



AI Impacts on the Research Lifecycle and AI for NRENs, What's next?

SIG-AI for NRENs 1st Meeting

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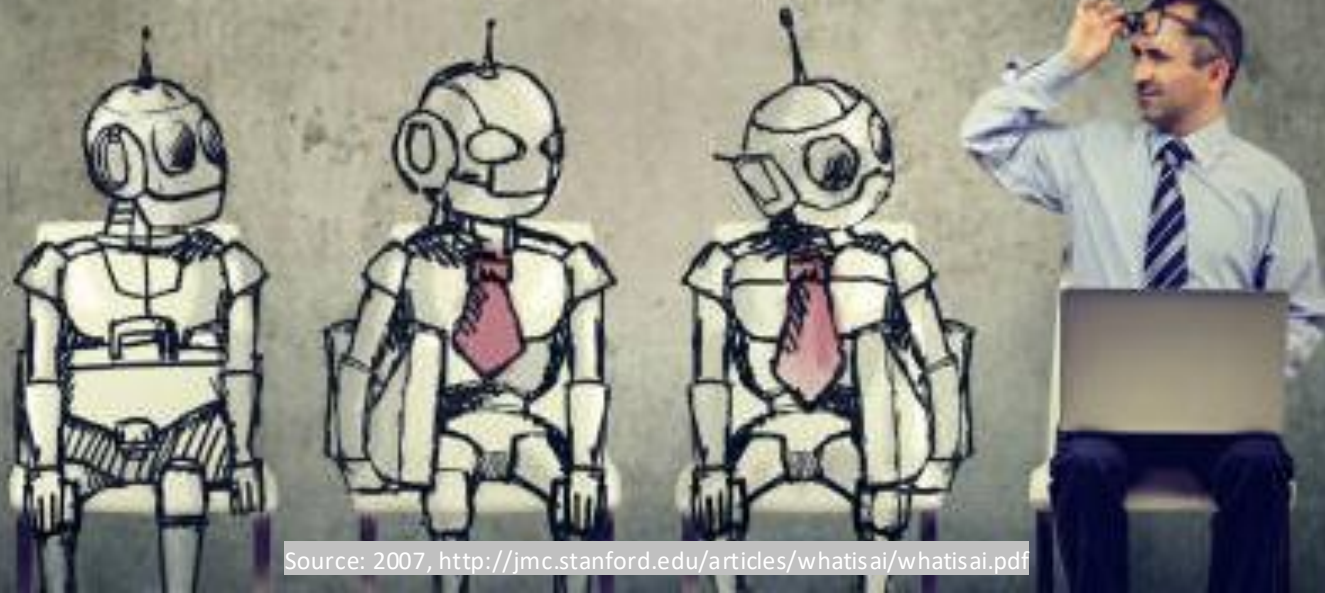
Agenda

- What about AI?
- Scientific method and AI impacts
- What scientists are doing?
- AI in the Research Lifecycle
- What NRENs are offering to support researchers in using AI? What's next?
- And AI for NRENs, can you turn your NREN a data-driven organisations? What's next?

Artificial intelligence...

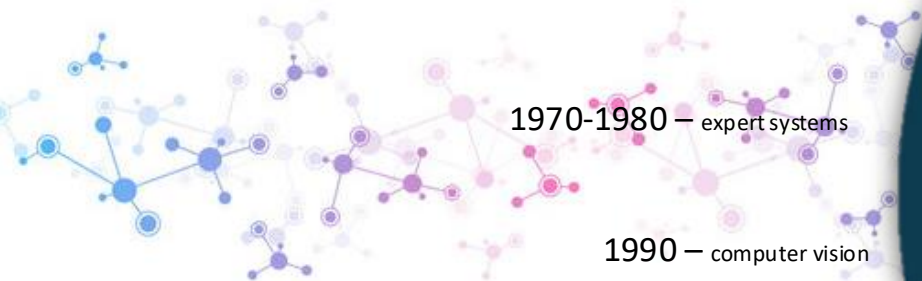
...is the science and engineering of making intelligent machines, especially intelligent computer programs.

1956 - John McCarthy, Stanford professor and father of AI.



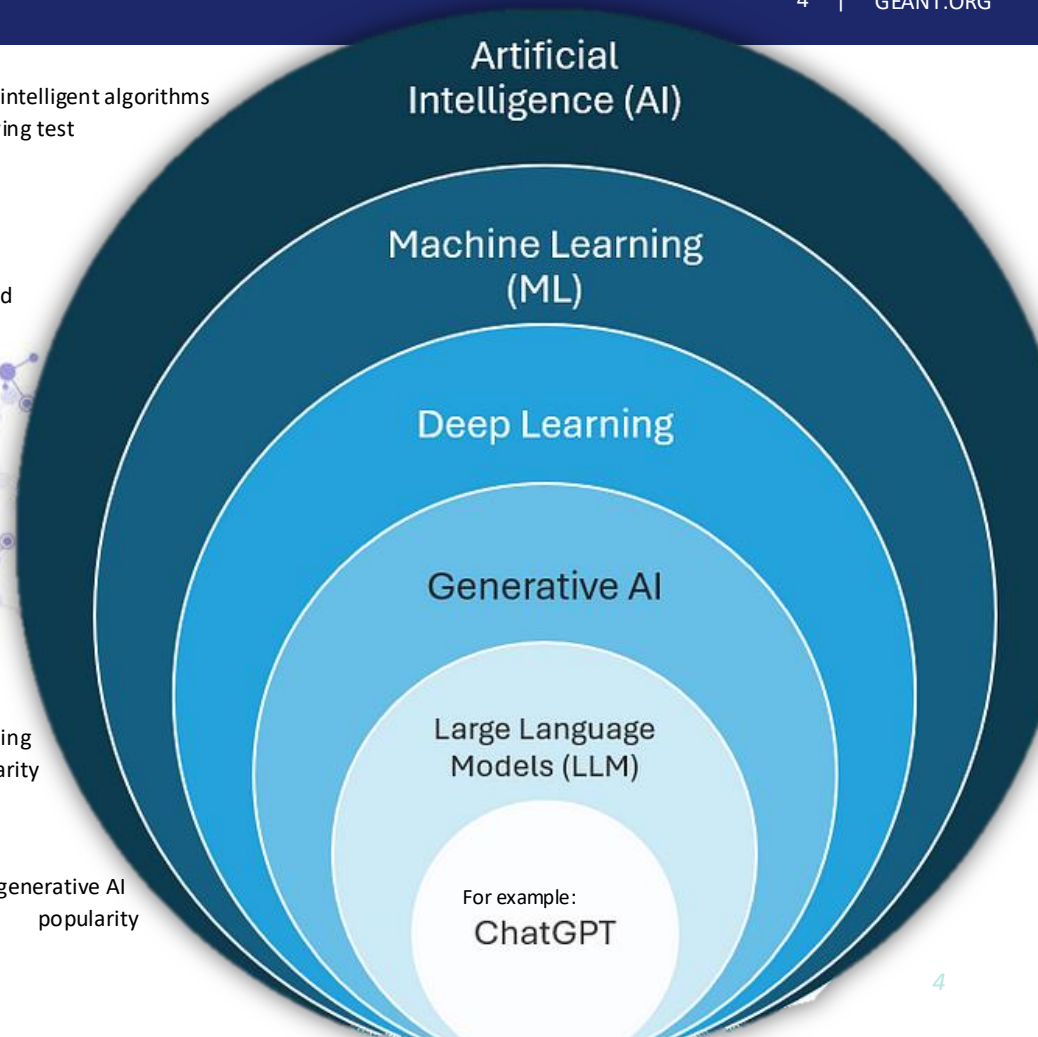
Source: 2007, <http://jmc.stanford.edu/articles/whatisai/whatisai.pdf>

