GRAPE DETECTION PROJECT

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Goal: Grape Segmentation

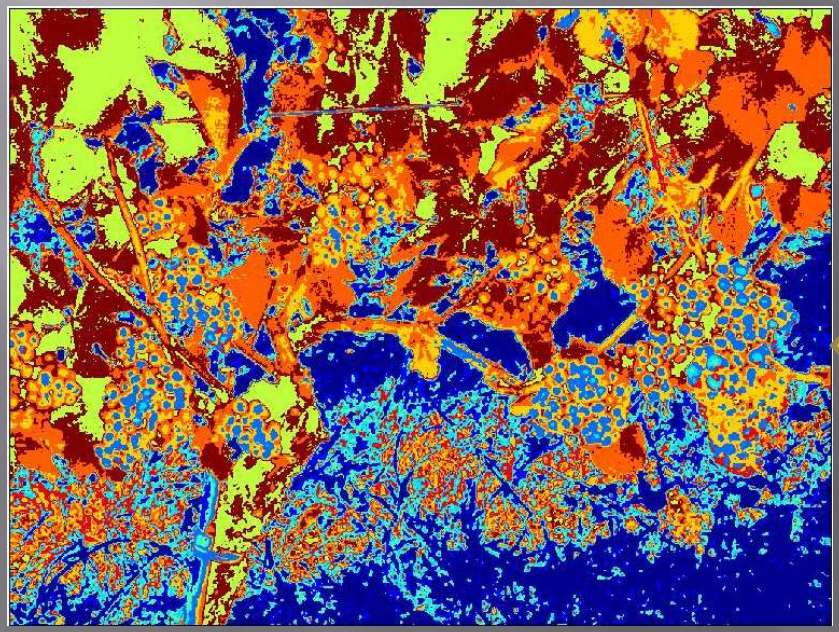
- Input: Vines' images with grapes
- Output: boolean matrix of image's size with:
  - 1 if the matching pixel on the image is on a grape
  - 0 if it is not

Phases

1. Reducing the image's color numbers and deriving it.
2. Eliminating non-grape points by:
   - Crowded mask
   - Angle mask
   - Color masks
3. Image clean-up by multicross mask
4. Eliminating remaining non-grape points by Bagel mask
5. Another image multicross mask clean-up

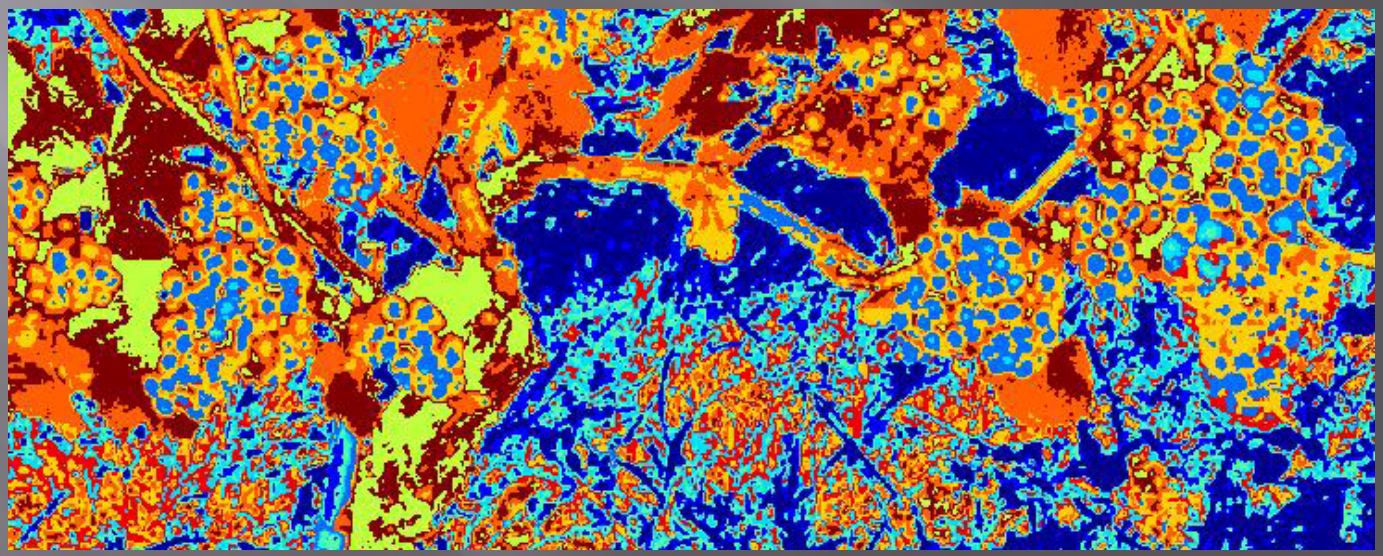
Color reduction

- We note that by mapping similar colors to a same color we can find outlines easily
- We want to find that mapping dynamically.
- Use clustering algorithm on the colors.



