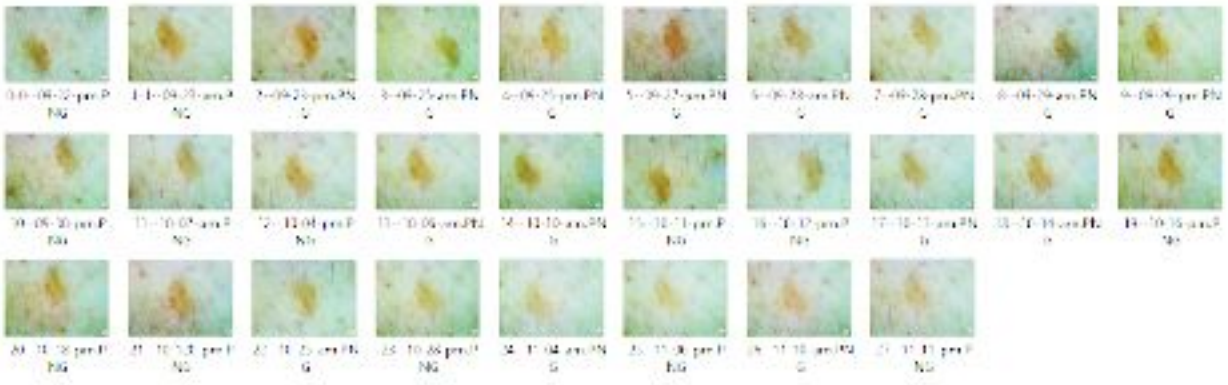
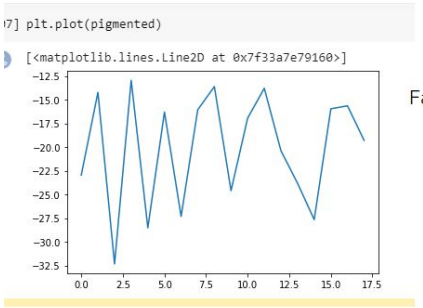
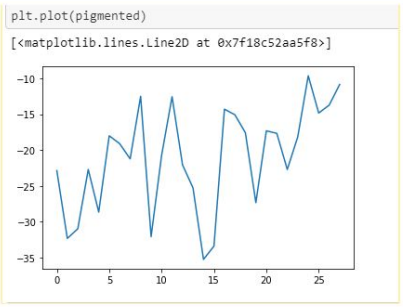
Hypothesis: <u>Pigment Fluctuates and Becomes Darker Before Improvement with 0.3% Retinol/Fision Active White combination</u>. *Question: can average colour panels, along with improved segmentation, help physicians evaluate progress more clearly? Statement: From a product standpoint, the current AI can be used to make recommendations for personalization to the user to encourage engagement and adherence, without much risk when there is error, as an advertising tool to keep users engaged, in response to changes observed. It is not better than a human eye, but good enough to send notices. Current segmentation failure rate is low: 15% on Melanoma test set. Future improvements can be made as more data is obtained. NOTE: a measure of longitudinal variability should be created "vol" as well as "level" because this is how we determine the last 4 days are below the noise floor with our eyes...*

Pigment fluctuations Seen in regular images:





Failed Formulation Trial



Successful Formulation Trial

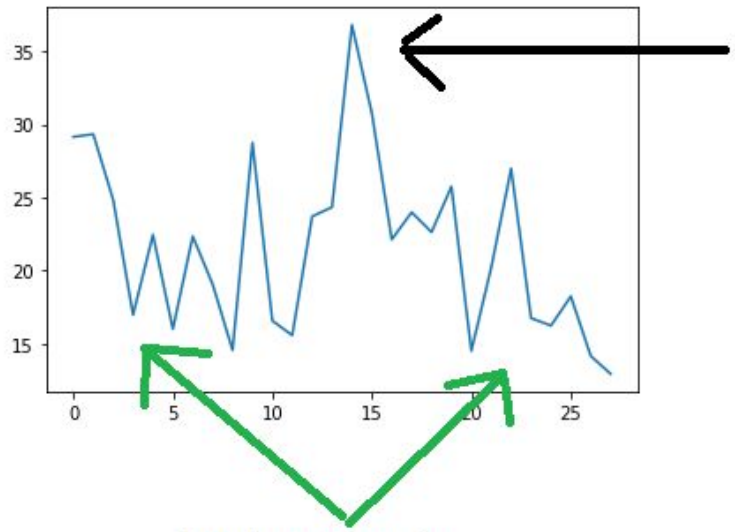
Failed Formulation shows noise only, successful formulation shows visible upward trend in blue-red light measure. Y axis is brightness of blue reflection minus red reflection. X axis is time.

And quantitatively tracked by AI. Blue light absorption is decreasing in both normal and pigmented regions, but moreso in the pigmented region by the end of the 6 week poc test period. Day 14 (counting from 0) looks darkest in the photos and shows darkest in the AI measure blue - red light. Day 5 is less pronounced as it is reddish and potentially caused by fluctuating erythema in that period.

Blue - Red

```
plt.plot(normal - pigmented)
```

```
[<matplotlib.lines.Line2D at 0x7f18c5a77a20>]
```

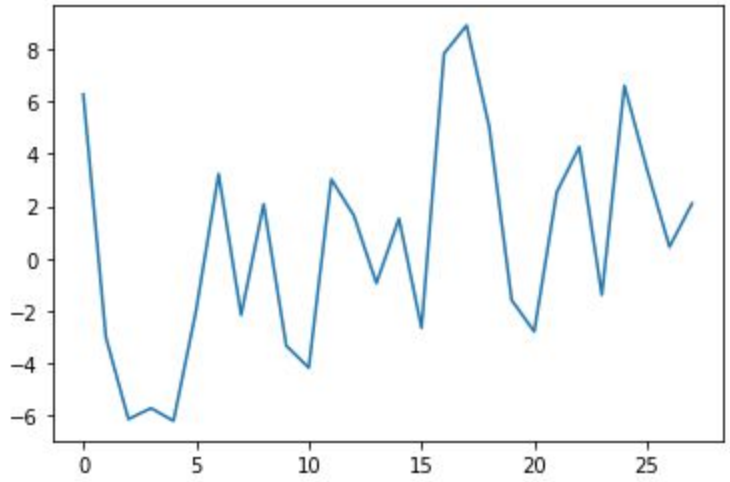


Progress is not steady and lesion may darken before lightening occurrs. This may be an ideal time for the AI to trigger an infomrative message or recommendation to encourage adherence. Timing of darkening may also be measured

leasion colour is measurably lighter at the end compared to the initiation of treatment

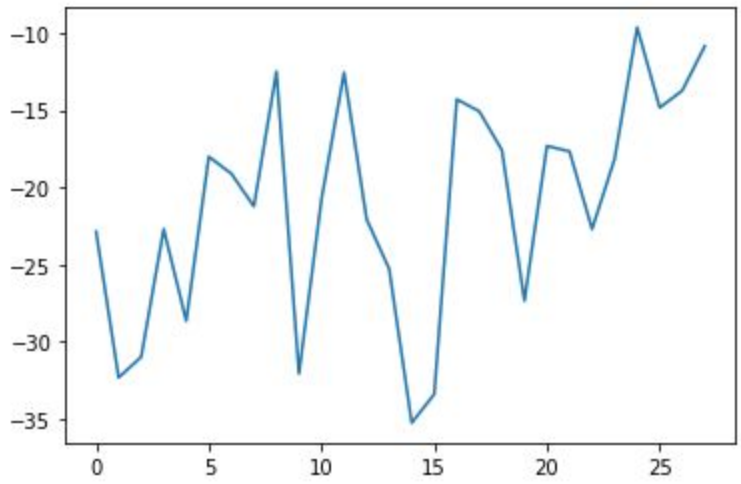
```
plt.plot(normal)
```

```
[<matplotlib.lines.Line2D at 0x7f18c7324a20>]
```

