Final Project: Harry Potter

Stephanie Gamino

University of California, Merced

Cogs 103

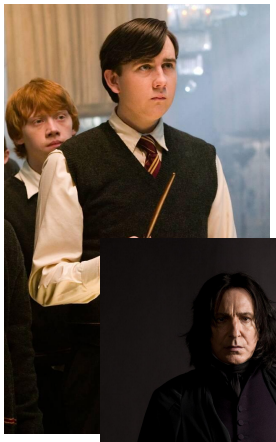
Jeff Yoshimi

Introduction

For this final project to simulate a neural network I based mine on the very famous novels and movies, Harry Potter. For this assignment, I used the characters from the Harry Potter series to represent the 5 prototype vectors and used 6-dimensional input vectors they would be rated in. The 6-dimensional input spaces I used were bravery, loyalty, cowardly, friendliness, arrogant, and lastly selfishness and the centers for the dimensions were placed between 0 and 1. Overall, the neural network performed very well in being about to categorize each character. There was a little bit of confusion when characters had overlapping characteristics/dimensional input spaces, but there was always one defining dimensional input space that paired with one of the categories.

Data

The characters used to represent the 5 prototypes are the main protagonist Harry Potter, two of his classmates Draco Malfoy and Neville Longbottom, as well as 2 of his professors at Hogwarts. Harry Potter is the chosen wizard after surviving the Killing curse casted by the Dark Lord named Voldemort. He is famous for that very reason and through his time at Hogwarts Schools of Witchcraft and Wizardry, tries to improve his skill as a wizard to come face to face with the Dark Lord. His two class mates Draco Malfoy and Neville Longbottom both play a role in Harry's upbringing in very different ways. Neville Longbottom belongs in the same house as Harry

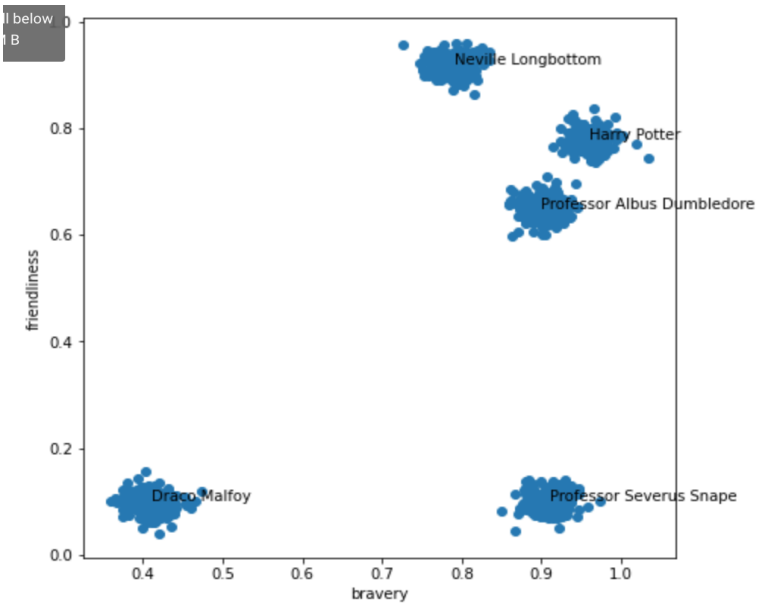


which is Gryffindor. He is a very sweet and passionate person who is always willing to do the right thing. On the other hand, Draco Malfoy although is a student and belongs to the Slytherin house at Hogwarts, followed the footsteps of his parents and is a servant to the Dark Lord. Although he didn't become an official servant or Death Eater until his later teen years, his father and mother both are Death Eaters and help the Dark Lord. The first professor is Severus Snape who is a professor who teaches potions, but has always wanted to teach Defense Against the Dark Arts. He too is a Death Eater, but only does so for the protection of Harry Potter. Although Professor Snape isn't the warmest person, he is very loyal to Harry and the greater good. Lastly, we have the last professor and headmaster of Hogwarts which is Albus Dumbledore. Professor Dumbledore has always been very close to Harry in that, he has always wanted what was best for Harry. He is very wise and very kind, but does have moments where he does look out for himself but the majority of the time, he is looking out for Harry. Although this is very interesting series, all these characters are fictional. In this assignment, I used each the five character as a prototype or graded category and placed them into the prototypical member of a category. My dataset specifically, I had one thousand randomly generated instances of rows that represented characters in the Harry Potter wizarding world and the characters are described along 6 features. The 6 features the characters were rated in were bravery, loyalty, cowardly, friendliness, arrogance, and selfishness. For the data, I used my knowledge on each character and what is seen in the movies to create the data. I made a table to classify the input dataset in which allows the prototypes vectors to be in row format and at the top we have the dimensional input spaces as columns. The numbers inside the table represent the associated value each prototype has to each dimensional input space.

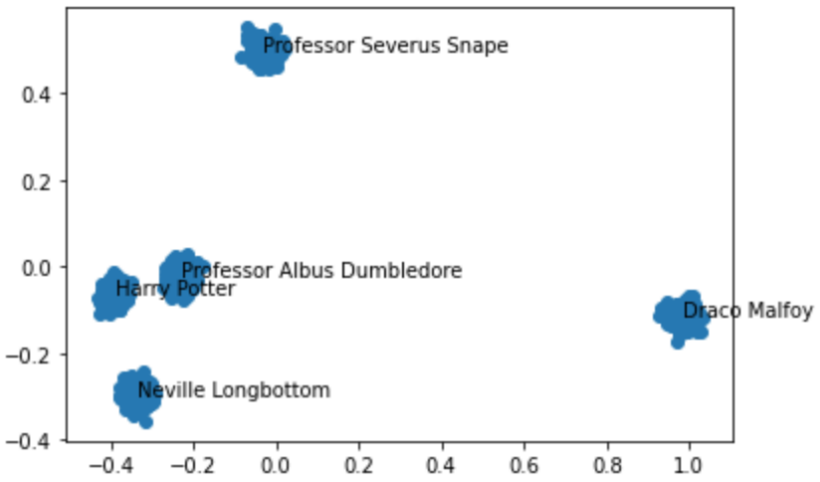
	bravery	loyalty	cowardly	friednliness	arrogant	selfishness
Harry Potter	.96	.95	.10	.78	.33	.20
Severus Snape	.91	.97	.14	.10	.32	.15
Draco Malfoy	.41	.36	.78	.10	.64	.68
Albus Dumbledor	.90	.97	.22	.65	.33	.27
Neville Longbottoms	.79	.92	.31	.92	.22	.16

To specify, in my data set, you will see that each individual character will have a rating between 0 and 1 and how that fit into the input spaces or categories listed above. For example, Harry was rated a .96 for bravery since he was courageous and was always ready to face the Dark Lord. Within my neural network, there were input and target data. An input dataset is, "a dataset whose rows correspond to input vectors to be sent to the input nodes of a neural network," (Yoshimi et. al. (2020)). This is explaining that an input data is input vectors that will be later sent to input nodes that help when running a neural network. Additionally, target dataset are examples that reflect corresponding desired target outputs that we want the neural network to produce with its corresponding input vectors.

