TERM PROJECT

SIGNALS & SYSTEMS

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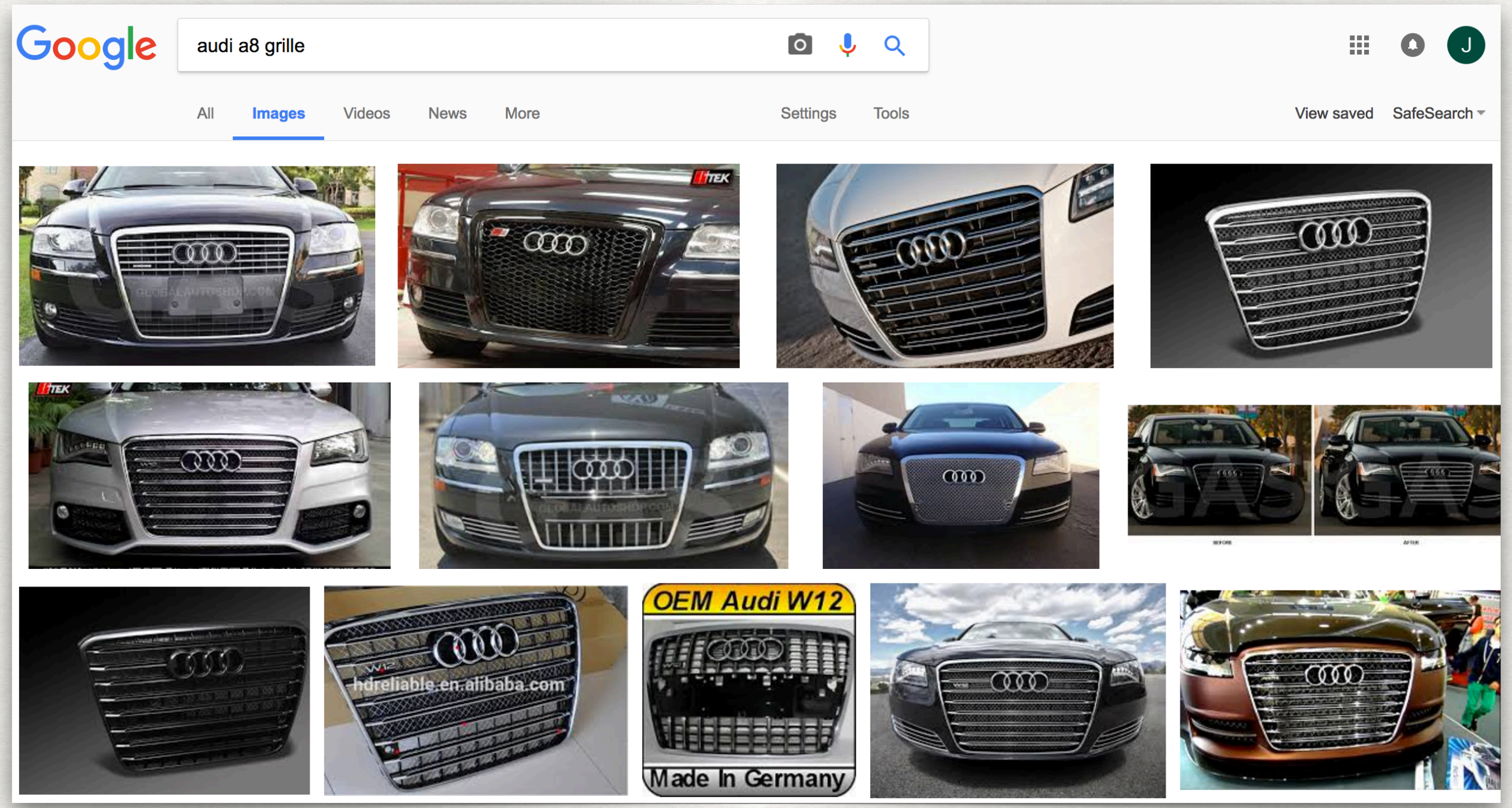
FLOW CHART

1. Download & Cut Image
2. HPF
3. 2D DTFS
4. Choose the Values among the Coefficients
5. Normalize Vector
6. K-mean Clustering
7. Adjust Centroid
8. Execute Test

DOWNLOAD & CUT



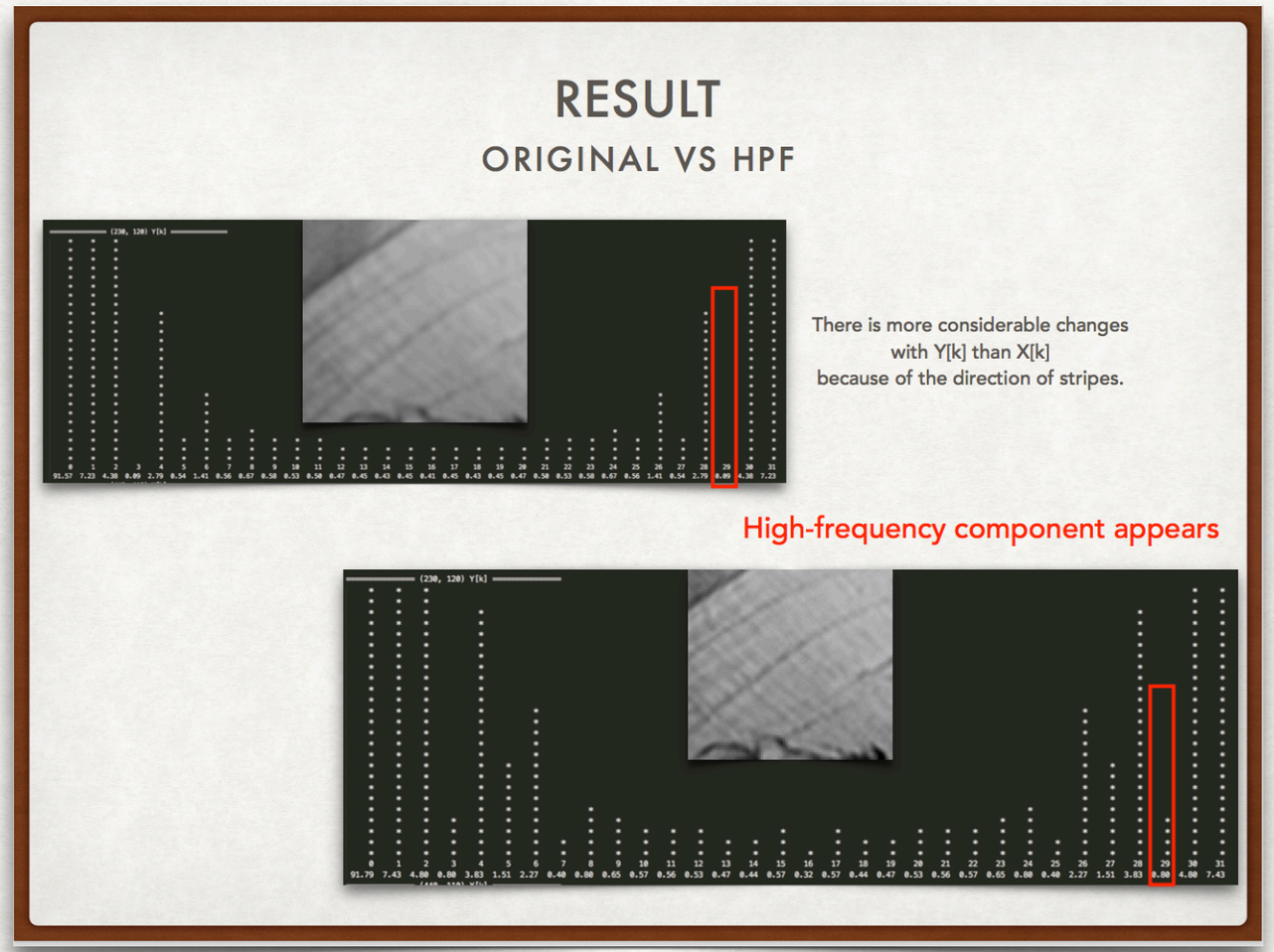
DOWNLOAD & CUT

1. K5
2. Starex
3. Genesis G80
4. Avante AD
5. Audi A8

x 50 images = 250 images

HPF

- make the boundary of an image clear



