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R&D activity:

Artificial Intelligence Algorithms, Platforms and Applications

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Artificial Intelligence (AI) Algorithms

Rules or instructions that a computer follows to perform tasks that typically require human intelligence. These tasks include learning from data, recognising patterns, making decisions, and predicting outcomes.

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Artificial Intelligence (AI) Platforms

Comprehensive environments that provide the needed tools, frameworks, and infrastructure to develop, train, deploy, and manage AI models.

AI platforms are essential, providing the tools and infrastructure **to build, efficiently and effectively, sophisticated and reproducible AI applications**.

AI algorithms and platforms can have multiple applications, from climate science and health science to astrophysics and high-energy physics (HEP).

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How does this technology apply to HEP and support the HL-LHC?

LHC experiments produce **enormous amounts of data**. Identifying rare events or new particles in a vast dataset is akin to finding a needle in a haystack! The HL-LHC will lead to more data generated by the LHC experiments.

AI algorithms are perfectly suited for processing and analysing this data, excelling at recognising patterns and anomalies that might indicate new physics phenomena.

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How does this technology apply to HEP and support the HL-LHC?

AI platforms on High-Performance Computing (HPC) infrastructures allow for the efficient processing of vast datasets, facilitating faster analysis and simulations.

AI applications can optimize the operation of particle accelerators, adjusting parameters in real time to maximize performance and minimize downtime, ensuring smoother and more reliable accelerator operations.

CERN openlab impact & synergies with industry

CERN openlab contributes to this area of innovation via **collaborations with technology providers and research institutions developing state-of-the-art platforms, services, and methodologies**. This includes both access to software and expertise, and access to large-scale resource testbeds for co-development of new models and workflows. Our expected impact is to **provide the community with access to resources and specific expertise**.

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CERN openlab impact & synergies with industry

Projects to assess and develop Deep Learning models and applications have been facilitated by CERN openlab since 2016 with the development of GAN networks for detector simulation.

We aim to **foster the widespread adoption of AI methods and techniques applicable to a wide range of AI use-cases**, providing the community with access to specific expertise and resources.

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How can this R&D activity transfer from HEP to other scientific areas?

Many other fields face similar big data challenges and can profit from the innovations made within the HEP community.

For example, **techniques developed for HEP data analysis can be used to process vast amounts of data from telescopes and space observatories**, aiding in the detection of exoplanets, black holes, and other celestial phenomena.

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How can this R&D work in HEP transfer to other scientific areas?

Machine learning techniques for predictive modelling in HEP can be employed to improve climate models, providing more accurate predictions of climate change impacts.

AI techniques for image recognition in HEP can improve the analysis of medical images (e.g., MRI, CT scans), leading to better diagnostics and early detection of diseases.

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How can this R&D work in HEP transfer to other scientific areas?

AI applications for optimising particle accelerator operations can be used to optimize energy grids, improving efficiency and reliability of energy distribution.

The **interdisciplinary nature of AI research in HEP** fosters skills in data science, programming, and critical thinking, which are valuable across many industries.

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- The **research and development of AI in HEP not only advances the field of particle physics** but also provides powerful tools and methodologies that can be transferred to other scientific disciplines.

- **These advancements have the potential to drive significant societal benefits**, from improving healthcare and enhancing energy efficiency to optimising transportation systems and fostering education.

- The **cross-disciplinary application of AI thus amplifies its impact**, contributing to technological progress and addressing complex global challenges.

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