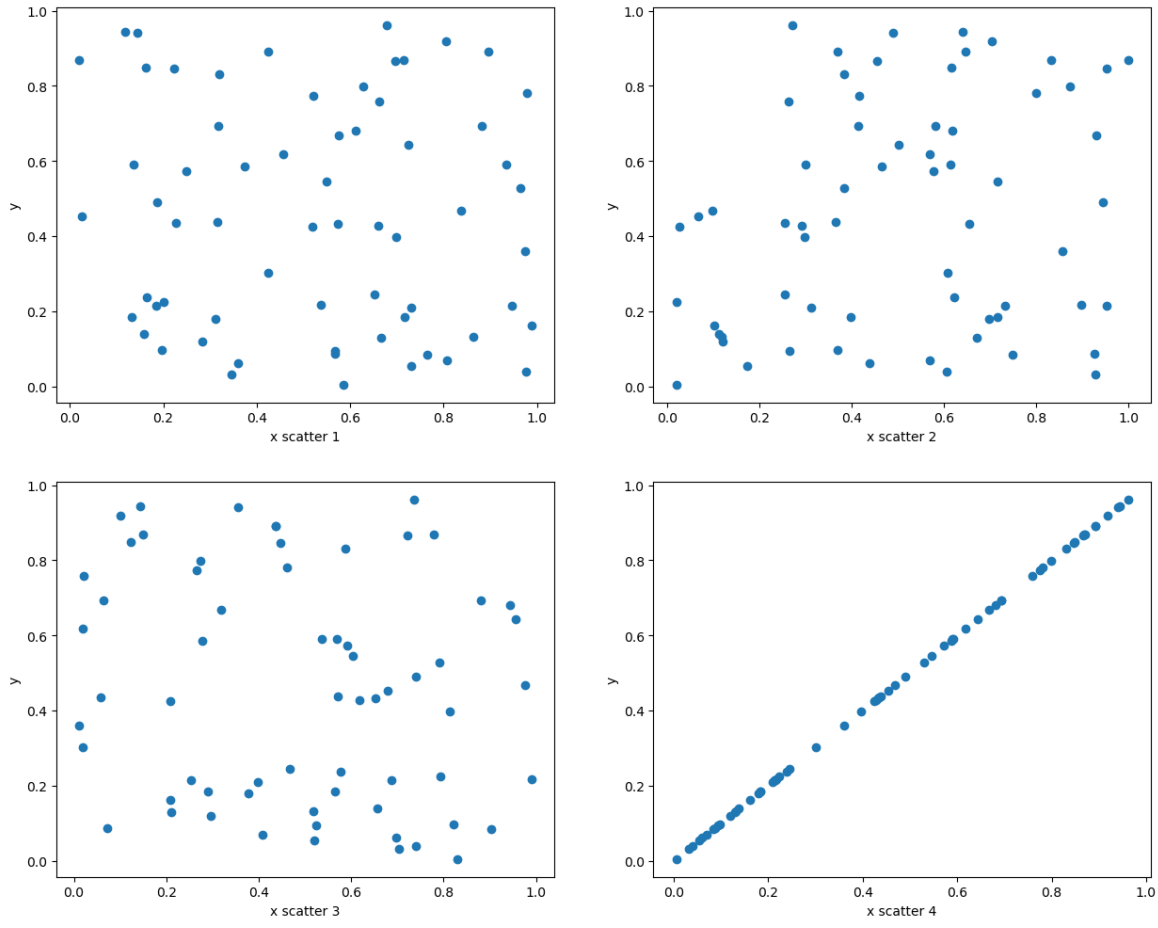
Assigment 3

This assigment focuses on getting comfortable with working with multidimensional data and linear regression. Key items include:

- Creating random n-dimensional data
- Creating a Model that can handle the data
- Plot a subset of the data along with the prediction
- Using a Dataset to read in and choose certain columns to produce a model
- Create several models from various combinations of columns
- Plot a few of the results

1. Create a 4 dimensional data set with 64 elements and show all 4 scatter 2D plots of the data x_1 vs. y, x_2 vs. y, x_3 vs. y, x_4 vs. y

