Capstone Project

Face Emotion Recognition

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Introduction

- What is the use of this project?
- What is facial emotion recognition?
- What is object behind the project?

Steps followed in completing this project

- Business understanding
- Data Collection
- Data Cleaning
- Data Visualization
- Data pre-processing
- Data Analysis
- Models that can be used
- Model or technique used for solving
- Transfer learning
- Creating and training the model
- Evaluating the model
- Retraining the model and tuning the model
- Evaluating and interpreting the results
- Making some sample predictions
- Model ready for deployment
- Creating necessary files for deployment
- Making the necessary installations
- Streamlit app is created and deployed in GCP

Problem statement

- The Indian education landscape has been undergoing rapid changes for the past 10 years owing to the advancement of web-based learning services, specifically, eLearning platforms.
- Global E-learning is estimated to witness an 8X over the next 5 years to reach USD 2B in 2021. India is expected to grow with a CAGR of 44% crossing the 10M users mark in 2021. Although the market is growing on a rapid scale, there are major challenges associated with digital learning when compared with brick and mortar classrooms. One of many challenges is how to ensure quality learning for students. Digital platforms might overpower physical classrooms in terms of content quality but when it comes to understanding whether students are able to grasp the content in a live class scenario is yet an open-end challenge.
- In a physical classroom during a lecturing teacher can see the faces and assess the emotion of the class and tune their lecture accordingly, whether he is going fast or slow. He can identify students who need special attention. Digital classrooms are conducted via video telephony software program (ex: Zoom) where it's not possible for medium scale class (25-50) to see all students and access the mood. Because of this drawback, students are not focusing on content due to lack of surveillance. While digital platforms have limitations in terms of physical surveillance but it comes with the power of data and machines which can work for you. It provides data in the form of video, audio, and texts which can be analyzed using deep learning algorithms. Deep learning backed system not only solves the surveillance issue, but it also removes the human bias from the system, and all information is no longer in the teacher's brain rather translated in numbers that can be analyzed and tracked.

Data collection, cleaning and pre-processing

- I collected the dataset from Kaggle
- There are some misplaced images into different emotions folder. So there was some mislabelled data images.
- I have removed such images from the data. As it was a huge dataset with each folder or emotion having more than 3000 images it was a bit difficult to clean and check every images.
- So there is a little chance of mislabelled data.
- By using ImageDataBunch from the emotion folders or dataset I have divided the data into train and test images used for proper evaluation of model after training.

Some of the images from the training set

```
# display some of the images from the training directory
data.show_batch(rows=3,figsize=(4,6))
```

