Acne Detection and Rating based on Mobile Phone Selfie Photos Report

Competition Question Number: 4

By: Team Anti Acne

Koay Xian Cong

Liang Han Sheng

Sum Yin Chuang

CONTENTS

INTRODUCTION

Without a doubt, most of the human faces acne's problem. More than 85% of teenagers have this common skin problem, which is marked by clogged pores (whiteheads, blackheads), painful pimples, and, sometimes, hard, deep lumps on the face, neck, shoulders, chest, back, and upper arms. [1] Based on the statistic by the American Academy of Dermatology Association, it is known that approximately 85% of people between 12 and 24 experience at least minor acne. Moreover, acne occur in adult is up to 15% of women. [2] Figure 1 below shows different types of acne.

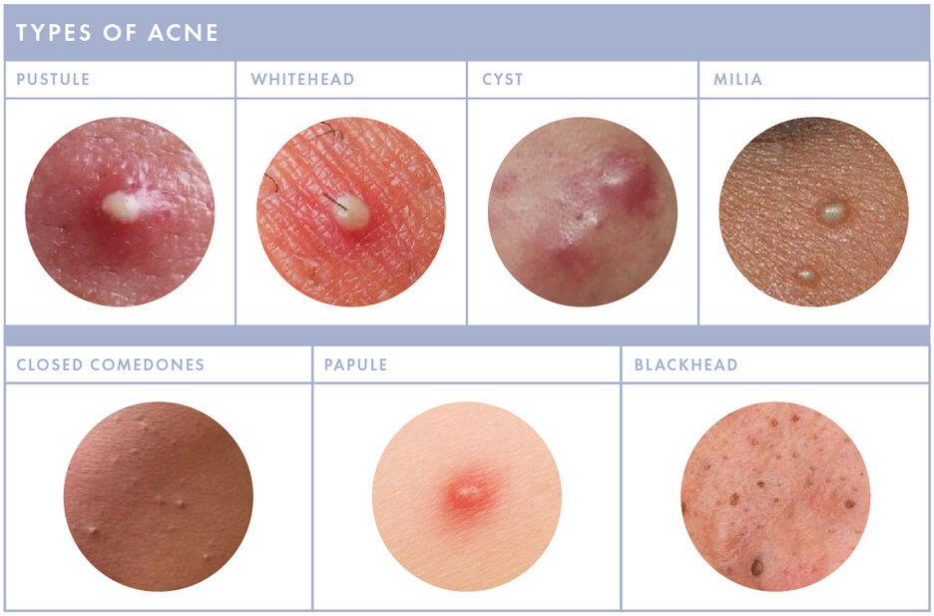


Figure 1: Types of Acne. (Source: https://www.lessenza.sg/blog/types-of-acnes-and-effective-treatments)

Causes of Acne

To understand acne, one needs to know how one's skin works. The pores in one's skin contain oil glands. When one hits puberty, there's an increase in sex hormones called androgens. The excess hormones cause one's oil glands to become overactive, enlarge, and produce too much oil, or sebum. When there's too much sebum, the pores or hair follicles become blocked with skin cells. The increase in oil also results in an overgrowth of bacteria called *Cutibacteriumacnes*.

If blocked pores become infected or inflamed, a pimple -- a raised red spot with a white center -- forms. If the pore clogs, closes, and then bulges, one has a whitehead. A blackhead

occurs when the pore clogs, stays open, and the top has a blackish appearance due to oxidation or exposure to air.

When bacteria grow in the blocked pore, a pustule may appear, meaning the pimple becomes red and inflamed. Cysts form when the blockage and inflammation deep inside pores produce large, painful lumps beneath the skin's surface.

Hormonal changes related to birth control pills, menstrual periods, and pregnancy can trigger acne. Other external acne triggers include heavy face creams and cosmetics, hair dyes, and greasy hair ointment -- all of which can increase blockage of pores.

Clothing that rubs one’s skin may also worsen acne, especially on the back and chest. So can heavy sweating during exercise, and hot, humid climates. Stress is known to trigger increased oil production, which is why many teens have a new crop of pimples on the first day of school or just before that big date. [1]

Problem Statement

Although there are a lot of medicines and treatments available for people to use as shown below,

- Azelaic acid
- Benzoyl peroxide
- Glycolic acid
- Lactic acid
- Retinoids (medications that come from vitamin A)
- Salicylic acid
- Various fruit acids

there isn't a guideline on how serious the acne is and what proper steps should be taken in order to cure the acne and prevent scars.

