



Anomalies in Water Consumption

Detecting Anomalies in Water Consumption Time Series

Summary

Smart water meters periodically collect household water consumptions. This data, stored as time series, open up a wealth of opportunities for water providers and stakeholders when empowered by data mining techniques. Anomalies in water consumption time series are particularly interesting as they lead to reveal *leaks*, *illegal water use* and *peak water use patterns*. Primary aim of this research is to develop an analytical solution to detect anomalies in water consumption time series as shown in Figure 1.

Motivation

Detecting abnormal water consumptions enables clarify causes for many problems, as shown in Figure 2. In this research we refer abnormal water use as anomalies. *Anomalies are patterns of data that do not conform to the normal pattern of data* [1].

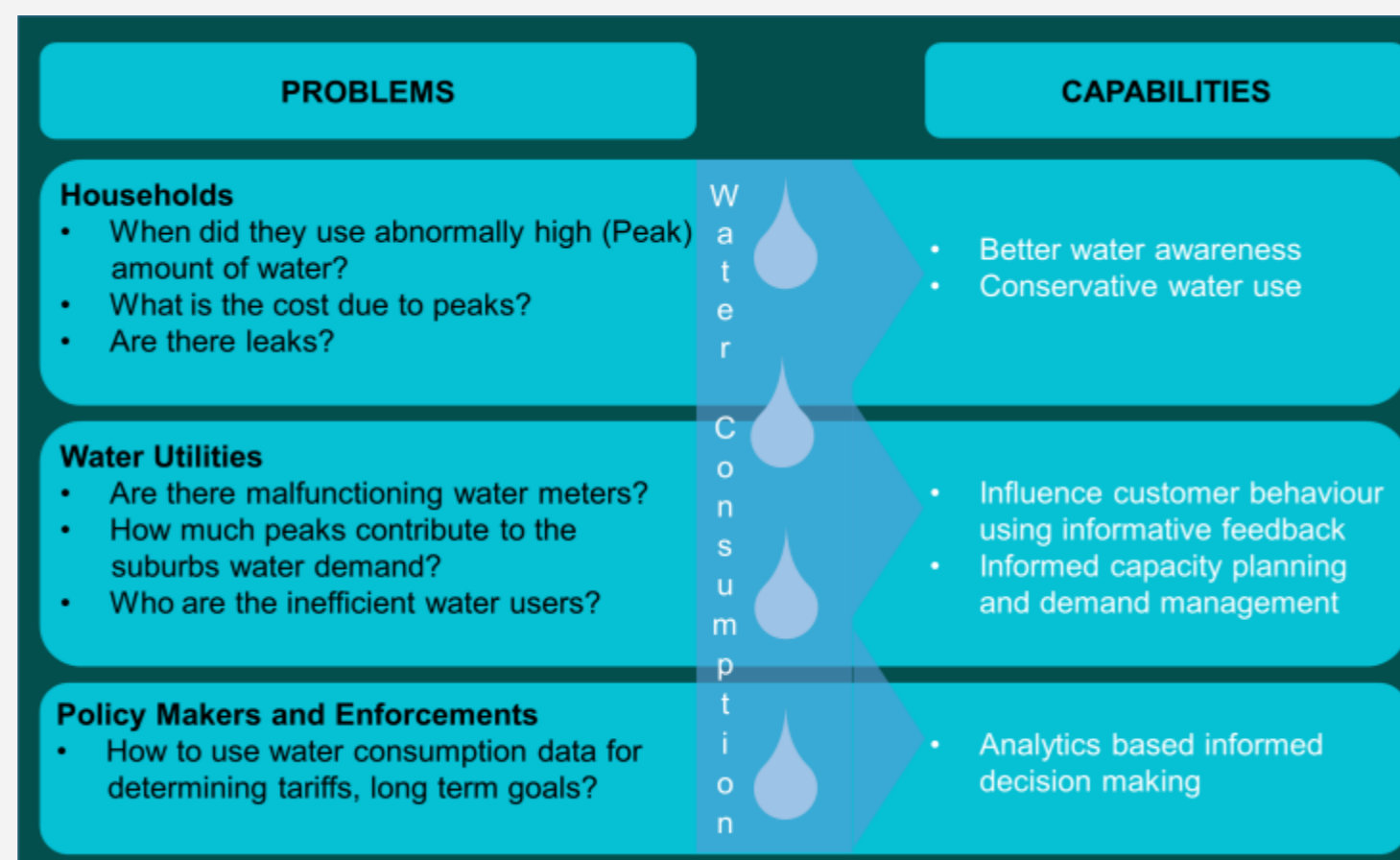


Figure 2: Water use problems faced by stakeholders and required capabilities

Anomaly detection in water consumption time series enables explanation and prediction of abnormal water uses.

Techniques

Three types of time series anomalies are found in recent literature. If the water consumption is very high (or very low) for a given a hour or a day, then it is a *point anomaly* [2].

If the shape of the water consumption values for a sequence of hours or days, then it is a *shape anomaly* [2]. If there is a change of occurring frequency of a point or a shape, then it is a *frequency anomaly*. Figure 2 maps, time series anomalies to their detection algorithms and possible causes for reasoning.

Open source R language is used to implement these algorithms. At the moment, we have categorised the types of anomalies, implemented and evaluated point anomaly detection algorithms. Implemented parts are in highlighted in orange colour in Figure 3.

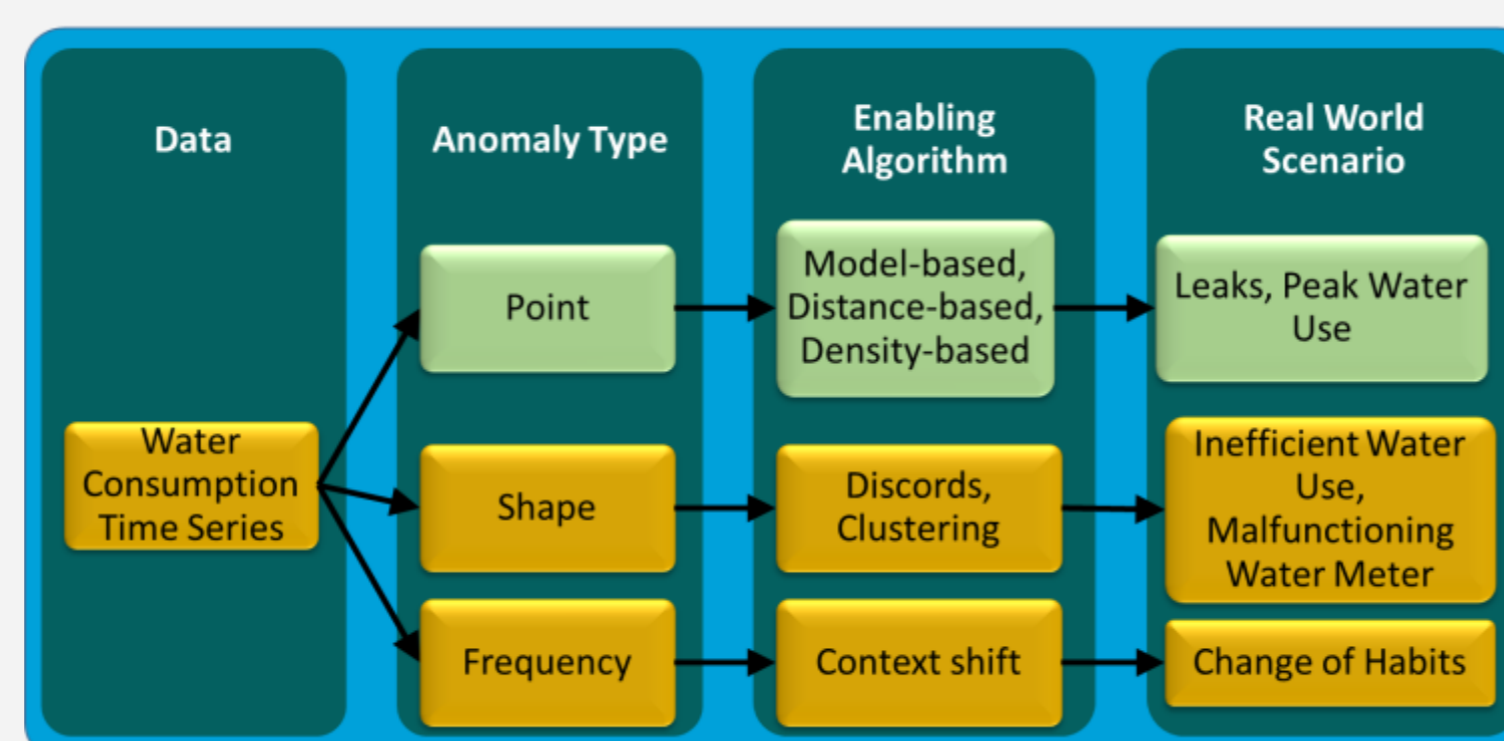


Figure 3: Mapping anomaly detection techniques to real world scenario

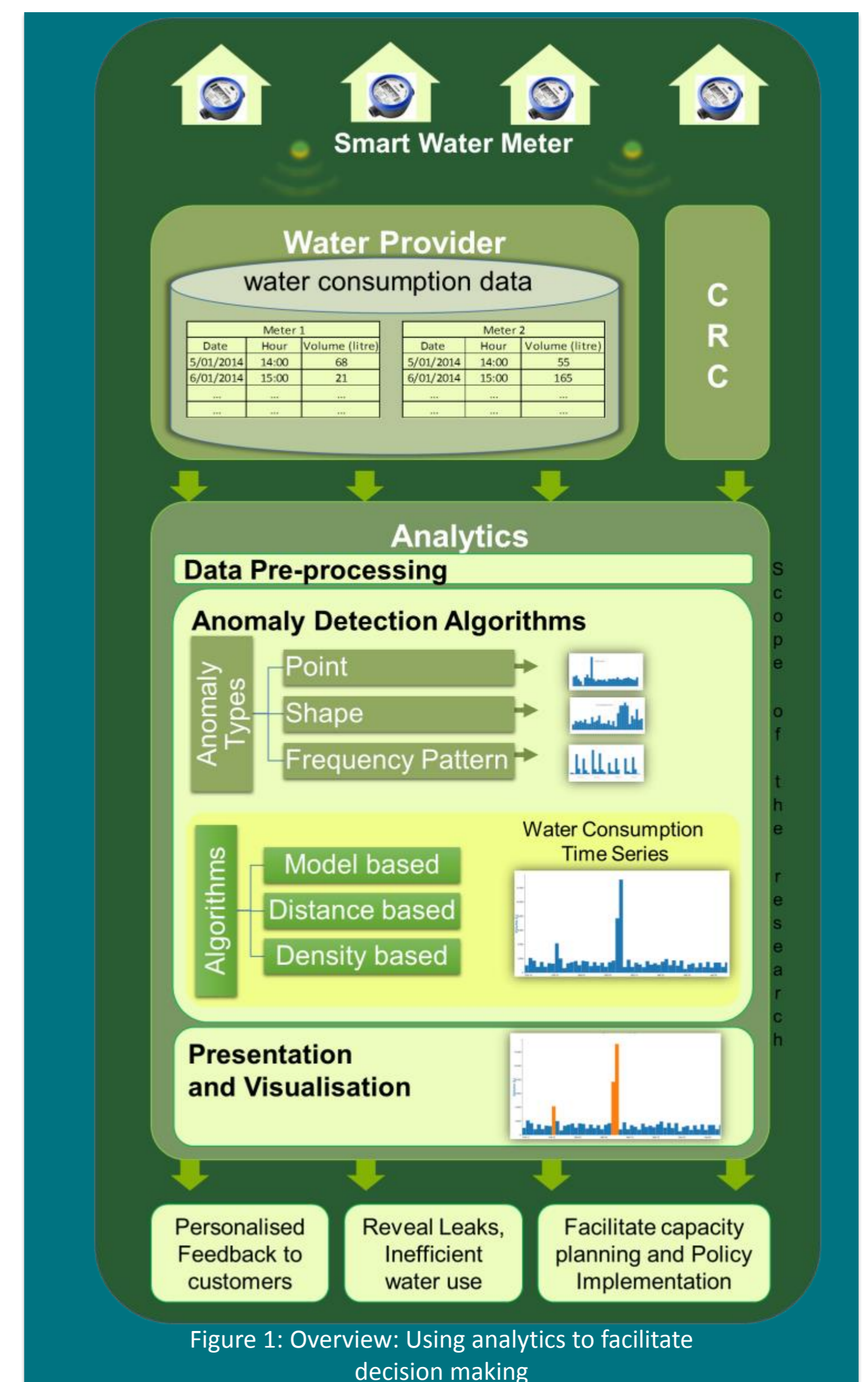


Figure 1: Overview: Using analytics to facilitate decision making

Reference

- Chandola, Varun, Arindam Banerjee, and Vipin Kumar. "Anomaly detection: A survey." ACM computing surveys (CSUR) 41.3 (2009): 15.
- Han, Jiawei, Micheline Kamber, and Jian Pei. Data mining: concepts and techniques: concepts and techniques. Elsevier, 2011.
- Cardell-Oliver, Rachel. "Water use signature patterns for analysing household consumption using medium resolution meter data." Water Resources Research 49.12 (2013): 8589-8599.