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Summer Workshop 25' London

GreenAItelier: Sustainable AI Systems from Open Data to Policy Integration

Project n° 17

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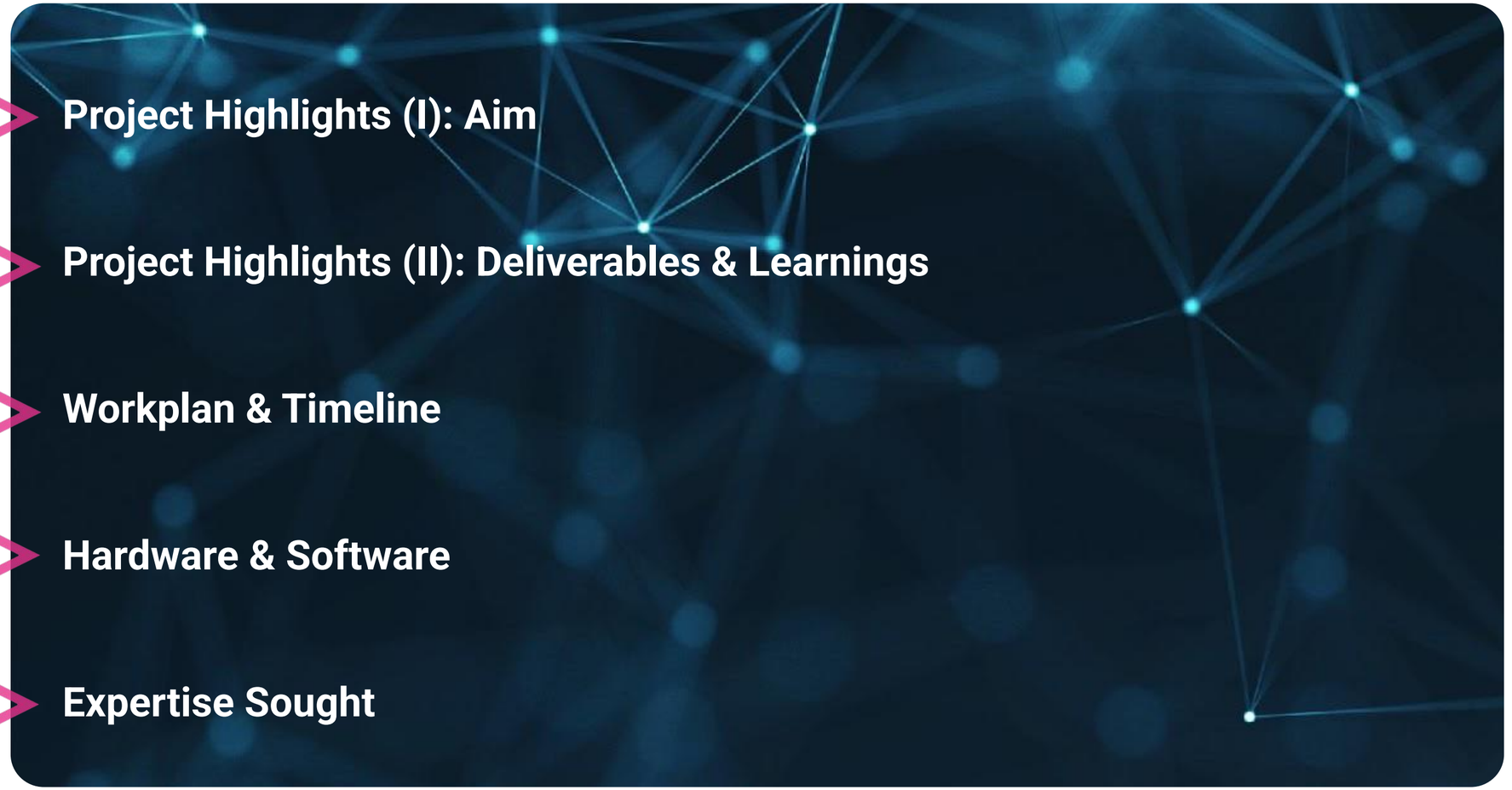

- Project Highlights (I): Aim
- Project Highlights (II): Deliverables & Learnings
- Workplan & Timeline
- Hardware & Software
- Expertise Sought

Motivations

We Need to Decarbonize Software

By Rina Diane Caballar • Illustrations by Elias Stein

The way we write software has unappreciated environmental impacts

https://ieeexplore.ieee.org/abstract/document/10491388/

Society | DOI:10.1145/3603746 Keith Kirkpatrick

The Carbon Footprint of Artificial Intelligence

Looking for ways to cut the release of greenhouse gases attributable to AI use, at a time that usage is very likely to grow.