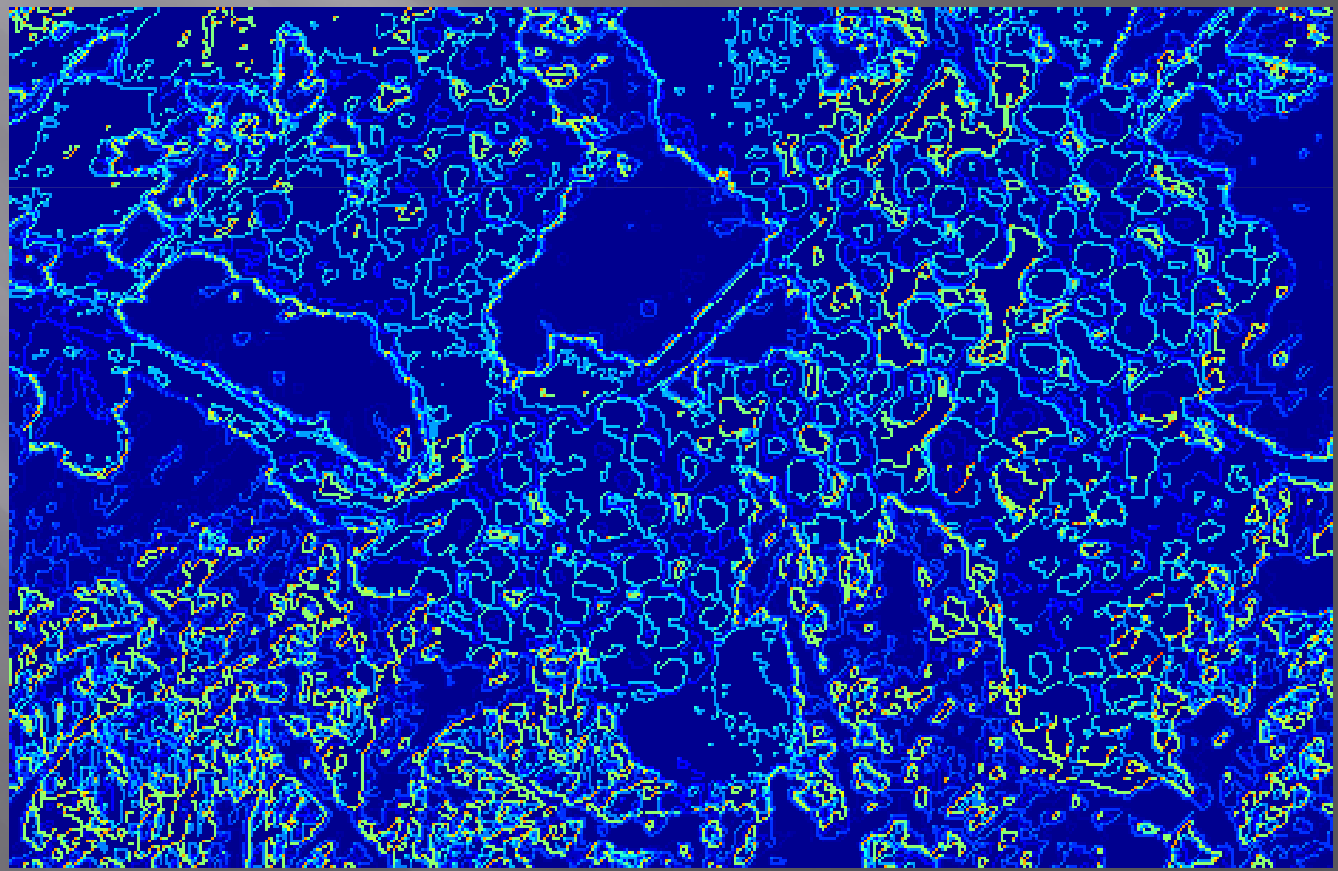
Color reduction

- The studied clustering algorithm input:
  - All colors as vectors of <red, green, blue>
  - Expected number of clusters - k=10
- On the output grapes resemble solid color concentric circles with similar size.



Deriving clustered image

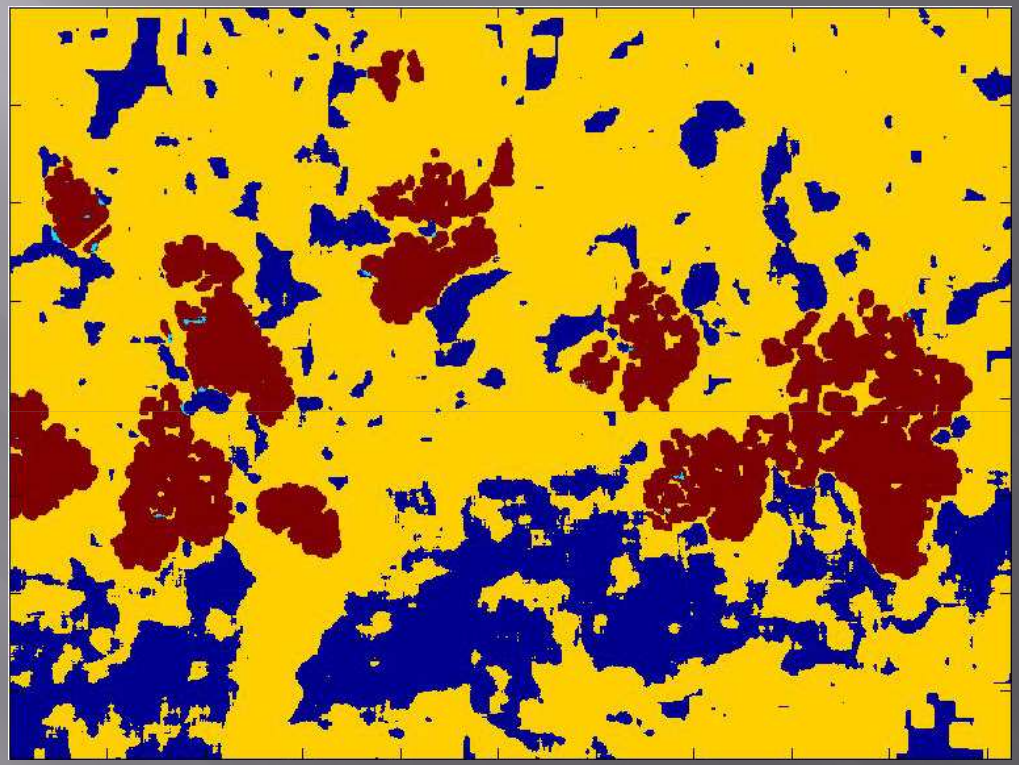
- We'll derive the clustering output for easier detection



Crowded mask

- Density of edges in grapes is bounded: less than background (grass) but more than other regions (leafs).
- Find the edge density and quantity of the most frequent gradients around the pixel
- Those densities that are not on the measured bounds will be eliminated as non-grapes

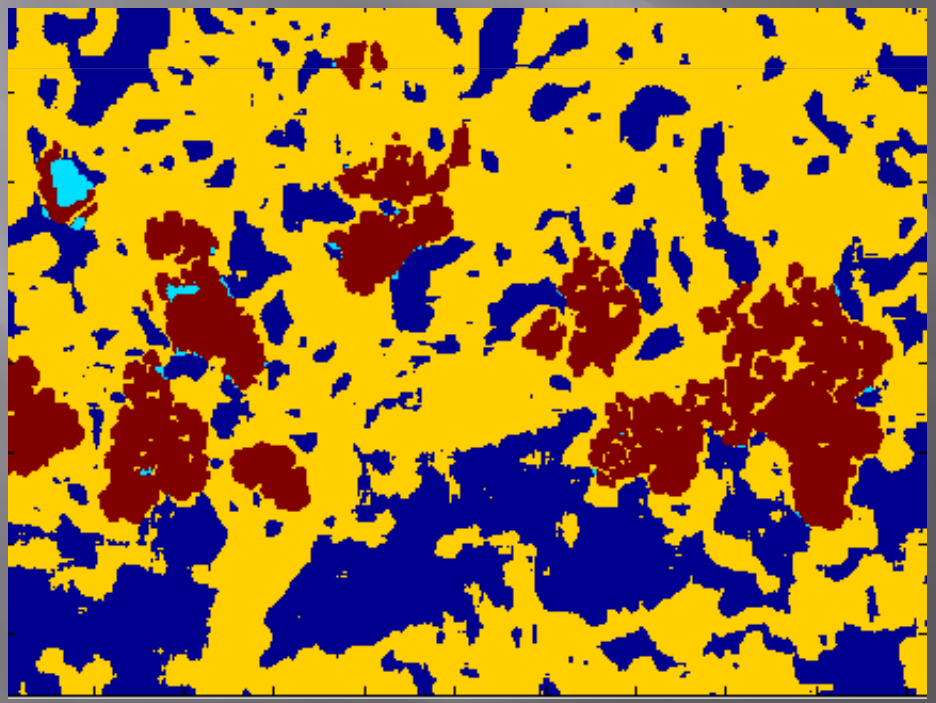
Crowded mask output



Red – regions not eliminated that contain true grapes
Blue – eliminated regions without true grapes
Yellow - regions not eliminated without true grapes (false positive)
Light blue - eliminated regions that contain true grapes (false negative)

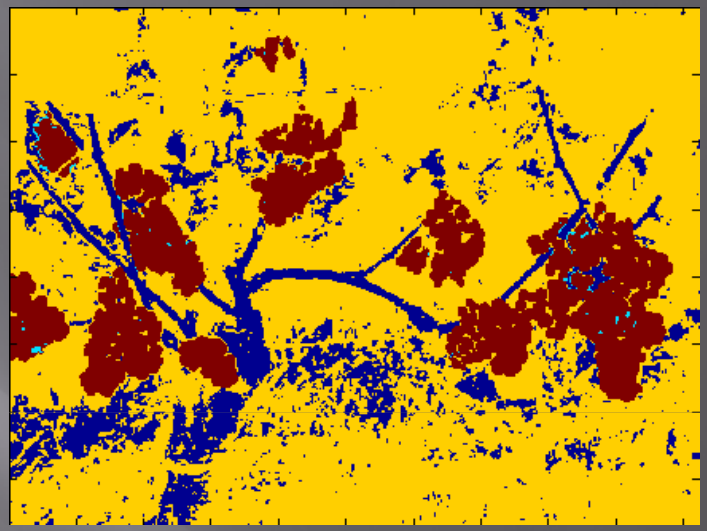
Angle mask

- Grape shape is round so gradient angle around it will be close to uniform.
- Bucketing of gradient angles and histogram

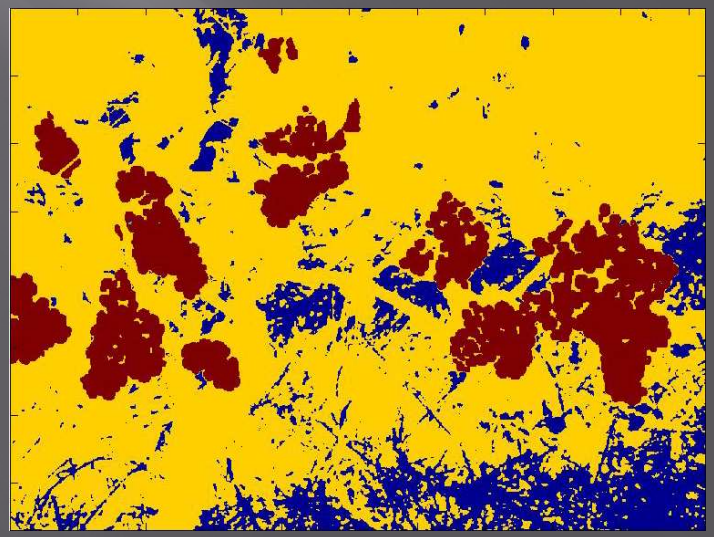


Color masks

- Grapes are green – have a certain range of green color part

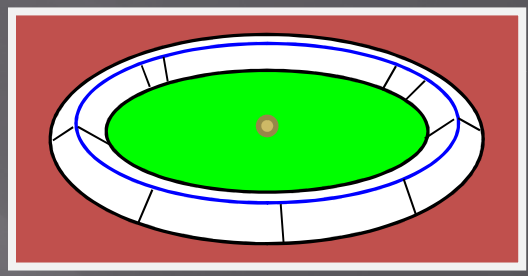


- Mostly grapes are shadowed by leafs, so their brightness is bounded



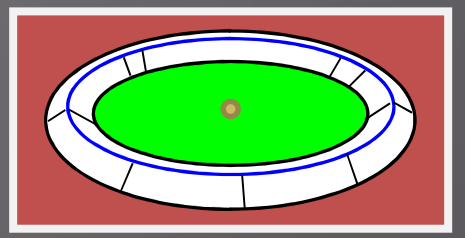
Bagel mask

- Grape's outline gradient is round its size is uniformic. Also its inside is relatively empty.
- Build 2 masks shown on the drawing:
  - The inside – noted as green
  - The bagel – noted as white
  - The bagel's average diameter is equal to the average grape diameter, empirically measured.

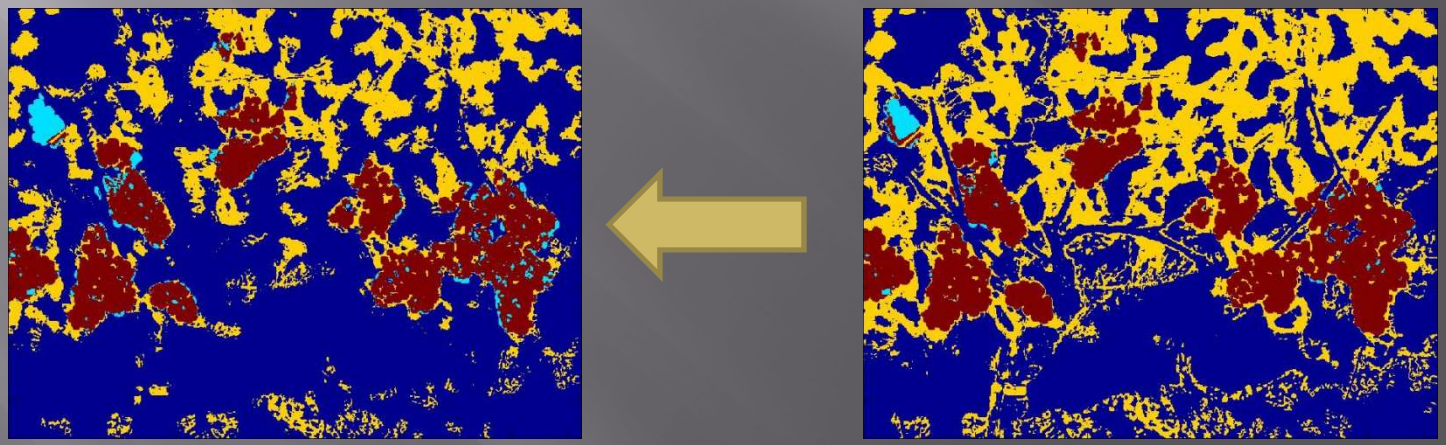


- Activate the masks around each point on the edge map generated by previous phases.

Bagel mask

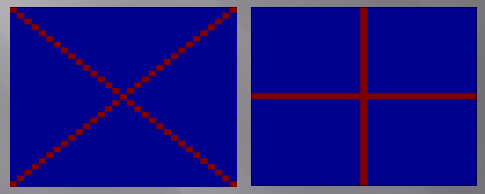


- If the inside (green) around the point has too many edge – eliminate it
- Find the most frequent edges on the bagel (white) around the points – if their number is not between bounds, eliminate the point.



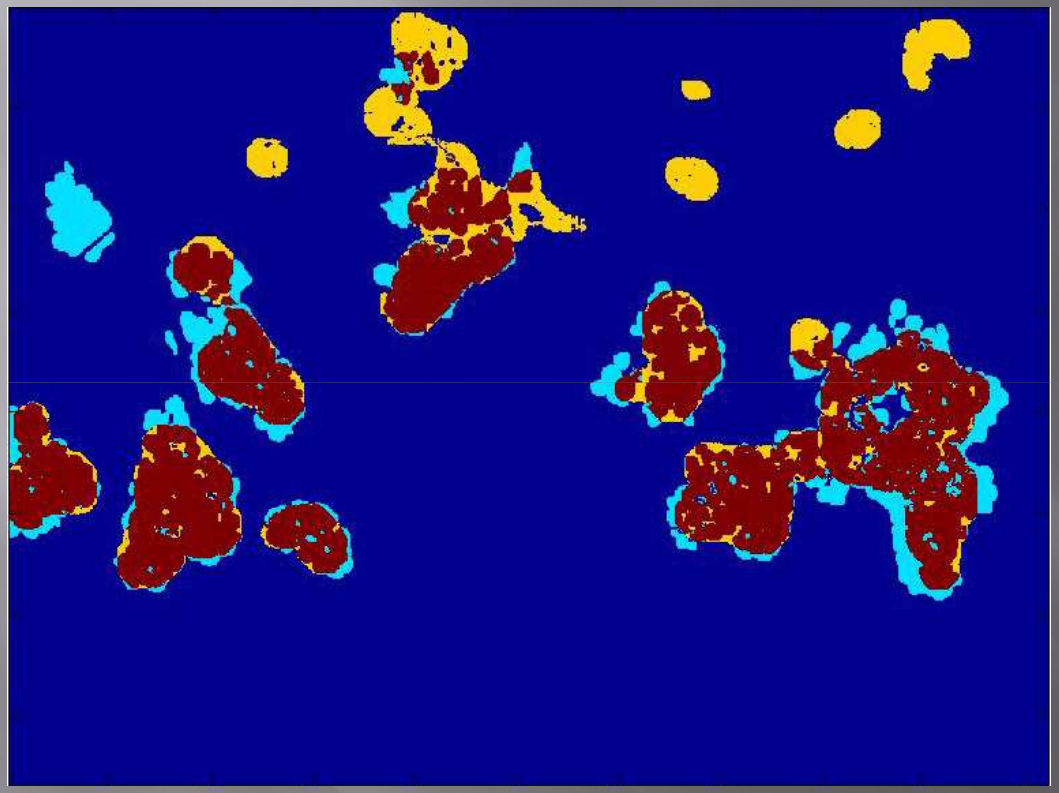
Multicross mask

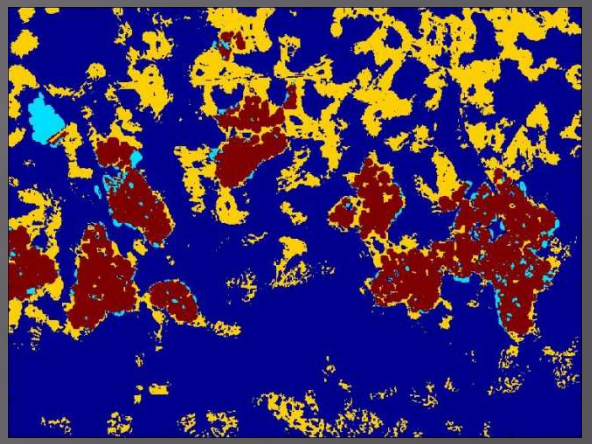
- Some phases generate segments too small to be grapes.
- Grapes are usually convex
- Convolve the segmentation map with each kernels alternately a number of times:



- Eliminate points with a low result

Final result





multicross mask input

Red – regions not eliminated that contain true grapes
Blue – eliminated regions without true grapes
Yellow - regions not eliminated without true grapes (false positive)
Light blue - eliminated regions that contain true grapes (false negative)