Use of Image Recognition to Screen for COVID-19 Masking Compliance

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Abstract

The use of convolutional neural networks for use in image recognition projects involving small datasets is presented in the Francois Chollet text 'Deep Learning With Python' as not being difficult. In fact, "…deep-learning models are by nature highly repurposable." (Chollet, 2018). Three strategies can be used: training a small model from scratch, feature extraction using a pretrained model, and fine-tuning a pre-trained model. This project attempts to train a dataset of humans both wearing masks and not wearing masks in an unbalanced binary classification problem, with the ultimate goal of implementing automated screening activities at buildings of a medical center that do not have patient care being provided within.

Keywords: image recognition, convolution neural network, face mask, COVID-19

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Purpose

As an employee in a healthcare facility with a 'campus' style layout, the cost of staffing a mask/symptom screener at the main entrance to each building during COVID-19 is staggering. Yet one person sitting in front of a bank of monitors would not be able to 'eyeball' each person entering every building, especially during peak change of shift times. Any progress toward an automated step in the screening process that results in removing the in-person 'screener' from, say, any building that does not provide direct patient care could have immediate financial benefits. The business problem then, is 'Can I train an image recognition system that is accurate enough to detect 90% of people entering buildings unmasked?' The Chollet text from DSC550 'Big Data' said ""…deep-learning models are by nature highly repurposable…reuse it on a significantly different problem with only minor changes…", so the approach used in the text was also used for this project. (Chollet, 2018).

Data Sources

Numerous datasets for image recognition of face mask wearers are available. The Kaggle competition dataset (https://www.kaggle.com/wobotintelligence/face-mask-detection-dataset) was used for this project due to the availability of comparative success rates. Images within the dataset were in the form of .png, .jpg, and .jpeg files, which were easily downloaded as a .csv file (although it took 20 minutes)! The dataset contained six variables, including one outcome variable, 'classname. The original 'train' file contained 6 columns and 15413 rows. There were no missing values within the dataset.

Methods

After importing the dataset into an Excel .csv file, several additional libraries had to be loaded prior to installing cvlib.

Variable Selection

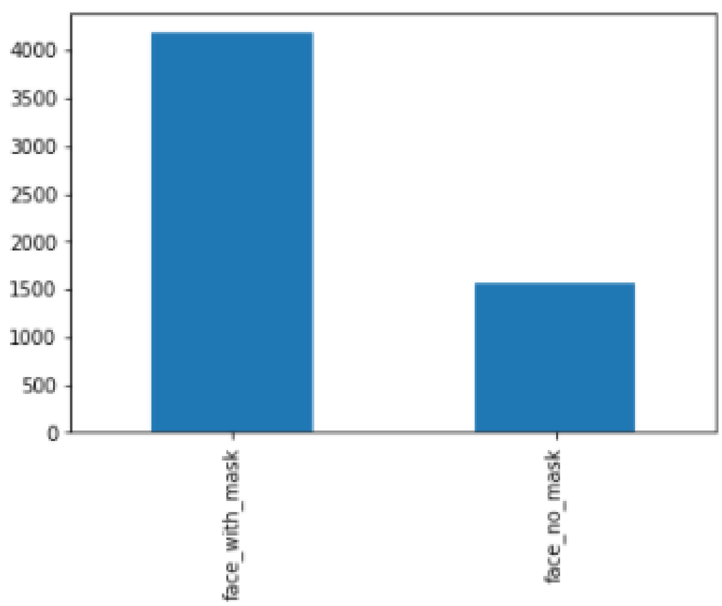
All six original variables were retained, as they contained the information needed for the convolutional neural network's model building.