In [7]:
```
import numpy as np
import matplotlib.pyplot as plt

#4D dataset
n = 64;
x = np.linspace(0, 1, n) + np.random.rand(4, n);
x = np.vstack([x, np.ones(len(x.T))]).T;
y = np.linspace(0, 1, n) + np.random.rand(n) - 1;

#Plots
plt.figure(figsize=(15,12))
for i in range(4):
    plt.subplot(2, 2, i+1)
    plt.scatter(data[:, i], data[:, -1])
    plt.xlabel(f"x scatter {i+1}")
    plt.ylabel("y")

plt.show()
```



2. Create a Linear Regression model (LIKE WE DID IN CLASS) to fit the data. *Use the example from Lesson 3 and DO NOT USE a library that calculates automatically*. We are expecting 5 coefficients to describe the linear model.

After creating the model (finding the coefficients), calculate a new column $v_n = \Sigma\beta_n \cdot x_n$

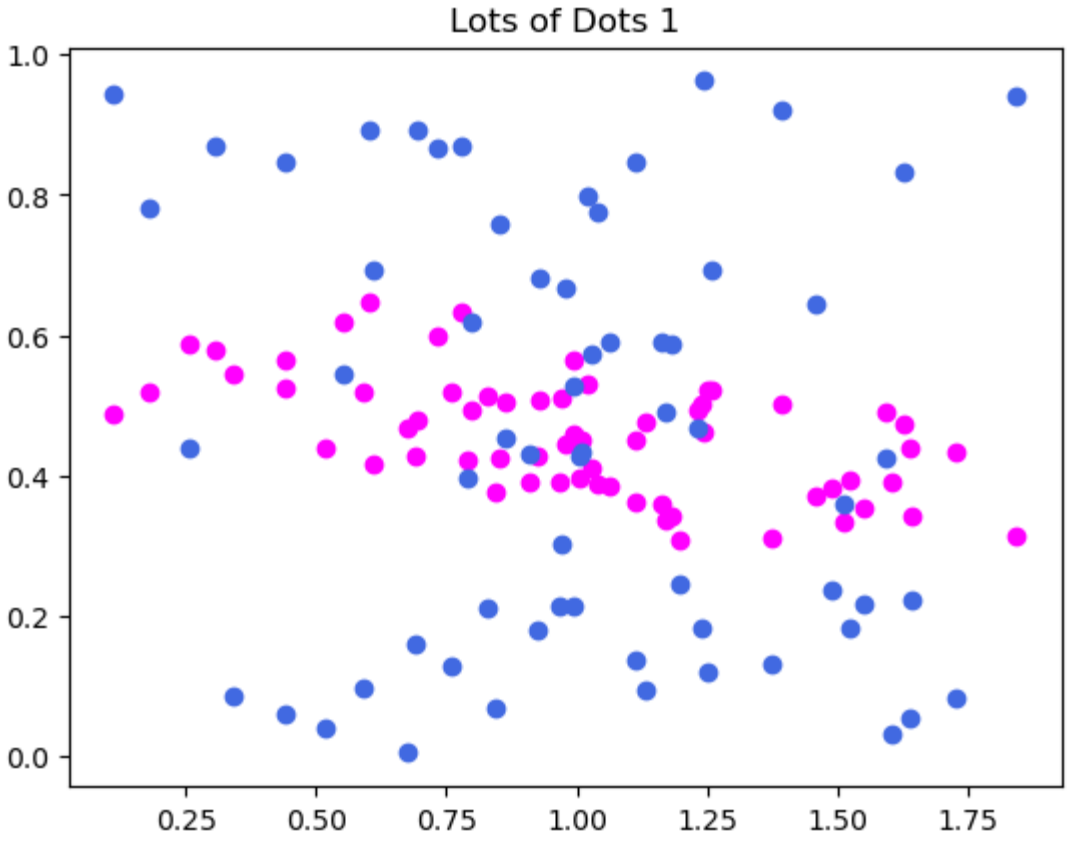
In [10]:
```
left = np.linalg.inv(np.dot(x.T, x))
right = np.dot(y.T, x)
np.dot(left, right)

my_model = np.linalg.lstsq(x, y, rcond=None)[0]
my_model
```