2D DTFS

$$c_{k_1,k_2} = \frac{1}{N_1 N_2} \sum_{n_1=0}^{N_1-1} \sum_{n_2=0}^{N_2-1} \tilde{x}[n_1, n_2] \exp\left(-jk_1 \frac{2\pi}{N_1} n_1 - jk_2 \frac{2\pi}{N_2} n_2 \right)$$

$$k_1 = 0..N_1 - 1, \quad k_2 = 0..N_2 - 1$$

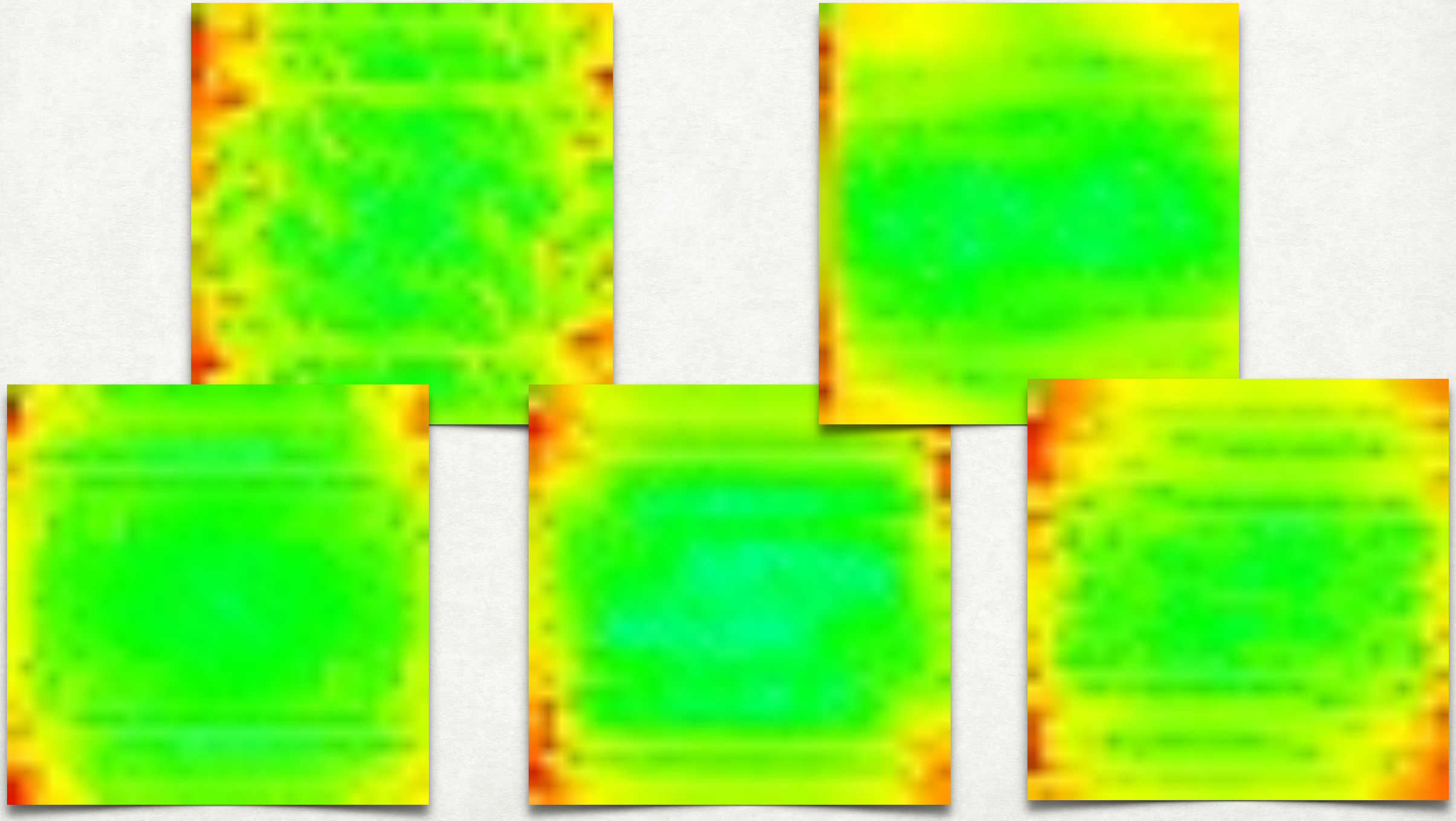
Due to the symmetry, we can do it half as much as the original.

