FRAUD DETECTION IN PYTHON

Normal versus abnormal behaviour

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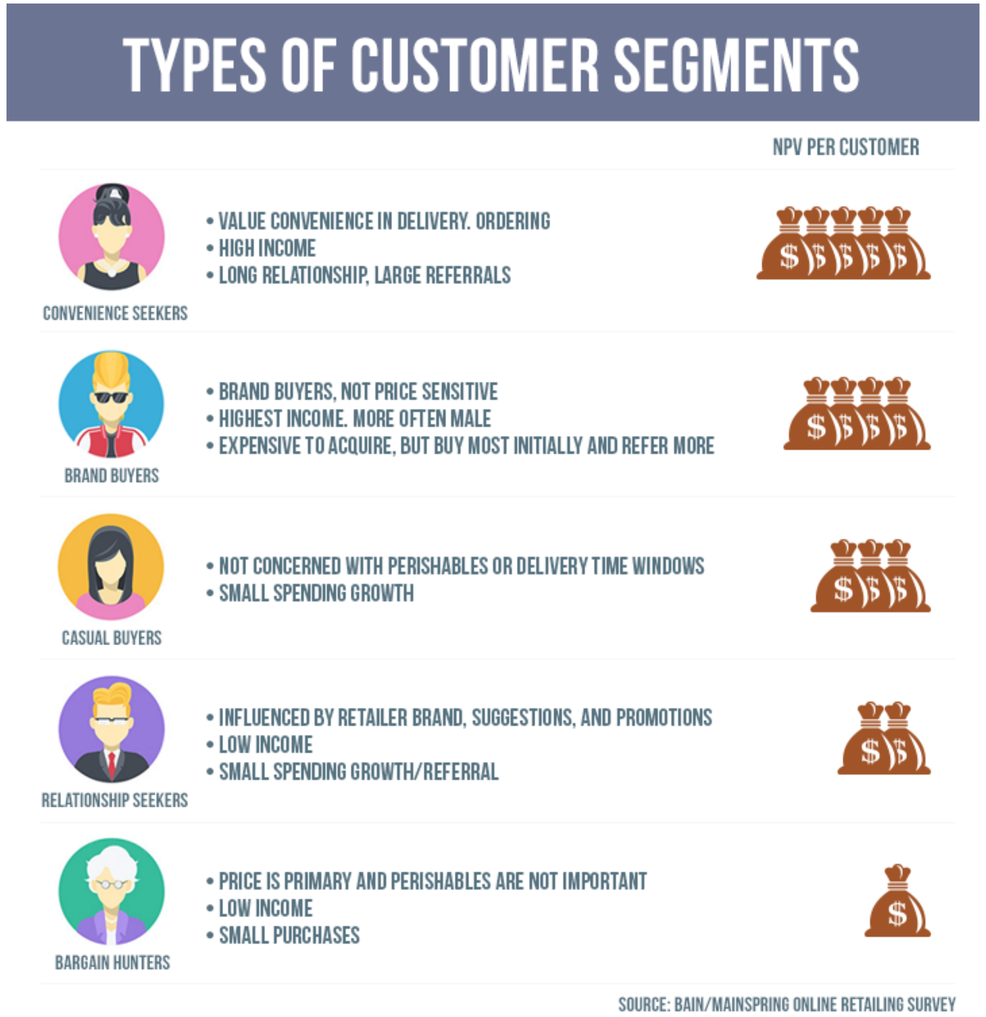
Fraud detection without labels

- Using unsupervised learning to distinguish normal from abnormal behaviour
- Abnormal behaviour by definition is not always fraudulent
- Challenging because difficult to validate
- But...realistic because very often you don't have reliable labels

What is normal behaviour?

- Thoroughly describe your data: plot histograms, check for outliers, investigate correlations and talk to the fraud analyst
- Are there any known historic cases of fraud? What typifies those cases?
- Normal behaviour of one type of client may not be normal for another
- Check patterns within subgroups of data: is your data homogenous?

Customer segmentation: normal behaviour within segments



TYPES OF CUSTOMER SEGMENTS

		NPV PER CUSTOMER
CONVENIENCE SEEKERS	• VALUE CONVENIENCE IN DELIVERY. ORDERING • HIGH INCOME • LONG RELATIONSHIP, LARGE REFERRALS	$$$$$
BRAND BUYERS	• BRAND BUYERS, NOT PRICE SENSITIVE • HIGHEST INCOME. MORE OFTEN MALE • EXPENSIVE TO ACQUIRE, BUT BUY MOST INITIALLY AND REFER MORE	$$$$
CASUAL BUYERS	• NOT CONCERNED WITH PERISHABLES OR DELIVERY TIME WINDOWS • SMALL SPENDING GROWTH	$$$
RELATIONSHIP SEEKERS	• INFLUENCED BY RETAILER BRAND, SUGGESTIONS, AND PROMOTIONS • LOW INCOME • SMALL SPENDING GROWTH/REFERRAL	$$
BARGAIN HUNTERS	• PRICE IS PRIMARY AND PERISHABLES ARE NOT IMPORTANT • LOW INCOME • SMALL PURCHASES	$

SOURCE: BAIN/MAINSPRING ONLINE RETAILING SURVEY

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Let's practice!

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Refresher on clustering methods

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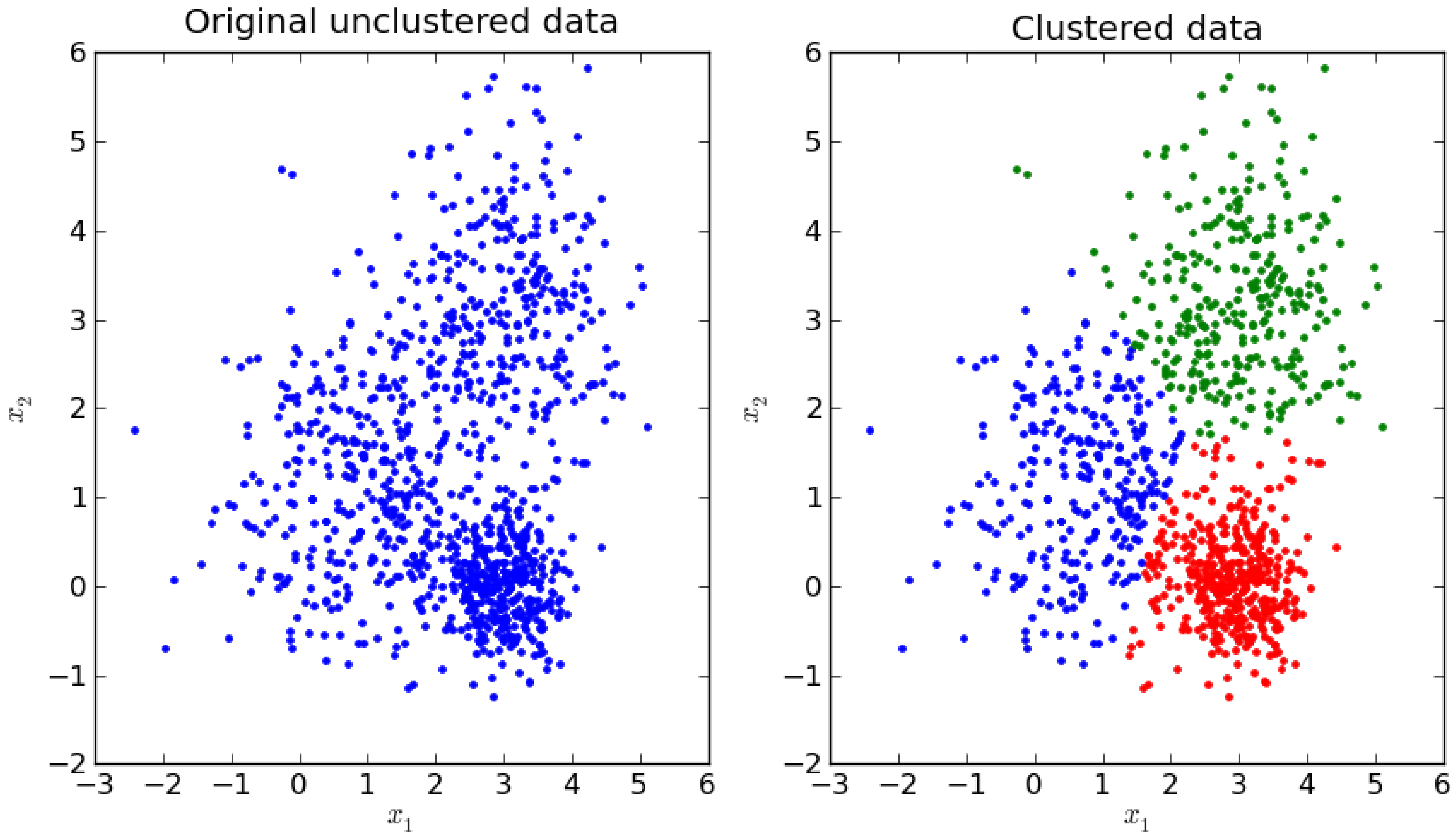
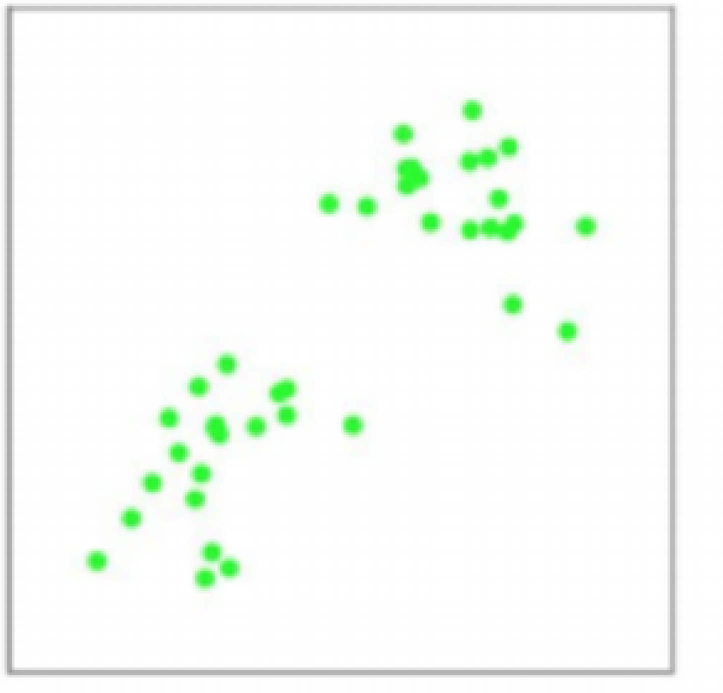
Clustering: trying to detect patterns in data

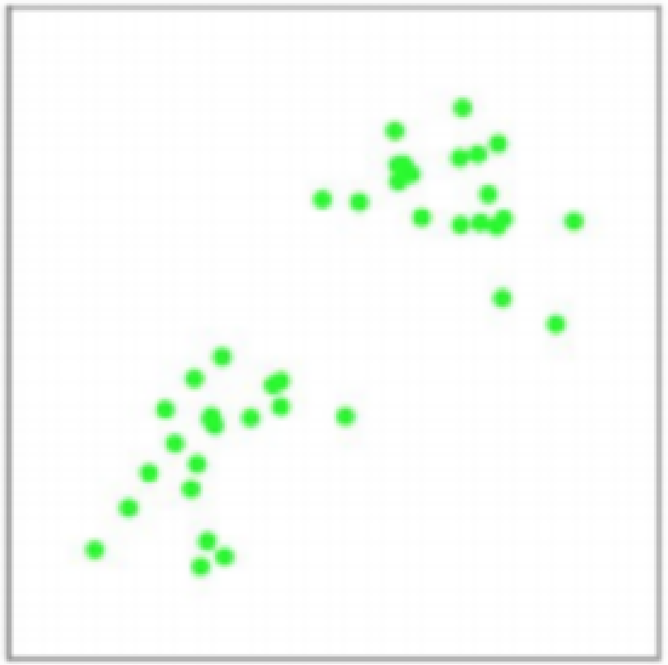


K-means clustering: using the distance to cluster centroids



A

K-means clustering: using the distance to cluster centroids



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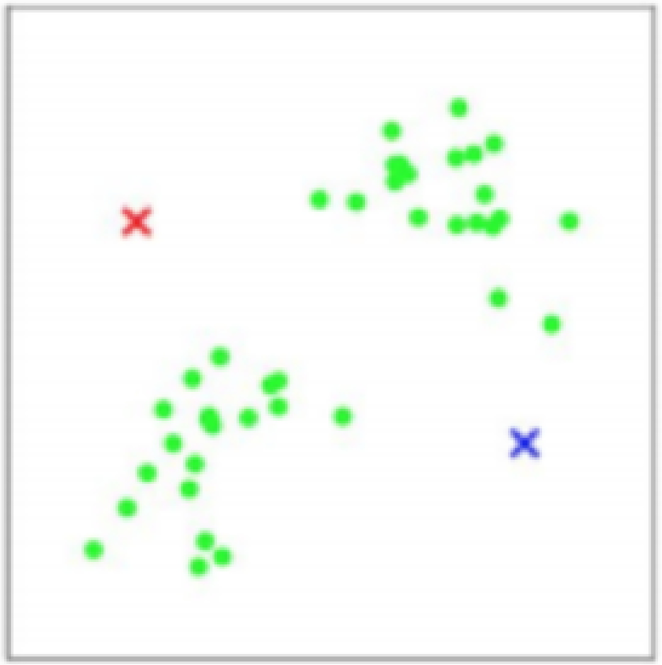
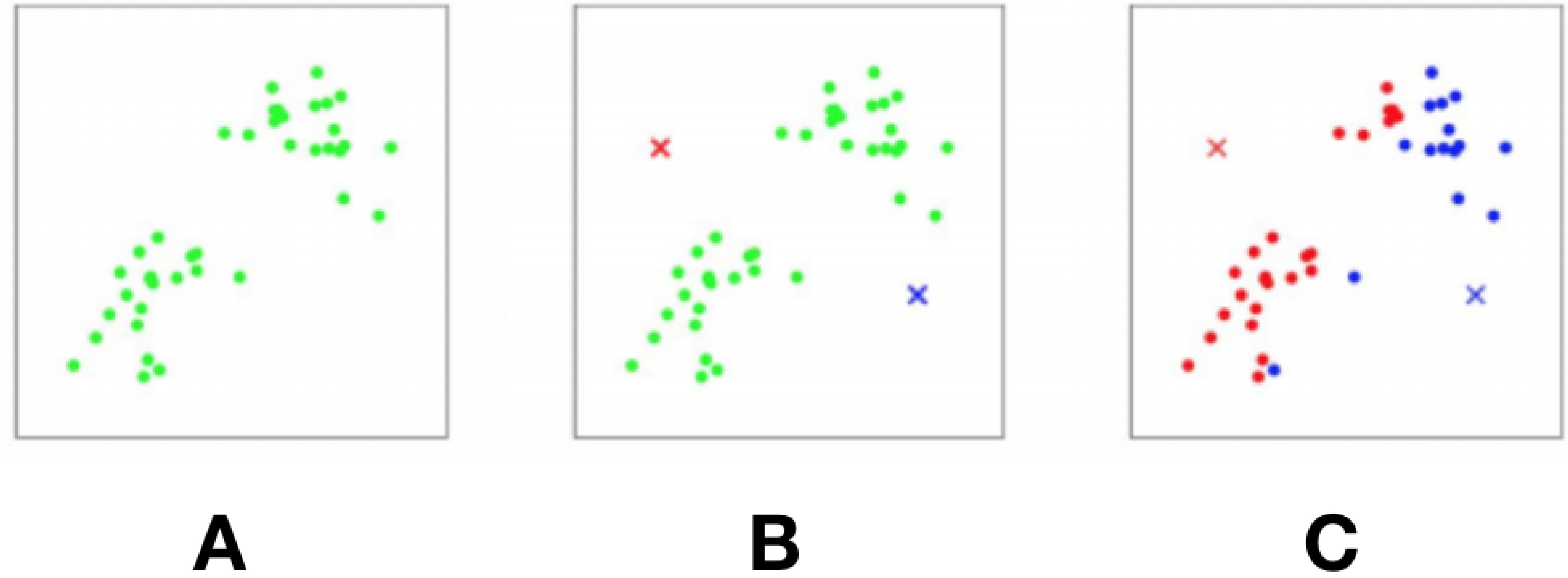
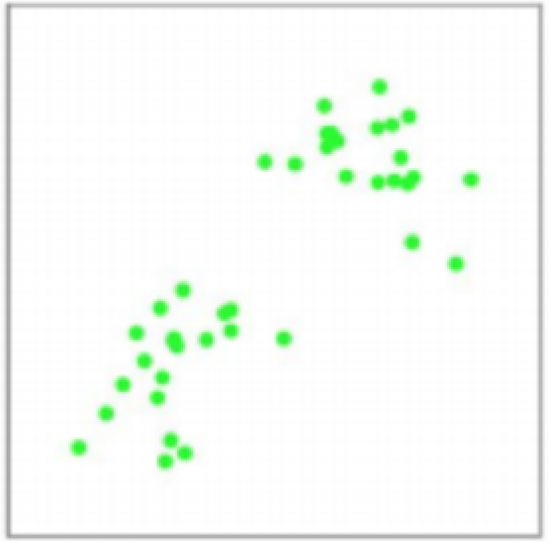


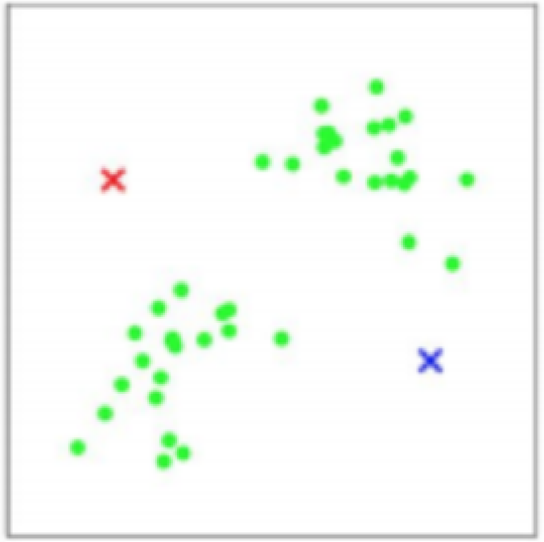
B

K-means clustering: using the distance to cluster centroids





A



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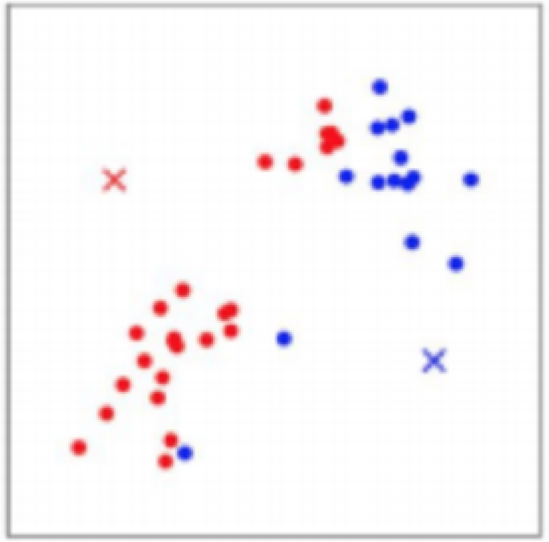

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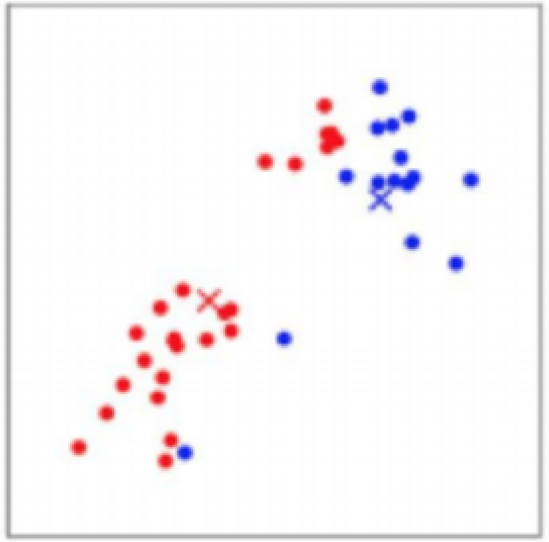
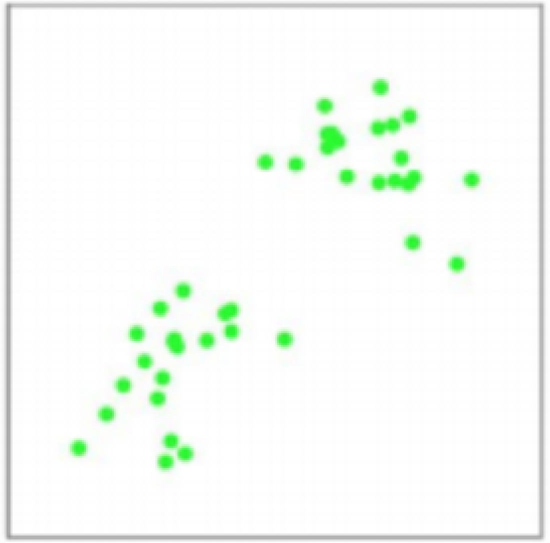
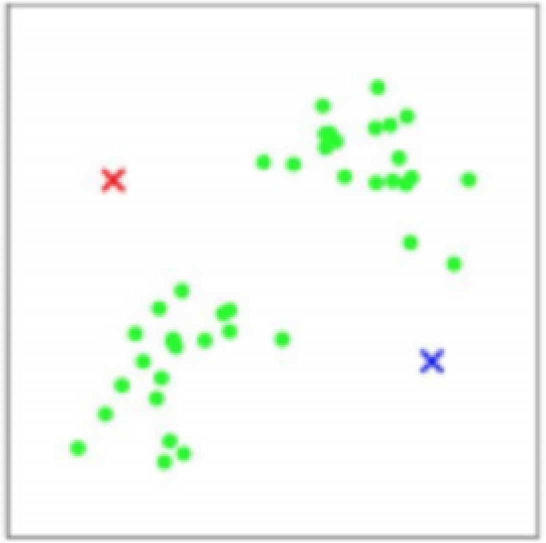


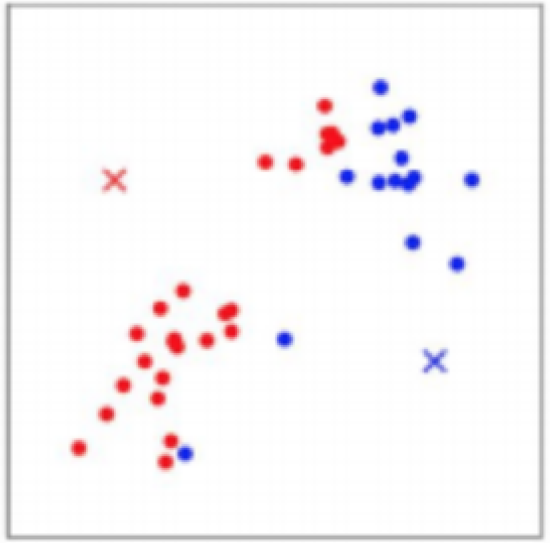
D



A



B



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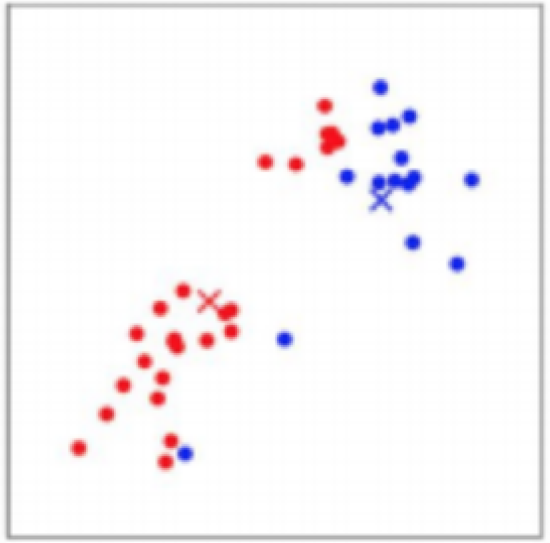

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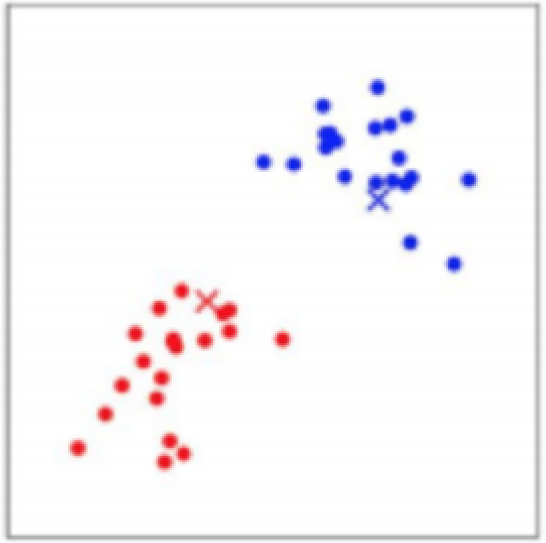
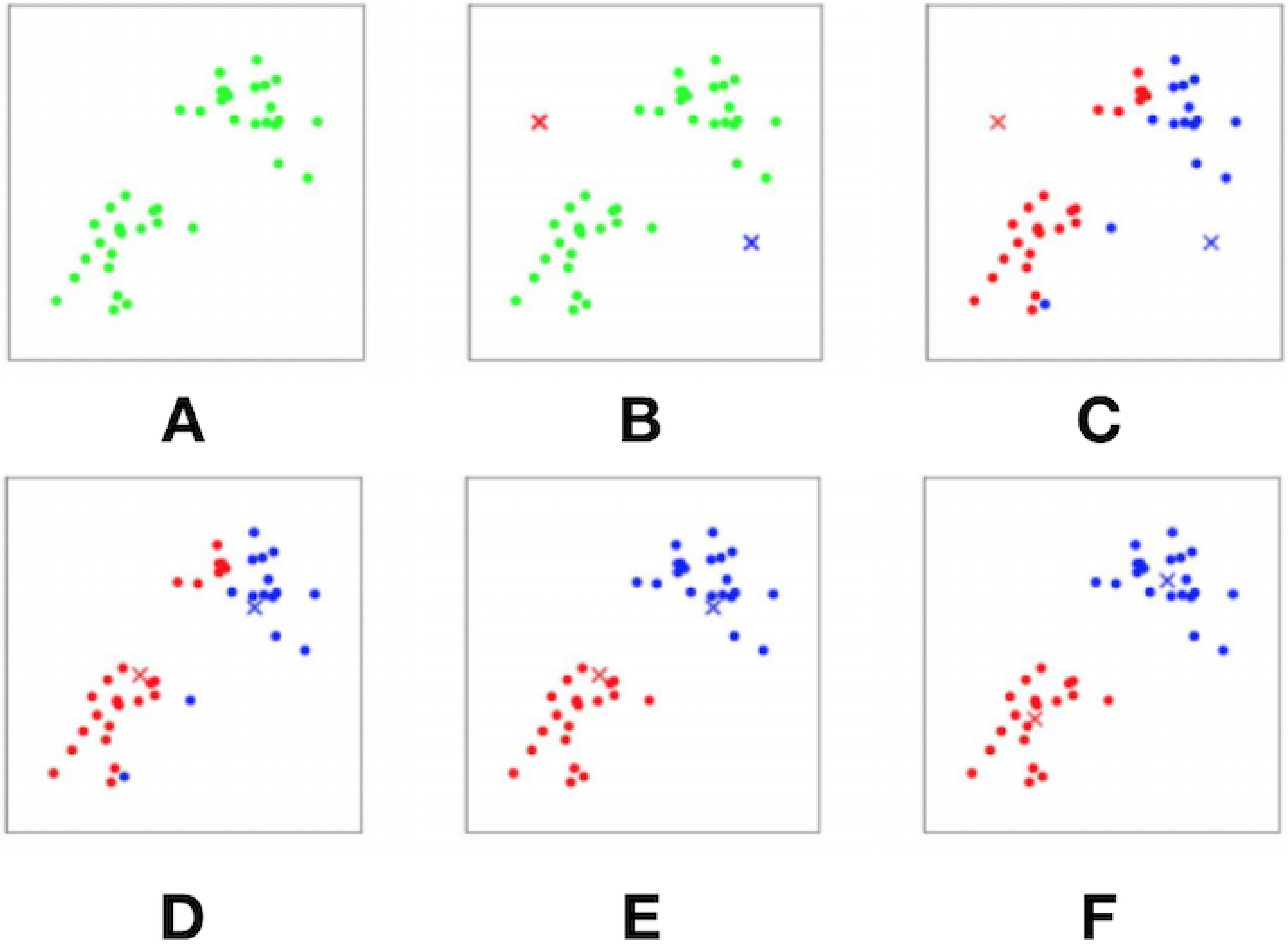


E


A
B
C
D
E
F

K-means clustering in Python

```
# Import the packages
from sklearn.preprocessing import MinMaxScaler
from sklearn.cluster import KMeans

# Transform and scale your data
X = np.array(df).astype(np.float)

scaler = MinMaxScaler()
X_scaled = scaler.fit_transform(X)

# Define the k-means model and fit to the data
kmeans = KMeans(n_clusters=6, random_state=42).fit(X_scaled)
```

The right amount of clusters

Checking the number of clusters:

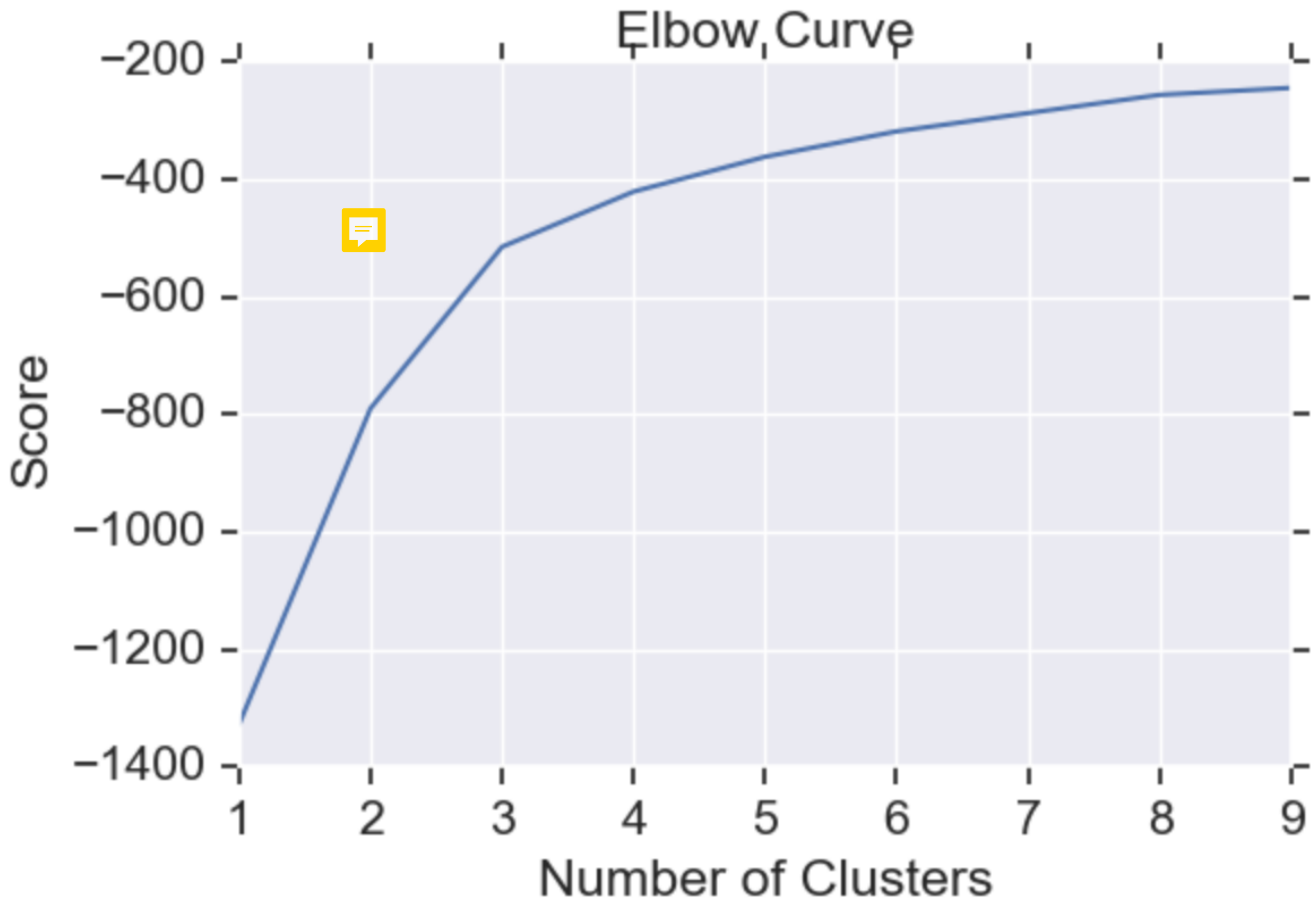
- Silhouette method
- Elbow curve

```
clust = range(1, 10)
kmeans = [KMeans(n_clusters=i) for i in clust]

score = [kmeans[i].fit(X_scaled).score(X_scaled) for i in range(len(kmeans))]
```

```
plt.plot(clust,score)
plt.xlabel('Number of Clusters')
plt.ylabel('Score')
plt.title('Elbow Curve')
plt.show()
```

The Elbow Curve



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Assigning fraud versus non-fraud cases

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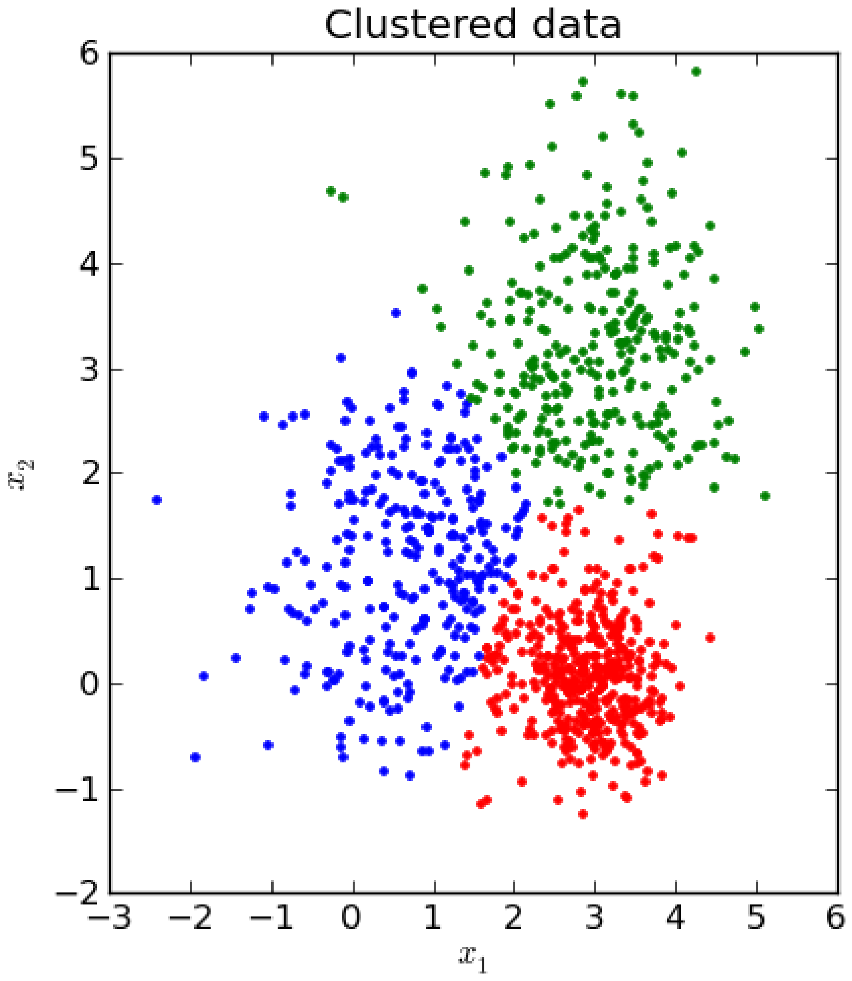
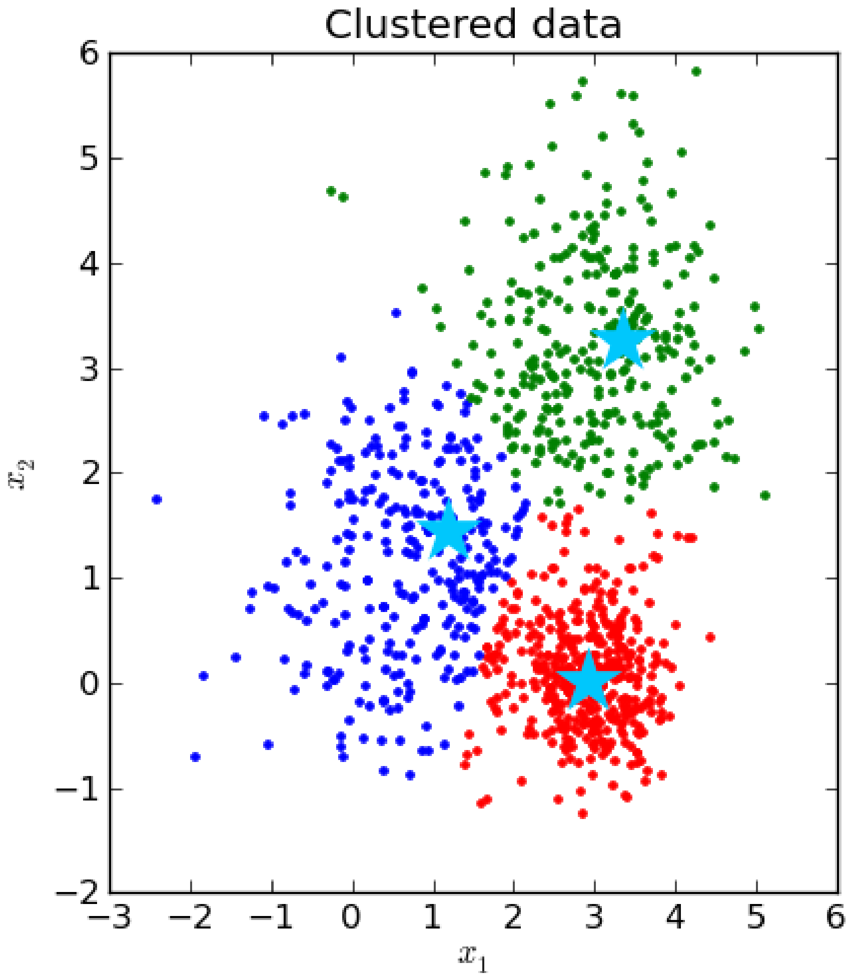
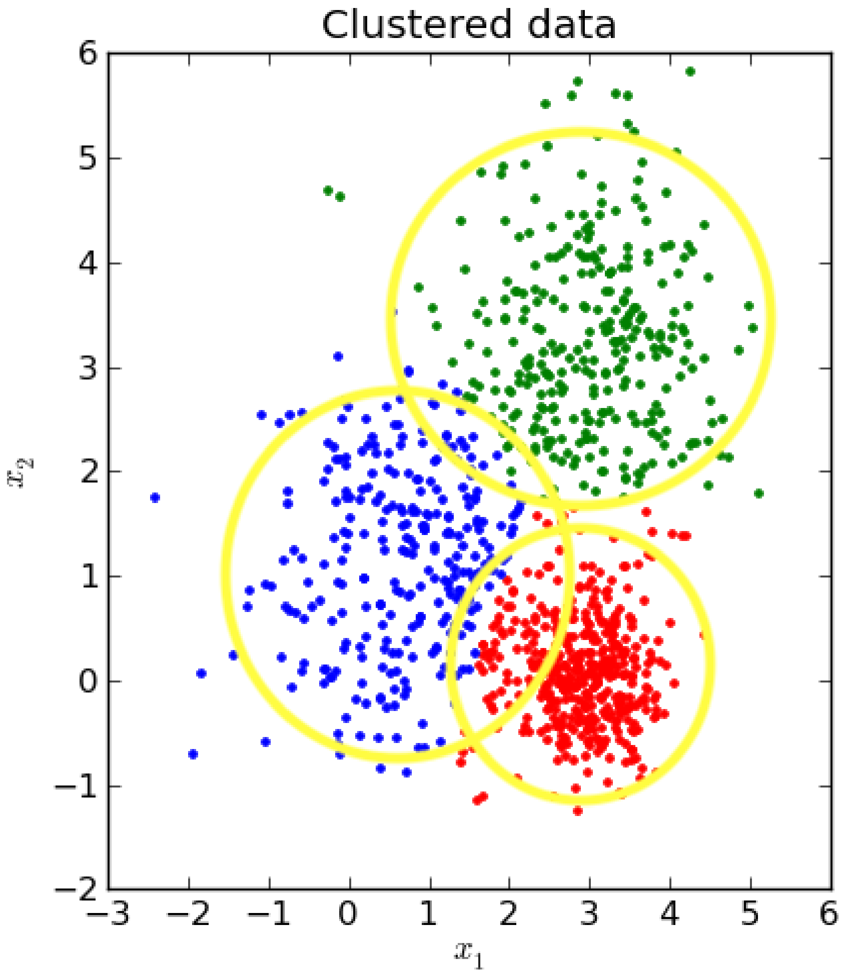
Starting with clustered data



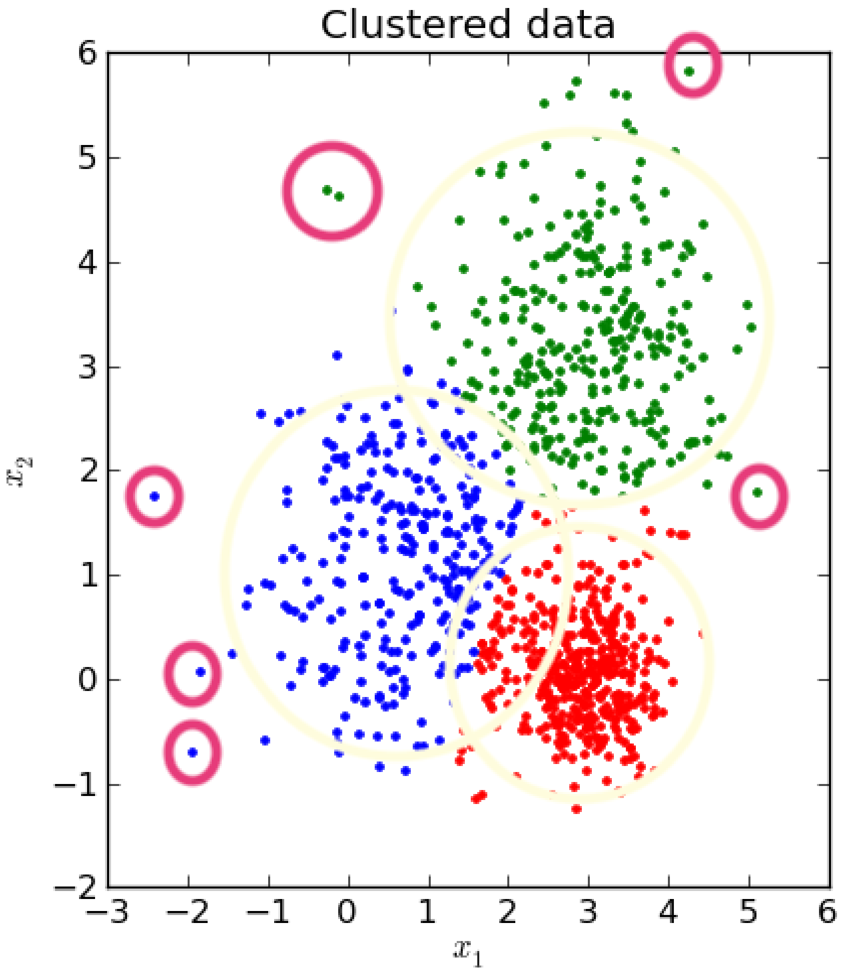
Assign the cluster centroids



Define distances from the cluster centroid



Flag fraud for those furthest away from cluster centroid



Flagging fraud based on distance to centroid

```
# Run the kmeans model on scaled data
kmeans = KMeans(n_clusters=6, random_state=42,n_jobs=-1).fit(X_scaled)

# Get the cluster number for each datapoint
X_clusters = kmeans.predict(X_scaled)

# Save the cluster centroids
X_clusters_centers = kmeans.cluster_centers_

# Calculate the distance to the cluster centroid for each point
dist = [np.linalg.norm(x-y) for x,y in zip(X_scaled,
X_clusters_centers[X_clusters])]

# Create predictions based on distance
km_y_pred = np.array(dist)
km_y_pred[dist>=np.percentile(dist, 93)] = 1
km_y_pred[dist<np.percentile(dist, 93)] = 0
```

Validating your model results

- Check with the fraud analyst
- Investigate and describe cases that are flagged in more detail
- Compare to past known cases of fraud

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Other clustering fraud detection methods

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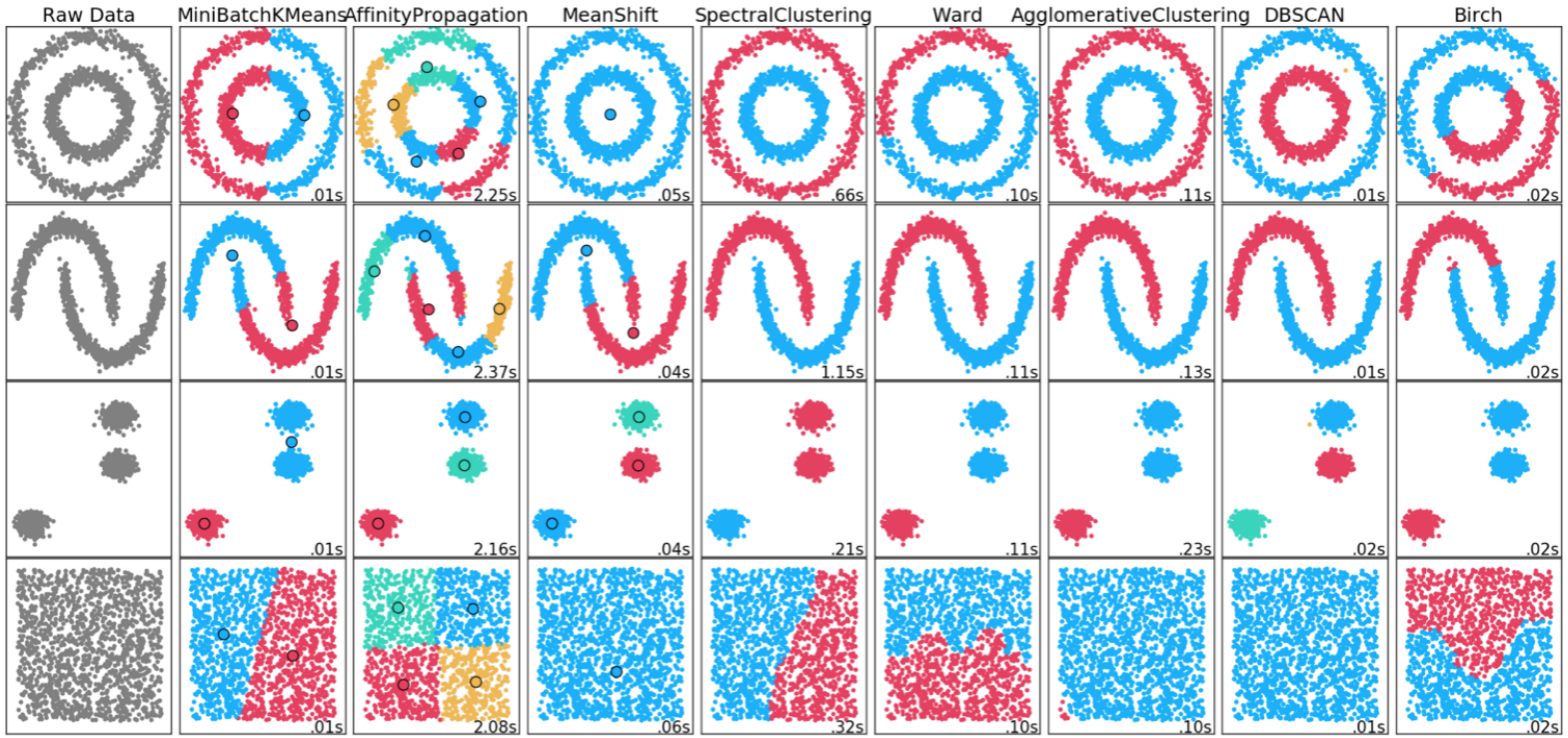
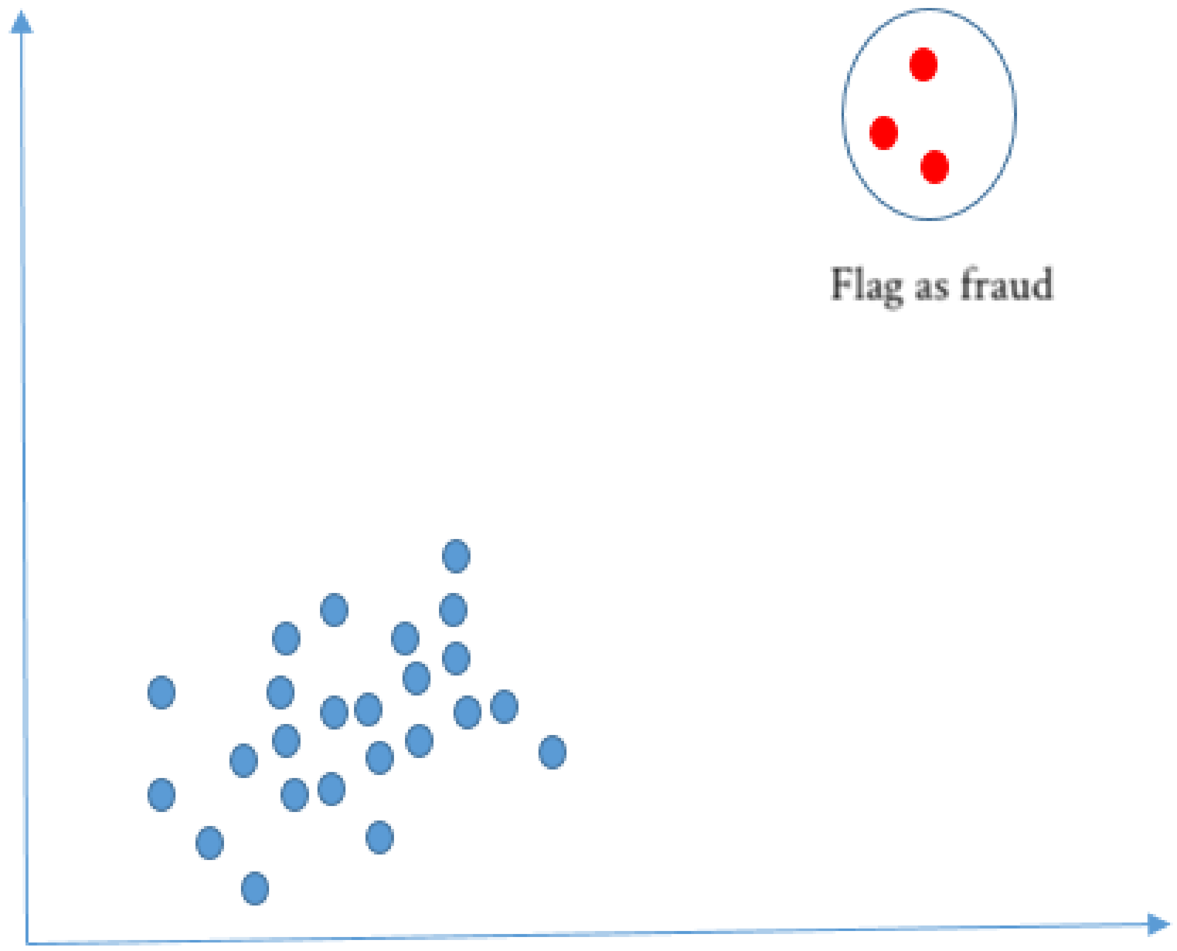
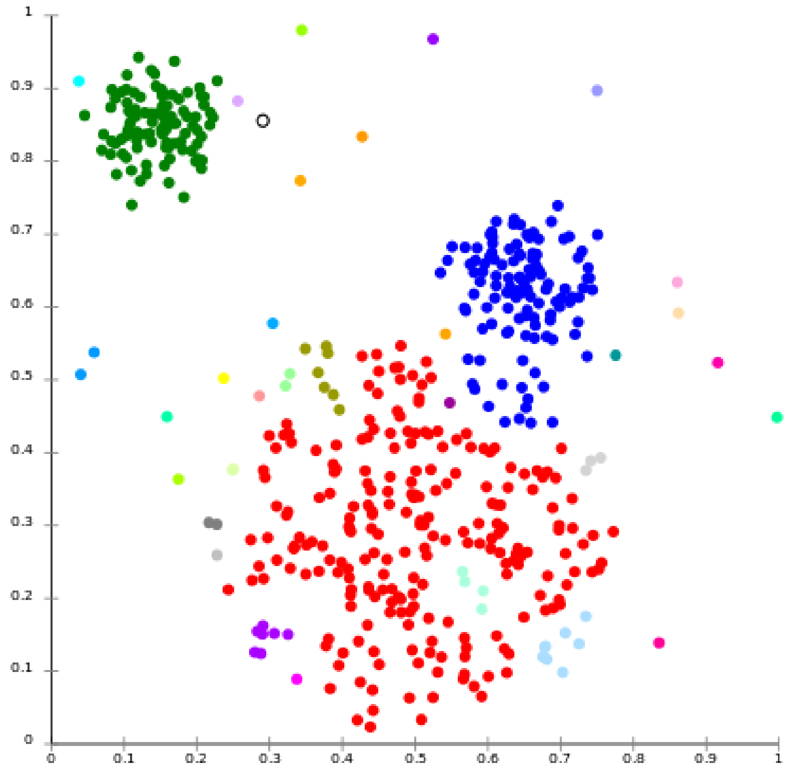
There are many different clustering methods



And different ways of flagging fraud: using smallest clusters



In reality it looks more like this



DBScan versus K-means

- No need to predefine amount of clusters
- Adjust maximum distance between points within clusters
- Assign minimum amount of samples in clusters
- Better performance on weirdly shaped data
- But..higher computational costs

Implementing DBscan

```
from sklearn.cluster import DBSCAN
db = DBSCAN(eps=0.5, min_samples=10, n_jobs=-1).fit(X_scaled)

# Get the cluster labels (aka numbers)
pred_labels = db.labels_

# Count the total number of clusters
n_clusters_ = len(set(pred_labels)) - (1 if -1 in pred_labels else 0)

# Print model results
print('Estimated number of clusters: %d' % n_clusters_)

Estimated number of clusters: 31
```

Checking the size of the clusters

```
# Print model results
print("Silhouette Coefficient: %0.3f"
      % metrics.silhouette_score(X_scaled, pred_labels))

Silhouette Coefficient: 0.359

# Get sample counts in each cluster
counts = np.bincount(pred_labels[pred_labels>=0])
print (counts)

[ 763  496  840  355 1086  676   63  306  560  134   28   18  262  128  332
   22   22   13   31   38   36   28   14   12   30   10   11   10   21   10
    5]
```

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