DAIAD

REPORT ON DELIVERABLE 5.3.1

Knowledge Discovery Workbench

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Abstract

This report presents an overview of the Prototype Deliverable D5.3.1 "Knowledge Discovery Workbench". The Workbench is collection of web based UI elements enabling users to analyze, discover, and experiment with water consumption data. The Workbench UI elements invoke our Analytics and Forecasting engine in a seamless manner, hiding away the inherent complexity of Big Data management and analysis, and enabling users to focus on exploration, analysis and knowledge extraction.

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Executive Summary

This report presents an overview of the Prototype Deliverable D5.3.1 “Knowledge Discovery Workbench”. The Workbench is collection of web based UI elements enabling expert users to analyze, discover, and experiment with water consumption data. In the content of the entire DAIAD system, the Workbench provides the essential building blocks for the DAIAD@commons and DAIAD@utility interfaces. In this manner, it invokes our Analytics and Forecasting engine in a seamless manner, hiding away the inherent complexity of Big Data management and analysis, enabling users to focus on exploration, analysis and knowledge extraction.

The remainder of this document is structured as follows.

In Section 1 we present the architecture of the Knowledge Discovery Workbench, elaborating on the intended functionality in the context of the entire DAIAD system. Further, we present the core libraries and frameworks used during development, as well as dependencies with DAIAD APIs.

In Section 2 we present the core UI elements of the Knowledge Discovery Workbench in detail, presenting for each one its high-level operation and implementation, its various properties, an invocation example, and indicative examples of its application within DAIAD. The full documentation and source code for each UI element are available in our public repository.

Abbreviations and Acronyms

API	Application Programming Interface
AJAX	Asynchronous JavaScript and XML
AOP	Aspect Oriented Programming
APK	Android application package
BT	Bluetooth
CI	Continuous Integration
CORS	Cross-Origin Resource Sharing
CSRF	Cross-Site Request Forgery
CSS	Cascading Style Sheets
DOM	Document Object Model
DTO	Data Transfer Object
JSON	JavaScript Object Notation
MR	MapReduce
MVC	Model View Controller
MVP	Minimum Viable Product
OGC	Open Geospatial Consortium
ORM	Object Relational Mapper
RERO	Release Early, Release Often
REST	Representational State Transfer
RF	Radio Frequency
RPC	Remote Procedure Call
SPA	Single Page Application
SWM	Smart Water Meter
UI	User Interface

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1. Implementation

1.1. Overview

The Knowledge Discovery Workbench is collection of web based UI elements enabling expert users to analyze, discover, and experiment with water consumption data. In the content of the entire DAIAD system, the Workbench provides the essential building blocks for the DAIAD@commons and DAIAD@utility interfaces. In this manner, it invokes our Analytics and Forecasting engine in a seamless manner, hiding away the inherent complexity of Big Data management and analysis, enabling users to focus on exploration, analysis and knowledge extraction.

Specifically, all software components and elements developed in the context of WP5 (see Figure 1) have the following responsibilities:

- D5.1.1 Big Water Data Management Engine. It handles the entire data lifecycle, providing scalable data management and querying services. An overview of the Data Engine is provided in the report for Prototype Deliverable D5.1.1.
- D5.2.1 Consumption Analytics and Forecasting Engine. It provides the full suite of analytics and forecasting services, executed within the Big Water Data Management Engine. Essentially, it provides the 'business logic' of both applications, executing the appropriate analysis algorithms and returning the results to the UI elements. An overview of the Engine is provided in the Report for Prototype Deliverable D5.2.1.
- D5.3.1 Knowledge Discovery Workbench. It provides all UI elements for presenting and invoking the analysis results of D5.2.1. In this manner, we hide the complexity of the underlying analytics and data engine, providing a coherent and simple to use interface for users.

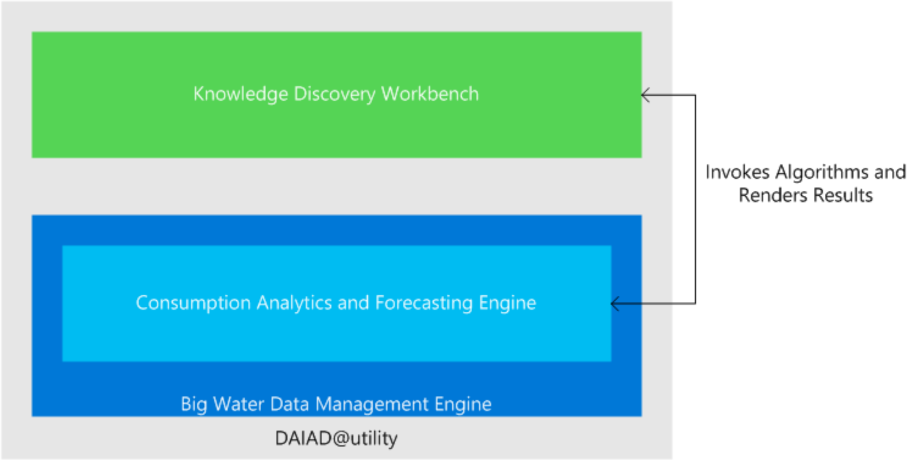
Knowledge Discovery Workbench
Invokes Algorithms and Renders Results
Consumption Analytics and Forecasting Engine
Big Water Data Management Engine
DAIAD@utility

Figure 1: Software components and elements developed in the context of WP5

The Knowledge Discovery Workbench applies external libraries and frameworks detailed in the following sub-sections. During the presentation that follows, we frequently make references to these libraries and frameworks, since they affect the implementation details of each component. For a thorough presentation of the complete DAIAD system architecture the reader in invited to consult the Report on Prototype Deliverable D1.3 'Beta DAIAD Integrated System'.

1.1.1. Application Patterns and Design

In DAIAD we apply the Model View Controller pattern (MVC) and the Single Page Application (SPA) web application design. This pattern and design are used extensively and they strongly influence the structure of the source code. A short explanation for each follows; a broader coverage of these topics is outside the scope if this document:

- **Model View Controller (MVC)**. The goal of the Model View Controller pattern is to separate code responsibilities into three parts. The Model, which represents application domain data and logic, the View, which is responsible for the data presentation and the Controller, who receives user interactions and updates the Model appropriately. This separation increases code testability and also improves a developer team's productivity. Nowadays, there are many variants of the MVC pattern and each MVC framework may implement the pattern in different ways. For the DAIAD implementation we are using the Spring Framework and its corresponding MVC module.
- **Single Page Applications (SPAs)** offer increased UI usability that is in par with desktop applications. In contrast to traditional web applications, a SPA application is initialized by loading only a single web page. After initialization, any additional resources such data or JavaScript code files are loaded dynamically on demand using Asynchronous JavaScript and XML (AJAX) requests. Moreover, client side code is usually implemented using the MVC pattern or some variant of it.

1.2. Libraries and Frameworks

1.2.1. React

React[1] is a JavaScript framework for building interactive User Interfaces. React can be thought as the View in the MVC pattern that allows users to build reusable UI components and promotes composition of existing ones. Each component maintains its internal state which controls the rendering process. Whenever state changes, only the parts of the Document Object Model (DOM) that are affected are updated. This is achieved by using a virtual representation of the DOM that efficiently detects changes to the actual DOM. The latter feature makes React interoperability with other UI libraries more challenging. Recommended templating in React is performed with the help of JSX[2], an XML-like syntax with a smooth learning curve for HTML-familiar developers.

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[1] https://facebook.github.io/react/

[2] https://facebook.github.io/jsx/

1.2.2. Redux

Redux[3] is a predictable state container for JavaScript applications that is very popular for handling the increased application logic complexity that arises in Single Page Applications. In such applications the state management becomes increasingly harder since various user interactions –which quite often involve asynchronous requests - result in state changes. Redux attempts to manage state in a predictable way by imposing specific restrictions on how and when state updates can occur. Redux makes a perfect match to React by deferring component state management to Redux. It was based on the principle ideas of Flux [4] for making the flow of an application unidirectional. The main difference Redux introduced is the core idea of keeping the state in a single store (following a Single source of Truth principle), instead of multiple stores. The single application state maps at any moment to its view representation via React UI components. User actions such as clicks may dispatch actions that change the state in a predefined way with the help of reducers that dictate how a specific action modifies the application state. In that way a one-way flow is achieved, making the application easy to reason about, debug and scale. The abstract application flow is shown in Figure 2.

- Store: In redux the store holds the entire application state, which is the representation of the application at any given time. It is an object containing any number of valid JS data types, such as numbers, strings, booleans, arrays, or other objects. A key concept is that the state object cannot be mutated directly, but only by emitting actions.
- Actions: Actions can be dispatched by user interactions or other actions and cause the state to change. There are two types of actions, simple and complex actions or thunks that execute with the help of a special thunk middleware[5]. Simple actions are plain objects containing the unique action type and any data that needs to be passed to the store. Thunks are functions that get access to the state and can perform asynchronous operations (such as fetching data from the API) and/or orchestrate multiple simple action dispatches.