CHOOSE THE VALUES

LINEAR SCALE

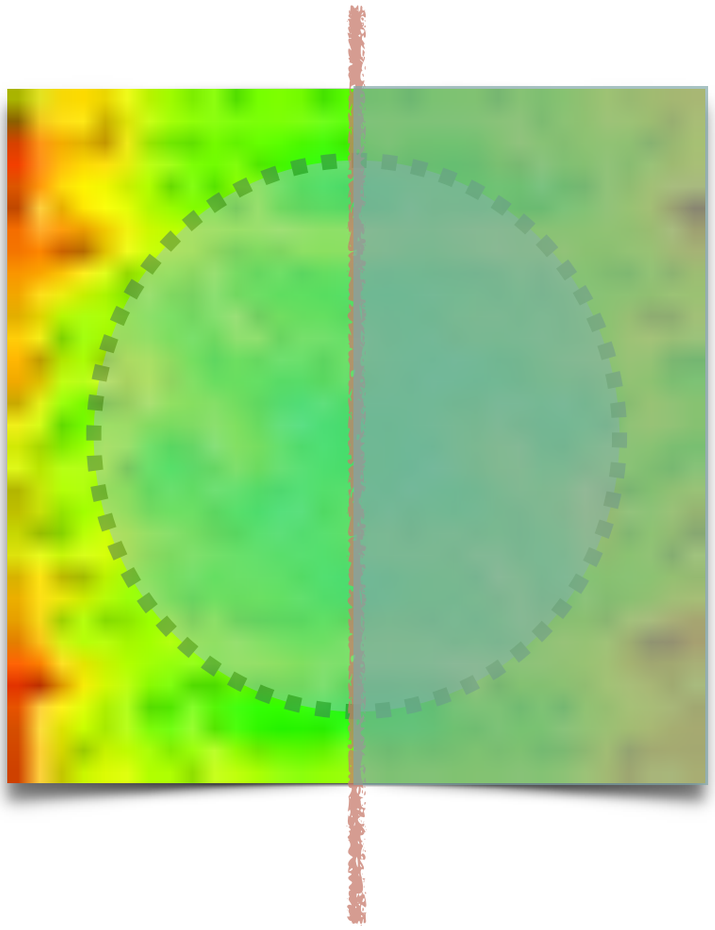
CHOOSE THE VALUES

LOGARITHMIC SCALE

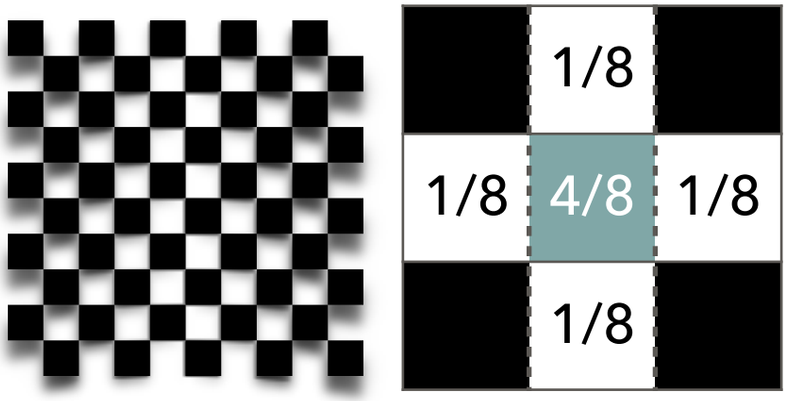


CHOOSE THE VALUES

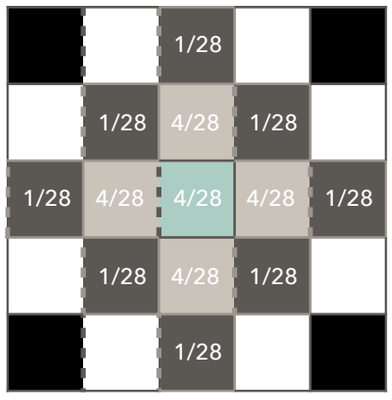
LOGARITHMIC SCALE



- CUT OFF the right half
- Ignore DC component
- Choose 1/2 in the rectangular outside the circle



- Choose 1/8 inside the circle



Finally, we got about 200 points

NORMALIZE VECTOR

- Make all the vectors have same LENGTH
- To reduce the relative (truncate) error, make the floating-point variable nearby 1.0

