Lecture 10
Image Feature Detection
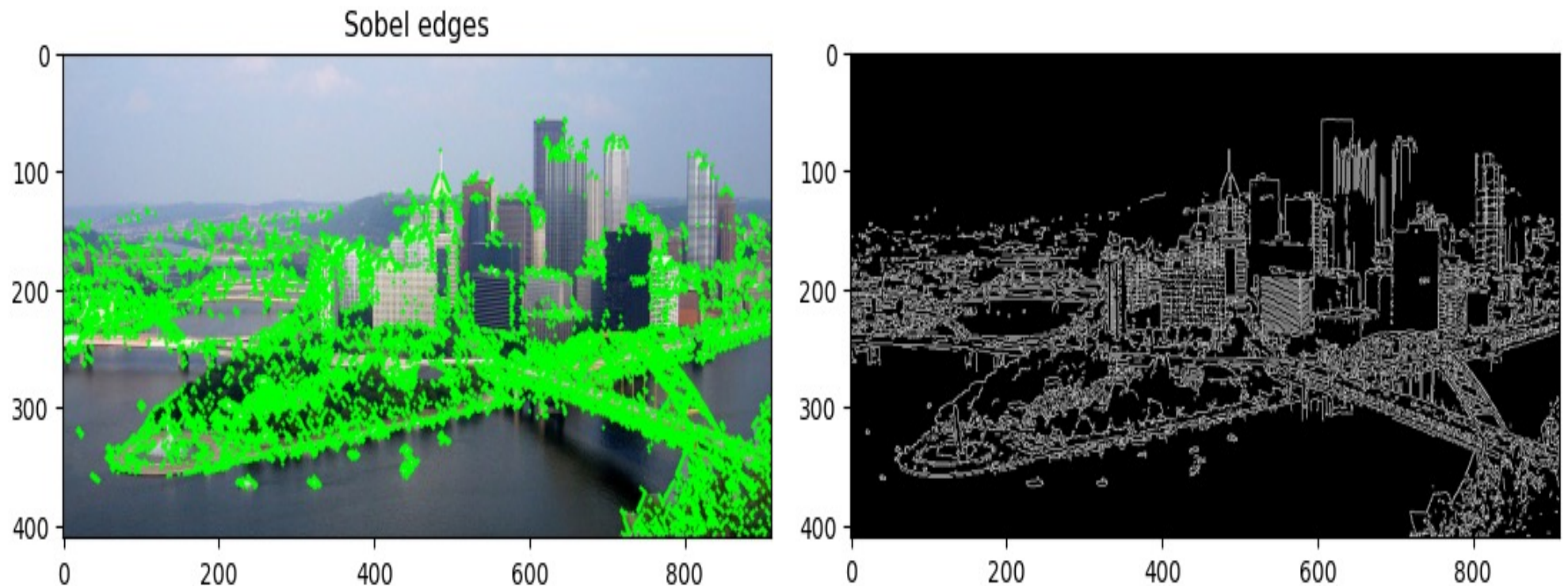
ECE 1390/2390

What is an image feature?
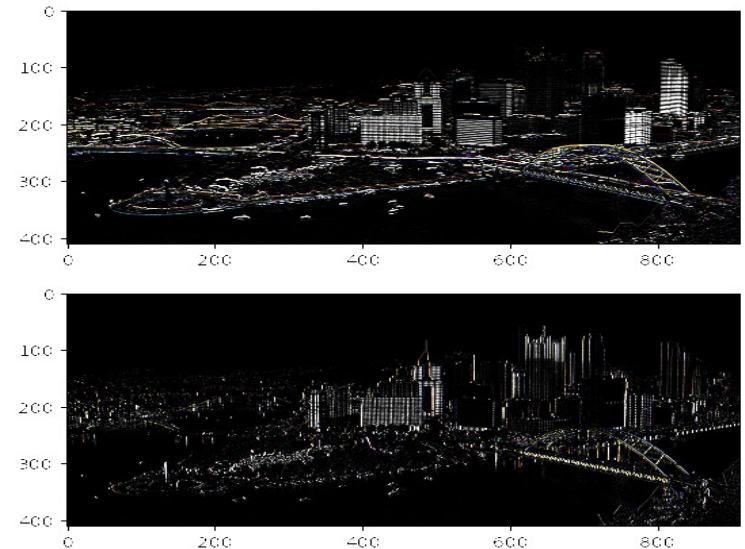
What is an image feature?

Edges

Sobel edges

What is an image feature?

Harris Corners

$$Kernel = \begin{bmatrix} -1 & 1 \end{bmatrix}$$

$$Kernel = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$$

Structure matrix

$$M[a,b] = \sum_{\{i,j\} \in W[a,b]} \begin{bmatrix} I_{x,x}(i,j) & I_{x,y}(i,j) \\ I_{y,x}(i,j) & I_{y,y(i,j)} \end{bmatrix}$$
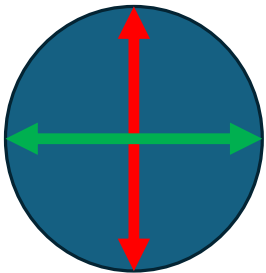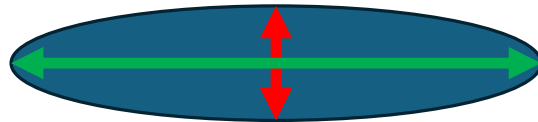
What is an image feature?

Harris Corners

$$M[a, b] = \sum_{\{i,j\}} \begin{bmatrix} I_{x,x}(i,j) & I_{x,y}(i,j) \\ I_{y,x}(i,j) & I_{y,y(i,j)} \end{bmatrix}$$

$$H[a, b] = \frac{DET(M[a,b])}{trace(M[a,b])} = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

$$\frac{0.5 * 0.5}{0.5 + 0.5} = 0.25$$

$$\frac{0.1 * 0.9}{0.1 + 0.9} = 0.09$$

What is an image feature?

Harris Corners

$$H[a,b] = \frac{DET(M[a,b])}{trace(M[a,b])} = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$
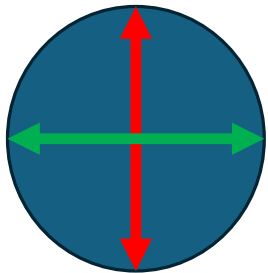
Non-maximum suppression

$$H_{NMS}[a,b] = Morph\ Max\ Filter(H[a,b], <3x3>)$$
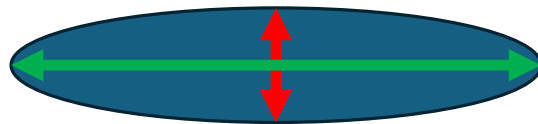
What is an image feature?

Harris Corners

$$H[a, b] = \frac{DET(M[a, b])}{trace(M[a, b])} = \frac{\textcolor{red}{\lambda_1}\textcolor{green}{\lambda_2}}{\textcolor{red}{\lambda_1} + \textcolor{green}{\lambda_2}}$$

$$\frac{\textcolor{red}{0.5} * \textcolor{green}{0.5}}{\textcolor{red}{0.5} + \textcolor{green}{0.5}} = 0.25$$

$$\frac{\textcolor{red}{0.1} * \textcolor{green}{0.9}}{\textcolor{red}{0.1} + \textcolor{green}{0.9}} = 0.09$$

$Both\ \lambda_1\ and\ \lambda_2\ are\ large\ \rightarrow Corner$
$Only\ \lambda_1\ is\ large\ \rightarrow edge$
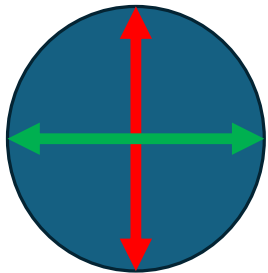$Both\ \lambda_1\ and\ \lambda_2\ are\ small\ \rightarrow no\ interest$
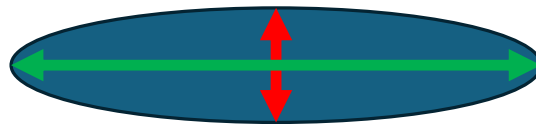
What is an image feature?

Harris Corners

$$H[a, b] = \frac{DET(M[a, b])}{trace(M[a, b])} = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

