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**Winner
ITEA Award
of Excellence
2025**

Innovation

Project Results

EXPLAIN

Human-centric, explainable AI for process industries

To increase the acceptance of artificial intelligence (AI) in industry, the ITEA project EXPLAIN (EXPLanatory interactive Artificial intelligence for INdustry) created an end-to-end machine learning (ML) lifecycle for industrial domain experts that improves the explainability of AI systems and ML models.

AI offers vast potential for increased efficiency, productivity, and sustainability in process industries. Yet widespread adoption remains low; AI is rarely trusted due to a lack of explainability or alignment with domain expertise. Industry-specific examples are uncommon and are usually derived from research, which can make them feel detached from the real-world setting. Additionally, technical explainability differs radically according to the needs of individuals. To increase the uptake of AI in industry and unlock its potential (including greater throughput and sustainability), clear, interactive, and contextually relevant explanations for users must be established.
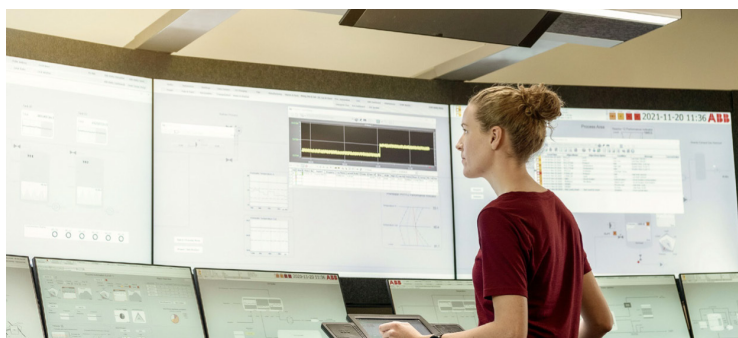
EXPLAIN aimed to involve the right stakeholders early in the ML development process by enriching the conventional ML lifecycle with human-centred explanations. In the explanatory training phase, ML experts and domain experts directly interact with an ML model and receive output explanations. Feedback can also be given through which the ML model can quickly be improved. In the explanation review, ML solutions are validated by enabling domain experts to gain insights into the internal reasoning of the trained model, ensuring that relevant concepts have been learned from the data provided and uncovering misleading biases in the training dataset. The output of the ML model is then explained to end users, who can provide feedback and trigger incremental explanatory training. These steps will be enabled via seamless ML operations (MLOps) architecture within the lifecycle, avoiding the decoupling of

ML developers and software developers currently hampering the development and operation of large-scale software systems utilising ML/AI.

Technology applied
EXPLAIN took a user-centric design approach to explainable AI (XAI) development, involving industrial stakeholders across eight use cases. The process began by systematically gathering

Operator reviewing system data in a control room - importance of clear and interpretable insights in industrial environments.

users' needs and functional requirements for explainability and user feedback through observations and interviews with domain experts in their working environment, ensuring direct collaboration and feedback from industrial stakeholders. These requirements guided the iterative development of prototypes tailored to specific challenges in the process industries, including anomaly detection, vibration monitoring, visual inspection, and operator support systems.

The prototypes underwent evaluation through user interviews, surveys, and real-world testing, driving continuous improvement informed by practical

insights. These detailed interactions allowed EXPLAIN to distil common concepts into generalised explainer and feedback components, establishing the foundation for an innovative XAI conceptual framework and practical guidelines. The guidebook explicitly links specific industrial problems to suitable explanation techniques, clearly identifying key assumptions and effectively addressing the needs of end users. Similarly, the feedback components systematically connect industrial challenges to actionable insights, enabling robust model refinement and supporting a comprehensive iterative improvement cycle.

The overall outcomes include a robust XAI conceptual framework and a set of practical guidelines grounded in real-world industrial cases, effectively aligning human needs with ML design and explanation strategies. The corresponding MLOps infrastructure system, publicly available on GitHub, is optimised for energy-efficient, on-site deployment. The comprehensive guidebook covering the full lifecycle of industrial human-centric explainable AI solutions – from design to deployment – is also provided. Both the XAI conceptual framework and comprehensive guidebook can be found on the EXPLAIN project website: https://itea4.org/project/explain.html.

