CS 153 Project Proposal
Mapping the density of flowers on California buckwheat plants

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1. Motivation

The motivation for this project is. . .

Proposed by Professor Matina Donaldson-Matasci at Harvey Mudd College.

Citation example [3].

Another citation [1].

Third citation [2].

Fourth citation [4].

2. Methods

The provided files include JPEG images taken by a drone, and corresponding JSON files that include annotations for the plants in the image. Each annotation includes a class ("EFRA" for *Eriogonum fasciculatum*) and a polygon representing the boundary of the plant. For an example, see Figure 1.

I have already been able to visualize the annotations by adapting code written by Tom Fu, one of Prof. Donaldson's research students.[1] The next step will be to convert the polygons into masks in order to isolate the portion of the image to analyze.

Given that the flowers

CNN, since flower features would probably work well in terms of dividing image into smaller parts

Idea: divide each plant into smaller regions, then pass those through Mask R-CNN

Don't have to annotate all images, but sample randomly from the 8 regions/experiments

HSV thresholding, morphology, more "classical" approach

Mask R-CNN ??

Try thresholding as baseline, and Mask R-CNN, see if it can outperform thresholding.

[1]https://github.com/tommyfuu/flower_map_new/blob/master/scripts/visualizePolygons.py

Figure 1. An example of an included polygon annotation outlining a California buckwheat plant.

3. Measuring success

Qualitative measure of the resulting masks Precision, recall as compared to annotated data

Baseline model could be HSV thresholding

4. Challenges

Regions are not square or even rectangular. So for CNN, what to do with the extra space? Could just use bounding box, or a bounding square, but then not using the extra information that flowers must occur within the boundary. Could just use a square/rectangular crop and then discard annotations outside the boundary.

Could take bounding rectangle, divide into regions of some regular size, run through CNN to get masks of flowers, then discard predictions outside the bounding polygon Idea: detecting flowers on plant are roughly translationally symmetric. We already know we're on a plant, so we can divide it up

Challenge from that: if flowers are at the edge Solution: could make squares overlap, then only take mask from inner square region, or some sort of union of overlapping masks

Overlapping masks, union them together in the end

Annotating all of the data. Within the data provided, there are 888 images including California buckwheat plants, and across all images there are 11,981 individual plants. It will be a challenge to annotate the enough of these images to train and test a model well. There is no need to annotate all of the raw data, but it would be good to use some images from each batch.

The total size of the data is 9 GB, so it may be a challenge to store it all on Knuth or XSEDE. A caveat here is that for the purposes of training this model, we will only need to use the portions of the images within the annotation polygons.

References

[1] Matina C. Donaldson-Matasci and Anna Dornhaus. How habitat affects the benefits of communication in collectively foraging honey bees. *Behavioral Ecology and Sociobiology*, 66(4):583–592, 2012. 1

[2] Philip Donkersley, Glenn Rhodes, Roger W. Pickup, Kevin C. Jones, and Kenneth Wilson. Honeybee nutrition is linked to landscape composition. *Ecology and Evolution*, 4(21):4195–4206, 2014. 1

[3] Simon G. Potts, Jacobus C. Biesmeijer, Claire Kremen, Peter Neumann, Oliver Schweiger, and William E. Kunin. Global pollinator declines: trends, impacts and drivers. *Trends in Ecology & Evolution*, 25(6):345–353, 2010. 1

[4] Michael Rzanny, Patrick Mäder, Alice Deggelmann, Minqian Chen, and Jana Wäldchen. Flowers, leaves or both? How to obtain suitable images for automated plant identification. *Plant Methods*, 15(1), 2019. 1