

Sustainability Budgets

Subjects: Computer Science, Software Engineering

Contributor: Rebecca Raper, Jona Boeddinghaus, