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1. Which of the following features is most commonly used to recognize faces? **1 / 1 point**

- ○ Corners
- ○ Edges
- ● Haar features
- ○ Blobs

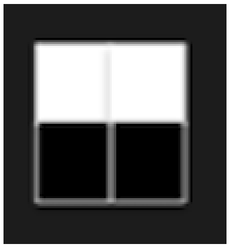
Correct
Corners, edges, and blobs cannot represent facial features that are distinct enough for face detection unlike Haar features.

2. Which of the following statements about Haar features is NOT true? **1 / 1 point**

- ○ They may approximate finding the derivatives of an image
- ○ They can be sensitive to the orientation of patterns
- ● One Haar filter can be used for multiple sizes of faces
- ○ They can be implemented as a convolution

Correct
A single Haar filter is incapable of recognizing multiple sizes of face in an image. Multiple Haar filters of different sizes allows us to handle different sizes of faces.

3. **2 / 2 points**



[Note: 2×2 Haar filter, white +1, black -1]

Compute the Haar feature by applying the 2×2 Haar filter to a 4×4 image

$$\begin{bmatrix} 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 0 & 1 \end{bmatrix}$$

- (selected) $\begin{bmatrix} -1 & -2 & -1 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$
- $\begin{bmatrix} 1 & 2 & 1 \\ 0 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$
- $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 1 \\ -1 & -2 & -1 \end{bmatrix}$
- $\begin{bmatrix} 1 & 0 & 1 \\ 2 & 2 & 2 \\ 2 & 1 & 1 \end{bmatrix}$

Correct

To compute Haar features, we need to correlate $\begin{bmatrix} 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 0 & 1 \end{bmatrix}$ with $\begin{bmatrix} 1 & 1 \\ -1 & -1 \end{bmatrix}$

4. Is the following a valid integral image? **1 / 1 point**

$$\begin{bmatrix} 1 & 2 & 112 & 114 \\ 3 & 6 & 201 & 322 \\ 8 & 13 & 250 & 579 \\ 10 & 28 & 314 & 800 \end{bmatrix}$$

- (●) Valid
- ( ) Invalid

Correct
We can derive the contents of each cell in the original image by subtracting the values of the cells to the left and on top and adding diagonal of the corresponding cell in the integral image. Since no cells have negative values, it is valid.

For example, taking the top 4 elements 1, 2, 3 and 6; 6 > 3 + 2 - 1

This applies to all 2 x 2 grids of this integral image.

5. Which is the correct original image that produces with the following integral image? **0 / 2 points**

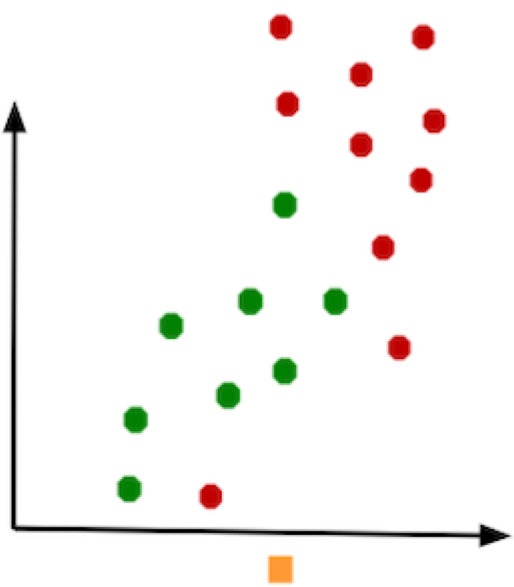
$$\begin{bmatrix} 8 & 10 & 100 & 234 \\ 10 & 20 & 130 & 282 \\ 16 & 32 & 144 & 312 \\ 24 & 41 & 192 & 470 \end{bmatrix}$$

- ( ) $\begin{bmatrix} 8 & 2 & 90 & 134 \\ 2 & 8 & 20 & 18 \\ 6 & 6 & 2 & 16 \\ 8 & 1 & 39 & 110 \end{bmatrix}$
- (●) $\begin{bmatrix} 8 & 2 & 80 & 194 \\ 2 & 15 & 140 & 100 \\ 14 & 20 & 216 & 300 \\ 10 & 30 & 298 & 755 \end{bmatrix}$

