CoGrammar

Neural Networks

SKILLS FOR LIFE
SKILLS BOOTCAMPS

Department for Education

Data Science Housekeeping

- The use of disrespectful language is prohibited in the questions, this is a supportive, learning environment for all - please engage accordingly. **(FBV: Mutual Respect.)**
- No question is daft or silly - **ask them!**
- There are **Q&A sessions** midway and at the end of the session, should you wish to ask any follow-up questions. Moderators are going to be answering questions as the session progresses as well.
- If you have any questions outside of this lecture, or that are not answered during this lecture, please do submit these for upcoming Open Classes. You can submit these questions here: **Open Class Questions**

Data Science Lecture Housekeeping cont.

- For all **non-academic questions**, please submit a query: **www.hyperiondev.com/support**
- Report a **safeguarding** incident: **www.hyperiondev.com/safeguardreporting**
- We would love your **feedback** on lectures: **Feedback on Lectures**

Prestigious Co-Certification Opportunities

New Partnerships!

- **University of Manchester & Imperial College London** join our circle along with The University of Nottingham Online.

Exclusive Opportunity:

- Co-certification spots awarded on a first-come basis.
- Meet the criteria early to gain eligibility for the co-certification.

New Deadlines:

- **11 March 2024**: 112 GLH & BYB tasks completion.
- **18 March 2024**: Record interview invitation or self-employment.
- **15 July 2024**: Submit verified job offer or new contract.

Lecture Objectives

- Define what a neural network is
- Understand the basic neural network structure
- Grasp how neural networks transform input data into meaningful output
- Comprehend what considerations must be made when building a neural network

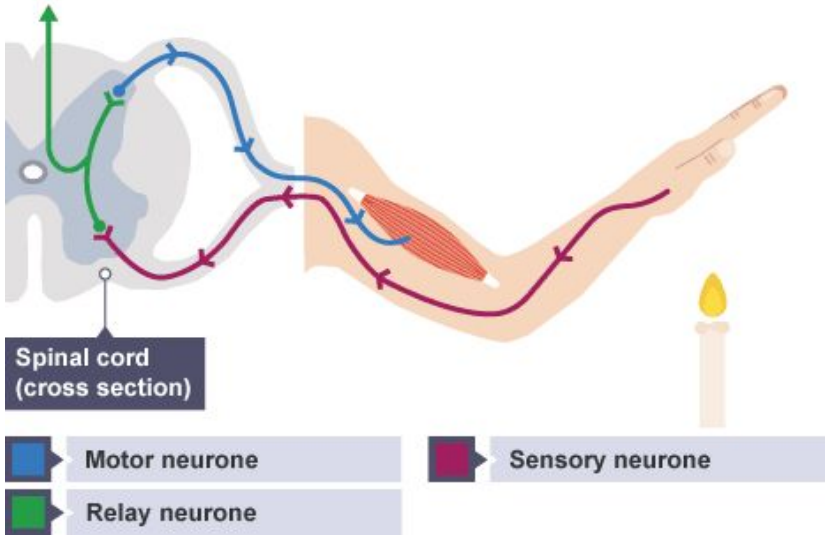
Introduction

- We are going to build a neural network to help solve the problem of missing information in a dataset

- We have a dataset containing weight and wing length measurements of 168 birds in a rainforest. There are three species of interest in this study. Unfortunately, there was a data entry error: one of the researchers took all the necessary measurements of 20 birds, but did not include the species of these birds in his record. Returning to the rainforest to correct this mistake is expensive, both logistically and resource-wise. The team opts to use the complete data they already have on the other 148 birds to figure out what the species of these 20 birds could be.

