

# Artificial Intelligence



Papers Dock

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COMPUTER SCIENCE 9618 PAPER 3

# Artificial Intelligence

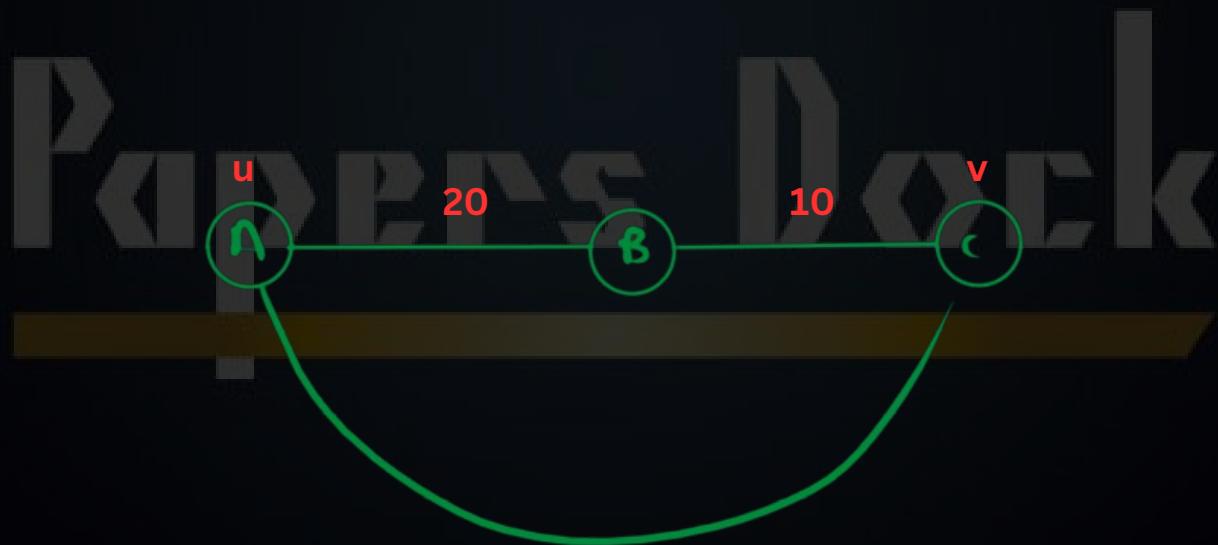
Artificial intelligence is the ability of a computer or a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence

## Dijkstra's Algorithm

Note: Maps, telephone network, social networking are all represented by graphs (nodes) and to find the shortest path between nodes we use Dijkstra's Algorithm.

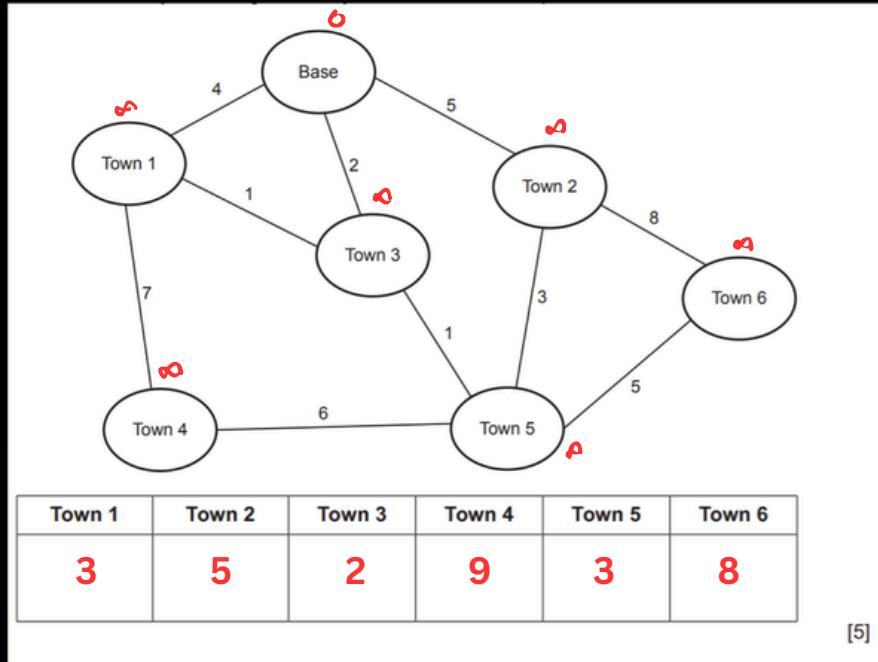


distance u (initial) + cost (u till v) < distance (final) (shortest) (stored)  
stored shortest distance  $\leftarrow$  distance u + cost (u till v)



Path 1  
 $0 + 40 < (\text{infinity})$   
then shortest distance = 40

Path 2  
 $0 + 20 + 10 < 40$   
then shortest distance = 30



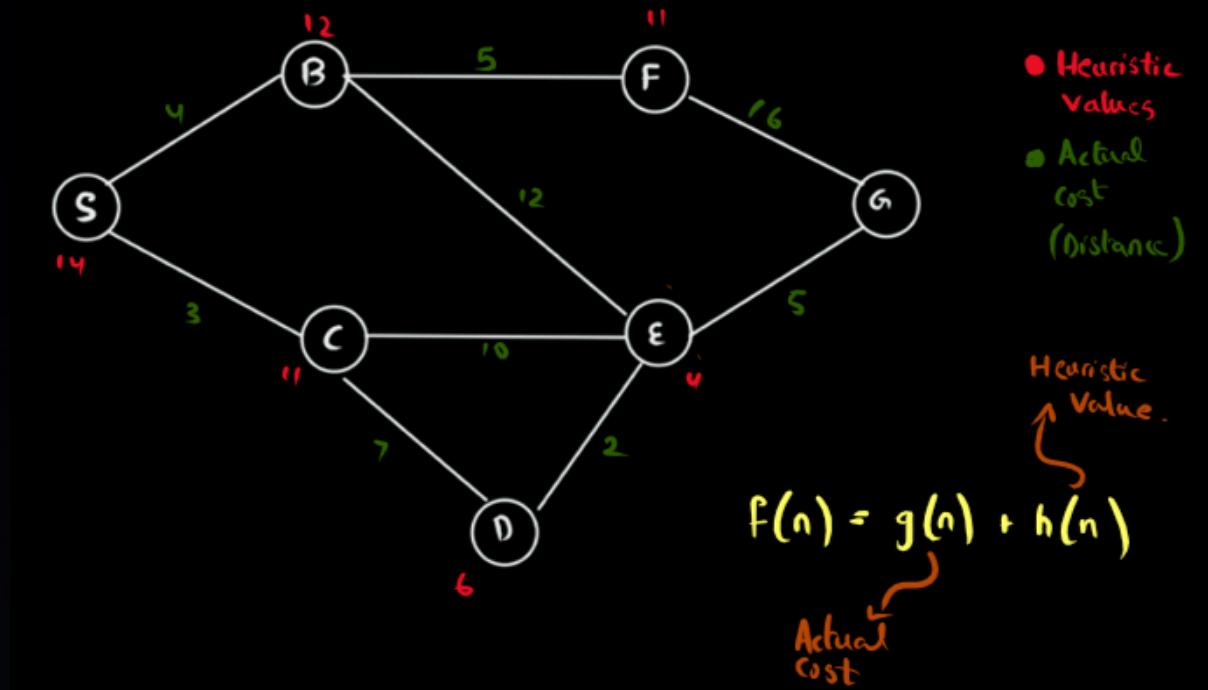
- Initialize base to 0
- Initialize nodes to infinity
- Make a table show all the steps

T1	T2	T3	T4	T5	T6
$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$
4	5	2	$\infty$	$\infty$	$\infty$
3	5	2	$\infty$	$\infty$	$\infty$
3	5	2	11	8	13
3	5	2	9	3	8

Note : There is no fixed answer to this question. It just that you have to show that you are aware of Dijkstra's Algorithm

# A\* Algorithm

A\* algorithm is based on dijkstra, but adds an extra heuristic value (intelligent guess) on how far we have to go to reach the destination most efficiently.



Find the shortest path to reach G from S

$$\begin{aligned} & SB \\ & f(n) = g(n) + h(n) \\ & \quad 4 + 12 \\ & f(n) = 16 \end{aligned}$$

$$\begin{aligned} & SC \\ & f(n) = g(n) + h(n) \\ & \quad 3 + 11 \\ & f(n) = 14 \end{aligned}$$

$$\begin{aligned} & SCE \\ & f(n) = g(n) + h(n) \\ & \quad 13 + 4 \\ & f(n) = 17 \end{aligned}$$

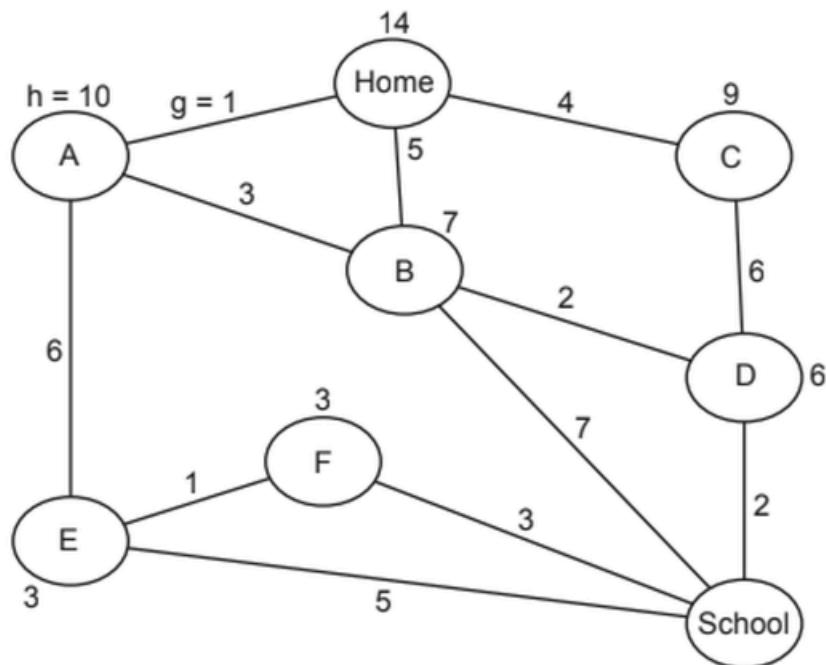
$$\begin{aligned} & SC\Delta \\ & f(n) = g(n) + h(n) \\ & \quad 10 + 6 \\ & f(n) = 16 \end{aligned}$$

$$\begin{aligned} & SCDE \\ & f(n) = g(n) + h(n) \\ & \quad 12 + 4 \\ & f(n) = 16 \end{aligned}$$

$$\begin{aligned} & SCDEG \\ & f(n) = g(n) + h(n) \\ & \quad 17 + 0 \\ & f(n) = 17 \end{aligned}$$

- (b) Find the shortest path between the Home and School nodes using the A\* algorithm. Show your working in the table provided.

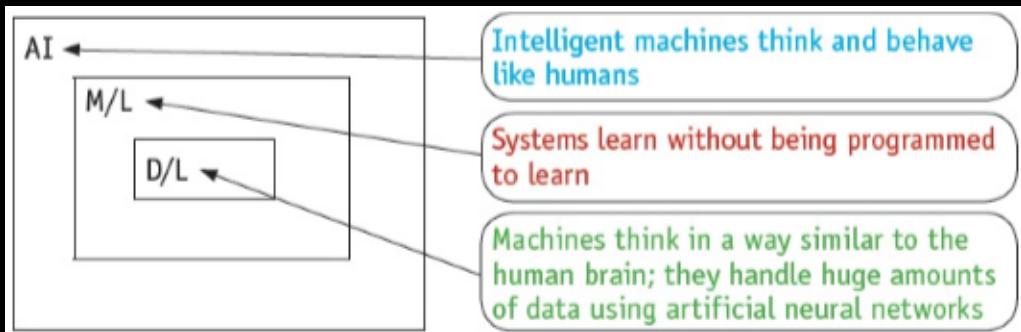
The first two rows in the table have been completed.



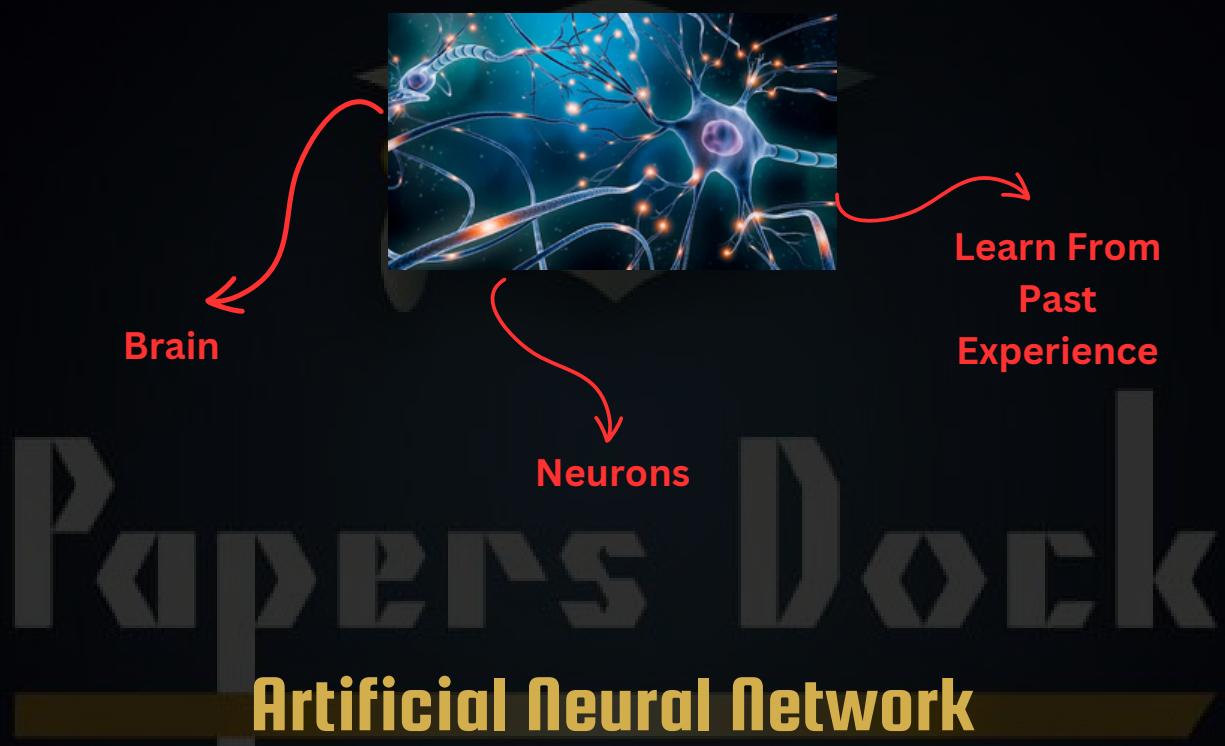
	<b>Node</b>	<b>Cost from Home node (g)</b>	<b>Heuristic (h)</b>	<b>Total (<math>f = g + h</math>)</b>
HA	Home	0	14	14
A	A	1	10	11
HB	B	5	7	12
HC	C	4	9	13
HAB	B	4	7	11
HAE	E	7	3	10
HAEF	F	8	3	11
HAES	School	12	0	12
HAEFS	School	11	0	11

Final path **Home -> A -> E -> F -> School**

# Machine Learning And Deep Learning



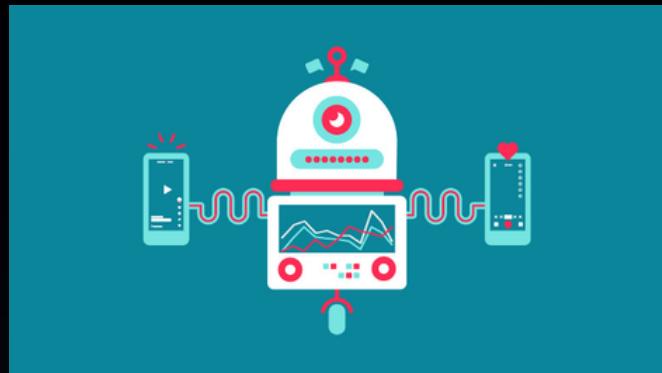
## Neural Network



Machines Are Created To Learn From Past Experience (Data)

# Machine Learning

Is a subset of AI in which algorithms are trained and learn from their past experiences



Tiktok Algorithm

## Labeled Data And Unlabeled Data

Unlabeled data: The data to which tag or label is not attached

Labeled data: The unlabeled becomes labeled data the moment a meaning is attached (label, tag)

## Types Of Machine Learning



## **Supervised Learning**

- **Supervised learning allows data to be collected, or a data output produced, from the previous experience.**
- **Supervised learning uses sample data with known outputs (in training), uses labelled input data.**
- **Able to predict future outcomes based on past data.**

## **Unsupervised Learning**

- **Unsupervised machine learning helps all kinds of unknown patterns in data to be found.**
- **Unsupervised learning only requires input data to be given.**
- **Uses any data, uses unlabeled input data.**

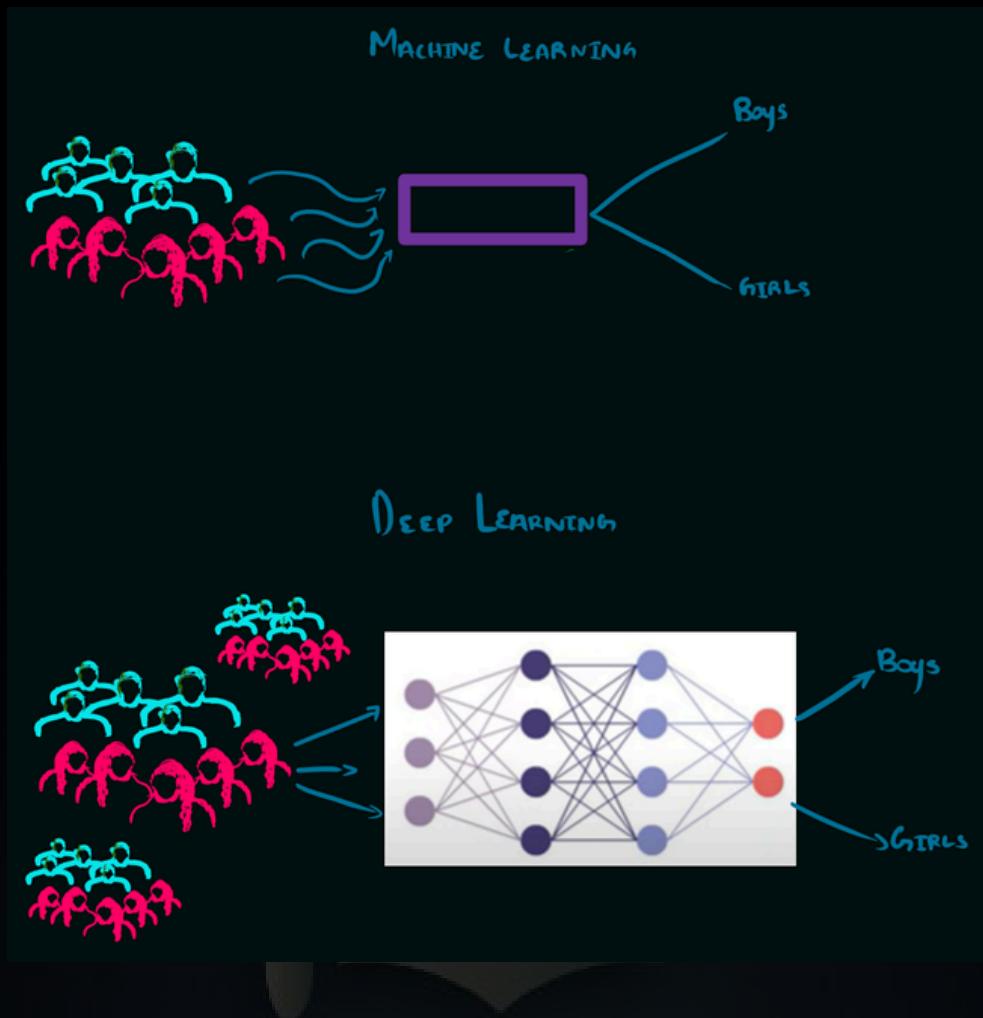
## **Reinforcement Learning**

- **Reinforcement learning is a machine learning technique based on feedback**
- **In which an agent learns to behave in an environment by performing the actions and seeing the results of the actions.**
- **For each good action, the agent gets positive feedback (reward) and each bad action receives negative feedback (punishment).**
- **The agent learns automatically using feedback without any labelled data.**
- **Using feedback to improve its performance at accomplishing similar tasks.**

## **Deep Learning**

**Is a subset of Machine Learning**

- **Deep learning is a type of machine learning inspired by the structure of the human brain. This structure is called Artificial Neural Networks.**
- **Extract patterns from data using neural networks.**



### Machine Learning Analogy: Sorting Fruits Manually

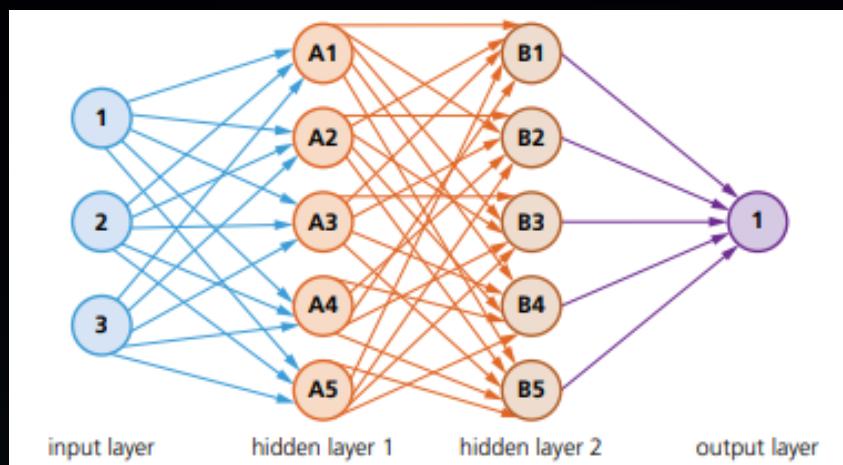
- Imagine you are sorting apples and oranges. In Machine Learning, you set rules like:
- If the fruit is round and red → It's an apple.
- If the fruit is round and orange → It's an orange.
- Here, you manually define the features (color, shape) and the system classifies based on those rules. It works well but depends on the quality of the rules you set.

