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EU-CIP
Project type B
Resilience Intelligence Tool

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General introduction

Business Intelligence (BI) for Critical Infrastructure (CI) Resilience Analysis (**BICRA**)

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Solution Description

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- In order to maintain and enhance a high level of resilience of modern critical infrastructures in Europe, it is necessary to manage and keep transparent huge amounts of varied data (measurement, monitoring, management systems, etc.) and maintain information interconnection integrity.

- A tool was developed with a goal of integrating data and information and providing transparent and smart decision making. The solution is a Business Intelligence (BI) tool, using Artificial Intelligence (AI) focused on the resilience of Critical Infrastructure (CI).

Solution Innovation

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The main problems addressed in the area of CIP/CIR are the three best identified ones in the industry so far:

a) “data/information flood” – solved by integrating intelligently large amount of different types/sources of data information – also in combination with data-lake/data-mart and digital twin technologies, on the leading side, and the legacy systems, on the lagging side;

b) “lack of transparency” – solved by providing interactive, BI-based intuitive interfaces;

c) “missing the early warnings and signals” – solved by smart focusing on most important subsets of resilience data/information.

Key features

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- We use the general Microsoft solutions (Microsoft Power BI and the Microsoft SQL server) as the development basis, but the final solution is fully customized to the end-user needs in terms of data and information sources addressed and used (documents, measurement records, analysis results…) from a whole spectrum of tools.
- The technology allows to perform the what-if analysis interactively and with practically no IT-training, all the knowledge prerequisites are related to the domain knowledge (e.g. risk assessment of the CI assets).

Sector Relevance

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- Power generating facilities
- Raw material processing plants
- Renewable energy stations

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How do we assess resilience in BICRA

Resilience: what happens when risk happens?

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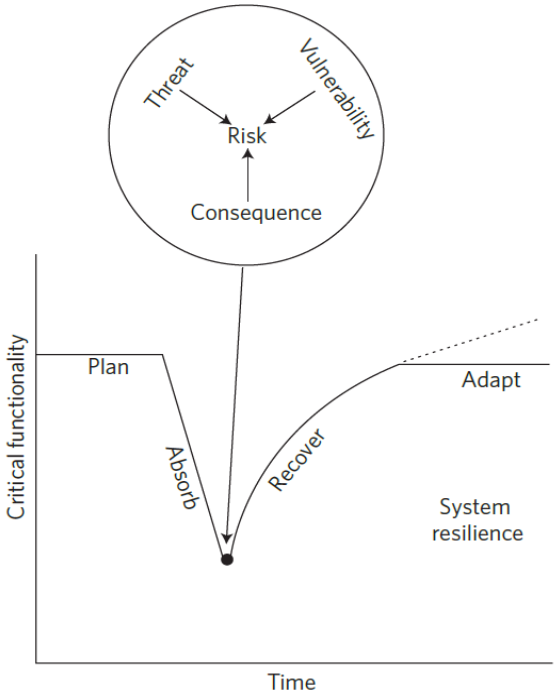

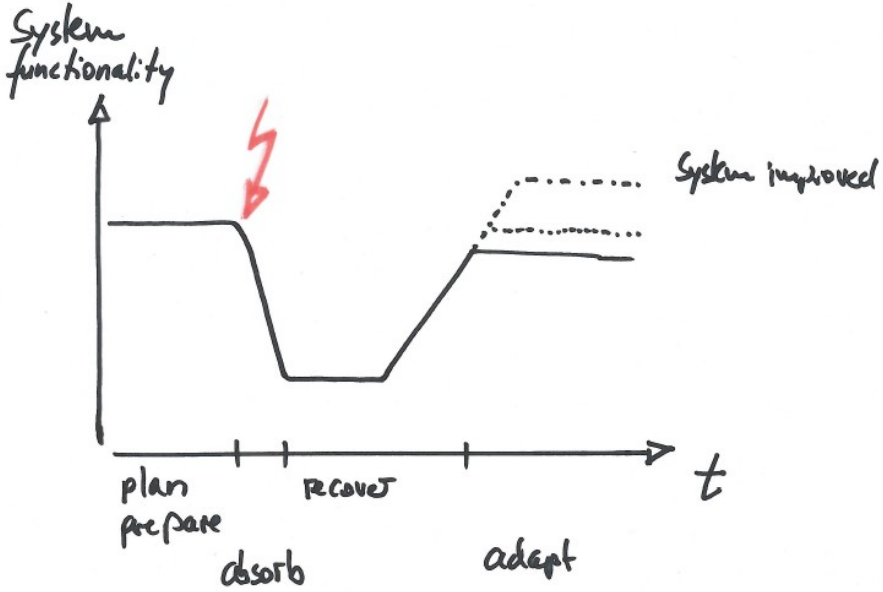

Resilience:

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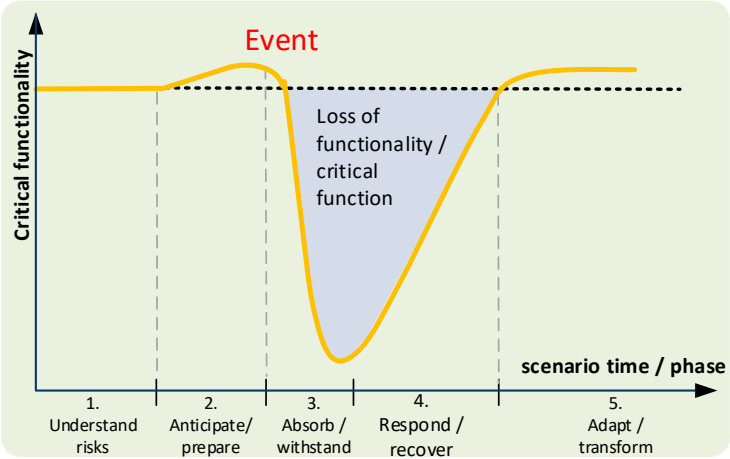
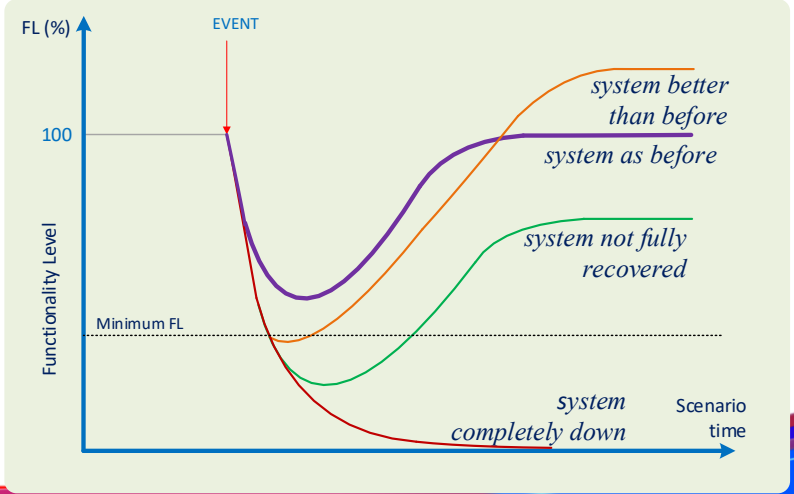
1. **understand and anticipate risks** – including new/emerging risks – threatening the critical functionality of the infrastructure,
2. **prepare** for anticipated or unexpected disruptive events, optimally
3. **absorb/withstand** their impacts,
4. **respond and recover** from them, and
5. **adapt/transform** the infrastructure or its operation based on lessons learned, thus reducing the critical infrastructure fragility.





