

Sustainable Digitalization

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Computer Science Department (former head) @ Engineering School ESIR
Co-head of the DiverSE team @ IRISA & Inria

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Agility and safety in the development of complex software-intensive systems

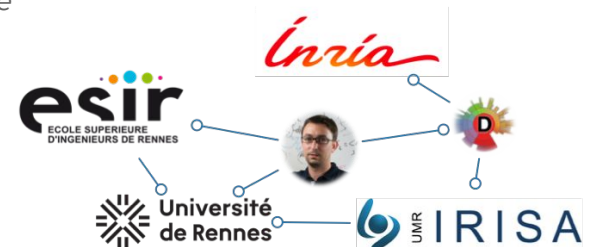
Research interest in Software and Systems Engineering, incl.: Model-Driven Engineering, Software Language Engineering, Domain-Specific Languages, Software-Product Lines, Software Validation & Verification, Resilience Engineering, Scientific Computing, Sustainable Digitalization, ICT for Sustainability.

Application domains: (smart) cyber-physical systems (transport, defense), internet of things (telecommunication, cities/farming, industry 5.0) and environmental sciences (climate change, sustainability).

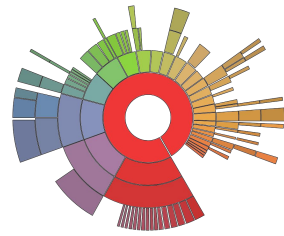
Editor-in-Chief of the Journal on Software and Systems Modeling (SoSyM), Spring Nature
Editor for the JOT (former Deputy Editor-in-Chief) and SQL Journals
Steering Committee member of the MODELS, SLE and ICT4S conferences

Chief Science Advisor at TwiinIT
Scientific Advisor in Software and Systems Engineering
Collaborations with Airbus, Safran, Thales, Orange, CEA, DGA, Obeo, Akka...

Working group and open-source project leader at the Eclipse Foundation



The DiverSE Group



- Inria/IRISA project-team in Software & Systems Engineering
 - Strong background in Model-Driven software/systems Eng.
 - Software languages, architecture, coevolution, simulation, variability and testing
 - Applied to smart, heterogeneous, and distributed CPS (e.g., IoT, Industry 4.0), scientific computing, cloud-native applications, etc.
 - 12 Prof. and Inria/CNRS researchers, 1 Inria RSE, ~20 PhD, 2 Post-doc, 4 SE
- Deductive and empirical scientific approaches
- Open source software development
- Strong contractual activity (esp. EU and industry projects)

Research in Software & Systems Eng.



Research in Software & Systems Eng.

- Multi-engineering approach
- Domain-specific modelling
- High variability and customization
- Software as integration layer
- Openness and dynamicity



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Diversity of...

- stakeholders
- requirements
- concerns
- configurations
- platforms
- environments...



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Diversity of...

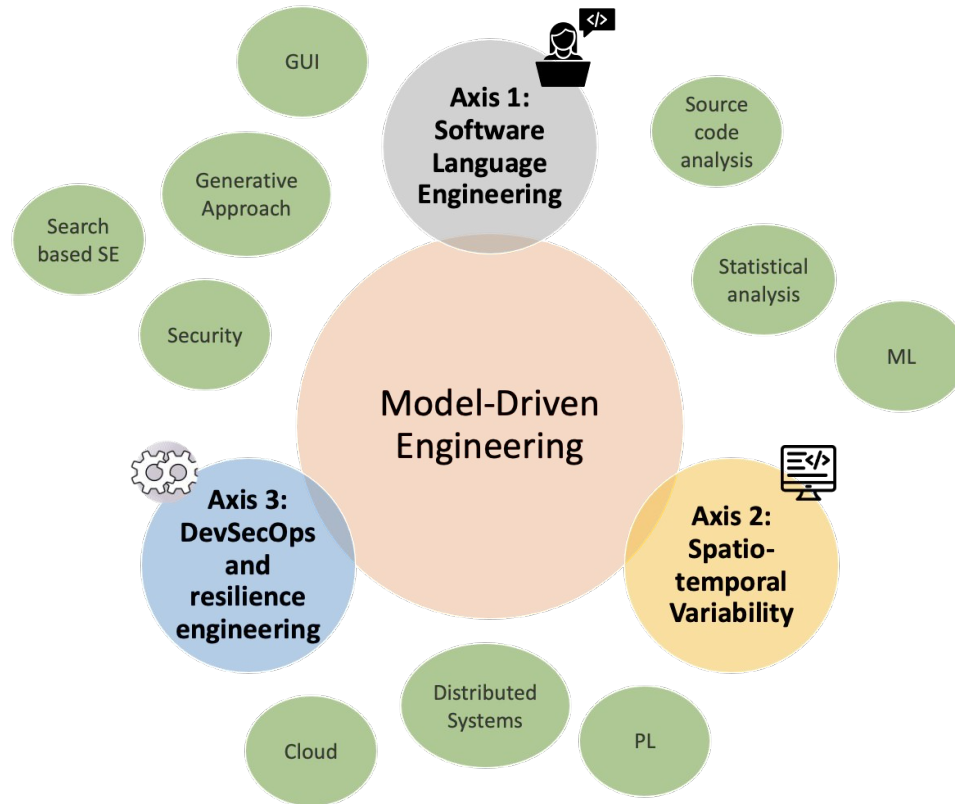
- stakeholders
- requirements
- concerns
- configurations
- platforms
- environments...

Hyper-agility extends the agility of humans to technical and technological agility. Complex trade off among:

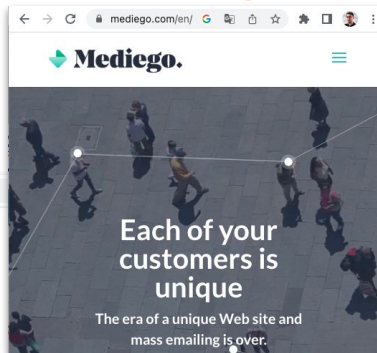
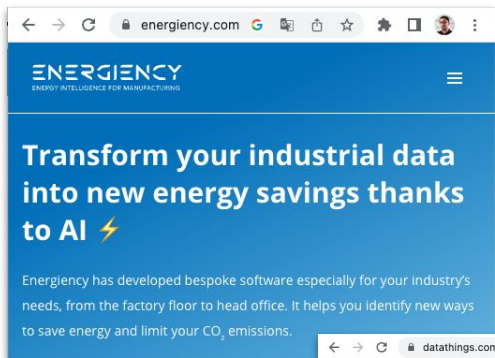
- configuration space,
- release frequency,
- execution platform,
- number of concerns,
- correctness space,
- correctness guarantee,
- Number of function points...



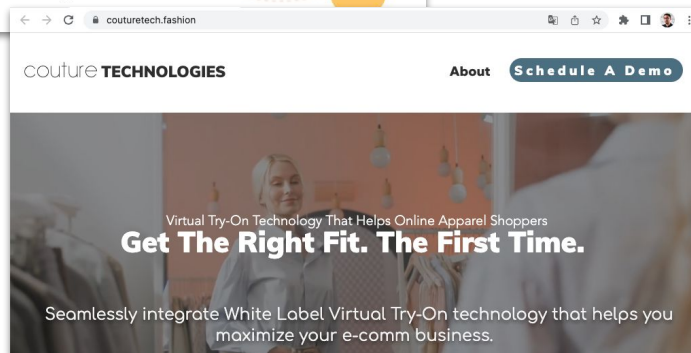
Research axis (2021-2025)



Some DiverSE's Alumni in Industry



Digital twins to understand, design, and operate your products



Are we contributing to the creation of a more sustainable world?



Wicked Problem

Regarding sustainability...:

- Software *could be* part of the *solution*
 - what an IPCC report will be without software?
 - software as a key tool for decarbonization (agriculture, industry, mobility, energy...)
 - ...
- Software *is* definitively part of the *problem*
 - huge impact on the overall energy consumption (e.g., electricity, rare earths elements...)
 - growing privacy concerns
 - ever growing technical complexity
 - ...

Objectives of the lecture

1. Awareness of different **sustainability dimensions** in software
2. Understanding on how software can convey **sustainability values**

Key message

- Context: Digital Humanism – how „responsible“ can a machine be?
 - I believe in personal responsibility.
- Don't offload responsibility to others or „the system“.
 - Yet, innovation and money matter, too.
- “Sustainability“ is not an AI concern only. It's a software concern.
 - Regulation later today.
- So what could we do?
 - Education: Raise awareness. Tech students love it. Effects unclear.
 - Research: Impact statements when submitting papers, IRBs or ERBs, ...
 - Certification: For (self-educated) software engineers? For companies?
 - Development: IRBs, LCA. Sustainability Deliberation in Agile Development
 - ...

Disclaimers

- Sustainability is broad
 - can not address all the points of view
- I'm software engineer
 - mostly a technical point of view

BTW, I have no solution, silver bullet or fixed answer... you will probably leave with more questions than before :)

“Software Is Eating the World”

Digitalization of our society

- personal context (health, music, video, social networks...)
- professional context (digitalization of numerous processes and activities)



“Every company is a software company. You have to start thinking and operating like a digital company. It’s no longer just about procuring one solution and deploying one. It’s not about one simple software solution. It’s really you yourself thinking of your own future as a digital company.”

— Satya Nadella, CEO, Microsoft



Scientific Computing

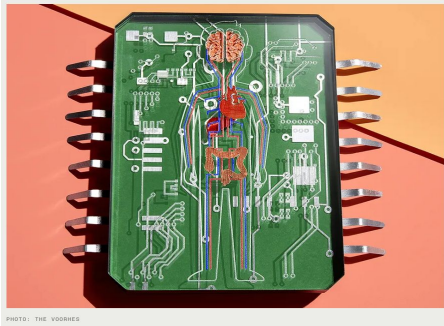
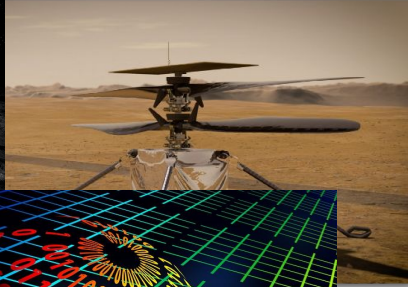
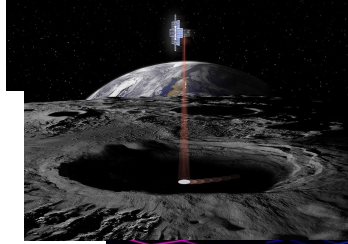
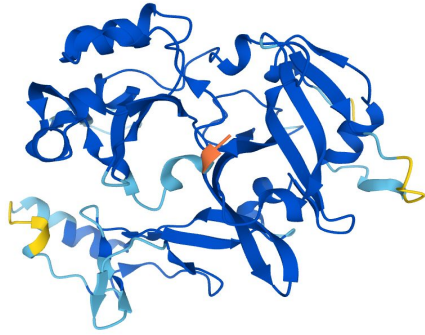
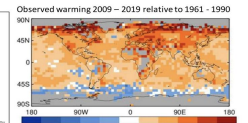
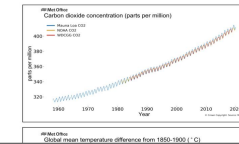


PHOTO: THE VOORDES

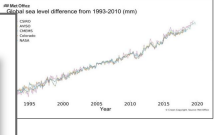
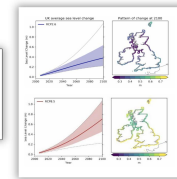
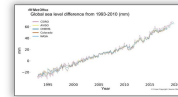


Climate is changing



Global mean temperature difference from 1850-1900 (°C)

The sea level is rising



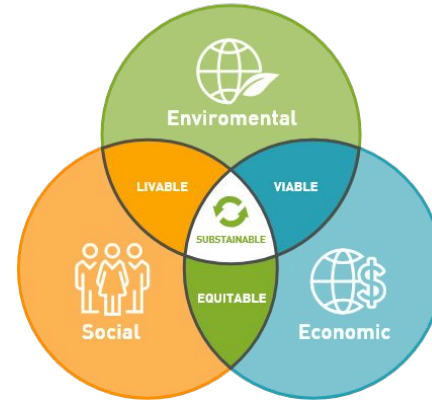
Cyber-Physical Systems



Data-Driven Software Systems



ICT & Sustainability?



ICT4S 2023: The Research Areas & Themes



ICT4S in/by/for society

Untangling degrowth & ICT
Obsolescence Paths
'Always on, necessary?'
Planetary boundaries in ICT



Energy efficiency

Electricity measurements
Impact of Green Feedback
Evolution of Kotlin Apps
Energy cost & ML accuracy
Architecture for IoT
VoD power consumption
5G Base Station Overhaul
Automated Power Modeling



SDG impact cases

Landscape of ICT4S
SDGs in the IT Sector
Carpooling for km traveled
CS virtual conferencing



LCA & Reviews

Tech4Bad in oil & gas
Input-Output Analysis
Review on Process Mining
Environmental Impact SLC



Business case studies

Long Road to Sobriety
Norwegian startup
Finnish green ICT ecosystem
Telecom Network Operators

Software Development

What is Software Engineering?

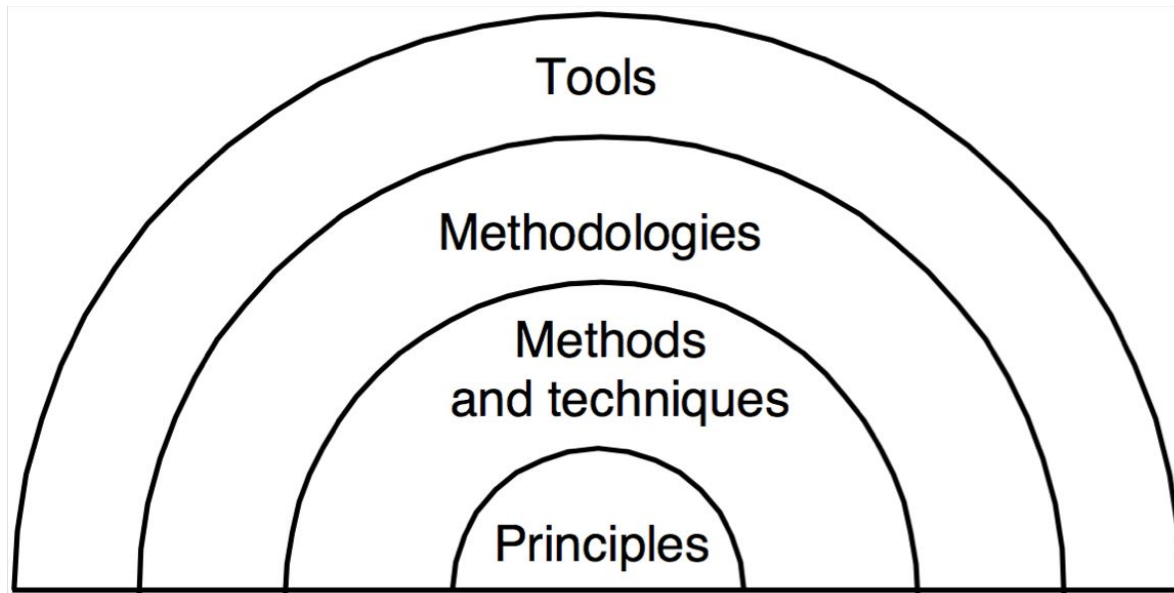
The production of operational software satisfying defined standards of quality...