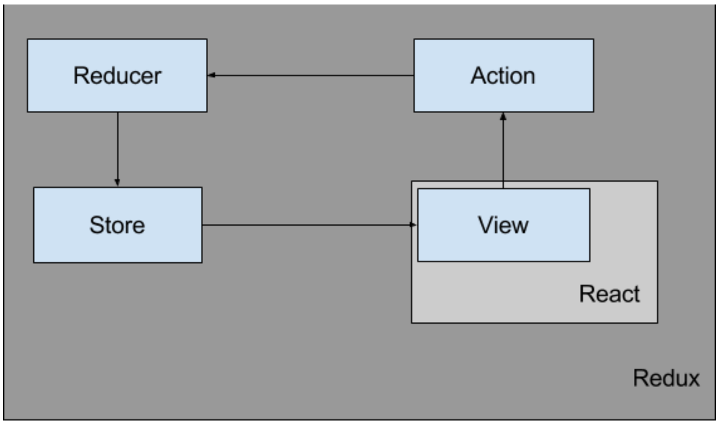

Figure 2: Redix Application flow

- Reducers: Reducers are pure functions that determine how an action modifies the state. Multiple

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[3] http://redux.js.org/

[4] https://facebook.github.io/flux/docs/overview.html

[5] https://github.com/gaearon/redux-thunk

reducers can be combined, each responsible for mutating a specific part of the state. Reducers do not mutate the state, but instead return a new state object, which allows easy recognition of any changes so that the view can be updated.

- Views: Redux combines very well with React as its view layer with the help of react-redux library. In react-redux terminology, React components are divided into two types: smart components or containers and pure or presentational components. Containers are aware of redux and map parts of the state and action callback functions to react component properties, and are responsible for causing the components to re-render any time a mapped property has changed. On the other hand, presentational components are just pure functions of their input properties, completely ignorant of redux, allowing successful separation of logic and templating.

1.2.3. React-Router-Redux

React Router Redux is a JavaScript library that allows an application implemented using React and Redux to keep the application state in sync with routing information. This feature is achieved by automatically storing additional data about the current URL inside the state. This information is then propagated to React which can in turn suitably change the component tree rendering process. If there is no need for syncing routing information and application state, a simpler implementation can be obtained by using the React Router[6] library. The latter provides support for keeping only the UI in sync with the URL.

1.2.4. React-Bootstrap

React-Bootstrap[7] is a library of reusable UI components for the React framework. It offers the look-and-feel of the Twitter Bootstrap[8] library using the React syntax, but has no dependencies on any 3rd party libraries like jQuery. React-Bootstrap offers a comprehensive list of UI components such as buttons, menus, form input controls, modal dialog, tooltips to name a few. All components can be used as provided or customized using CSS.

1.2.5. ECharts

ECharts[9] is a rich and versatile JavaScript charting library for building interactive charts, based on a standalone and lightweight rendering framework (ZRender). It manages (using an opaque handle) a given DOM node as a subtree, and directly draws to a canvas element lying inside this subtree. It supports a great variety of chart types including line, column, scatter, pie, radar, candlestick, chord, gauge, funnel, map and heatmap charts. It also supports data visualizations, not usually regarded as charts, including a tree map, a tree graph and a Venn diagram. Moreover, individual charts can be composed to create more complex data representations.

ECharts is highly optimized for handling hundreds of thousands (can easily cope with 200K) of data points, making it a seamless solution for big data analysis and visualization. Further, Echarts is *theme-able*, i.e. a great subset of appearance-related chart options can be supplied by referencing an external theme JSON object.

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[6] https://github.com/reactjs/react-router

[7] https://react-bootstrap.github.io/

[8] http://getbootstrap.com/

[9] https://ecomfe.github.io/echarts/index-en.html

This allows an entire application to share (or override) a uniform look-and-feel for charts by keeping appearance-related options in a single place.

1.3. Dependencies

1.3.1. Data API

The Data Application Programming Interface (API) supports querying data persisted by the Big Water Data Management Engine developed in WP5 and presented in deliverable D5.1.1. It is exposed as a Hypertext Transfer Protocol (HTTP) Remote Procedure Call (RPC) API that exchanges JSON encoded messages and has two endpoints, namely, the Action API and HTTP API endpoints. The former is a stateful API that is consumed by the DAIAD web applications. The latter is a Cross-Origin Resource Sharing (CORS) enabled stateless API that can be used by 3rd party applications.

The API exposes data from three data sources, namely, smart water meter data, amphiro b1 data and forecasting data for smart water meters. The query syntax is common for all data sources. Moreover, smart water meter and amphiro b1 data can be queried simultaneously. However, a separate request must be executed for forecasting data.

The API accepts a set of filtering criteria as parameters and returns one or more data series consisting of data points which in turn have one or more aggregate metrics like sum, min or average values. More specifically the input parameters are:

- **Time**: Queries data for a specific time interval. An absolute time interval or a relative one (sliding window) can be defined. Optionally, the time granularity i.e. hour, day, week, month or year, can be declared that further partitions the time interval in multiple intervals. The Data API returns results for every of these time intervals.
- **Population**: Specifies one or more groups of users to query. For every user group a new data series of aggregated data is returned. A query may request data for all the users of a utility, the users of a cluster, the users of an existing group, a set of specific users or just a single user.
- Clusters are expanded to segments before executing the query. A segment is equivalent to a group of users. As a result, declaring a cluster is equivalent to declaring all of its groups.
- Optionally, the users of a group may be ranked based on a metric.
- **Spatial**: A query may optionally declare one or more spatial constraints and filters. A spatial constraint aggregates data only for users whose location satisfies the spatial constraint e.g. it is inside a specific area. On the contrary, a spatial filter is similar to the population parameter and creates a group of users based on their location; hence a new data series is returned for every spatial filter.
- **Metric**: The metrics returned by the query. Data API supports min, max, sum, count and average aggregate operations. Not all data sources support all metrics.
- **Source**: Declares the data source to use. When forecasting data is requested, this parameter is ignored.

Detailed documentation on the Data API syntax and request examples can be found at:

- https://app.dev.daiad.eu/docs/api/index.html.

The Data API is implemented as part of the DAIAD Services presented in Deliverable 1.3. Figure 3 illustrates the Data API implementation in more detail.

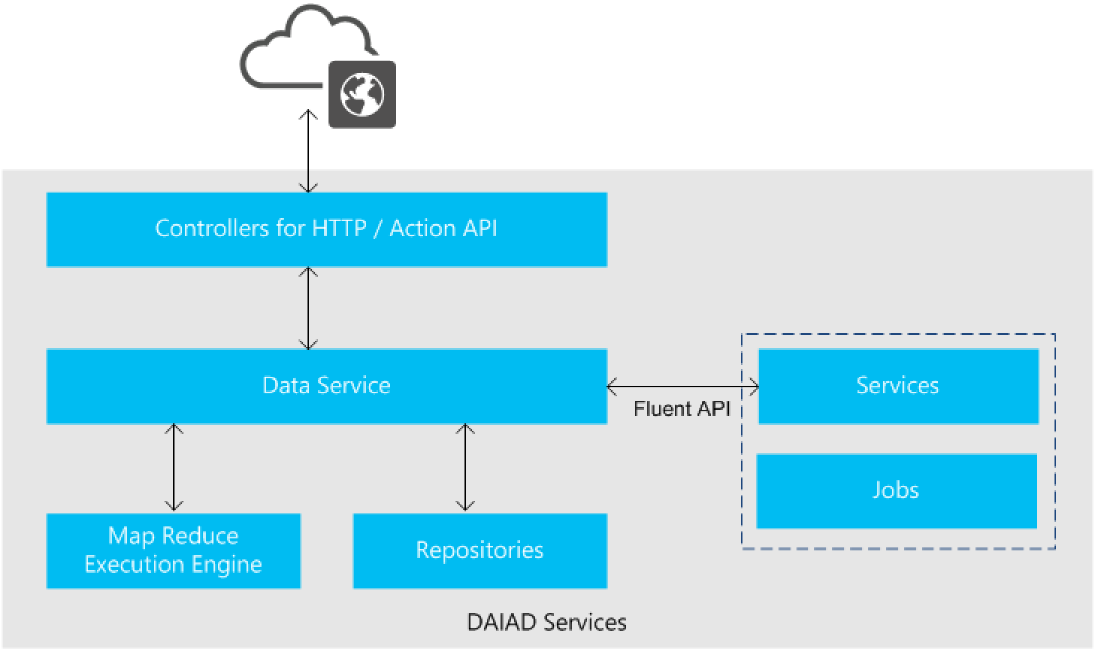
Controllers for HTTP / Action API
Data Service
Fluent API
Services
Jobs
Map Reduce Execution Engine
Repositories
DAIAD Services

Figure 3: Data API implementation

Query requests are received by the DAIAD Services controller components and forwarded to the Data Service. The Data Service orchestrates data query execution. It accesses data from several repositories such as user profile information and smart water meter registration data and expands the query before execution. Query expansion refers to the process that selects all individual users and their corresponding devices for all groups to query. In addition, any spatial constraints are applied at this stage. The expanded query is submitted to the Map Reduce execution engine for computing the query results.

- In addition to the HTTP endpoints, Data API also provides a fluent API for building queries at the server side. This feature is used by other services and jobs for querying water consumption data. Two distinctive examples are the Message Service[10] and the User Clustering Job[11] respectively. The former queries utility and individual user consumption data in order to generate alerts and recommendations. The latter clusters the users based on their total water consumption over a predefined time interval.

1.3.2. Configuration API

The client application, once initialized, will attempt to load configuration fragments from the server. Because the client is a single page application (SPA), this configuration step will only happen once and only when

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[10] https://github.com/DAIAD/home-web/blob/master/src/main/java/eu/daiad/web/service/message/DefaultMessageService.java

[11] https://github.com/DAIAD/home-web/blob/master/src/main/java/eu/daiad/web/jobs/ConsumptionClusterJobBuilder.java

needed (i.e. in a lazy manner). Loading the configuration is not really different than setting something in global state, so it is actually performed using the known mechanism of Redux actions.

In order to fetch the configuration, the client sends requests to several Configuration API endpoints which are also part of the broader Action API. The basic endpoints contacted during a configuration action are capable of the following:

- Fetch all utilities.
- Fetch all groups inside a utility.
- Fetch all groups of groups (I.e. clusters) inside a utility.

2. UI Elements

In this section we present the core UI elements comprising the Knowledge Discovery Workbench. As analyzed in the previous section, they consist the essential building blocks for the interfaces of DAIAD@commons and DAIAD@utility applications.

2.1. LineChart

The LineChart UI element is a general-purpose UI control that represents a line (line/area) chart. It visualizes series of data points on a 2-dimensional Cartesian grid, while supporting a wide set of options and customizations. The source code is available at:

- https://github.com/DAIAD/react-echarts/blob/master/src/js/components/line.js

The LineChart UI element is a class that implements a React component and wraps an Echarts chart, thus making a subset of Echarts functionality available to React-based applications. It is designed to be a presentational-only component, so it assumes nothing about the origin of data, nor it attempts to shape them in any way. The capabilities of this element are:

- Draws data points and corresponding line/area segments on the grid. If requested so, it draws instead a best-fit curve for input points (based on spline interpolation).
- Draws axes, grid lines, and grid zones.
- Places axis ticks and generates customizable labels on those ticks.
- Provides customizable tooltips on data points or marker lines.
- Provides a customizable legend for input series under display. The legend allows a subset of selected series to be switched off in order to focus our interest on the rest.

The LineChart UI element has been implemented as follows:

- We have developed a class that wraps the opaque handle provided by Echarts library and acts as a React portal component. A React portal component excludes itself from React's change-render lifecycle and instead manages updates in a completely self-governed manner. In order to do so, it prevents normal re-rendering triggered by React, intercepts all "change" events and properly maps them to calls on the underlying Echarts handle.
- We have developed a properties interface that acts as a facade to a common subset of Echarts functionality. A basic duty of our class is to translate received properties to a consistent set of Echarts-specific options. On every "change" event, we re-compute and validate all options and then re-configure the underlying Echarts handle. Because a minimal set of properties is actually required by

our interface, we reside on multiple levels (theme-level, class-level) of fallback defaults in order to allow external themes or derived classes to provide charts with "pre-packaged" appearance.

- We have mapped the React component lifecycle events to object lifecycle events (*initialize, reset, cleanup*) of the underlying handle. This is required because React demands that all components follow certain lifecycle steps while mounting or unmounting to a target document.

The LineChart UI element receives properties which are categorized and described in the tables below:

- Properties for the portal element and the placement of the chart inside the parent document (Table 1)
- Properties for the appearance of the actual chart (Table 2).
- Properties for input series that feed the chart (Table 3).
- Properties for the status of plotted data (Table 4).

Table 1: Properties for placement of the chart inside the parent document

Name	Type	Description	Example
width*	Number, String	The width (pixels) of the container element.	250, 40%
height*	Number, String	The height (pixels) of the container element.	250, 40%

Table 2: Properties related to chart's appearance

Name	Type	Description	Example
xAxis.data	array	An array of distinct (aka category) values that x can take	['Mon', 'Tue', 'Wed', 'Thu', 'Fri', 'Sat', 'Sun']
xAxis.formatter	(x)=>(<String>)	Formatter callback for x values	(x)=>(x.toString() + 'Km')
xAxis.labelFilter	(i, x) => (<Boolean>)	Decide if a label should be shown on the X axis.	(i)=>(i%2 == 0)
xAxis.numTicks	Number	A hint for the number of ticks on X axis	5
xAxis.boundaryGap	Boolean	Add a gap between min/max x value and axis boundaries	false

xAxis.min	Number	A maximum for displayed x values (meaningless if xAxis.data is supplied)	0
xAxis.max	Number	A minimum for displayed x values (meaningless if xAxis.data is supplied)	5.0
yAxis.formatter	(y)=>(<String>)	Formatter callback for y values	(y)=>(y.toString() + 'lt')
yAxis.numTicks	Number	A hint for the number of ticks on y axis	5
yAxis.min	Number	A maximum for displayed y values	-100
yAxis.max	Number	A minimum for displayed y values	+100
grid.x	String or Number	See EСharts - grid.x	15%
grid.y	String or Number	See ECharts - grid.y	10%
grid.x2	String or Number	See ECharts - grid.x2	15%
grid.y2	String or Number	See ECharts - grid.y2	10%
color	Array of String	A palette of preferred colors	['#C23531', '#2F4554']
tooltip	Boolean	Display tooltips for data points or marker points/lines	true
smooth	Boolean	Smoothen lines for all series (spline interpolation)	false
lineWidth	Number	The width (pixels) of all plotted lines	2
legend	Boolean or Array	Display legend. If an array is supplied, then it can control the order and layout of items (a nested array generates a legend that wraps over multiple lines)	true, [['A', 'B'], ['C', 'D']], ['A', 'C', 'D', 'B']

Table 3: Properties for input series. The series property is an array that provides the actual data to be plotted. Each item inside series, carries the above (nested) properties.

Name	Type	Description	Example
series.0.name*	String	The name of this dataset	Temperature - Athens
series.0.data*	Array	The actual array of data points. If xAxis.data is present (categorical data), then we expect an array of values mapping 1-1 to xaxis values. Else, we expect an arbitrary array of numerical (x,y) points.	[11.0, 11.5, 13, 14, 13, 15, 17]
series.0.color	String	The color for this line/area	'#C23531'
series.0.smooth	Boolean	Smoothen line for this series (perform spline interpolation)	false
series.0.fill	Number	Fill areas with the given opacity	null or 0.55
series.0.symbolSize	Number	Radius for symbols for (x,y) points	4
series.0.symbol	String	Choose a symbol for (x,y) points. One of: circle, rectangle, triangle, diamond, emptyCircle, emptyRectangle, emptyTriangle, emptyDiamond	emptyCircle
series.0.lineWidth	Number	The width (pixels) for this line	false
series.0.mark.points	Object	Describe marker points	[{type: "max", name: "Max Temperature"}]
series.0.mark.lines	Object	Describe marker lines	[{type: "min", name: "Min Temperature"}]

Table 4: Properties for the status of plotted data

Name	Type	Description	Example
loading	Object or Boolean	Provide a visual feedback on progress (spinner, progressbar)	{text: "Loading data...", progress: 0.7}

In the following, we provide a simple example of how the LineChart UI element can be invoked. We plot (fictional) temperatures for 3 cities over a period of 1 week. In this particular example, we supply our LineChart with categorical data, i.e. all X values are drawn from a set of predefined distinct values (days of a week).

```
<LineChart
    width='500px'
    height='300px'
    legend={[
        ['Athens', 'Thesalloniki'], ['Herakleion'],
    ]}
    xAxis={{
        data: ['Mo','Tu','We','Th','Fr','Sa','Su'],
    }}
    yAxis={{
        name: "Temperature",
        numTicks: 3,
        formatter: (y) => (y.toString() + " oC")
    }}
    series={[
        {
            name: 'Athens',
            smooth: true,
            fill: 0.4,
            data: [11.0, 11.5, 13, 14, 13, 15, 17],
            mark: {
                lines: [{type: "max", name: "Max Temperature"}],
            },
        },
        {
            name: 'Thesalloniki',
            data: [5.0, 8.5, 13.5, 14.7, 16, 19, 21.5],
        },
        {
            name: 'Herakleion',
            data: [15.0, 18.5, 19.5, 24.7, 26, 29, 31.5],
        },
    ]}
/>
```

The above example will produce the chart shown at Figure 4:

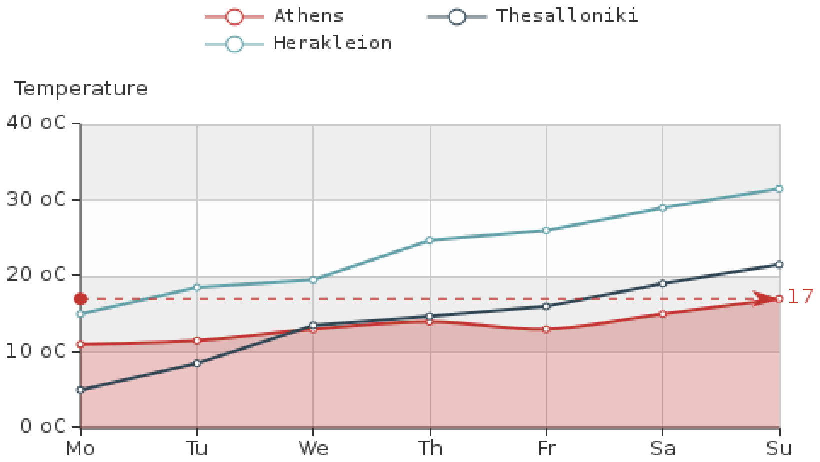


Figure 4: Result of example invocation

The following figures present some indicative uses of the LineChart UI element inside DAIAD's web applications.

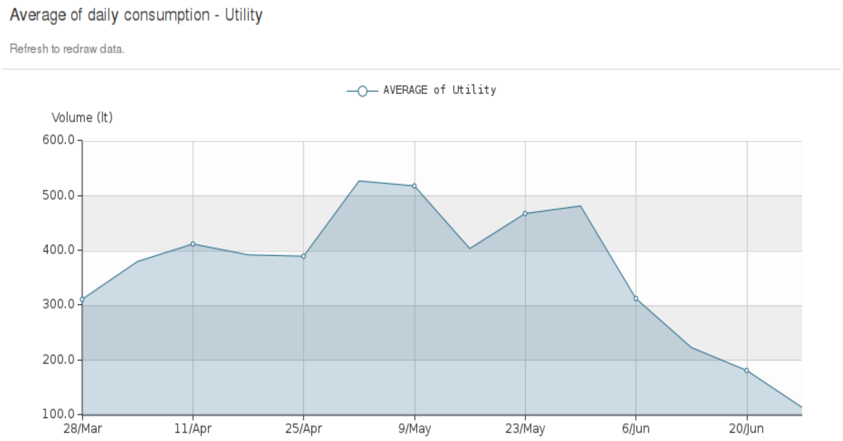


Figure 5: Average of daily consumption chart

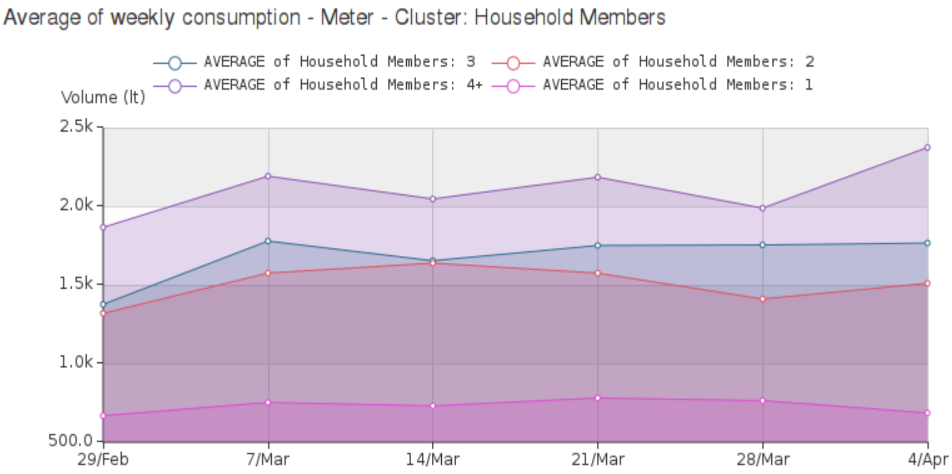


Figure 6: "Average of weekly consumption" for consumer groups of the "Household Members" cluster

2.2. Chart

The Chart UI element is a specialization of the LineChart element that focuses on the visualization of time-series data. The source code is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/reports-measurements/chart.js

Specifically, it is a class that implements a presentational-only React component. It is built entirely on the LineChart component by making some assumptions on the nature of input data and adding data-shaping logic and defaults. More precisely:

- Narrows its input to time-series data, expected as series of (t, y) pairs. The time part is always expected as an Epoch timestamp, not necessarily at even steps.
- Assumes that represented time-varying entities are linked to metadata (e.g. unit of measurement) accessible via global client-side configuration.
- Is capable to perform data shaping in order to provide a requested level of detail. It does so by grouping data points into evenly-sized time buckets (of the target level) and then applying an aggregate function on them.
- Adds another layer of class-level defaults related to the time nature of the X axis.

The Chart UI element receives properties described in the table below. All properties marked as enumeration may take a value from a set of constants globally available as part of client-configuration.

Table 5: Properties for Chart UI element

Name	Type	Description	Example
width*	String, Number	The width of LineChart element	`400`
height*	String, Number	The height of LineChart element	`400`
field*	String	The name of the physical entity under consideration (enumeration).	`volume`
level*	String	The desired level of detail (enumeration).	`Week, day`
reportName*	String	The name of the current report (enumeration).	`avg`

series*	Array	Input series of data points.	`[{`
			`source: "volume",`
			`data: [`

			`[t1, y1],`
			`[t2, y2]`
			`]`
			`}]`

finished	Boolean, Number	Are series data considered as finished. If this is false, means that there is a ongoing request. If is a number represents the timestamp of last successful request.	`1467716293`
draw	Boolean	Allow parental control to redrawing. Used to explicitly prevent component updates.	`true`

In the following, we provide an example (expressed as JSX) of how the Chart UI element can be invoked:

```
<Chart
  draw={true}
  field="volume"
  level="week"
  reportName="avg"
  series={[
    source: "volume",
    data: [[t1, y1], [t2, y2], ... [tN, yN]]
  ]}
/>
```

The above example will produce the chart shown at Figure 7.

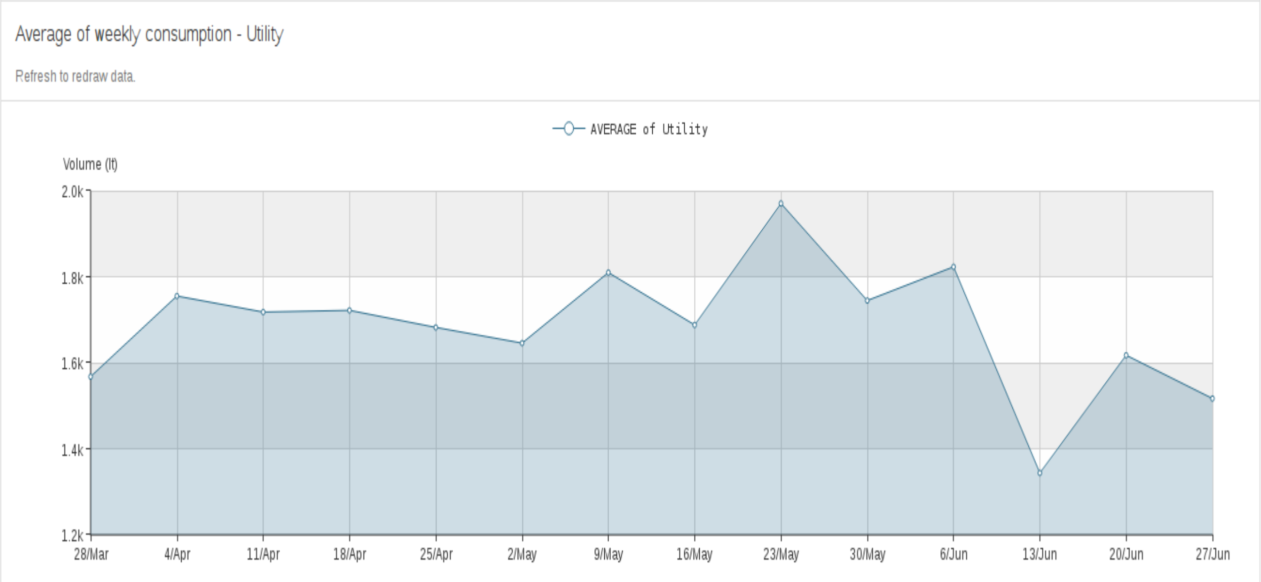


Figure 7: An example invocation of Chart UI element producing an "Average of Weekly Consumption" chart at DAIAD@utility application

2.3. ChartContainer

The ChartContainer UI element is a container of the Chart element capable to request and receive measurement data from DAIAD's Data API. The source code is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/reports-measurements/chart-container.js

The ChartContainer UI element is a class that implements a container React component. It acts as a transparent proxy to an enclosed Chart component adding data-acquisition methods. Since we are using Redux to manage global client-side state, these methods just emit actions that Redux store will dispatch to the appropriate reducer. Briefly, these actions will result to the following:

- Request measurement data on the given Data API.
- Receive data from Data API and shape them according to way global state expects them. Handle possible failure in any phase of the request cycle.
- Feed the overall status of the request to the contained component.
- Select and feed (successfully) received data to the contained component.

The ChartContainer UI element has been implemented as a typical Redux container around Chart component. We have provided the two needed mapping functions to map global state and dispatch functions to component properties.

The ChartContainer UI element receives exactly the same properties as Chart element. As explained above, the only difference is that in ChartContainer some properties (series) are not passed explicitly from the owner component but instead are "silently" injected from Redux mappers.

2.4. LeafletMap

The LeafletMap UI element is a component for creating interactive maps and is based on the Leaflet[12] JavaScript mapping library. It uses Open Street Maps (OSM) as the base layer and supports the rendering of choropleth and heat maps, drawing of polygons and rendering GeoJSON features. The code for LeafletMat UI element is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/LeafletMap.js

The LeafletMap UI element supports several layer types including vector, choropleth and heat map layers. The vector layers render GeoJSON data which can be either set explicitly or be downloaded asynchronously from a remote source. Moreover, a drawing tool is provided for creating, editing and deleting polygon geometries.

