Assignment-2:

Title: Employ RSA to describe similarities/differences of representational spaces in different data types (neural data, behavioural ratings, and deep neural networks). Does the representational space for each data type reflect object visual appearance (appearance model) or object animacy properties (animacy model)?

Introduction: Using the advanced multivariate methods to decode and analyze patterns of brain activity. The study focused on three areas of interest (ROIs): the main visual cortex (V1), the anterior ventral temporal cortex (VTC_ant), and the posterior ventral temporal cortex (VTC_post). We used a multiclass (9-way) decoding method to sort brain activity patterns into groups. This study makes use of the CoSMoMVPA toolbox's strong features to work with fMRI data and do representational similarity analysis (RSA). The main goal of this task was to figure out patterns of brain activity and see how well different neural models can represent these patterns. The animacy model and the appearance model were the ones we looked at the most. Our goal was to figure out how the brain represents things by comparing these models to neural data, behavioral data, and deep neural network (DNN) traits.

Methodology:

Dataset Preparation:

1. **Behavioral Data:** To begin, we loaded behavioral data from the given file. This data is very important for figuring out how humans make judgments based on what they see and matching those judgments with neural representations.
2. **Brain Data for VTC Anterior:** We used the VTC_anterior mask to separate the area of interest from other fMRI data from various subjects. The CoSMoMVPA toolbox was used to organize the data. This included setting goals and chunks and checking the dataset for errors.

Model of a Deep Neural Network (DNN):

1. **Feature Extraction:** We took features from images that matched our inputs using the AlexNet DNN model. To do this, pictures had to be resized to fit the size that AlexNet needed as input, and activation patterns had to be taken from different layers of the network.
2. **RDM Calculation:** We found the representational dissimilarity matrices (RDMs) for each layer of the DNN to see how the stimuli are shown by the different levels of the network.

Representational Similarity Analysis (RSA):

1. **Model Preparation:** The dissimilarity matrices for the animacy and look models were turned into vectors to make the models.
2. **RSA for Neural Data:** We found the RSA for neural data in the VTC by connecting neural RDMs with the models of movements and looks. For each person, this analysis was done, and the results were averaged to get the mean RSA scores and standard errors.
3. **RSA for Behavioral Data:** In the same way, RSA was done for behavioral data by connecting behavioral RDMs with the immobility and look models.Last but not least, RSA was run on each layer of the DNN to see how well the network's representations match up with the animation and look models.

Analysis of Statistics:

1. **t-tests:** We used t-tests to see how statistically significant our results were by comparing the RSA scores for animacy and look models across neural data, behavioral data, and DNN layers. The p-values and hypothesis test results were summed up to find changes that were statistically significant.

Results:

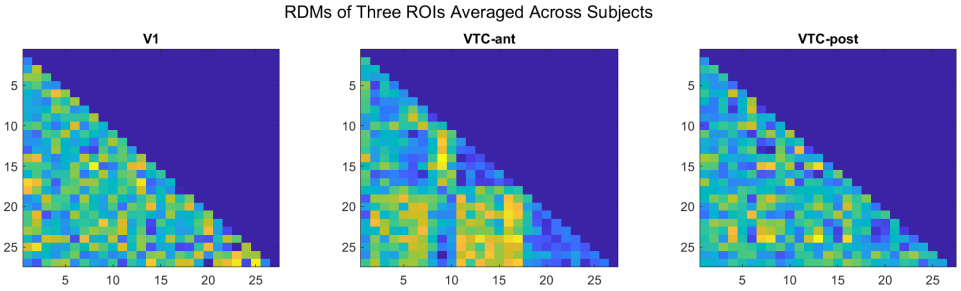

Figure-1: Representational Dissimilarity Analysis for three ROIs

The dissimilarity matrices (RDMs) for three areas of interest (ROIs) are shown in this figure. They are the main visual cortex (V1), the anterior ventral temporal cortex (VTC_ant), and the posterior ventral temporal cortex (VTC_post). Based on neural activity in each ROI, the RDMs show how different cues are from one another. Because V1 is so important for early visual processing, the RDM for V1 shows that different types of inputs should be very different from each other. The RDM for VTC_ant shows how inputs are shown in a more complex part of the brain that processes vision. Patterns in this area may show higher-level visual traits like object categories. The RDM for VTC_post gives us information about how stimuli are represented in a different higher-order visual processing region. This could mean that VTC_post and VTC_ant show different features of object recognition.