### Deep Learning Analogy: A Child Learning to Recognize Fruits

- Now, imagine a child who sees many apples and oranges but isn't given any rules. Instead, they learn by observing patterns:
- They see different shapes, colors, and textures.
- Over time, they naturally figure out which is an apple and which is an orange without explicit rules.
- This is Deep Learning, the system learns patterns by itself, just like the child, without needing manual feature selection.

**Artificial neural networks are based on the interconnection between neurons in the human brain. The system is able to think like a human using these neural networks, and its performance improves with more data.**

**The hidden layer is where data from the input layer is processed into something which can be sent to the output layer.**

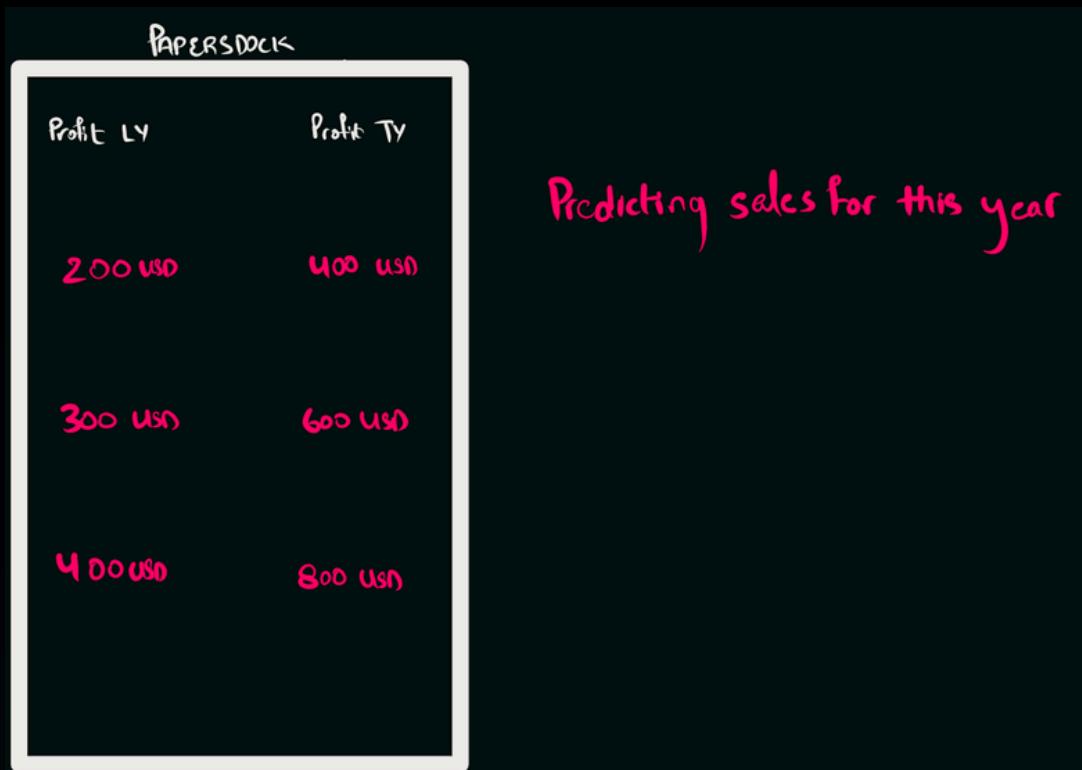


**State the reason for having multiple hidden layers in an artificial neural network?**

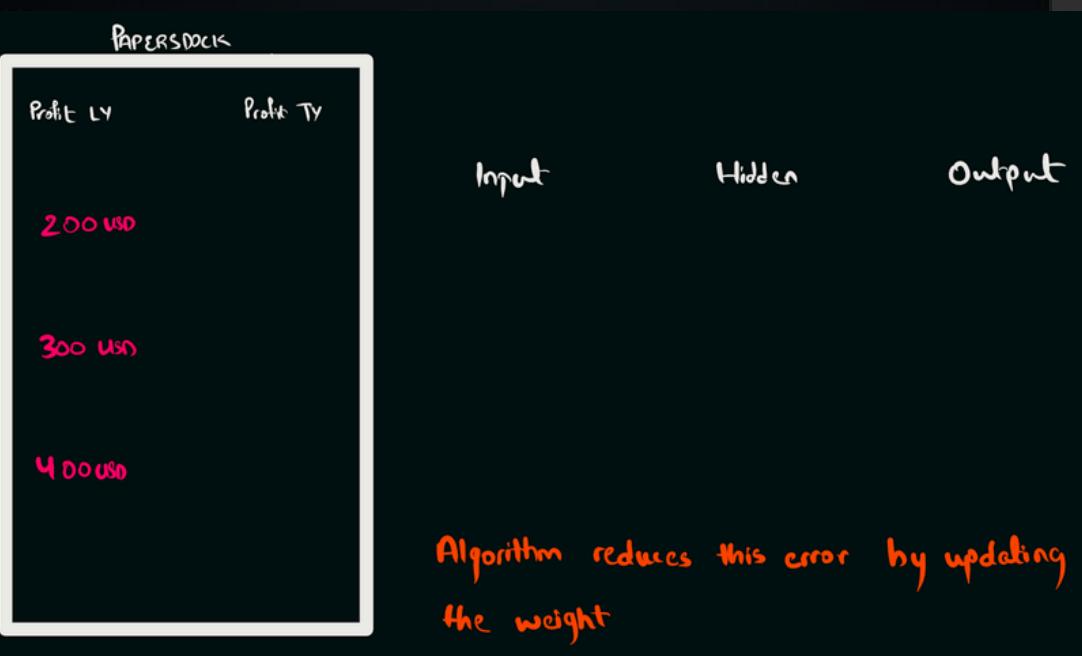
- Enables deep learning to take place.
- When the problems you are trying to solve have a higher level of complexity, it requires more layers to solve.
- To enable the neural network to learn and make decisions on its own.
- To improve the accuracy of results.

machine learning	deep learning
enables machines to make decisions on their own based on past data	enables machines to make decisions using an artificial neural network
needs only a small amount of data to carry out the training	the system needs large amounts of data during the training stages
most of the features in the data used need to be identified in advance and then manually coded into the system	deep learning machine learns the features of the data from the data itself and it does not need to be identified in advance

# Back Propagation And Regression



Neural Networks Take Random Weight Values



- Training program is iterative
- The errors are propagated back into the neural networks
- in order to update the initial networking weightings
- This training process is repeated until the desired outputs are eventually
- obtained

### Describe the Backpropagation process?

- The initial outputs from the system are compared to the expected output, and the error is calculated.
- The system weightings are adjusted to minimize the difference between actual and expected results.
- This process is repeated multiple times, gradually reducing errors.
- Once the errors are minimized sufficiently, the neural network is well-trained and produces accurate outputs.

### Describe regression?

- Is one of the ways of analyzing data before it is input into a system.
- Is used to make predictions from given data by learning some relationship between the input and the output.

## **Explain how artificial neural networks enable machine learning ?**

- **Artificial neural networks are intended to replicate the way human brains work.**
- **Weights are assigned for each connection between nodes.**
- **The data are input at the input layer and are passed into the system.**
- **They are analyzed at each subsequent hidden layer, where outputs are calculated.**
- **This process of learning is repeated many times to achieve optimum outputs.**
- **Decisions can be made without being specifically programmed.**
- **The deep learning network will have created complex feature detectors.**
- **The output layer provides the results.**
- **Backpropagation of errors will be used to correct any errors that have been made**

## **What is meant by Deep Learning?**

- **Uses artificial neural network(s)**
- **that contain(s) a high number of hidden layers**
- **modelled on the human brain**
- **Deep learning uses many layers to progressively extract higher-level features from the (raw) input**
- **Deep learning is a specialised form of machine learning**

## **Outline the reasons for using Deep Learning?**

- **Deep learning makes good use of unstructured data.**
- **Deep learning outperforms other methods if the data size is large.**
- **Deep learning systems enable machines to process data with a nonlinear approach.**
- **Deep learning is effective at identifying (hidden) patterns / patterns that humans might not be able to see / patterns that are too complex or time-consuming for humans to carry out.**
- **It can provide a more accurate outcome with higher numbers of hidden layers.**

**Describe the purpose of both A\* and Dijkstra algorithm**

- To find the optimal, shortest or most cost-effective route
- between two nodes
- based on distance / cost / time.

**Explain what is meant by the term artificial network ?**

- An artificial neural network is a component of artificial intelligence that is meant to simulate the functioning of a biological brain.
- Artificial neural networks are a key component of machine learning.
- They can solve problems that would prove impossible or difficult for humans.
- Artificial neural networks have self-learning capabilities that enable them to produce better results as more data becomes available.
- Artificial neural networks can be layered (input, hidden, and output layers).
- Artificial neural networks have many interconnected layers, some/many of which are hidden.
- Weights are assigned between nodes.
- Weights are adjusted through training to give a more accurate result.
- More complex learning capabilities / more accurate results are available with larger numbers of hidden layers.

**Explain the use of graphs to Aid Artificial Intelligence ?**

- **Artificial Neural Networks can be represented using graphs**
- **Graphs provide relationships between nodes**
- **AI problems can be defined/solved as finding a path in a graph**
- **Graphs may be analyzed by a range of algorithms**
- **e.g. A\* / Dijkstra's algorithm**
- **used in machine learning.**
- **Example of method e.g. Back propagation of errors / regression methods**



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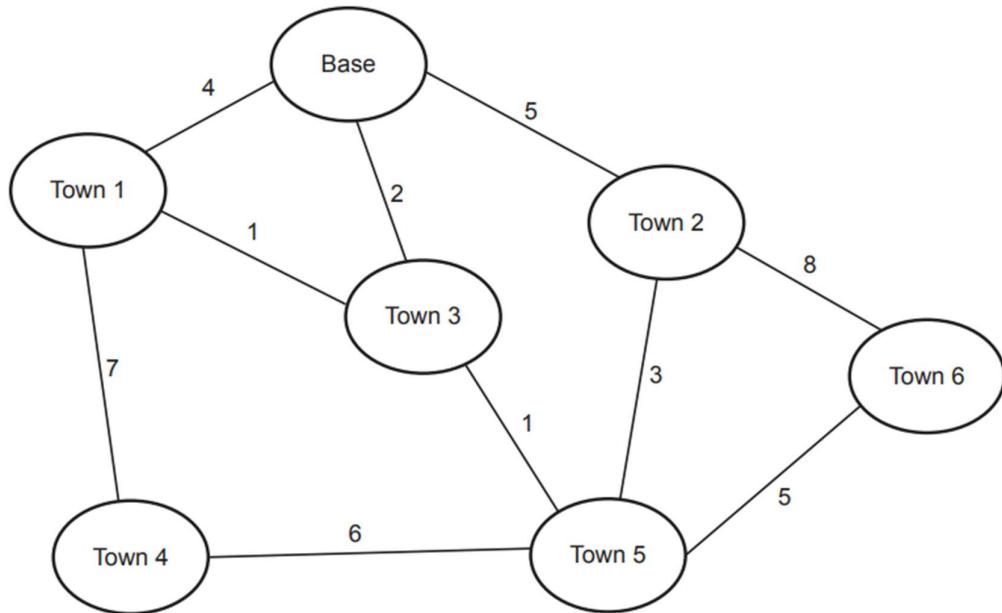
# Artificial Intelligence

## Questions

### Question 1 (9618\_s21\_qp\_31)

- 5 (a) Calculate the shortest distance between the base and each of the other towns in the diagram using Dijkstra's algorithm.

Show your working **and** write your answers in the table provided.



Working .....

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Answers

Town 1	Town 2	Town 3	Town 4	Town 5	Town 6

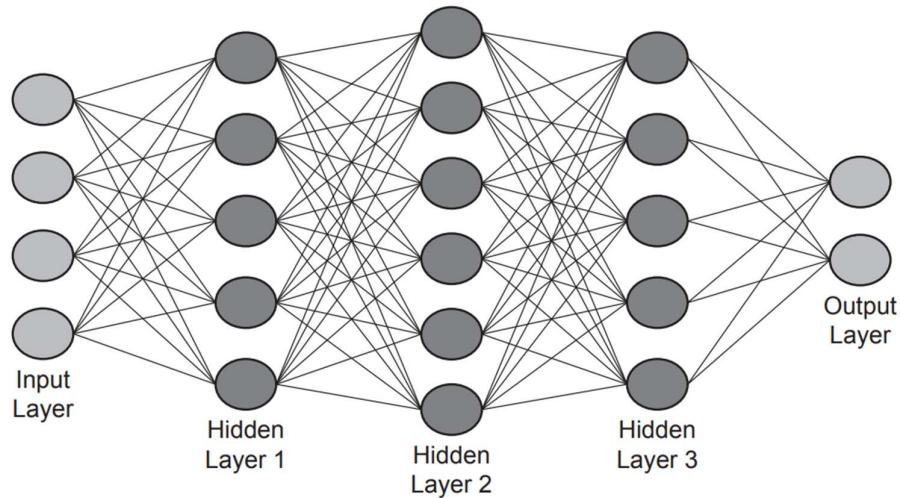
[5]

- (b) Explain the use of graphs to aid Artificial Intelligence (AI).

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..... [3]

## Question 2 (9618\_w21\_qp\_31)

- 9 (a) The diagram shown represents an artificial neural network.



- (i) State the reason for having multiple hidden layers in an artificial neural network.

