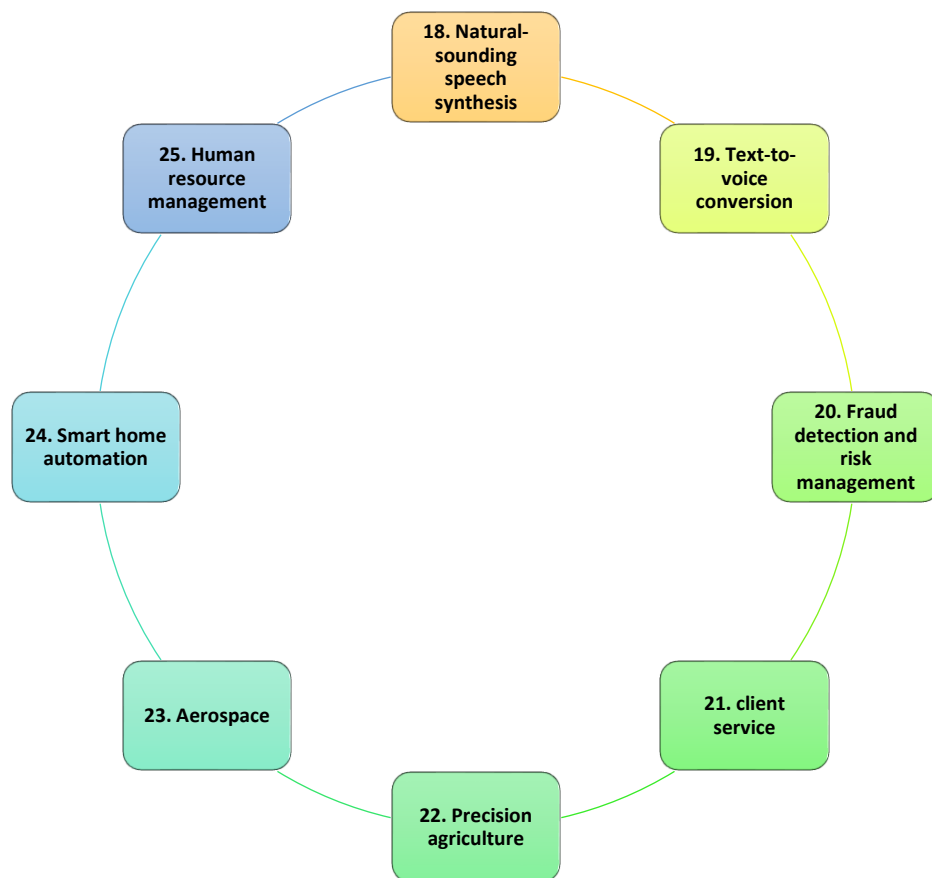
- Deep learning algorithms analyse user sentiment and trends in social media monitoring and online reputation management.

- Sentiment Analysis API classifies text as positive, negative, or neutral using deep learning.
- ❖ **Robotics:**
 - Deep learning improves vision, autonomous control, and decision-making.
 - Boston Dynamics employs deep learning techniques to improve robot control and operation.
- ❖ **Virtual assistants:**
 - Siri, Alexa, and Google Assistant employ deep learning to analyse voice, natural language, and user requests.
- ❖ **Programmatic advertising:**
 - Deep learning algorithms optimise ad targeting and performance.
 - Deep learning helps Google AdWords forecast user behaviour and target adverts.
- ❖ **Financial modelling:**
 - Deep learning helps anticipate stock prices and market movements.
 - Nasdaq predicts stock fluctuations via deep learning.
- ❖ **Energy management:**
 - Deep learning optimises energy use and reduces waste in the energy business.
 - S&P Global Platts forecasts energy consumption via deep learning.
- ❖ **Gaming:**
 - Deep learning algorithms enhance game AI and realism.
 - The "Starcraft II" AI employs deep learning to enhance gameplay and decision-making.



- ❖ **Drug discovery:**
 - Deep learning predicts drug-target interactions and finds novel drug candidates to speed drug discovery.

