

IS3R 2023

Berlin/Germany

August 24–26, 2023

**Artificial
Intelligence**

Are

**algorithms
sufficiently
robust?**

**How close are
continuous
learning
solutions?**

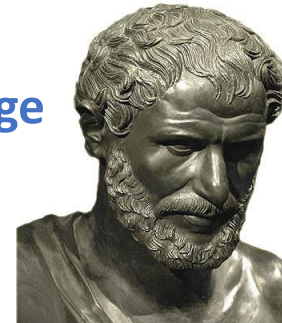
Disclosures Luis Marti-Bonmati

- Director of **Medical Imaging Department and Biomedical Imaging Research Group** at University and Polytechnic Hospital La Fe and Health Research Institute, Valencia, Spain.
- Member of **Scientific Advisory Boards** of Quibim SL, the Girona Biomedical Research Institute (IDIBGI), and the Institute of Instrumentation for Molecular Imaging (CSIC-UPV).
- Editor in Chief of **Insights Into Imaging**.

- **Images:** vendors, models, updates, acquisition protocols (technical parameters, new images), patient source of variation (heart rate, glucose level, movement, body constitution, weight), processing (denoising), annotations (intra/interobserver detection and segmentation biases).
- **Clinical:** diseases (MAFLD) and classification systems (TNM versions).
- **Ground Truth:** units and thresholds (140 to 126 mg/dl glucose), pathology (observer, criteria, molecular diagnosis).
- **All AI algorithm performance degrades over time:** naturally occurring changes in local data, environment and targets.

Heraclitus of Ephesus: the only permanent thing is change

Pianykh OS, Langs G, Dewey M, Enzmann DR, Herold CJ, Schoenberg SO, Brink JA (IS3R). Continuous Learning AI in Radiology: Implementation Principles and Early Applications. Radiology. 2020;297:6-14.



FAIRNESS:

UNIVERSALITY:

TRACEABILITY:

USABILITY:



ROBUSTNESS:

EXPLAINABILITY:

Equitable; Bias controlled

Use of standards; Actionable

Documentation; Monitoring; Code accessibility

Acceptability; Deployable; RWD Performance

Replication & Reproducibility (independent RWD)

Meaningful



FUTURE^{AI}

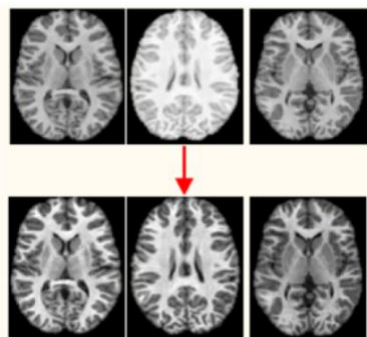
<https://future-ai.eu/>



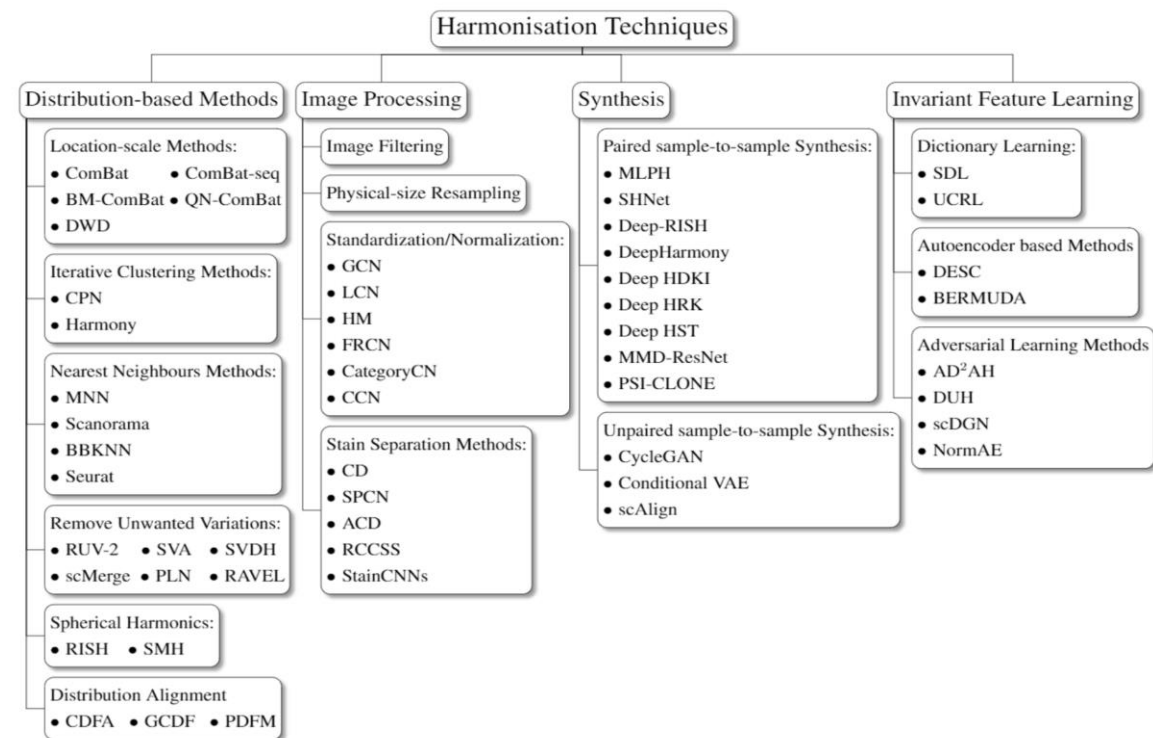
↓ **Efficacy-Effectiveness Gap**

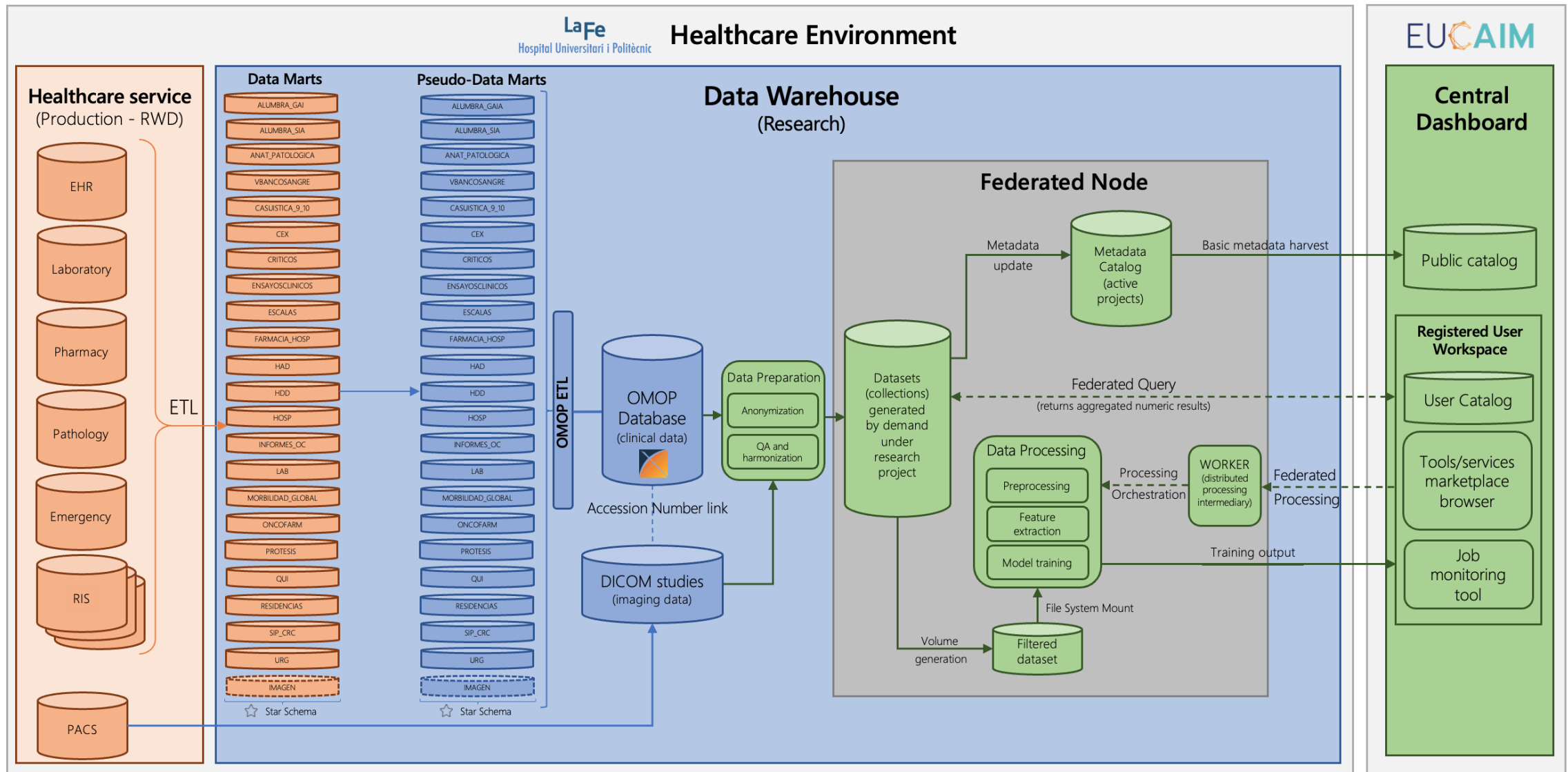
- Ability of an AI tool to maintain its performance and accuracy, under expected or unexpected variations in the input data.
- Ability to maximize the out-of-sample generalizability.
- Harmonizing datasets – images.
- Continuous training on new data.

