

Class VII



My Dream Book of
ARTIFICIAL
INTELLIGENCE

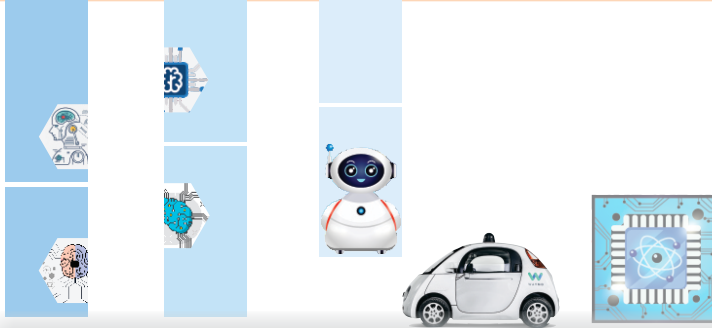
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A WORD TO THE LEARNERS AND THE MENTORS

MACHINES ARE COMING! They aren't dumb anymore! Machines are processing language, identifying pictures, recognising faces, voices and patterns, sensing trends, controlling vehicles, making forecasts using enormous data produced in past decades and still continued as you read this.

Our children are growing up with smart devices loaded with intelligence and intuitive interactions. When they grow up, the world would be unimaginably different. How? In terms of career opportunities, smart public services, smart homes, schools and hospitals and a daily life inhabited by smart machine-citizens.

This is the time to prepare them for the rapidly changing future.

This book – **My Dream Book of Artificial Intelligence**, is a primary effort in this direction. As CBSE has already announced about its endeavours in integrating AI with every subject and exposure to children about artificial intelligence in a fun oriented way, this book fulfils that very requirement.

HOW THIS BOOK IS ORGANISED?

Considering the very young age of the learners, this book brings fun to the learning desk. Children will explore AI concepts through the following:

- Fun activities to explore concepts.
- Games and challenges to understand the techniques.
- Mini projects (assignments and online exploration) to reinforce their learning.
- Exposure to computer programming logic development through Python Turtle library.
- Key Learning is a set of keywords used in the chapter.
- Learning Point to summarize the chapter.

GAME DEVELOPMENT

The book encourages kids to design and develop a game to inculcate in them the strong traits of problem solving, critical thinking, team dynamics and communication skills.

We strongly believe that our sincere efforts in bringing this book to you will surely help learners explore AI concepts in the most interesting ways and at the same time, teachers will enjoy conducting this course.

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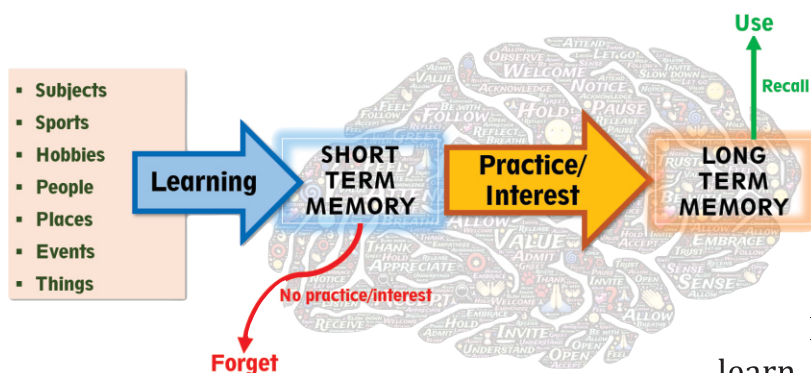
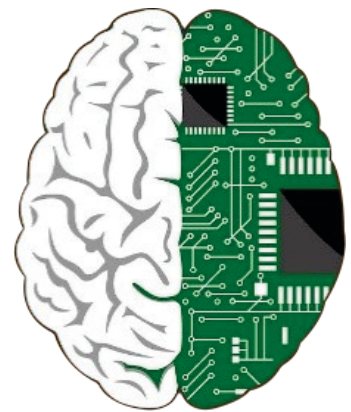
Understanding Intelligence

Dear children,

We have learnt that *computers cannot learn*. Computers cannot have the kind of memory that remembers!

Computers can store data but they do not have their own intelligence to use it. To use that data, they need instructions from humans. Computers cannot decide and handle a situation on their own.

Whatever we humans learn, first goes in our short-term memory just like primary memory of the computer. By constant practice and repeating, this learning shifts from short-term memory to our long-term memory. In long-term memory, the learning remains for pretty long time, even for lifelong. For example, basic Math, knowledge of other subjects, things we use, people around us, sports and games we play, the books we read, the movies we watch and the songs and jokes we listen to. We remember all this because with constant exposure and practice, we retain it in our long-term memory.



Sometimes, certain unfortunate events like accidents and shocks occur in many people's lives. Their experience directly embeds in our long-term memory deep for almost lifelong. For example, the electric shock or touch of a hot object.

Remember? That first shock made us learn that hot objects need to be handled carefully. So, shocking experiences – good or bad –

influence the depths of our brain without going through short-term memory and stay there permanently.

Besides practice and exposure, there is *interest*. Our interest determines how much we shall learn and remember about anything. That is why we all have favourite subjects and favourite things we like to do. Interest determines our likes and dislikes for learning about the things in the world.



It is the learning that has brought us from the stone age to the modern information age. And, today, we have modern technology, sophisticated machines, advanced software and several individuals of great intellect.

Today, we want our machines, our computers to learn and exhibit intelligence – **Artificial Intelligence!**

Exploring Intelligence

Brain is far superior than a computer. Computers are faster but they are not as smart as the brain is.

Let us try to decode the term *intelligence*.

Many a times we hear that such and such person is very intelligent. Scientists are intelligent. Astronauts are intelligent. Dog and horse are most intelligent animals. Parrot and Cockatoos are among most intelligent birds.

Ants, Bees and Termites are intelligent insects.

You must have noticed that while you are good at one thing, your friends are good in other things. One likes mathematics and the other likes to compose poetries. One of your friends is a good dancer while another has a nice voice.

Some other people play musical instruments and some are very good at making friends. You agree? People possess multiple skills, talents and abilities.

Can you name five of your friends who are good at different things?

Let us see how our intelligence works.

FRIEND

EXCELLENCE



Download the activity sheets from eduitspl.com – Teacher's Corner and let the students complete the challenges given in them.



So, you sure have enjoyed these teasers.

But what was the purpose of having you go through these activities?

To help you discover the facts that:

Intelligence comes from learning

Intelligence is used to draw conclusions and solve problems

To solve different types of problems, different types of intelligence are needed

Different Types of Intelligence

Can you confidently tell who is intelligent and who isn't? Do you think dogs and parrots are intelligent? If yes, how? Ants are not good at math but they sure are great engineers! We all have a combination of various types of intelligence, if not all. Let us have a look at them.

Verbal Intelligence

Such people love words. They love reading, writing and making speeches. They like to argue, debate and discuss things. They have good vocabulary and they compose poems, write essays, participate in spellathons. They make great writers, poets, scriptwriters, lyricists and orators.



Logical Intelligence

Such people love numbers. They like solving math problems and analysing numbers and data values. They make good computer programmers and strategy game players such as Chess and Go. They believe in deriving the conclusions from the given facts.

Spatial Intelligence

Such people love visuals. They perceive and think about things in graphics. They have strong visualisation power. They are creative in designing things. They are good at reading maps, drawing pictures and depicting concepts in graphical forms such as charts and diagrams. They make good graphics designers, animators and film makers.



Kinaesthetic Intelligence

These people love activity, movement and touch. They are dynamic in spirit. They like to do the things and experience first-hand. They would like to visit the place instead of learning about it in the books. They are outgoing and like to meet people. They make good sportspersons, soldiers, dancers, stage performers, mountaineers, travellers, builders, engineers, sculptors, carpenters and makers.

Musical Intelligence

They are feelers and thinkers. They like to perceive through listening. They look for harmony and balance in everything. They have a special knack to understand music and master it. They make good composers and singers, meditators, nature-healers and counsellors since they are good listeners.



Interpersonal Intelligence

These people love to meet other people, connect with them, develop contacts and have a good social circle. They possess strong communication skills irrespective of language. They have many friends and they are popular among the masses. Such people make businessmen, teachers, sales persons, counsellors, lawyers, public figures, political leaders and influencers.



Intrapersonal Intelligence

These people are often labelled as introverts or shy. They feel, think and ponder. They do not haste. They take their time to reach at conclusions. They are deeply aware of their needs and wants. They love to do things alone and stay away from the crowd. They are reluctant in sharing their ideas openly with others. Such people make great thinkers, spiritual personalities and writers, painters, seekers and mentors.



Naturalistic Intelligence

These people are empathetic, feelers and kind in nature. People find them sweet and forgiving. Such people are closely interested in nature and its phenomena. They have a special knack to identify characteristics of living beings, plants and other natural elements such as rocks, soil etc. They are highly sensitive towards the threats to the nature. They are concerned about the ill practices that destroy

natural bodies such as water, forests, animals and natural beauty. They make farmers, social workers, philanthropists, nature activists, geologists, environmental scientists, green fighters, marine or wildlife researchers and forest officers.

Now that you have better understanding of various types of intelligence and learning styles can you rethink on the challenges you did earlier as to which type of intelligence helped you in solving them.

Which types of intelligence helped in solution?

Challenge 1



Challenge 2

Challenge 3

Challenge 4

Challenge 5

Challenge 6

Challenge 7

Challenge 8

Intelligence testing is a complex process and involves different types of assessments carried out by experts. However, to assess yourself as to which mix of intelligence type you possess, you can use this online assessment.

<https://www.literacynet.org/mi/assessment/findyourstrengths.html>

Learning Points



- Intelligence comes from learning.
- Intelligence helps us draw conclusions and solve problems.
- Intelligence is of different types.







- Verbal:** Related to reading, writing and speech.
- Logical:** Related to reasoning.
- Spatial:** Related to visuals.
- Kinaesthetic:** Related to movement and touch.
- Interpersonal:** Among the people.
- Intrapersonal:** Within one-self.
- Naturalistic:** Having inclination towards nature and environment.

Exercise



A. Select the correct answer.

- The process of learning enhances our _____.
a. Knowledge b. Intelligence
c. Both a) and b) d. None of these
- Our intelligence helps in which of the following?
a. Draw conclusions from the facts b. Solve problems
c. Learn more d. All of these
- To solve different types of problems, different types of _____ are needed.
a. People b. Plans
c. Places d. Intelligence
- People with which type of intelligence make great writers and poets?
a. Verbal b. Logical
c. Musical d. Kinaesthetic

5. People possessing which of the following type of intelligence are considered introverts?
- | | | | |
|------------------|-----------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| a. Interpersonal |  | b. Kinaesthetic |  |
| c. Intrapersonal |  | d. Verbal |  |

B. Match the column A with column B.

- | A | B |
|-------------------------------|----------------------------------------------------------|
| 1. Verbal intelligence | a. Good at reading maps, designing things, animators. |
| 2. Logical intelligence | b. Love reading, writing, compose poetries, orators. |
| 3. Spatial intelligence | c. Composers, singers, good listeners. |
| 4. Musical intelligence | d. Mostly quiet, spiritual thinkers, painters. |
| 5. Kinaesthetic intelligence | e. Empathetic, feelers, philanthropists. |
| 6. Interpersonal intelligence | f. Have good social circle, strong communication skills. |
| 7. Naturalistic intelligence | g. Outgoing, dynamic, like to explore things themselves. |
| 8. Intrapersonal intelligence | h. Drive conclusions from facts, good at analysis. |

C. Mark the following statements as True or False.

1. Some people are intelligent while some are utter fools.
2. Computers only know English language.
3. Computers are faster but not smarter than human brain.
4. Everyone is intelligent in different ways.
5. People can have multiple intelligences.

D. Answer the following questions.

1. What do you mean by learning?
2. How can you say that all the people are intelligent in different ways?
3. Where does intelligence come from? How does it help us?
4. List various types of intelligence.
5. Write one major trait of any five types of intelligence.



Mini Project...

Prepare a set of 10 questions asking the likes and dislikes of people. Identify any 3 of your friends. Ask them to fill answer the questions. Then, analyse their answers to the questions and find out the combination of intelligence types they possess.



Watch & Learn

www.eduitspl.com

www.youtube.com/edusoftknowledgeverse

2

Artificial Intelligence in Daily Life

Dear children,

Picking up from the previous learning



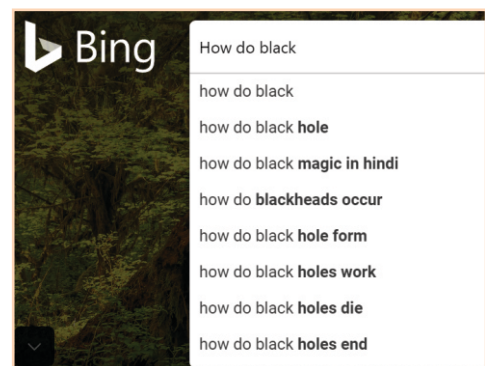
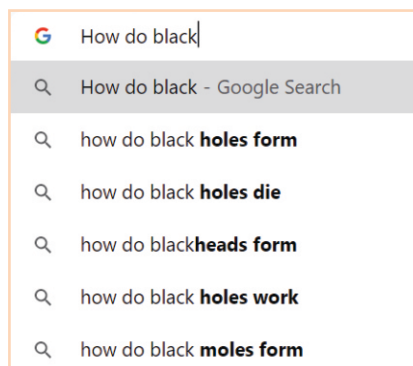
We have learnt...

- That computers work differently than human brain.
- About the possibilities of a machine to learn like humans.
- Everyone is intelligent in their own ways.
- About different types of intelligence.
- That there are different types of learning styles.
- How different types of learning aid in different types of intelligence?

Before delving deep into the concepts of artificial intelligence (AI), let us explore how AI has already begun influencing our lives and industries in various exciting ways as we read this.

Smart Search

Go to Google or Bing or any popular search engine. As you type what you need to search, the search engine displays recommended words for you. These recommendations are generated by AI algorithms on the basis of your previous searches and the data collected




about you from your online activities. Such predictions of words in search is called **predictive search**.

Product Recommendations

Try buying online your favourite book or running shoes and see how similar books and shoes are recommended to you. Along with this, other products related to these are also listed e.g. you buy a wallet and the belts are also recommended. AI algorithms do this by analysing the data collected about your buying habits and preferences in the past. This also happens when you browse new movies, music and articles online.

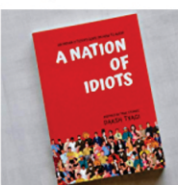
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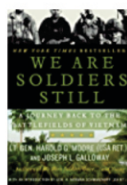
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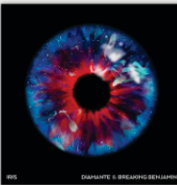
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Sun Tzu
★★★★☆ 5,491



We are Soldiers Still: A Journey Back to the Battlefields of Vietnam



A Short History of the World
H. G. Wells



Iris

DIAMANTE, Breaking Benjamin July 9, 2020 ★★★★★ 10
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REVIEWS


4.6
★★★★★
10 total

BUG'S LIFE ★★★★★ July 11, 2020
This version of the song tugs your heart strings very hard! So... don't drink and listen to this or you'll end up calling your ex gf or bf.


Kai tisdale

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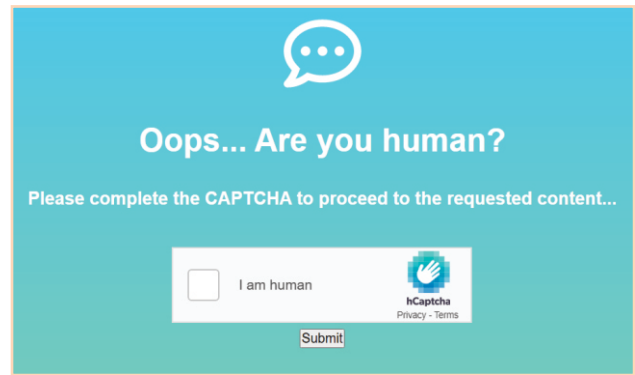


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★★★★★ ₹140.00

Fraud Detection and Prevention

Ask your parents or elders, if a transaction of huge amount is done online, the bank sends an alert on the phone of the customer. AI algorithms on financial websites, such as banks and loan companies, are programmed to look for unusual trends like huge amount, number and speed of transactions in an account at a time, repeated attempts of login in an account etc. In such cases AI algorithms respond in different ways such as confirming user's identity in multiple ways before executing the transaction, blocking the account temporarily, asking customer to call the bank, alerting authorities in case of huge amounts.

Such detections also help in tracing terrorist funding activities, black money trail, fraudulent businesses, illegal finances etc.



Location and Directions

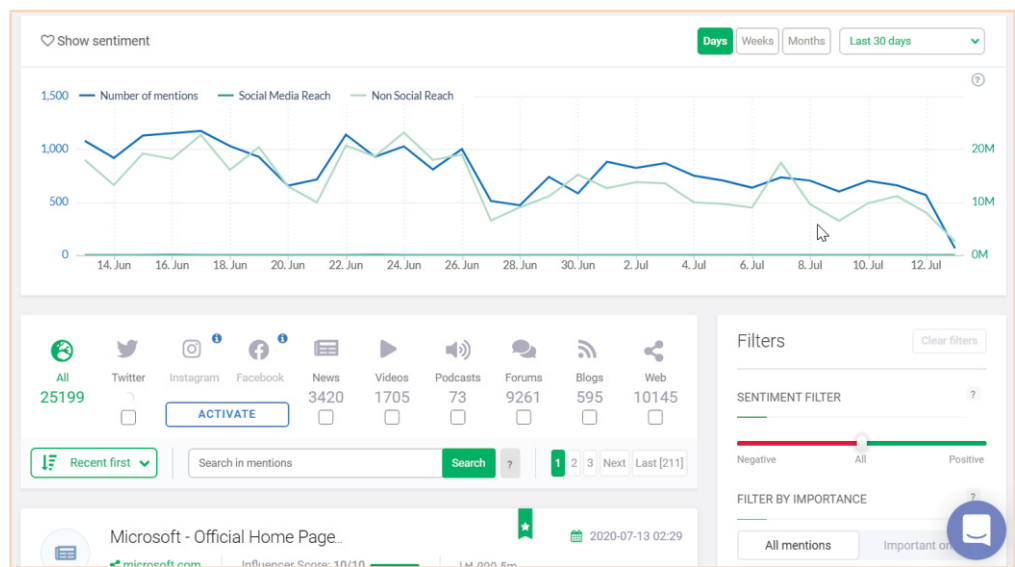
Google Maps is indispensable today for those who travel. Its AI enabled system calculates commute time, displays traffic conditions, finds the best possible shortest or fastest route e.g. orange route indicates busy road while red means traffic jam.

Depending on your live location and specified destination, the apps display the current rides which you can share.



Sentiment Analysis

We interact with friends and other people online. We share tweets, messages, pictures, videos and we do online chat. All these details help in training AI algorithms to learn more about us and analyse our reactions towards things, events and personalities. These reactions help AI algorithms classify us as potential customers, assess our satisfaction level, likes/dislikes for a product or movie or song. This analysis helps



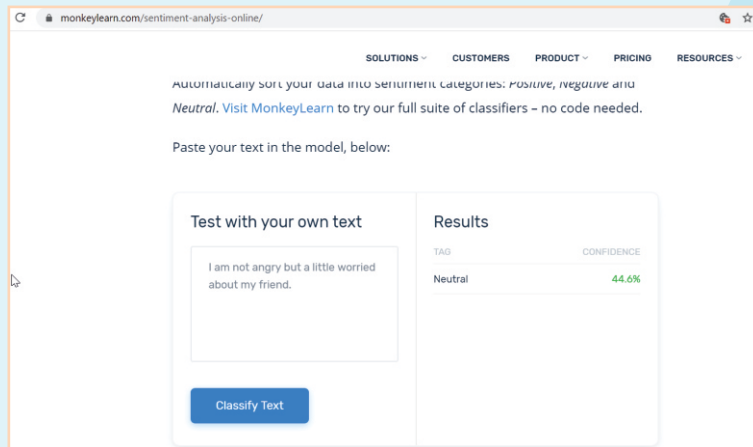
businesses devise their marketing and advertisement strategies. Sentiment analysis helps celebrities and political parties assess their popularity among masses. Our online responses make the digital pattern of our sentiments.

Activity



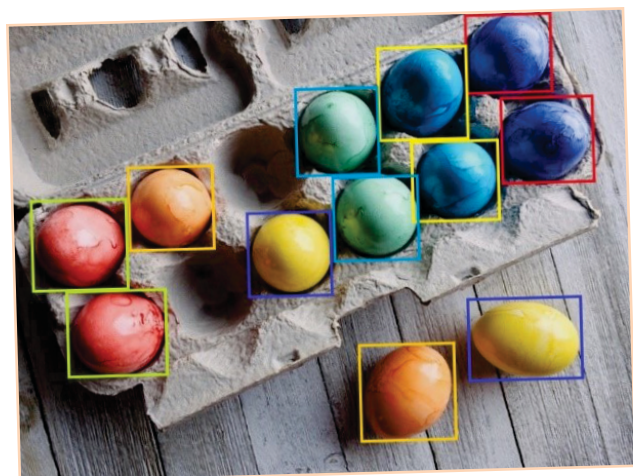
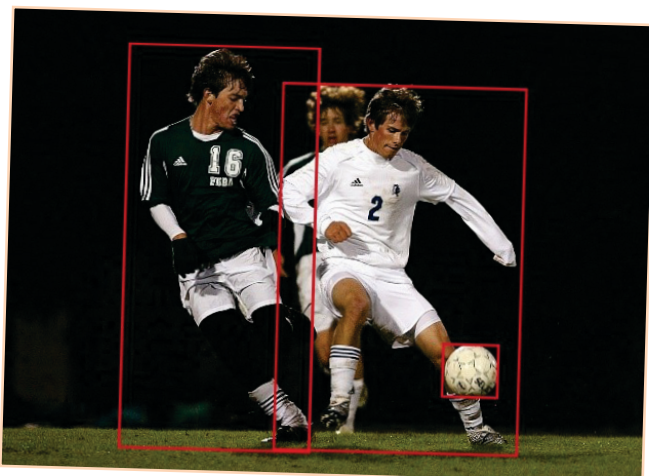
Sentiment Analysis

Go to monkeylearn.com/sentiment-analysis-online and try out different sentences expressing different emotions. See how the AI engine performs sentiment analysis.



