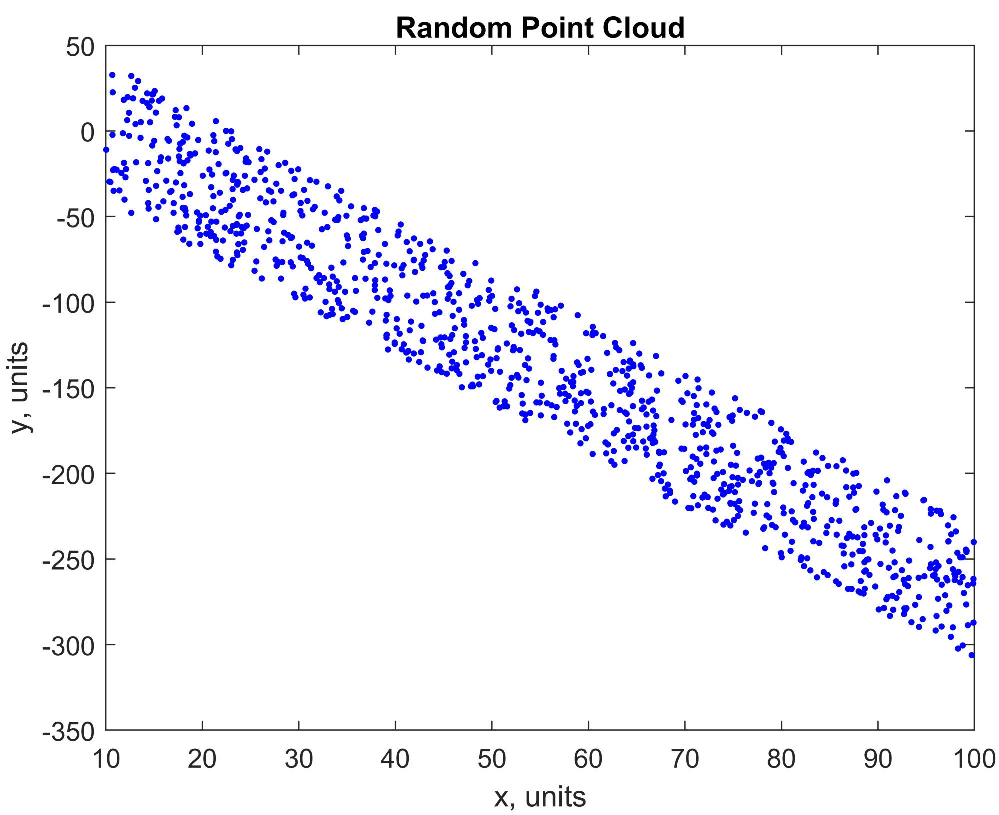
# Lab 9

## How to represent a point cloud as an ellipse

The core idea, that major and minor axis of ellipse are eigenvectors of our covariance matrix of point cloud

## Generate some points around a line

```
intercept = -10; slope = -3;
npts = 1000; noise = 80;
xs = 10 + rand(npts, 1) * 90;
ys = slope * xs + intercept + rand(npts, 1) * noise;
% Plot the randomly generated points
figure;
plot(xs, ys, 'b.', 'MarkerSize', 8)
title("Random Point Cloud")
xlabel("x, units")
ylabel("y, units")
```




## Find eigenpairs of the matrix

```
A = [xs ys];
covmat = cov(A)
```

```
covmat = 2×2
```

```
10^3 ×
    0.6656   -2.0010
   -2.0010    6.5510
```

```
[e,b] = eig(covmat)
```

```
e = 2×2
   -0.9558   -0.2942
   -0.2942    0.9558
b = 2×2
10^3 ×
    0.0497         0
         0    7.1669
```

```
% Just for curiosity - eigenvectors from A'A is almost the same as from cov(A),
% but not eigenvalues
covmat_A = A'*A
```

```
covmat_A = 2×2
10^7 ×
    0.3681   -0.9488
   -0.9488    2.5138
```

```
[e_A,b_A] = eig(covmat_A)
```

```
e_A = 2×2
   -0.9352   -0.3542
   -0.3542    0.9352
b_A = 2×2
10^7 ×
    0.0088         0
         0    2.8732
```

```
error = e-e_A
```

```
error = 2×2
   -0.0206    0.0600
    0.0600    0.0206
```

```
% We are interested in both correct eigenvalue and eigenvector, hence we
% will use data from covatiance matrix
```

## Find centroid of a point cloud, major and minor axes and orientation of an ellipse

```
% formulas were given on the previous slide
b = 2*sqrt(diag(b))
```

```
b = 2×1
   14.1018
  169.3146
```

```
ang = rad2deg(atan2(e(1,2),e(2,2)))
```

```
ang = -17.1073
```

```
centroid = mean([xs,ys])
```

```
centroid = 1×2
   54.9191 -136.3597
```

## Plot

```
figure; plot(xs, ys, 'b.', 'MarkerSize', 5)
title("The ellipse, wich represent a point cloud")
xlabel("x, units")
ylabel("y, units")
hold on
p = calcEllipse(centroid(1), centroid(2), b(1),b(2) , deg2rad(ang), 50);
plot(p(:,1), p(:,2), '.-')
```