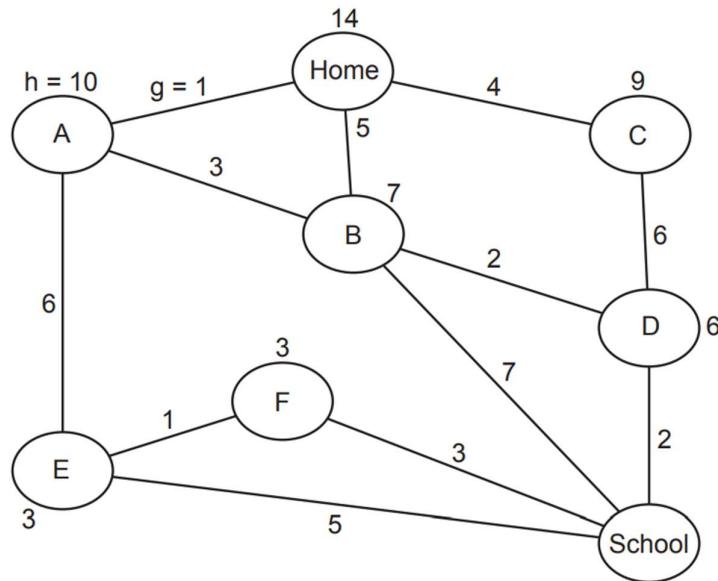
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- (ii) Explain how artificial neural networks enable machine learning.

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..... [4]

- (b) Find the shortest path between the Home and School nodes using the A\* algorithm. Show your working in the table provided.

The first two rows in the table have been completed.



**Final path**

[5]

### **Question 3 (9618\_w22\_qp\_31)**

9 Deep learning is used in Artificial Intelligence (AI).

(a) Describe what is meant by **deep learning**.

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..... [2]

(b) Outline the reasons for using deep learning.

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..... [2]

### **Question 4 (9618\_w22\_qp\_32)**

7 Supervised and unsupervised learning are two categories of machine learning.

Describe supervised learning and unsupervised learning.

Supervised learning .....

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Unsupervised learning .....

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.....

[4]

## Question 5 (9618\_s23\_qp\_31)

- 2 (a) Draw **one** line from each machine learning category to its **most appropriate** description.

Machine learning category	Description
Supervised learning	simulates the data-processing capabilities of the human brain to make decisions
Reinforcement learning	enables learning by mapping an input to an output based on example input–output pairs
Deep learning	enables information related to errors produced by the neural network to be transmitted
Unsupervised learning	enables learning in an interactive environment by trial and error using its own experiences
	enables learning by allowing the process to discover patterns on its own that were previously undetected

[4]

- (b) Describe the purpose of both the A\* algorithm and Dijkstra's algorithm.

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[2]

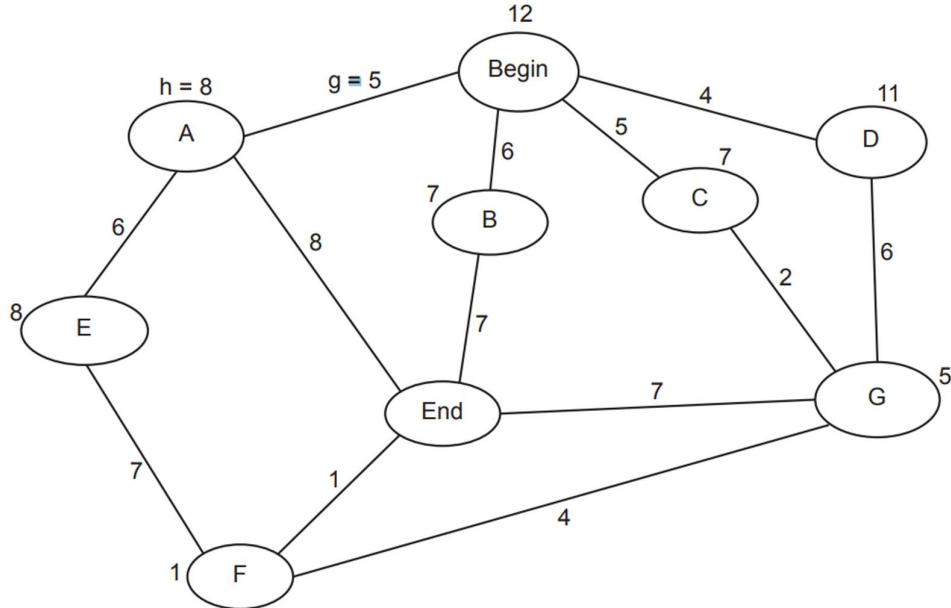
## Question 6 (9618\_s23\_qp\_32)

10 (a) State **one** category of machine learning.

..... [1]

- (b) Calculate the path that takes the shortest time to travel from the Begin node to the End node, using the A\* algorithm.  
Show your working in the table provided.

The first two rows have already been completed.



Start node	Destination node	Cost from start node (g)	Heuristic (h)	Total (f = g + h)
Begin	Begin	0	12	12
Begin	A	5	8	13

Final path	
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[5]

### Question 7 (9618\_w23\_ms\_31)

- 12 Artificial neural networks have played a significant role in the development of machine learning.

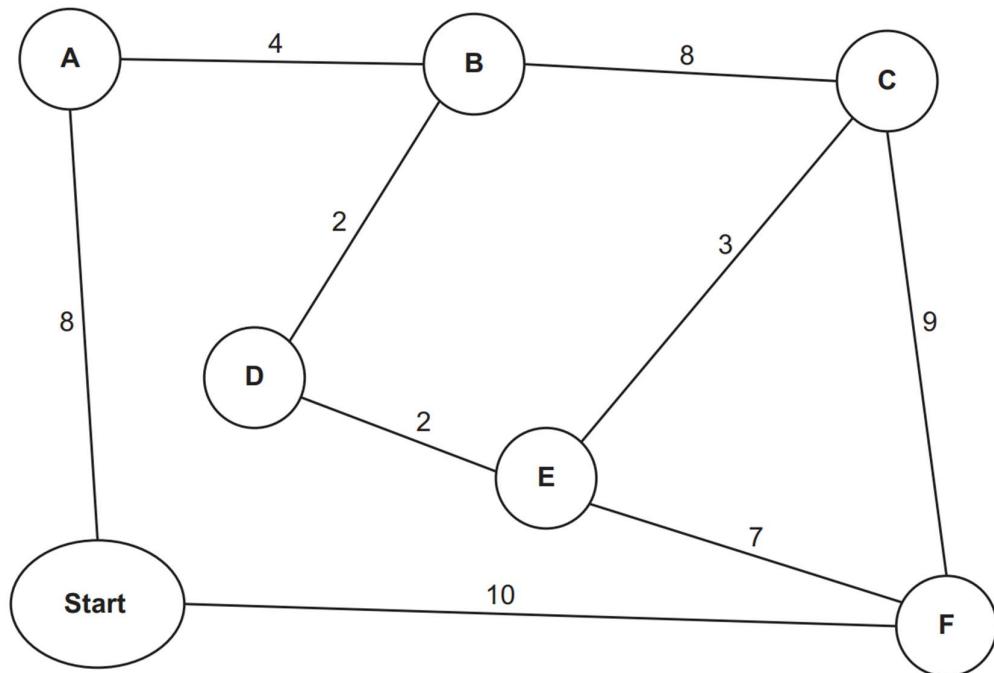
Explain what is meant by the term **artificial neural network**.

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 ..... [4]

### Question 8 (9618\_w23\_qp\_32)

- 8 Calculate the shortest distance between the **Start** and each of the destinations in the diagram using Dijkstra's algorithm.

Show your working **and** write your answers in the table provided.



Working .....

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Answers:

A	B	C	D	E	F

[5]

### Question 9 (9618\_s24\_qp\_31)

- 9 Explain what is meant by **Deep Learning** in relation to Artificial Intelligence (AI).

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[3]

### Question 10 (9618\_s24\_qp\_32)

- 11 Explain what is meant by **Reinforcement Learning** in relation to Artificial Intelligence.