Furthermore, due to the Covid-19 pandemic, seeking assistance from dermatologist or undergoing facial treatment is unideal. Individuals should take the responsibility by practicing social distancing and staying at home. By using the acne classifier, individuals can take care of their acne issues themselves as well as saving costs.

Solution

Hence, acne classification is developed using deep learning. It is carried out using Resnet-18 model in this project. It is able to classify acne seriousness into:

- Normal
- Level 0
- Level 1
- Level 2

An example of acne classfier is shown in Figure 2 below.

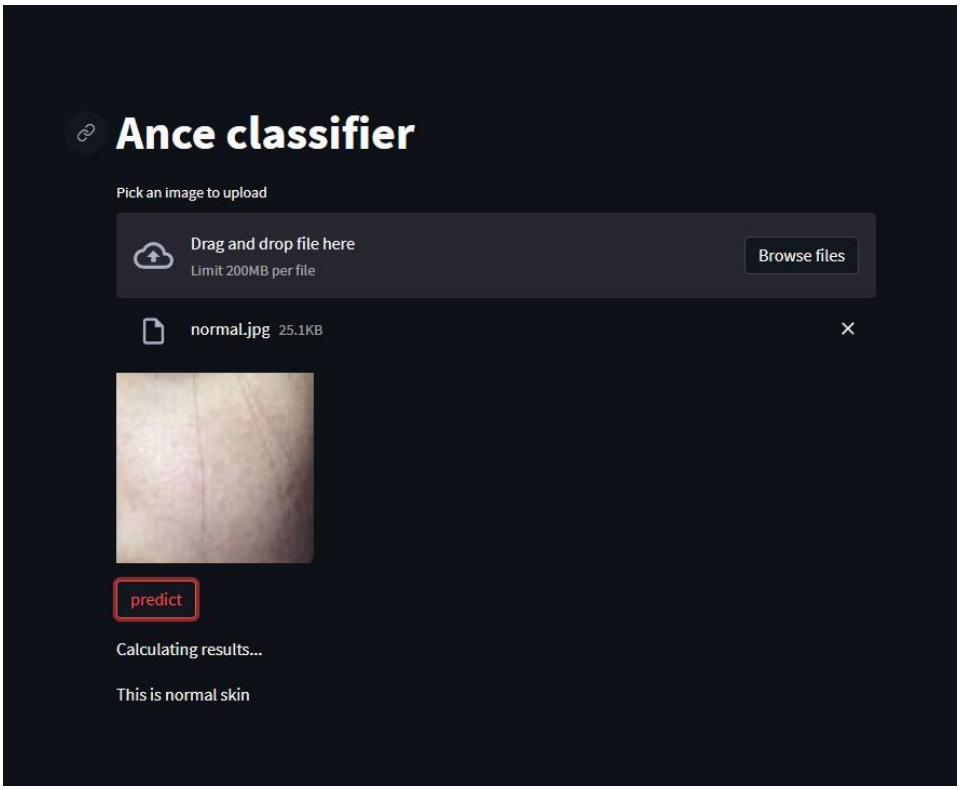


Figure 2: Example of Acne Classifier.

METHODOLOGY

Data Collection

For the acne dataset, we handpicked it from Kaggle with light skin complexion. Inside the dataset we downloaded, it contains 999 images with 3 classes. Figure 3 below shows the dataset we handpicked.

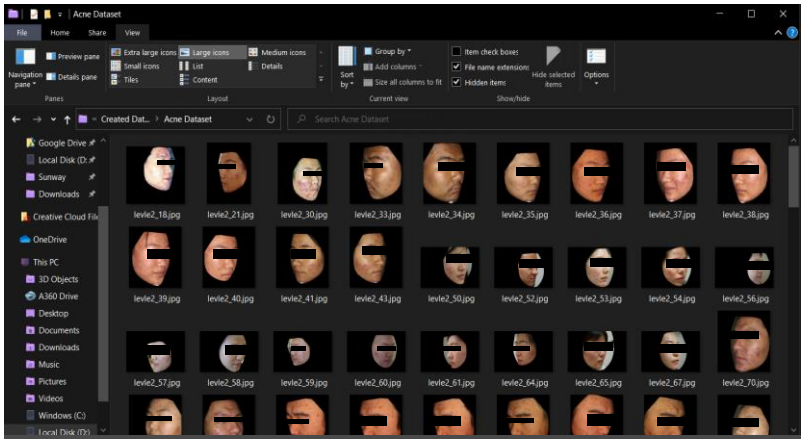


Figure 3: Data Collection.

