

# Week 2: AI Applications and Methodologies

## Introduction

In this chapter, we will be learning about the key fields of application where AI can be applied. These are the applications that are having an impact on society, both positive and negative. We will be navigating through such applications we all may have used at some point in time or have become part of our daily lives.

We will also learn about the machine-learning techniques behind these applications. These applications have the capacity to bring about global societal changes. It is therefore very necessary to get ready for the future, the AI age.

## Key fields of application in AI

In this section, we will be discussing applications like chatbots, text-based voice assistants, computer vision, autonomous systems like self-driving cars and others that are inherently using AI technologies.

### **Chatbots (Natural Language Processing, speech)**

Chatbots are very common text-based applications used in various ways to reach out and interact with people. Let us take an understanding of chatbots and the technology they are based on.

### **What are chatbots**

As the name implies, a “Chatbot” is a conversational robot. AI powered Chatbots can grasp and understand natural languages or multiple human languages like English, Dutch, Hindi, French, German, and so on. These chatbots can, therefore, respond to people online using the “live chat” feature on webpages or portals, or applications.

AI powered chatbots have the ability to mimic human-like conversations without the need for any human intervention at their end, enacting a real-life agent.

These chatbots are based on machine learning and build a database of answers, eventually pulling the relevant info before pushing it to the user at the other end.

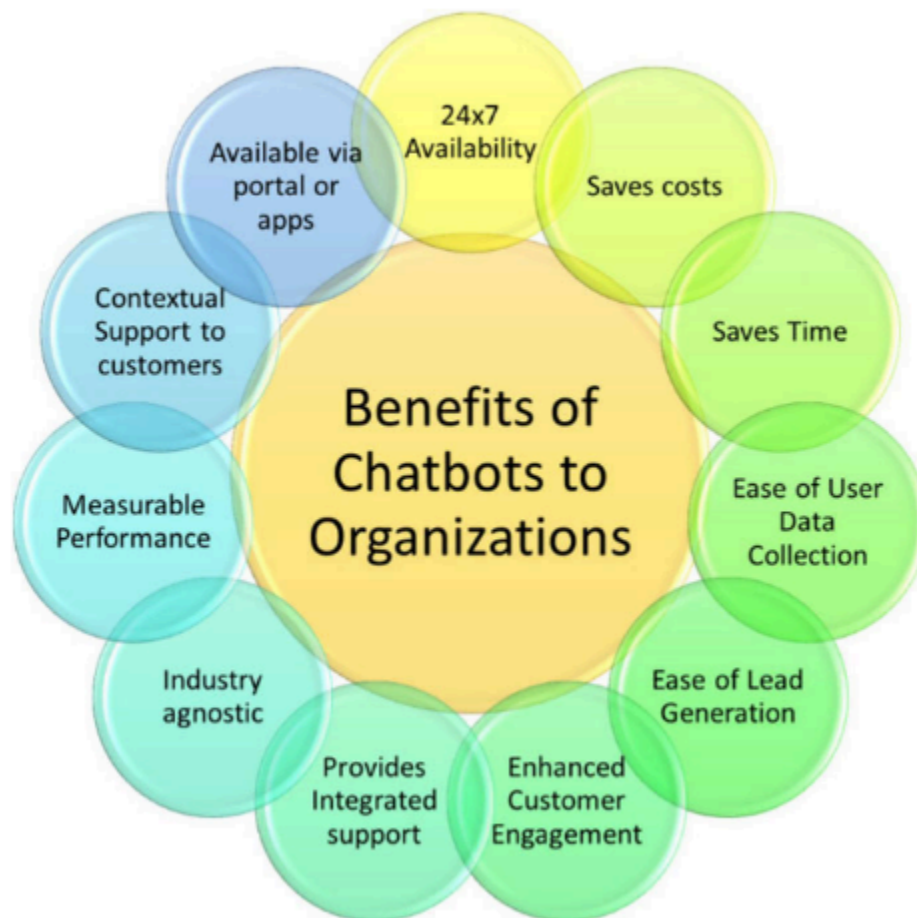
Chatbot systems can communicate via written or voice messages. The talking robots are usually termed “voice bots”.

## Benefits of chatbots

The chatbots are used to provide customer support, answer inquiries, issue tracking, or any other contextual support enhancing customer engagement and satisfaction. These chatbots can be replicated across industry verticles integrated with various informational, customer, and business offerings centric databases.

Since these chatbots are automated, it provides immense value to both the users and the organizations/businesses hosting them.

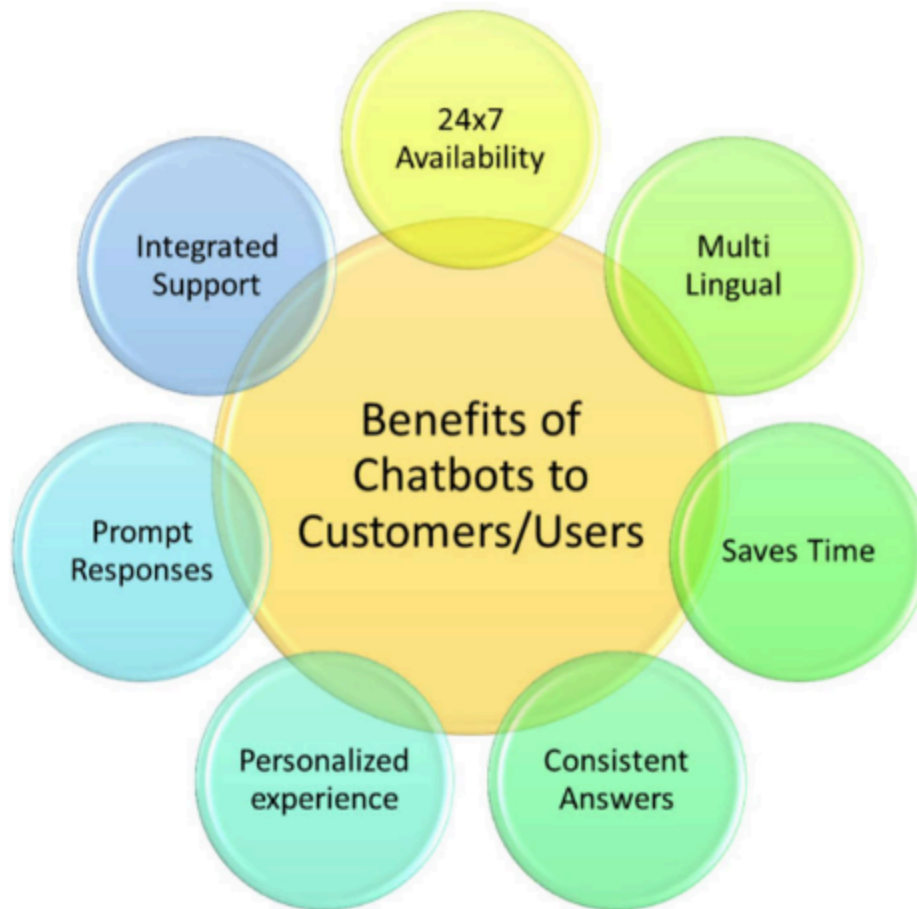
The following Figure 2.1 illustrates some benefits of chatbots in organizations:



