Isolation Forest

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Cases

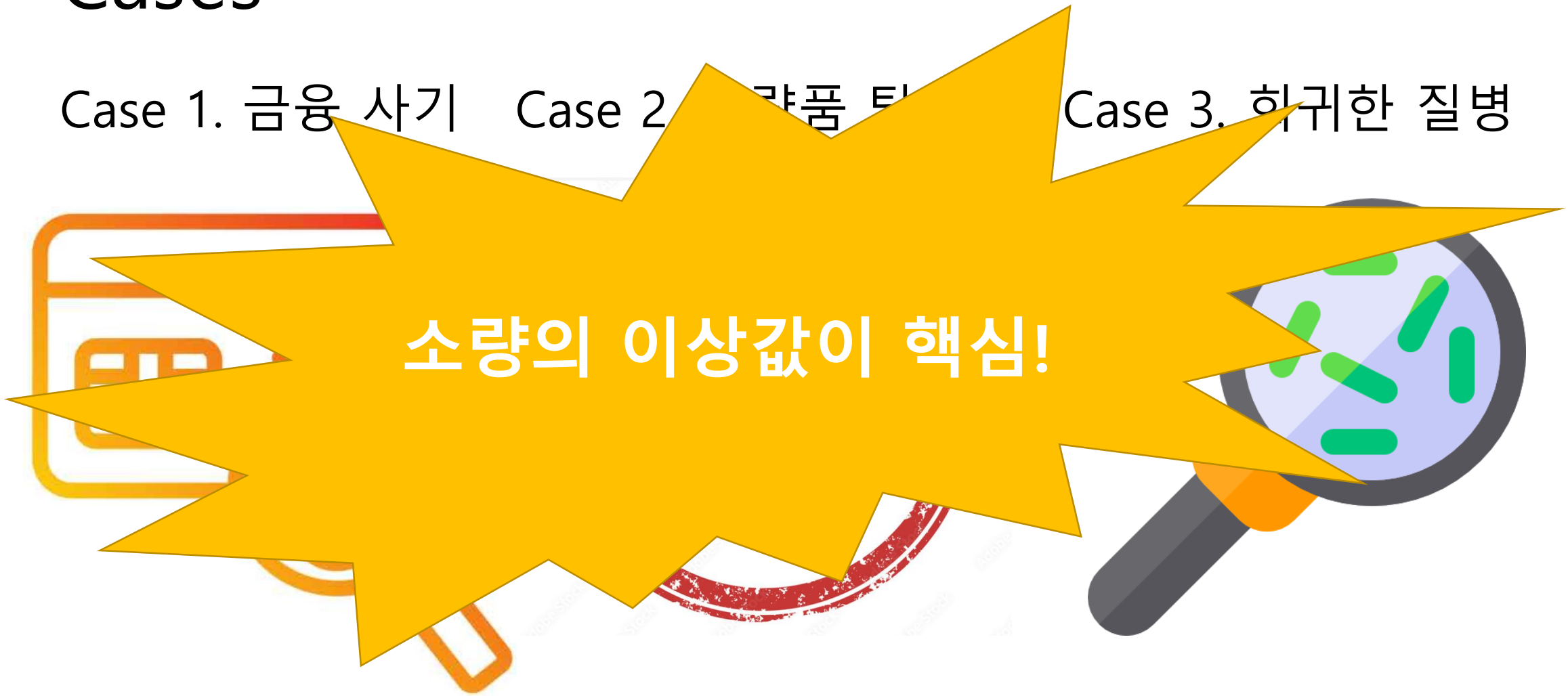
Case 1. 금융 사기

Case 2. 불량품 탐지

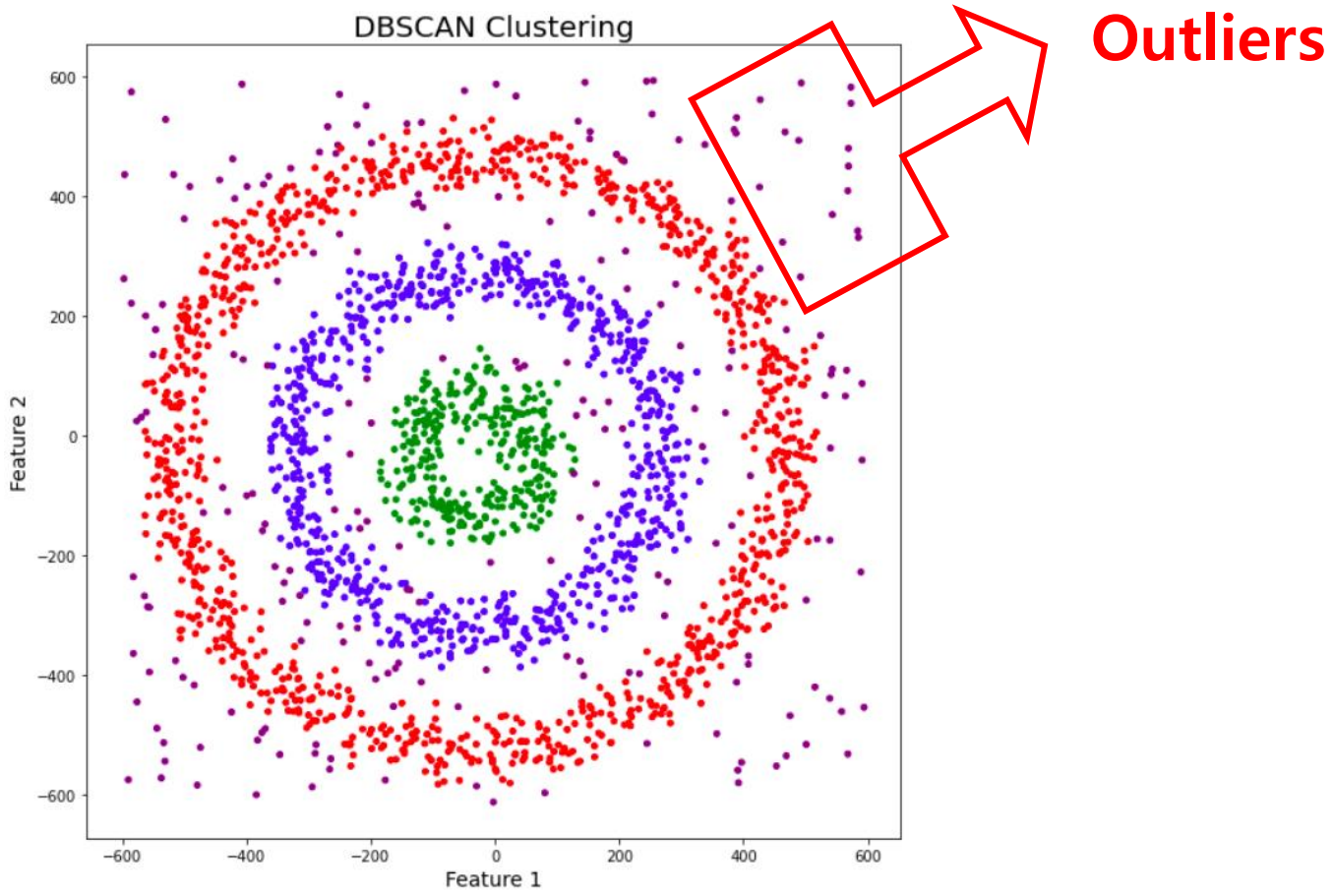
Case 3. 희귀한 질병

Cases

Case 1. 금융 사기　Case 2.　　Case 3. 희귀한 질병

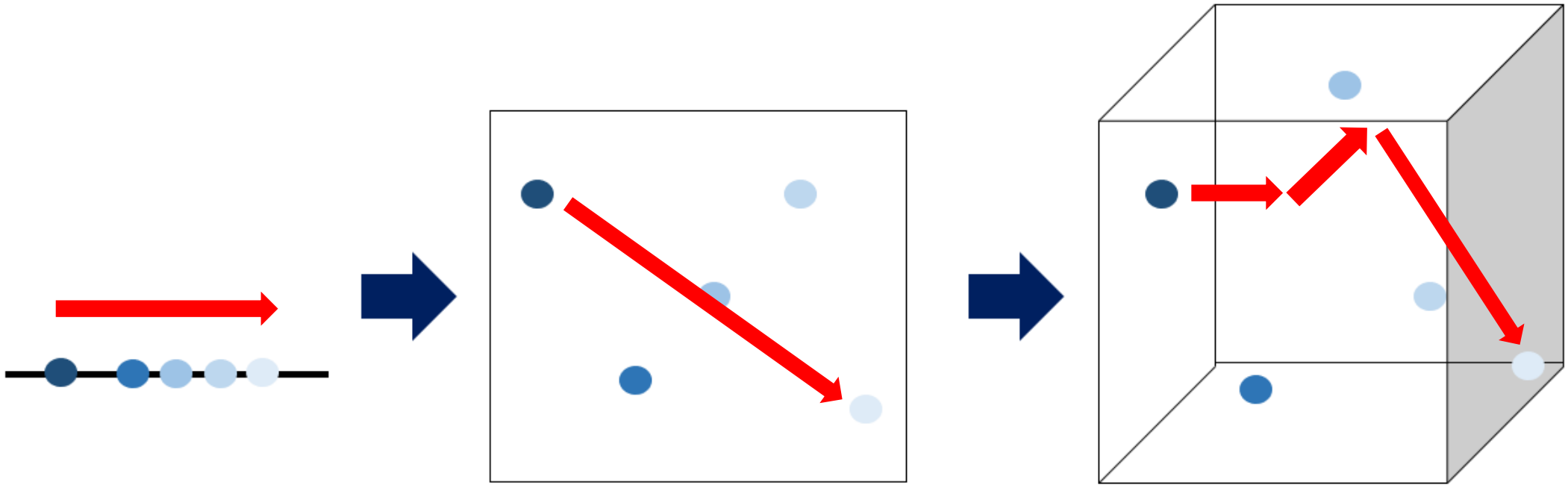


DBSCAN Algorithm



https://miro.medium.com/v2/resize:fit:875/0*PAjsvIpK5dmNXfM0.png

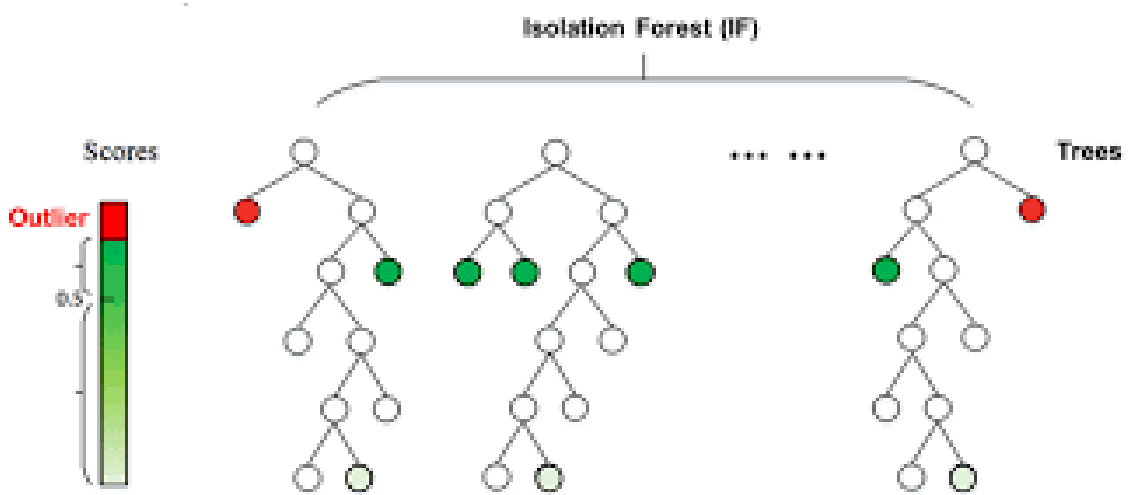
Problem of DBSCAN, Dimensional Curse



https://blog.kakaocdn.net/dn/6g8f5/btqv0yFthYE/NqRQzG0fTTuhYxeCJe865k/img.png

Division, instead of Distance

1. Based on decision tree
2. Add random forest concept
3. Assume that outliers may be detected with a little division



Process

- **Step 1. Select Random data points for training**
  - Prevent masking(When outliers are clustered together and are mistaken for normal)
- **Step 2. Partition the data until each data point become unique**
  - Using random features (difference from decision tree)
- **Step 3. Calculate the number of divisions of each data**
  - It will be used in calculating **anomaly score**

Process

- **Step 4. Create multiple trees randomly**
  - Concept of random forest

- **Step 5. Calculate the anomaly score**

$$s(x,n) = 2^{-\frac{E(h(x))}{c(n)}} \qquad s(x,n) = \begin{cases} 1 & \text{if } E(h(x)) = 0 \\ 0.5 & \text{if } E(h(x)) = c(n) \\ 0 & \text{if } E(h(x)) = n-1 \end{cases}$$

  - E(h(x)) = (average number of divisions for each data x)
  - C(n) = (average number of division for every data)
  - Example1) E(h(x)) increasing gradually -> $2^{-\infty}$ ≒ 0
  - Example2) E(h(x)) decreasing gradually -> 2^{-0} ≒ 1

Toy Example

- Iris data(150) + Outlier data(10)
  - Add column (Iris = 1, Outlier = -1)

```
IsolationForest(n_estimators=100, max_samples=256, contamination=0.0625, random_state=19)
```

  - n_estimators: number of decision trees
  - max_samples: number of data to use
  - contamination: Detecting outlier rate

Fig1

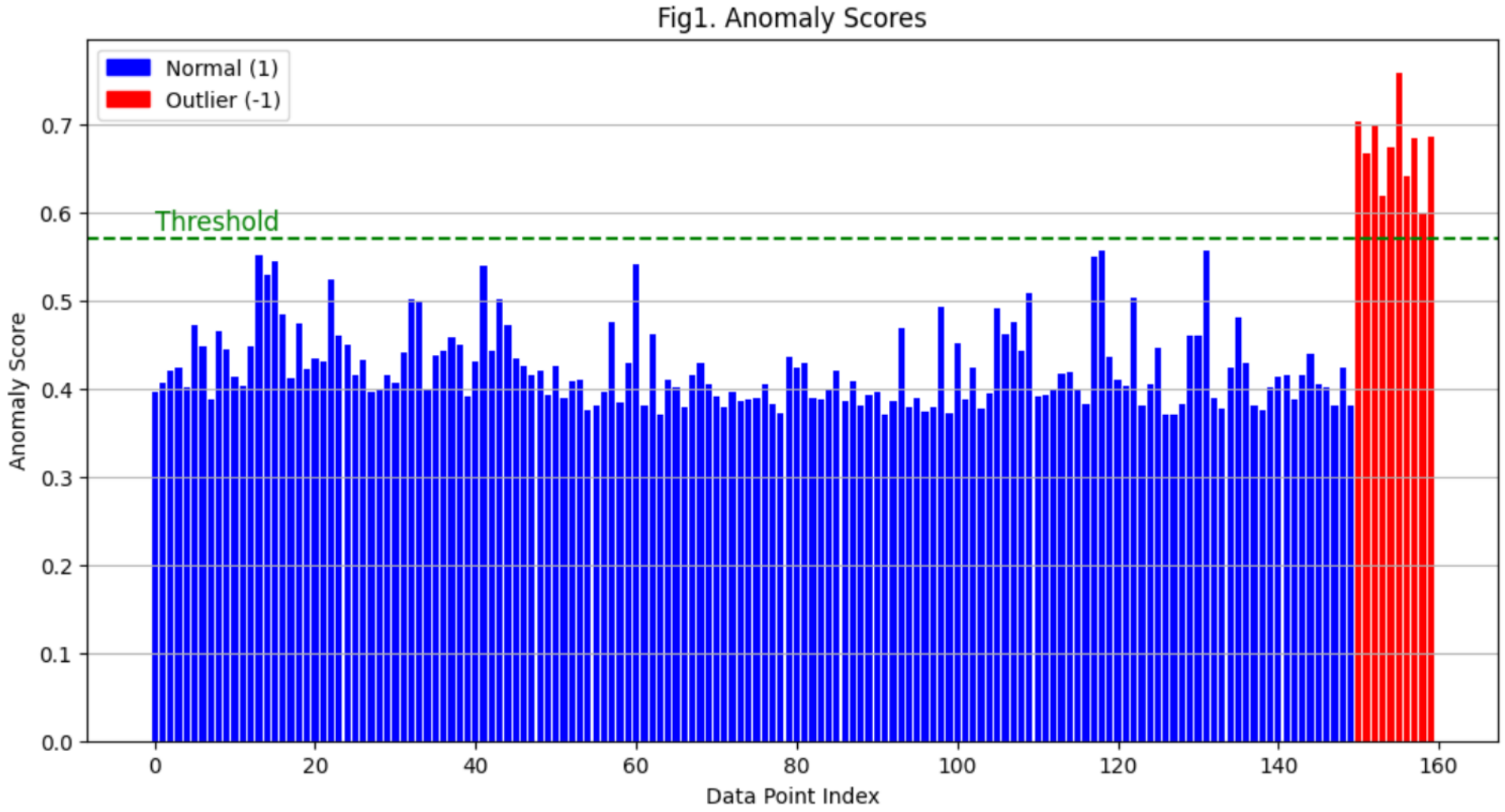


Fig1. Anomaly Scores
Normal (1)
Outlier (-1)
Threshold
Anomaly Score
Data Point Index
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
20
40
60
80
100
120
140
160

