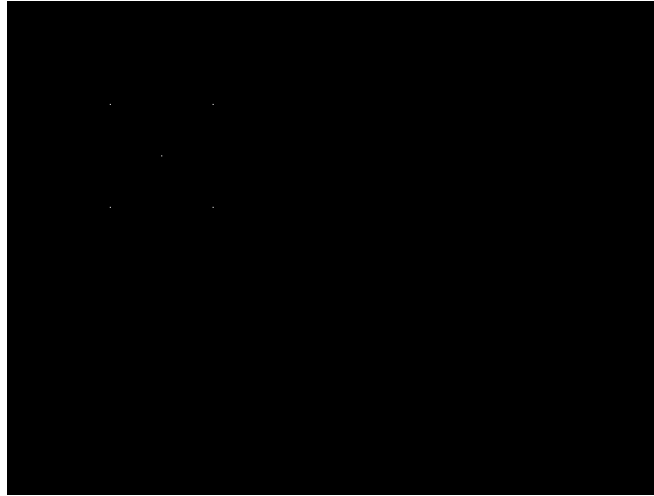# Lab 06

Hough Transform

# Contents
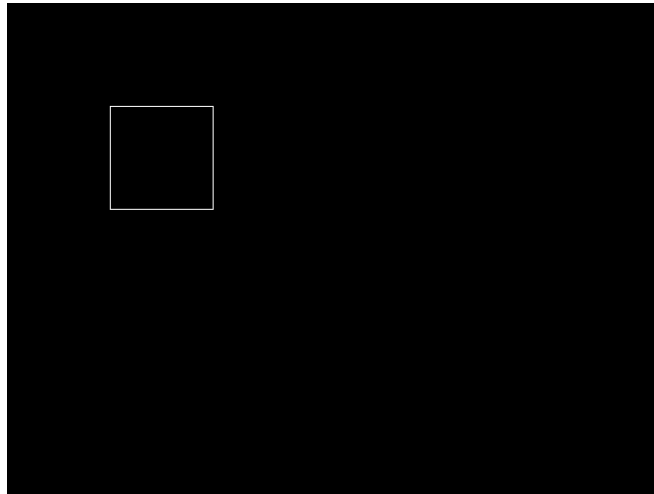
- images
- Prepare Hough Space
- Hough Transform
- Find Peak

# images

- 5 points
