FACE MASKS DETECTION SYSTEM

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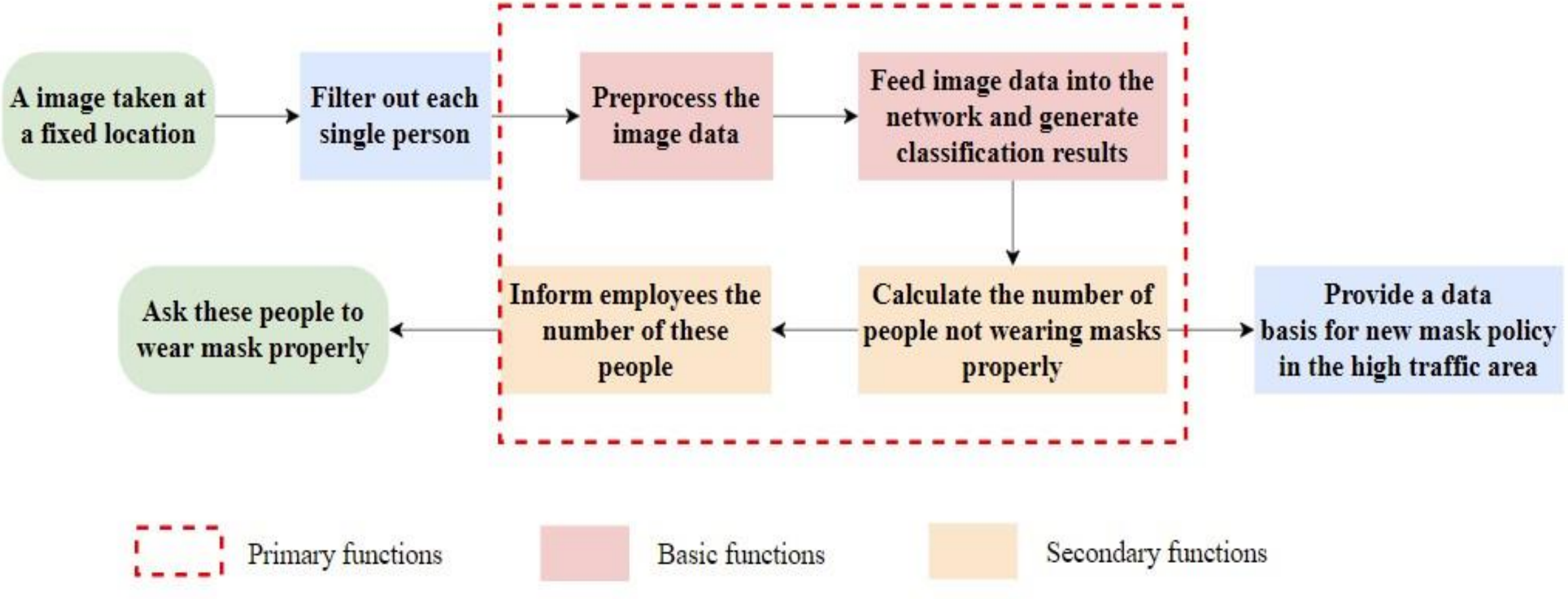
Introduction

- The covid pandemic was a global problem since 2019, it caused the deaths of millions of people and seriously damaged the world economy.
- Many countries nowadays still have many strict measures in place to suppress the spread of the virus.
- Wearing the masks properly is the easiest and most effective way against the virus.
- It's costly to hire staff for detection all the time. Hence, a face mask detection system would be very useful.

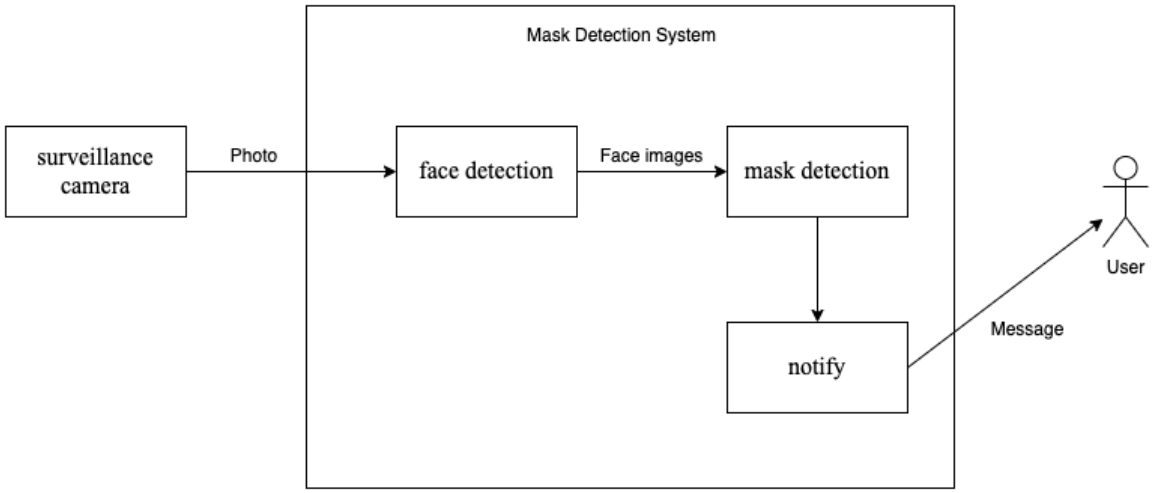
Project Scope



Project Objectives

- We had 2 weeks to develop the model and another 2 weeks to tune the models and make them perform better. We focused on the best model in the last week and tuned it together in order to make it work better.
- The final performance of the model will be measured based on 2 aspects:
  - Accuracy
  - Processing Time
- The expected accuracy was at least 85% and the expected processing time was within 3 seconds per image.

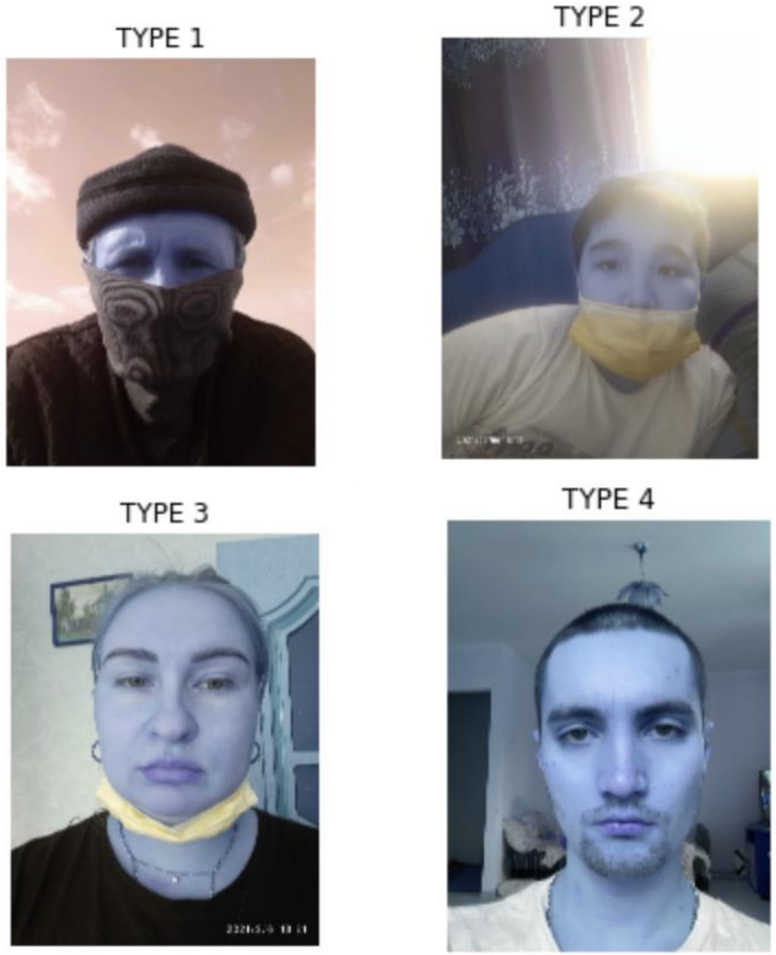
Design Solution – The Whole System



- Requirements:
  - The project should be easy to use even for people without a technical background.
  - The functions in the system are easy to modify and extend.
- Design Idea
  - divide the system into different parts according to different functions.
  - divide the system into 4 parts:
    - surveillance cameras
    - face detection module
    - mask detection module
    - notify module