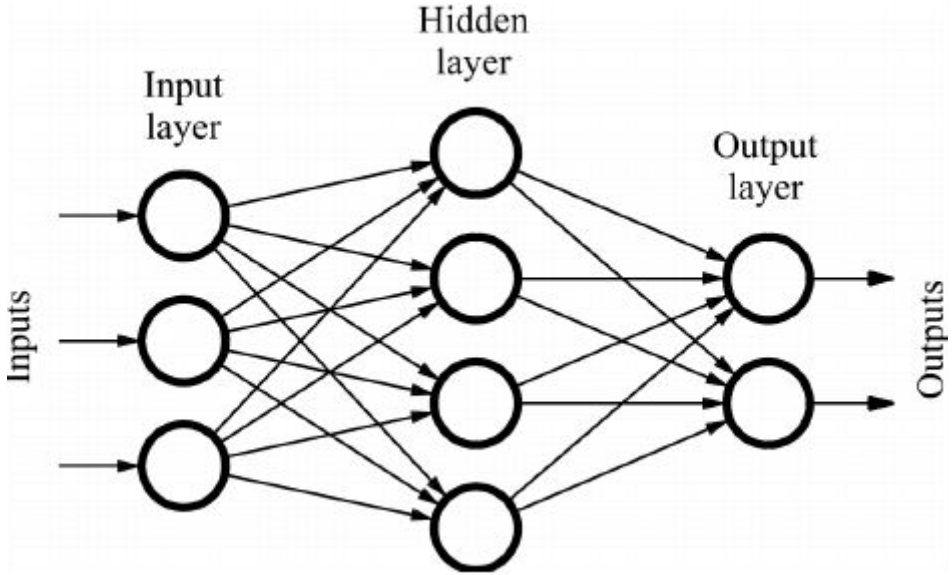
What is a neural network?

- A neural network is a computational model inspired by the structure and function of the human brain



What is a neural network?

- The structure of a feedforward network:



Basic network structure for our problem

- When building a neural network for a specific task, you need to make the following considerations in order to determine the network's basic structure:

    1. How many nodes should be in the input layer?
    2. How many nodes should be in the output layer?
    3. How many hidden layers and how many nodes in each layer?

Basic network structure for our problem

- The number of nodes in the input layer is determined by the number of features.

- The number of nodes in the output layer is determined by the nature of the problem. Traditionally:

    - ★ For classification tasks, you will have one node for each class of the categorical target variable
    - ★ For regression tasks, you will have one node in the output layer representing the numeric target variable

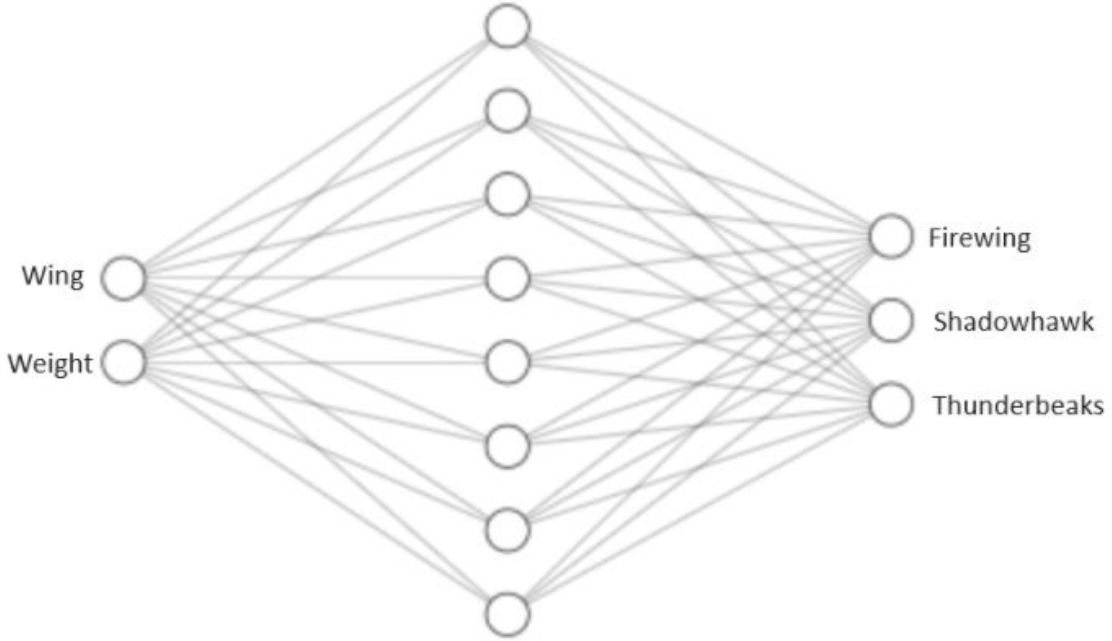
Basic network structure for our problem

- Determining the number of hidden layers and the number of nodes in the hidden layer(s) depends on several of factors:

    1. Problem complexity
    2. The size of the dataset
    3. The results of empirical experimentation

  to name a few. Determining the number of hidden layers as well as the number of nodes in each layer will require hyperparameter tuning to find the optimal values.

