Laboratory of Analysis of Systems for the Assessment of Reliability, Risk and Resilience

LASAR 3

Laboratory of Analysis of Systems for the Assessment of Reliability, Risk and Resilience

POLITECNICO MILANO 1863

General overview

Partnership

Intervention Areas

M.Sc. Theses Available

LASAR³: *Laboratory of Analysis of Systems for the Assessment of Reliability, Risk and Resilience*

Research in developing methods of system analysis, and computational and artificial intelligence models to leverage knowledge, information and data for reliability, risk and resilience assessment of components, industrial systems and critical infrastructures.

LASAR³: *Laboratory of Analysis of Systems for the Assessment of Reliability, Risk and Resilience*

Ibrahim Ahmed (PhD, Assistant Professor) research activity is on modeling, simulation, data analytics, machine learning, artificial intelligence for Prognostics and Health Management (PHM) and maintenance, and for safety, security, risk, resilience assessment and management.

Piero Baraldi (PhD, Full Professor) is the principal investigator of the projects on modeling, simulation, data analytics, machine learning, artificial intelligence for Prognostics and Health Management (PHM) and maintenance

Francesco Di Maio (PhD, Full Professor) is the principal investigator of the projects on modeling, simulation, data analytics, machine learning, artificial intelligence for safety, security, risk, resilience assessment and management.

Enrico Zio (PhD, Full Professor) is the scientific director of the research and development activities carried out by LASAR³.

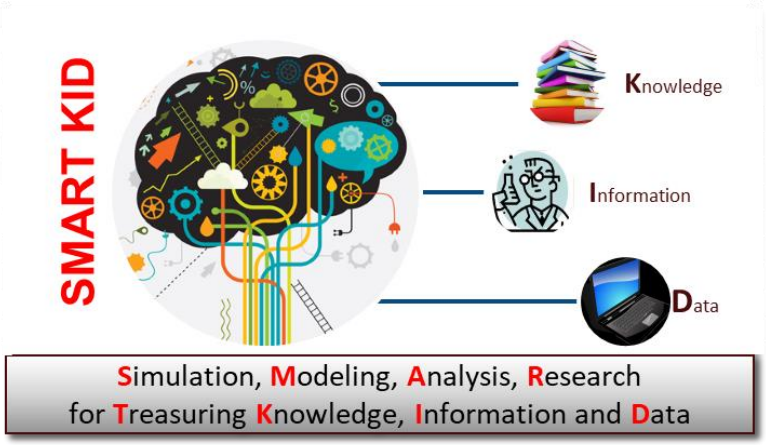
Collaborators:

5 Postdocs researchers
20 PhD students
20 Visiting PhD Students

Main Intervention Areas

Large amount of deployed algorithms (more than 25yrs R&D)

Approach



The Team

20 PhD students

Giovanni Floreale

Chenyang Lai

Giovanni Roma

Maria Valentina Clavijo Mesa

Jinming Zhang

Leonardo Andres Miqueles Leiva

Stefano Marchetti

Yike Zhao

Juan Pablo Futalef

Santiago Taguado Menza

Mei Chen

Nicolás Javier Cárdenas Pantoja

Weijun Xu

Bo Yao

Jia Li

Thomas Matteo Coscia

Haoran Liu

Zhiqiang Zhu

Wujin Deng

Rulan Ma

5 Postdocs researchers

Joaquin Figueroa Barraza

Seyed Ali Hosseini

Dario Valcamonico

Luca Pinciroli

Maolin Luo

20 Visiting PhD students

Jiarong Wang

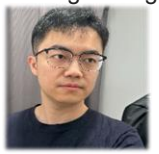
Zijun Wang

Zongyao Wang

Xueying Huang

Zihang Liu

Hancheng Huang



Haoyuan Shen

Jian Du

Jiashan Gao

Hongchen Qu

Zhiqian Zhao

Shishun Chen

Jianxin Xu

Shen Liu

Jiajian Li

Kaixin Shen

Wenyi Liao

Yuxuan Tao

Jiawei Fan

Yuan Sun

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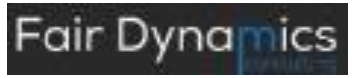
Industrial Partners



