AI and Computational Modelling

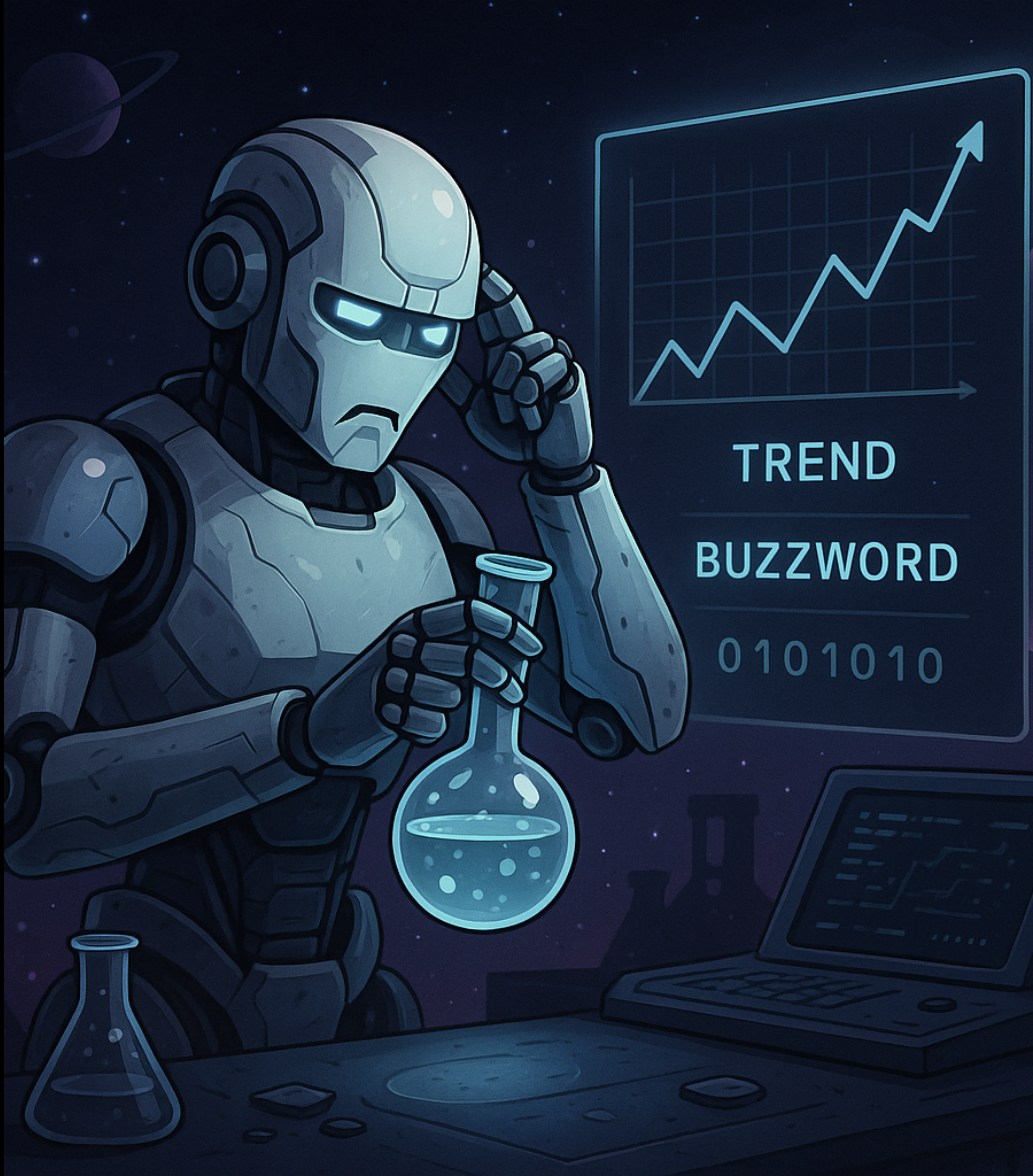
Their Impact on Research

Prof. Frédéric LE MOUËL - INSA Lyon
Puentes en La Ciencia
02/10/2025 - Buccaramanga, Colombia

EL-BONGÓ physics
Co-funded by the European Union

AI - a trend or a buzzword ?

(5s for attention)



Prof. Frédéric Le Mouël

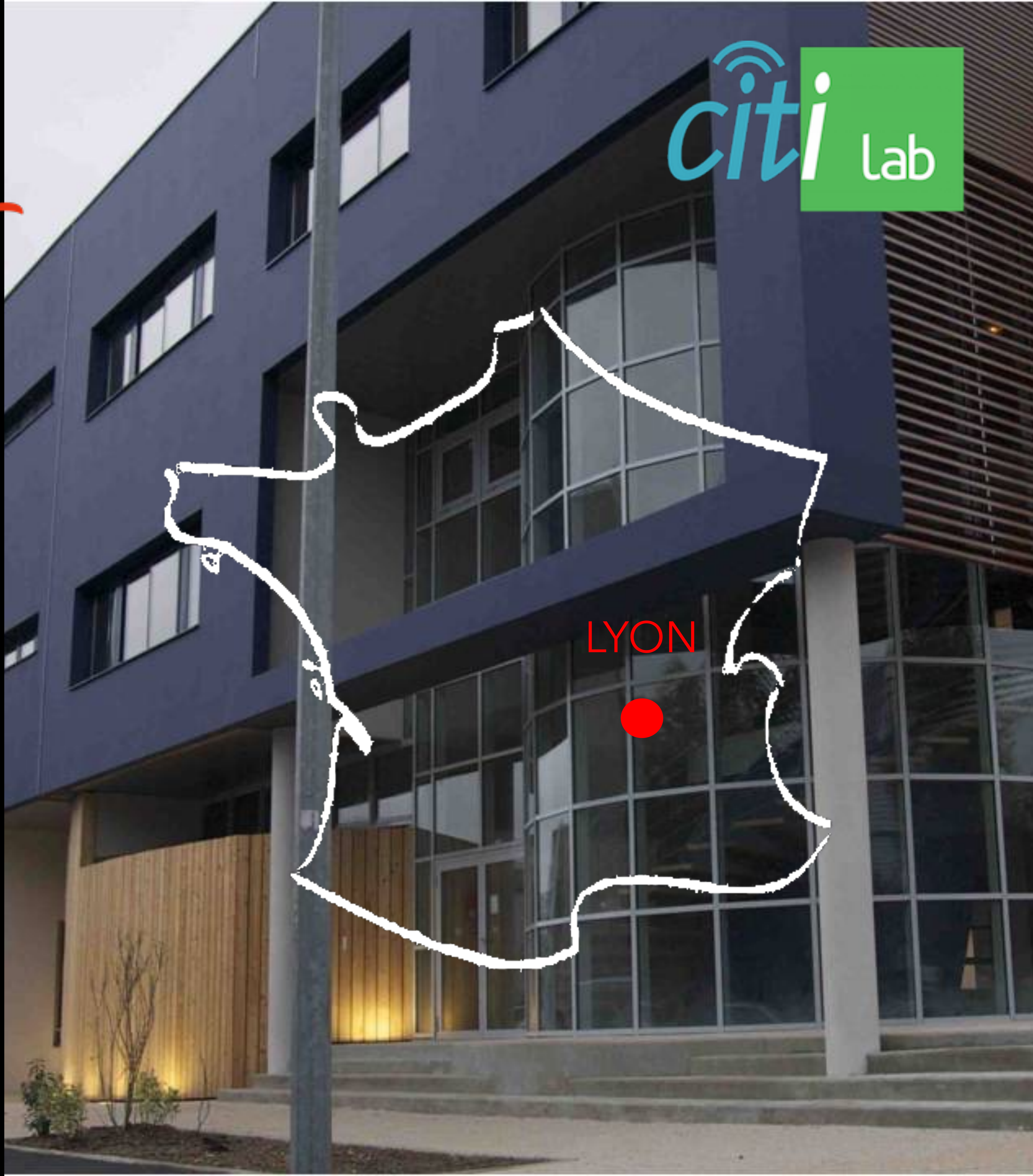
INSA Lyon

- Head of CITI Lab
- Topics: Distributed Systems, Middleware/OS, Edge/Fog Computing, Mobile Networks, Internet of Things, Embedded AI
- INSA / SPIE ICS Chair on Edge AI: Data-flow Infrastructures
- http://perso.citi.insa-lyon.fr/flemouel

CITI Lab

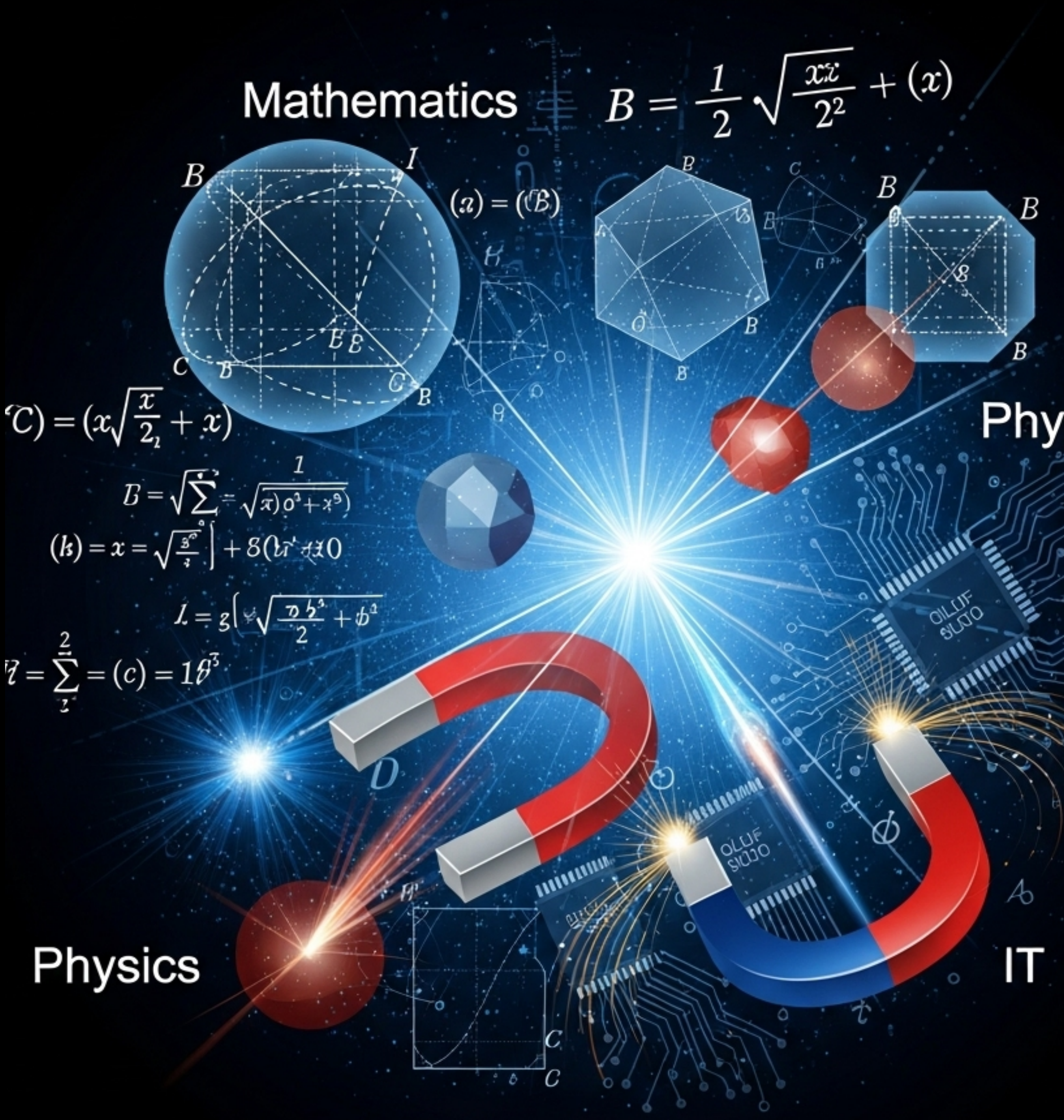
Telecommunication Dpt

- Topics: Radiocommunications, Networks, Embedded and Distributed Systems, Robotics, Security and Privacy
- ~150 members (~40 prof/researchers, ~20 engineers, ~50 PhD students, ~20 postdocs, ~10 staff) in 10 teams
- 11M€ budget (2019-2029), 5.3M€ budget 2025 (4% Europe, 42% France, 20% PEPR, 31% industry)
- https://www.citi-lab.fr/



Agenda

- Artificial Intelligence: Definition, Classes
- Computational Modelling: Definition, Classes
- Convergence of AI & CM in EL BONGO Physics
- Impacts on Research Methodologies: Challenges and Limitations
- Impacts on Research Platforms: HPCs Evolution, SLICES
- Future Works: Trends in AI & CM, Collaborations in EL BONGO Physics



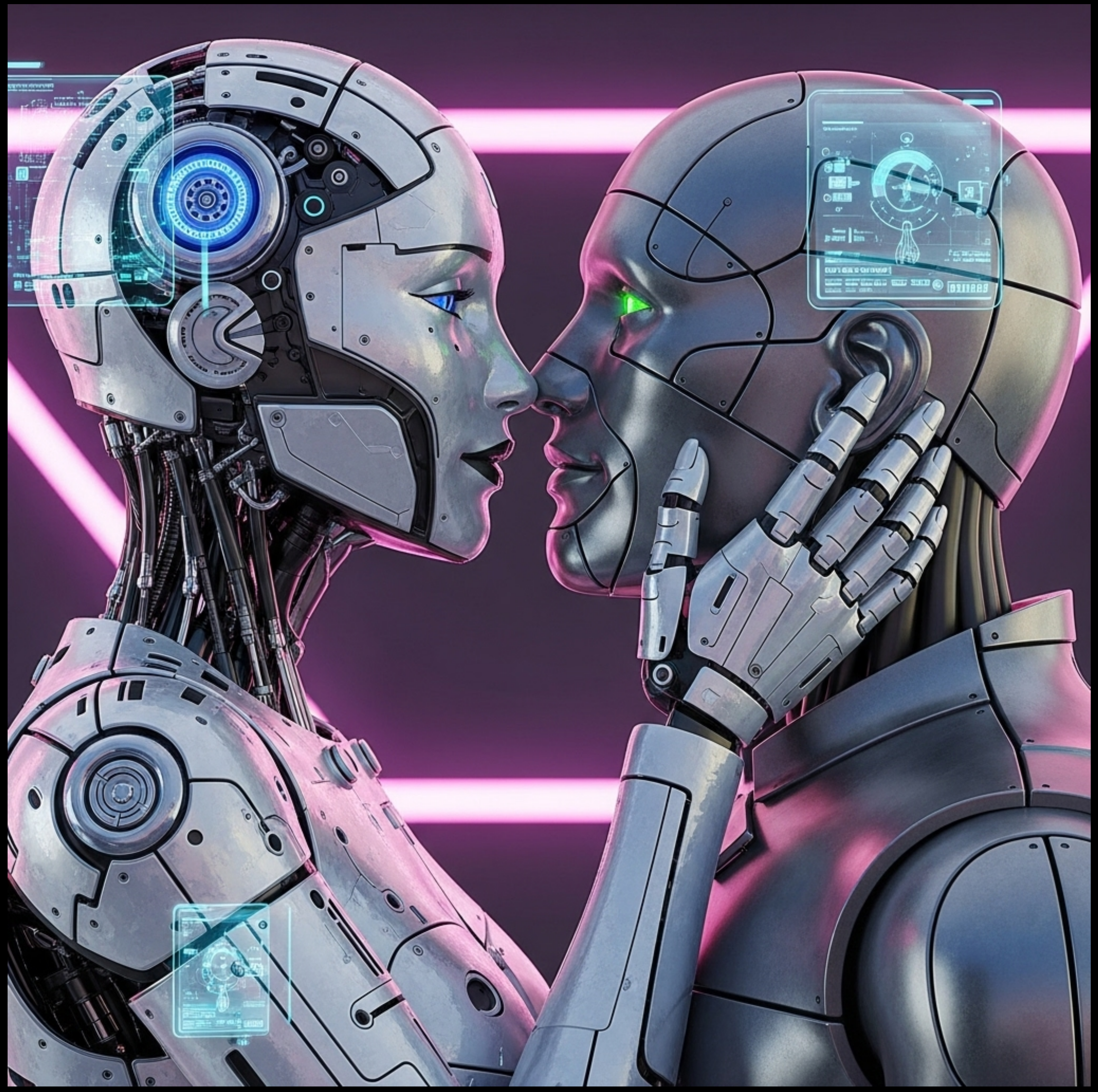
Artificial Intelligence

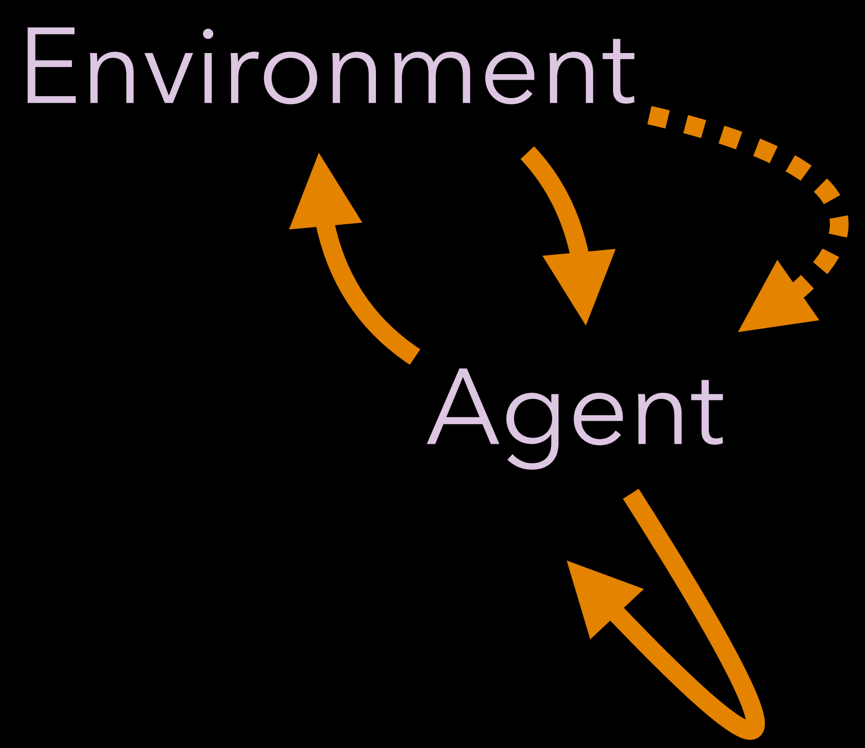
Artificial Intelligence

Definition

- « Artificial intelligence (AI) is the capability of computational systems to perform tasks typically associated with human intelligence, such as
  - Perception
  - Reasoning
  - Learning
  - Problem-solving
  - Decision-making […] »

https://en.wikipedia.org/wiki/Artificial_intelligence

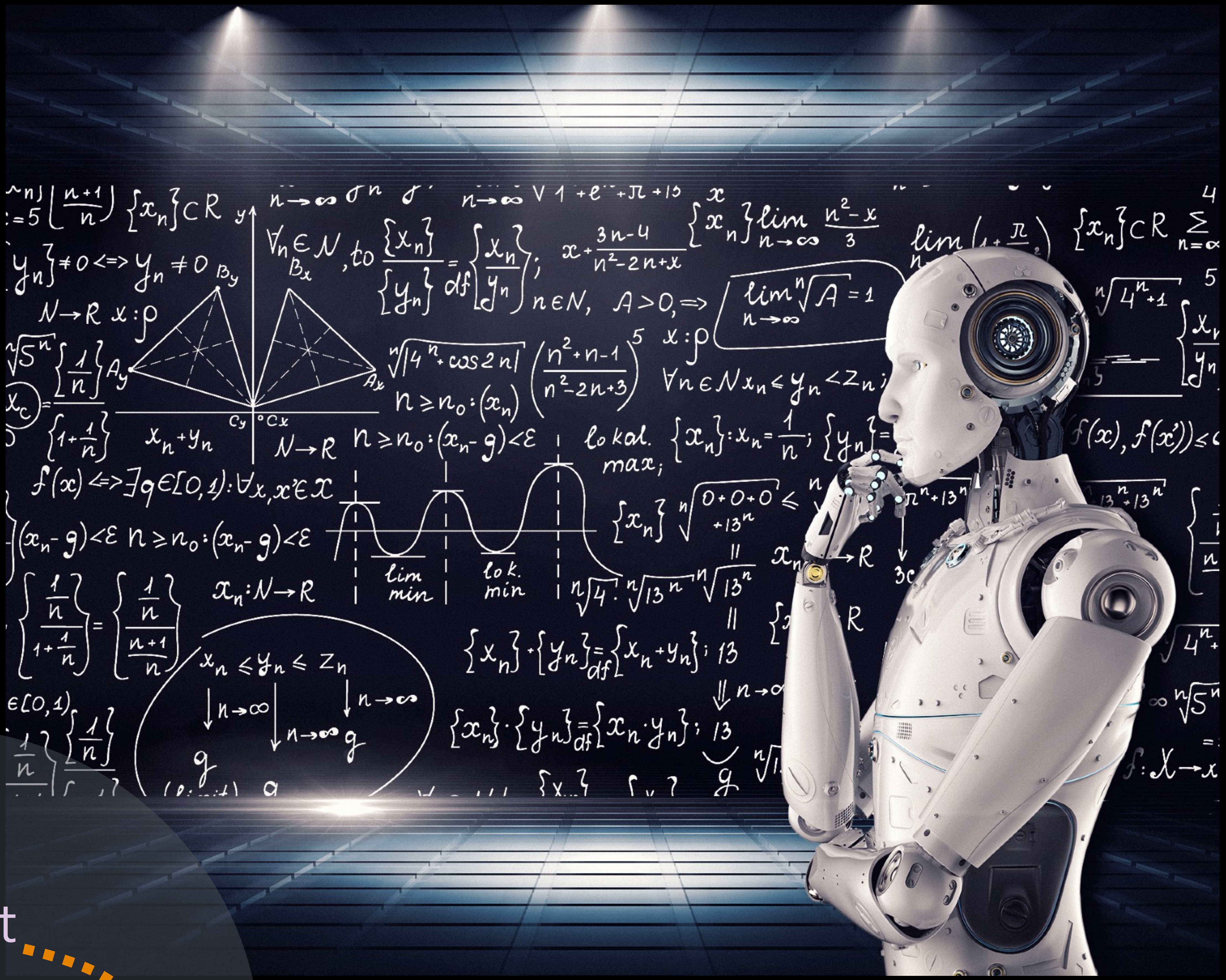




Artificial Intelligence

Definition

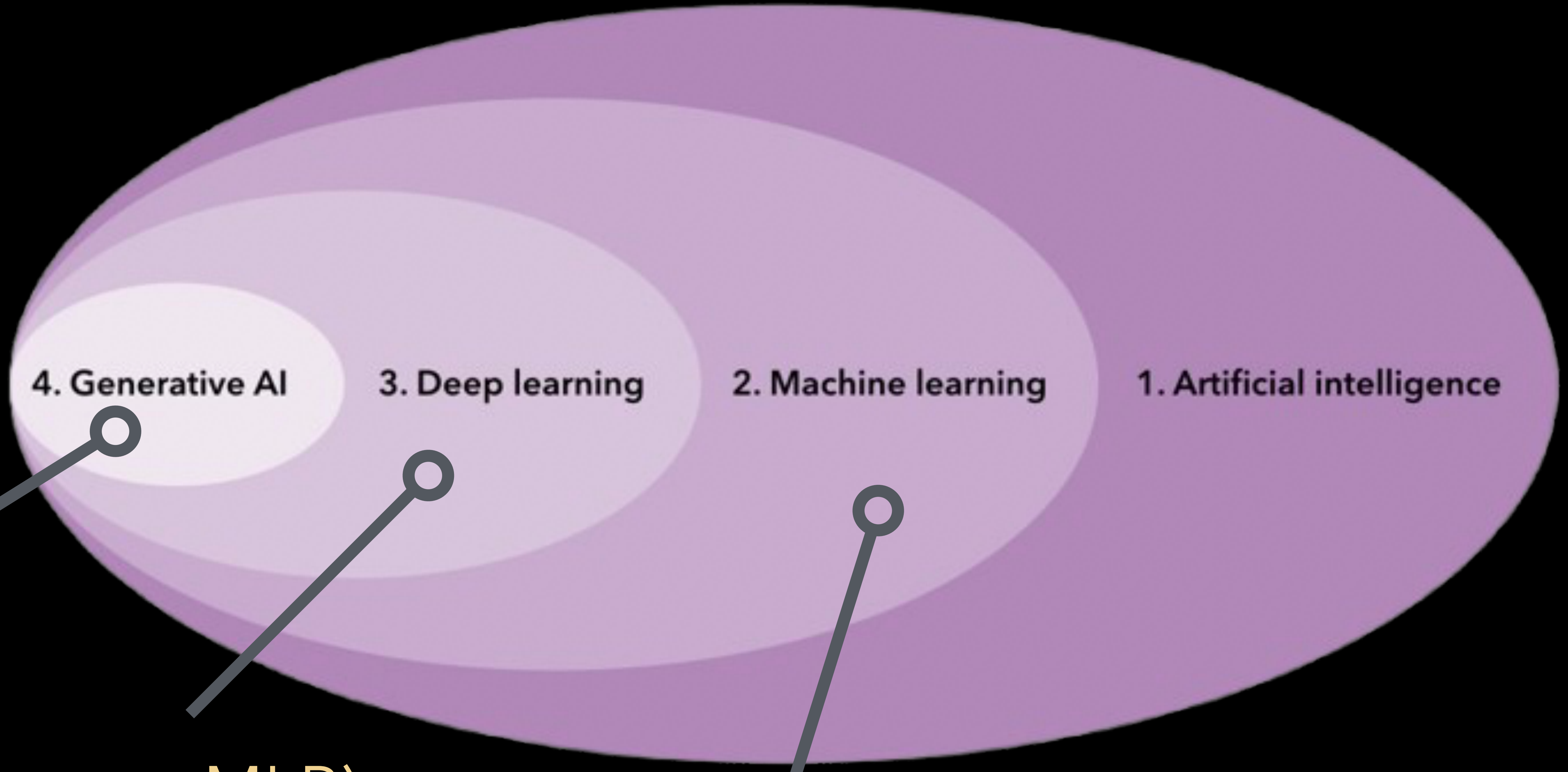
- « […] It is a field of research in computer science that develops and studies methods and software that enable machines to perceive their environment and use learning and intelligence to take actions that maximize their chances of achieving defined goals. »



Russell, Stuart J.; Norvig, Peter (2021). Artificial Intelligence: A Modern Approach (4th ed.). Hoboken: Pearson. ISBN 978-0-1346-1099-3. LCCN 20190474

Artificial Intelligence

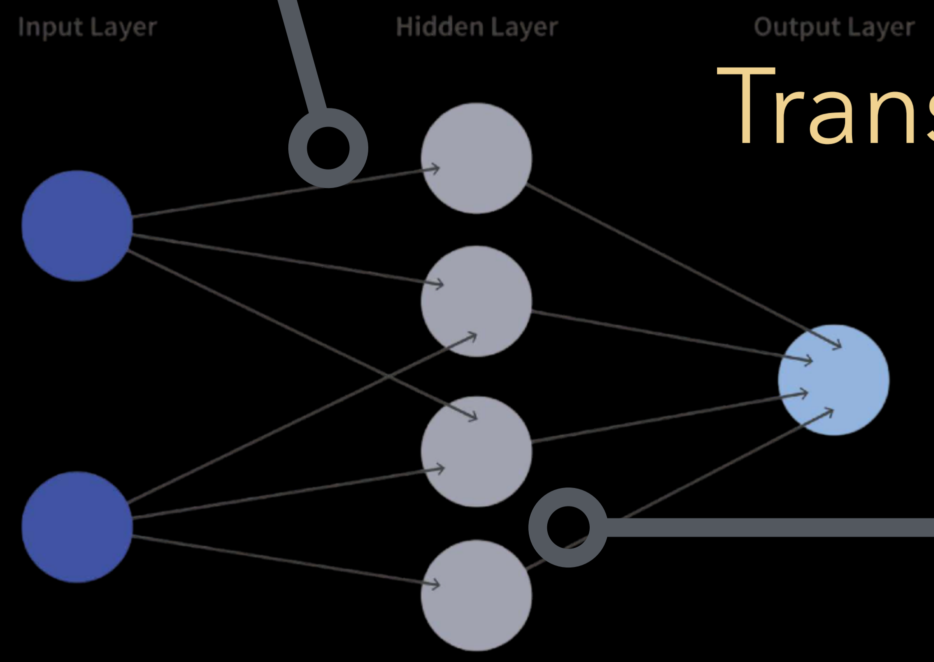
Taxonomy - Hierarchy



Transformers (self-attention), Diffusion (Autoencoders+U-net+attention), GAN

Layers ?

Neural Networks: FFNN (Perceptron, MLP), RNN (GRU, LSTM), CNN, Autoencoders, Transformers (CNN+attention)



Transition Function ?

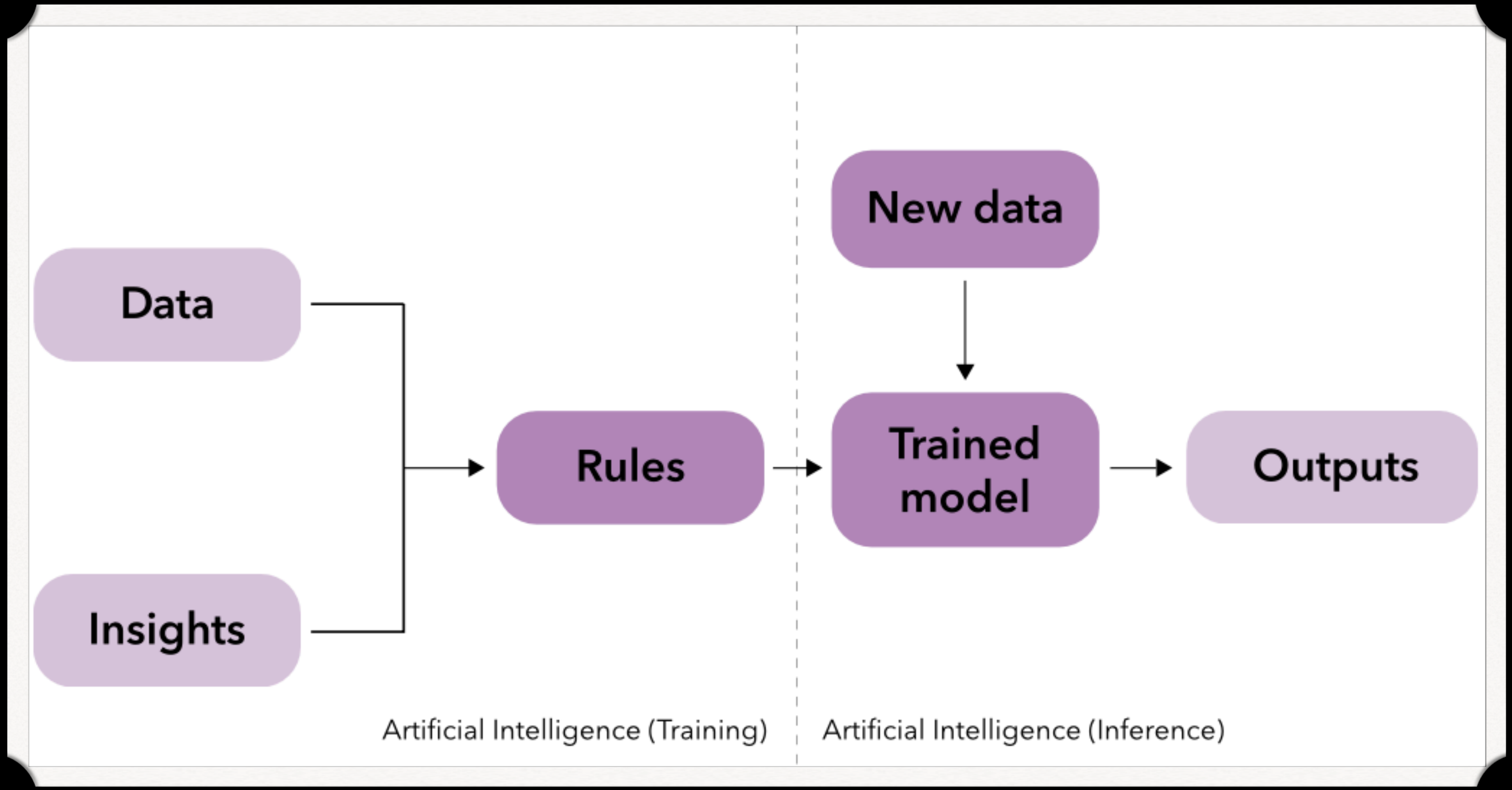
Decision Tree, Random Forests, SVM, clustering (kmeans, KNN, DBSCAN), Bayesian, regression, XGBoost/LightGBM

https://www.icaew.com/insights/viewpoints-on-the-news/2024/nov-2024/types-of-ai-how-are-they-classified

Artificial Intelligence

Taxonomy - Methods

Supervised Learning

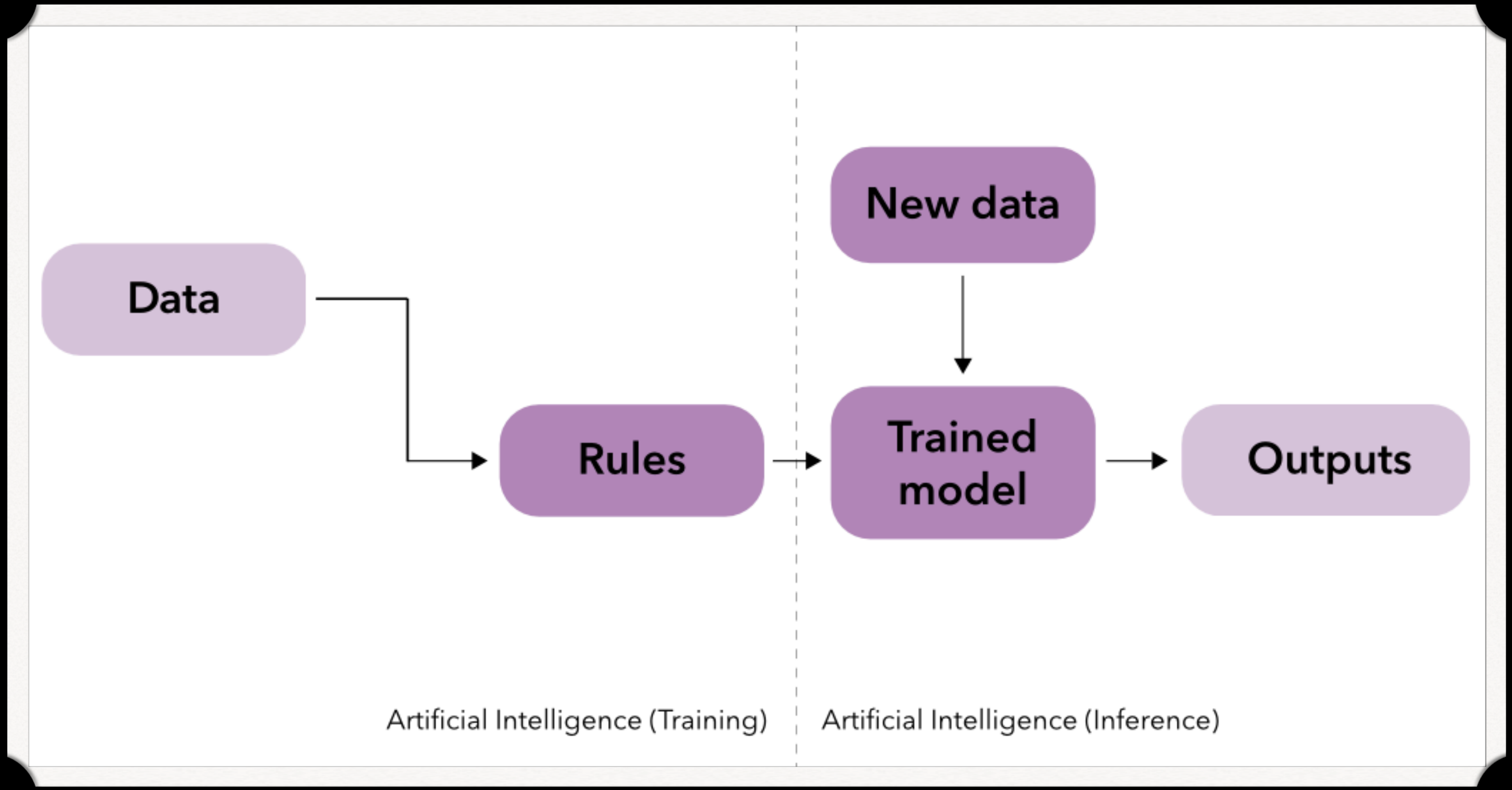


https://www.icaew.com/insights/viewpoints-on-the-news/2024/nov-2024/types-of-ai-how-are-they-classified

Artificial Intelligence

Taxonomy - Methods

Unsupervised Learning



https://www.icaew.com/insights/viewpoints-on-the-news/2024/nov-2024/types-of-ai-how-are-they-classified

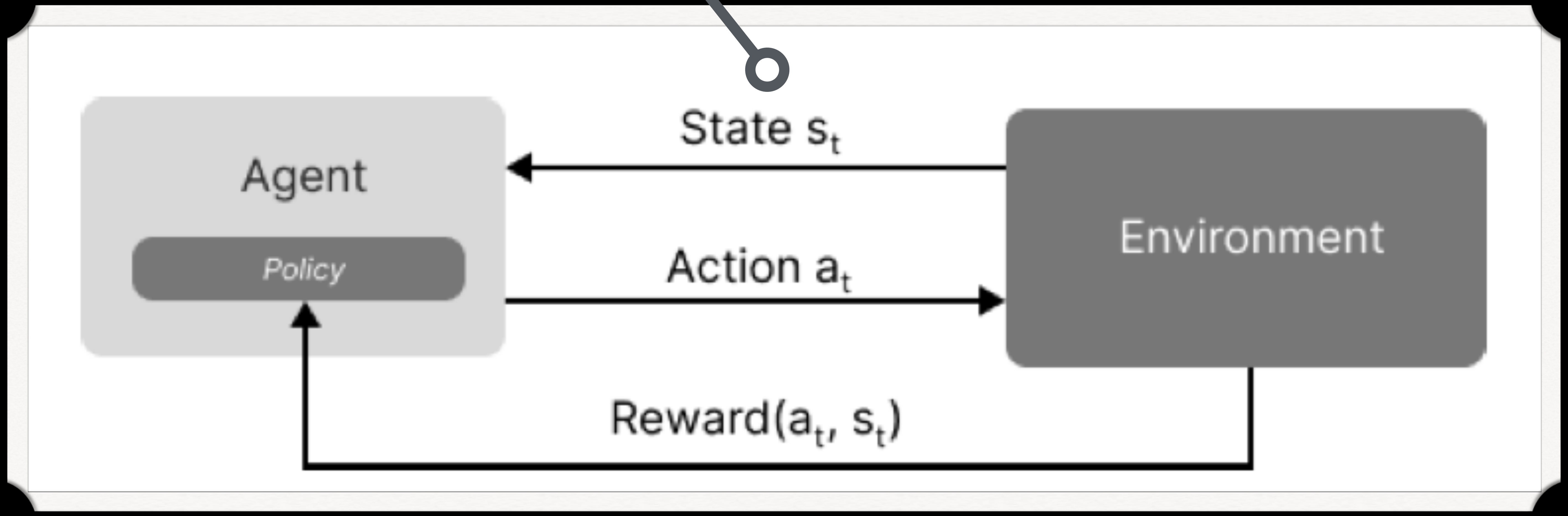
Artificial Intelligence

Taxonomy - Methods

Reinforcement Learning

(Could be super-, semi- or unsupervised)