A bit of the evolution of AI



2010 – deep learning popularity

2020 – generative AI popularity





CMS Experiment at the LHC, CERN
Data recorded: 2018-Sep-06 05:06:55.343296 GMT
Run / Event / LS: 322332 / 851591650 / 487

detect anomalies

Predicts failures

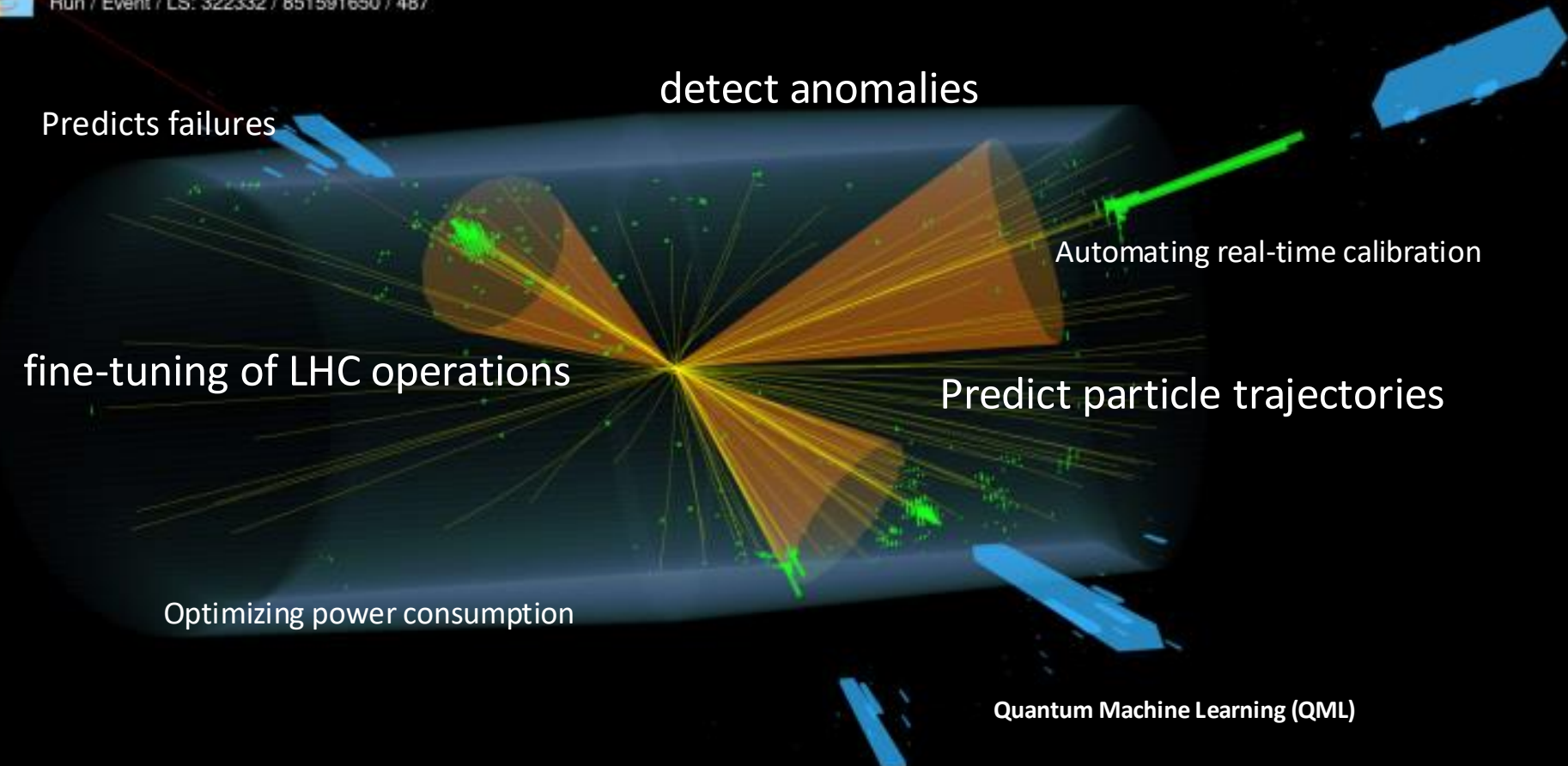
Automating real-time calibration

fine-tuning of LHC operations

Predict particle trajectories

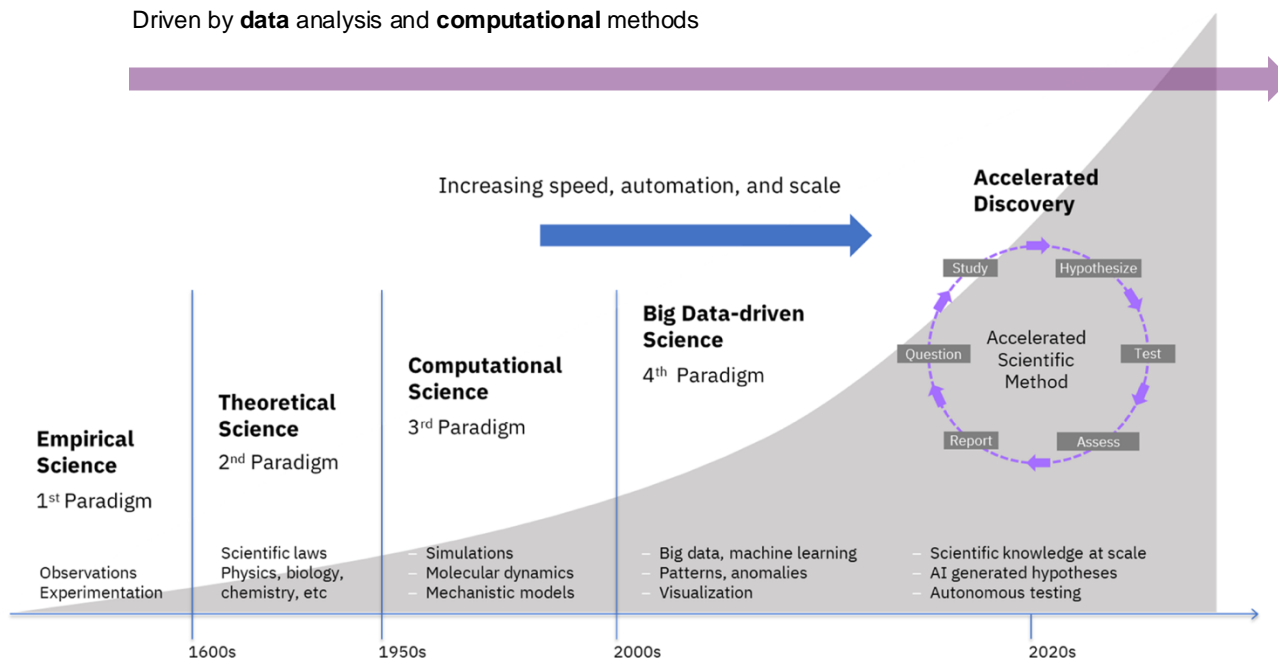
Optimizing power consumption

Quantum Machine Learning (QML)