Out[10]:
```
array([-0.11647018, -0.17950826,  0.14122151,  0.05866884,  0.5579511
8])
```

3. Plot the model's prediction as a different color on top of the scatter plot from Q1 in 2D for all 4 of the dimensions
$(x_1 \rightarrow y_p, x_2 \rightarrow y_p, x_3 \rightarrow y_p, x_4 \rightarrow y_p)$

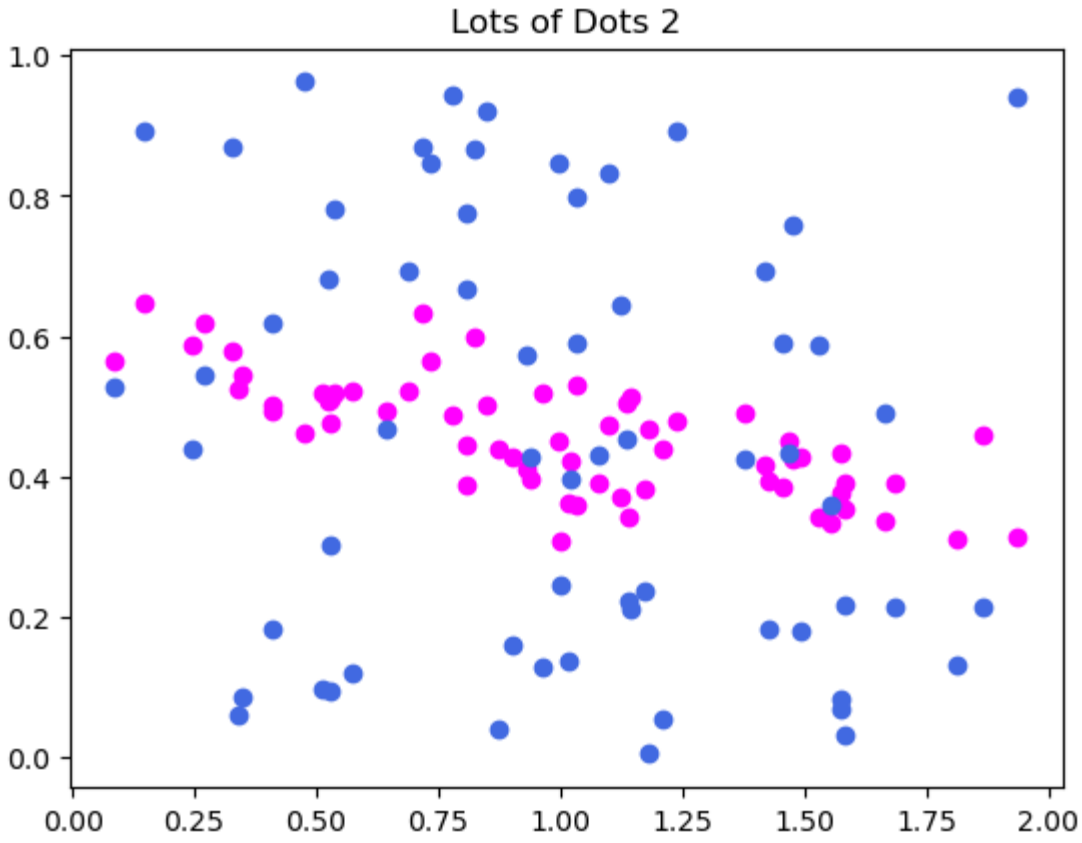
In [20]:
```
my_mod_vis = np.dot(x, my_model)

plt.scatter(x.T[0], my_mod_vis, c = "magenta")
plt.scatter(x.T[0], y, c = "royalblue")
plt.title("Lots of Dots 1")
```

Out[20]:
```
Text(0.5, 1.0, 'Lots of Dots 1')
```



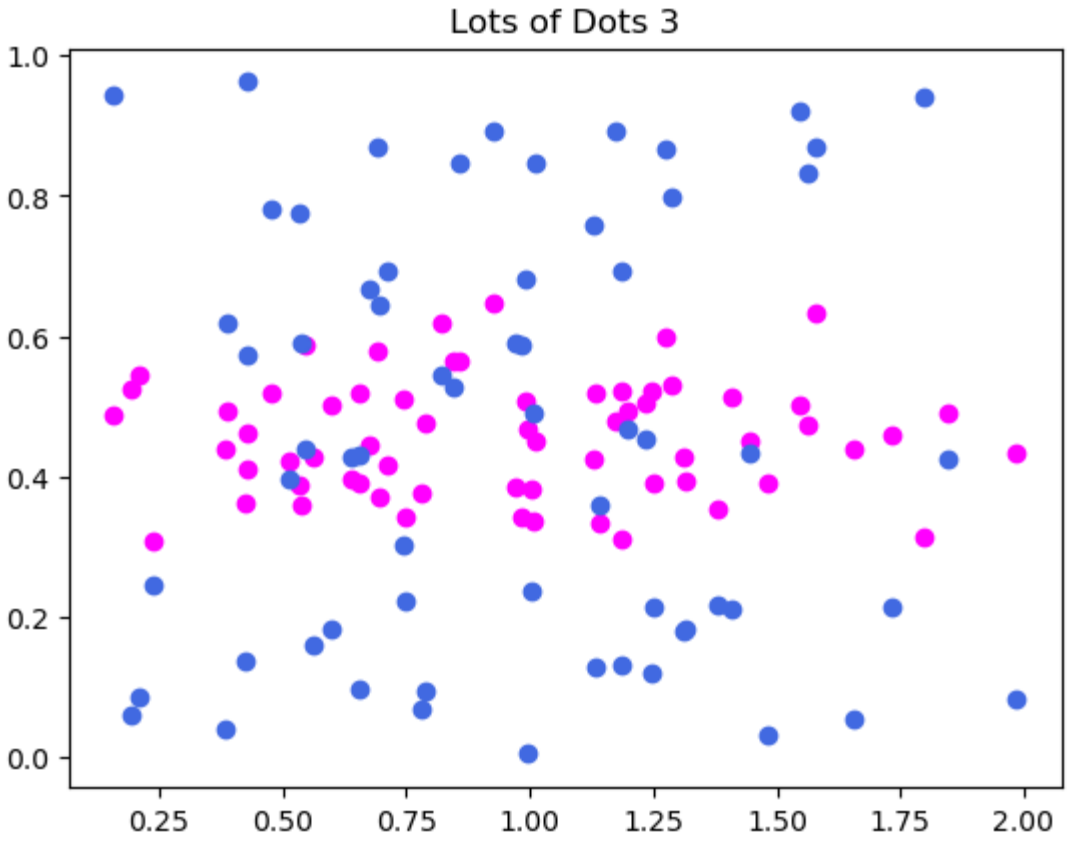
In [21]:
```
plt.scatter(x.T[1], my_mod_vis, c = "magenta")
plt.scatter(x.T[1], y, c = "royalblue")
plt.title("Lots of Dots 2")
```

Out[21]:
```
Text(0.5, 1.0, 'Lots of Dots 2')
```



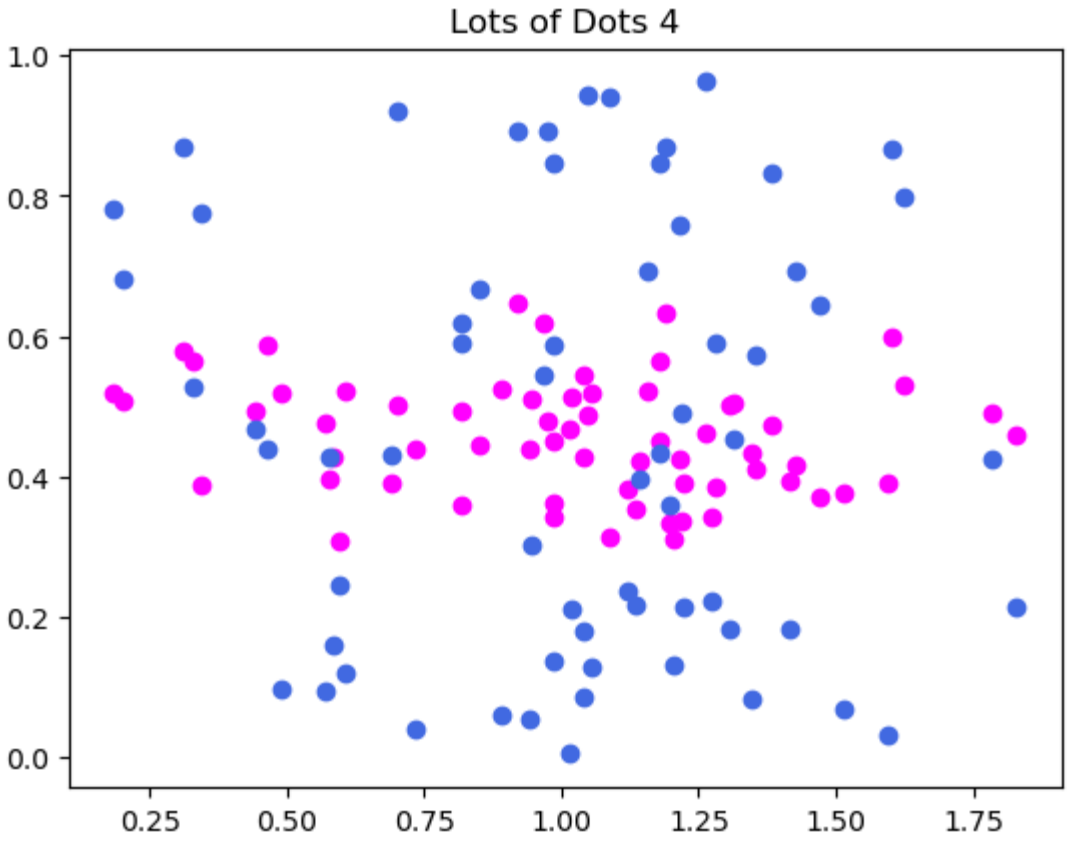
In [22]:
```
plt.scatter(x.T[2], my_mod_vis, c = "magenta")
plt.scatter(x.T[2], y, c = "royalblue")
plt.title("Lots of Dots 3")
```

Out[22]:
```
Text(0.5, 1.0, 'Lots of Dots 3')
```



In [23]:
```
plt.scatter(x.T[3], my_mod_vis, c = "magenta")
plt.scatter(x.T[3], y, c = "royalblue")
plt.title("Lots of Dots 4")
```

Out[23]:
```
Text(0.5, 1.0, 'Lots of Dots 4')
```



4. Read in `mlnn/data/Credit.csv` with Pandas and build a Linear Regression model to predict Credit Rating (`Rating`). Use only the numeric columns in your model, but feel free to experiment which which columns you believe are better predicters of Credit Rating (Column `Rating`)

In [49]:
```
import pandas as pd
import numpy as np
credit = pd.read_csv('../data/Credit.csv')
credit.head()
```

Out[49]:

	Unnamed: 0	Income	Limit	Rating	Cards	Age	Education	Gender	Student	Married	Ethn
0	1	14.891	3606	283	2	34	11	Male	No	Yes	Cauca
1	2	106.025	6645	483	3	82	15	Female	Yes	Yes	A
2	3	104.593	7075	514	4	71	11	Male	No	No	A
3	4	148.924	9504	681	3	36	11	Female	No	No	A
4	5	55.882	4897	357	2	68	16	Male	No	Yes	Cauca

Choose multiple columns as inputs beyond `Income` and `Limit` but clearly, don't use `Rating`

In [50]:
```
columns = ['Income', 'Limit', "Education", "Balance"]
X = credit[columns].values

X = np.vstack([X.T, np.ones(len(X))]).T
X
```