---

[12] http://leafletjs.com/

At any given time only a single polygon geometry can exist on the map. The aforementioned features, named modes, can be composed in order to implement more complex scenarios. As an example, a map may contain a choropleth layer and one or more GeoJSON layers in addition to the polygon drawing tool. Some modes expose events or callback properties to which users can attach event handlers or set callback functions for receiving notifications or controlling the component's behavior respectively. GeoJSON layers support a callback function for rendering the contents of a popup dialog whenever a feature is selected. The drawing tool supports the onDraw event for accessing the newly created geometry.

The LeafletMap UI element has been implemented as follows:

- We have created a reusable mixin class, namely PortalMixin[13], in order to incorporate into React third-party components that directly manipulate the DOM. The mixin implements all functions necessary for handling the react lifecycle, like mounting and unmounting. Also, we have included common functionality such as creating an enclosing element, adding class names or handling window events such as resizing.
- We have developed a reusable presentational map component, as a wrapper to the Leaflet JavaScript library. Integration with React is achieved with the help of the previously mentioned Portal PortalMixin class. The LeafletMap component provides several properties for easily configuring choropleth and heat maps, enabling polygon drawing and displaying GeoJSON feature collections.
- Polygon drawing is implemented using the Leaflet.draw[14] plugin. This plugin supports drawing points, lines and polygons. The current version of the component exposes only the functionality for drawing polygons.
- Heat maps are implemented using the Leaflet.heat[15] plugin. This is an experimental feature and is currently under evaluation. There are a few known issues related to layer ordering when a heat map layer is combined with GeoJSON layers.

The configuration options for the LeafletMap UI element are documented in the tables below. Optional parameters have their names in square brackets:

Table 6: LeafletMap configuration options

Name	Type	Description	Example
width	Number, String	The width of the container	100, 100%
height	Number, String	The height of the container	200, 50%
[center]	Array	Map center coordinates expressed in WGS84[16] Coordinates Reference System (CRS)	[38.36, 0.47]

---

[13] https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/PortalMixin.js

[14] https://github.com/Leaflet/Leaflet.draw

[15] https://github.com/Leaflet/Leaflet.heat

[16] https://epsg.io/4326

[zoom]	Number	Map zoom level	13
[mode]	Array	Array of constants representing the supported modes. Can be any of: LeafletMap.MODE_DRAW: Enables the polygon drawing tool LeafletMap.MODE_VECTOR: Renders GeoJSON data. The data must be set during the component configuration LeafletMap.MODE_CHOROPLETH: Adds a choropleth layer to the map LeafletMap.MODE_HEATMAP: Adds a heat layer to the map	
[choropleth]	Object	Configuration for the LeafletMap.MODE_CHOROPLETH mode	
[heatmap]	Object	Configuration for the LeafletMap.MODE_HEATMAP mode	
[vector]	Object	Configuration for the LeafletMap.MODE_VECTOR mode	
[overlays]	Array	Array of one or more Overlay objects. Overlays are used for rendering GeoJSON data from remote sources	
[draw]	Object	Configuration for the LeafletMap.MODE_DRAW mode	

Table 7: Choropleth configuration options

Name	Type	Description	Example
[colors]	Array	Array of String with colors	['#2166ac', '#67a9cf', '#d1e5f0', '#fddbc7', '#ef8a62', '#b2182b']
min	Number	Minimum for the value range of the property that controls color selection	
max	Number	Maximum for the value range of the property that controls color selection	
data	Array	Array of objects representing GeoJSON features. Every feature is expected to have to properties, namely, label and value. The label is a string that is shown whenever the user moves the mouse pointer over an area. The value is a number that controls the color of the area	

Table 8: Heatmap options

Name	Type	Description	Example
data	Array	An array of arrays containing the values for latitude, longitude and intensity	[[38.35, -0.51, 0.43], [38.32, -0.52, 0.70]]

Table 9: Vector options

Name	Type	Description	Example
features	Object	GeoJSON feature collection	
[autofit]	Boolean	Set zoom and center of the map to fit all the geometries of all features	
[renderer]	function	Callback function for rendering the content of the feature popup. If null is passed, no popup is displayed. The function accepts the feature as an argument	

Table 10: Overlay options

Name	Type	Description	Example
url	String	URL to load. The component expects the data to be valid GeoJSON data	
[popupContent]	String	If the feature has a property with this name, a popup is automatically displayed when the geometry is clicked and the value of this property is rendered	

Table 11: Draw configuration options

Name	Type	Description	Example
[onFeatureChange]	function	Event callback function for the polygon drawing tool. An array of the features managed by the drawing tool is passed as an argument to the callback function	

In the following, we provide an example of how the LeafletMap UI element can be invoked. In this particular example, we create a heat map at the area of Alicante and load an overlay with smart water meter locations.

```
const data = [
  [38.35158029009623,-0.5127149340684682,0.489274714584645],
  [38.351475013417634,-0.5144934140654951,0.18531167537882554],
  [38.35084224374121,-0.5068995478363351,0.8293466197666137],
  [38.355866667260536,-0.5050425443046236,0.1784871162216637],
  [38.35702028182229,-0.5188455797556075,0.2567012202637913],
  [38.35149328949548,-0.5023014604226804,0.399384261912348],
  [38.35151379113833,-0.5174211838483379,0.5221763231545455],
  [38.35774806820126,-0.5182871324024617,0.43892445229463806],
  [38.35311661602698,-0.5127421639764359,0.7031278132331256],
  [38.359908032645684,-0.5040170430576278,0.47949428908247205]
];
<LeafletMap style={{ width: '100%', height: 300}}
    center={[38.36, -0.479]}
    zoom={13}
    mode={[LeafletMap.MODE_HEATMAP]}
    heatmap={{ data : data}}
    overlays={[
        {  url: '/assets/data/meters.geojson',
           popupContent: 'serial'
        }
    ]}
/>
```

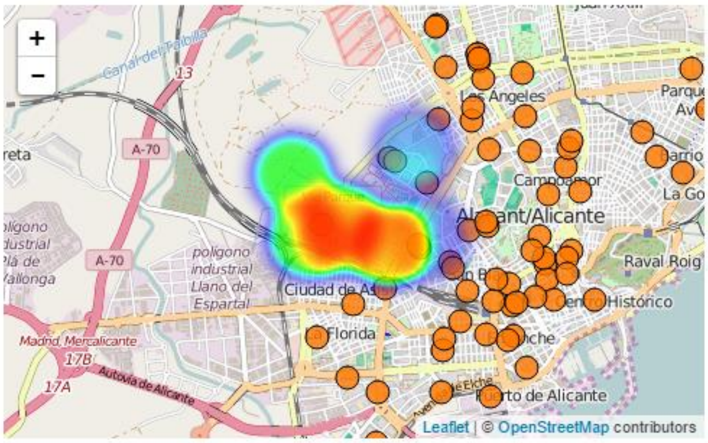


Figure 8: Example of LeafletMap component usage

In the following figures, we provide two representative examples of how the LeafletMap UI element is used in the context of the DAIAD@utility web application.

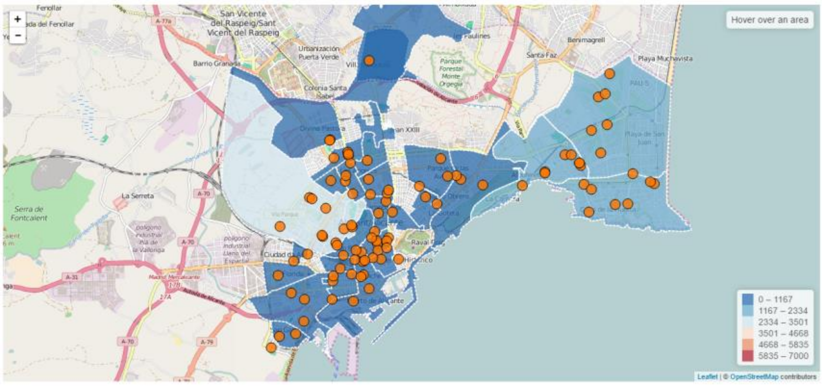


Figure 9: Choropleth of smart water meter data combined with a GeoJSON overlay of the meters' locations

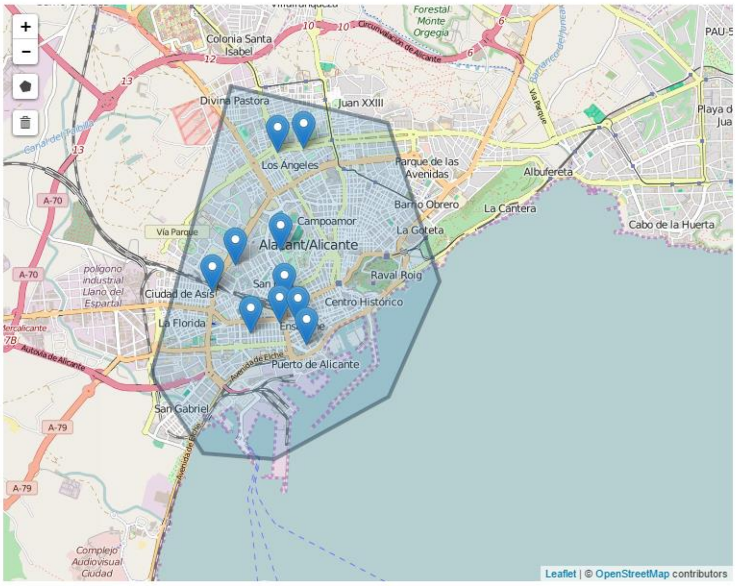


Figure 10: Combination of the vector and draw modes for displaying a user defined spatial filter and selected smart water meters' locations

2.5. Table

The Table UI element is a component for displaying data in tabular format. The component can be used with minimal configuration and requires only the definition of table column names and row data. Row data is expressed as an array of JSON objects and is application specific. Column names correspond to row object properties. The component does not support nested properties for rows. The code for Table component is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/Table.js

The Table UI element implements the following features:

- Data paging: The table element supports both client and server side data paging. Server side data paging is application specific and must be managed by the application using the Table element. The application is responsible for initializing the data.pager configuration options properly.