The progression of the scientific method: e-Science

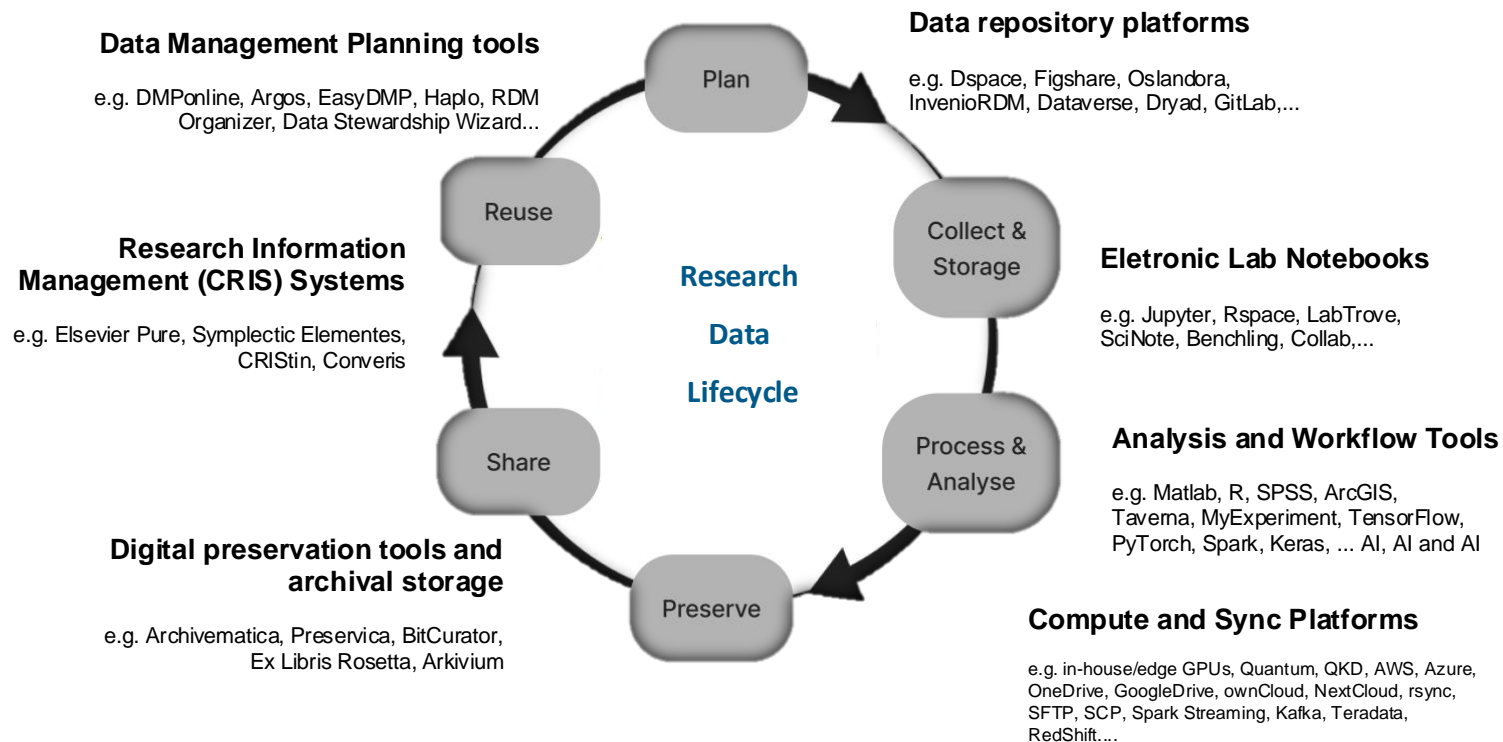
Researcher needs are also evolving



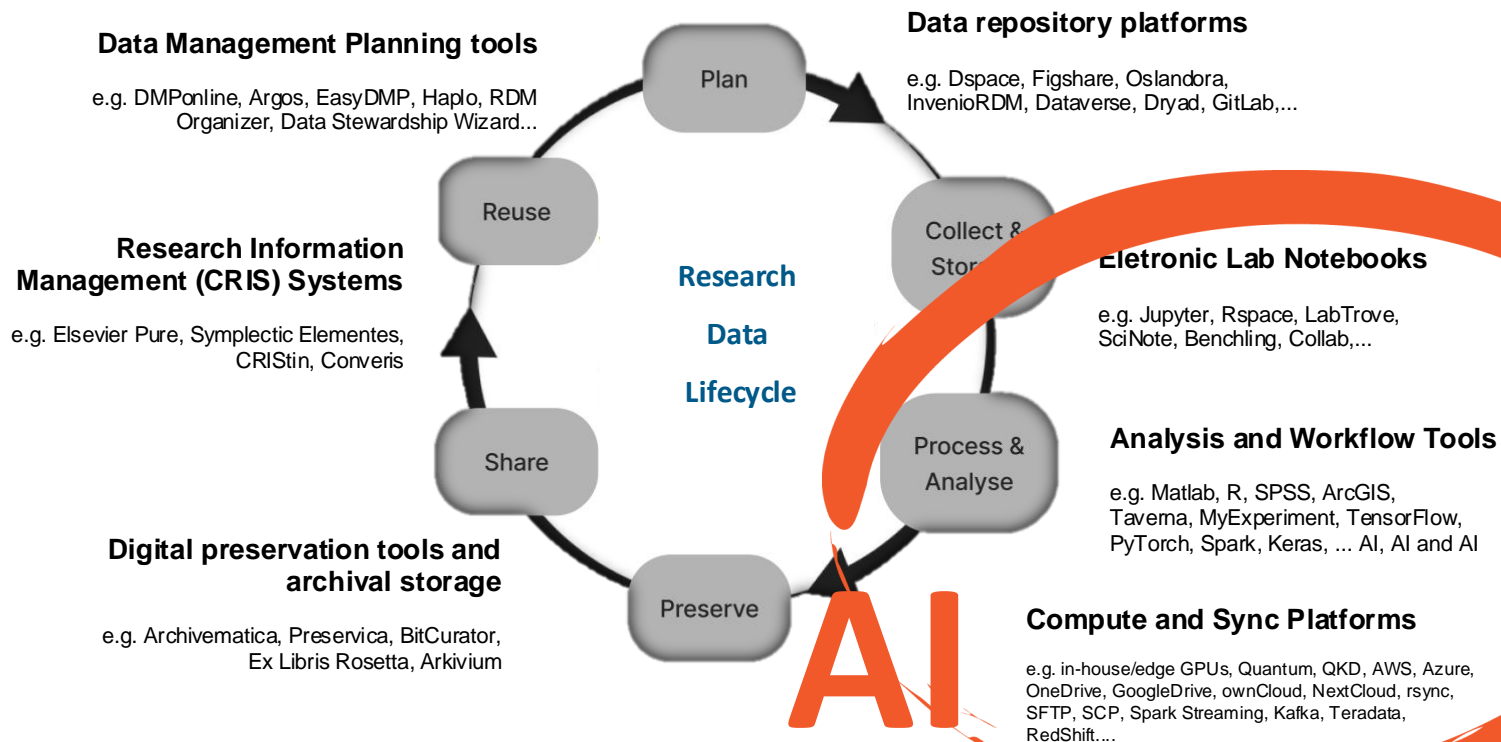
**High-quality,
accurate, and
comprehensive
DATASETS**
are essential for
training AI models