Out[50]:
```
array([[1.48910e+01, 3.60600e+03, 1.10000e+01, 3.33000e+02, 1.00000e+00],
       [1.06025e+02, 6.64500e+03, 1.50000e+01, 9.03000e+02, 1.00000e+00],
       [1.04593e+02, 7.07500e+03, 1.10000e+01, 5.80000e+02, 1.00000e+00],
       ...,
       [5.78720e+01, 4.17100e+03, 1.20000e+01, 1.38000e+02, 1.00000e+00],
       [3.77280e+01, 2.52500e+03, 1.30000e+01, 0.00000e+00, 1.00000e+00],
       [1.87010e+01, 5.52400e+03, 7.00000e+00, 9.66000e+02, 1.00000e+00]])
```

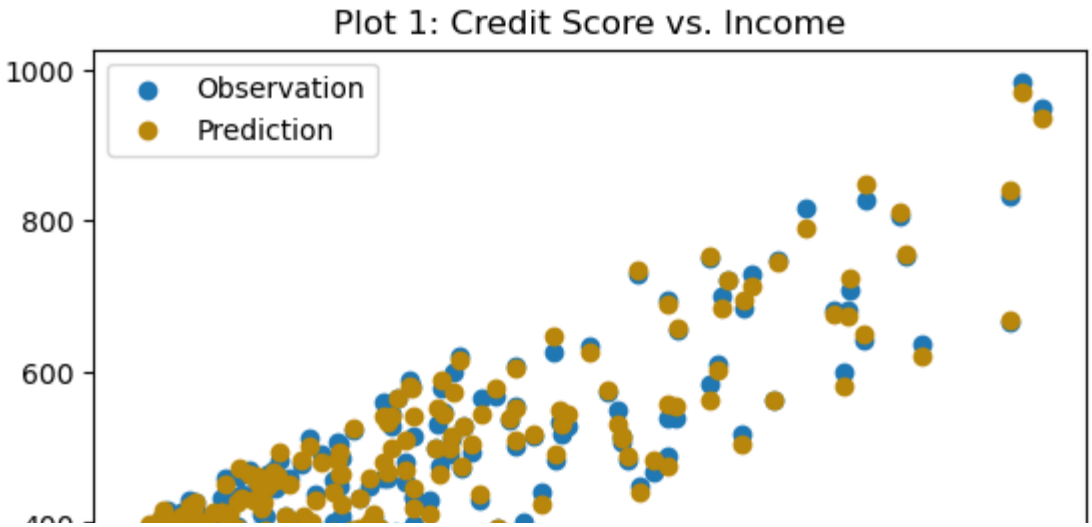
In [51]:
```
y = credit['Rating']
```

Out[51]:
```
0      283
1      483
2      514
3      681
4      357
      ...
395    307
396    296
397    321
398    192
399    415
Name: Rating, Length: 400, dtype: int64
```

5. Plot your results using scatter plots (just like in class). Show as many of your columns vs. credit rating that you can.

In [55]:
```
left = np.linalg.inv(np.dot(X.T, X))
right = np.dot(y.T, X)
print("dot product: ", np.dot(left, right))
beta = np.dot(left, right)

pred = np.dot(X, beta)

#Plot 1
plt.scatter(X.T[0], y, label = "Observation")
plt.scatter(X.T[0], pred, c='darkgoldenrod', label = "Prediction")
plt.title("Plot 1: Credit Score vs. Income")
plt.legend()
plt.show()

#Plot 2
plt.scatter(X.T[1], y, label = "Observation")
plt.scatter(X.T[1], pred, c='darkgoldenrod', label = "Prediction")
plt.title("Plot 2: Credit Score vs. Limit")
plt.legend()
plt.show()

#Plot 3
plt.scatter(X.T[2], y, label = "Observation")
plt.scatter(X.T[2], pred, c='darkgoldenrod', label = "Prediction")
plt.title("Plot 3: Credit Score vs. Education")
plt.legend()
plt.show()

#Plot 4
plt.scatter(X.T[3], y, label = "Observation")
plt.scatter(X.T[3], pred, c='darkgoldenrod', label = "Prediction")
plt.title("Plot 4: Credit Score vs. Balance")
plt.legend()
plt.show()
```

```
dot product:  [ 1.34036346e-01  6.26373011e-02 -3.43052578e-01  1.487
96968e-02
  4.91302144e+01]
```



In [ ]: