



Greening AI

Is it too complex?

June Sallou



January 23rd, 2026
Journée GT Logiciel Éco-Responsable

Who am I?

(Sustainable) Software
Engineering
& Green AI



AI-Based Software is eating the world

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ÉCONOMIE • INTELLIGENCE ARTIFICIELLE

Les assistants d'IA s'ouvrent à la publicité, de ChatGPT à Google

OpenAI a officialisa

Les Echos

En continu Le journal Mes articles

Par Alexandre Economie Politique Municipales 2026 Entreprises Finance - Marchés Bourse Monde Tech-Médias Start-up Régions Patrimoine Trav

Publié le 16 j

Lire plus

Article ré

« On doit accepter de coexister avec ChatGPT » : quand les IA font des diagnostics avant les médecins

Les outils d'IA comme ChatGPT bouleversent la relation médecin-patient. S'ils permettent aux patients de mieux s'informer, ils posent aussi des risques, notamment des erreurs ou des prescriptions inappropriées.

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NEWS RELEASE | Publication 11 February 2025

EU launches InvestAI initiative to mobilise €200 billion of investment in artificial intelligence

Artificial Intelligence (AI) Action Summit in Paris, Commission President Ursula von der Leyen launched InvestAI, an initiative to mobilise €200 billion for investment in AI, including a new Jean Monnet fund of €20 billion for AI gigafactories.

Artificial intelligence infrastructure is needed to allow open, collaborative development of the most complex models and to make Europe an AI continent.

Commission President Ursula von der Leyen said:

"AI will improve our healthcare, spur our research and innovation and boost our competitiveness. We want AI to be a force for good and for growth. We are doing this through our own European approach – based on openness, cooperation and excellent talent. But our approach still needs to be supercharged. This is why, together with our Member States and with our partners, we will mobilise unprecedented capital through InvestAI for European AI gigafactories. This unique public-private partnership, akin to a CERN for AI, will enable all our



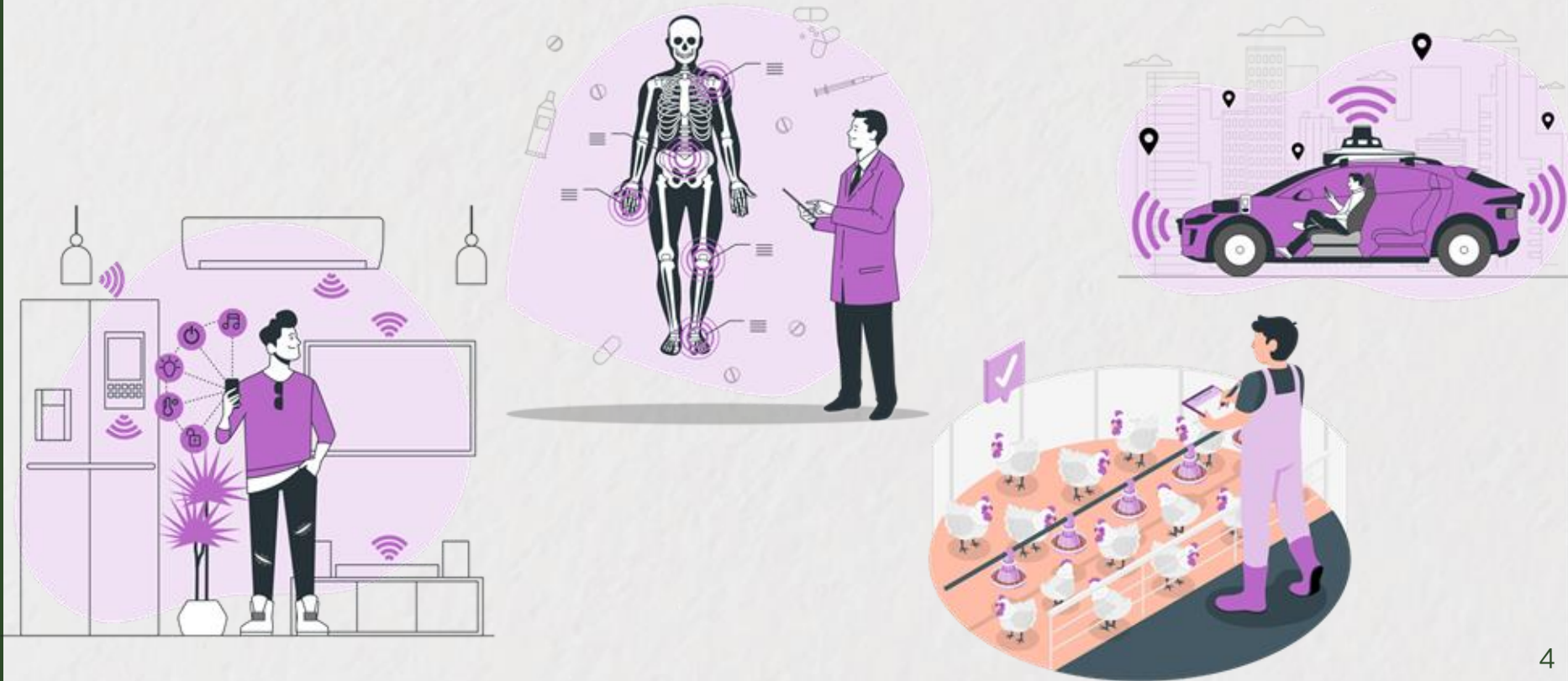
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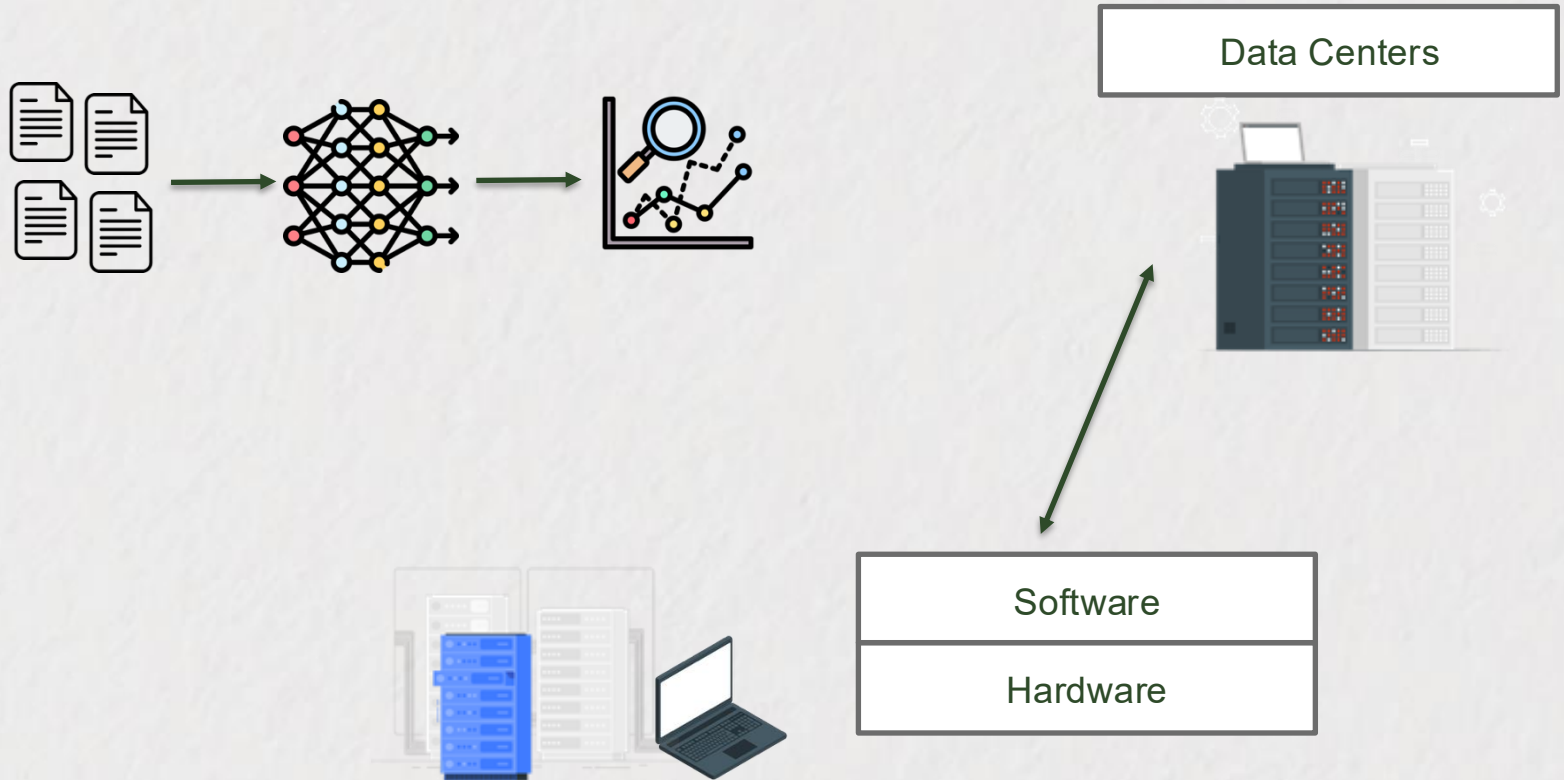
Artificial intelligence

Screenshot

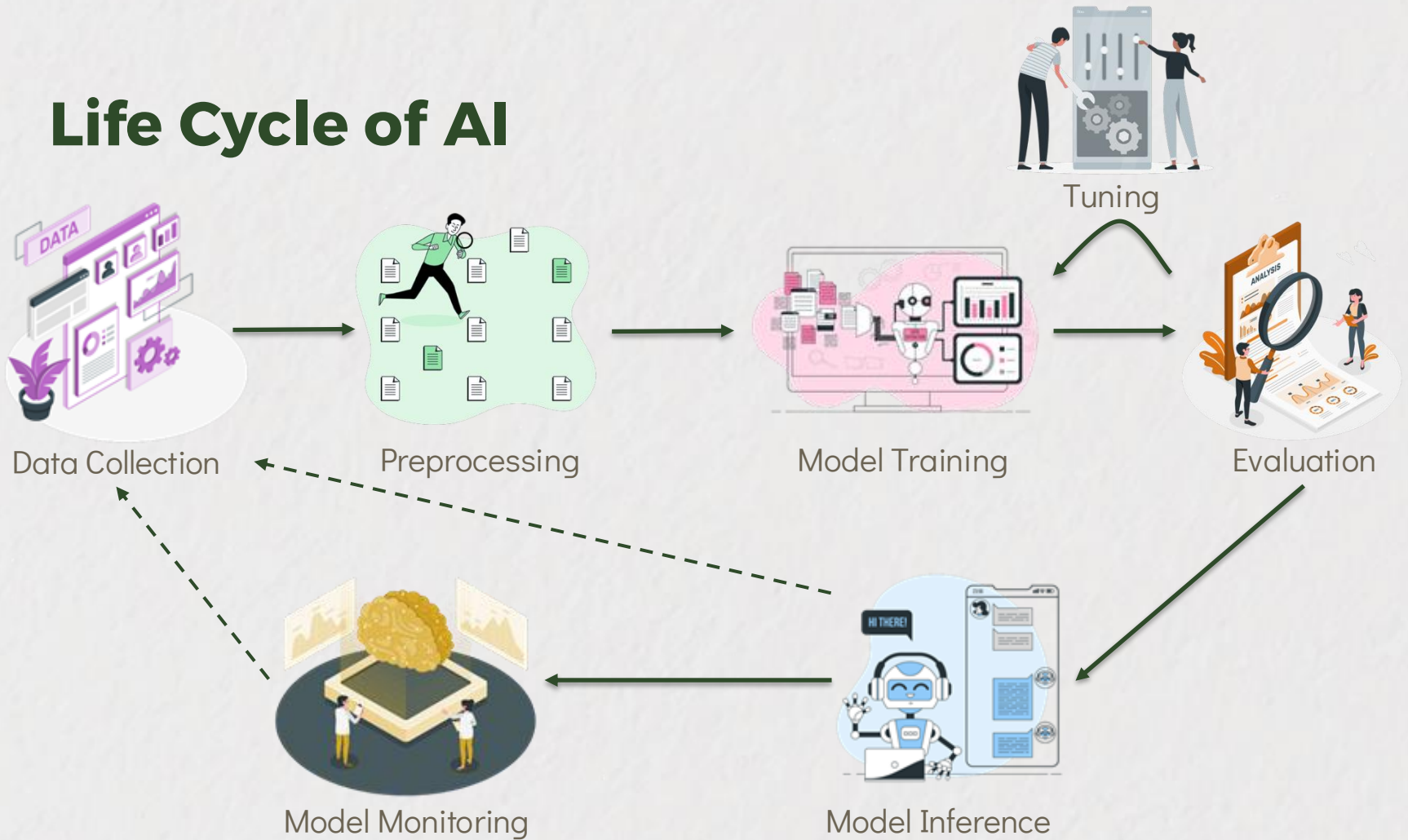
AI-Based Software is eating the world



Architecture of AI-based systems



Life Cycle of AI



AI: What is the limit?

AlexNet to AlphaGo Zero: 300,000x increase in compute

Log scale Linear Scale



Two Distinct Eras of Compute Usage in Training AI Systems



Computing for AI training has been **doubling** every **3.4 month** since 2012.

[\[https://openai.com/research/ai-and-compute, 2018\]](https://openai.com/research/ai-and-compute, 2018)

AI-Based Software is Heating the world



"By 2026, the AI industry is expected to have grown exponentially to consume at least **ten times** its demand in 2023."

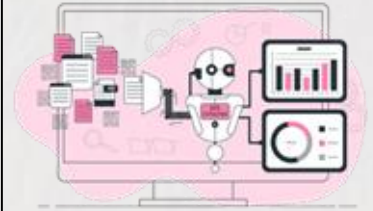
Training 1 NLP model: 5x lifetime emissions of a car.

AI-Based Software is Heating the world

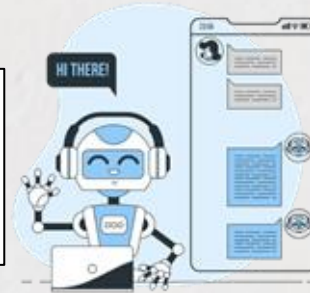
Google's global data centers consumed ~6 billion gallons of potable water in 2024



Training GPT-3 was equivalent to supplying electricity for about 120 U.S. homes annually, or emitting 552 t CO₂



Chat-GPT emits 4.3 g of CO₂ for a single query and uses nearly 0.5 L for 10-50 queries (GPT-3).



Greening AI-Based Software

Green AI

“Green AI regards practices aimed at [...] mitigating the impact that AI itself can have on the natural environment.”

Red AI vs Green AI

Red AI



Accuracy: 0.999999999999

Green AI

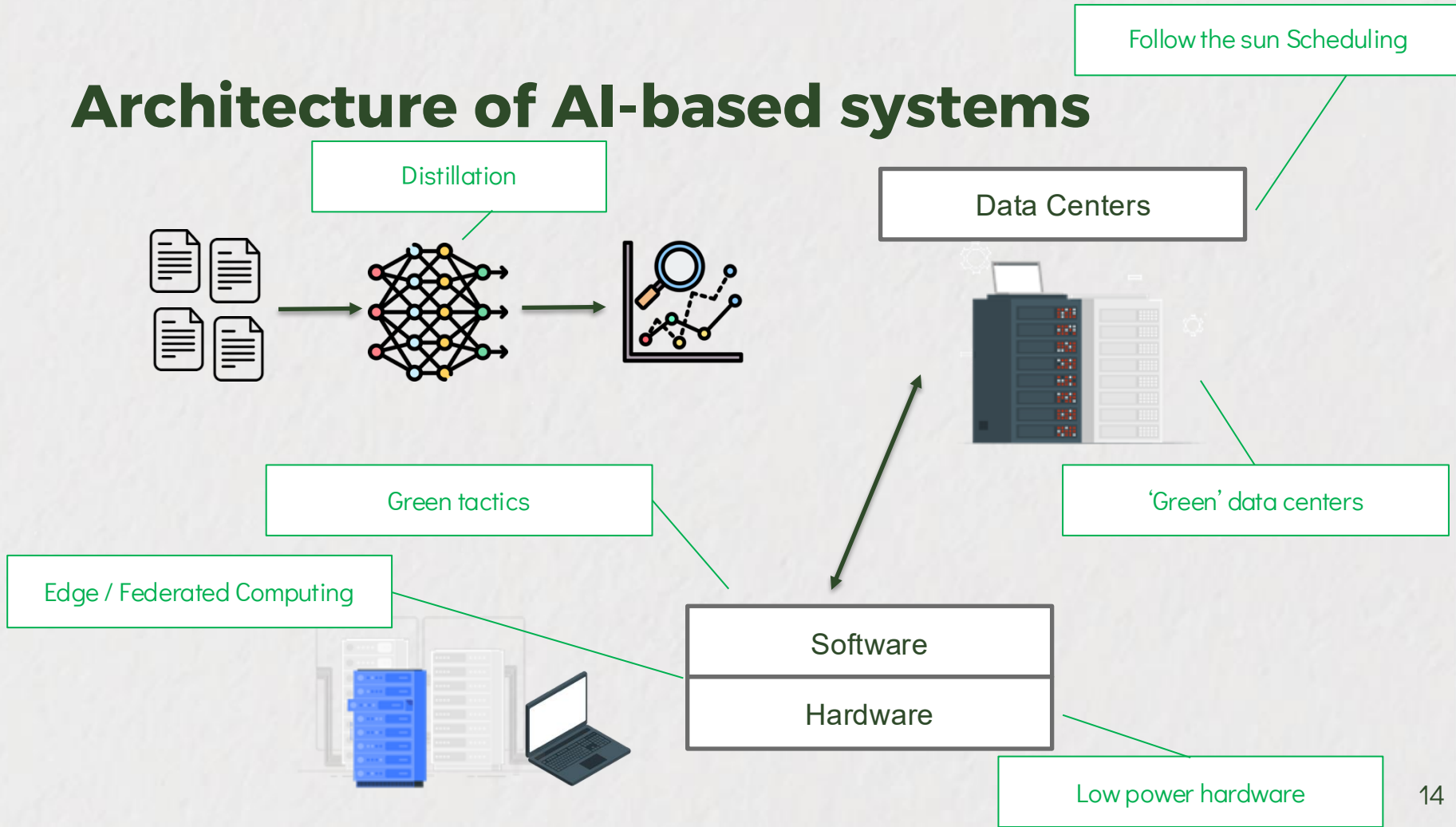


Energy
Time
Reproducibility
Reusage

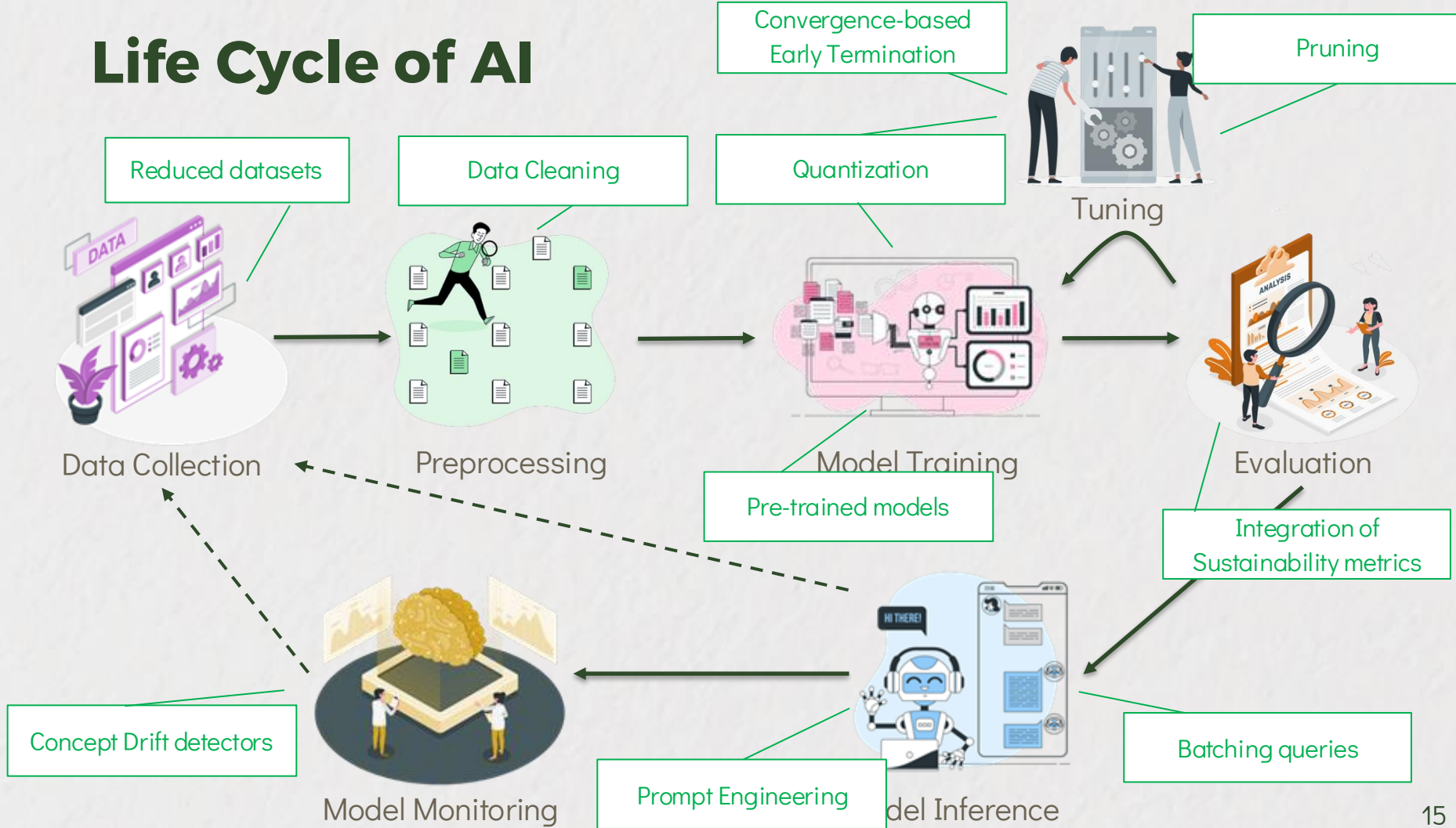
Green AI: Where are we now?



Architecture of AI-based systems



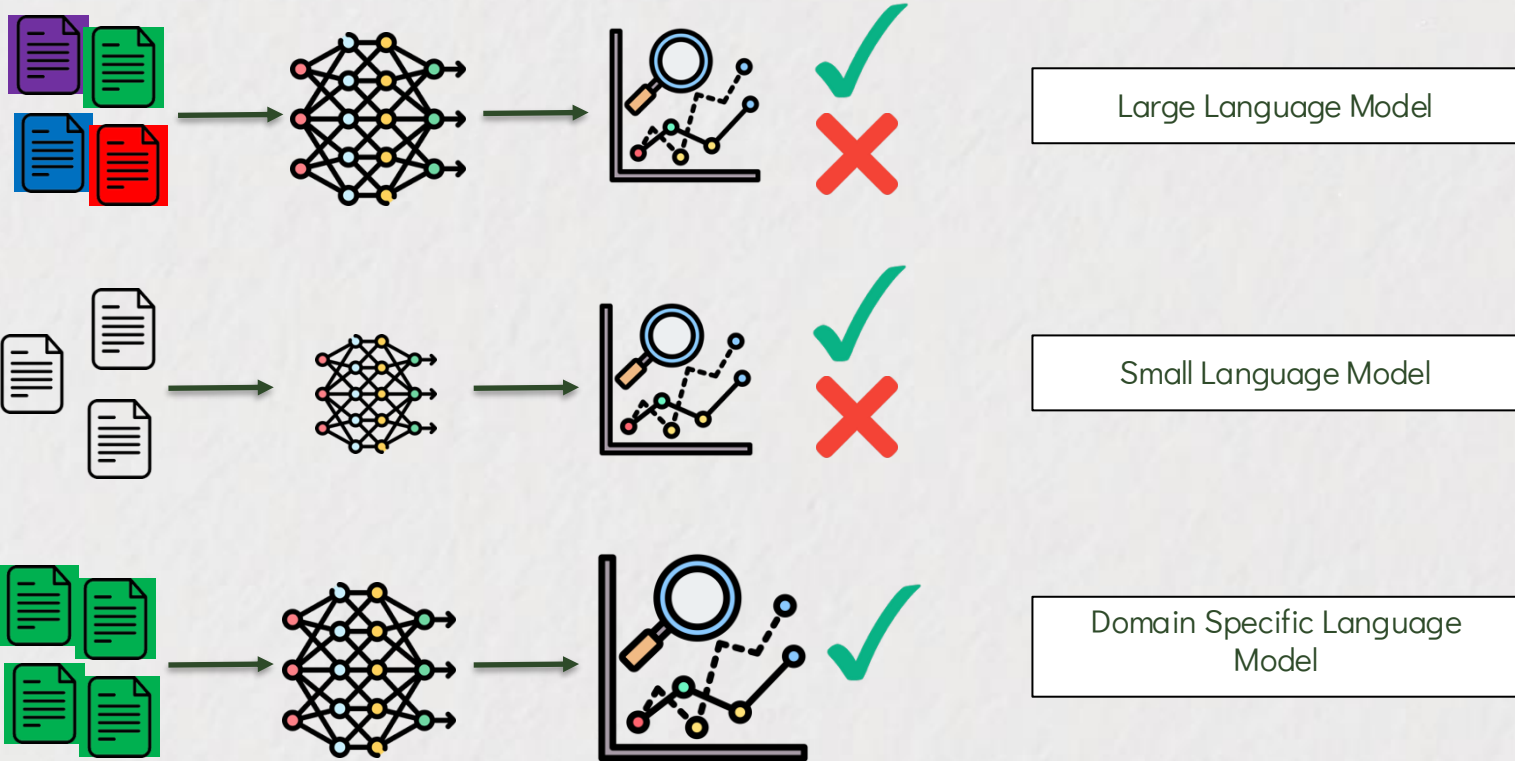
Life Cycle of AI



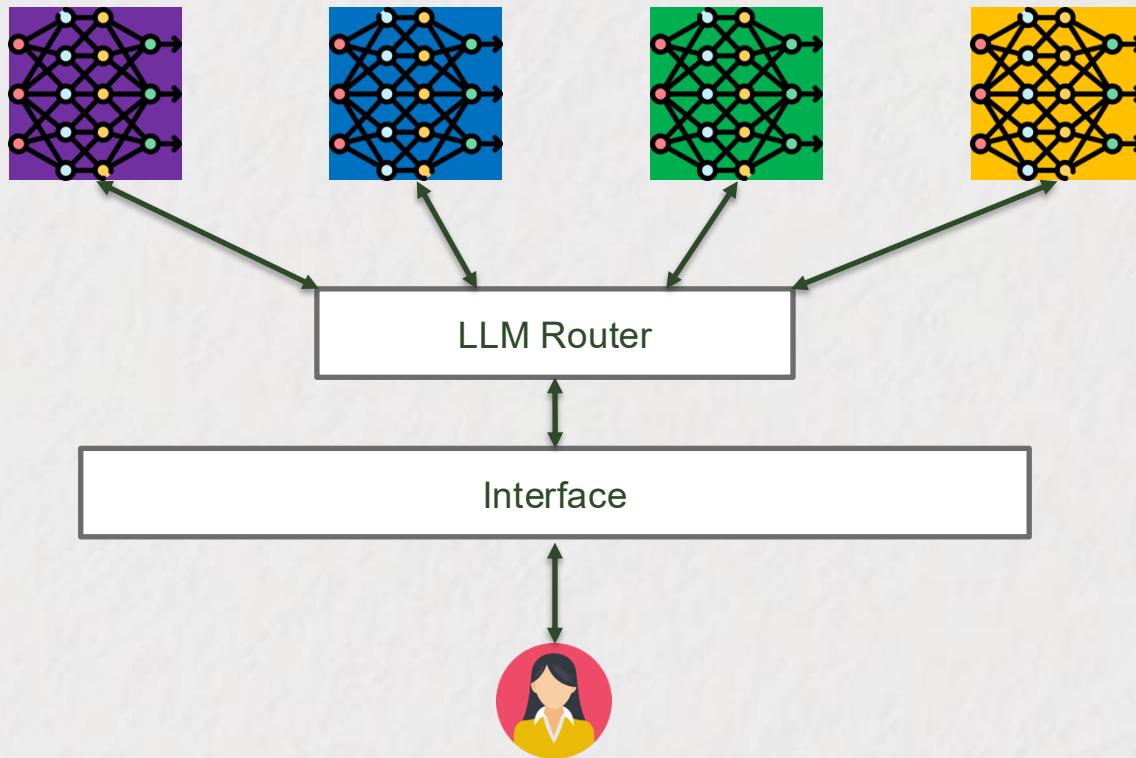
Research General Directions



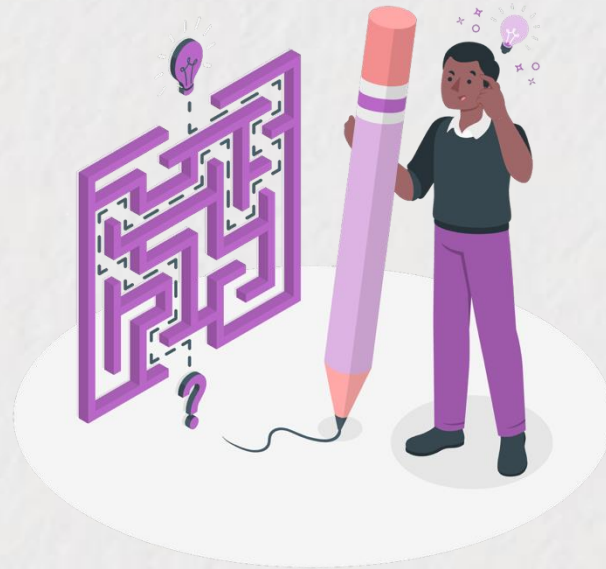
From LLMs to (D)SLMs



AI as microservices



Complexity everywhere?



