Decision Makers Ltd   Research & Educational Simulations

Mindset Detectors

Detectors setup

Version 2.0

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Terms and Definitions

Term	Meaning
Detector	Software algorithm for detecting data abnormality
Model state	Indicates if model is in RUN, Pause, Edit or Error
Event state	Idle, Pending, Triggered, Canceled, Closed. For details see section 5 of this document
Detector state	ON / OFF

1. Introduction

1.1 Basic concept of detectors

Detectors are the heart of the Mindset Detector. They give the system the ability to sense that something is wrong. Detectors are software components. Each detector is capable of doing a single task. Each detector may be assigned different severity and different alarming policy.

1.2 How to access detector's screen

Detectors may be accessed from the main screen of a model by clicking the **Detectors** button. (See figure 1 rounded by red circle). Once clicked it opens the list of detectors currently defined in the selected model. (See figure 2)

By using the first three buttons located on the left side of the panel (figure 2), the user may **Add** a new detector. **Edit** existing one or **Delete** a detector.
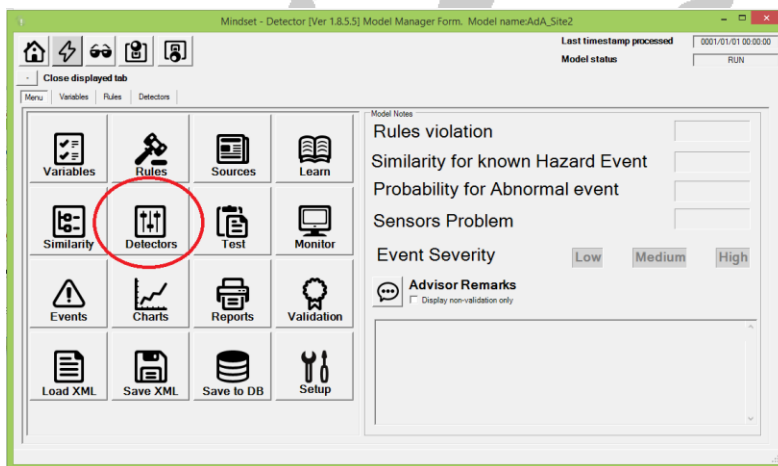

Figure 1: Detectors button in main model's panel

1.3 Detectors types

There are two types of detectors: single-variable detector and multi-variable detector. The first one monitors the time series values of a single variable. The second monitors combination of variables. Each detector is capable of performing a single task. For example, a User Limit detector is capable of detecting whether a single variable is violating the user's defined limits for the relevant variable.

Once a model is put into a RUN state, each incoming record is examined by all detectors. When one of the detectors detects that the incoming record is abnormal according to its algorithm, a new event is started. In case an event is already ON the new triggered detector is added to the current event. For more details see the Managing Events document.

Figure 2: Currently configured detectors

1.4 Automatic generation of Detectors

When a new model is created, none detectors are defined. However, the user may automatically generate all default detectors with their default setups by using the lower-most button on the left side of the panel. Detectors generated by this process have common setup value.

1.5 Filter Detectors list

The **Check Box lists** at the right side of the panel (figure 2) enable the user to filter the list of detectors - either by variable name (the upper list) or by detector type (the lower list). For example, if the user clicks the CL variable and checks the checkbox "Activate filter by variable names" located above the list, only detectors associated with the CL variable will be displayed.

The **Copy** button enables the user to duplicate the setup of a single detector to many other detectors.

Please note that once a detector is defined and activated, it is used by the system's run time engine.

2. Parameters common for all detectors

2.1.   Insert or Update Detector

Setting the specific parameters of a detector is done via the Detector Policy Editor (see figure 3).

Figure 3: Detector Policy Editor

This window can be activated in two forms. Insert or update. If the user clicks the **Add** detector button (in figure 2) this window is popped up with the fields **Detector Type** and **Detector Key** enabled for editing. If the user selects a detector from the list of detectors (figure 2) and click the **Edit** button, the fields **Detector Type** and **Detector Key** will be locked.

2.2.   Properties common for all detectors

The upper part of figure 3 contains parameters which are common for all detectors. Not all of them are mandatory. This section gives explanation about the common parameters for all detectors.

2.2.1. Active

This check box defines if the detector is scanned by the runtime engine of the Mindset-Detector or not. Changing the value of this fields affects the next scan of the detector immediately. I.e. if the detector is in a non-check state and the user change it to checked, the detector will be processed a5tr the next scan of the mindset engine. Please note that this may happen few minutes or more after the change has been committed.