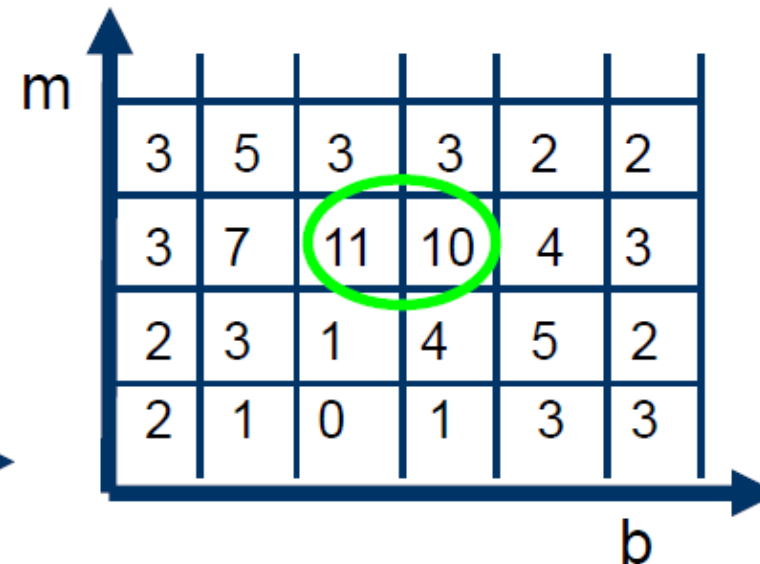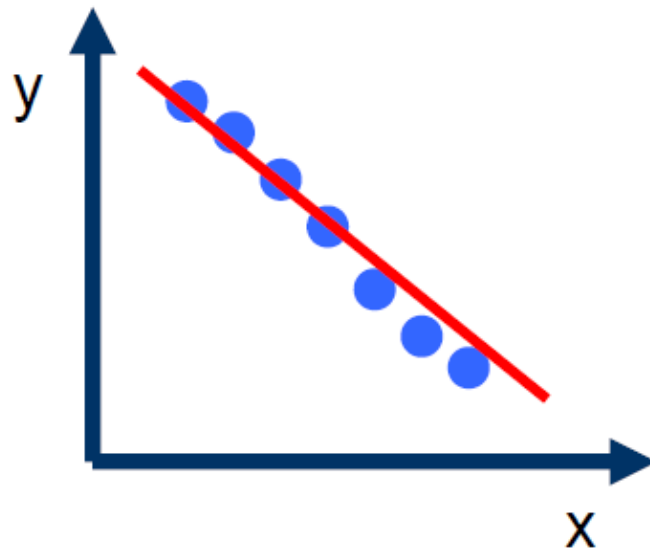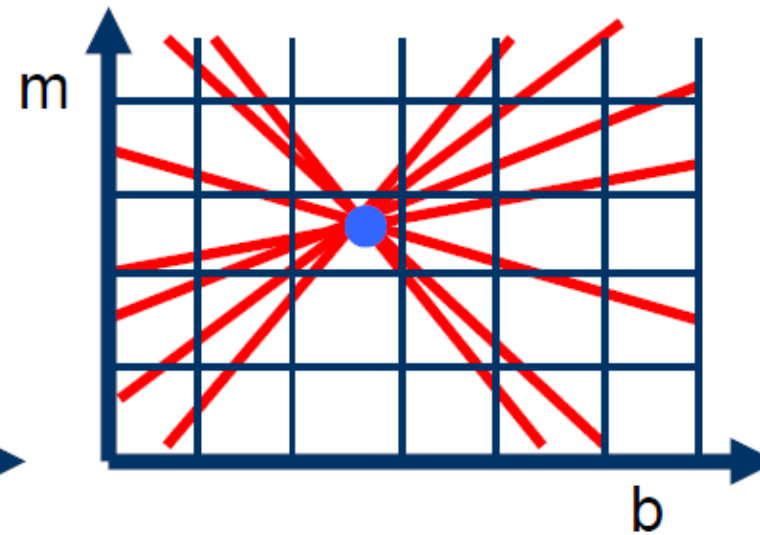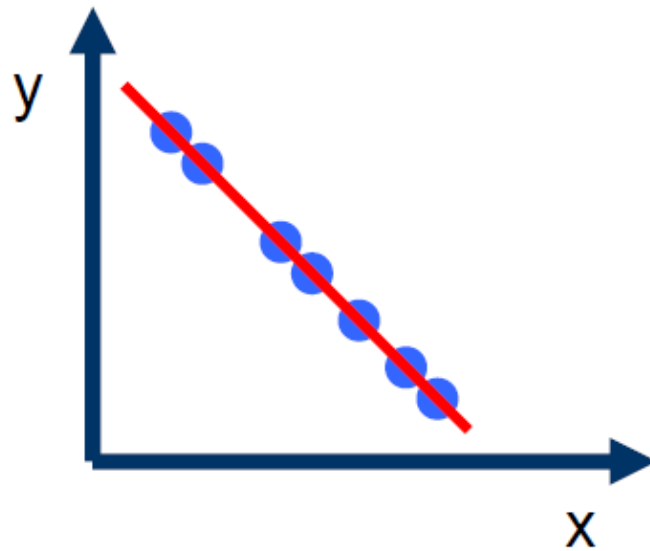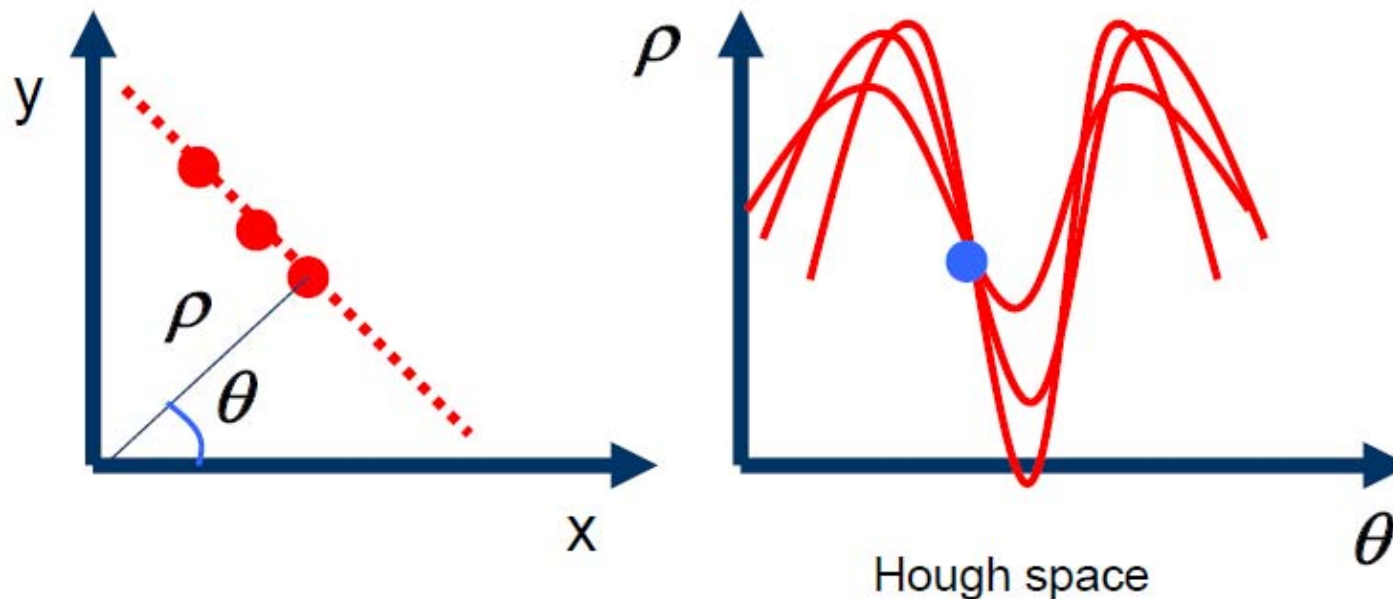


