INFS 5102 – Unsupervised Methods in Analytics

Practical #7: Anomaly Detection

1. Assume that the given data follows a normal distribution. Use the 3-sigma method to detect if there are outliers in this dataset. List the outlier(s) and present the steps in your answer (e.g.,how you calculated / what approach you used to detect the outlier(s)). (Hint: calculate the mean and standard deviation of the data set and decide the outlier using the individual value's z-score)

Methodology

The 3-sigma method employs the following steps:

1. **Calculate Mean and Standard Deviation**: The average (μ) and standard deviation (σ) of the dataset are calculated.

$$\text{Mean}(\mu) = \frac{\sum x}{n}$$

$$\text{Standard Deviation}(\sigma) = \sqrt{\frac{\sum (x-\mu)^2}{n}}$$

2. **Compute Z-score**: The Z-score for each data point x is calculated using the formula:

$$Z = \frac{x-\mu}{\sigma}$$

3. **Identify Outliers**: Data points with an absolute Z-score greater than 3 are considered outliers.

Analysis

Calculate Mean and Standard Deviation

After loading the dataset, the mean and standard deviation were calculated to be:

- Mean (μ) = 1.7355

- Standard Deviation (σ) = 0.107

Compute Z-score

The Z-score for each data point was calculated using the formula mentioned above.

Identify Outliers

Upon computing the Z-scores, it was found that a single data point with a value of 2.12 had a Z-score of approximately 3.600, thereby qualifying as an outlier as per the 3-sigma rule.

Visualization Explanation

The plot visualizes the data points, the mean (red dashed line), and the 3-sigma bounds (green dashed lines). The outlier is highlighted in red.

- **Data Points**: Represented as blue dots.
- **Mean**: The red dashed line indicates the mean value ($\mu = 1.7355$).
- **3-Sigma Bounds**: The green dashed lines indicate $\mu \pm 3\sigma$.
- **Outliers**: Highlighted in red, the outlier has a value of 2.12.

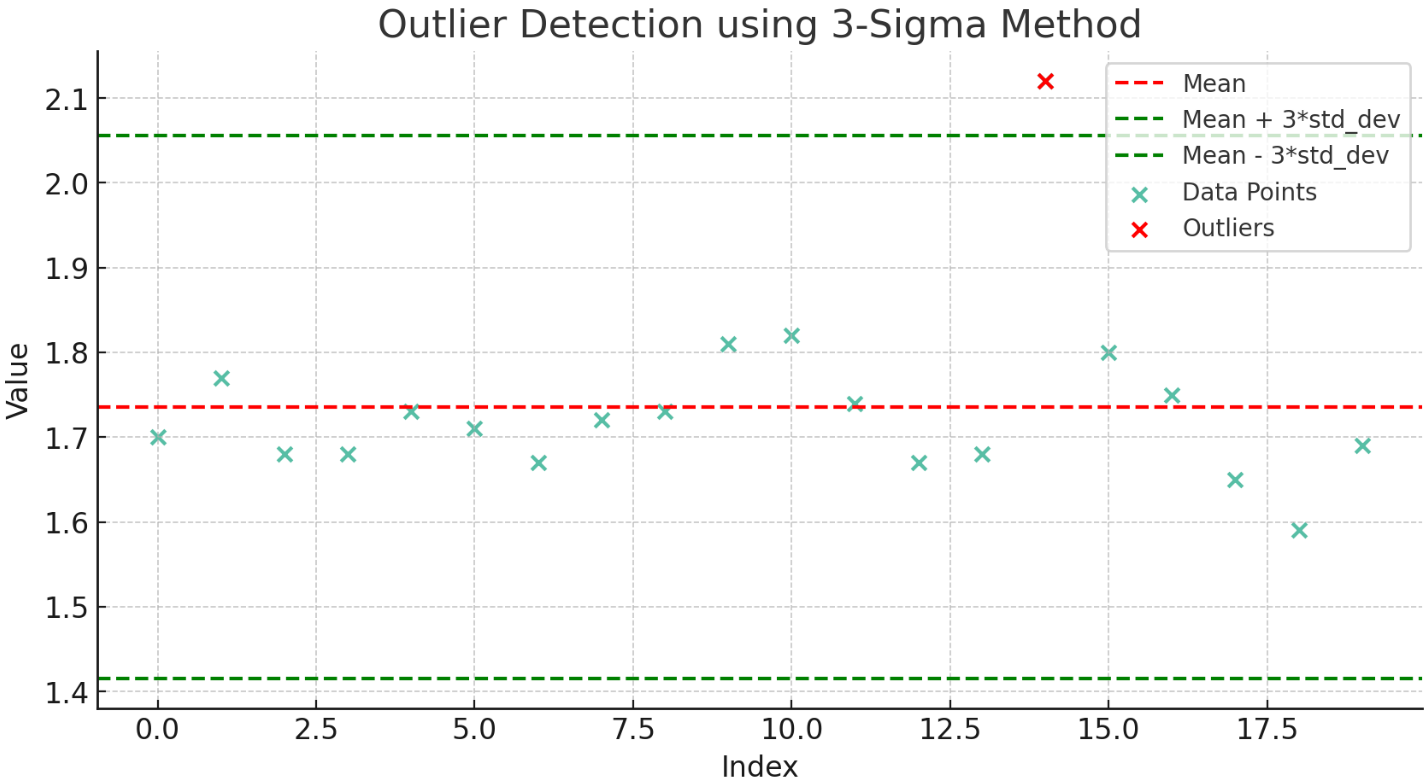


Figure 1. Data points and the identified outlier. The red x that above the $\mu \pm 3\sigma$ represent the outlier in the data.

The 3-sigma method was employed to detect an outlier in the dataset. The outlier has a value of 2.12 and a Z-score of approximately 3.600, which exceeds the 3-sigma threshold.

2. Within SAS Enterprise Miner, the Filter node can be used to remove outliers from a data set using the 3-Sigma method. Import the given dataset to SAS Enterprise Miner and learn to use the Filter node to identify and remove outlier(s) from the given dataset with the 3-sigma method.

In SAS Enterprise Miner, the Filter node facilitates outlier detection and removal. The workflow diagram and data point distribution are illustrated below:

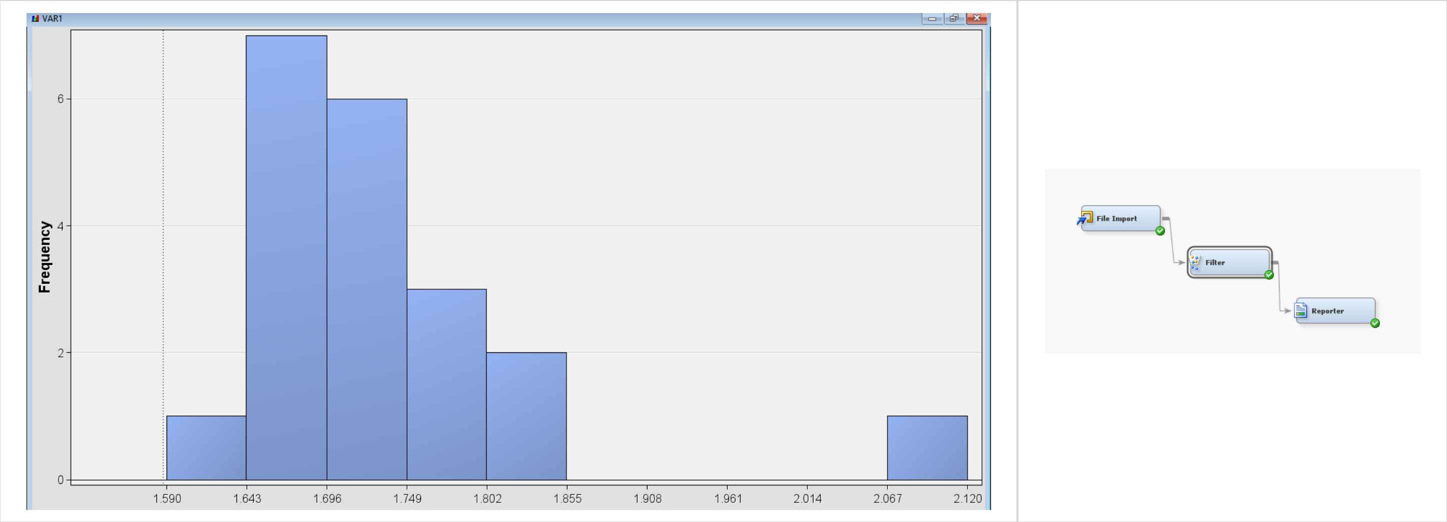
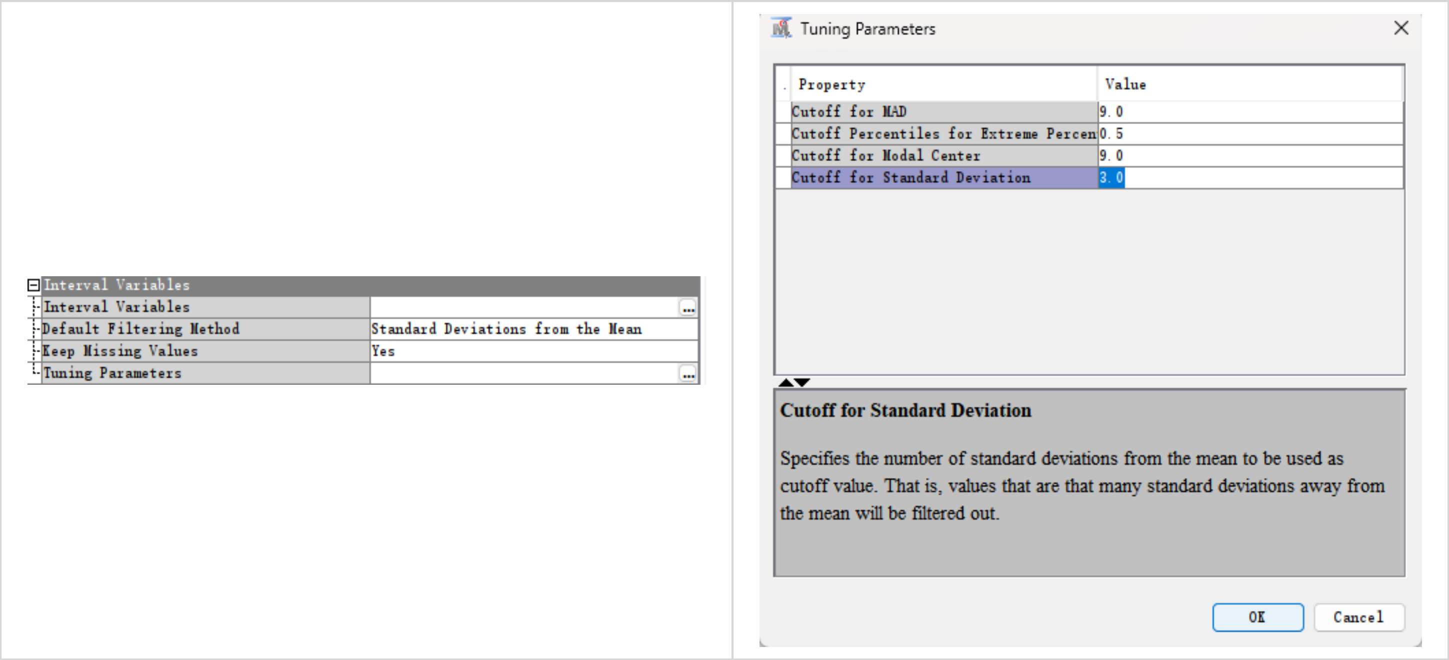


Figure 2. Distribution of the data points (left) and the diagram of the workflow (right).

3. To apply the 3-Sigma method to remove outlier(s) from the given dataset using the Filter node, how would you set up the Filter node?

The Filter node was configured with precision to apply the 3-Sigma method for outlier detection. The setup screenshots are as follows:



Interval Variables	
Interval Variables	...
Default Filtering Method	Standard Deviations from the Mean
Keep Missing Values	Yes
Tuning Parameters	...

Tuning Parameters

Property	Value
Cutoff for MAD	9.0
Cutoff Percentiles for Extreme Percen	0.5
Cutoff for Modal Center	9.0
Cutoff for Standard Deviation	3.0

Cutoff for Standard Deviation

Specifies the number of standard deviations from the mean to be used as cutoff value. That is, values that are that many standard deviations away from the mean will be filtered out.

Figure 3. The Filter node setup (left) and the 3-sigma method setup (right).

Parameters and Settings

- Standard Deviations from the Mean: Set to 3.

This setting is crucial for implementing the 3-Sigma method. By setting the threshold to 3 standard deviations, we align the methodology with the 3-Sigma rule. This parameter quantifies how many standard deviations a data point can be from the mean before it is considered an outlier.