$$H[a, b] = \lambda_1 \lambda_2 - \kappa \cdot (\lambda_1 + \lambda_2)^2$$

$$\frac{0.5 * 0.5}{0.5 + 0.5} = 0.25$$

$$\frac{0.1 * 0.9}{0.1 + 0.9} = 0.09$$
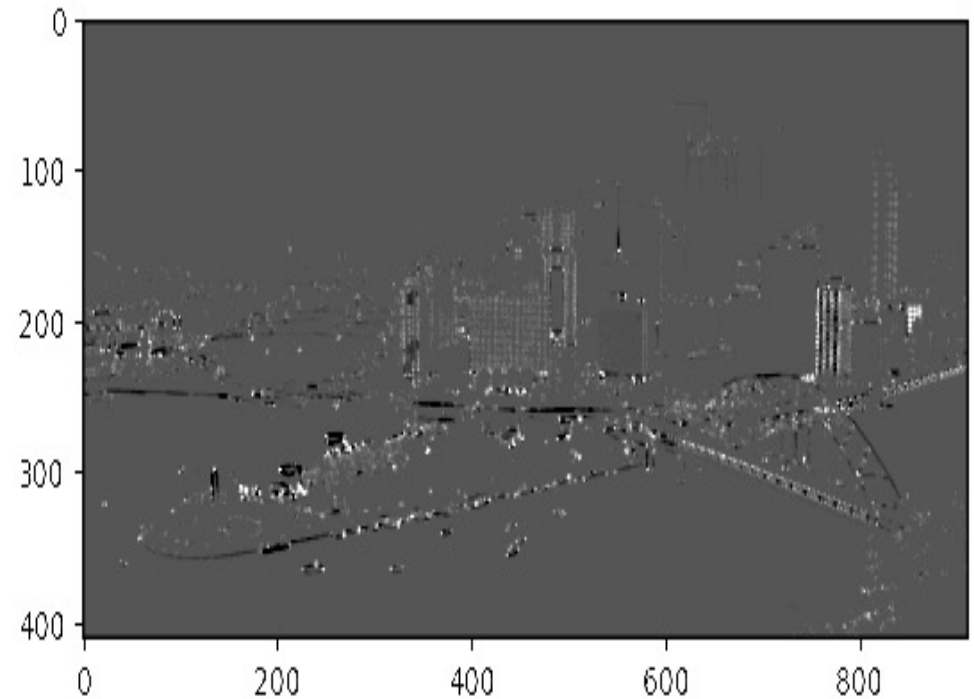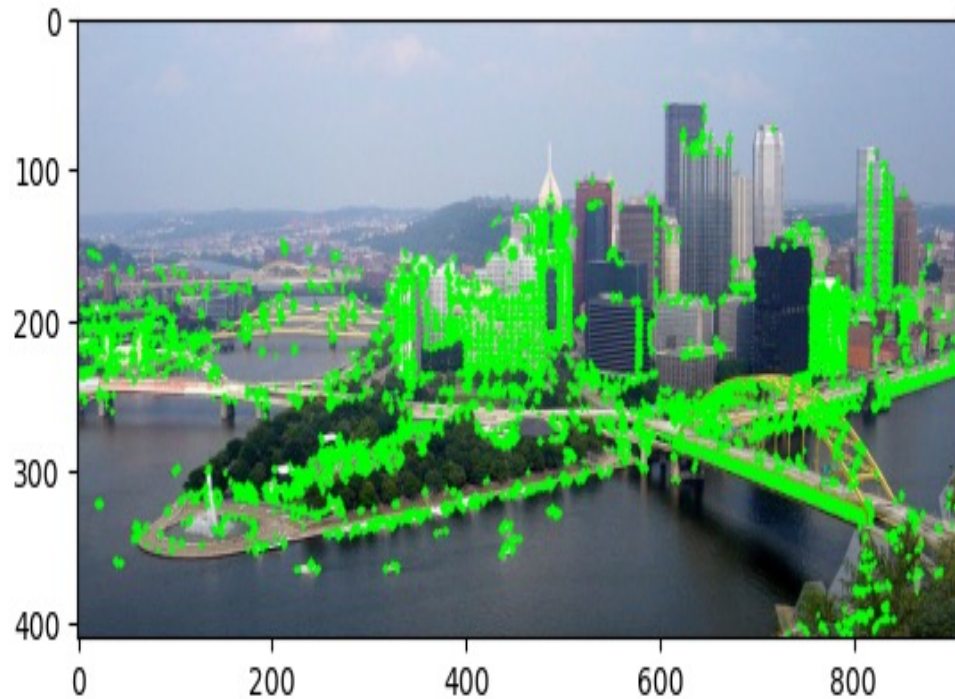
κ Quality factor $[\sim 0.02 - 0.15]$

$Both \; \lambda_1 \; and \; \lambda_2 \; are \; large \; \rightarrow Corner$
$Only \; \lambda_1 \; is \; large \; \rightarrow edge$
$Both \; \lambda_1 \; and \; \lambda_2 \; are \; small \; \rightarrow no \; interest$
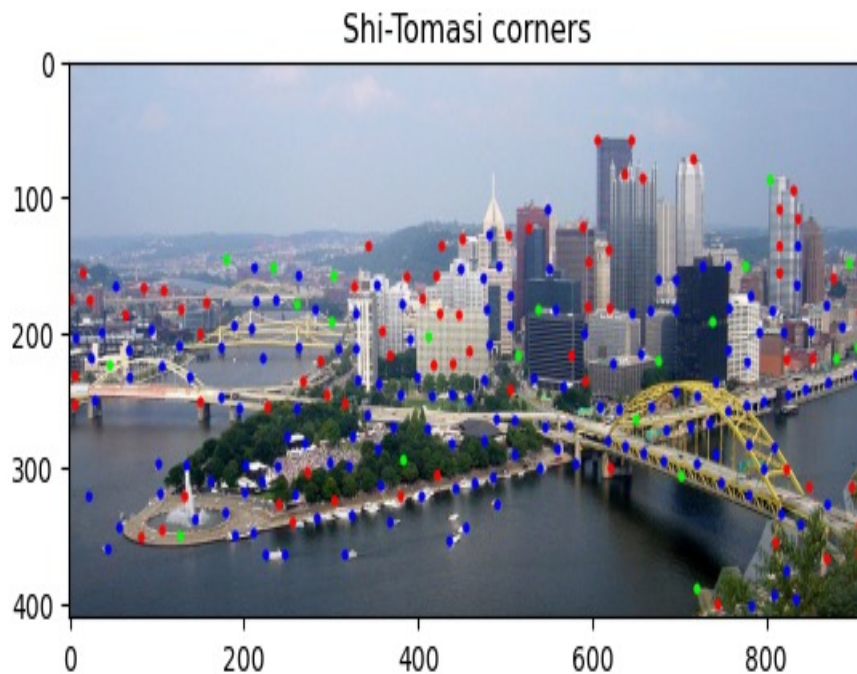
What is an image feature?

Corners

What is an image feature?