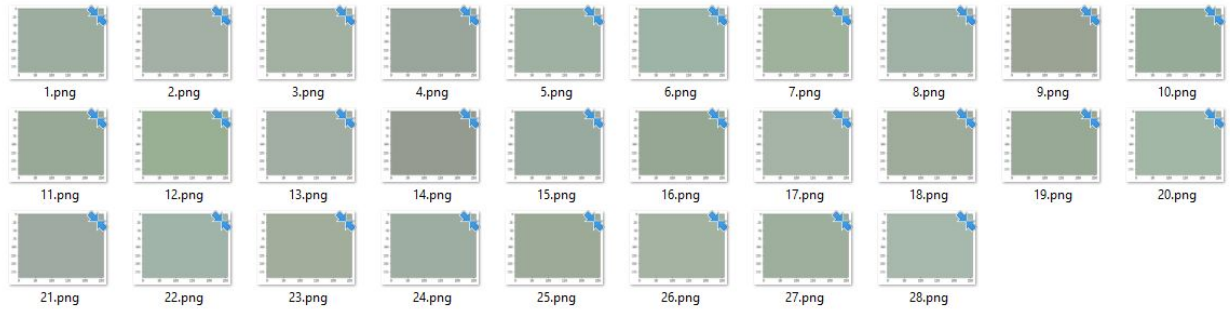


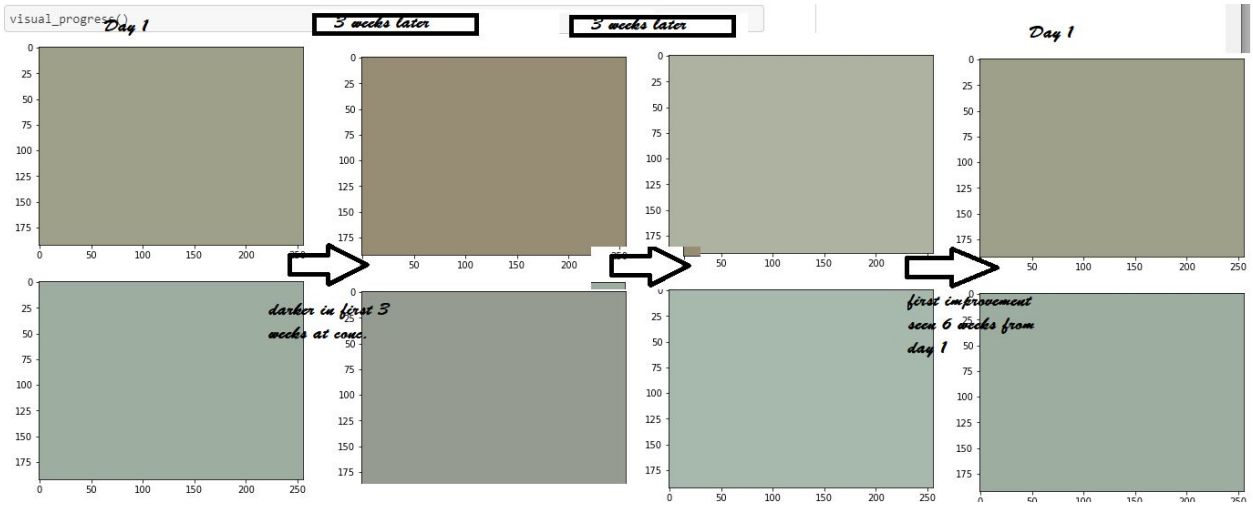

```
plt.plot(pigmented)
```

```
[<matplotlib.lines.Line2D at 0x7f18c52aa5f8>]
```



Tracked visually with segmentation: The below images measure the average colour inside the segmented region (top, representing the lesion) and outside the segmented region (bottom, representing the normal skin).[Product note: Users may be sent messages timed with AI observations that inform them about pigmentation, retinol etc. in a timely manner, for example: “don’t worry if you notice your pigmentation gets darker before it gets lighter…”, can be timed with the AI seeing the spot get darker].