Academic Partners

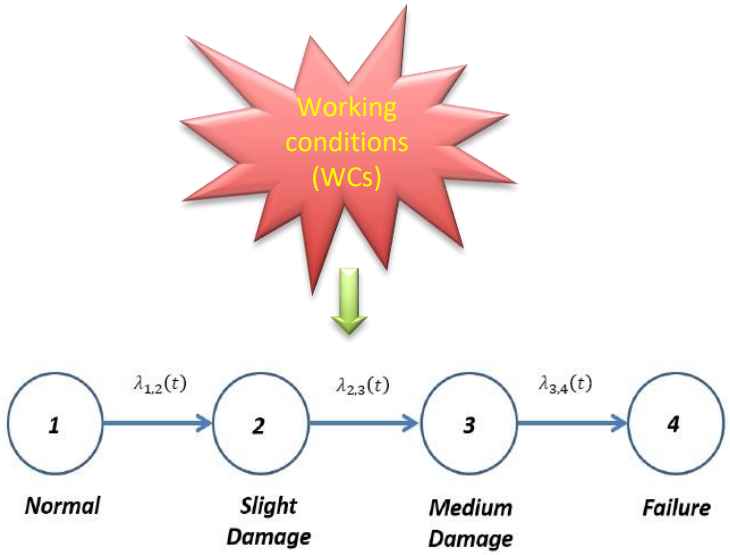
General overview

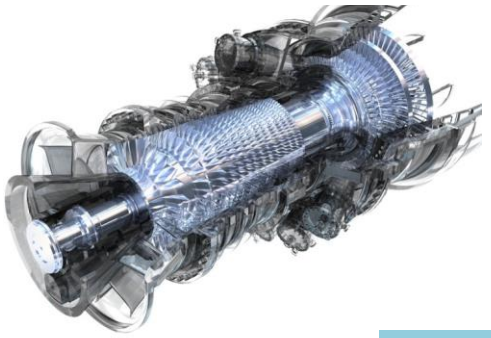
Partnership

Intervention Areas

M.Sc. Theses Available

Reliability & Availability



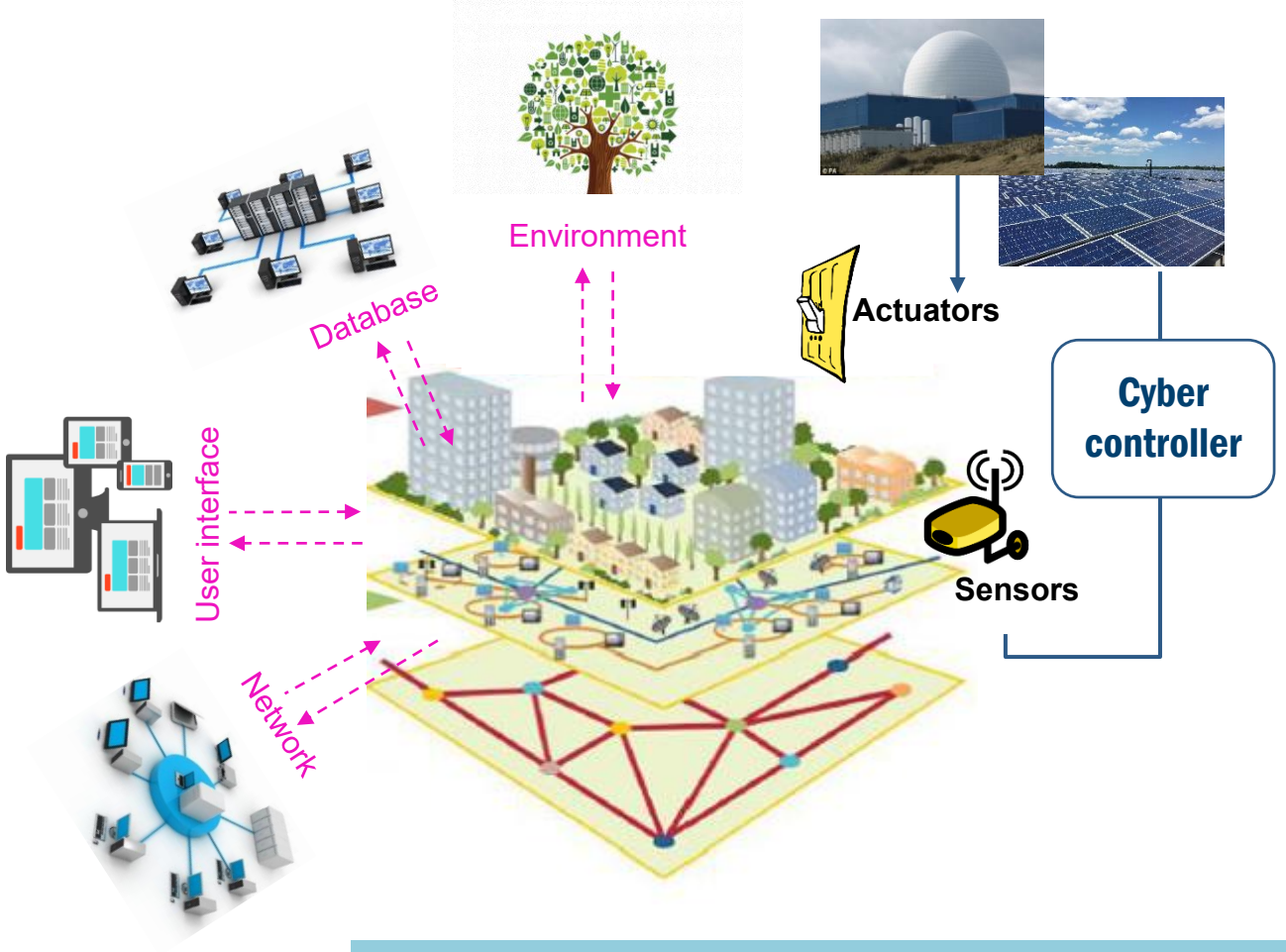


- Design support during its development (RAMS requirement definition)
- Optimal redundancy allocation and reliability design
- Optimal inspection times and maintenance procedures
- Life Cycle Cost estimation
- Importance measures to effectively improve the design
- Uncertainty and sensitivity analyses to cope with uncertainty
- Dynamic reliability modeling
- Safety margins
- Survival analysis
- Human reliability

Reliability and Availability of complex systems

Multi-state degradation modeling, also in case of imprecise data, to improve the prediction capability

Risk & Vulnerability



- Probabilistic Safety Assessment (PSA) of Nuclear Systems
- Living PSA
- Condition-based PSA
- Cyber-physical Systems (CPS) Safety and Security Analysis
- Resilience and Vulnerability analysis of complex systems and critical infrastructures

Safety & Security and Vulnerability analysis
for decision analysis also in the presence of imprecise information

Maintenance & PHM

Ambient & Operating Conditions

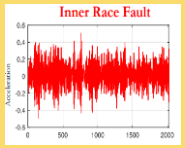
Industrial Systems and processes

Safety improvement, Cost Saving

- Maximum Availability
- Business continuity
- Warehouse savings
- Zero-defect production
- Zero-waste production

Knowledge, Information and Data (KID)

- Sensors Signals
- Maintenance Reports
- Device's Error Logs
- Images

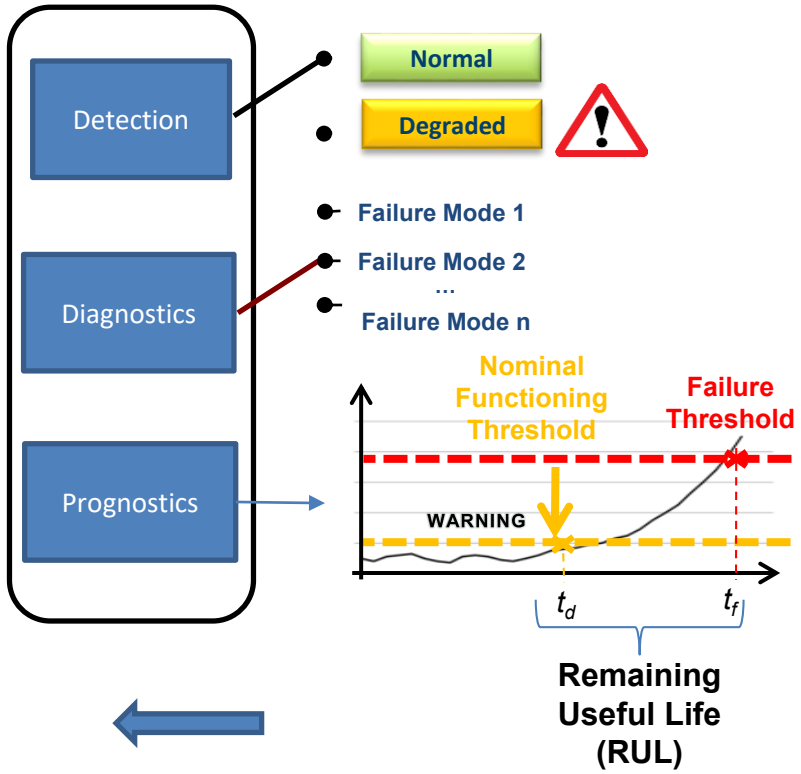


Optimal Maintenance Decisions

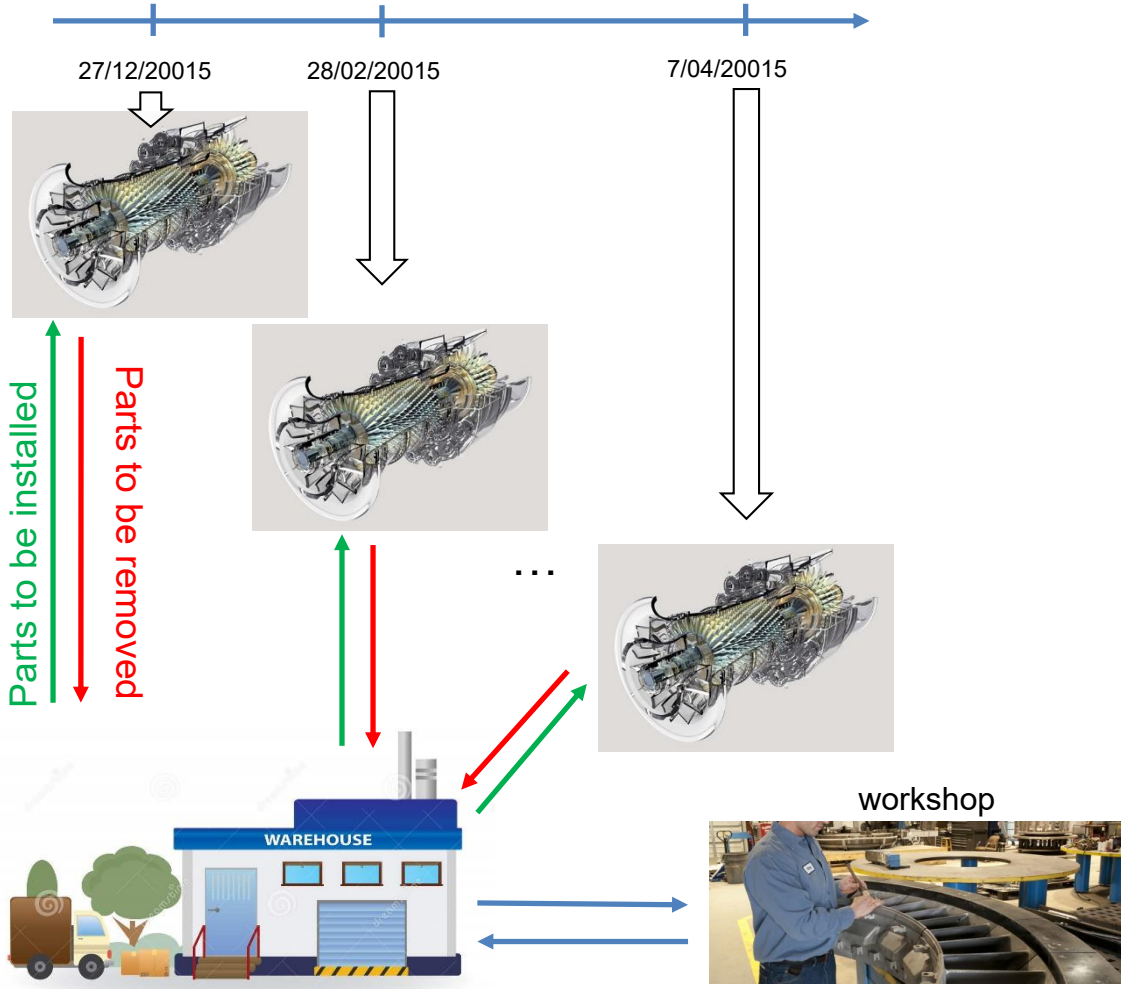
(Production Centered)

