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Application of Artificial Neural Networks in the Processing of Deformation Measurements

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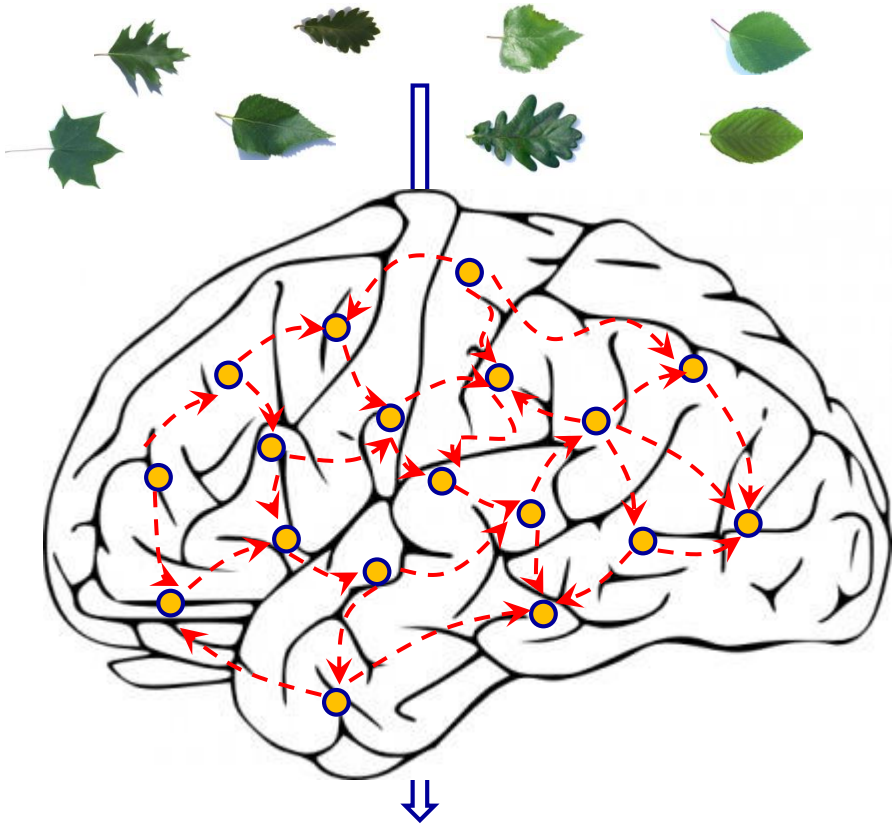
Biological neural networks

The human brain essentially consists of around 86 billion nerve cells. They communicate with each other by transmitting signals chemically between neurons and electrically within neurons. Through this communication we can react appropriately to different stimuli within a few seconds. And it works with a very impressive success rate, otherwise humanity wouldn't exist.



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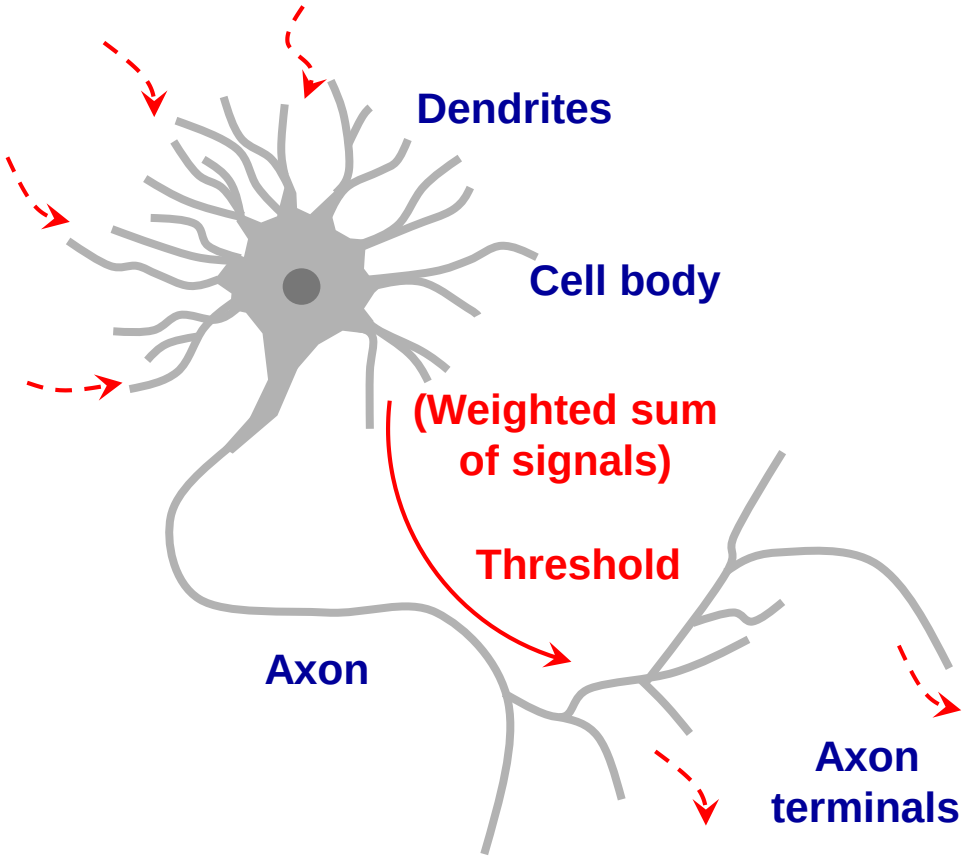
Birch, oak, maple….



Artificial Neural Networks (ANN)

In recent years, artificial intelligence (AI) techniques have been increasingly used in various engineering areas. These are often so-called artificial neural networks (ANN), which are to be understood as a special AI solution and are modeled to a certain extent on the structure of the biological brain.