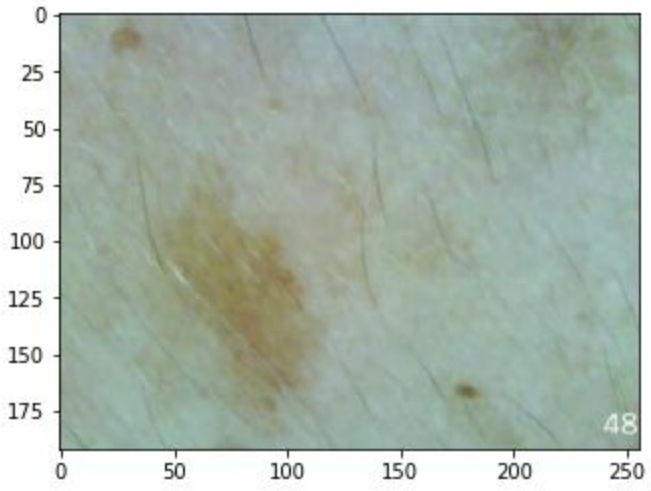
As well as quantitatively, the darkest spots on days 16 and 5, where a reddish hue shows strong blue absorption, (counting from 0) can be seen in the longitudinal photos: The below plots show reflection from the skin to the blue channel of the CHOWIS images inside the segmented, pigmented region (top) and outside the segmented pigmented region (bottom)[1] . The difference between the first and the last day should become more pronounced with further algorithm improvements. *However, the best use of the algorithm will be to send users timely information and personalization suggestions.* Users may also be provided with a question: was this helpful y/n, which can be used to improve the algorithm.

[1] Check whether or not cnn weights are re-initialized during sequential predictions and whether or not this introduces an error, in particular for day 17 +/- a day.

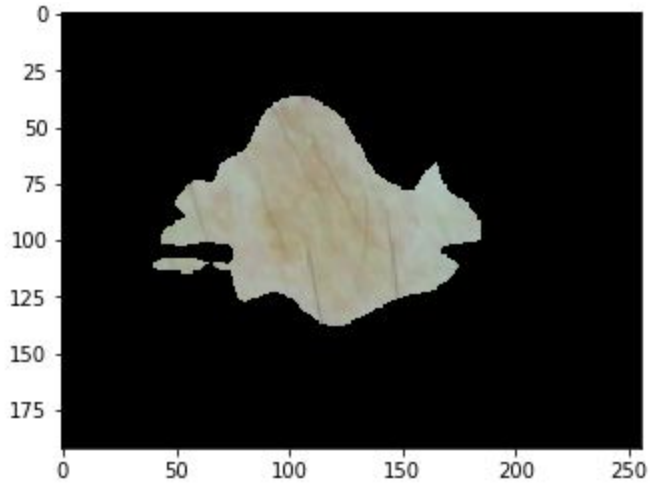
It can be seen that the AI algorithm can discern that the region outside the segmentation reflects more blue light than the region inside the segmented region. However, changes in the *differences* between blue light absorption in normal skin and pigmented lesion are not as clearly discernible, except on day 6, day 14 (starting from 1), and the final day. Hypothesize that this is due to the small region of the photograph area, and the fact that formulation is not sufficiently localized within this region to effect clear changes at the boundary on this timescale. The “noise” may be primarily biological in nature and not due to a limitation of the AI. [Product note: users can be sent explanatory messages from the AI about this, depending on their results] Furthermore, the segmentation algorithm can be further improved through baggining techniques as well as data augmentation techniques, possibly also the use of RESNET based architecture, in order to improve generalization. However, the current algorithm should be sufficient to serve as a first proof of concept. Finally, tracking blue light absorption may be influenced by the presence of shadows. In what is presented the metric has been chosen as blue - red. This allows for melanin absorption spectrum (blue) to be distinguished from shadows (blue and red).