2.2.2.   Delay before trigger (minutes)

This field sets the amount of time (in minutes) the detector waits while moving from **Pending** to **Trigger** status. For details about Detector's different statuses see section 5 of this document. In case the conditions which starts the **Pending** status no longer exist, the Detector goes back to **Idle** status.

2.2.3.   Delay after operational change (minutes)

An operation change is defined as a state in which one of the variables which has been defined as an operational variable has been changes. Normally, after operational change the water system needs some time to reach steady state. Thus, the detector must wait. This field set the waiting time after operational change when no new events will be declared.

2.2.4.   Delay after last event closed (minutes)

This parameter is aim to avoid a situation in which small events start and stop in short intervals. If a new event starts and the elapsed time since the previous event is small than the value of this parameter, the Mindset-Detector will glue these two events into one event.

2.2.5.   Notification policy

This parameter sets the time interval by which the user is notify about event. Options are:

Policy	Meaning
None	No email will be send to the monitored system personal
Every hour	A message will be sent every hour in case the events is ON
Every Day	A message will be sent once a day in case the events is ON
Every trigger	A message will be sent once the events goes from Pending to Triggered.

Please note that in order for messages to be email to the system personal, the outgoing mail target should be defined. This operation is done in the Mail option under the setup panel. For more details about the Setup panel see the Setup panel documentation.

2.2.6.   Base severity

This parameter defines the base severity of the events in case the current detector is triggered. Note that the severity of the event is equal to the severity of the detector with the highest severity.

Options for severity are:

Policy	Meaning
None	No severity (technical problem)
Low	Event do not create hazard to water users
Medium	Check should be performed by technical personal before escalating situation.
High	Immediate check should be performed.

2.2.7.   Block ON Rule

Block ON Rule is a rule which allows the Mindset-Detector to activate this detector only if the value of the rule is ON. This field should contain the name of the relevant rule.
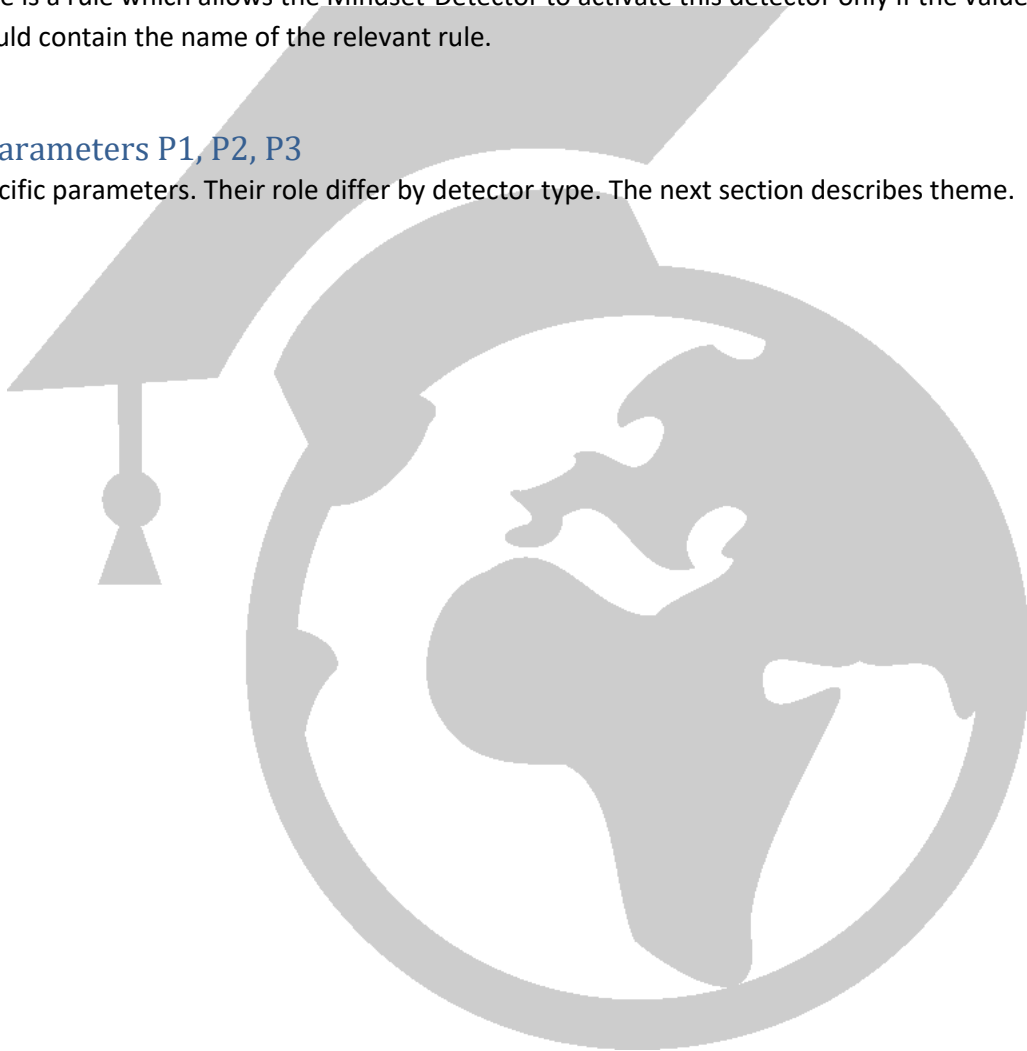
2.2.8.   Block OFF Rule

