

**Ain Shams University**

**Faculty of Computer and Information Science**

**Scientific Computing department**

**Ain shams university**

**Faculty of computer and information science**

**Bioinformatics department**

**Assignment 1 – Deep Learning & Neural Networks Course**

**Single Layer Perceptron**

**By Team: SC\_H26**

|  |  |  |
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## Features Linearity Visualization

1. Between the 3 classes

Chart, scatter chart

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A picture containing chart

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Chart, scatter chart

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Chart, scatter chart

Description automatically generatedText

Description automatically generated

Chart

Description automatically generatedChart, scatter chart

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1. Between class Adelie (red) and Chinstrap (black)

Chart, scatter chart

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Chart

Description automatically generated with medium confidenceChart, scatter chart

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Chart, scatter chart

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Chart, scatter chart

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Description automatically generated

Chart, scatter chart

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Description automatically generated

The following combinations can discriminate between the 2 classes:

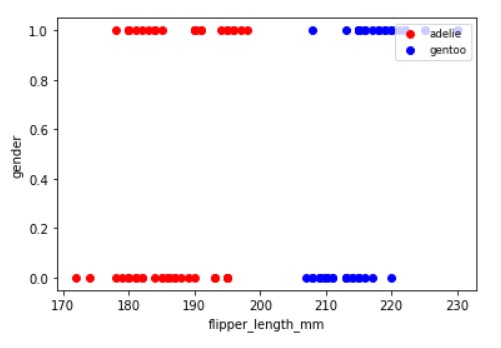
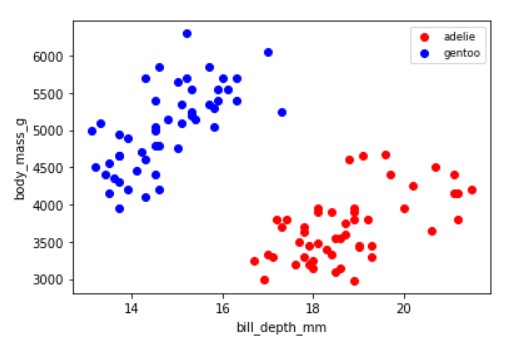
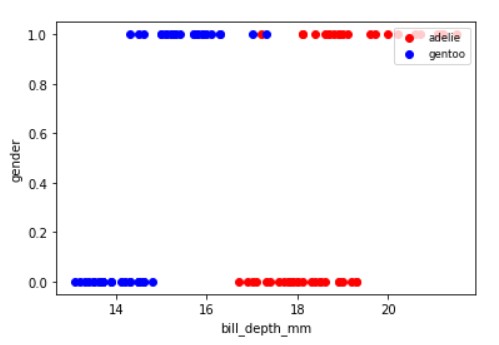
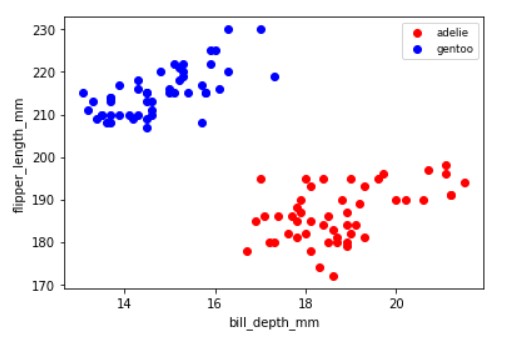
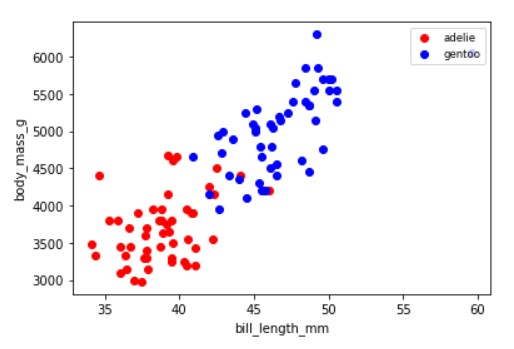
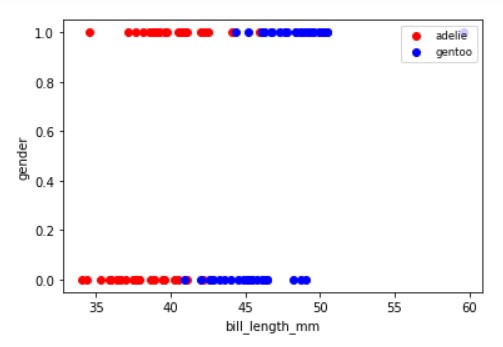
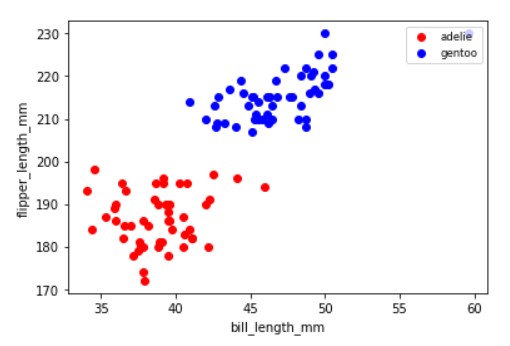
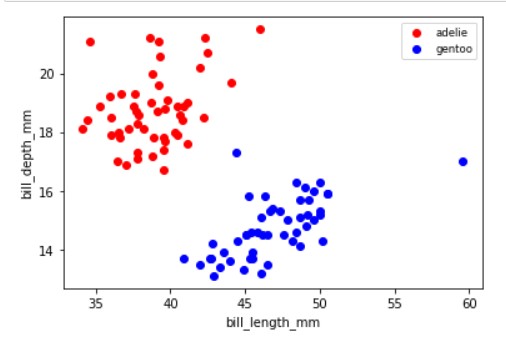
* Bill length & bill depth
* Bill length & gender