Practical ways of assessing resilience – e.g. indicators

Resilience Level (RL) as composite index based on resilience indicators

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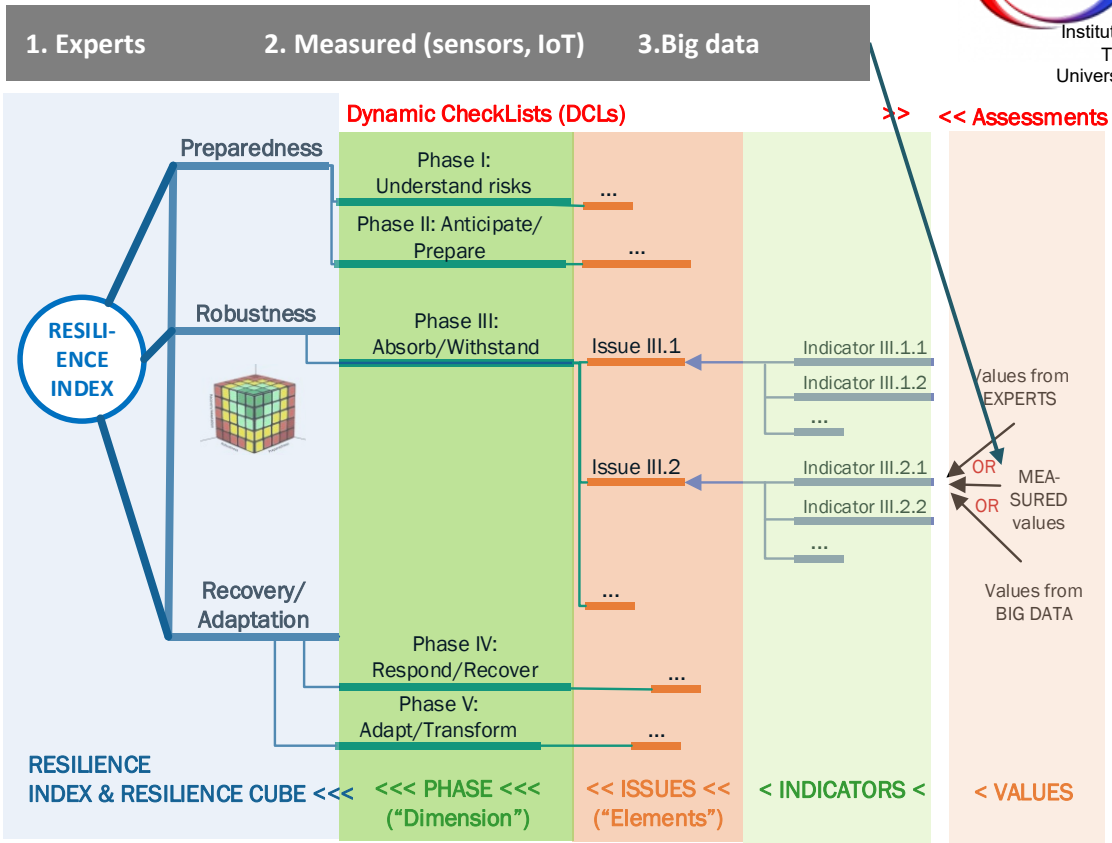
- Hierarchical organisation of indicators in a dynamic checklist (DCL)
- Bottom-up process (right to left!)
- Indicator values aggregated to a single summarized index value:

Resilience Level: 0-5



How does a dynamic checklist of indicators look like?

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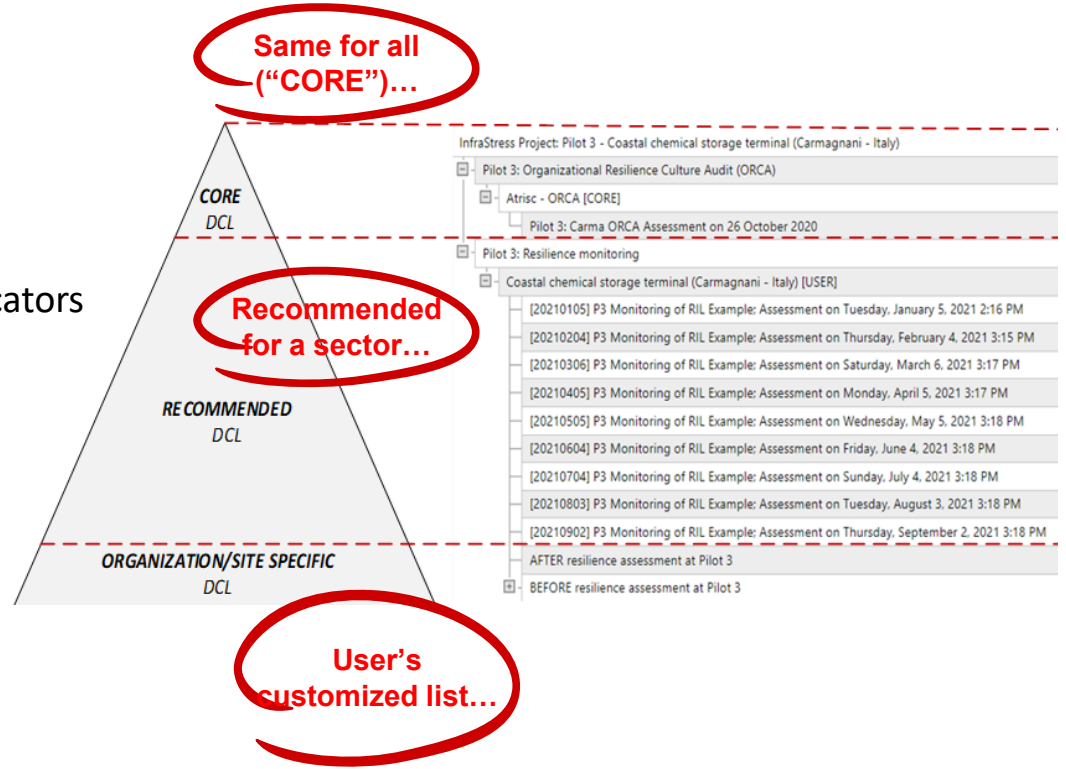
- General indicators
- Industry-specific indicators
- Plant-specific indicators



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Use of AI in BICRA

Mostly used in BICRA

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1. FCM:
   Fuzzy C-mean clustering - Continuous and dynamic data mining over the data already acquired and results already achieved
2. NN/ML (neural networks & machine learning):
   Prediction based on neural networks

FCM:
Fuzzy C-mean clustering

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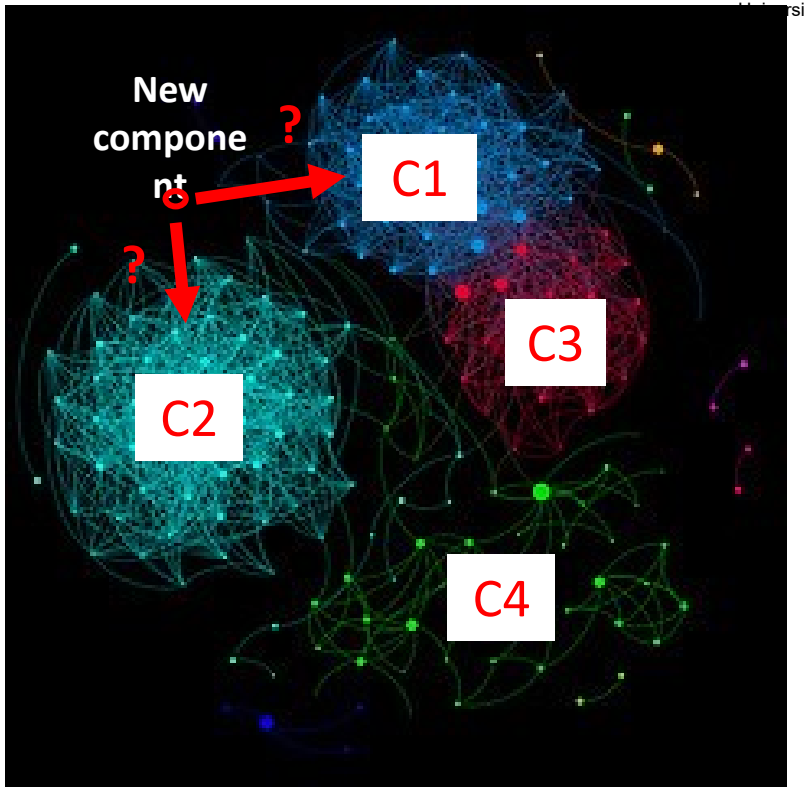
- Practically it means that the components are dynamically clustered (e.g. “all superheater outlet headers”) according to their characteristics and associated risks
- Based on their characteristics, the new, yet to be analysed components (e.g. a new superheater), can than be pre-assigned to the corresponding clusters and a preliminary, “automatic” risk assessment made (e.g. “medium risk”)



Application of FCM

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- 1134 valve data from projects
- 7 characteristics of valves

Cluster Centers						
Design Pressure	Design Temperature	Nominal Diameter	Cr%	Operating Pressure	Operating Temperature	Risk
25850,401	312,616	89,979	0,749	18819,224	274,327	0,076
11377,388	516,103	101,974	1,477	9563,869	498,621	0,125
13862,614	267,932	96,588	0,878	10368,124	235,766	0,055
5732,171	349,437	85,160	0,415	3058,279	296,933	0,038

Clustering (Fuzzy C-Means)

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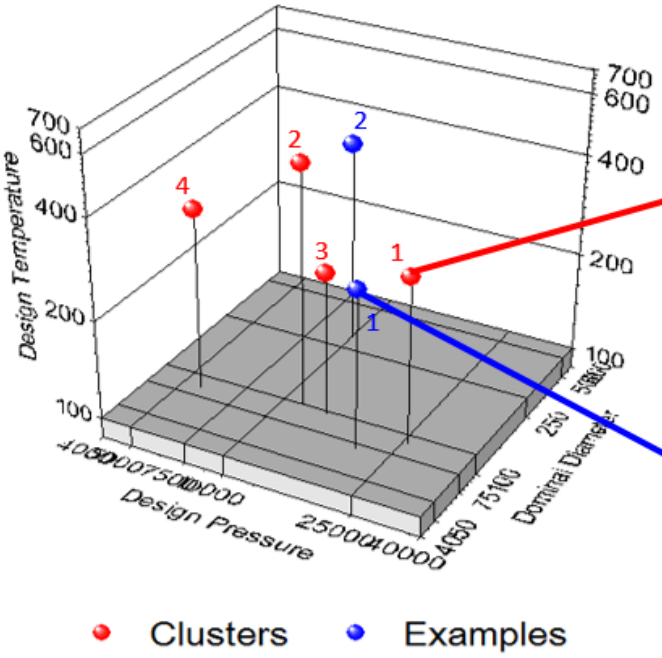
- Possible valve examples are positioned.
  - 4 clusters (regarding Design Pressure, Design Temperature and Nominal Diameter characteristics)
  - 2 examples



Clusters		
Design Pressure	Design Temperature	Nominal Diameter
25850,401	312,616	89,979
11377,388	516,103	101,974
13862,614	267,932	96,588
5732,171	349,437	85,160

Examples		
Design Pressure	Design Temperature	Nominal Diameter
20000	300	70
10000	400	300

NN:
Prediction based on neural networks

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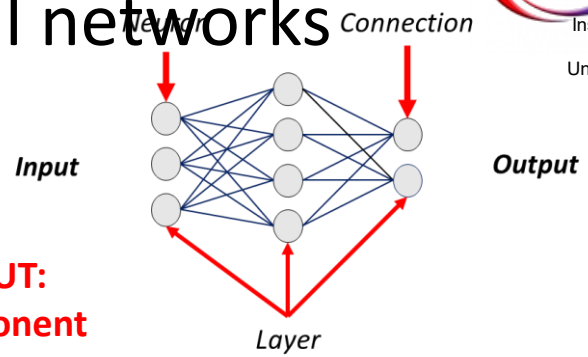
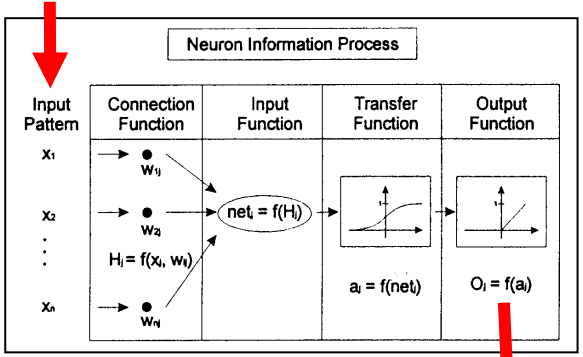
- The of NN is imitating the structure and workings of the human brain through mathematical models. Three basic qualities of the human brain are taken as foundations for NN models:
  - knowledge (distributed over many neurons within the brain)
  - neurons (can communicate locally with one another)
  - brain (can adapt)
- There are basically three types of NN models:
  - Multilayer perceptron



INPUT: Component Characteristics



OUTPUT: Component Risk

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Neural Network (Multilayer Perceptron)

- for training process 168 data
- for testing process 8 data
- as input parameters 7 characteristics of valves
- as output parameter “risk” characteristic are used

	DesignPressure []	DesignTemperature []	NominalDiameter []	Cr% []	OperatingPressure []	OperatingTemperature []	B_Risk []	*
1	25.000,000	280,000	300,000	0,300	19.250,000	250,000	0,000	
2	33.130,000	280,000	300,000	0,300	19.250,000	250,000	0,000	
3	20.500,000	367,000	32,000	0,300	19.250,000	250,000	0,000	
4	33.130,000	367,000	150,000	0,300	18.500,000	280,000	0,000	
5	20.070,000	405,000	65,000	0,300	18.500,000	250,000	0,000	
6	20.070,000	405,000	80,000	0,300	18.500,000	250,000	0,000	
7	20.070,000	405,000	65,000	0,300	18.500,000	250,000	0,000	
8	20.070,000	405,000	80,000	0,300	18.500,000	250,000	0,000	
9	20.070,000	405,000	80,000	0,300	18.500,000	250,000	0,000	
10	18.700,000	545,000	250,000	2,250	17.500,000	530,000	0,000	

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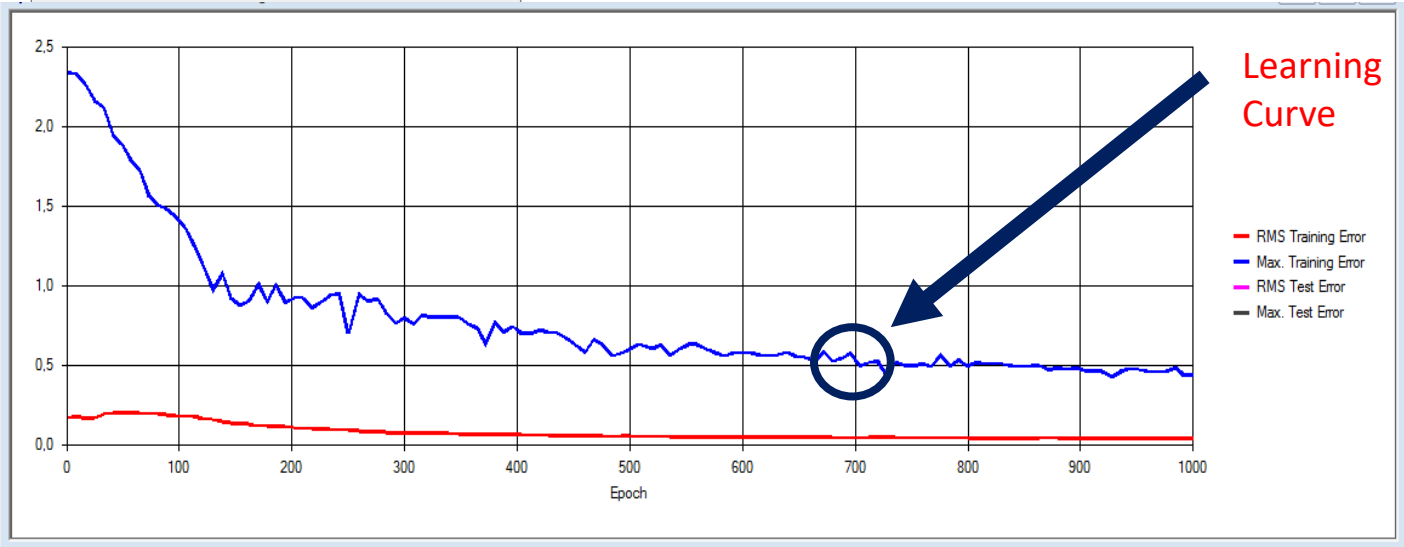
Neural Network (Perceptron)

Epoch:	1000
max. Training Error:	0,437259517652
RMS Training Error:	0,0407957785263
max. Test Error:	0,872059094254
RMS Test Error:	0,179391417557

Update every 100 steps

Prediction of risk by NN



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BI (Business Intelligence) in BICRA

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Why Power BI?

- **Fast development and deployment:** Power BI provides vast amount of built-in visualization and functionality, eliminating the need to develop these from scratch. This significantly speed up deployment time.
- **Data connectivity:** Power BI supports connections to numerous data sources, as well as real-time streaming of data and monitoring.
- **Ease of use:** Allows end-users to conduct their analytics without relying heavily on IT, promoting more agile decision-making processes.

Why Power BI?