Block OFF Rule is a rule which allows the Mindset-Detector to activate this detector only if the value of the rule is OFF. This field should contain the name of the relevant rule.

2.2.9.   Parameters P1, P2, P3

These are specific parameters. Their role differ by detector type. The next section describes theme.

3. Detector details

The current section describes each one of the detectors in details. For detectors with additional parameters (P1,P2,P3) an explanation about the parameters is detailed also.

3.1.   Variables out of User Limits

Detector symbol: `VAR_OUT_OF_USER_LIMITS`

Detector code: 1

Variable out of user limits checks that the value of the variable is not above or below the limits the user has defined for this variables. These limits can be set at the variable properties window as seen in figure 4.
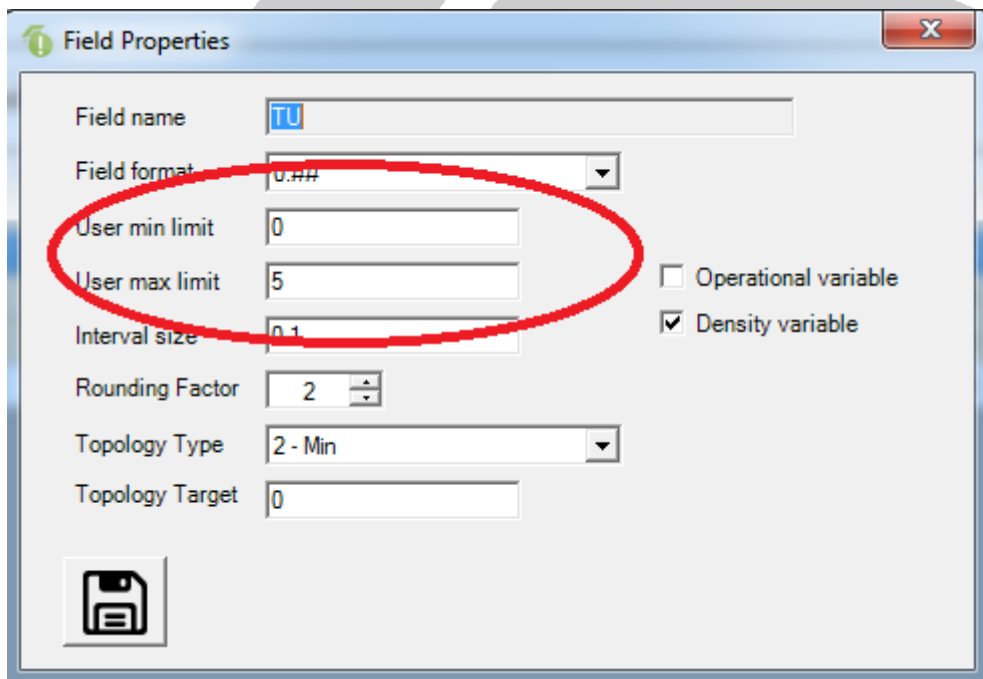
Figure 4: Variable properties

This detector does not have additional parameters.