Data Annotation

Next, we perform data annotation by splitting the dataset into different classes which are:

- Normal – Normal skin without acne.
- Level 0 – Very minor amount of acne can be seen and can be ignored.
- Level 1 – Few acnes can be seen on face and treatment is needed.
- Level 2 – Very serious acne issue and dermatologist is needed.

Figure 4 below shows how the dataset was annotated.

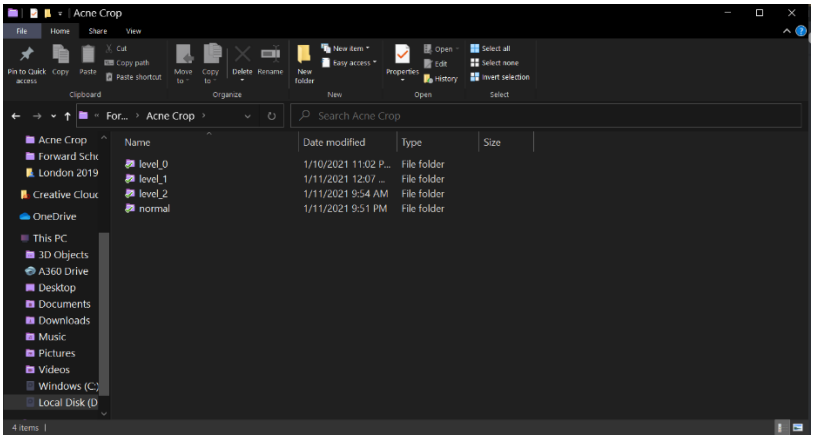


Figure 4: Data Annotation.

Figure 5 shows the difference between each class.

Figure 5: Difference between each class.

Data Pre-Processing

This is one of the most important steps for the model to get high accuracy when trained and tested. We firstly remove the noise and extract out the cheek where acne is most commonly found. Hence, the model will not learn the eyes, nose and so on that can be found from the datasets. This will greatly improve the quality of the dataset.

Next, we perform different data processing methods to increase the amount of data since the data that can be found through open source online is limited. The types of data pre-processing methods which is shown in Figure 6 include:

- Flip : Horizontal, Vertical
- 90° Rotate : Clockwise, Counter-Clockwise, Upside Down
- Crop : 0% Minimum Zoom, 50% Maximum Zoom
- Rotation : Between -15° and +15°
- Blur : Up to 10px
- Rotate :30 degree

Figure 6: Different pre-processing methods applied to the dataset.

Data Architecture & Modelling

The model we used in the acne classifier is ResNet-18 pretrained model. ResNet-18 is a convolutional neural network that is 18 layers deep. Figure 7 below shows the architecture for ResNet-18.

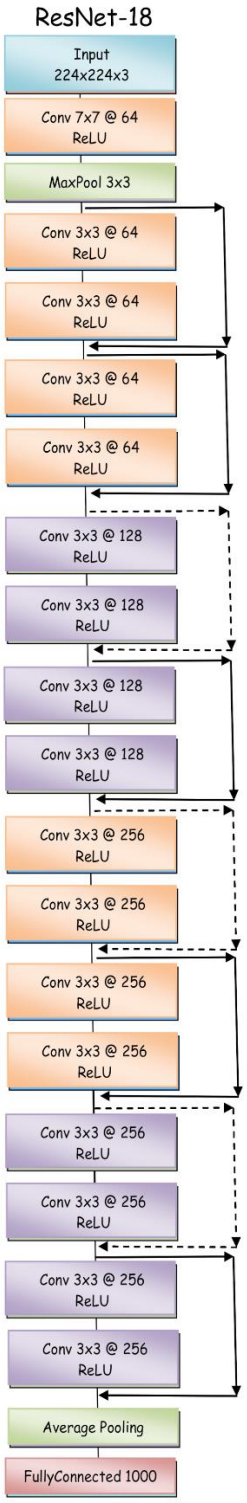


Figure 7: Architecture of ResNet-18.

Code

Import library and dataset.

```
!pip list | grep -e fastai -e torch -e torchvision
!pip install roboflow
from roboflow import Roboflow
rf = Roboflow(api_key="vcr5XJxITweIbIfriOOk")
project = rf.workspace("xian-cong").project("acne-classification")
dataset = project.version(3).download("folder")
```

List out classes and number of files in the dataset.

```
import os
labels = os.listdir("acne-classification-3/train")
print("No. of labels: {}".format(len(labels)))
print("-----------------")

for label in labels:
    print("{}, {} files".format(label, len(os.listdir("acne-classification-3/train/"+label))))
```

Assigning seed to reproduce model and show the dataset images with labelled data.

```
import numpy as np
import matplotlib.pyplot as plt
from PIL import Image

np.random.seed(42)

fig, ax = plt.subplots(nrows=2, ncols=2)
fig.tight_layout()
cnt = 0
for row in ax:
    for col in row:
        image_name = np.random.choice(os.listdir("acne-classification-3/train/" + labels[cnt]))
        im = Image.open("acne-classification-3/train/{}/{}".format(labels[cnt],image_name))
        col.imshow(im)
        col.set_title(labels[cnt])
        col.axis('off')
        cnt += 1
plt.show()
```

Import model and evaluation metrices.

```
from fastai.vision import *
from fastai.metrics import accuracy
```

Declare path, size, and batch size.

```
path = "./acne-classification-3/"
size = 224
bs = 64
data = ImageDataBunch.from_folder(path,valid_pct=0.2, size=size, bs=bs)
```

Normalize dataset.

```
data.normalize(imagenet_stats)
```

Automatically get a pretrained model (ResNet-18) from a given architecture with a custom head that is suitable for our data.

```
learner = cnn_learner(data, models.resnet18, metrics=[accuracy], callback_fns=ShowGraph)
```

Launch a mock training to find a good learning rate and return suggestions.

```
learner.lr_find()
learner.recorder.plot()
```

This Callback allows us to easily train a network using Leslie Smith's 1cycle policy. [3] It uses the learning rate suggested from previous mock training to perform faster training with optimized learning rate.

```
learner.fit_one_cycle(15, max_lr=slice(1e-3, 1e-1))
```

Save model. The model exported can be apply into web app, mobile app, etc.

```
from fastai.callbacks import *
save_best_model = SaveModelCallback(learner, name='best_resnet')
```

Load the model architecture.

```
learner.load('best_resnet')
```

Plot out confusion matrix for the model.

```
interp = ClassificationInterpretation.from_learner(learner)
interp.plot_confusion_matrix()
```

Show images in top_losses along with their prediction, actual, loss, and probability of actual class.

```
interp.plot_top_losses(9, figsize=(15,15))
```

RESULTS

By using ResNet-18 pretrained model, we optimize the model to our custom dataset and achieve an accuracy up to 90% as shown in Figure 8 below.

epoch	train_loss	valid_loss	accuracy	time
0	1.275670	0.998097	0.765677	00:08
1	0.892795	0.743409	0.811881	00:08
2	0.880464	1.535807	0.821782	00:07
3	0.871721	1.634758	0.808581	00:07
4	1.088481	5.388702	0.656766	00:07
5	1.044595	1.901320	0.762376	00:07
6	0.863624	0.809342	0.858086	00:07
7	0.710001	0.676677	0.894389	00:07
8	0.532709	0.652870	0.897690	00:07
9	0.408114	0.615403	0.894389	00:07
10	0.343163	0.756864	0.854786	00:07
11	0.276528	0.694668	0.894389	00:08
12	0.217420	0.604474	0.897690	00:07
13	0.181705	0.625304	0.900990	00:07
14	0.141823	0.635878	0.900990	00:07

Figure 8: Accuracy over epochs for Acne Classification.

Furthermore, the result can be visualized through the loss function graph over time as shown in Figure 9 below.

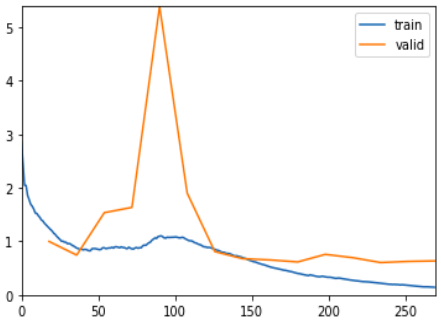


Figure 9: Loss Function Graph.

Finally, a confusion matrix for the model is plotted out and shown in Figure 10 below.