... includes programming, but is more than programming!

The five components of **Software Engineering** [Meyer]:

- **Describe:** requirements, design, specification, documentation...
- **Implement:** modeling, programming
- **Assess:** testing and other V&V techniques
- **Manage:** plans, schedules, communication, reviews
- **Operate:** deployment, installation...

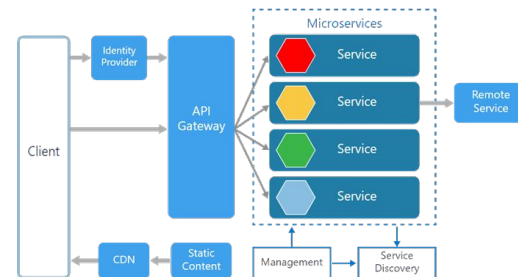
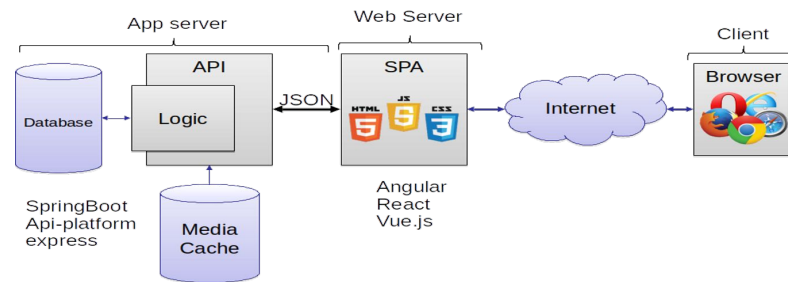
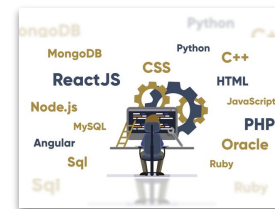
What is Software Engineering?



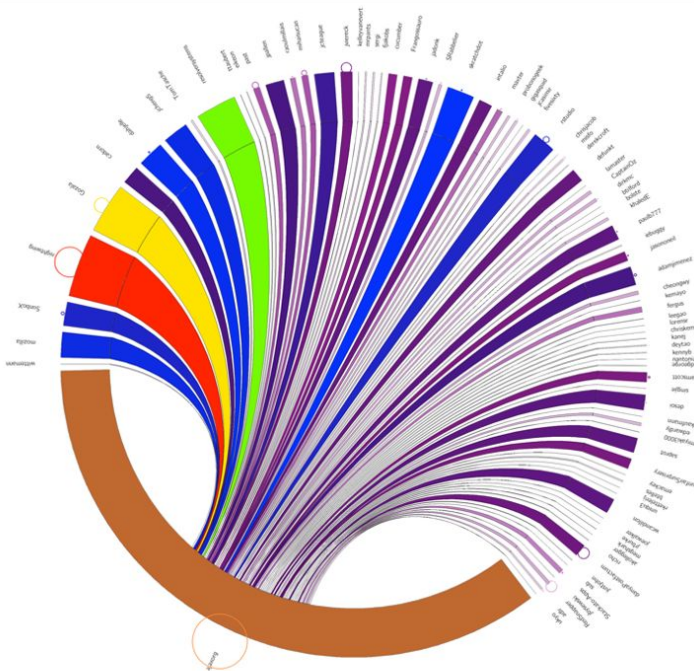
Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli.
Fundamentals of Software Engineering, 2nd edition. 2002.

Modern Software Development

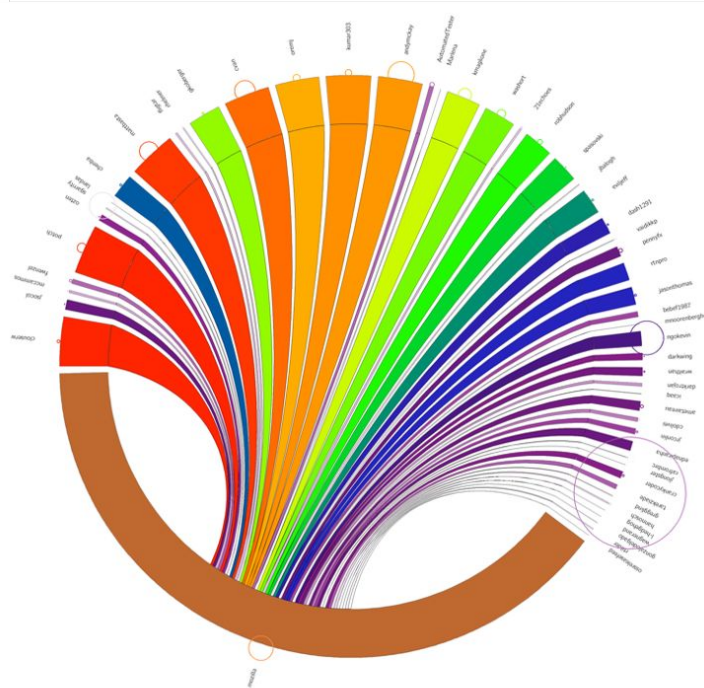
- Polyglot development
- Highly distributed software architectures
- Flexible orchestration of (micro)services



Collaborative Development



137 contributors, 5000 commits, 1300 forks
<https://github.com/ajaxorg/ace>

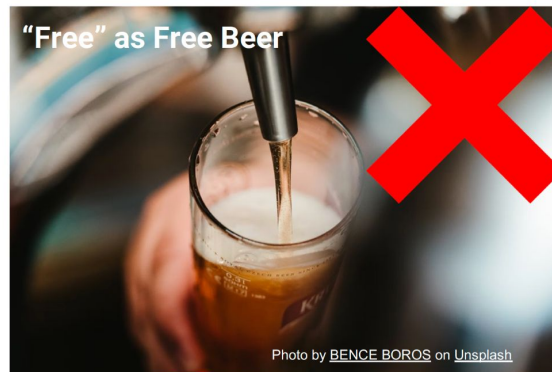


97 contributors, 10000+ commits, 173 forks
<https://github.com/mozilla/zamboni>

Open-Source Software

Free Software:

- The freedom to run the program as you wish, for any purpose
- The freedom to study how the program works, and change it so it does your computing as you wish
- The freedom to redistribute copies so you can help your neighbor
- The freedom to distribute copies of your modified versions to others



Open-Source Software

Open Source Software vs. Free Software?

Stallman explains:

"The two terms describe almost the same category of software, but they stand for views based on fundamentally different values.

- **Open source** is a development methodology,
- **Free software** is a social movement."

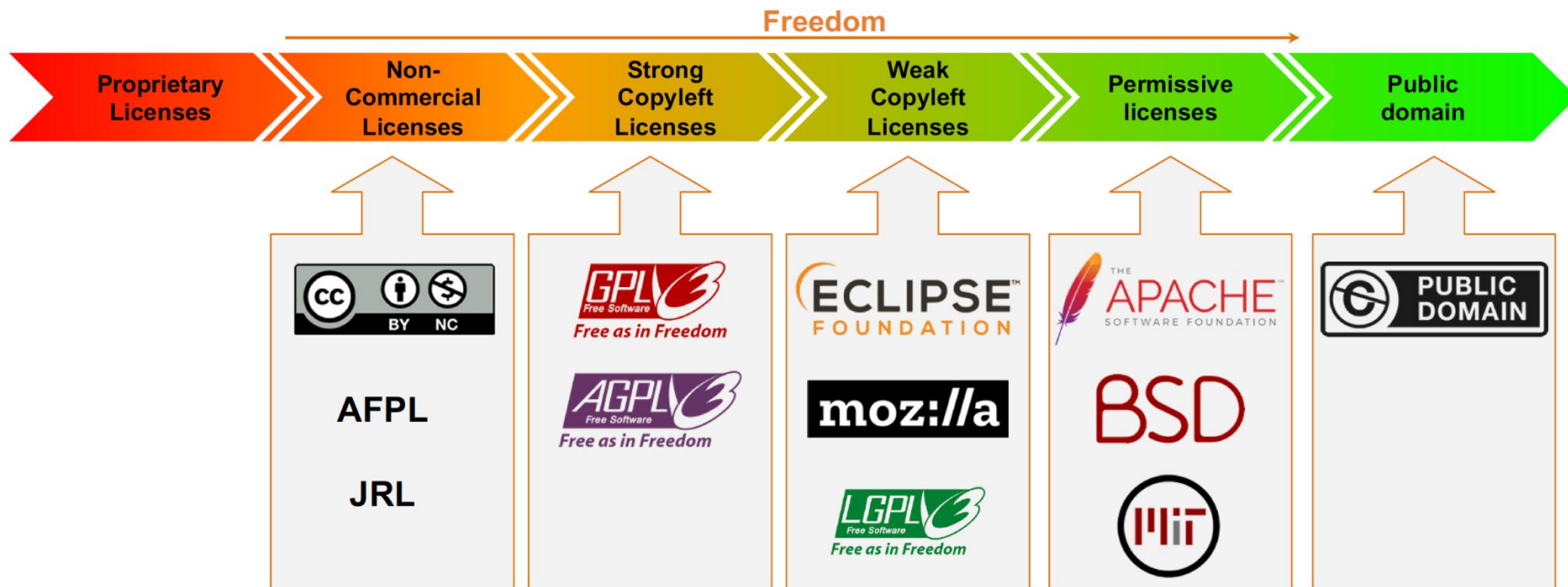
Open-Source Software

Best practices:

- Transparency
- Openness
- Meritocracy

Open-Source Software

Licences:



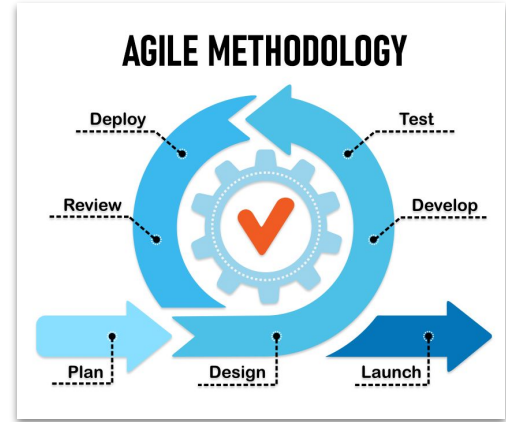
Agile Methods

Principles from lean management

- Continuous improvement
- Respect for people
- Question every chosen one
- Embrace changes

Focus on added value working software

- The customer is at the heart of the process
- The product is built through dialogue with the customer
- The team is self-organized

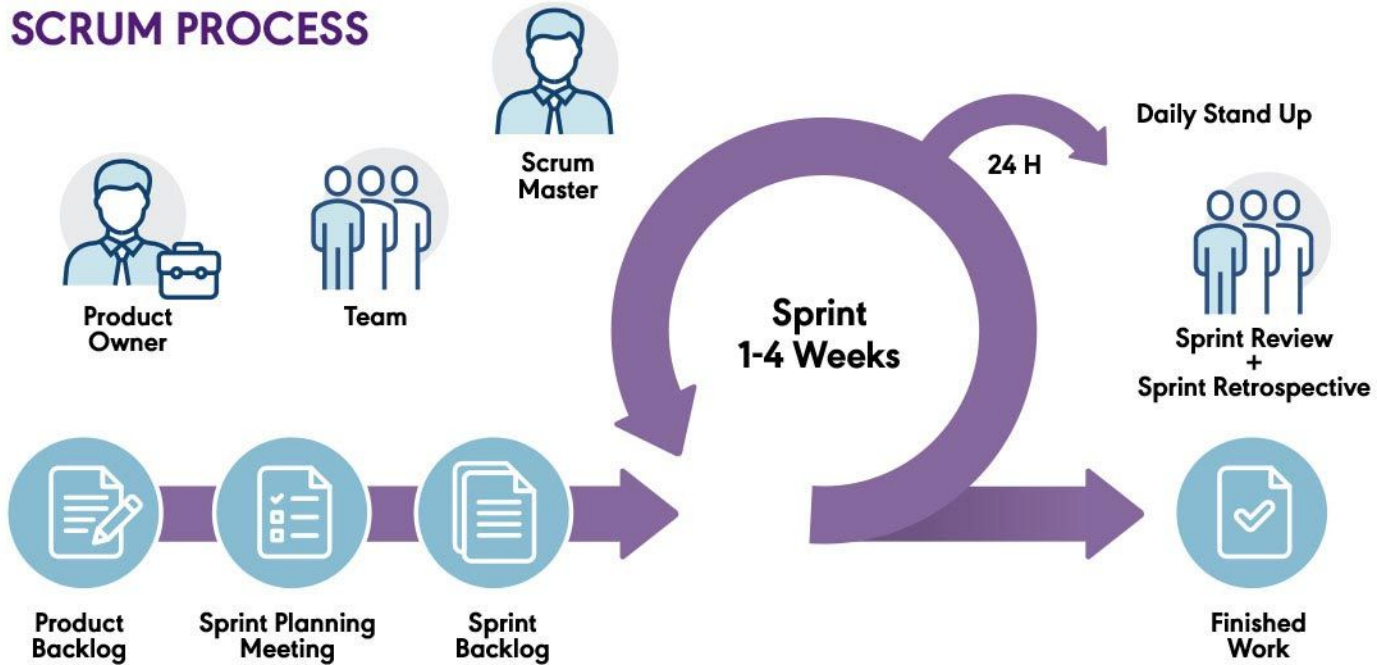


Individual and interactions	over	Process and tools
Working software	over	Comprehensive documentation
Customer collaboration	over	Contract negotiation
Responding to change	over	Following a plan

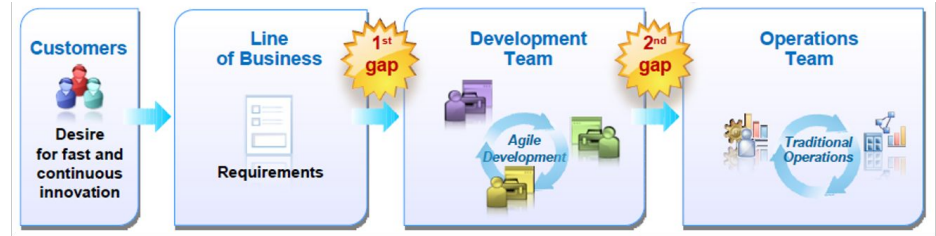
<https://agilemanifesto.org>

Agile Methods

SCRUM PROCESS

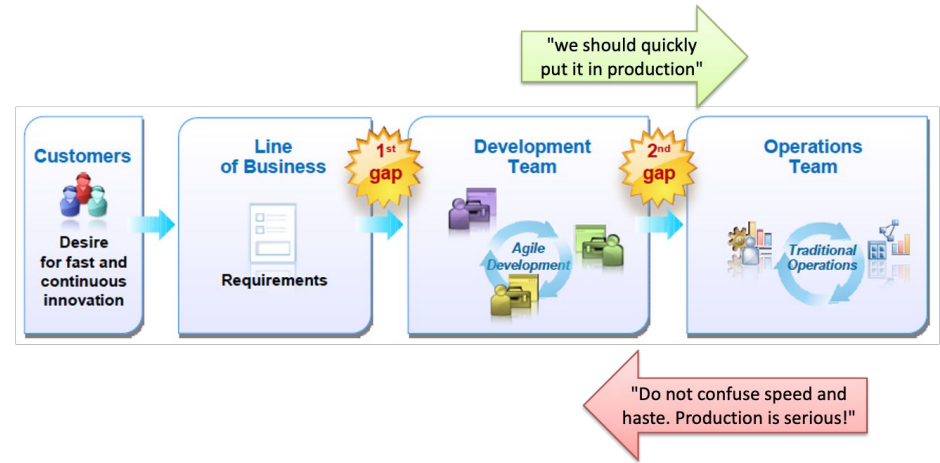


DevOps



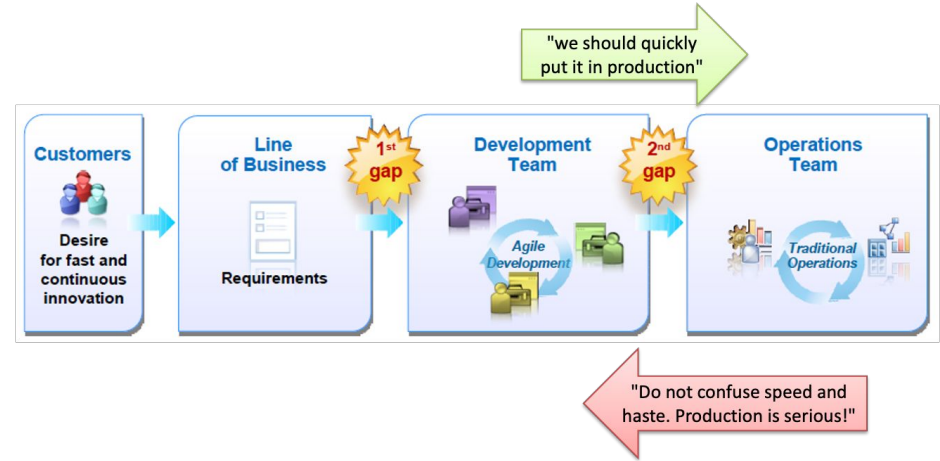
DevOps

A software engineering practice that aims at unifying software development (Dev) and software operation (Ops).



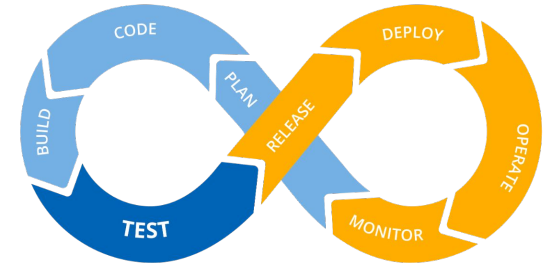
DevOps

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Main motivations:

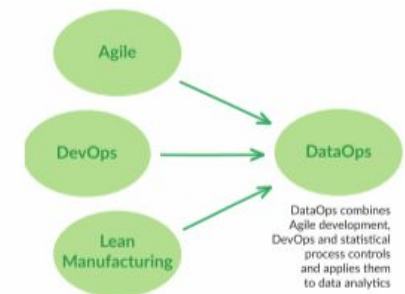
- Reduce the release cycle (time to market, lead time between fixes...)
- More fragmented approach (small increments vs. bigbang)
- Seamless updates
- Shared responsibilities (all in the same boat)
- Continuous improvement



DataOps

“DataOps is a set of practices, processes and technologies that combines an integrated and process-oriented perspective on data with automation and methods to improve quality, speed, and collaboration and promote a culture of continuous improvement in the area of data analytics”

Aims at developing and operating software tools & frameworks that help support data analytics initiatives across an organization



From Wikipedia

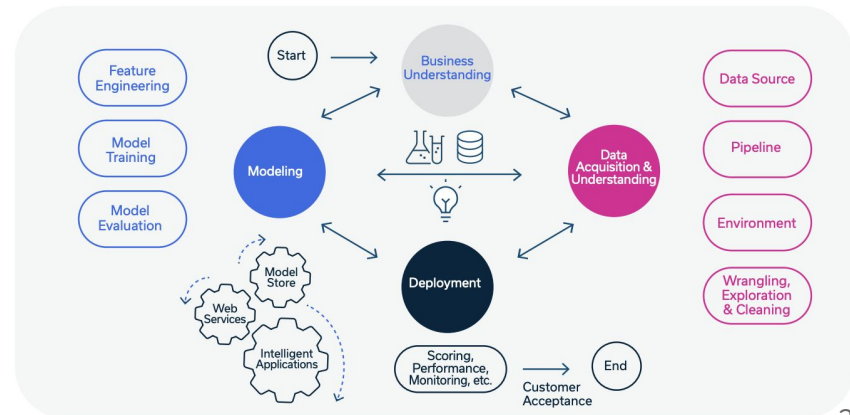
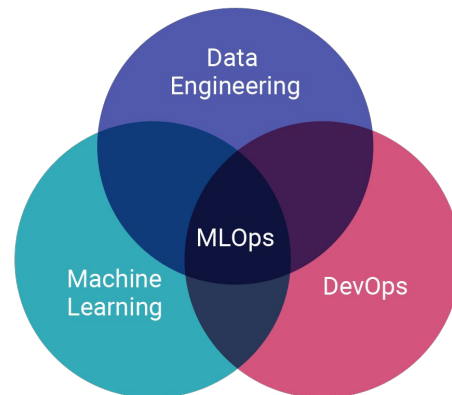
MLOps

Machine Learning Operations

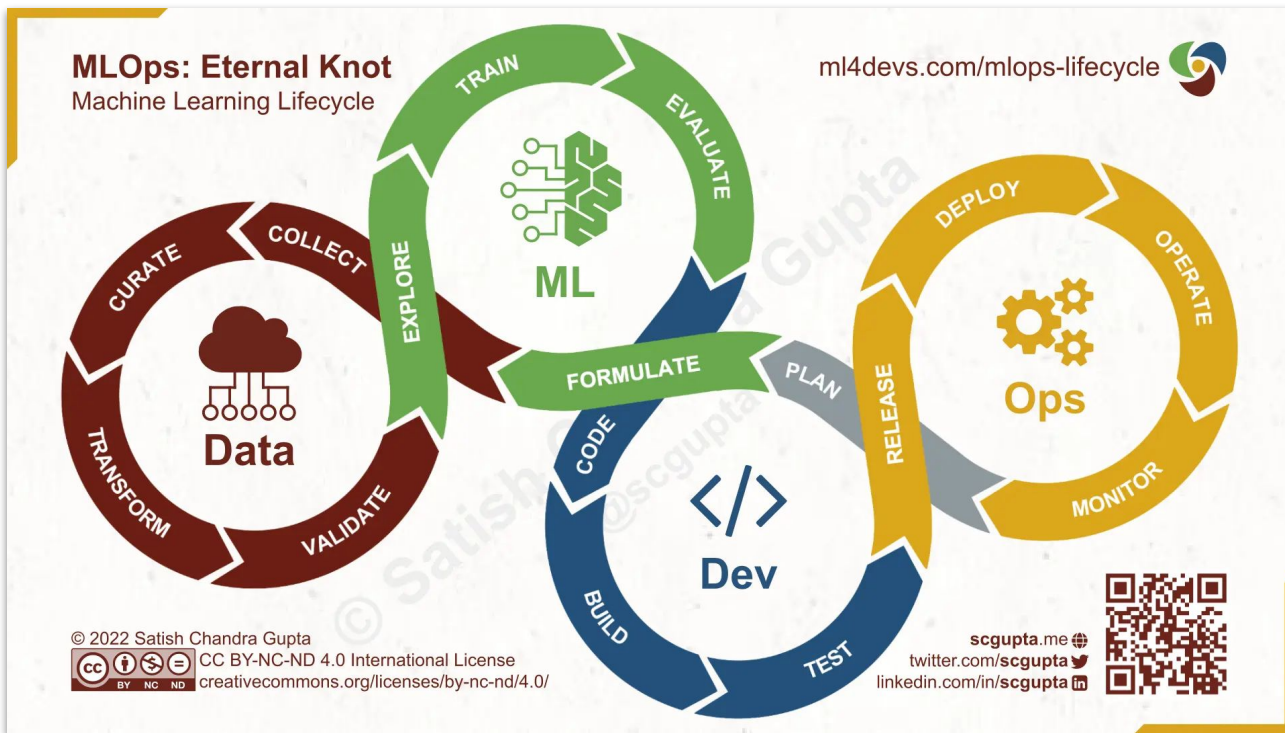
- Technology and practices to design, build and manage reproducible, testable, and evolvable ML-powered software
- End-to-end, iterative, and incremental machine learning development process

MLOps Principles

- Versioning
- Testing
- Deployment
- Monitoring
- Automation
- Reproducibility



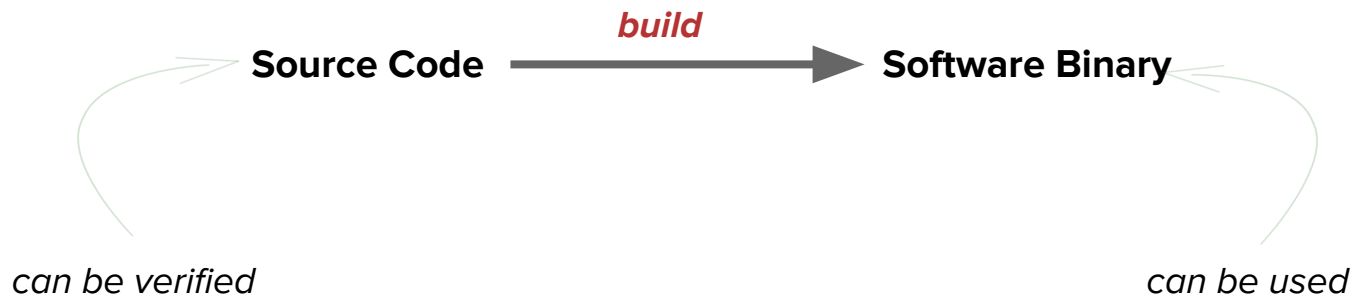
MLOps



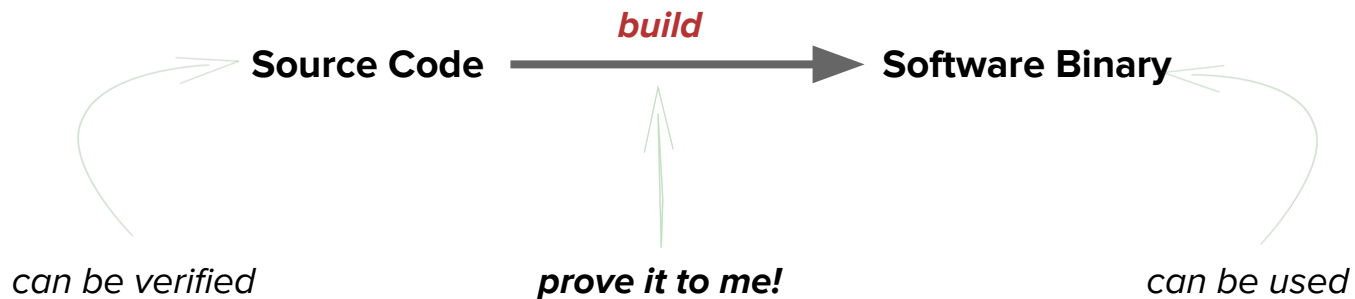
Reproducible Build



Reproducible Build



Reproducible Build

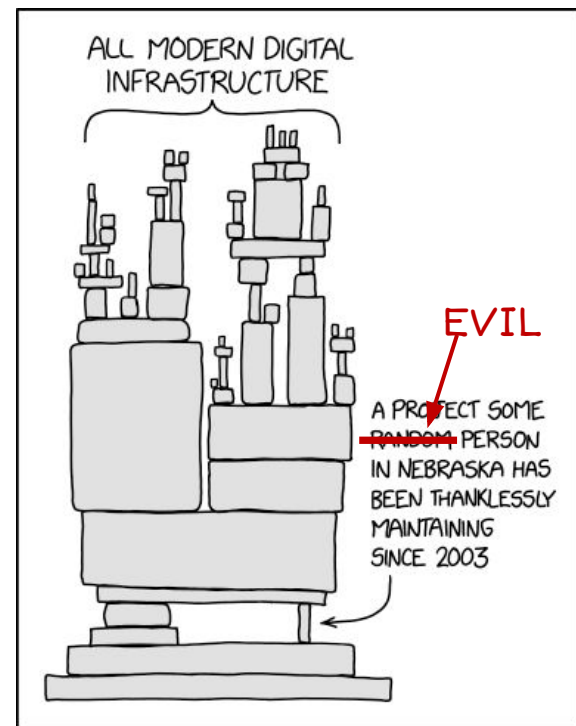


Software Supply Chain

SoK: Taxonomy of Attacks on Open-Source Software Supply Chains, by Ladisa Piergiorgio, Henrik Plate, Matias Martinez, Olivier Barais. In IEEE Symposium on Security and Privacy (forthcoming 2023)

Risk Explorer for Software Supply Chains: Understanding the Attack Surface of Open-Source based Software Development, by Ladisa Piergiorgio, Henrik Plate, Matias Martinez, Olivier Barais, Serena Elisa Ponta. In ACM Workshop on Software Supply Chain Offensive Research and Ecosystem Defenses (SCORED '22)

- Cited as guidance resource in [Microsoft's OSS SSC Framework](#)
- Cited in [Adam Shostack's Application Security Roundup of September '22](#)
- Risk Explorer used internally at SAP and at Citigroup Inc. for threat modelling and development of best-practices. Submission to RSA Conference in forecast.
- Discussion of whether to transfer the taxonomy under [OpenSSF](#)



In collaboration with



Environmental Impact



JEAN JOUZEL

GLOBAL WARMING: THE NEED FOR A NEW MODEL OF DEVELOPMENT AND THE KEY ROLE OF HIGHER EDUCATION

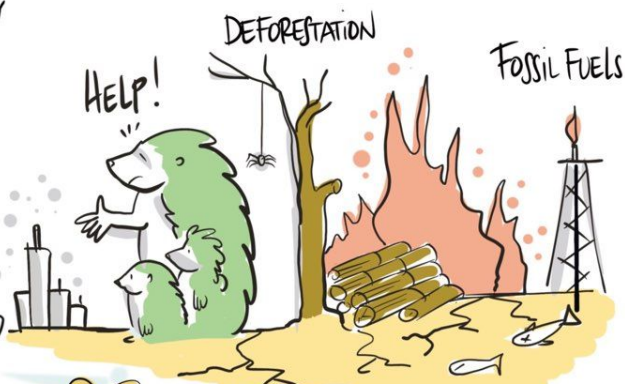
EMERGENCY!
2050



GREEN HOUSE GAS EMISSIONS



N₂ CO₂



DEFORESTATION

FOSSIL FUELS

HELP!

IMPACT ON ECOSYSTEMS



POPULATION INCREASE

TRANSPORTATION

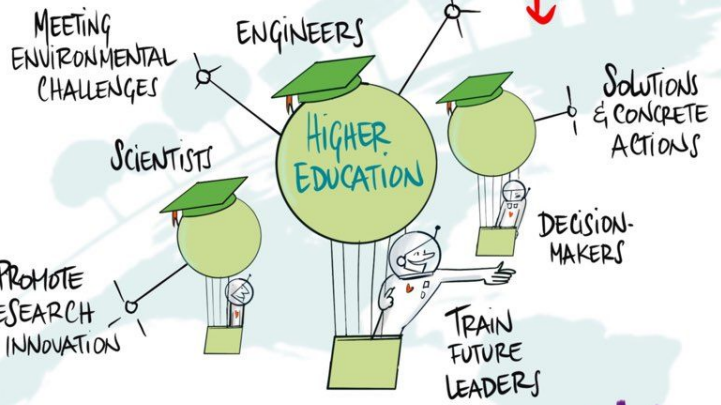
HUMAN CAUSES



WASTE

CH₄ INTENSIVE FARMING

H₂O



AMBITIOUS CLIMATE POLICIES



INTERNATIONAL COOPERATION

ENGAGEMENT OF CIVIL SOCIETY

REK

KEYNOTE

What significance does this hold for software?

Climate crisis:

- Planetary boundaries
- Decent and fair standard of living

Digitalization:

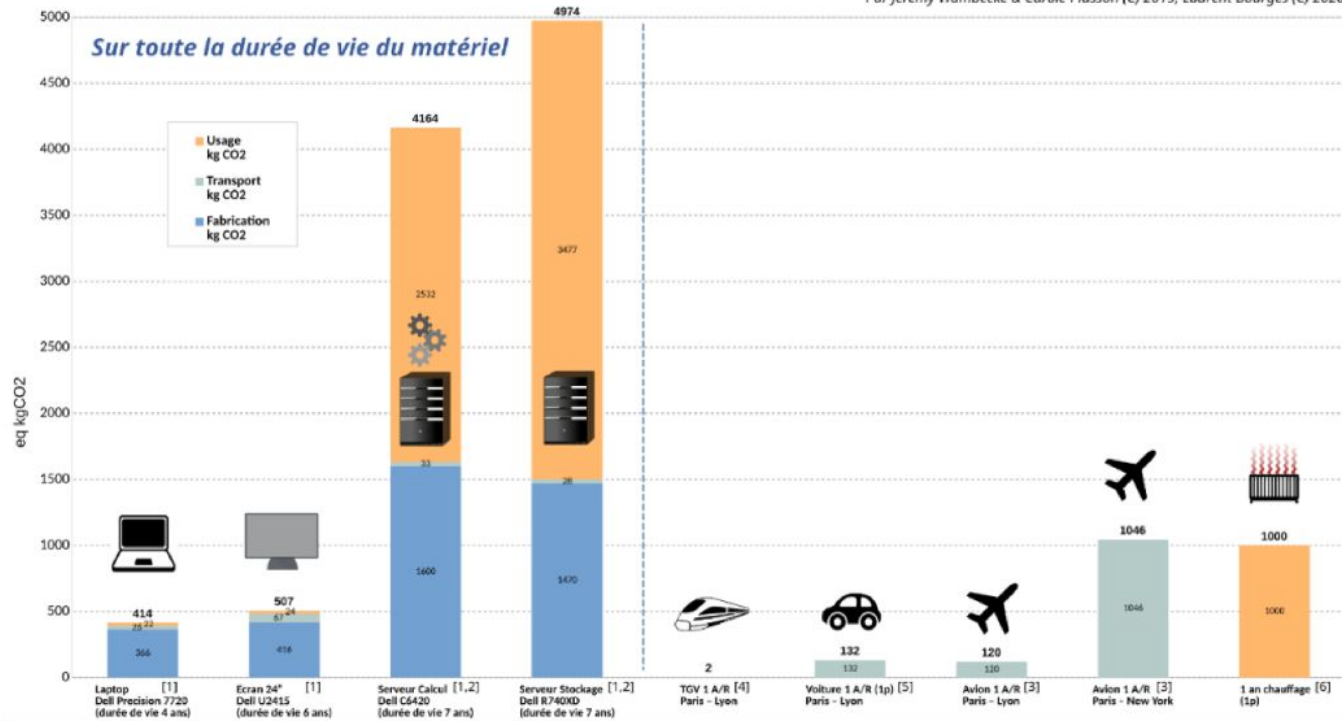
- In the global carbon footprint: 2,1% to 3,9% in 2021
- In the French electricity consumption: 11% in 2020

Green IT vs IT for Green?

- Often presented as part of the **solution** to climate problems (optimizations, smart systems, etc.)
- But definitely part of the **problem**

Green IT: Some Examples

Par Jérémy Wambecke & Carole Plasson (C) 2019, Laurent Bourgès (C) 2020



[1] Données Fiches Dell (usage corrigé pour usage FR) : https://www.dell.com/learn/us/en/uscorp1/corp-comm/environnement_carbon_footprint_products
 [2] Usage à partir de la consommation moyenne (Berthoud et al. 2020) d'un noeud = 275W (C6420), 375W (R740XD) (<https://hal.archives-ouvertes.fr/hal-02549565>)
 [3] <https://eco-calculateur.dta.aviation-civile.gouv.fr/>

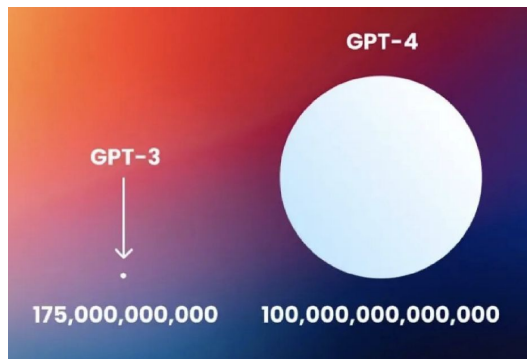
[4] <https://ressources.data.sncf.com/explore/dataset/emission-co2-tgv/table/>
 [5] Trajet de 473km, pour une voiture émettant 140g CO2/km
 [6] <https://www.insee.fr/fr/statistiques/fichier/1281320/ip1445.pdf>
Facteur d'impact : 0,108 kgCO2e/kWh (FR)

Example: Generative AI, the case of ChatGPT

Estimated energy consumption for GPT-3 training: 1,297Mwh

Estimate cost: between 0.5 to 4.6 million dollars

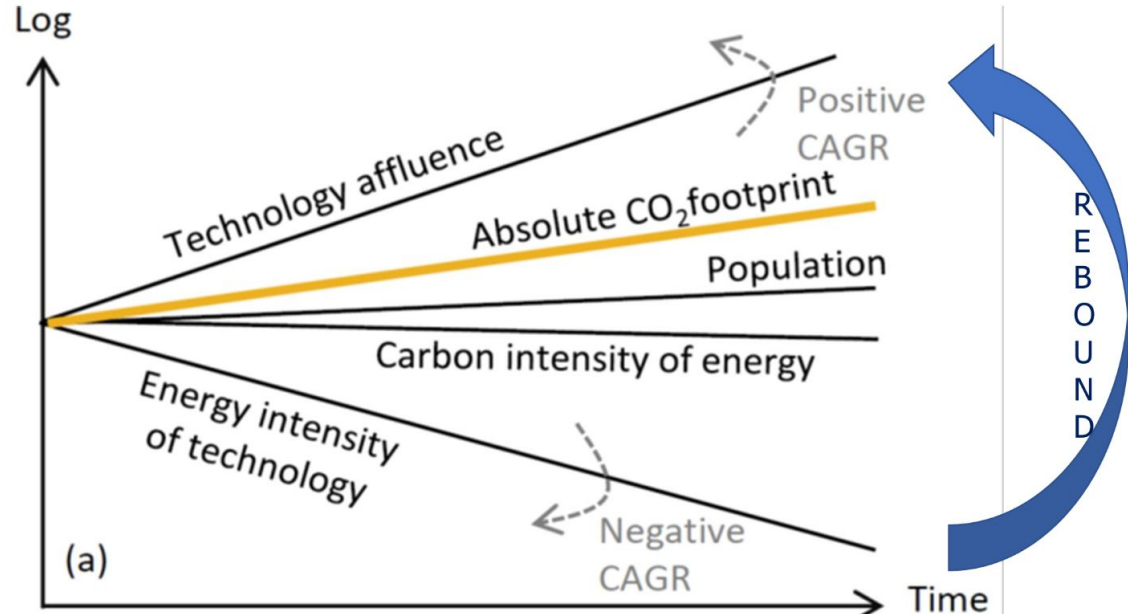
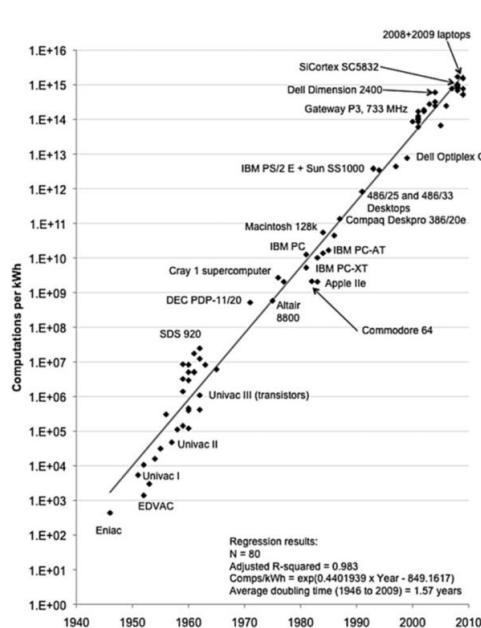
Cf. <https://dl.acm.org/doi/10.1145/3442188.3445922>



Nb of hyper-parameters

Technology affluence grows more than energy efficiency

Digital CO2 footprint = Population × Digital Technology Affluence × Energy Intensity of Technology × Carbon Intensity

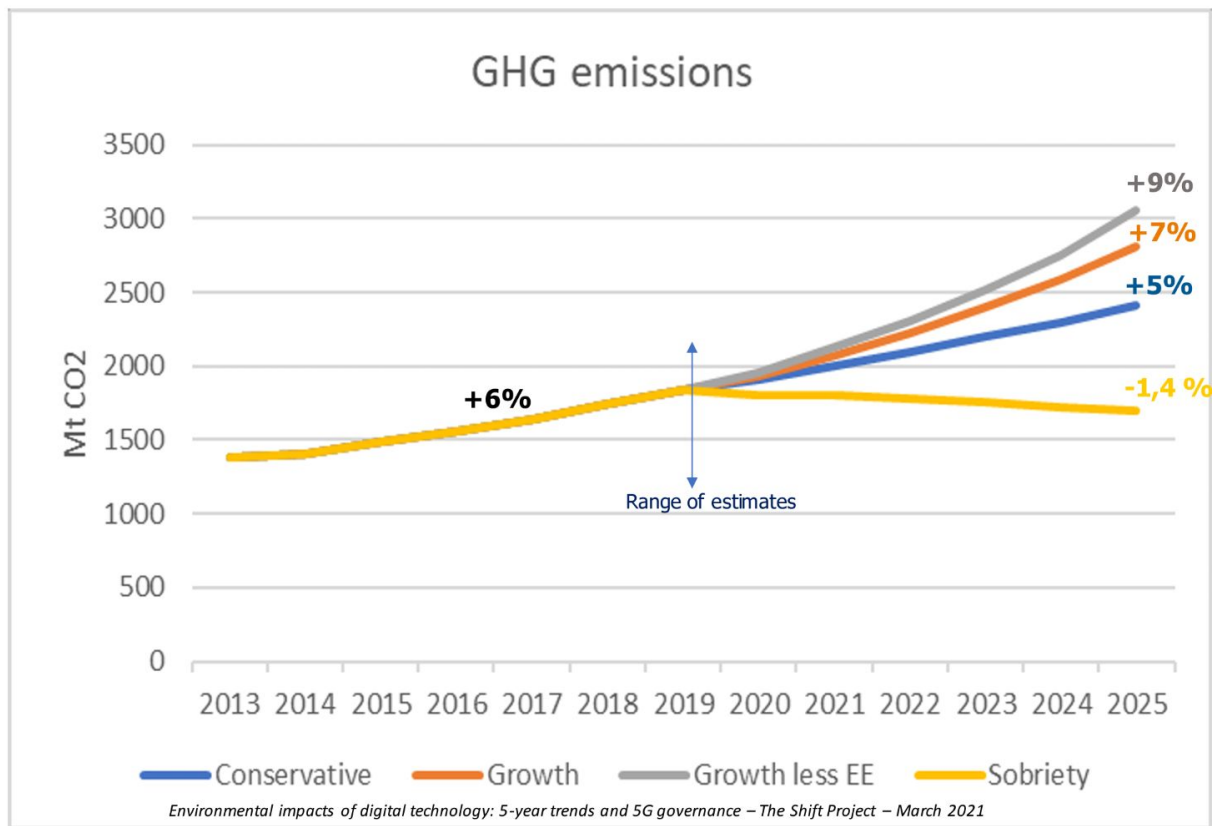


Digitalization is currently unsustainable

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The growth is sustained and will continue except if there is a shift **towards digital sobriety/sufficiency**

Current trend would eat up 15% of global GHG reduction by 2030



Example: the case of the Gson library

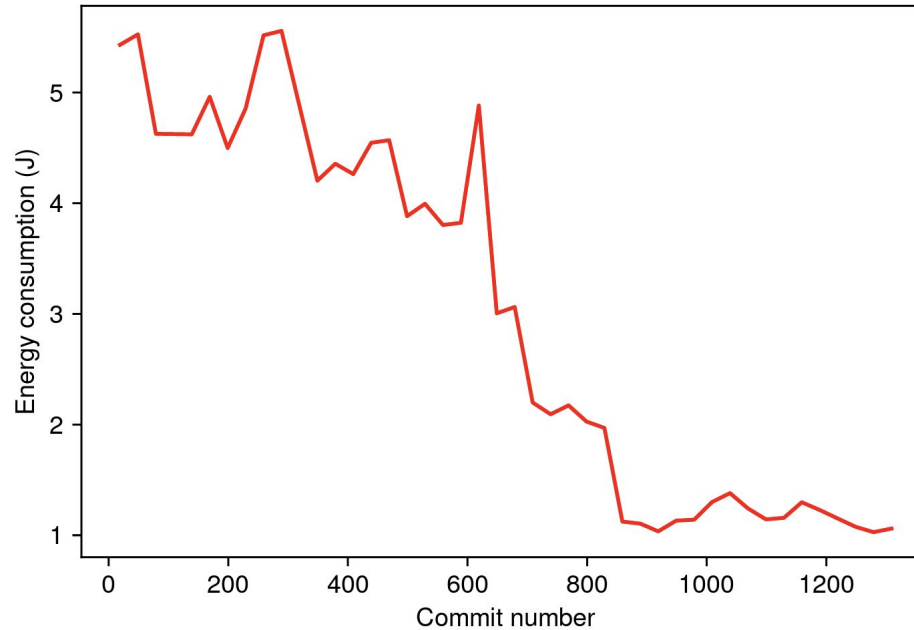


Fig. 4: Gson energy consumption across for every 25th commit.

We face a system design issue

Digital technology affluence is growing due to societal and economic behaviours:

- Digital consumers unaware of the impacts (environment, health, behavior etc) and digitally hungry
- Enterprises engaged in digital transitions without connecting them to increasingly stringent environmental/energy transitions (e.g., IoT)
- Public authorities encouraging “digital transition projects” bound to yield economic growth
- Software-induced obsolescence boosting hardware production in line with linear business models
- Big Tech (GAFAM, BATX) relying on audience maximization (two-sided market business model) and using addictive design techniques

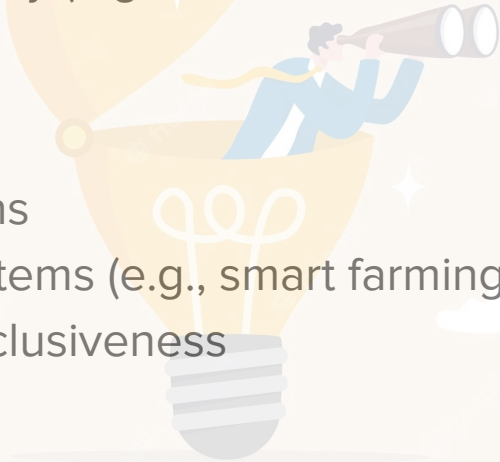
(Some) Open *Sw Eng.* Research Questions

Green IT

- Measure, best practices, guidelines, automatic analysis / optimization
- Sustainability requirement elicitation, Life-Cycle Assessment
- Computational sustainability (e.g., software debloating, approximate computing, self-adaptive system)

IT for Green

- Virtual lab and Digital twins
- Smart Cyber-Physical Systems (e.g., smart farming/cities/home/grid)
- Social interactions and inclusiveness



Social Impact

Ethics in Software Engineering

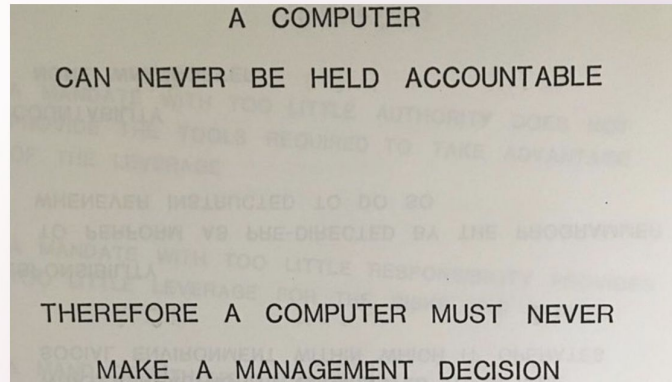
We must come to understand that “every line of code we write has a moral and ethical implication.” -- Grady Booch's keynote at ICSE 2015

Software systems are developed by people and that therefore "social, organizational, and psychological aspects" play a predominant role in successfully developing software -- Lionel Briand Keynote at ICSE 2022

Our Responsibilities



An IBM slide from 1979.



6:00 PM · 19 Dec, 2022

266 replies 10.5K shares 74.2K likes

Our Responsibilities

 MIT CSAIL 
@MIT_CSAIL

An IBM slide from 1979.

A COMPUTER
CAN NEVER BE HELD ACCOUNTABLE
THEREFORE A COMPUTER MUST NEVER
MAKE A MANAGEMENT DECISION

6:00 PM · 19 Dec, 2022

266 replies 10.5K shares 74.2K likes

Victims of Post Office Horizon scandal awarded millions more in compensation

Horizon was a faulty computer system that incorrectly showed shortfalls of money within the Post Office. The error, which led to hundreds of employees being wrongly convicted, has been described as the most widespread miscarriage of justice in UK history.

© Thursday 30 June 2022 12:31 UK



<https://news.sky.com/story/victims-of-post-office-horizon-scandal-awarded-millions-more-in-compensation-12643049>

Ethics Vs. Morals

Ethics and morals relate to “right” and “wrong” conduct. While they are sometimes used interchangeably, they are different:

- Ethics refer to rules provided by an external source, e.g., codes of conduct in workplaces or principles in religions.
- Morals refer to an individual’s own principles regarding right and wrong.

Ethics Vs. Morals

	Ethics	Morals
What are they?	The rules of conduct recognized in respect to a particular class of human actions or a particular group or culture.	Principles or habits with respect to right or wrong conduct. While morals also prescribe dos and don'ts, morality is ultimately a personal compass of right and wrong.
Where do they come from?	Social system - External	Individual - Internal
Why we do it?	Because society says it is the right thing to do.	Because we believe in something being right or wrong.
Flexibility	Ethics are dependent on others for definition. They tend to be consistent within a certain context, but can vary between contexts.	Usually consistent, although can change if an individual's beliefs change.
The "Gray"	A person strictly following Ethical Principles may not have any Morals at all. Likewise, one could violate Ethical Principles within a given system of rules in order to maintain Moral integrity.	A Moral Person although perhaps bound by a higher covenant, may choose to follow a code of ethics as it would apply to a system. "Make it fit"
Origin	Greek word "ethos" meaning "character"	Latin word "mos" meaning "custom"
Acceptability	Ethics are governed by professional and legal guidelines within a particular time and place	Morality transcends cultural norms

Ethics in Software Engineering

- Values and Impact: Deontological and consequentialist ethics
- Reproach to ethicists: “Useless!”
 - and to software engineers: “This is not informatics anymore!”
- Indeed: >120 Codes of Conduct for Software/Systems Engineering rather fruitless
- Reason: Software context-specific; hence values and trade-offs context-specific
 - Contexts: application domain, technology, users’ culture, developers’ culture, optimization goals, ...
- Examples: Corona app, face recognition, data integration, care robots, resume analyzers, etc. – but also software without AI/data: camera surveillance w/o FR, BitTorrent, Telegram, Bitcoin, website preferences/fingerprinting...
- Genericity of CoCs hence necessary. Only way out: schema that caters to context specificity

Airlines tickets during Hurricane Irma

Supply and demand software pricing systems that unexpectedly led to price gouging on airline tickets for those trying to evacuate from Hurricane Irma – as the New York Times reported at the time, **“There are no ethics valves built into the system that prevent an airline from overcharging during a hurricane.”**

The Meta group

Changes in WhatsApp's terms and privacy policy led millions of its users to migrate to alternative messaging apps

Facebook's Cambridge Analytica privacy case a few years back! Violation of more than 87 millions profiles' privacy!

- \$643,000 fine to the U.K.'s Information Commissioner's Office
- " We have a responsibility to protect your data, and if we can't then we don't deserve to serve you" M. Zuckerberg

Ethics in Software Engineering

BuzzFeed News

"I've found multiple blatant attempts by foreign national governments to abuse our platform on vast scales to mislead their own citizenry, and caused international news on multiple occasions. I have personally made decisions that affected national presidents without oversight, and taken action to enforce against so many prominent politicians globally that I've lost count." **"I Have Blood on My Hands": A Whistleblower Says Facebook Ignored Global Political Manipulation**

A 6,600-word internal memo from a fired Facebook data scientist details how the social network knew leaders of countries around the world were using their site to manipulate voters -- and failed to act.

<https://www.buzzfeednews.com/article/craigsilverman/facebook-ignore-political-manipulation-whistleblower-memo>

Volkswagen Dieselgate!

- Volkswagen, USA was accused by the US Environment Protection Agency (EPA) of installing an **illegal “defeat device” software** that dramatically reduces nitrogen oxide (NOx) emissions - but only when the cars were undergoing strict emission tests
- **11 million cars** were affected leading to around **25 billion Euro** being wiped off the company’s market value
- VW’s CEO in USA, Michael Horn in a testimony before US Congress identified the true authors of his company’s deception: **“This was a couple of rogue software engineers who put this in for whatever reason.”** As a further justification, he described the **“defeat device” as a line of code “hidden in millions of software code”**

The Algorithm That Beats Your Bank Manager

The site rejects 70% of its applicants after tapping into about 7,000 pieces of data on each one to decide if they're credit worthy, taking data primarily from credit bureaus as well as "other databases."

"He and his team obsessively check over their loan risk numbers, getting a **26-page report on user data every two hours** and tweaking the parameters on a daily basis"

<https://www.forbes.com/sites/parmyolson/2011/03/15/the-algorithm-that-beats-your-bank-manager>

Code of conducts are not enough!

- Both US and Germany have strong engineering codes of ethics, yet this didn't prevent those scandals and lack of Ethics to happen.
- Germany has even finalized the code of ethics for driverless cars
 - <https://www.bmvi.de/SharedDocs/EN/publications/report-ethics-commission.pdf>
- Consumers will only switch from human-driven vehicles to autonomous vehicles if they understand the origins of the ethical principles that are programmed into these vehicles [Awad 17]
- => The MIT Initiative: <https://www.moralmachine.net/>

- CoC necessarily generic - McNamara et al. (2018) find no evidence that CoCs influence behaviour

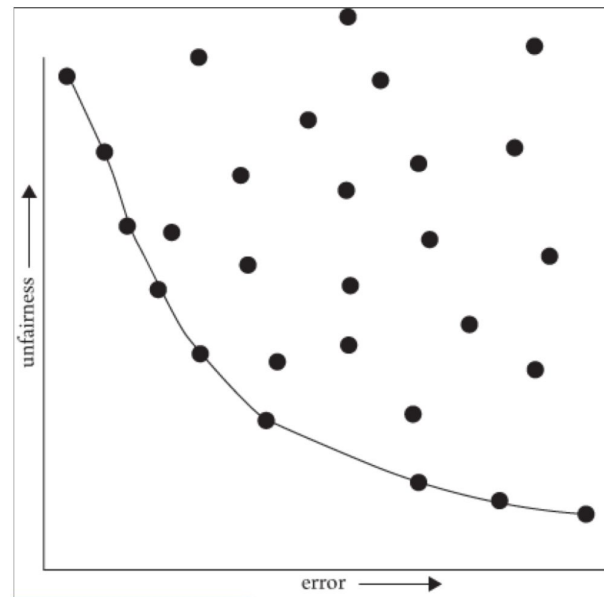
20 principles for Ethics of Driverless cars

“Learning systems that are self-learning in vehicle operation and their connection to central scenario databases may be ethically allowed if, and to the extent that, they generate safety gains. Self-learning systems must not be deployed unless they meet the safety requirements regarding functions relevant to vehicle control and do not undermine the rules established here. It would appear advisable to hand over relevant scenarios to a central scenario catalogue at a neutral body in order to develop appropriate universal standards, including any acceptance tests.”

⇒ Would you trust those self-learning systems? 😐

Code of conducts are not enough!

- Specifically, CoCs do not tell us what to do when values interfere with each other, like privacy vs. transparency, freedom vs. safety, etc.
- When we try to optimise a model/software that relies on two (or more) values a good shot is Pareto optimality
- Only solutions on the frontier are reasonable
- But ... where on the curve?
(and Pareto optimality is problematic as such)

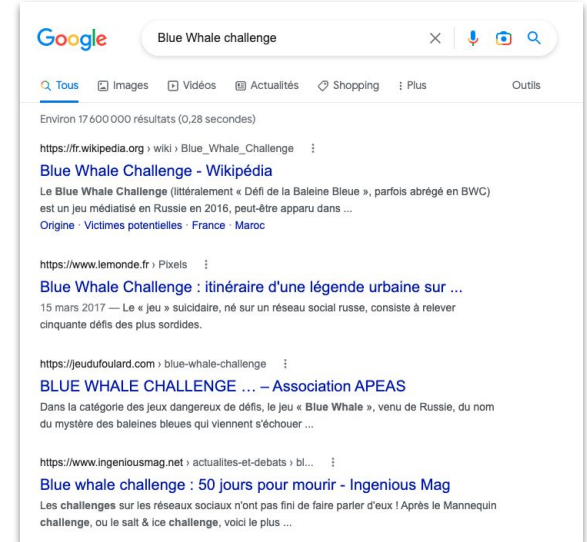


Example Covid App: Ethical Deliberation

- Privacy vs. public health [“Privacy”? – GDPR? Informational self-determination? What “society wants”? What is used as argument in the public debate?]
- Helps the collective not the individual
- Might lead to false sense of security
- Adverse effects for the user (battery life, traffic data) Might become a requirement to participate in public life
- Accessibility restricted to smartphone users; different distribution across age

Blue Whale challenge !

- “Blue Whale Challenge” – a game conducted through social media apps was responsible for the **death of 153 teenagers around the world!**
- The game presented its players with 50 tasks in 50 days, and the 50th task was to take your own life



**Is there any initiatives to reinforce
Ethics in software/systems?**

IEEE Code of Ethics

IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members, and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

I. To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.

1. to hold paramount, the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment;
2. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;
3. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
4. to avoid unlawful conduct in professional activities, and to reject bribery in all its forms;
5. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest, and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others;
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

II. To treat all persons fairly and with respect, to avoid harassment or discrimination, and to avoid injuring others.

7. to treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;
8. to not engage in harassment of any kind, including sexual harassment or bullying behavior;
9. to avoid injuring others, their property, reputation, or employment by false or malicious actions, rumors, or any other verbal or physical abuses;

III. To strive to ensure this code is upheld by colleagues and co-workers.

10. to support colleagues and co-workers in following this code of ethics, to strive to ensure the code is upheld, and to not retaliate against individuals reporting a violation.