AI is a critical part of the **Research Data Management**



AI is a critical part of the **Research Data Management**





Scientific knowledge discovery has becoming dependent of huge
data analysis and high performance **computational resources.**

e-Science

data

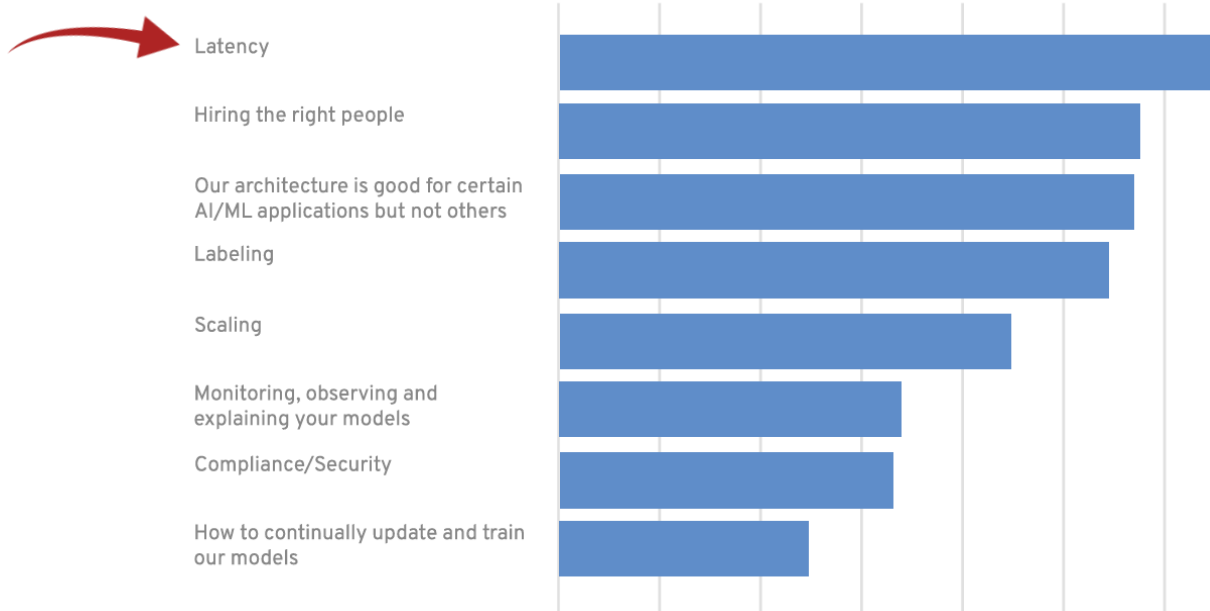
compute

e-Infrastructures

A photograph of a supercomputer facility. The room is filled with long, dark-colored server racks arranged in rows. The lighting is a cool blue, creating a futuristic atmosphere. The racks have a textured, metallic appearance. In the foreground, a white cabinet with several glass doors is visible. The floor is a light-colored, polished surface.

For **expansive workloads** of simulations
the promise are **exascale** and **quantum**.

Most significant challenges in AI infrastructure



A futuristic, glowing cloud-shaped structure containing a complex network of data centers and server racks, symbolizing AI and cloud computing. The structure is illuminated with a warm orange and yellow glow, set against a dark blue background. The cloud is composed of various server racks, cables, and data centers, all interconnected and glowing with light. The overall aesthetic is high-tech and digital.

AI wakes up old discussions:

On-premise vs Cloud vs Edge

A stylized illustration on a blue background. A businessman in a dark suit and white shirt stands with his arms crossed on a light blue rectangular pedestal. The pedestal is supported by a large, white, stylized robotic hand that extends from the right side of the frame. The background is a solid blue color with a subtle gradient.

...and is giving the floor to **security** and **trust** discussions
from explainable AI to privacy issues...

but also **trust & identity issues** and the need of **Trusted Research Environments**



More complex environment....

...and the researchers are cooperating in major research topics,

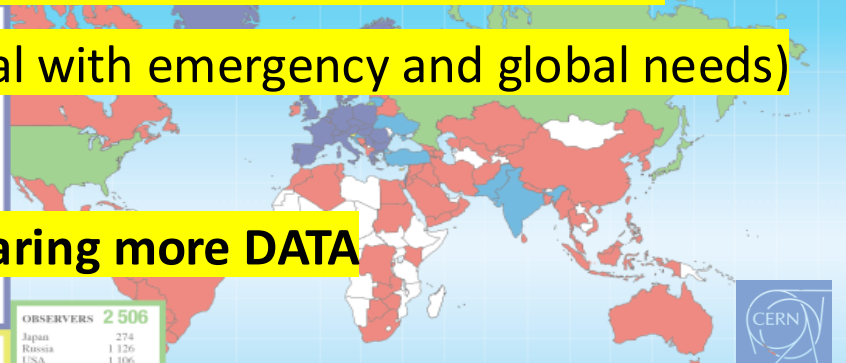
(driven by high costs of in-house research infrastructures and

multidisciplinary intersections to deal with emergency and global needs)

Be **FAIR** Findable Accessible Interoperable Reusable and **CARE** Collective Benefit Authority to Control Responsibility Ethics

MEMBER STATES

Denmark	52
Finland	72
France	778
Germany	1 177
Greece	216
Hungary	77
Israel	59
Italy	1 856
Netherlands	170
Norway	49



They are also sharing more DATA

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP

Cyprus	21
Slovenia	35

ASSOCIATE MEMBERS 770

OTHERS

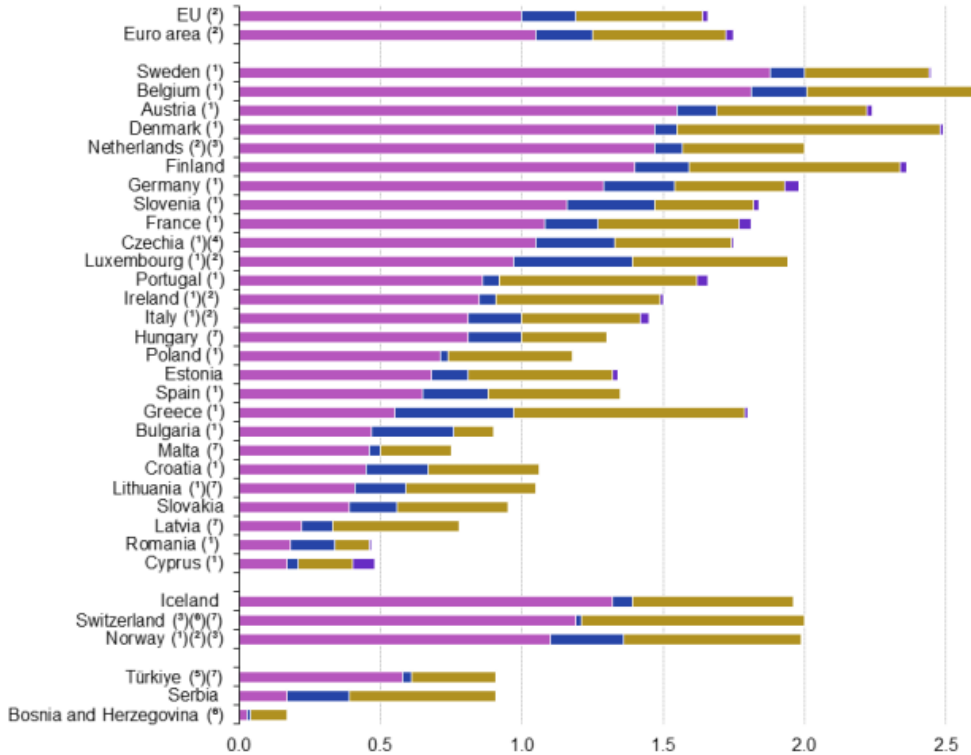
Albania	4	Bolivia	2	Egypt	26	Iceland	14	Montenegro	8	Saint Kitts and Nevis	1	Uzbekistan	3
Argentina	22	Bosnia & Herzegovina	2	El Salvador	1	Jamaica	1	Morocco	26	Saudi Arabia	2	Viet Nam	10
Australia	18	Burkina Faso	1	Estonia	16	Jordan	2	Myanmar	1	Senegal	8	Yemen	1
Azerbaijan	7	Chile	21	Georgia	54	Kazakhstan	12	Nepal	8	Singapore	4	Zambia	1
Bahrain	3	China	569	Ghana	1	Kyrgyzstan	1	New Zealand	6	South Africa	54	Zimbabwe	1
Bangladesh	5	Colombia	35	Ireland	1	Korea	161	Nigeria	1	Sri Lanka	6		
Belarus	49	Congo	1	Guatemala	1	Latvia	4	North Macedonia	2	Sudan	2		
Berm	1	Costa Rica	1	Hong Kong	1	Lebanon	23	Qatar	1	Syria	2		
		Cuba	16	Indonesia	13	Luxembourg	3	Palestine	7	Taiwan	47		
		Ecuador	11	Iran	46	Malta	5	Paraguay	1	Thailand	24		
				Iraq	1	Mexico	80	Peru	6	Tunisia	5		
								Philippines	4	Uruguay	1		

TRUST

Transparency, Accountability, User Focus, Sustainability, Trustworthiness

R&D personnel by sector, 2023

(% of total employment, based on full-time equivalents)



Where are EU R&D personnel?

56.6% of FTEs researchers are in **business**

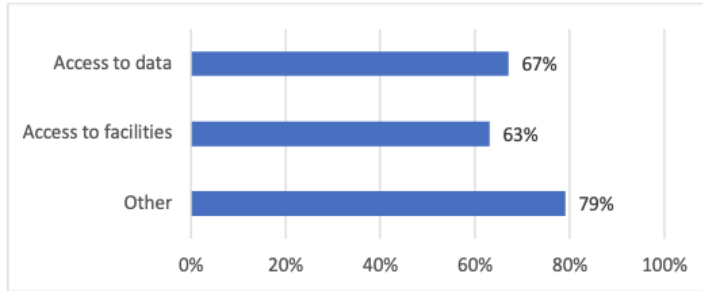
31.8% in higher education

10.2 % in government and non-profit organisations

- Business enterprise sector
- Government sector
- Higher education sector
- Private non-profit sector

Research infrastructures (RIs) – are being shared!

Types of services offered to the industry



*Other: personnel, computing/data facilities, training, joint development,...

49% of RIs regularly cooperate with industry

91% are planning to expand cooperation with industry

“The cooperation between Research Infrastructures (RIs) and industry plays a crucial role in achieving scientific excellence and fostering innovation potential. However, the level of cooperation and its challenges remain less defined and monitored.” (ESFRI,2023)

Going deeper on the Researcher needs

on Research Data Management

Data Management Planning tools

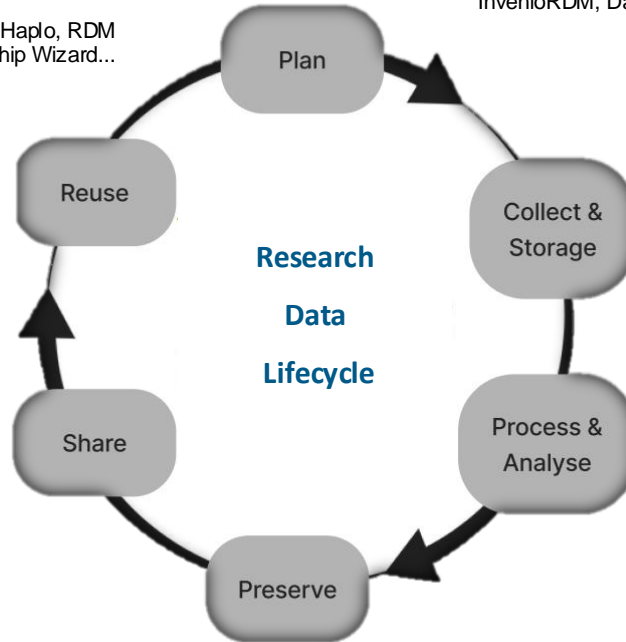
e.g. DMPonline, Argos, EasyDMP, Haplo, RDM Organizer, Data Stewardship Wizard...

Research Information Management (CRIS) Systems

e.g. Elsevier Pure, Symplectic Elementes, CRIStin, Converis

Digital preservation tools and archival storage

e.g. Archivematica, Preservica, BitCurator, Ex Libris Rosetta, Arkivium



Data repository platforms

e.g. Dspace, Figshare, Oslandora, InvenioRDM, Dataverse, Dryad, GitLab,...

Electronic Lab Notebooks

e.g. Jupyter, Rspace, LabTrove, SciNote, Benchling, Collab,...

Analysis and Workflow Tools

e.g. Matlab, R, SPSS, ArcGIS, Tavema, MyExperiment, TensorFlow, PyTorch, Spark, Keras, ... AI, AI and AI