Learning:

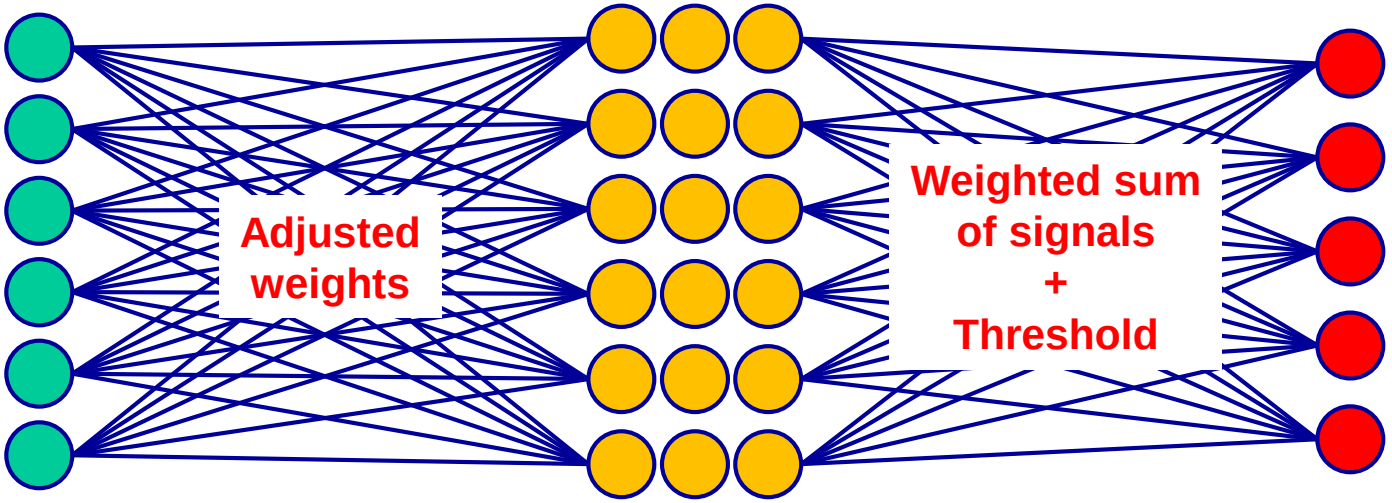
forward

backward

Birch, oak, maple….

Optimization algorithm

Input Layer **Hidden Layers** **Output Layer**



Apply

Birch

Convolutional Neural Network (CNN)

ANN technology has been known for more than 70 years. Due to changes in hardware and the invention of new, much more efficient algorithms, this technology is now experiencing a new heyday in many areas of application. One such solution is hidden under the abbreviation Convolutional Neural Network (CNN).

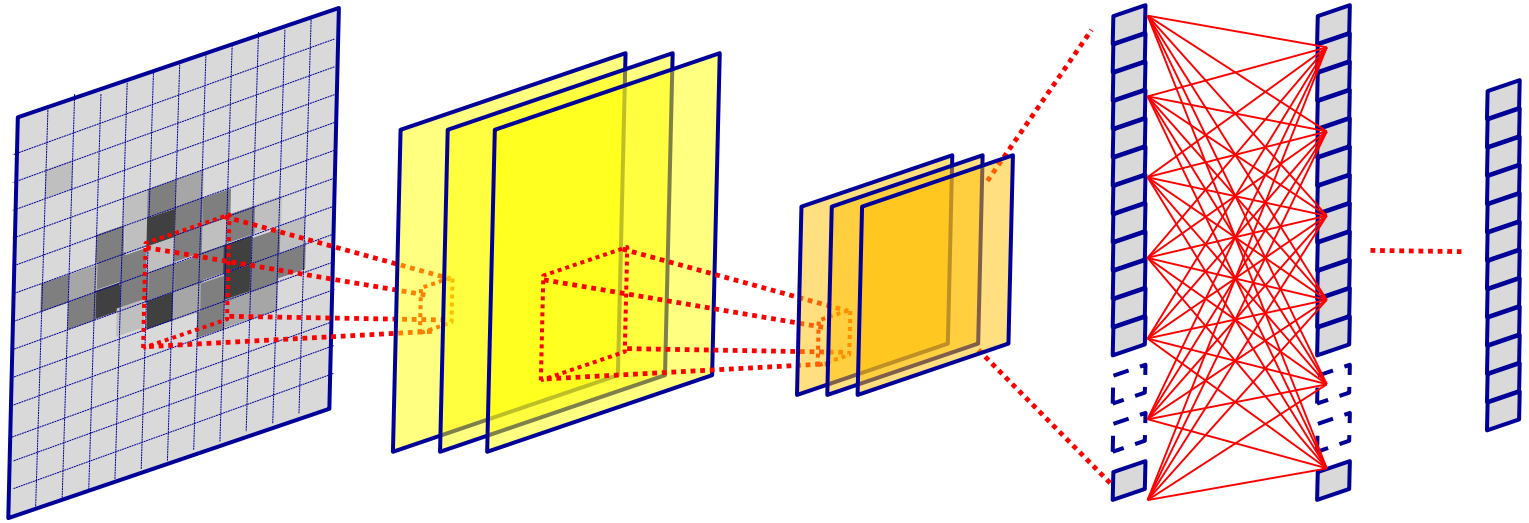
Learning:

forward

backward

Birch, oak, maple….