Harris Corners

$$H[a,b] = \frac{DET(M[a,b])}{trace(M[a,b])} = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

Shi-Tomasi corners

$$H[a,b] = \lambda_1 \lambda_2 - \kappa \cdot (\lambda_1 + \lambda_2)^2$$

κ Quality factor $[\sim 0.02 - 0.15]$

Both λ_1 and λ_2 are large $\rightarrow$ Corner
Only λ_1 is large $\rightarrow$ edge
Both λ_1 and λ_2 are small $\rightarrow$ no interest
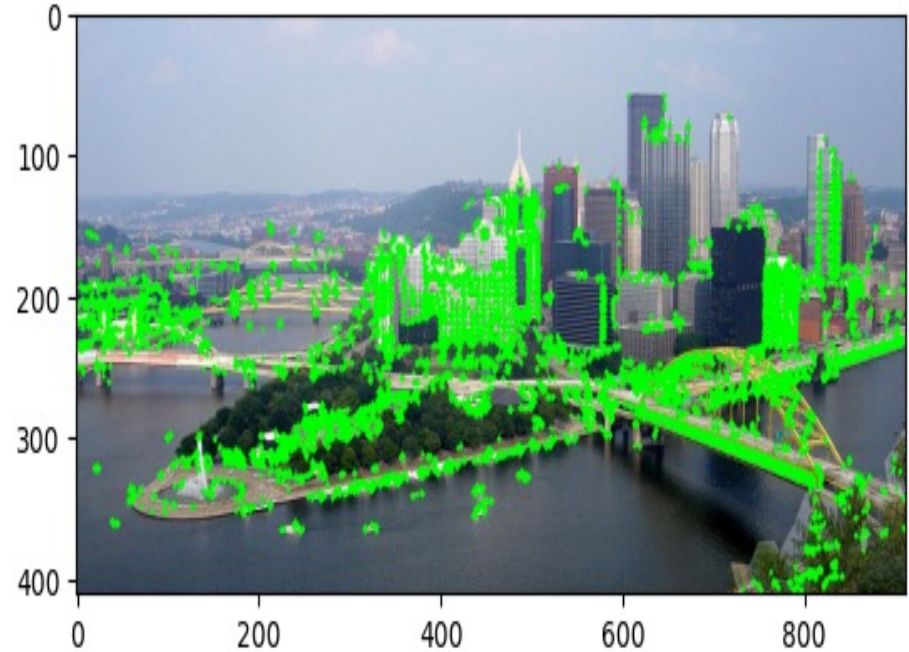
What is an image feature?