- Atomwise employs deep learning to discover disease-specific medication possibilities.
- ❖ **Logistics and supply chain optimisation:**
 - Deep learning optimises processes and reduces costs.
 - UPS optimises delivery routes and reduces emissions via deep learning.
- ❖ **Cybersecurity:**
 - Deep learning is used in cybersecurity to identify malware and intrusions.
 - Fortinet detects and mitigates cyberthreats through deep learning.
- ❖ **Climate modelling:**
 - Deep learning improves climate modelling and forecasts to minimise climate change.
 - Deep learning improves weather predictions at Google and NOAA.



❖ **Natural-sounding speech synthesis:**

- Natural-sounding speech synthesis using deep learning.
- Baidu's Deep Voice 3 model produces almost human-sounding synthetic voices.

❖ **Text-to-voice conversion:**

- Deep learning algorithms make speech more lifelike and accurate.
- Google's WaveNet model has cut voice synthesis mistakes by 50%.

❖ **Financial fraud detection and risk management:**

- Financial fraud detection and risk management using deep learning.
- JP Morgan detects credit card theft via deep learning.

❖ **Client service:**

- Deep learning analyses client input and makes personalised suggestions to enhance service.
- Zendesk employs deep learning to personalise customer enquiries.

❖ **Precision agriculture:**

- Deep learning algorithms optimise agricultural yields and eliminate waste.
- John Deere predicts agricultural yields using deep learning to analyse soil moisture and plant development.

❖ **Aerospace:**

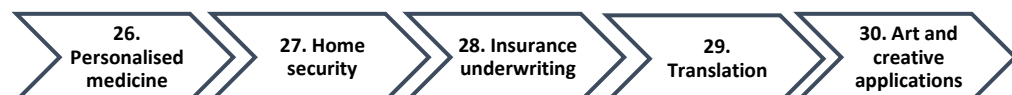
- Deep learning improves flight safety, lowers costs, and optimises operations.
- NASA analyses flight data and improves aircraft design via deep learning.

❖ **Smart home automation:**

- Deep learning learns user routines and optimises energy consumption.
- Nest adjusts thermostats depending on user behaviour using deep learning.

❖ **Human resource management:**

- Deep learning algorithms increase employee retention, identify training needs, and anticipate turnover.
- PepsiCo analyses employee data using deep learning to improve.



❖ Personalised medicine:

- Deep learning is being used to find genetically tailored treatments.
- Memorial Sloan Kettering Cancer Centre recommends personalised cancer therapy using deep learning.

❖ Home security:

- Deep learning alerts homeowners of possible attacks.
- Ring alerts residents to unusual behaviour near their houses using deep learning.

❖ Insurance underwriting:

- Deep learning improves risk assessment.
- For example, Zurich Insurance uses deep learning to analyze customer data and predict insurance claims.

❖ Translation:

- Deep learning systems enhance translation accuracy and speed.
- Google Translate correctly translates over 100 languages in real time using deep learning.

❖ Art and creative applications:

- Deep learning is improving music composition and picture development by generating new material.
- Adobe employs deep learning algorithms to produce creative material and support artists.

Overall, deep learning has the potential to revolutionize many industries and applications by enabling machines to learn and make decisions on their own.

Question10: Discuss the Role of Government Policies and Public-Private Partnerships in Promoting AI Research and Development in Japan.

Japanese AI research relies on government policy and public-private cooperation. Their contributions to Japan's AI field include:

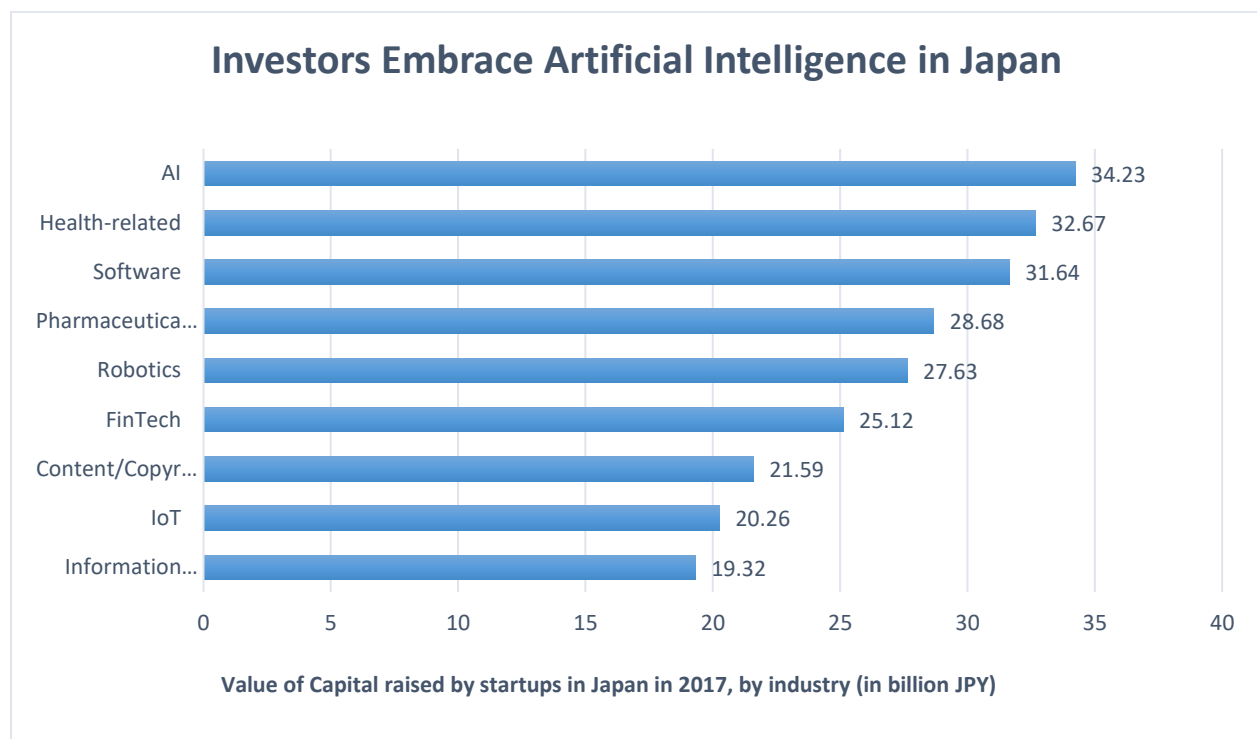
The role of Government policies:

The Japanese government has promoted AI research and development for decades. These government measures have advanced AI in Japan:



Chart: The role of Government Policies

- **Funding:** The Strategic Innovation Promotion Program (SIP) and other Japanese government programs have funded AI research and development. Universities, research institutes, and corporations may invest in AI and develop new technology and applications using this financing. Government funds AI research and development. As for example, in 2017, the government committed 84 billion yen (\$784 million) towards AI research and development, according to METI. Following chart shows funding on AI keeping on top by Japanese government:



(Source:Stastica)

- **Initiatives and Programs:**
 - The 2016 Next Generation Artificial Intelligence Strategy (AIS) promotes and supports AI research and development.
 - This policy promotes AI technology development and makes Japan a global leader.

▪ **Research and Development Centre:**

- The government's AIIC and AIRC at the National Institute of Advanced Industrial Science and Technology (AIST) promote AI development.

▪ **Public-commercial Partnerships:**

- Japan has partnered with commercial enterprises to advance AI research.
- The Toyota Research Institute-Advanced Development (TRI-AD) develops self-driving automobiles with government support.

▪ **Education:**

- The government gives priority AI researcher and developer training.
- Tokyo and Kyoto universities provide AI-focused graduate programs funded by the government.