$$\mathrm{d}(\mathbf{p},\mathbf{q}) = \mathrm{d}(\mathbf{q},\mathbf{p}) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \cdots + (q_n - p_n)^2}$$

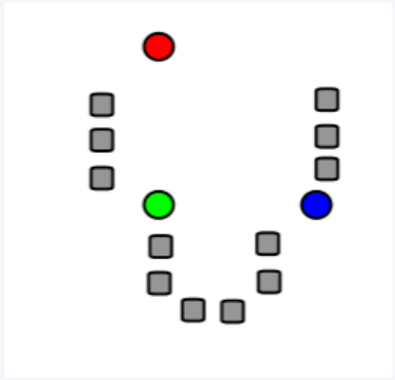
$$= \sqrt{\sum_{i=1}^{n} (q_i - p_i)^2}.$$

extremely small

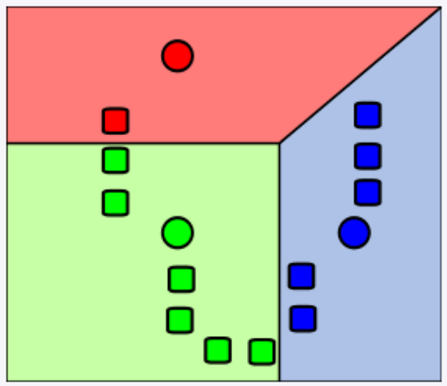
- Length = 1.0 * (dimension)

K-MEAN CLUSTERING

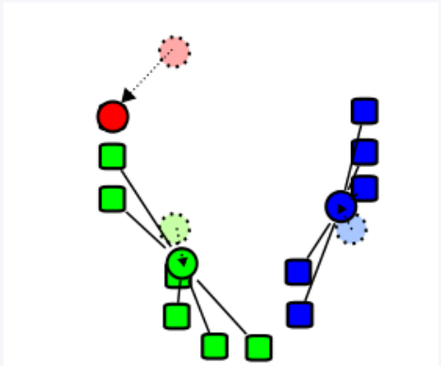
Demonstration of the standard algorithm



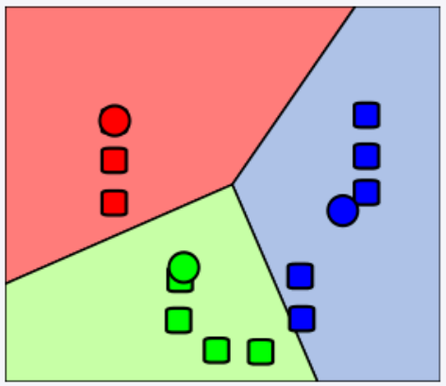
1. *k* initial "means" (in this case *k*=3) are randomly generated within the data domain (shown in color).



2. *k* clusters are created by associating every observation with the nearest mean. The partitions here represent the Voronoi diagram generated by the means.

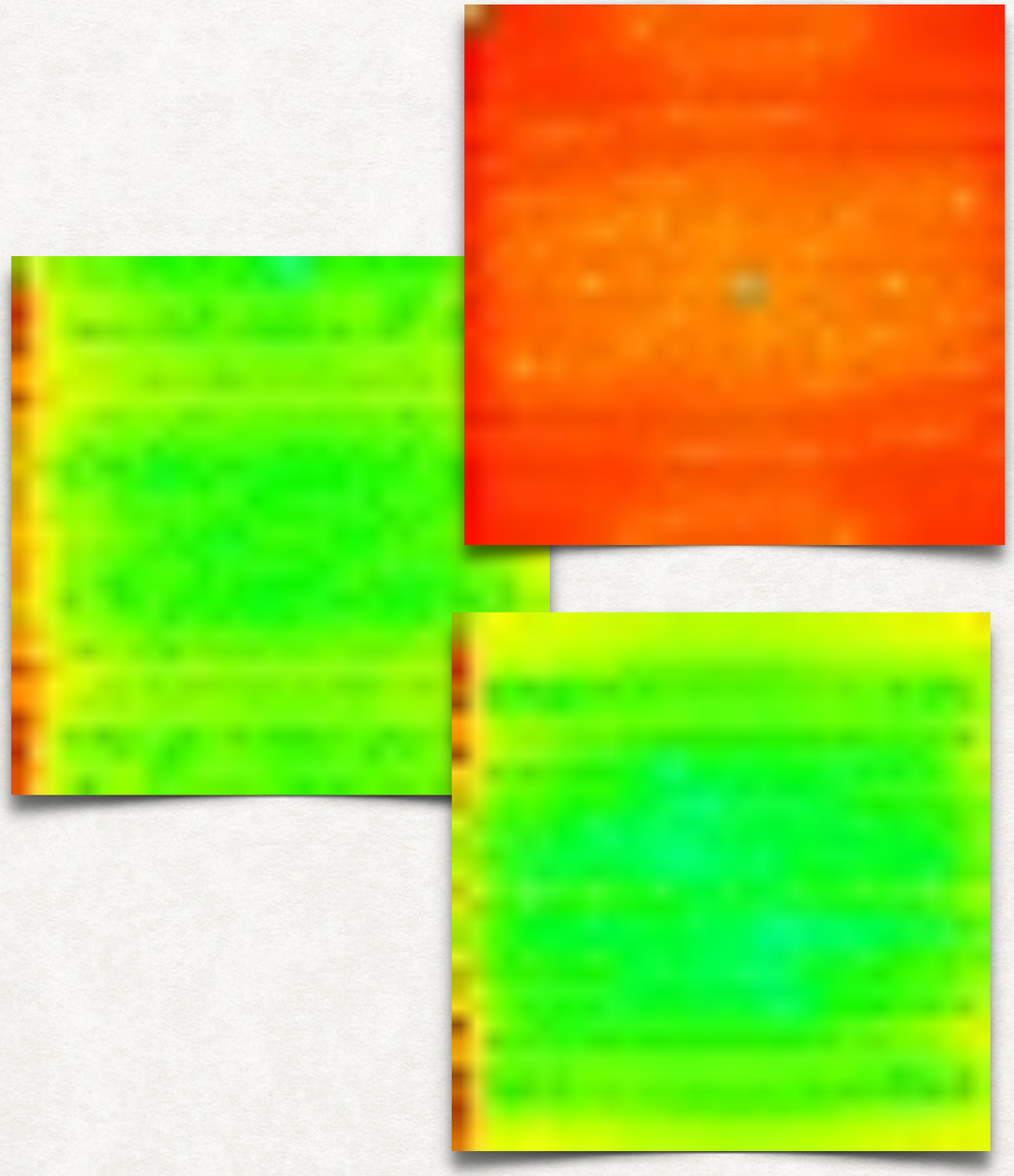


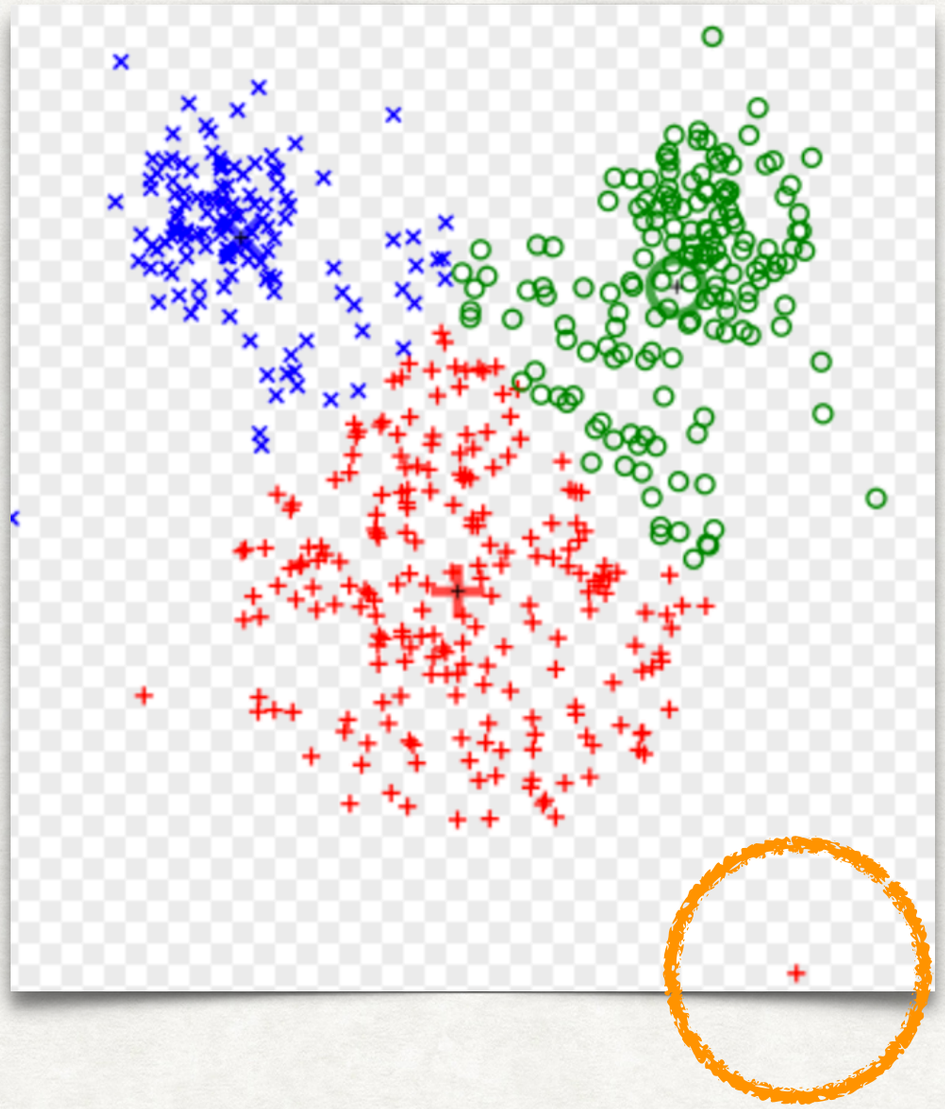
3. The centroid of each of the *k* clusters becomes the new mean.



4. Steps 2 and 3 are repeated until convergence has been reached.

ADJUST CENTROID





EXECUTE TEST

WITHOUT HPF, NORMALIZATION

OpenCV Version : 3.0.0
[CPU Time]= 8.970104 sec. Analysing 224 Images Completed.
[CPU Time]= 8.970214 sec. Clustering Completed.
[CPU Time]= 9.689396 sec. Classifying 26 Images Completed.
Type = 01, Success Rate = 40.00% (2 / 5)
Type = 02, Success Rate = 66.67% (4 / 6)
Type = 03, Success Rate = 25.00% (1 / 4)
Type = 04, Success Rate = 80.00% (4 / 5)
Type = 05, Success Rate = 0.00% (0 / 6)

Total Sucess Rate = 42.31% (11 / 26)

EXECUTE TEST

WITH HPF

OpenCV Version : 3.0.0
[CPU Time]= 8.334871 sec. Analysing 224 Images Completed.
[CPU Time]= 8.334976 sec. Clustering Completed.
[CPU Time]= 9.071938 sec. Classifying 26 Images Completed.
Type = 01, Success Rate = 20.00% (1 / 5)
Type = 02, Success Rate = 83.33% (5 / 6)
Type = 03, Success Rate = 75.00% (3 / 4)
Type = 04, Success Rate = 0.00% (0 / 5)
Type = 05, Success Rate = 66.67% (4 / 6)

Total Sucess Rate = 50.00% (13 / 26)

improved 7.69 %p

EXECUTE TEST

WITH HPF, NORMALIZATION

OpenCV Version : 3.0.0
[CPU Time]= 8.739225 sec. Analysing 224 Images Completed.
[CPU Time]= 8.739335 sec. Clustering Completed.
[CPU Time]= 9.482151 sec. Classifying 26 Images Completed.
Type = 01, Success Rate = 40.00% (2 / 5)
Type = 02, Success Rate = 83.33% (5 / 6)
Type = 03, Success Rate = 75.00% (3 / 4)
Type = 04, Success Rate = 80.00% (4 / 5)
Type = 05, Success Rate = 50.00% (3 / 6)

Total Sucess Rate = 65.38% (17 / 26)

improved 23.07 %p

EXECUTE TEST

WITH HPF, NORMALIZATION, ADJUSTING CENTROID

OpenCV Version : 3.0.0
[CPU Time]= 8.399481 sec. Analysing 224 Images Completed.
[CPU Time]= 8.399612 sec. Clustering Completed.
[CPU Time]= 9.175937 sec. Classifying 26 Images Completed.
Type = 01, Success Rate = 80.00% (4 / 5)
Type = 02, Success Rate = 83.33% (5 / 6)
Type = 03, Success Rate = 75.00% (3 / 4)
Type = 04, Success Rate = 100.00% (5 / 5)
Type = 05, Success Rate = 83.33% (5 / 6)

Total Sucess Rate = 84.62% (22 / 26)

improved 42.31 %p !

EXECUTE TEST

WITH LESS SAMPLES

OpenCV Version : 3.0.0
[CPU Time]= 5.701056 sec. Analysing 199 Images Completed.
[CPU Time]= 5.701179 sec. Clustering Completed.
[CPU Time]= 7.128032 sec. Classifying 51 Images Completed.
Type = 01, Success Rate = 20.00% (2 / 10)
Type = 02, Success Rate = 100.00% (10 / 10)
Type = 03, Success Rate = 71.43% (5 / 7)
Type = 04, Success Rate = 80.00% (8 / 10)
Type = 05, Success Rate = 0.00% (0 / 14)

Total Sucess Rate = 49.02% (25 / 51)

DISCUSS

- To improve the accuracy,

  1. choose more values from the coefficients
  2. use more precise floating-point system
  3. collect much more samples

- To improve the speed,

  1. use FFT algorithm (NlgN)
  2. use pre-computed trigonometric value

You could get the full source code at https://github.com/iriszero


Q
&
A