- Data formatting: The Table element uses the field.type configuration option for deciding which format to use for a cell value. If no type is defined, the value is treated as plain text. The component supports custom formatting for boolean, data and time values.
- Dynamic cell rendering: The configuration options for fields allow the dynamic computation of values at runtime using callback functions. Users can dynamically set the color of text, the icon of actions, the visibility of actions and the class of cell values using callbacks.
- Actions: Table UI element allows user interaction through the **action** field type. Actions are rendered as icons or images and can invoke a callback when clicked.

The Table UI element is a composite element. The components used for building a Table are enumerated below. A user can build a table explicitly by using these components but this syntax is a lot more verbose since properties for every component must be set manually.

- Table: This is the top level component that configures the table layout. It renders the Bootstrap pagination component if data.pager property is defined and renders the template.empty component if no data is found.
- Header: Renders the table header row and sets column visibility based on the data.field configuration options
- Body: Renders the table rows. Before rendering the Body component filters table rows depending on the pagination options. If pagination is done locally, the Body component selects the rows of the currently selected page index to display.
- Row: Renders the cells of a row and sets the column visibility based on the data.field configuration options.
- Cell: Renders the value for a single row object property. The rendering process is driven by the configuration options of the corresponding data.field object. Optionally, if callback functions are used, values of other row object properties effect the rendering process.

The configuration options for the Table UI element are documented in the tables below. Optional parameters have their names in square brackets:

Table 12: Table configuration options

Name	Type	Description	Example
data	Object	Table schema, rows and data paging configuration options	
[onPageIndexChange]	function	Callback function invoked when the current data page index changes. The new data page index is passed as an argument	
[template]	Object	Configuration options for the table default views	
[style]	Object	Table elements custom styles	

Table 13: Data configuration options

Name	Type	Description	Example
fields	Array	Array of objects with configuration options for table columns	
rows	Array	Array of objects with row data	
[pager]	Object	Data paging options	

Table 14: Field options

Name	Type	Description	Example
name	String	Field name. Each row Object is expected to have a property with this name	
title	String	Column header	
[hidden]	Boolean	True if the column is visible; Otherwise False, Default value is True	
[type]	String	Field data type. Default value is undefined and the cell value is treated as text. Valid values are: **action**: Renders a button using an icon **datetime**: Formats the value of the cell as a date time value **date**: Formats the value of the cell as a date value **time**: Formats the value of the cell as a time value **progress**: Renders a progress bar. The value is expected to be a number in the interval 0 to 100 inclusive. **boolean**: A read-only checkbox. The value is expected to be a boolean **alterable-boolean**: A writable checkbox. The value is expected to be a boolean	
[icon]	String, Function	Applicable only to fields of type **action**. The icon to display for the action. If a string is specified, it is treated as a Font Awesome[17] class name. If a function is specified, the class name is the function call return value. The function accepts two arguments. The field configuration object and the row object the value belongs to.	clock-o

---

[17] http://fontawesome.io/

[image]	String	Applicable only to fields of type **action**. The image to display for the action. This property is overridden by the icon property.	
[color]	String, Function	If a string is specified, it is treated as a color value. If a function is specified, the color value is the function call return value. The function accepts two arguments. The field configuration object and the row object the value belongs to.	#9E9E9E
[handler]	Function	Applicable only to fields of type **action**. The callback function invoked when the action is executed. The function accepts two arguments. The field configuration object and the row object the value belongs to.	
[visible]	Booelan, Function	Applicable only to fields of type **action**. Shows or hides the contents of a cell dynamically at runtime. The visibility status is the function call return value. The function accepts two arguments. The field configuration object and the row object the value belongs to.	
[align]	String	Header and cell text alignment. Valid values are left, right, center and justify. Default value is left.	
[width]	Number	Column width in pixels	
[link]	String, Function	Renders a link instead of the property value. If a string is specified, it is treated as a link template. Link templates contain place holders which are column names in curly brackets e.g. the {address} placeholder is replaced with the value of the row object address property. If a function is specified, the template is created dynamically before generating the actual link. The function accepts the row object as an argument.	
[className]	Function	Returns a class name to apply to the cell contents. The function accepts the value of the cell as an argument.	

Table 15: Pager options

Name	Type	Description	Example
[index]	Number	Current data page index. Default value is 0.	
[size]	Number	Number of rows per data page. Default value is 10.	
[count]	Number	Total number of rows. Default value is 0.	
[mode]	String	Enables data paging at the client or server side. Valid values are: Table.PAGING_CLIENT_SIDE	

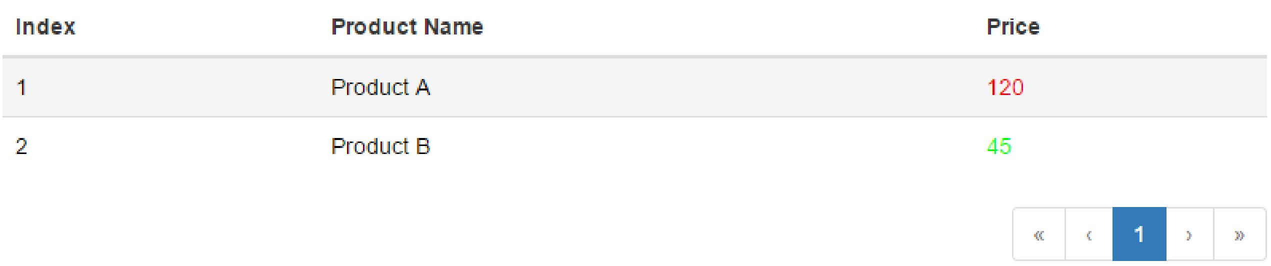
		Table.PAGING_SERVER_SIDE Default value is Table.PAGING_CLIENT_SIDE.	

Table 16: Style configuration options

Name	Type	Description	Example
[row]	Object	Style for cells of a row	{ color: '#9E9E9E' }

In the following, we provide an example of how the Table UI element can be invoked. In this particular example, we create a simple table with three columns and two rows. For the third column, a callback is defined for setting the cell value color dynamically at runtime.

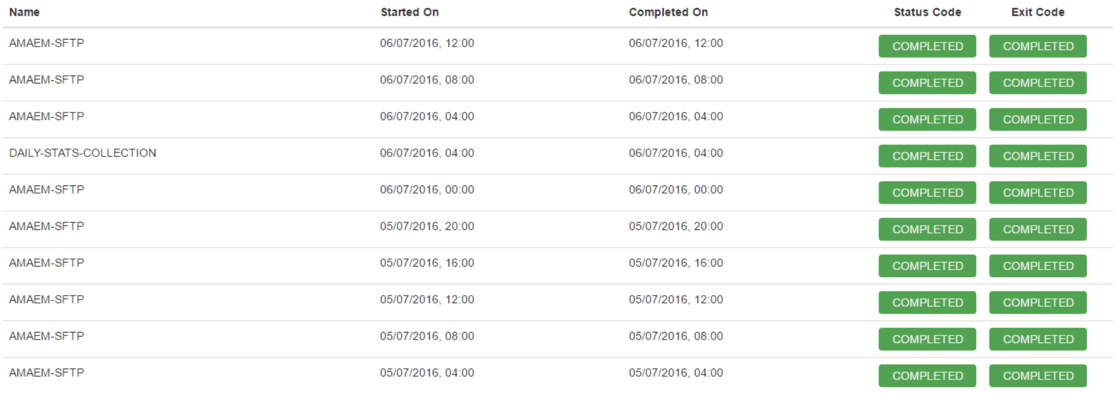
```
const config = {
  fields: [{
    name: 'index',
    title: 'Index'
  }, {
    name: 'name',
    title: 'Product Name'
  }, {
    name: 'value',
    title: 'Price',
    color: function (field, row) {
      if (row.value > 100) {
        return '#FF0000';
      }
      return '#00FF00';
    }
  }],
  rows: [
    {index: 1, name: 'Product A', value: 120.0},
    {index: 2, name: 'Product B', value: 45.0}
  ],
  pager: {
    index: 0,
    size: 10,
    count: 2,
    mode: Table.PAGING_CLIENT_SIDE
  }
};
<Table data={config} />
```