- Future demand
- Production planning
- Logistics options

Prognostics and Health Management (PHM)



Logistics & Operations



- Maximize the profit of a contract
- Maximize the usage of a part
- Minimize the number of stops to perform maintenance
- Find opportunities for maintenance
- Reduce the consignment stock
- Sensitivity analysis of the performance of the contract

Warehouse optimization of large plants

Part flow modeling and optimization of the strategy to manage the consignment stock

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COLLABORATIONS

- Theses with international collaborations
- Theses with industrial partners
- Theses internal at LASAR^3

TOPICS

- Theses on Risk and Resilience Assessment of Complex and Critical Infrastructures
- Theses on Reliability Assessment
- Theses on Prognostics and Health Management for Predictive Maintenance
- Other

Theses with international collaborations

Theses on Risk and Resilience Assessment of Complex and Critical Infrastructures (1/2)

- Guided probabilistic risk assessment of complex systems using reinforcement learning optimization (with UCLA, USA)
- Resilience assessment and management of power grids in response to extreme weather conditions (heat wave, storm, flood, wildfire, etc.) (with UCLA, USA)
- Development of a neural network for Critical Heat Flux predictions (with CEA, France)
- Real-Time Condition-Informed Safety Assessment of a Microreactor (with MIT, USA)
- Inverse Uncertainty Quantification with Deep Learning Surrogate Models of Accident Scenarios in Nuclear Microreactors (with MIT, USA)
- Development of a Digital Twin of a Nuclear Microreactor: on the Multi-fidelity
- Uncertainty Quantification (with MIT, USA)
- Advanced methods of dynamic risk assessment for energy systems (with Leibniz University of Hannover, Germany)
- Safety analysis of nuclear power plants: quantification of the uncertainty in nuclear thermal-hydraulic codes based on heterogeneous experimental data (ATRIUM Consortium) (with CEA, France)
- Data adequacy assessment in thermal-hydraulic experimental tests of Intermediate Break Loss of Coolant Accident (IBLOCA) (ATRIUM Consortium)
- Inverse uncertainty quantification of nuclear thermal-hydraulic codes for safety analysis of Integral Effect Tests nuclear power facilities (ATRIUM Consortium) (in collaboration with ENEA and Politecnico di Torino)
- Advanced uncertainty quantification models for the prediction of critical/safety parameters in nuclear power systems by artificial intelligence (EGMUP Task force on AI/ML)
- Interpretability and explainability of artificial intelligence models for the prediction of the critical/safety parameters in nuclear power systems (EGMUP Task force on AI/ML)
- Hydrogen Safety in Transportation – Focusing on Hydrogen-Fueled Ships
- Enhancing Resilience in Net Zero Energy Systems
- Enhancing Safety in Nuclear-Powered Green Hydrogen Production

Theses with international collaborations

Theses on Prognostics and Health Management for Predictive Maintenance

- Development of State-of-Health Indicators for Researchable Batteries Using Deep-Transfer Learning Methods (with Ecole Polytechnique, France)
- Deep Transfer Learning Methods for Prognostics and Health Management (PHM) of Batteries (with Tsinghua University, China)
- Cross-Modal Temporal-Spatial Synchronization for Holistic Fault Evolution Analysis in Industrial PHM Applications (Beihang University, China)
- Dual-Layer Collaborative Architecture for Knowledge and Physics Integration in PHM Large Models (Beihang University, China)
- Intelligent Agent-Based Optimization for Multimodal PHM Model Training Under Uncertainty (Beihang University, China)

