1. Intro Class

Sustainable Software Engineering

CS4295

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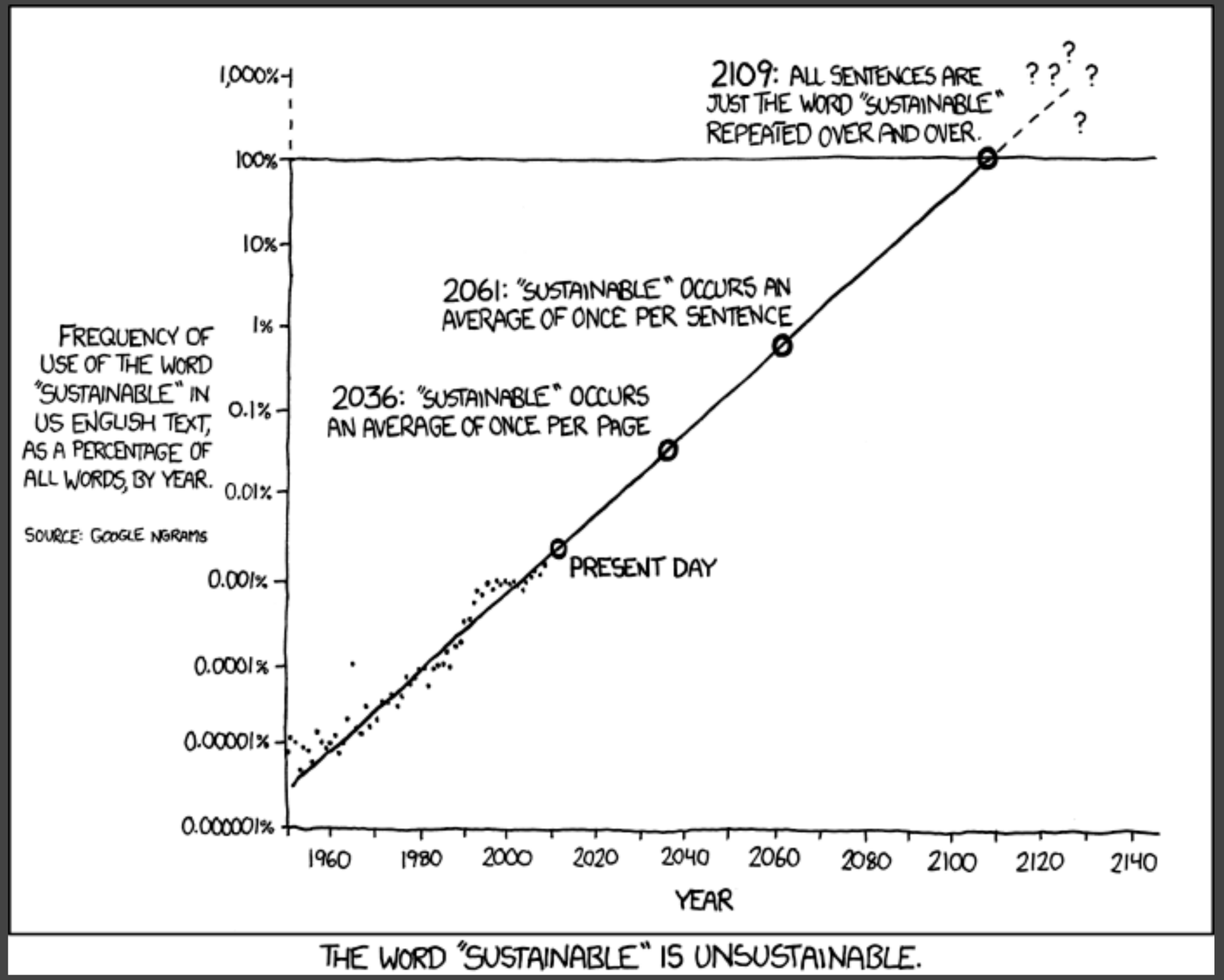
1. Intro to Sustainable SE
2. Intro to the course

Sustainability



https://xkcd.com/1007/

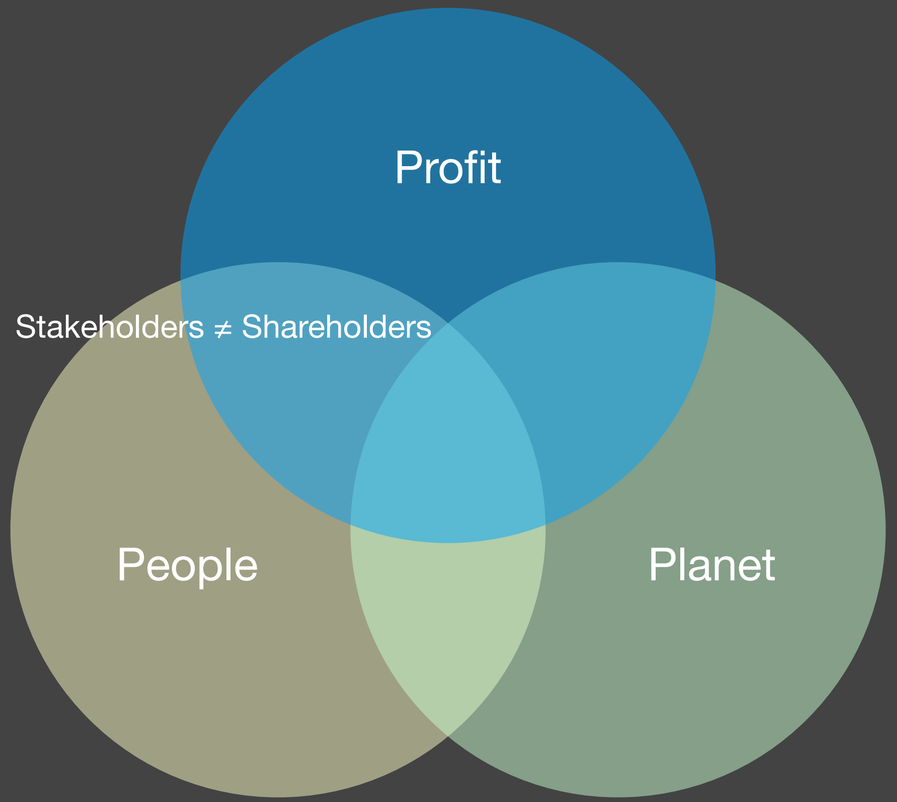
Buzz words

- Eco-friendly
- Climate change, action, adaption
- Energy efficiency
- Environmental-responsible
- Carbon-neutral; Climate-neutral; Net zero
- Carbon-offsetting
- Carbon-free
- Clean technology
- E-waste

Triple Bottom Line (TBL or 3BL)

?

- Framework used to understand business's **sustainability efforts**.
- 3 P's: **p**rofit, **p**eople, **p**lanet
- Concept from **Economics**
- Address the world's most pressing challenges to drive **business success**
- Defining sustainability **goals** and create a **strategy** is not trivial



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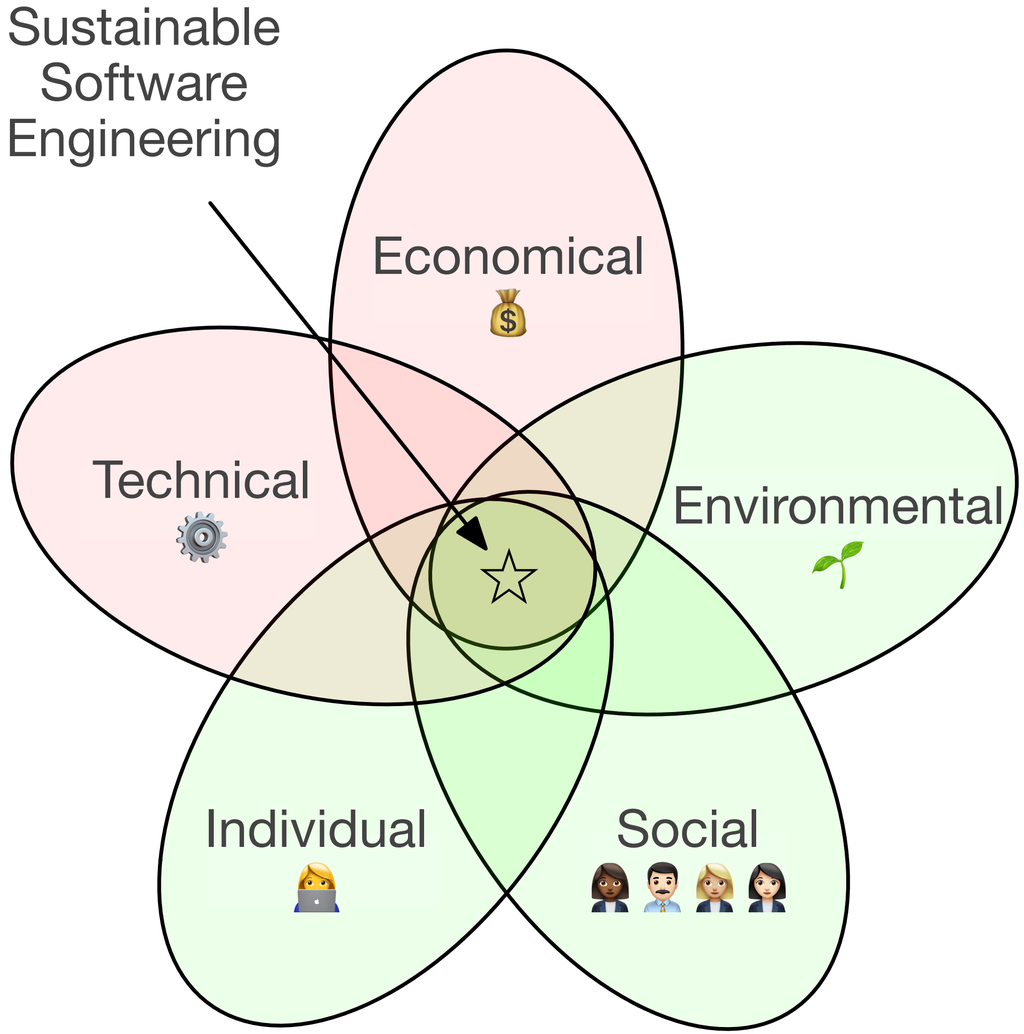
What is **Sustainable Software Engineering**?

https://www.menti.com/uns9d89kzn

Sustainable Software Engineering is…

…the discipline that studies the process of creating software systems that are able to create value in the long term without hindering its surrounding environment.