Fig2

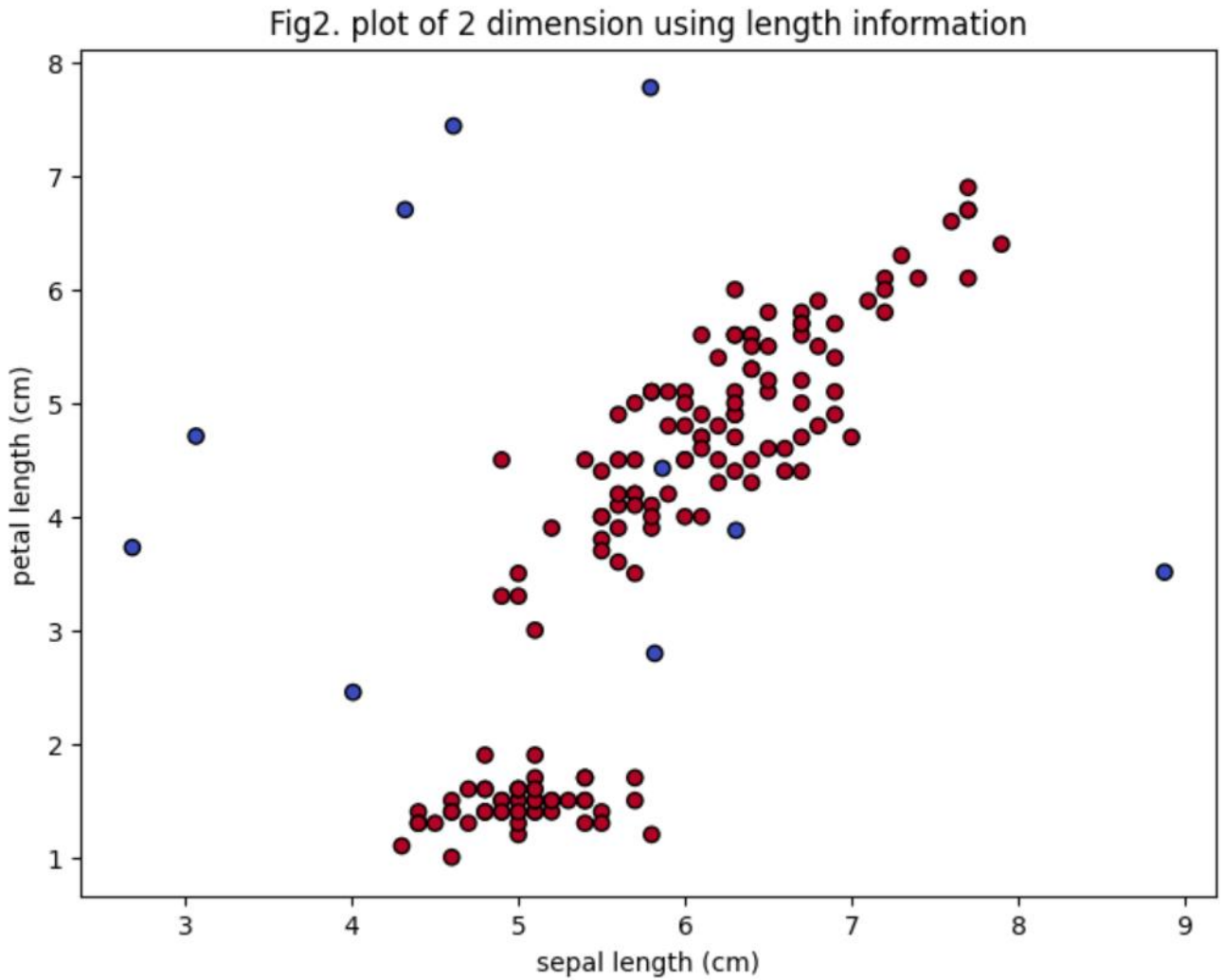


Fig2. plot of 2 dimension using length information
petal length (cm)
sepal length (cm)
1
2
3
4
5
6
7
8
3
4
5
6
7
8
9

Reality Example

- Creditcard data(Normal=170,614 / Outlier=136 / %=0.0797)

```
IsolationForest(n_estimators=200, contamination="auto",
```

```
Time taken to train the model: 0.50seconds

<Evaluation of Isolation Forest>
[[82542  2765]
 [   23   113]]

Accuracy: 0.9674
Precision: 0.0393
Recall: 0.8309
```

```
dbscan = DBSCAN(eps=2, min_samples=3)
```

```
Time taken to train the model: 91.98seconds

<Evaluation of DBSCAN>
[[41052 44255]
 [    8   128]]

Accuracy: 0.4820
Precision: 0.0029
Recall: 0.9412
```

comparison

- Isolation Forest
  - Good in both time and accuracy
  - FP(2,765) > FN(23) -> Find as many fraud cases as possible

- DBSCAN
  - Accuracy 50% means randomly choose
  - Improvement: decrease the number of outlier detection
    -> eps=2 is too short to make large group (curse of dimension)
    -> time, and memory are consumed more

More information..

- E-mail: verysp129@handing.ac.kr
- Github: https://github.com/jayjo9/bigdata_design