Illustration of AI use in CEA Fundamental Research Direction

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IN2P3/IRFU Machine Learning workshop

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Amphi CC-IN2P3

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OUTLINE

- Preamble
- The developments and uses of AI at CEA/DRF
- AI Ecosystem at CEA

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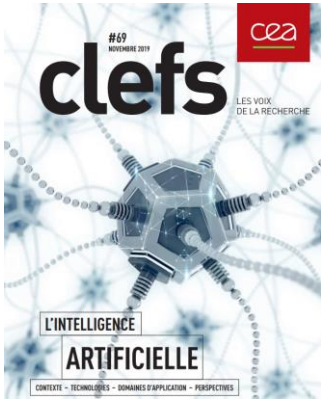
Preamble

- The application and use cases listed in this presentation do not represent an exhaustive list of :
  - What is implemented at the CEA Fundamental Research Direction (DRF): uses and expertise
  - What is implemented at CEA level



- Clefs CEA #69: AI at CEA

- Pitfalls
  - Identification of AI actors at CEA (development, use, implementation, experimentation …)
  - Implementation of an effective communication / networking channel on AI themes at the CEA
  - Extend this communication to CEA's partners (academic & industrial)

Aim of this talk:

- Provide an overview of what's done or experimented in AI at Fundamental Research Direction CEA
- Enhance communication between CEA & IN2P3 on AI topics

- Use of AI for data analysis (real or simulated)

  - Context: Data are not or not sufficiently exploited. Machine Learning (ML) and/or Deep Learning (DL) algorithms used to quickly and efficiently exploit this data

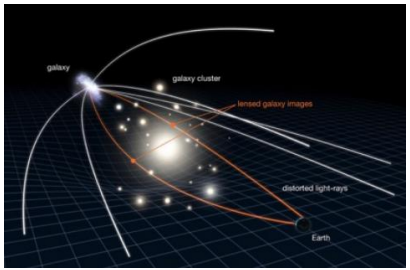
  - Examples:
    - Pre/post processing of data (real or simulated)
    - Data analysis
    - Reconstruction of information from partial data
    - Detection of body/patterns/information

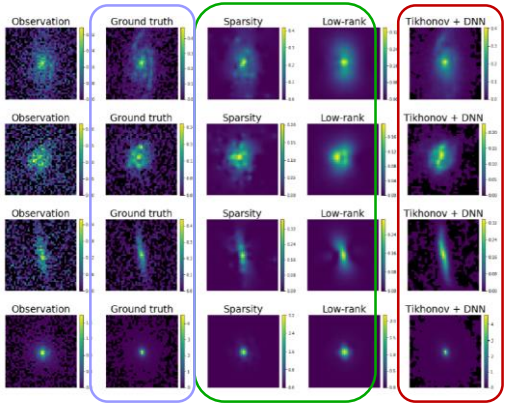
Data (images) → Results (images)

- AI Applications in astrophysics(DRF/IRFU)

De-convolution for weak gravitational lenses

- Use of Deep Learning (DL) methods for image processing of galaxies
- Improves restorations of galaxy images
- Obtain a precise size of the celestial bodies





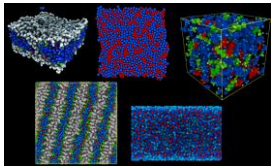
Obtained with the Deep Learning algorithm

Obtained with a "classic" simulation

Real size

Data (images) → Result (numerical parameter)

- Material science applications

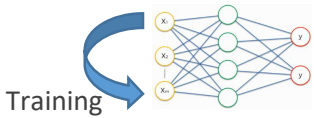


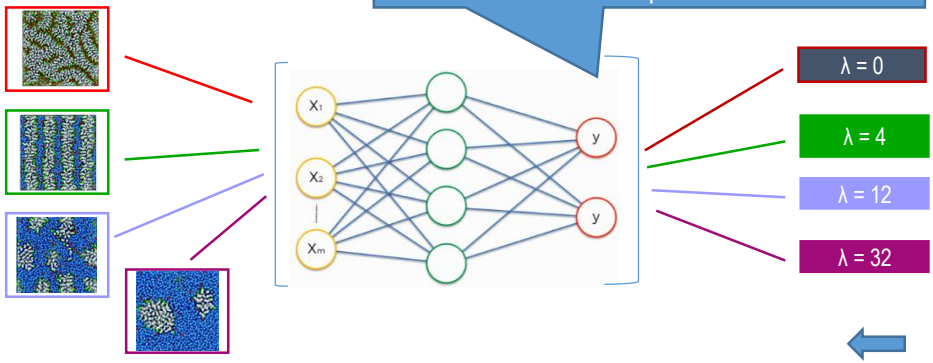
DRF – IRIG (Grenoble): Classification of materials using the ML

- Find the value of numerical parameter λ by analyzing an image
- Advantages: fast, robust algorithm, avoids costly HPC simulation, data available

CNN training on existing data: databases associating image and λ

Inference: from an experimental image, recover the parameter λ





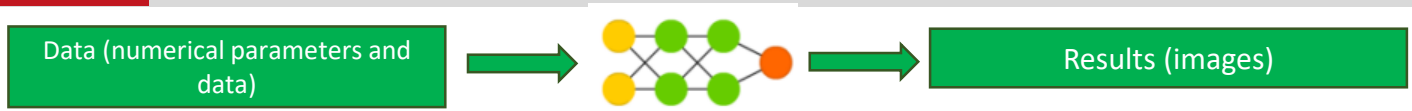
- Use of AI in addition/complement to simulations
  - Context: Use of learned models to complement or replace digital models
  - Exemples:
    - ML or DL instead of numerical models / simulations
    - In addition to numerical simulations (integrated into the simulation)
    - Estimate / compare the relevance of a numerical model
    - Select the relevant numerical simulations

- Using AI to build new models
  - Context: In some application cases, the data (parameters, simulated, calculated data, etc.) are linked via a complex model (equation, simulation, etc.), but we cannot demonstrate a rapid and direct correlation.

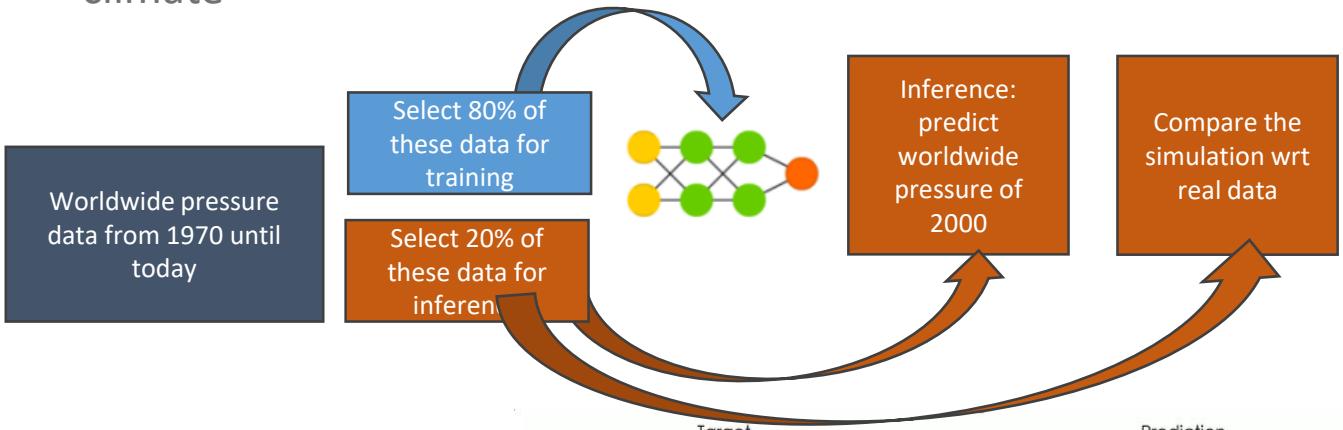
    The ML and DL algorithms can highlight correlations between the data.

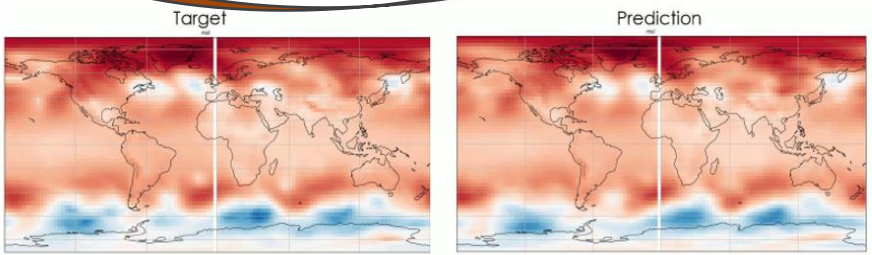
  - Exemples:
    - Complex physical systems
    - Data modeling

