**Homework 9: Model fitting and parameter estimation**

(2+2+6=10 points) Write Python or Matlab code for N=7 for algorithms (1),(2) and (3) below.

Row and column index of 7 edge pixels are given below:

Coordinates Pi(Xi,Yi) for i=1 to 7



(2, 1), (3,5),(6,9), (12,7), (15,20), (18, 16), (22,30).

Fit a straight line to them and print the parameters of the line using the following 3 methods:

1. **Linear Least squares:** min(sum (Yi-mXi-b)^2)

  You need to initialize matrix A using the point data:

(2, 1), (3,5),(6,9), (12,7), (15,20), (18, 16), (22,30).

It will be

A = ( 2   1 ;

3    1 ;

6    1 ;

.....

22  1 )

with one row for each point.

The column vector y is

1

5

9

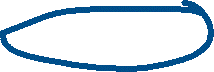
...

30

And

p = [ m   b ]'

and p = A \ y;   (in MATLAB.)



Just, compute and print p=[ m , b].

**2.** **Total linear least squares** min(sum(aXi+bYi+C)^2) such that a^2+b^2=1  (get rho, theta)

Set up matrix A with i-th row containing

xi-xbar   yi-ybar

Then the solution for (a,b) is the eigenvector corresponding to the smallest eigen value of A'A.

In Matlab,  [ v , lambda ] = eig(A' A).

Then get c as in the slide.

You need to compute only a,b, and c, as in the slides.

**3. Linear Least-Median Squared algorithm** (Algorithm 6.3, page 218 in Jain et al's Machine Vision book). In this problem, use a maximum of 6 trials.

**Algorithm 6.3 Least-Median-Squares Regression**

* *Assume that there are n data points and* ***p*** *parameters in the linear model.*
* *Choose* ***p*** *points at random from the set of n data points.*
* *Compute the fit of the model to the* ***p*** *points.*
* *Compute the median of the square of the residuals.*
* *The fitting procedure is repeated until a fit is found with sufficiently small median of squared residuals or up to some predetermined number of resampling steps.*
* In least-median-squares regression, the estimates of the model parameters
* are given by minimizing the median of the squares of the residuals:

Min(theta) [ median(i) (Residual\_i)^2 ]

Express the equation of the line through two chosen points in the form ax+by+c=0 using the following steps.

If a line passes through two points (x1,y1) and (x2,y2), then the equation of the line is

(x-x1)/(x2-x1)= (y-y1)/(y2-y1).

Simplyfying, we get a’x+b’y+c’=0 where

a’= (y2-y1) , b’ = (x1-x2), and c’ = y1(x2-x1)-x1(y2-y1)

Then, divide a’, b’, and c’, by sqrt(a’^2+b’^2) to get a,b, and c respectively. (These new a,b,c, are a=Cos(Theta), b=Sin(theta), and c = -rho.)

The perpendicular distance of any point (x3,y3) from the line is

d=  a x3 + b y3 +c .