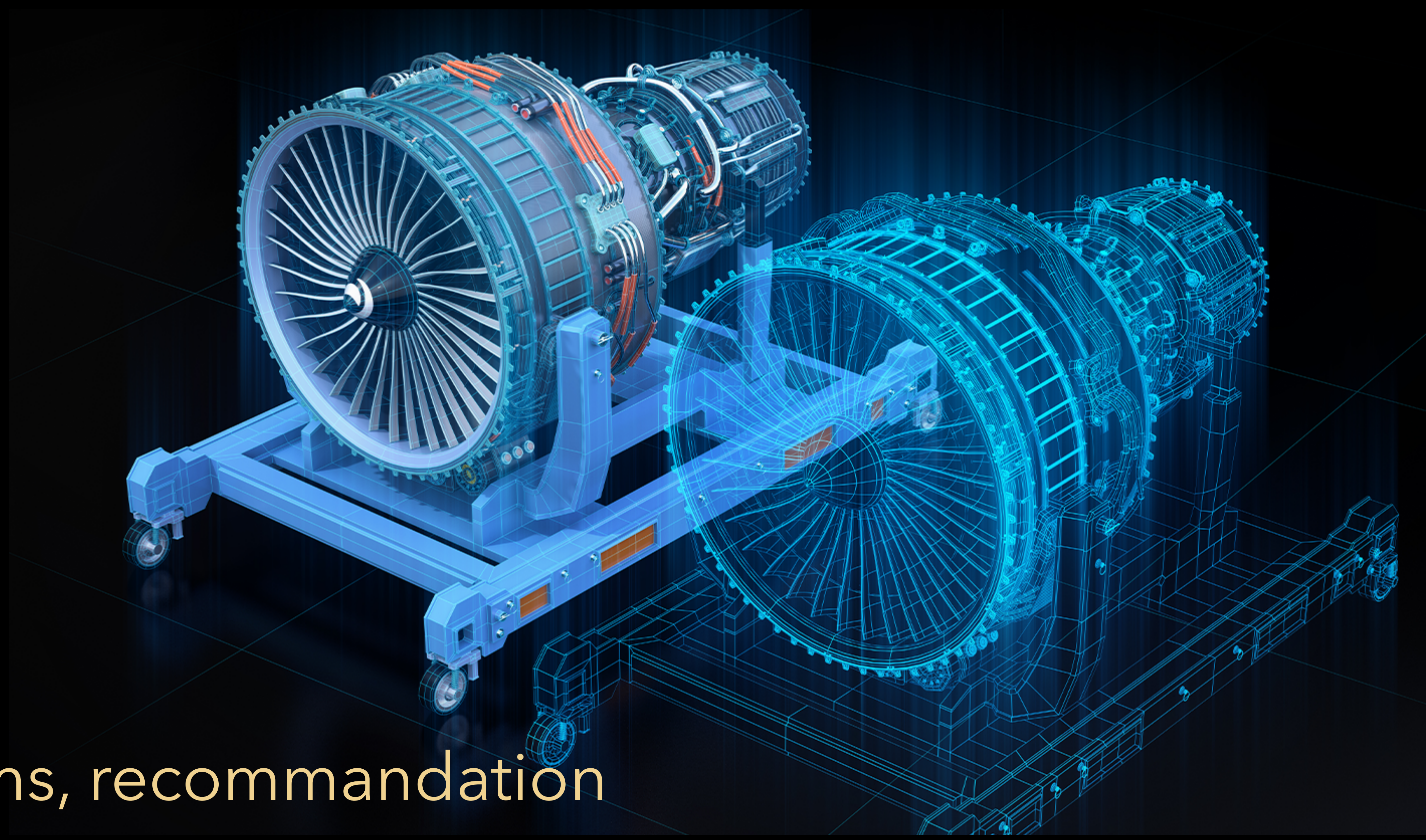
Good output ?



B. Saghrouchni, F. Le Mouël and B. Szanto, "Towards an Unsupervised Reward Function for a Deep Reinforcement Learning Based Intrusion Detection System," 2024 8th Cyber Security in Networking Conference (CSNet), Paris, France, 2024, pp. 157-160, doi: 10.1109/CSNet64211.2024.10851732

Artificial Intelligence

Taxonomy - Usecases



- The environment to tackle can be:
  - To predict: forecasting, time series, regression algorithms, recommandation systems, Natural Language Processing (NLP - next token)
  - To simulate/optimize: digital twins, evolutionary algorithms, synthetic data generation/augmentation
  - To sort: classification, clustering, anomaly detection, ranking
  - To pattern: image recognition, computer vision, audio/video processing, NLP (sentiment analysis, part-of-speech tagging, named entity recognition, toxicity detection)
  - To interact: conversational agents/chatbots, code generation, agentic orchestration, VR
  - To act: robotics (drones), games, autonomic vehicles

Computational Modelling

Computational Modelling

Definition

- « A computational model uses computer programs to simulate and study complex systems using an algorithmic or mechanistic approach […] »

https://en.wikipedia.org/wiki/Computational_model

Physical World

Model

Kurma (Vishnu incarnation) wearing the world - modelled by ChatGPT

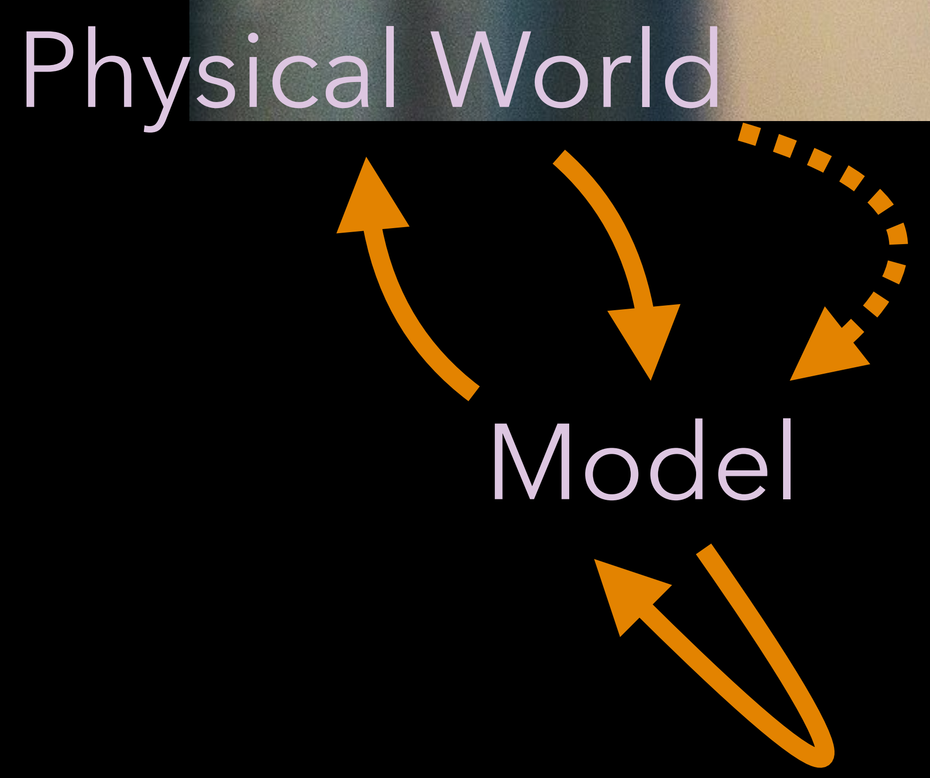
"And what does the turtle stand on?" "You're very clever, young man, but it's turtles all the way down!"

Computational Modelling

Definition

- « […] The system under study is often a complex nonlinear system for which simple, intuitive analytical solutions are not readily available. Rather than deriving a mathematical analytical solution to the problem, experimentation with the model is done by adjusting the parameters of the system in the computer, and studying the differences in the outcome of the experiments. Operation theories of the model can be derived/deduced from these computational experiments. »

https://en.wikipedia.org/wiki/Computational_model



Turbopump Modeling Software Propels Fluid-Flow Simulations
https://www.techbriefs.com/component/content/article/36558-turbopump-modeling-software-propels-fluid-flow-simulations

Computational Modelling

Taxonomy - Methods

- Deterministic Models
  - Analytical models (e.g., ODEs, PDEs, algebraic systems)
  - Optimization models (e.g., linear/nonlinear programming)
  - Discrete models (e.g., cellular automata, discrete-event simulation)
- Stochastic / Probabilistic Models
  - Monte Carlo simulations
  - Markov processes (e.g., Markov chains, HMMs)
  - Random population processes
- Agent-Based Models (ABMs)
  - Rule-based agents
  - Cognitive agents (decision-making, adaptive behaviors)
  - Hybrid ABM–PDE or ABM–statistical models
- Hybrid / Multi-Scale Models
  - Coupled micro/meso/macro-level systems
  - Mixed discrete–continuous formulations
  - Equation-free models / closure approximations
- Emulation Models
  - Surrogate models for high-cost simulations (e.g., kriging, Gaussian processes)
  - Dimension reduction (e.g., PCA, autoencoders)

Von Rüden, L., et al. (2021). Informed Machine Learning – A Taxonomy and Survey of Integrating Knowledge into Learning Systems. Artificial Intelligence, 296, 103504. https://arxiv.org/abs/1903.12394

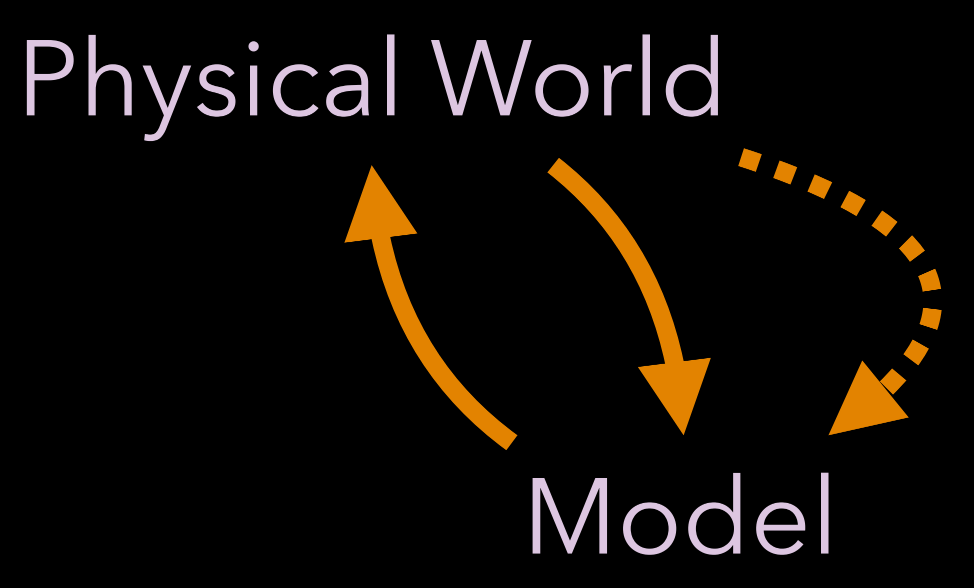
Kulikov, G., et al. (2021). Multiscale modeling: A survey of major computational approaches. Journal of Computational and Applied Mathematics, 392, 113493. https://doi.org/10.1016/j.cam.2021.113493

Convergence of AI & CM in EL BONGO Physics

Convergence of AI & CM

EL BONGO Physics

- « A computational model [...] is widely used in a diverse range of fields spanning from physics, engineering, chemistry and biology to economics, psychology, cognitive science and computer science. »

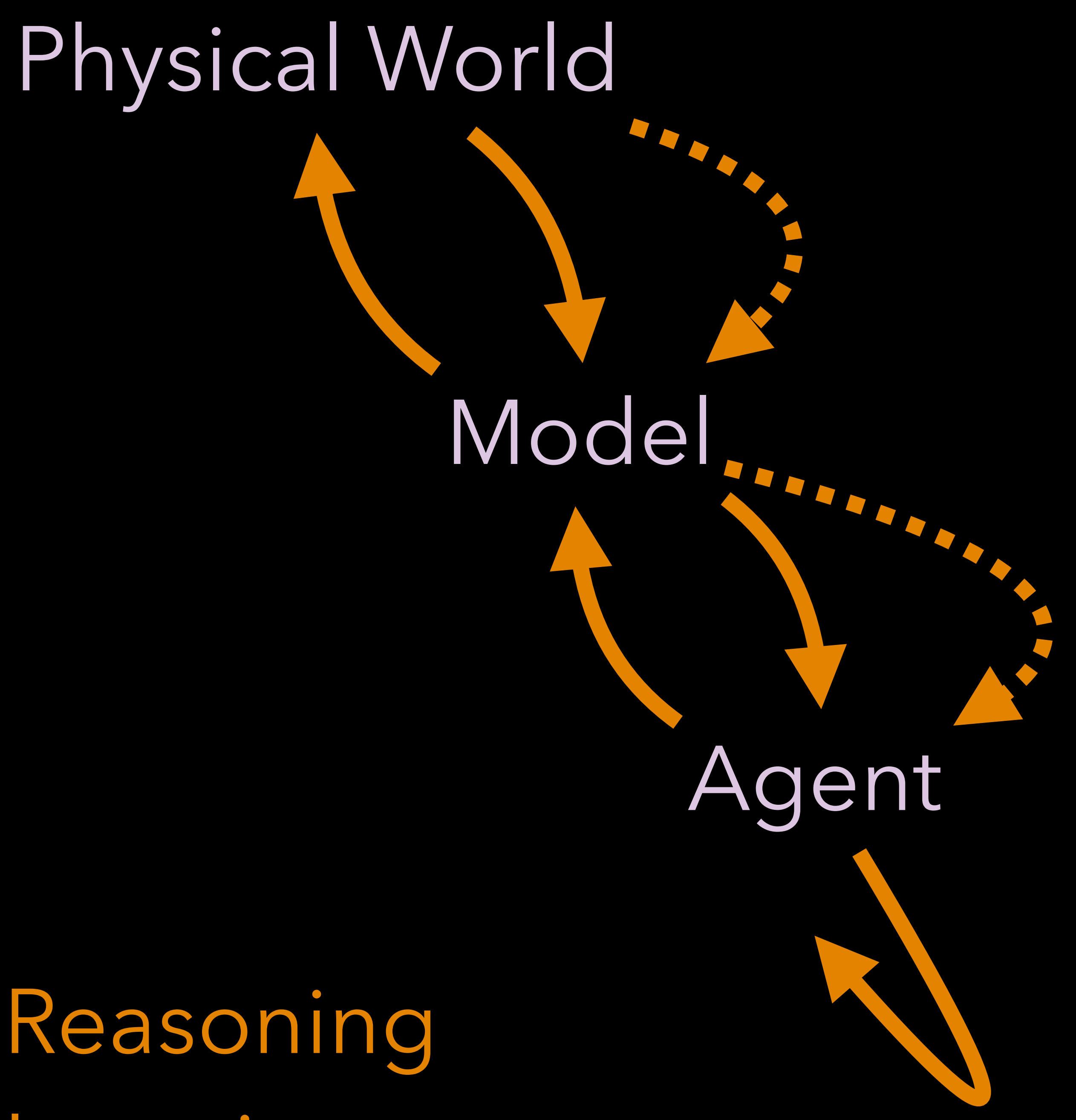


https://en.wikipedia.org/wiki/Computational_model

Convergence of AI & CM

EL BONGO Physics

- « A computational model […] is widely used in a diverse range of fields spanning from physics, engineering, chemistry and biology to economics, psychology, cognitive science and computer science. »



- Reasoning
- Learning
- Problem-solving

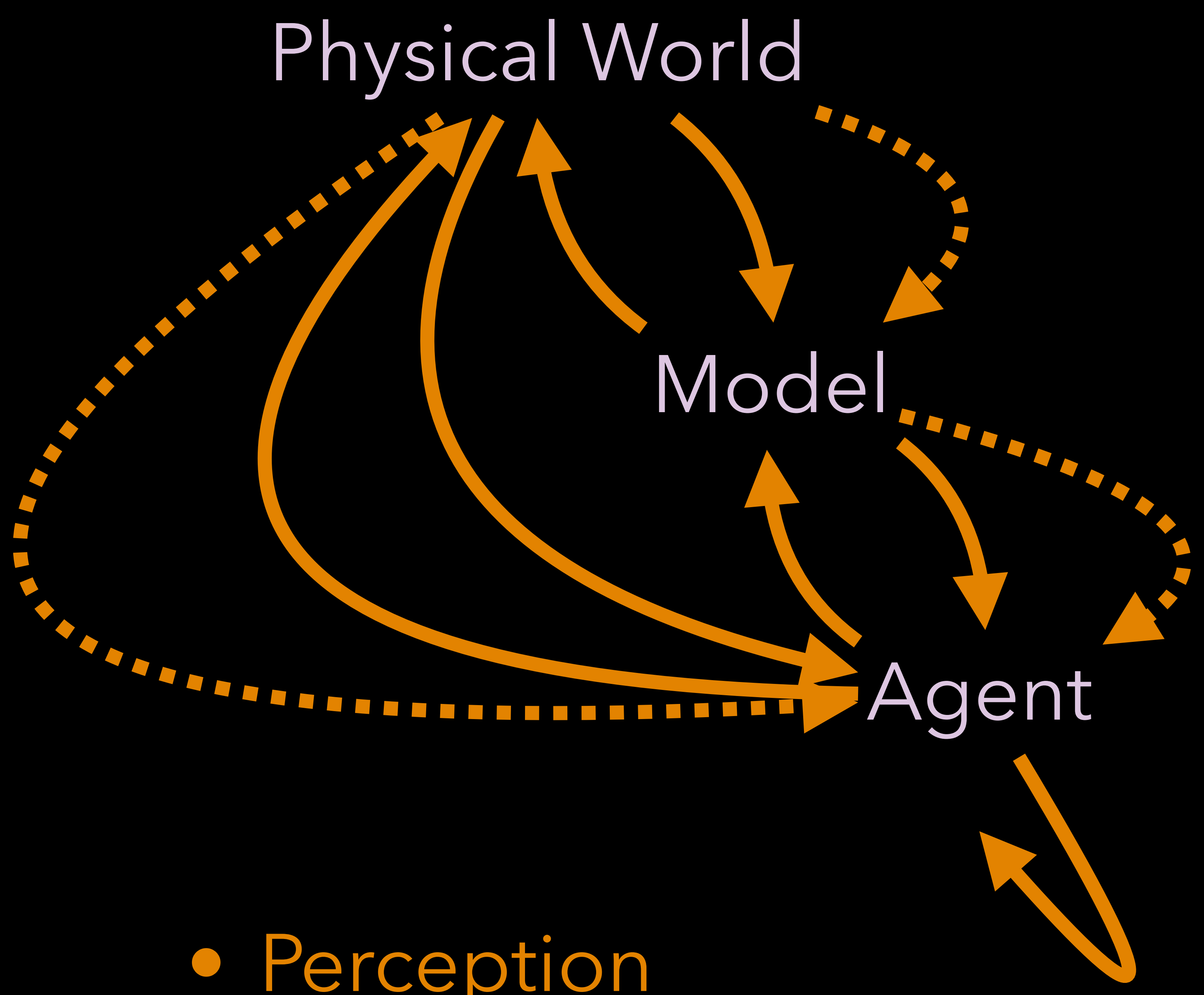
To better modelling / predicting

https://en.wikipedia.org/wiki/Computational_model

Convergence of AI & CM

EL BONGO Physics

- « A computational model [...] is widely used in a diverse range of fields spanning from physics, engineering, chemistry and biology to economics, psychology, cognitive science and computer science. »



- Perception
- Decision-making

To better experimenting / deploying / monitoring

https://en.wikipedia.org/wiki/Computational_model

Impacts on Research Methodologies

Impacts on Research Methodologies

From Hypothesis-driven to Data-driven Approaches: Benefits

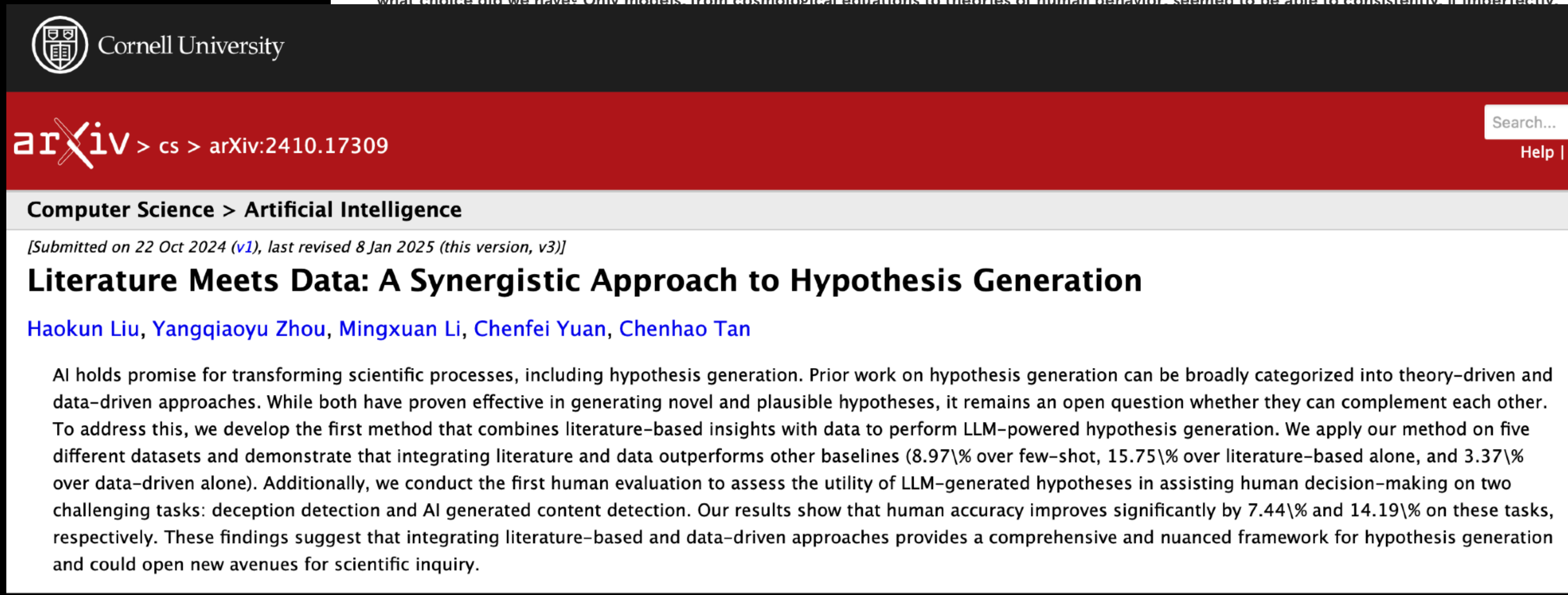
- Big Data
- Automation of Simulation & Analysis
- Massive Reproduction & Reproducibility
- Examples : AI Model Parameters Self-tuning, AI-generated Hypothesis

WIRED SECURITY POLITICS THE BIG STORY BUSINESS SCIENCE CULTURE REVIEWS NEWSLETTERS

CHRIS ANDERSON SCIENCE JUN 23, 2008 12:00 PM

The End of Theory: The Data Deluge Makes the Scientific Method Obsolete

Illustration: Marian Bantjes "All models are wrong, but some are useful." So proclaimed statistician George Box 30 years ago, and he was right. But what choice did we have? Only models, from cosmological equations to theories of human behavior, seemed to be able to consistently, if imperfectly



Cornell University

arXiv > cs > arXiv:2410.17309

Search...

Help |

Computer Science > Artificial Intelligence

[Submitted on 22 Oct 2024 (v1), last revised 8 Jan 2025 (this version, v3)]

Literature Meets Data: A Synergistic Approach to Hypothesis Generation

Haokun Liu, Yangqiaoyu Zhou, Mingxuan Li, Chenfei Yuan, Chenhao Tan

AI holds promise for transforming scientific processes, including hypothesis generation. Prior work on hypothesis generation can be broadly categorized into theory-driven and data-driven approaches. While both have proven effective in generating novel and plausible hypotheses, it remains an open question whether they can complement each other. To address this, we develop the first method that combines literature-based insights with data to perform LLM-powered hypothesis generation. We apply our method on five different datasets and demonstrate that integrating literature and data outperforms other baselines (8.97\% over few-shot, 15.75\% over literature-based alone, and 3.37\% over data-driven alone). Additionally, we conduct the first human evaluation to assess the utility of LLM-generated hypotheses in assisting human decision-making on two challenging tasks: deception detection and AI generated content detection. Our results show that human accuracy improves significantly by 7.44\% and 14.19\% on these tasks, respectively. These findings suggest that integrating literature-based and data-driven approaches provides a comprehensive and nuanced framework for hypothesis generation and could open new avenues for scientific inquiry.

The End of Theory […], Wired 2008 https://www.wired.com/2008/06/pb-theory/
Could Big Data be the end of theory in science? EMBO Rep. 2015 Sep 10;16(10):1250–1255. doi: 10.15252/embr.201541001 https://pmc.ncbi.nlm.nih.gov/articles/PMC4766450/
Literature Meets Data: A Synergistic Approach to Hypothesis Generation, arXiv:2410.17309, 22 Oct 2024 (v1), last revised 8 Jan 2025 https://arxiv.org/abs/2410.17309

Impacts on Research Methodologies

From Hypothesis-driven to Data-driven Approaches: Limitations

- Black-box Nature of AI Models
- Data Bias and Representativity
- Computational Costs
- Ethical and Reproducibility Concerns

> Big Data. 2017 Jun;5(2):153-163. doi: 10.1089/big.2016.0047.

Fair Prediction with Disparate Impact: A Study of Bias in Recidivism Prediction Instruments

Alexandra Chouldechova [1]

Affiliations + expand

PMID: 28632438 DOI: 10.1089/big.2016.0047

Home > ACM Journals > ACM Computing Surveys > Vol. 54, No. 6 > A Survey on Bias and Fairness in Machine Learning

RESEARCH-ARTICLE

A Survey on Bias and Fairness in Machine Learning

Authors: Ninareh Mehrabi, Fred Morstatter, Nripsuta Saxena, Kristina Lerman, Aram Galstyan | Authors Info & Claims

ACM Computing Surveys (CSUR), Volume 54, Issue 6 • Article No.: 115, Pages 1 - 35 • https://doi.org/10.1145/3457607

Published: 13 July 2021 Publication History

Check for updates

Ninareh Mehrabi, Fred Morstatter, Nripsuta Saxena, Kristina Lerman, and Aram Galstyan. 2021. A Survey on Bias and Fairness in Machine Learning. ACM Comput. Surv. 54, 6, Article 115 (July 2022), 35 pages. https://doi.org/10.1145/3457607

Chouldechova A. Fair Prediction with Disparate Impact: A Study of Bias in Recidivism Prediction Instruments. Big Data. 2017 Jun;5(2):153-163. doi: 10.1089/big.2016.0047. PMID: 28632438.

Impact on Research Platforms: High-Performance Computing (HPC) to HPCs

Impacts on Research Platforms

No Platform, No Experiment

- Kate Keahey (Univ. Chicago / Argonne Lab) from Chameleon Project @CARLA_Conf 2025 :
- « Breakthroughs in computer science have allowed us to make science for all »
- « For Better ou Worse, Scientific Instruments Shape a Field »

research highlights

DOI:10.1145/2209249.2209271

Technical Perspective
For Better or Worse, Benchmarks Shape a Field

By David Patterson

LIKE OTHER IT fields, computer architects initially reported incomparable results. We quickly saw the folly of this approach. We then went through a sequence of performance metrics, with each being an improvement on its predecessor: average instruction time, millions of instructions per second (MIPS), millions of floating point operations per second (MEGAFLOPS), synthetic program performance (DHRYSTONES), and ultimately average performance improvement relative to a reference computer based on a suite of real programs (SPEC CPU).

When a field has good benchmarks, we settle debates and the field makes rapid progress. Indeed, the acceleration in computer performance from 25% to 50% per year starting in the mid-1980s is due in part to our ability to fairly compare competing designs as well as to Moore's Law. Similarly, computer vision made dramatic advances in the

a victim of its own success. The SPEC organization has been selecting old programs written in old languages that reflect the state of programming in the 1980s. Given the 1,000,000X improvement in cost-performance since C++ was unveiled in 1979, most programmers have moved on to more productive languages. Indeed, a recent survey supports that claim: only 25% of programs are being written in languages like C and C++.[c] Hence, the authors supplement SPEC's C and C++ programs, which manage storage manually, with Java programs that manage storage automatically. They called the former programs *native* languages and the latter *managed*.

	Sequential (Non-Scalable)	Parallel (Scalable)
C and C++ (Native)		
Java (Managed)		

The paper reflects a second impor-

Given this measurement framework, the authors then measured eight very different Intel microprocessors built over a seven-year period. The authors evaluate these eight microprocessors using 61 programs, which each fit into one of the four quadrants in the matrix here.

This treasure chest of data—recorded in large tables in the ACM Digital Library in addition to this paper—allows the authors (and the rest of us) to ask and answer many questions based on real hardware. This opportunity is a refreshing change from research results based on simulation, which has dominated the literature for the last decade.

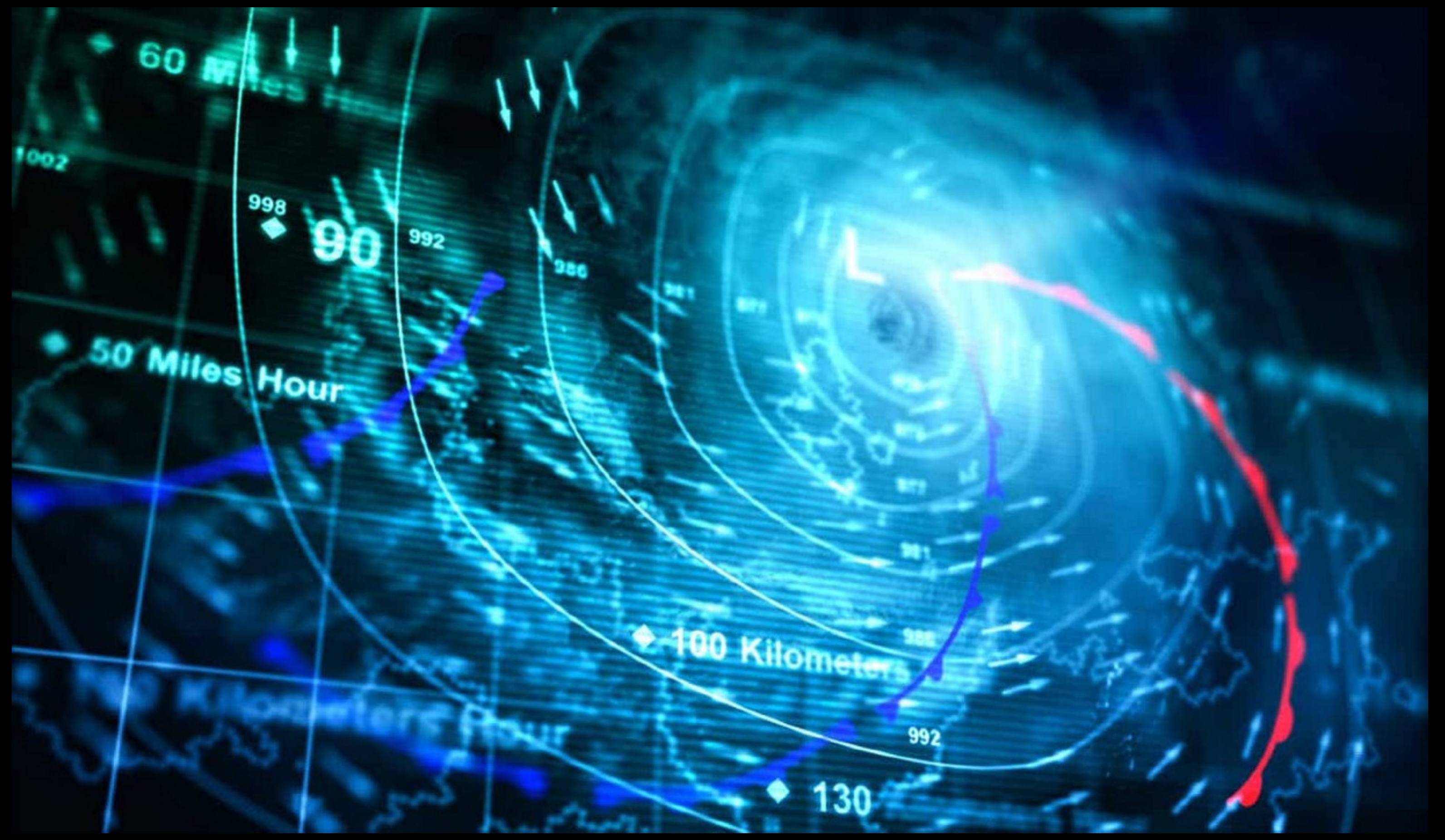
Here are four examples of questions we can now address:

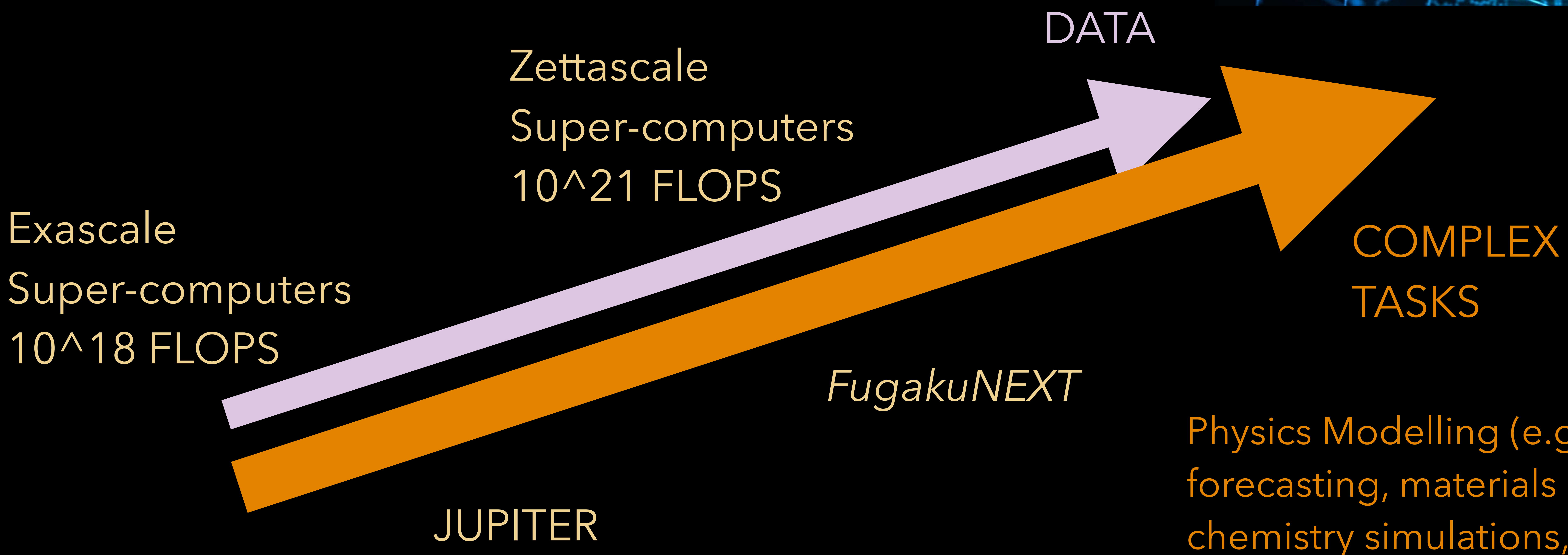
▸ Do performance, power, or energy of the red quadrant programs predict the results of any of the programs from the other quadrants? (If not, the architects must extend their conventional

David Patterson. 2012. For better or worse, benchmarks shape a field: technical perspective. Commun. ACM 55, 7 (July 2012), 104. https://doi.org/10.1145/2209249.2209271

HPC to HPCs

Super-computers
More Computing





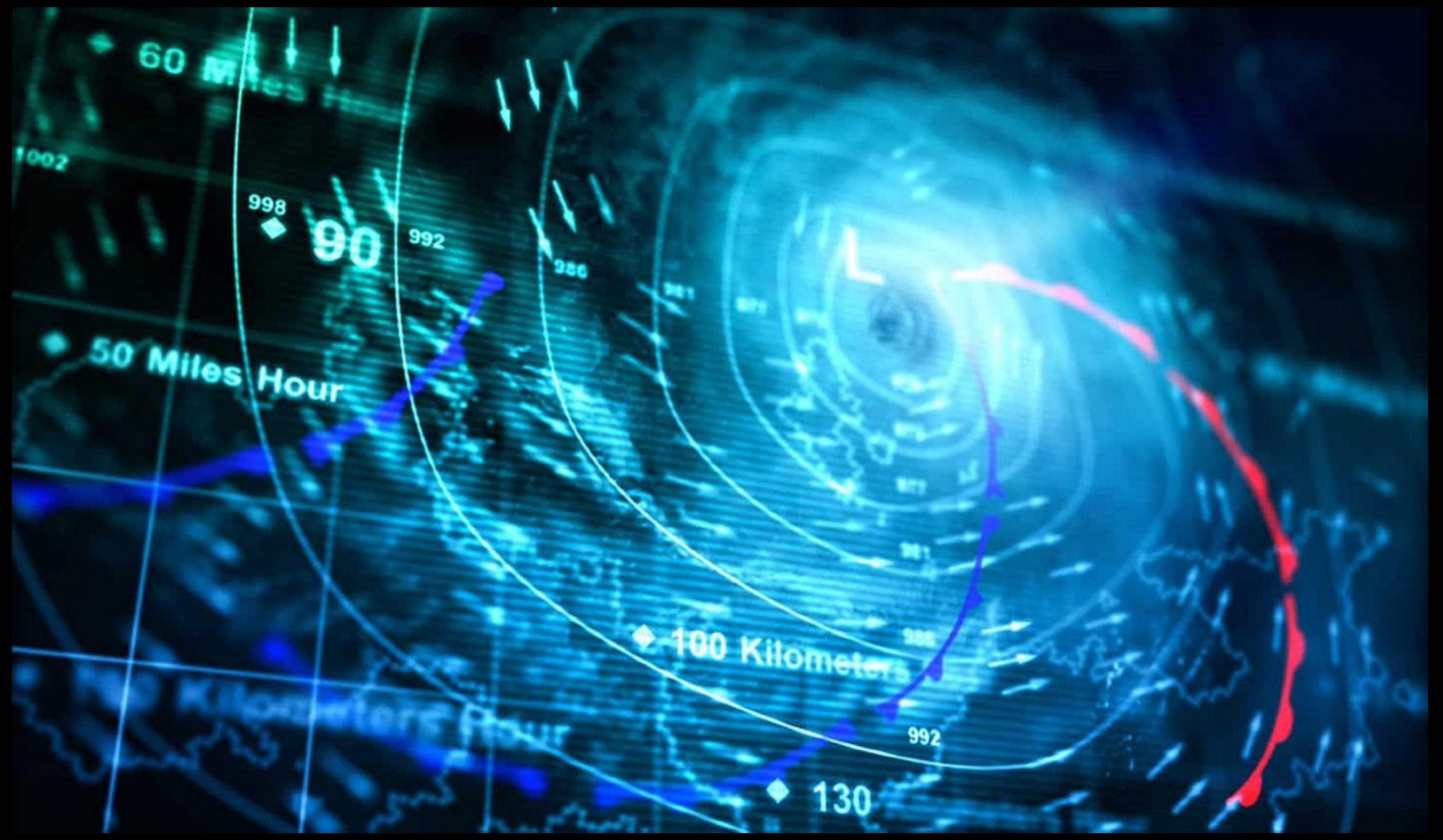
Physics Modelling (e.g., weather forecasting, materials science, chemistry simulations, DNA dynamics, etc)

https://ec.europa.eu/commission/presscorner/detail/en/ip_25_2029
https://blogs.oracle.com/cloud-infrastructure/post/first-principles-zettascale-oci-superclusters
https://www.datacenterdynamics.com/en/news/japans-riken-partners-with-nvidia-and-fujitsu-for-zettascale-fugakunext-supercomputer

HPC to HPCs

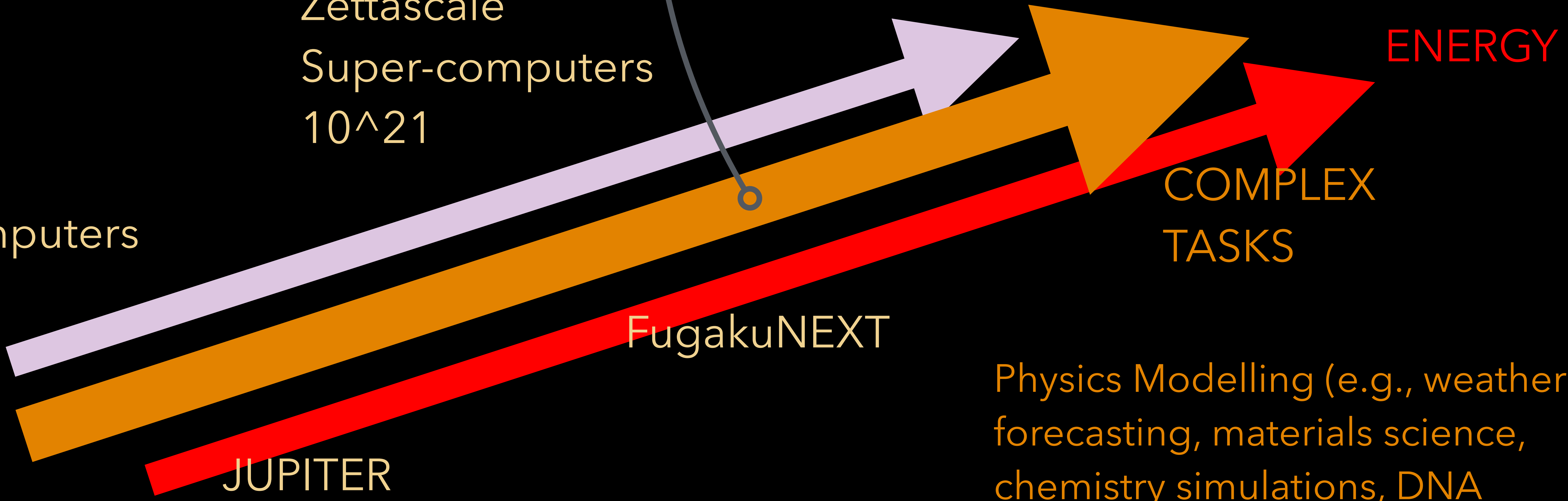
Super-computers
More Computing

Research key points:
OS, Scheduling, Parallel Computing



Exascale
Super-computers
10^18

Zettascale
Super-computers
10^21



Physics Modelling (e.g., weather forecasting, materials science, chemistry simulations, DNA dynamics, etc)

https://ec.europa.eu/commission/presscorner/detail/en/ip_25_2029
https://blogs.oracle.com/cloud-infrastructure/post/first-principles-zettascale-oci-superclusters
https://www.datacenterdynamics.com/en/news/japans-riken-partners-with-nvidia-and-fujitsu-for-zettascale-fugakunext-supercomputer

HPC to HPCs

Many Computers
More Data Processing

DATA

Datacenters

Computer
Clusters

Clouds

SPECIFIC
TASKS

FPGA

TPU

GPU

Quantum
Processor

AI/ML (e.g., classification, clustering, training deep neural networks, reinforcement learning, generative networks, NLP, LLMs, image recognition), Cryptography

https://cloud.google.com/blog/products/compute/ai-hypercomputer-inference-updates-for-google-cloud-tpu-and-gpu?hl=en

HPC to HPCs

Many Computers
More Data Processing

Research key points:
Mathematical Modelling,
Hardware, Computer
Arithmetics

DATA

Datacenters

Computer
Clusters

Clouds

ENERGY

SPECIFIC
TASKS

FPGA

TPU

GPU

Quantum
Processor

AI/ML (e.g., classification, clustering, training deep neural networks, reinforcement learning, generative networks, NLP, LLMs, image recognition), Cryptography

https://cloud.google.com/blog/products/compute/ai-hypercomputer-inference-updates-for-google-cloud-tpu-and-gpu?hl=en

HPC to HPCs

Many Computers
Less Data Processing

High Performance
Data Analytics (HPDA)

Time series

IoT

5G/6G

Edge/Fog
Computing

DATA

SIMPLE
TASKS

ARM

ESP32

AI/ML (e.g., signal denoising, dimensionality reduction, regression, inference, time series, anomaly detection), Sensing fusion/ aggregation

https://spectrum.ieee.org/smartphone-data-centers
https://www.rechargenews.com/corporate-power/microsoft-plan-to-turn-wind-farms-into-mini-ai-data-centres-massive-power-opportunity/2-1-1860728
https://scitechdaily.com/scientists-build-quantum-computer-that-snaps-together-like-legos

HPC to HPCs

Many Computers
Less Data Processing

Research key points:
Embedded OS, Orchestration, Networks

High Performance Data Analytics (HPDA)

Time series

IoT

5G/6G

Edge/Fog Computing

DATA

ARM

ESP32

ENERGY

SIMPLE TASKS

AI/ML (e.g., signal denoising, dimensionality reduction, regression, inference, time series, anomaly detection), Sensing fusion/ aggregation

https://spectrum.ieee.org/smartphone-data-centers
https://www.rechargenews.com/corporate-power/microsoft-plan-to-turn-wind-farms-into-mini-ai-data-centres-massive-power-opportunity/2-1-1860728
https://scitechdaily.com/scientists-build-quantum-computer-that-snaps-together-like-legos

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?

WHERE TO COMPUTE / STORE ?


WHERE TO COMPUTE / STORE ?
Sensing Energy
Transport Energy
Energy Mix
Performance Computing
Performance Latency
Location
HP(C) as CONTINUUM
https://sighpc-continuum.acm.org/

WHERE TO COMPUTE / STORE ?

Home > Nano-Micro Letters > Article

Fibre Computer Enables More Accurate Recognition of Human Activity

Editorial | Open access | Published: 06 June 2025
Volume 17, article number 286, (2025) Cite this article

Qianyi Cheng, Jianfeng Li & Qichong Zhang

Cheng, Q., Li, J. & Zhang, Q. Fibre Computer Enables More Accurate Recognition of Human Activity. Nano-Micro Lett. 17, 286 (2025). https://doi.org/10.1007/s40820-025-01809-x

HP(C) as CONTINUUM

WHERE TO COMPUTE / STORE ?

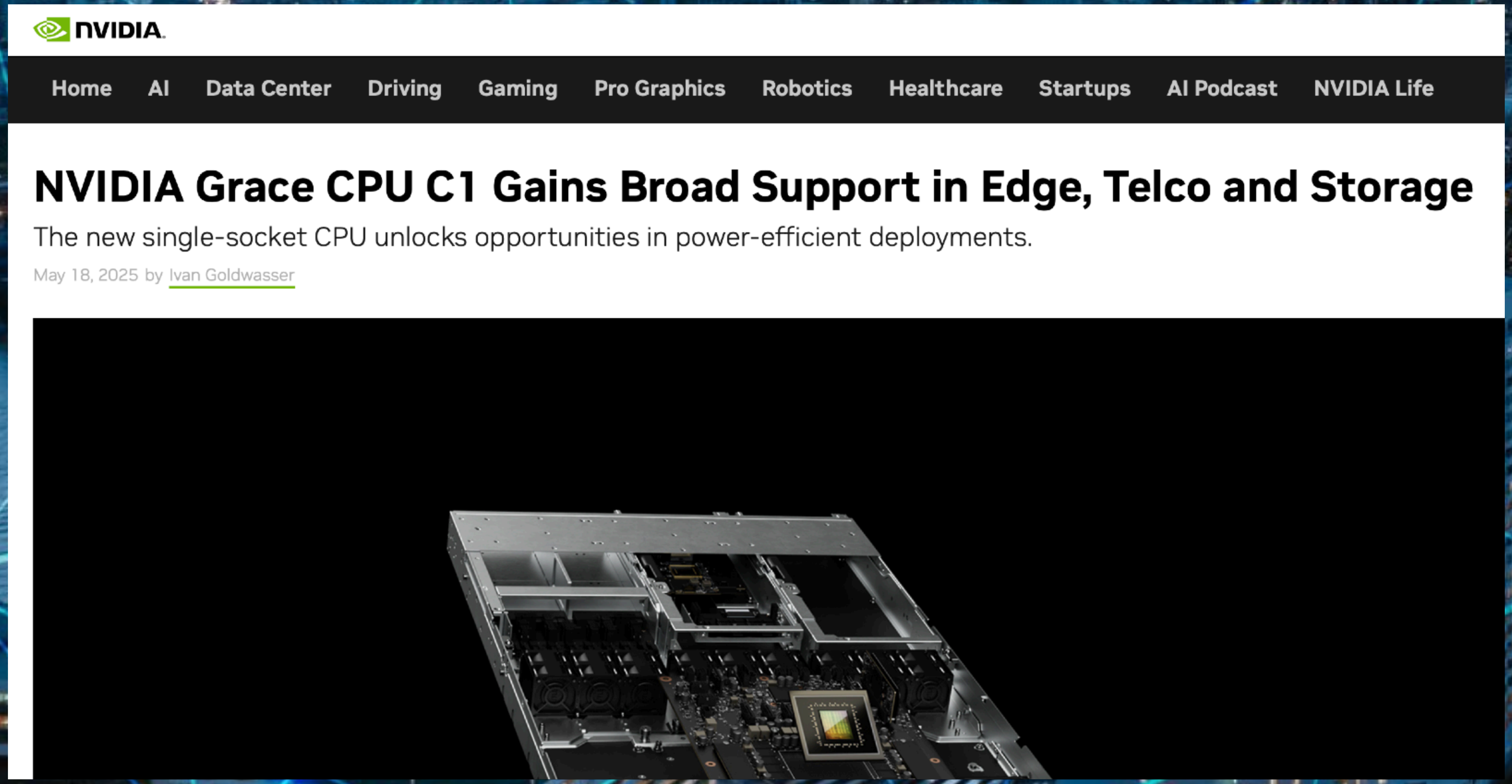
Microsoft plan to turn wind farms into mini AI data centres: 'massive power opportunity'

Research team at tech giant claims 'AI Greenferencing' can bypass grid issues by tapping cheap wind power at source

https://www.rechargenews.com/corporate-power/microsoft-plan-to-turn-wind-farms-into-mini-ai-data-centres-massive-power-opportunity/2-1-1860728 - 28/08/2025

HP(C) as CONTINUUM

WHERE TO COMPUTE / STORE ?


NVIDIA

Home AI Data Center Driving Gaming Pro Graphics Robotics Healthcare Startups AI Podcast NVIDIA Life

NVIDIA Grace CPU C1 Gains Broad Support in Edge, Telco and Storage

The new single-socket CPU unlocks opportunities in power-efficient deployments.

May 18, 2025 by Ivan Goldwasser

SMART NIC - Bluefield - DPU / HPC+AI

SMART NIC - Grace CPU C1 - Distributed AI-RAN

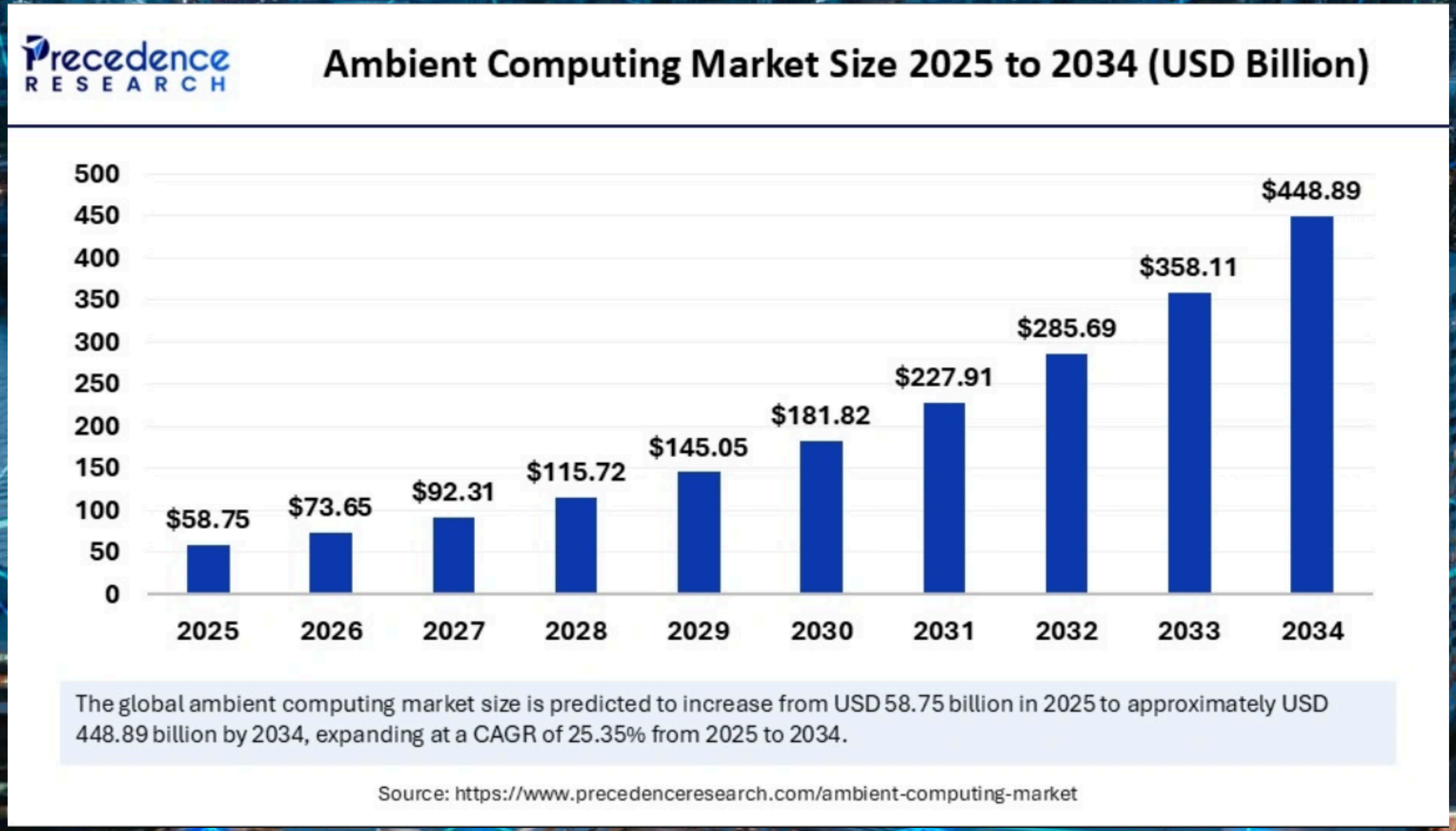
https://blogs.nvidia.com/blog/grace-cpu-c1/

P4 switches/routers - Broadcom Jericho2, Intel Tofino

https://techblog.comsoc.org/2025/09/

HP(C) as CONTINUUM

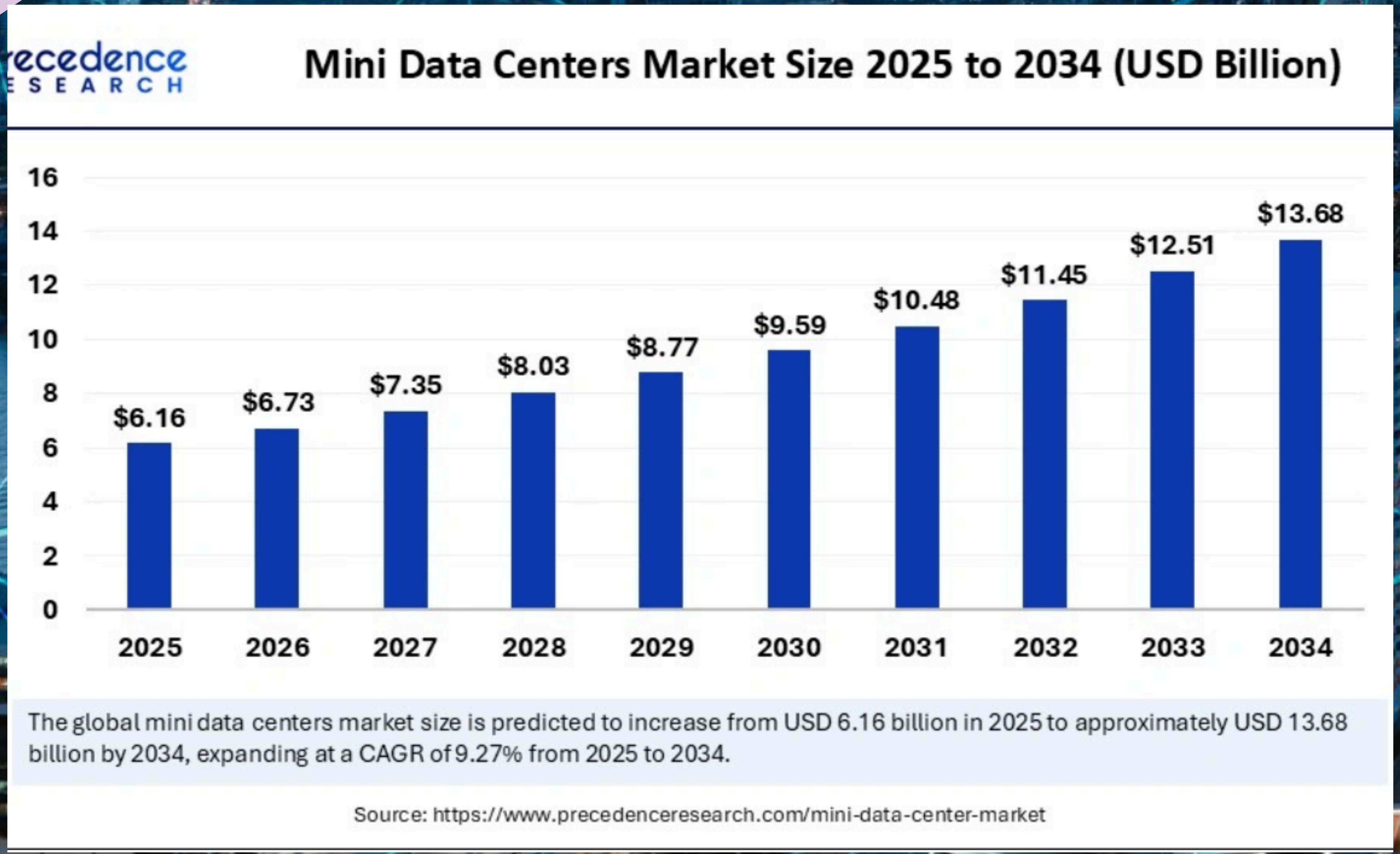
WHERE TO COMPUTE / STORE ?



