1.

Classifier/ Datatype	Original Data			Translated		
Metric	Accuracy	Precision	Recall	Accuracy	Precision	Recall
SVM	0.479934439	0.501819345	0.480169768	0.490679117	0.511818661	0.490935128
Random Forest	0.337356379	0.329021409	0.338146077	0.341263534	0.346426989	0.342151343
Decision Tree	0.283550214	0.279320554	0.284202802	0.27967617	0.27897393	0.280289974

	180 Rotation about axis					
	X			Y		
	Accuracy	Precision	Recall	Accuracy	Precision	Recall
SVM	0.485546836	0.508311115	0.485765346	0.487930863	0.511826907	0.488165312
Random Forest	0.336810039	0.330321846	0.337559438	0.34952485	0.344912961	0.35024731
Decision Tree	0.275951127	0.271221017	0.276641752	0.272656535	0.268141577	0.273251287

180 Rotation about axis Z		
Accuracy	Precision	Recall
0.489106321	0.513231262	0.489344330
0.334094898	0.328723326	0.334905366
0.270603622	0.26520501	0.27131716

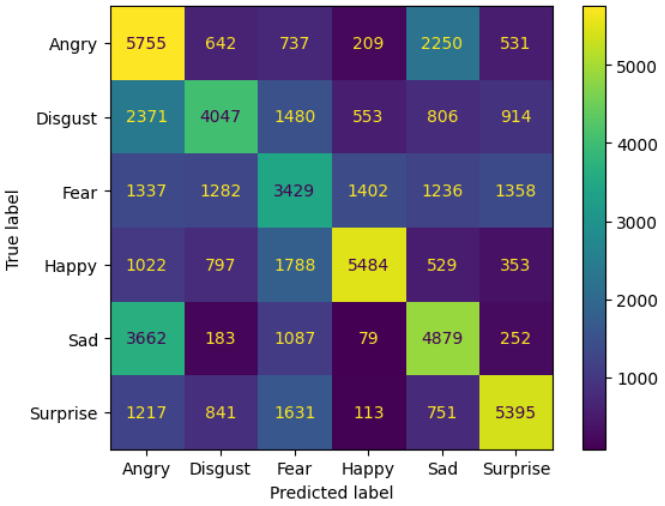
2.

Classifier SVM worked best across all data types with Random Forest as second and Decision Tree as third. SVM provides hyperplanes that differentiate between classes, usually two. While Random Forest applies multiple decision trees and combines them for a stable prediction. Which is why Random Forest outperformed Decision Tree on every data type. However, SVM worked better given that it was better at differentiating via hyperplane given the nature of expressions were easier to differentiate through a hyperplane. Moreover, SVM took a significant amount of time to run compared to the other classifiers. SVM (1.5hrs), RF (14mins), DT (4mins)

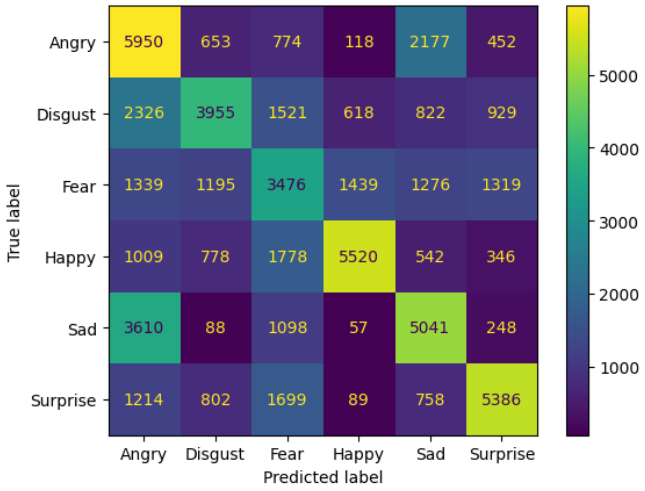
The best metric for expression recognition would be Recall. Recall is the percentage of correctly classified expressions amongst all positive expressions on the model. A high recall percentage also means that there are low false positives. While Accuracy itself is a good metric, given the nature of the data - as seen during converting raw data into dataset - the data is unbalanced therefore some expressions may have higher weights on the accuracy. Which is why I would assume the order of metric importance to be Recall, Accuracy, Precision. Therefore, works best means the models that have higher Recalls compared others.