Nan Y et al. Data harmonisation for information fusion in digital healthcare: A state-of-the-art systematic review, meta-analysis and future research directions. *Inf Fusion*. 2022;82:99-122.

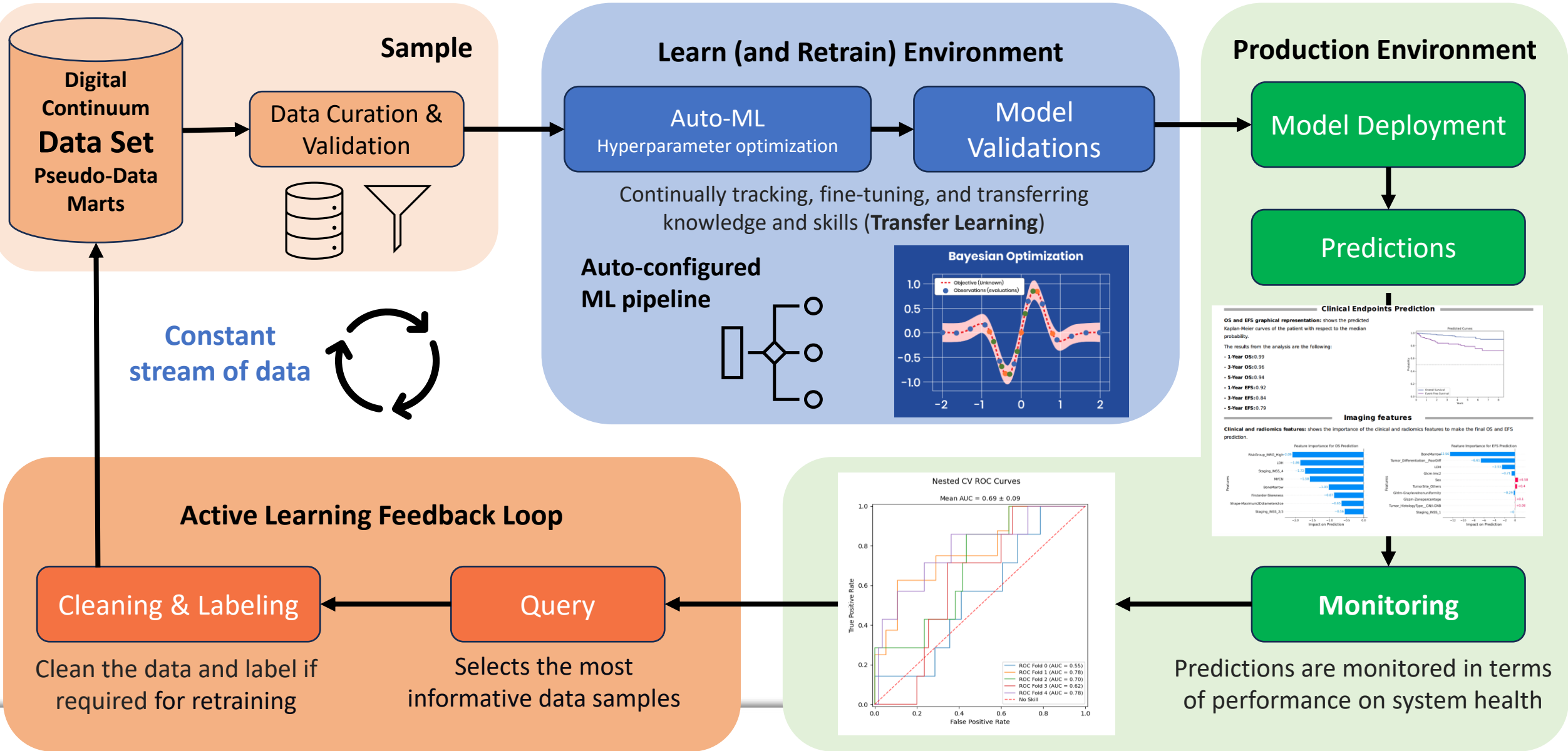


CHAI MELEON Project – GA: 952172





Continual-Active Learning (NB OS)



- A hurdle of continual learning solutions is catastrophic forgetting.
- Limitations for regulatory clearance and implementation as a Medical Device.
- **Catastrophic Forgetting:** “Phenomenon where AI systems lose information from previous tasks while learning new ones.”
- Dissimilar tasks should be taught early in the continual learning process, but rarely happens. Multitask dynamic models with versatile cognitive abilities improves the ability to subsequently learn more similar tasks down the line.
- Recent solutions:

Vladymyrov M, Zhmoginov A, Sandler M.
Continual Few-Shot Learning Using HyperTransformers.
2023 arXiv:2301.04584v2