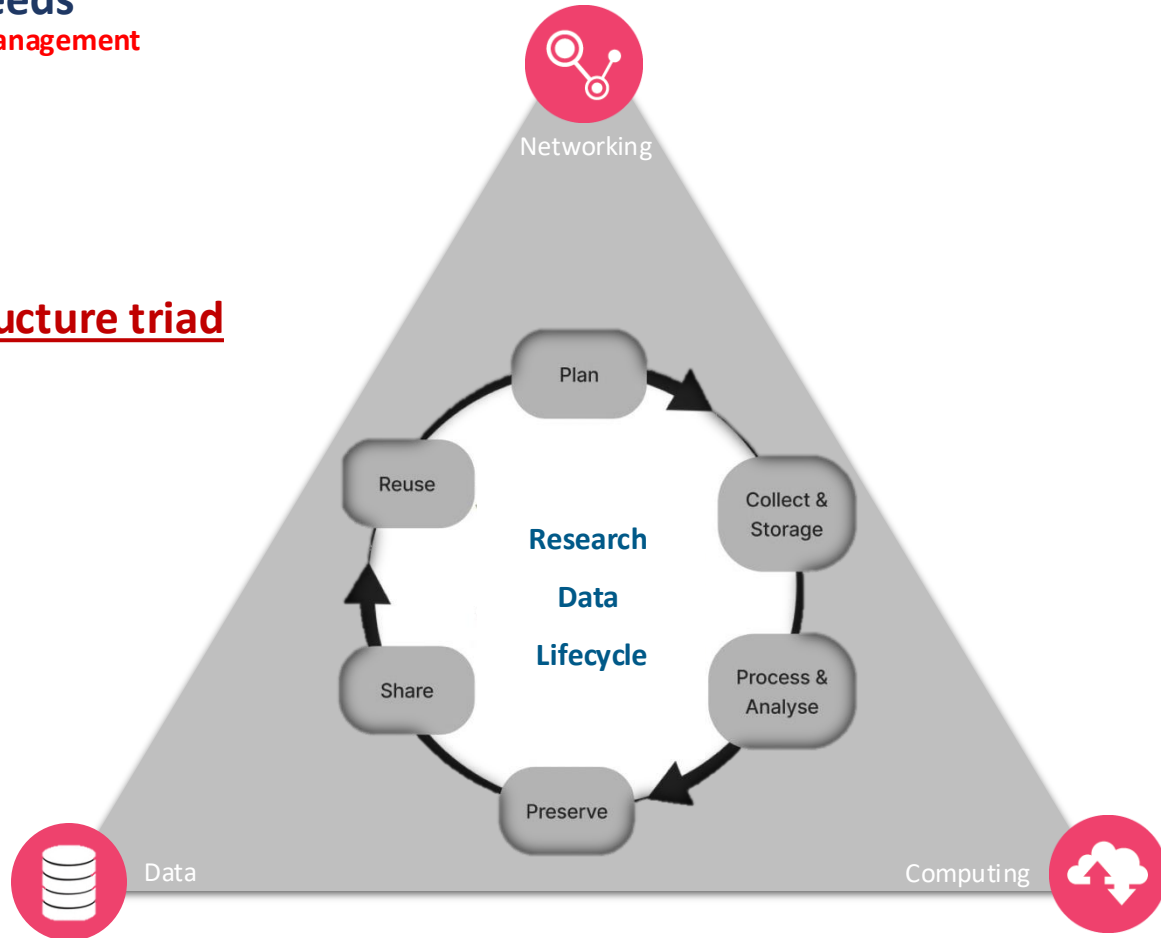
Compute and Sync Platforms

e.g. in-house/edge GPUs, Quantum, QKD, AWS, Azure, OneDrive, GoogleDrive, ownCloud, NextCloud, rsync, SFTP, SCP, Spark Streaming, Kafka, Teradata, RedShift,...

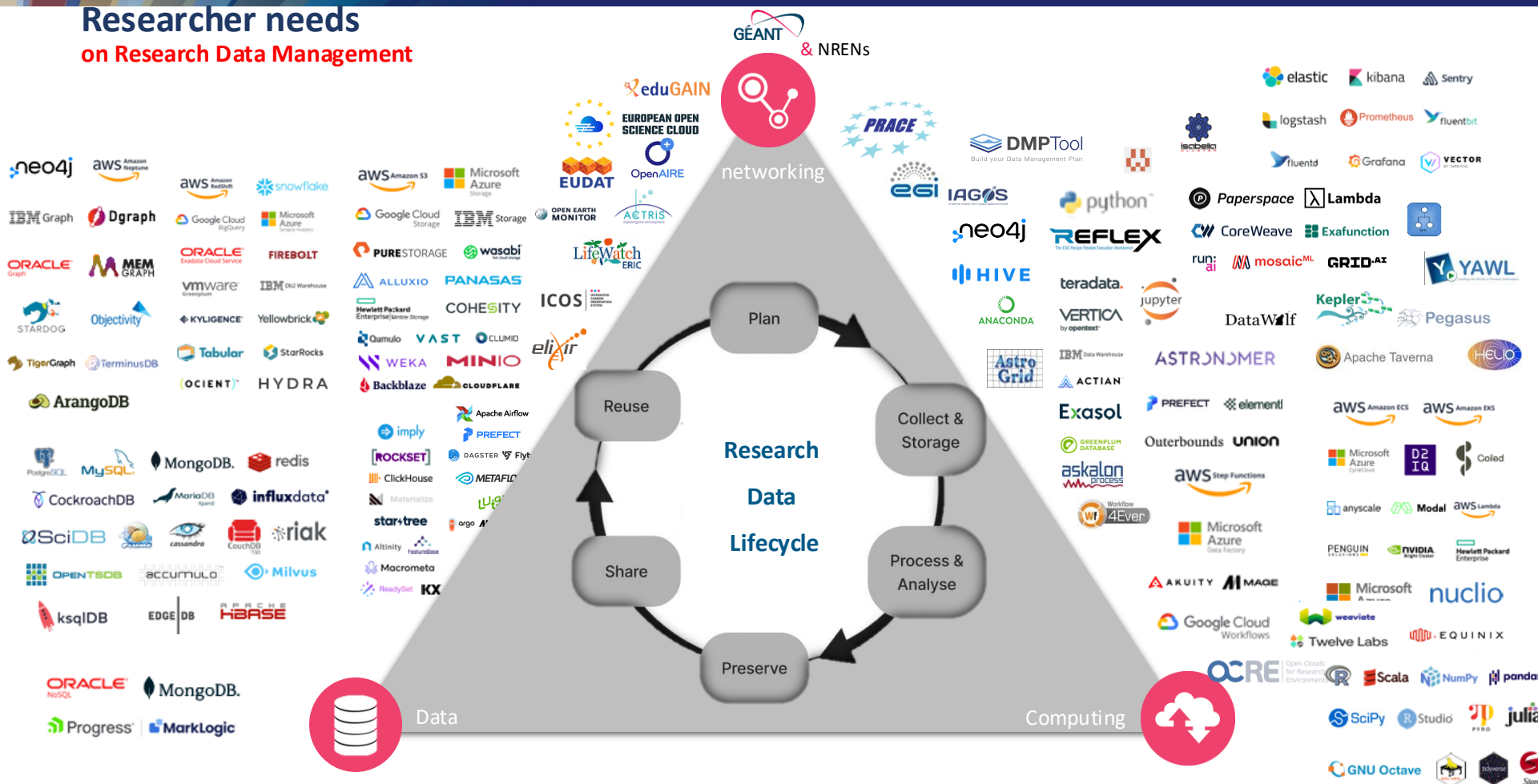
Researcher needs on Research Data Management

The e-Infrastructure triad

- data
- compute
- networking

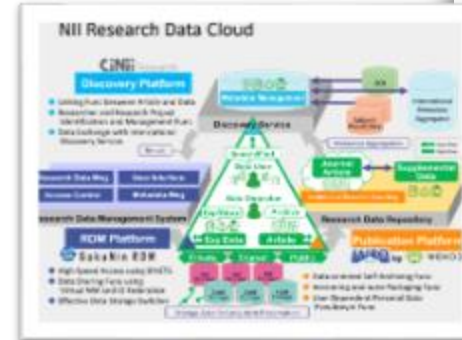
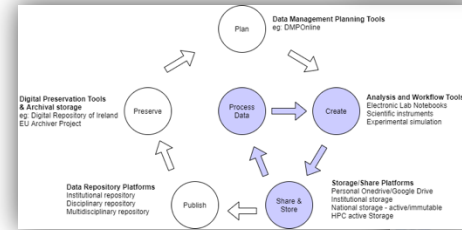
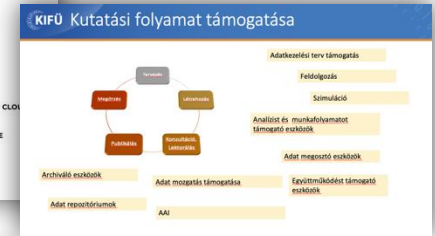
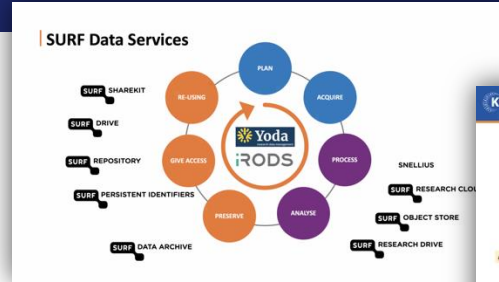


Researcher needs on Research Data Management



What NRENs are doing?