The salient dimension of the input space has an x-axis that represents bravery and a y-axis that represents levels of friendliness. These two dimensions are very distinguishable mainly because a person can be different levels of bravery and friendliness. In the picture, you can see some of the prototype vectors such as Neville Longbottom and Harry Potter are high in both bravery and friendliness, while others such as Draco Malfoy are low in both bravery and friendliness. Whereas in contrast, we can see that Professor Snape is very high in bravery, but not as friendly in comparison to the other prototype vectors. This allow us to see similarity within the prototypes as



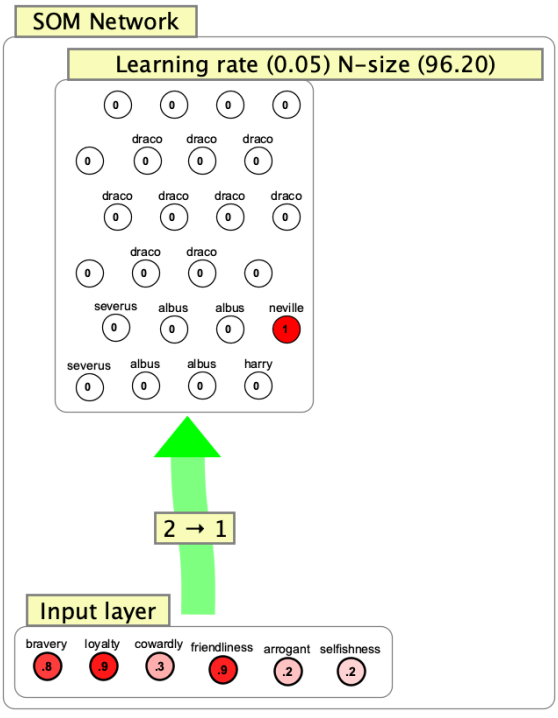
well as differences between them. For this example, I made the standard deviation for the clusters a smaller size in order to make the clusters more differentiable.



The image above, represents a plot of input spaces using a PCA plot. PCA stands for Principle Components Analysis which is, "… a set of fan-in weights, the resulting network performs a meaningful type of dimensionality reduction," (Yoshimi et. al. (2020)). In short, PCA is part of Oja's dimensionality reduction which is seen when there are more input nodes than output nodes, or otherwise known as feed-forward networks. In my neural network, we can see that the PCA plot has the 5 prototypes which I made to represent Harry Potter characters. They way each cluster is plotted is how they are rated based off the dimensionality input spaces. We interpret similarity between Professor Dumbledore and Harry Potter since they are very close to each other in plot. Neville is also relatively close to those two prototypes and can indicate a few differences between them. On the other hand, there is are Professor Snape and Draco Malfoy who are relatively different in comparison to the other prototype vectors.