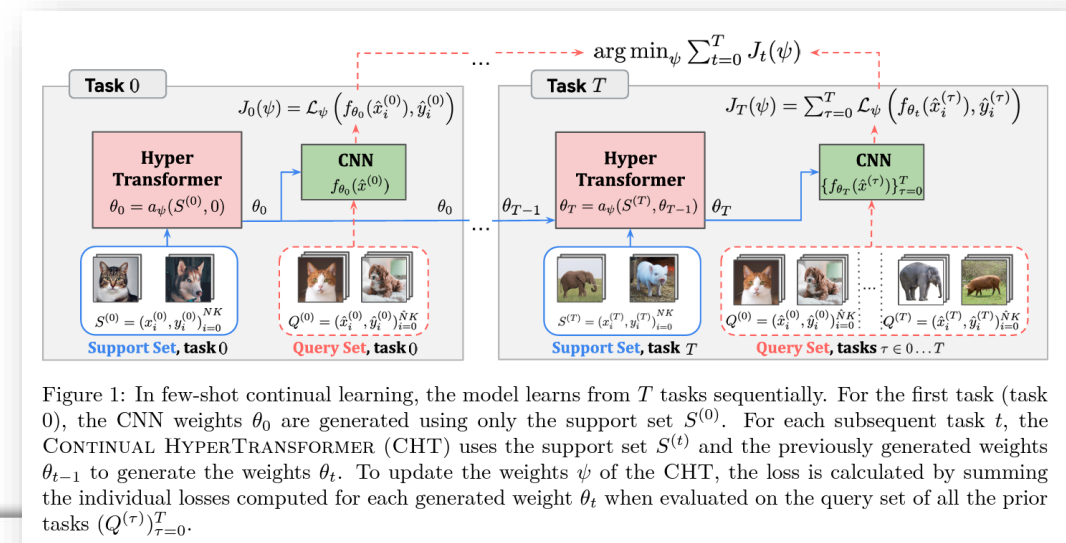
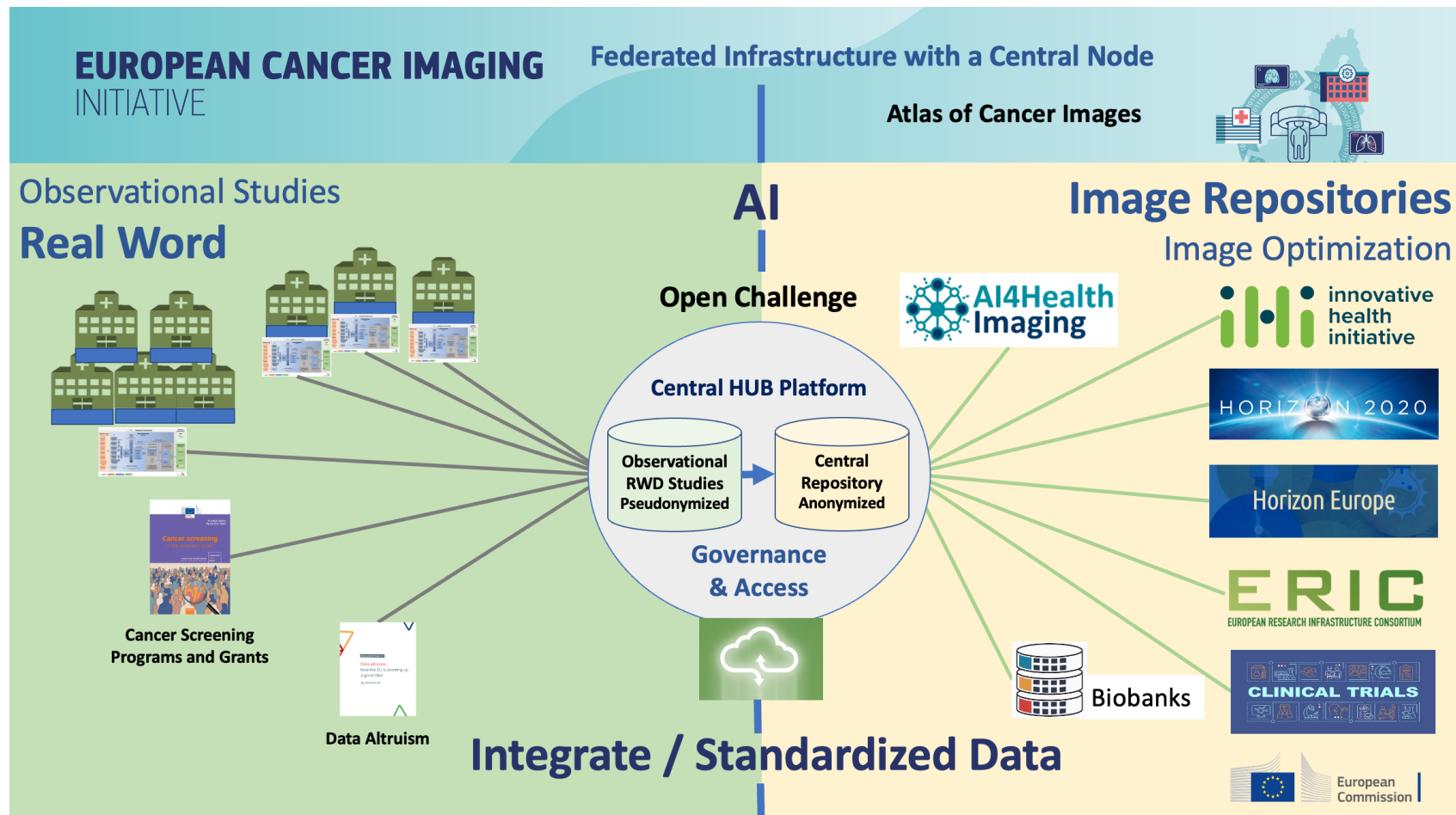


Figure 1: In few-shot continual learning, the model learns from T tasks sequentially. For the first task (task 0), the CNN weights θ_0 are generated using only the support set $S^{(0)}$. For each subsequent task t , the CONTINUAL HYPERTRANSFORMER (CHT) uses the support set $S^{(t)}$ and the previously generated weights θ_{t-1} to generate the weights θ_t . To update the weights ψ of the CHT, the loss is calculated by summing the individual losses computed for each generated weight θ_t when evaluated on the query set of all the prior tasks $(Q^{(\tau)})_{\tau=0}^T$.

- Robust AI models should be periodically trained and retrained with new data (either local or decentralized from numerous sites) on dynamically evolving and diverse population samples.
- Role for the **EUCAIM** Infrastructure.





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