- Some NRENs are aware and are also mapping it to improve services offers and research support;
- NRENs run essential services on supporting data exchanges;
- Some NRENs are running specific services on the support of the RDM: e.g.: file sender, cloud, data catalogs, PID services, data repositories, research data planning, SUNET drive, SURF drive, TRES,...
- others are working on procurement frameworks for RDM services;
- Actively participating/supporting data initiatives e.g.: EOSC, Dataspaces, EUDAT, and user communities like SKAO, Copernicus,...
- Building really interesting things on metadata management; e.g.: RaID SURF



BUT...

Networking Stack (and NRENs' services focus)

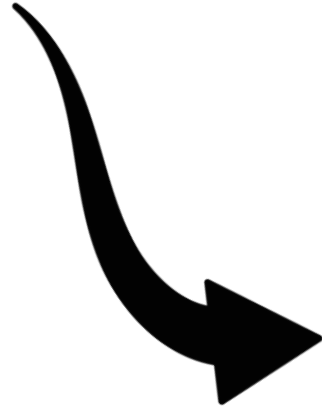


pre-2000...
connectivity,
performance,
distributed
apps...

Networking Stack (and NRENs' services focus)



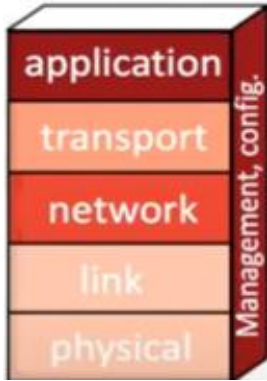
pre-2000...
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AI/ML Stack

AI Applications	Network Security	Home security	Warehouse automation	Robotic surgery	Autonomous Vehicles	Risk Analysis	Supply Chain Optimization	Natural resource optimization	Back-office automation (Cognitive RPA)	Customer support
Compound Services	Fraud Detection		Product Recommendation		Risk Analytics		Auto Data Cleansing		Chatbots	
Discrete Services	Speaker recognition	Speech to text	Text to speech	Language comprehension	Sentiment analyzer	Personality analysis	Form Recognition	Video Indexing	Ink Recognition	Face Recognition
Auto ML Platforms	AUTO ML platforms (they let you focus on the business problem and they manage all the underlying models, tuning, hyperparameter combinations, model mgmt and infrastructure that's required for dev, test, and production. Examples: Google AutoML)									
Manual ML Platforms	ML Platforms <small>(e.g. AWS SageMaker, Azure ML, Google ML)</small>	Data Processing Tools <small>(e.g. Data labelling services)</small>		Model Diagnostics		AI Infrastructure provisioning		Pre-built software stacks		Model Optimization / Rationalization <small>(e.g. AWS SageMaker NEO)</small>
ML Frameworks	MXNet	TensorFlow		Chainer		Gluon		PyTorch		Horovod <small>(and many others)</small>
Data Types	Structured Data			Unstructured Data <small>Copyright 2020 Troy Angriquin, Version 2</small>				Semi-structured data		Time series data
Data	Data Warehouse	Big Data Processing <small>(e.g. MapReduce/Hadoop)</small>		Data Orchestration & ETL (& ELT!)		Analytics & Visualization		Relational Databases		NoSQL/Non-relational databases
Compute Virtualization	Virtual Machines			Containers				Serverless <small>(e.g. AWS Lambda, Microsoft Functions)</small>		
Compute Hardware	Inference + Training Accelerators <small>(e.g. AWS Inferentia, Google TPU, etc.)</small>				GPUs <small>(NVIDIA, ARM, etc.)</small>			CPUs <small>(Many)</small>		
Storage Infrastructure	File storage	Object storage		Block storage		Hybrid storage		Archiving & Backup storage		Bulk data transfer systems
Network	Virtual Network		Connectivity		Domain Name Services		Direct Connections		Load Balancing Services	
Security	Identity & Access Mgmt	Directory Services		Multi-factor authentication		Role based access control		Firewalls		Encryption & PKI
Deployment Target	Cloud <small>(AWS, Google, Azure)</small>		Datacenter		Mobile		IoT <small>(Camera, Raspberry Pi, etc.)</small>		Edge <small>(Vehicle, Factory, etc.)</small>	

Networking Stack (and NRENs' services focus)



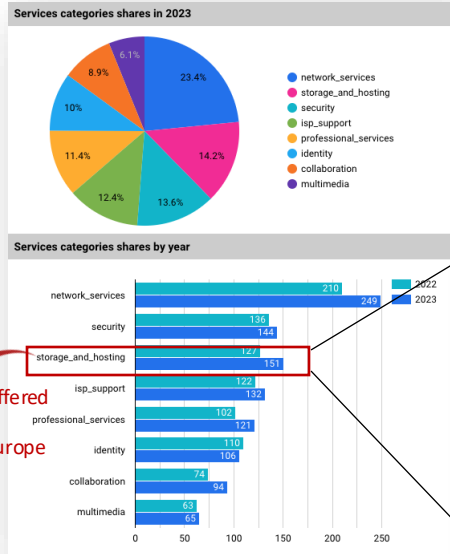
from 2010...
data centers,
cloud,
SaaS,
mobility

AI/ML Stack

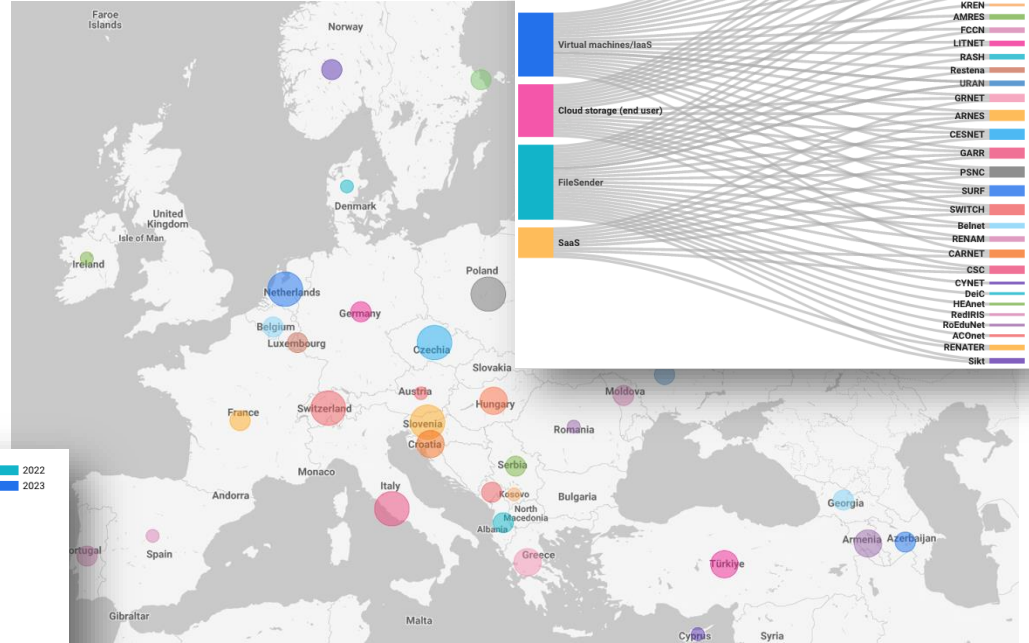
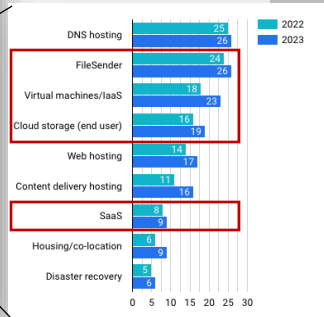
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NRENs services *GÉANT Compendium data 2023