**Adopted by the
IEEE Board of Directors
June 2020**



www.ieee.org

ACM Code of Ethics

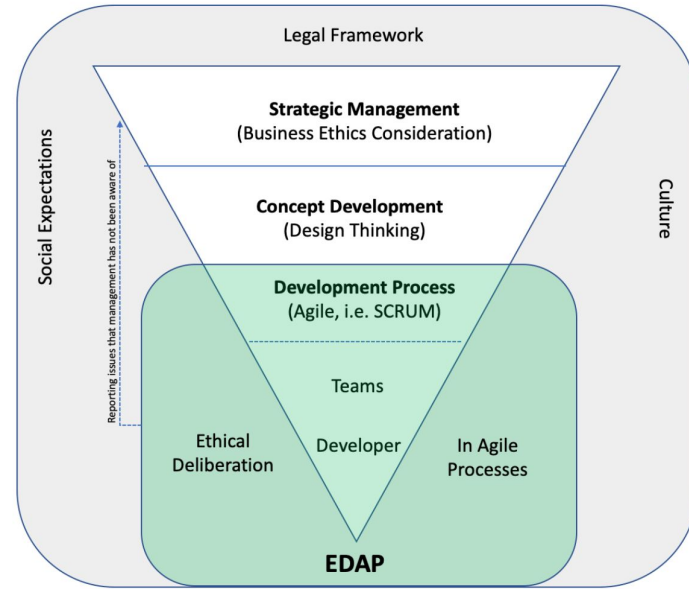
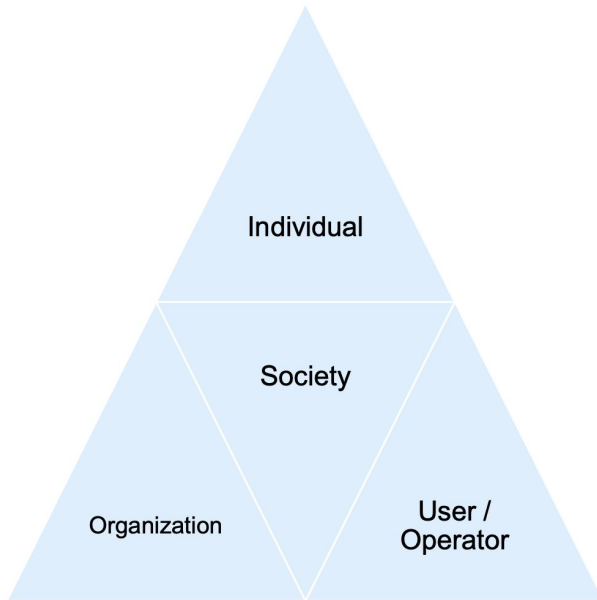
No.	Principles	Meaning in Short
1	Public	Software engineers shall act consistently within the public interest.
2	Client and Employer	Software engineers shall act in a manner that is in the best interests of their client and employer consistent within the public interest.
3	Product	Software engineers shall ensure their products and related modifications meet the highest professional standards possible.
4	Judgment	Software engineers shall maintain integrity and independence in their professional judgment.
5	Management	Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.
6	Profession	Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.
7	Colleagues	Software engineers shall be fair to and supportive of their colleagues.
8	Self	Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

The Ethics Compliance Initiative (2015, US)

The Ethics Compliance Initiative recommends that when members of the team make a decision they should apply a set of Alters which may be summarized as the PLUS group:

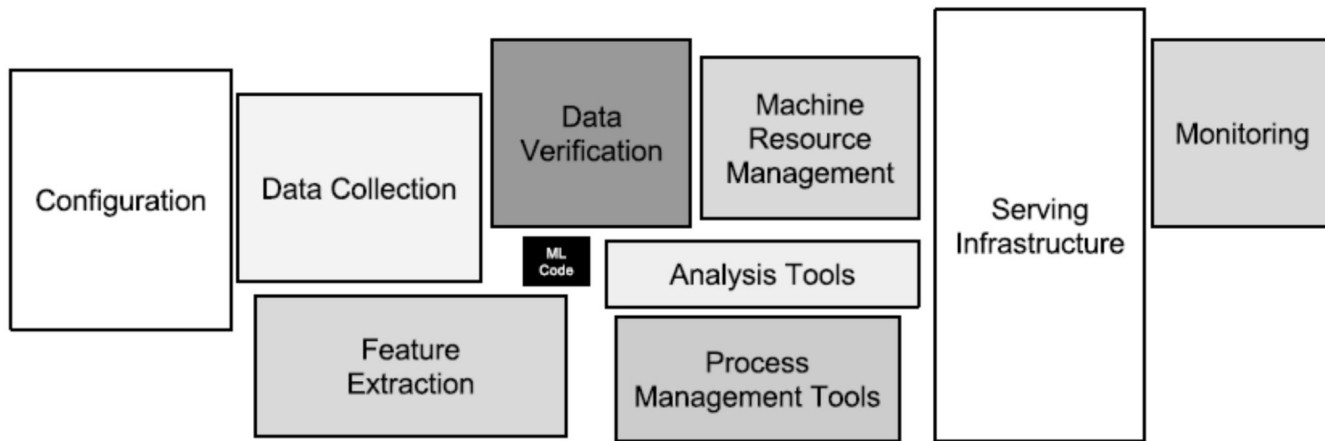
- P = Policies
 - Is the decision in conformity with the practice policies, procedures and guidelines?
- L = Legal
 - Is the decision acceptable under the applicable laws and regulations?
- U = Universal
 - Does the decision conform to universal principles which the practice has adopted?
- S=Self
 - Does the decision satisfy personal definitions of right, good and fair?

Who is responsible?

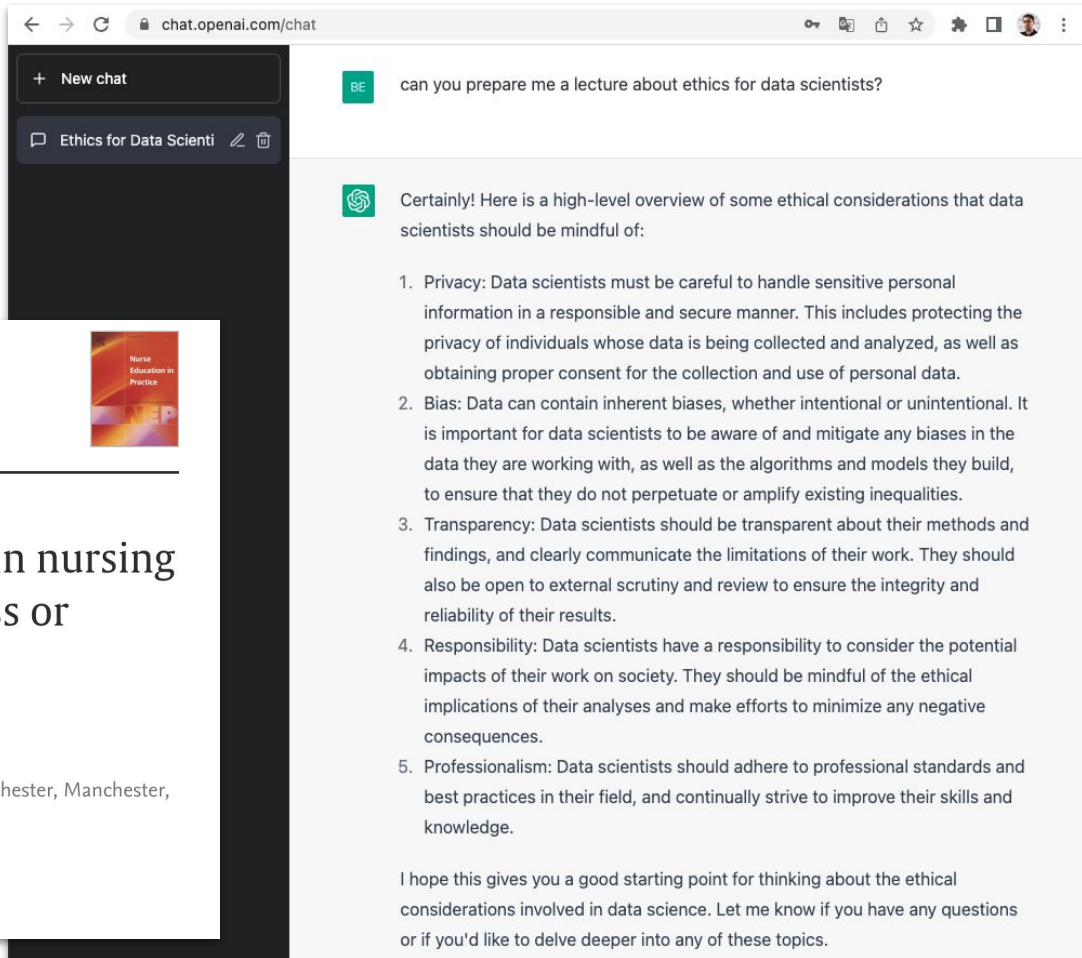


Ethics in Software Engineering & AI

Ethical issues are not confined to AI – but this is suggested by the current debate!
A centralized Corona app? Palantir Foundry? Integration of registers?



ChatGPT



The screenshot shows a web browser window at chat.openai.com/chat. The user has asked: "can you prepare me a lecture about ethics for data scientists?". The AI response is as follows:

Certainly! Here is a high-level overview of some ethical considerations that data scientists should be mindful of:

1. **Privacy:** Data scientists must be careful to handle sensitive personal information in a responsible and secure manner. This includes protecting the privacy of individuals whose data is being collected and analyzed, as well as obtaining proper consent for the collection and use of personal data.
2. **Bias:** Data can contain inherent biases, whether intentional or unintentional. It is important for data scientists to be aware of and mitigate any biases in the data they are working with, as well as the algorithms and models they build, to ensure that they do not perpetuate or amplify existing inequalities.
3. **Transparency:** Data scientists should be transparent about their methods and findings, and clearly communicate the limitations of their work. They should also be open to external scrutiny and review to ensure the integrity and reliability of their results.
4. **Responsibility:** Data scientists have a responsibility to consider the potential impacts of their work on society. They should be mindful of the ethical implications of their analyses and make efforts to minimize any negative consequences.
5. **Professionalism:** Data scientists should adhere to professional standards and best practices in their field, and continually strive to improve their skills and knowledge.

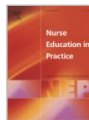
I hope this gives you a good starting point for thinking about the ethical considerations involved in data science. Let me know if you have any questions or if you'd like to delve deeper into any of these topics.



ELSEVIER

Nurse Education in Practice

Volume 66, January 2023, 103537



Editorial

Open artificial intelligence platforms in nursing education: Tools for academic progress or abuse?

Siobhan O'Connor^{a 1}  , ChatGPT^b 

^a Division of Nursing, Midwifery, and Social Work, The University of Manchester, Manchester, United Kingdom

^b OpenAI L.L.C., 3180 18th Street, San Francisco, CA 94110, USA

Available online 16 December 2022, Version of Record 20 December 2022.

Ethics in AI

PRINCIPLED ARTIFICIAL INTELLIGENCE

A Map of Ethical and Rights-Based Approaches to Principles for AI

DOCUMENT TIMELINE



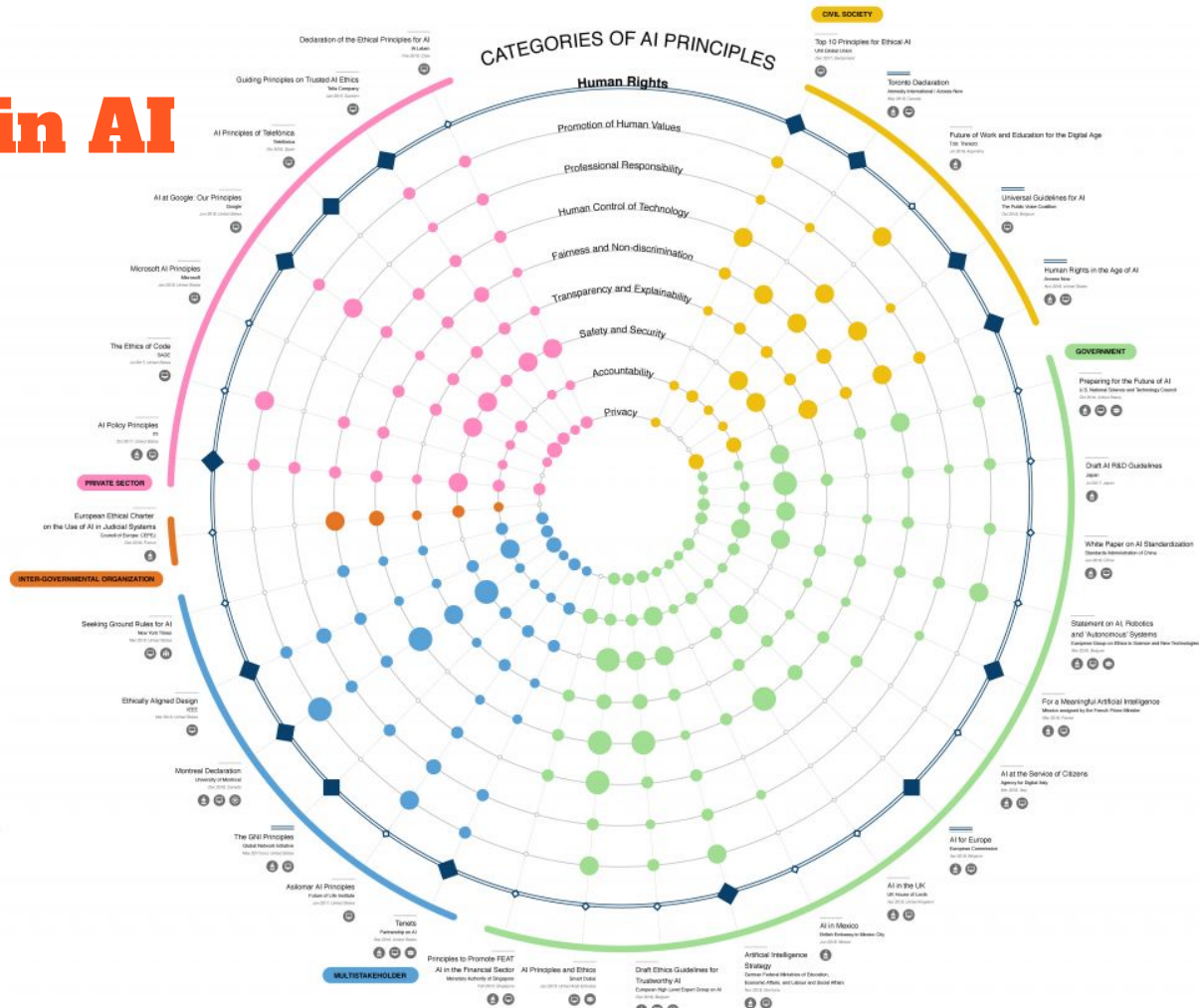
Nature of Actors

- Civil Society
- Government
- Inter-governmental Organization
- Multistakeholder
- Private Sector

Further information on findings and methodology is available in *Principled Artificial Intelligence: Mapping Consensus in Ethical and Rights-Based Approaches* (Berkman Klein, 2020) available at cyber.harvard.edu.



Ethics in AI



Identified as an important research topic by EU

- Has been adopted by the European Commission as a crosscutting activity that will govern all research funded under Horizon 2020,
- The European research framework program that ran from 2014 to 2020 and had an overall value of more than 70 billion.
 - Approximately 8 to 9 billion of this amount.
 - Activities directly related to RRI are concentrated in a funding stream on 'Science with and for Society', which has a budget of s462 million over the lifetime of the Horizon 2020

Ethics in Education: Harvard initiative

DOI:10.1145/3330794

A Harvard-based pilot program integrates class sessions on ethical reasoning into courses throughout its computer science curriculum.

BY BARBARA J. GROSZ, DAVID GRAY GRANT, KATE VREDENBURGH, JEFF BEHREND, LILY HU, ALISON SIMMONS, AND JIM WALDO

Embedded EthiCS: Integrating Ethics Across CS Education

Embedded EthiCS: Integrating Ethics Across CS Education
By Barbara J. Grosz, David Gray Grant, Kate Vredenburg, Jeff Behrends, Lily Hu, Alison Simmons, Jim Waldo
Communications of the ACM, August 2019, Vol. 62 No. 8, Pages 54-61 10.1145/3330794

- Embedding ethical reasoning throughout the entire CS curriculum has the potential to habituate students to thinking ethically as they develop algorithms and build systems, both in their studies and as they pursue technical work in their careers.
- Without creating a multitude of additional courses, CS programs can meet student demand for learning about ethics and the potential societal impact of their work as well as for acquiring computer science technical competencies.
- By working with philosophy colleagues and students, CS faculty can integrate ethical reasoning into their courses more easily and more expertly. As a beneficial side effect of this approach, CS faculty gain competence in ethical reasoning and philosophers acquire a greater depth of understanding of technology.

Ethics in Education

CS236r and CS265 are graduate courses; other courses are primarily for undergraduates, with 100-level courses being at intermediate level. CS1, 134, and 179 were offered twice; only enrollments for 134 differed significantly and both are given. Boldface indicates courses discussed in the article.

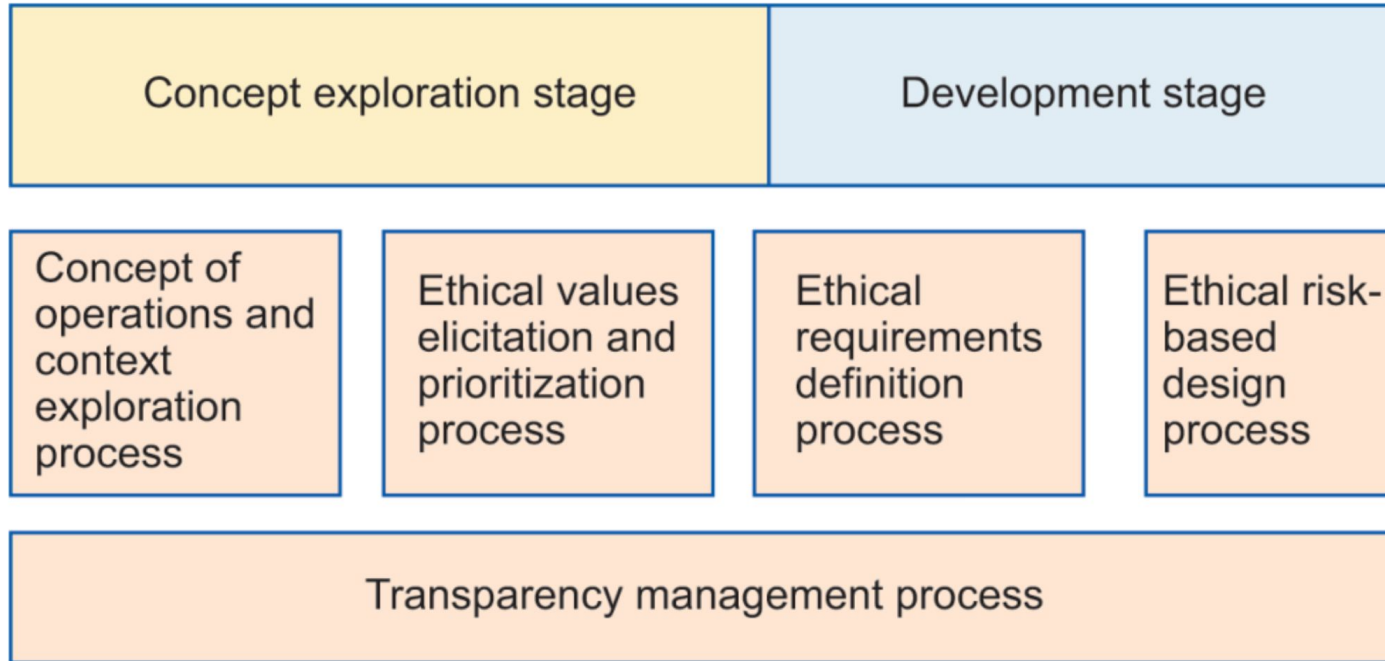
Area	Course Title	Challenges	Enrollment
Introductory Courses	CS 1: Great Ideas in Computer Science	The Ethics of Electronic Privacy	76
	CS 51: Introduction to Computer Science II	Morally Responsible Software Engineering	283
	CS 109b: Advanced Topics in Data Science	Moral Considerations for Data Science Decisions	93
Theory	CS 126: Fairness, Privacy, and Validity in Data Analysis	Diversity and Equality of Opportunity in Automated Hiring Systems	11
Computer Science and Economics	CS 134: Networks	Facebook, Fake News, and the Ethics of Censorship	162 (S'17); 21 (F'17)
	CS 136: Economics and Computing	Matching Mechanisms and Fairness	55
	CS 236r: Topics at the Interface of Economics and Computing	Interpretability and Fairness	24
Programming Languages and Computer Systems	CS 152: Programming Languages	Verifiably Ethical Software Systems	79
	CS 165: Data Systems	Data and Privacy	25
	CS 265: Big Data Systems	Privacy and Statistical Inference from Data	12
Human-Computer Interaction	CS 179: Design of Useful and Usable Interactive Systems	Inclusive Design and Equality of Opportunity	62
Artificial Intelligence	CS 181: Machine Learning	Machine Learning and Discrimination	296
	CS 182: Introduction to AI	Machines and Moral Decision-Making	164
	CS 189: Autonomous Robot Systems	Robots and Work	20

Impressive list of (fresh) IEEE Standards

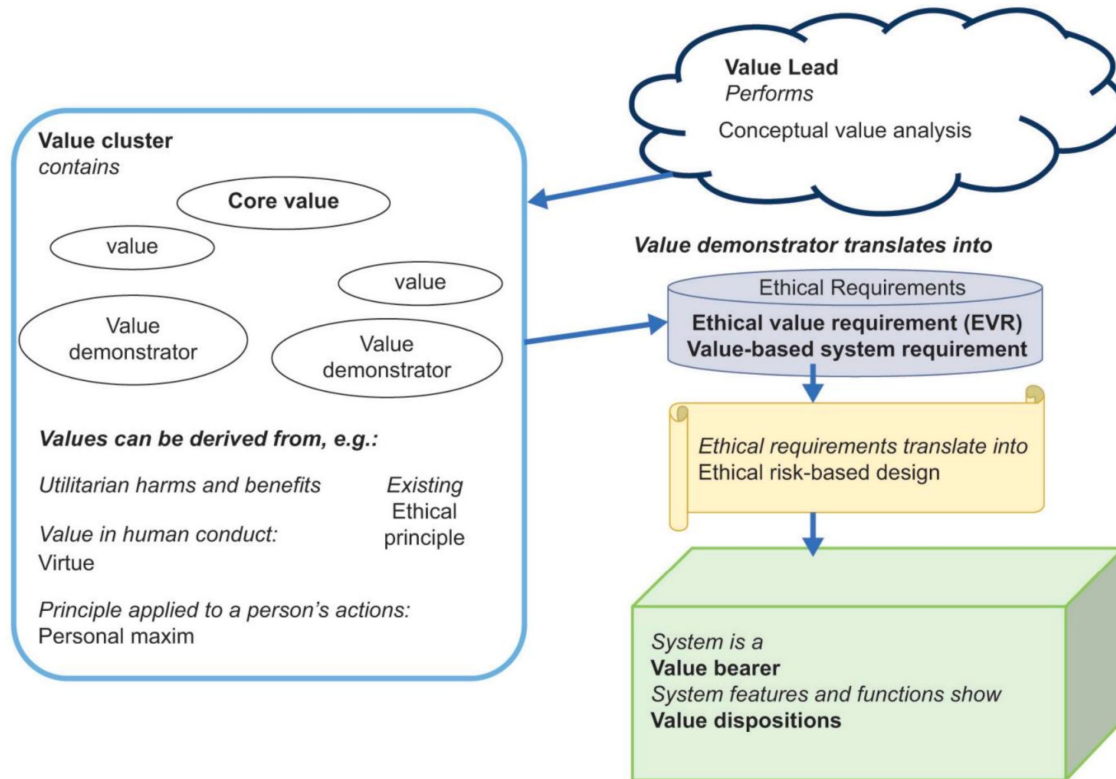
<https://ethicsstandards.org/p7000>

- IEEE 7000TM-2021 – Model Process for Addressing Ethical Concerns During System Design
- IEEE P7001TM – Transparency of Autonomous Systems
- IEEE P7002TM – Data Privacy Process
- IEEE P7007TM – Ontological Standard for Ethically driven Robotics and Automation
- IEEE 7010TM-2021 – Wellbeing Metrics Standard for Ethical Artificial Intelligence and Autonomous Systems

IEEE 7000-2021 in a Nutshell: the process



IEEE 7000-2021: Value Elicitation process



IEEE 7000-2021: Example

- A systems engineering organization anticipates that a full-body scanner at an airport should protect the **value of privacy**.
- **Privacy value demonstrators to be respected:** for instance, avoidance of exposure of genitals, avoidance of exposure of passengers' figures to other passengers.
- translated into explicit **value-based systems requirements (EVR)** => "The system shall display images of suspected contraband metal, plastic, ceramic, and explosive items positioned on a generic body outline."

- **EVR=> "value dispositions":**
 - the security screens depicting passengers don't display the passengers' exact body contours or genitals.
 - the encryption and immediate deletion of passengers' scanner profiles once the passenger has cleared security

Ethical values from IEEE 7000-2021

Table G.1—Typical ethical values for systems design

Ethical value applicable to system design	Related value	Opposing value
Autonomy	Moral agency, dignity, independence, freedom, liberty, mobility, self-direction, power, self-actualization, ownership	Accountability, responsibility, responsiveness, reciprocity, paternalism, slavery
Care	Accountability to shareholders, investors, suppliers, and other stakeholders; understanding; compassion; love; empathy; protection of the vulnerable; affection; support; friendliness; beneficence; benevolence; generosity; gentleness; helpfulness; kindness; comfort; quality of life; paternalism	Torture, maleficence, persecution, machine capability, logic, objectivity
Control	Human responsibility, governance, usability, portability, logic, sense of accomplishment, moderation	Trust, accountability to stakeholders; imagination, reminding, obedience
Fairness	Responsible position on conflicts of interest, tolerance, justice, balance, equality (legal, gender, minority)	Bias, suspicion, discrimination, arbitrariness
Inclusiveness	Participation, partnership, solidarity, interdependence, compatibility, accessibility, diversity	Control, bias, detachment
Innovation	Modifiability, adventure, novelty, excitement, playfulness, diversity, development, learning, curiosity, creativity	Tradition, distraction
Perfection	Integrity, truth, honesty, achievement, transcendence, universalism, wisdom	Competence, feasibility, over-capacity,
Privacy	Respect for confidentiality, intimacy, anonymity	Transparency, inclusiveness, alerting
Respect	Politeness, courtesy, respect for environment and natural habitat, respect for information and confidentiality, respect for norms, reputation	Self-esteem, maleficence

Table G.1—Typical ethical values for systems design (continued)

Ethical value applicable to system design	Related value	Opposing value
Sustainability	Respect for environment and natural habitat, efficiency, maintainability, operability, supportability, reliability, durability, resilience, forgiveness, robustness, redundancy, reusability, re-configurability, simplicity, economy, renewability	Cost (extravagance), wastefulness, poverty, consumption
Transparency	Openness, cleanliness, explicability, explainability, access to data, auditability	Privacy, bribery, corruption
Trust	Predictability, dependability, veracity	Control
NOTE—Opposing values can be positive or negative.		

(current) Limitations!

- *"The use of IEEE Std 7000 cannot guarantee that the system as designed and subsequently built is ethical, because the ethicality achieved in a system depends on the moral capabilities and choices of those who use the standard and the commitment of the organization offering the system to adhere to the recommendations made as a result of ethically aligned design"*
[IEEE 7000-2021]
- **Software Engineering perspective (!):** one way to enforce the standard and best practices is tooling and systematic approaches, Design Patterns...

Challenges

- Establishing practical definitions for human values,

"unlike functional and non-functional requirements, which represent the “what” and ‘how’ of a software system, respectively, values represent the ‘why’ of a software system" [Whittle]

- Integrating values into software design/processes
 - not only in the Requirement elicitation phase!!
- Operationalizing human values
 - very interesting body of work start to emerge !
- Measuring human values in software development life cycle.
- Education!

(Some) Open *Sw Eng.* Research Questions

- **Process Perspective**

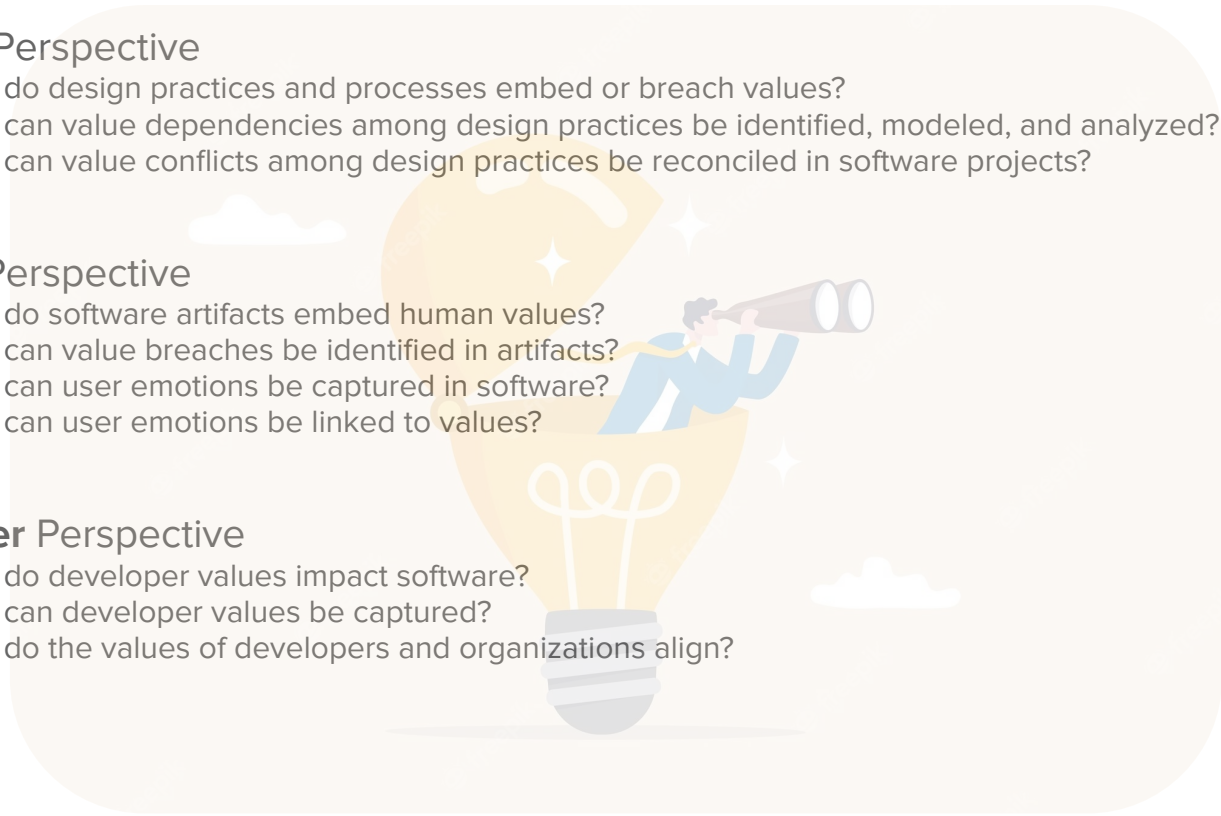
- How do design practices and processes embed or breach values?
- How can value dependencies among design practices be identified, modeled, and analyzed?
- How can value conflicts among design practices be reconciled in software projects?