Fastai – The framework behind this project

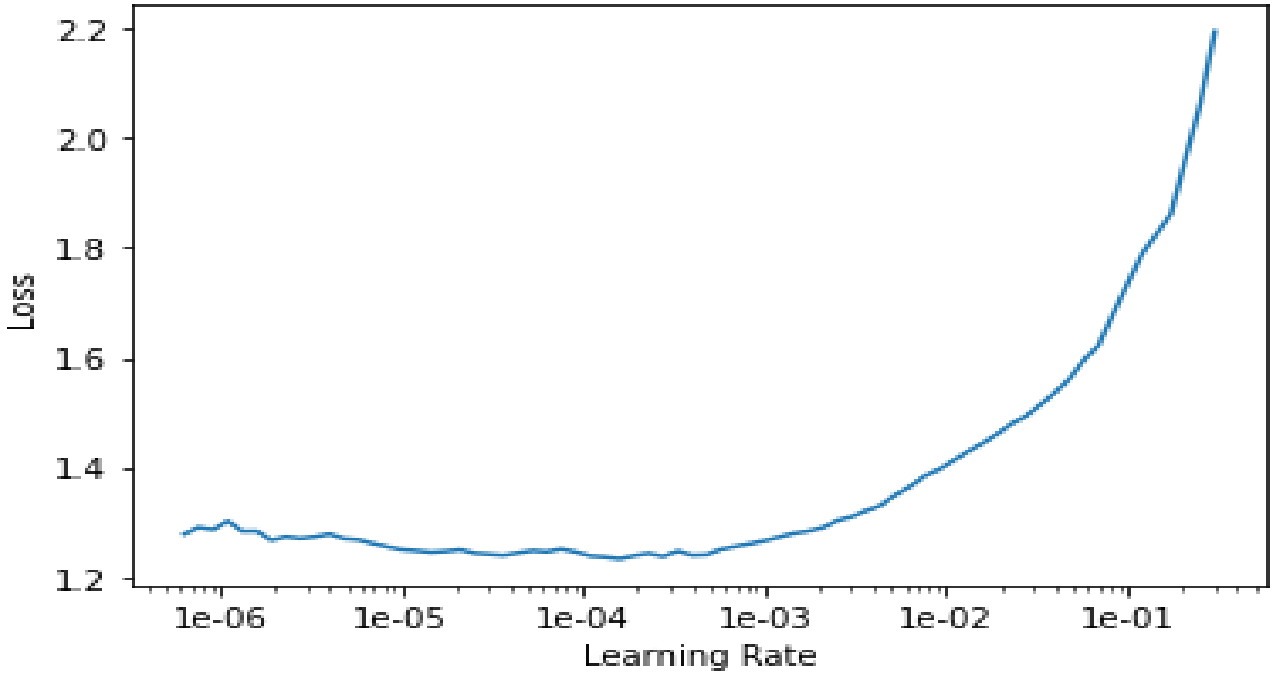
- fastai is a deep learning library which provides practitioners with high-level components that can quickly and easily provide state-of-the-art results in standard deep learning domains, and provides researchers with low-level components that can be mixed and matched to build new approaches. It aims to do both things without substantial compromises in ease of use, flexibility, or performance. This is possible thanks to a carefully layered architecture, which expresses common underlying patterns of many deep learning and data processing techniques in terms of decoupled abstractions. These abstractions can be expressed concisely and clearly by leveraging the dynamism of the underlying Python language and the flexibility of the PyTorch library.

Transfer learning models in fastai

```
#Models available in fastai with transfer learning models
dir(fastai.vision.models)
```

```
['BasicBlock',
 'Darknet',
 'DynamicUnet',
 'ResLayer',
 'ResNet',
 'SqueezeNet',
 'UnetBlock',
 'WideResNet',
 'XResNet',
 '__builtins__',
 '__cached__',
 '__doc__',
 '__file__',
 '__loader__',
 '__name__',
 '__package__',
 '__path__',
 '__spec__',
 'alexnet',
 'darknet',
 'densenet121',
 'densenet161',
 'densenet169',
 'densenet201',
 'mobilenet_v2',
 'resnet101',
 'resnet152',
 'densenet201',
 'mobilenet_v2',
 'resnet101',
 'resnet152',
 'resnet18',
 'resnet34',
 'resnet50',
 'squeezenet1_0',
 'squeezenet1_1',
 'unet',
 'vgg11_bn',
 'vgg13_bn',
 'vgg16_bn',
 'vgg19_bn',
 'wrn',
 'wrn_22',
 'xception',
 'xresnet',
 'xresnet101',
 'xresnet152',
 'xresnet18',
 'xresnet18_deep',
 'xresnet34',
 'xresnet34_deep',
 'xresnet50',
 'xresnet50_deep']
```

Model building and finding optimal lr rate



Model retraining and optimizing the performance

- After finding the optimal learning rate model is retrained to certain number of epochs and performance can be monitored at every stage and the model can start training again from the left out stage using callbacks which saves the model at every stage.
- Model is retrained till the evaluation metric reaches its maximum performance. There are many evaluation metrics that can be optimized. They are error rate, r2 score, accuracy, kappa score, mse, rmse, precision, recall etc.

Models performance and the optimal stage

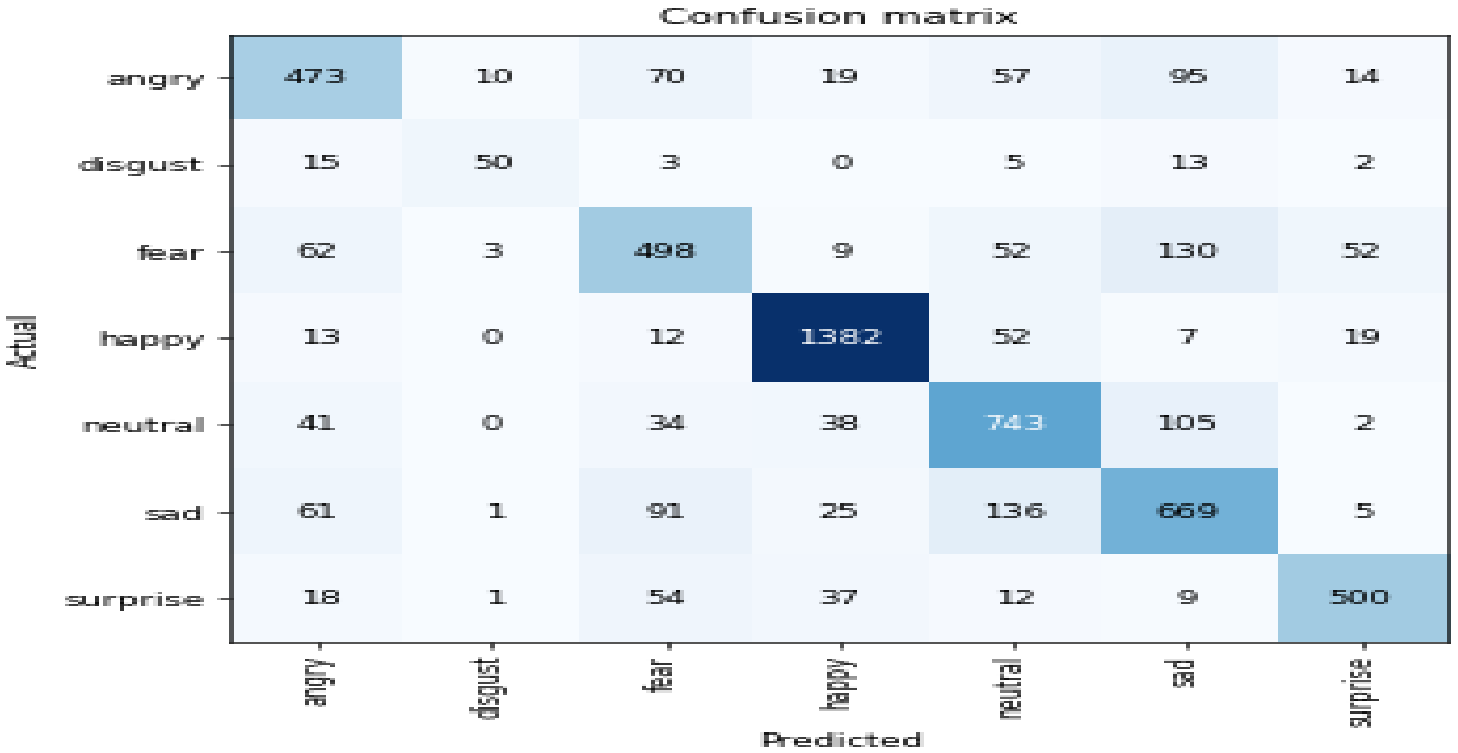
```
learn.fit_one_cycle(3, max_lr=slice(1e-4,40e-5), callbacks=[callbacks.SaveModelCallback(learn,every='epoch',\
                                                                                        monitor='error_rate',name='callba
```

epoch	train_loss	valid_loss	error_rate	time
0	0.742474	0.793938	0.284611	4:16:12
1	0.677608	0.735303	0.271802	3:24:10
2	0.473517	0.702031	0.242850	3:14:00

- Tracking and saving the performance in every epoch
- It can be seen that the error rate has drastically decreased from 57% to 24%
- Also learn-5 stage gives less residual state then there is some overfitting happened with train and validation set so I have chosen learn-4 which is having almost the same accuracy and error rate.