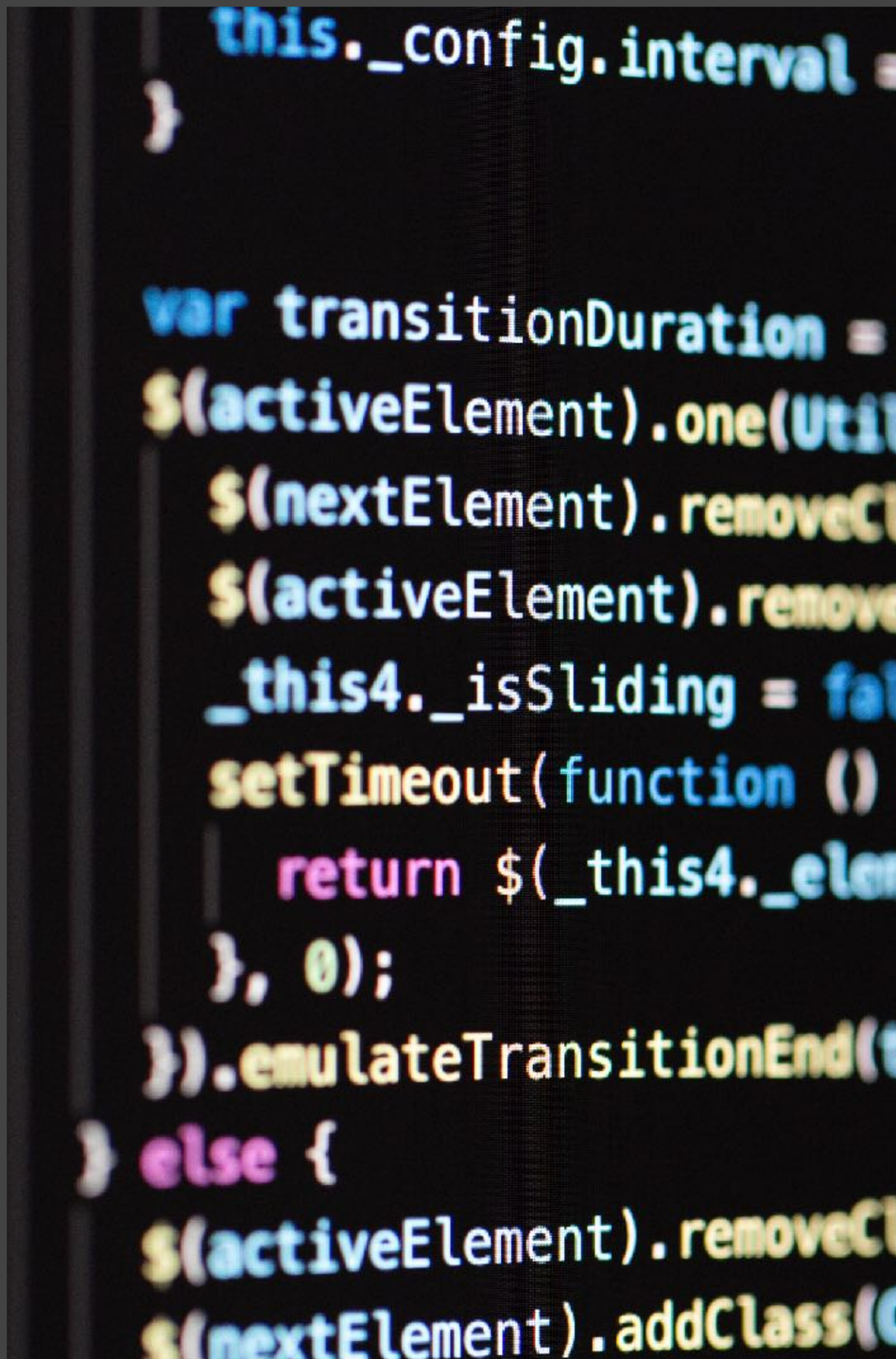

Sustainable
Software
Engineering
Economical
Technical
Environmental
Individual
Social

Economical

- Focused on **assets**, **capital** and **added value** (wealth creation, prosperity, profitability, capital investment, income, etc.)
  - Nr of customers
  - Man-day-rate estimate
  - Next round of funding
  - Meet requirements in the contract

Technical

- Longevity of information, systems, and infrastructure and their adequate evolution with changing surrounding conditions.
- Examples:
  - **Technical Debt**
  - Does it scale?
  - Software testing
  - **Truck-factor**
  - Data integrity
  - Innovation
  - …



Individual

- **Well-being of the individuals** in an organisation.
  Note that it also includes how well individuals interact with each other within the org.
- Examples:
  - mental and physical **well-being**
  - **self-respect**
  - **education/skills**
  - **career development**
  - …

Social

- concerned with **societal communities** (groups of people, organisations) and the factors that erode **trust in society**.
- Examples:
  - **Social equity**
  - **Justice**
  - **Employment**
  - **Democracy**
  - …
- Also includes compliance with policies and regulations

Environmental Sustainability

- the branch of Software Engineering that studies the *development of software that has **minimal impact in our planet** throughout its **whole lifecycle***.
- Looking at software at different levels:
  - Developing, Using, Serving, …
- Also includes **e-waste**.
- Almost identical to **Green Software**. (?)

Bordallo II

Green Software

- **Sustainability** and energy **efficiency**.
- Building **energy-efficient software** is important also from a **technical sustainability** POV.
- Smartphones, smart wearables, IoT devices, etc. run on **limited power resources**.
  - Developing software to these devices require energy-efficiency testing and improvement.
- It also leads to environmental sustainability (e.g., less battery cycles)
- Important for **UX** (e.g., no need to walk around with power banks)

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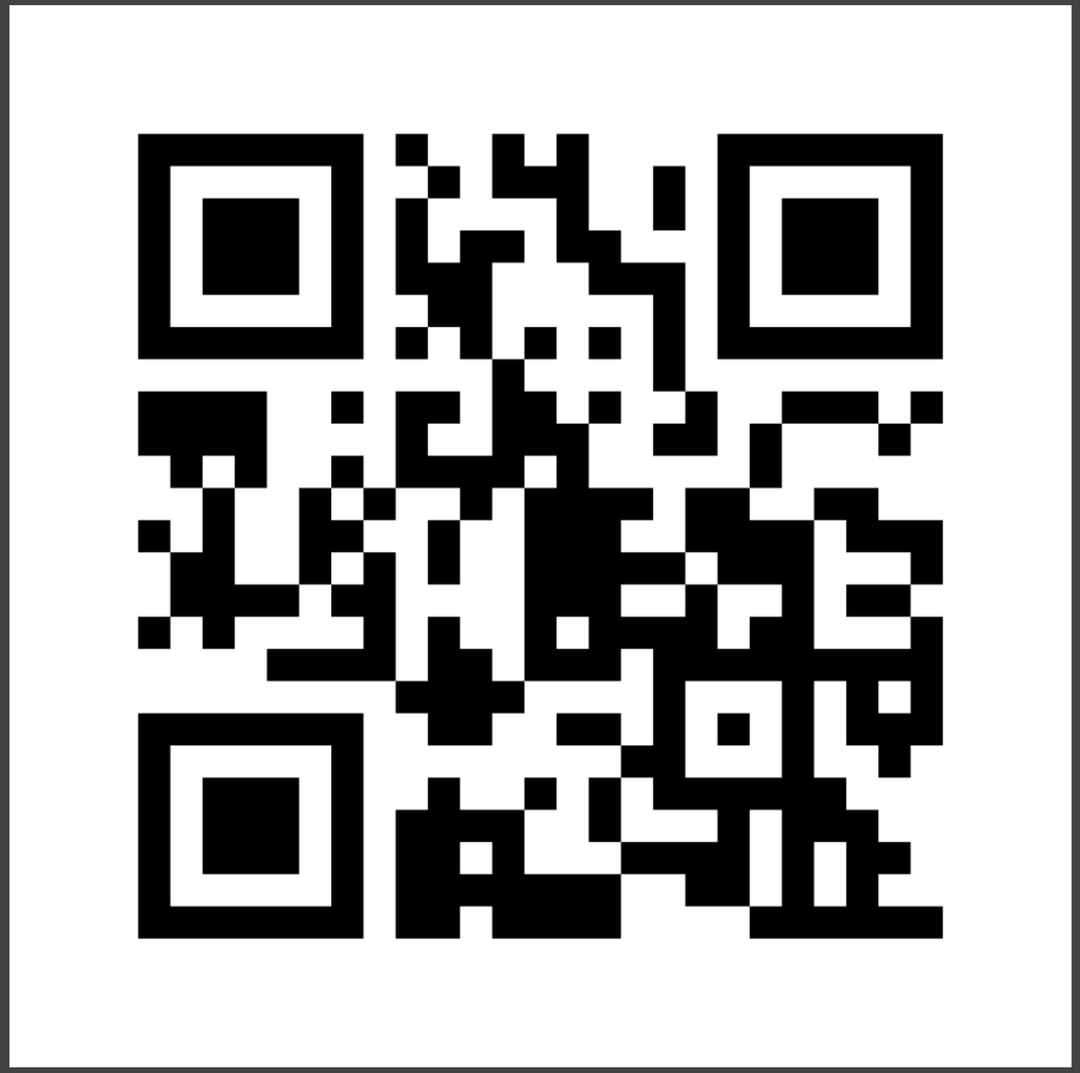
What is the **sustainability dimension** you are most **interested** in?



