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**Project 2: Approaches**

## Wink

In line with what the professor said, the accuracy of the base detector for winking was low. Considering this, I attempted several approaches, which will be described below, each with varying accuracy.   
  
The most successful method makes multiple attempts at locating eyes, taking into account the strength and weaknesses of each Haar classifier. When the program first receives the frame, it sharpens the features by a set amount, then constrains all further operations to any detected faces in the image. The first pass is attempting to identify a face, then a pair of eyes on the face. If successful, the program uses multiple passes from several Haar cascade classifiers to detect the eyes of the subject. If it fails to find a pair of eyes, it then makes a pass on the entire face with its most accurate classifiers, then its less accurate. It was observed during testing that the Haar classifiers trained for distinguishing between the left and right eyes is very inaccurate in this test case. They remained useful, however, for their ability to identify closed eyes as well as open ones. The most accurate classifiers were good at identifying open eyes, but not closed ones. The advantage of using fast but less accurate classifiers is that it allows this relatively accurate method to run in real-time on low-power hardware. Since this program was developed on a Raspberry Pi, this was essential to development.

The second best, though ultimately unsuccessful, was giving each classifier a weighted vote, as in boosting. In this method, each classifier had a set of weights that would determine the weighted vote in the event that a classifier found 0, 1, or more than 2 eyes in one pass. While preliminary testing yielded interesting results, it would take more time to tune these parameters than just using the method described above.

An unsuccessful method was to identify the eye pair, then divide the region into sectors: one for each eye. Then, by applying Haar cascades over both sectors and seeing if eyes existed in both, it would be possible to decide whether the subject is winking. Unfortunately, this method had a problem where neither eye would be detected in either sector, causing reduced accuracy.

## Silence

Interestingly, detecting the gesture for silence is made considerably more accurate by detecting the face, then constraining further operations to a bounded area just below the half-way point of the face. The basic idea behind this method comprises of whether the subject in the image has a mouth. By applying preprocessing to the grayscale image and restricting myself to the bottom 6/5th ‘s of the subject’s face and tuning the parameters of the mouth classifier, we were able to get considerably better accuracy than the base line classifier.

An interesting note is that detecting the eyes and nose of the subject are unnecessary, and can in fact harm the overall accuracy of the classifier. Mouths can be detected as noses, and while eyes provide useful landmarks on the face for identifying the middle point of the face, proved less than successful during testing.