The accuracy of this model is 75.715% ¶

Interpreting the results



Sample predictions

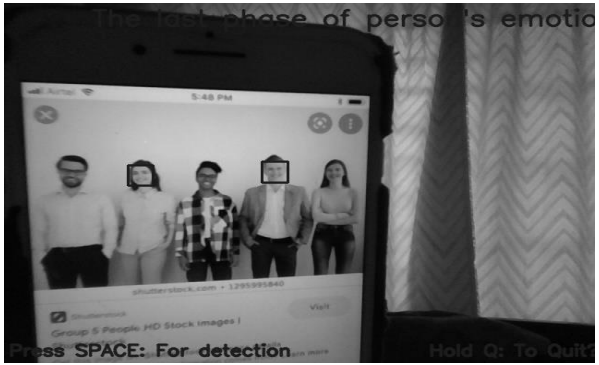
```
test1=cv2.imread('./3756.jpg')
t = pil2tensor(test1, dtype=np.float32) # converts to numpy tensor
#t = t.permute(2,0,1) # Move num_channels as first dimension
im = Image(t) # Convert to fastAi Image - this class has "apply_tfms"
model3_test.predict(im)
```

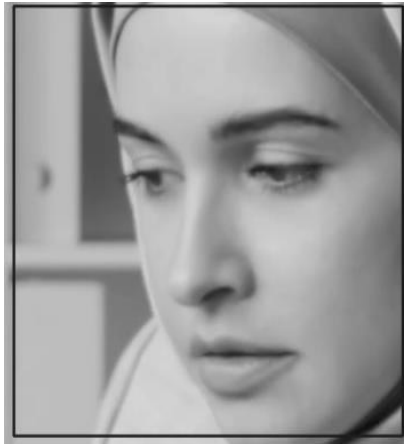
```
(Category tensor(0),
 tensor(0),
 tensor([9.9617e-01, 0.0000e+00, 5.2409e-43, 0.0000e+00, 1.6755e-03, 2.1535e-03,
         0.0000e+00]))
```

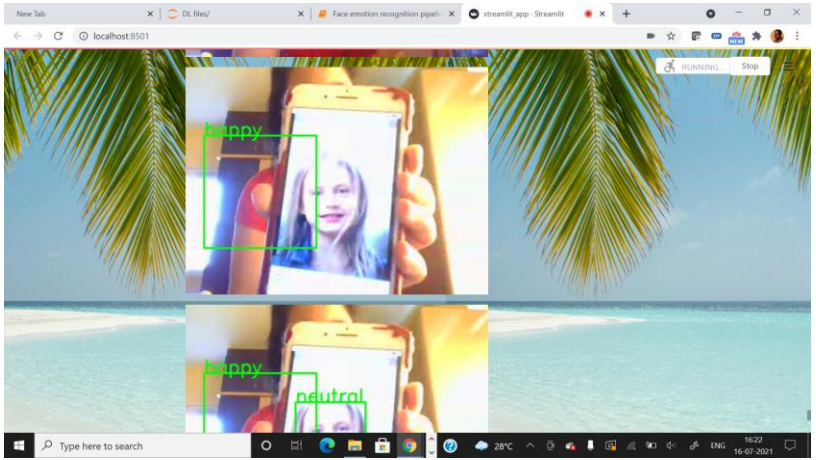
```
plt.imshow(test1)
```

```
<matplotlib.figure.AxesImage at 0x2573261f550>
```

Detected images and some captures







Conclusion

- The accuracy of this model came up to 76% then there are some challenges because of which there was more error rate here. There are some of the images which are misclassified. Even though I have cleaned some images as there are more than 3000+ images in each category it was difficult to check every image.
- So, there may be some images where it has been not correctly labelled and also training for some more epochs would increase the accuracy.
- May be using resenet50 or more advanced algorithm would yield greater accuracy then it requires greater computational power and time to use them.
- In spite of all these when tested with new images or videos the detection was very good and accurate.
- Some of the detected images and videos results are provided in the pipeline notebook.
- Automatic facial expression recognition system has many applications including, but not limited to, human behaviour understanding, detection of mental disorders, and synthetic human expressions.
- This is one most useful project or topic for future technologies which brings humans closer to the technology and make the tasks easier.
- Facial emotion recognition has many advantages than can be made or thought of. This helps in human-robot interactions, medical field, teaching field, Human resources field do their task much easily.

Thank you 😊