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- **Integration with Microsoft Ecosystem:** As part of the Microsoft ecosystem, BICRA integrates seamlessly with other Microsoft products and other Power BI dashboards/reports in use by critical infrastructures
- **Advanced analytics**: Leverage AI capabilities and integrate machine learning models to perform advanced analytics directly within Power BI, as well as have capabilities to run R and Python scripts

Power BI integration into Microsoft Fabrics

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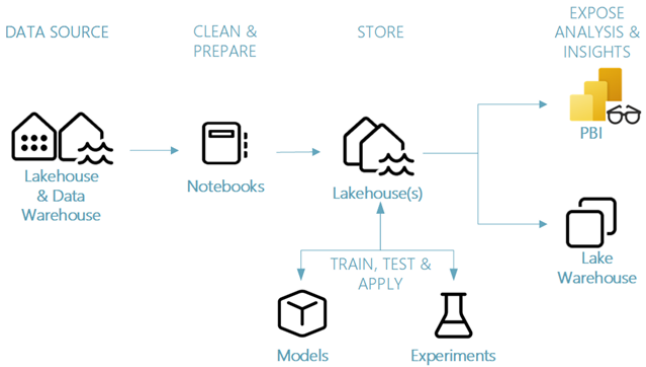
- Recently Power BI has been integrated into Microsoft Fabrics data platform. This integration significantly expand capabilities of Power BI, allowing seamless move from data ingestion to transformation and visualization within one environment. This allows us to, beside usage of our own AI models, leverage AI-powered features available in Microsoft Fabric to enrich the insights generated through Power BI reports and dashboards.



Power BI integration into Microsoft Fabrics

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- We use Power BI Desktop to create report/dashboards that can then be shared and used by end-users via Power BI Server.
- Typical workflow within Power BI Desktop includes following steps:

1. Connect to data, including multiple data sources.
2. Shape the data with queries that build insightful, compelling data models.
3. Use the data models to create visualizations and reports.
4. Share created report files for others to leverage, build upon, and share.

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BICRA Demonstration

Power plants (PP) and heating plants (HP) in Serbia

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- PP TENT A
- PP TENT B
- HP Novi Beograd
- PP Kolubara A
- PP Kolubara B
- PP Kolubara C
- HP Novi Sad
- 7 smaller plants incl. industry (as 1 location)

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BICRA outlook

Business Intelligence (BI) for Critical Infrastructure (CI) Resilience Analysis (**BICRA**)

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Key features or unique selling points of the product/service

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- The **general BI tools are available around** (e.g., the Oracle and Microsoft ones) but not the dedicated ones. We use the general Microsoft solutions (Microsoft Power BI and the Microsoft SQL server) as the development basis, but the **final solution is fully customized to the end-user needs** in terms of data and information sources addressed and used (documents, measurement records, analysis results…) from a whole spectrum of tools.
- The technology allows to **perform the what-if analysis interactively** and with practically no IT-training, all the knowledge prerequisites are related to the domain knowledge (e.g. risk assessment of the CI assets).

Future of the product

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- Preliminary market search done for Serbia and the Balkans region
- Collaboration with companies in Serbia and Hungary established
- Contacts and collaboration with companies is expected to be established with help of EU-CIP project
- Pilot project costs/duration: 50-70 k€ / 6-12 months

Future of the project - Marketing

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- **Social Media Marketing**: Establish a strong presence on relevant social media platforms; Create a content calendar and engage with the audience regularly.
- **Email Marketing**: Build and maintain an email list for targeted communication; Implement email campaigns for product updates, promotions, and customer engagement.
- **Partnerships and Collaborations**: Explore opportunities for partnerships with other businesses or organizations; Collaborate on joint promotions or events.
- **Customer Feedback and Testimonials**: Encourage and showcase customer reviews and testimonials to build trust.

Final conclusion

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BICRA contributes to EU-CIP by

1. Identifying gaps: solutions for managing big data
2. Defining needs: power plants
3. Analyzing market: Serbia, Western Balkans
4. Providing scalability and flexibility: Generic tool adapted for highly customized/tailored solutions
5. Engaging stakeholders: In the region not represented in EU-CIP so far
6. Continuous improvements: Each solution is an improvement, also because the basic tool (PowerBI™) improves (now Fabric™)

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Thank you for your attention!
Any questions?