Making the difference

Having started from scratch, with almost no existing use-cases or prototypes for the process industries, EXPLAIN has delivered structured guidance on how to get started with XAI within companies. This approach is particularly notable for its involvement of process operators from the beginning, making it more likely that the tools generated will be used. To increase awareness and uptake, the project has published the guidebook Human-Centered Explainable AI for Process Industries, which shares practical insights, recommendations and best practices on human-centric XAI gathered from EXPLAIN. This supports developers, engineers and decision-makers in designing and deploying safe, efficient XAI solutions. Additionally, over 70 scientific publications have been released and new partnerships have been instigated between industry and academia, resulting in three PhD students, five master's students and one bachelor's student working on project-related research.

From a commercial perspective, four prototypes have already reached TRL6 or higher: anomaly detection, vibration monitoring, visual product inspection, and flotation support for operators. In the latter, for instance, EXPLAIN tackled the complex issue of froth flotation by designing more user-friendly interfaces that offer better support to operators. Early exploitation is now beginning: Viking Analytics has released a vibration monitoring tool to help users understand operational behaviour and prioritise machines that need attention, while Prodrive is using a visual product inspection tool internally to allow non-experts to set up ML-based automatic visual inspection in a less costly and time-consuming manner.

Future outlook

With a consortium covering over USD 100 billion in market share, these early results are just the tip of the iceberg. The partners are now looking to further build on EXPLAIN, including potential research on generative AI to enhance interaction between users and systems, as well as a decision by the German partners to begin a productisation pilot. In the longer run, these efforts will offer a variety of benefits. For companies, XAI is not just about creating more efficient processes but about transferring the knowledge of more experienced operators, ensuring that this is not lost when they retire. At the European level, a trustworthy, human-centric approach can help the process industries to avoid missing out on the potential of AI, and EXPLAIN has laid an important foundation to realise this.

Major project outcomes

Dissemination and Human resources
> One guidebook, 70 scientific publications, a special session dedicated to XAI at IEEE INDIN 2023 and the Best paper award at IEEE INDIN 2024
> New employees/students: 2 research assistants, 2 UX designers, 3 PhD, 5 MSc, 1 BSc

Exploitation (so far)
Technology Readiness Level (TRL) ≥ 6 for four prototypes:
> Anomaly Detection: Enhancing reliability and predictive capabilities in industrial processes.
> Vibration Monitoring: Partner has commercially launched this solution, enabling operators to better understand operational behaviours and effectively prioritise machine maintenance.
> Visual Product Inspection: Internal deployed intuitive tool, allowing non-expert users to efficiently configure ML-based visual inspections, significantly reducing time and cost.
> Operator Support for Processes: This prototype specifically addresses complex process challenges by providing user-friendly interfaces that enhance operational effectiveness.

Standardisation
> XAI framework available on GitHub
> User-Centric Design, Approach and Evaluation
> Comprehensive Guidebook: Detailed guidance for the full design-to-deployment cycle of industrial Explainable AI solutions

ITEA is the Eureka RD&I Cluster on software innovation, enabling a large international community of large industry, SMEs, start-ups, academia and customer organisations, to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth and benefits for society. ITEA is part of the Eureka Clusters Programme (ECP).

https://itea4.org

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Partners

Germany
> ABB AG Forschungszentrum Deutschland
> Eraneos Analytics Germany GmbH
> Lausitz Energie Kraftwerke AG
> Technische Universität Darmstadt
> University of Hildesheim

The Netherlands
> Delft University of Technology
> Mek Europe BV
> Prodrive Technologies Innovation Services B.V.
> Signify Netherlands B.V.

Sweden
> ABB AB Corporate Research
> Boliden Mineral AB
> Linköping University
> Södra Skogsägarna Ekonomisk Förening
> Umeå university
> Viking Analytics AB

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May 2022

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Project website
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