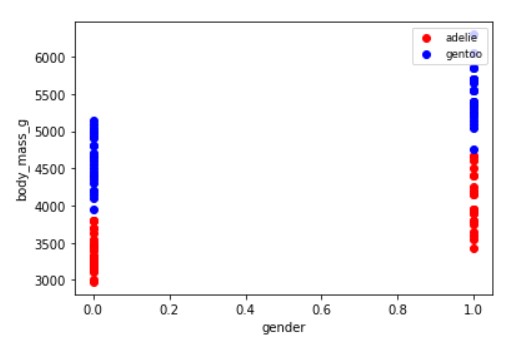
The following combinations can discriminate between the 2 classes but with some error as they are not linearly separable:

* Bill length & flipper length
* Bill length & body mass

The rest of the features cannot be separated linearly at all

1. Between class Adelie (red) and Gentoo (blue)

Chart, scatter chart

Description automatically generated

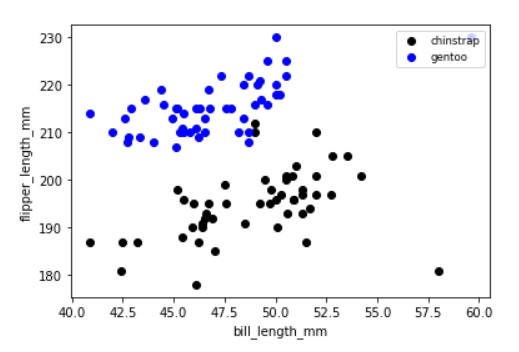
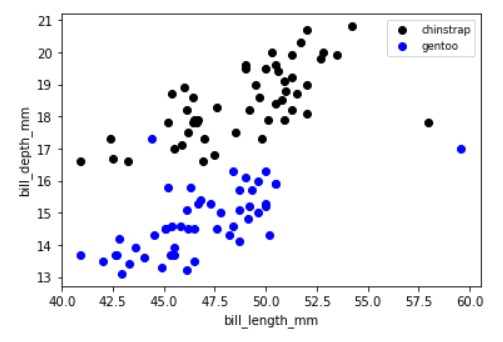
The following combinations can discriminate between the 2 classes as they are linearly separable:

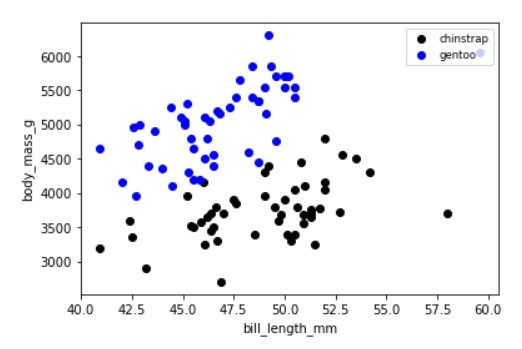
* Bill length & bill depth
* Bill length & flipper length
* Bill depth & flipper length
* Bill depth & body mass
* Flipper length & gender
* Flipper length & body mass
* Gender & body mass

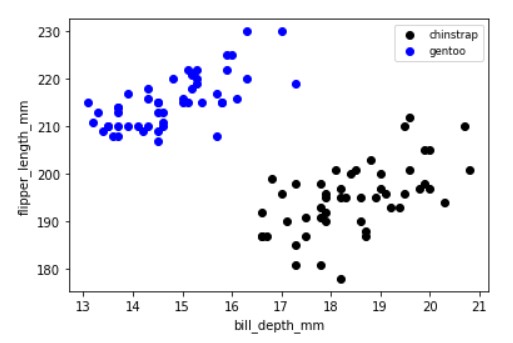
The following combinations can discriminate between the 2 classes but with some error as they are not linearly separable:

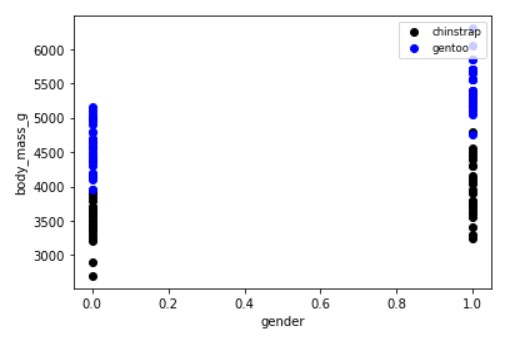
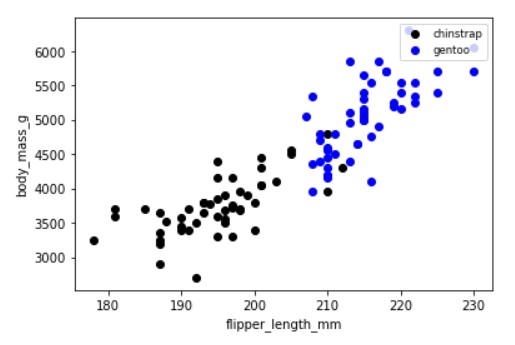
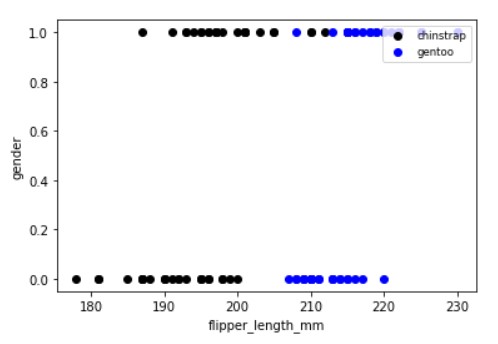
* Bill length & gender
* Bill depth & gender (error in 1 point)

1. Between class Chinstrap (blue) and Gentoo (black)

A picture containing text

Description automatically generatedChart, scatter chart

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Description automatically generated

The following combinations can discriminate between the 2 classes:

* Bill depth & body mass
* Bill depth & flipper length
* Bill depth & gender

The following combinations can discriminate between the 2 classes but with some error as they are not linearly separable:

* Bill length & bill depth
* Bill length & flipper length
* Bill length & body mass
* Flipper length & body mass
* Flipper length & gender

**Preprocessing:**

* For numerical features, we checked the skewness and the kurtosis of the feature, all the features had negative kurtosis and a magnitude far from zero and for the skewness.

1. Bill depth skewness had a magnitude close to zero, almost following a normal distribution.
2. All other features’ skewness magnitude was a number far from zero, not following a normal distribution at all.