### *Figure 2.1: Benefits to the organizations*

- **24x7 availability:** A chatbot is available along with the portal/application where it is hosted, enabling organizations to reach out to intended users all the time.
- **Availability on digital platforms:** Chatbots can be accessed via digital devices from anywhere at any hour, again easing out organizations on complete human dependency at odd hours.
- **Saves Times:** These chatbots help in saving time by providing prompt replies to the users, thus catering to multiple of them in parallel.
- **Ease of Users' data collection:** The Organization gathers meaningful huge customer data sets in less time. This data helps.
- **Ease of lead generation:** Based on customer likes and inclinations, chatbots intelligently recommend products that help increase lead generation (identifying and cultivating potential customers for products or services offerings.).
- **Enhanced customer engagement:** The ease of use of chatbots, prompt support, consistent replies, personalized experience, and most of the previously mentioned benefits allows the customer to seek more info and be ready to provide feedback. This enhanced customer engagement can benefit any organization in achieving the intended purpose of these chatbots.
- **Provides integrated support:** Chatbots pull answers from databases which could be product/service offerings, customer info, ticket status, and so on. The customer, thereby, gets one channel for all info that is sought.
- **Industry agnostic:** The chatbots can be deployed across industries as all it needs is the right set of data to pull info from.
- **Measurable performance:** The chatbots can be upgraded as the performance is measurable.
- **Contextual support to customers:** With access to databases, chatbots can provide customers with accurate answers and information as desired.

The following Figure 2.2 illustrates some benefits of Chatbots to users/customers:



*Figure 2.2: Benefits to the users*

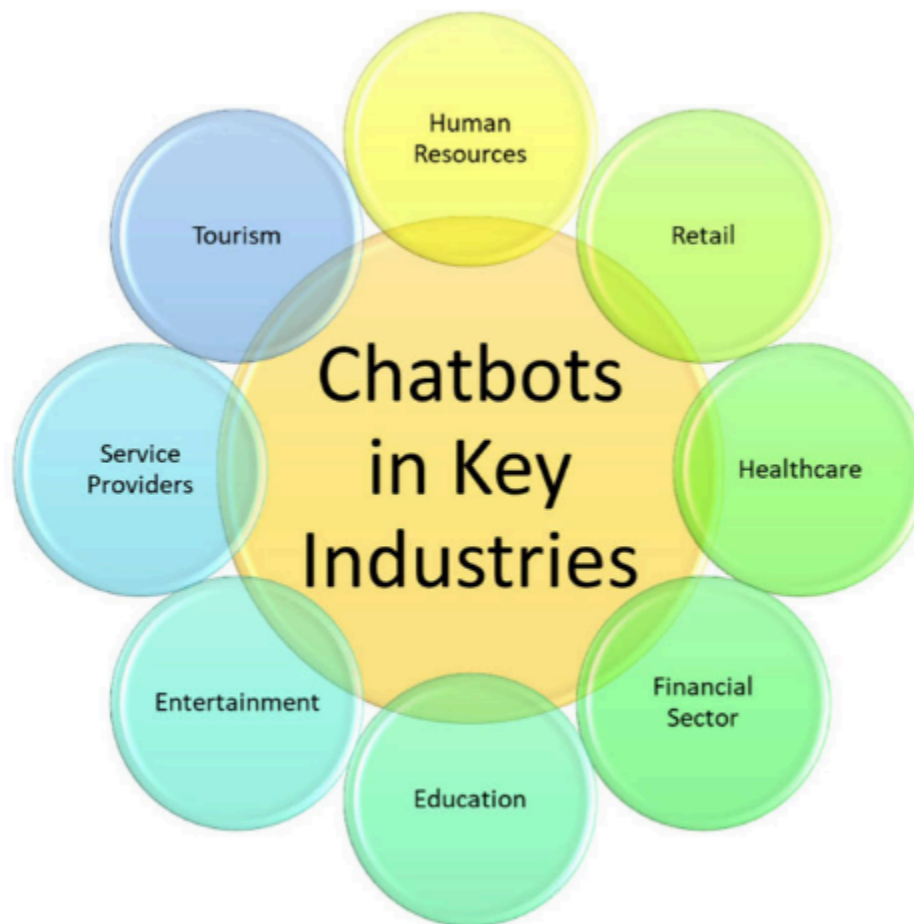
- **24x7 availability:** Ease of Access on digital devices from portals and apps that are always ON.
- **Multi-lingual support:** Current chatbots are designed to provide multi- lingual support, enhancing customer support by removing language barriers irrespective of the region the customer is based in.
- **Saves time:** With prompt and accurate responses and consistency in answers, customer time is saved considerably, and the customer is prompted to seek more info and provide valuable feedback.
- **Consistent answers:** Receiving consistency in replies to their queries on chatbots is an added benefit to the customer experience while using chatbots.
- **Personalized experience:** By pulling data from various sources and having access to the customer profile, chatbots are capable of providing a personalized experience to the users.
- **Prompt responses:** Getting immediate responses with next to no waiting period or being put on hold saves time for the users.

- **Integrated and contextual support:** Having access to data, chatbots can provide accurate and personalized answers to complex user queries.

## Chatbots in key industries

Chatbots can benefit various industries irrespective of the business. Chatbots can provide support in, but not limited to, marketing, sales, customer support, or IT service helpdesk. These can also be used for scheduling appointments, reviews, feedback, and much more. Let's have a look at a handful of key industries where chatbots can revolutionize user/customer experience and ease of doing business.

Figure 2.3 lists these industries:



*Figure 2.3: Chatbots in Industries*

- **Human resources:** Chatbots can help in the recruitment process right from searching for candidates and evaluating their skills as per the job description.