Design Solution – Mask Detection Module

- Requirement
  - High accuracy and low execution time
  - classify the images into four categories:
    - The mask is worn correctly, covers the nose and mouth.
    - The mask covers the mouth but does not cover the nose.
    - The mask is on but does not cover the nose or mouth.
    - There is no mask on the face.



Design Solution – Mask Detection Module

- Design Idea
  - Using Convolutional Neural Network (CNN) and Deep residual network (ResNet) to extract features (Other options: AlexNet, VGG)
    - ResNet, AlexNet and VGG are enhanced models of CNN, therefore we decide to use CNN as our basic model.
    - We made another decision based on the time they were proposed.
      - ResNet: 2015, VGG: 2014, AlexNet: 2012
  - Using softmax function and SVM as classification layer (Other options: KNN, Decision tree)
    - Softmax function is the original classification layer
    - KNN and Decision tree are not good at large sample size and not suitable to be a layer of the network

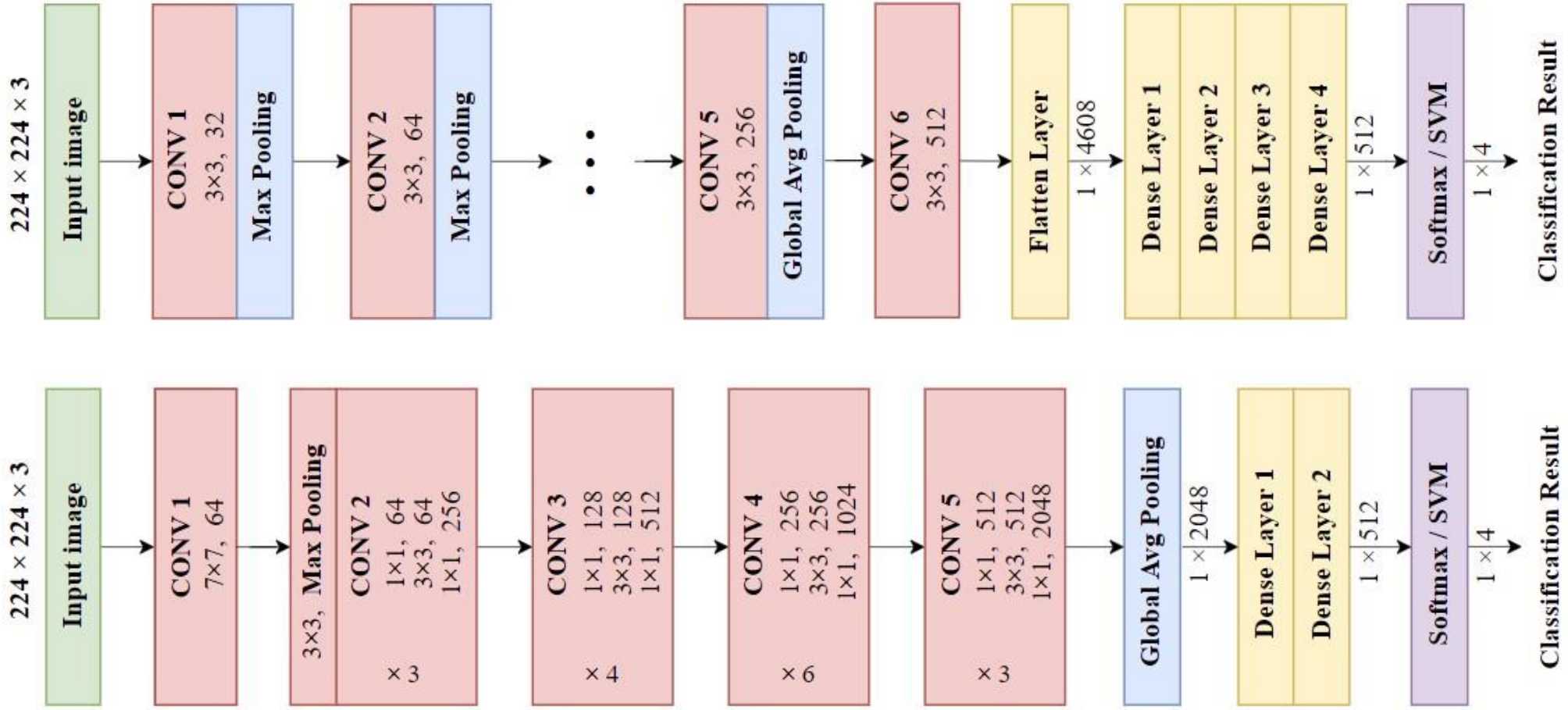
Design Solution – Mask Detection Module

- 4 final model
  - CNN with softmax as its last layer (classification layer),
  - CNN with svm as its last layer,
  - ResNet with softmax as its last layer,
  - ResNet with svm as its last layer.
- Implement
  - implement our models in the Google Colab platform using python
  - Import Sequential, Dense, MaxPooling2D and Flatten from Tensorflow package to build our self-designed CNN
  - Import ResNet50 from Tensorflow package

Design Analysis - System input and output

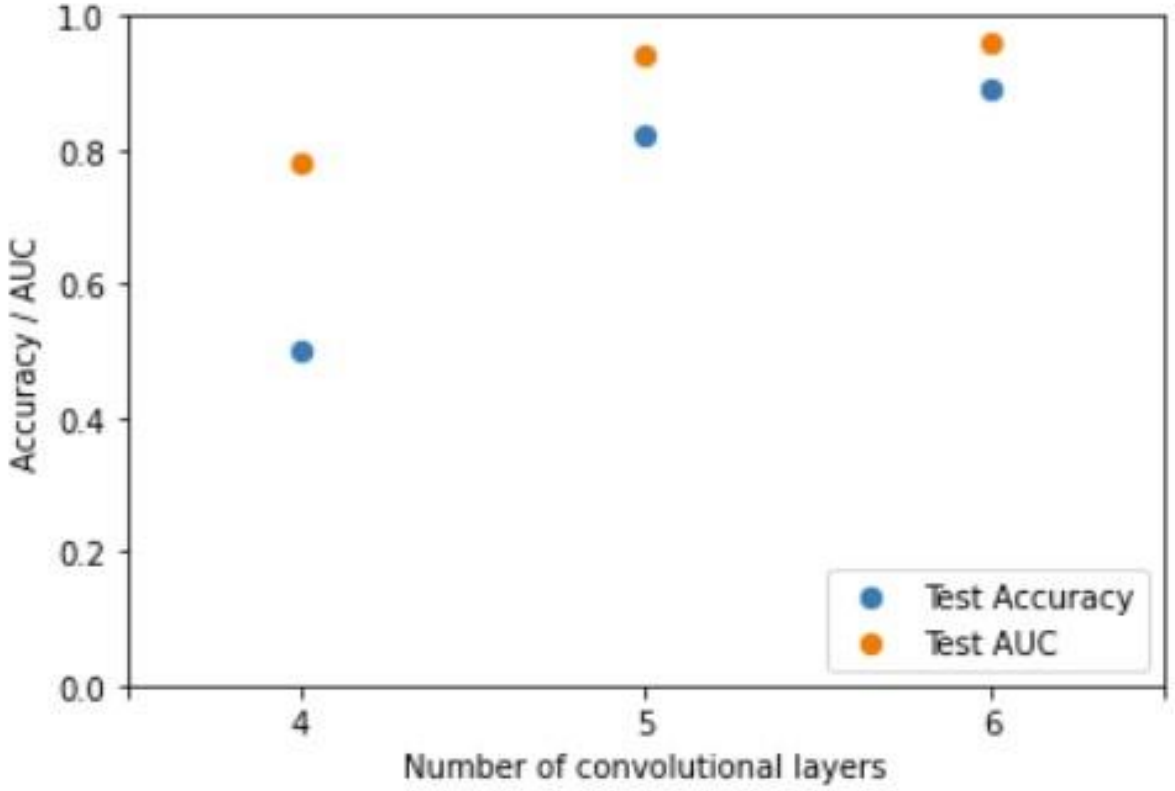
- a RGB image (JPG or PNG) of single person
- Input images are resized into the size of 224×224×3
- Probability of each class the image classified into is generated
- Output the specific mask wearing type of each image
- Calculates the number and the percentage of people who are not wearing a mask properly and display a red warning on the screen