- [ ] $$\begin{bmatrix} 8 & 2 & 98 & 136 \\ 2 & 8 & 42 & 222 \\ 14 & 6 & 152 & 242 \\ 10 & 59 & 103 & 695 \end{bmatrix}$$
- [ ] $$\begin{bmatrix} 1 & 2 & 87 & 91 \\ 2 & 8 & 53 & 48 \\ 6 & 28 & 20 & 32 \\ 8 & 50 & 254 & 250 \end{bmatrix}$$

Incorrect

6. **1 / 1 point**



In the plot above, the red and green data points represent the training features from the face and non-face classes, respectively. If the nearest neighbor algorithm is used to classify the orange point, what would it recognize as?

- [x] Face
- [ ] Not a face
- [ ] Both
- [ ] Cannot be determined from the information provided

Correct

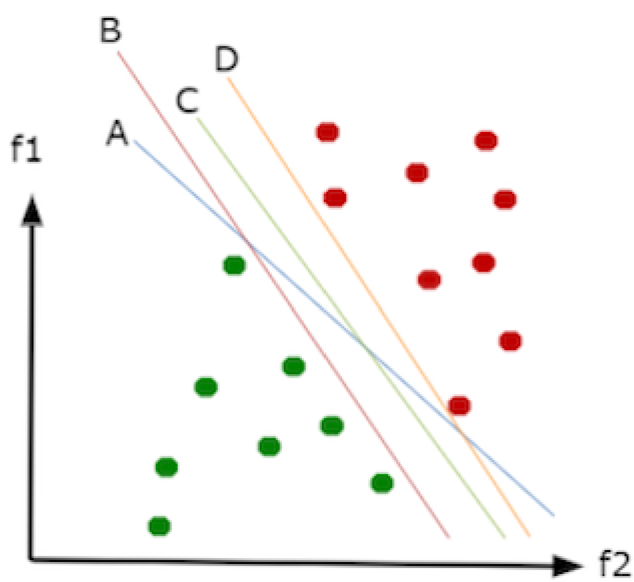
Nearest neighbor classifies the orange point based on the label of the closest point to itself. Based on the information given, red (face) is the closest point and hence, the orange data point is classified as a face.

7. After extracting features from images, how can we use these features to detect a face? **1 / 1 point**

- ○ Classify the features into faces and non-faces.
- ○ Use a Support Vector Machine (SVM) to determine the faces and non-faces.
- ○ Identify whether it belongs to a face or not based on the label of its nearest neighbor in the feature space.
- ◉ All of the above.

Correct
The first, second, and third answer choices are just different methods of classification to identify if the feature belongs to a face or not.

8. **2 / 2 points**



Which of the following potential decision boundaries is the most likely to result from training an SVM?

- ○ A
- ○ B

- (●) C
- ( ) D

Correct

A SVM doesn't only seek to divide the space appropriately, but also tries to maximize the margin, that is, the shortest distance from the boundary to a point on either side. C is the only line that fulfills this goal.

9. Given a SVM decision boundary with weight matrix $\begin{bmatrix} 4 & 3 \end{bmatrix}$, a bias of 3, and a margin of 3, classify the following point: $\begin{bmatrix} 1 \\ -2 \end{bmatrix}$. Recall that faces are on the positive side of the boundary. **0 / 2 points**

- ( ) Face
- ( ) Probably Face
- (●) Probably Not Face
- ( ) Not Face

Incorrect

10. **2 / 2 points**

A SVM can also be used as a classifier by projecting the Haar features to an embedding space. Given the set of face features (green) and non-face features (red) below, can you solve this problem using SVM by projecting to an embedding space composed of x^2 and y^2?

- (•) Yes
- ( ) No
- ( ) Cannot be determined from the provided information

Correct
By projecting the point to an embedding space of x^2 and y^2, we can classify the points using the orange circle. This is because the orange circle in the original space maps to a line (and hence forms a linear classifier) in the embedding space.