Image Classification

ADS – Project 3

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Overview

Goal

- Building an image classification model for two categories: Compound and Simple emotions.

- Computational efficiency and run time are key factors.

- Since the dataset is imbalanced, but the model will be tested on balanced data, we assigned weights in order to train the model.

- Features:

We used both the pairwise distance between the fiduciary points, and raw image data as our classification features, depending on the model and its specific limitations.

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Models

GBT – Baseline

Accuracy	Weighted Accuracy	AUC	Total Run Time
0.78	0.70	0.79	7.15 s

XGBoost

Accuracy	Weighted Accuracy	AUC	Total Run Time
0.81	0.72	0.83	37.27

- XGBoost is the first model we tried after running the GBT model.
- Both model use the same principle of gradient boosting. However, XGBoost better addresses over-fitting, by applying a more regularized model formalization. This tends to improve performance.
- The results confirm that XGBoost is better suited for this task, and it does not consume additional running time.

Random Forest

Accuracy	Weighted Accuracy	AUC	Run Time
0.80	0.58	0.81	8.61 s

- Random Forest was a natural candidate to use after GBT and XGBoost as it uses decision trees to operate.
- However, we received very poor Accuracy of 0.58 and AUC declined as well.

SVM

Accuracy	Weighted Accuracy	AUC	Run Time
0.66	0.71	0.79	59.24 s

- Support Vector Machines, or SVM, is especially effective in high dimensional spaces, and it is still effective in cases where the number of dimensions is greater than the number of samples.

- Our data has these properties, so SVM is an appealing candidate.

KNN

Accuracy	Weighted Accuracy	AUC	Run Time
0.76	0.50	0.51	88.53 s

- KNN can be useful as a classification method when the sample data has overlapping class domains this is because KNN mainly relies on the limited neighboring sample, rather than the method of discriminating class domains to determine the categories.
- KNN has high computation cost when dealing with large data. For this reason, combined with the low accuracy we received, led us to abandon this model.

LDA with PCA

Accuracy	Weighted Accuracy	AUC	Run Time
0.72	0.59	0.80	0.02s

- We used PCA to reduce dimensions. We then used LDA for classification.
- PCA is a good way to remove correlated features, improve the algorithm's performance and reduce overfitting.
- Because the classification is binary, linear discriminant analysis may prove useful.
- Since the feature dimension is large in the original sample, it contained a lot of redundant information and noise, which led to the inaccuracy of the LDA method.
- Therefore, PCA dimension reduction is generally used first: PCA dimension reduction is performed on the features, and then LDA is used for classification, which can be highly effective

Neural Network

Accuracy	Weighted Accuracy	AUC	Run Time
0.81	0.73	0.83	110.42 s

- Neural Network is a simplistic representation of how human brain neuron works. It has an input layer, one or more hidden layers, and one output layer. The hidden layer can be seen as a "distillation layer" that distills some important patterns from the inputs and passes it onto the next layer to see.
- The activation function serves as a tool to capture the non-linear relationship between inputs and to help convert the input to a more useful output.
- In our model, we used the RELU activation function for hidden layers, and the sigmoid function. This creates an output with probability of being classified to label 1 in the output layer.
- In an effort to avoid overfitting, we used Dropout layers in the NN, which randomly sets input units to 0 at certain frequency at each step during training. helping prevent overfitting.
- Potential improvement to the model can be choosing a different optimizer. We chose Adam.

Convolutional Neural Network

Accuracy	Weighted Accuracy	AUC	Run Time
0.52	0.52	0.51	278 s

- Convolutional Neural Networks is one of the variants of neural networks and it is extensively used in image analysis.
- Instead of using NN's normal activation functions, convolution and pooling functions are sued as activation functions.
- CNN is the go-to-model for image analysis as it automatically detects the important features of the image. It is also computationally efficient when dealing with image data.
- For future research, perhaps we can improve the model by adjusting brightness, contrast etc.

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CONCLUSION

Model	Accuracy	Weighted Accuracy	AUC	Train Time	Test time	Link
Baseline Model (GBT)	0.78	0.70	0.79	7.13 s	0.02 s	GBT
XGBoost	0.81	0.72	0.83	37.21 s	0.06 s	XGBoost
Random Forest	0.80	0.58	0.81	8.38 s	0.23 s	Random Forest
SVM	0.66	0.71	0.79	51.37 s	7.87 s	SVM
Neural Networks	0.81	0.73	0.83	110.419 s	0.3 s	NN
CNN	0.52	0.52	0.51	278 s	25 s	CNN
KNN	0.76	0.50	0.51	73.33 s	15.2 s	KNN
LDA	0.70	0.53	0.68	20.34 s	0.14 s	LDA
LDA with PCA	0.72	0.59	0.80	0.02 s	0.02 s	LDA with PCA

Baseline Vs. Neural Network

Model	Accuracy	Weighted Accuracy	AUC	Train Time	Test time
Baseline Model (GBT)	0.78	0.70	0.79	7.13 s	0.02 s
Neural Networks	0.81	0.73	0.83	110.419 s	0.3 s

As we can see in the comparison table above, NN, as expected, preforms better than the baseline model in all parameters, excluding run time.

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Q & A