Optimization algorithm

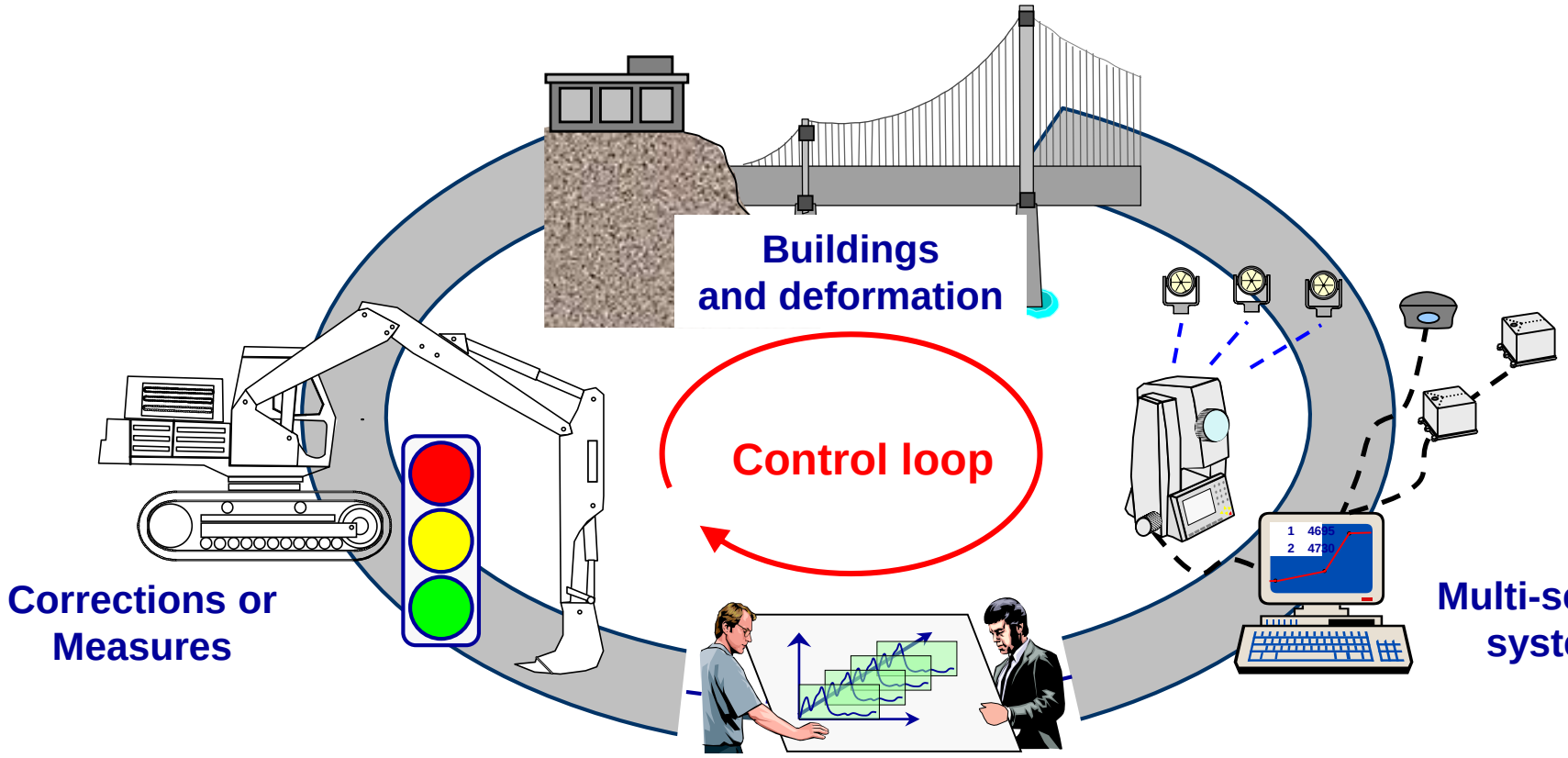


Input **Feature Extraction** **Classification**

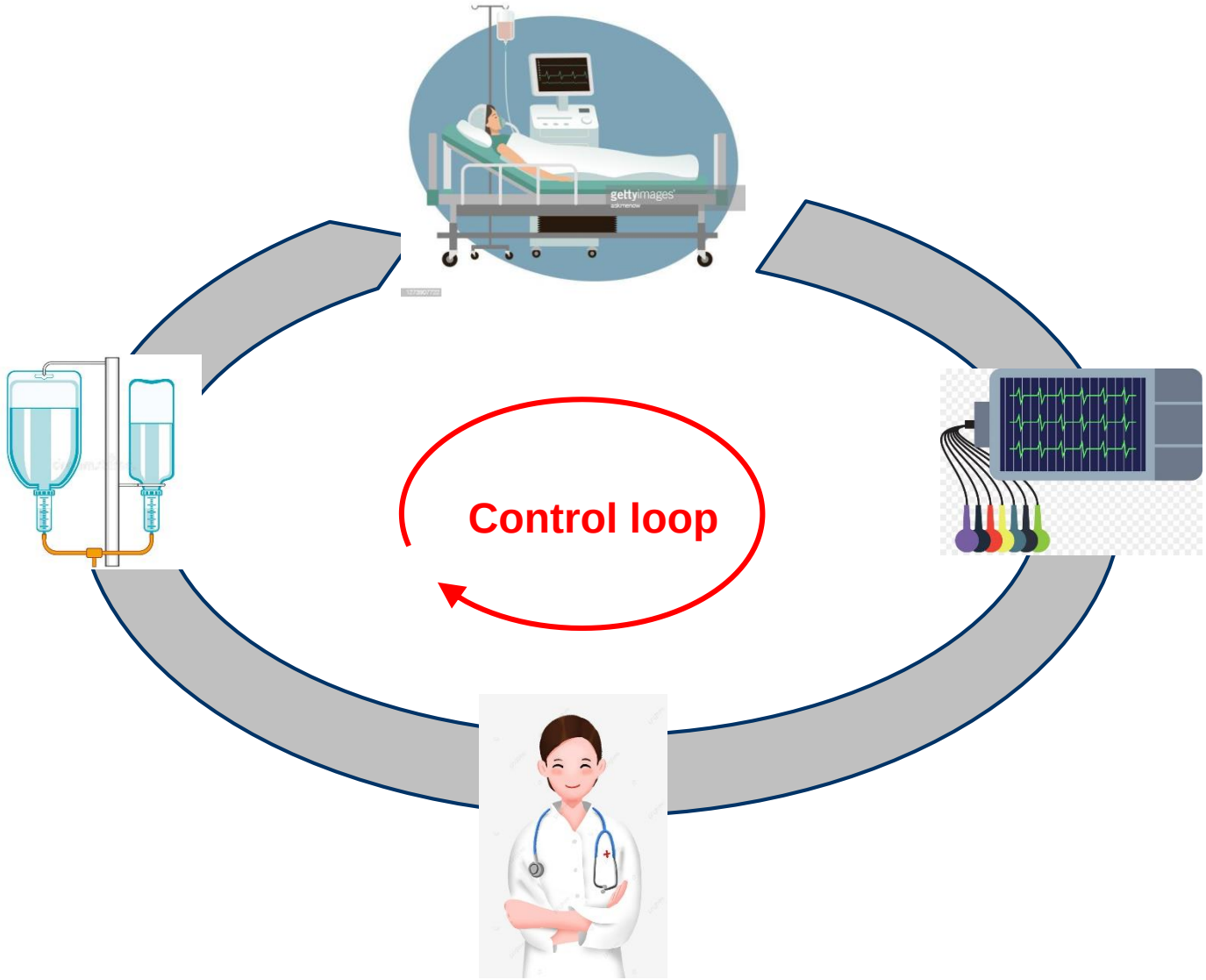
Apply **Birch**

Monitoring as part of a control loop

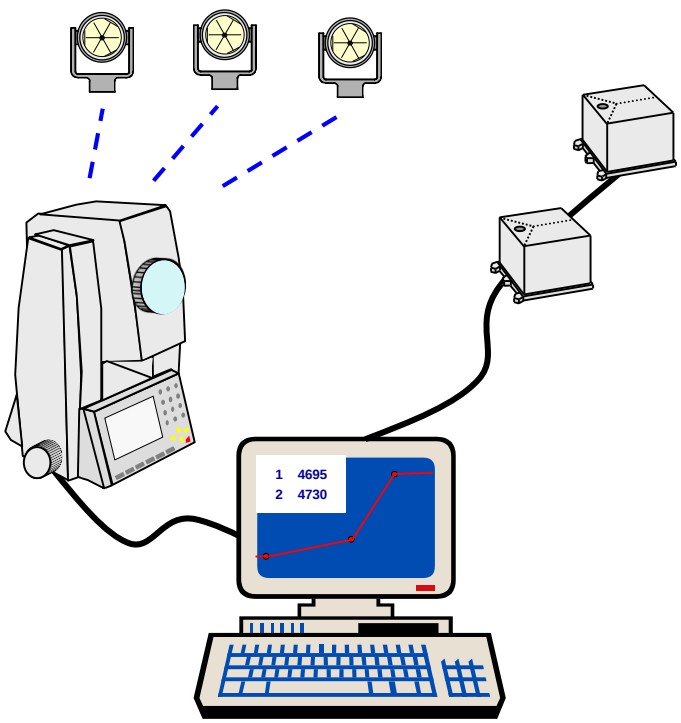
Although the typical monitoring measurements now have a very high degree of automation, the interpretation of their results is usually carried out by experts. The automation of this step too, for example due to the need to analyse the situation practically in real time, requires the conversion of expert knowledge into a computer-controlled analysis system. Generally, this is a typical task of Artificial Intelligence (AI) or Artificial Neural Networks (ANN)



Application in medicine for comparison



Computer programs for automated continuous monitoring



Features of a computer program for automated continuous monitoring:

- continuous and simultaneous collection of measurement data from different origins;

- preparation of measurement results, data management, creation of protocols, graphical presentation of results;

- data transmission to the operator's monitoring computer of stored data at specified intervals;

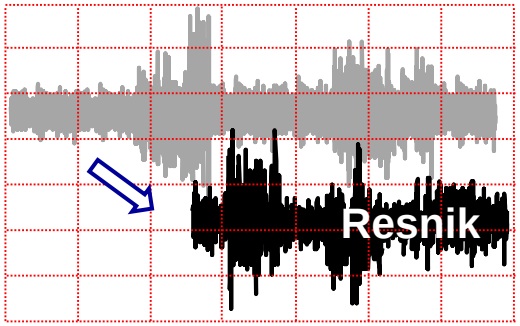
- alerting using suitable technical means if limit values are exceeded.

Pattern recognition in deformation analysis

As a result of a typical monitoring, data are obtained that can be assigned to certain instants of time. Based on these time series, the current state of the monitored object should be estimated. Generally, this is achieved by identifying significant events or deviations from a pre-defined "normal" behavior.

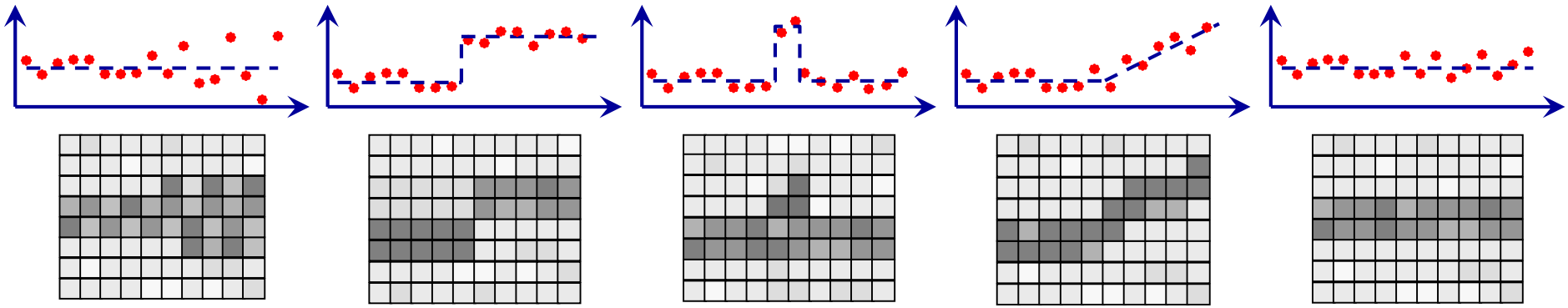
Face recognition

Text recognition



Speech recognition

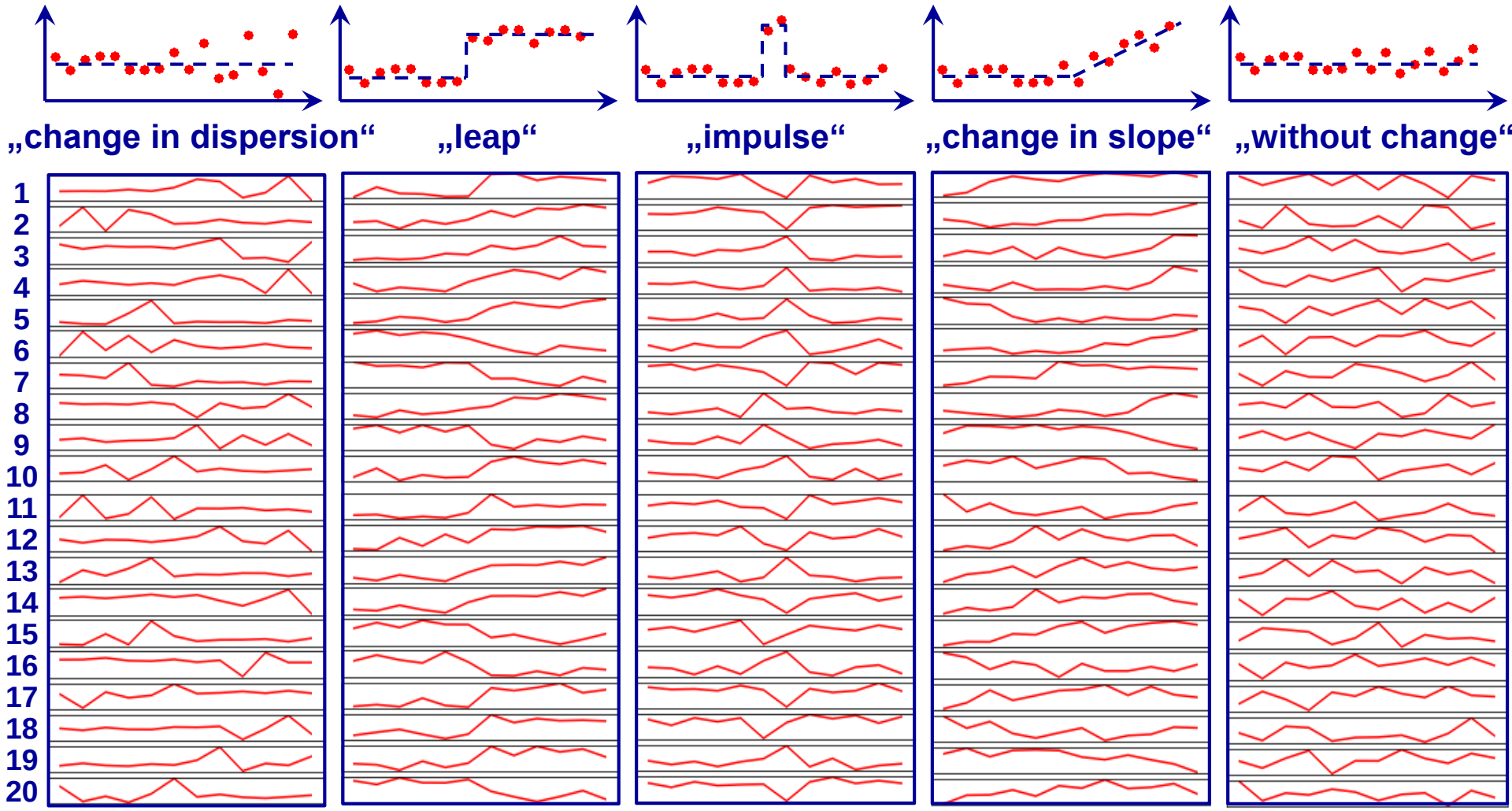
Pattern Recognition in On-Line-Monitoring (example)



„change in dispersion“ „leap“ „impulse“ „change in slope“ „without change“

Training of a neural network

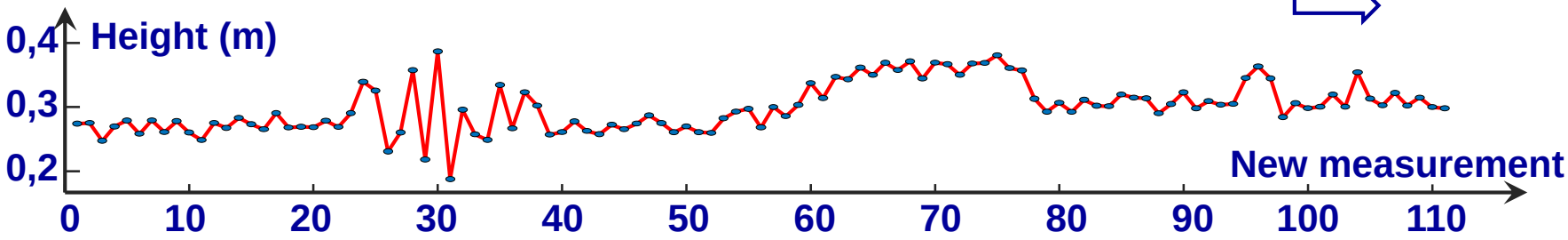
The training of a neural network from a given example is usually conducted by determining the difference between the processed output of the network (often a prediction) and a target output.



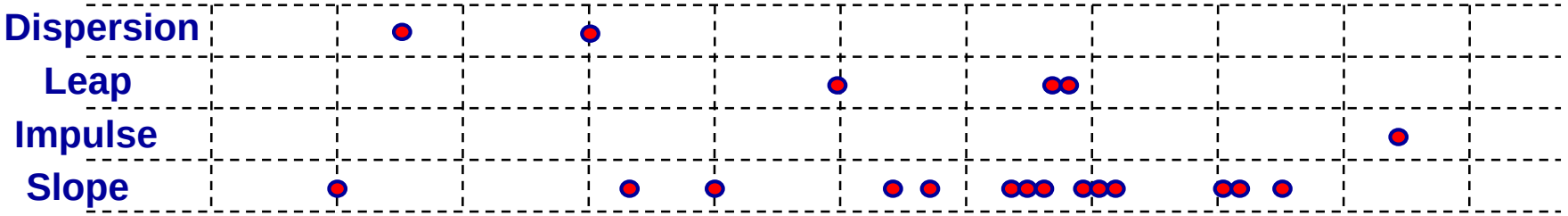
Typical example of data analysis

The data analysis is illustrated using a typical example (fully automatic trigonometric height measurement with a total station in real-time mode).

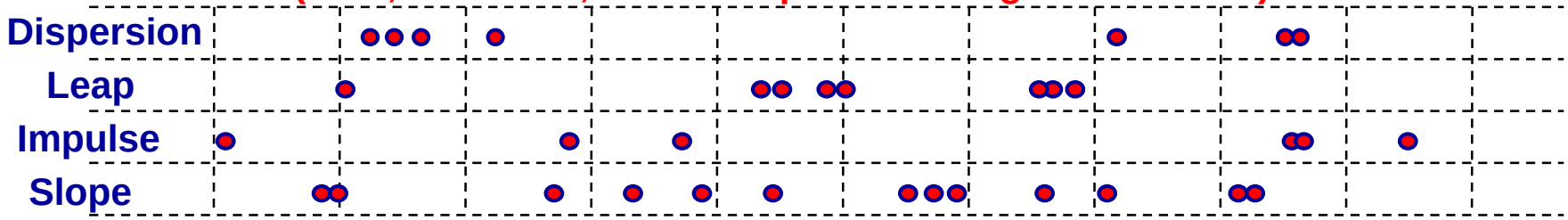
Real time: New measurement – new analysis in the last window



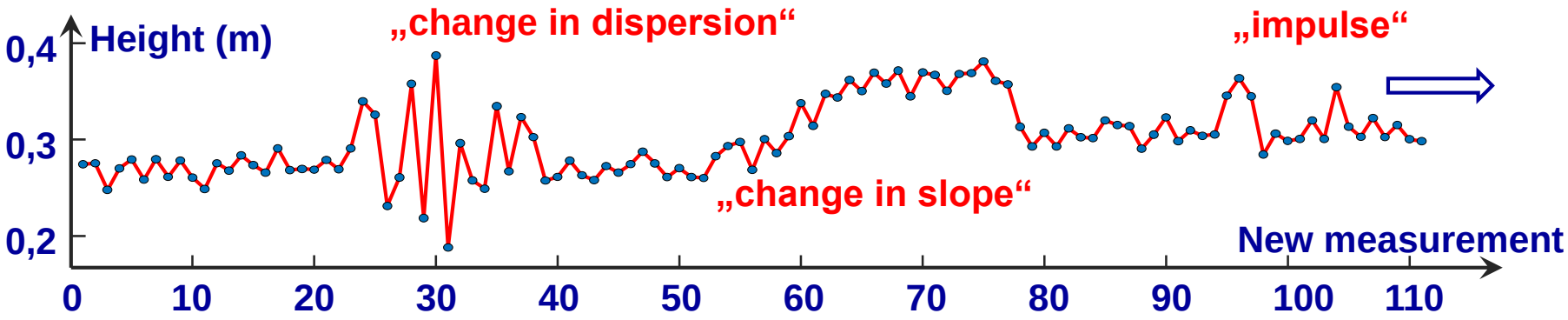
Classification (statistics, 12 values, error probability of 5%)

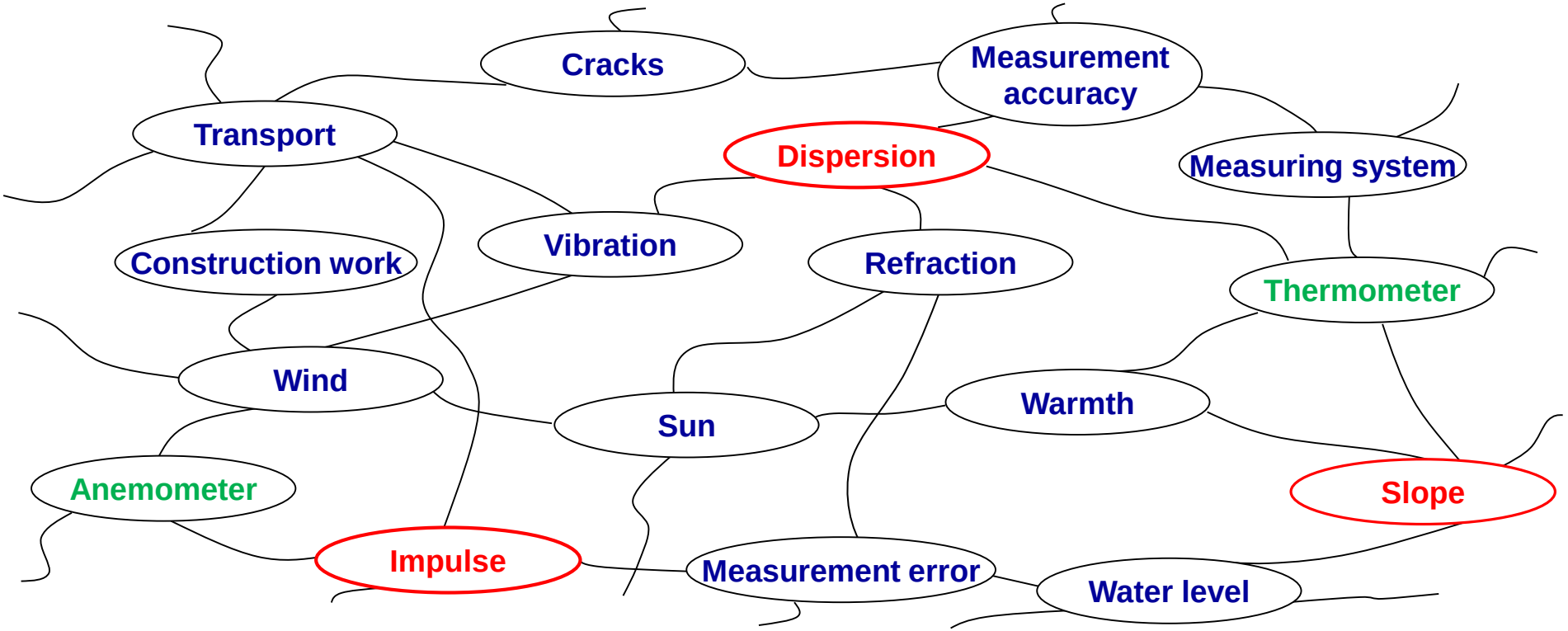


Classification (ANN, 12 values, cutoff for pattern recognition of 95%)



Joint analysis for multiple sensors





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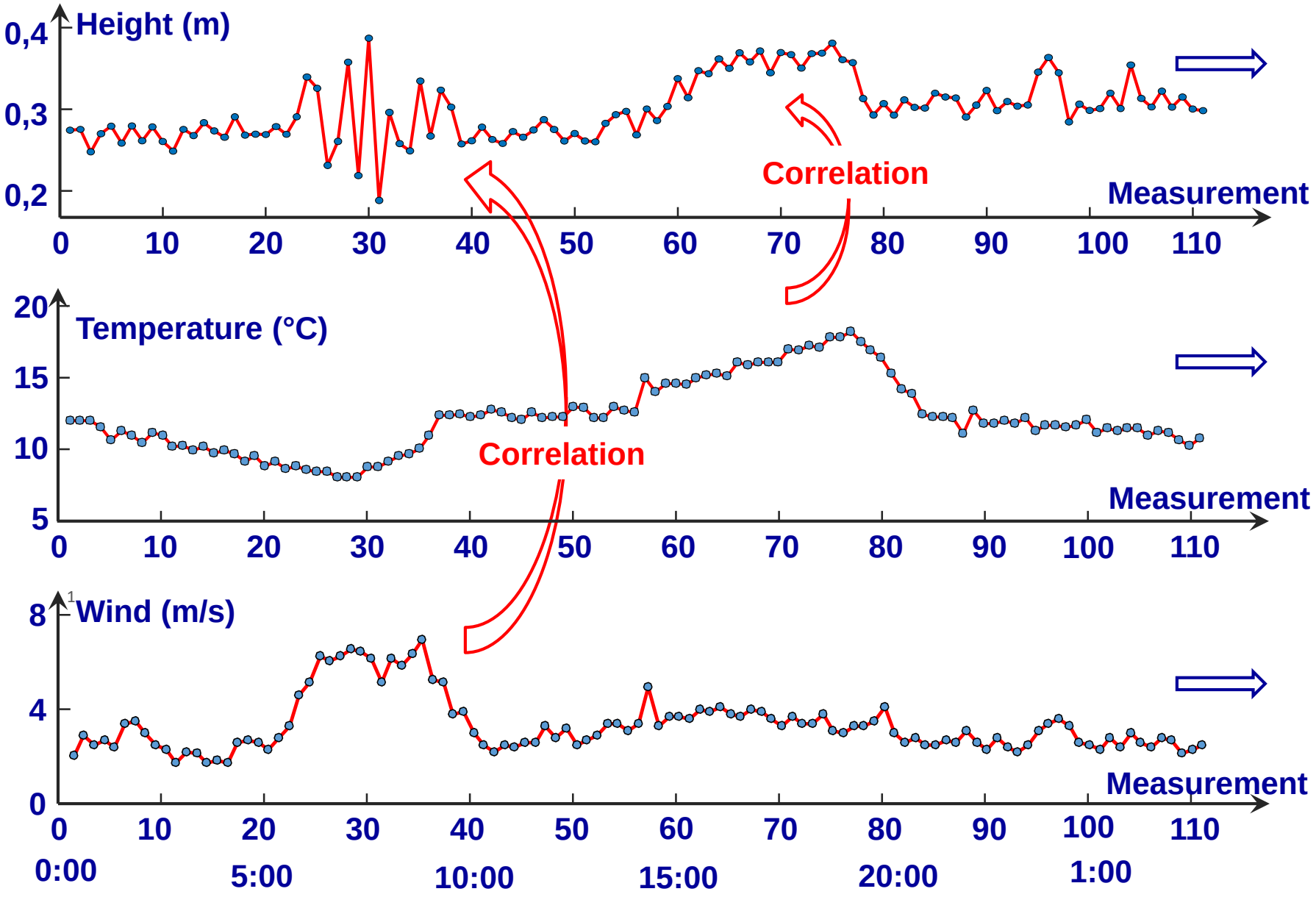
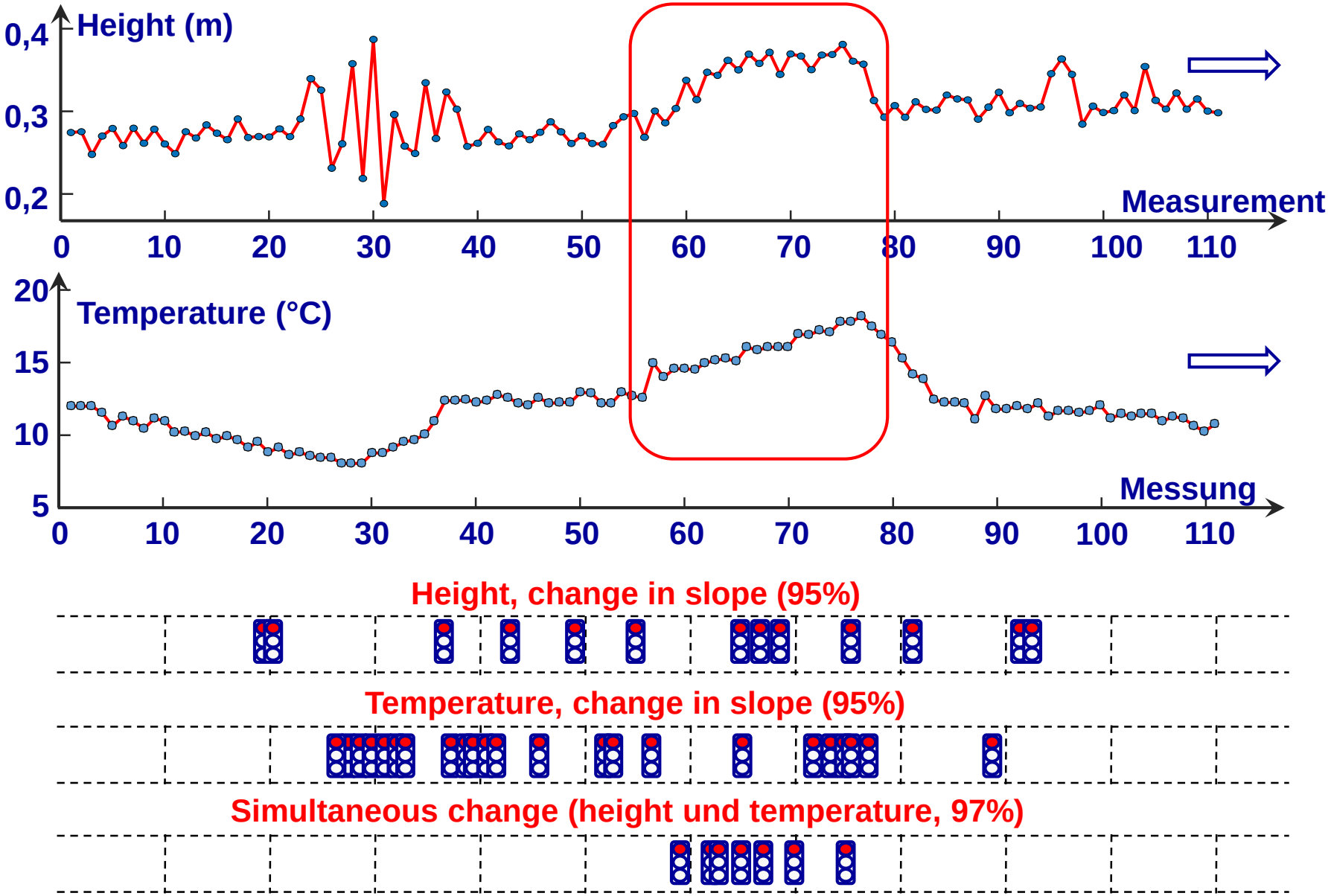
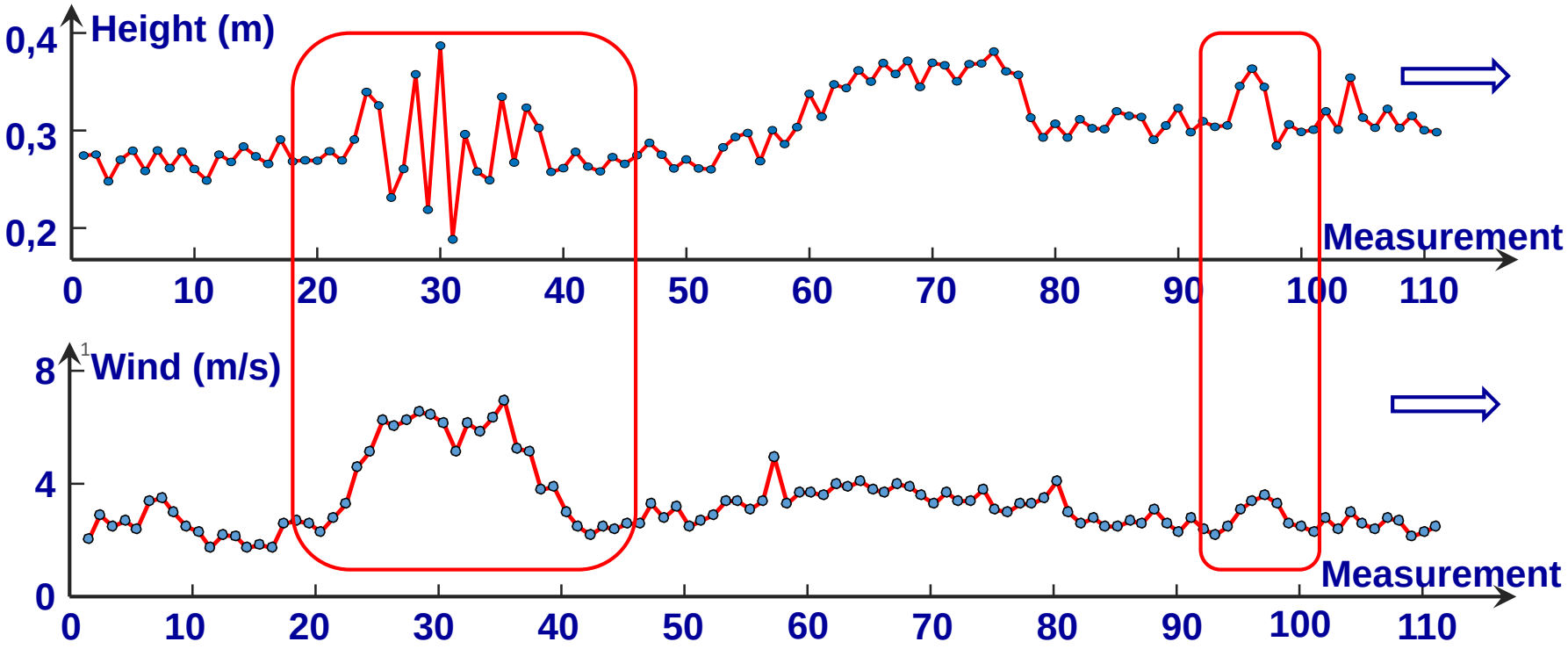
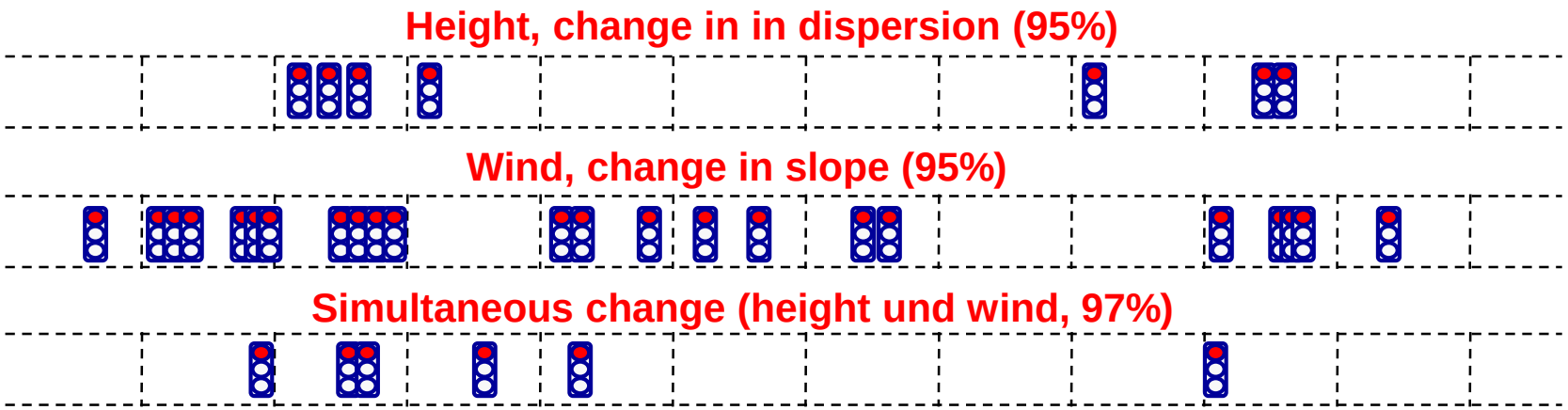


Joint analysis for multiple sensors (height – temperature)



Joint analysis for multiple sensors (height – wind)





Thank you for your attention!