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# Co-occurrence Pattern Detection

## Terminology

* **Event:** Discretized continuous explainable variables (dimensions)
* **Event Pattern:** Sequence of events (for one or multiple dimensions) in a time series
* **NWC:** Non-compliant window cooccurrence i.e., a zonal function over a target defying expectation.
* **NWC pattern:** All candidate patterns (event sequences) from either one or many explainable variables, that occur with or in delta time interval of non-compliant window.
* **JoinSet Cardinality:** No of times a pattern |C| co-occurs in delta time interval of an anomalous window |W| i.e., ⋈ Wn|.
* **Local Upper Bound:**
* **Lattice Upper Bound:**
* **Support:** Denotes popularity of the pattern in data i.e.,
* **Confidence:**  i.e., No. of times a pattern co-occurs with an anomalous window (not taking delta into account).
* **Ripley’s-k:**
* **Lattice graph:** Representing all combinations of dimensions in a hierarchical fashion to analyze all possible combination of candidate patterns. E.g., for 4 dimensions, lattice graph would look like:

**Diagram

Description automatically generated**

## MTNMiner: A Multi-Parent Tracking Approach for Mining NWC patterns

* A simplified and earlier version of BDNMiner algorithm.
* Has the same control flow, but no bottom-up pruning.
* The only difference with Top-down pruning in BDNMiner are:
  + Used queue to perform a BFS traversal (adding a child when it’s last parent is being visited).
  + Maintaining a visited parent count at each child (to avoid repetition).

## BDNMiner: A Bi-Directional approach for mining NWC patterns

* Non-compliant Window Co-occurrence (NWC) pattern detection in time series data.
* The algorithm tries to find candidate patterns that co-occur with anomalous behavior of a target feature in time series data.
* The main contribution is pruning of the combination tree (called **lattice**) for each comparative analysis made with an anomalous window.
* Top-down pruning based on **Upper Bound** and bottom-up pruning based on **Support i.e.** (**Apriori algorithm** from association analysis).

### pattern\_mining:



enumerate\_with\_upper\_bound\_pruning:  
   


### enumerate\_with\_min\_support:



root\_enumeration:  
  


### leaf\_enumeration:



PS: The other functions are implementation dependent and do not require an overview at the moment.