- **Retail:** Chatbots in retail or e-commerce can help answer customer queries, recommend products and services, place an order, make payments, and streamline overall sales and marketing processes.
- **Healthcare:** Chatbots can help in scheduling appointments, setting reminders, recommending health checkups, providing medical assistance, and more features based on underlying algorithms and design.
- **Financial sector:** Chatbots can assist in making financial transactions, reporting card losses in banking, opening accounts, answering customer queries related to product offerings and services, recommending desired loans, and so on.
- **Education:** Chatbots can help create a personalized learning environment for students. Students' responses can be analyzed to assist them further with new learning material or courses via chatbots.
- **Entertainment:** Chatbots can help share available movies, book tickets, recommend movies based on previous feedback on movies watched, and much more.
- **Service providers:** Service providers like direct-to-home (DTH) can use chatbots to help users navigate their portals, recommend new products, and help with billing and technical customer support.
- **Travel and tourism:** Chatbots play a major role in this sector. These can provide weather information, and law order situations and assist with bookings and packages being offered.

## Machine learning in AI-powered chatbots

AI powered chatbots use machine learning (supervised or deep or ANN) to be trained to provide human-agent-like responses to the users. These chatbots use Natural language processing (NLP), covered later in the chapter, to understand human language.

Chatbots based on these advanced technologies identify human conversation patterns and learn and remember data efficiently, compared to human agents.

Supervised training to test chatbot algorithm

These chatbots are trained using predefined responses, based on the responses and the learnings; thereby, these chatbots may learn rude responses that can hamper brands' reputations. For example, the chatbots may pick up racist, sexist, or abusive remarks.

This possibility of providing incorrect answers raises the need for human operators to rectify the mistakes. These may need to be upgraded for consistency in answers in the future. Human-in-the-loop (HITL) becomes necessary to regularly update and train the chatbot.

The role of human agents then becomes overlooking chatbots' conversations and answering the question that chatbots are unable to handle.

There is regular updating of the algorithms of this chatbot as well as training of these chatbots.

## **Generative chatbots – Deep learning**

Generative chatbots are based on deep learning. These advanced chatbots can answer complex queries of users.

Deep learning technology allows chatbots to understand users' questions with the help of neural networks, at times from famous movies and books. Such chatbots get smarter with every conversation and can imitate real people.

These chatbots can also act like voice bots by their ability to understand voice commands and recognize speech.

## **Artificial neural networks to replicate a human brain – Intelligent chatbot**

Intelligent chatbots based on Artificial neural networks can replicate human brains. It can easily learn the new intent of the customer and engage in meaningful conversations with the users/customers.

## **Natural Language Processing (NLP) – Natural conversation**

Natural language processing is one subset of Artificial Intelligence technology that enables computer programs to process or understand human language – both written and spoken in the same ways as humans do.

NLP combines computational linguistics (that is, analysis and synthesis of language and speech by applying computer science techniques) with statistical, machine learning, and deep learning models.

NLP can help computer programs translate text from one language to another.

As such NLP in Artificial Intelligence technology helps chatbots to converse like a human. Chatbots based on NLP can easily understand users' intent and their purchasing intent.

## **Natural language understanding (NLU) – Complex questions**

Chatbots process the input information as human text or speech through NLP and understand these human interactions through NLU.

NLU enables computer programs to communicate back to humans in their own languages. As such, after processing the human conversation through NLP, Natural language understanding is used to understand the structure of the conversation and converse with the customers. To interpret human texts for speech, NLU breaks complex sentences into simpler ones.

NLU uses algorithms to reduce human speech or text into a structured ontology -- a data model consisting of semantics and pragmatics definitions.

Recognition – both intent and entity – are two fundamental concepts of NLU.

Intent recognition is the first and most important part of NLU. This process is used to identify the user's sentiment in input text or speech and determine their objective. This helps establish the meaning of the input.

Entity recognition, as the name suggests, is a specific type of NLU that focuses on identifying the entities in the input. It then extracts important information about those entities. The entities are of two types: named and numeric. Named entities can be categorized such as people, companies, and locations. Numeric entities can be numbers, currencies, and percentages.

## **Voice assistants (Alexa, Siri, and others)**

Voice assistants or digital assistants or virtual assistants, or AI assistants are software programs that carry out tasks via voice commands as input. Voice assistants are based on AI and ML technologies that help recognize voice inputs, and convert voice to digital data efficiently for software to analyze and perform desired tasks in accordance.

## **Benefits**

Voice assistants are used to accomplishing everyday tasks. Say, for example, they can answer queries, integrate with smart homes to turn on and off lights and electrical appliances, and more. These voice-activated assistants come preinstalled on smartphones. Voice-activated speakers are becoming common platforms in homes and workplaces.



Having these assistants can be a great help to perform tasks on a mere voice command, as seen in the following scenarios:

- **Stay updated about current and trending:** At a voice command, get all kinds of information available on the Internet, as well as seek info about the weather, current affairs, news, traffic, and more.
- **Music:** Command voice assistants to play music matching certain moods or command a playing a particular song.
- **Devices' control:** Control electrical and electronic devices and other smart appliances by voice commands like “switch on the geyser”, “switch off lights”, and “set AC temperature”.
- **Banking assistance:** Voice assistants can help check balances, order banking products, and get transaction details for those banks that allow access to such services via AI assistance.
- **Organize the day:** Voice assistants can be used to set reminders for the day's schedule by accessing the calendar.
- **Support for differently abled or dependent folks:** Voice commands to operate devices, and voice search function support visually-impaired, elderly, and dependent persons in their routine reducing the dependency on human intervention.

## Pitfalls

Every technology has two sides. With the ease voice assistants bring to perform our routine tasks, they also do have a few downsides:

- **Privacy at stake:** With the machine learning methodologies at their backend, these voice assistants are continuously taking voice inputs and learning. Hence, they learn a lot more than desired.
- **Sharing personal data:** Voice commands for performing various tasks cannot be achieved without giving access to personal data to these voice assistants, which can be challenging in case these assistants are hacked into. In case smart homes are hacked into, imagine the damage it can cause with personal data being exposed.
- **Familiarity with lifestyle:** Voice assistants do learn the arrival timings, the day's schedule, and calls made along with bank details (if provided access). They also record habits like preferred room temperature, songs, usual moods, and much more. In some cases, it may also record food and shopping preferences.
- **Identity theft:** With all the personal data recorded, if any hacker is able to hack this voice assistance, it will be more like an identity theft than a mere financial or trespassing hit.

## Examples

Voice assistant systems can be found preinstalled on smart speakers, smartwatches, mobile phones, tablets, and other digital devices.

A few of the known names in households are:

- Alexa (Amazon)
- Siri (Apple)
- Google Assistant (Google)
- Bixby (Samsung)
- Cortana (Microsoft)

## Computer vision

As the name suggests, computer vision may be considered the ability of a computer to see. Computer vision is based on artificial intelligence (AI) technology and gives computer systems the ability to obtain meaningful data from visual inputs such as photos and videos.

Again, like other AI-based systems, the insights gained from computer vision are used to perform desirable automated actions.