NEW MODEL DESIGN



- Use cases in for climate prediction
  - DRF/Irfu/LSCE: Use of “Recurrent neural network” to predict the climate





NEW MODEL DESIGN

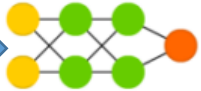
observational data (MRI) and Simulated data →  → Unaccessible observational data

- Application cases for brain modeling (DRF/Joliot/Neurospin)

Cytoarchitecture → HPC Simulation → Simulated MRI → {IRM; cytoarchitecture}

Simulated MRI → 

Inference: predicts cytoarchitecture associated with simulated MRI → Use this model to predict the cytoarchitecture of a measured MRI

MRI Image →  → cytoarchitecture

Construction of an {IRM, cytoarchitecture} model unreachable via simulation / measurement

AND MANY OTHER WORKS…

- AI to select the “best” simulation
  - DRF/IRFM Cadarache – Gyrokinetic plasma simulation
  - Use of AI to stop simulations that will not provide satisfying results
- Molecular Imaging Research Center (MIRCen): perspectives to use AI to analyze brain images
  - Detect and count the # of neurons on each brain image
- AI for analyzing integrated heterogeneous health data (imaging, omics, clinical data …) → personalized medecine
- Many other to be identified:
  - We need to provide adapted compute platforms to researchers with large observational data to analyze them with AI

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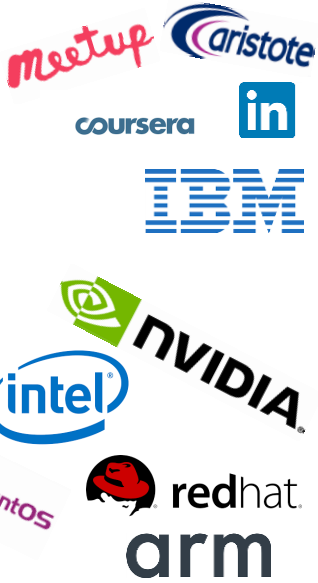
AI Ecosystem at CEA

ETHICS AND IA

- Integrate ethical issues related to AI at the heart of the model design
  - Explicability of AI, sensitive data…
- Trap: Ethics is not an “optional” notion
- College of ethics created at CEA
  - Moderator: Christian GAMRAT
  - Commission mandated by the Haut Commissaire (end of 2017)
    - Think tank on "moral issues in automatic decision-making"
    - Brings together all the CEA departments

Federate an AI community **with** the CEA



- Community outside the CEA:
  - Local communities: Saclay, Grenoble,…
  - Interdisciplinary
- With other academic partners
  - INRIA (Scikit-Learn)
  - CNRS
  - Universities
  - Other…
- With industries (manufacturers or applications)
  - Manufacturers: Manufacturers (Intel, NVIDIA, NEC, AMD, ARM, IBM, Google, AWS, Redhat… and many many many other!) Offer
    - **FREE trainings**
  - on their tech and / or software
    - **FREE equipment loans**

AI and computing needs: French context

- French “late” response to propose national calculation means
  - Problem with the power / visibility of GAFAMI Cloud platforms
  - Late response but adapted in terms of resources
  - Jean Zay platform at IDRIS: 1044 GPUS for AI

- Study of the implementation of a French AI Cloud for research
  - Data storage, management and accessibility issues (no sovereign cloud, long tail of science)

SOME ONGOING PROJECTS ON AI AT CEA/DRF


- CEA/RIKEN Collaboration
  - French/Japanese collaboration since 2017 (5 years collab.)
  - AI focus on:
    - HPC for AI: Optimizing AI framework for HPC platforms
    - AI for predictive maintenance
    - AI for HPC: Use of AI to help/improve/replace HPC simulations
- AIDAS: AI, Data Analytics and Scalable Simulation
  - French/German collaboration (FZJ Juelich)


    - Focus on AI for the following scientific domains:
      - HPC
      - Human Brain
      - Material Science
      - Energy
- Human Brain project
  - 10 y project started in 2013, 133 partners (academic, private and public)
  - HPC focus and data analytics (Cf presentation regarding MRI/cytoarch.)

THANK FOR YOUR ATTENTION

QUESTIONS?

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