Ambient Computing Market Explore Innovations Enhancing Privacy, Security, and Personalization, Report Code : 6755, Precedence Research, Sep 2025
https://www.precedenceresearch.com/ambient-computing-market

HP(C) as CONTINUUM

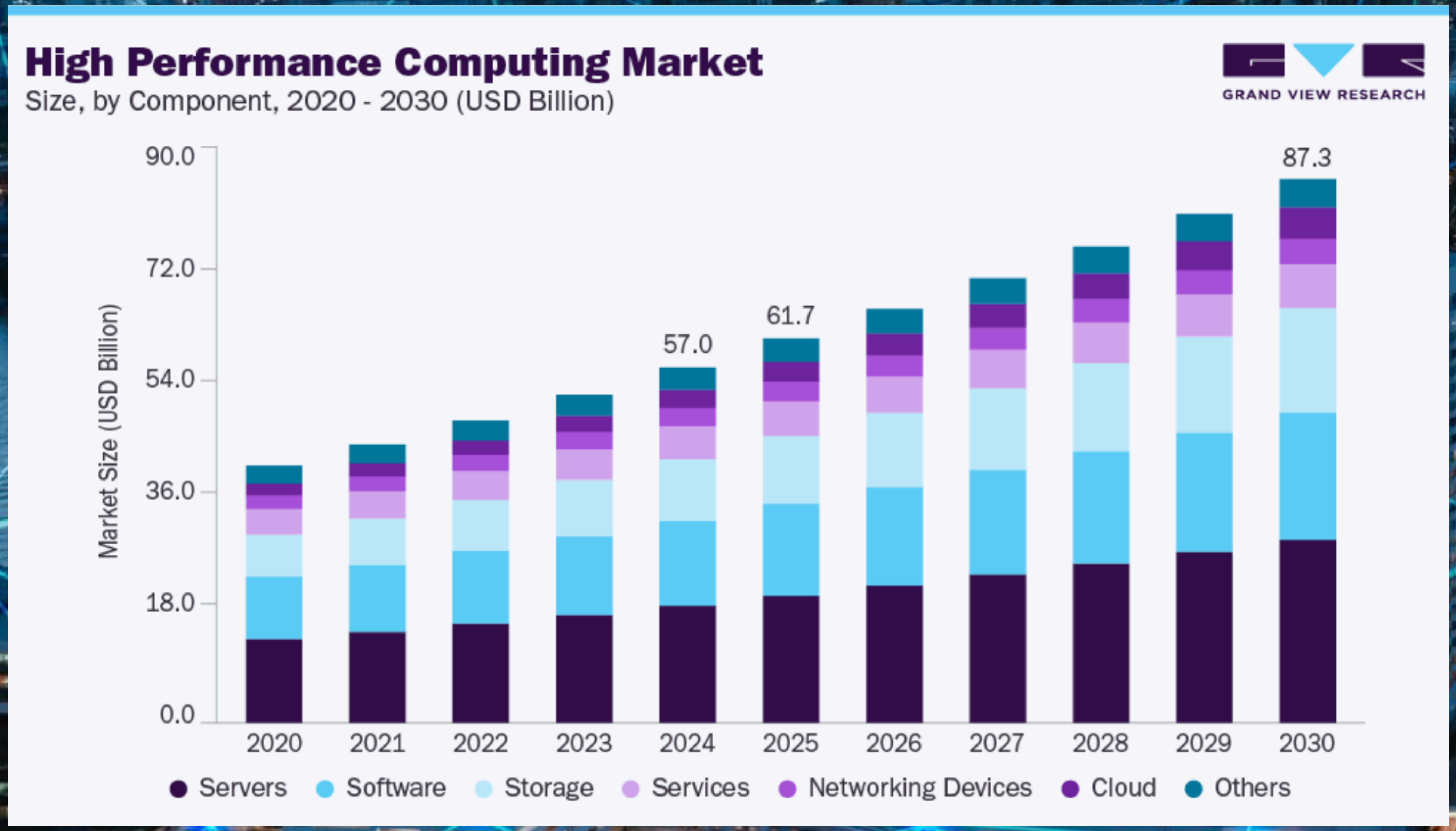
WHERE TO COMPUTE / STORE ?



Mini Data Centers Market Size, Share and Trends 2025 to 2034, Report Code : 6788, Precedence Research, Sep 2025
https://www.precedenceresearch.com/mini-data-centers-market

HP(C) as CONTINUUM

WHERE TO COMPUTE / STORE ?



High Performance Computing Market (2025 - 2030) Size, Share & Trends Analysis Report By Component (Servers, Storage, Networking Devices, Software, Services, Cloud), By Deployment (On-premise, Cloud), By End-use, By Region, And Segment Forecasts, Report ID: GVR-2-68038-492-5, GRV Research https://www.grandviewresearch.com/industry-analysis/high-performance-computing-market

HP(C) as CONTINUUM

WHERE TO EXPERIMENT AT (SMALL|LARGE)-SCALE ?

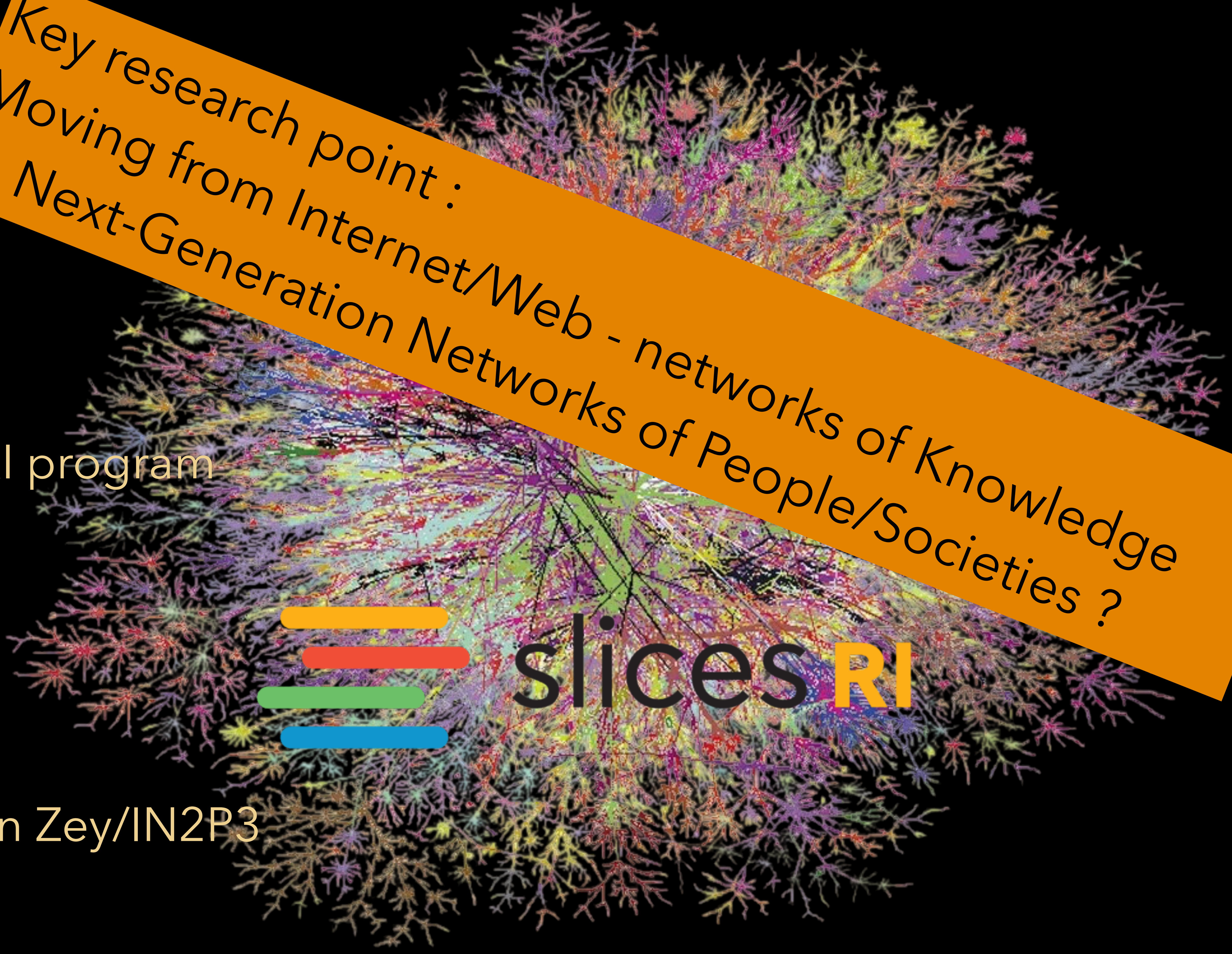
On-going project : SLICES-RI ––– scaling plateforms

HP(C) as CONTINUUM

SLICES

The CERN of Computer Scientists

Key research point :
Moving from Internet/Web - networks of Knowledge
to Next-Generation Networks of People/Societies ?



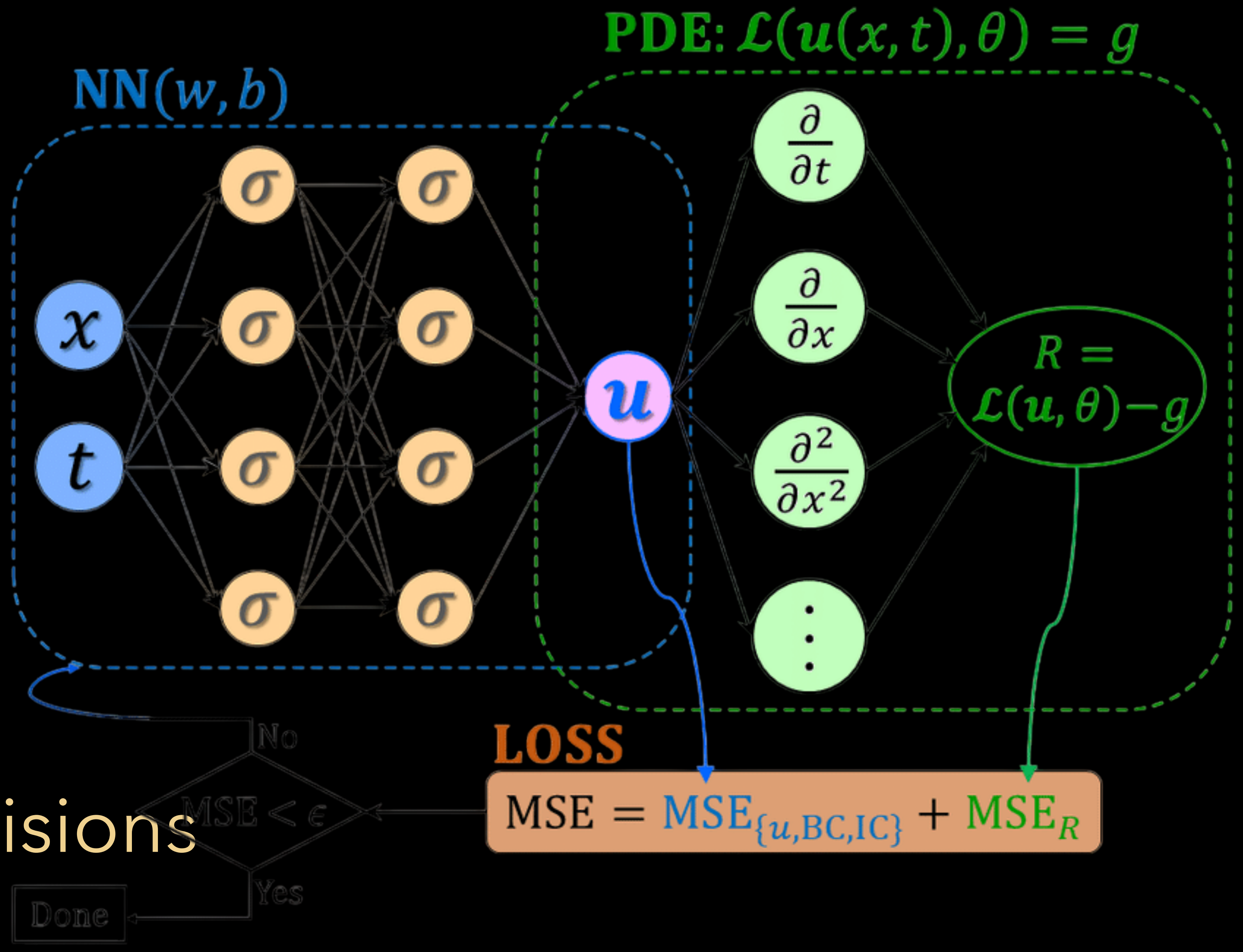
- Research Infrastructure as a Scientific Instrument : ESFRI program
- 2017 - 2042 : ~35 M€
- 25 partners in 15 countries in Europe
- Related existing infrastructures: Chameleon, and <> Jan Zey/IN2P3
- Goals :
  - Reproducible Experiments
  - Large-scale Experiments (social networks, mobility, planetary services, federated Smart Cities)

https://www.slices-ri.eu/

Future Works

Future Work

… to integrate in EL BONGO ?



- Research:
  - Information Theory/Graph Theory to illustrate Particles Collisions
  - Explainable AI in Physics
  - Physics-Informed Neural Networks (PINNs), Spiking Neural Networks (SNN)
- Collaborations:
  - Top-down : European COST program, Distributed Quantum Computing & Networking

https://www.cost.eu/

Luca Longo et al., Explainable Artificial Intelligence (XAI) 2.0: A manifesto of open challenges and interdisciplinary research directions, Information Fusion, Volume 106, 2024, 102301, ISSN 1566-2535, https://doi.org/10.1016/j.inffus.2024.102301.

Future Work

… to integrate in EL BONGO ?

- HPC/AI lecture:
  - Module(s) on AI Ethics / AI Sustainability (Energy/CO2 in Grid5k) / AI Regulation
- Plaforms:
  - APIs to connect CortexLab/YOUPI (CITI, Lyon) + Grid5k (Lyon) platforms to demo HPC Continuum in HPC lecture
  - APIs to connect SCALAC platforms to demo HPC in Latin-America in HPC lecture


The New York Times

Artificial Intelligence › | California's A.I. Law | Chatbots for Financial Advice | A.I. Influencers | 'Open-Source' OpenAI | The 'Hard Tech' Era

California Governor Signs Sweeping A.I. Law

Gavin Newsom signed a major safety law on artificial intelligence, creating one of the strongest sets of rules about the technology in the nation.

Listen to this article · 4:23 min Learn more

Share full article

https://www.nytimes.com/2025/09/29/technology/california-ai-safety-law.html
https://scalac.redclara.net/en/
https://youpi.citi.insa-lyon.fr/
https://www.cortexlab.fr/
https://www.grid5000.fr/

AI - a trend or a buzzword ?

... but while a valuable tool for scientists
... a potentially misleading tool for uninitiated users

@flemouel
frederic.le-mouel@insa-lyon.fr

https://elbongo.redclara.net

EL-BONGÓ physics
Co-funded by the European Union

Appendix:
SLICES project details

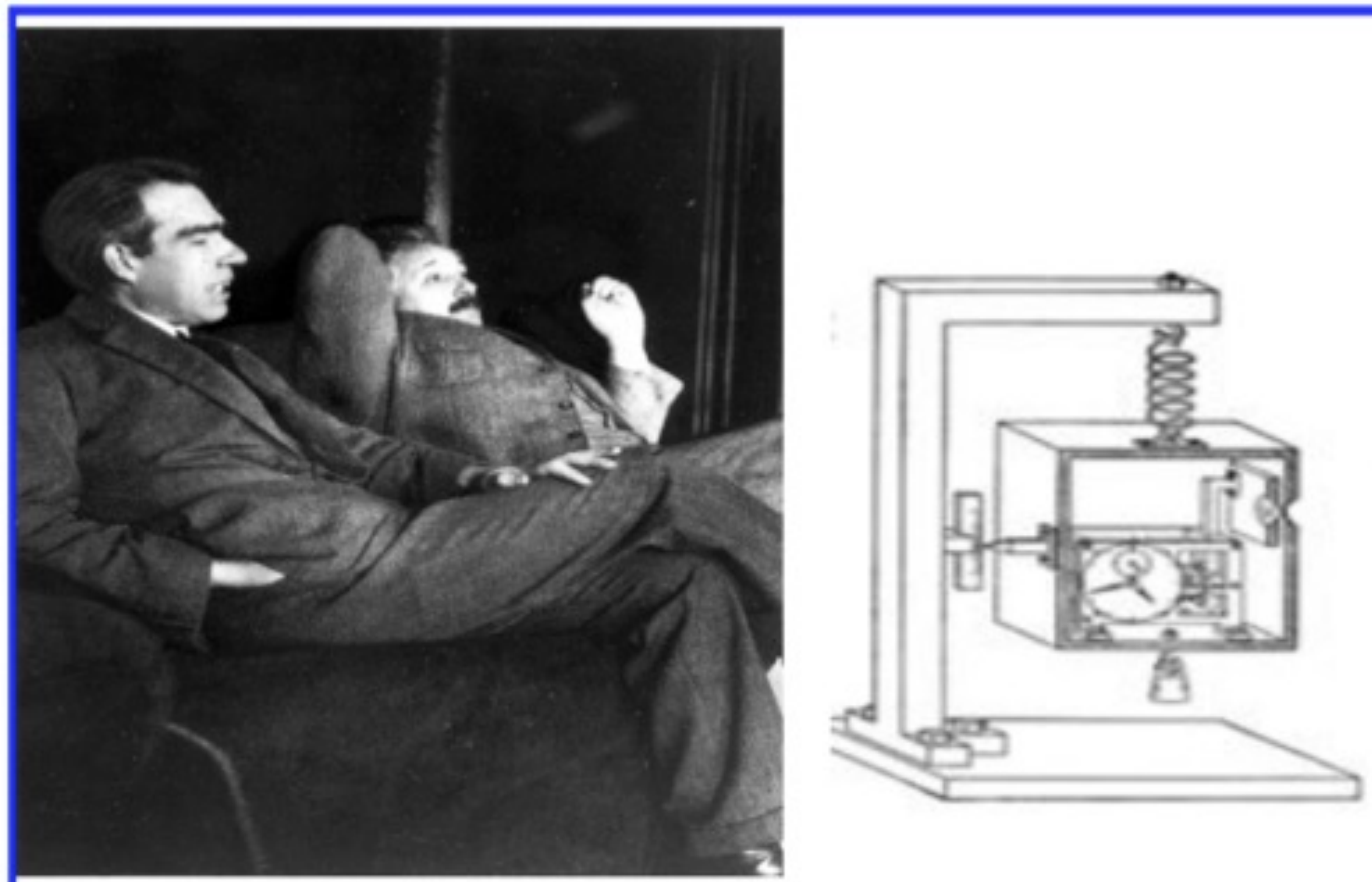
SLICES Europe

www.slices-ri.eu

Strategy Report on Research Infrastructures

ROADMAP **2021**

Thought experiments



Einstein, Bohr and their Photon Box...
a kind of experiment that Schrödinger considered impossible to realize....

THE NOBEL PRIZE

Nobel Price in Physics 2022

Entangled states – from theory to technology

Alain Aspect, John Clauser and Anton Zeilinger have each conducted **groundbreaking experiments** using entangled quantum states, where two particles behave like a single unit even when they are separated. Their results have cleared the way for new technology based upon quantum information.

THE NOBEL PRIZE

Thought experiments

Nobel Price in Physics 2023

for experimental methods that generate attosecond pulses of light for the study of electron dynamics in matter

Ill. Niklas Elmehed © Nobel Prize Outreach

Pierre Agostini

Prize share: 1/3

Ill. Niklas Elmehed © Nobel Prize Outreach

Ferenc Krausz

Prize share: 1/3

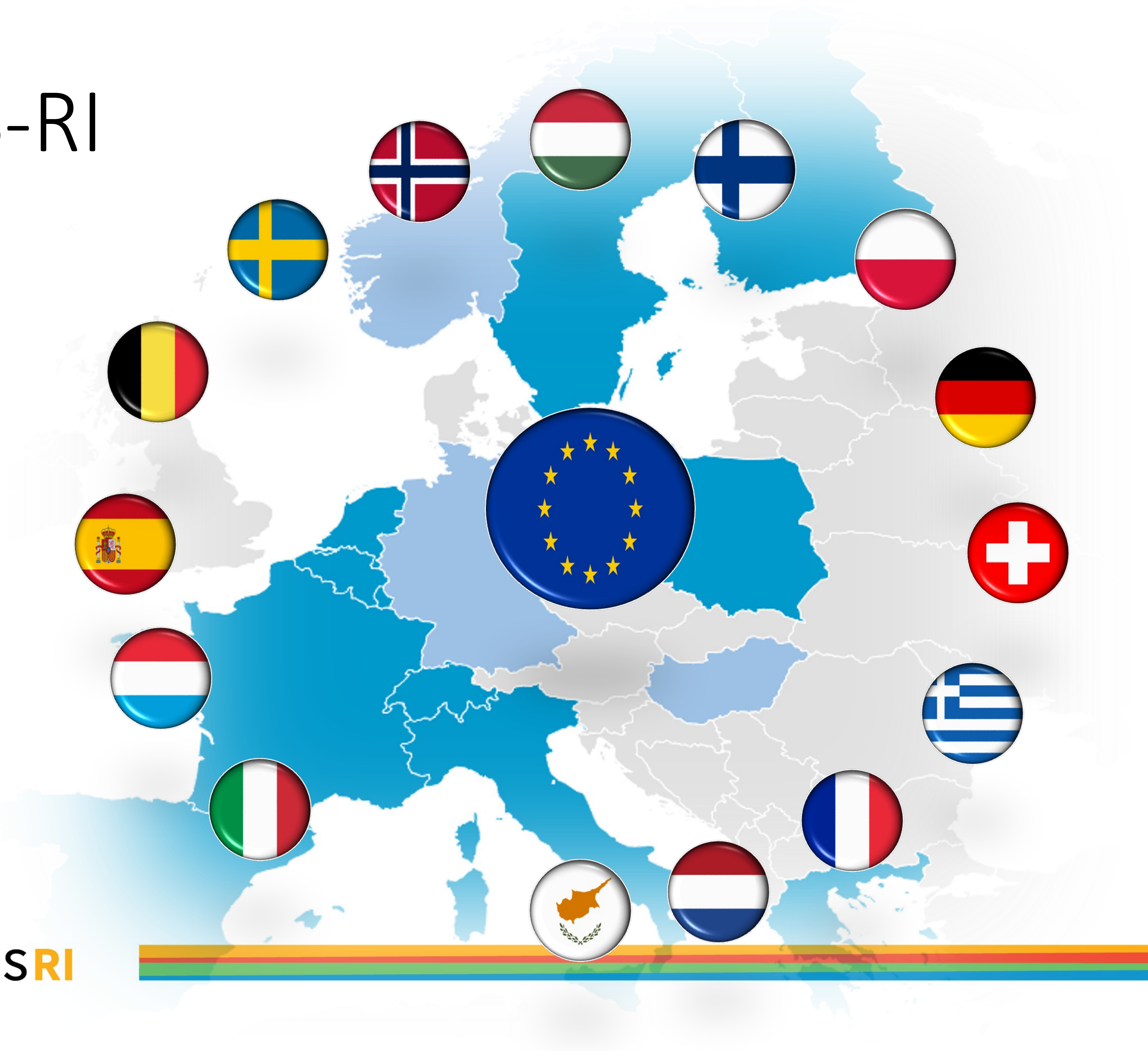
Ill. Niklas Elmehed © Nobel Prize Outreach

Anne L'Huillier

Prize share: 1/3

The three Nobel Laureates in Physics 2023 **are being recognised for their experiments**, which have given humanity new tools for exploring the world of electrons inside atoms and molecules. Pierre Agostini, Ferenc Krausz and Anne L'Huillier have demonstrated a way to create extremely short pulses of light that can be used to measure the rapid processes in which electrons move or change energy.

SLICES-RI



slices RI

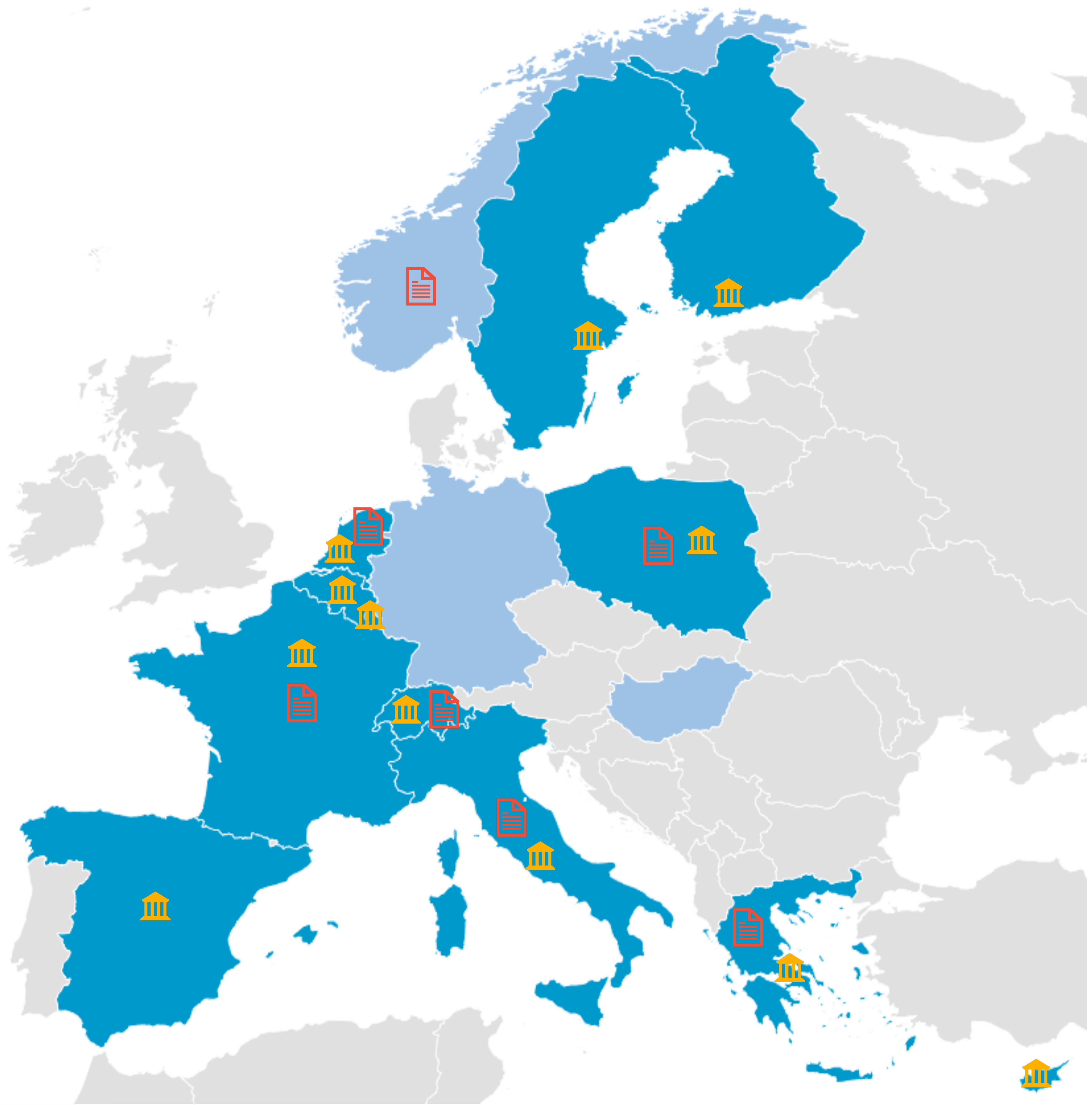
SLICES leverages access to national funding

SLICES on the ESFRI Roadmap 2021 *(indicative)*

- ***Belgium (Flanders):*** 1.6M€, 2023-2026
- ***Finland:*** 6.2M€, 2022-2025
- ***France:*** 15M€, 2022-2028, PEPR Cloud – PEPR 5G
- ***Italy:*** 5.6M€, 2022-2025, +
- ***Poland:*** 6M€, 2021-2025 years, +
- ***Spain:*** 1M€ 2023-2024

slicesRI

SLICES for research on Digital Infrastructures



Initiated in 2017, **25 partners** from 15 countries:

- **12 political support** from National Ministries
- included in **7 national roadmaps**

SLICES will enable **scientific excellence and breakthrough** and will **foster innovation in the ICT domain**, strengthening the **impact of European research**, while contributing to European agenda to address **societal challenges**, and in particular, the twin transition to a sustainable and digital economy.

ESFRI

MAKING SCIENCE HAPPEN

A new ambition for Research Infrastructures in the European Research Area

http://www.esfri.eu/

Research Infrastructures as a Scientific Instrument

From mid-Scale (~100M€) to Large-Scale (~B€)

ESFRI

MAKING SCIENCE HAPPEN

A new ambition for Research Infrastructures in the European Research Area

PILLAR 1
Excellent Science

a) European Research Council
b) Marie Skłodowska-Curie Actions
c) Research Infrastructures

PILLAR 2
Global Challenges and European Industrial Competitiveness

a) Clusters:
- Health
- Culture, Creativity & Inclusive Society
- Civil Security for Society
- Digital, Industry & Space
- Climate, Energy & Mobility
- Food, Bioeconomy, Natural Resources, Agriculture & Environment

b) Joint Research Centre

PILLAR 3
Innovative Europe

a) European Innovation Council
b) European Innovation Ecosystems
c) European Institute of Innovation and Technology

Widening Participation and Strengthening the European Research Area

a) Widening Participation and Spreading Excellence
b) Reforming and Enhancing the European R&I System

The European ESFRI framework

European Strategy Forum on Research Infrastructures

Supporting a scientific methodology

Joint investment strategy between EU and Member States

http://www.esfri.eu/

slicesRI

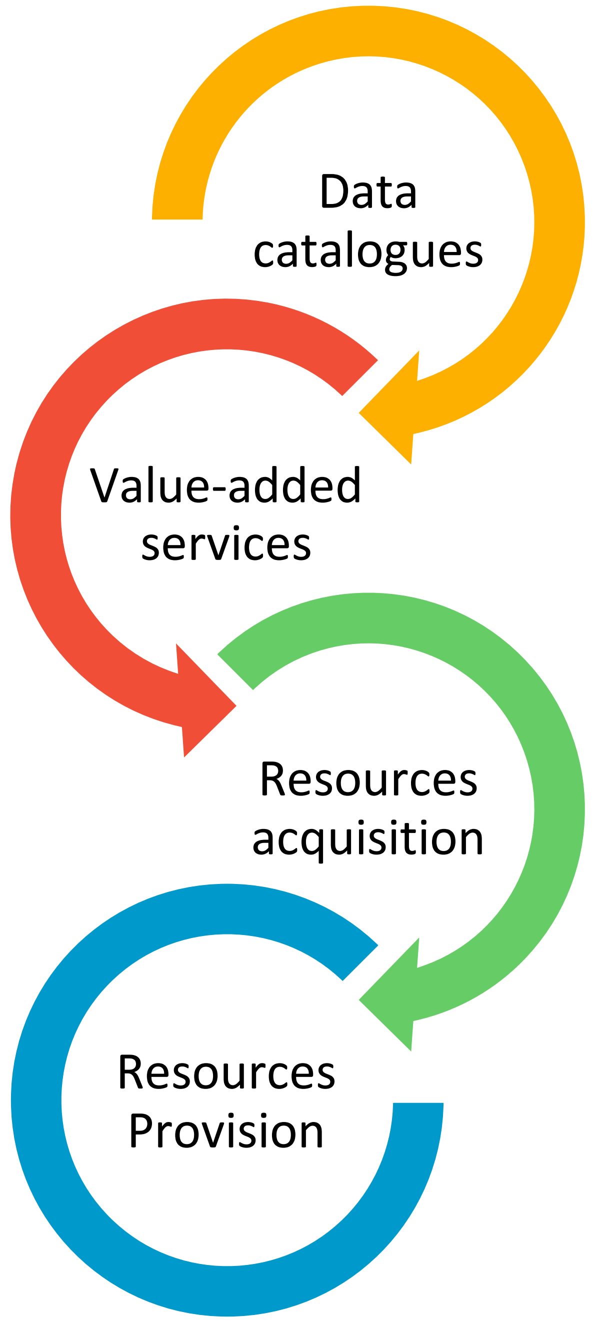
SLICES, first in digital sciences to entered the ESFRI Roadmap 2021

Strategy Report on Research Infrastructures
ROADMAP **2021**

what we offer

- Launched in 2017, **SLICES** is an **RI** to support the **academic and industrial research community** that will design, develop and deploy the **Next Generation** of **Digital Infrastructures:**
  - **SLICES-RI** is a **distributed RI** providing several **specialized instruments** on challenging research areas of Digital Infrastructures, by **aggregating** networking, computing and storage **resources** across countries, nodes and sites.
  - ***Scientific domains***: networking protocols, radio technologies, services, data collection, parallel and distributed computing and in particular cloud and edge-based computing architectures and services.

www.slices-ri.eu



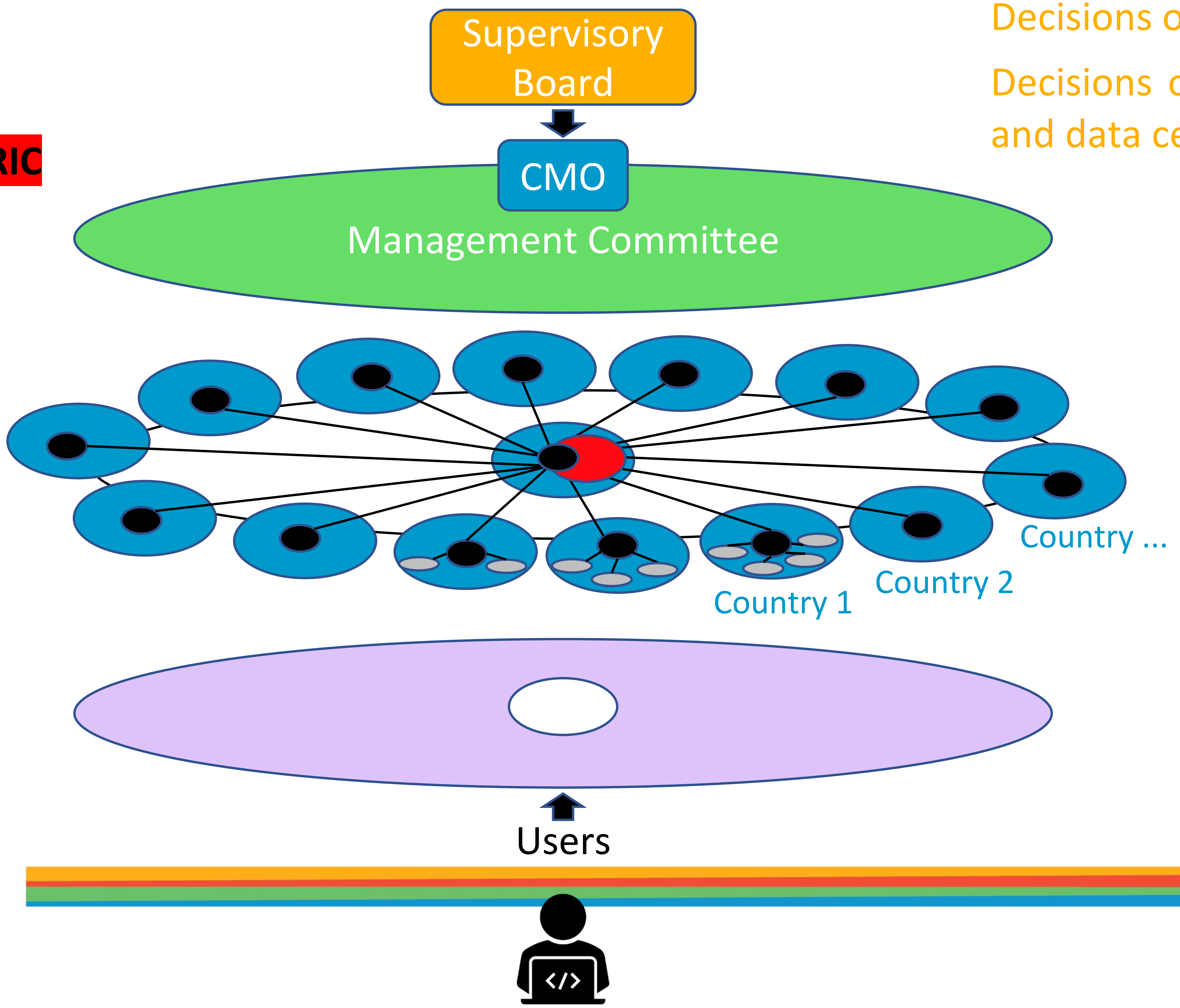
slicesRI

SLICES is a distributed RI

Centralised governance: ERIC

Distributed Infrastructure

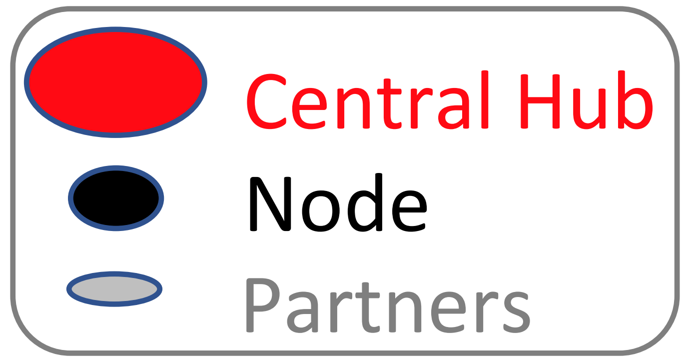
Single entry point, single access policy



Joint investment strategy

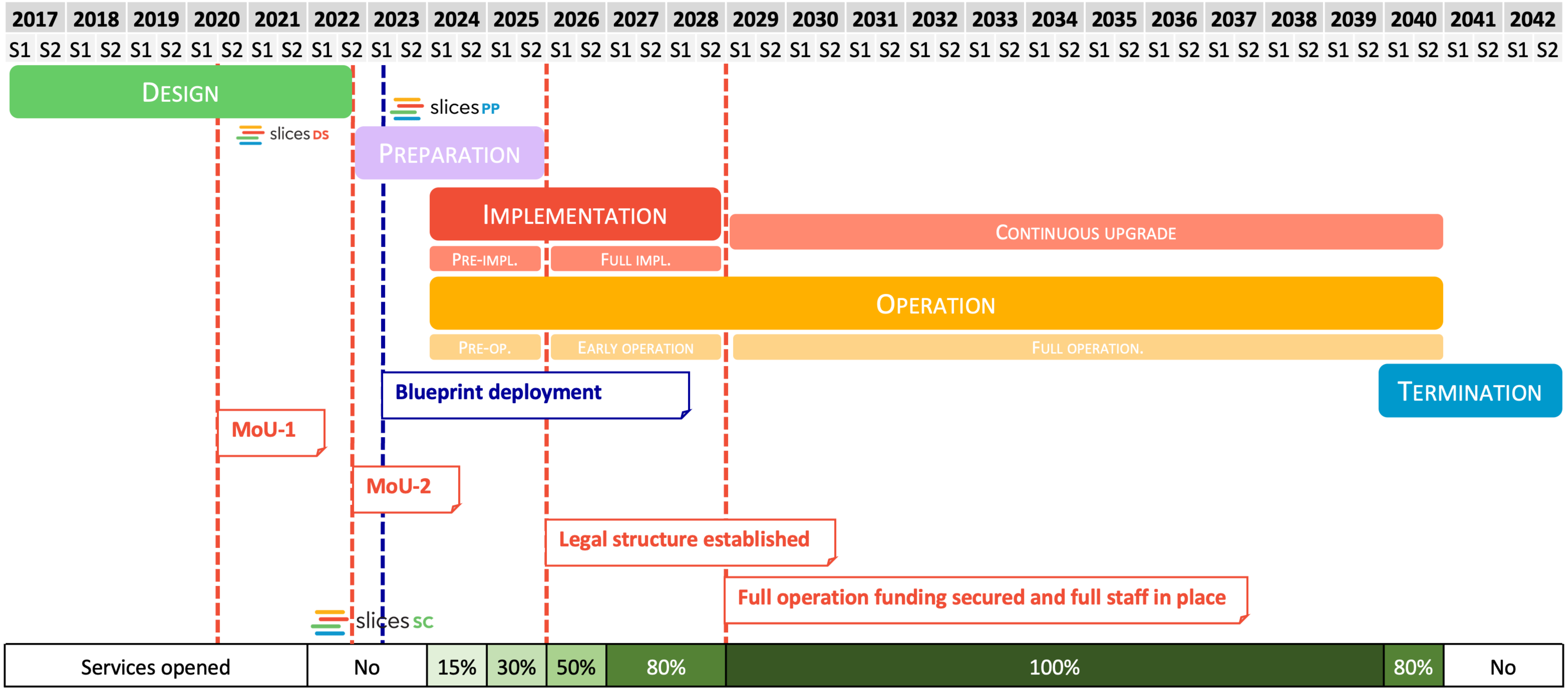
Decisions on new nodes

Decisions on core functions and data centre



Optimize the distribution of resources according to needs and competences: control plane, edge computing and slicing, terahertz, MIMO, ….