Currently, deep learning techniques are commonly used for computer vision. Computer vision-based systems acquire, process, analyze (based on specified criteria), and render visual information thereafter in various formats such as 3D models, images, videos, or related volumetric data.

## Weather predictions

Climate change is increasing the intensity and frequency of extreme weather events that are being recorded across the globe.

Older weather forecasting systems relied on supercomputers needed to process large amounts of data gathered from across the globe such as temperature, pressure, humidity, and wind speed.

This came with the need to create a computationally efficient model, capable of accurately predicting upcoming weather. Scientists called such a system **Deep Learning Weather Prediction (DLWP)**. The DLWP is based on an AI algorithm. The system learns and recognizes patterns in historical weather data based on global grids.

AI-Powered weather forecasting systems can help identify accurately potential extreme weather 2–6 weeks into the future or in months. Extreme weather prediction is made accurately and well in advance, giving communities and critical sectors such as public health, water management, energy, and agriculture to mitigate potential disasters.

## Price forecast for commodities

Commodities play a crucial role in the global economy and are one of the major motivators of inflation and economic activities. A significant percentage of the market is composed of just the oil industry and natural gas industries. Other significant contributors include metal, mineral, and agricultural commodities.

Price forecast for commodities refers to the process of making forecasts against products' prices based on previous and present data or trends analysis.

AI-based systems can help mitigate risks of investment and returns thereby. These systems can be fed with data pertaining to historical price trends, factors that drive the prices, volatility in price variation, and the impact of various seasons. AI-based price forecasting systems thus eliminate human emotions and gut feelings in their predictions.

Based on the commodity or service, price prediction AI-powered systems use algorithms to analyze it based on the characteristics, demand, and market trends. The system then sets a price it predicts that attracts customers and maximizes sales.

## Self-driving cars

One of the characteristics of AI-based autonomous systems is that they function on their own while adapting and responding to dynamic environments and changing situations.

A common application of autonomous computer systems is in the transportation industry, especially, consumer vehicles that use automated and assistive technology but are not fully autonomous in nature as of date. Where autonomous is defined as “having the freedom to govern itself or control its own actions”

A self-driving car, also known as a driverless car, or robotic car incorporates vehicular automation AI-powered systems. In a sense, a self-driving car is capable of sensing its environment and moves safely with little or no human intervention.

The surroundings are perceived using a set of sensors like:

- **Thermographic cameras:** A thermographic camera is a device that creates an image using **infrared (IR)** radiation

- **Radar:** Radar sensors transform microwave echo signals into electrical signals. They detect motion by perceiving an object's position, shape, motion characteristics, and motion trajectory using wireless sensing technology.
- **LiDAR: Light Detection and Ranging (LiDAR)** sensors in autonomous vehicles provide a high-resolution 3D view of the surroundings.
- **Sonar:** Sonar or an ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves. The reflected sound is then converted into an electrical signal.
- **GPS:** Global positioning system sensors use a satellite-based navigation system in orbit around the earth to provide position, velocity, and timing information.
- **Odometry:** Odometry is the use of data from motion sensors to estimate the change in position over time, relative to an earlier known position.
- **Inertial sensors:** An inertial sensor is used to gather the acceleration and angular velocity of an object.

The environment for a self-driving car includes obstacles, paths, relevant traffic signals, signages, speed limits, traffic diversion, other vehicles, distance from moving objects, and much more.

Artificial intelligence-powered control systems are deployed in these robot-cars that learn all the gathered sensory information in order to control the vehicle and support various autonomous-driving tasks and operations.

As a key future technology, AI-powered self-driving cars are predicted to have a comprehensive impact on various industries including, but not limited to, automobile, health, welfare, urban planning, traffic, insurance, services, and much more.

**Connected, Autonomous, Shared, and Electric (CASE)** Mobility is a future mobility vision based on self-driving cars combined with other emerging automotive technologies such as electric vehicles, connected vehicles, and shared mobility.

**SAE** International, formerly named the **Society of Automotive Engineers**, is a United States-based, globally active professional association and standards-developing organization for engineering professionals in various industries (as per Wikipedia).

SAE International has developed a framework that categorizes different levels of autonomy in vehicles. The levels in the framework are not fixed, for instance, some break their hierarchy into five layers and some into six. The distinctions between various levels are also not firm and some algorithms may exhibit behavior from two or three levels at the same time.

These levels can be described as:

- **Level 0:** No automation; the human does all operations except some automatic systems like windshield wipers or heating.
- **Level 1:** Hands-on/shared control; some operations like braking or lane following are delegated to the car.
- **Level 2:** Hands off; The car does all major operations like braking, acceleration, or lane following; however, the human must remain alert to take control at all times, maybe by also having to have hands on the steering wheel all the time.
- **Level 3:** Eyes off; The human may not remain alert all the time and may occasionally turn attention away from the road for a short amount of time, however, must be ready to respond to an alarm in case needed. The car is in self-control over mapped routes but not on paths that are new and not mapped in advance.
- **Level 4:** Mind off, this level may require humans to take control in cases where the paths aren't well understood by the AI.
- **Level 5:** Steering wheel optional. This level is more like a cab service that humans need not control.

Well-known automobile companies that have implemented predictive analytics in their autonomous vehicles are:

- Tesla
- Ford
- Volkswagen

## Characteristics and types of AI

AI is a technology that enables systems to develop cognitive skills and think and behave like humans. The main components of AI are:

- **Feature engineering:** This primarily means the feature extraction process of identifying a nominal set of attributes from given data sets.
- **Artificial Neural Networks**
- **Deep Learning**

Other characteristics that utilize the maximum efficiency of this technology are:

- **Natural Language Processing**
- **Intelligent Robotics:** Robotics is the amalgamation of engineering, science, and technology that produces programmable machines known as robots that can

mimic human actions or assist humans. AI powered robots are systems that can learn and adapt to perform independently without human intervention.

- **Perception:** Take inputs from sensors and process the collected data to give the desired output. Applications based on these processes are facial recognition, computer vision, and much more.
- **Automate Simple and Repetitive tasks:** As the heading suggests, this is for performing monotonous and repetitive tasks that may involve large data sets as input or voice assistant systems performing daily routine tasks.
- **Data Ingestion:** The process of saving unstructured data extracted from various sources to a huge database medium for accessing, analyzing, and preparing AI models.
- **Imitation of Human Cognition:** An example of such capabilities is Chatbots that can imitate human-like conversations by intent and entity recognition.
- **Quantum computing:** AI has helped by solving complex quantum physics. Quantum computing focuses on developing complex algorithms of quantum for revolutionizing and advancing computational tasks.
- **Cloud computing:** Introducing AI capabilities in cloud computing can assist organizations in addressing the never-ending growing data ingested in their data centers and systems.
- **Ethical gene editing:** AI has the potential to contribute successfully in the medical field, especially in the treatment of common complex diseases or disorders caused by gene mutations.
- **Intelligent disaster response:** With advancements in technology, Modern rescue systems utilize sensor-based systems, unmanned aerial vehicles, or AI-powered robots to collect accurate information about the location of victims or extent of damage, or a forecast of upcoming disasters.