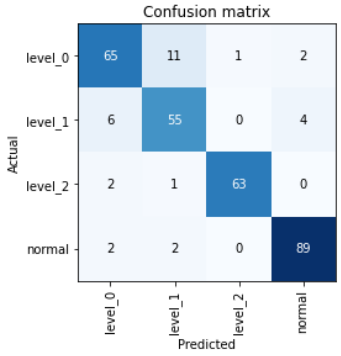
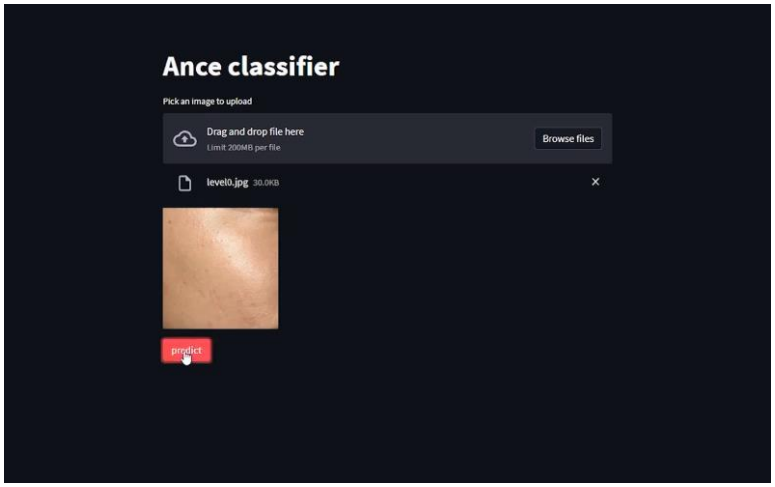


Figure 10: Confusion Matrix for our model.

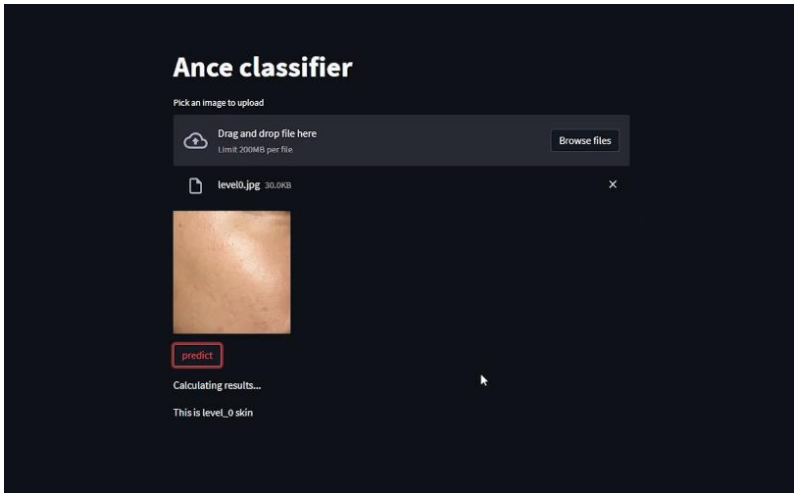
DEMO

1. Visit the web app.

2. Upload image that wants to be classified.



3. Results.



DISCUSSION AND FUTURE IMPROVEMENTS

Development Blockers

Problem: We built and trained using our own model initially. However, the model does not improve much over time and is only able to achieve up to 50.6% accuracy after tuning for several weeks.

Solution: We decided to train using pre-trained model – ResNet-18 and not only the model trains faster but also able to achieve 90% accuracy.

Problem: We obtained dataset from open-source website, Kaggle and the images contain a lot of noise such as nose, eyes, etc which causes the model to be confused when trained.

Solution: We cropped out the unwanted noise and left with cheeks in which acne normally occurs to improve the quality of the dataset.

Problem: We obtained dataset from open-source website, Kaggle in which the dataset has inconsistent brightness which will confuse the model when training.

Solution: We performed data augmentation and pre-processed the dataset using various filters to normalize the dataset.

Problem: Since we only crop out the cheek on the face to train the model, acnes that grows on forehead need to be tested the second time.

Problem: Images tested might be filtered through the camera app.

Problem: Our current model only suits lighter Asian skin complexion due to limitation of dataset available.

Future Improvements

1. A Platform to Discuss about Skin Care Products

   Individuals who have tried certain skin care products are able to review and give comments or rating through the platform.

2. Cross geographical samples

   One of the limitations now is we have limited resources, and we can only classify acne for Asians.

3. Collaboration with Dermatologists

   Individuals can contact dermatologists through this platform to know more details about their skin conditions.

4. Make into a Smartphone App

   By developing the Acne Classifier into a smartphone app, individuals can check their acne condition anytime, anywhere! Individuals can take picture with no filters directly from the mobile app.

