

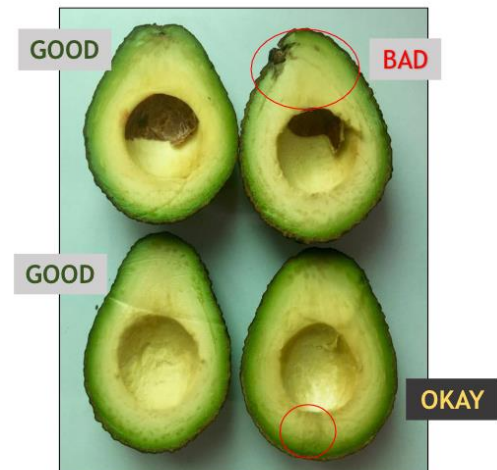
## UCSB ECE Capstone Project Sponsored by Apeel Sciences

1. Automated Analysis of the Quality of Avocados
2. Apeel Sciences is a research and technology company founded in Santa Barbara, California by researchers from the Materials Science Department at UCSB. The company develops and delivers products for farmers, packers, distributors, and growers to protect their crops and increase the shelf life of harvested fresh produce. Operating at the interface of the agricultural, materials science, chemistry, biotechnology, and engineering industries, Apeel's mission is to eliminate food waste and reduce reliance on pesticides.

Apeel's products are a natural way to protect food surfaces from environmental stressors to keep your produce fresher longer. Through the use of natural lipids and glycerolipids, the products are able to protect produce from common abiotic stressors including water loss (transpiration) and oxidation.

3. One of the primary crop types protected by Apeel Sciences is the avocado. In order for improvement to be demonstrated over conventional handling, metrics need to be established to measure the quality of the fruit. Typically this includes but is not limited to things like the following:
  - Shriveling or desiccation
  - Presence of fungus or mold
  - Bruising
  - Discoloration

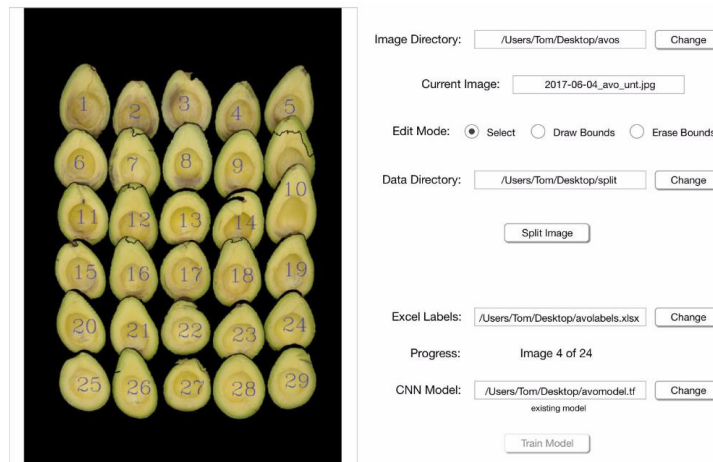
Examples of "good" avocados with diffuse browning



Examples of the Subjective Nature of Quality Analysis

Many of these characteristics cannot be measured in an objective or quantitative method and require individual evaluation by trained evaluation staff. Currently the process

involves the slicing of individual avocados and arranging them in a grid within a photo box. The pictures are then analyzed for type and extent of issues.



Current GUI for Quality Analysis

The result of the quality analysis is used for both internal development as a method for comparing the efficacy of different product formulations and as a sales tool to show the benefits of Apeel's products over alternative treatments of storage methods.

The goal of this project is to develop and implement an algorithm capable of receiving an input image of multiple pieces of produce and accurately determining the quality of the individual units in the image.