## Data-driven

Consumer-centric businesses are usually driven by data-capturing customer profiles, likes, dislikes, purchasing power, frequency of purchases, and unending lists that can help improve offerings and revenue growth.

Next-generation data-driven AI is a game changer for such businesses.

Let us analyze the most common of the customer-centric businesses we come across on a day-to-day basis.

- **Groceries:** Forecast customer needs and ensure product availability based on location and purchasing preferences.

- **Restaurant:** Analyze customer footfall and stock up on resources accordingly. Also, analyze preferred dishes during the time of the year minimizing wastage and achieving customer satisfaction too.
- **Hotel:** Analyze footfall in various seasons and plan the resources accordingly. The data can also help offer optimal pricing and offer relevant packages to maintain business throughout the year.
- **Retail:** Analyze discounts to be offered in various seasons that cause a positive impact on sales. Ensure the demand and supply are well balanced and also identify cross-selling opportunities.
- **E-commerce:** Analyze procurement trends like items bought together and build pricing models. Forecast product sales depending on its pricing and features and targeted customers based on similar products.

## Autonomous systems

Current AI-powered systems are automated but not entirely autonomous. Autonomous artificial intelligence systems will be a reality when robots, cars, planes, and other devices are able to execute extended sequences of operations without guidance and intervention from humans.

To achieve and build autonomous systems, researchers are continually refining their algorithms and also their approach. To have a better understanding, the entire job is divided into layers as mentioned follows:

- **Sensing:** Incorporate sensors that collect all possible data that can impact the outcome. We had seen the sensors used in self-driving cars earlier in the chapter.
- **Fusion:** The collected data must be holistically analyzed to get a complete view of the ecosystem so as to build a model that enables the system to take the most accurate or human-like decisions independently.
- **Perception:** After the model is constructed, the system must be able to identify and perceive the ecosystem completely.
- **Planning:** Having perceived the environment, the next expected step is to plan the best possible action to be taken.
- **Control:** The action must be executed in a controlled manner and independently

## Recommender systems

As the name suggests, a recommender system or a recommendation system provides suggestions or / recommends items most relevant or applicable to a particular user.

The suggested items could refer to products, services or even music to be played, or news to be heard. These systems are best used when the list available to choose from is huge and overwhelming. Recommender systems help in decision-making processes.

## Human-like

Scientists and engineers continue to push the boundaries of what can be achieved with AI. But we are short of the machines that we witness in sci-fi movies. Current systems do not understand how the world works.

AI research scientists are still figuring out how to make the paradigm shift from data-driven to more intuitive human-like thinking systems displaying cognitive skills.

However, these machines will be learning from watching humans achieve human-like capabilities.

**Things to ponder:** We have subtle gender bias displayed by humans in almost all walks of life and even at-home setups. Will the AI-powered human systems pick up the same learning and behavior? These are abstract behavioral aspects that cannot be programmed as right or wrong via data sets.

## Cognitive computing

Cognitive computing is an attempt to have computers imitate the working of a human brain.

Cognitive computing refers to the use of artificial intelligence and underlying technologies like language processing, and machine learning to the top with human capabilities that help regular computing better solve problems and analyze data to tackle complex decision-making processes.

The characteristics of cognitive computing are:

- **Perception:** Five senses: sight, taste, smell, sound, and touch contribute towards forming a human perception. Perceptions are a cognitive process as we often consciously and unconsciously process information gained through our senses, forming thoughts, and opinions and giving emotional reactions.
- **Learning:** Learning can be achieved through many cognitive processes, such as memory, thought, and perception. To learn quickly and retain information, multiple processes need to be combined. For example, reading, writing, listening, verbal communication, and thinking can help learn things faster.



- **Reasoning:** It is the ability to analyze and perceive any given information from various perspectives by breaking it down and structuring it in a logical order.

## Deep-dive into NLP, CV, and much more

Computer machines understand bits, which could take a value of zero or one. **Natural Language Processing (NLP)** comes in handy as a processing tool for computers to understand input words, languages, and sentences. NLP includes various language preprocessing techniques. These include the following techniques:

- **Tokenization:** Involves breaking down sentences into smaller units, that is, words.
- **Stemming:** Involves extracting the core context from words by cutting the suffixes of words. For example, worries → worri.
- **Lemmatization:** Similar to stemming but involves reducing the word to its root. For example, worries → worry.
- **Bag of Words:** Involves representing the significant words in the collection in the form of vectors.
- **TF-IDF:** This is similar to a bag of words and adds higher weightage to significant words and vice versa.

The output of the above techniques is prepared data which is then passed on to complex models to generate meaningful outputs such as sentiment analysis, word prediction or fully conversing chatbots.

While NLP deals with textual data, **Computer Vision (CV)** involves processing images by computer and extracting useful information or performing meaningful tasks on those images.

A computer views images as pixels and channels (red, green, blue). The combinations of these channels form the basis of Computer Vision. Few of the Computer Vision techniques as mentioned as follows:

- **Edge detection:** Detecting objects' edges in the image.
- **Color segmentation:** create a mask for the image by grouping similar pixels together.
- **Noise filtering:** This involves making the image clearer by removing unwanted entities.
- **Adding filters:** This involves changing colors, cropping and adding blurs, to the image, and more.

Examples of real-world applications based on NLP and CV are as follows:

- Siri, Alexa, and other voice assistants use NLP
- Google search by voice is based on NLP
- Real time filters in Snapchat are based on CV

## AI and society

Our society can be categorized into people who use AI and are aware, who use AI and are not aware, people who are impacted by AI as part of a community or group, and people who are not impacted by AI systems. These four categories can be disjoint sets or have a common data set.

Let us have a look at a few of the AI applications that are top AI trends

across the world:

### Computer vision

We are using AI-powered computer vision (capturing and interpreting information from images and video data) while unlocking smartphones. Here by applying ML models, analyze various features of the face, such as the placement of eyes and nose, images, and combine them all into a unique code to match against the face stored. Chances of a random person unlocking are as rare as one in a million.

### Autonomous vehicle industry

Self-driving vehicles are going to be the future. With their inbuilt AI-powered technologies and the right set of hardware, these would reduce the fatality rates over time as compared to human-driven vehicles.

