TU Delft

SEAA 2023

The Two Faces of AI in Green Mobile Computing

A Literature Review

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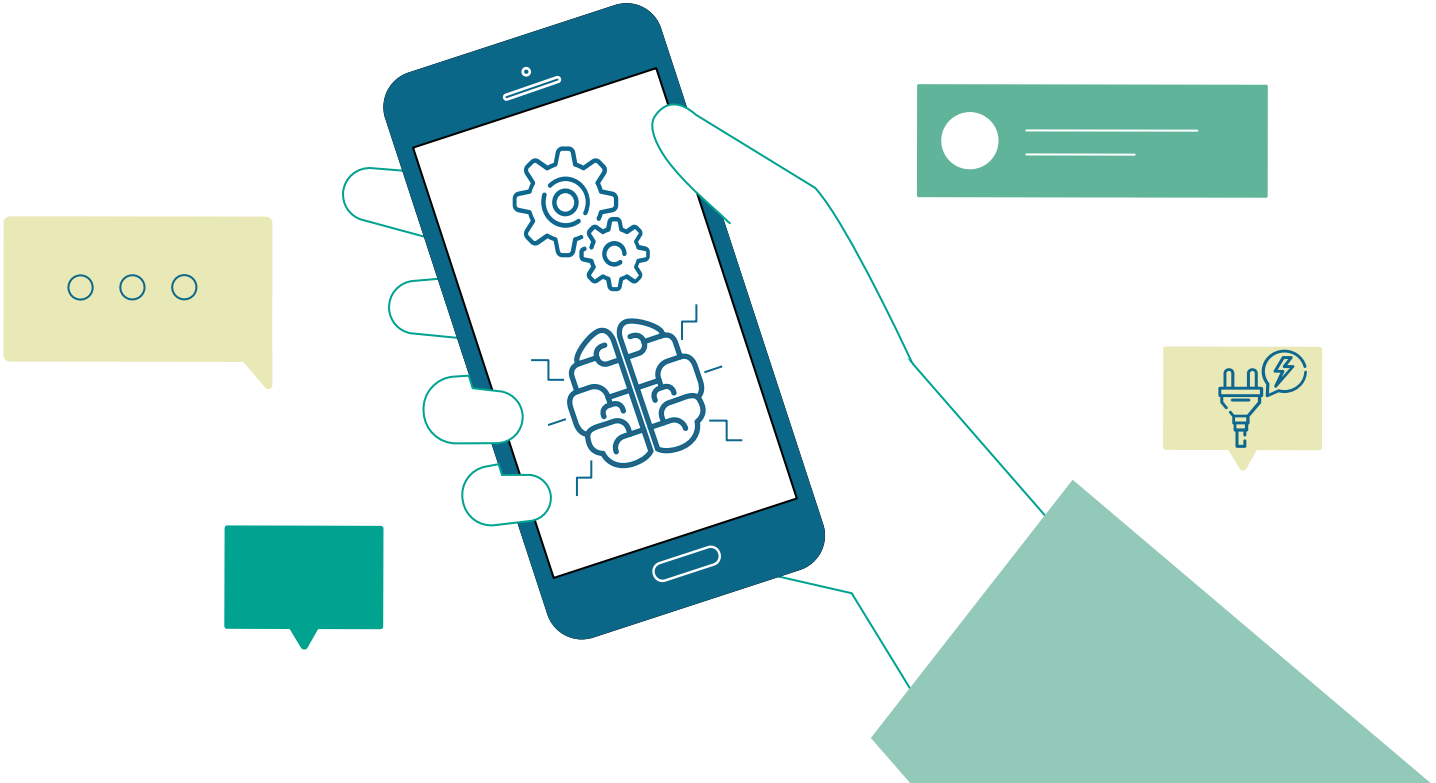
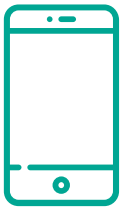
01.
MOTIVATION

“Smart” Mobile & Software/AI



The need for Green Mobile Software

- Energy consumption of ICTs
  - worst case scenario: ~ 21% of the global total electricity usage by 2030[1]
- More and more devices
  - 7 Billion smartphones worldwide in 2023[2]
- Time spent on phone : > 3 hours per day
- Non-extendable battery size



[1] *A. S. Andrae and T. Edler, "On global electricity usage of communication technology: trends to 2030," Challenges, vol. 6, no. 1, pp. 117–157, 2015*
[2] *Ericsson*

What about AI in all of that?

- Green AI
  - Making AI-based software more energy-efficient
- AI for Green
  - Using AI to reach better energy efficiency

02.
GOAL

Research Objective

Analyze *Green Mobile AI literature*

For the purpose of *knowledge collection and categorization*

With respect to *AI*

From the viewpoint of *researchers and practitioners*

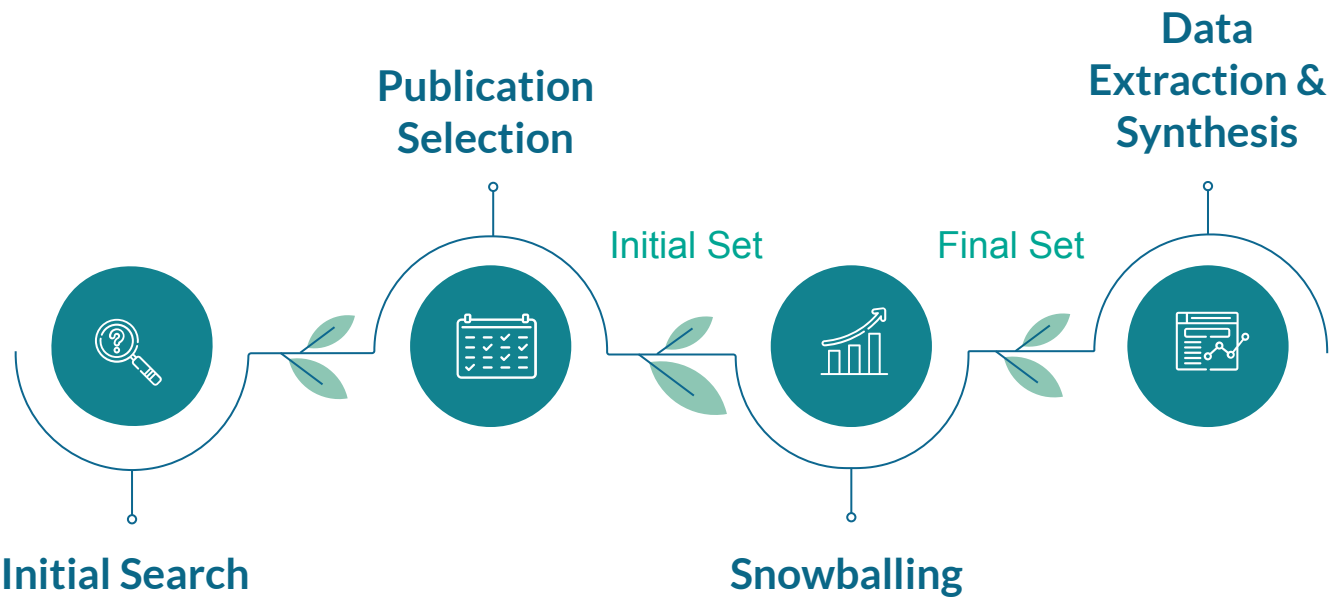
In the context of Mobile Computing and *Environmental Sustainability*

Research Question

What are the characteristics of the state-of-the-art research regarding Artificial Intelligence in Green Mobile Software?

03.
METHODOLOGY

Methodology



Initial Search

- Search Query

("AI-Based" OR "machine learning" OR "Artificial Intelligence") AND "mobile" AND ("energy" OR "efficient" OR "green")

- Database : Google Scholar

- Tool: Publish or Perish

Publication Selection

- Inclusion Criteria
  - I-1. The study regards mobile devices (smartphones/tablets)
  - I-2. The study regards energy consumption
  - I-3. The study regards artificial intelligence: either by treating how AI can be used to reduce mobile energy consumption or by treating the energy consumption of mobile AI itself
  - I-4. The study regards the software level
- Exclusion Criteria
  - E-1. The study is not written in English
  - E-2. The study is not accessible
  - E-3. The study is not peer-reviewed
  - E-4. The study is in the form of citations, patents, editorials, tutorials, books, extended abstracts, thesis, etc.
  - E-5. The study is not a primary study, such as a review paper.
  - E-6. The study was published before 2012

Snowballing

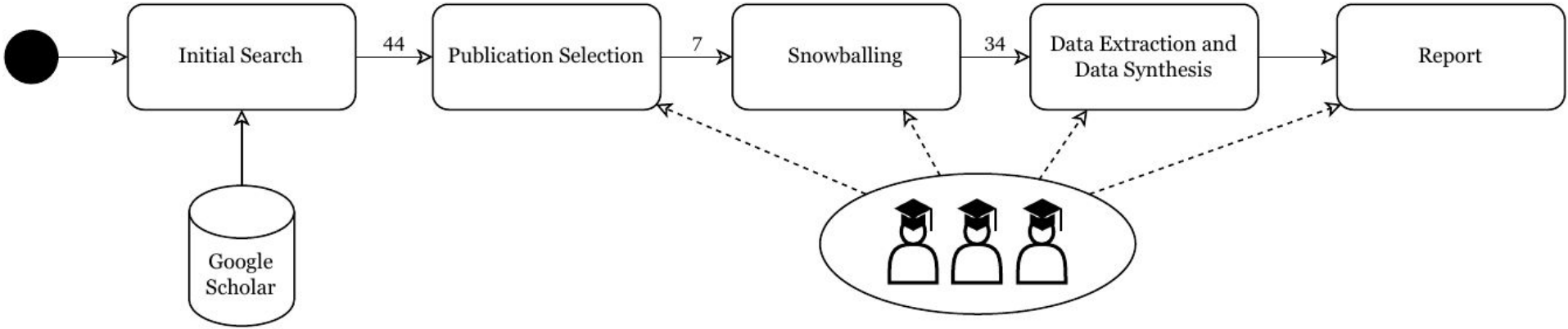
- Bidirectional Snowballing
  - Backward
    - Papers cited by the paper of the initial set
  - Forward
    - Papers citing the paper of the initial set

Data Extraction

- Publication year
- Study type
  - position
  - observational
  - solution
- Category of AI Role
  - AI for Energy (AI4E)
  - Energy of AI (EofAI)
- Topic
- Level of study
  - Device
  - System
- Industry Involvement
  - Academic
  - Industrial
  - Mix
- Tool Provision

04.
RESULTS

Overview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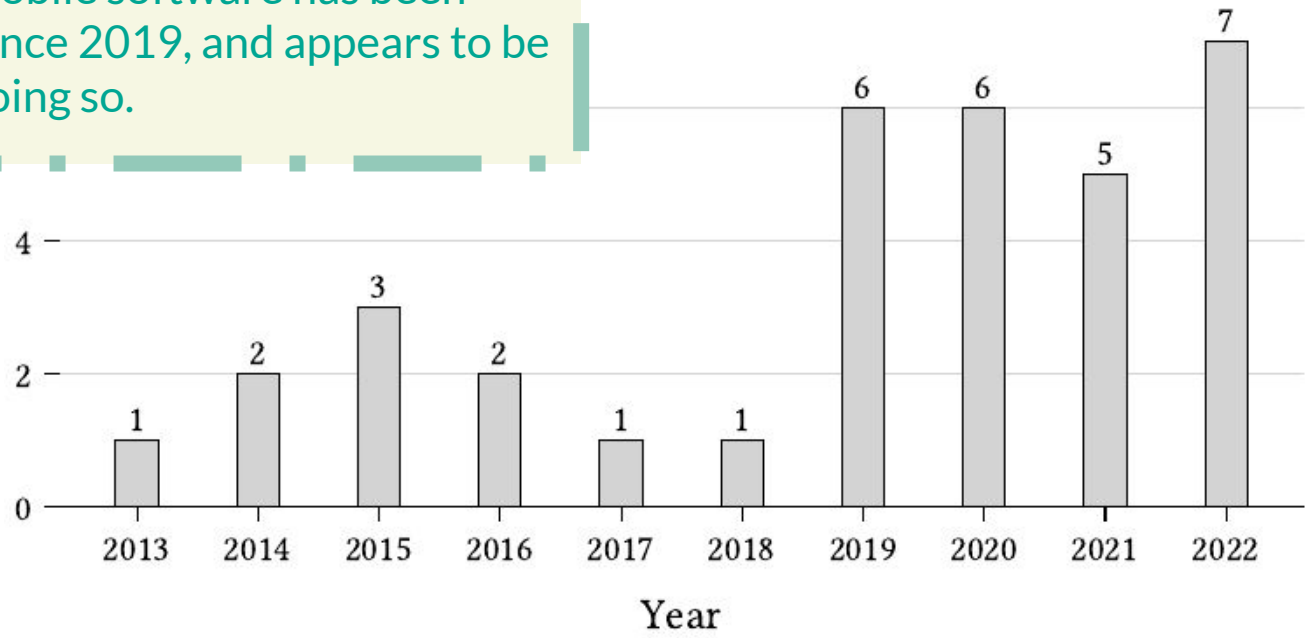
Publication Year

