1. Kalman Filter : point anomaly detection에 사용

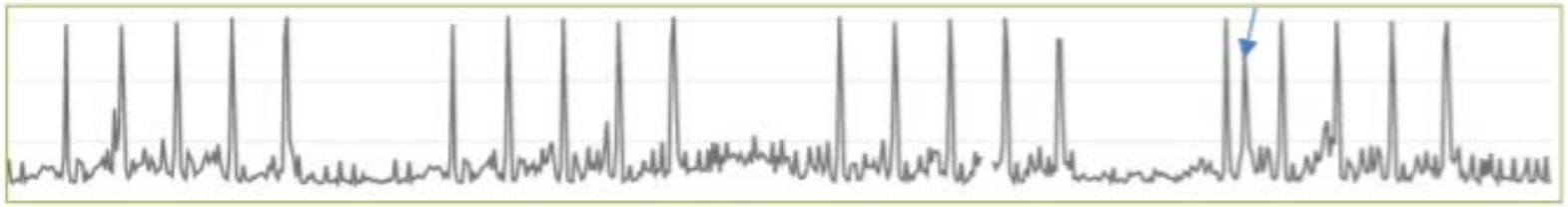

Figure 3 An example of a point anomaly that can be detected with our Kalman filter method

- Learn a model of normal behavior from a few weeks of historical data
- Forecast a week of future values
- Collect new data over the week
- Flag a data point as an anomaly if its actual value is far from the forecasted value
- 설명 : https://deepai.org/machine-learning-glossary-and-terms/kalman-filter

구현

- https://core.ac.uk/download/pdf/297011203.pdf
- https://medium.com/blogyuxiglobal/kalman-filter-the-way-to-remove-outliers-bb6aa616788e
- http://www2.stat.duke.edu/~mw/Smith+West1983.pdf
- https://parkgeonyeong.github.io/Deep-Kalman-Filter/

적용 예시

- https://www.mitre.org/sites/default/files/publications/pr-18-0941-machine-learning-anomaly-detection.pdf (1.4, 3.1)

2. DBSCAN : collective anomaly detection에 사용

Figure 4 An example of an abnormal period that can be detected with our DBSCAN method

- Detect an anomalous data sequence
- Collect new data over the week
- Flag a data point as an anomaly if its actual value is far from the forecasted value

구현

- https://scikit-learn.org/stable/modules/generated/sklearn.cluster.DBSCAN.html
- https://github.com/bwcho75/dataanalyticsandML/blob/master/Clustering/5.%20DBSCANClustering-IRIS%204%20feature-Copy1.ipynb
- https://towardsdatascience.com/machine-learning-clustering-dbscan-determine-the-optimal-value-for-epsilon-eps-python-example-3100091cfbc

적용 예시

- https://www.mitre.org/sites/default/files/publications/pr-18-0941-machine-learning-anomaly-detection.pdf (1.4, 3.2)

3. ARIMA

- Autoregressive Integrated Moving Average : 자기회귀 + 이동평균
- It’s based on an approach that several points from the past generate a forecast of the next point with the addition of some random variable, which is usually white noise. As you can imagine, forecasted points in the future will generate new points and so on. Its obvious effect on the forecast horizon: the signal gets smoother.

구현

- https://www.digitalocean.com/community/tutorials/a-guide-to-time-series-forecasting-with-arima-in-python-3
- https://www.statsmodels.org/stable/generated/statsmodels.tsa.arima_model.ARIMA.html
- https://github.com/Anomaly-Detection-Research/arma-arima

4. 이동 평균

$$Avg_0 = a_0$$

$$Avg_n = \frac{1}{n}\left((n-1)Avg_{n-1} + a_n\right)$$

구현 및 적용 예시

- https://github.com/HamishWoodrow/anomaly_detection
- https://rfriend.tistory.com/502

5. 이동 중앙값

구현 및 적용 예시

- https://anomaly.io/anomaly-detection-moving-median-decomposition/index.html
- https://daewonyoon.tistory.com/236 (번역 버전)
    - Cons : R로 구현되어 있음

6. RE-ADTS

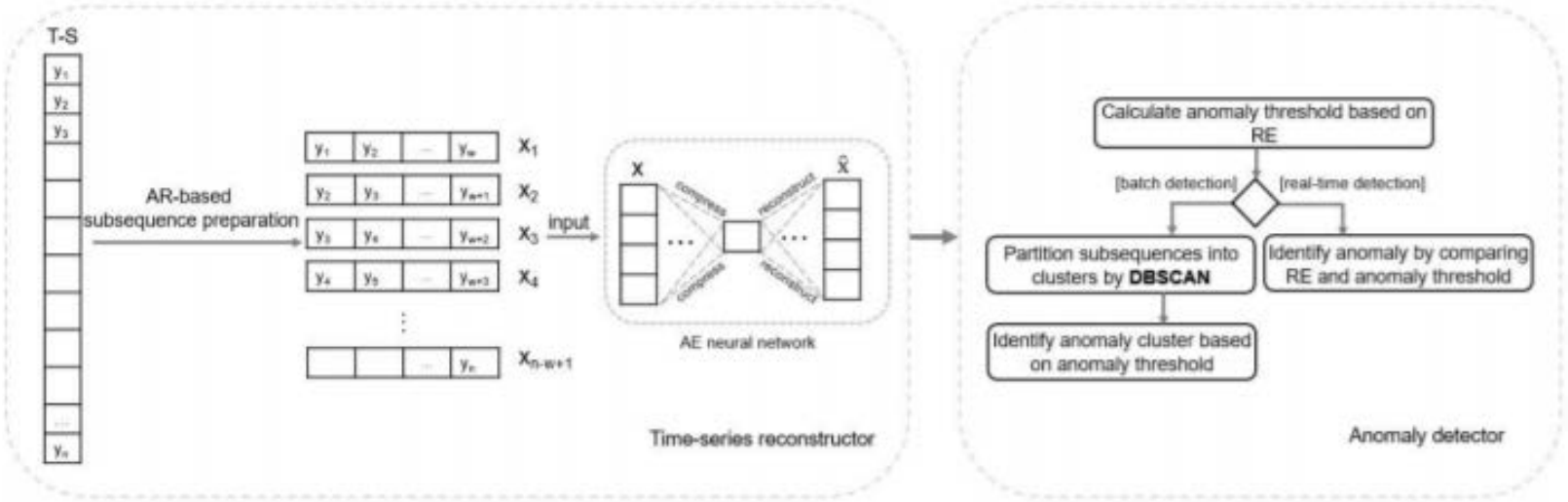

Figure 1. The general architecture of the proposed method. T-S, Time-series; AR, Autoregressive; AE, Autoencoder; RE, Reconstruction error.

- Foremost, it prepares subsequences based on the optimal window width that is selected using the AR model. After that, the prepared subsequences are compressed into 2-dimensional space by the deep AE model. In the anomaly detector module, first, the RE based anomaly threshold is calculated from the reconstruction errors in the compressed dataset. For batch anomaly detection, the compressed subsequences are grouped by the density-based spatial clustering of applications with noise (DBSCAN) algorithm, and the RE of each subsequence in a cluster is compared with the anomaly threshold.

구현

- https://www.researchgate.net/publication/343331745_Unsupervised_Anomaly_Detection_Approach_for_Time-Series_in_Multi-Domains_Using_Deep_Reconstruction_Error

7. Otsu

- 이미지 이진화에 쓰이는 기법

구현

- https://bskyvision.com/49
- https://j07051.tistory.com/364 (번역 버전)
- http://www.labbookpages.co.uk/software/imgProc/otsuThreshold.html
- https://www.sciencedirect.com/science/article/abs/pii/S016786550600119X

8. VATU : Variable window-size adaptive threshold updating

- To handle the threshold setting procedure needed to detect outliers in a nonstatic data stream without requiring an inordinate amount of time and in the absence of labeled data beyond the initial set of background or normal data on which the anomaly detector is trained

구현 및 적용 예시

- https://www.researchgate.net/publication/330880327_Adaptive_Threshold_for_Outlier_Detection_on_Data_Streams
  - III-B

9. MAX-LCS : MAX Local neighborhood based composite scores

구현

- http://proceedings.mlr.press/v22/saligrama12/saligrama12.pdf

10. 기타

- https://imagej.net/Auto_Local_Threshold