**Cover sheet for submission of**

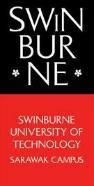
**work for assessment**

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| **UNIT DETAILS** | | | | | | | | | | |
| Unit name | | Data Science Principles | | | | | | Class day/time | 1PM - Friday | Office use only |
| Unit code | | COS10022 | | | Assignment no. | | 1 | Due date | 01/Oct/2023 |  |
| Name of lecturer/teacher | | | | Huy Truong | | | | | |  |
| Tutor/marker’s name | | | Huy Truong | | | | | | | Faculty or school date stamp |
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# Swinburne University of Technology Hawthorn Campus Dept. of Computer Science and Software Engineering

**COS10022 Data Science Principles**

Assignment 1 - *Semester 3, 2023*

**Assessment Title**: Predictive Model Creation and Evaluation

## Assessment Weighting: 20%

**Due Date**: Sunday, 1st October 2023 at 11.59 pm (GMT+7)

**Assessable Item:**

* One (1) piece of a written report no more than 10-page long with the signed Assignment Cover Sheet.
* A unit peer must review your submission before it can be marked.

The submitted report should answer all questions listed in the assignment task section in sequence.

You must include a digitally signed Assignment Cover Sheet with your submission.

1. Follow the instructions above to split the source data into training and test sets. Answer the following questions after splitting the data. **[10 marks in total]**
   1. A diagram of a computer

      Description automatically generated with medium confidencePast a clear screenshot of the whole workflow of assignment 1 in the report. **[2.5 marks]**

The whole workflow contains 29 nodes divided into 6 different groups. The detail of each group is as follow:

|  |  |  |  |
| --- | --- | --- | --- |
| **Group** | **Designation** | **Functions** | **Explanation** |
|  | Data preparation group | Read the raw CSV data and assign colours to different types of entries (i.e., fishes).  Randomise the data set (with seed **3122**). Separate data in the **80-20** ratio.  Normalize data (for Logistic Regression) based on **Min-Max** normalization. | This group prepares the data to be used in the Linear Regression group, where 80% of the prepared data will be used as the **training** set, while the other 20% will used for the **test** set.  Prior to partitioning, the data is normalized to ensure the best result when calculating Linear Regression. |
|  | Counting Group | **Group** and **count** the number of fish present in the training and testing dataset. | Counting the number of fishes in a particular species is obtained by appending a duplicated column of the species name and then counting the grouped number. |
|  | Visualizing group | **Visualized** data using scatter plot and pie chart nodes. | This group visualize the original data (i.e., data read from the CSV reader.). The visualized data is put in the **scatter plot** and the **pie chart** node to achieve the respective visualization. |
|  | Linear Regression Model 1 | Perform Linear Regression on the data.  Output **prediction**, **calculations** of the Linear Regression Process  **Visualised** scatter plot data. | This group is the initial linear regression model built to **predict** the value of the “Weight\_of\_Fish\_in\_Gram” attributes. Via Scatter plot, it visualised the original and the prediction data, allowing us to observe the LRM result better. Calculations (i.e., R2, means, etc.) made by the model are captured by the Numeric Scorer. |
|  | Logistic Regression Model | Perform Logistic Regression on the data.  Output **categorization** of each fish species | This model **categorizes** fish species and outputs the **confusion matrix** via the Scorer, which details the fish species' TP, FP, and FN cases. |
|  | Linear Regression Model 2 | **Removes** specified **unwanted** data and performs Linear Regression on the data.  Output **prediction**, **calculations** of the Linear Regression Process, and **visualized** scatter plot data.  Calculate collinearity between the attributes. | This model is the **improved** version of the initial model. It predicts the value of the "Weight\_of\_Fish\_in\_Gram" attributes of only one fish species (i.e., Perch). The improvement over the other model is made by having some data (**high collinearity** attributes) **removed** beforehand (via the nominal value row filter node) to **increase** the model's prediction accuracy. |

* 1. How many tuples are included in the training set? **[2.5 marks]**

The original data contains 150 tuples; using the partitioning tool, we received 80% of tuples in the training set, which amounted to 120.

Ans: 120 tuples.

* 1. A screenshot of a computer

     Description automatically generatedHow many species are included in the test set? **[2.5 marks]**

With the help of the groupby node, the number of species can be observed to be 7 in the test set.

Ans: 7 species.

* 1. Do species *Whitefish* and *Smelt* have the same number of tuples included in the test set?   
     **[2.5 marks]**

Ans: The number of tuples from *Whitefish* & *Smelt* are similar, they both have 2 tuples.

1. Build a Linear Regression Model using **all** available attributes to predict the value of the “Weight\_of\_Fish\_in\_Gram”. Answer the following questions after completing the model training and test. **[40 marks in total]**
2. A screenshot of a computer error

   Description automatically generatedWhat is the value of your test result? **[5 marks]**

The coefficient calculation is inside the numeric scorer nodes; per inspecting the node, it is evident that the R2 value is 0.918.

Ans: 0. 918

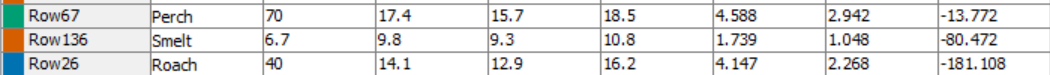
1. **A graph with different colored dots

   Description automatically generated**Give the screenshot of the scatter plot result of your test output using “Weight\_of\_Fish\_in\_Gram” on the x-axis and the prediction value on the y-axis. Assign different colours to the data points based on the “species.” **[15 marks]**
2. A screenshot of a table

   Description automatically generatedWhich species has the heaviest predicted weight in your test result? **[5 marks]**

From the data predicted via the Linear Regression Predictor,the Pike is the heaviest fish, with a weight reaching 1269.986 grams.

Ans: *Pike*

1. How many prediction results are infeasible in your test result? **[5 marks]**

3 infeasible records were found, as their weight are all in the negatives.

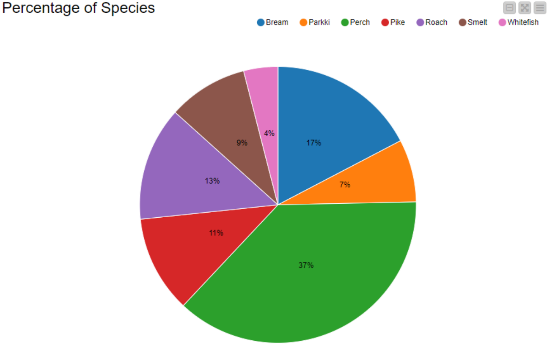
Ans: 3

1. A graph with many colored dots

   Description automatically generatedLooking at your source data before splitting them, which two species can be easily separated from others if looking at the “Height\_in\_cm” and “Diagonal\_Width\_in\_cm” attributes? Post your visualisation result on data observation in the report. **[5 marks]**

As inspected in the image, Beam and Smelt stand out most from the rest of the population. Smelt’s values form a cluster at the bottom-left of the chart, while Beam’s values spread out on the opposite end.

Ans: *Beam* and *Smelt*

1.  Draw a pie chart of the original input data before splitting it into training and test sets. Use different colours for each species and show the percentage of data in the pie chart. **[5 marks]**
2. Build a Logistic Regression Model with **all** attributes and use “Smelt” as the reference category. The maximal number of epochs and epsilon should be set to **10,000** and **0.0001**, respectively. Use **3122** as the seed in the logistic regression node. Answer the following questions after completing the model training and test. **[40 marks in total]**

A screenshot of a data

Description automatically generatedWe can observe the full confusion matrix via the scorer node and draws some information from there:

1. Which species has no “True Positive (TP)” case in the prediction result? **[5 marks]**

As seen in the summarised table, *Whitefish* has no TP cases.

Ans: *Whitefish*.

1. For the species with no TP case, which species will be misplaced? **[5 marks]**

A screenshot of a computer

Description automatically generatedVia the Logistic Regression Predictor node, we can observe what the *Whitefish* has been replaced with:

Ans: *Whitefish* is misplaced with *Roach*.

1. What is the overall accuracy of the prediction result? **[5 marks]**

A white background with black and white clouds

Description automatically generated with medium confidenceThe overall accuracy can be calculated by manually counting the records, assuming there are few records in the data. However, for a quicker method, the accuracy can be inspected via the Scorer.

Ans: The overall accuracy is **86.667%**

1. List all species names that have 100% correctly classified test results. **[15 marks]**

We use the following formula to calculate the accuracy of prediction of each species of fish.

Based on the confusion matrix, the *Beam*, *Parkki*, *and* Pikehave 0 FP and 0 FN. Hence, the accuracy rate is calculated, which amounts to a 100% accuracy rate.

Ans: *Beam*, *Parkki*, and Pike

1. Which species has a 50% chance of being misplaced into another species in the test result? **[5 marks]**

The chance of a species being misplaced into another one is calculated based on the False Negative rate:

𝐹𝑁𝑅 = 1 − 𝑅𝑒𝑐𝑎𝑙𝑙

We have the recall value for each species as follow:

|  |  |
| --- | --- |
| **Species** | **Recall** |
| Whitefish | 0.0 |
| Smelt | 0.(6) |
| Roach | 0.5 |
| Pike | 1.0 |
| Perch | 1.0 |
| Parkki | 1.0 |
| Beam | 1.0 |

Using the FNR formula, we can calculate the recall rate and then compare the recall rate to all species to find the species that has a 50% chance of being misplaced:

50% = 1 – Recall => Recall = 0.5

*Roach* is the species with the exactly 0.5 Recall’s. Hence, the species with a 50% rate of being misplaced is *Roach*.

Ans: *Roach*

1. In the test result, what percentage of the species “Pike” is misplaced into others? **[5 marks]**

The treatment above will be used for this one:

𝐹𝑁𝑅Pike = 1 − 𝑅𝑒𝑐𝑎𝑙𝑙Pike => 𝐹𝑁𝑅Pike = 1 – 1 = 0

Ans: *Pike* has 0% chance of being misplaced into others.

1. Build a new linear regression model different from the one built when answering question 2. This time let’s focus on the species “Perch” only. You are limited to using three attributes in the input to predict the “Weight\_of\_Fish\_in\_Gram.” Use a “Scatter Matrix (local)” node to observe your data and decide the suitable attributes to be included. The linear regression model should be the same as the one used in question 2 except for the input attributes. Build, train, and test the model and then answer the questions below. **[10 marks in total]**
2. Give the reasons for each eliminated attribute and why they are not selected as the input. **[5 marks]**

***A screenshot of a computer

Description automatically generatedA screenshot of a table

Description automatically generated***To determine which attribute should be removed, one of the most significant considerations is checking for the collinearity between the attributes; this can be achieved using the Linear Correlation (for the exact measurement) and the Scatter matrix (for a more abstract observation) node.

A screenshot of a computer

Description automatically generated

As inspected within the nodes, ***Diagonal\_Length\_in\_cm*** and ***Height\_in\_cm*** are the attributes that ought to be eliminated as they present strong collinearity with each other as well as many other attributes. To get into more details:

* ***Height\_in\_cm*** collinear with: ***Weight\_of\_Fish\_in\_Gram***, ***Vertical\_Length\_in\_cm***, ***Diagonal\_Length\_in\_cm***, ***Cross\_Length\_in\_cm***.
* ***Diagonal\_Length\_in\_cm*** collinear with: ***Weight\_of\_Fish\_in\_Gram***, ***Height\_in\_cm****,* ***Vertical\_Length\_in\_cm***, ***Cross\_Length\_in\_cm***.

The other items that were not opted for elimination fall into one or more of the categories listed below:

* Their correlation value is less significant than the two items chosen above.
* They don not collinear with many other attributes.
* Only two attributes should be removed.

This level of collinearity and quite possibly multicollinearity of ***Diagonal\_Length\_in\_cm*** and ***Height\_in\_cm*** lowers the statistical significance of the original regression model as they reduce the accuracy of the estimated coefficients.

Ans:

The remaining attributes: ***Vertical\_Length\_in\_cm***, ***Cross\_Length\_in\_cm***, ***Diagonal\_Width\_in\_cm***.

The eliminated attributes: ***Diagonal\_Length\_in*** and ***Height\_in\_cm.***

1. List the of your test result and compare it with the one in question 2. Reveal both values obtained in question 2 and in question 4. If you can improve the model, you get the mark. **[5 marks]**

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Description automatically generated Original Model Improved ModelA white background with black text

Description automatically generated

After completing the necessary steps to improve the model, the model has indeed been improved. The indicator for this is that the *R2* has been improved by 0.04 from the original 0.918 to 0.957, and the higher the *R2,* the higher the prediction strength, ultimately leading to an increase in model accuracy.

Ans: The *R2*value has increased by 0.04, which increased the prediction strength. The accuracy of the model has been improved.