Tesla, an American multinational automotive company, designs and develops electric vehicles. Based on advanced AI for vision and planning, Tesla plans to achieve full self-driving cars and beyond. Their current autopilot feature requires active supervision by a human. That means their vehicles are not yet autonomous.

Refer to their page <https://www.tesla.com/autopilot>.

Other automotive companies engaged in developing autonomous vehicles

are:

- Flux Auto (<https://fluxauto.xyz/>) - Self-driving trucks.
- Minus Zero (<https://minuszero.in>) – India's first self-driving vehicles prototypes.

- Ati Motors (<https://atimotors.com/>) – automate trolley and bin movements.
- Swaayatt Motors (<http://www.swaayatt-robots.com/>) - developing level-5 autonomous driving technology.
- AutoNxt Automation Pvt Ltd (<https://www.autonxt.in/>) – Electric Autonomous tractors.

## Chatbots and virtual assistants

Chatbots have proved to be a success as virtual assistants. Let us consider

examples:

- Indigo airlines chatbot (<https://www.goindigo.in/support.html>). Their chat assistant, called Dottie, is a conversational AI-powered assistant. It kind of replaces customer care for help regarding commonly asked questions such as travel protocols, flight cancellations, check-ins, and so on.
- Valyant AI (<https://valyant.ai/>): conversational AI platform for the **Quick Serve Restaurant (QSR)** industry.

## Language modeling

**Language Modeling (LM)** is a fundamental task in natural language processing. Language modeling in NLP can be based on statistical models or neural language models.

Top Language Models examples are:

- **Speech recognition:** Voice assistants such as Siri, Alexa, Google Homes, and more.
- **Machine Translation:** Google Translator and Microsoft Translate are machines translating linguistics units into various languages.
- **Parsing tools:** That enable spell check and apply grammar rules and syntax.
- **Information retrieval:** Google search engine is used for searching information.

Other areas where AI-powered applications are very common are:

- **Online shopping:** personalized recommendations provided to users based on certain parameters. Examples of companies providing AI technology for online shopping customer experience are:
- Scalefast (<https://www.scalefast.com/>)
- Trendalytics (<https://www.trendalytics.co/>)
- Zeta Global (<https://zetaglobal.com/>)

- Clairfai (<https://www.clarifai.com/solutions/ai-in-ecommerce>)

**Cybersecurity:** AI systems can help fight cyberattacks based on pattern recognition and backtracking attacks. A few AI-driven cybersecurity companies are:

- CrowdStrike (<https://www.crowdstrike.com/>)
- Darktrace (<https://darktrace.com/>)
- Blue Hexagon (<https://bluehexagon.ai/>)
- Cybereason (<https://www.cybereason.com/>)
- SparkCognition (<https://www.sparkcognition.com/>)
- Tessian (<https://www.tessian.com/>)

**Pandemic support:** In the case of Covid-19, AI is being used in identifying outbreaks and categorizing containment zones, tracking the spread of the disease, and also in processing claims.

- Researchers from DarwinAI and VIP Lab (University of Waterloo) have collaborated to develop COVID-Net - a convolutional neural network that detects COVID-19 using chest radiography. Refer to (<https://darwinai.com/case-studies/covid-net-an-open-source-convolutional-neural-network-for-covid-19-detection-via-chest-radiography/>)

**Healthcare:** AI in healthcare is used in multiple operations:

- **Administration:** managing day-to-day administrative tasks, thereby minimizing human errors and maximizing efficiency.
- **Telemedicine:** in non-emergency situations, patients can reach out to a hospital's AI system to analyze if there is a need for medical attention.
- **Assisted diagnosis:** AI-powered computer vision and convolutional neural networks make it possible to read MRI scans and so on at an exponentially faster pace with a considerably lower margin of error.
- Additionally, it has made its value in Robot-assisted surgery.

**Other industries** where AI is in use are e-commerce, human resources, customer service, and packaging.

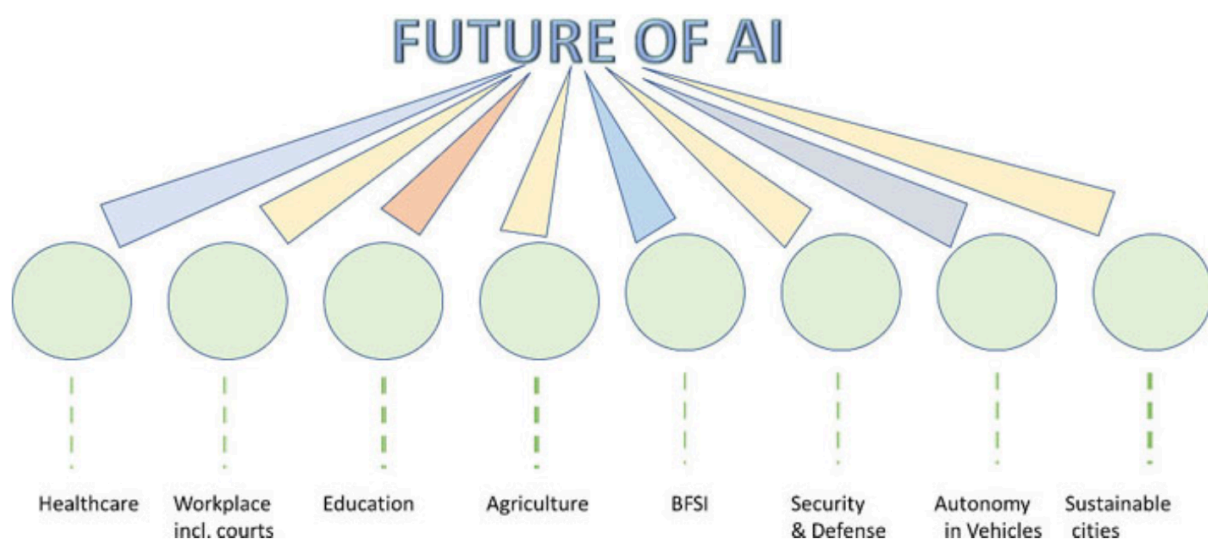
## The future with AI and AI in action

Nations across the globe are focusing on investing in AI research centers. Presenting the budget on 1st Feb 2023, India's Finance Minister, Nirmala

Sitharaman announced that the central government would create three centers of excellence to boost Artificial Intelligence (AI) in India. The centers are planned to be established in top Indian institutions to ensure the realization of the vision of 'Make AI in India' and 'Make AI work for India.'

"Leading industry players will partner in conducting interdisciplinary research and develop cutting-edge applications and scalable problem solutions in the areas of Agriculture, Health, and sustainable cities," Sitharaman said in her budget speech.