Basic network structure for our problem

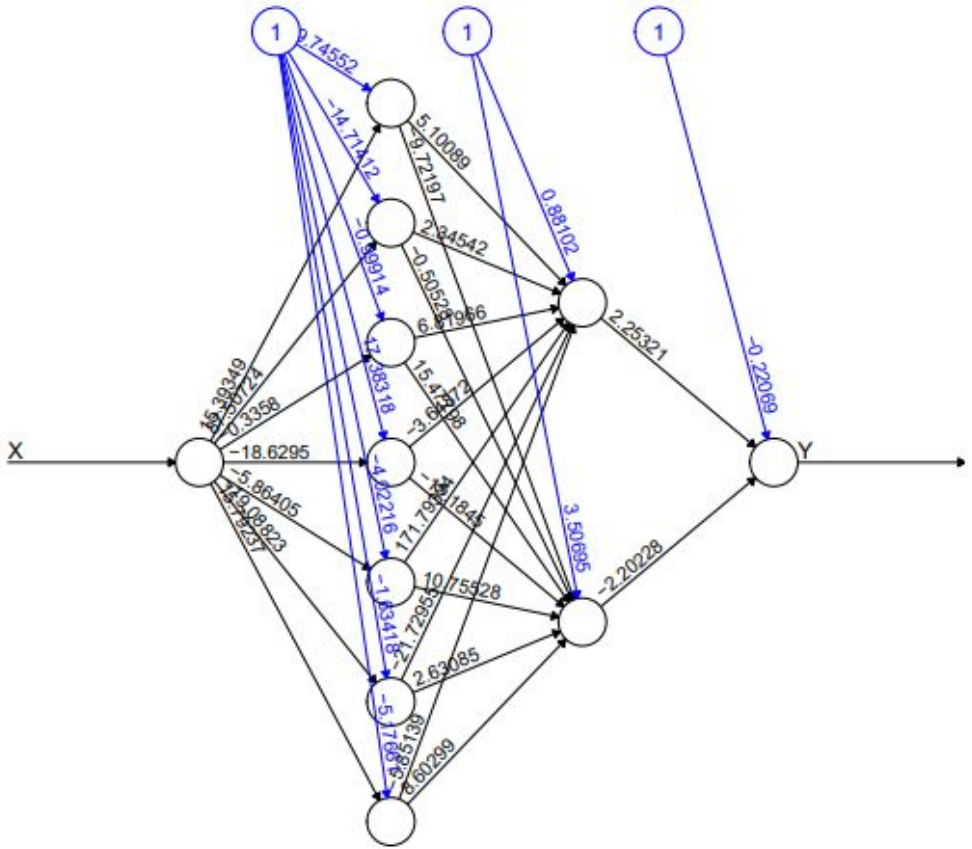


How the neural network transforms inputs into outputs

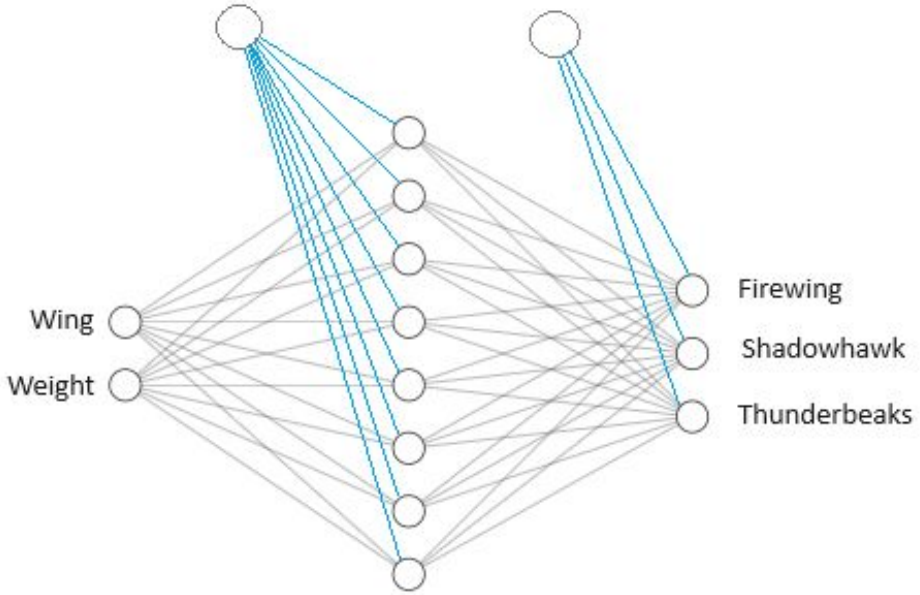
We now have to discuss weights, bias terms and activation functions.