- **Artifact Perspective**

- How do software artifacts embed human values?
- How can value breaches be identified in artifacts?
- How can user emotions be captured in software?
- How can user emotions be linked to values?

- **Developer Perspective**

- How do developer values impact software?
- How can developer values be captured?
- How do the values of developers and organizations align?



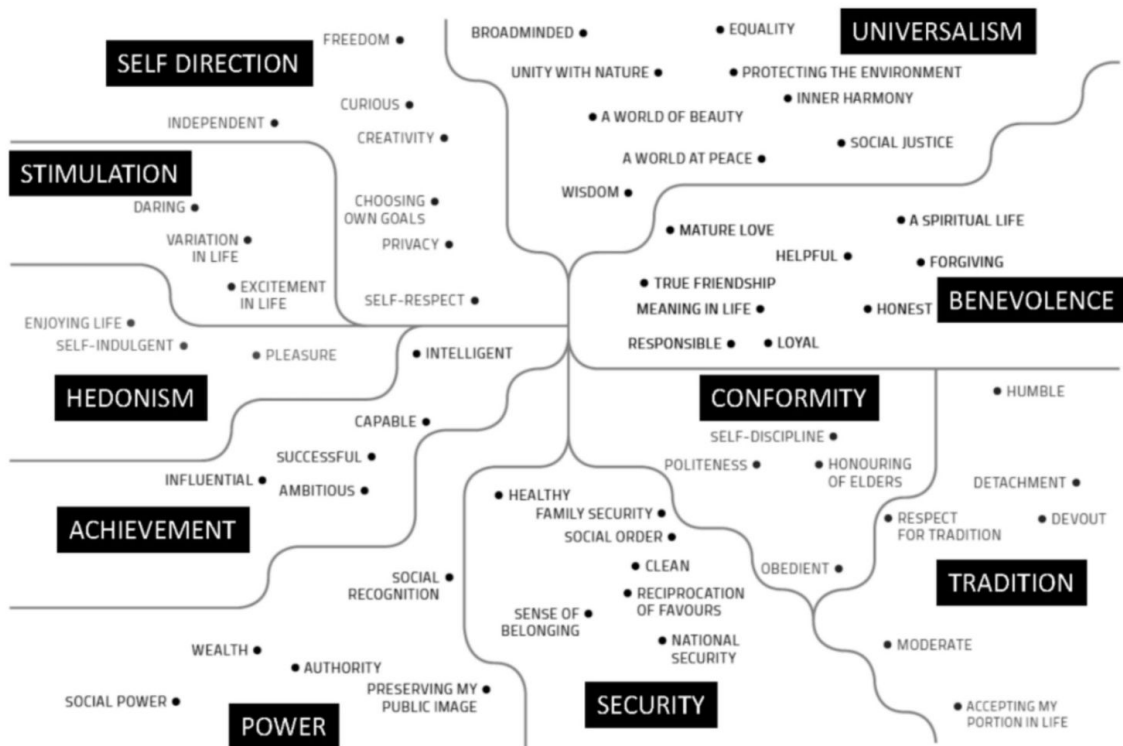
Artefact Perspective

- How do software artifacts embed human values?
- Operationalizing the GDPR is a good example
 - The GDPR act comprises 99 articles and 173 recitals in total.
 - The **6 principles outline the main obligations** that organizations need to comply with when collecting, processing and storing personal data. GDPR also empowers data subjects with **9 rights to exercise control over their personal information**
- Contributions have been made to operationalize GDPR
 - Mapping GDPR principles to values
 - Tracing data and its lifecycle
 - GDPR Anti-patterns
- Fairness has been measured in recruitment systems [Y. Brun FSE 18, 17]
- **How do you measure Transparency? Trust?**
 - FERTD (Fairness, Explainable, Robustness, Transparency, Data Privacy [IBM 20])

Value-Driven Software Engineering

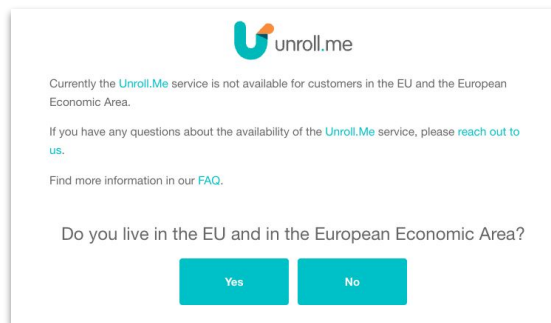
Schwartz model

- **58 values** grouped in **10 categories**.
- Empirically tested in 82 countries.
- Arguably these values are considered universal human values.



Impact of non-compliance with GDPR

- Compliance with GDPR has been a challenge for many companies that collect personal data. **A number of companies like Klout and Unroll.me terminated their services in Europe** to avoid the hassles of compliance.



- Gartner reports that less than 50% of the companies affected by GDPR were compliant by the end of 2018. This challenge is further exacerbated by the **performance impact that GDPR compliance imposes on current systems.** (due to monitoring, encryption and metadata indexing)

Impact of non-compliance with GDPR

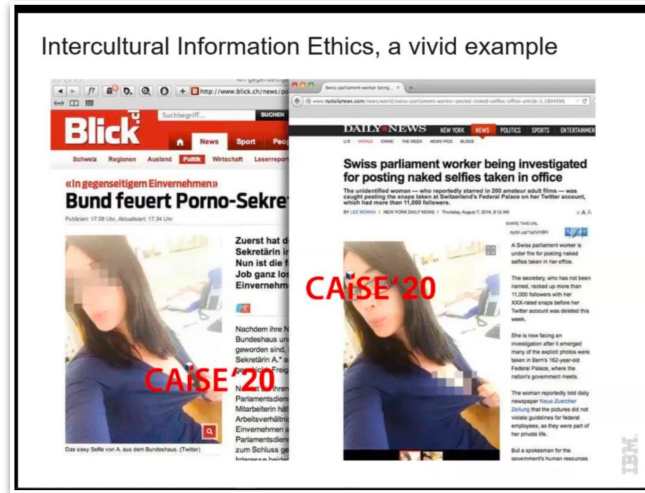
Google cloud describes the deletion of customer data as an iterative process that could take up to 180 days to fully complete. This is because, for performance, reliability, and scalability reasons, **parts of data get replicated in various storage subsystems** like memory, cache, disks, tapes, and network storage; multiple copies of data are saved in redundant backups and geographically distributed datacenters.

Impact of non-compliance with GDPR

- The EU data protection board reports having **received 144,376 complaints from individuals and organizations in the first year of GDPR.**
- Surprisingly, even the **companies have been forthcoming in reporting their security failures and data breaches, with 89,271 breach notifications sent to regulators in the same 12-month period.**
- In 2019, several companies have been levied hefty penalties for GDPR violations: **€50 million for Google, €99M for Marriott International, and €183M for British Airways.**

Perspective: what about Variability?

Values can be perceived differently from one country/society/company to another...



- Can we embed variability into software according to user's preferred values?
- How to identify complementary / conflictual values?

Social impact of Software

- TODO (conclu / transition)

Economic Impact

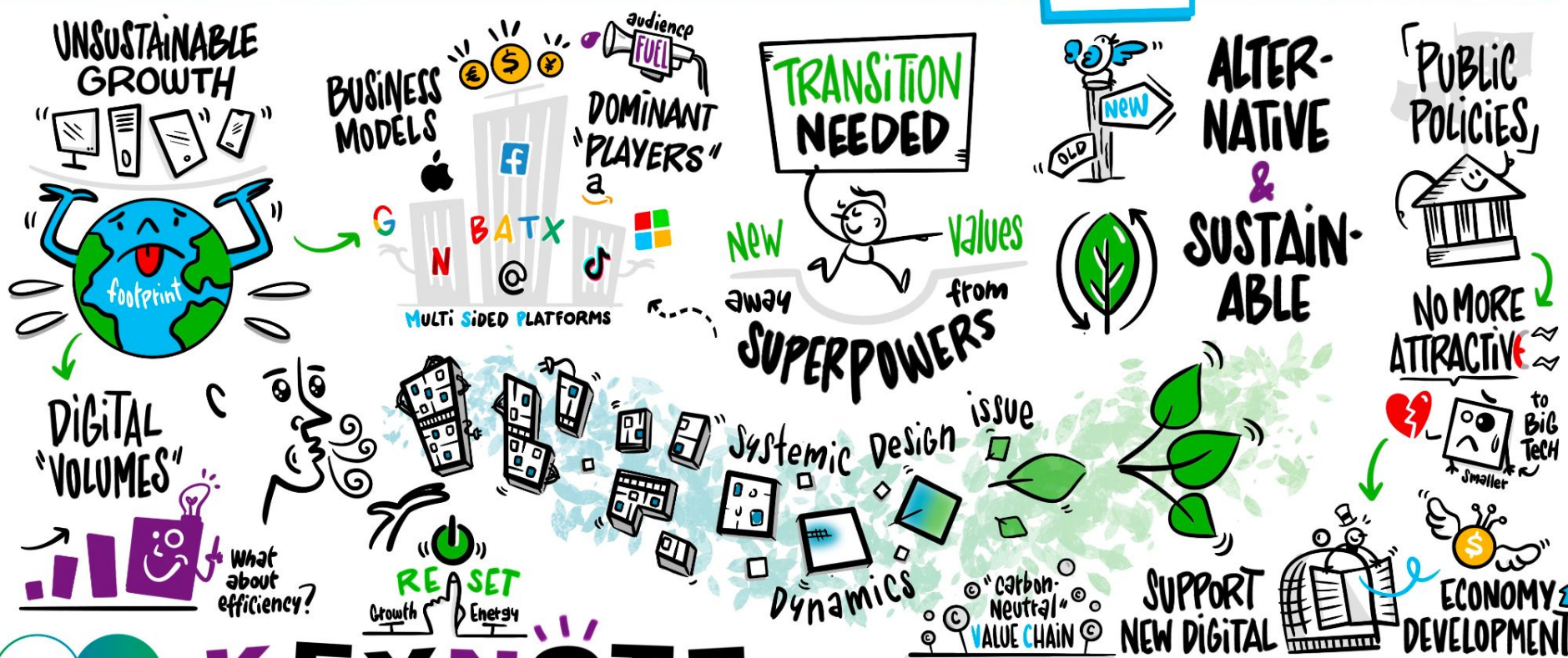
SUSTAINABLE DIGITALIZATION:

WHY WE NEED TO **SHIFT AWAY** FROM **BIG TECH BUSINESS MODELS**



my True Belief!
Hugues Fetteboeuf

THE SHIFT PROJECT



KEYNOTE

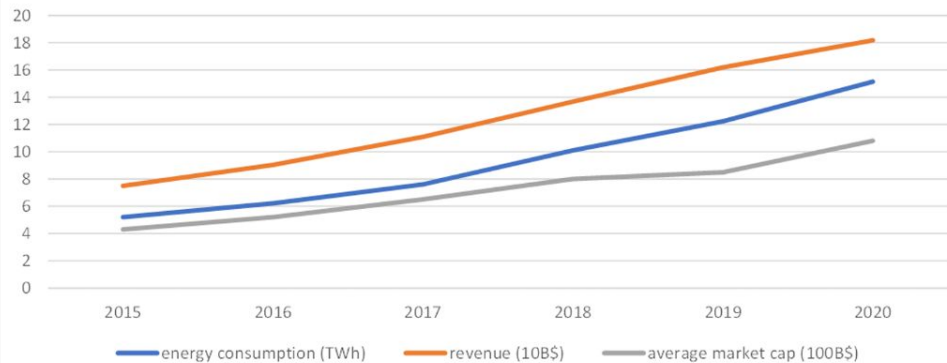


<https://www.youtube.com/live/p7eMRggZ1lk>

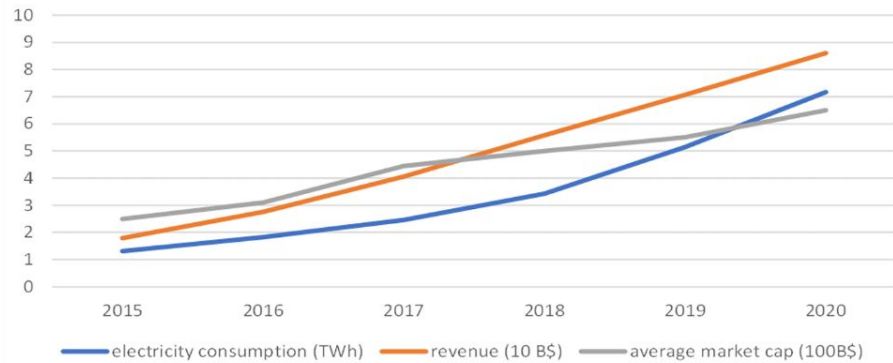
Graphic facilitation by AKENIUM

The Big Tech business models: energy intensive, data hungry

Google: revenue, energy consumption, market cap



Meta: revenue, energy consumption, market cap



Alternative platform business models

Moving away from business models where revenue is generated by the sale of user-related information in exchange to free access to platform services and where the capture of user-related data is optimized thanks to addictive design techniques and digitally rich targeted advertising

Examples:

- Subscription-based services (e.g., mail, search, etc..)
- Cooperative platforms: voluntary provision of specific personal data, buyer/seller community
 - Platformization of existing cooperatives
 - Start-ups
- Public platforms

Towards public policies forcing changes

- Make Big Tech smaller: taxes, regulations, anti-trust measures etc...
- Make Big Tech business models less financially attractive: reinternalize externalities (e.g., network costs)
- Enforce scope 3 (value chain) carbon footprint measurement
- Forbid the acquisition of personal data by default (# current terms of reference)
- Support and adopt new web standards (web 3 ?) giving individual users full control over the usage of their data
- Support (including financially) alternative platforms

What if?

- What would be the impact if tomorrow' systems has to be Transparent regarding AI algorithms and routines?
- What if your system has to be Sustainable by gov. regulations?
 - already started with our heating systems, Thermal insulation, etc.
- Better include Sustainability values by design than by maintenance!!

Digital Reset

A fundamental redirection of the purpose of digital technologies for the deep sustainability transformation

Take Away Messages

Software is impactful and complex

Sustainability is threefold

- Environmental
- Social
- Economic

Sustainability is a matter of all

- CoC are not enough
- Education is required
- Human values are plurals
- Value-driven engineering is an emerging area

 **Sustainable software engineering**