Figure 2.4 describes a few of the industries that are expected to witness advanced adoption of AI that will directly impact humans across the globe:



**Figure 2.4:** AI across all major industries directly impacting humans across the globe

While the future with AI is expected to witness major developments across various industries across the globe, leading to increased efficiency and productivity in various sectors, its deployment raises concerns about job displacement and the need for reskilling of humans. There is also grave risk and potential for AI to be used for malicious purposes. It is essential to responsibly develop and govern AI to ensure its positive impact on society.

According to some experts, AI is predicted to eventually surpass human intelligence. The active contribution of AI in social settings and the quality of human lives will lead to debates around ethics and ideologies about the future of humanity.

Quantum computing is a multidisciplinary field that focuses on building quantum algorithms. These focus on improving computational tasks within AI along with related

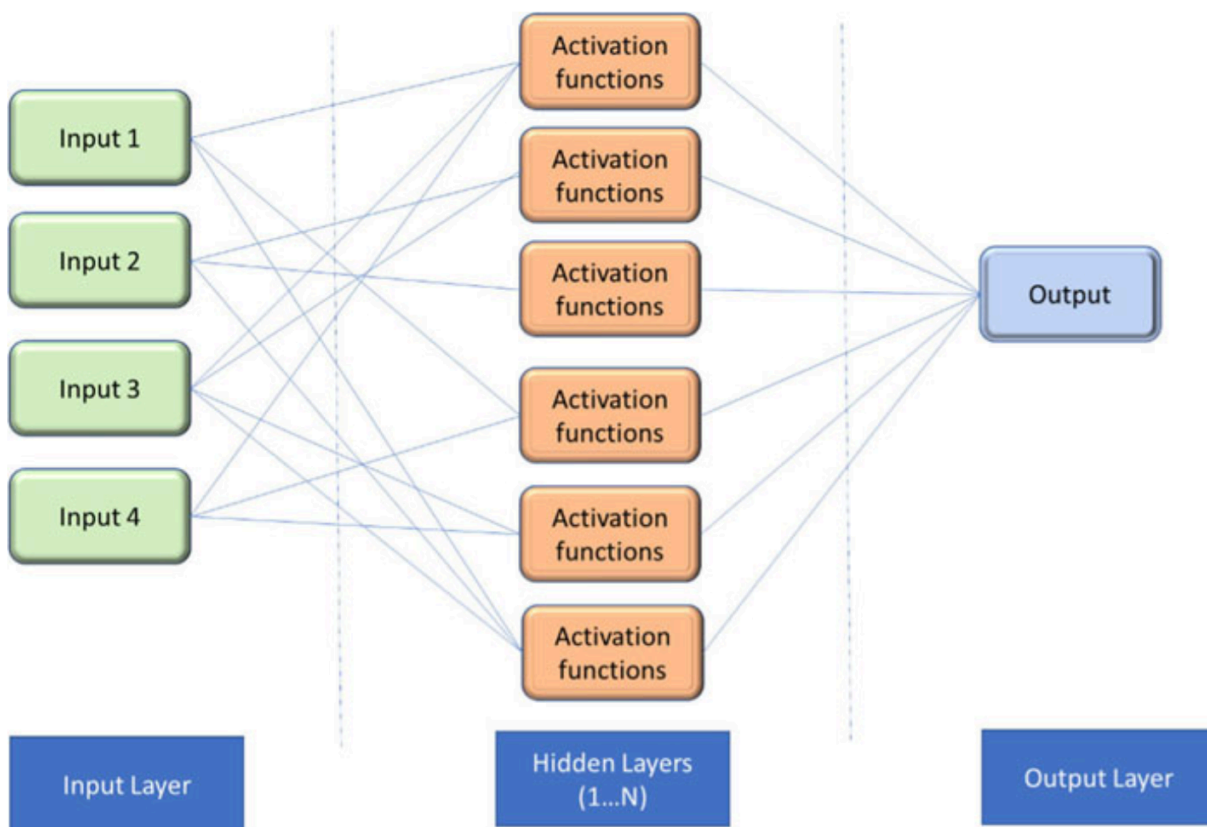
fields like machine learning. As of now, the concept of quantum-enhanced AI algorithms remains in the abstract research realm.

Advancements in the technology of autonomy will create new opportunities in medicine, scientific research, and space exploration.

One thing is for sure, human lives will not be the same with each milestone achieved in AI from both technology benefits and associated risks.

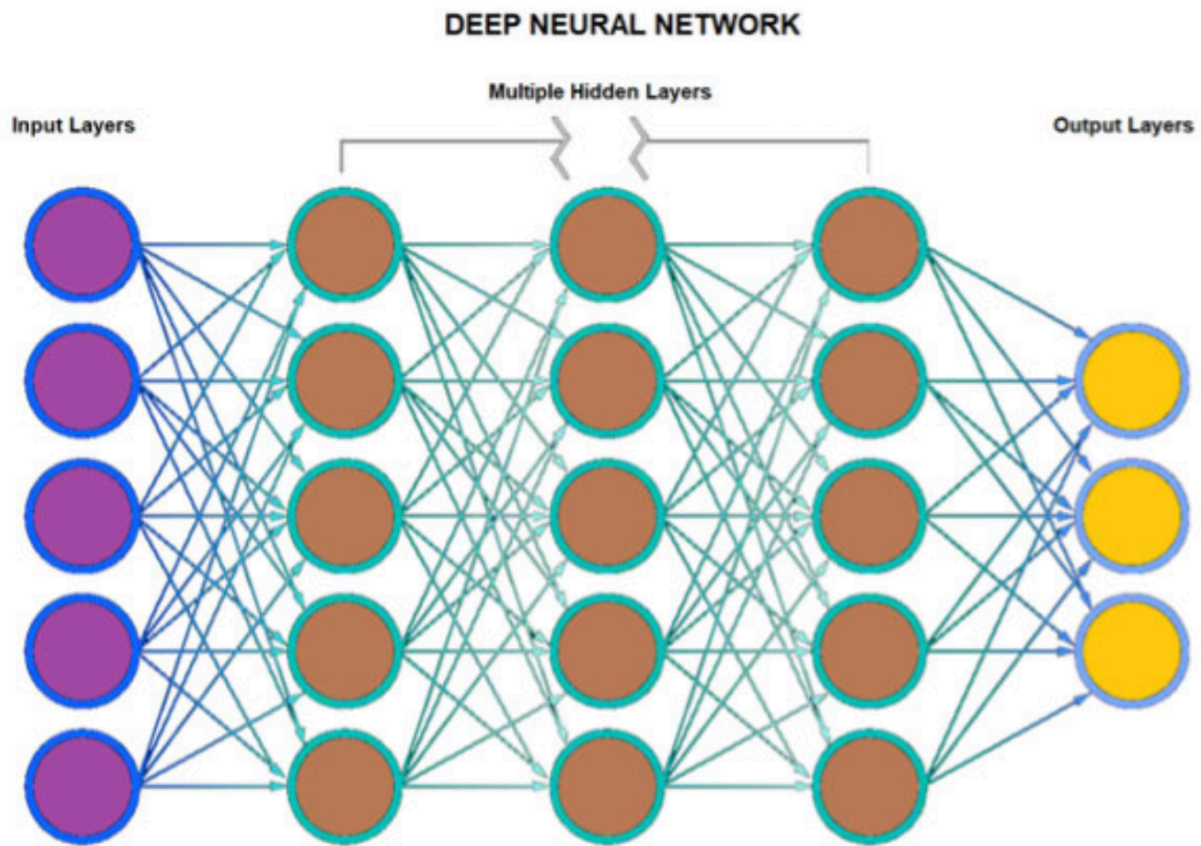
## Non-technical explanation of deep learning