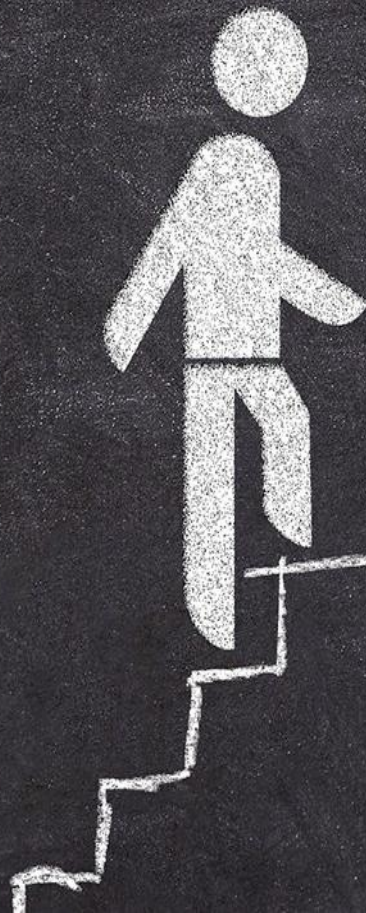
In 2023 storage and hosting services surpassed the security services in NRENs portfolio.



2nd most offered services by NRENs in Europe



- LABNET
- AzScienceNet
- DFN
- GRENA
- MREN
- SUNET
- ASNET-AM
- KIFU
- ULAKBIM
- KREN
- AMRES
- FCCN
- LITNET
- RASH
- Rostelecom
- URAN
- GRNET
- ARNES
- CESNET
- GARR
- PSNC
- SURF
- SWITCH
- Belnet
- RENAM
- CARNET
- CSC
- CYNET
- DeIC
- HEAnet
- RedIRIS
- Rodanet
- ACONet
- RENATER
- Sikt



WHAT'S
NEXT



And about AI for NRENs?

Where is the data?



Structured Data



Unstructured Data

PDFS

WORD DOCUMENTS

SPREADSHEETS

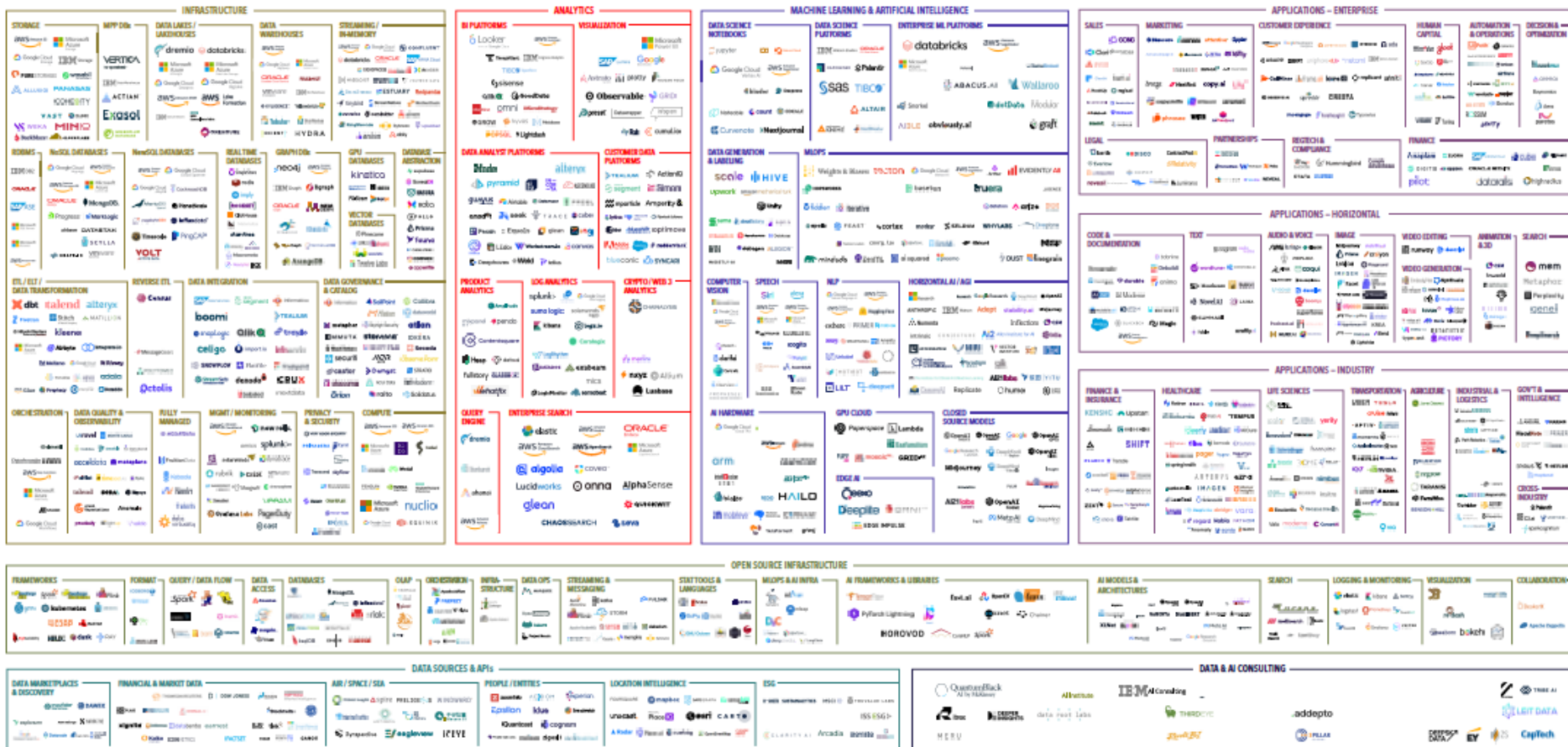
PRESENTATIONS

SOCIAL MEDIA POSTS

BOOKS

OPERATIONAL DATA (LOGs, Measurements)

THE 2023 MAD (MACHINE LEARNING, ARTIFICIAL INTELLIGENCE & DATA) LANDSCAPE





The secret of data science is that the tools are almost irrelevant...



The secret of data science is that the tools are almost irrelevant...

WE NEED THE RIGHT QUESTIONS TO SUPPORT DECISION MAKING

85% of big data projects fail

(Gartner)

**87% of data science projects
will never go to production**

(VentureBeat)

Fonte: <https://www.datascience-pm.com/project-failures/>

Decision Making

The process of choosing the most suitable path for business decisions.

Used for directions in order to solve problems or seize opportunities.



Conditions for Decision Making



- data - information

+ data + information

Uncertainty

Risk

Certainty

Managers should always seek to reduce uncertainties, anticipate risks and improve predictability and effectiveness.

Lots of questions...

- Where is the NREN's data?
- Does we have the right business questions?
- Does we have the right operational questions?
- What are the risks and impacts? (skills, reliability, security, GDPR,...)
- Are we sharing data with other NRENs? Can we share models?
- How we will be organising our community to share experiences?

What's next?

1. What are the current AI use cases in your organisation? Or potential uses?
2. What are the top 3 AI-driven projects or initiatives you'd like to see in your organisation / NREN / GÉANT in the next 2-3 years?
3. What are the key challenges, ethical considerations and potential risks associated with AI in NRENs?



Thank You

Any questions?

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