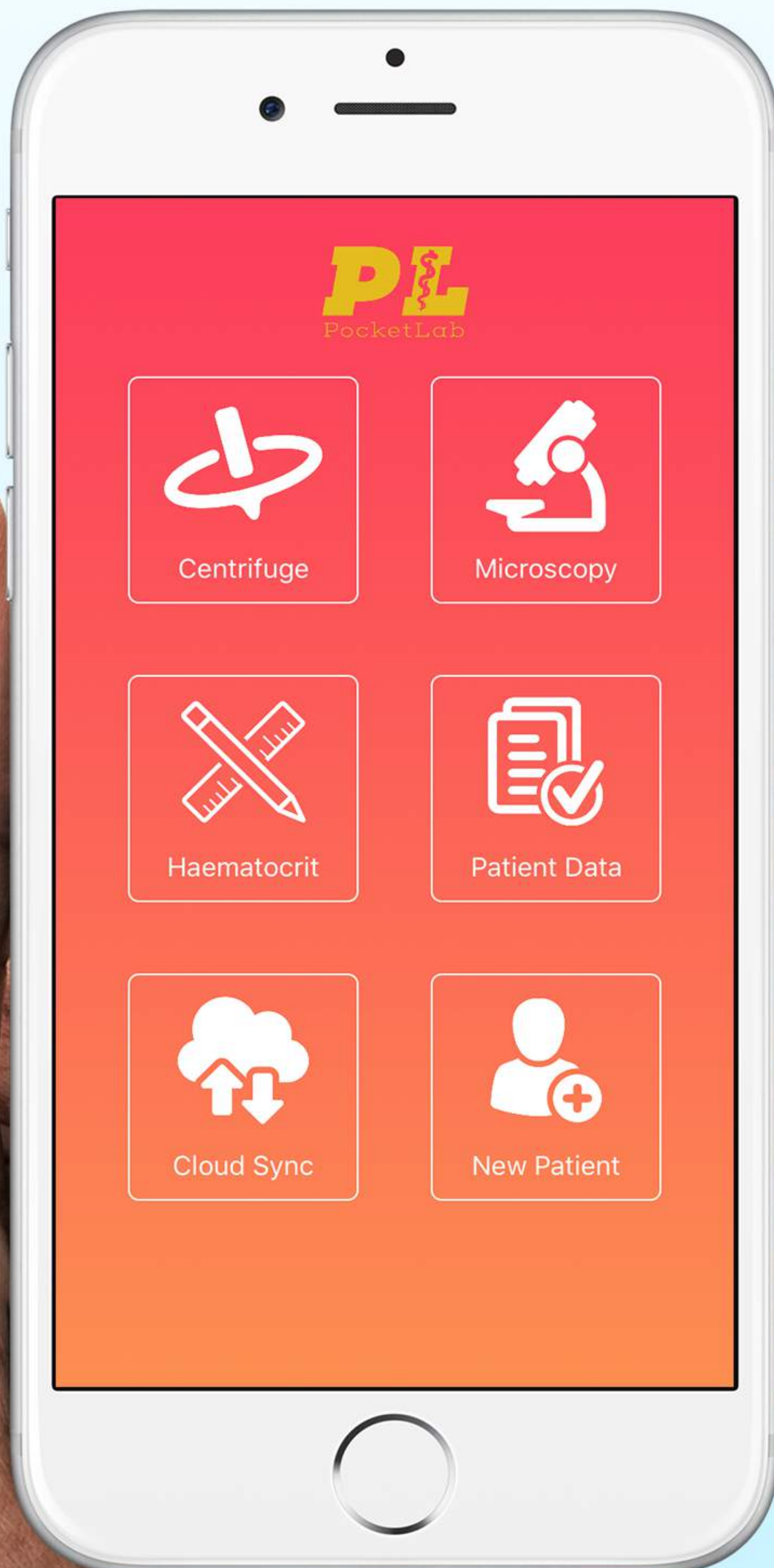


POCKET LAB

By Avery Lamp



Brief Intro

PocketLab is an app that my team created in 36 hours at PennApps XII, hosted by the University of Pennsylvania in September 2015. It ended up winning the Hottest Health Hack Prize

The idea behind Pocket lab, was to make a collection of tools capable of dramatically reduce the cost and time for blood analysis in underdeveloped countries. With the tools in PocketLab, we aim to determine if a patient is afflicted with:

Anemia

Leukemia

Hereditary Elliptocytosis

Sickle Cell

Hemolytic Anemia

High Red Blood Cell Distribution Width (RDW)

Low Blood Oxygenation Level

The full submission to PennApps XII, including a video overview can be found on my Devpost profile.

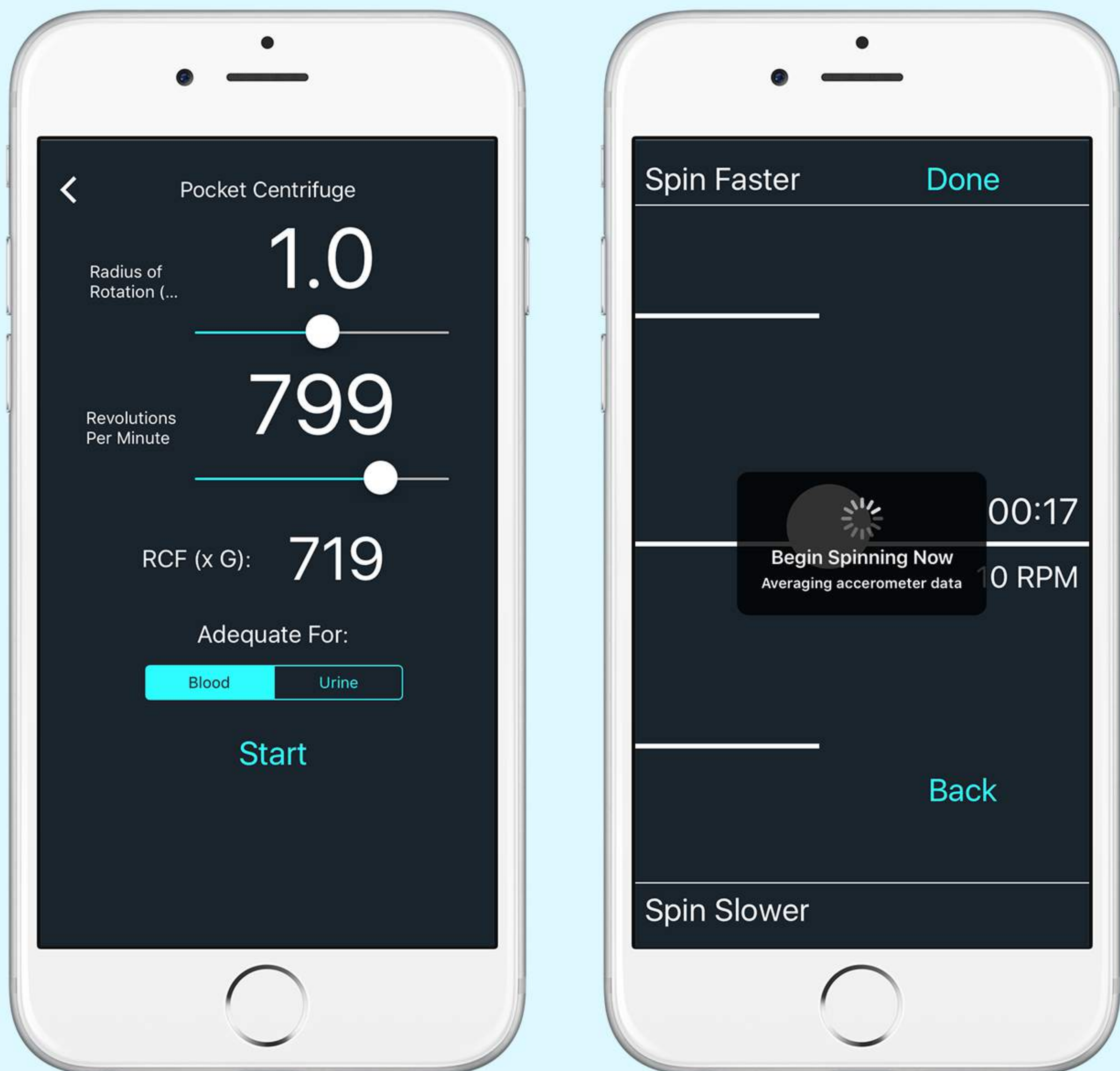
<http://devpost.com/averylamp>

PENNAPPS XII

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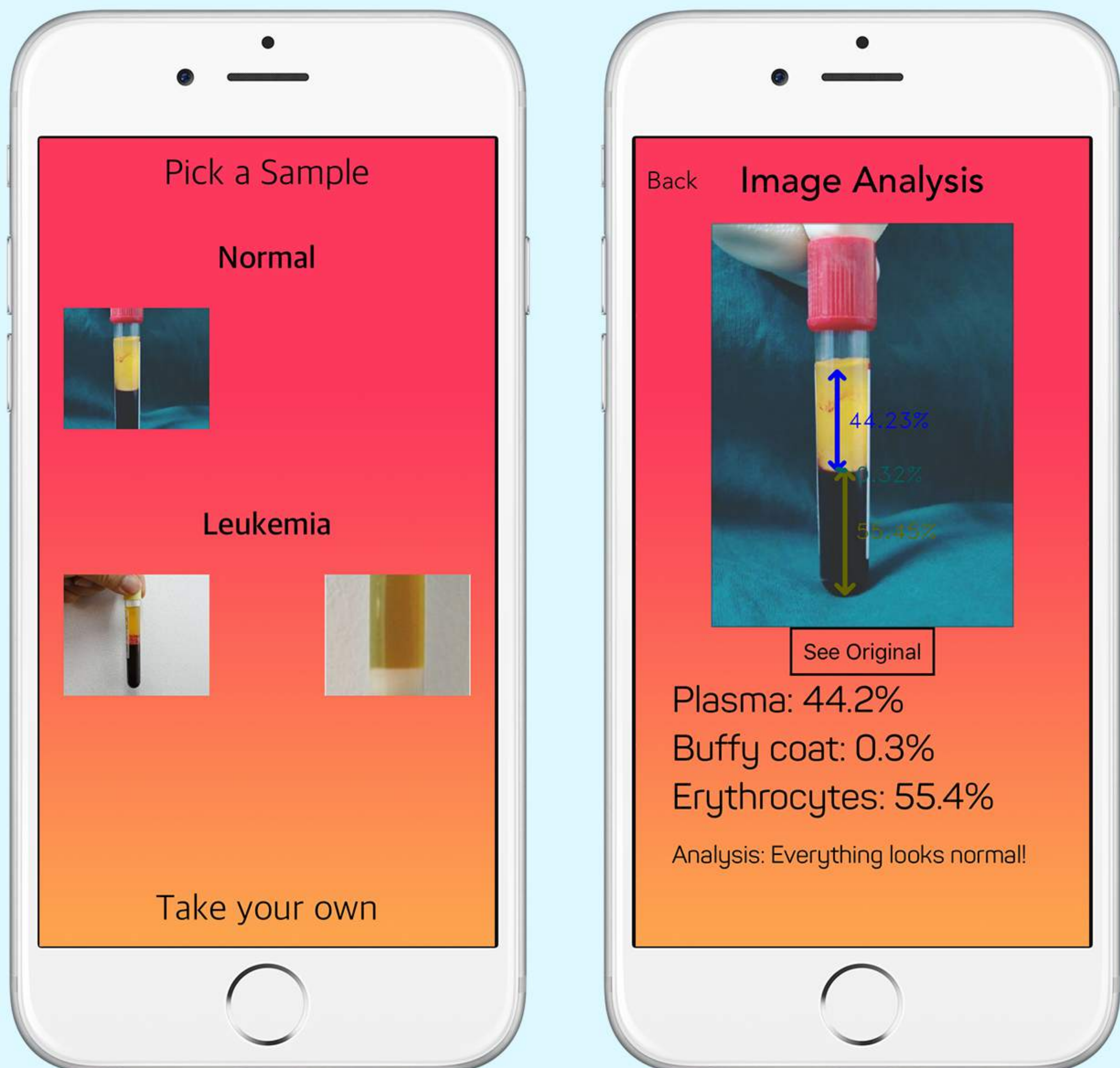
2000 Hackers | September 4th - 6th

Centrifuge



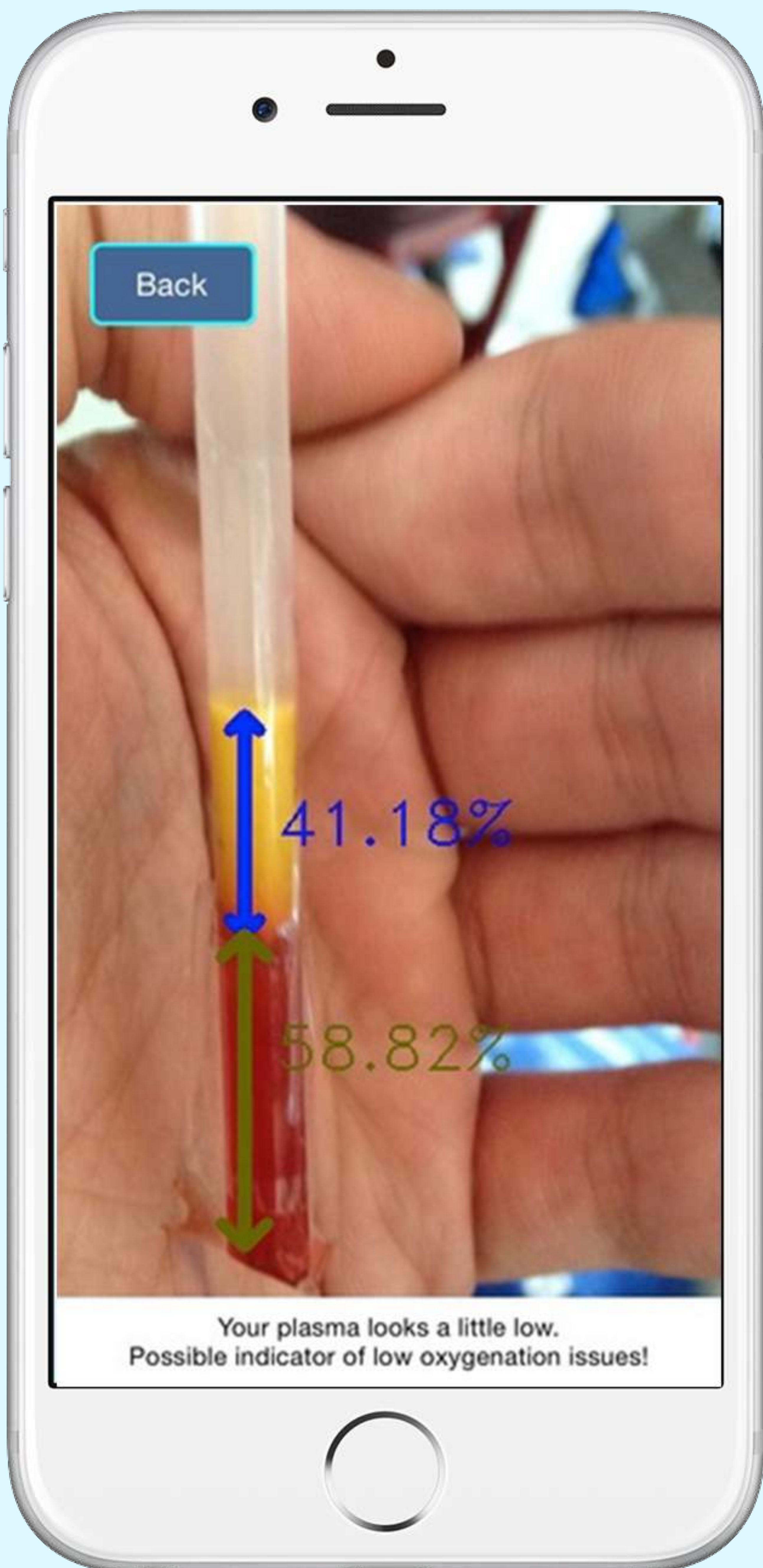
The first step to blood analysis is centrifugation. To do this, we used the iPhone's accelerometer and user inputted data. After a user inputs a desired revolutions per minute, the app goes to a live centrifuge screen that detects how many revolutions per minute the blood sample is spinning at and gives feedback to the user on whether or not he or she needs to spin the sample faster or slower to reach the desired input force. Blood separates by itself over time, but centrifugation accelerates the separation process. The centrifuge tool of the app is sufficient to help accelerate the separation of the blood to be analyzed although it is not as fast as an expensive and large centrifuge machine.

Hematocrit Analysis



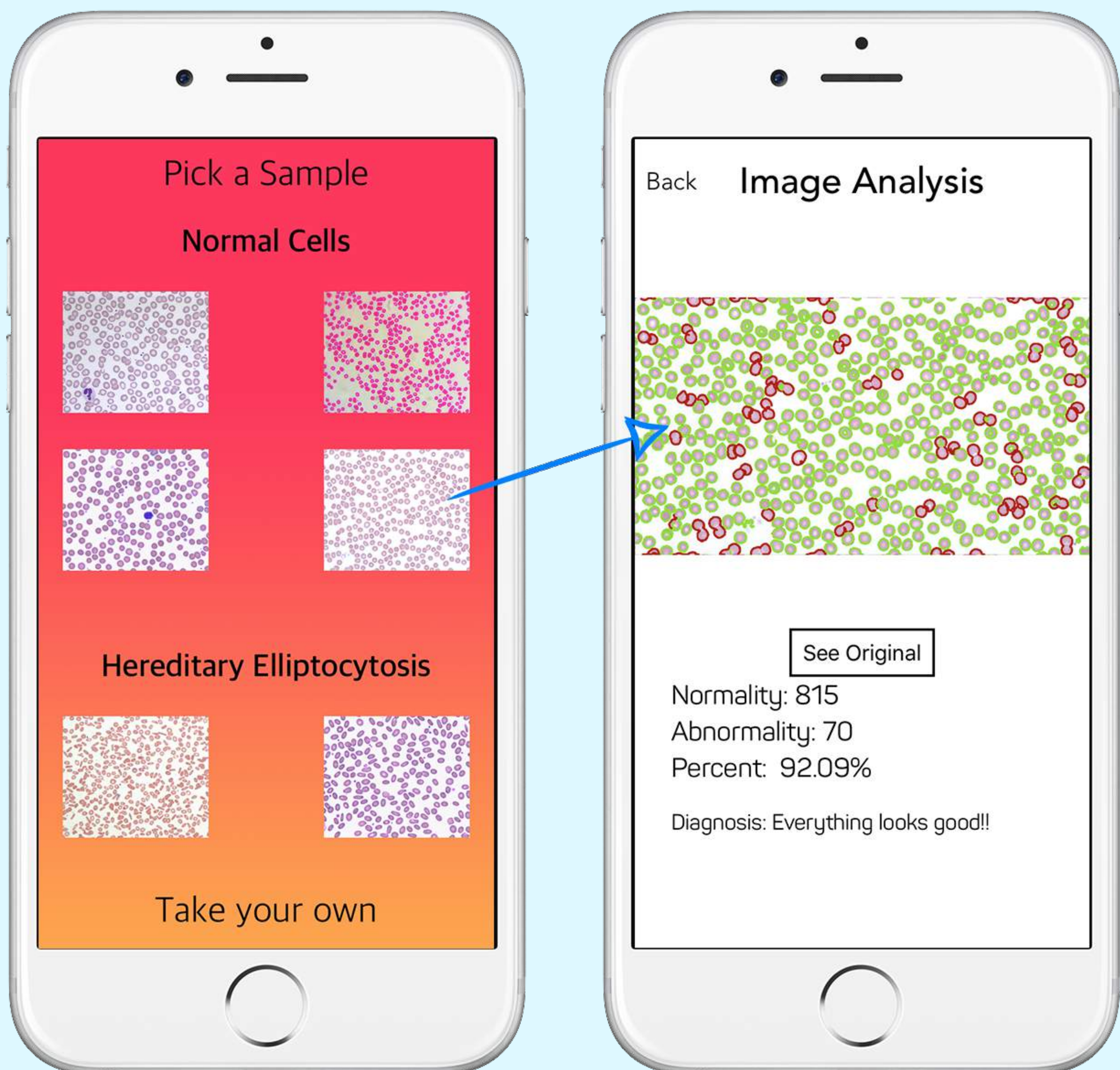
When a doctor has centrifuged blood in a test tube, a hematocrit test can be performed on the blood to help the doctor form a diagnosis. When blood separates from centrifugation, it separates into layers of blood plasma (top yellow), a buffy coat (very small whitish layer, visible in the leukemia images), and red blood cells (bottom dark layer). Using computer vision, PocketLab analyzes images of centrifuged test tubes and determines the percentage of each layer of the blood components. Based on the composition of the blood, doctors can diagnose leukemia, anemia, and several other deficiencies.

Live Analysis



The Hematocrit Analysis tool also does live image analysis. This is a picture of a sample we made for demos. It was not real blood (mustard and strawberry jelly in a straw), but it demonstrated that the image analysis algorithms we wrote would work on real test tubes in a lab. Using real blood was not allowed at the hackathon, and we got quite a few laughs from the organizers when we asked if we could ship lamb's blood to be used in the event.