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[3]

# Answers

## Answer 1 (9618\_s21\_ms\_31)

Question	Answer	Marks											
<p>5(a) Working (<b>Max 3</b>)</p> <p>May be seen on diagram</p> <ul style="list-style-type: none"> <li>• Initialisation: setting Base to 0</li> <li>• ... and the rest of the towns to <math>\infty</math></li> <li>• Evidence to show values at nodes being updated</li> <li>• Evidence to show 'visited node(s)'</li> </ul> <p>May be seen in working section of paper</p> <ul style="list-style-type: none"> <li>• Evidence to show calculation of at least one route</li> <li>• Evidence to show more than one route has been calculated for at least one town</li> </ul> <p><b>Correct Answer (Max 2)</b></p> <p><b>One mark</b> for four correct values...  <b>... One mark</b> for all values correct</p> <table border="1" style="margin-top: 10px; width: 100%; text-align: center;"> <tr> <th>Town 1</th> <th>Town 2</th> <th>Town 3</th> <th>Town 4</th> <th>Town 5</th> <th>Town 6</th> </tr> <tr> <td>3</td> <td>5</td> <td>2</td> <td>9</td> <td>3</td> <td>8</td> </tr> </table>	Town 1	Town 2	Town 3	Town 4	Town 5	Town 6	3	5	2	9	3	8	<b>5</b>
Town 1	Town 2	Town 3	Town 4	Town 5	Town 6								
3	5	2	9	3	8								

Question	Answer	Marks
<p>5(b) <b>One mark</b> for each correct marking point (<b>Max 3</b>)</p> <ul style="list-style-type: none"> <li>• Artificial Neural Networks can be represented using graphs</li> <li>• Graphs provide structures for relationships // graphs provide relationships between nodes</li> <li>• AI problems can be defined/solved as finding a path in a graph</li> <li>• Graphs may be analysed/ingested by a range of algorithms</li> <li>• ...e.g. A* / Dijkstra's algorithm</li> <li>• ...used in machine learning.</li> <li>• Example of method e.g. Back propagation of errors / regression methods</li> </ul>	<b>3</b>	

## Answer 2 (9618\_w21\_ms\_31)

Question	Answer	Marks
9(a)(i)	<p><b>One mark for correct statement (Max 1)</b></p> <ul style="list-style-type: none"> <li>• Enables deep learning to take place</li> <li>• Where the problem you are trying to solve has a higher level of complexity it requires more layers to solve</li> <li>• To enable the neural network to learn and make decisions on its own</li> <li>• To improve the accuracy of the result.</li> </ul>	1
9(a)(ii)	<p><b>One mark for each correct marking point (Max 4)</b></p> <ul style="list-style-type: none"> <li>• Artificial neural networks are intended to replicate the way human brains work</li> <li>• Weights / values are assigned for each connection between nodes</li> <li>• The data are input at the input layer and are passed into the system</li> <li>• They are analysed at each subsequent (hidden) layer where characteristics are extracted / outputs are calculated</li> <li>• ... this process of training / learning is repeated many times to achieve optimum outputs // reinforcement learning takes place</li> <li>• Decisions can be made without being specifically programmed</li> <li>• The deep learning net will have created complex feature detectors</li> <li>• The output layer provides the results</li> <li>• Back propagation (of errors) will be used to correct any errors that have been made.</li> </ul>	4

Question	Answer	Marks
9(b)	<p><b>One mark for each correct calculation as follows (Max 4)</b></p> <ul style="list-style-type: none"> <li>• Node B (from Home) (Line 3 in table)</li> <li>• Node C (from Home) (Line 4 in table)</li> <li>• Node B and Node E (from A) (Lines 5 and 6 in table)</li> <li>• Node F and Node School (from E) (Lines 7 and 8 in table)</li> <li>• Node School (from F) (Line 9 in table)</li> </ul> <p><b>One mark for correct path (Max 1):</b></p> <ul style="list-style-type: none"> <li>• Home <math>\Rightarrow</math> A <math>\Rightarrow</math> E <math>\Rightarrow</math> F <math>\Rightarrow</math> School</li> </ul>	5

	Node	Cost from Home Node (g)	Heuristic (h)	Total (f = g + h)	
1	Home	0	14	14	
2	A	1	10	11	
3	B	5	7	12	
4	C	4	9	13	
5	B	$1 + 3 = 4$	7	11	
6	E	$1 + 6 = 7$	3	10	
7	F	$7 + 1 = 8$	3	11	
8	School	$7 + 5 = 12$	0	12	
9	School	$8 + 3 = 11$	0	11	

**Final Path** | Home  $\Rightarrow$  A  $\Rightarrow$  E  $\Rightarrow$  F  $\Rightarrow$  School

## Answer 3 (9618\_w22\_ms\_31)

Question	Answer	Marks
9(a)	<p><b>One mark for each correct point (Max 2)</b></p> <ul style="list-style-type: none"> <li>• Uses artificial <b>neural</b> network(s)</li> <li>• ... that contain(s) a high number of <b>hidden layers</b></li> <li>• ... modelled on the human brain.</li> <li>• Deep learning uses <b>many</b> layers to progressively extract higher level features from the (raw) input.</li> <li>• Deep learning is a <b>specialised</b> form of machine learning.</li> </ul>	2
9(b)	<p><b>One mark for each correct point (Max 2)</b></p> <ul style="list-style-type: none"> <li>• Deep learning makes good use of unstructured data.</li> <li>• Deep learning outperforms other methods if the data size is large.</li> <li>• Deep learning systems enable machines to process data with a nonlinear approach.</li> <li>• Deep learning is effective at identifying (hidden) patterns / patterns that humans might not be able to see / patterns that are too complex / time consuming for humans to carry out.</li> <li>• It can provide a more accurate outcome with higher numbers of hidden layers.</li> </ul>	2

## Answer 4 (9618\_w22\_ms\_32)

Question	Answer	Marks
7	<p><b>One mark for each point</b></p> <p><b>Supervised learning (Max 3 of 4)</b></p> <ul style="list-style-type: none"> <li>• Supervised learning allows data to be collected, or a data output produced, from the previous experience.</li> <li>• In supervised learning, known input and associated outputs are given // uses sample data with known outputs (in training) // uses labelled input data.</li> <li>• Able to predict future outcomes based on past data.</li> </ul> <p><b>Unsupervised learning (Max 3 of 4)</b></p> <ul style="list-style-type: none"> <li>• Unsupervised machine learning helps all kinds of unknown patterns in data to be found.</li> <li>• Unsupervised learning only requires input data to be given.</li> <li>• Uses any data // not trained on the right output // uses unlabelled input data.</li> </ul>	4

## Answer 5 (9618\_s23\_ms\_31)

Question	Answer	Marks												
2(a)	<p><b>One mark for each correct line connecting a machine learning technique to its most appropriate description (Max 4).</b></p> <table> <thead> <tr> <th>Machine learning category</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Supervised learning</td> <td>simulates the data processing capabilities of the human brain to make decisions</td> </tr> <tr> <td>Reinforcement learning</td> <td>enables learning by mapping an input to an output based on example input-output pairs</td> </tr> <tr> <td>Deep learning</td> <td>enables information related to errors produced by the neural network to be transmitted</td> </tr> <tr> <td>Unsupervised learning</td> <td>enables learning in an interactive environment by trial and error using its own experiences</td> </tr> <tr> <td></td> <td>enables learning by allowing the process to discover patterns on its own that were previously undetected</td> </tr> </tbody> </table>	Machine learning category	Description	Supervised learning	simulates the data processing capabilities of the human brain to make decisions	Reinforcement learning	enables learning by mapping an input to an output based on example input-output pairs	Deep learning	enables information related to errors produced by the neural network to be transmitted	Unsupervised learning	enables learning in an interactive environment by trial and error using its own experiences		enables learning by allowing the process to discover patterns on its own that were previously undetected	4
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	enables learning by allowing the process to discover patterns on its own that were previously undetected													