1. Every node-to-node connection has a weight
2. Every layer has a bias term
3. We apply activation functions to the resulting weighted sums that have had a bias term added to them

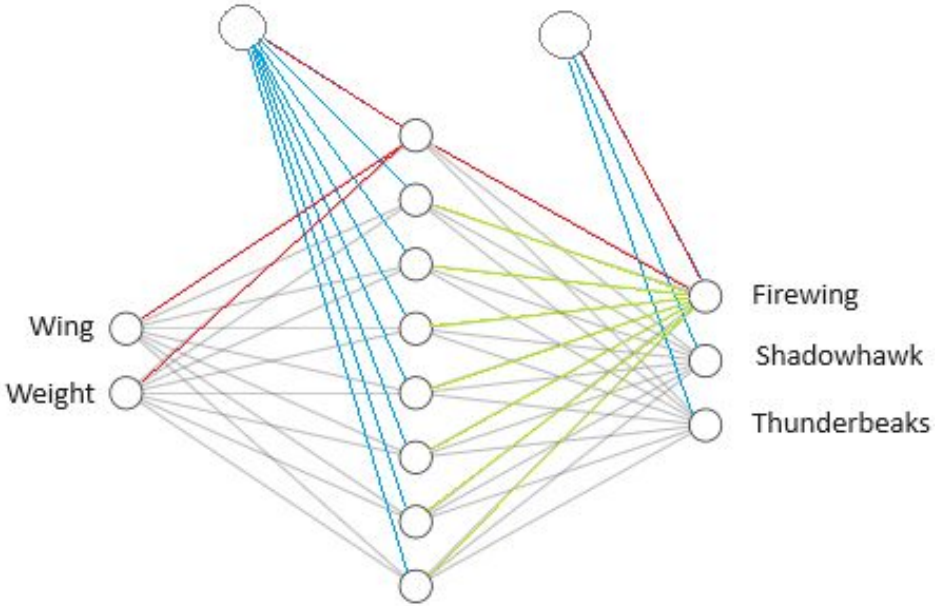
Neural network with weights and biases



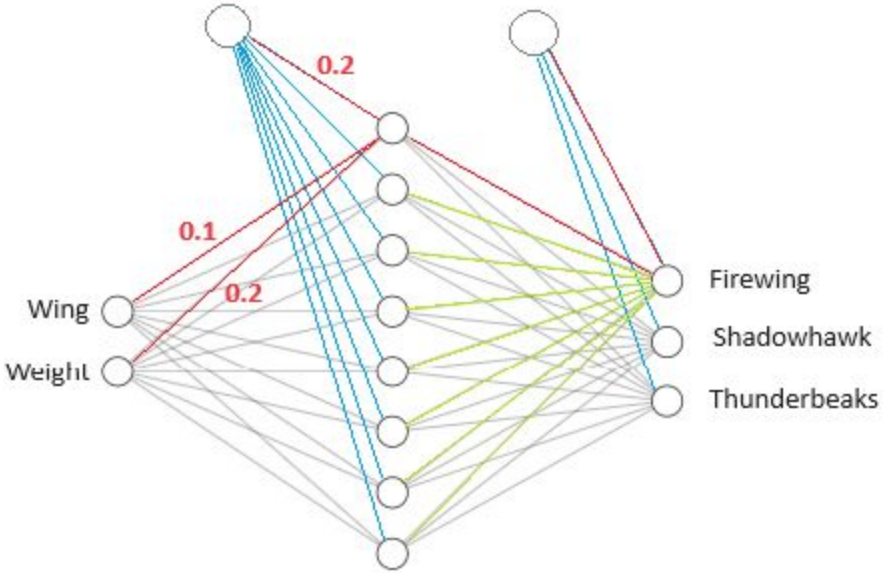
Our neural network with bias terms added