- rectangle

# Hough transform

$Y=mx+b$

# Hough transform

P.V.C. Hough, *Machine Analysis of Bubble Chamber Pictures,* Proc. Int. Conf. High Ener gy Accelerators and Instrumentation, 1959
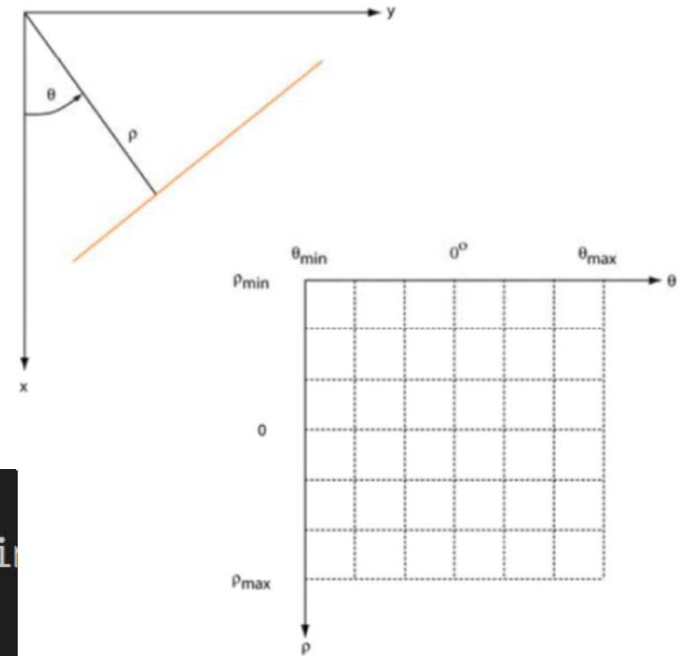
Issue : parameter space [m,b] is unbounded…

Use a polar representation for the parameter space



Hough space

$$x\cos\theta + y\sin\theta = \rho$$

Slide from S. Savarese

# Prepare Hough Space

- (=accumulator cells)



Polar representation of lines

```
// prepare Hough space
int RhoLimit = sqrt( img_edge.cols*img_edge.cols + i
int nRho = RhoLimit*2+1;
double thetaSamplingFreq = 0.0025;
int nTheta = CV_PI / thetaSamplingFreq + 5;
Mat canvas_HoughSpace = Mat::zeros( nRho, nTheta, CV_32FC1 );
```