Data Cleaning and Dataset Trimming

The absence of missing values and the standardization or values within each variable caused the initial dataset to require very little cleaning and trimming. The 'classname' column was reduced so it only contained 'face_with_mask' and 'face_no_mask.' This resulted in an unbalanced dataset, with 4180 'face_with_mask' images and 1569 'face_no_mask' images.

```
In [59]:  1  # from https://www.kaggle.com/abhaymudgal/dogs-vs-cats
          2  train['classname'].value_counts().plot(kind = 'bar')

Out[59]: <matplotlib.axes._subplots.AxesSubplot at 0x1cd4362dc48>
```

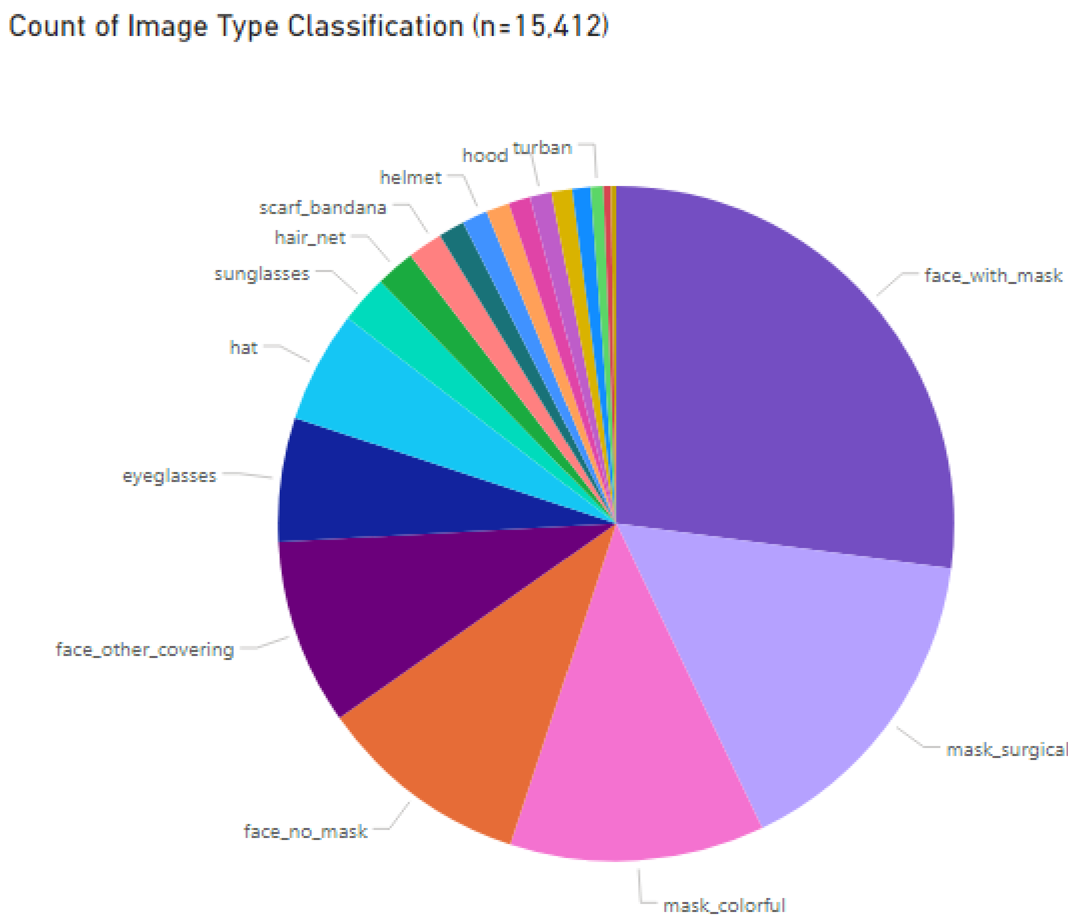


Note: Dataset containing only images classified as 'face_with_mask' or 'face_no_mask.'

After creation of train, test, and validation folders, shutil.copyfile() was used to indicate the source and the destination folders, and then use a for loop to only include files of a certain category type within each new destination file.

Outlier Detection and Missing Value Decisions

While the lack of missing values was an unexpected surprise, the presence of potentially unnecessarily detailed sub-categories within the data (such as 'mask_surgical' and 'mask_colorful') could cause their count values to be seen as outliers, when they would be better served by rolling them up into the category of face_with_mask. Changing the values in place is an option for dealing with these sub-categories.



Note: Breakdown of mask-wearing status sub-categories.