Index	Product Name	Price
1	Product A	120
2	Product B	45

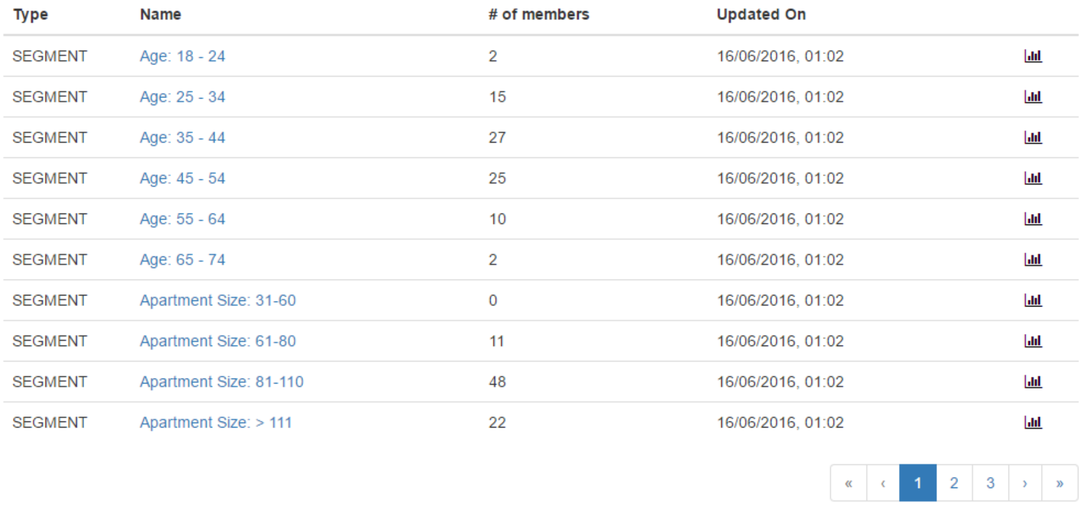
Figure 11: Result of Table code example

In the following figures we provide two representative examples of how the Table UI element is used in the context of the DAIAD@utility web application.



Name	Started On	Completed On	Status Code	Exit Code
AMAEM-SFTP	06/07/2016, 12:00	06/07/2016, 12:00	COMPLETED	COMPLETED
AMAEM-SFTP	06/07/2016, 08:00	06/07/2016, 08:00	COMPLETED	COMPLETED
AMAEM-SFTP	06/07/2016, 04:00	06/07/2016, 04:00	COMPLETED	COMPLETED
DAILY-STATS-COLLECTION	06/07/2016, 04:00	06/07/2016, 04:00	COMPLETED	COMPLETED
AMAEM-SFTP	06/07/2016, 00:00	06/07/2016, 00:00	COMPLETED	COMPLETED
AMAEM-SFTP	05/07/2016, 20:00	05/07/2016, 20:00	COMPLETED	COMPLETED
AMAEM-SFTP	05/07/2016, 16:00	05/07/2016, 16:00	COMPLETED	COMPLETED
AMAEM-SFTP	05/07/2016, 12:00	05/07/2016, 12:00	COMPLETED	COMPLETED
AMAEM-SFTP	05/07/2016, 08:00	05/07/2016, 08:00	COMPLETED	COMPLETED
AMAEM-SFTP	05/07/2016, 04:00	05/07/2016, 04:00	COMPLETED	COMPLETED

Figure 12: Job execution history



Type	Name	# of members	Updated On	
SEGMENT	Age: 18 - 24	2	16/06/2016, 01:02	📊
SEGMENT	Age: 25 - 34	15	16/06/2016, 01:02	📊
SEGMENT	Age: 35 - 44	27	16/06/2016, 01:02	📊
SEGMENT	Age: 45 - 54	25	16/06/2016, 01:02	📊
SEGMENT	Age: 55 - 64	10	16/06/2016, 01:02	📊
SEGMENT	Age: 65 - 74	2	16/06/2016, 01:02	📊
SEGMENT	Apartment Size: 31-60	0	16/06/2016, 01:02	📊
SEGMENT	Apartment Size: 61-80	11	16/06/2016, 01:02	📊
SEGMENT	Apartment Size: 81-110	48	16/06/2016, 01:02	📊
SEGMENT	Apartment Size: > 111	22	16/06/2016, 01:02	📊

Figure 13: List of cluster segments

2.6. Toolbar

The Toolbar UI element is a general-purpose control that builds a button toolbar as a group of button groups. A common set of options and customizations (icons, text, tooltips) is supported. The source code is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/toolbars.js

The Toolbar UI element is a class that implements a presentational-only React component. It receives (as a property) a plain JSON specification that describes each button in a button group, and according to that specification it builds a toolbar element. Finally, it also receives a callback property to be invoked with the particular key of a button that was just clicked.

The Toolbar UI element has been implemented as follows:

- We have developed a React component that receives a toolbar specification and renders a toolbar based on React-Bootstrap buttons and button groups. This specification should assign a unique key to each button and should describe the appearance (icons, text, CSS classes) and its status (enabled, activated).
- We attach to all (enabled) buttons an event handler that wraps and calls the user-supplied (property) callback function using group's key and button's key as the first 2 parameters.
- We use the FontAwesome icon set (http://fontawesome.io/icons/) to improve a button's appearance and/or give a visual clue of its function. If an icon is to be used, the specification must refer to it by its name in FontAwesome set.

The Toolbar UI element receives properties described in the tables below.

Table 17: Properties for Toolbar UI element

Name	Type	Description	Example
groups*	Array	The spec that describes the toolbar	[{<group-spec>}, ...]
groups.0.key*	String	A unique key for a group of buttons	actions
groups.0.buttons*	Array	An array of button specs	[{<button-spec>}, ...]
onSelect*	(groupkey, key) => ()	A callback to be invoked when a button is clicked.	(groupKey, key) => (alert(key))
className	String	An additional CSS class for the toolbar HTML element	toolbar-a

Table 18: Specification for a button inside Toolbar UI Element

Name	Type	Description	Example
key*	String	A unique key for a button	save
text	String	Text for a button	Save
tooltip.message	String	A message for a button tooltip	Save everything
tooltip.placement	String	A hint for the placement of the tooltip. One of: bottom, top, left, right	bottom

iconName	String	A name for a button icon. Must refer to FontAwesome icon set.	save
buttonProps	Object	A set of properties to be forwarded to Bootstrap button	{disabled: false}

In the following example (expressed as JSX) we create a toolbar that consists of 2 button groups.

```
var toolbarSpec = [
      {
        key: 'parameters',
        buttons: [
          {
            key: 'source',
            tooltip: {message: 'Select source of measurements', placement: 'bottom'},
            iconName: 'cube',
          },
          {
            key: 'report',
            tooltip: {message: 'Choose type of report', placement: 'bottom'},
            iconName: 'area-chart',
          },
          {
            key: 'timespan',
            tooltip: {message: 'Define a time range', placement: 'bottom'},
            iconName: 'calendar',
          },
          {
            key: 'population-group',
            tooltip: {message: 'Define a population target', placement: 'bottom'},
            iconName: 'users',
          },
        ],
      },
      {
        key: 'actions',
        buttons: [
          {
            key: 'export',
            tooltip: {message: 'Export to a CSV table', placement: 'bottom'},
            text: 'Export',
            iconName: 'table',
            buttonProps: {disabled: true},
          },
          {
            key: 'refresh',
            tooltip: {message: 'Re-generate report and redraw the chart', placement:
'bottom'},
            text: 'Refresh',
            iconName: 'refresh',
            buttonProps: {bsStyle: 'primary' },
          },
        ],
      },
    ];
<Toolbar
  groups={toolbarSpec}
  onSelect={(groupKey, key) => (console.log(key))}
/>
```

The above example will build a toolbar as the one shown in Figure 14.

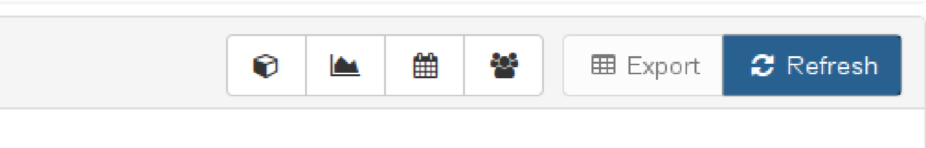


Figure 14: A toolbar built from a Toolbar UI element

2.7. ReportPanel

The ReportPanel UI element is a control that facilitates the generation of custom reports on measurement data. It collects common report-related parameters via user-friendly graphical interaction, validates and sanitizes input parameters, and finally generates an on-demand report. The source code is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/reports-measurements/pane.js

The ReportPanel UI element is class that implements a React component. It carries both presentational and container logic and is composed of several other React components:

- A Toolbar component that navigates the user through several form fragments and provides a set of actions on the report itself (e.g. refresh, export).
- A Form component that collects and validates user input for various report parameters (e.g. time interval, source of measurements etc.)
- A ChartContainer component that holds the chart generated by the last user-supplied active set of parameters.
- An Info component that displays helpful messages on the overall status (e.g. last successful update).

The ReportPanel UI element has been implemented as follows:

- We have developed a class for a presentational React component that renders a React-Bootstrap panel. The panel header contains a button toolbar (a Toolbar UI element) built from a proper button specification. The panel body contains several subsections arranged as React-Bootstrap ListGroup items:
    - Form section: a form fragment that collects user input relevant to the current group of parameters (e.g. parameters related to the population target). All available report parameters are logically grouped into form fragments, and the user can switch to another group of parameters using the header toolbar.
    - Report title section: a brief description of the currently active report. Essentially, it translates the active set of parameters to a human-friendly textual description (e.g. "Average of weekly consumption").
    - Chart section: a chart generated (on-demand) by the active set of parameters. This section consists of a ChartContainer UI element on which we explicitly control when a re-rendering will take place (so that the canvas is redrawn).