3.2.   Variables out of statistical limits

Detector symbol: VAR_OUT_OF_STATSTICAL_LIMITS

Detector code: 2

Variable out of statistical limits checks that the value of the variable is not above or below the limits as was set by the learning procedure. Figure 5 below shows where these statistical limits are set during the learning procedure.
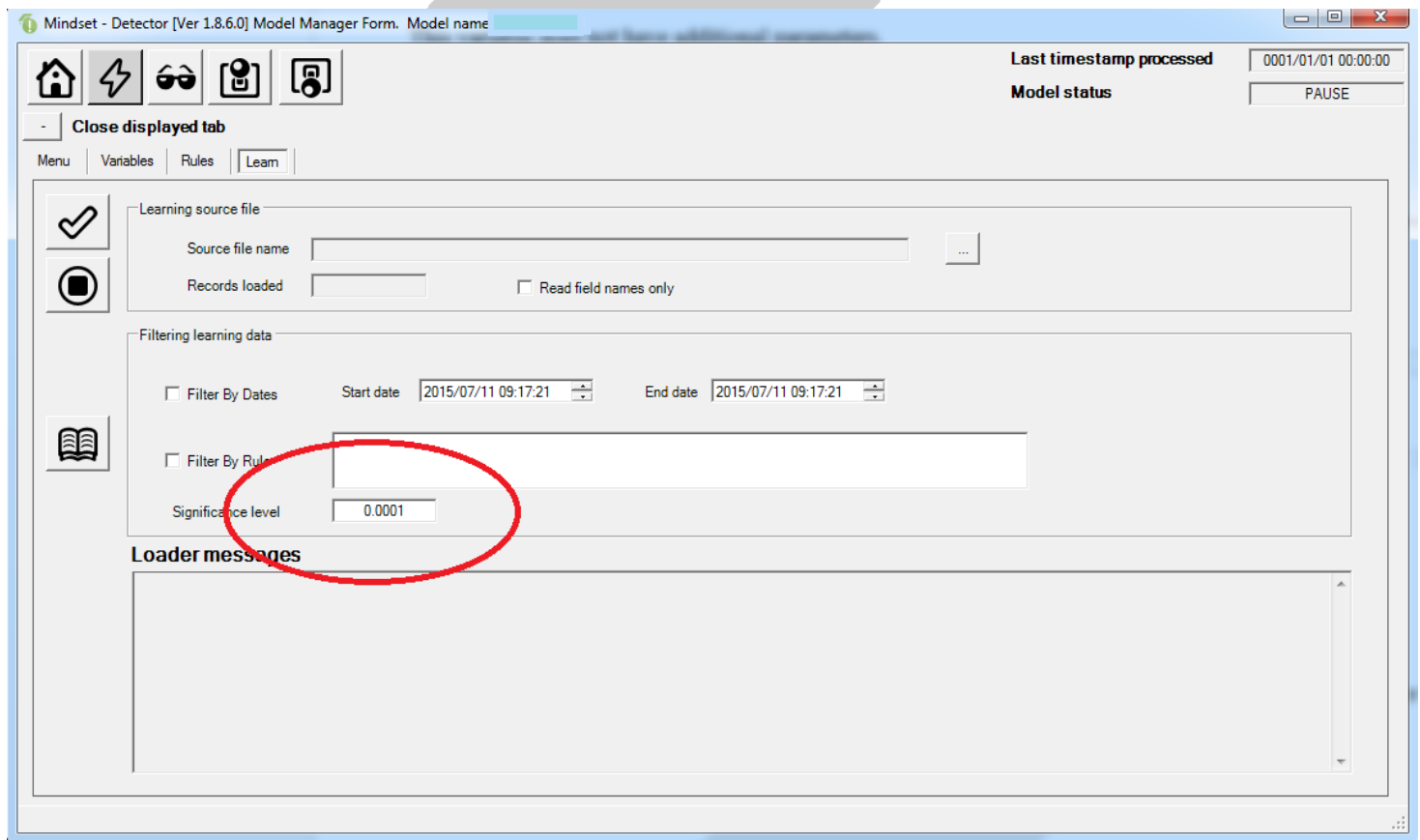
Figure 5: Setting the statistical limits

In case auto learning is ON, these statistical limits will be updated automatically each time an auto learning is performed.

Parameters for the detector are:

Parameter	Units	Meaning
P1	Var units	Add this value to low statistical limit
P2	Var units	Add this value to high statistical limit
P3		

3.3. Variable Fixed

Detector symbol: `VAR_FIXED`

Detector code: `4`

Variable value is fixed checks that the value of a variable is fixed for a period of time more than the allowed.

This detector does not have additional parameters.

3.4.   Variable long trend

Detector symbol: `VAR_LONG_TREND`

Detector code: 8

Variable long trend checks that the base line of a variable has not been checked over a requested period of time. This detector performed an ANOVA test over average from two time windows with significance of 95%. If the result is true, and event is generated.