Design Analysis - Model architecture



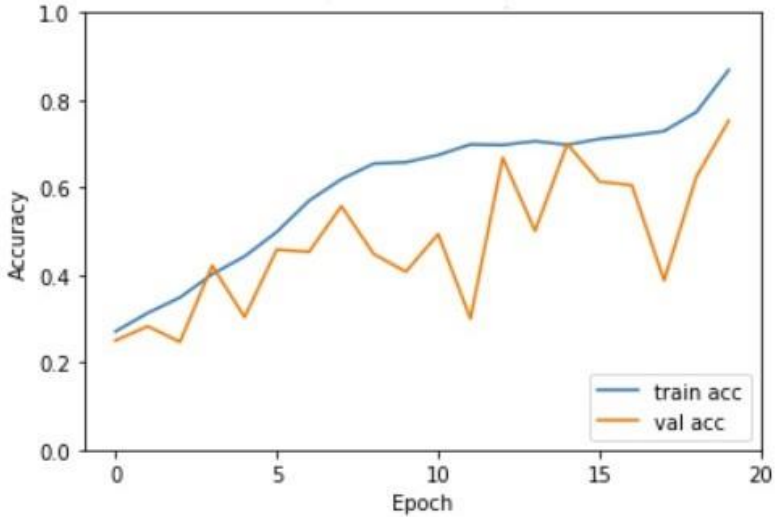
Design Parameters – Number of Conv layers

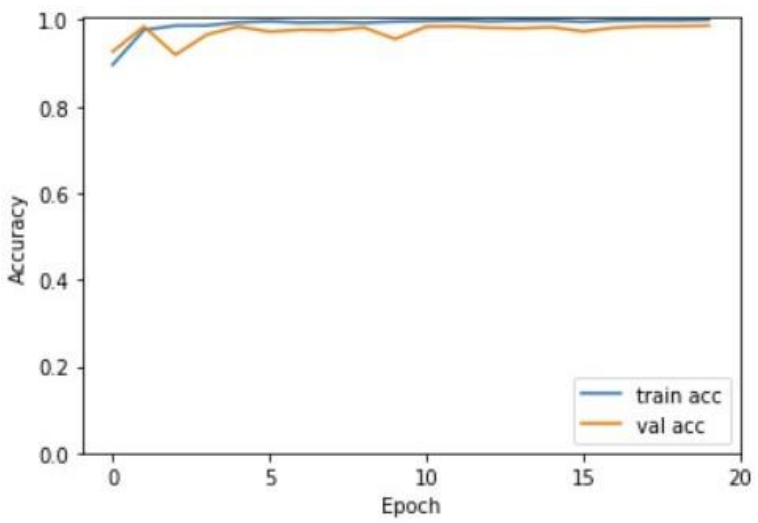
- Test our basic CNN model with 4, 5, and 6 convolutional layers.
- The number of filters in the model increased from 16, 32, 64, 128, 256 to 512 .
- Other hyperparameters remain the same in all convolutional layers.

