Data Analysis Tools For FIESTA

KAT Tool

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December 1, 2015
The proposed KAT toolkit

1. Pre-processing
2. Dimensionality reduction
3. Feature extraction
4. Abstraction
Pre-processing

- **Data selection:**
  - Select a desired category when there are several categories inside a data source, e.g. select temperature among the available information (e.g. wind speed, humidity, temperature, pressure) recorded at a weather station
  - Select a desired time-period\(^1\), for instance days 3 to 10

- **Cleaning:** Check for the missing data, e.g. those occurred due to the sudden power cut-off or sensor malfunction

- **Resample:** To bring data from different sources into a unique shape for further processing\(^1\)

- **Noise removal:** Remove transmission cost and filter unwanted data, such as noise and outliers. This can be done using different algorithms including Min-Max, Mean-Median, Variance or Bandpass filters

- **Normalisation:** To compare datasets with different offsets and amplitudes

\(^1\) This feature would require a common label for ‘time’ in the registry output
Dimensionality reduction I

To reduce the size and length of the data while keeping the key features and patterns

- Non-data adaptive:
  - **Discrete Fourier Transform (DFT):**
    - ✗ DFT loses the time information of the data and transforms the data globally, which causes a slow calculation.
  - **Discrete Wavelet Transform (DWT):**
    - ✓ DWT preserves the time dimension and transforms the data locally which leads to a faster calculation.
    - ✓ Wavelets have the useful multiresolution property, but are only defined for time series that are an integer power of two in length.

- Data adaptive:
  - **Piecewise Aggregation Approximation (PAA):**
    - ✗ PAA works with a fixed window length. In times of low data activity, the same event is aggregated over and over. In contrast, if there is a lot of activity, aggregation can lead to information loss.
Symbolic Aggregate Approximation (SAX): Transforms a time-series into a discretised series of letters referred to as a word.

- The DWT, DFT, and PAA representations are real valued, and this limits the available algorithms. This limitation is addressed using symbolic representation methods such as SAX.
- SAX algorithm provides both dimensionality and storage reduction (as fewer bits are required for letters and repetitive sequences can refer to a single store position). While general symbolic methods provide storage reduction, but not dimensionality reduction.
- SAX can be also referred as a pattern creator technique to create abstract patterns and human/machine interpretable observations from the sensory data.
- If the standard deviation of the sequence before normalisation is below an epsilon, the entire word can be set to the middle-ranged alphabet.
To extract representative features from the sensor data and provide low-level abstractions in a local sensor data

- **Clustering (k-means):** Group samples with similar attributes into the same class. \(k\)-means algorithm only requires the expected number of groups
Abstraction

To provide higher level abstractions using the generate low-level abstraction to get the global picture about occurring events

- **Markov Chains**: Construct a model which represents likelihood of temporal relations between values
Modification of KAT tool

**Implemented**
- Selecting a desired time-period
- Saving the data after every step of analysis
- Additional normalisation method in the pre-processing step

**In progress**
- Perform cleaning and resampling\(^2\) algorithms on all input data
- Apply consecutive pre-processing algorithms

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\(^2\)This feature would require a common label for ‘time’ in the registry output
Main References


The End