Theses with industrial partners

Theses on Risk and Resilience Assessment of Complex and Critical Infrastructures

- Benchmark of dynamic methods for Probabilistic Safety Assessment of nuclear power plants (EDF, Paris)
- Dynamic Probabilistic Safety Assessment (PSA) of Small Modular Reactors (SMRs): Reduced Order Modeling and Advanced Sampling (TRACTEBEL, Belgium)
- System-Theoretic Accident Model and Processes (STAMP) for Probabilistic Safety Assessment (PSA) in Gen IV Reactor Technologies (TRACTEBEL, Belgium)
- Automated System Logic Representation by P&I Digitalization (TRACTEBEL, Belgium)
- Development of Explainable Multiphysics-Informed Machine Learning for the Prediction of Critical Parameters in Water-cooled Nuclear Reactors (TRACTEBEL, Belgium)

Theses on reliability assessment:

- Functional Reliability of Passive Safety Systems of Nuclear Power Plants (NPPs) Reduced Order Modeling and Advanced Sampling (TRACTEBEL, Belgium)
- Caratterizzazione affidabilistica di componenti industriali (Pietro Fiorentini SpA, Rosate (MI))

Theses with industrial partners

Theses on Prognostics and Health Management for Predictive Maintenance

- Development of machine learning methods based on sensor data for maintenance optimization and failure analysis (Fluid-o-Tech)
- Development of Physics-informed Deep Learning methods for Remaining Useful Life prediction of Metal-Oxide Semiconductor Field-Effect Transistors (SAFEPOWER European project)
- Development of a framewok for causal modeling (Aramix)

Other

- Deep reinforcement learning for the optimization of loading plans for NPPs (TRACTEBEL, Belgium)
- Well Drilling Location Scheduling Using Deep Reinforcement Learning and Graph Neural Networks in Oil and Gas Extraction Projects (ENI, Italy)
- Development of a Bayesian Optimization of Experimental Design (BOED) framework (Aramix)

Theses internal at LASAR³

Theses on Risk and Resilience Assessment of Complex and Critical Infrastructures

- Advanced Sensitivity Analysis of Models of Groundwater Contaminant Transport in Scenarios of Climate Change
- Large Language Models for Risk Assessment of Industrial Systems
- Ecology network analysis methods for balancing efficiency and resilience of critical systems and infrastructures
- Resilience of energy production plants exposed to Natural-Technological (Natech) scenarios of increasing frequency and severity in the climate change context
- Methods for the evaluation and optimization of the resilience of systems, plants and infrastructures
- Climate change impact on the risk assessment of energy production plants
- Enabling the Resilience of Integrated Energy Systems to Tsunami by Early Warning Hazard Nowcasting

Other

- Well Drilling Location Scheduling Using Deep Reinforcement Learning and Graph Neural Networks for Contaminant Remediation in Nuclear Sites

Theses internal at LASAR³

Theses on Prognostics and Health Management for Predictive Maintenance

- Large Language Models for Maintenance Engineering with Applications to Energy Systems
- Large Language Models for Reliability-Centered Maintenance of Energy Systems
- Deep Learning Methods for Extracting Information from Text Documents in Prognostics and Health Management Applications
- Graph Neural Networks for Anomaly Detection in Controlled Mechanical Systems of Aircrafts
- Risk-Aware Maintenance Optimization in Energy Components and Systems using Deep Reinforcement Learning and Graph Neural Networks
- Physics-informed Neural Networks for Fault Prognostics of Equipment
- Transfer Learning Methods for Reliability Predictions in Nuclear Power Systems
- Development of eXplainable Artificial Intelligence (XAI) methods for time series analysis
- Causality-Enhanced Artificial Intelligence for Explainable Predictive Maintenance in the Industry

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