https://www.menti.com/uns9d89kzn

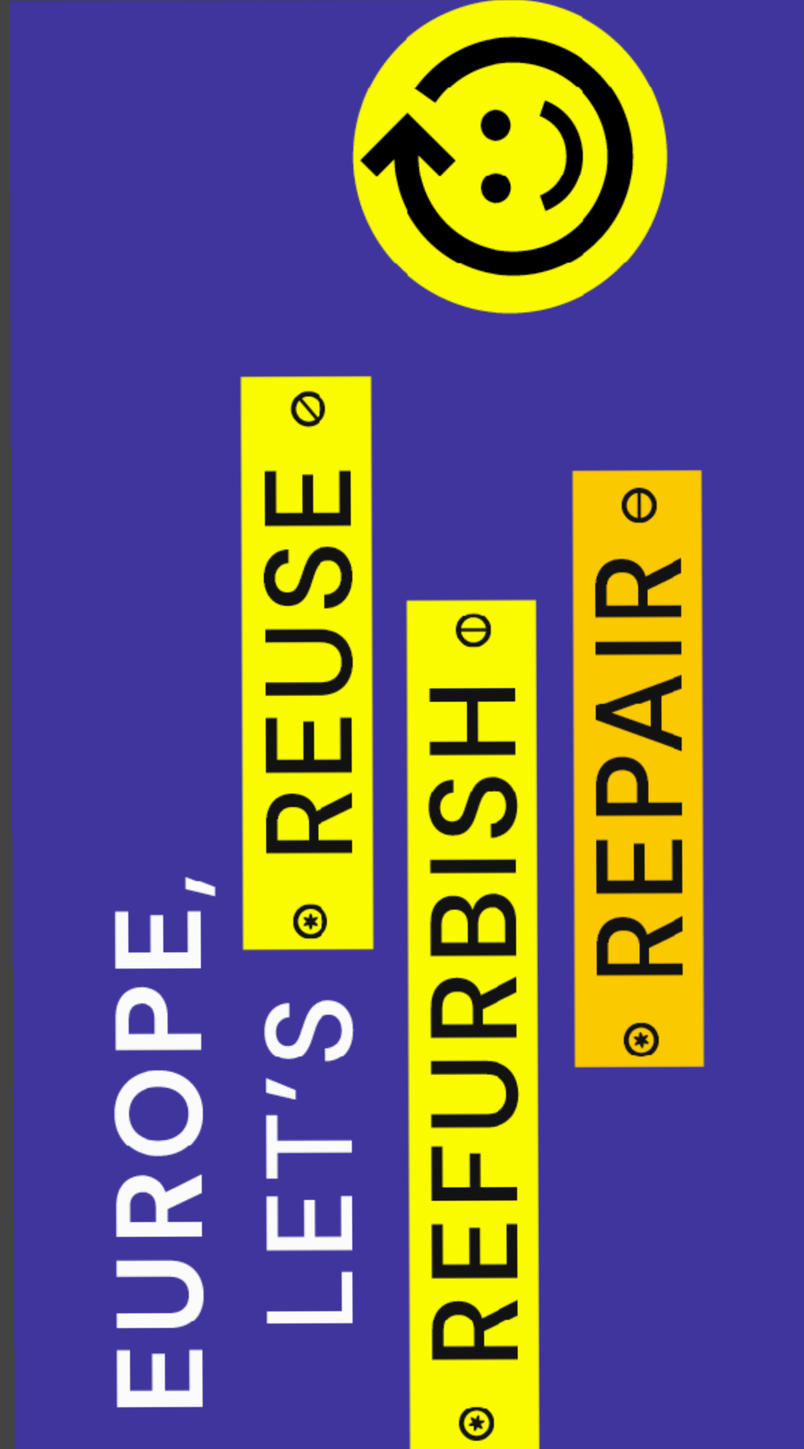
How can we drive sustainability in the SE industry?

Green Procurement

- Customers decide on providers that **share their values**
- This is currently the **main trigger** reason why organisations worry about Sustainability and Green Software.
- Examples of green procurement:
  - Customers that only buy green services/products
  - Companies that only use green providers
  - Developers that only work for green companies
- Green procurement makes environmental sustainability essential for economical sustainability.

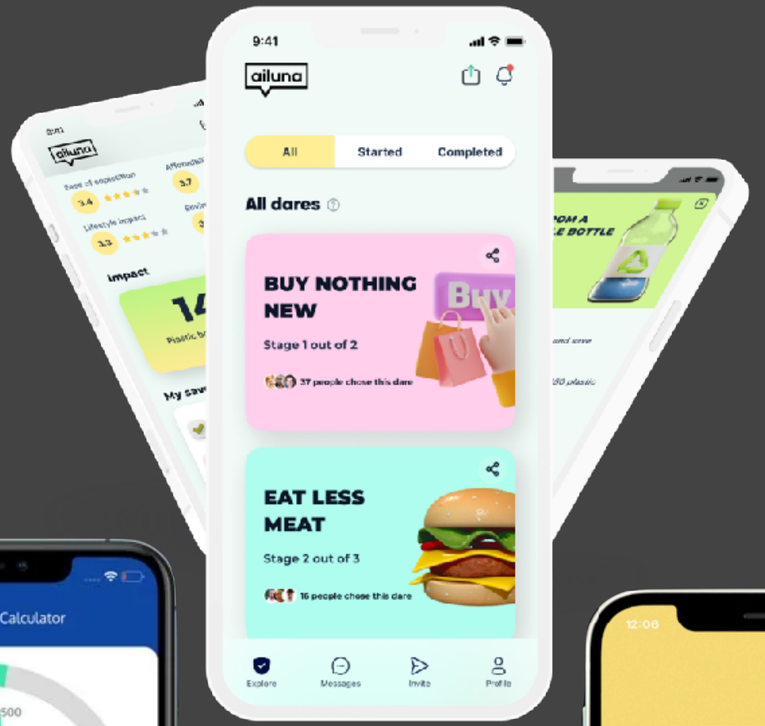
Sustainability via compliance

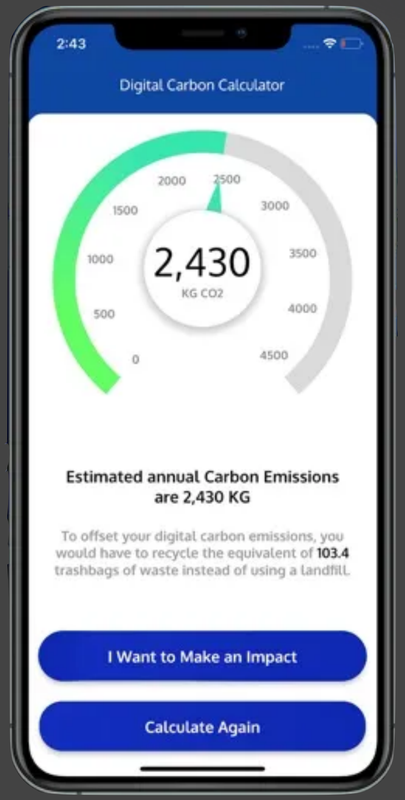
- EU wants to be **carbon neutral** by 2030
- This also affects the **ICT sector**. Estimated to impact **14% of the global carbon footprint** by 2040.
- Some initiatives are already being negotiated.
  - Extending the smartphone lifetime to **7 years**.
  - **Right-to-repair** movement. https://repair.eu
  - Making IT services relying on clean energy more accessible (e.g., less taxes).

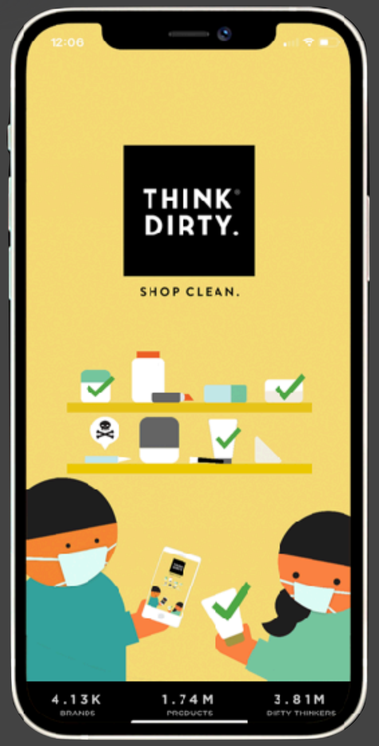


Software for Sustainability

- We are not covering it in this course.

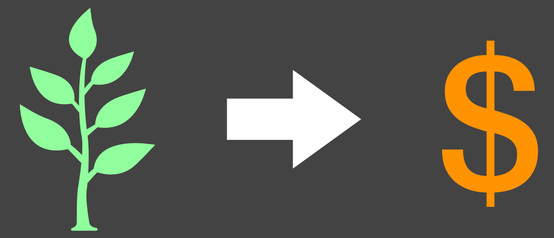






Economical sustainability tops the environment

- In general, a software project will not survive if it’s not economical sustainable
- Yet, a project can survive even if it is not environmental sustainable
- **The mindset is changing!**
  - Software consumers have started to worry about the **climate impact of their behaviour as users**.
  - Being environmentally sustainable is now an important competitive factor
- Marketing teams are already using all eco-friendly labels. Technical teams are not there yet, though.
  - **It’s easier said than done!**



Green Washing

- Deceptively use marketing techniques to claim being eco-friendly.
- Opting for **green-coloured designs**.
  - Red/orange is usually perceived as tasty.
  - Green is perceived as eco-friendly.
- The VW case. (?)

The VW scandal

Greenwashing

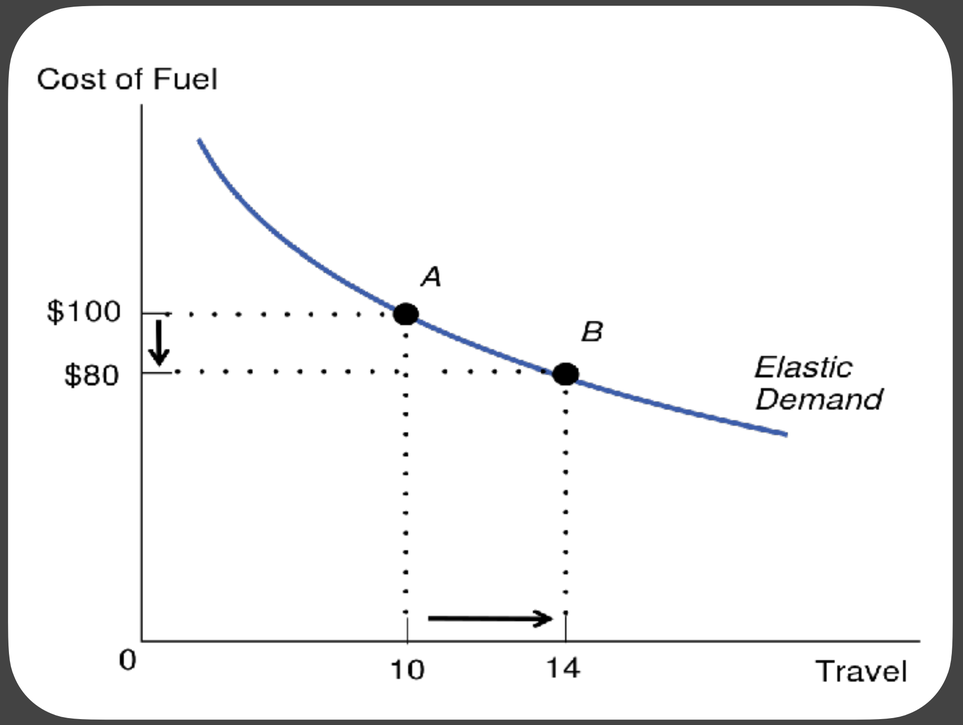
- Used software to **cheat on vehicle emissions tests**.
- The vehicle’s software **could detect** whether they were being **tested**, **changing the performance** accordingly to improve results.
- Affected **11M cars** worldwide, 8M in Europe.

Carbon-free giants

- **Google**, **Microsoft**, **Meta/Facebook** want to be **carbon free by 2030**
  - **Carbon free** is different from **carbon neutral**
  - Green IT experts are needed to meet these goals

The Rebound Effect

- It happens when you make a technology more energy-efficient but it does not necessarily lead to less usage of energy.
- Imagine that you reduce the energy consumption of training a neural network by 50%.
  - Hence, data scientists saw an opportunity to improve the model by increasing the complexity of the neural network and the size of the input data.
  - Although you have a more energy-efficient network, you might not be saving energy.
- (Other fields have their own paradoxes: **Jevons Paradox** – economics; **Downs–Thomson paradox** – mobility)



Is sustainability an ethical issue?

- Climate change is more likely to affect **the poorest** countries.
  - Less financial resources to adapt
  - Climate-impact does not necessarily affect polluting countries.
- Poorest countries have contributed less to the climate change.
- We need to figure out how to **do more using less** resources.

Political ideology?

- Some environment activists address sustainability as a tool to fight capitalism.
  - “Capitalist corporations need to pay for the damage”…
- Indeed we need to control/promote/enforce sustainability practices.
- But we want **everyone together** and we need to acknowledge everyone’s contribution to society.
- Other concerns need to be addressed separately in their own thread.

Morality ≠ Moralising

- We should not use climate action as a **shaming weapon**
- Climate action should be agnostic of political views, ideology, social status, etc.
- We need **everyone** to take action!

Why?

- Throughout your career you might:
  - Design/maintain/contract data centers
  - Set up **operations**/**devops**
  - Develop **AI for IoT** devices
  - Be the next **CEO**/**CTO** of a software company
- Sustainability can be your **main role**:
  - Green Software Developer
  - Sustainability Consultant
  - Green Advocate
  - Founder of a **Green Tech startup** (B2B?)

How?

- Improve **Green Literacy**. The more people understand it the better it gets.
- Learn how to **measure** software energy efficiency.
- **Carbon-aware design**
- Efficient software **integration processes** (ci/cd?)
- Add energy metrics to **operations**. E.g., scale servers down to zero.
- Do **research** in this topic.
- …

Format of classes

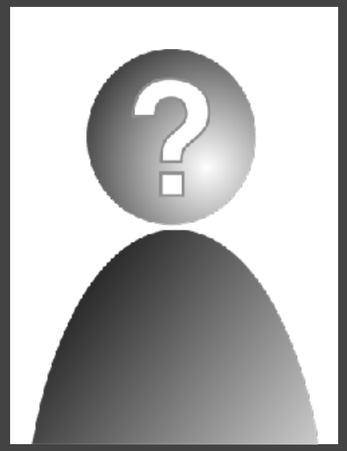
- **In-person** with online fallback.
- Lectures (like today)
- Guest lectures (online/hybrid/in-person – depends on the guest)
- Labs (bring laptop)
- Steering meetings (after week 5, new schedule)

Format of classes - Lectures

- There’s no exam in this course. It’s more important that we learn how to discuss this topic and come up with new ideas than learning all the theory. **Critical thinking over checkboxes.**
- Mix of content and discussion
- Ultimately, the lectures aim to give you food for thought and the necessary knowledge to excel in Project 2. (We will talk about it later)

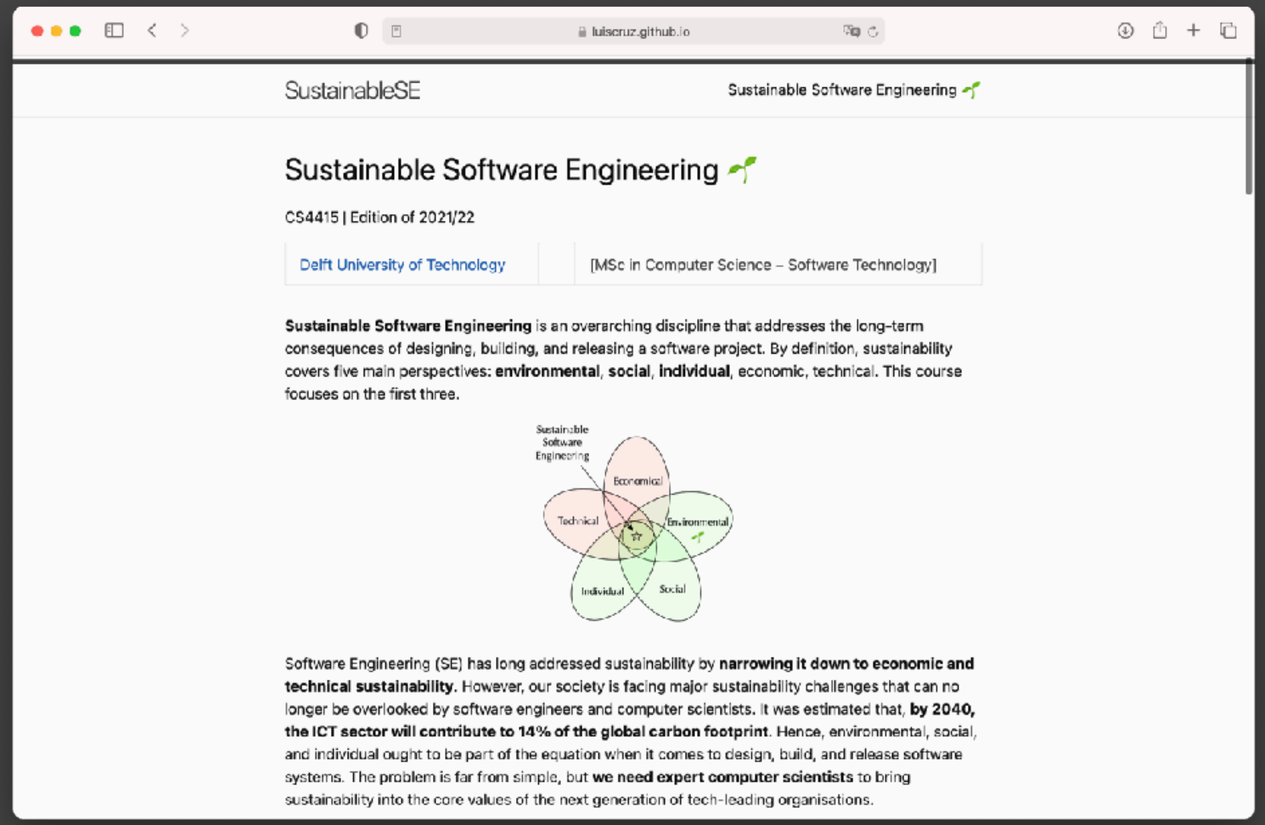
Guest Lectures

Daniel Feitosa
University of Groningen
Netherlands 🇳🇱

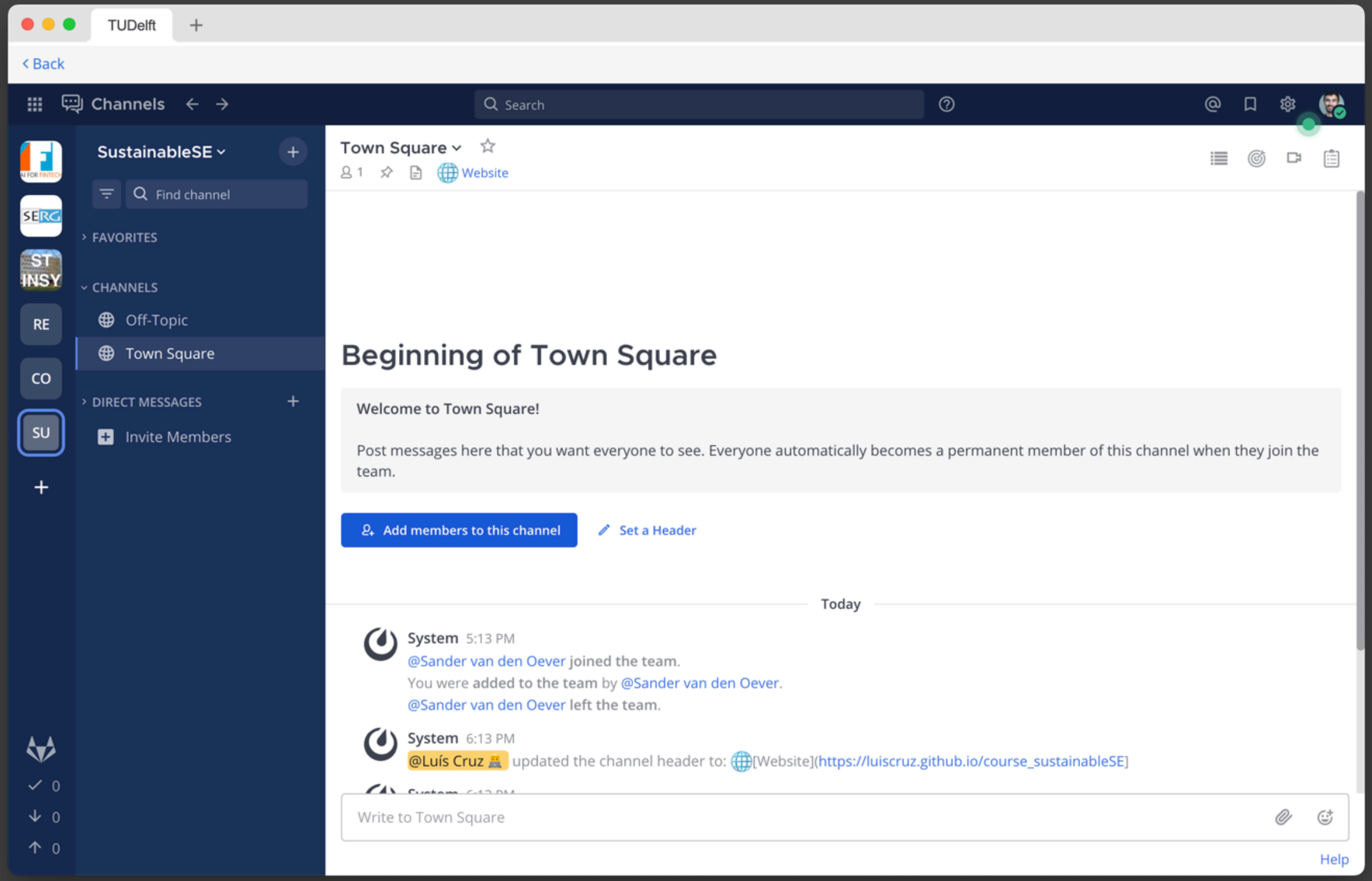


T.B.D.

Content of the course 👇

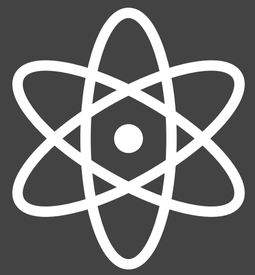


https://luiscruz.github.io/course_sustainableSE/



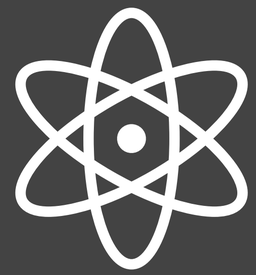
Sign-up link: https://mattermost.tudelft.nl/signup_user_complete/?id=nob1cyhto3nstp7muqhahs95nh

Project 1



- **Goal:** Measure the energy consumption of software applications.
- **Approach**: energy measurement tools; use case testing.
- **Deliverable:** blog-style report (approx. 2500 words)
- **Deadline:** Week 3, Mar 3 2023
- **Group size**: TBD

Project 2



- **Goal:** Create a solution/tool/technique that helps building green software. (You can come up with **your own idea** or choose one from a **list of suggestions**).
- **Approach**: open-source software development; literature review.
- **Deliverable:** library/tool/app; paper; presentation.
- **Two deadlines:**
  1. Week 7, March 31, 2023
  2. Week 9, April 14, 2023
- **Group size**: TBD

Steering Meetings

- Can be **online** or **in-person**!
- Weekly meeting 15–20 minutes
- Mostly for progress updates and feedback
- Weeks 5—9
- To be scheduled in week 5.

Community
How to get involved?

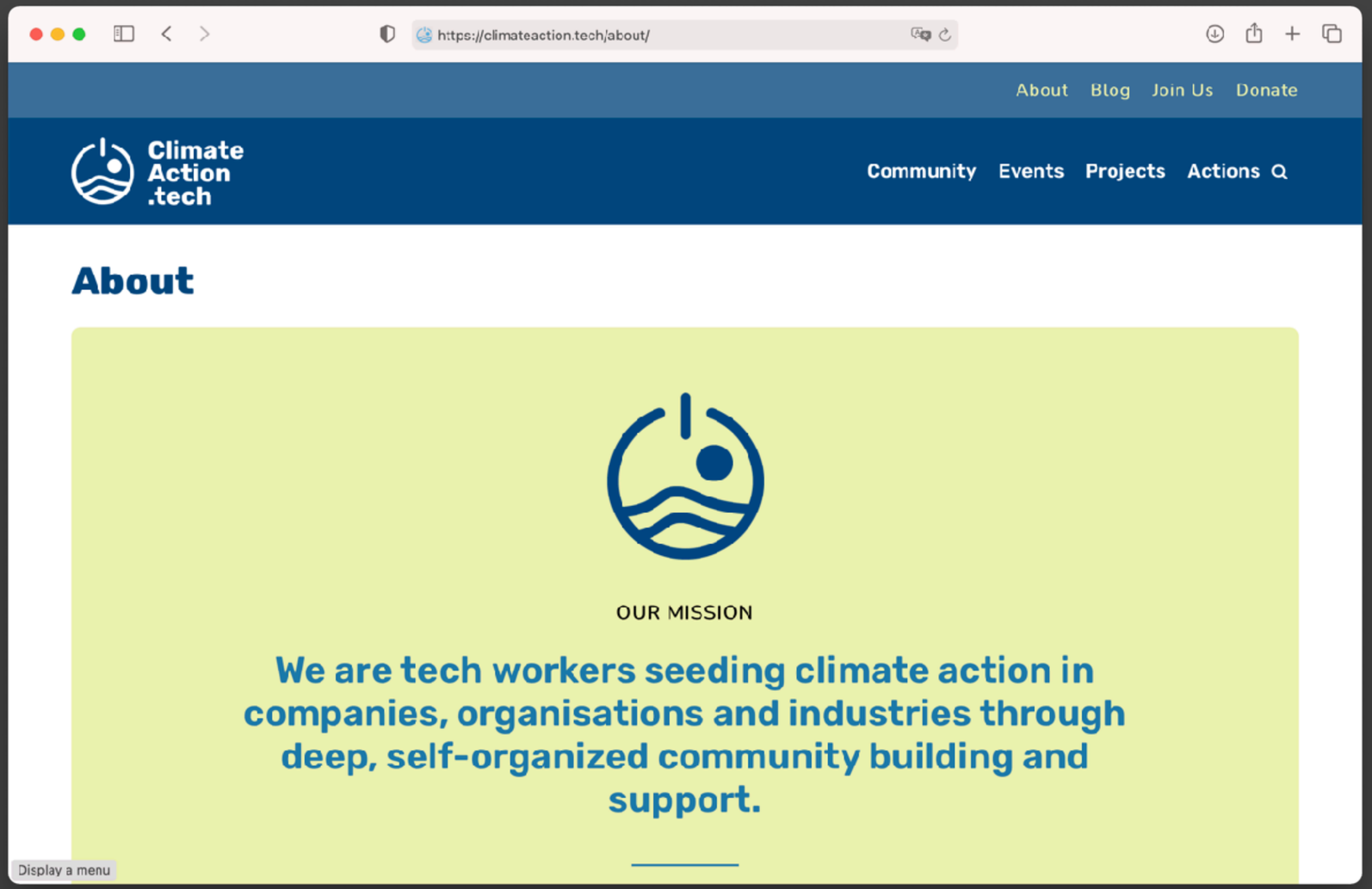
Green **TU**

- https://www.tudelft.nl/sustainability/get-involved/greentu
- Student organisation at the TU Delft devoted to stimulating sustainability in **education**, **research**, **university operations** and **community engagement**.

ClimateAction.tech

- Great **community** for outreach
- Based on Slack
- Regular meetings, talks, social events
- You can join as a volunteer or simply to connect to other techies
- Also good to for **job hunting on green tech**.

ClimateAction.tech



Branch magazine

- Stay **up-to-date** on sustainable tech
- **Creativity** booster
- **Carbon-aware** UI
- https://branch.climateaction.tech 🔗

This is the second edition

- Any feedback is welcome! **Email** or **DM**!