# Prepare Hough Space

- (=accumulator cells)

```
# prepare Hough space
RhoLimit = math.floor(np.linalg.norm( image.shape ))
nRho = RhoLimit*2+1 # -limit to +limit
thetaSamplingFreq = 0.0025
nTheta = math.floor( math.pi / thetaSamplingFreq )
canvas_HoughSpace = np.zeros( (nRho, nTheta ))
```
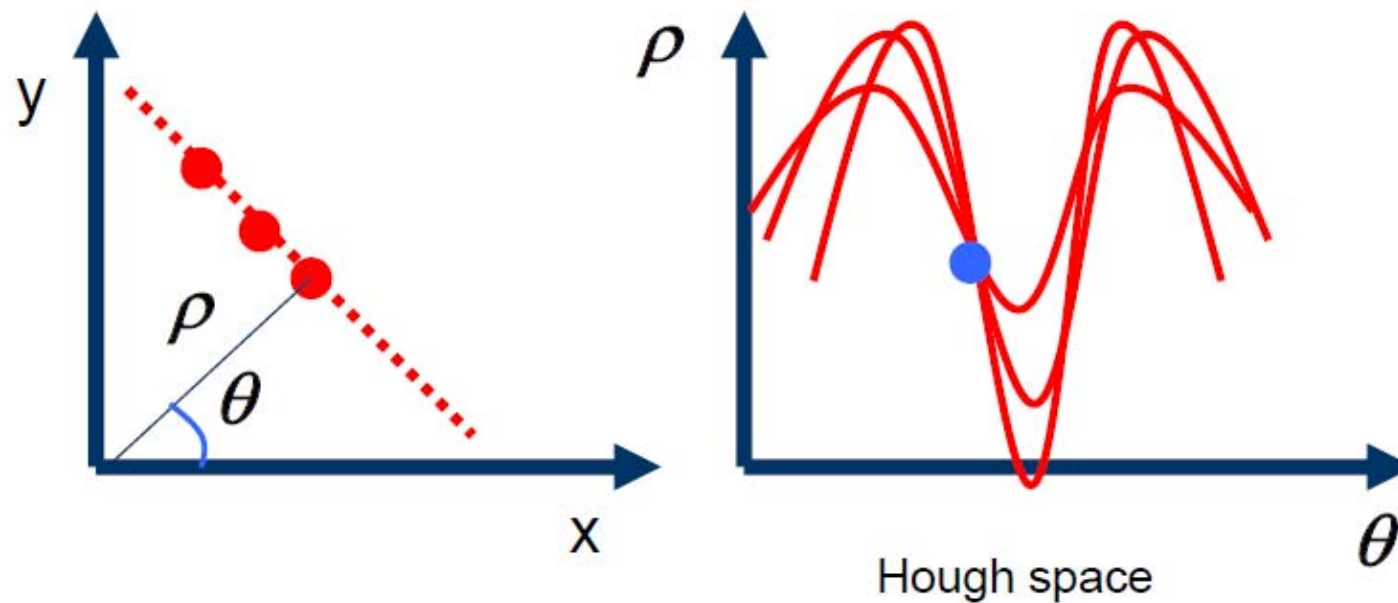
# Pre-calculate trigonometric functions

```python
# pre-calculated trigonometric functions
cosine = np.zeros(nTheta)
sine = np.zeros(nTheta)
for theta in range(nTheta):
    cosine[theta] = math.cos(theta*thetaSamplingFreq)
    sine[theta] = math.sin(theta*thetaSamplingFreq)
```

# Hough Transform

- Find possible polar coordinates of each point



Hough space

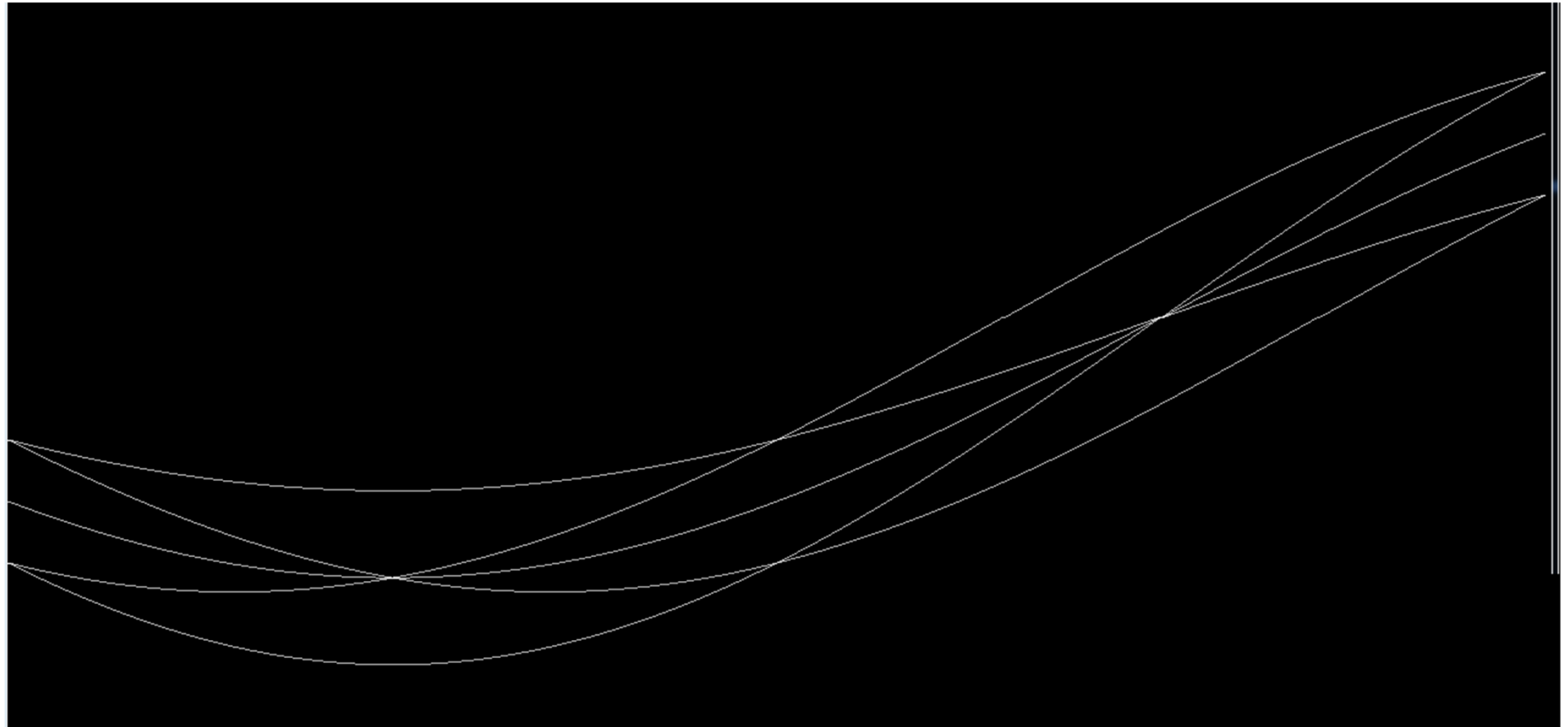$$x\cos\theta + y\sin\theta = \rho$$

# Hough Transform

For each point, vote on polar coordinates (c code)

# Hough Transform

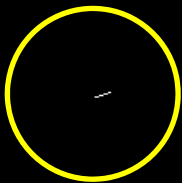For each point, vote on polar coordinates
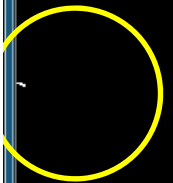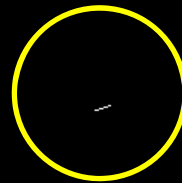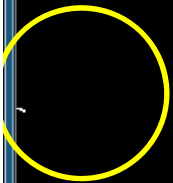
normalize

# Hough Transform

# Find Peak

```
// find peaks
Mat canvas_HoughSpace_peak;
threshold( canvas_HoughSpace, canvas_HoughSpace_peak, 0.3, 1, THRESH_BINARY );
imshow( "canvas_HoughSpace_peak", canvas_HoughSpace_peak );
waitKey();
```

$$dst(x,y) = \begin{cases} maxval & \text{if } src(x,y) > thresh \\ 0 & \text{otherwise} \end{cases}$$
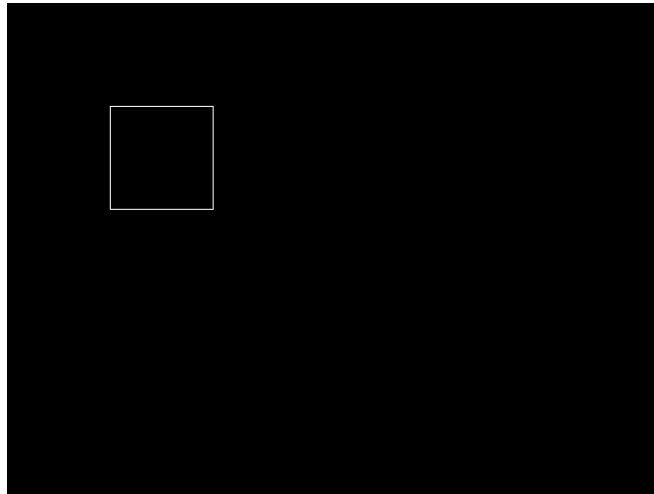
# Hough Transform

Threshold
Convert back

Draw lines

# images

- 5 points



- rectangle

# Hough Transform

# results