# IN-CLASS EXERCISE (I5)

Student ID:..... Duration: 15 mins Date: 12/04/2023

Student name: ..... Score: ...../ 3

**Question 1 (2pts)** A robot in a lumber yard learns to discriminate Oak wood from Pine wood by observing the appearance of a given piece of wood. The aside table shows the training data set.

| # | Density | Grain | Hardness | Class |
|---|---|---|---|---|
| 1 | Light | Small | Hard | Oak |
| 2 | Heavy | Large | Hard | Oak |
| 3 | Light | Large | Hard | Oak |
| 4 | Heavy | Small | Medium | Oak |
| 5 | Light | Small | Medium | Pine |
| 6 | Heavy | Large | Soft | Pine |
| 7 | Light | Large | Soft | Pine |
| 8 | Heavy | Small | Soft | Pine |

a) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

Evaluate all attributes and circle the attribute that is selected for the root node of the ID3 decision tree.

| | Whole dataset | Density | | Grain | | Hardness | | |
|---|---|---|---|---|---|---|---|---|
| | | Heavy | Light | Large | Small | Hard | Medium | Soft |
| Entropy | | | | | | | | |
| Average Entropy | | | | | | | | |
| Information Gain | | | | | | | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

| | Whole subset | Density | | Grain | | Hardness | | |
|---|---|---|---|---|---|---|---|---|
| | | Heavy | Light | Large | Small | Hard | Medium | Soft |
| Entropy | | | | | | | | |
| Average Entropy | | | | | | | | |
| Information Gain | | | | | | | | |

b) (0.5pt) Draw the complete decision tree.

**Question 2 (1pt)** Give an example of the classification problem. Describe the problem context. State clearly the list of attributes (and their values) and the target attribute (and its values).

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# IN-CLASS EXERCISE (I5)

Student ID:..... Duration: 15 mins Date: 12/04/2023

Student name: ..... Score: ...../ 3

**Question 1 (2pts)** A robot in the aquarium section of a pet store learns to discriminate Red fish from Blue fish by observing their body parts. The aside table shows the training data set.

| # | Fins | Tail | Body | Class |
|---|---|---|---|---|
| 1 | Thin | Tiny | Slim | Red |
| 2 | Wide | Big | Slim | Red |
| 3 | Thin | Big | Slim | Red |
| 4 | Wide | Tiny | Medium | Red |
| 5 | Thin | Tiny | Medium | Blue |
| 6 | Wide | Big | Fat | Blue |
| 7 | Thin | Big | Fat | Blue |
| 8 | Wide | Tiny | Fat | Blue |

a) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

Evaluate all attributes and circle the attribute that is selected for the root node of the ID3 decision tree.

| | **Whole dataset** | **Fins** | | **Tail** | | **Body** | | |
|---|---|---|---|---|---|---|---|---|
| | | Thin | Wide | Big | Tiny | Fat | Medium | Slim |
| Entropy | | | | | | | | |
| Average Entropy | | | | | | | | |
| Information Gain | | | | | | | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

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|---|---|---|---|---|---|---|---|---|
| | | Thin | Wide | Big | Tiny | Fat | Medium | Slim |
| Entropy | | | | | | | | |
| Average Entropy | | | | | | | | |
| Information Gain | | | | | | | | |

b) (0.5pt) Draw the complete decision tree.

**Question 2 (1pt)** Give an example of the unsupervised learning problem. Describe the problem context. State clearly the list of attributes (and their values) to group data points into clusters.

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# IN-CLASS EXERCISE (I5)

Student ID:..... Duration: 15 mins Date: 12/04/2023

Student name: ..... Score: ...../ 3

**Question 1 (2pts)** A robot in a fish farm learns to discriminate Infected fish from Healthy fish by observing the appearance of a fish. The aside table shows the training data set.

| # | Color | Toughness | Fungus | Class |
|---|---|---|---|---|
| 1 | Green | Hard | No | Infected |
| 2 | Green | Hard | Yes | Infected |
| 3 | Brown | Soft | No | Infected |
| 4 | Brown | Hard | Yes | Infected |
| 5 | Orange | Hard | No | Healthy |
| 6 | Green | Soft | No | Healthy |
| 7 | Green | Soft | Yes | Healthy |
| 8 | Orange | Hard | No | Healthy |

a) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

Evaluate all attributes and circle the attribute that is selected for the root node of the ID3 decision tree.

| | Whole dataset | Toughness | | Fungus | | Color | | |
|---|---|---|---|---|---|---|---|---|
| | | Hard | Soft | No | Yes | Brown | Green | Orange |
| Entropy | | | | | | | | |
| Average Entropy | | | | | | | | |
| Information Gain | | | | | | | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

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| | | Hard | Soft | No | Yes | Brown | Green | Orange |
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b) (0.5pt) Draw the complete decision tree.