We tried transforming the numbers using 3 mathematical equations: the square root, log, and the reciprocal of the function, but not one of them resulted in a normal distribution so numbers were kept as they are.

* Gender was the only feature that had null values, 6 null values to be exact, in order to fix that we trained a simple logistic regression model that is able to predict the gender, but we only trained it on two species only as classes (Adelie and Gentoo) were the only classes that had null values, there was no need to train on the other species if they are not present in the null values, we trained on 94 samples on classes (Adelie and Gentoo), the resulting accuracy was 93% and tested on the 6 null values.
* Feature body mass was in grams so we transformed it to kilograms (/1000) so that the range of numbers in the feature would be closer.
* Features (flipper length, bill length, bill width) were in millimeters so we transformed it to centimeters (/10) so that the range of numbers in the feature would be closer.

**Training:**

* The dataset has 3 penguin species (classes) with 50 samples of each class.
* We split the dataset into 30 training samples and 20 testing samples for each class.
* We created "Perception.py" class to make the code more maintainable and extendable.
* The training loop exist inside of method "fit" that's in perception class.
* We built the confusion matrix by looping through the predicted target and actual target and then counting:

1. True positive

2. False negative

3. True negative

4. False positive

* In main file, we first split data into training and testing.

Then we split them further into (X\_train, Y\_train, X\_test, Y\_test)

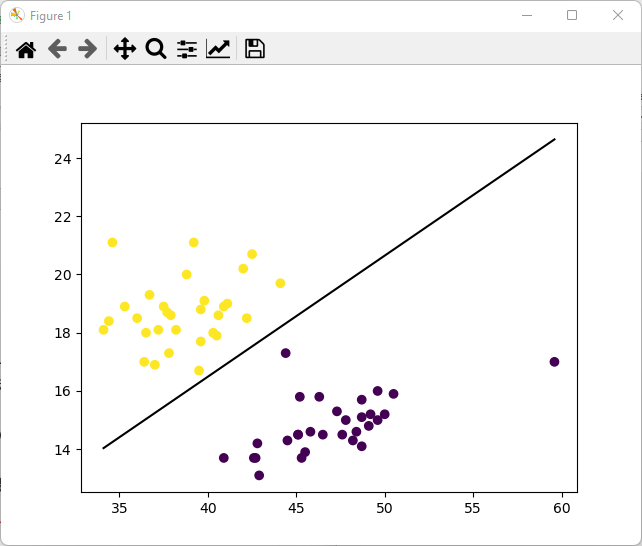
* And we create a perceptron object from class perception and give in the classes that the user selected in the GUI.

The user would select 2 classes and 2 features, and the decision boundary would be plotted:

Supposing that the learning rate is 0.01 and epochs is 1000

1. Between class Adelie and Gentoo

Features: bill\_length\_mm vs bill\_depth\_mm, **Accuracy =1**



bill\_length\_mm - flipper\_length\_mm, **Accuracy =** **0.975**

Chart, scatter chart

Description automatically generated

bill\_depth\_mm - gender, **Accuracy = 0.975**

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Description automatically generated

bill\_length\_mm - body\_mass\_g, **Accuracy= 0.925**

Chart, scatter chart

Description automatically generated

Classes Gentoo & Chinsrtrap

bill\_length\_mm - body\_mass\_g, **Accuracy= 0.825**

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Description automatically generated

gender - body\_mass\_g , **Accuracy = 0.925**

Chart

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Classes Adelie & Chinstrap:

flipper\_length\_mm – gender, Accuracy = 0.725

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bill\_depth\_mm - body\_mass\_g , **Accuracy = 0.5**

**Chart, scatter chart

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flipper\_length\_mm - body\_mass\_g , **Accuracy= 0.775**

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bill\_length\_mm - gender , Accuracy = 0.95

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**Conclusion:**

Based on the stated results**,**

**Features:**

* bill\_length\_mm vs bill\_depth\_mm
* bill\_length\_mm - flipper\_length\_mm
* bill\_length\_mm - body\_mass\_g
* bill\_length\_mm - gender
* bill\_depth\_mm - gender