Question	Answer	Marks
2(b)	<p><b>One mark per mark point (Max 2)</b></p> <ul style="list-style-type: none"> <li>• to find the optimal / shortest / most cost-effective route</li> <li>• ... between two nodes in a</li> <li>• ... based on distance / cost / time.</li> </ul>	2

## Answer 6 (9618\_s23\_ms\_32)

Question	Answer	Marks
10(a)	<p><b>One mark from:</b></p> <p>Supervised (learning) Unsupervised (learning) Reinforcement (learning) Deep (learning)</p>	1

Question	Answer	Marks																																																										
10(b)	<p><b>One mark for each correct calculation as follows (Max 2):</b></p> <ul style="list-style-type: none"> <li>• Node B (from Begin) (Line 3 in table)</li> <li>• Node C (from Begin) (Line 4 in table)</li> <li>• Node D (from Begin) (Line 5 in table)</li> </ul> <p><b>One mark for each correct calculation as follows (Max 2):</b></p> <ul style="list-style-type: none"> <li>• Node G (from C) (Line 6 in table)</li> <li>• Node F and Node End (from G) (Lines 7 and 8 in table)</li> <li>• Node End (from F) (Line 9 in table)</li> </ul> <p><b>One mark for correct path (Max 1):</b></p> <ul style="list-style-type: none"> <li>• Begin <math>\Rightarrow</math> C <math>\Rightarrow</math> G <math>\Rightarrow</math> F <math>\Rightarrow</math> End</li> </ul>	5																																																										
	<table border="1"> <thead> <tr> <th>Start node</th> <th>Destination node</th> <th>Cost from start node (g)</th> <th>Heuristic (h)</th> <th>Total (f = g + h)</th> </tr> </thead> <tbody> <tr> <td>Begin</td> <td>Begin</td> <td>0</td> <td>12</td> <td>12</td> </tr> <tr> <td>Begin</td> <td>A</td> <td>5</td> <td>8</td> <td>13</td> </tr> <tr> <td>Begin</td> <td>B</td> <td>6</td> <td>7</td> <td>13</td> </tr> <tr> <td>Begin</td> <td>C</td> <td>5</td> <td>7</td> <td>12</td> </tr> <tr> <td>Begin</td> <td>D</td> <td>4</td> <td>11</td> <td>15</td> </tr> <tr> <td>C</td> <td>G</td> <td><math>5 + 2 = 7</math></td> <td>5</td> <td>12</td> </tr> <tr> <td>G</td> <td>F</td> <td><math>5 + 2 + 4 = 11</math></td> <td>1</td> <td>12</td> </tr> <tr> <td>G</td> <td>End</td> <td><math>5 + 2 + 7 = 14</math></td> <td>0</td> <td>14</td> </tr> <tr> <td>F</td> <td>End</td> <td><math>5 + 2 + 4 + 1 = 12</math></td> <td>0</td> <td>12</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2"><b>Final Path</b></td><td>Begin <math>\Rightarrow</math> C <math>\Rightarrow</math> G <math>\Rightarrow</math> F <math>\Rightarrow</math> End</td></tr> </tbody> </table>	Start node	Destination node	Cost from start node (g)	Heuristic (h)	Total (f = g + h)	Begin	Begin	0	12	12	Begin	A	5	8	13	Begin	B	6	7	13	Begin	C	5	7	12	Begin	D	4	11	15	C	G	$5 + 2 = 7$	5	12	G	F	$5 + 2 + 4 = 11$	1	12	G	End	$5 + 2 + 7 = 14$	0	14	F	End	$5 + 2 + 4 + 1 = 12$	0	12						<b>Final Path</b>		Begin $\Rightarrow$ C $\Rightarrow$ G $\Rightarrow$ F $\Rightarrow$ End	
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## Answer 7 (9618\_w23\_ms\_31)

Question	Answer	Marks
12	<p><b>One mark per mark point (Max 4)</b></p> <p>MP1 An artificial neural network is the component of artificial intelligence that is meant to simulate the functioning of a biological brain.</p> <p>MP2 Artificial neural networks are a key component of machine learning.</p> <p>MP3 They can solve problems that would prove impossible or difficult for humans // Artificial neural networks have self-learning capabilities that enable them to produce better results as more data becomes available</p> <p>MP4 Artificial neural networks can be layered (input, hidden and output layers) // Artificial neural networks have many interconnected layers, some / many of which are hidden</p> <p>MP5 Weights are assigned between nodes</p> <p>MP6 Weights are adjusted through training to give a more accurate result</p> <p>MP7 More complex learning capabilities / more accurate results are available with larger numbers of hidden layers</p>	4

## Answer 8 (9618\_w23\_ms\_32)

Question	Answer	Marks												
8	<p><b>One mark per mark point - working (Max 3)</b> May be seen on diagram or in working section</p> <p>MP1 Initialisation – setting Start to 0 MP2 ...and the rest of the towns to MP3 Evidence to show values at nodes being updated MP4 Evidence to show 'visited node(s)' MP5 Evidence to <b>show a correct calculation</b> of at least one route MP6 Evidence to show more than one route has been calculated for at least one town</p> <p><b>Correct Answers (Max 2)</b> <b>Two marks for all six correct values</b> <b>One mark for four or five correct values.</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>A</td> <td>B</td> <td>C</td> <td>D</td> <td>E</td> <td>F</td> </tr> <tr> <td>8</td> <td>12</td> <td>19</td> <td>14</td> <td>16</td> <td>10</td> </tr> </table>	A	B	C	D	E	F	8	12	19	14	16	10	5
A	B	C	D	E	F									
8	12	19	14	16	10									

## Answer 9 (9618\_s24\_ms\_31)

Question	Answer	Marks
9	<p><b>One mark per mark point (Max 3)</b></p> <p>MP1 Deep learning learns by finding hidden patterns that are <b>undetectable to humans</b>. MP2 It structures algorithms in layers: <b>input</b> layer, <b>hidden</b> layers and <b>output</b> layer. MP3 ... to create an artificial neural network to learn and make intelligent decisions on its own. MP4 It is trained using large quantities of unlabelled data. MP5 Deep learning requires/uses a <b>large number</b> of hidden layers. MP6 ... the larger the number of layers, the higher the level of success.</p>	3

## Answer 10 (9618\_s24\_ms\_32)

Question	Answer	Marks
11	<p><b>One mark per mark point (Max 3)</b></p> <p>MP1 Reinforcement learning is a machine learning technique based on feedback / rewards / punishment.</p> <p>MP2 ... in which an agent learns to behave in an environment by performing the actions and seeing the results of the actions.</p> <p>MP3 ... for each good action, the agent gets positive feedback / reward and each bad action receives negative feedback / punishment.</p> <p>MP4 The agent learns automatically using feedback without any labelled data / specific instructions.</p> <p>MP5 Adjust node weightings to achieve the correct outcome. // Using feedback to improve its performance at accomplishing similar tasks.</p>	3