

271 Assignment 3

10103388

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Code and Explanation for Calculating Center and Radius:

```
function [center,radius] = leastSq(group)
for j=1:100
    x=group(:,j);
    M(j,:) = [-2*(x'),1];
    b(j,:) = -(x')*x;
end

[Q,R] = qr(M);
y = (Q')*b;
x1=R\y;
center = [x1(1),x1(2),x1(3)];
g=sum(center);
radius = sqrt((g*g)-x1(4));
```

The “leastSq” function calculates the center and radius of the spheres from the 4 data groups. It takes a group as input and calculates M and b. Calculations of M and b are based on this equation:

$$\equiv \begin{bmatrix} -2\vec{x}_j^T & 1 \end{bmatrix} \begin{bmatrix} \vec{g} \\ \sigma \end{bmatrix} = -\vec{x}_j^T \vec{x}_j$$

It then calculates Q and R from M using QR decomposition and back substitution to find the center coordinates of the sphere and the radius. Calculations are based on $R*x=Q'*b$ and

$$\hat{\rho} = \sqrt{\hat{g} \cdot \hat{g} - \hat{\sigma}}$$

The center points of the sphere are estimated in x1(1:3) and the radius is estimated in x1(4).

Code and Explanation for Calculating Error:

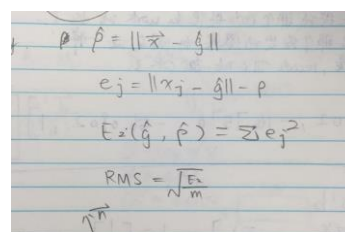
```
for i=1:100

    e=abs(group(:,i)-center);
    direction= e/norm(e);
    difference= e-radius*direction;
    err(i,:)=sum(difference.^2);
end

r= sqrt(sum(err)/100);
```

Error is calculated by finding the distance between points to the center minus the radius.

Rooted mean squared error is calculated by the substituting this formula to the calculated error:



Handwritten formulas showing the calculation of error and RMS:

$$\rho = \|\vec{x} - \hat{g}\|$$
$$e_j = \|\vec{x}_j - \hat{g}\| - \rho$$
$$E(\hat{g}, \hat{\rho}) = \sum e_j^2$$
$$RMS = \sqrt{\frac{E}{m}}$$

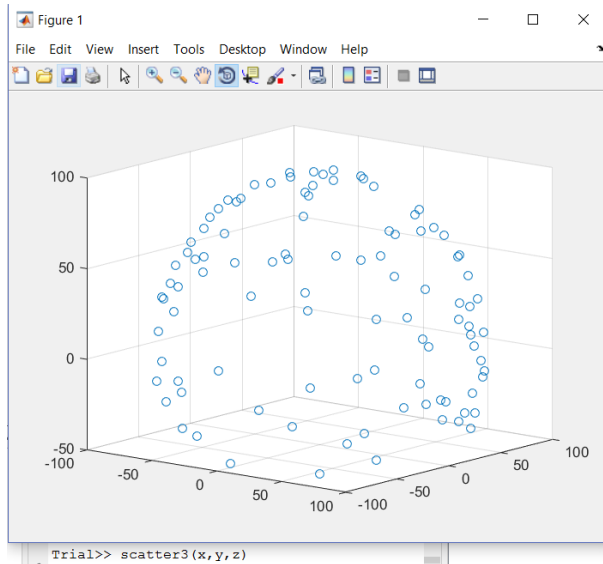
↑ n

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Results for Group 1:



```
Trial>> [center,radius] = leastSq(group1)
```

```
center =
```

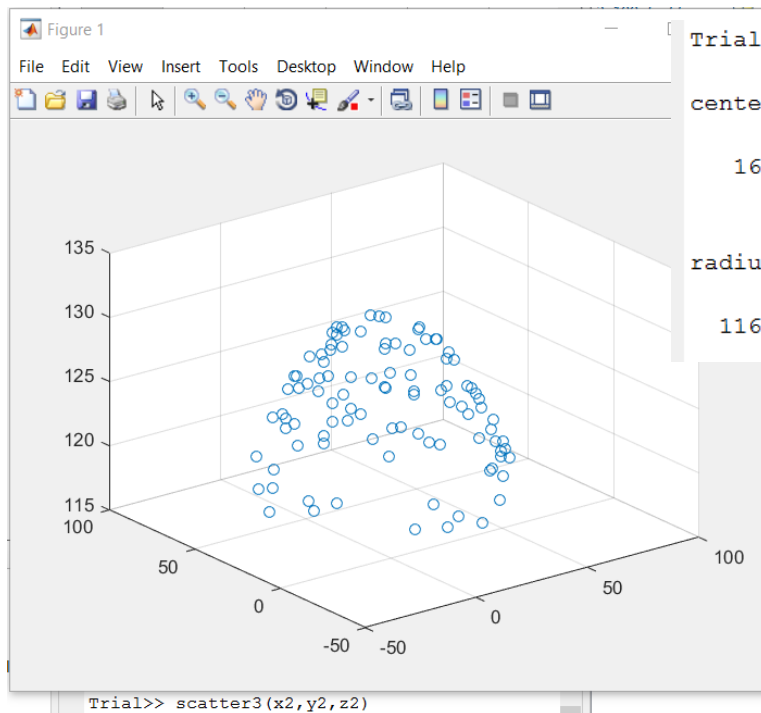
```
-0.0053    0.0043   -0.0049
```

```
radius =
```

```
100.0014
```