Analysis and Findings

Challenges associated with properly separating and reading the image types into the test/train/validation folders created an insurmountable obstacle in analysis of the utility of the model. Referencing of numerous peoples' attempts at creating this model is thought to be contributory, akin to the problems revealed in the Johnny Cash classic song 'One Piece At a Time.' "The narrator recognizes that he'll never be able to afford one of his own, so he and a co-worker decide to steal one by taking small parts from work in a comically large lunchbox…" (Dunn, 2021). But alas, the parts do not fit together correctly, as they are from different years. This is what happened when using bits and pieces of code from various authors and books, without a strong framework to begin.

Conclusions

Initial hypotheses (in the form of questions) proved to be as likely to be correct as incorrect. This is due to inability to validate hypotheses based on malfunctioning code.

Due to the unsuccessful attempts to wrangle this image recognition dataset into train/test/validation folders, the success of other Kaggle competition entrants is the best predictor of the success at face mask compliance image recognition modeling. This project did *not* add to the pool of knowledge. At best, it acknowledges the fact that sometimes projects fail, and that being up-front about the reason for failure is itself a positive trait in a student or employee!

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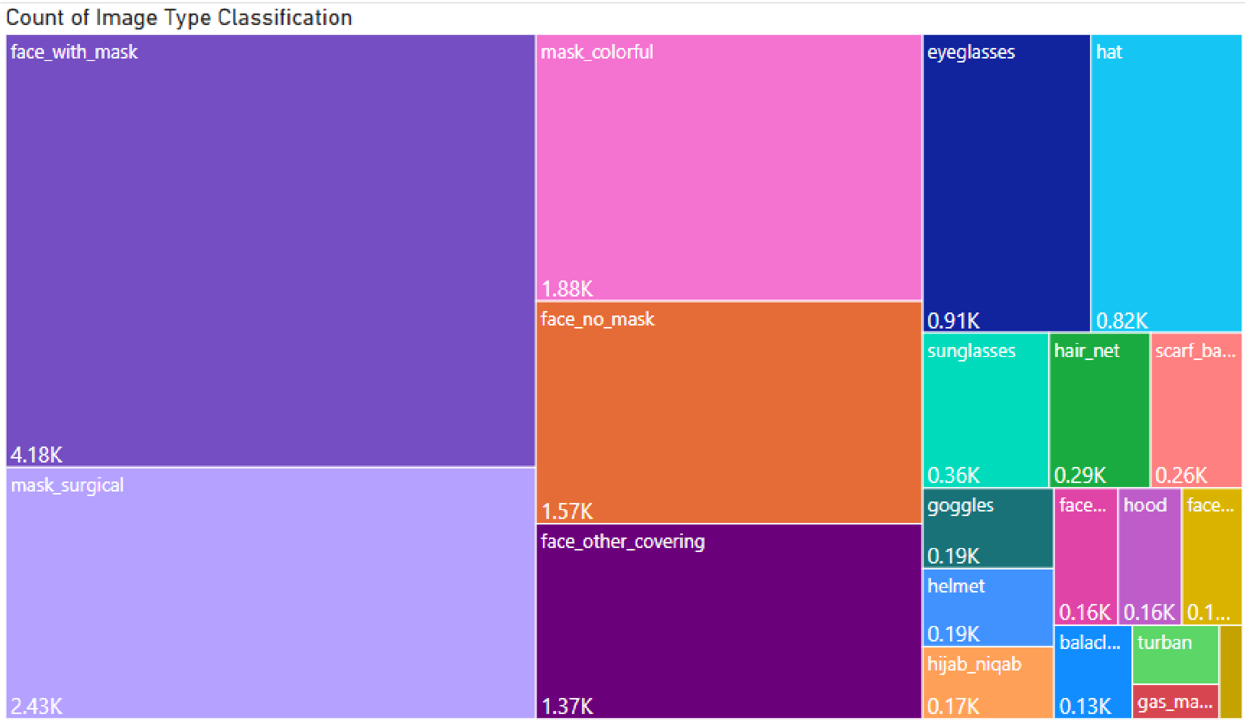
Appendix



Source: Power BI, Image Classification, by variable 'classname' from
https://www.kaggle.com/wobotintelligence/face-mask-detection-dataset