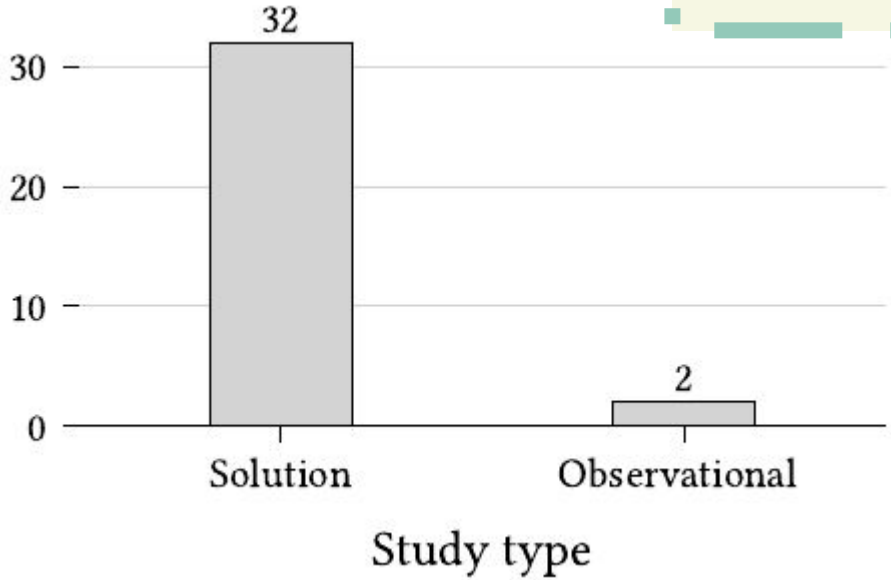
Publication Trends: The research topic of artificial intelligence in green mobile software has been gaining in popularity since 2019, and appears to be on track to continue doing so.

Mapping of studies in the paper

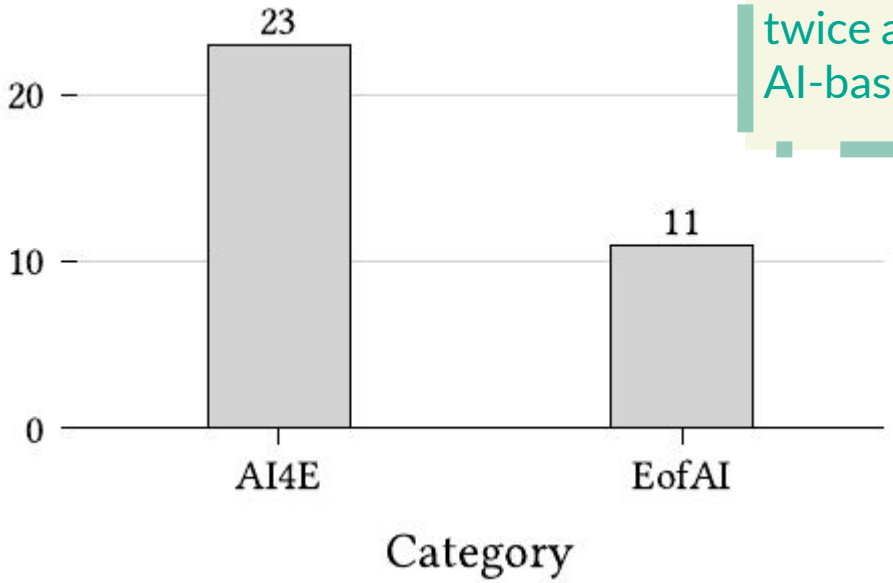


Type of Study

Type of Study: The majority of the literature consists of studies proposing solutions, with a very small number of observational studies.