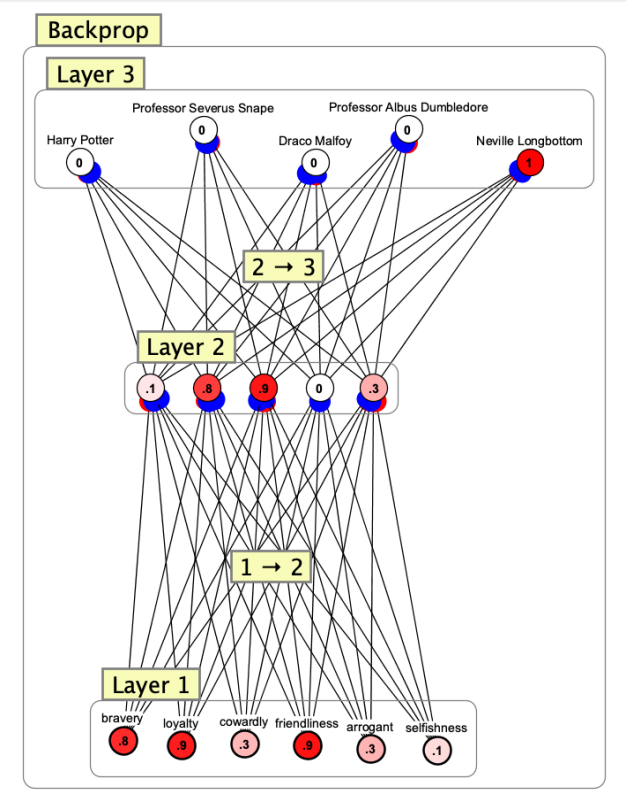
Unsupervised Learning

Unsupervised learning is, “a learning rule in which weights are adjusted without an explicit representation of desired outputs,” (Yoshimi et. al. (2020)). Meaning that it is a way of learning without any training set. For unsupervised learning, we take input data and train neural networks to have, “… statistical features,” (Yoshimi et. al. (2020)) or outputs. A Self Organizing Map or SOM is, “a network trained by unsupervised competitive learning, in which the layout of the outputs corresponds to the layout of the input space,” (Yoshimi et. al. (2020)). This means that SOM is an unsupervised learning network where the inputs and outputs correspond to one another. Below I have my image of my SOM with its labeled input and output nodes. In this specific network, I have 24 SOM nodes and 6 input nodes that represent the 6 dimensional of input data. After training and validating the Harry Potter character data, it allowed the output layer to put a node in its specified category. As seen below, you can see that there is a spatial arrangement of categories. For example, toward the top of the network, there are many Draco Malfoy labeled nodes. An important thing to note, is that not all the categories have the same number of nodes labeled. There is only one SOM node that represents Neville which you can see in the image.



Supervised Learning

Supervised learning is data that is already labeled and the data is used to train a network to get desired outputs. In addition, a classification task is, “a supervised learning task in which each input vector is associated with one or more discrete categories,” (Yoshimi et. al. (2020)). This means that a classification task is a type of supervised learning model that has each input vector that corresponds to one or more specific categories. A backpropagation or otherwise known as backprop can solve non-linear inseparable problems and can work with networks that have hidden layers that are between the input and output layer. Backpropagation is superior to LMS which is a part of gradient descent that minimizes error in a training set. The reason backprop is superior to LMS is mainly because backpropagation is an extension of LMS meaning backprop can work with multi-layer networks, while LMS only works for two-layer networks. To your right is a picture of my backprop network. In my backprop network there are 6 neurons/nodes in the input layer which is layer 1, 5 nodes in the hidden layer, and lastly, 5 nodes in the output layer. The nodes in layer 1 represent the 6-dimension input spaces and layer 3 represents the 5 categories or prototypes. The classification task my network is



a one-hot encoding which means that the data from one of the inputs coincide to only one output node that corresponds to a category. In my network, the categories are characters from the Harry Potter series. After training the backprop network the error for the network reached to be 0.0020. Additionally, since there was a 6-dimensional input space, that means that there are 5 decision boundaries the input space must be partitioned in which solves the classification task.

Conclusion

Neural networks are used for many different reasons. One is to use them as engineering tools which help solve problems such as creating machines to fix those problems. The use of neural networks to solve real-world problems or tasks is called machine learning. Machine learning is trained and not programed and while there are codes, they are made to tackle tasks that don't necessarily have mathematical way to solve problems. Although it is used to help to make engineering tools, neural networks are also used to simulate how the mind and brain work. The neural networks over this course also simulated how both the brain work, as well as machine learning. When it comes to connectionism and neural networks, it models psychological data with, "…no direct effort to understand the brain," (Yoshimi et. al. (2020)). An example of a connectionist network I have created is an IAC network which replicates human semantic memory. In my specific IAC network, I based it on Harry Potter as well and after training it, it was able to classify characters, what Hogwarts house they belong in and their classification title. I believe connectionisms suggests that there are multiple categories in input data that correspond to one output vector. When we think about the "output", different categories come to mind that fit that specific output. With this assignment, there are some categories that are easier to classify compared to others. Many output categories had similar rating when it came to the 6-dimensional

input vectors, but there was always one dimension that made the classification of the category clear. Overall, I really enjoyed that we were able to use neural network to simulate actual neurons while also using subjects such as Harry Potter to make it more interesting and engaging.

Reference Page

Yoshimi, J., Hotton, S., Gordon, C., & Tosi, Z. Neural Networks in Cognitive Science. 2020.

Department of Cognitive and Information Sciences, University of California, Merced.