R E
W S

Time Series Clustering of High Gamma Dose Rate Incidents

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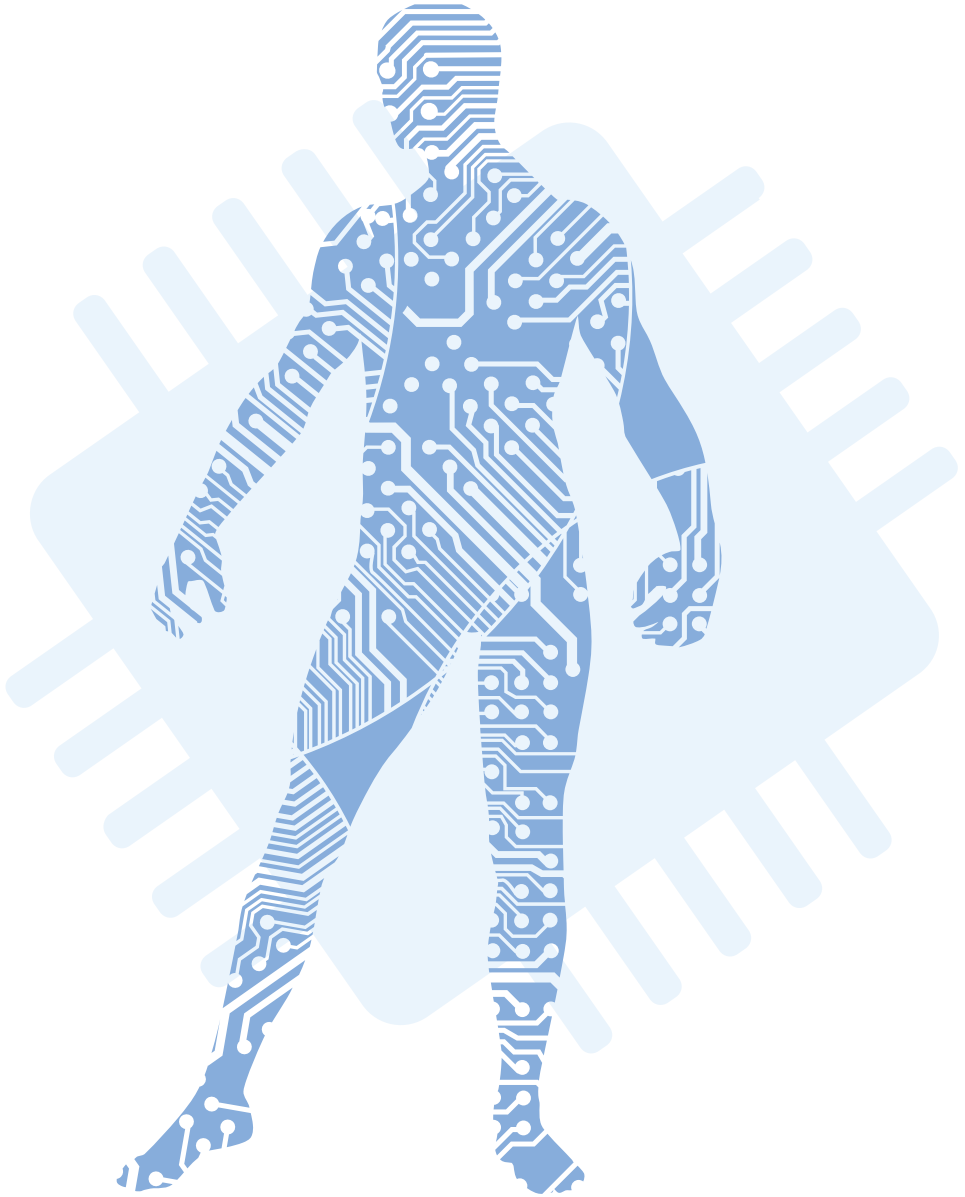
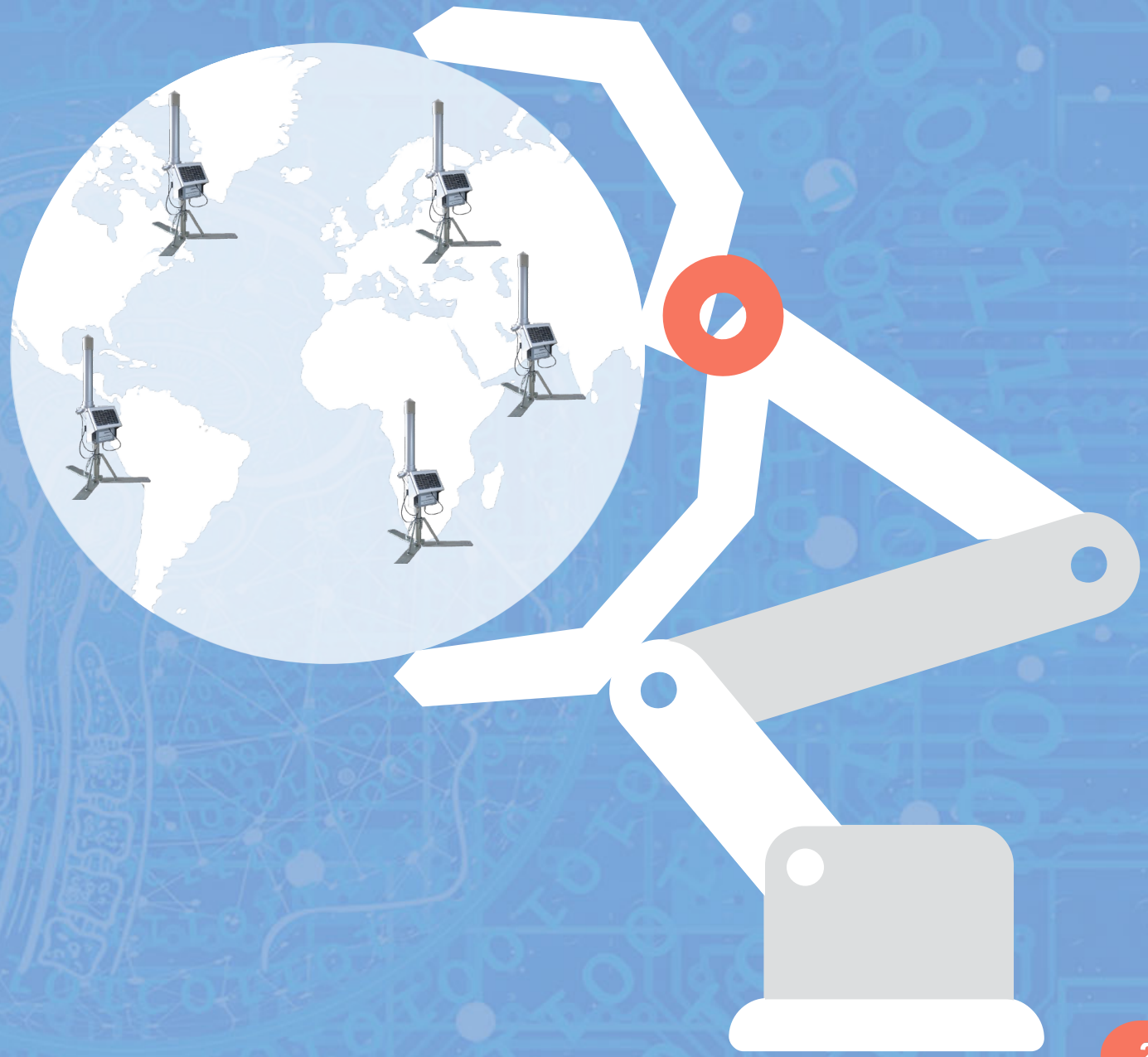
Outline

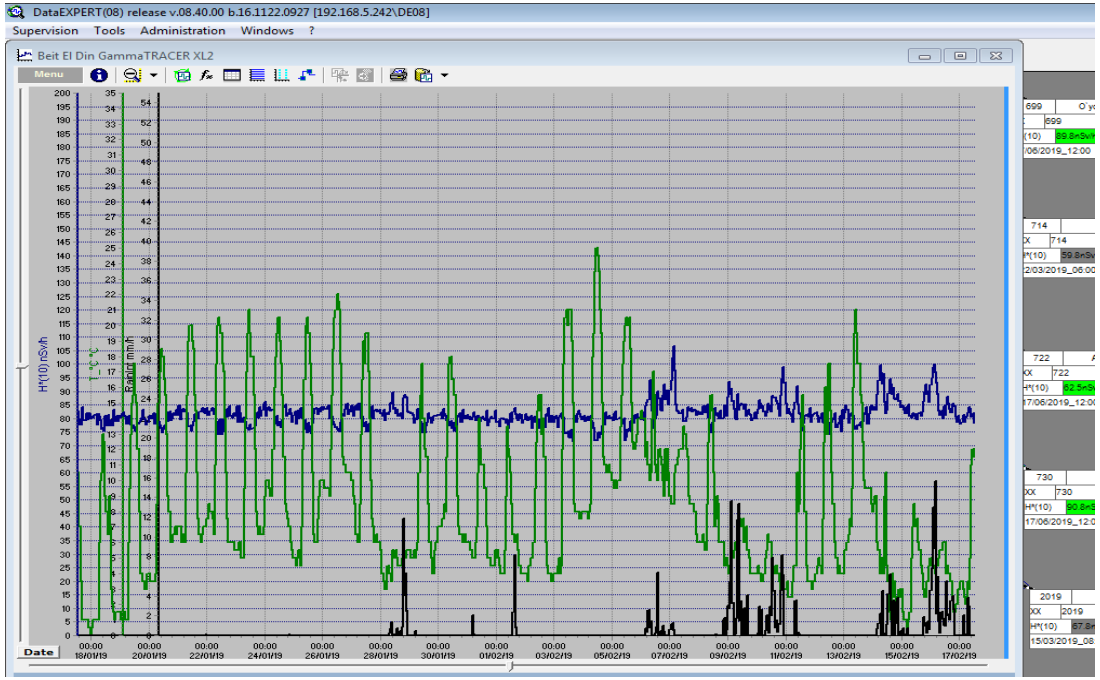


Used to detect Gamma Dose Rate in the Environment

In case of high dose rate take the necessary procedures

Many Sensors (Probes) send continuous readings





Time Consuming

Lot of Incidents
(95% Innocent)

Risk

Alarm
Upon high gamma dose rate, an alarm will be triggered.

Step 1

Notification
Experts will be notified to start the evaluation process.

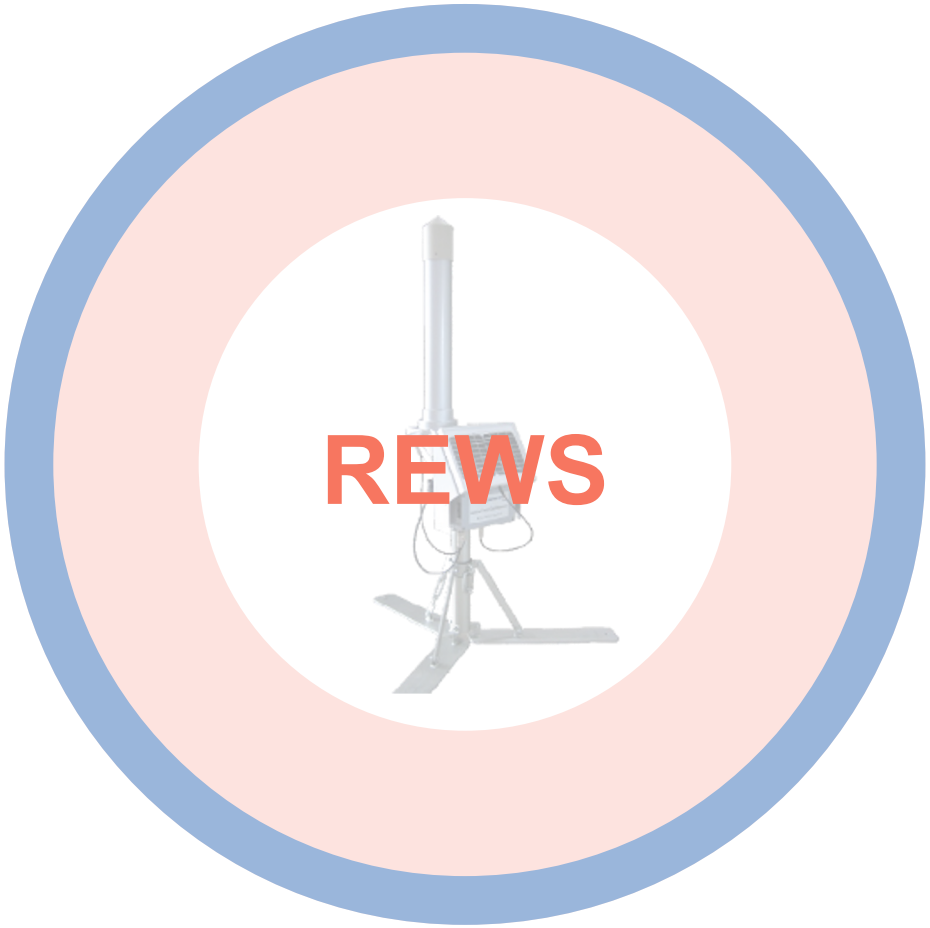
Step 2

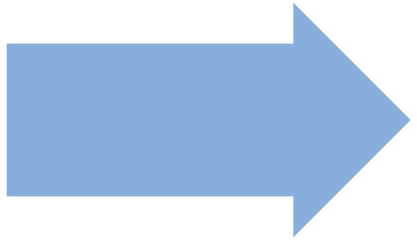
Evaluation
Several procedures will be followed to evaluate the case.

Step 3

Monitoring
Experts will keep monitoring to make sure that gamma dose rate return to normal level.

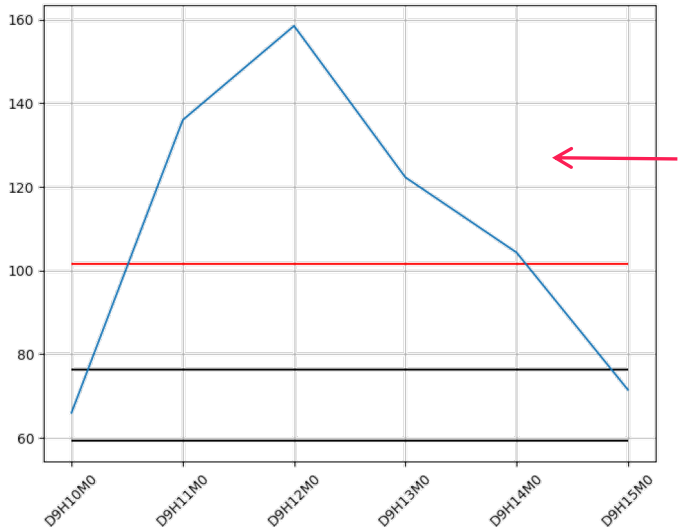
Step 4


REWS



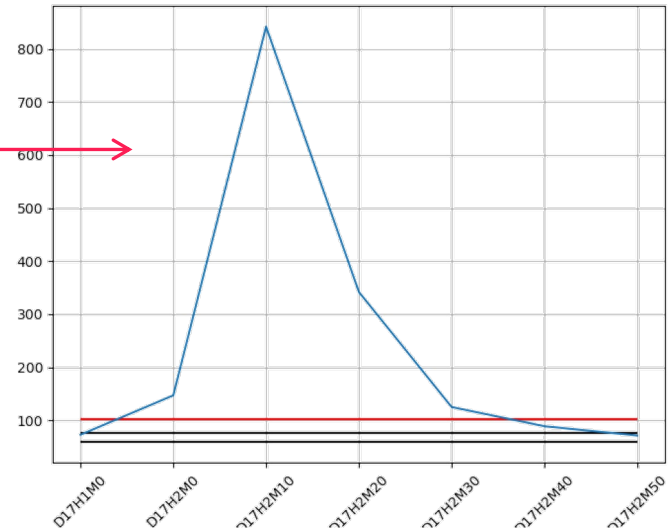

Intelligent
REWS

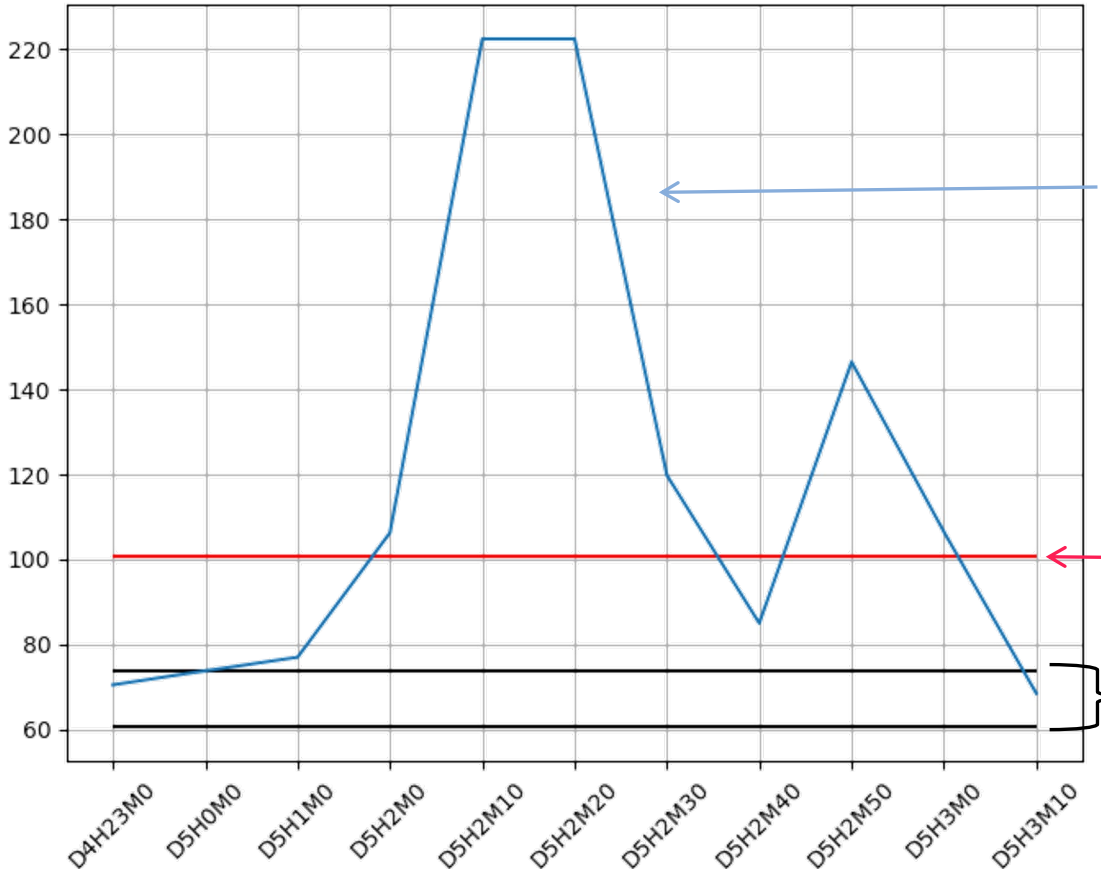
Extracted Incidents



Soft Parabola Incident

Hard Parabola Incident



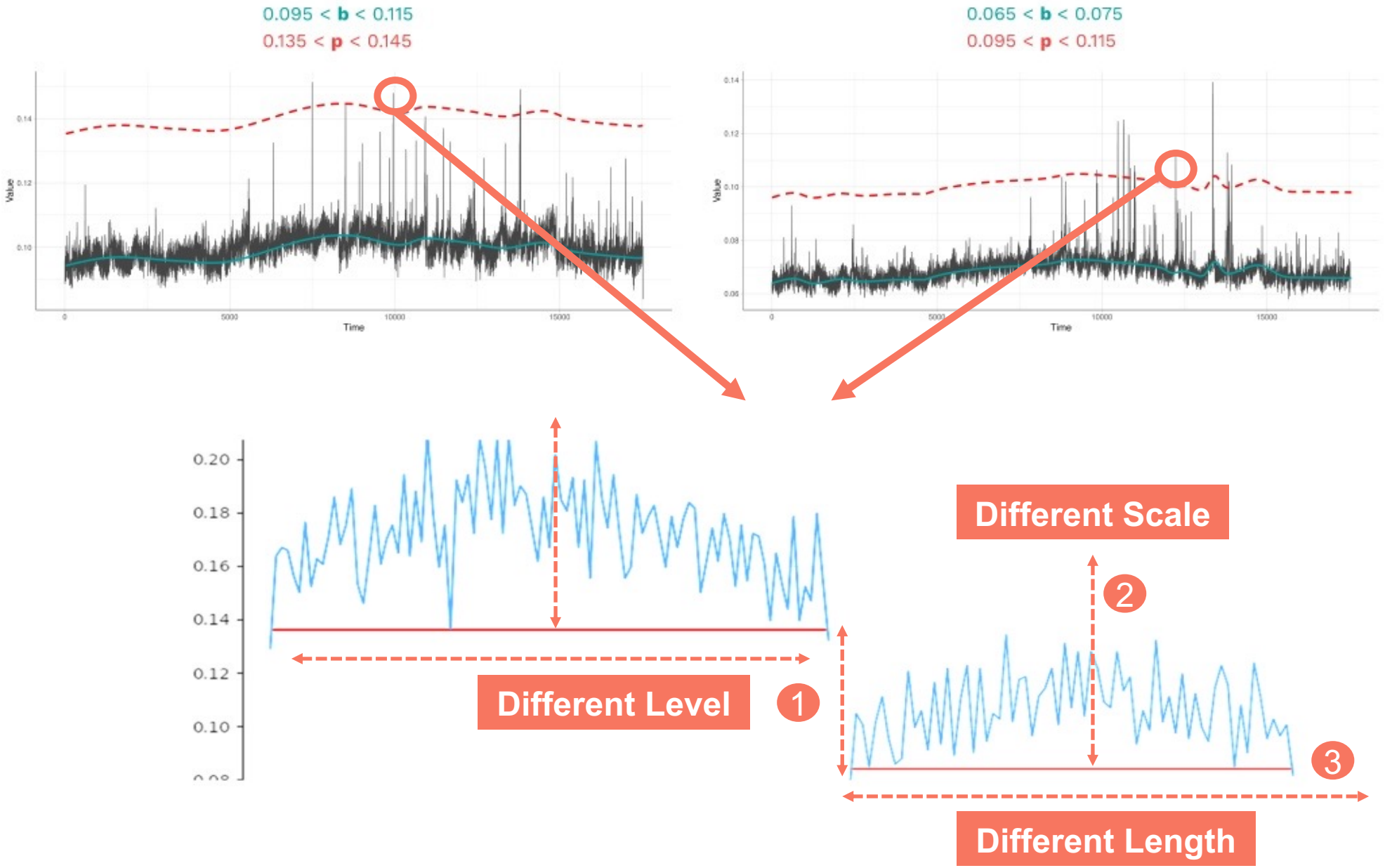


Incident Fragment

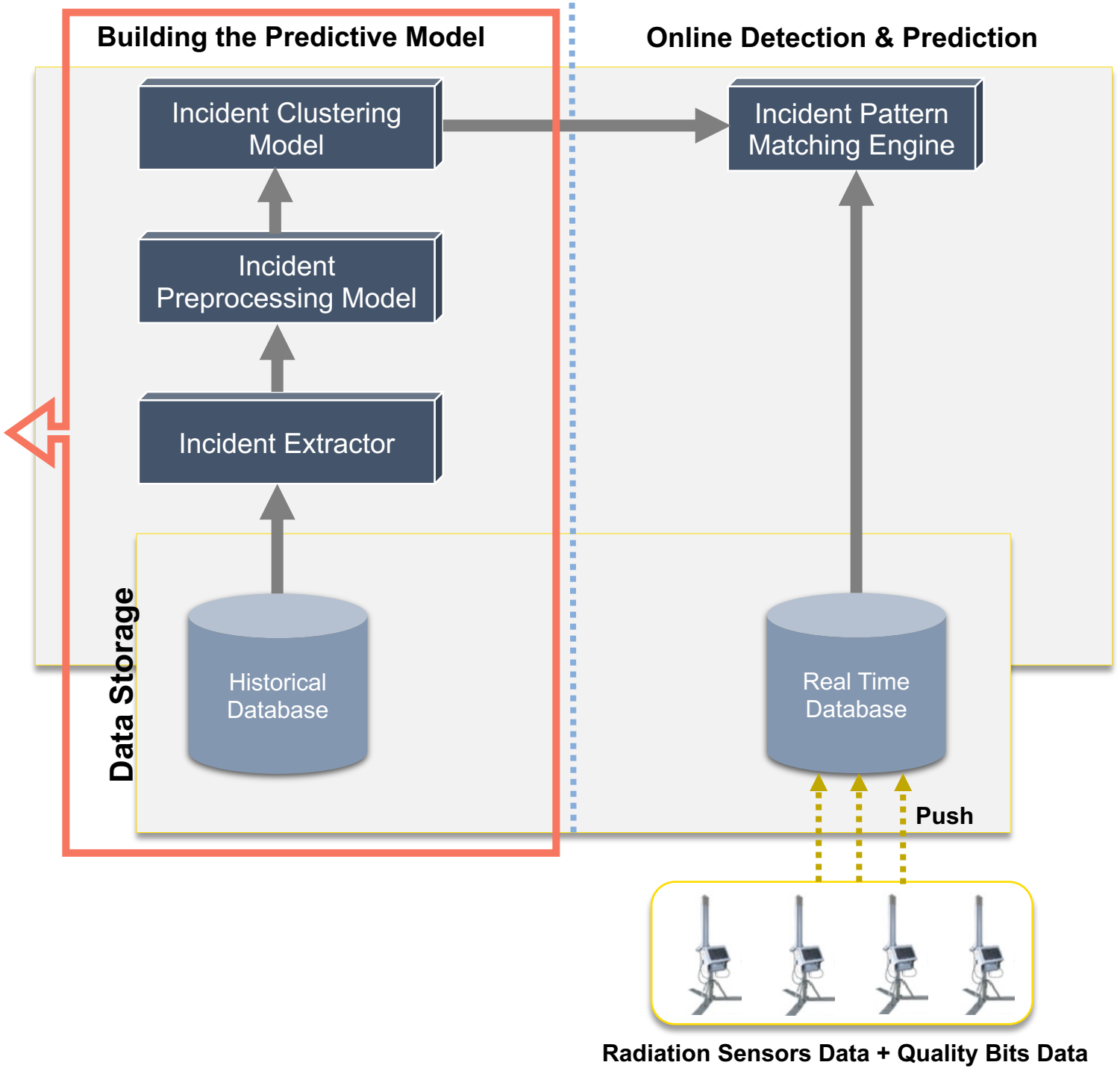
peak threshold

background interval

> 1000 probe data
Past 10 years (> 5 GB)


0.095 < b < 0.115
0.135 < p < 0.145
0.065 < b < 0.075
0.095 < p < 0.115
Value
Time
0.20
0.18
0.16
0.14
0.12
0.10
Different Level
1
Different Scale
2
3
Different Length

- **Time Series Clustering Problem**
- **Investigate Unsupervised Machine Learning Techniques**



Research Problem

"What is the best fit machine learning model that should be used for time series clustering of varying lengths and different scales?"

- Unlabeled Data
- Unsupervised Learning

What is a Clustering Model?

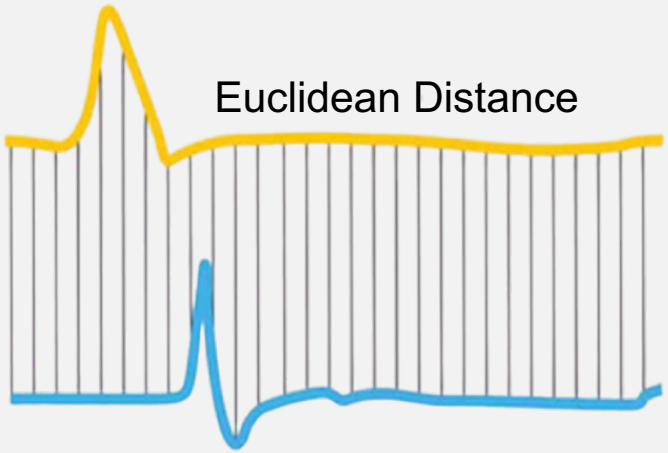
Similarity Measure

Clustering Algorithm

Choose Similarity Measure

Lock-step Measures

- Point to point (time shift intolerant)
- Efficient
- Requires samples of equal length



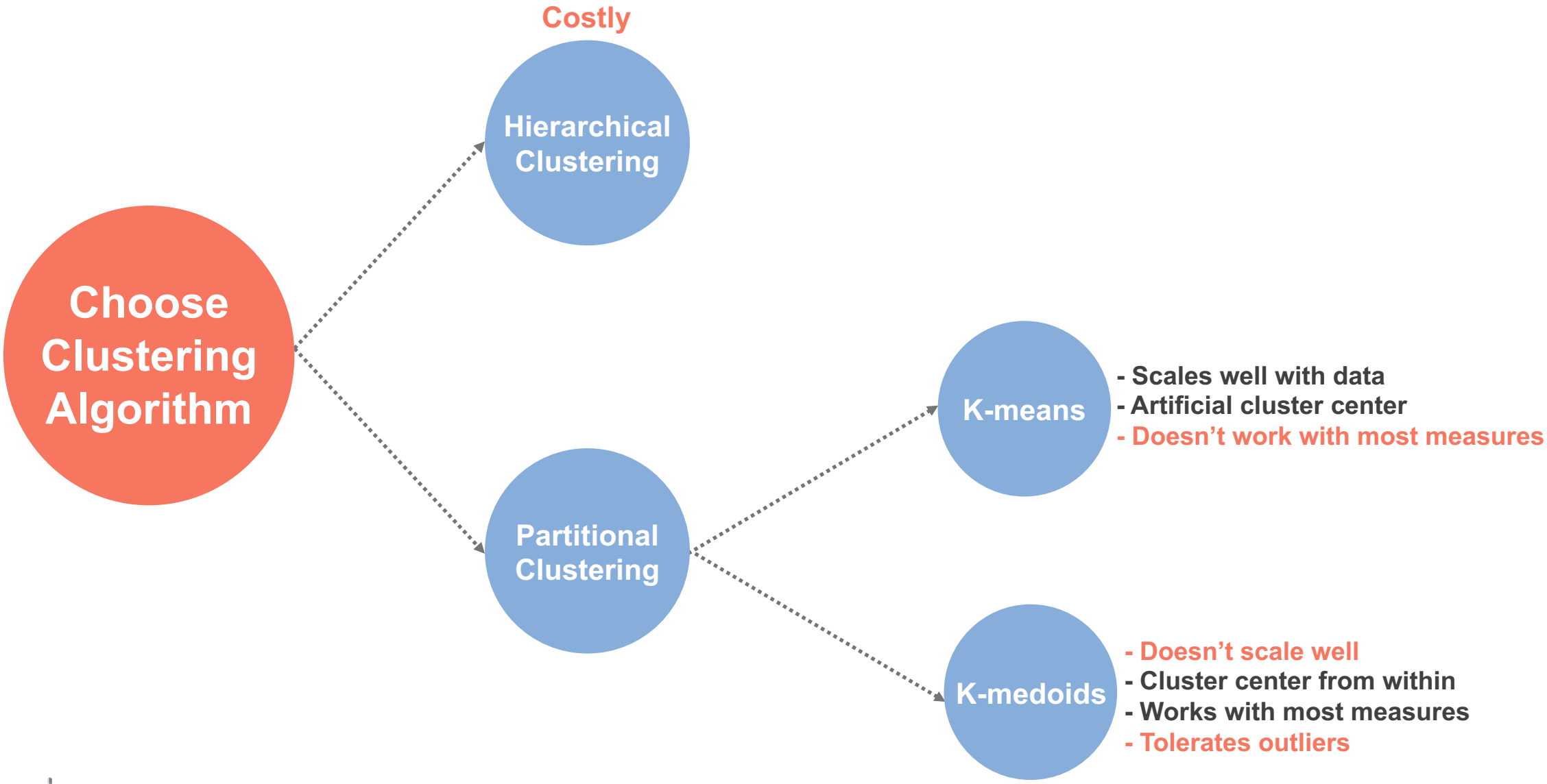
Elastic Measures

- Many-to-one or One-to-none
- Costly
- Tolerates varying length samples

Incident Clustering Model

Similarity Measure

Clustering Algorithm


Costly
Hierarchical Clustering
Choose Clustering Algorithm
Partitional Clustering
K-means
- Scales well with data
- Artificial cluster center
- Doesn't work with most measures
K-medoids
- Doesn't scale well
- Cluster center from within
- Works with most measures
- Tolerates outliers

Literature Review

Similarity Measure

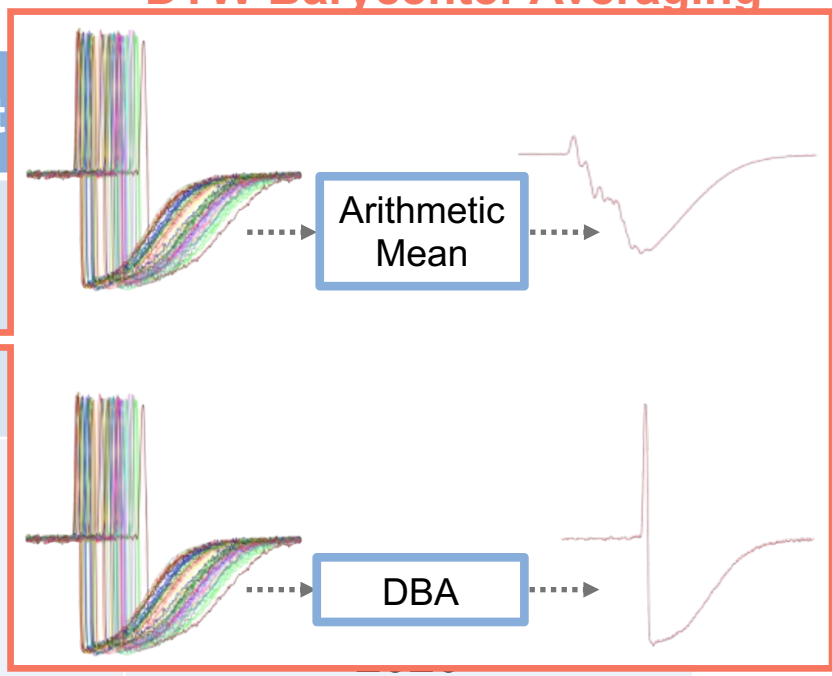
- **LCSS**
- **DTW**

Clustering Algorithm

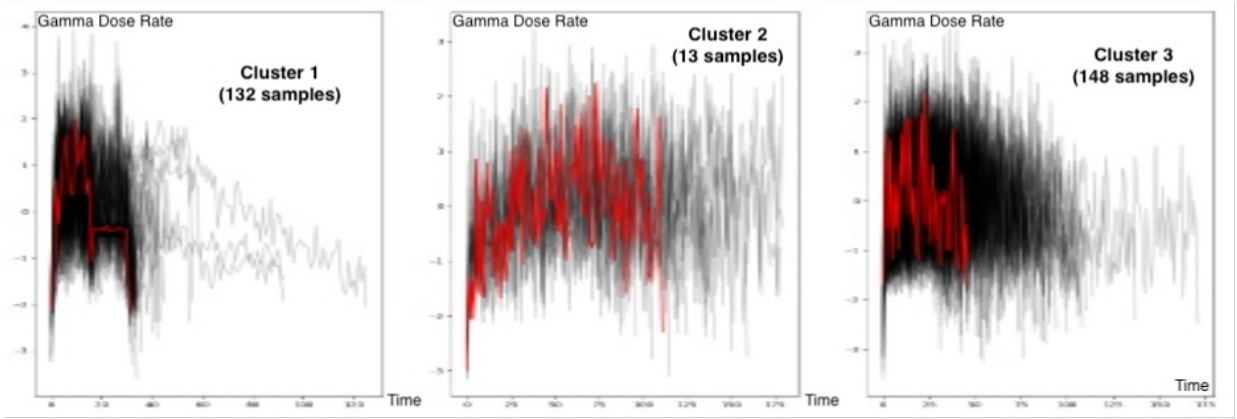
- **Hierarchical**
- **K-means**
- **K-medoids**

Similarity Measure	Clustering Algorit	
DTW	K-means (DBA)	
	K-medoids	
LCSS	K-medoids	Soleimany et al., 2019

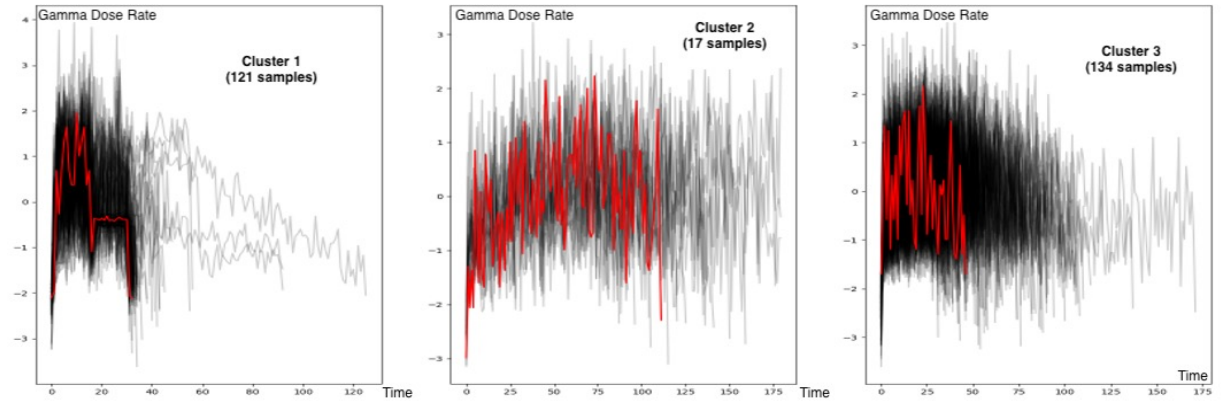
DTW Barycenter Averaging



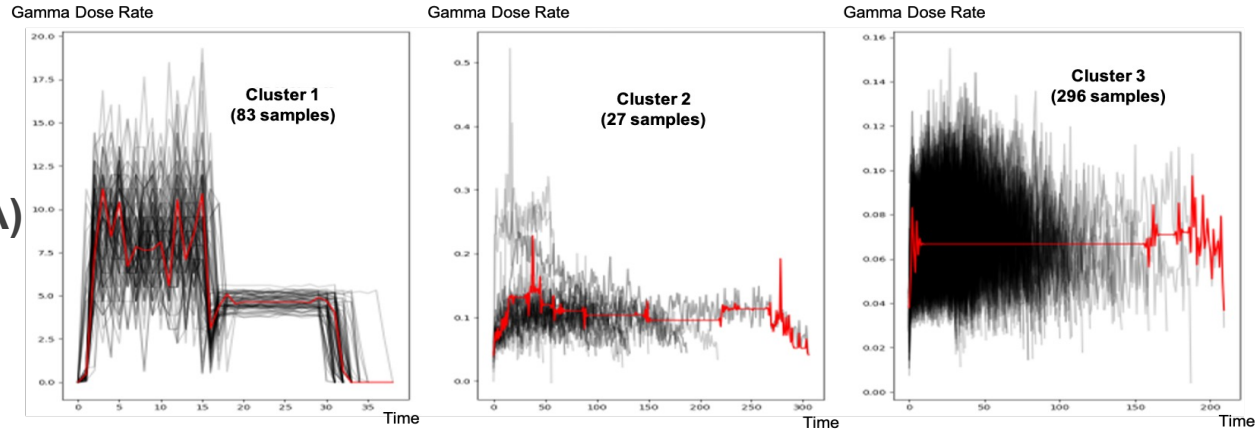
LCSS + K-medoids



DTW + K-medoids

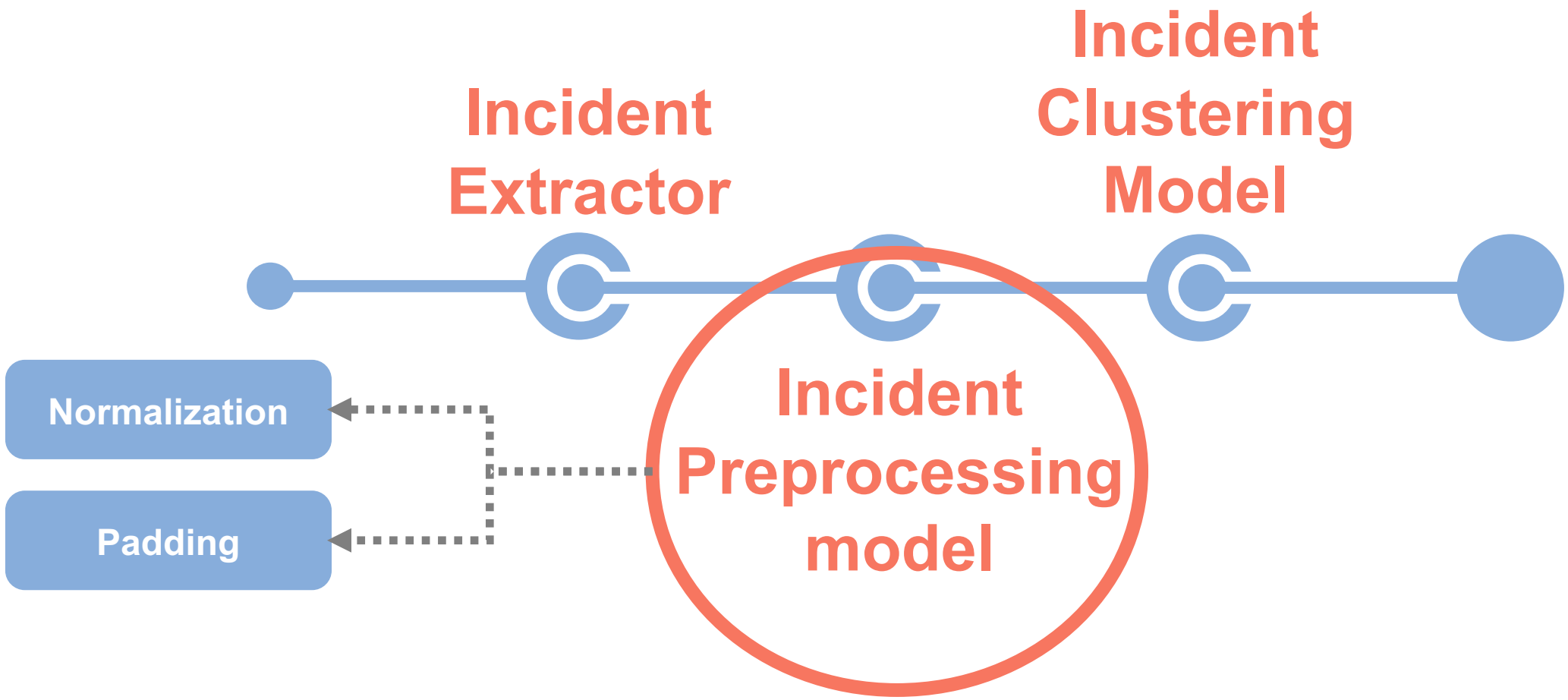


DTW + K-means (DBA)



- Not representing any information for us
- Based on our dataset, these techniques don't work

Framework Main Components



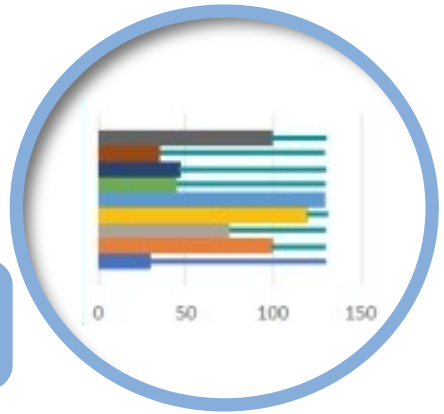
Z-normalization is an essential operation in several applications, because it allows similarity search irrespective of shifting and scaling (Rakthanmanon et al., 2012)

K-means

DTW (DBA)

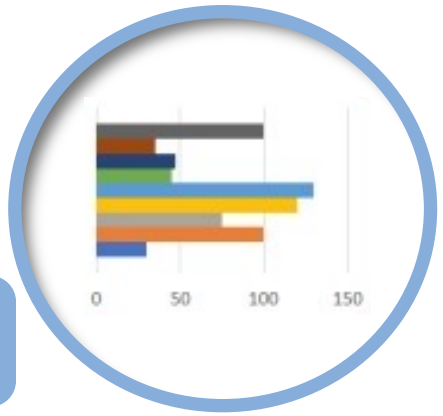
Clustering

Zero Padding

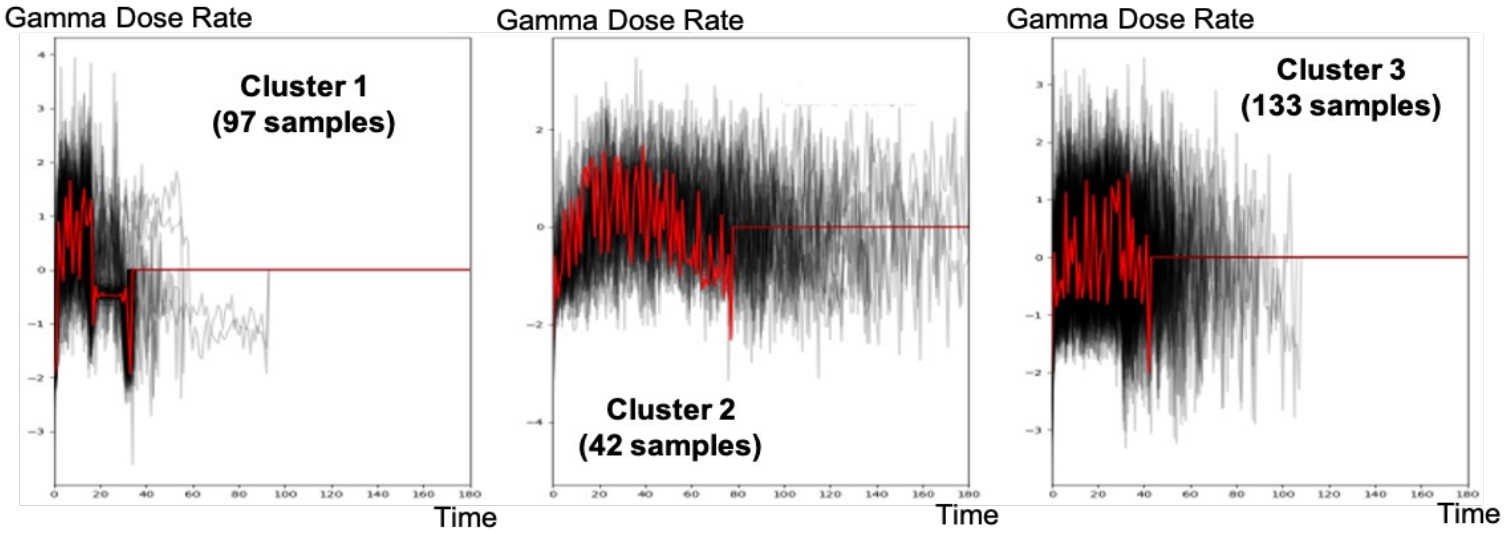


Z-normalization

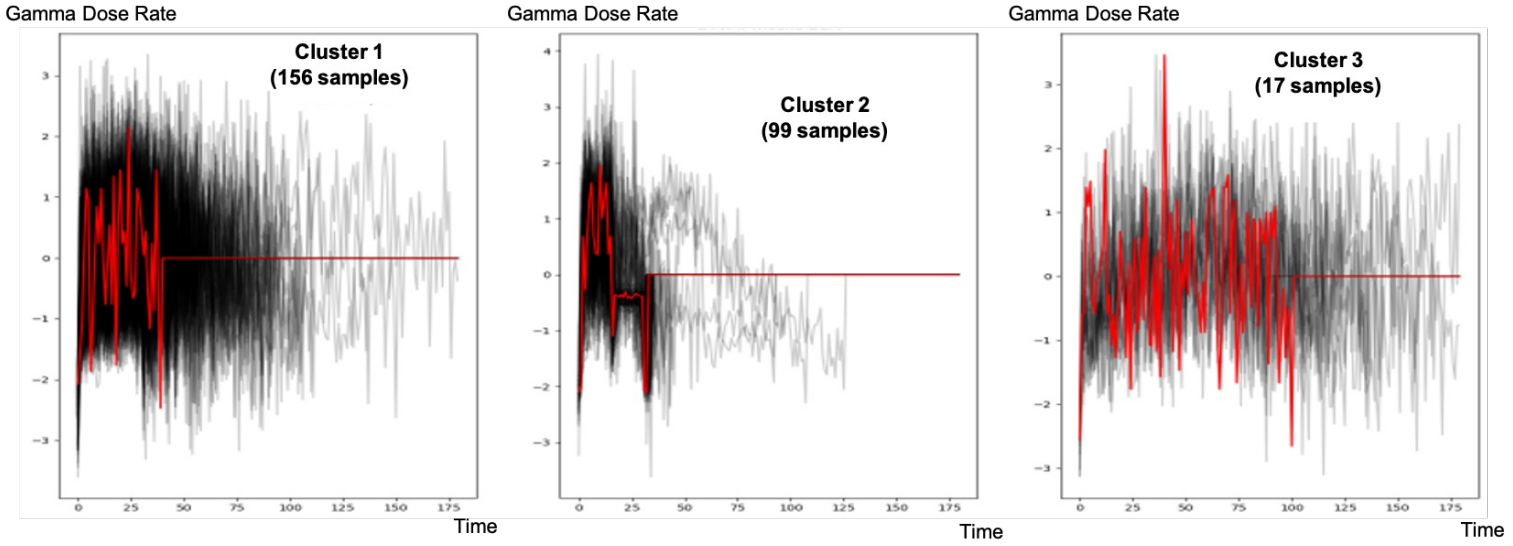
Incident Samples



Introduced Clustering model for Clustering Sequences of Varying Length



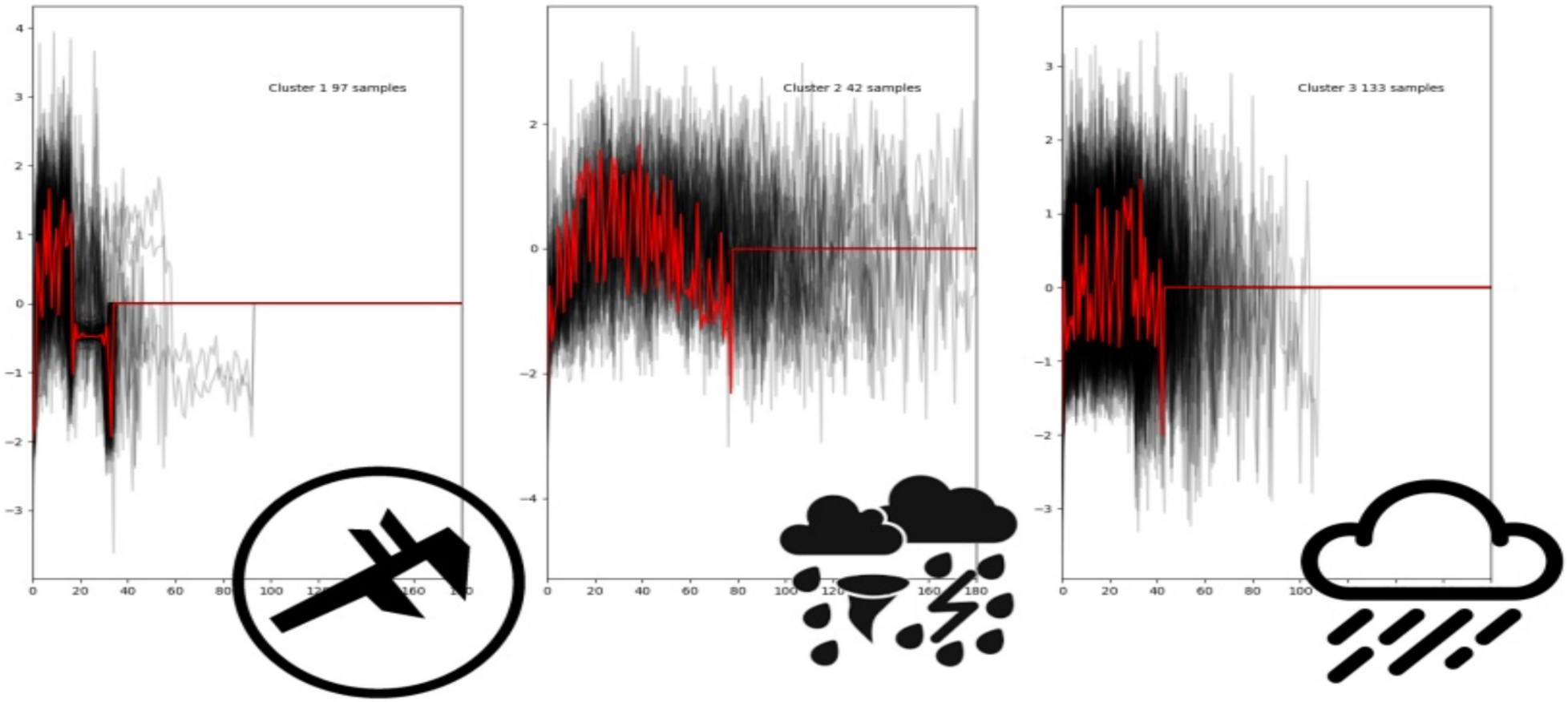
Preprocessing + K-means (DBA) + DTW



After Z-normalization + Zero Padding

DTW + K-medoids

Evaluating Clusters



Conclusion

REWS

We introduced the existing Radiation Early Warning System used in most countries around the world.

Shortcomings

We highlighted the current shortcomings behind the existing REWS.

Proposed Framework

We introduced our framework called RIMI that will address these shortcomings.

Intelligent REWS

- We are aiming to turn the existing REWS into an intelligent system that is independent of experts.
- We have feeling that our work can be beneficial for other people datasets.


Thank You