Task-C: Regression outlier effect.

Objective:Visualization best fit linear regression line for different scenarios

In [1]:
```python
# you should not import any other packages
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")
import numpy as np
from sklearn.linear_model import SGDRegressor
```

In [2]:
```python
import numpy as np
import scipy as sp
import scipy.optimize

def angles_in_ellipse(num,a,b):
    assert(num > 0)
    assert(a < b)
    angles = 2 * np.pi * np.arange(num) / num
    if a != b:
        e = (1.0 - a ** 2.0 / b ** 2.0) ** 0.5
        tot_size = sp.special.ellipeinc(2.0 * np.pi, e)
        arc_size = tot_size / num
        arcs = np.arange(num) * arc_size
        res = sp.optimize.root(
            lambda x: (sp.special.ellipeinc(x, e) - arcs), angles)
        angles = res.x
    return angles
```

In [3]:
```python
a = 2
b = 9
n = 50

phi = angles_in_ellipse(n, a, b)
e = (1.0 - a ** 2.0 / b ** 2.0) ** 0.5
arcs = sp.special.ellipeinc(phi, e)

fig = plt.figure()
ax = fig.gca()
ax.axes.set_aspect('equal')
ax.scatter(b * np.sin(phi), a * np.cos(phi))
plt.show()
```
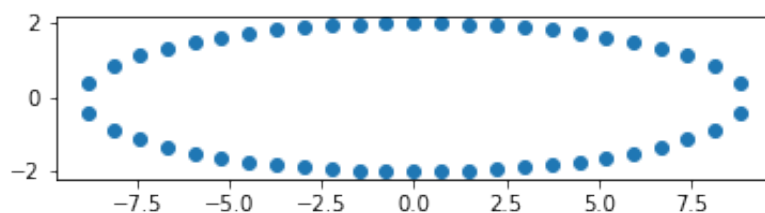
```
In [4]:    X= b * np.sin(phi)
           Y= a * np.cos(phi)
```

1. As a part of this assignment you will be working the regression problem and how regularization helps to get rid of outliers

2. Use the above created X, Y for this experiment.

*3. to do this task you can either implement your own SGDRegression(prefered) excatly similar to "SGD assignment" with mean sequared error or you can use the SGDRegression of sklearn, for example "SGDRegressor(alpha=0.001, eta0=0.001, learning_rate='constant',random_state=0)" note that you have to use the constant learning rate and learning rate **eta0** initialized.*

4. as a part of this experiment you will train your linear regression on the data (X, Y) with different regularizations alpha=[0.0001, 1, 100] and observe how prediction hyper plan moves with respect to the outliers

5. This the results of one of the experiment we did (title of the plot was not metioned intentionally)
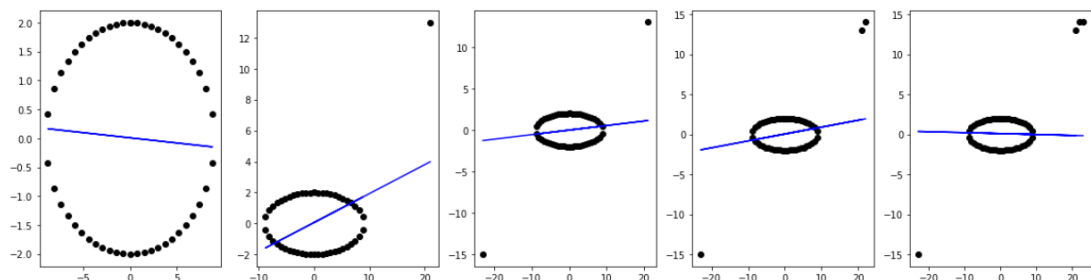
in each iteration we were adding single outlier and observed the movement of the hyper plane.

6. please consider this list of outliers: [(0,2),(21, 13), (-23, -15), (22,14), (23, 14)] in each of tuple the first elemet is the input feature(X) and the second element is the output(Y)

7. for each regularizer, you need to add these outliers one at time to data and then train your model again on the updated data.

8. you should plot a 3*5 grid of subplots, where each row corresponds to results of model with a single regularizer.

9. Algorithm:

for each regularizer:

> *for each outlier:*
> > *#add the outlier to the data*
> > *#fit the linear regression to the updated data*
> > *#get the hyper plane*
> > *#plot the hyperplane along with the data points*

> *10. MAKE SURE YOU WRITE THE DETAILED OBSERVATIONS, PLEASE CHECK THE LOSS FUNCTION IN THE SKLEARN DOCUMENTATION*
> *(please do search for it).*

In [5]:
```python
from sklearn import preprocessing
from sklearn.metrics import mean_squared_error
```

In [6]:
```python
## referred https://stackoverflow.com/questions/59367939/how-to-correct-the

c = 1
alpha = [0.0001, 1, 100]
outliers = [(0,2),(21, 13), (-23, -15), (22,14), (23, 14)]
plt.figure(figsize=(20,15))
for i,a1 in enumerate(alpha):
    X1= b * np.sin(phi)
    Y= a * np.cos(phi)
    for j,o in enumerate(outliers):
        plt.subplot(3,5,c)
        c += 1
        X1 = np.append(X1, o[0]).reshape(-1,1)    ## adding the outliers
        Y = np.append(Y, o[1]).reshape(-1,1)
        sgdr = SGDRegressor(alpha = a1, eta0=0.0001, max_iter=1000, learnin
        sgdr.fit(X1,Y)
        Y_pred = sgdr.predict(X1)
        plt.scatter(X1,Y)
        plt.plot(X1, Y_pred, color='red')   ## plotting the hyperplane
        plt.title('alpha = '+ str(a1))

print("sgd regressor")
plt.show()
```

sgd regressor
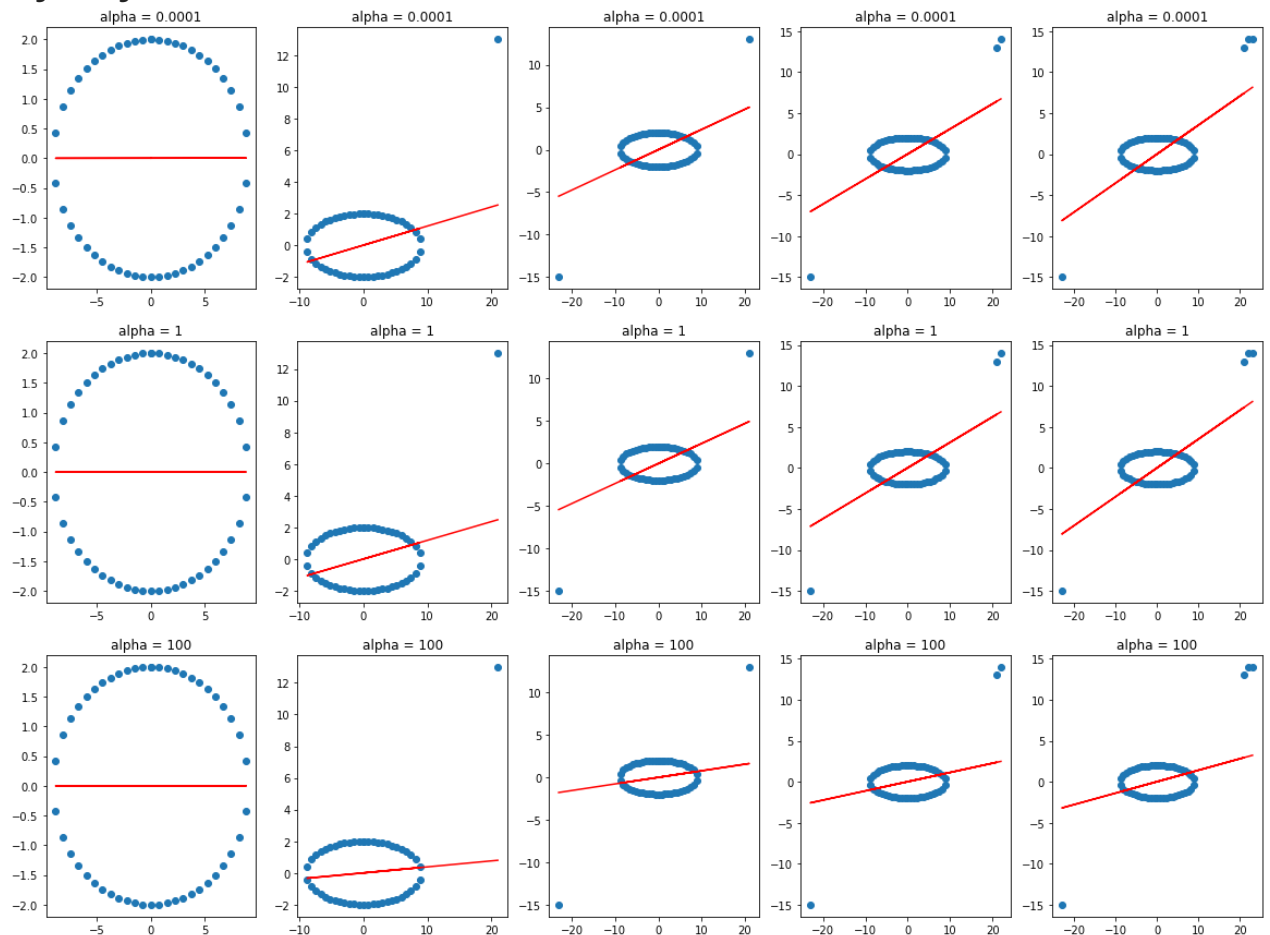
Observation:

- When there is only one outlier, the datapoints are fairly spread and the hyperplane passes from between the points horizontally.
- As number of outliers increase for low alpha value, the hyperplane changes its inclination to cover all the points.
- As number of outliers increase for alpha value of 1, the hyperplane position is similar to one when alpha = 0.0001
- And as outliers increase, the hyperplane adjusts itself slightly to include all the points.
- The position of hyperplane in alpha 100 is better than the previous ones.
- It can be concluded that when alpha is too low, hyperplane is much inclined towards the outliers. As alpha and outliers increase, there is a slight change in hyperplane position but it fits better than the previous ones.