**Question 2 (1pt)** Give an example of the reinforcement learning problem. Describe the problem context. State clearly the rewards and how the agent uses that information to improve its performance.

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# IN-CLASS EXERCISE (I5)

Student ID:..... Duration: 15 mins Date: 12/04/2023

Student name: ..... Score: ...../ 3

**Question 1 (2pts)** A robot in a fruit farm learns to determine whether an avocado is Tasty or Bad by observing the avocado's appearance. The aside table shows the training data set.

| # | Shape | Skin | Hardness | Class |
|---|---|---|---|---|
| 1 | Round | Rough | Soft | Tasty |
| 2 | Round | Rough | Hard | Tasty |
| 3 | Oval | Smooth | Soft | Tasty |
| 4 | Oval | Rough | Hard | Tasty |
| 5 | Long | Rough | Soft | Bad |
| 6 | Round | Smooth | Soft | Bad |
| 7 | Round | Smooth | Hard | Bad |
| 8 | Long | Rough | Soft | Bad |

a) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

Evaluate all attributes and circle the attribute that is selected for the root node of the ID3 decision tree.

| | Whole dataset | Skin | | Hardness | | Shape | | |
|---|---|---|---|---|---|---|---|---|
| | | Smooth | Rough | Hard | Soft | Long | Oval | Round |
| Entropy | | | | | | | | |
| Average Entropy | | | | | | | | |
| Information Gain | | | | | | | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

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| | | Smooth | Rough | Hard | Soft | Long | Oval | Round |
| Entropy | | | | | | | | |
| Average Entropy | | | | | | | | |
| Information Gain | | | | | | | | |

b) (0.5pt) Draw the complete decision tree.

**Question 2 (1pt)** Distinguish between supervised learning and reinforcement learning.

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# SOLUTION

# IN-CLASS EXERCISE (I5)

Student ID:..... Duration: 15 mins Date: 12/04/2023

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| 5 | Light | Small | Medium | Pine |
| 6 | Heavy | Large | Soft | Pine |
| 7 | Light | Large | Soft | Pine |
| 8 | Heavy | Small | Soft | Pine |

c) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

Evaluate all attributes and circle the attribute that is selected for the root node of the ID3 decision tree.

| | Whole dataset | Density | | Grain | | Hardness | | |
|---|---|---|---|---|---|---|---|---|
| | | Heavy | Light | Large | Small | Hard | Medium | Soft |
| Entropy | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| Average Entropy | | 1 | | 1 | | 0.25 | | |
| Information Gain | | 0 | | 0 | | 0.75 | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

| | Whole subset | Density | | Grain | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Heavy | Light | Large | Small | | | |
| Entropy | 1 | 0 | 0 | 0 | 1 | | | |
| Average Entropy | | 0 | | 1 | | | | |
| Information Gain | | 1 | | 0 | | | | |

d) (0.5pt) Draw the complete decision tree.

Hardness = Hard: Class = Oak

Hardness = Soft: Class = Pine

Hardness = Medium

|-------- Density = Heavy: Class = Oak

|-------- Density = Light: Class = Pine

**Question 2 (1pt)** Give an example of the classification problem. Describe the problem context. State clearly the list of attributes (and their values) and the target attribute (and its values).

Students do it by themselves.....