Error: $r =$
0.0269

Results for Group 2:



```
Trial>> [center,radius] = leastSq(group2)
```

```
center =
```

```
16.2138    27.2190    31.4175
```

```
radius =
```

```
116.6757
```

Error:

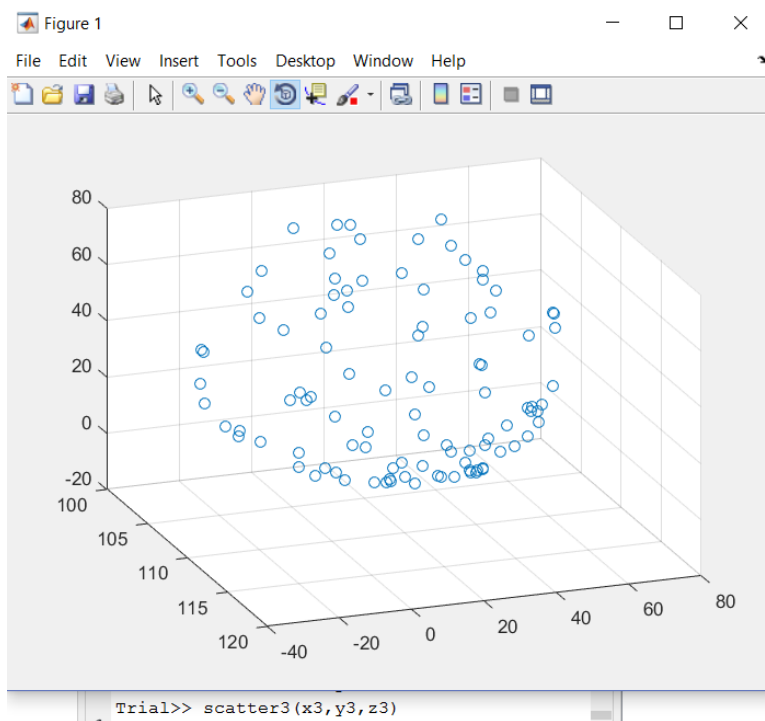
$r =$
16.6686

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Results for Group 3:



```
Trial>> [center,radius] = leastSq(group3)
```

center =

16.1838 27.1818 31.4189

radius =

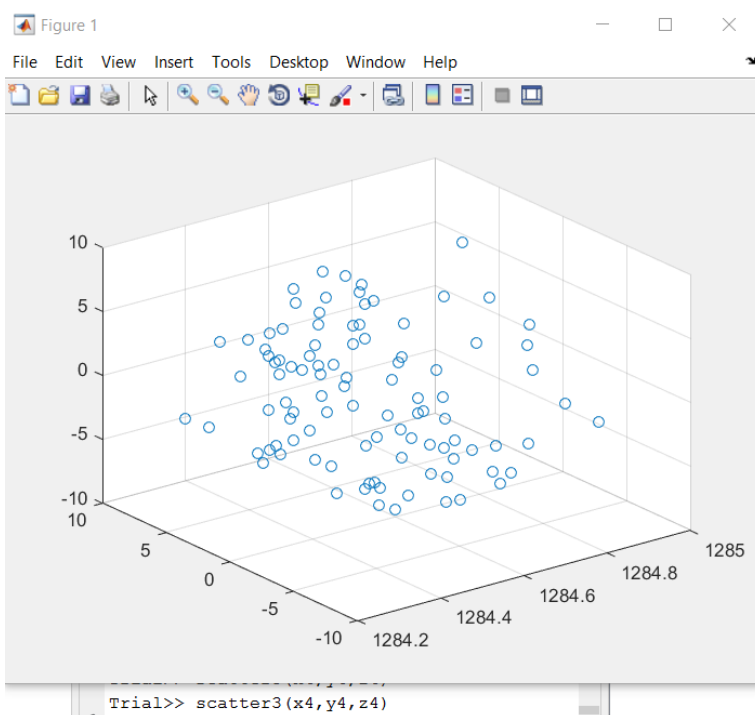
116.6386

Error:

r =

16.6399

Results for Group 4:



```
Trial>> [center,radius] = leastSq(group4)
```

center =

1.0e+03 *

1.3369 0.0000 -0.0000

radius =

52.8272

The exact values of center for group 4:

1x3 double			
	1	2	3
1	1.3369e+03	0.0014	-3.2212e-04

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Error: (for group 4)

$r =$

0.1608

The errors are larger for group 2 and 3. Group 2 has error 16.67 and radius 116.67 and group 3 has error 16.64 and radius 116.64. These two groups have very similar radius and error values. This might be because they are both bigger in size than group 1 and group 4.

In the plane fit experiment I found that the first group had a good fit, the second and third is similar but has a better sphere, and last group has a good plane.