Parameters for the detector are:

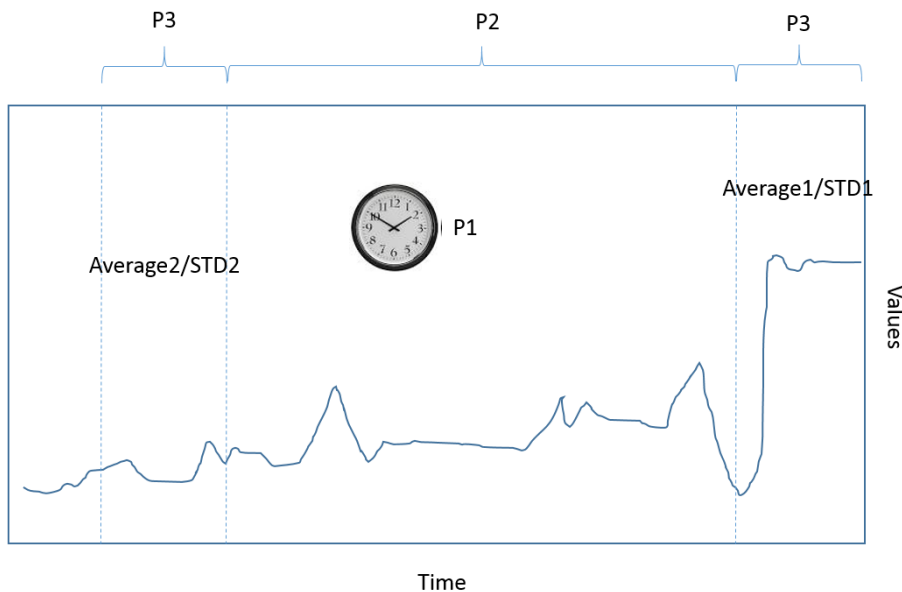| Parameter	Units	Meaning
P1	Minutes	Checked Intervals. Defines time interval between check. E.g. if value is 60, detector will be evaluated every 60 minutes (if new record arrives)
P2	Days	History length. Defines the difference in time for trend check.
P3	Minutes	History window. Define the size of the averaging window.

Figure 6: History trend detector schema

3.5.   Variable rate of change

Detector symbol: `VAR_ROC`

`Detector code: 16`

Variable Rate of Change (ROC) checks short time changes in the value of a variable.

Parameters for the detector are:

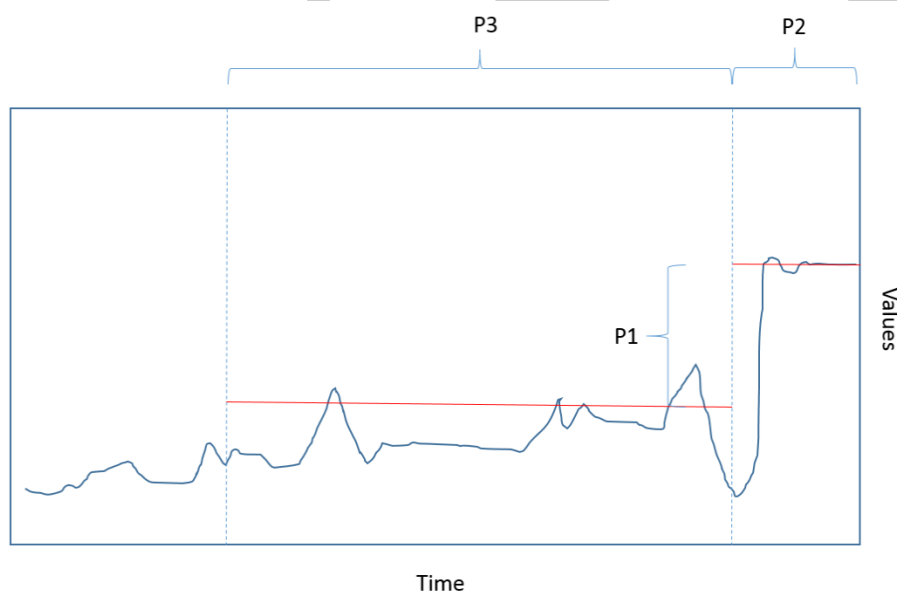| Parameter	Units	Meaning
P1	Var units	Change in var units (may be negative)
P2	Minutes	Change period
P3	Minutes	History window.

Figure 7: ROC detector schema

3.6.   Rule violation

Detector symbol: `RULE_VIOLATION`

Detector code: `32`

Rule violation checks that none of the active rules have been violated by the checked record. Rules are define by the rules editor as can be seen in figure 8.
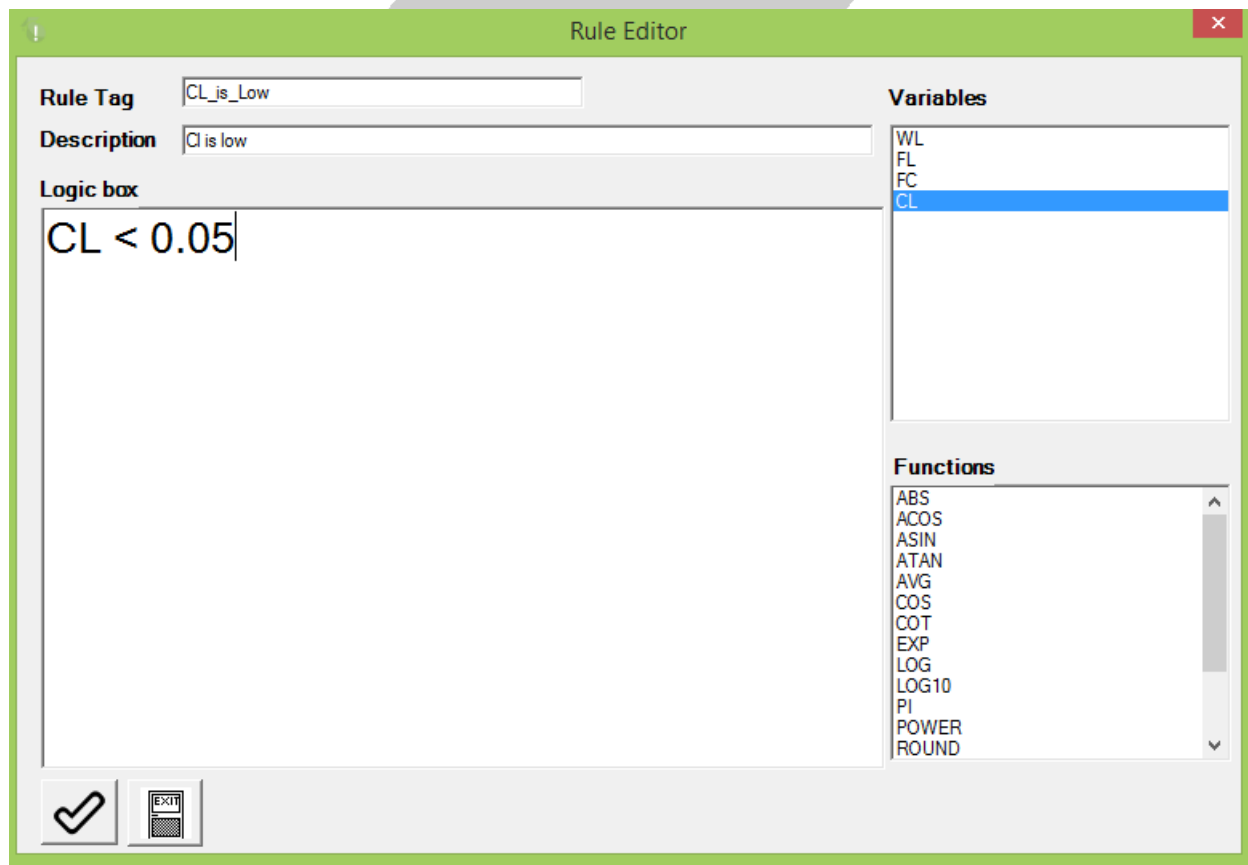

Figure 8: Rules editor

This detector does not have additional parameters.

3.7.   No similarity

Detector symbol: `NO_SIMILARITY`

Detector code: 64

No similarity is a multi-variable detector. It checks that the current data combination is not similar to any know combination from the past. Combination from the past is shown in the similarity table.

Parameters for the detector are:

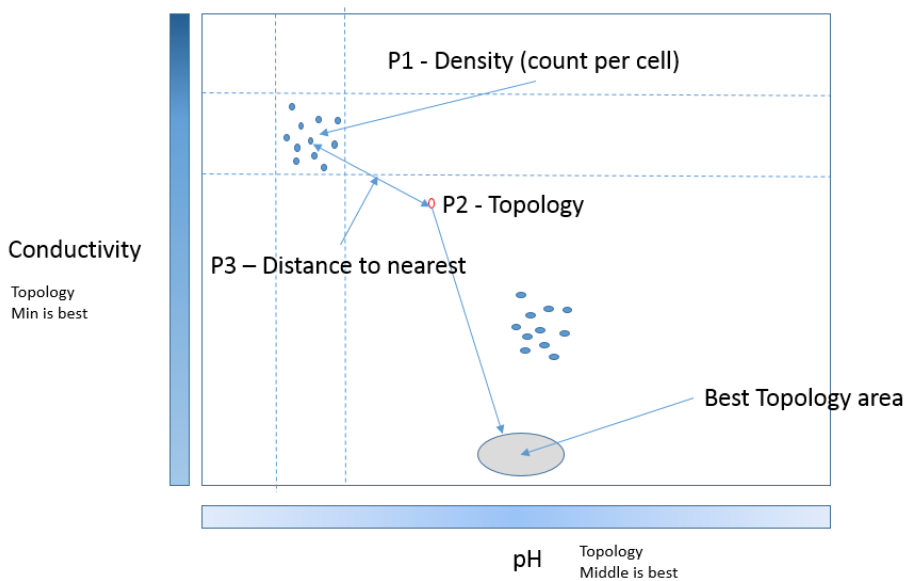| Parameter	Units	Meaning
P1	Percentage	Minimal density for alert
P2	0-1	Minimal Topology for alert
P3	Norm	Distance to known combination

Figure 9: Similarity detector schema

3.8.   Bad similarity

Detector symbol: BAD_SIMILARITY

Detector code: 128

No similarity is a multi-variable detector. It checks that the current data combination is not similar to any know combination from the past. Combination from the past is shown in the similarity table.

Parameters for the detector are:

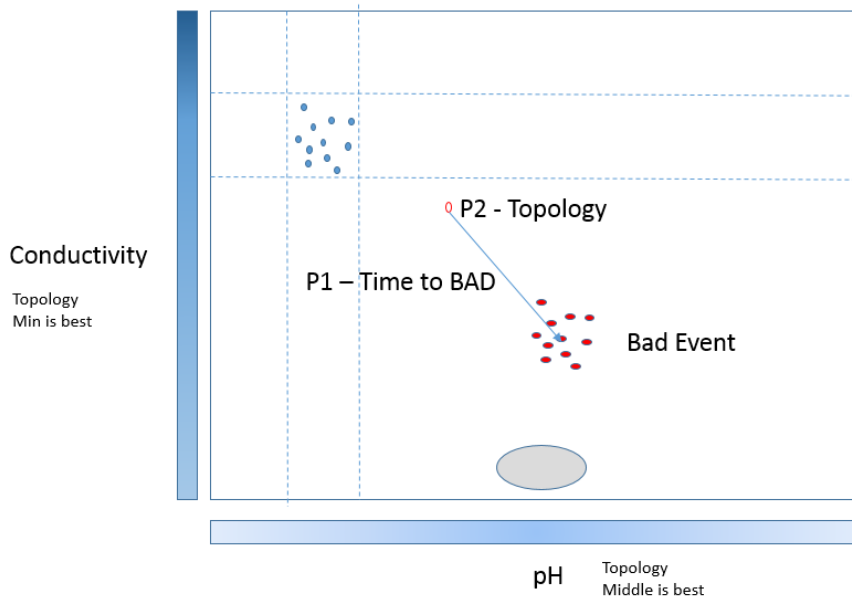| Parameter	Units	Meaning
P1	Minutes	Time to arrive to BAD zone
P2		
P3		

Figure 10: Similarity BAD detector schema

3.9.　Dynamic change rare

Detector symbol: DYNAMIC_CHANGE_RARE

Detector code: 256

Dynamic change rare checks how common is the amount of noise currently measured in the process.

Parameters for the detector are:

Parameter	Units	Meaning
P1	0-5	Level of noise
P2	Minutes	Time back to check process noise
P3		