Evolving AI Systems

- Rapid emergence of new models and architectures
- Continuous hardware and accelerator (e.g., GPU, AI chips) innovation
- Frequent changes in software frameworks and stacks

Measuring Environmental Impact

- Multiple metrics with different meanings and scopes (e.g., J, W, CO₂eq)
- Environmental impact varies over time and location (e.g., rebound effect)
- Sustainability spans full system lifecycle (e.g., LCA)



Limited Access and Representativeness

- Limited access to large scale industrial infrastructure
- Studies focus on small or local systems by necessity
- Difficulty validating results at realistic scale
- Dominant AI systems often remain opaque

Comparing and Reusing Results

- Results are highly context dependent
- Hardware, configuration, and workload strongly influence outcomes
- Lack of shared reporting formats and metadata
- Hard to generalise findings across systems

People and Organisational Change

- Sustainability impact is indirect and delayed
- Limited incentives to optimise for energy or carbon
- Low trust in complex or uncertain measurements
- Tools are not adapted to existing workflows

Greening AI : From Complexity to Actionable Directions



Evolving AI Systems

- Rapid emergence of new models and architectures
 - Continuous hardware and accelerator (e.g., GPU, AI chips) innovation
 - Frequent changes in software frameworks and stacks
- Focus on system level abstractions rather than model specific optimisations
 - Study trends across model and hardware generations
 - Encourage software hardware co-design for energy efficiency

Measuring Environmental Impact

- Multiple metrics with different meanings and scopes (e.g., J, W, CO₂eq)
 - Environmental impact varies over time and location (e.g., rebound effect)
 - Sustainability spans full system lifecycle (e.g., LCA)
- Use multiple complementary metrics instead of a single score
 - Support component level attribution where possible (critical path)
 - Evaluate impact across the full AI system lifecycle (Adaptive systems)

Limited Access and Representativeness

- Limited access to large scale industrial infrastructure
 - Studies focus on small or local systems by necessity
 - Difficulty validating results at realistic scale
 - Dominant AI systems often remain opaque
- Identify when small scale experiments are valid proxies
 - Develop trusted industry academia collaboration models
 - Report scope and representativeness limits explicitly

Comparing and Reusing Results

- Results are highly context dependent
 - Hardware, configuration, and workload strongly influence outcomes
 - Lack of shared reporting formats and metadata
 - Hard to generalise findings across systems
 - ➔ Risk of misleading comparisons and rankings
- Standardise reporting formats and contextual metadata
 - Focus on patterns and practices rather than rankings
 - Hardware agnostic programming

People and Organisational Change

- Sustainability impact is indirect and delayed
 - Limited incentives to optimise for energy or carbon
 - Low trust in complex or uncertain measurements
 - Tools are not adapted to existing workflows
- Align incentives with sustainability goals
 - Provide role specific guidance for researchers, engineers, and managers
 - Establish specific regulation
 - Design easy/ready to use tools for existing workflows
 - Education
 - Multidisciplinary research

Behave Workshop at ICT4S 2026 (12/06/26)

Behave Workshop at ICT4S 2026



BEHAVE 2026: THE 2ND INTERNATIONAL WORKSHOP ON MULTI-DISCIPLINARY STRATEGIES FOR GREENING SOFTWARE ENGINEERING (AT ICT4S 2026)

ABOUT THE WORKSHOP

The ICT community has been tackling the rising environmental impacts of devices and software with approaches ranging from measuring these impacts to minimizing them. In contrast, humans are often forgotten in the energy-efficiency equation, and in particular in software systems. For instance, end users are increasingly interacting with smart devices and objects, and in particular with the software running and piloting them. Focusing on software system optimizations without integrating users in the energy reduction strategies might lead to rebound effects (*i.e.*, the Jevons paradox).

The Behave workshop aims to foster and build a multi-disciplinary community around green software. We aim to explore, study and propose strategies to reduce the energy consumption of software systems through a multi-disciplinary approach. We also aim to build bridges between the different communities working on improving the **energy efficiency of the technological foundation (hardware and software)**, those working around **design factors (HCI, UI/UX design)**, those working on **social aspects (behavioral studies, sociological impacts)**, and those working on **individuals (environmental psychology)**.

IMPORTANT DATES

- Presentation submissions deadline: Submissions will be reviewed on a **rolling basis** until **Friday, May 22, 2026**.
- Acceptance notification: Submissions are reviewed as they are received, and applicants will be notified of decisions in a timely manner.
- Workshop date: **12 June 2026, from 9 am to 4 pm**.

Submission of proposals to: adel.noureddine@lip6.fr



Wrap Up

Philosophy





Human Intelligence before Artificial Intelligence



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THANKS

Do you have any questions?



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