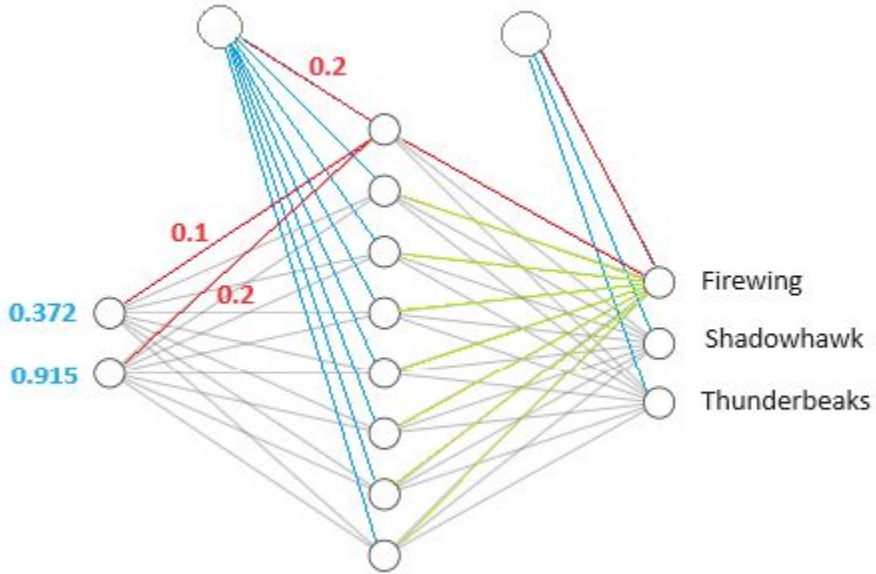
Path to focus on (red)



Activation value calculation

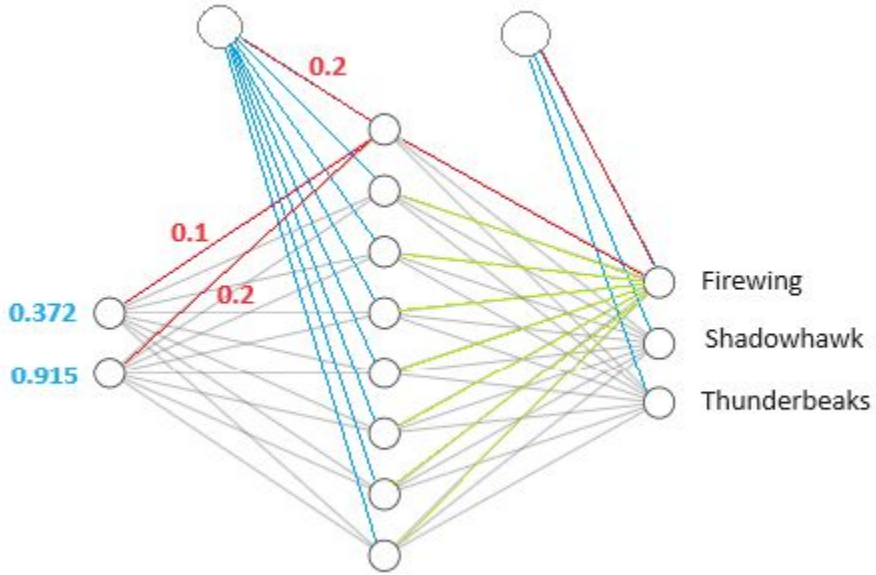


Activation value calculation



Calculation: get the weighted sum of all connections leading to the node + the bias

Activation value calculation



(0.372 x 0.1) + (0.915 x 0.5) + 0.2 = 1.0983

Hidden Layer

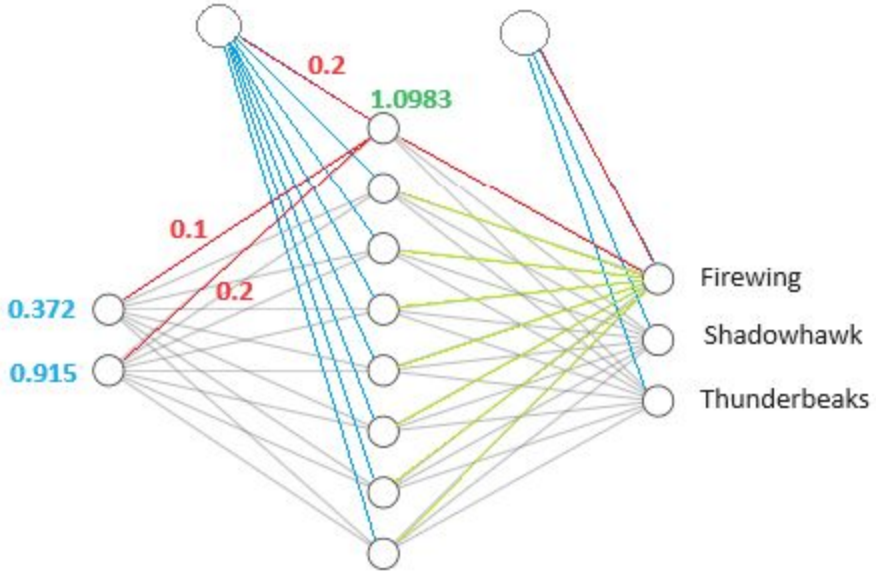
So now we proceed to the hidden layer with the 1.0983 value we just calculated. Here, we will apply the ReLU activation function. Activation function introduce non-linearity which gives neural networks the ability to capture complex patterns/relationships.

ReLU activation function is defined as $f(x) = max(0, max)$ which essentially means any negative values will be set to 0.

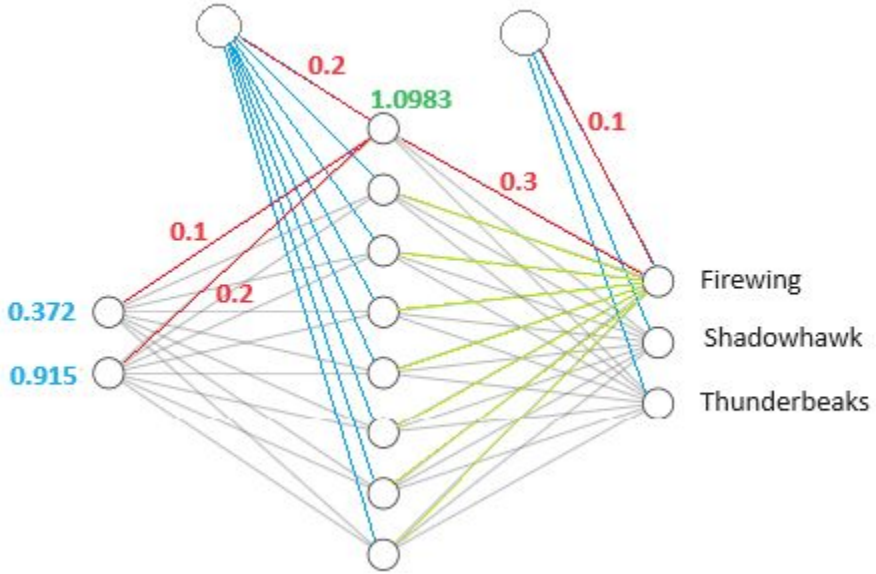
So we have $f(1.0983) = max(0,1.0983) = 1.0983$

Thus, 1.0983 is the output from the hidden layer.