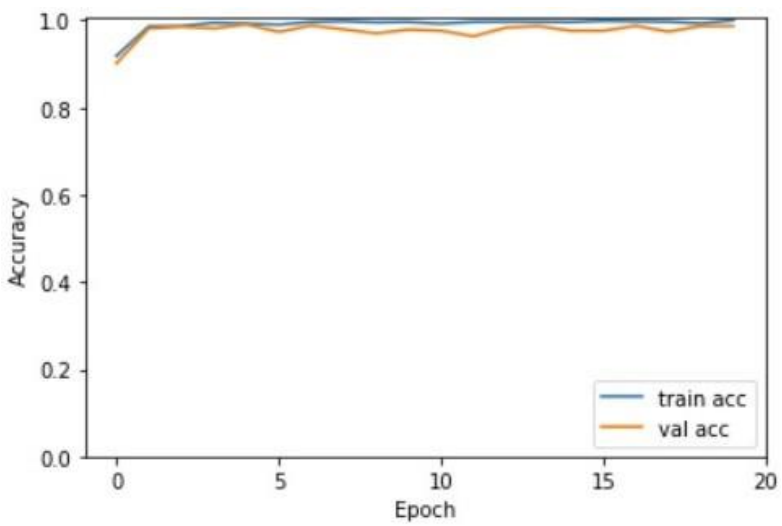


Design Parameters – Learning rate

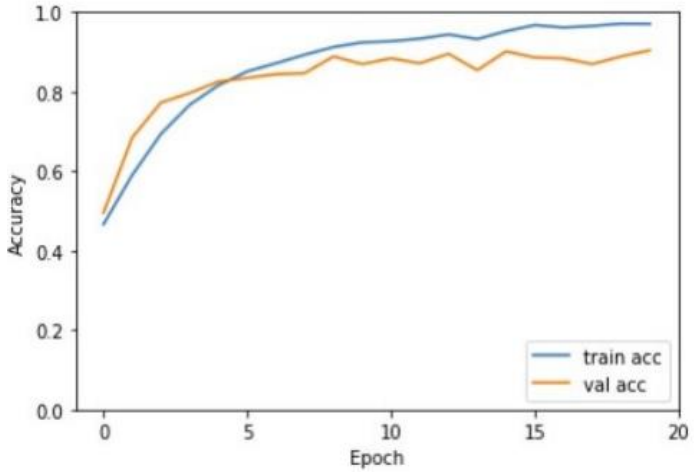
- Test the learning rates of 0.01, 0.001 and 0.0001 in out ResNet50 model.