Segmentation Results by Image:

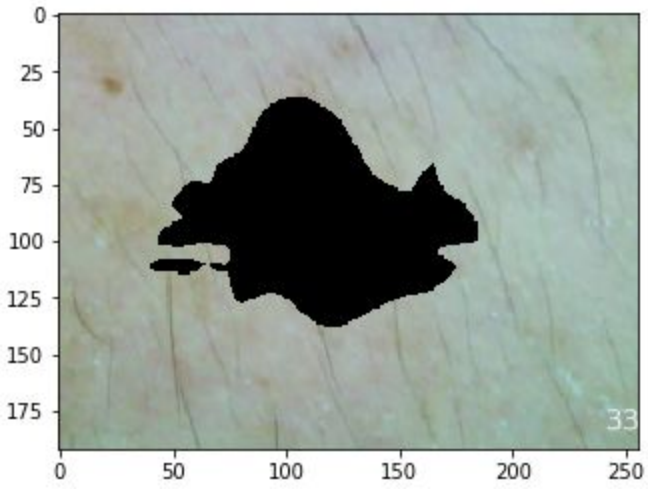
Example image of pigmentation:



Example of segmentation of pigmented region:



And non-pigmented region on the same photo:



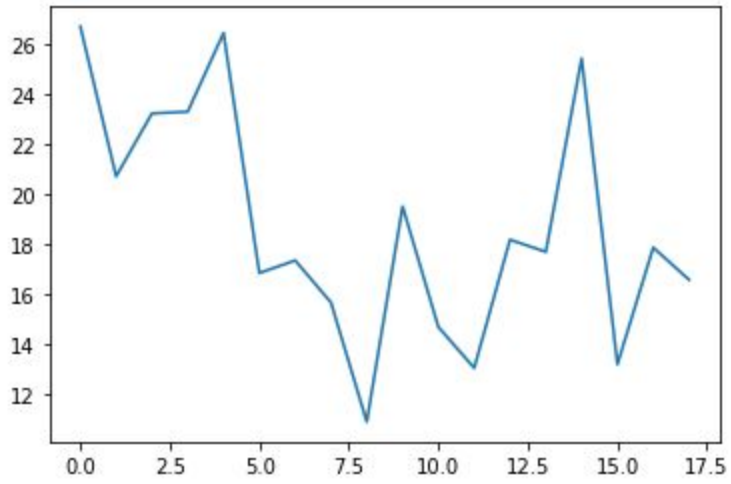
Sources: see the below link for more details (and newer runs)

https://github.com/NoelleI/Pigmentation/blob/master/Melanoma_with_CNN_with_Sigmoid_4_Pigmentation_rotate_flip.ipynb

Experiment 2 Spot 1 - considered A FAIL

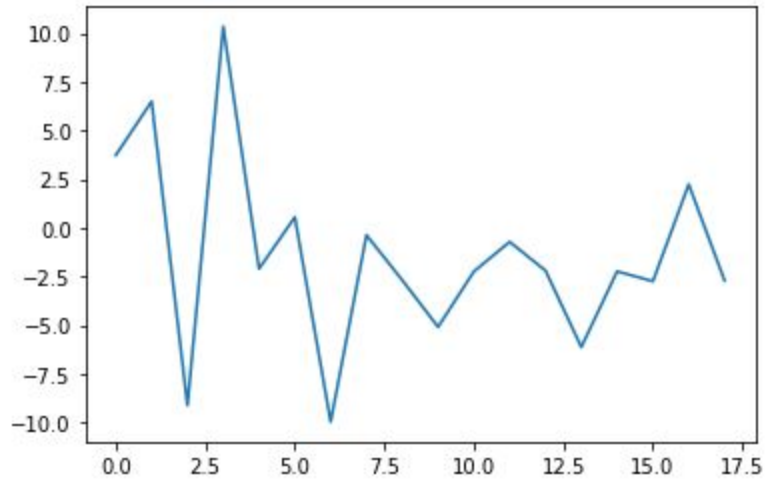
```
[105] plt.plot(normal - pigmented)
```

```
[<matplotlib.lines.Line2D at 0x7f33a7a40630>]
```



```
plt.plot(normal)
```

```
[<matplotlib.lines.Line2D at 0x7f3578112080>]
```




```
]7] plt.plot(pigmented)
```

```
[<matplotlib.lines.Line2D at 0x7f33a7e79160>]
```