Activation value calculation



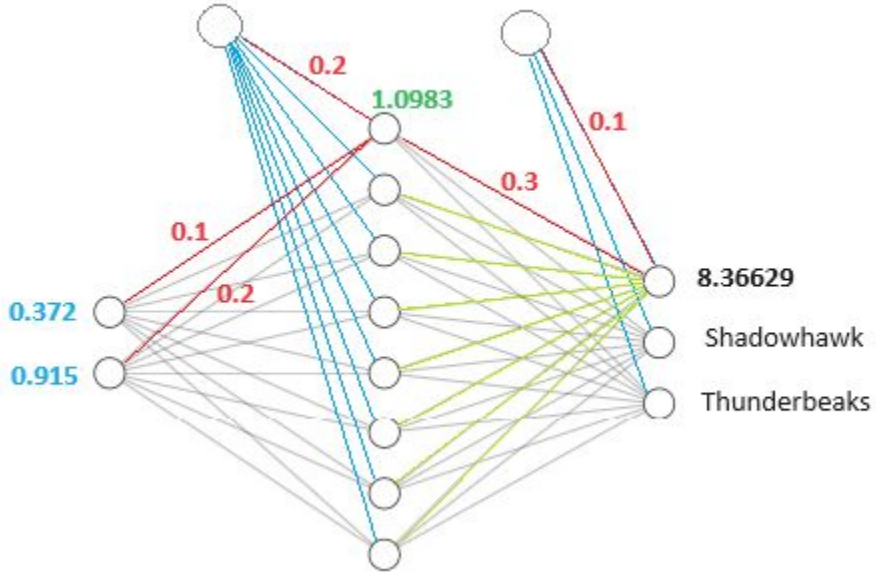
Activation value calculation



$$(1.0983 \times 0.3) + 0.6742 + 1.5224 + 1.9465 + 1.1703 + 1.5111 + 0.2248 + 0.8875 + 0.1 = 8.36629$$

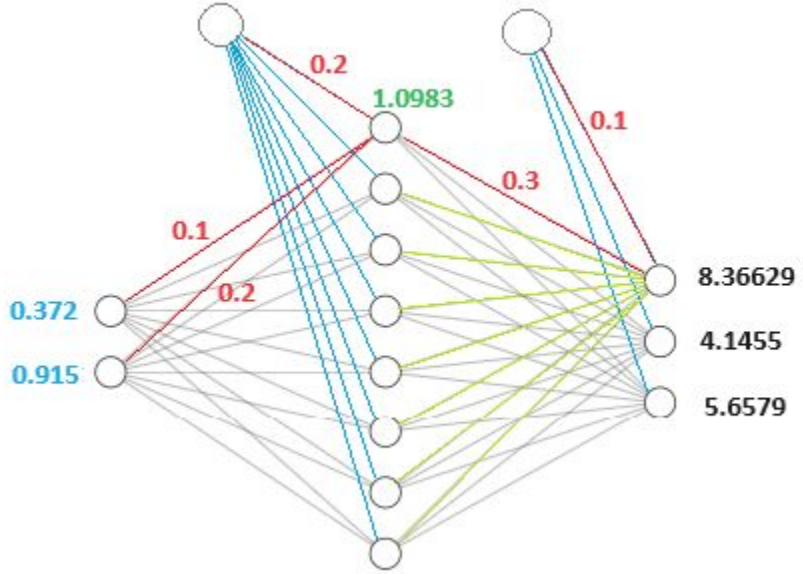
Activation value calculation

We now have a raw output score for the Firewing species.



Activation value calculation

We obtain the raw output score for the other species.



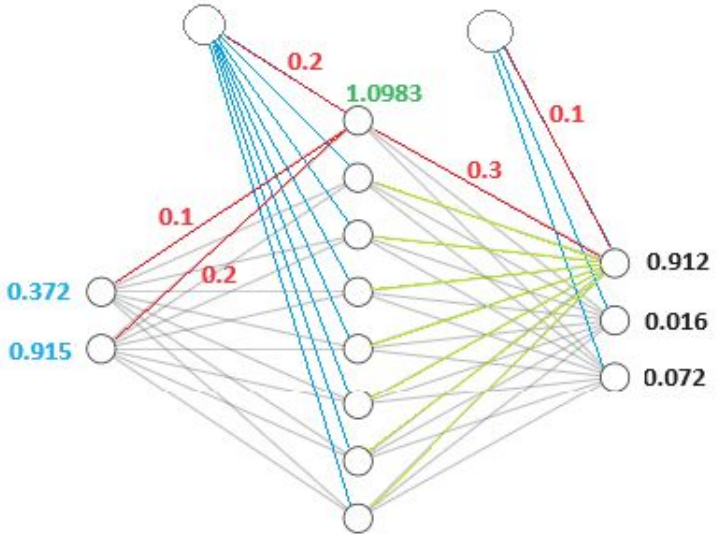
Output Layer

We have 3 raw output scores that we will apply the softmax activation function to. The softmax function is commonly used in multi-class classification tasks to convert raw score into probabilities.

Why do we want to convert them into probabilities?

- After applying the softmax function, the node with the highest probability is chosen as the predicted class for that observation.

Output layer after applying softmax activation to the raw output scores



The node with the highest probability represents the Firewing species. Therefore, the bird with the given measurements belongs to the Firewing species.

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Q & A SECTION

Please use this time to ask any questions relating to the topic, should you have any.

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Thank you for joining!