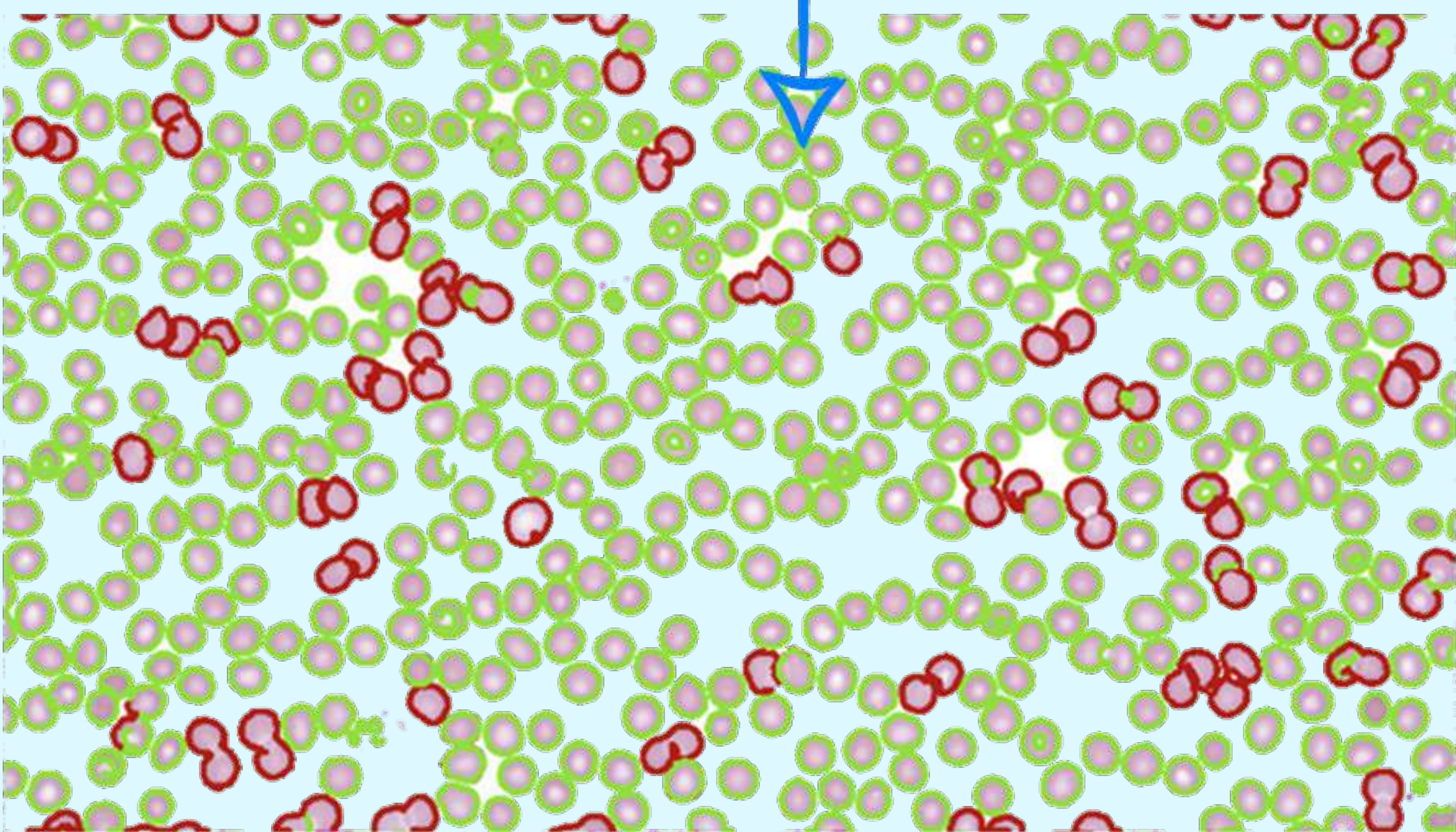
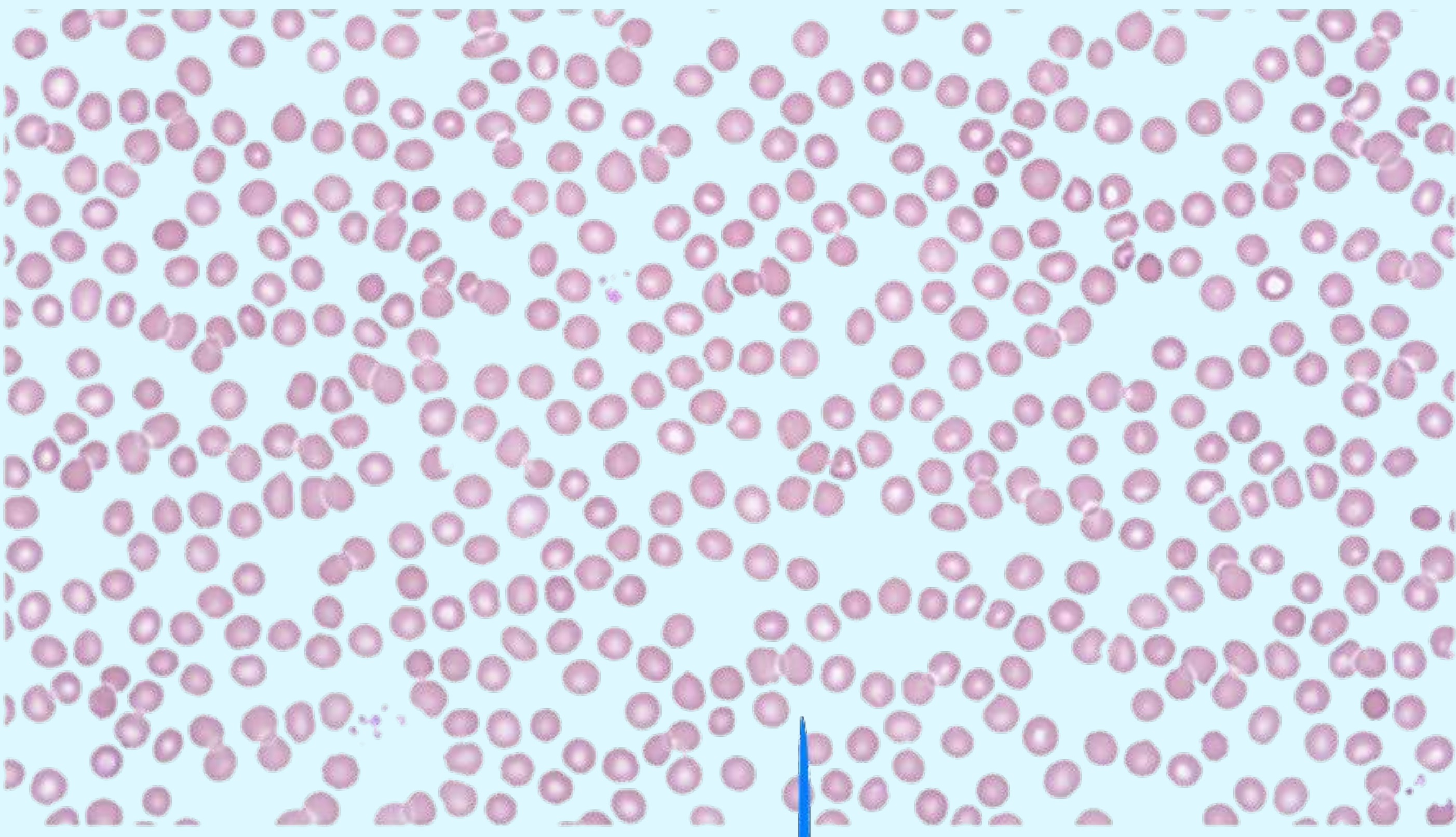
Microscopy



After a hematocrit test, a doctor can also do analysis on a blood smear. For the Microscopy tool, we took sample images from Google, as the iPhone 200x microscope attachment ordered from Amazon (\$12) did not have quite enough resolution. In the left screen, a user picks a sample to analyze. When a sample is selected, PocketLab does a variety of checks to determine if the cells are normally shaped. Using computer vision the app detects the shape of the cells, and then draws red highlights around abnormally detected cells and green highlights around those that are circular and normal. I found that the ratio of normal to abnormal cells gives a good indication of a possible diagnosis. As I had computer vision experience from a freelance job over the summer, I programmed almost the entirety of the cell analysis tool in PocketLab. It was my greatest contribution to the project.

Microscopy

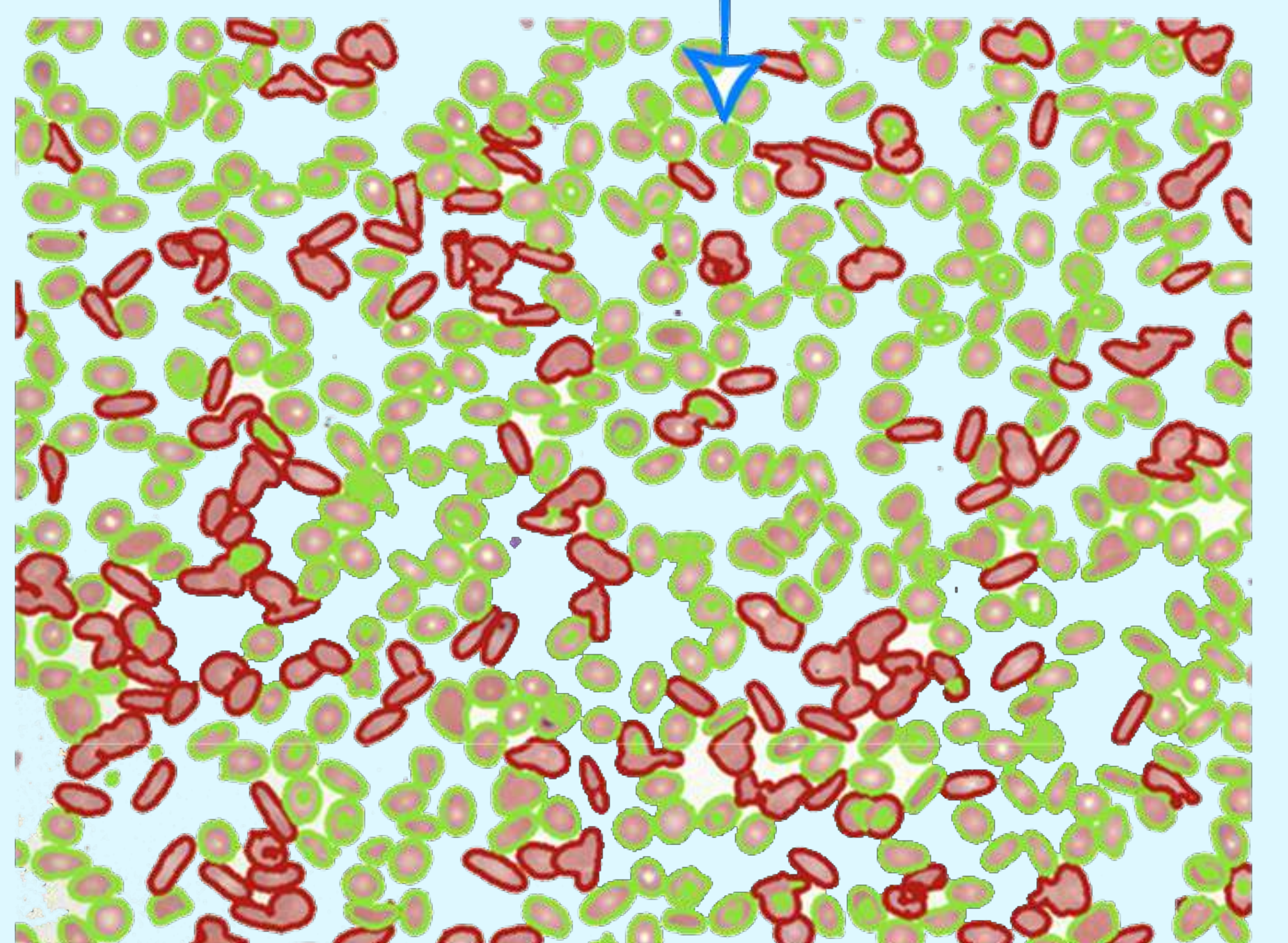
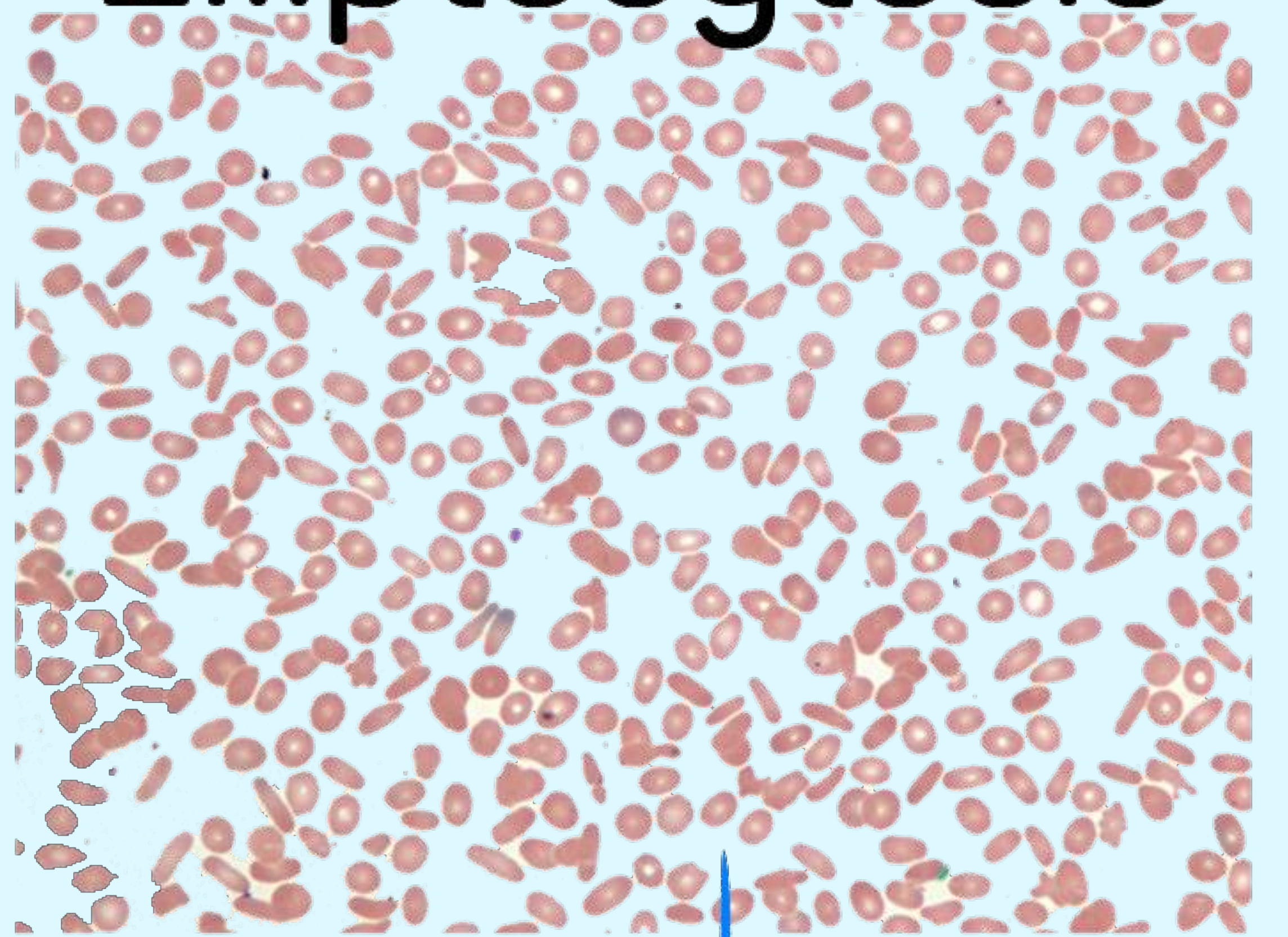
Normal Cells



Normality: 815
Abnormality: 70
Percent: 92.09%

Diagnosis: Everything looks good!!

Hereditary Elliptocytosis

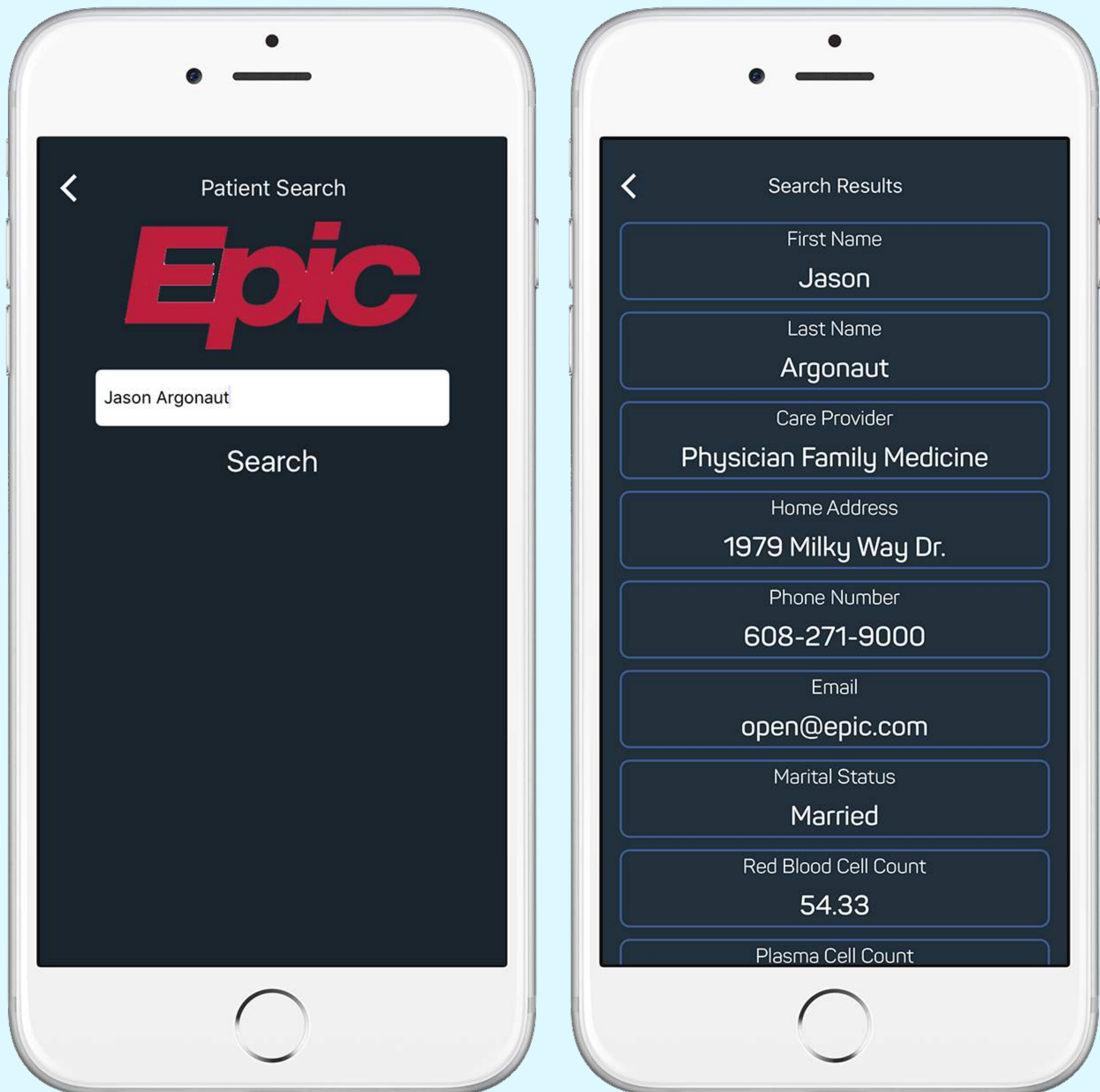


Normality: 679
Abnormality: 195
Percent: 77.69%

Diagnosis: Many cells are abnormal.
It could be Elliptocytosis

In this photo, we have a side by side comparison of a normal blood smear and a blood smear with hereditary elliptocytosis. The images on top are unaltered, and the bottom images are the produced images with the red and green analysis markings. On the right, there is a much higher ratio of abnormal cells to normal cells leading to a conclusion that a diagnosis could be elliptocytosis. My samples lined up well, but in the field I doubt that it would work so well. I believe that machine learning can improve the cell analysis and diagnosis tremendously by grouping cells more accurately based on different aspects of their shape, instead of using a single metric.

Epic Database



Along with the blood analysis, we provided access to the Epic Health Database. It would allow doctors to look at their patients' data before their appointments to get any relevant information. It also allows doctors to add patients and their data to the database for other doctors to use in the future.

Future

For the future, Pocket Lab will not be published as a polished app. It works as a proof of concept, showing that some blood analysis can be done with tools such as an iPhone and a \$12 dollar microscope attachment. Pocket Lab will be open sourced in the future.

Still interested?

Check out the full PennApps XII submission

<http://devpost.com/software/pocketlab-a-field-blood-diagnosis-tool>