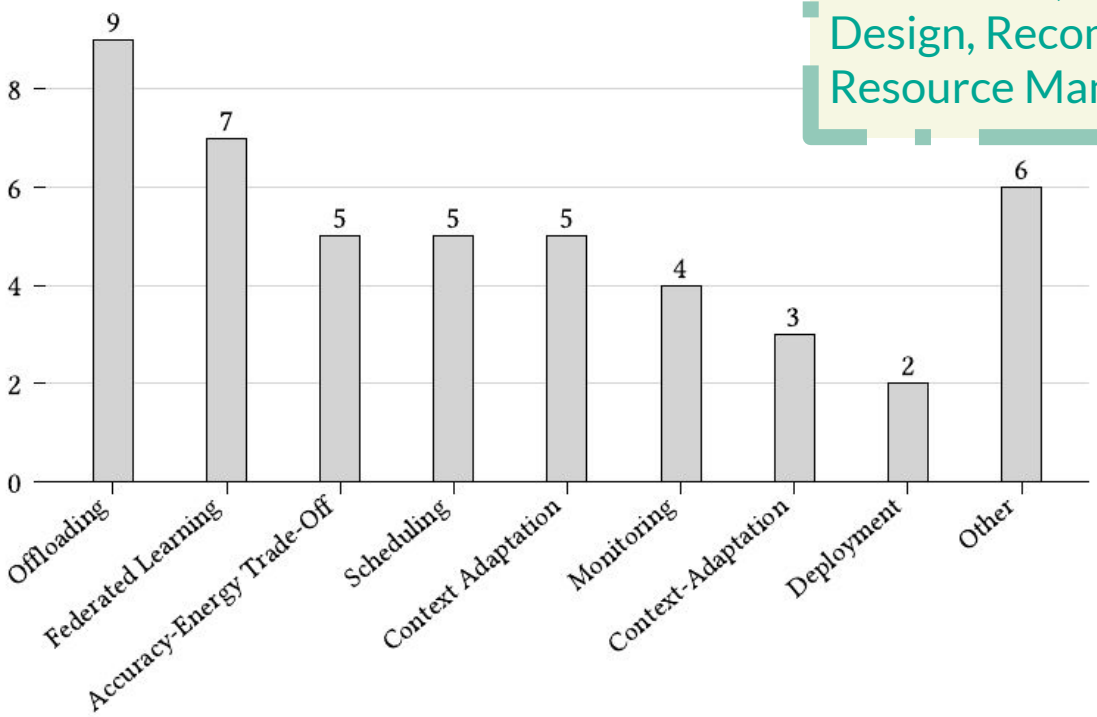
Roles of AI



Category of AI Role: The use of AI to make mobile software more energy-efficient is being studied twice as much as the energy consumption of AI-based mobile software.

Topics

Topics: The literature on AI in Green Mobile Software covers 13 main topics. 50% = Offloading, Federated Learning. But currently underexplored: Benchmark, Approximate Computing, Model Design, Recommenders, Energy Measurement, and Resource Management.



Level of Study

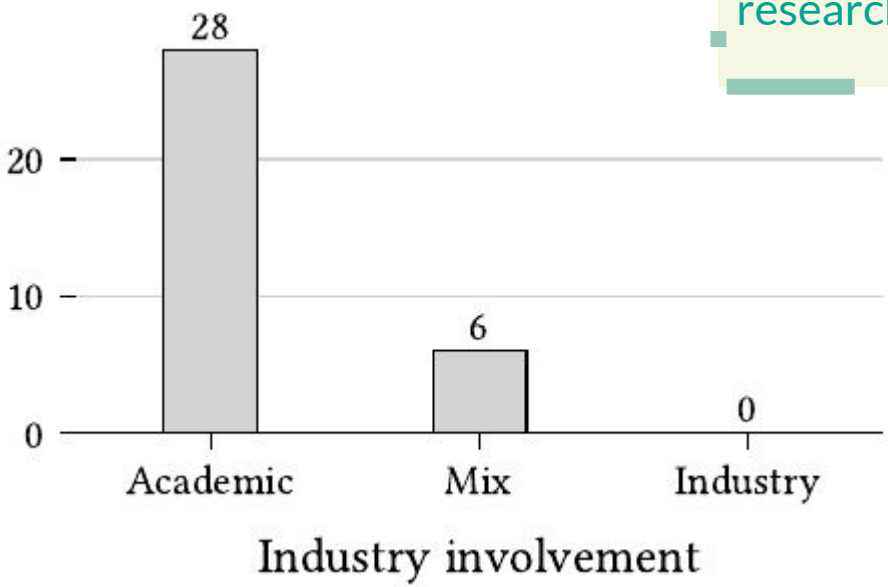
Approximately two thirds (22/34) of the literature focus on Green Mobile software at the system- level, compared to the device-level. More attention is given to the topic in the context of a network of mobile devices.

Tool Provision

Although many studies provide solutions to address mobile energy consumption involving AI, only a small portion of them (2/34) make the solution- based tools readily available online

Industry Involvement

Industry Involvement: The presence of industrial researchers among the authors is still scarce.



05.
TAKEAWAYS

Takeaways

More Green AI in mobile computing!

- a recent increase in the number of papers published on the topic can be observed
- topics highly specific to a specific technology (e.g., Federated Learning)
- having access to up-to-date benchmarks is a major challenge in this field
- systematic provision of tools addressing AI and Green Mobile Software is far from optimal
- we need to promote the involvement of the mobile software industry

THANKS!

Do you have any questions?
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