Best Classifier for all Data types was SVM

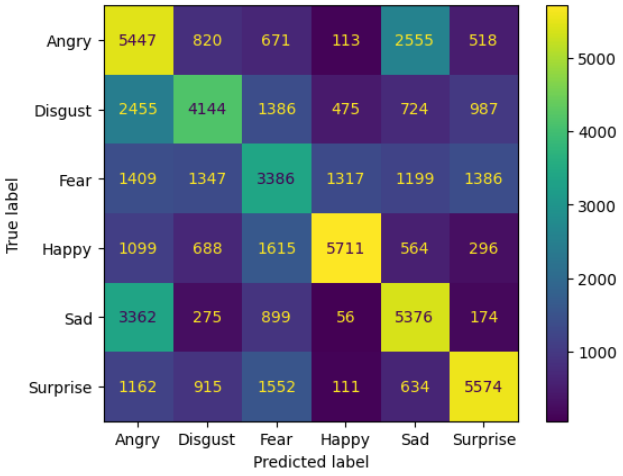
Original Data on SVM



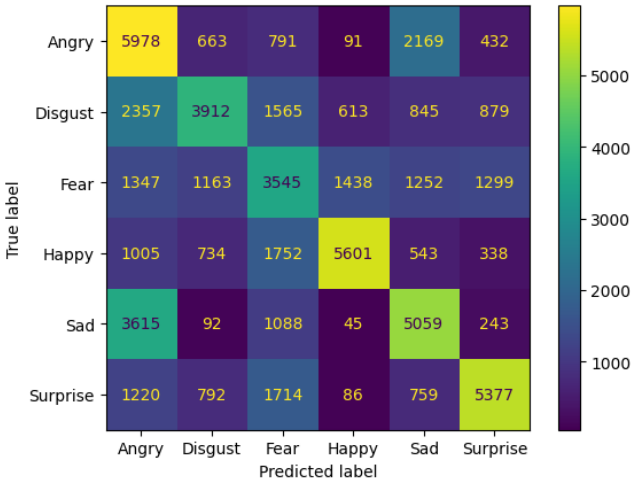
180 X rotation on SVM



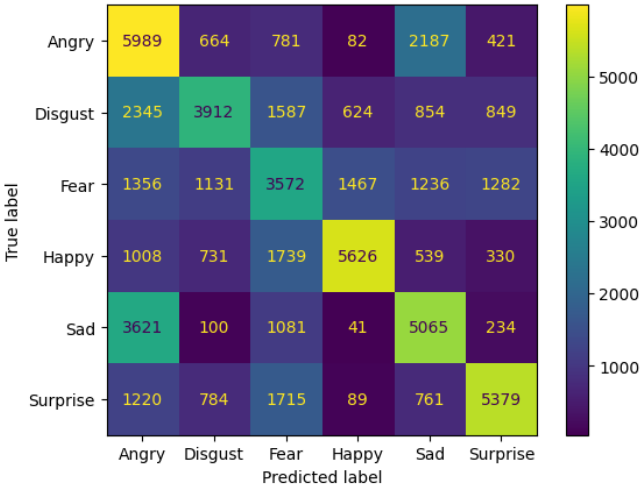
Translated to Center on SVM



180 Y rotation on SVM

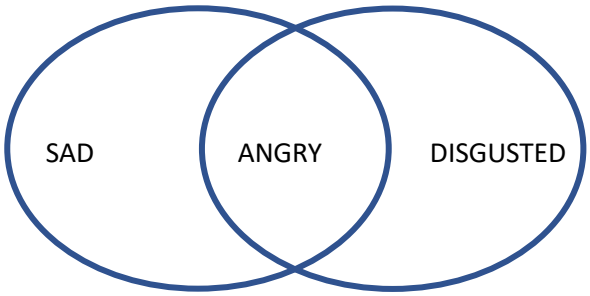


180 Z rotation on SVM



3.

In accordance with the general trend seen in the confusion matrix. It appears that the models misclassified Sad as Angry, Disgust as Angry, and Angry as Sad in decreasing order the most. The misclassification makes sense as Sad and Angry have similar lower face expressions, where the cheeks are relaxed and hence the mouth is slightly curved downwards. Moreover, if sadness is an intense feeling, it may result in the furling of brows that is characteristic of anger. Disgust as Angry also makes sense as disgust also has similar upper face expression like the furling of eyebrows. Therefore, Angry and Disgust are quite similar, Angry and Sad are also similar. But Sad and disgusted are not similar. Angry and Sad have lower face similarities while Angry and Disgusted have upper face similarities. Therefore, Sad and Disgust are dissimilar.



4.