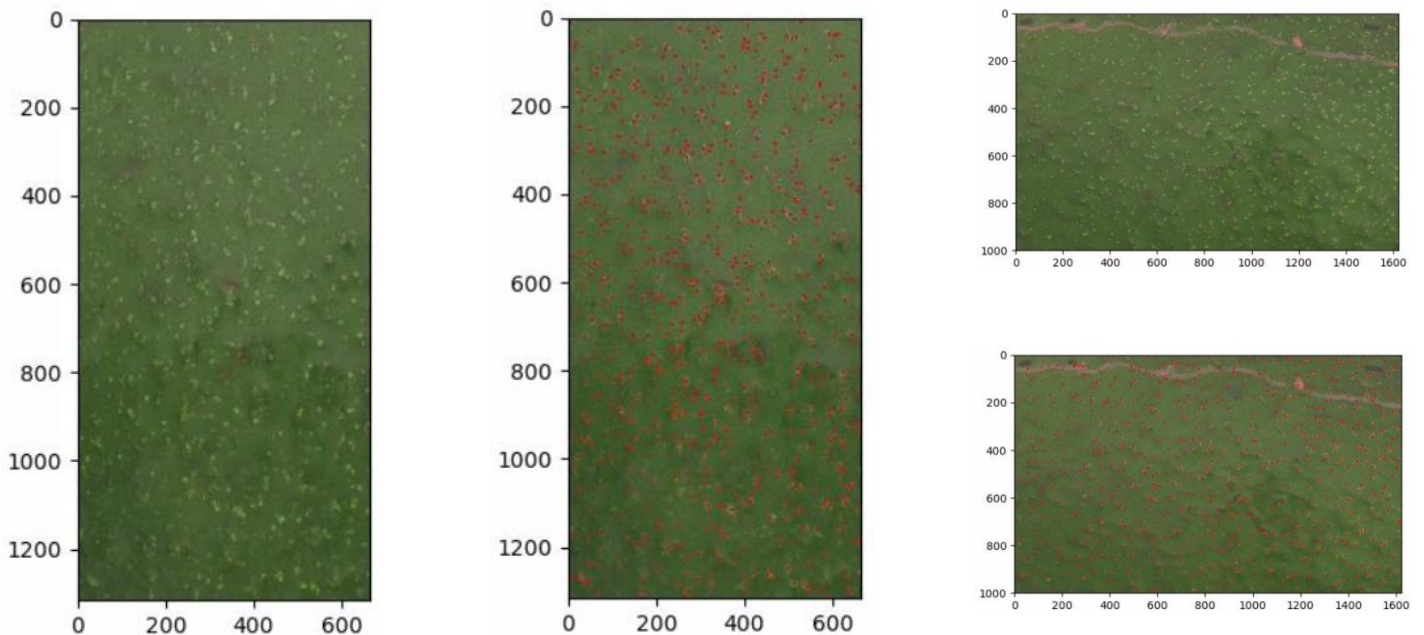


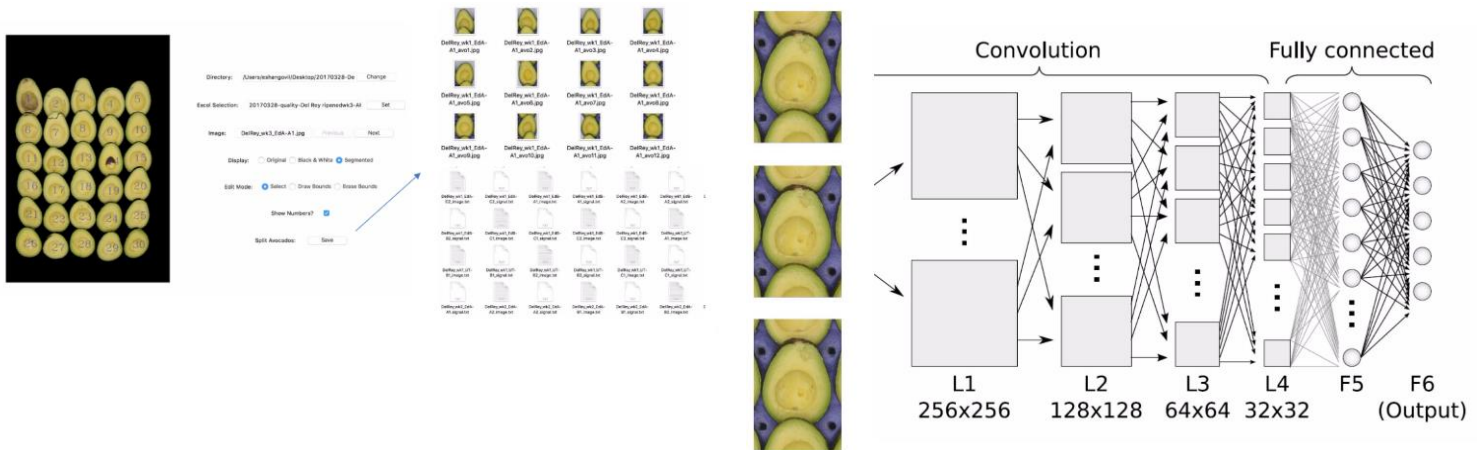
Image Processing to Detect Avocado Blemishes

### Project Goals & Considerations

- Improve model accuracy on test sets
- Develop or propose alternate parameters for analysis or methods of classification
  - Better quantification of edible/saleable
  - Method for identification of specific quality problems
    - Chilling injury, stem end rot, etc.
- Compensate for labeling subjectivity and data cleanliness. This could be solved through the use of:
  - Crowdsourcing classification of data
  - Use of mathematical modeling to account for human bias
  - Improved image preprocessing
- Identification of multiple algorithms as alternatives
- Throughput or speed for both training and analysis

### Stretch Goals & Considerations

- Speed and accuracy strongly exceed baseline targets
- Develop algorithm for predicting potential future quality problems using an alternate data set of the images of the same avocados over time.
- Propose methods for extending algorithm to other produce types



Example of Pre-Processing of Avocado Image

Example of Convolutional Neural Net for Image Sorting

#### 4. Student Requirements:

Students will be required to sign a Confidentiality Agreement and Invention Agreement. This project will require travel to the company facility in Goleta. Students will be expected to meet or communicate regularly with the team at Apeel.

5. Student Qualifications:  
Students with an interest in image processing, machine learning, agriculture, data analytics will enjoy this project. Familiarity with machine learning, color & light, and databases is recommended for this project.
  
6. Apeel will provide the following assets:
  - Data set of fruit images and current quality classification
  - Access to Apeel's facility and equipment
  - Avocados at various quality levels
  
7. [www.apeelsciences.com](http://www.apeelsciences.com)