Data_type	h-value	p-value
Behavioral_data	0	0.1536
Neural_data	1	0.0085401
DNN_layers	0	0.3388

Figure-2: Summary of Statistical Test

If the h-value is 0, it means that the behavioral data does not show a significant difference at the 0.05 level. This is supported by the p-value of 0.1536, which shows that there is no statistically significant link between the behavioral data and the models. With a p-value of 0.0085401, the h-value of 1 means that there is a significant difference in the brain data. This means that the neural representations are very similar to the models of animation or look. The h-value of 0 means that there is no significant difference between the DNN layers, and the p-value of 0.3388 means that the DNN's internal representations do not significantly match the models.

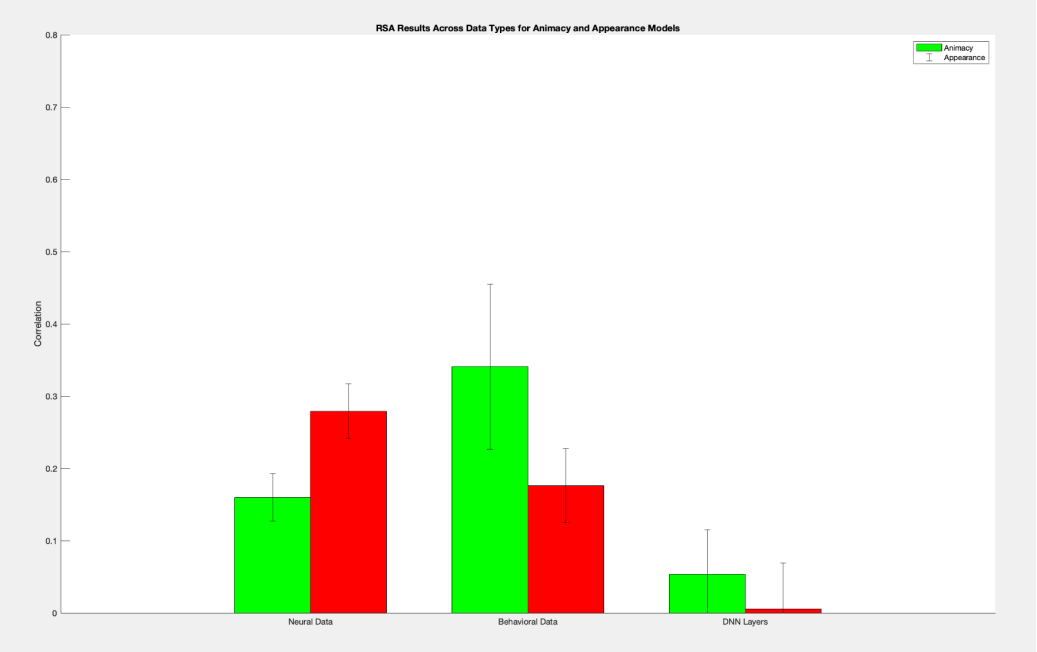

Figure-3: Results for Representational Simmilarity Analysis

For the neural data, the RSA score of 0.15995 with a SEM of 0.032794 indicates a moderate correlation with the animacy model, though not statistically significant (p-value = 0.17178).A higher RSA score of 0.27905 with a SEM of 0.037761 suggests a stronger correlation with the appearance model, approaching statistical significance (p-value = 0.063202). For the behavioral data, the RSA score of 0.34055 with a SEM of 0.11433 indicates a strong correlation with the animacy model, with a p-value of 0.052611, indicating a trend towards significance. The RSA score of 0.17598 with a SEM of 0.051561 suggests a moderate correlation with the appearance model, but it is not statistically significant (p-value = 0.11437). For DNN Layers, the RSA score of 0.053221 with a SEM of 0.061582 shows a weak correlation with the animacy model, which is statistically significant (p-value = 0.003959). The RSA score of 0.005233 with a SEM of 0.064094 indicates a very weak correlation with the appearance model, and it is not statistically significant (p-value = 0.36754).

Data_type	RSA_Scores_Animacy	SEM_Scores_Animacy	p_values_Animacy	RSA_Scores_Appearance	SEM_Scores_Appearance	p_values_Appearance
Neural Data	0.15995	0.032794	0.17178	0.27905	0.037761	0.063202
Behavioral Data	0.34055	0.11433	0.052611	0.17598	0.051561	0.11437
DNN Layers	0.053221	0.061582	0.003959	0.005233	0.064094	0.36754

Figure-4: Summary table of RSA