5. More detailed classifier

   Develop the acne classifier to classify detailed acne problems such as blackhead.

6. Higher Accuracy

   Due to lacking resources and computational power, we can only achieve optimum accuracy. However, higher accuracy can be obtained by enhancing our model.

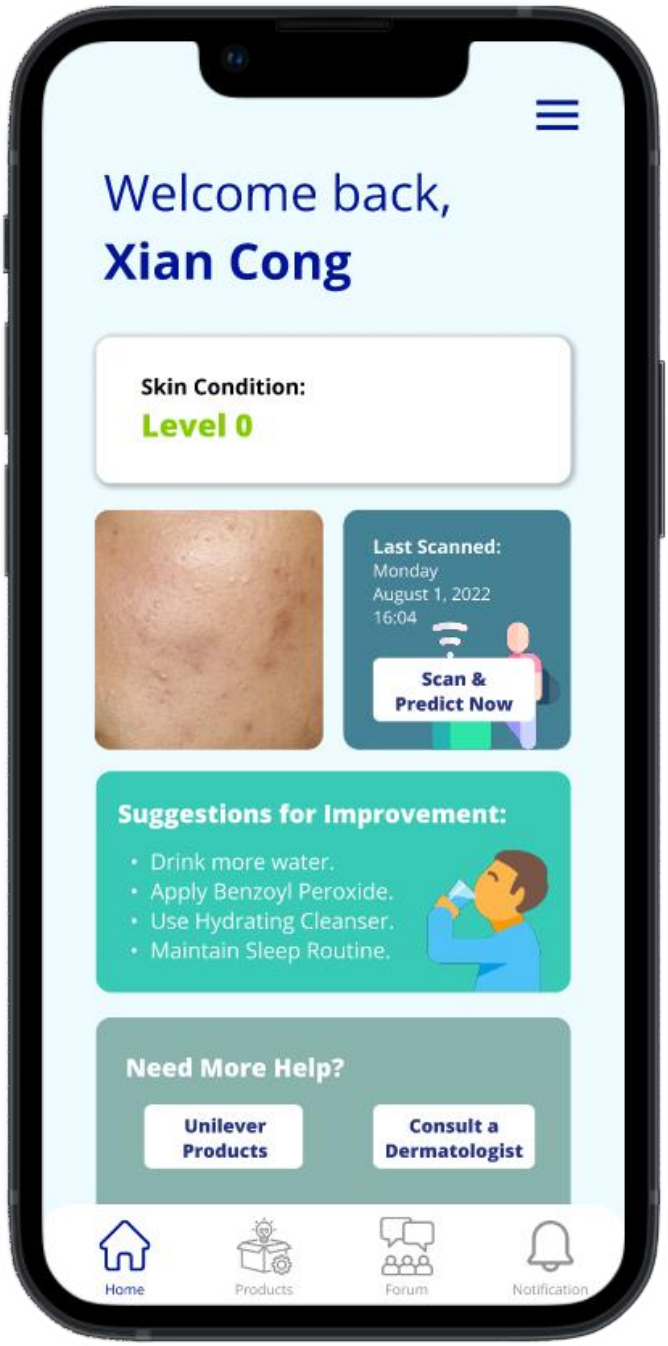
7. Develop an Object Detection Model

   Since one of the problems now is that the acne classifier can only detect one part of the face, an object detection model will solve the problem by drawing a bounding box around acne detected on the whole face.

8. Suggestions of Treatments

   Once the model detects the level of seriousness of the acne, it is able to provide some basic treatment suggestions before escalating to seek for dermatologist for help.

MOBILE APP OVERVIEW



CONCLUSION

To sum up, the acne classifier is able to classify level of seriousness into 4 classes, which are normal, level 0, level 1, and level 2 up to 90% accuracy. Many improvements can be done if given with better quality dataset, higher computational power and more time.

REFERENCES

[1] WebMD. 2022. *Teens and Acne*. [online] Available at: <https://www.webmd.com/skin-problems-and-treatments/acne/what-is-acne#:~:text=More%20than%2085%25%20of%20teenagers,good%20that%20you%20will%2C%20too.> [Accessed 18 July 2022].

[2] Aad.org. 2022. *Skin conditions by the numbers*. [online] Available at: <https://www.aad.org/media/stats-numbers> [Accessed 18 July 2022].

[3] Gugger, S., 2022. *The 1cycle policy*. [online] Another data science student's blog. Available at: <https://sgugger.github.io/the-1cycle-policy.html> [Accessed 18 July 2022].