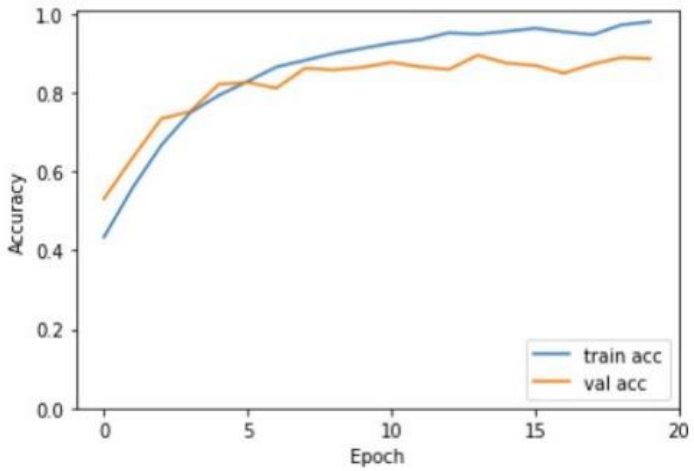




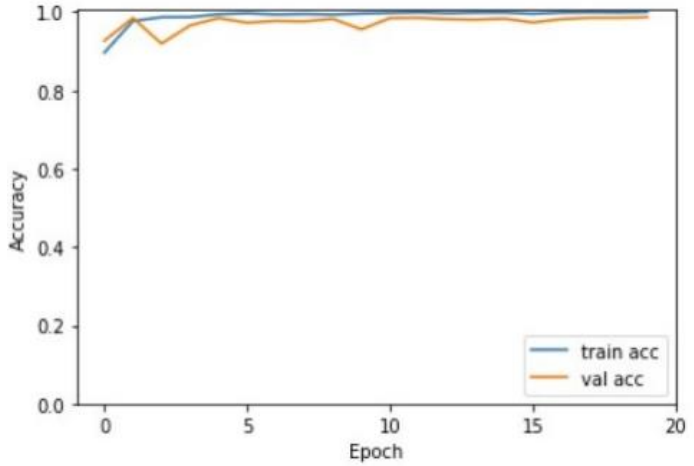
Model performance



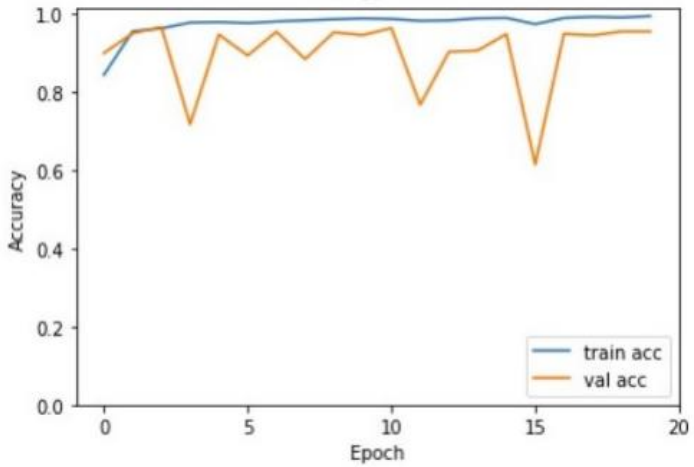
(a) CNN+Softmax



(b) CNN+SVM



(c) ResNet+Softmax



(d) ResNet+SVM

TABLE II: The accuracy of each model(%).

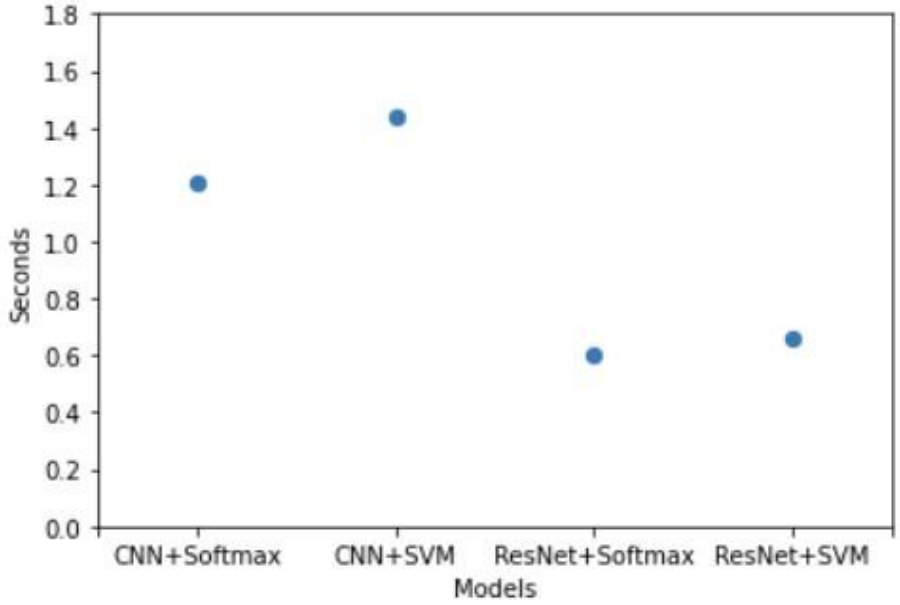
Model	CNN+ Softmax	CNN+ SVM	ResNet50+ Softmax	ResNet50+ SVM
Training	99.39	95.28	99.93	95.87
Validation	96.74	87.73	99.65	94.67
Testing	89.49	87.39	98.21	94.24

TABLE III: The precision and recall values of each model.

Model	CNN+ Softmax	CNN+ SVM	ResNet50+ Softmax	ResNet50+ SVM
Precision	0.88	0.87	0.98	0.95
Recall	0.88	0.87	0.98	0.94

Conclusion

- We chose the Resnet+softmax model as our final product.
- Much better performance than what we expected, great success.
- The model ended up having
  - 98.21% Accuracy
  - 0.6s Processing time



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Thank you!