SLICES timeline



slices RI

SLICES and EOSC Interoperability and Integration

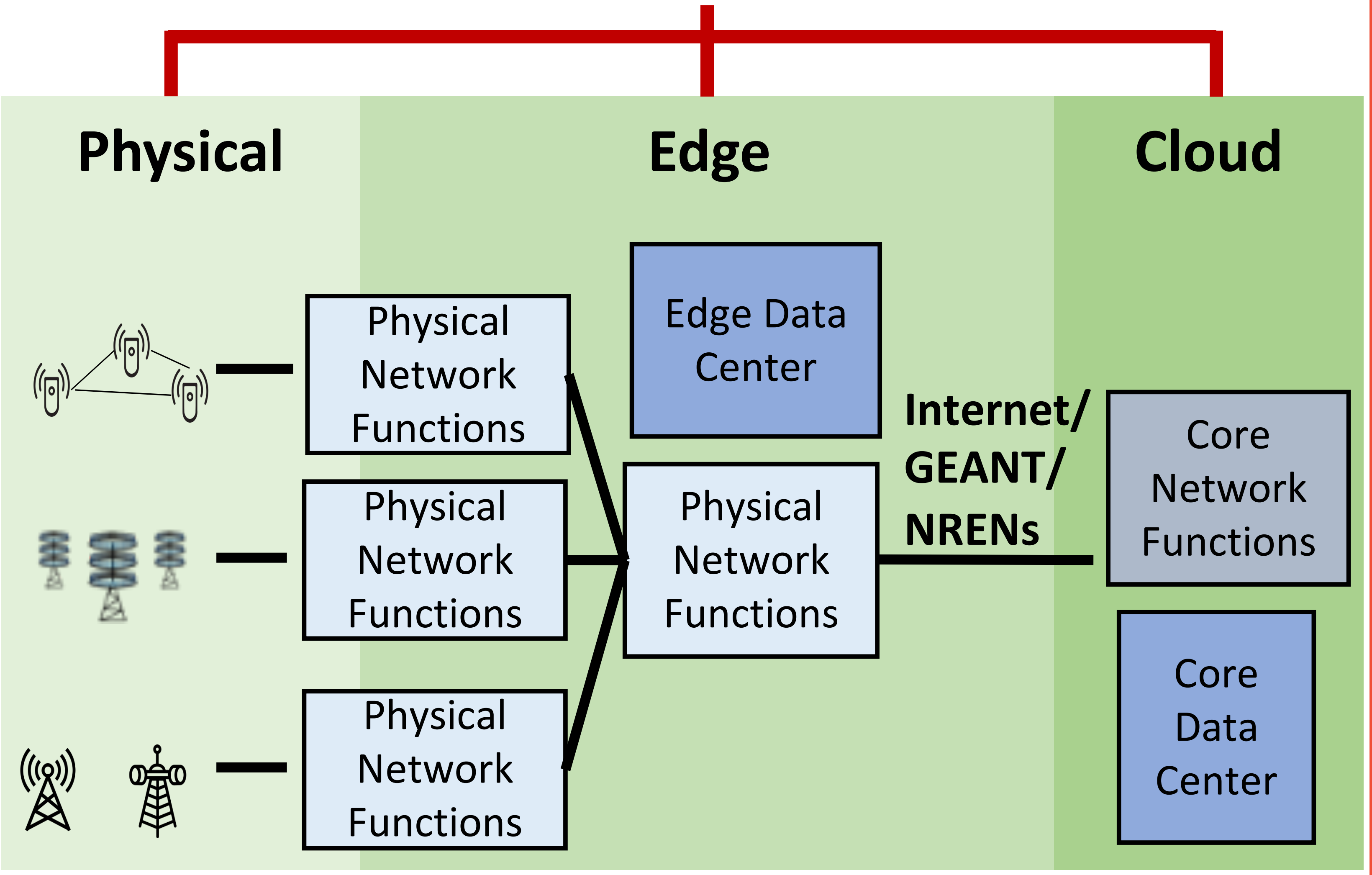
EOSC: European Open Science Cloud

https://eosc-portal.eu/

SLICES contribution to the development of the EOSC

Objectives: **federate existing research data infrastructures in Europe** and **realise a web of FAIR data** and **related services for science.**

#1 Enable experimentation at multiple network levels through **SLICES RI**



Allow experimentation with future/emerging digital, IT and network technologies (e.g., 6G, IoT, Edge, AI, hyper-converged infrastructure).

#2 EU-wide availability of **unique Software and App Repositories**

- ICT research-related services (e.g., testing new infrastructure and network solutions);
- Applications deployed within SLICES;
- Simulation tools;
- Data analysis tools.

Published in the EOSC Catalog and Marketplace and accessible with different access options.

open access	Orderable via provider channel	Orderable via EOSC hub

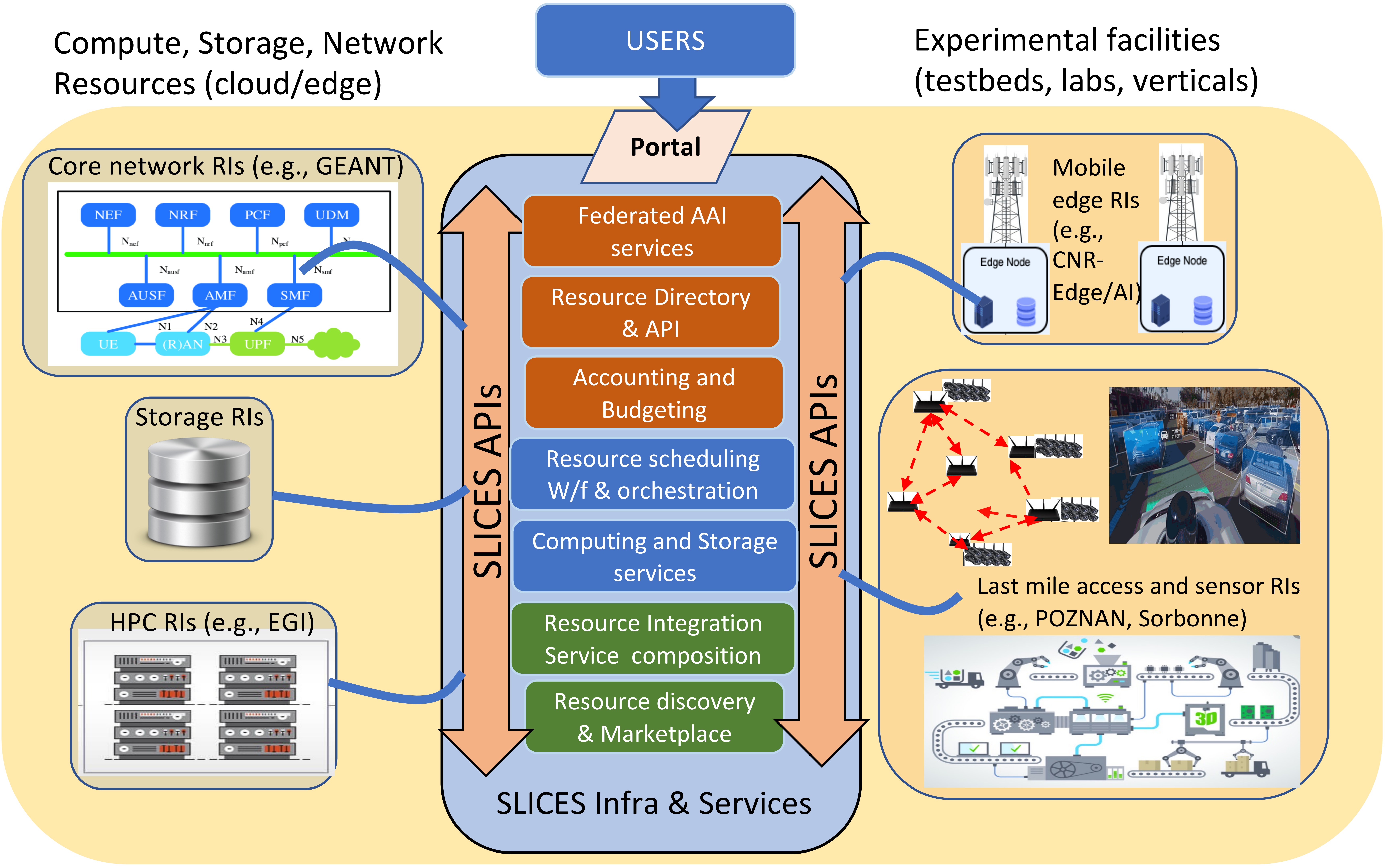
#3 Interoperability with **Open and FAIR data**

- Producers of unique data;
- Maximize data reuse by adopting of FAIR data principles in Data Management and Governance;
- Processing of sensitive and personal information.

#4 Integration of the **SLICES communities to EOSC**

- SLICES community building
  - More than 120 participants to the 1st SLICES workshop;
  - Thousands of users of existing infrastructures.
- Training services

SLICES Interoperability and Integration Architecture



SLICES Reproducible Experiment Workflow

Experiment Workflow

Setup phase

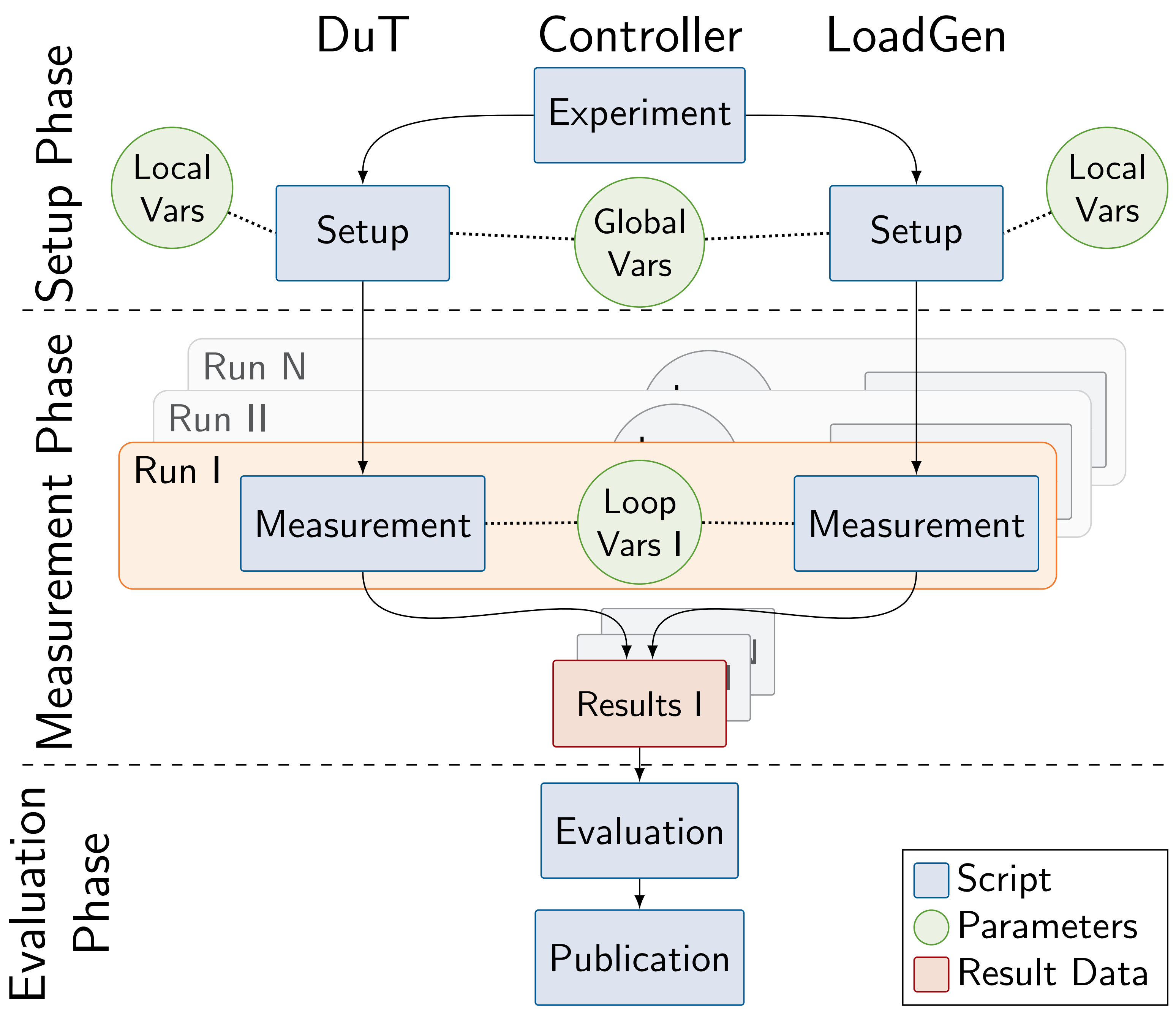
- Controller manages experiment
- Controller configures experiment nodes (DuT, LoadGen)
- Global/local variables (vars) parametrize setup

Measurement phase

- Repeated execution of measurement script
- Loop variables parameterize each measurement run
  - e.g., different packet rates
  - data of each run is connected to a specific set of loop vars

Evaluation phase

- Collected results/loop vars used for experiment evaluation
- Automated experiment release (git repository, website)



Structured Experiment Workflow with pos

SLICES Academy

SLICES Academy

Skills

- Networking, Edge Cloud Orchestratio n Virtualization
- 6G Compute Quantum Security
- Research Methodology Open source
- AI/ML Data Management and Analytics

Audience

- General public
- IT Staff
- Msc and Doctoral students
- Industry

Tools

- National Roadshow
- The Networking Channel
- SLICES Summer School
- Training events

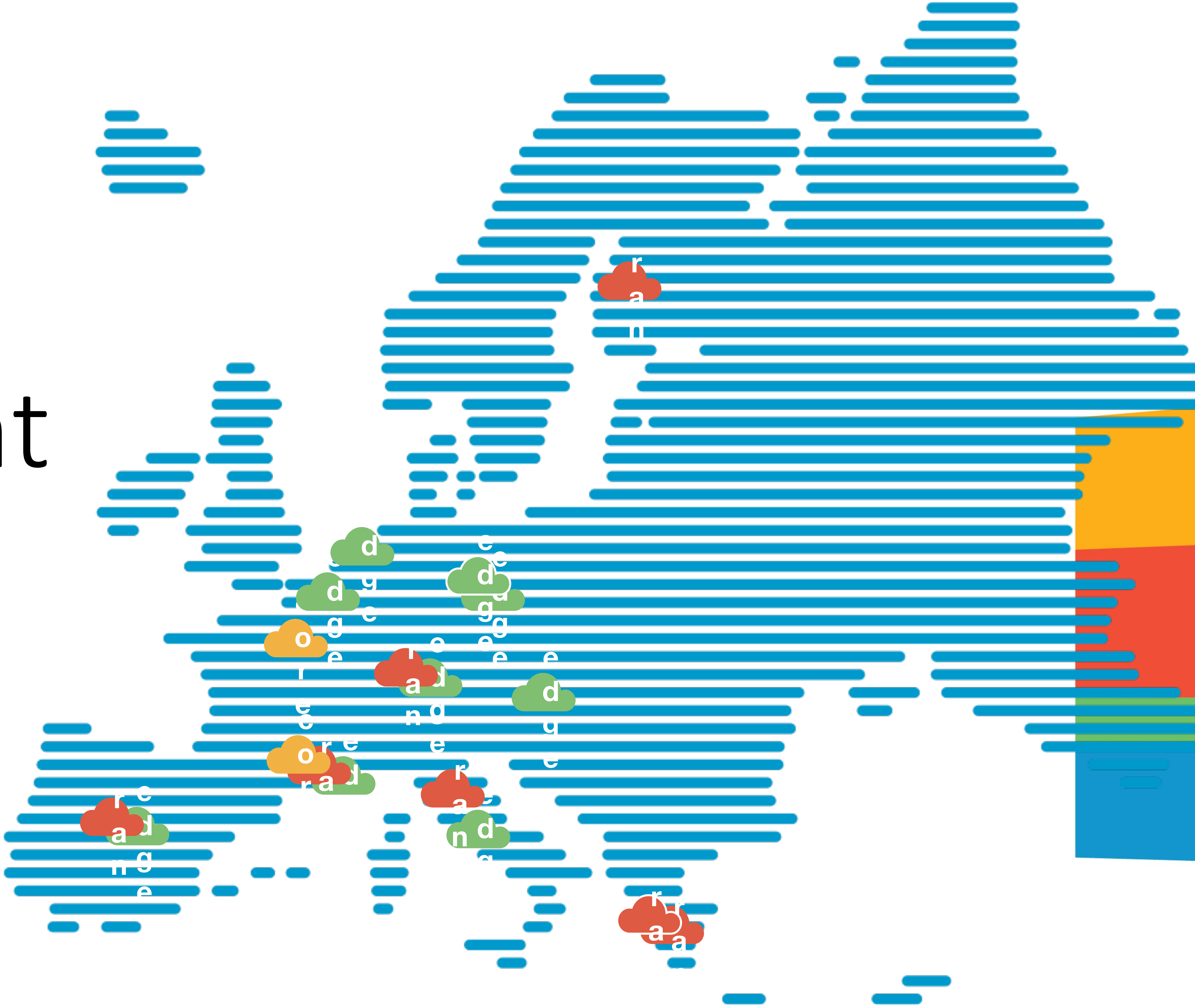
Funding

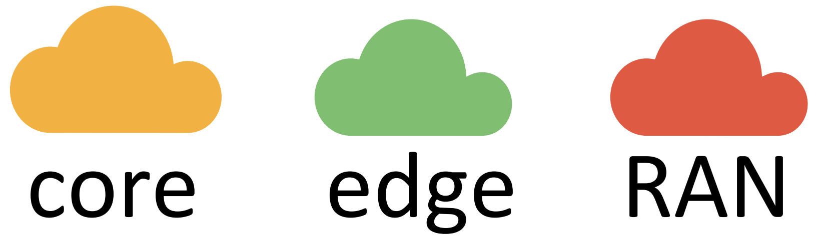
- ERASMUS +
- Shared Digital Europe Programme
- National Initiatives
- Micro-credentials

slicesRI

slices RI

Blueprint





Agenda

- The **blueprint** develops according to:
  - Engagement of the relevant community and critical mass
  - Identification of thoughts experiments

- Post 5G
- Edge-Cloud continuum
- Open Data and reproducibility

- In line, fed by SLICES-DS and SLICES-PP WPs
- Open to other topics

Open, large scale, reproducible

- Reuse and contribute to open-source initiatives
  - Common software/hardware base
- Complex deployments:
  - Multi-region
  - Multi-tenancy
  - Multi-management
- Full documentation
- Fine-grain automatic control

SLICES USP and partnerships

SLICES able to engage a large community

SLICES Infrastructure and open data

SLICES Academy

Stimulate cooperation with important stakeholders

- *EU:* SNS program (Stream C)
- *USA:* NSF PAWR, ONF/Aether
- Brazil: RNP
- O-RAN NGRG