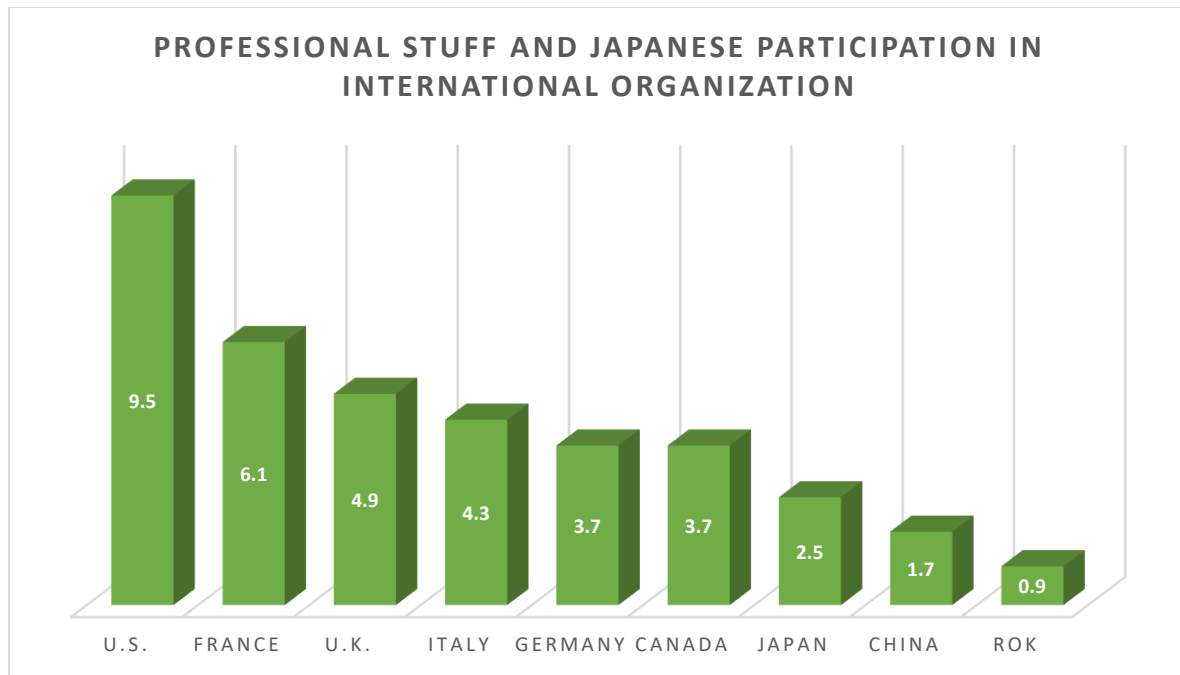
▪ **Legal Framework:**

- The Act on the Promotion of Use of Information and Communications Network legalized AI research and development.

▪ **Talent development:**

- To guarantee Japan has a qualified workforce to drive AI innovation, the government has invested in talent development programs.
- The government offers AI-focused education and training at universities and vocational institutions

International collaboration: worldwide engagement: Through partnerships and OECD membership, the government has fostered worldwide AI collaboration. Japan has learned from others and shared its AI skills through this partnership.



(Source: UN Document)

This graph shows professional staff and Japanese participation in international organizations (As of December 31, 2015). Japanese active in international organizations supports international partnership.

Overall, the Japanese government has taken a comprehensive approach to promoting AI research and development. This has led to significant advancements in the field, including the development of cutting-edge technologies in areas such as robotics, self-driving cars, and healthcare.

The role of Public-Private Partnerships:

Japan's AI research and development has relied on Public-Private Partnerships (PPP). PPPs have advanced Japanese AI in several ways:



❖ **Industry-Academia Collaboration:**

- The Japanese government promotes AI research and development with commercial firms and academic institutions.
- The government and Hitachi founded the Kyoto University Hitachi AI Technology/Laboratory to create intelligent healthcare solutions.

❖ Funding:

- Japanese PPPs have invested much in AI research and development.
- As for example, in 2018, the government and commercial sector financed the RIKEN Centre for Advanced Intelligence Project, which develops cutting-edge AI technology.

❖ Resource Sharing:

- PPPs let private enterprises and academic institutions share resources and knowledge.
- The University of Michigan and Toyota Research Institute-Advanced Development exchange AI and robotics resources.

❖ Technology Transfer:

- PPPs have helped universities transfer AI technology to private firms.
- The National Institute of Advanced Industrial Science and Technology (AIST) has licensed image recognition and speech recognition technology to commercial enterprises.

❖ Commercialization:

- PPPs have helped commercialize academic AI technology.
- Fujitsu and the University of Tokyo developed a crowd-analysis AI system to avert accidents.

Overall, PPPs have been instrumental in promoting AI research and development in Japan. By facilitating collaboration between private companies and academic institutions, PPPs have supported the development and transfer of cutting-edge AI technologies, leading to significant advancements in several industries.