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| 5 | Thin | Tiny | Medium | Blue |
| 6 | Wide | Big | Fat | Blue |
| 7 | Thin | Big | Fat | Blue |
| 8 | Wide | Tiny | Fat | Blue |

c) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

Evaluate all attributes and circle the attribute that is selected for the root node of the ID3 decision tree.

| | Whole dataset | Fins | | Tail | | Body | | |
|---|---|---|---|---|---|---|---|---|
| | | Thin | Wide | Big | Tiny | Fat | Medium | Slim |
| Entropy | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| Average Entropy | | 1 | | 1 | | 0.25 | | |
| Information Gain | | 0 | | 0 | | 0.75 | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

| | Whole subset | Fins | | Tail | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Thin | Wide | Big | Tiny | | | |
| Entropy | 1 | 0 | 0 | 0 | 1 | | | |
| Average Entropy | | 0 | | 1 | | | | |
| Information Gain | | 1 | | 0 | | | | |

d) (0.5pt) Draw the complete decision tree.

Body = Slim: Class = Red

Body = Fat: Class = Blue

Body = Medium

|-------- Fins = Wide: Class = Red

|-------- Fins = Thin: Class = Blue

**Question 2 (1pt)** Give an example of the unsupervised learning problem. Describe the problem context. State clearly the list of attributes (and their values) to group data points into clusters.

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| 6 | Green | Soft | No | Healthy |
| 7 | Green | Soft | Yes | Healthy |
| 8 | Orange | Hard | No | Healthy |

c) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

Evaluate all attributes and circle the attribute that is selected for the root node of the ID3 decision tree.

| | Whole dataset | Toughness | | Fungus | | Color | | |
|---|---|---|---|---|---|---|---|---|
| | | Hard | Soft | No | Yes | Brown | Green | Orange |
| Entropy | 1 | 0.971 | 0.918 | 0.971 | 0.918 | 0 | 1 | 0 |
| Average Entropy | | 0.951 | | 0.951 | | 0.5 | | |
| Information Gain | | 0.049 | | 0.049 | | 0.5 | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

| | Whole subset | Toughness | | Fungus | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Hard | Soft | No | Yes | | | |
| Entropy | 1 | 0 | 0 | 1 | 1 | | | |
| Average Entropy | | 0 | | 1 | | | | |
| Information Gain | | 1 | | 0 | | | | |

d) (0.5pt) Draw the complete decision tree.

Color = Brown: Class = Infected

Color = Orange: Class = Healthy

Color = Green

|-------- Toughness = Hard: Class = Infected

|-------- Toughness = Soft: Class = Healthy

**Question 2 (1pt)** Give an example of the reinforcement learning problem. Describe the problem context. State clearly the rewards and how the agent uses that information to improve its performance.

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| 4 | Oval | Rough | Hard | Tasty |
| 5 | Long | Rough | Soft | Bad |
| 6 | Round | Smooth | Soft | Bad |
| 7 | Round | Smooth | Hard | Bad |
| 8 | Long | Rough | Soft | Bad |

c) (1.5pts) Use **ID3 algorithm** to build a decision tree from the given data. Fill in the following tables with your numerical results, each of which is rounded to three decimal places. Attributes having the same best metric values are chosen in alphabetical order.

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| | Whole dataset | Skin | | Hardness | | Shape | | |
|---|---|---|---|---|---|---|---|---|
| | | Smooth | Rough | Hard | Soft | Long | Oval | Round |
| Entropy | 1 | 0.918 | 0.971 | 0.918 | 0.971 | 0 | 0 | 1 |
| Average Entropy | | 0.951 | | 0.951 | | 0.5 | | |
| Information Gain | | 0.049 | | 0.049 | | 0.5 | | |

For the branch that still contains a mixture of positive and negative examples, evaluate the remaining attributes and circle the attribute that is selected for the next node (you may leave irrelevant cells blank).

| | Whole subset | Skin | | Hardness | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Smooth | Rough | Hard | Soft | | | |
| Entropy | 1 | 0 | 0 | 1 | 1 | | | |
| Average Entropy | | 0 | | 1 | | | | |
| Information Gain | | 1 | | 0 | | | | |

d) (0.5pt) Draw the complete decision tree.

Shape = Oval: Class = Tasty

Shape = Long: Class = Bad

Shape = Round

|-------- Skin = Rough: Class = Tasty

|-------- Skin = Smooth: Class = Bad

**Question 2 (1pt)** Distinguish between supervised learning and reinforcement learning.

A supervised learning agent receives the expected outputs during training so that it can precisely estimate the differences between the actual outputs and the expected outputs. A reinforcement learning agent receives rewards or penalties during the operation; however, this information only indicates whether the agent did properly, not a guide of "how far" it is from the desired goal.