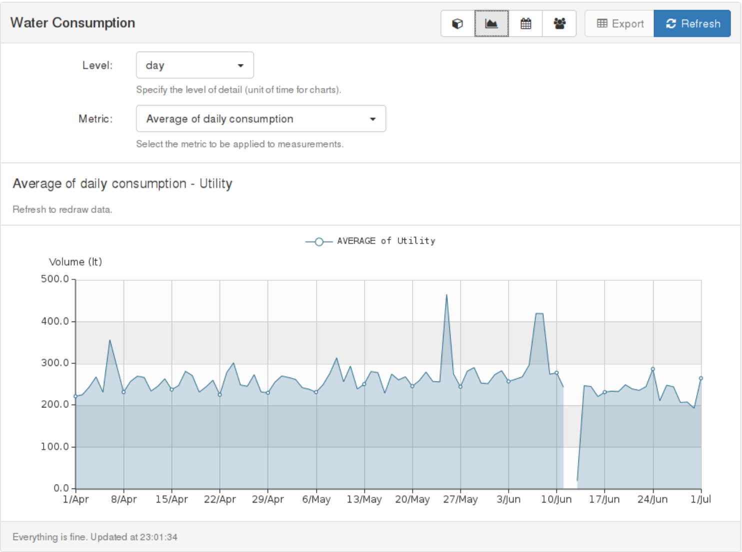
  - Info section: an informational section summarizing the status of the report, implemented as a local component. The status of the current report (as reflected by the global state) is translated to a human-friendly message.
- We have wrapped the presentational part of ReportPanel into a Redux container component, which provides the following facilities:
  - Dispatch methods that emit actions to Redux store. These actions push user-supplied report parameters to the global state (setting them as active), and also trigger requests that fetch measurement data (on top of Data API) for the active report.
  - Properties reflected from global state. These properties include the active report, the active set of parameters for that given report, received measurement data and overall status of the report.

The ReportPanel UI element does not receive any properties directly from its owner component. Instead, all properties are injected from Redux mappers by reflecting a part of global state.

Due to the fact that no properties are explicitly passed to this component, an example invocation (expressed as JSX) would be as simple as:

```
<ReportPanel />
```

The result of the above invocation is shown at Figure 15.



Water Consumption

Level: day

Specify the level of detail (unit of time for charts).

Metric: Average of daily consumption

Select the metric to be applied to measurements.

Average of daily consumption - Utility

Refresh to redraw data.

Everything is fine. Updated at 23:01:34

Figure 15: The ReportPanel UI element

2.8. UnitReport

The UnitReport UI element is a control that includes and enables several views on measurement data while staying in a level of detail and spanning over a period expressed as a multiple of some given time unit (e.g.

week as a unit, 3 weeks as a period). The mainly examined period spans over exactly one time unit and starts at a given reference time (e.g. last week referring to May 12, 2016). The source code is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/reports-measurements/unit-reports.js

The UnitReport UI element is a class that implements a React component. It carries both presentational and container logic, so it is actually a Redux container wrapping a presentational component. For a given level of detail and for a given period, several views share a lot of request and data-shaping logic. Taking this into account, the UnitReport UI element is the container that preprocesses report data, understands a set of views as drop-ins and renders a proper visual representation for each view. UnitReport will scan and will try to recognize its children from a set of predefined views (e.g. a summary view). Once a child is matched against a known view, the respective view is activated and is rendered from the parent component. We must note that this matching mechanism is not interface-based, simply a set of view classes are recognized as valid views. The source code that defines the available views can be found at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/reports-measurements/views.js

The UnitReport UI element has been implemented as follows:

- We have created a set of view classes as pseudo-components. These pseudo-components do not actually render anything, they only serve to enable a certain view inside UnitReport (once found as a child of it) and possibly hold view-specific parameters. For the time being, the following views are recognized:
  - summary: display totals of the main period (e.g. totals for the last day).
  - simple-chart: display a chart over the main period (e.g. last day).
  - comparison-chart: display a chart that compares main period with previous over an interval of one time unit (e.g. compare last day to last 3 days).
- We have developed a class for a React component that will play the role of the UnitReport UI element. Whenever this component receives new properties, it preprocesses report data and holds them as part of the internal state. This preprocessing includes:
  - Sorting of data points by ascending time.
  - Consolidation of data points at the current level of detail.
  - Creating a dense array of data points with even steps (original data points may be sparse).
  - Computing important aggregates (e.g. totals) for the main period.
- We have made the render method of UnitReport aware of the aforementioned views. The component scans all its children and if an instance of known view is encountered then an inner view-specific rendering method is invoked to generate the respective component's sub-tree.
- We have wrapped the presentational part of UnitReport into a Redux container that provides:

- Dispatch methods that emit actions to Redux store. These actions initialize and refresh measurement data for a certain report.
- Data series received for a certain report, as a property reflected from global state.

The UnitReport UI Element receives the properties described in the table below:

Table 19: Properties of UnitReport UI element

Name	Type	Description	Example
source*	String	The name of the data source. One of: meter, device	meter
field*	String	The name of the measured physical entity. It depends on the source,	volume
uom*	String	The unit of measurement for field	lt
now*	Integer	An Epoch timestamp for the reference time	1457481600000
report.reportName	String	The name of the report. Refers to a static set of names included in global configuration	avg
report.startsAt	String	The boundary at which a period starts. One of: hour, day, week, isoweek, month, quarter, year.	day
report.level	String	The level of detail. One of hour, day, week, isoweek, month, quarter, year.	hour
title	String	A title for this collection of views	Last Day

In the following example (expressed as JSX) we create a UnitReport around a timestamp of 1457481600000 (8 Mar 2016), for a time unit of a day and with three enabled views. Note that ReportByDay is just a subclass of UnitReport adding some class-level defaults for a day (e.g. date formatting).

```
var views = require('./views');
var reports = require('./unit-reports');
var ReportByDay = (reportProps) => (
  <reports.ReportByDay
    field="volume"
    uom="lt"
    report={{reportName: 'sum', startsAt: 'day', level: 'hour'}}
    source="meter"
    now={1457481600000}
   >
    <views.Summary />
    <views.SimpleChart />
    <views.ComparisonChart />
  </reports.ReportByDay>
);
```

The above example will produce a report as shown in Figure 16.

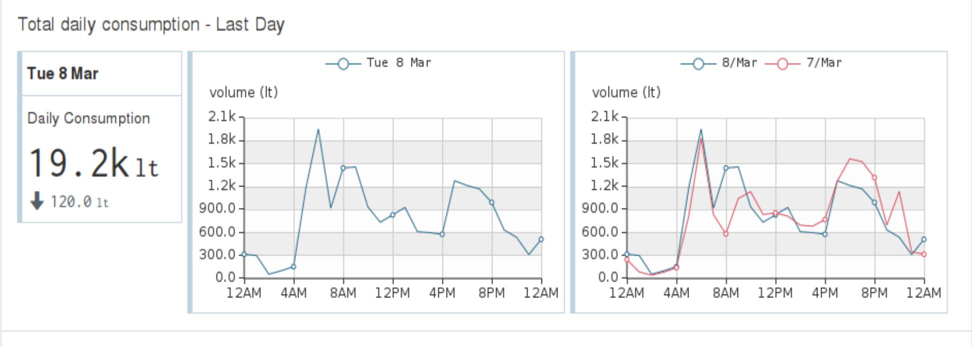


Figure 16: A UnitReport at a unit of a day, with the following views: a summary, a simple chart and a comparison chart

2.9. Widgets

The Widgets UI element is a simple control that displays values of measured quantities in a gauge-like fashion. It serves the purpose of displaying important values and highlighting the difference with respective previous values. The source code is available at:

- https://github.com/DAIAD/home-web/blob/master/src/main/resources/public/assets/js/src/utility/components/reports-measurements/measurement-value.js

The Widgets UI element is a class that implements a presentational-only React component. It receives as properties a current value and a previous value, and displays the current value, the difference with the previous value, and the increasing/decreasing tendency.

The Widgets UI element receives properties described in the table below:

Table 20: Properties of Widgets UI element

Name	Type	Description	Example
value*	Integer, Float	The current value	19200
prevValue*	Integer, Float	The previous value	19320
unit*	String	The unit of measurement for values	lt
title*	String	A title for the widget	Tue 8 Mar
subtitle*	String	A subtitle for the widget	Daily Consumption

In the following example, we create a Widgets UI element by supplying needed values and titles:

```
var {Widget: MeasurementValue} = require('./measurement-value');
<Widget
  value={19200}
  prevValue={19320}
  unit="lt"
  title="Tue 8 Mar"
  subtitle="Daily Consumption"
/>
```

The result of the above invocation is shown at Figure 17.

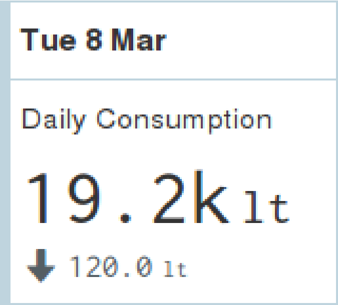


Figure 17: A Widgets UI element showing measurement values