Object Detection

AI algorithms are today detecting faces to unlock devices and matching fingerprints to access applications. This is called **biometrics**. Some AI algorithms can record the 3D details of your face using several thousand infrared dots that fall on your face and a unique facial signature is created. Algorithms can detect specific objects in an image or a video still. E.g. detecting forest fire, emerging storm, dangerous tidal waves, approaching flying object or underwater object, identifying species of birds, animals and fish, creating visual patterns of population distribution, traffic control, self-driven cars etc. Object detection and object classification is a very useful application aided by AI. It can be used in all major industries to serve humanity.



Fun Fact



Self-driven Car - Waymo

Google's subsidiary Waymo developed this self-driven car after research that began in 2007. After several test drives and improvements the self-driven version of Waymo with no driver and any human help was tested successfully on real roads in Texas.

Waymo is equipped with a rooftop camera - LiDAR to create a 3D vision for the car 200 meters around. Overall, it has 6 such sensors. It has GPS sensors to help it assess road conditions and lane positions. Gyroscopes, tachometers and altimeters fitted inside the car help it maintain its direction and balance. The car is able to identify other vehicles and obstacles in front and around. It identifies traffic signals and hand gestures made by other commuters.

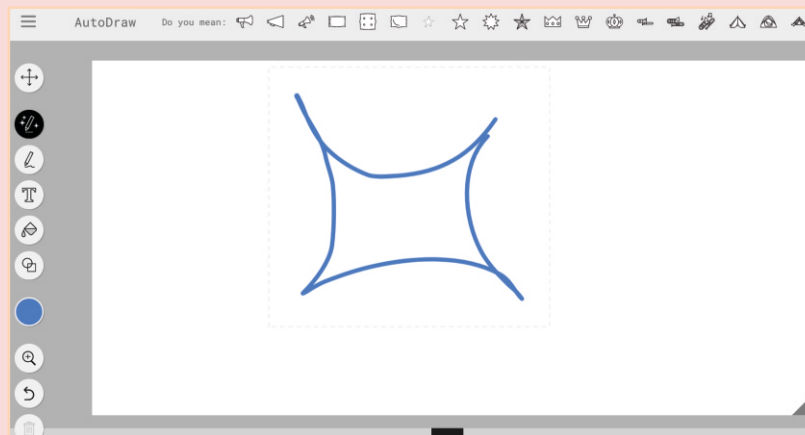


Activity



Drawing with Object Detection

Go to www.autodraw.com. This site detects the drawing strokes made by you, tries to guess the closest shapes and lists them. Users can select the shape they try to draw from among the list of shapes.



Language Processing

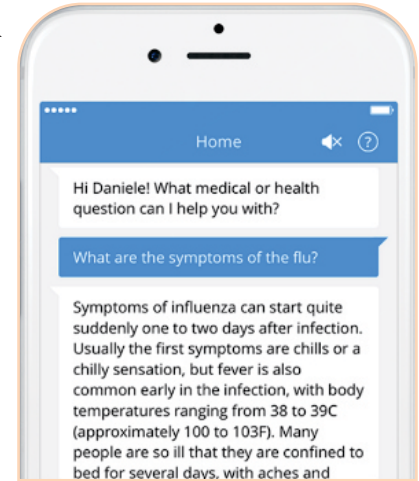
Computers equipped with AI algorithms are able to process language in various forms – spoken and written. This is called **Natural Language Processing (NLP)**.

AI algorithms can identify keywords in the text and execute tasks accordingly. Digital assistants

such as Amazon Alexa use NLP AI algorithms to understand human spoken language and respond in human-like voice (identified as Alexa's voice). NLP can also be used to identify and classify various documents like categorising books in a library under different genre. In any field where text, documents and speech are involved, NLP has its tremendous use.

There are two interesting terms worth knowing about – **Speech recognition**, which means recognising *what* is spoken and **Voice recognition**, which means who has spoken. Most of the applications work on speech recognition rules. Voice recognition is important where authorisation of a person is required.

One of the most popular applications of NLP are Digital Assistants and Chatbots. Digital Assistants can understand speech and execute the routine tasks such as playing a song, switching on the TV, checking email etc. Chatbots are used to handle customer queries and execute common requests such as placing request for cheque book with the bank, ordering food, securing appointment with the doctor etc.



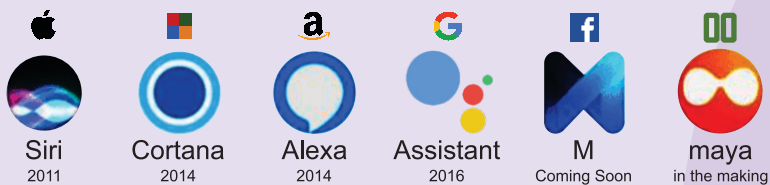
Fun Fact



Amazon Alexa, Google Assistance, Apple Siri And Microsoft Cortana

Alexa, Assistant, Siri and Cortana are voice driven virtual assistants by their respective companies. They are just like voice-

driven wizards, equipped with speech recognition and natural language processing technologies, which can do a lot of things for you such as answering almost any question on any topic, set reminders for you, doing weather forecasts, playing your preferred music, delivering messages, switch to various channels such as sports, education, markets, entertainment etc. Today Alexa has around 90000 functions and skills that it can perform for the user. Google Assistant identifies objects, songs, user preferences and allows E-commerce by voice. Users can set voice shortcuts for common commands. Siri can navigate locations. Cortana is available with Windows 10 systems to provide voice based commands and search features using Microsoft's search engine Bing.



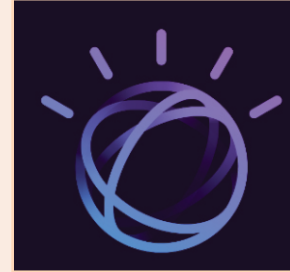
Fun Fact



IBM Watson

Watson by IBM is an AI based Question-Answer system that answers the questions asked in natural language. It is developed by the team headed by David Ferrucci. Its first successful implementation was done at Memorial Sloan K. Cancer Centre, New York where it helps in lung cancer treatment.

Watson is able to gather massive data from encyclopaedias, newspapers, dictionaries, and databases. Then it analyses the immense amount of data to generate various hypotheses which help it to answer the new questions posed by the users. It runs on Linux operating system and 90 powerful server computers of IBM equipped with 16 TB RAM and 3,5 GHz 8-core micro-processors.



Activity



My Smart School

Imagine that your school needs to run on artificial intelligence software. Right from coming to the school till leaving the school, think of various tasks and areas where AI can be used. Use your imagination and creativity to suggest what amazing things you would like AI to do for your school.

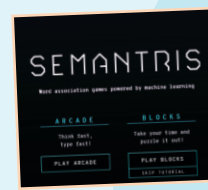
Activity



Word Association

Go to <https://research.google.com/semantis/> and click on PLAY BLOCK button. It shows a set of blocks with words. You need to enter a clue for any word and AI system tries to guess the related word. For example, if you type: vast blue waves then it will guess the word Ocean.

The AI system is trained into several million examples and variations of text pieces so that it is capable to relate the phrase entered by you with the closest possible word.



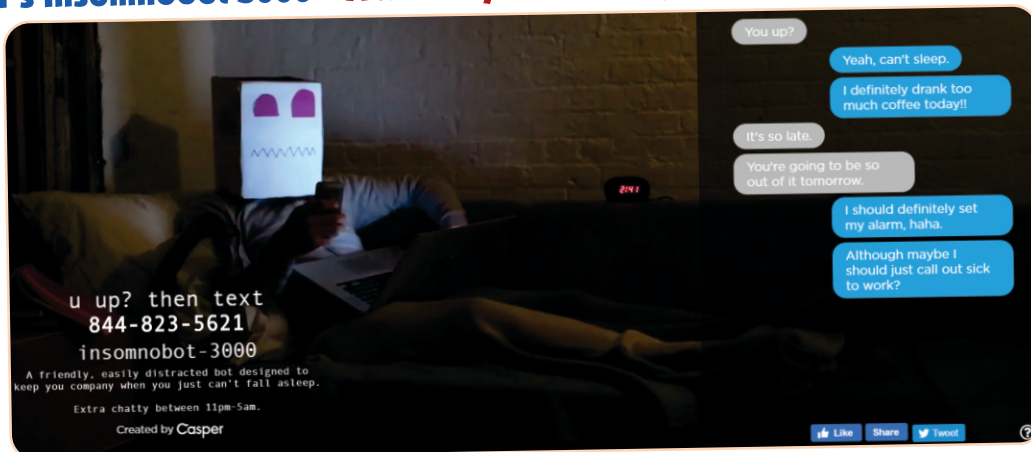
Semantris is built by Ben Pietrzak, RJ Mical, Steve Pucci, Maria Voitovich, Mo Adeleye, Diana Huang, Catherine McCurry, Tomomi Sohn, and Connor Moore.

How does it work? This is a demonstration of how a computer can understand what you speak to it in everyday language.

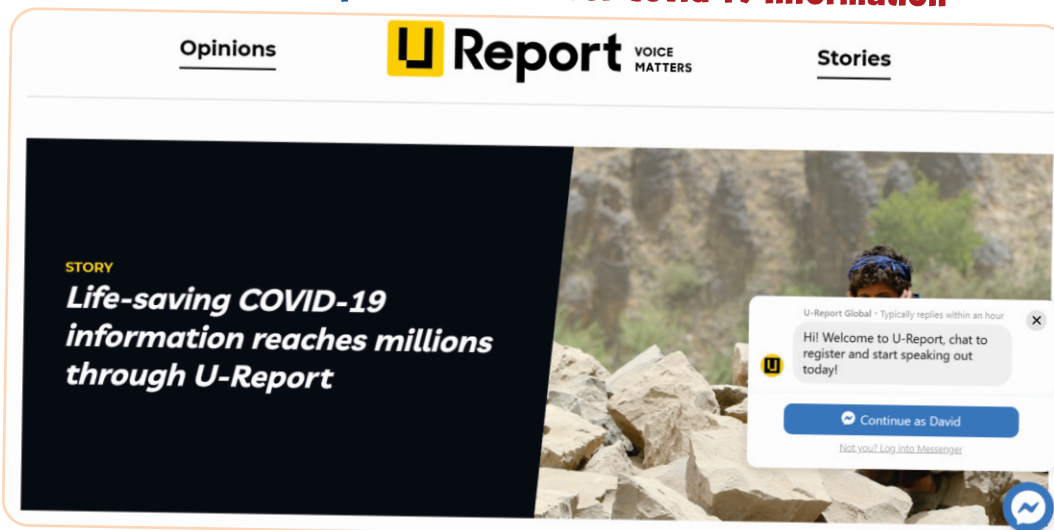
Several millions of lines of human conversations have been used to teach this AI system to figure out how real human conversations occur.

Once the AI is trained, it is able to predict how likely one statement would follow another as a response. The AI is simply taking in what you type and doing a lookup into a pool of many possible responses to find the most likely ones. The technique used is called **machine learning**. In the next section you will learn about machine learning.

Casper's Insomnobot 3000 – A friendly bot to keep you company if you can't sleep.



UNICEF – U-Report – Chatbot for Covid 19 Information

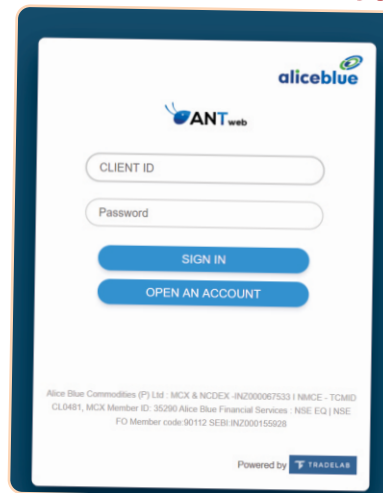




MedWhat – Virtual Medical Assistant



ALICE – Bot for Assistance in Stock Trading



Activity



Interact with a Chatbots

Go to these URLs and try interacting with chatbots. Discuss your observations and experience.

<https://watson-assistant-demo.ng.bluemix.net/>

<https://sites.google.com/site/webtoolsbox/bots>



Practical Activity

Train A Computer



This project will give you a simple experience of how machine algorithms are trained with data and how they perform the desired task based on the training. This is called supervised machine learning since you are telling the machine what it is supposed to do with the data.

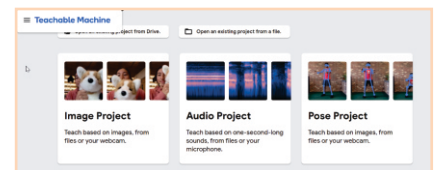
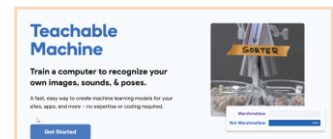
In Teachable machine project, we are taking up image project to train the machine algorithm in identifying some image. After training, the machine will be able to identify and match the image shown through the web cam if a match is really found.

A. Preparing and Uploading the Data

Follow the steps given in the sections below:

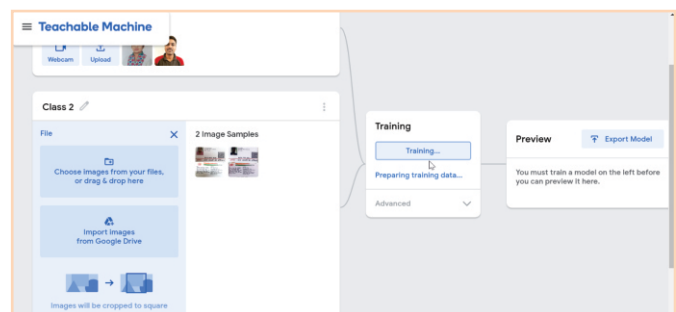
Arrange a dozen of images of which 4 should be yours and rest of other people. Then upload the images following the steps given here.

1. Visit <https://teachablemachine.withgoogle.com/> and click on **Get Started**.
2. Click on **Image Project**.
3. Upload 6 images in each class (Class 1 and Class 2) one-by-one by clicking **Upload button**.



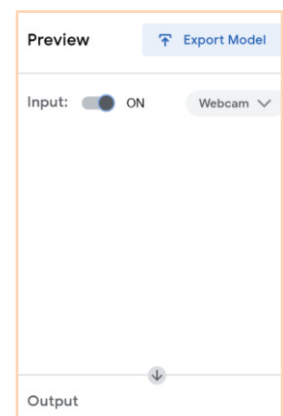
B. Train the Algorithm

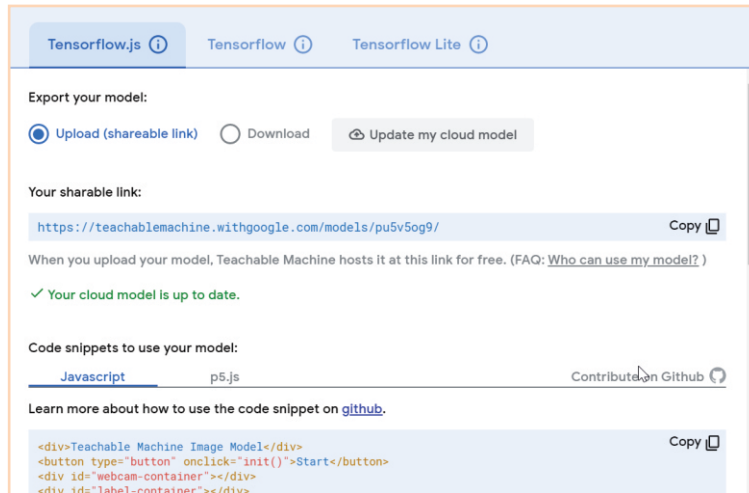
1. When all the images are uploaded, click on **Train Model** button. It will take a while to train the algorithm with the uploaded images.



C. Export and Test your Model

1. After training, click on **Export Model** button.
2. In the popup, Click on **Update my cloud model**. A link to your teachable machine will be created.
3. Copy this link and paste it in new browser window to test.

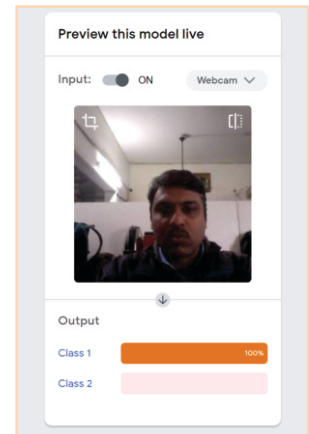




Note: During the test, webcam should be on and working. The machine algorithm will try to recognise your face with the trained data and tell you how much percentage your face match was found. Also, try any other different printed image in front of web cam or ask a friend to show his/her face in the web cam. See if algorithm is able to tell that the match was not found.

Way Ahead

Similarly, try out **Audio project** and **Pose projects** also. **Have fun!**



Learning Points

- Prediction of words while typing search string in a search engine is called predictive search.
- Some common applications of AI are smart search, fraud detection, product recommendation, location and direction, sentiment analysis, object detection and language processing.



- **Biometrics:** Process and applications of detecting fingerprints, faces etc.
- **NLP:** Natural Language Processing - a domain of AI.
- **Sentiment:** Like/ dislike about something or someone.
- **Predictive:** To be predicted or forecasted on the basis of collected data.

Exercise



A. Select the correct answer.

1. Predictive search is the feature of which of the following?

a. Chatbot <input type="checkbox"/>	b. Digital assistant <input type="checkbox"/>
c. Search engine <input type="checkbox"/>	d. Database <input type="checkbox"/>
2. Product recommendations during online shopping is based on which of the following?

a. Our bank balance <input type="checkbox"/>	b. Our profile picture <input type="checkbox"/>
c. Our hobbies <input type="checkbox"/>	d. Our buying habits <input type="checkbox"/>
3. Blocking a bank account is a response to which of the following?

a. Zero balance in bank account <input type="checkbox"/>	
b. Fraudulent transaction <input type="checkbox"/>	
c. Payment of credit cards defaulted <input type="checkbox"/>	
d. No login in account for long time <input type="checkbox"/>	
4. Identifying face by its features is an example of which of the following?

a. Biometrics <input type="checkbox"/>	b. Predictive search <input type="checkbox"/>
c. Digital fingerprinting <input type="checkbox"/>	d. Classification <input type="checkbox"/>
5. How we feel and think about a product is called our _____.

a. Sentiment <input type="checkbox"/>	b. Nature <input type="checkbox"/>
c. Experience <input type="checkbox"/>	d. Feedback <input type="checkbox"/>

B. Match the column A with column B.

- | A | B |
|---------------------------|---------------------------------------------------------|
| 1. Predictive search | a. Identify a face in a video clip. |
| 2. Fraud detection | b. Our buying habits and preferences. |
| 3. Product recommendation | c. Words recommended based on the previous searches. |
| 4. Sentiment analysis | d. Transfer of a huge amount from one account to other. |
| 5. Object detection | e. Our online interactions about a product or service. |

C. Fill in the blanks.

- Fraud,
Chatbot,
Digital assistant,
NLP,
Sentiment analysis
1. Customers can find out about services and products of a company by using its _____.
 2. _____ can understand speech and execute routine tasks.
 3. Identifying and classifying documents is an application of _____.

4. _____ helps in assessing the popularity of a product or celebrity.
5. Repeated attempts of login in a bank account could be an attempt of _____.

D. Mark the following statements as True or False.

1. Speech recognition means what has been spoken.
2. Voice recognition means what has been spoken.
3. Chatbots are applications of NLP.
4. Fingerprint recognition is a feature of fraud detection.
5. The features of AI can be used to serve humanity.



E. Answer the following questions.

1. How does search engine determine what words to recommend while typing the search text?
2. Mentions ways through which AI algorithm detects online fraudulent transactions.
3. How does an online map application help us?
4. What is sentiment analysis?
5. List any 3 applications of Object detection.
6. What is NLP?
7. How is speech recognition different from voice recognition?
8. What are digital assistants and chatbots?



Mini Project...

Visit kids.kiddle.co/Chatterbot and create a short report on chatbots and their use.



Watch & Learn

www.eduitspl.com

www.youtube.com/edusoftknowledgeverse

3

Introduction to Artificial Intelligence

Dear children,

Picking up from the previous learning



We have learnt...

- That computers work differently than human brain.
- About the possibilities of a machine to learn like humans.
- About different types of intelligence.
- That there are different types of learning styles.
- How different types of learning aid in different types of intelligence?
- Various applications of AI presently.
- AI-enabled machines have variety of applications such as Smart search, product recommendations, fraud detection, sentiment analysis, object detection and language processing etc.

We now know that human brain is capable to process information in various forms and ways. Since birth, even before birth (remember the story of brave Abhimanyu?), brain develops the tendency to take inputs and process them to train itself. As tiny tots, we used to identify various objects around us by their properties and behaviour. Properties such as shape, size, colour, features etc. Behaviour such as speaking, walking, rolling, turning, stopping, starting etc. How does a child record the learning about a television in his mind? Infants do not have language. They express in gesture, giggles and cries. Slowly, as they grow, the brain grows in learning about surroundings. Language is learnt in bits and pieces – alphabets, words, phrases, simple sentences, basic grammar and so on. By the time we grow up past our teenage, our mind is mature enough to learn about new things faster depending on our interest and aspirations. Then the learning becomes deeper instead of broader. Deeper learning means detailed knowledge in a particular subject or field. This deeper learning becomes expertise which is utilised in earning our livelihood and in making discoveries, inventions and innovations.

At what level of learning do you think today's machines are? Are they novice or intelligent or expert? Do you think the machine that beat Kasparov in Chess was expert? Or, the robots that work in factories are intelligent? Or, the device that recognises you by your voice or face is sharper than a human being?

Fun Fact



IBM DEEP BLUE

In 1997, the world chess champion Gary Kasparov was beaten by IBM's Deep Blue - a chess playing supercomputer. Earlier versions of Deep Blue were beaten by Kasparov. Deep Blue was capable of computing 200 million positions or moves per second with a processing speed of 11 Gigaflops. The Deep Blue program was written in C programming language and it ran on AIX operating system over 480 VLSI chips.



Possibilities of a Computer to Learn?

What kind of efforts and approaches are needed to have a computer “think” like humans can only be assessed by comparing human intelligence with artificial intelligence. There are 2 aspects to AI – expectations from a computer to exhibit intelligence and reality. To see the possibilities of a computer to learn, we first need to understand the difference between how human brain functions and how does a computer brain (processor, memory and storage) works.

BRAIN	COMPUTER
Brain is composed of millions of neurons which store and transmit information in entire nervous system.	Computer's brain (processor, memory and storage) is controlled and used by set of instructions issued in the form of programs and software.
<p>Note: A logical set of instructions is called a program. To run similar instructions again and again, we can keep them as a single program and run it as and when required. A software is a set of several programs packaged together.</p>	
Structure is far more complex and still the subject of research.	Computer architecture is not as much complex as that of natural brain.
Few neurons in brain process a lot of information while consuming very little amount of energy.	If a computer system is made to utilise as many neurons, it will need a lot of energy.



Performs a lot of processing simultaneously.	Performs the tasks in a linear fashion and a sequence of steps.
All the neurons are utilised.	Has artificial neurons where, certain neurons may remain idle during an operation.
Processing speed is slower (thousand instructions/sec).	Processing speed is higher (million instructions/sec)
The learning mechanism is complex.	Computers with AI logic are continuously fed with immense amount of data for training and then they are fed with separate sets of immense data for testing.
Processes complex and rich variety of information hence it is less accurate in outcome.	More accurate since they mostly deal with processing which is sequential and focused on a selective set of tasks only.
Can be distracted by various signals and stimuli. Such unwanted stimuli are termed as <i>noise</i> .	Computers do not get distracted.
Encodes information in the memory in a way which is still part of study and research.	Retain information in numeric form as patterns and trends recognised in the data used to train them.
Can decide and deduct suitably in different situations. This is called generalised intelligence.	Take decisions on the basis of the data used to train them. They simply overlook anything which they are not trained to deal with.

Looking at the comparison above, it is not necessary to have machines as intelligent as human brain or rather more intelligent. Important is to have useful machines with enough intelligence to perform assigned tasks efficiently. There are many such examples such as object recognition, smart image recognition, speech recognition, video processing, text recognition and pattern recognition in data. There are several applications of these functionalities which make computers simulate intelligence.

Defining Artificial Intelligence

So, how do you define the term Artificial Intelligence?



Artificial intelligence is the field to develop machines which should learn and act like humans.

In simple terms:

Artificial intelligence is the art and science of developing machines intelligent like humans.

We know human intelligence is of different types. Same goes for artificial intelligence. Some machines are good at playing different sports, some are good at driving a vehicle on road or fly a drone, other machines can detect cancer cells while others can churn huge amount of numbers to do useful predictions yet there are some machines which can understand natural language to execute voice commands, classify documents and process hundreds of thousands of pages of text.

Weak and Strong Artificial Intelligence

Broadly, AI has two categories of machines. First are those which are intelligent at performing certain specific and specialised tasks. The other type includes the machines which are able to perform complex tasks by taking their own decisions. As of this writing, the second type of AI is hypothetical only and under research. Second type of AI machines do not exist.

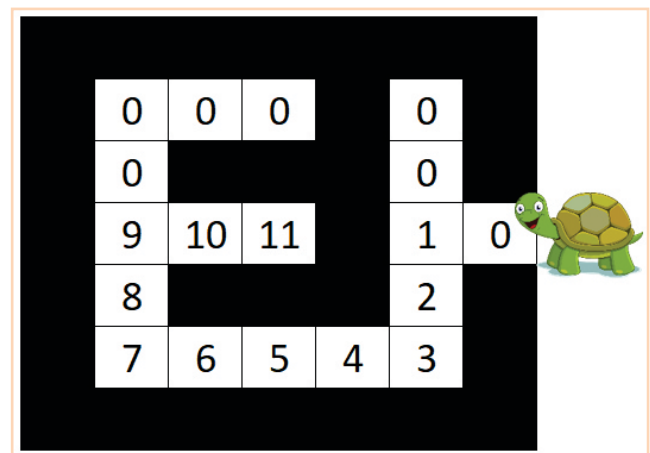
Weak/Narrow AI

Machines with weak AI perform tasks with some guided instructions. They simulate intelligence which is not like true intelligence. In specialised tasks, AI-enabled machines are doing wonders. A majority of them we have seen in earlier chapter on applications of AI. Machines that exhibit intelligence in a limited area or to perform specific tasks are said to be showing **weak or narrow intelligence**. Today weak AI machines are being used extensively in variety of tasks in various industries and disciplines.

Narrow AI Game

Below are the 3 sets of rules which will help Tinu the turtle to reach to the square number 11. Tinu is at square numbered 0 currently.

The game begins with reading instructions from **Rule Set 1**. Whenever an instruction fails (false), jump to the next rule set. If rule set 3 is finished then come back to rule set 1 and this cycle goes on until the task is accomplished. Let's take out a sheet of paper and begin the workout.



Rule Set 1

Check Front
If White
Move Forward
If Number Smaller
Move Backward
Turn Left

Strong/Generalised AI

Machines showing generalised intelligence with autonomous ability of decision making are said to possess **strong or generalised intelligence**. Such machines are in research phase and are expected to simulate human brain. The algorithms of such a machine will have mental abilities such as thinking, deciding, remembering, emoting etc. These machines can perform tasks without any guidance and they work constantly like our brain does.

Our brain is capable of autonomous thinking after we reach certain age. Similarly, it is thought that if a strong AI machine is made, it would take a few years to learn things like children do.

Weak AI vs Strong AI

Let us compare the two types of AI:

WEAK AI	STRONG AI
Needs guiding rules to perform tasks.	Can perform tasks autonomously.
Programmed by developer. Does not learn in true sense.	Programmed once and then learns on its own.
Simulate human intelligence.	Can think, decide and evolve in intelligence.
Perform specific tasks in controlled way.	Work constantly and learn from it.

Artificial Superintelligence

Artificial superintelligence is a futuristic hypothesis that mentions about machines which will not only attain general, strong intelligence but surpass human brain capacity and human intelligence. They will be far more intelligent than the most intelligent person on the planet. It will be champion in all the activities humans do. The theory is appealing and at the same time scary. Have you seen the movie AI by Steven Spielberg which shows the emotional aspect of a child robot? Or, Terminator series showing machines trying to rule the world in future? Or, I, Robot where a good robot saves all? There are many such science fiction movies and TV series. So, ASI is just a fantasy today but who knows what future holds.

Note

Artificial intelligence has been divided on the basis of functionality of the machines also in categories like reactive machines, limited memory, theory of mind and self-awareness. You shall learn about them in higher classes. Here is a brief introduction:

Reactive machine: This is the most basic (weak) kind of intelligence with no previous memory or learning. They perform specific tasks that involve responding to some event or stimuli like playing a strategy game or simulated sport.

Limited memory: These machines retain memory and utilise it for immediate future use only, not for longer time. For example, self-driven car can retain memory of the surroundings while going through the traffic and detecting objects and obstacles around it. Another example is chatbots.

Theory of mind: These machines are able to interact socially. They understand emotions and know how to respond accordingly.

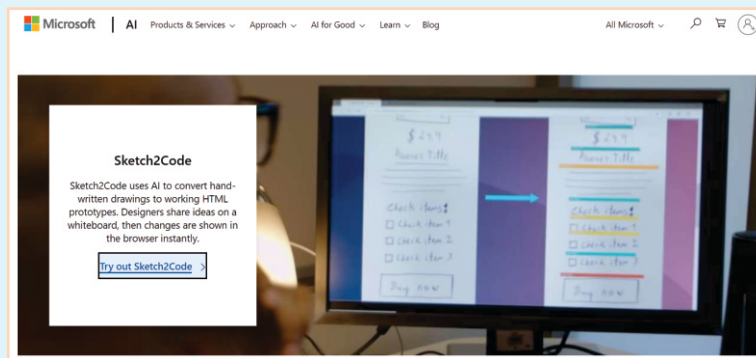
Self-awareness: A machine that is near human-intelligent. Such machines are hypothetical and part of research and development.

Activity



Experience Narrow AI

Go to <https://sketch2code.azurewebsites.net/> and show the computer your hand-drawn diagram of a web form. Click or upload its picture and let the computer generate HTML code for it. HTML is used to create web pages.



Learning Points



- Human brain and computer function in a completely different way.
- Artificial intelligence is the field to develop machines which should learn and act like humans.
- Machines with weak AI perform tasks with some guided instructions.
- Machines with generalised intelligence have ability of autonomous decision making.
- Artificial superintelligence is a futuristic hypothesis of machines having stronger intelligence that will surpass human intelligence.
- On the basis of functionality, AI is of 4 types namely reactive machine, limited memory, theory of mind and self-awareness.



- 👁️ **Narrow intelligence:** Intelligence that can perform specific tasks well.
- 👁️ **Strong intelligence:** Intelligence that is capable of autonomous decision making.

Exercise



A. Select the correct answer.

- Brain is composed of which of the following to store and transmit information?
a. Arteries b. Veins
c. Neurons d. Chips
- Unwanted signals in communication are called which of the following?
a. Pollution b. Noise
c. Distraction d. Short circuit
- Machines that execute voice commands are able to understand which of the following?
a. Grammar b. Commands
c. Machine language d. Natural language
- Today, which of the following intelligent machines are used in most of the industries?
a. Weak intelligence b. Narrow intelligence
c. Both a) and b) d. Strong intelligence

B. Fill in the blanks.

Narrow, Limited memory, Self-awareness, Generalised, Weak

- Machines with _____ intelligence are under research.
- _____ intelligence needs guiding rules to perform the tasks.
- Another name for weak intelligence is _____ intelligence.
- Self-driven car is said to possess _____ intelligence.
- _____ is the highest form of machine intelligence on the basis of functionality.

C. Mark the following statements as True or False.

- AI-enabled machine function exactly like human brain.
- Computer's processing speed is higher than that of human brain.
- Just like human intelligence, AI is also of different types.

4. Generalised machines can also be used for performing a specialised task.
5. Strong AI is capable to evolve in intelligence.



D. Answer the following questions.

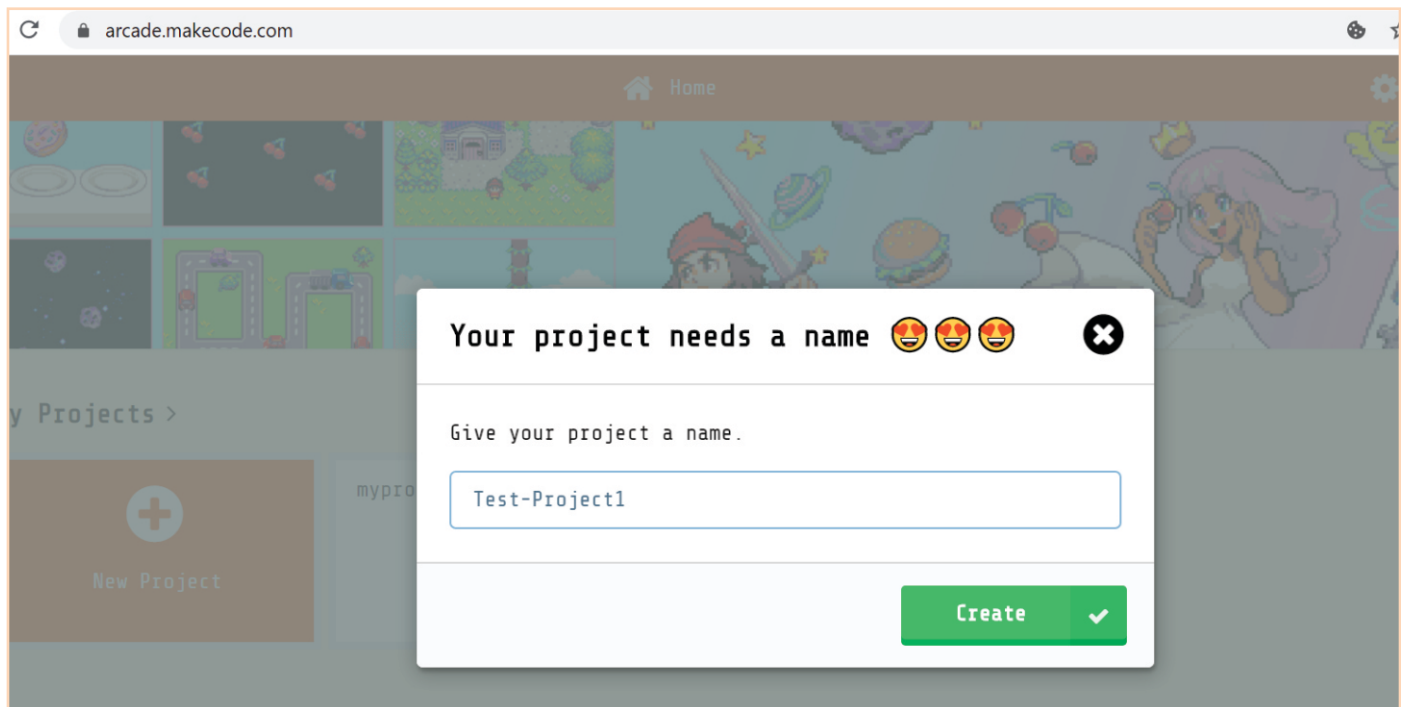
1. Define the term Artificial Intelligence. Name its 4 types on the basis of functionality.
2. How is narrow intelligence different from generalised intelligence?
3. Briefly describe any 2 types of artificial intelligence based on functionality.
4. List any 4 difference between the functioning of human brain and computer.
5. What do you mean by a program and software?



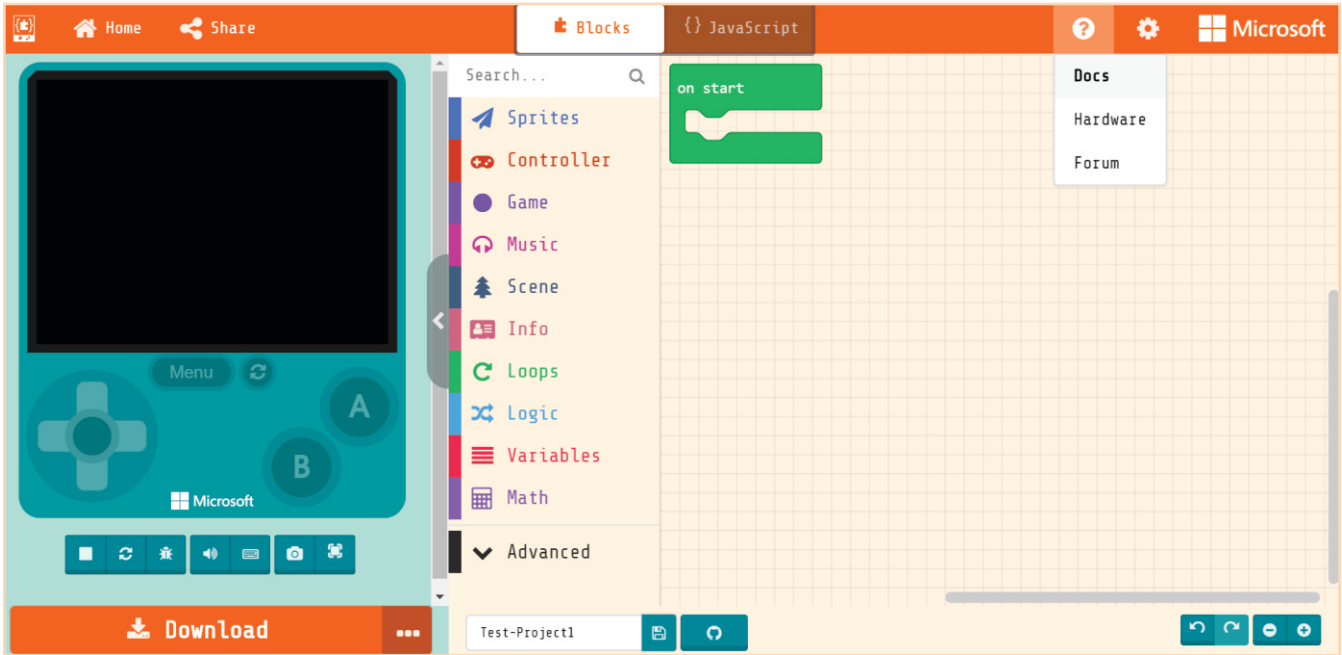
Mini Project...

The purpose of this project is to introduce you with the step-wise, logical thinking approach that makes the foundation of computer programming. As you learn further in higher classes, this foundation will help you in grasping AI programming easily. Your teacher will stipulate a time frame for you to complete this project.

Go to <https://arcade.makecode.com/>. Click on **New Project**. Give a relevant name to your project and click on **Create**.



On the next screen, click on Help (?) icon and select **Docs**.



In the slide-out, scroll down and select **Lessons > Cherry Pickr**.



Follow the instructions and develop the game.



Watch & Learn

www.eduitspl.com

www.youtube.com/edusoftknowledgeverse

4

Artificial Intelligence and Visual Data

Dear children,

Picking up from the previous learning



We have learnt...

- That computers work differently than human brain.
- About different types of intelligence and learning styles.
- How learning types and intelligence types relate?
- Various applications of AI presently.
- Various types of artificial intelligence.

We learnt that data is one of the main domains of AI. The other two domains of AI are **Computer Vision and Natural Language Processing**.

We know that computers understand numbers but in real life, data is in many forms such as numbers, text, symbols, images, audio and video. As far as numbers are concerned, there is no problem in feeding them to the computer as they are but, what about images and language?

How do computers understand visuals and human language? This is where the other two domains of AI come into picture. In this chapter we shall explore computer vision.

Computer Vision

Computer Vision is the AI domain that deals with analysing visual data such as images, spatial data (images taken by satellite), video frames and live feed of data like face, video recording etc. How do we recognise people by their faces? Our brain is made up of millions of neurons. These neurons store the features of the faces we see and later when we meet those people, we recognise them even from a distance or by their picture. Brain is very clever in recording unique features of faces and things so that we remember them.

How does a computer do this? For a computer, everything should be in the form of a number. When we click a photograph using a digital camera, the image captured by the camera is converted into its numeric form and stored in the memory of the device.

How Computer Understands Colours?

When you make a painting with water colours, you mix some colours to get new colours. You mix different quantities of water to have different colour intensity. A similar concept (but no water!) works with digital images.

To understand how digital images are understood by computers, first we need to understand the basics of colours.

Download **Just Color Picker** from annystudio.com/software/colorpicker

Open Just Color Picker.

Select **RGB**. RGB stands for **R**ed, **G**reen and **B**lue. These are 3 basic digital colours. Their combinations make other colours.

You will notice that each of the 3 colours have a range of intensity from 0 to 255.

Change the intensity of Blue to 0 and that of other 2 colours to 255. Which colour did you get? Yes, Yellow.

0 to 255 is the intensity of these colours. If you set all three colours' intensities to 0, you will get black. Check it out. What will you get if you set all three colours' intensities to 255 (maximum)? White? Correct.

Now try out blends of various intensities of these 3 basic colours to get different colours. There are $256 \times 256 \times 256 = 16777216$ colours in RGB model.

This way, computers store the colour information.

There are other colour models also like **C**yan, **M**agenta, **Y**ellow, **blacK** (CMYK) used by printers but RGB is most common of all.

Try mixing equal intensities of all 3 colours such as 100,100,100 or 65,65,65 or 150,150,150. Observe which shades of a particular colour are produced.

How Computer Understands Images?

So, colour basics are clear. All the basic colours – Red, Green and Blue have intensity 0 to 255.

Digital images are composed of tiny elements called **pixels** (Picture elements). Think of an image as a grid of several thousand tiny pixels. Here is a conceptual representation of the concept. Notice that pixel 1 is blue, pixel 446 is white and pixel 198 is dark.

1	17	33	49	65	81	97	113	129	145	161	177	193	209	225	241	257	273	289	305	321	337	353	369	385	401	417	433	449	465	481	497	513
2	18	34	50	66	82	98	114	130	146	162	178	194	210	226	242	258	274	290	306	322	338	354	370	386	402	418	434	450	466	482	498	514
3	19	35	51	67	83	99	115	131	147	163	179	195	211	227	243	259	275	291	307	323	339	355	371	387	403	419	435	451	467	483	499	515
4	20	36	52	68	84	100	116	132	148	164	180	196	212	228	244	260	276	292	308	324	340	356	372	388	404	420	436	452	468	484	500	516
5	21	37	53	69	85	101	117	133	149	165	181	197	213	229	245	261	277	293	309	325	341	357	373	389	405	421	437	453	469	485	501	517
6	22	38	54	70	86	102	118	134	150	166	182	198	214	230	246	262	278	294	310	326	342	358	374	390	406	422	438	454	470	486	502	518
7	23	39	55	71	87	103	119	135	151	167	183	199	215	231	247	263	279	295	311	327	343	359	375	391	407	423	439	455	471	487	503	519
8	24	40	56	72	88	104	120	136	152	168	184	200	216	232	248	264	280	296	312	328	344	360	376	392	408	424	440	456	472	488	504	520
9	25	41	57	73	89	105	121	137	153	169	185	201	217	233	249	265	281	297	313	329	345	361	377	393	409	425	441	457	473	489	505	521
10	26	42	58	74	90	106	122	138	154	170	186	202	218	234	250	266	282	298	314	330	346	362	378	394	410	426	442	458	474	490	506	522
11	27	43	59	75	91	107	123	139	155	171	187	203	219	235	251	267	283	299	315	331	347	363	379	395	411	427	443	459	475	491	507	523
12	28	44	60	76	92	108	124	140	156	172	188	204	220	236	252	268	284	300	316	332	348	364	380	396	412	428	444	460	476	492	508	524
13	29	45	61	77	93	109	125	141	157	173	189	205	221	237	253	269	285	301	317	333	349	365	381	397	413	429	445	461	477	493	509	525
14	30	46	62	78	94	110	126	142	158	174	190	206	222	238	254	270	286	302	318	334	350	366	382	398	414	430	446	462	478	494	510	526
15	31	47	63	79	95	111	127	143	159	175	191	207	223	239	255	271	287	303	319	335	351	367	383	399	415	431	447	463	479	495	511	527
16	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320	336	352	368	384	400	416	432	448	464	480	496	512	528

Note

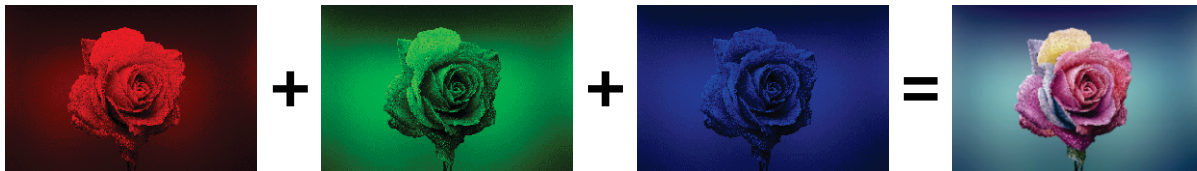
This is just a conceptual presentation. Actual pixels are microscopic in size and there are millions in an image.

A coloured digital image has 3 layers - red layer, green layer and blue layer.

Imagine 3 transparent sheets – one red, one green and one blue, kept above each other.

When these 3 layers are combined, their combined intensities create the colour of that pixel.

				101	105	150	147	147	149	113	149
				106	103	130	122	139	143	144	109
		156	164	164	193	191	160	171	171	134	143
		157	158	183	152	181	188	179	154	137	131
200	208	219	224	253	249	210	239	187	169	148	100
215	251	230	252	218	203	247	209	161	168	136	130
251	255	208	200	252	252	203	211	178	175	133	124
244	232	253	246	203	200	239	247	151	177	135	148
206	253	231	249	205	230	240	243	170	150		
210	231	200	227	237	243	215	200	167	168		
238	202	205	205	206	255	246	224				
237	210	254	234	247	203	215	243				



These individual layers of colours in the coloured image are called **channels**.

Activity

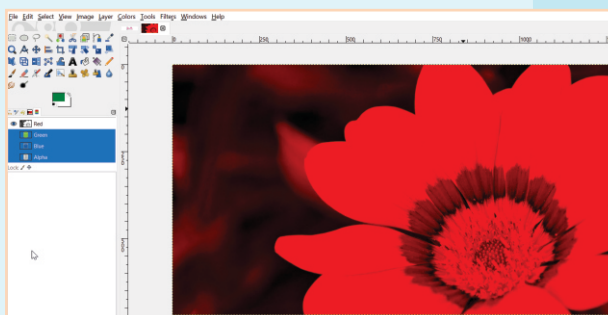
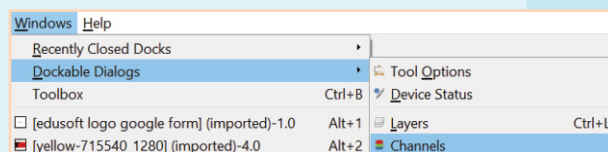
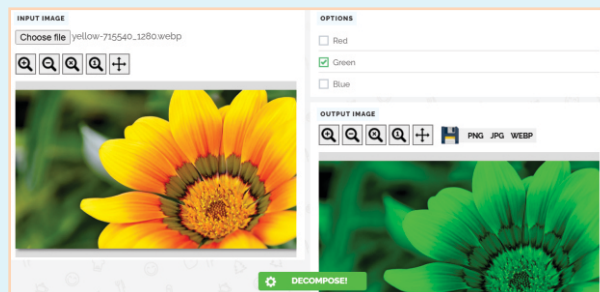


Split Image Channels

Go to pinetools.com/rgb-channels-image and upload any image on it. Then, select any one channel and click on **DECOMPOSE** button. It will show that channel.

If you have free image manipulation program **GIMP** downloaded from gimp.org then you can see the channels of an image in it. Just open the image in it and then **Windows > Dockable Dialogs > Channels**

Then remove the eye icon beside the channels in the side panel and see the change.



Activity



Secret Message of a Spy

Consider the 26 images given here. Each image is a grid of 5X5 squares. Each grid is representing an English alphabet which is denoted by the grey cells in the grid. For example, L = 1, 6, 11, 16, 21, 22, 23.

Assume that each cell is a pixel. So, each image is composed of 25 pixels. If an Artificial Intelligence algorithm is given these figures then it can detect the pixels which are grey coloured and easily decode the alphabet.

Each image has 2 parts:

- 1. Edge:** Each grey pixel is forming the outline (edge) of the alphabet.
- 2. Corner:** Corner has 2 edges. For example, in alphabet A, there are 2 corners - 6,1,2 and 4,5,10.

By scanning the images, AI algorithm can learn the sequence of gray cells to deduct an alphabet. For example, the learning would look like this:

(1,5,6,10-16, 20,21,25)(1-6, 11-16, 21-25)(1,6,11,16,21-23)(1,6,11,16,21-23)(1-6, 10, 11, 15, 16, 20-25)

This can be decoded as the word: **HELLO**. Can you do this?

In the code above, comma is for separate pixels and dash means contiguous pixels. For example, in alphabet H, **10-16** = 10, 11, 12, 13, 14, 15 and 16.

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

1	2	3	4	5
6	7	8	9	10
11	2	13	14	15
16	17	18	19	20
21	22	23	24	25

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

1	2	3	4	5
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21	22	23	24	25

1	2	3	4	5
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21	22	23	24	25

1	2	3	4	5
6	7	8	9	10
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21	22	23	24	25

1	2	3	4	5
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11	2	13	14	15
16	17	18	19	20
21	22	23	24	25

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1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

So, AI-enabled applications developed for processing images look for the pixels that are similar in colours and intensity. They also check the density of pixels in each region of the image. Then, they check if similar pixels are in a continuous series.

All this information help AI algorithm to learn about the image.

This is just a conceptual representation of Computer Vision, actual implementation involves a lot of computations but at the base of entire concept is the values of pixels.

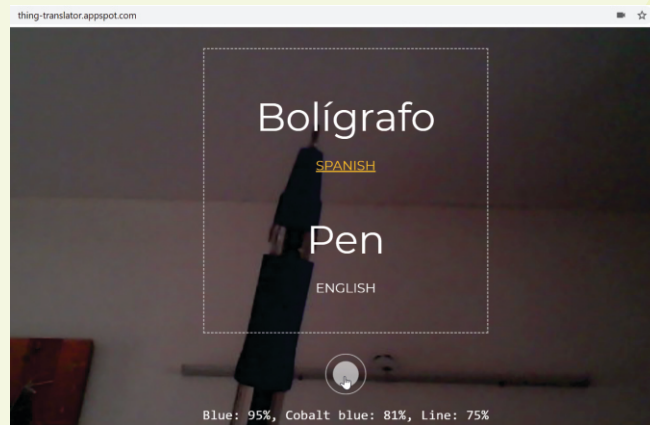
You can use these images to create your own secret messages.

Activity



Translating Things using Computer Vision

Go to thing-translator.appspot.com and take the picture of any object using webcam. See how the AI algorithm identifies that object. Try a pen with and without cap.



Applications of Computer Vision

Where ever processing of images is involved, there is scope for AI-enabled visual data processing for various useful purposes. Some common uses of computer vision are:

1. Image based search.
2. Location detection and driving directions.
3. Processing satellite images (spatial data).
4. Navigation of vehicles, ships, airplanes etc.
5. Object detection – faces, fingerprints, food items, stationery, fabrics etc.
6. Cancer cells detection.
7. Security scanners detecting and identifying faces and hidden objects.
8. Detecting forest fires and flood situations etc.
9. Intelligent night vision for security forces.
10. Autonomous vehicles.

Smart devices such as security locks.

Learning Points



- Computer Visions is the AI domain that deals with the visual data.
- Digital images are composed of tiny elements called pixels.
- Coloured digital images are composed of 3 channels - red, green and blue.
- Computer Visions applications are image identification, object detection, navigation, imaging in medical field, autonomous vehicles and navigation etc.



- 👁️ **Domain:** An area related to common features or functionality.
- 👁️ **Spatial:** Related to imaging.
- 👁️ **RGB:** Colour model based on the basic colours red, green and blue.
- 👁️ **CMYK:** Colour based on the basic colours cyan, magenta, yellow and black.
- 👁️ **Pixel:** Smallest unit of a digital image that holds its colour information.

Exercise



A. Select the correct answer.

1. Which of the following domains of AI deals with visual data?

a. NLP	<input type="checkbox"/>	b. CV	<input type="checkbox"/>
c. Both a) and b)	<input type="checkbox"/>	d. Robotics	<input type="checkbox"/>
2. What is the range of intensity of basic colours in an RGB model?

a. 0-285	<input type="checkbox"/>	b. 0-275	<input type="checkbox"/>
c. 0-265	<input type="checkbox"/>	d. 0-255	<input type="checkbox"/>
3. In the colour model CMYK, what does K stand for?













a. Grey	<input type="checkbox"/>	b. Blue	<input type="checkbox"/>
c. Black	<input type="checkbox"/>	d. Red	<input type="checkbox"/>
4. Computers understand type of data in the form of which of the following?

a. Text	<input type="checkbox"/>	b. Number	<input type="checkbox"/>
c. RGB	<input type="checkbox"/>	d. Pixels	<input type="checkbox"/>
5. In RGB colour model, 100, 0, 0 will give which colour?






a. Yellow	<input type="checkbox"/>	b. Magenta	<input type="checkbox"/>
c. Cyan	<input type="checkbox"/>	d. Red	<input type="checkbox"/>
6. If a rectangle is displayed on computer screen in green colour, then what will be its RGB values?

a. 255, 255, 255	<input type="checkbox"/>	b. 0, 0, 0	<input type="checkbox"/>
c. 0, 255, 0	<input type="checkbox"/>	d. 255, 0, 255	<input type="checkbox"/>
7. Coloured digital images are composed of how many channels?

a. 1	<input type="checkbox"/>	b. 3	<input type="checkbox"/>
c. 255	<input type="checkbox"/>	d. 4	<input type="checkbox"/>

8. How many edges does a corner in an image have?
- a. 2  b. 0 
 c. 1  d. 3 
9. AI applications look for which of the following in an image?
- a. Colour  b. Intensity 
 c. Both a) and b)  d. None of these 
10. Which of the following is not an application of Computer Vision?
- a. Image identification  b. Object detection 
 c. Identifying voice of the user  d. Autonomous vehicle 

B. Mark the following statements as True or False.

1. Data is one of the main domains of AI. 
2. For computers, all data should be in text form. 
3. In a pixel, 0 intensity means absence of that colour (black). 
4. Cancer cell detection is easier using Computer Vision techniques. 
5. RGB model is the basic colour model used by printers. 

C. Fill in the blanks.

- | | | | | |
|---------|-------|----------|-------------|--------|
| Images, | Gray, | Numbers, | Satellites, | Yellow |
|---------|-------|----------|-------------|--------|
1. Computers can easily process _____.
 2. The _____ are stored in digital camera in the numeric form.
 3. Pixels (0, 255, 0) and (0, 0, 255) will give together _____ colour.
 4. Spatial data is usually provided by _____.
 5. Pixel (100, 100, 100) will give _____ colour.

D. Answer the following questions.

1. Name the 3 domains of artificial intelligence. What does Computer Vision domain deal with?
2. What is a pixel? What do you mean by RGB colour model?
3. How is colour model RGB different from CMYK?
4. What do you mean by the terms edge and corner with reference to an image?
5. List any 4 applications of computer vision.



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5

AI and Human Language

Dear children,

Picking up from the previous learning



We have learnt...

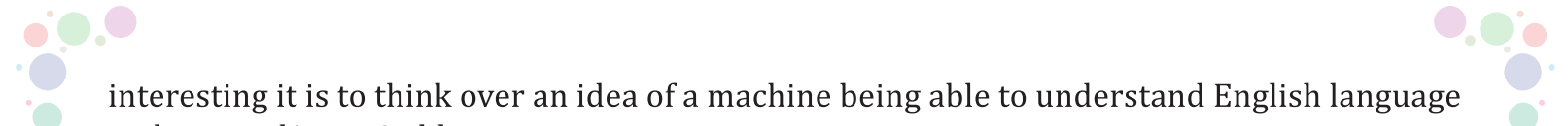
- That computers work differently than human brain.
- About different types of intelligence and learning styles.
- How learning types and intelligence types relate?
- Various applications of AI presently.
- Various types of artificial intelligence.
- Data is the core domain of AI.
- Continuous, huge bulk of data is called big data.
- How computers understand images?

We have understood the basics of computer vision which deals with how machines understand visuals and use them in various fields.

In this chapter, we shall understand how computers process natural language spoken by humans. The process is called **Natural Language Processing** (NLP). The applications and devices that fall in this domain are called NLP-enabled applications or simply NLP applications and NLP devices. The digital assistants and chatbots are common examples of NLP devices and application.

Human Language

We are generally able to speak in two languages – mother tongue and a second language. For example, Hindi and English. Let us here stick to the English language and discover how



interesting it is to think over an idea of a machine being able to understand English language and respond in a suitable manner.

Natural language is a complex thing to deal with. At your age, as you are growing, even you need a few years in getting well conversant in English language. And, in spite of being well conversant, it cannot be said that one has mastered the entire language. Then, think how challenging it is for a machine to do so which understands every thing in the form of numbers only.

NLP intends to bridge the gap between human language and the way computer understands it.

The Communication Cycle

Language is used in communication. The process of communication involves 3 objects:

1. **Sender:** The agent person who needs to send the message across.
2. **Receiver:** The agent or person for whom the message is sent.
3. **Channel:** The medium through which message is sent.

Communication channel could be air when persons are talking one-to-one in close proximity. It can be over a phone line, internet connection in real-time. It can be through written letter by post or an email sent instantly.

The sender is responsible to convey the message in such a way that it is understood by the receiver. This is called **encoding**. The receiver is responsible to understand the message and interpret its intent. This is called **decoding**.

During a communication cycle, the sender and receiver keep switching the roles until the communication cycle completes.

Natural language is the major tool of communication.

Language Challenges for Machines

A machine cannot work in the way human brain works in dealing with natural language. This is a matter of research which is in progress and no one can predict exactly what future holds.

There are many challenges in the way a machine should be able to process natural language.

Let us see.

Language Syntax and Semantics

Syntax refers to the structure of the language such as articles, verb, phrases, nouns, pronouns, adverbs, adjectives etc. form the structure of the language. They are the building blocks of the language. Using them we frame the sentences and narrative.

Semantics refers to the sense or meaning that the description holds. There could be sentences which are syntactically (grammatically) correct but lack semantics (meaning).

Can you translate and describe what the following sentence means?

All the nuts in the backyard are up the trees while all the trees have gone nuts.

What did you notice?

The sentence is grammatically correct but it means nothing sensible. A perfect English

sentence breaking no rules of grammar but does it make sense? You can translate it and tell that it doesn't but a machine can only translate it without figuring out its sense.

Human brain, through its lifelong training, can figure if the sentence really makes sense even if it is grammatically correct but a machine would not bother about sense as long as it can work out the grammar correctly. Grammar can be learnt but the subtlety to detect the sense is a challenge for a machine.

Context and multiple meanings

Can a machine understand the meaning of the message in a certain context? See the following examples:

Shoot! (A photography director commands his photographer to begin clicking pictures.).

Shoot! (An army commander commands his men to shoot the target.).

Shoot! (A manager asks the journalist to begin with his questions.).

Here, the single word **Shoot** carries different interpretations in different contexts.

Similarly, the word fast holds very contradicting meanings.

fast colour - the colour that does not stay and is removed by washing.

fast runner – talking about speed.

Observing **fast** – religious connotation, keeping fast (not eating).

Hold **fast** – holding in one place firmly (this is contrast of fast colour).

There are numerous such examples in natural language which pose a challenge for a machine in understanding the message accurately.

Multiple meanings in tone and emotions

Various emotions can be expressed while using the same word. For example:

I feel **sorry** for his condition. (feeling)

I am **sorry** for my mistake. (apology)

I am **sorry**, I can't help you in this. (helplessness)

Sorry, where was I? (Picking the conversation thread)

Text Processing by Machines

Despite having big challenges getting machines trained in processing text, many achievements have been done in this field. Few popular ones we already know such as digital assistants and chatbots. Others are classification of documents and organising documents, handwriting recognition and analysis, text extraction from images, education and research, sentiment analysis (finding out what customers think about products by reading their online posts) etc.

For above applications, machines need not to bother with all complex details of language grammar. For example, to figure out what a piece of text is talking about, machine needs to detect only main words and keywords.



Document Classification

Consider the following sentences:

1. Government policies are to make education accessible for all to fight the curse of poverty. Poverty is a long-lasting social problem.
2. Poverty is one of the biggest curses in society.
3. Education is a powerful tool that can help in eradicating poverty.
4. Hunger is another demon to fight with the sword of education.

Now, answer the following questions:

1. What are these 4 sentences talking about?

2. Which 2 problems need to be eradicated?

3. Which tool is effective in fighting these 2 problems?

4. Which sentence are talking about poverty?

5. Which sentences are talking about education?

6. Which sentences are talking about hunger?

7. Group the sentences in following 2 categories:

Poverty	Hunger

Let us assume that these 4 sentences are from 4 separate documents. Due to lack of space and time we cannot have 4 large documents so let us workout on these 4 sentences.

Remove the unnecessary words and punctuations. Sentence 1 is done here for you:

1. Government policies make education accessible fight curse poverty long lasting social problem
2. _____



- 3. _____
- 4. _____

Next, convert the various forms of the words into their simplest, root forms. Root is the basic word from which other variations are made by adding affixes. For example, strongest > strong, studies > studi > study.

Sentence 1 is done for you (see the words in boldface):

- 1. **Government** **policy** **make** **education** **access** **fight** **curse** **poverty** **poverty** **long** **last** **social** **problem**
- 2. _____
- 3. _____
- 4. _____

Convert all the sentences into lowercase.

- 1. **government** **policy** **make** **education** **access** **fight** **curse** **poverty** **poverty** **long** **last** **social** **problem**
- 2. _____
- 3. _____
- 4. _____

Pick up each word and write down how many times that word has appeared in all sentences combined.

Word	Frequency	Word	Frequency
Curse	2		

Looking at the frequency highest frequency, can you classify, which document is talking about which topic?

The purpose of this activity was to take you through a basic algorithm to process the text and classify its genre either as *poverty* or *hunger*.

A machine can be trained into the following:

1. Removing special characters, punctuation and unnecessary words such as prepositions, articles, pronouns etc.
2. Convert various forms of words into their simplest root forms. For example, *happiest* > *happi* > *happy*.
3. Convert the words into same case (usually lowercase).
4. Calculate frequency of each word in the set of documents.

Note

This is a very basic form of approach. Many other algorithms work together in processing the text for document classification. You will learn about their actual functioning and programming in higher classes.

Sentiment Analysis

Sentiment analysis is a process to find out what people feel about something by analysing their social interaction data. For example, a company wants to know how many people like/dislike their new product or a celebrity wants to gauge the mood of his/her fans.

Sentiment analysis determines the polarity in the data. Polarity could be positive (like, happy, satisfied, feeling proud, positive mood emojis) or negative (dislike, unhappy, dissatisfied, disheartened, negative mood emojis). Sometimes sentiments can be so balanced to be classified as neutral.

Simple algorithm: In this algorithm, the machine is already given a long list of positive and negative words that reflect different emotions. When machine reads the customer reviews and their social interaction data, it counts how many positive and negative terms are appearing. Depending on this count the text is classified positive or negative. If the difference is almost negligible between the two counts then neutral. This approach makes use of text cleaning which you did in the previous activity.

Complex algorithm: Complex algorithms work in truly AI-based machines which are first trained into detecting sentiments by the help of a lot of previous data collected. When this AI model is trained with several thousand samples to classify sentiments then it is tested with a lot of samples of new data sets. If the results of testing are accurate and precise then this model is implemented for new data. Certain AI models which work on these algorithms are called regression models and deep learning models. You shall learn about them in detail in higher classes.

How is speech-to-text conversion done?

Converting spoken word into text is a highly complex task and it is accomplished in following phases.

Phase 1 – Analog voice signal to digital pulses: The spoken word i.e. analog signal is converted into digital signal by the modulating device. Sound card on the computer is one such common device. It also normalises the audio signals to a constant volume level, filters the noise and adjusts the speed of the spoken words to a constant speed by using in-built logic.

Phase 2 – Segmentation of the digital signals: The digital form of sound is broken down into tiny segments (hundredth part of a second).

Phase 3 – Comparison of segments with language segments: The machine compares the tiny segments with the English language dictionary of words and phrases. This comparison helps machine in figuring out what has been spoken and then the matching text is generated. Accuracy depends on the vocabulary in the dictionary.


For example, word **WHAT?** is segmented into **WH + AU + T**, then

WH + AU + T	H + AU + T (HOT)
WH + AU + T	V + AU + L + T (VAULT)
WH + AU + T	W + AU + TT (WATT)
WH + AU + T	WH + AU + T (WHAT)

How digital assistants work?

Digital assistants like Alexa, Siri, Cortana etc. have their knowledge of vocabulary stored on the servers over internet. Spoken words are sent to the servers where the text is processed. The spoken words are interpreted. Then the keywords are separated. Keywords tell the algorithm which commands to execute to accomplish the task. Once this is done, the information required by the user is gathered and converted into a audio file in human-like voice which is played back to the user.

For example, *Which theatres are showing The good, the bad and the ugly this weekend?* Here, the keywords are *theatres, showing, name of the movie* and *weekend*. Notice that rest of the words and ? are unnecessary and removed.



Activity
Favourite and Not-so-favourite

Collect two paragraph samples from your friends describing which subject they like or hate and why. Then go to aidemos.microsoft.com/text-analytics and copy the paragraphs one by one to check the sentiments in them as well as to identify the keywords used by the AI algorithm in detecting the sentiments. An example is given here with 96% positive sentiment.

Text Analytics

Step #1: Enter Your Message

My favourite subject is biology since I love to know about nature and its mysteries. I am also good at drawing and biology has a lot of scope of drawing diagrams. Diagrams also make study easier.

Next Step

Step #2: Sentiment & Key Phrases

This API analyzes your text to identify the keywords and discern the sentiment.

Next Step >

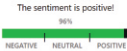
Step #3: Entity Linking

This API ascertains which of the key words are entities and links them in Wikipedia.

My favourite subject is biology since I love to know about nature and its mysteries. I am also good at drawing and biology has a lot of scope of drawing diagrams. Diagrams also make study easier.

The sentiment is positive!

96%



NEGATIVE NEUTRAL POSITIVE

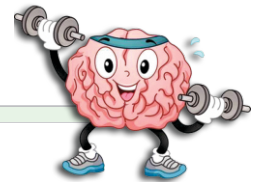
Learning Points

- Natural language processing domain of AI deals with natural human language.
- Communication cycle includes sender, receiver and communication channel.
- Message sent by sender is encoded while received by receiver, it is decoded.
- Syntax refers to the structure of the language.
- Semantics refers to the meaning of the language.
- NLP has its application in document processing, document classification, chatbots, sentiment analysis and digital assistants etc.

Key Learning

- **NLP:** Natural Language Processing.
- **Syntax:** Structure and grammar of a language.
- **Semantics:** Underlying meaning of language.
- **Sentiment:** Data that informs how someone feels about a product, service or person etc.
- **Digital Assistant:** An interactive digital device that understands natural spoken language.

Exercise



A. Select the correct answer.





1. Which of the following domains of AI deals with human speech and language?





a. NLP <input type="checkbox"/>	b. CV <input type="checkbox"/>
c. Both a) and b) <input type="checkbox"/>	d. Robotics <input type="checkbox"/>
2. Common example of NLP application is _____.





a. Digital assistant <input type="checkbox"/>	b. Chatbot <input type="checkbox"/>
c. Both a) and b) <input type="checkbox"/>	d. None of these <input type="checkbox"/>
3. Encoding the message is the responsibility of which of the following?





a. Sender <input type="checkbox"/>	b. Receiver <input type="checkbox"/>
c. Communication channel <input type="checkbox"/>	d. All of these <input type="checkbox"/>





4. Decoding the message is the responsibility of which of the following?





a. Sender		b. Receiver	
c. Communication channel		d. All of these	
5. Which of the following is not an example of communication channel?





a. Email		b. telephonic call	
c. online chat		d. None of these	
6. Nouns, pronouns, verbs and adjectives are the part of which of the following?

a. Semantics of the language		b. Syntax of the language	
c. Both a) and b)		d. None of these	
7. Tones, emotions, context and multiple meanings change which part of the language?

a. Semantics of the language		b. Syntax of the language	
c. Both a) and b)		d. None of these	
8. Machines are less concerned with which part of the language while processing it?

a. Grammar		b. Words	
c. Frequency of words		d. Sense of the words	
9. Affixes and roots together make which of the following?

a. Paragraph		b. Sentence	
c. Word		d. All of these	
10. Finding out what people feel about something by analysing their online details called _____?

a. Speech recognition		b. Voice recognition	
c. Digital fingerprinting		d. Sentiment analysis	

B. Match the column A with column B.

- | A | B |
|--------------------------|---------------------|
| 1. Encoding | a. Adjective |
| 2. Decoding | b. Air |
| 3. Syntax | c. Sender |
| 4. Semantics | d. Neutral |
| 5. Polarity | e. Multiple meaning |
| 6. Communication channel | f. Receiver |

C. Fill in the blanks.

Semantics, Communication, Frequency, Digital assistant, NLP, Syntax

1. Alexa and Siri are examples of _____.
2. _____ tends to bridge the gap between human language and machines.
3. Written letter is a mode of _____.

4. _____ helps framing a sentence while _____ helps in understanding it.
5. Document classification depends on the _____ of words in them.

D. Answer the following questions.

1. What do you mean by the term NLP?
2. List the functions of 3 components of communication cycle.
3. What do you mean by the terms: syntax and semantics. Give distinct example of each.
4. Remove the affixes of the following words and write their pure forms: studies, evolution, training, simplest, classification, data, easiest, qualification, eligibility, formation. Did you find any term that does not need cleaning?
5. What is the use of digital assistants?
6. How does sentiment analysis help businesses in retaining their customers?



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6

Think Like a Computer

Dear children,

Picking up from the previous learning



We have learnt...

- ...that computers work differently than human brain.
- ...about different types of intelligence.
- ...how different types of learning aid in different types of intelligence.
- ...what is Artificial Intelligence.
- ...about major applications of AI.
- ...Weak/Narrow AI.
- ...how computers understand images.
- ...how computers process human language.

Learning fundamentals of AI concepts is one aspect. The other aspect is to know how to write programs to develop AI algorithms. We know that computers can be instructed to perform various tasks. You must have heard people say “**program the computer**”. When we need to give similar set of instructions frequently to a computer then instead of typing all the instructions every time, we store the instructions in the desired sequence in a file. Such a file is called **executable file**. Then we just need to load that file in computer’s memory so that it reads the file and executes the instructions one-by-one. **Easy!**

Do You Know?
A set of instructions arranged in a logical sequence is called a program.

Computers only understand machine language (binary sequence of 0s and 1s) so our computer program is translated into machine language by a utility software called **translator**.

In programming, logical order or sequence of instructions is very important. Let us learn to think logically and type instructions for computer using an exciting tool called **Python turtle library**. *The purpose of this chapter is to develop your logical thinking and prepare you to understand serious programming in near future.*

What is Python?

Python is the most popular programming language today used to build programs for websites, artificial intelligence algorithms, games and robots. You will learn in detail about Python in higher classes. Let us have a quick look at its features:

Python is absolutely free.

Python is simple to learn and use.

Python has a rich collection of built-in libraries of programs to pick and use. These libraries are arranged in uniquely named packages such as turtle, statistics, nlp etc.

Python can run on all types of devices and operating systems.

Python Packages

Python has a huge collection of pre-designed programs called python libraries. These programs are organised in various collections called packages. To use the programs in a **package**, you just need to **import** that package in your Python script.

Note

Python programs are called **scripts**.

Opening Python Script Editor

To launch Python development environment, open the **Python n.x** folder in the **Start** menu and click on **IDLE (Python n.x...)** option.

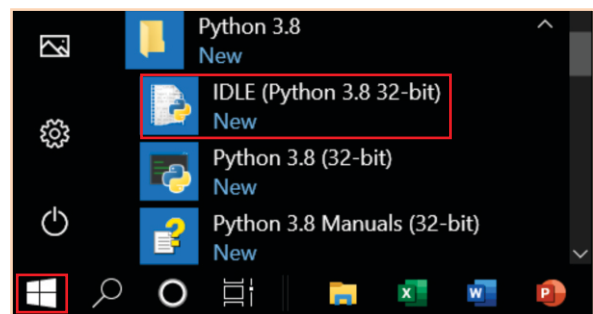
Python IDLE

IDLE is Python's **Integrated Development and Learning Environment**. It allows interactive as well as script modes to work with Python interpreter. It provides an editor to write and edit your scripts (programs) and to save them. Python shell is built into IDLE which interprets the commands and scripts submitted to it.

The script editor can be opened using Python shell window.

Click **File > New File** (or press Ctrl+N).

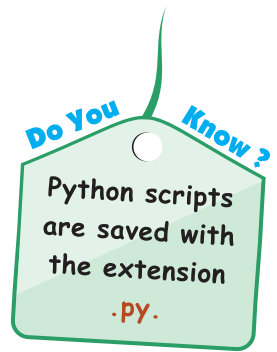
A separate window of script editor will open. Type the desired Python program.



Python Turtle Graphics

Turtle graphics is a drawing library of python which is used as an exciting tool to develop logical thinking while drawing amazing patterns and graphics on a canvas.

Let us dive right into drawing with turtle! From this point onwards, you are supposed to create your scripts by following the steps given here and understand the output by the explanation given along with.



Tom the turtle

Turtle is denoted by a small arrow which moves and draws on the canvas like a pen does on the paper. We call our turtle **Tom!** Let us begin. Open script editor and type the following lines as shown here:

Save the script by your_name_tom1.

```
tom1.py - C:/Users/ESOFT/Desktop/tom1.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3 tom.forward(100)
4
```

To run the script, press **F5** or **Run** menu > **Run Module** option.

What did you notice? Let us understand what is happening in this 3-line program.

import turtle

All your turtle graphics scripts will begin with this line because **import** command is making **turtle** library available to your script.

tom = turtle.Pen()

All the functions of turtle library can be accessed by mentioning **turtle** followed by a dot and then the required function. Here, we are using a function **Pen()** and assign a name to it i.e. **tom**.

Now all the drawing capabilities are available in tom.

Note

Turtle can also be created by function Turtle() such as tom = turtle.Turtle().

tom.forward(100)

Function **forward()** takes **100** as an argument and move tom forward by 100 steps.

Note

By default, turtle faces east (rightward). Turtle always moves forward or back in its current direction.

Note

What is a function?

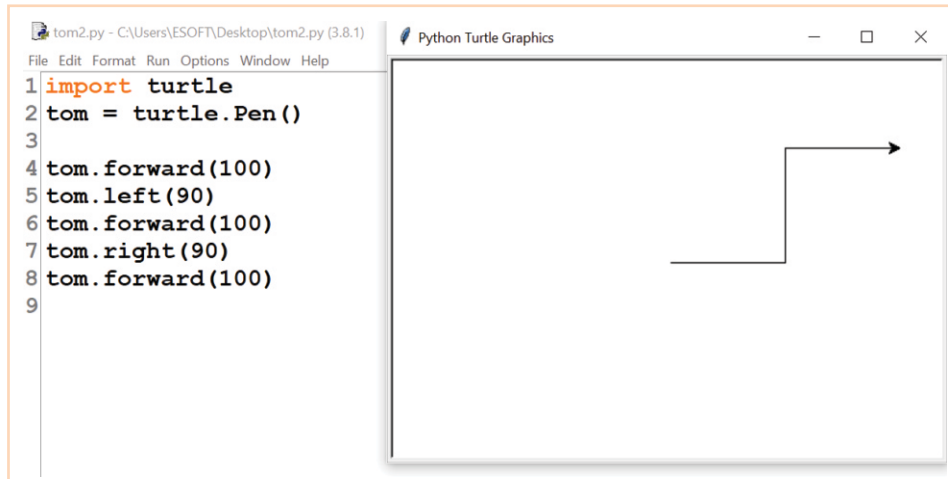
A function is a pre-designed program to do some useful task. It can be invoked by mentioning its name.

What is an argument?

Certain functions need some inputs to perform their task. Such inputs are called arguments. E.g. function **forward()** takes a number as argument to move the turtle as many steps.

Moving tom around

Let us try a small program to move our friend tom around on canvas as it draws. Open a new blank script and try this code:



```
tom2.py - C:\Users\ESOFT\Desktop\tom2.py (3.8.1) Python Turtle Graphics
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 tom.forward(100)
5 tom.left(90)
6 tom.forward(100)
7 tom.right(90)
8 tom.forward(100)
9
```

The screenshot shows a Python Turtle Graphics window with a script on the left and a canvas on the right. The script defines a turtle named 'tom' and moves it in a path that forms a right-angled shape: a horizontal line to the right, a vertical line upwards, and another horizontal line to the right. The turtle's head is at the end of the final horizontal line.

Let us compare output with the script.

Line 4: **tom.forward(100)** - First horizontal line is drawn.

Line 5: **tom.left(90)** – tom turns left (i.e. north or up direction in canvas).

Line 6: **tom.forward(100)** - Vertical line is drawn.

Line 7: **tom.right(90)** – tom turns right from its current position (i.e. east).

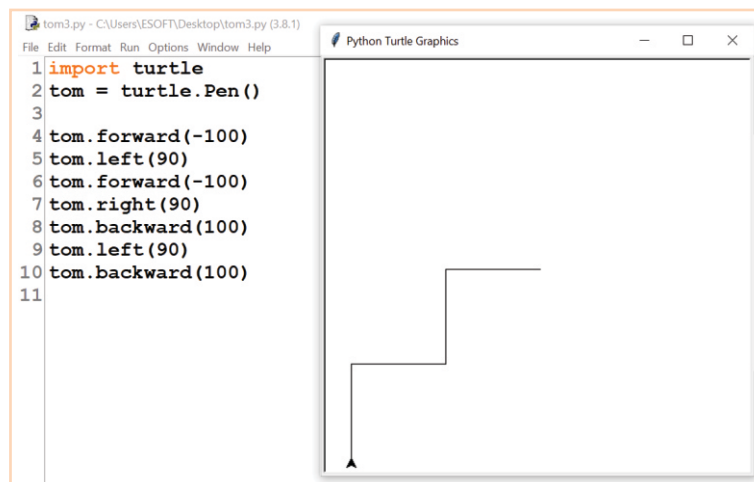
Line 8: **tom.forward(100)** – Second horizontal line is drawn.

What did you learn?

Turtle can be turned left and right by certain degrees.

Some functions take arguments to complete their task.

Try this script:



```
tom3.py - C:\Users\ESOFT\Desktop\tom3.py (3.8.1) Python Turtle Graphics
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 tom.forward(-100)
5 tom.left(90)
6 tom.forward(-100)
7 tom.right(90)
8 tom.backward(100)
9 tom.left(90)
10 tom.backward(100)
11
```

The screenshot shows a Python Turtle Graphics window with a script on the left and a canvas on the right. The script moves the turtle in a path that forms a right-angled shape, but with negative forward values and backward values. The turtle's head is at the end of the final backward movement.

Notice lines 4 and 8.

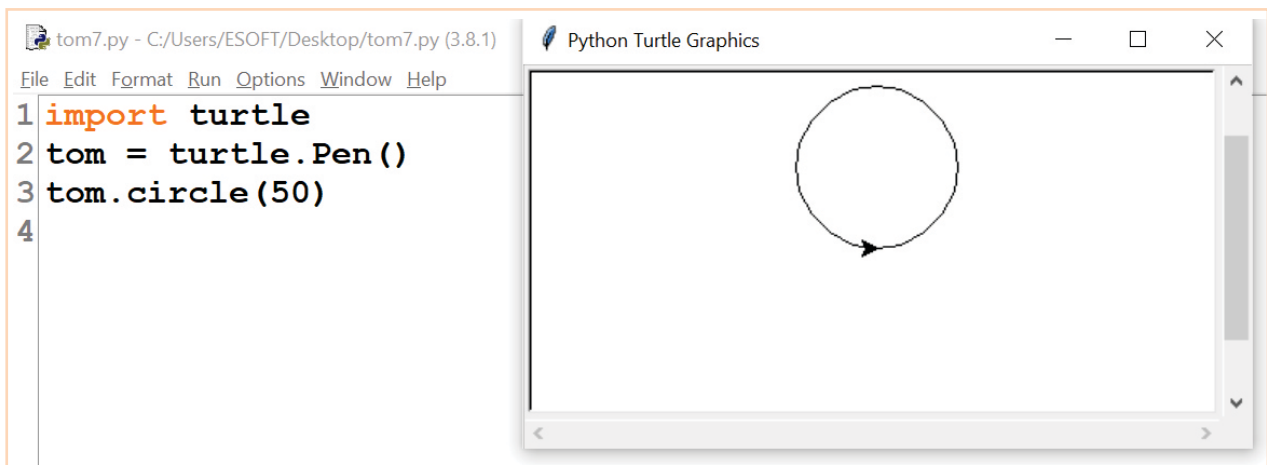
In line 4, **forward()** is passed **-100** that means 100 steps **backwards**. Same can be achieved by passing **100** to function **backward()** – see lines 8 and 10.

Also, compare this output with previous. Earlier, drawing is at the tail of the turtle while this drawing is at the mouth or tip of the turtle because it finally moved backwards while drawing.

- A. Draw a square of 100 steps.
- B. Draw a rectangle of 100 steps by 50 steps.

Drawing Circle

Function **circle()** takes the radius as argument and draws the circle. See this script drawing a circle of radius 50.



Repeating Tasks

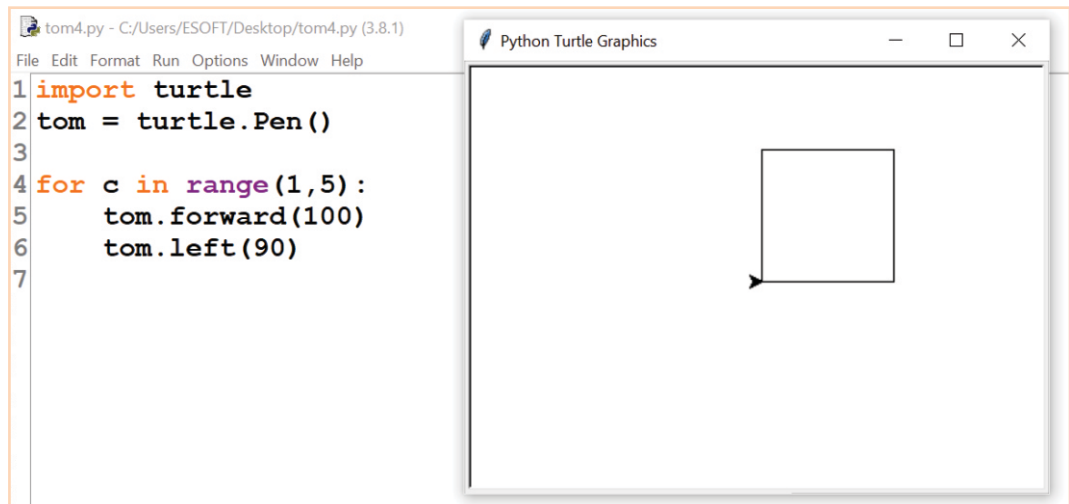
One great aspect of programming is that computer can repeat tasks for you several times as long as you need. You just need to tell the computer how many times you need it to execute the tasks. Such process of executing tasks repeatedly is called

looping. Let us

understand it. Try the following script:

To tell the computer how many times tasks should execute, use **for** keyword.

Notice line 4: **for c in range(1,5):** (it terminates with a colon)



Consider the function **range(1,5)**. This function creates a list of numbers in a range. Here, it is creating a list **1, 2, 3, 4**. (5 is the limit. List is created always one less from the upper limit.)

Now, see **for** keyword. It tells the computer to count from first number till last number of the list. But, **for** cannot count itself. It needs a name to identify each count. Here, that name is **c**. It is just an imaginary name given to each count. The value of **c** will be **1** for the first time.

Let us look at the task now. Notice lines 5 and 6. Line 5 will move the turtle 100 steps forward. Line 6 will turn the turtle left at right angle (90 degrees).

The value of **c** is **1** for the first time. A horizontal line is drawn. After that, program control will again return to line 4 and next count will occur. This time, value of **c** will become **2**. Still, upper limit is not reached, so lines 5 and 6 will execute the second time. Vertical line will be drawn at right angles to the horizontal line.

Next, program control will again return to line 4 and next count will occur. This time, value of **c** will become **3**. Still, upper limit is not reached, so lines 5 and 6 will execute the third time. Second horizontal line will be drawn at right angles to the vertical line.

Finally, program control will again return to line 4 and next count will occur. This time, value of **c** will become **4**. Still, upper limit is not reached, so lines 5 and 6 will execute the fourth and last time. Second vertical line will be drawn at right angles to the second horizontal line.

Program control will again return to line 4. This time count is over so looping will stop.

We got a square and turtle is back to home!

How does computer know which tasks to repeat? How did computer know in our program that line 5 and 6 are exactly the part of loop? Well, that is done by the help of **indentation**. Notice, lines 5 and 6 are shifted rightwards a little. This is called indentation. It is done by pressing **tab** key once. Python looks at indented lines and figures out which lines belong to which loop.

Activity



Draw the Output of the Script

Try this script and answer the questions that follow:

Q1: Which lines are the part of loop? How did you know?

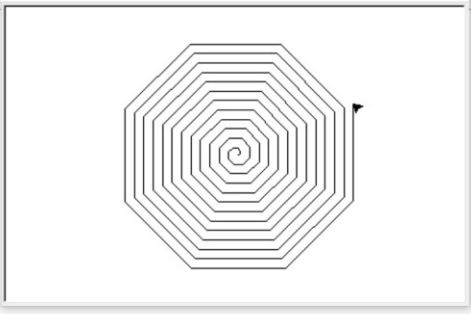
Q2: How many times lines 7 and 8 will execute?

```
tom5.py - C:/Users/ESOFT/Desktop/tom5.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 for c in range(1,5):
5     tom.forward(100)
6     tom.left(90)
7 tom.left(45)
8 tom.forward(140)
9
```

Playing with loop counter

You can use loop counter to create interesting drawings. Try this script:

```
tom6.py - C:/Users/ESOFT/Desktop/tom6.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 for c in range(1,100):
5     tom.forward(c)
6     tom.left(45)
7
```



Line 4: **for** loop is counting **99** times. In line 5, function **forward(c)** is taking value of counter **c** which is changing every time the loop executes. That is why, the lines drawn get longer and longer in the output. The shape is an octagon (**8** sides) because of line 6 which turns the turtle **45 degrees**. ($45 \times 8 = 360$ degrees complete).

Try changing values of **c** and draw different patterns.

Try the following scripts and draw their outputs.

```
tom7.py - C:/Users/ESOFT/Desktop/tom7.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 for c in range(1,9):
5     tom.circle(50)
6     tom.right(45)
7
```

```
tom6.py - C:/Users/ESOFT/Desktop/tom6.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 tom.forward(50)
5 for c in range(1,28):
6     tom.forward(c)
7     tom.left(c)
8
9 tom.right(18)
10 tom.forward(50)
11
12 for c in range(1,28):
13     tom.forward(c)
14     tom.left(c)
```

Background Colour, Pen Colour and Pen Width

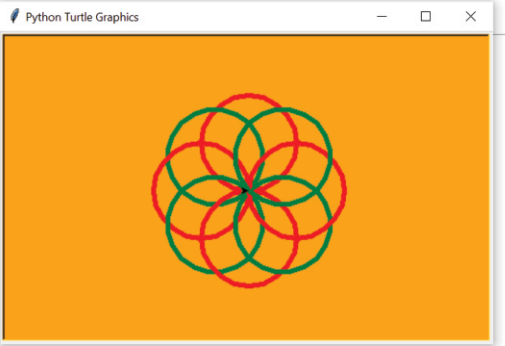
You can set the colour and width of the pen to draw.

The white background of the canvas can be set to a colour using function **turtle.bgcolor()**. It takes the name of the colour as argument.

Function **pencolor()** takes the name of the colour as argument and function **width()** takes a number for width as argument.

See this script.

```
tom8.py - C:/Users/ESOFT/Desktop/tom8.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2
3 tom = turtle.Pen()
4 tom.width(5)
5 turtle.bgcolor("orange")
6
7 for c in range(1,5):
8     tom.pencolor("red")
9     tom.circle(50)
10    tom.left(45)
11    tom.pencolor("green")
12    tom.circle(50)
13    tom.left(45)
14
```



Here, in line 4, width of the pen is set to 5 pixels.

In line 5, background colour of the canvas is set to **orange**.

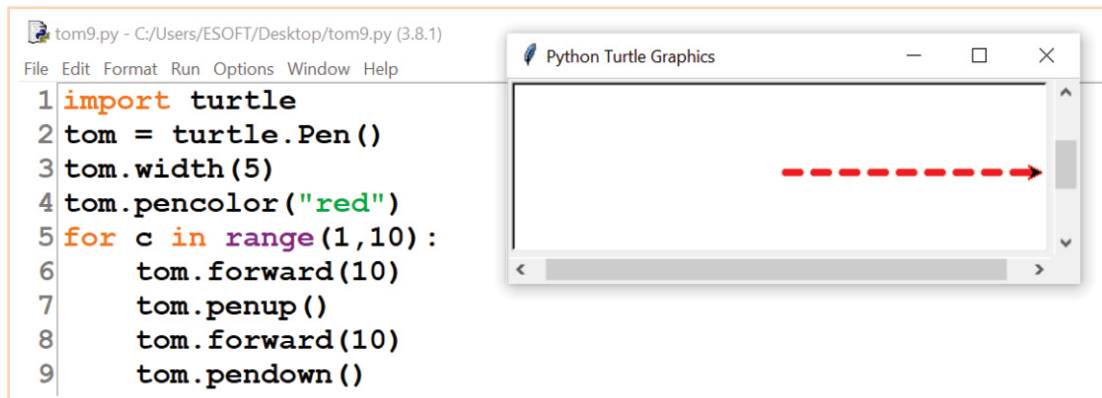
In lines 8 and 11, colour of the pen is set to **red** and **green** respectively.

The loop is running **4** times, drawing 8 circles. Every time a circle is drawn, the turtle turns **left** by **45** degrees and colour changes alternatively. (Every red circle is at 90 degree (45+45) and green circle at 45 degree.)

To draw or not to draw

Function **penup()** makes the turtle move without drawing. Function **pendown()** makes the turtle draw. Both these functions do not need any argument.

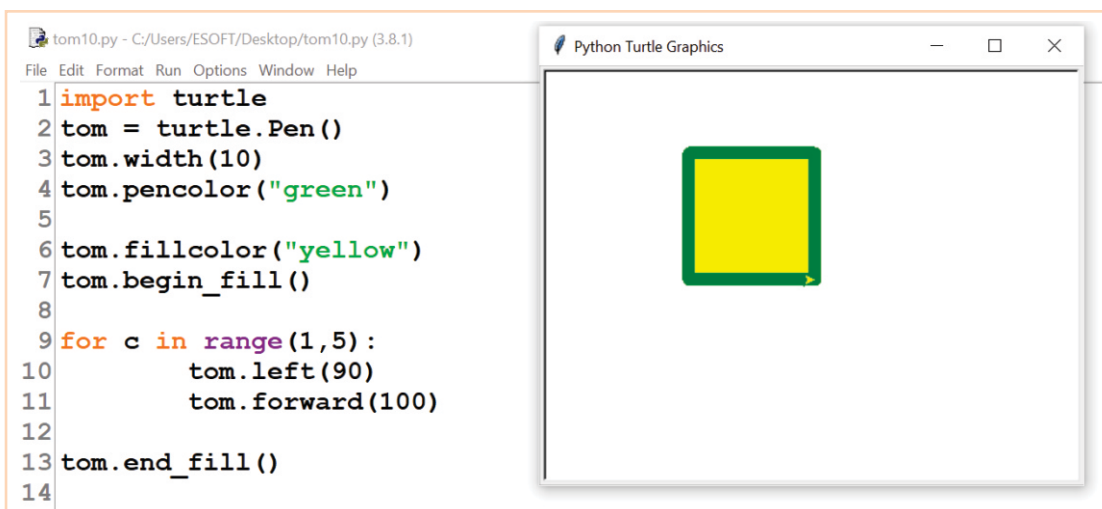
See this script that draws dashed line using **penup()** and **pendown()** alternatively in a loop which runs **9** times (notice the number of dashes is 9).



```
tom9.py - C:/Users/ESOFT/Desktop/tom9.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3 tom.width(5)
4 tom.pencolor("red")
5 for c in range(1,10):
6     tom.forward(10)
7     tom.penup()
8     tom.forward(10)
9     tom.pendown()
```

Filling Colours in Drawings

Function **fillcolor()** takes the name of the colour as argument and fills colour in the drawing. To fill the colour, we must inform the computer when the drawing is beginning and when it is ending. To do this, functions **begin_fill()** and **end_fill()** are used. **fill_color()** always falls between them. See this script drawing a yellow square with green outline.



```
tom10.py - C:/Users/ESOFT/Desktop/tom10.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3 tom.width(10)
4 tom.pencolor("green")
5
6 tom.fillcolor("yellow")
7 tom.begin_fill()
8
9 for c in range(1,5):
10     tom.left(90)
11     tom.forward(100)
12
13 tom.end_fill()
14
```

See line 6. In it, function **fillcolour()** is taking colour name **yellow** as argument.

Notice lines 7 and 13. They are marking the beginning and end of the drawing. Between them, the drawing is done by the code in lines 9, 10 and 11. When drawing ends, yellow colour is filled.

Note

Function `fillcolor()` also sets the colour of the turtle. Similarly, function `pencolor()` also sets the outline colour of the turtle.

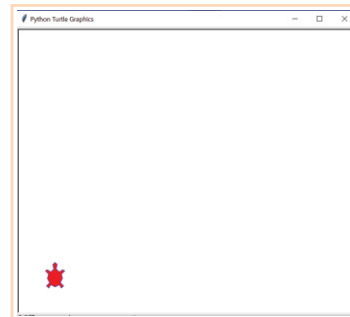
Other Common Turtle Functions

There are certain other functions you can apply on the turtle such as:

<code>shape()</code>	Changes the shape of the <i>turtle</i> to <i>turtle</i> , <i>arrow</i> , <i>triangle</i> , <i>circle</i> , <i>square</i> and <i>classic</i> .
<code>shapeseize()</code>	Changes the size of the turtle.
<code>setpos()</code>	Moves the turtle to specified x,y coordinates on the canvas.
<code>undo()</code>	Cancel the last action done by turtle.
<code>clear()</code>	Clears the canvas.
<code>reset()</code>	Clears the canvas, resets turtle to all default settings and brings the turtle to coordinates 0,0.

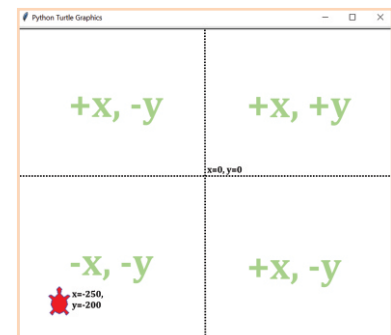
See the example below (lines 4, 6 and 8):

```
tom16.py - F:/Edusoft/AI-417_2020/A1-417-VI/Book-v2/pyj
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Turtle()
3
4 tom.shape("turtle")
5 tom.fillcolor("red")
6 tom.shapesize(2)
7 tom.penup()
8 tom.setpos(-250,-200)
9 tom.pencolor("blue")
10 tom.left(90)
```



Canvas Coordinates

The centre of the canvas is $x=0, y=0$. As you move **up**, y coordinate **increases** and as you move **down**, y coordinate **decreases**. As you move **right**, x coordinate **increases** and as you move **left**, x coordinate **decreases**.



Learning Points



- Computers only understand machine language.
- Computer program is translated into machine language by a utility software called translator.
- Python programming language is free, simple to learn and loaded with powerful libraries.
- Python IDLE is an integrated learning and development environment to develop and manage Python programs.
- Python IDLE works in interactive and script modes.
- Python turtle library is useful to learn Python basics.
- Python files have extension .py.
- Python turtle draws on a canvas.



- Translator:** Utility software that converts computer language program into machine language.
- Library:** Collection of pre-designed programs.
- Package:** Organisation of libraries.
- Script:** A Python program.
- Function:** An independent piece of code identified by a unique name.
- Argument:** Value passed to a function.
- Loop:** The block of program executing repeatedly.
- Indentation:** Tab-shifting the line of code to align them as the part of a block.

Exercise



A. Select the correct answer.

1. A computer file containing a computer program is called a/an _____ file.
- | | | | |
|---------------|--------------------------|-----------------|--------------------------|
| a. Logic | <input type="checkbox"/> | b. Instructions | <input type="checkbox"/> |
| c. Executable | <input type="checkbox"/> | d. Icon | <input type="checkbox"/> |

2. A translator is which of the following types of software?
- | | | | |
|-------------|--------------------------|------------|--------------------------|
| a. Computer | <input type="checkbox"/> | b. Useful | <input type="checkbox"/> |
| c. Utility | <input type="checkbox"/> | d. Machine | <input type="checkbox"/> |
3. Python is which of the following?
- | | | | |
|-------------------------|--------------------------|---------------|--------------------------|
| a. Software | <input type="checkbox"/> | b. AI Program | <input type="checkbox"/> |
| c. Programming language | <input type="checkbox"/> | d. Utility | <input type="checkbox"/> |
4. Collections of useful, predesigned programs are called which of the following?
- | | | | |
|------------|--------------------------|-----------------|--------------------------|
| a. Library | <input type="checkbox"/> | b. Template | <input type="checkbox"/> |
| c. Theme | <input type="checkbox"/> | d. All of these | <input type="checkbox"/> |
5. Python libraries are organised as which of the following?
- | | | | |
|-------------------|--------------------------|--------------|--------------------------|
| a. Themes | <input type="checkbox"/> | b. Templates | <input type="checkbox"/> |
| c. Both a) and b) | <input type="checkbox"/> | d. Packages | <input type="checkbox"/> |
6. Python programs are called which of the following?
- | | | | |
|--------------|--------------------------|--------------|--------------------------|
| a. Utilities | <input type="checkbox"/> | b. Libraries | <input type="checkbox"/> |
| c. Packages | <input type="checkbox"/> | d. Scripts | <input type="checkbox"/> |
7. We can save our Python programs in which of the following modes of IDLE?
- | | | | |
|---------------------|--------------------------|------------------|--------------------------|
| a. Interactive mode | <input type="checkbox"/> | b. Script mode | <input type="checkbox"/> |
| c. Both a) and b) | <input type="checkbox"/> | d. None of these | <input type="checkbox"/> |
8. The extension of Python program files is which of the following?
- | | | | |
|---------|--------------------------|---------|--------------------------|
| a. .ipy | <input type="checkbox"/> | b. .pyt | <input type="checkbox"/> |
| c. .pyn | <input type="checkbox"/> | d. .py | <input type="checkbox"/> |
9. One of the most appealing features of Python is that it _____.
- | | |
|--------------------------------------------|--------------------------|
| a. is free | <input type="checkbox"/> |
| b. is simple to learn and use | <input type="checkbox"/> |
| c. has huge collection of useful libraries | <input type="checkbox"/> |
| d. All of these | <input type="checkbox"/> |
10. To use a package in our Python programs, we need to _____ it.
- | | | | |
|-----------|--------------------------|-----------|--------------------------|
| a. Insert | <input type="checkbox"/> | b. Export | <input type="checkbox"/> |
| c. Import | <input type="checkbox"/> | d. Select | <input type="checkbox"/> |
11. The two ways to run a Python script in Python IDLE are:
- | | | | |
|-------------------------------|--------------------------|-------------------------------|--------------------------|
| a. Press F5, Run > Run Module | <input type="checkbox"/> | b. Press F6, Run > Run Module | <input type="checkbox"/> |
| c. Press F5, Run > Run Script | <input type="checkbox"/> | d. Press F6, Run > Run Script | <input type="checkbox"/> |
12. turtle.forward(50) - in this statement, what is 50?
- | | | | |
|-------------|--------------------------|--------------|--------------------------|
| a. A number | <input type="checkbox"/> | b. Direction | <input type="checkbox"/> |
| c. Argument | <input type="checkbox"/> | d. Output | <input type="checkbox"/> |

13. turtle.right(45) - in this statement, what is 45?
- | | | | |
|-----------|--------------------------|-------------------|--------------------------|
| a. Steps | <input type="checkbox"/> | b. Degree | <input type="checkbox"/> |
| c. Length | <input type="checkbox"/> | d. How many times | <input type="checkbox"/> |
14. turtle.backward(-50) and turtle.forward(50) means what?
- | | | | |
|------------------------|--------------------------|------------------|--------------------------|
| a. Same | <input type="checkbox"/> | b. Not same | <input type="checkbox"/> |
| c. Error in statements | <input type="checkbox"/> | d. None of these | <input type="checkbox"/> |
15. for x in range(1,10): - this loop should execute how many times?
- | | | | |
|-------|--------------------------|------------------|--------------------------|
| a. 11 | <input type="checkbox"/> | b. 10 | <input type="checkbox"/> |
| c. 9 | <input type="checkbox"/> | d. None of these | <input type="checkbox"/> |
16. The statement which are a part of a block such as loop are _____ together.
- | | | | |
|----------|--------------------------|-------------|--------------------------|
| a. Coded | <input type="checkbox"/> | b. Kept | <input type="checkbox"/> |
| c. Saved | <input type="checkbox"/> | d. Indented | <input type="checkbox"/> |
17. If Python turtle has to draw a dashed line (----) then it must us _____.
- | | | | |
|-------------------|--------------------------|-----------------|--------------------------|
| a. penup() | <input type="checkbox"/> | b. pendown() | <input type="checkbox"/> |
| c. Both a) and b) | <input type="checkbox"/> | d. draw(yes/no) | <input type="checkbox"/> |
18. turtle.fillcolor("red") - this statement is doing what?
- | | |
|-----------------------------------------|--------------------------|
| a. Filling colour in the figure drawn | <input type="checkbox"/> |
| b. Only setting the colour to be filled | <input type="checkbox"/> |
| c. Filling the outline colour | <input type="checkbox"/> |
| d. Only setting the outline colour | <input type="checkbox"/> |
19. To clear the canvas, reset default settings and bring the turtle to the centre of the stage, we use which of the following functions?
- | | | | |
|-------------------|--------------------------|------------|--------------------------|
| a. clear() | <input type="checkbox"/> | b. reset() | <input type="checkbox"/> |
| c. Both a) and b) | <input type="checkbox"/> | d. undo() | <input type="checkbox"/> |
20. The centre of the turtle canvas is denoted by which of the following values of coordinates x,y?
- | | | | |
|------------|--------------------------|------------|--------------------------|
| a. 0,0 | <input type="checkbox"/> | b. 100,100 | <input type="checkbox"/> |
| c. 500,500 | <input type="checkbox"/> | d. 1,1 | <input type="checkbox"/> |

B. Match the functions in column A with their use in column B.

- | A | B |
|---------------|-------------------------------------------------------|
| 1. Pen() | a. Clear the canvas. |
| 2. range() | b. Creates a turtle by some name. |
| 3. bgcolor() | c. Marks the end of filling colour in a figure drawn. |
| 4. end_fill() | d. Brings turtle to coordinates 0,0. |
| 5. clear() | e. Creates a list of numbers. |
| 6. reset() | f. Sets the colour of the canvas. |

C. Explain the following terms in one sentence.

1. Program

2. Script

3. Translator

4. Python Library

5. Package

D. Answer the following questions.

1. How is interactive mode of Python IDLE from Script mode?
2. Explain the use of the term import with an example.
3. List major features of Python.
4. What is turtle? Why do we need to import it in Python script?
5. What is a function Python programming?
6. What is a function argument? Explain with a small example.
7. What is the significance of indentation in Python programming?
8. Which function help in starting and stopping filling colour in a figure drawn by Python turtle?
9. How can we set the outline colour of a figure to be drawn by Python turtle? Give example.
10. Briefly explain Python turtle canvas coordinates.

E. Draw the output of the following Python turtle scripts. Give brief explanation wherever you think necessary.

```
import turtle
t = turtle.Pen()
for x in range(1,9):
    t.forward(100)
    t.left(45)
    t.backward(25)
```

```
import turtle
t = turtle.Pen()
for x in [50, 60, 80, 90,
100]:
    t.circle(x)
    t.left(180)
```

```
import turtle
t = turtle.Pen()

for x in [5, 10, 15]:
    t.forward(100)
    t.width(x)
    t.left(-120)
```

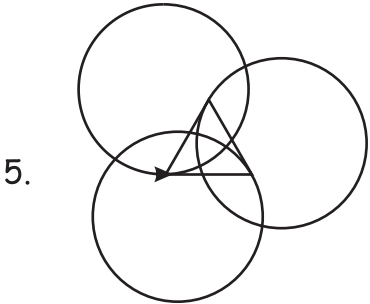
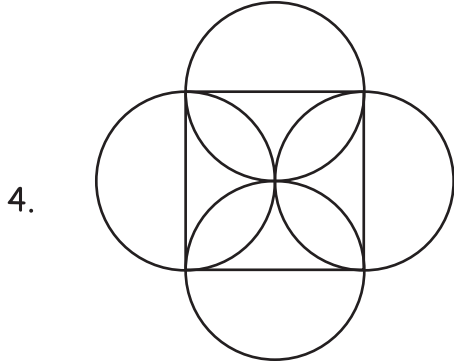
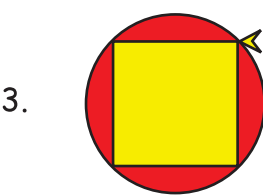
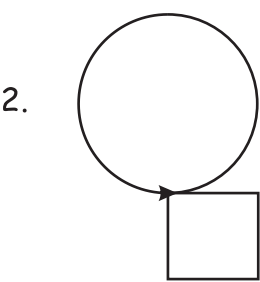
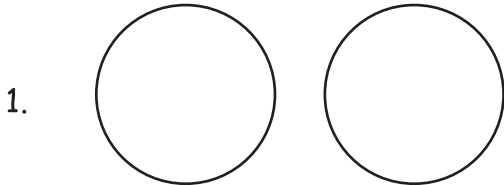
```
import turtle
t = turtle.Pen()

t.fillcolor("yellow")
turtle.bgcolor("blue")
t.circle(50)
```

```
import turtle
t = turtle.Pen()

t.fillcolor("red")
turtle.bgcolor("yellow")
t.pencolor("green")
t.width(10)
t.begin_fill()
t.circle(50)
t.end_fill()
```

F. Write Python turtle scripts to display following outputs.



Watch & Learn

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7

Programming with Python

Dear children,

Picking up from the previous learning



We have learnt...

- ...that computers work differently than human brain.
- ...about different types of intelligence.
- ...how different types of learning aid in different types of intelligence.
- ...what is Artificial Intelligence.
- ...about major applications of AI.
- ...how computers understand images.
- ...how computers process human language.
- ...what is python.
- ...how a computer thinks one step at a time and in loops.

In this chapter, we shall look at Python programming in little more detail with complete input-process-output cycle and learn many powerful features of the language.

Fun with Python Arithmetic

Open Python IDLE and try out the following commands on the Python shell prompt >>> directly.



Command	Explanation
2 + 2	Simple addition using + operator.
43 - 7 * 9	Simple arithmetic using subtraction and multiplication operators.
(23 + 2 * 5)/5	Division using / operator.
15/2	This division will return float value that means number with decimal places.
17/3	Division with several decimal places.
17//3	Decimal places are suppressed using // instead of /.
5%2	Remainder of division will be returned using modulus (pron: modulo) operator %.
5**2	Calculating 5 to the power 2.
2**8	Calculating 2 to the power 8.

Python IDLE Working Modes

What did you notice and learn from the commands? What you have been working in is called **Interactive mode** of Python IDLE. IDLE stands for **I**ntegrated **D**evelopment & **L**earning **E**nvironment. IDLE is a combination of command prompt, script editor, Python interpreter to execute scripts and to debug (finding errors and fixing them) scripts. Such a development environment is called IDE. In interactive mode, we issue commands one at a time and get their output immediately. You have already worked in the other mode that is **Script mode** in which we write Python script (program), save it and can run it any time later.

The screenshot shows two windows from Python IDLE. The left window is the 'Python 3.8.1 Shell' showing the following output:

```
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 22:39:24) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> 25%12
1
>>> 25/12
2.0833333333333335
>>> 25//12
2
>>> |
```

The right window is a script editor showing a Python script:

```
1 import turtle
2 tom = turtle.Pen()
3
4 for c in range(1,5):
5     tom.forward(100)
6     tom.left(90)
7 tom.left(45)
8 tom.forward(140)
9
```

Python Arithmetic Operators

Various arithmetic operators in Python you practiced are summarised here.

Operator	Type	Explanation	Example
+	Binary	Addition operator	a = 5 + 2
-	Binary	Subtracts the two number	a = 5 - 2

*	Binary	Multiplication	$a = 5 * 2$
/	Binary	Division	$a = 5 / 2$ (will return float 3.5) $b = 4 / 2$ (will return integer 2)
//	Binary	Division and discards decimal places in result	$a = 5 // 2$ (will return integer 2) $b = 23 // 5$ (will return integer 4)
%	Binary	Modulus (pronounced: modulo returns remainder of the division)	$a = 3 \% 2$ (will return 1) $b = 4 \% 2$ (will return 0)
**	Binary	Exponentiation (to the power of)	$a = 5 ** 2$ (will return 25)

Activity



Simple Calculations

Create a Python script and write statements to calculate the following:

- 25% discount of the amount 2947.
- $(13 - 25)^2$ Consider the formula: $(a - b)^2 = a^2 + b^2 - 2ab$.
- How many feet are there in 13 feet, 4 inches (13.4)?
- Inches from 12.8 feet. (i.e. 0.80).
- 8 to the power 4.

Python Variables

What we input to the computer, goes into its memory. The values in scripts can be identified by unique names called **variables**. See this familiar example:

Here, loop counter c is holding values 1, 2, 3, and 4 after each iteration of the loop. c is a variable.

Value of a variable usually changes during the execution of the program hence the term **variable**.

Variables can store various values such as whole numbers (called integers), numbers with decimal places (called floats) and strings (any value enclosed in quotes e.g. "hello", "265", 'how are you?', 'I am in single quotes')

```
1 import turtle
2 tom = turtle.Pen()
3
4 for c in range(1, 5):
5     tom.forward(100)
6     tom.left(90)
```

Simple Input and Output

Every programming language has ways of receiving input from the user and to display the output.

input(): In Python, input() function is used to display a prompt to the user to enter a value and it returns the input from the user. The returned value can be stored in a variable. The value returned by input() is in string format. Even if a number has been entered, it would be returned by input() as a string.

```
n = input("What is your name?")
print("Welcome ",n)
```

For example, in this script, notice the first line. The prompt What is your name is passed into input() within double quotes.

This line will display this prompt to the user and when user enters the value, it will be returned into the variable n. The value returned by input() is assigned to the variable on the left hand side of the **assignment operator (=)**.

print(): Python's print() accepts values to be displayed as parameter and displays them as output. Values can be separated by comma or combined by arithmetic operators if any calculation is required. In the previous example, notice the second line. print() is passed two parameters, string Welcome and the variable n (which holds

```
What is your name?ARJUN
Welcome ARJUN
>>>
```

user's input). Notice that variable is not within quotes since its value will be substituted in its place when print() will execute. Can you figure the output? See for yourself. User had entered the string ARJUN.

Activity



Simple Swap

Create a Python script with 3 variables: x, y and z. Accept numbers in variables a and b. Then, swap (interchange) their values by the help of variable z and display them back to the user showing that now a has b's value and vice versa.

Dual role of + Operator

We know that + operator is an arithmetic operator to perform addition. But, with strings, it works as **concatenation** operator. In simple terms, it joins the strings.

```
File Edit Format Run Options Window Help
a = input("Enter a number:")
b = input("Enter another number:")
print(a + b)
```

For example, consider the script given here. What should be its output if user enters first number as 23 and second as 12?

Here, 23 entered by the user will be returned by input() into the variable a. Value 12 will be stored in variable b. Notice the output. Instead of performing addition, + operator has combined the two numbers to make them 2312. The reason is, input() returns every value as a string and + operator has concatenated (joined) the two. That is why explicit conversion of the values is needed to perform desired operation.

```
Enter a number:23
Enter another number:12
2312
```

Implicit and Explicit Data Type Conversion

During an arithmetic operation, if required, Python automatically does data conversion known as implicit data type conversion.

For example: `a = 2 * 3.5`

This will result into a float value since data conversion is automatically taken care of by Python.

For explicit conversion, Python provides a set of built in data conversion functions as follows:

Function	Example
<code>int()</code>	<code>a = 3.5, b = 2 * int(a)</code> <code>int()</code> converts the given float value to integer. Here, value 3.5 of the variable <code>a</code> will be converted to 3 (note that it is not rounded off, just decimal part is discarded) <code>x = "3" y = 5 + int(x)</code> <code>int()</code> will convert string 3 into its numeric equivalent integer 3
<code>float()</code>	<code>a = 3 b = 2 * float(a)</code> <code>float()</code> converts the given value to integer. Here, value 3 of the variable <code>a</code> will be converted to 3.0 and variable <code>b</code> will store 6.0. Since, here the other number (ie. 2) is plicitly convert the result into float.
<code>str()</code>	<code>a = 62 b = str(a)</code> <code>str()</code> converts the given value to string. Here, integer value 62 of the variable <code>a</code> will be converted to string type 62

For example, in this program, the string type values are converted and returned as integers by `int()` function while they are now added by `+` operator, giving the desired result.

```
File Edit Format Run Options Window Help
a = input("Enter a number:")
b = input("Enter another number:")
print("The answer is:", int(a) + int(b))
```

```
Enter a number:23
Enter another number:12
The answer is: 35
```

Activity



Intelligent Swap

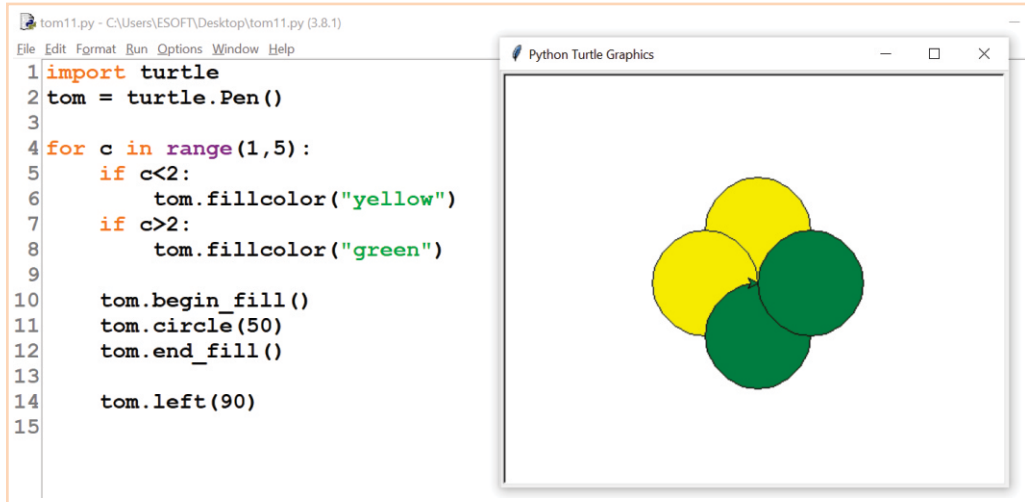
Consider the script created in the previous activity **Simple Swap**. Optimise the script to do the same thing without using any third variable.

Decision Making

You can add ability of taking decisions into your scripts by using `if` keyword.

`if` checks a condition and if that condition is true, it allows required statements to be executed.

Let us understand this with a script shown here.



This is a very interesting script. Notice line 5: **if c<2:** (ending with colon)

if keyword is followed by a condition. **A condition compares two values.** Here, value of c is compared for less than (<) 2.

Line 6 is part of **if** and it will execute only if condition **c<2** is true. Similarly, in line 7, value of c is compared with greater than (>) 2. Line 8 is part of **if** and it will execute only if condition **c>2** is true. Let us see the flow of the script:

```
5     if c<2:
6         tom.fillcolor("yellow")
```

```
7     if c>2:
8         tom.fillcolor("green")
```

Value of c	c<2	c>2	Statement executed	Output
1	True	False	<pre>5 if c<2: 6 tom.fillcolor("yellow") 10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90)</pre>	Yellow circle
2	False	False	<pre>10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90)</pre>	Yellow circle (yellow colour already set)
3	False	True	<pre>7 if c>2: 8 tom.fillcolor("green") 10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90)</pre>	Green circle
4	False	True	<pre>7 if c>2: 8 tom.fillcolor("green") 10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90)</pre>	Green circle

Here, most interesting thing is happening when value of **c** is **2**. In this case, neither of the two ifs will execute but last set fill colour yellow remains in computer memory so the second circle drawn will have yellow fill colour.

For values of **c** as **3** and **4**, line 8 will execute.

All comparison operators are given here.

Operator	Type	Example
<	Less than	5<10 (true) 5>10 (false)
>	Greater than	5<10 (false) 5>10 (true)
==	Equal to	5==5 (true) 5==10 (false)
<=	Less than or equal to	3<=5 (true) 5<=5 (true) 5<=3 (false)
>=	Greater than or equal to	5>=3 (true) 5>=5 (true) 3>=5 (false)
!=	Not equal to	3!=5 (true) 3!=3 (false)

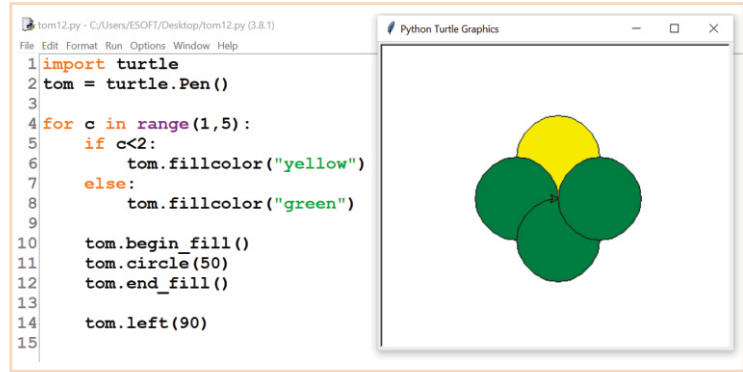
Previous example of if is modified a little in this script (see lines 9 and 10). Can you guess the output?

```
tom11.py - C:\Users\ESOFT\Desktop\tom11.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 for c in range(1,5):
5     if c<2:
6         tom.fillcolor("yellow")
7     if c>2:
8         tom.fillcolor("green")
9     if c==2:
10        tom.fillcolor("blue")
11    tom.begin_fill()
12    tom.circle(50)
13    tom.end_fill()
14
15    tom.left(90)
```

This, otherwise that

Along with **if** keyword, we can use **else**. It executes when **if** fails (i.e. condition of if returns false).

Keyword **else** does not need to evaluate any condition. See this example.



```

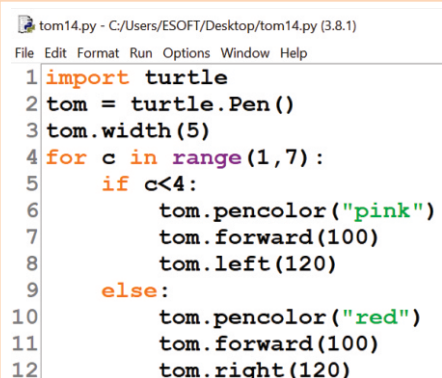
1 import turtle
2 tom = turtle.Pen()
3
4 for c in range(1,5):
5     if c<2:
6         tom.fillcolor("yellow")
7     else:
8         tom.fillcolor("green")
9
10    tom.begin_fill()
11    tom.circle(50)
12    tom.end_fill()
13
14    tom.left(90)
15

```

Why 3 green circles? Line 7 is the reason. See the flow of the script.

Value of c	c<2	Else	Statement executed	Output
1	True	Skipped	<pre> 5 if c<2: 6 tom.fillcolor("yellow") 10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90) </pre>	Yellow circle
2	False	Executes	<pre> 7 else: 8 tom.fillcolor("green") 10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90) </pre>	Green circle
3	False	Executes	<pre> 7 else: 8 tom.fillcolor("green") 10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90) </pre>	Green circle
4	False	Executes	<pre> 7 else: 8 tom.fillcolor("green") 10 tom.begin_fill() 11 tom.circle(50) 12 tom.end_fill() 13 14 tom.left(90) </pre>	Green circle

What figure should this script draw?



```

1 import turtle
2 tom = turtle.Pen()
3 tom.width(5)
4 for c in range(1,7):
5     if c<4:
6         tom.pencolor("pink")
7         tom.forward(100)
8         tom.left(120)
9     else:
10    tom.pencolor("red")
11    tom.forward(100)
12    tom.right(120)

```

Fun with Python Lists

Python allows to store various values as a list of items. We identify the list in our scripts by a unique name. Python lists look like this:

```
["yellow", "green", "pink", "red", "blue", "white", "black", "orange"]
```

```
[1, 2, 3, 4, 5, 6, 7, 8]
```

```
["delhi", "monkey", "spiderman", 22, 15.5, "welcome", 59]
```

Notice that list is heterogenous since it can store different types of values.

Let us see its use through some examples:

Example 1

Script

```
list.py - F:/Edusoft/AI-417_2020/A1-417-VI/Book-v2/py/list.py (3.8.1)
File Edit Format Run Options Window Help
1 mylist = ["red", 25, "delhi", 45.56, "saturday"]
2
3 print("Full list is: ")
4 print(mylist)
5
6 print("\nFirst item in list ")
7 print(mylist[0])
8
9 print("\nLast item in list ")
10 print(mylist[4])
11
12 i = int(input("\nWhich item:"))
13 print(mylist[i])
14
15 print("\nALL ITEMS:")
16 for c in range(0,5):
17     print(mylist[c])
```

Output

```
Full list is:
['red', 25, 'delhi', 45.56, 'saturday']

First item in list
red

Last item in list
saturday

Which item:4
saturday

ALL ITEMS:
red
25
delhi
45.56
saturday
```

\n is a special character that inserts a new blank line.

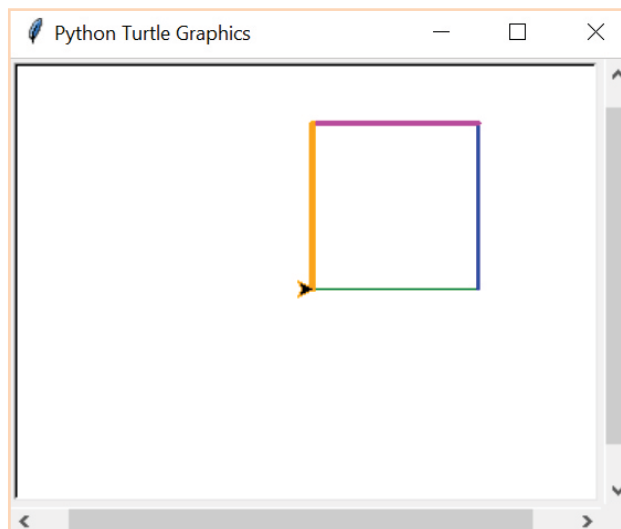
Command	Explanation
1	A list mylist declared with 5 items (3 strings, 1 integer, 1 float).
4	Function print() takes list name mylist to display it completely.
7	Lists use zero based index, hence mylist[0] refers to value red .
10	mylist[4] refers to value saturday .
12	Value of variable i is given by user which is used as index.
17	mylist[c] has current value of c substituted. One by one, all value at index 0 to 4 are displayed.

Example 2

Script

```
list1.py - F:\Edusoft\AI-417_2020\A1-417-VI\Book-v2\py\list1.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 colors = ["red", "green", "blue", "magenta", "orange"]
5
6 for c in range(1,5):
7     tom.pencolor(colors[c])
8     tom.width(c)
9     tom.forward(100)
10    tom.left(90)
```

Output

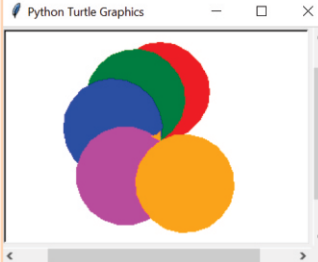


Line #	Explanation
4	A list colors declared with 5 colour names.
7	Function pencolor() takes list name colors along with c as index in [and]. Current value will fetch colour name at current index in the list.
8	Function width() takes current value of variable c to set the pen width. Notice the output - every next line is thicker than the previous one due to increasing value of c (1, 2, 3, 4).

Read the previous script and explain why red line was not drawn in the output.

Example 3

```
list2.py - F:\Edusoft\AI-417_2020\A1-417-VI\Book-v2\py\list2.py (3.8.1)
File Edit Format Run Options Window Help
1 import turtle
2 tom = turtle.Pen()
3
4 colors = ["red", "green", "blue", "magenta", "orange"]
5 angles = [30, 45, 60, 75, 90]
6
7
8 for c in range(0,5):
9     tom.begin_fill()
10    tom.pencolor(colors[c])
11    tom.circle(50)
12    tom.fillcolor(colors[c])
13    tom.left(angles[c])
14    tom.end_fill()
```



Line #	Explanation
4	A list colors declared with 5 colour names.
5	A list angles declared with 5 integers.
9, 11	Functions pencolor() and fillcolor() take list name colors along with c as index. Current value will fetch colour name at current index in the list. Notice the output - every circle has outline and fill in the current color.
12	Function left() takes current value of variable c to set the angle of turning left. Notice the output - every circle is at different angle (30, 45, 60, 75,90).

Example 4

```
list3.py - F:\Edusoft\AI-417_2020\A1-417-VI\Book-v2\py\list3.py (3.8.1)
File Edit Format Run Options Window Help
1 students = ["ravi", "ajay", "amit", "kunal", "sameer"]
2 math = [89, 92, 66, 75, 55]
3 IT = [98, 86, 74, 78, 91]
4
5 print("RESULT:")
6 print("STUDENT\tMATH\tIT")
7 print("-----")
8 for i in range(0,5):
9     print(students[i], "\t", math[i], "\t", IT[i])
```

Script

RESULT:		
STUDENT	MATH	IT

ravi	89	98
ajay	92	86
amit	66	74
kunal	75	78
sameer	55	91

Output

Note that `\t` is a special character to display a tab (usually 6 spaces).

List **students** stores the names of 5 students and their marks in math and IT are in lists **math** and **IT** respectively.

Loop runs five times (0 to 4) to display values of lists in a formatted output. Values in the lists are accessed by using the values of variable **i** as index.

Read the following script and fill the values of variables **i**, **x** and **y** in the table. Then write the final output.

```
list4.py - F:/Edusoft/AI-417_2020/A1-417-VI/Book-v2/py/list4.py (3.8.1)
File Edit Format Run Options Window Help
1 math = [89, 92, 66, 75, 55]
2 IT = [98, 86, 74, 78, 91]
3 x=y=0
4
5 for i in range(0,5):
6     x = x + math[i]
7     y = y + IT[i]
8
9 print(x)
10 print(y)
11 print(x/5)
12 print(y/5)
```

Iteration	i	x	y
1			
2			
3			
4			

Output

Example 5

Script

```
list5.py - F:/Edusoft/AI-417_2020/A1-417-VI/Book-v2/py/list5.py (3.8.1)
File Edit Format Run Options Window Help
1 nums = [1, 17, 4, 28, 19, 72, 103, 68, 47]
2 x=0
3
4 for i in range(0,9):
5     x = nums[i]%2
6     if x==0:
7         print("Yes")
8     else:
9         print("No")
```

Output

No
No
Yes
Yes
No
Yes
No
Yes
No

Explanation

List **nums** has 9 odd and even numbers. Inside the loop, each number in the list is accessed by its index determined by the value of variable **i** and **modulus** by 2 (line 5). If the number is even, the value in variable **x** will be 0 and **if** will display **Yes** (line 7) otherwise **No** (line 9).

Breaking the loop

Sometimes you need to come out of a loop while loop is still continued. In Python, **break** keyword terminates the loop and brings you out of the loop. See this script.

```
tom17.py - F:/Edusoft/AI-417_2020/A1-417-VI/Book-v2/py/tom17.py (3.8.1)
File Edit Format Run Options Window Help
1 for c in range(1,10):
2     x = int(input("Enter a number between 1 and 10 or 0 to end. "))
3     if x==c:
4         break
5     if x==0:
6         break
7     print("Looping...")
8 print("End")
```

Here, line 2 is accepting a number from the user in variable **x**. Line 3 checks, if entered number equals (==) counter **c** then loop is terminated (line 4: **break**). Same will happen if user enters **0** in variable **x** (lines 5 and 6). The two outputs of the script are given here.

```
Enter a number between 1 and 10 or 0 to end.4
Looping...
Enter a number between 1 and 10 or 0 to end.3
Looping...
Enter a number between 1 and 10 or 0 to end.2
Looping...
Enter a number between 1 and 10 or 0 to end.4
End
>>>
===== RESTART: F:/Edusoft/AI-417_
Enter a number between 1 and 10 or 0 to end.0
End
```

Generating Random Numbers

Every programming language allows to generate numbers randomly. Python allows to provide a range of numbers to the computer and computer generates numbers randomly between that range. To use random number generator, you need to import **random** package. See the script given here.

```
tom16.py - F:/Edusoft/AI-417_2020/A1-417-VI/Book-v2/py/tom16.py (3.8.1)
File Edit Format Run Options Window Help
1 import random
2 x = 0
3 n=0
4 for c in range(1,4):
5     x = int(input("Guess a number between 1 and 5. "))
6     n = random.randint(1,5)
7     if x==n:
8         print("LUCKY YOU!")
9         break
```

```
Guess a number between 1 and 5.2
Guess a number between 1 and 5.3
LUCKY YOU!
```

Here, in line 6, function **randint()** of package **random** is generating a random number between **1** and **5** which are the arguments passed to it. Generated random number is returned in variable **n**. In line 7, if user's input equals the random number then loop breaks (line 9) after a message (line 8).

Learning Points



- The values in scripts can be identified by unique names called **variables**.
- **if** checks a condition and if that condition is true, it allows required statements to be executed.
- A condition compares two values.
- Comparison operators are $<$, $>$, $<=$, $>=$, $=$, $!=$
- It executes when condition with **if** returns false.
- Python allows to store various values as a list of items.
- $\backslash n$ is a special character that inserts a new blank line.
- Note that $\backslash t$ is a special character to display a tab (usually 6 spaces).
- **break** keyword terminates the loop and brings you out of the loop.
- Lists use zero-based index to access items in it.
- To use random number generator, you need to import **random** package.



- **Condition:** An expression composed of values and comparison operators.
- **List:** A set of values which can be browsed by the help of loop or index.
- **List Index:** Position of an item in the list. It is zero-based i.e. first item is at index zero and last is at (count of list items - 1).
- **Random:** That which is not fixed. It is a library (random) in Python also used to generate random numbers.

Exercise



NOTE: It is advised to assess the students in this chapter for practical only. Skills of chapter 5 should also be included in assessment.

A. Select the correct answer.

1. Which Python IDLE mode lets you run the program in the form of .py file?
 - a. Interactive mode
 - b. Script mode
 - c. Both a) and b)
 - d. Program mode

3. If input is 0 and 150.

```
1 #Simple decision making
2 MAX_OVERS=20
3 OVER_SIZE=6
4
5 ballsPlayed, runsMade=0,0
6
7 ballsPlayed = int(input("HOW MANY BALLS DID THIS PLAYER PLAY? "))
8
9 if ballsPlayed < 0:
10     print("Minimum balls played can be 0. Setting balls played to 0.")
11     ballsPlayed = 0
12
13 if ballsPlayed > (MAX_OVERS * OVER_SIZE):
14     print("Too many balls played. Setting balls played to 0.")
15     ballsPlayed = 0
16
17 print("BALLS PLAYED = ",ballsPlayed, "RUNS MADE = ",runsMade)
```

4. If input is 10, 32 and 60

```
1 i = input("Enter a number: ")
2 i = int(i)
3 f = i%12
4 if f!=0:
5     f = i//12
6     i = i %12
7 else:
8     f=i
9     i=0
10 print(f, '.', i)
```

5.

```
1 import turtle
2 t = turtle.Pen()
3
4 for i in range(1,4):
5     t.forward(50)
6     t.left(90)
7     t.backward(50)
```

6.

```
1 import turtle
2 t = turtle.Pen()
3
4 for i in range(1,9):
5     t.forward(50)
6     t.left(90)
7     t.backward(50)
8     t.right(45)
```

```

7. 1 import turtle
    2 t = turtle.Pen()
    3
    4 for i in range(1,4):
    5     t.forward(100)
    6     t.left(60)
    7     t.left(60)
    8
    9 t.right(90)
   10 for i in range(1,4):
   11     t.forward(100)
   12     t.left(90)

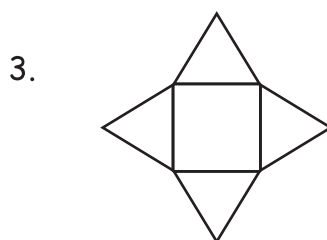
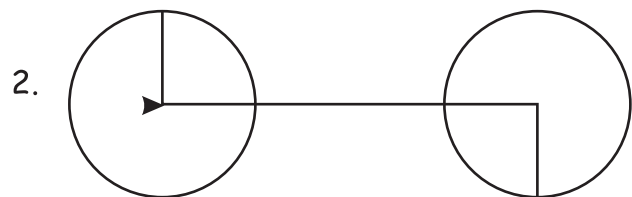
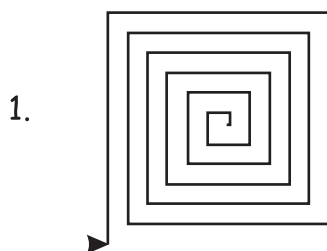
```

```

8. 1 import turtle
    2
    3 spiral = turtle.Turtle()
    4 x = 10
    5 a = 100
    6 spiral.width(5)
    7 for i in range(1,5):
    8     spiral.forward(a)
    9     spiral.left(90)
   10
   11 spiral.left(90)
   12
   13 for i in range(1,10):
   14     spiral.forward(a)
   15     spiral.left(120)
   16     if i==3:
   17         spiral.left(210)
   18     if i==5:
   19         spiral.left(210)
   20     if i==7:
   21         spiral.left(210)

```

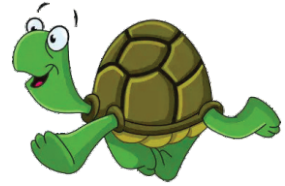
C. Write the turtle scripts to generate following outputs.



Watch & Learn

www.eduitspl.com

www.youtube.com/edusoftknowledgverse



TURTLE BET GAME

NOTICE: To develop this project, you need to apply your Python knowledge. In addition to this, you will learn certain things which you need to explore and find on Internet how to add certain enhancements such as pausing the game for a few seconds, setting text font and size etc.

Project Objectives

1. The purpose of the project is to engage the learner into gathering around their learning of Python and think in a stepwise manner to layout the game and execute it.
2. Explore for more information online to add certain features to the game by their own efforts.



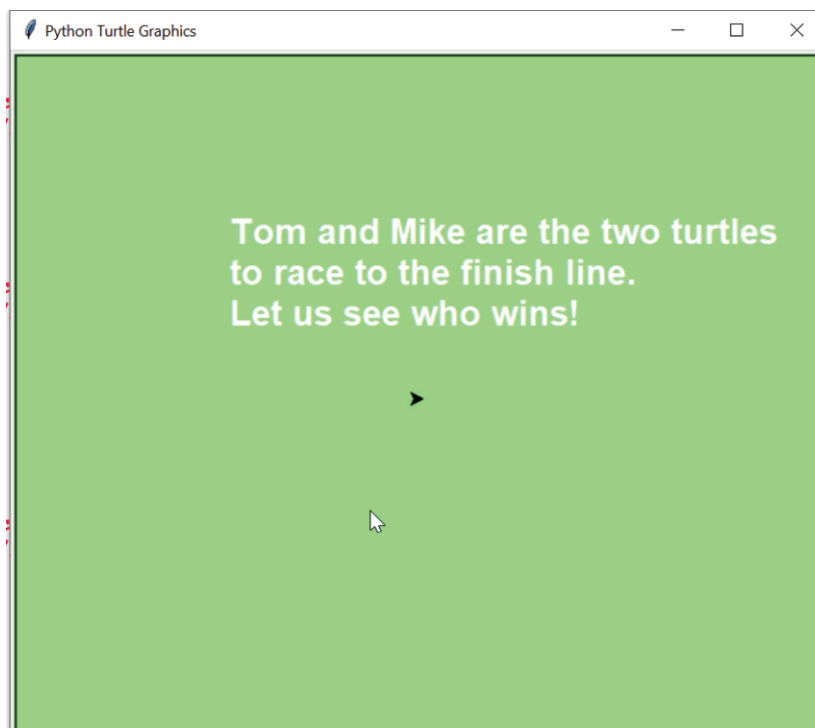
The Simple Game



Tom and Mike are two turtles who will run random steps in the direction of yellow finish line.

Opening Screen

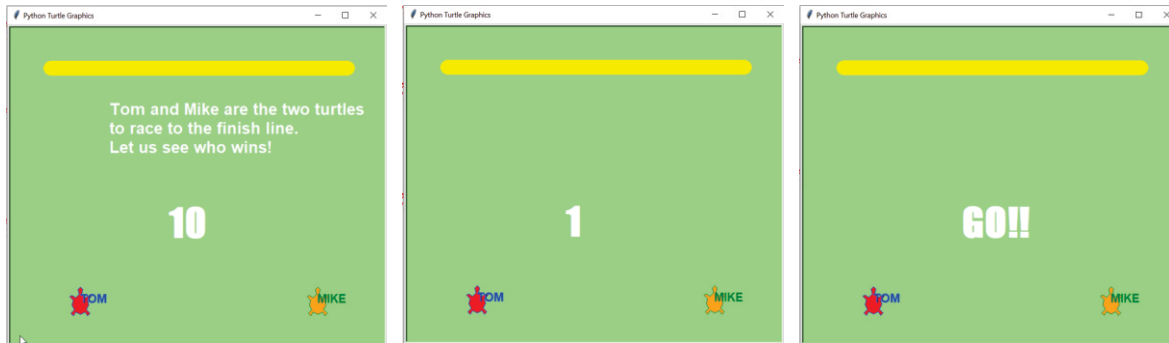
The game should begin by displaying the message as shown here.



Game Layout

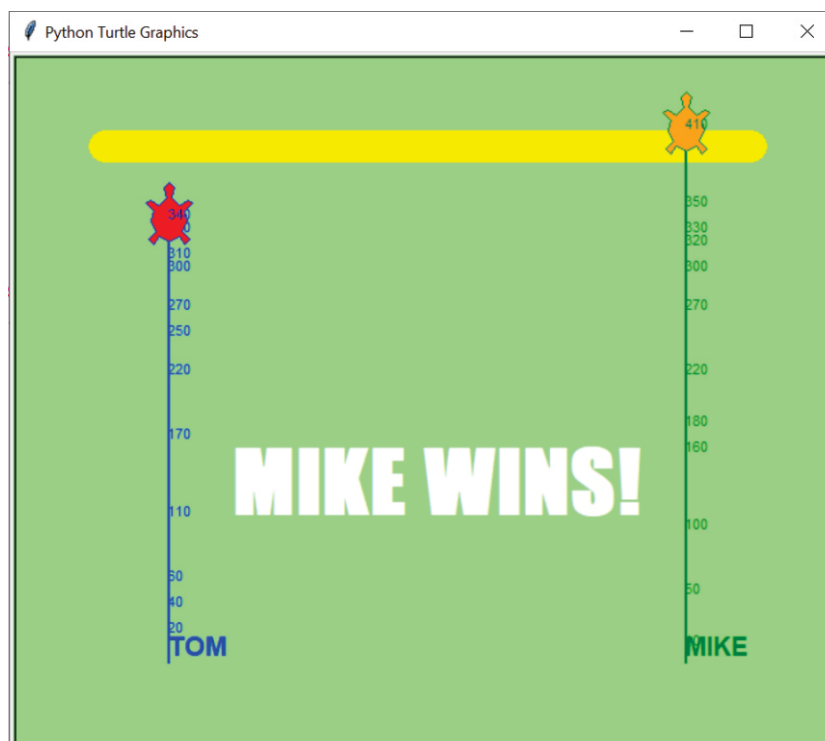
Next, following is done as shown here:

1. The yellow finish line is drawn.
2. Turtles - Tom and Mike are placed on the starting points (notice their colour and size)
3. A countdown to zero begins at a pause of 1 second.



Game Begins

The turtles leave a trail behind and with every move they display the number of steps covered. Whichever turtle touches the finish line, the final result is displayed accordingly.



Go ahead and create this game. You can even add your ideas once it is made. All the best and enjoy!

SUPPLEMENT

Simple Data Analysis Using a Spreadsheet

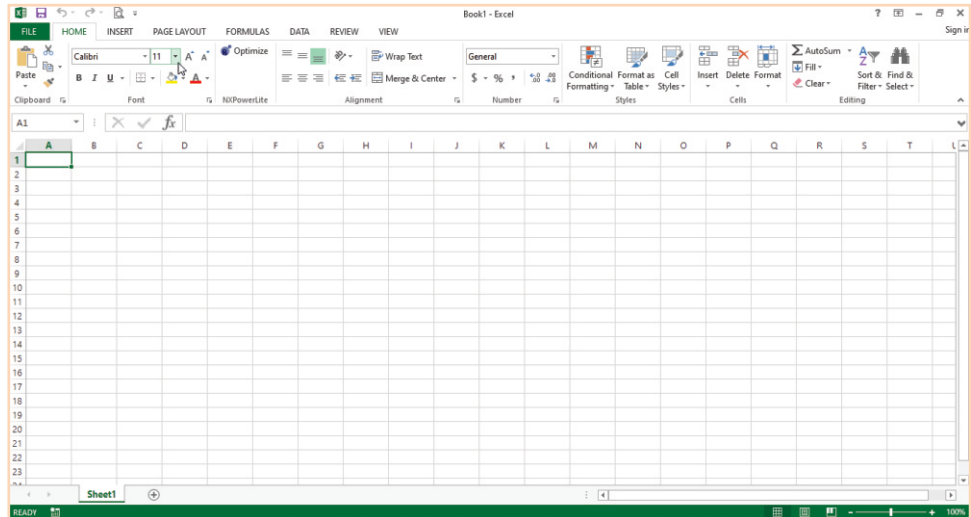
Data analysis means understanding data and deriving conclusions.

Spreadsheets are the simplest tools to store data in tabular form and perform analysis on it.

Some popular spreadsheet applications are Microsoft Excel, OpenOffice Calc and Google Sheets online. All these are similar in basic functionality and standard interface.

Each spreadsheet is a set of rows (numbered) and columns (alphabet). So, it looks like a grid of cells. Each cell has address in a pattern **CR**. For example, first row is **1** and first column is **A** then first cell in the spreadsheet will be **A1**.

What will be the position of cell **D5**? D means fourth column and 5 is fifth row.



Let us work with a data set given here. Open a spreadsheet on your computer with teacher's help. In Windows, press **Window** button + **R**. Type **excel** in it and press **Enter** key.

	A	B	C	D	E
1	STUDENT	ROLL NO	CLASS	SECTION	PERCENTAGE MARKS
2	ANU KUMAR	1	6	A	98
3	RAJ SHARMA	2	6	A	87
4	SHARIQ KHAN	3	6	A	89
5	JASMEET KAUR	4	6	B	84
6	VARUN SAINI	5	6	B	76
7	AJIT SINGH	6	6	A	56
8	MAMTA DESAI	7	6	B	75
9	GURPURAB SINGH	8	6	A	59
10	RAVI SHANDILYA	9	6	A	65
11	SEEMA DEB	10	6	B	87

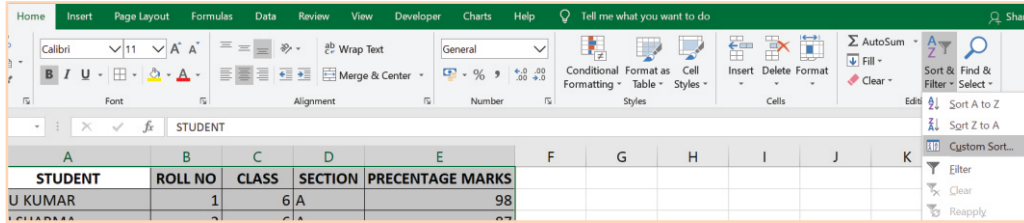
Data Sorting

Let us sort the marks on the basis of sections A and B:

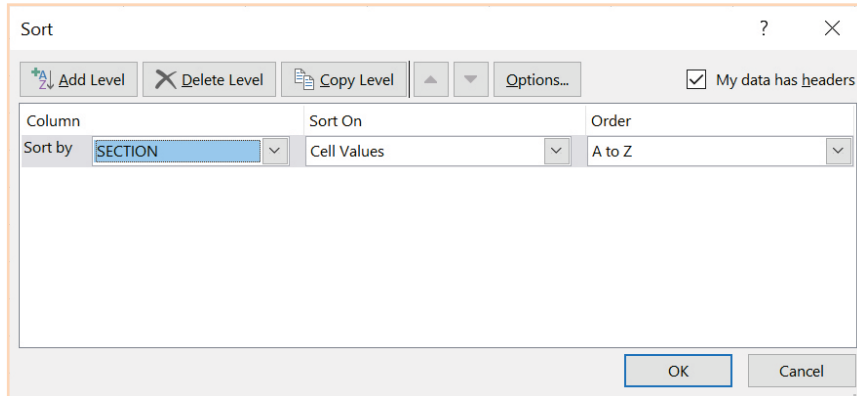
1. Select the data set.

	A	B	C	D	E	F	G
1	STUDENT	ROLL NO	CLASS	SECTION	PERCENTAGE MARKS		
2	ANU KUMAR	1	6	A	98		
3	RAJ SHARMA	2	6	A	87		
4	SHARIQ KHAN	3	6	A	89		
5	JASMEET KAUR	4	6	B	84		
6	VARUN SAINI	5	6	B	76		
7	AJIT SINGH	6	6	A	56		
8	MAMTA DESAI	7	6	B	75		
9	GURPURAB SINGH	8	6	A	59		
10	RAVI SHANDILYA	9	6	A	65		
11	SEEMA DEB	10	6	B	87		
12							
13							
14							

2. Home > Sort & Filter > Custom Sort.



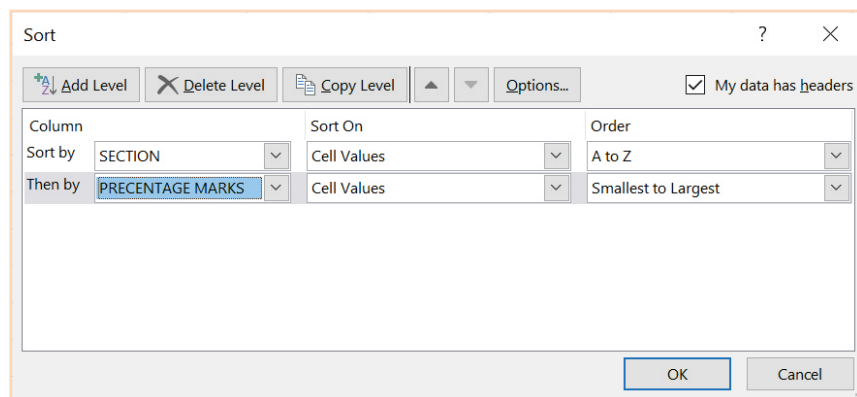
2. In the dialog box, select column as **SECTION** and click **OK**.



Notice SECTION column. Entire data set is sorted.

	A	B	C	D	E
1	STUDENT	ROLL NO	CLASS	SECTION	PRECENTAGE MARKS
2	ANU KUMAR	1	6	A	98
3	RAJ SHARMA	2	6	A	87
4	SHARIQ KHAN	3	6	A	89
5	AJIT SINGH	6	6	A	56
6	GURPURAB SINGH	8	6	A	59
7	RAVI SHANDILYA	9	6	A	65
8	JASMEET KAUR	4	6	B	84
9	VARUN SAINI	5	6	B	76
10	MAMTA DESAI	7	6	B	75
11	SEEMA DEB	10	6	B	87

Still, percentage marks are not sorted. Let us sort percentage marks section-wise. To do so, select the data set and open Custom sort dialog box again. Click on **Add Level** button. In the new level, select column as PERCENTAGE MARKS. Click **OK**.



Notice the percentage marks are sorted section-wise.

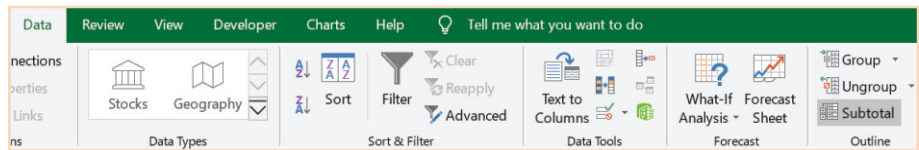
	A	B	C	D	E
1	STUDENT	ROLL NO	CLASS	SECTION	PERCENTAGE MARKS
2	AJIT SINGH	6	6 A		56
3	GURPURAB SINGH	8	6 A		59
4	RAVI SHANDILYA	9	6 A		65
5	RAJ SHARMA	2	6 A		87
6	SHARIQ KHAN	3	6 A		89
7	ANU KUMAR	1	6 A		98
8	MAMTA DESAI	7	6 B		75
9	VARUN SAINI	5	6 B		76
10	JASMEET KAUR	4	6 B		84
11	SEEMA DEB	10	6 B		87

Now it is easier to spot best performers in each section and also, those who are below satisfactory level. Can you sort the marks in reverse order section-wise to bring the toppers to the top?

Calculating Section-wise Average and Total

Let us calculate section-wise average marks now.

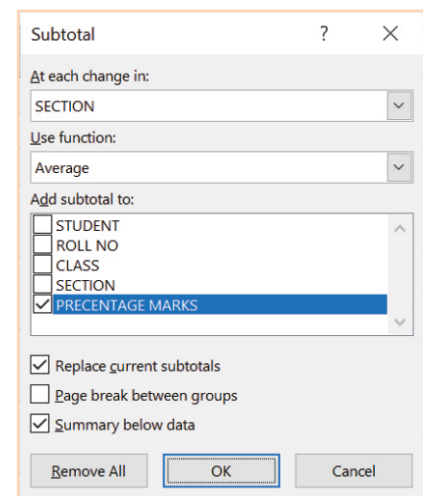
1. Select the data set.
2. **Data > Subtotal.**



3. In the dialog box, select SECTION in **At each change in** list, **Average** in **Use Function** list and tick PERCENTAGE MARKS in **Add subtotal** to list.
4. Click **OK**.

Notice the average calculated for each section and grand average also.

	A	B	C	D	E
1	STUDENT	ROLL NO	CLASS	SECTION	PERCENTAGE MARKS
2	AJIT SINGH	6	6 A		56
3	GURPURAB SINGH	8	6 A		59
4	RAVI SHANDILYA	9	6 A		65
5	RAJ SHARMA	2	6 A		87
6	SHARIQ KHAN	3	6 A		89
7	ANU KUMAR	1	6 A		98
8				A Average	75.66666667
9	MAMTA DESAI	7	6 B		75
10	VARUN SAINI	5	6 B		76
11	JASMEET KAUR	4	6 B		84
12	SEEMA DEB	10	6 B		87
13				B Average	80.5
14				Grand Average	77.6
15					

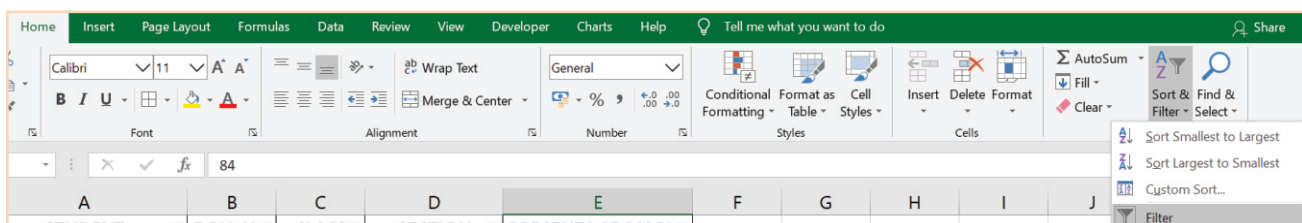


To remove subtotals, click **REMOVE ALL** in the Subtotal dialog box. Can you calculate section-wise sum?

Filtering – Displaying required records

You can filter the selective records. To do so:

1. **Home > Sort & Filter > Filter.**



Notice the arrows in the column headings.

2. Click on SECTION arrow and select only A section and click OK.

STUDENT	ROLL NO	CLASS	SECTION	PERCENTAGE MARK
AJIT SINGH				56
GURPURAB SINGH				59
RAVI SHANDILYA				65
RAJ SHARMA				87
SHARIQ KHAN				89
ANU KUMAR				98

Notice only section A records are displayed.

Can you bring back section B?

1. Now, click on the arrow in PERCENTAGE MARKS.
2. Select **Number Filters > Between**.

STUDENT	ROLL NO	CLASS	SECTION	PERCENTAGE MARK
AJIT SINGH	6	6 A		
GURPURAB SINGH	8	6 A		
RAVI SHANDILYA	9	6 A		
RAJ SHARMA	2	6 A		
SHARIQ KHAN	3	6 A		
ANU KUMAR	1	6 A		
MAMTA DESAI	7	6 B		
VARUN SAINI	5	6 B		
JASMEET KAUR	4	6 B		
SEEMA DEB	10	6 B		

3. In the dialog box, mention **60** and **90** as shown here and click **OK**.

Custom AutoFilter

Show rows where:

PERCENTAGE MARKS

is greater than or equal to 60

And Or

is less than or equal to 90

Use ? to represent any single character
Use * to represent any series of characters

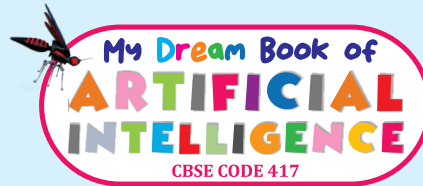
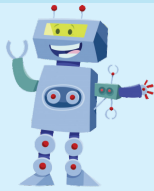
OK Cancel

What did you notice? Records below 60 and above 90 are not displayed now.

Can you display records having distinction marks only (≥ 75)?

To remove filter, **Home > Sort & Filter > Filter**.

So, this was a quick glimpse to data analysis. In higher classes, you will learn more on this.



Class VII

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Artificial Intelligence is the fuel of the future. Its subsets – Machine Learning, Deep Learning and regression have the power to revolutionise the way industries function. It is also going to influence economic growth and social development.

My Dream Book of Artificial Intelligence series is developed for classes VI and VII to introduce the children with the basics of artificial intelligence in an exciting way through lots of fun and engaging activities. The purpose of this course is to engage young minds to prepare easily to learn emerging technology as they grow and move to higher classes. The series is designed considering the recommendations done by CBSE to integrate AI at different levels. This short course can be taken up by the students to prepare for a different line of career in future.

This series is an extension to the endeavours by CBSE in creating the ecosystem for skill-based education under National Skills Qualifications Framework propounded by Ministry of Skill Development and Entrepreneurship.


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- **Objective:** Preparing young minds to explore about AI, its applications and related technologies in easiest possible way.
- **Skill development:** Developing skills like problem understanding, creative thinking, critical analysis and problem solving.
- **Challenge-based activities:** Engage students in solving puzzles and accomplish tasks to explore understanding about human intelligence and machine intelligence.
- **Mini Projects:** Small, workable projects to assimilate learnt concepts easily.
- **Fun Facts:** Keep the interest of the learners in the lesson and rouses curiosity to learn more.
- **Game Development with Python Turtle:** Inculcates programming and logical techniques through simple game.

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- An Internet connection - preferably 3G or higher.

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"Is artificial intelligence less than our intelligence?"

— Spike Jonze aka Adam Spiegel (American filmmaker)



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