Three Main Areas of R&D

**Increase data centre performance** with hardware accelerators (FPGAs, GPUs, ..) optimized software

**Scale out capacity** with public clouds, HPC, new architectures

**Change the computing paradigms** with new technologies like Machine Learning, Deep Learning, Advanced Data Analytics, Quantum Computing
IP Management, Open

• The basic principle of any CERN openlab collaboration is openness

• We assume shared (or at least very fair) IP of results among project members
  • More specific IP agreements can be discussed with the CERN KT Office

• Within the respect of limited confidentiality agreements and short embargo periods, we expect the results of the projects to be released to the scientific communities following open policies
KNOWLEDGE SHARING

Working with communities beyond high-energy physics

Working closely with CERN KT and external public entities on initiatives aimed at transferring tools, skills, and knowledge from the high-energy physics community to other research fields and vice versa.

Aligned with the officially approved knowledge transfer strategies for the benefit of other research fields like medical applications.
As scale grows, a sound digital ecosystem is generated by four main elements and a way for those elements to interact on common terms.

Platforms are the unifying services at the intersections that enable:

- commoditization
- best practices
- aggregation and integration
- share and reuse of data
- reproducibility
- collaborations, etc.
Reusable and Reproducible?

https://www.nature.com/news/1-500-scientists-lift-the-lid-on-reproducibility-1.19970

Half of researchers cannot reproduce their own experimental results
Smart Knowledge Platforms

• **Common challenge** across many activities: harness the growing amounts of information being produced every second of our lives

• **Convergence** of fast hardware, smart algorithms, and increasingly sophisticated models is getting us closer to practical solutions

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**Education**

Adaptative, personalized education environments, guiding the students to achieve their learning objectives

**Research**

Data Analysis, Preservation, Reproducibility, Knowledge Discovery and Sharing platforms, automating complex tasks, suggesting non-obvious links across disciplines and people

**Industrial/Social**

Smart personal assistants informing you about your environment, the use of your personal information, and your rights
Why CERN?

• Although CERN mission is to support research in the field of High-Energy Physics, it has a long history of proven results in the art of collaborative research

• It is a unique place where ideas and people can “collide” to generate innovation

• It has developed and keeps developing unique technologies that can and have to be made universally available to other research and to industry and society at large

• There are common challenges that can benefit from broader discussions and solutions

• CERN openlab wants to take part in this successful and valuable mechanism of “giving-and-taking” to everybody’s benefit
Reusing analyses

Reproducible research data analysis platform

Flexible  Scalable  Reusable  Free

http://www.reana.io/
Medical Applications

• Aligned with the CERN knowledge transfer strategy for the benefit of medical applications established in 2017
  • Centred around the three main areas of Accelerators Technology, Imaging/Sensors, and Computing
• Three main areas of interest
  • Biological simulation: using ongoing research on code modernization and new ML/DL algorithms, possible links with expertise on radio/hadron-therapy
  • Medical image analysis, connectome studies, genotype/phenotype mapping: using ML/DL algorithms being developed for simulation and track reconstruction, new techniques for training models with scarce data, DNN back-tracing and interpretation
  • System Biology: large-scale data analysis to find correlation across different medical domains and very heterogeneous datasets, using experience on large-scale distributed systems and ML/DL
Societal Applications

Counting shelters in refugee camps

Scan million pixels satellite photos for disaster relief:
  - Evolution of refugee camps
  - Natural disasters
  - Buildings damage
High precision is required (> 95%)
  - UN decisions depend on this data
Manual scan
SMART PLATFORMS, IOT, NLP

Understand the potential and impact of technologies such as Internet of Things, fast wireless/mobile communication (5G), large-scale DA/ML, NLP and chatbots.

Raise awareness among the community by collecting and aggregating interests and setting up PoC projects.

Currently investigating applications for mobility, smart environments, and human-system interfaces.

Possible applications in control systems, environmental control, self-help and diagnostics engines, knowledge discovery.
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