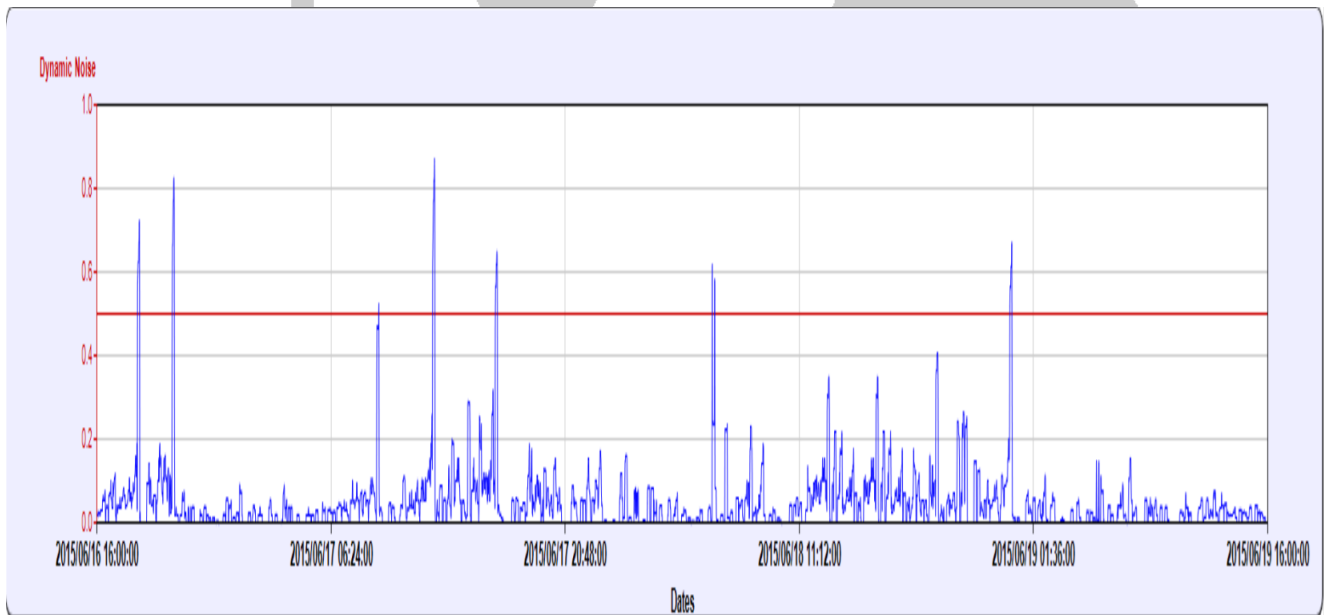*Figure 11: Dynamic change detector*

3.10. Dynamic change bad

Detector symbol: DYNAMIC_CHANGE_BAD

Detector code: 512

This detector is not implemented yet.

3.11. No Data

Detector symbol: NODATA

Detector code: 1024

This detector checks how long data did not arrived to this model.

Parameters for the detector are:

Parameter	Units	Meaning
P1	Minutes	Minimum time to alert
P2	Minutes	Maximum time to alert
P3		

P1 sets the start alerting time.

P2 sets when the detector stops to alert. This to avoid endless alert if parameter has been disconnected.

4. Auto Calibration

Auto calibration procedure assist the user with setting the detectors parameters by minimizing the false positive and false negative for a given amount of data.

Start from version 1.9 the Detector-Mindset updates the limits of the detectors listed below automatically when a learning procedure is performed as shown in figure 5.

Event	Detectors limits updated
Learning process for single variables	Out of User Limits Out of statistical limits Variable is fixed.
Updating density table	No similarity Dynamic change

5. Event Run-Time Flow

Figure 12 shows the flow of an event.

When event is at idle state and one of the detector is detecting, the events enters a Pending state.

Events in Pending state with delay time ended goes to triggered state.

If during pending time all detectors turn off, event is canceled.
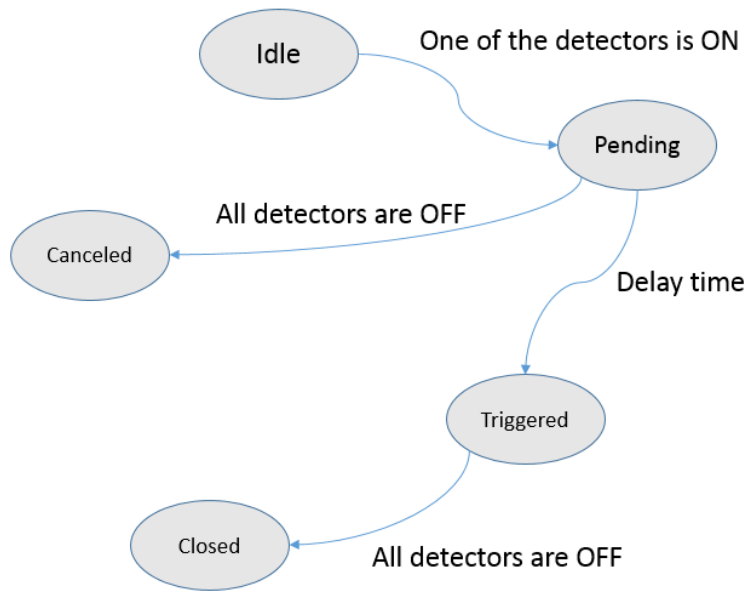
If during triggered time all detectors turn off, event is closed.

Figure 12: Event flow diagram