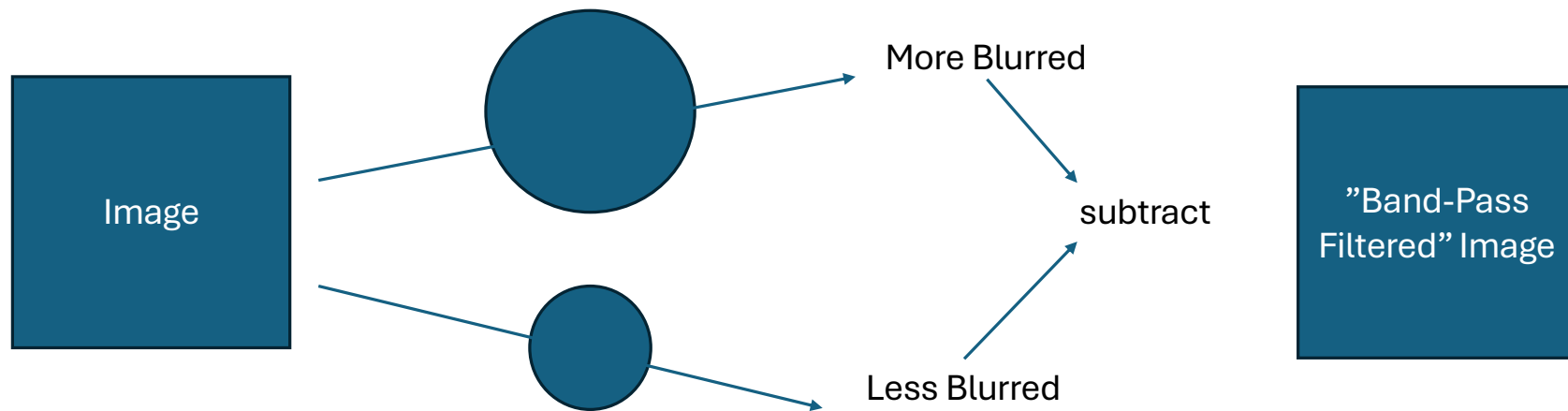Corners

Shi-Tomasi corners
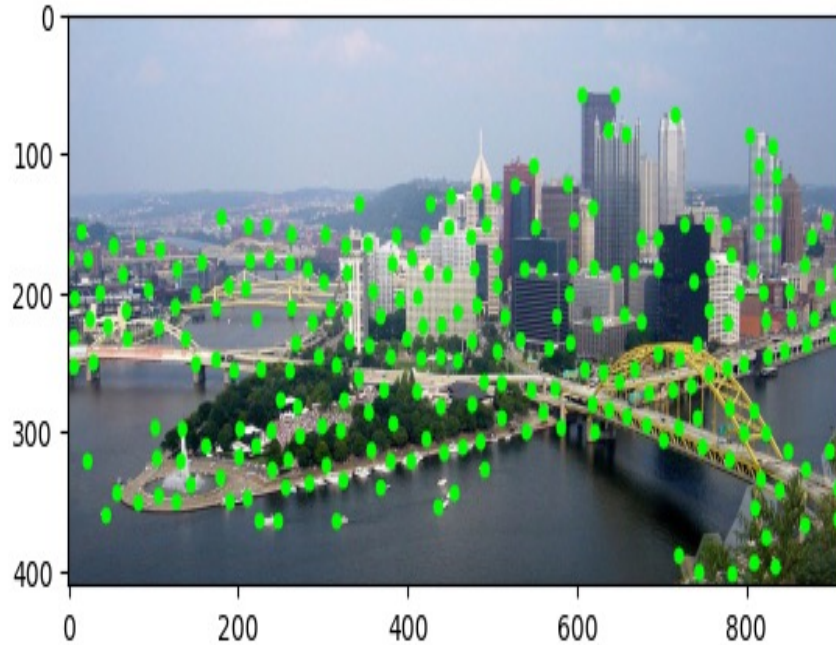
Harris Corners

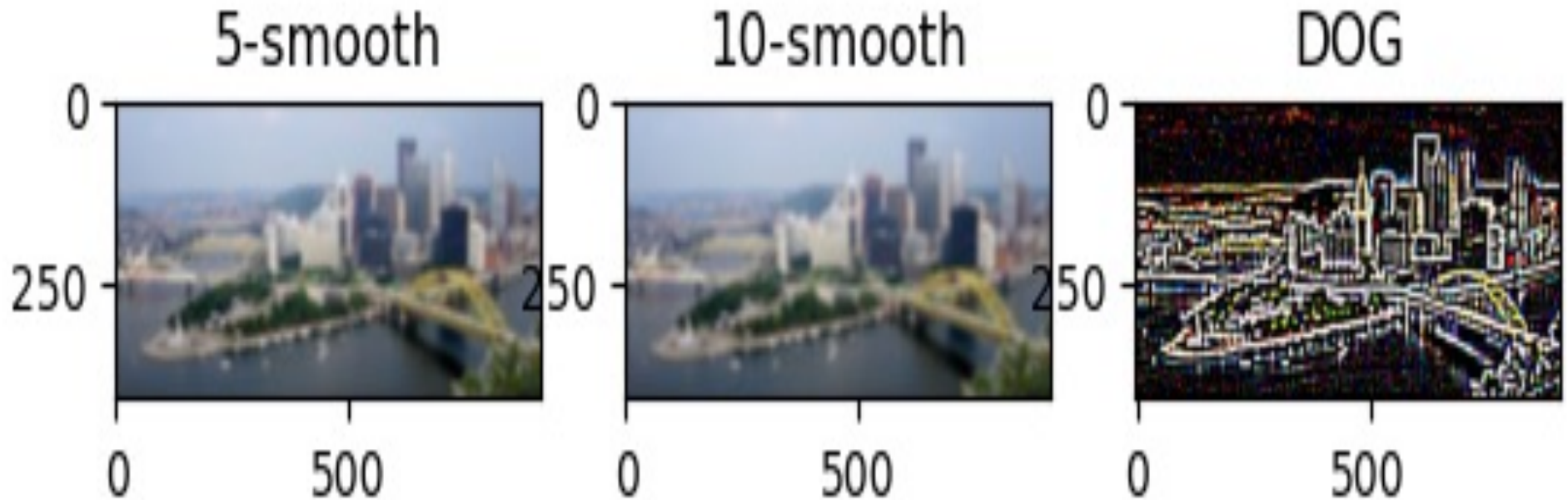# What is an image feature?

Blob detection

Differences of Gaussians approach
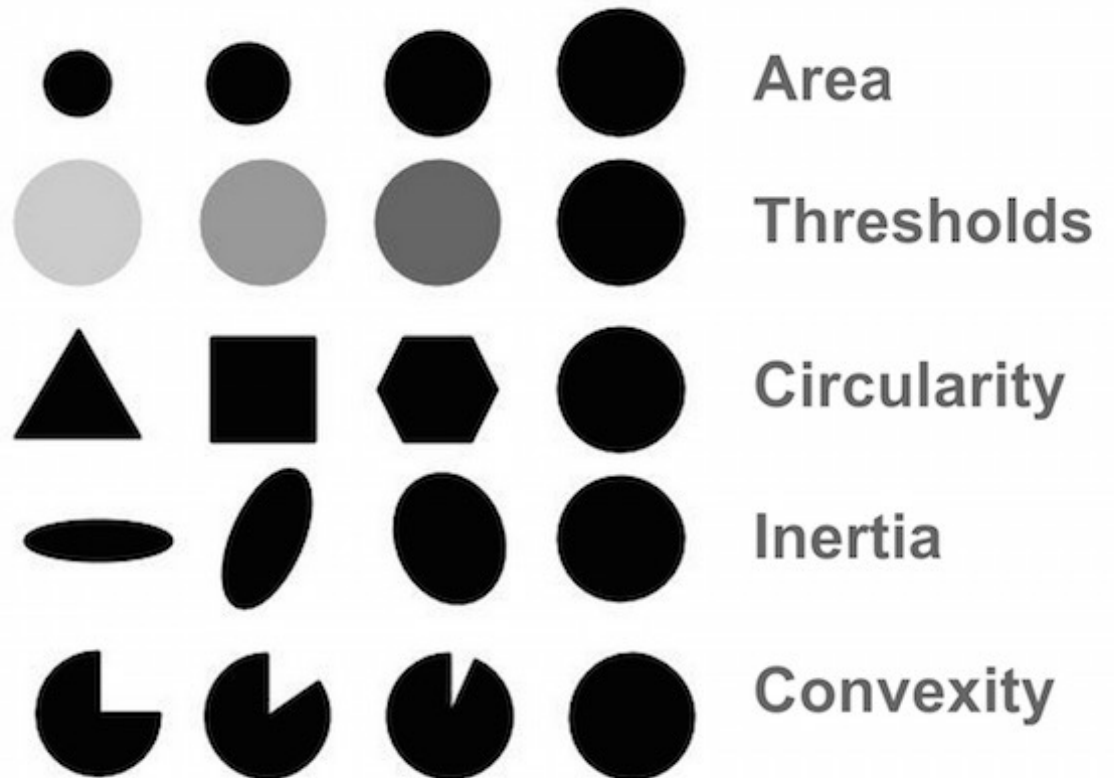
What is an image feature?

Blob detection

```
im2= cv2.GaussianBlur(im,(15,15),5,5)
im3= cv2.GaussianBlur(im,(15,15),10,10)
```

What is an image feature?

```python
params = cv2.SimpleBlobDetector_Params()
params.filterByArea = True
params.minArea = 50
params.filterByCircularity = False
params.filterByConvexity = False
params.filterByInertia = False
```


Area

Thresholds
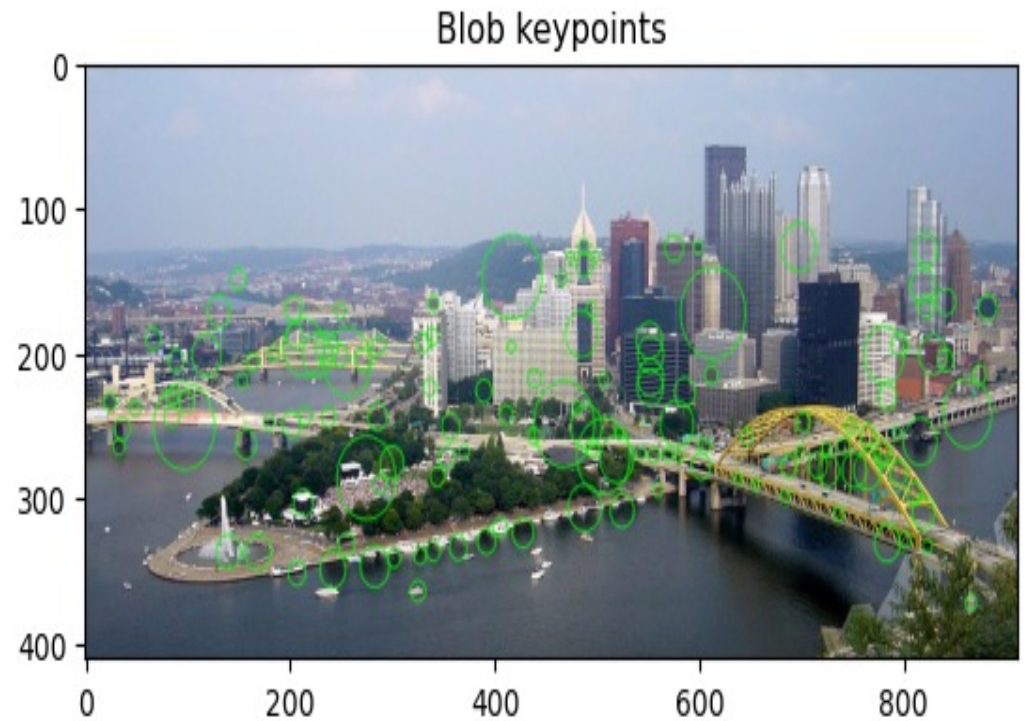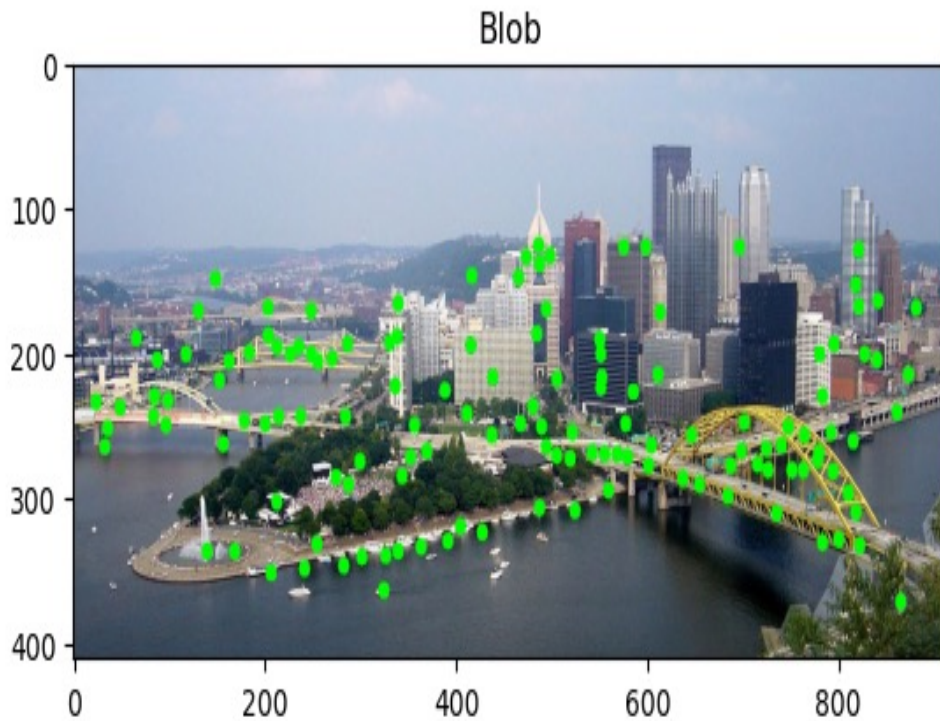
Circularity

Inertia

Convexity

Blobs

- `params = cv2.SimpleBlobDetector_Params()`
- `params.filterByArea = True`
- `params.minArea = 50`
- `params.filterByCircularity = False`
- `params.filterByConvexity = False`
- `params.filterByInertia = False`
- `detector = cv2.SimpleBlobDetector_create(params)`
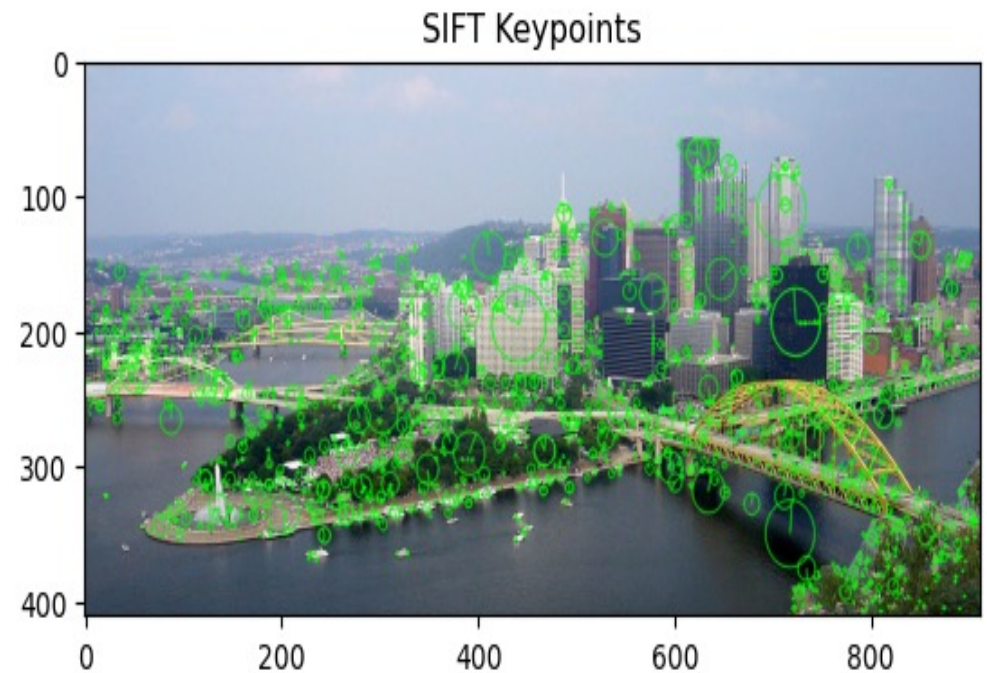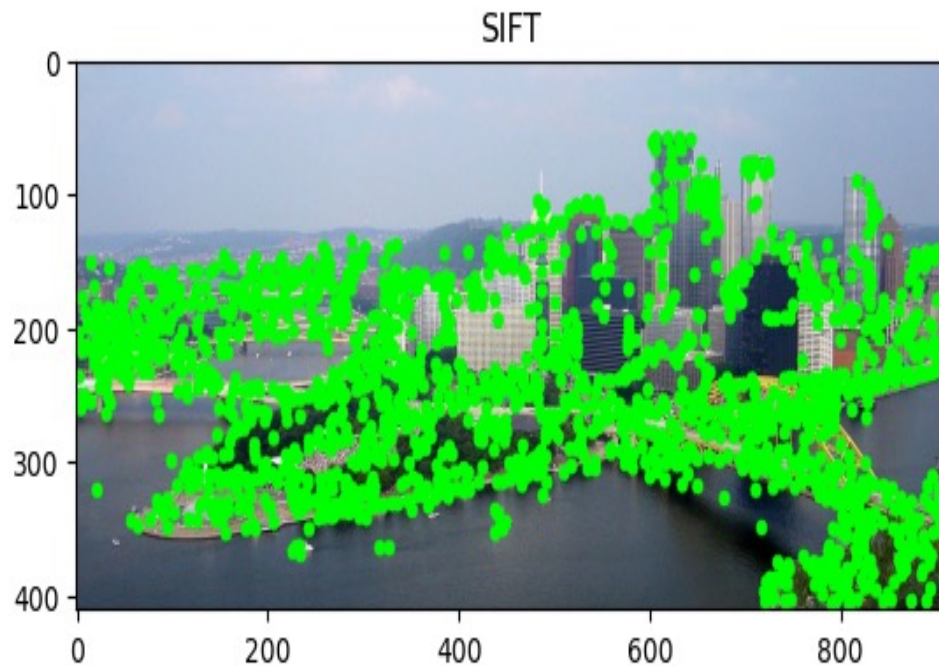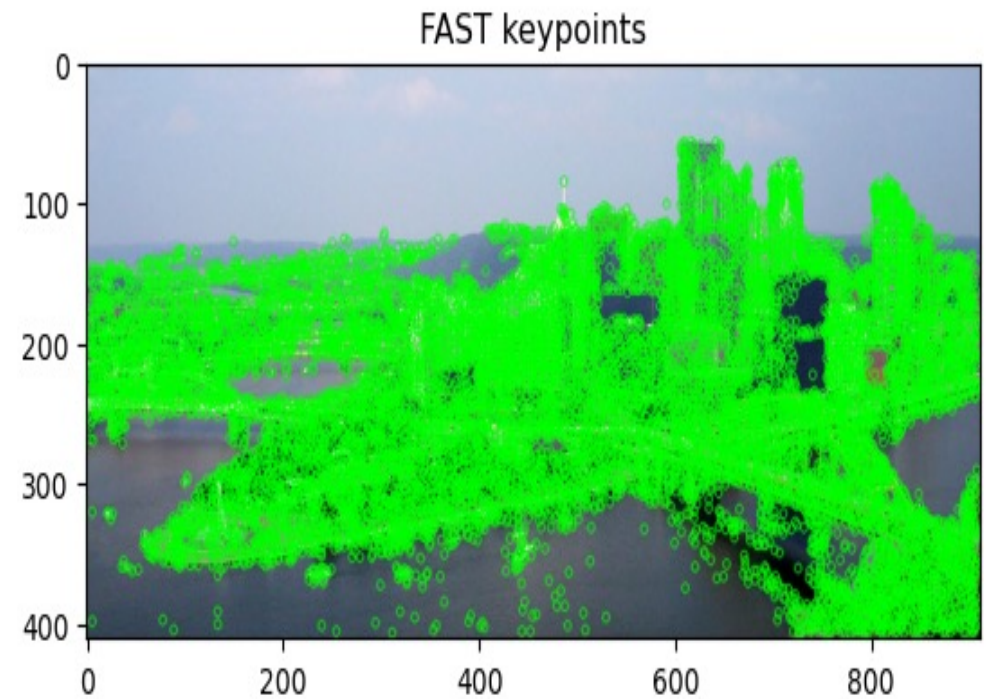- `keypoints = detector.detect(im_blob)`
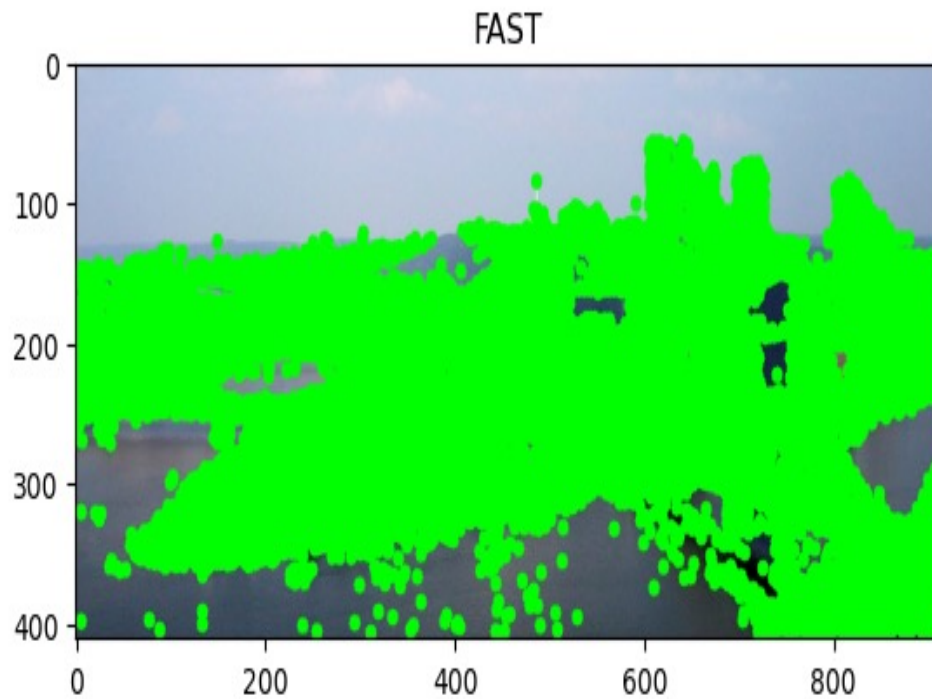
What is an image feature?

Blobs

What is an image feature?

SIFT

What is an image feature?

FAST

What is an image feature?

ORB