THE GROWING UTILIZATION of artificial intelligence (AI) is apparent across all facets of society, from the models used to enable semi-autonomous cars, to models that serve up recommendations on streaming or e-commerce sites, and in the language models used to create more natural, intuitive human-machine interaction. However, these technological achievements come with costs, namely the massive amounts of electrical power required to train AI algorithms, build and operate the hardware on which these algorithms are run, and to run and maintain that hardware throughout its life cycle.

https://dl.acm.org/doi/pdf/10.1145/3603746

Carbon-Efficient Software Design and Development: A Systematic Literature Review

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The ICT sector, responsible for 2% of global carbon emissions, is under scrutiny calling for methodologies and tools to design and develop software in an environmentally sustainable-by-design manner. However, the software engineering solutions for designing and developing carbon-efficient software are currently scattered over multiple different pieces of literature, which makes it difficult to consult the body of knowledge on the topic. In this article, we precisely conduct a systematic literature review on state-of-the-art proposals for designing and developing carbon-efficient software. We identify and analyse 65 primary studies by classifying them through a taxonomy aimed at answering the 5W1H questions of carbon-efficient software design and development. We first provide a reasoned overview and discussion of the existing guidelines, reference models, measurement solutions, and techniques for measuring, reducing, or minimising the carbon footprint of software. Ultimately, we identify open challenges and research gaps, offering insights for future work in this field.

https://dl.acm.org/doi/pdf/10.1145/3728638

SCI Specification

Software Carbon Intensity (SCI) Specification

Introduction

Software systems cause emissions through the hardware that they operate on, both through the energy that the physical hardware consumes and the emissions associated with manufacturing the hardware. This specification defines a methodology for calculating the rate of carbon emissions for a software system. The purpose is to help users and developers make informed choices about which tools, approaches, architectures, and services they use in the future. It is a score rather than a total; lower numbers are better than higher numbers, and reaching 0 is impossible. This specification is focused on helping users and developers understand how to improve software to reduce or avoid the creation of emissions.

https://sci.greensoftware.foundation/

Highlights (I)

Project Aim

- Design and prototype **methods for assessing** and reducing the **environmental footprint** of **AI**-based and data-intensive **software applications**, while accounting for emerging **regulatory frameworks**

- Measure the sustainability impact of software systems through **standardised metrics**, e.g., Software Carbon Intensity (SCI) score

- Exploring **software engineering strategies** to reduce carbon emissions while maintaining functional and operational quality.

Highlights (II)

Deliverables & Learnings

Through the two-week **research sprint** will deliver

- a preliminary environmental impact **assessment prototype**
- a **case study application** of the prototype
- a **roadmap** for integrating sustainability metrics into future AI engineering pipelines, aligned with emerging national and international **regulatory frameworks**

You will **learn** how to

- compute the **carbon footprint** of computer software and analysis pipelines
- access & interpret the **legal requirements** and policy frameworks
- identify the **relevant components** of AI workflows that drive the carbon footprint
- build a **general model for determining** the environmental footprint
- understand how to reduce emissions by **what-if analyses**

Work Plan

WP1 – Phase I: (25th August – 27th August)

Introductory Lecture *(led by Stefano Forti)*

- Models on estimating the energy consumption and carbon emissions of ICT systems and software
- Requirements elicitation from case study applications

Teamwork

- coordinate development, focussing on adapting SCI metrics to AI workflows
- finalise the methodological framework and define a case study

WP2 – Phase II: (28th August – 1st September)

Prototype Development & Testing

- Align the methodology with emerging environmental policy frameworks
- A first proof-of-concept prototype will be developed and tested

WP3 – Phase III: (2nd September – 3rd September)

Assessment of Results

- preliminary environmental impact assessment
- regulatory compliance analysis

WP4 – Phase IV: (4th September – 5th September)

Project Roadmap and Presentation

- consolidate results into a presentation and a roadmap for future interdisciplinary research

Hardware & Software Specs

We suggest the following, but not compulsory,
since it will be mainly programming & lightweight AI models to run in the Cloud (e.g. Google Colab)

Hardware:

- Intel(R) Core (TM) i5-14600K CPU or i7-9750H CPU
- 8G or 16G RAM
- >256GB SSD storage

Software:

- Windows 11 OS / MacOS Sonoma / Linux
- Python 3.9+

BYO: Bring your own laptop
(+ we provide cloud access)

Expertise Sought

Research or Strong Interest in (BUT not limited):

- Software Engineering
- Data Science and AI
- Environmental Sustainability

Familiarity with:

- Python
- Data Processing/Integration
- Working with REST APIs (beneficial)

Others:

- Teamwork spirit
- Communication
- Collaboration
- Learning attitudes

BYO: Bring your own AI project and analyze the carbon footprint!
(+ we will provide case studies to choose from)

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Thank you for your attention &
see you soon in London!

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