Let us start with neural networks and their relation to deep learning. Figure 2.5 describes a neural network when the number of hidden layers is 1:



**Figure 2.5:** Neural network when the count of the hidden layer is equal to 1

The “deep” in deep learning refers to the depth of or multiple hidden layers in a neural network. A deep learning algorithm is, therefore, a neural network that consists of more than three layers, inclusive of the inputs and the output layers. Figure 2.6 describes a typical deep learning system or a deep neural network:



**Figure 2.6:** Deep neural network when the count of the hidden layer is greater than 1

Deep neural networks flow in one direction only from input to output. However, they can also train your model through backpropagation, that is, move in opposite directions from output to input. Backpropagation allows us to calculate and attribute the error associated with each neuron, allowing us to adjust and fit the algorithm appropriately.

## Commonly used deep learning algorithm explained

Let us also understand **Recurrent Neural Network (RNN)**, which is the underlying methodology for applications such as:

- Language modeling and generating text Speech recognition
- Machine translation
- Image recognition, face detection
- Time series forecasting



In a traditional neural network (which we learned in Chapter 1, Introduction to AI), inputs and outputs are independent of each other. Whereas RNN is a type of neural network where the output from the previous step is taken in as input to the current step, that is, output at a specific stage is dependent on output from its previous stage.

In the case of a sentence, a word is predicted based on previous words to give a particular meaning to the sentence. As such, there is a need to remember previous words.

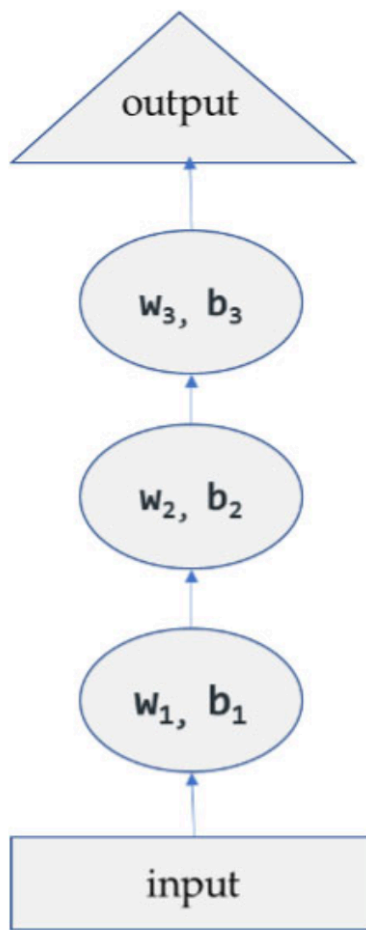
RNN solves such issues with a hidden layer that remembers the information about a sequence. It has a memory that remembers the past sequence. Since the same parameters are applied to each input, the complexity is reduced, unlike in neural networks.

Let us understand how these RNNs work. For this, we first understand the flow of a deep neural network. In our example, we assume one input, three hidden, and one output layer for a deep neural network, with each hidden layer having its own weights and biases represented as  $(w_l, b_l)$ , where 'l' takes values 1, 2, and 3 for respective layers.

These layers are totally independent of each other; that is, they do not learn or memorize the previous outputs.

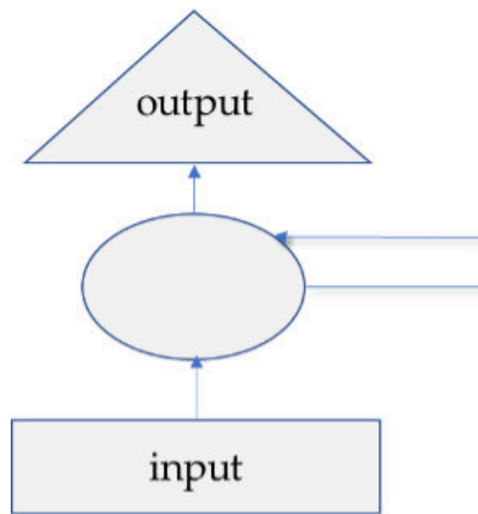
Figure 2.7 shows such a deep neural network:





**Figure 2.7:** Example of Deep Neural Network

While in RNN, all layers have the same weight and biases, thereby reducing the complexity of parameters. All these layers are then joined together in a single recurrent layer. This converts independent activations into dependent activations and memorizes each previous output by providing each output as input to the next hidden layer. Figure 2.8 displays this for the recurrent neural network:



**Figure 2.8:** Example of Recurrent Neural Network

The formula for calculating the current state is:

$$h_l = f(h_{l-1}, x_l)$$

Where,

$h_l$  is the current state

$h_{l-1}$  is the previous state

$x_l$  is the input state

The formula for applying the activation function (tanh) is:

$$h_l = \tanh(w_{hh}h_{l-1}, w_{xh}x_l)$$

where,

$w_{hh}$  is the recurrent neuron

$w_{xh}$  is the input neuron

The formula for calculating output is:

$$y_l = w_{hy}h_l$$

where,

$y_l$  is output

$w_{hy}$  is the weight of the output layer.

### **Advantages of Recurrent Neural Network**

- It is useful in time series prediction because of its feature of memorizing previous output.
- RNNs are even used with convolutional layers (the main building block of a convolutional neural network that analyzes visual imagery) to extend the effective pixel neighborhood.

## **Conclusion**

AI is already being adopted by various industries and is available for access to all in some form or the other. The future will see far deeper adoption of AI with its own challenges and risks like any other technology poses. Hence factors like ethics and governance become priorities while achieving advancements in areas of AI.

In the next chapter, we will learn the application of mathematics in AI. We will also revisit the basics of linear algebra, statistics, and data visualization in terms of graphs and representation in mathematical formulas.

