

Empowering Software for a Sustainable Cloud



Vrije Universiteit Amsterdam

Presented at: ECP Digitalization and Sustainability, Sep. 2022







What is software sustainability?

Software can help or hinder sustainability





WE CAN TALK ABOUT "SUSTAINABILITY" IF AND ONLY IF WE ADDRESS BOTH THE DIMENSION(S) OF FOCUS AND THE TIMESCALE

The case: Cloud-based Software

Data Center energy efficiency ≠ Cloud sustainability

PATRICIA LAGO ©2016 (Inaugural lecture)

Energy consumption is software defined. The cloud is there because software needs it, and if software is bloat and data management inefficient, any optimization will be just wasted.

Photo: Act Two-Um

Implicit question: Performance

• EE = resource efficiency

Real question: Degrowth

• E.g., data removal, consolidation, scaling down

N. Jones, Nature 561, 163-166 (2018)

Borrowed from: Hans Hilgenkamp (Mission 10-X)

Software can help ...

Credits: from Mark Hoogendoorn, Inaugural Lecture, VU Amsterdam (9 Sep. 2022)

AI'S CARBON FOOTPRINT

The emissions associated with training the language-learning model BERT depend on the time of year, and on the location of the data centre.

Do Al algorithms differ in terms of energy consumption?

Does modifying the dataset impact the energy efficiency of AI algorithms?

1.5

OF DATAPOINTS: UP TO 92% SAVING

FEATURES: UP TO 76% SAVING

0.008

0.006

0.00

0.010

0.008

0.006

0.004

0.002

SVA

1000 2000 3000 4 Number of Datapoints

2000 4000 6000 8000

Number of Features

0.10

0.08

0.06

0.04

0.02

0.10

0.08

0.06

0.04

UP TO A 99.49% ENERGY CONSUMPTION DECREASES

Al Centric

UNIVERSITEIT

VU

0.6

0.5

0.4

0.3

0.1

0.6

0.5

0.4

0.3

0.2

0.1

0.9

0.9

Verdecchia, R. et al. (2022) Data-Centric Green AI: An Exploratory Empirical Study. ICT4S Conference, IEEE.

Edge- vs. Cloud-based software: How much is the impact of Architectural Tactics on energy consumption?

The state of the Country: Data Center Industry

- The word "software" is absent
- The focus is on making the DC (the "box") energyaware, not its content
- Responsibility is pushed to customers, support is limited to e.g., powersaving settings

Dutch Data Center Association, June 2022

Verdecchia, R., Lago, P. and de Vries, C., (2022). The future of sustainable digital infrastructures: A landscape of solutions, adoption factors, impediments, open problems, and scenarios. Journal of Sustainable Computing: Informatics and Systems. Elsevier.

Reflection point

EXTREME FLEXIBILITY

<u>Context</u> can be simplified, but <u>Software-driven adaptation</u> is still a challenge

REUSABLE ARCHITECTING PRACTICES

We can (and must) create and adopt innovative know-hows

An open archive to share, collaborate, crowdsource

Toczé, K., Madon, M., Garcia, M., & Lago, P. (2022). The Dark Side of Cloud and Edge Computing: An Exploratory Study. Workshop on Computing within Limits. Vos, S. et al. (2022) Architectural Tactics to Optimize Software for Energy Efficiency in the Public Cloud. ICT4S Conference, IEEE. van den Hoed, R., et al. (2016). Greening the cloud (AUAS). https://www.nederlandict.nl/wp-content/uploads/2016/09/greeningthecloudweblr-2.pdf

https://s2group.cs.vu.nl/AwesomeAndDarkTactics

Thank you

Credits: slides, ideas and results are a collective effort with my bright and energetic colleagues in the S2 Group @Vrije Universiteit Amsterdam <u>s2group.cs.vu.nl</u>

Build successful & repeatable sustainability practices

ASSESSMENT FRAMEWORK

someAndDarkTactics https://s2group.cs.vu.nl/A

My virtual presence: www.patricialago.nl

Green Lab