The performance of each classifier across the different types of data is relatively consistent. Especially if only the original, and all 3 rotated data are considered. Since changing the rotation does not change the raw data. The data is only rearranged. Moreover, these classifiers are not trained specifically to facial landmarks. Which is why if the face is oriented differently over the 3D plane, it does not make a difference. The performance of all Classifiers improved on central translated data as making the face centered helped the classifiers better. This is since every face was now central. This reduces the use of weights to learn on different positions, since all the facial landmarks are now central. Z rotation also performs better than all the other rotations as if switches all the outliers on one side, as seen on question 5.

Overall SVM worked significantly better than Random Forest. And Random Forest worked significantly better than Decision Tree. The latter is since Random Forest is a more efficient version of Decision Tree. Furthermore, SVM worked the best as it just better at training on facial landmarks.

5.

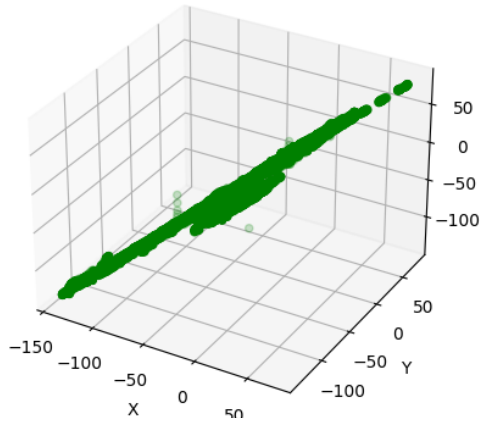


Figure 2: ORIGINAL

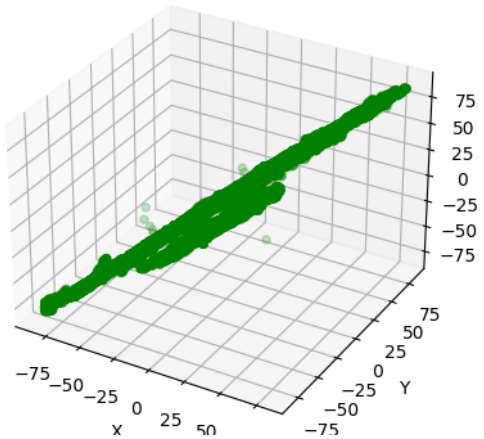


Figure 1: CENTERED

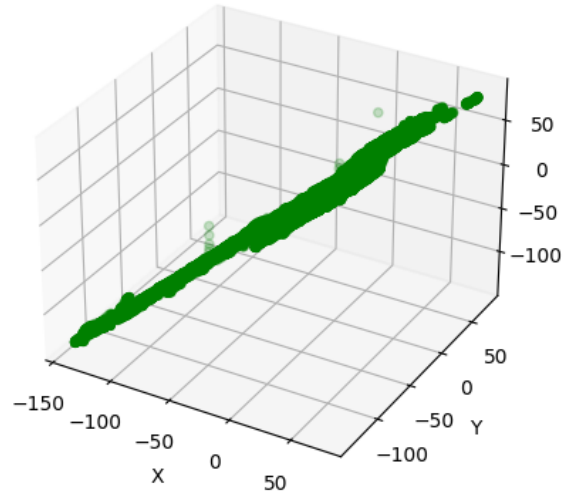


Figure 3: Z Rotation 180

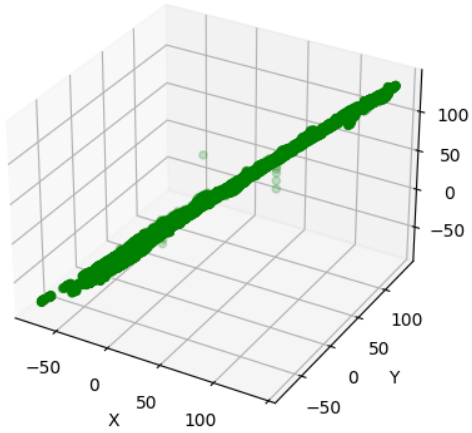


Figure 5: X Rotation 180

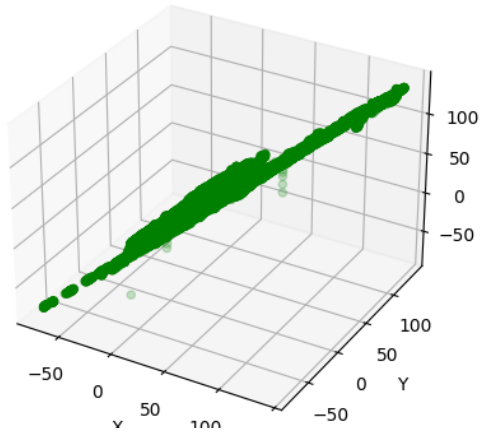


Figure 4: Y Rotation 180