HOW DO WE MANAGE OUR (NATURAL) RESOURCES?
LINKING KNOWLEDGE WITH SUSTAINABLE CHANGE

SOFTWARE WITH A SUSTAINABILITY INTENT

@patricia_lago
WHAT IS SOFTWARE WITH A SUSTAINABILITY INTENT?

WHAT CHALLENGES DOES IT BRING?
Research and Education
Research in Engineering Smart and Sustainable Software: this is what we do…

Software and Services
Homepage of the Software and Services Research Group of the VU University Amsterdam

About us

The group carries out research on software and services in general, and specifically on their social- and environmental sustainability aspects. Software and services play an important role in modern societies. Europe focuses on sustainability and innovation more than ever. Our focus is on devising systematic, disciplined, and quantifiable methods and approaches for designing, developing and maintaining business and software services.

More specifically, we center around defining service value networks, supporting service engineers and architects in managing the service development process and service-oriented architectural knowledge, migrating legacy assets to modern services, understanding social structures in service-oriented software and exploit them in supporting modern software development, addressing environmental sustainability issues in ICT, and last but not least guiding the reasoning of stakeholders for all above matters.

Our philosophy is that research should be industrial-relevant and serve the final purpose of being applied in practice. To this end, we specifically focus on the “real” needs of industrial partners. In short, the results of the research contribute to the European agenda by providing sustainable and innovative solutions.
Education:
CS Master – Track Software Engineering and Green IT

HOW GREEN IS OUR DIGITAL SOCIETY?

Software-intensive systems support most if not all aspects of modern society. Processing power, data storage, network speed, and energy have become increasingly more powerful and less expensive. However, the energy necessary to keep them on and available is becoming scarce, and is a major global problem that all major nations aim at tackling aggressively. The time has come to build energy-aware software.

PROGRAMME

This extended Master’s track allows you to choose either to specialize in energy-aware software engineering, or address the general software engineering competencies while still creating awareness of the implications of software-intensive systems to the environment.

The programme provides both current professionals and future generations with the appropriate skills to build an energy-aware digital society. It provides opportunities for inter-disciplinary assignments and projects addressing societal, business, technical, and social aspects of energy-efficient and sustainable software systems. Selected industrial partners will offer innovative case studies and challenging projects.

SELECTED COURSES

Service-oriented design: it includes an industry-sponsored project in energy-aware software services (already active since three years, no change).

Software metrics: provides the background on defining and applying software metrics to assess quality requirements of software in general, and energy efficiency and other sustainability-related qualities in the particular case of energy-aware software.

Green Lab: will let students experiment with engineering energy-aware software-intensive systems, measuring, estimating, monitoring their energy consumption, and learning the energy impact of different software engineering practices and design decisions.

“IT SOLUTIONS ARE NOWADAYS MOSTLY EASY TO MIND, BUT THE GREEN ONES ARE HARD TO GET. THINKING GREEN OPENS THE CREATIVE MIND!”

Sarah Lakrit, student

MASTER’S TRACK IN SOFTWARE ENGINEERING AND GREEN IT

2 YEARS
ENROLL BEFORE APRIL 1ST / JUNE 1ST (INL STUDENTS)

MORE INFORMATION

More info about the Green-IT track in the two years Master in Computer Science can be found at www.vu.nl/computerscience

Questions about the research or courses: Dr. Patricia Lago (Computer Science), T +31-1020-5987745, E. p.lago@vu.nl
Companie
Universites
Transportation providers
Workers
Municipality
Citizens
Universities
Companies
Students
"Software is eating the world". Marc Andreessen, 2011
“Software is eating the world”. Marc Andreessen, 2011
The software industry and unsustainability

Hardware optimizations are negated by software inefficiencies [cf. Wirth’ Law]

Potential 87% energy savings with cloud migration of legacy software [Berkeley Labs]

Steve Jobs unveils the iPhone (2007)
Photo: Wikimedia Commons

9.7 Billions connected things by 2020 [Gartner]
Image: 盧柏宇, Wikimedia Commons
Software intent:
“the fundamental laws that capture a software system’s intended behavior”

[Huisman et al, Software that meets its intent, 2016]
Software with a sustainability intent: *intended sustainability behavior*”

Software with a sustainability intent: A multi-dimensional problem over *time*
Sustainable software:
Cost-effective, socio-technical savvy, energy-aware, reliable, …
Smart software: from Energy-aware to Socially-aware

Resource scarce environment

Mission impossible II (2000), the motion picture

Smart home
<table>
<thead>
<tr>
<th>ID</th>
<th>Practice</th>
<th>Description</th>
<th>Category</th>
<th>Environment</th>
<th>Implementation</th>
<th>Energy Consumption Measures</th>
<th>Energy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use efficient queries</td>
<td>complex queries can be performed to increase the responsiveness of the application at the expense of energy efficiency. Can be useful to avoid unnecessary “ORDER BY” or to use indexes.</td>
<td>Database</td>
<td>SEFLab</td>
<td>MySQL Server + Wikipedia DB, measure response time during query</td>
<td>System level, resource level incl. usage ratio, software execution measures (response time, number of request/query served)</td>
<td>-25% energy consumption</td>
</tr>
<tr>
<td>2</td>
<td>Put application to sleep</td>
<td>in order to save energy the application can be put in sleep mode. An event, a signal, or an interrupt can resume the application.</td>
<td>Coding</td>
<td>SEFLab</td>
<td>Apache WebServer</td>
<td></td>
<td>-8.5% energy consumption</td>
</tr>
</tbody>
</table>

[S2 Green Software Wiki, wiki.cs.vu.nl/green_software](wiki.cs.vu.nl/green_software)

Energy-efficient software: By design

Research need: a knowledge bank
Make software practices available

Sources: Lago, Lewis, ME, PROCACCINTI (WICSA 2014, ECSA 2015, ECSA 2016)
Some numbers: true or false?

EFFICIENT DATABASE QUERIES
-25% energy consumption

OPTIMIZED DATA MANAGEMENT
+70% performance

FLEXIBLE COMPUTATION OFFLOAD
-40% power consumption

SMART USE OF WEB RESOURCES
-8,5% energy consumption

WEBSITE CONTENT DELIVERY
-45% energy consumption

SOFTWARE REFACTORIZING
-50% energy consumption
-20% power consumption
Research need: new empirical methods
Too many variables, too much “noise”, too little time, …
Research need: A green label for software, too
What should a green label *mean* for software?
Smart software: from Business innovation to Technical breakthrough
Smart software:
Cyber-foraging software tactics make the cloud smarter

Serverless Architectures → Internet Architectures
1-Person Responsibility → Collective process

[Hope et al. The Software Architect’s Role in the Digital Age, IEEE Software, 33(6), 2016]
SOFTWARE REFACTORING
-50% energy consumption
-20% power consumption

NEW EMPIRICAL METHODS

NEW ARCHITECTURE METHODS
Thank you

Credits: slides, ideas and results are a collective effort with my bright and energetic colleagues in the S2 Group @Vrije Universiteit Amsterdam

www.s2group.cs.vu.nl

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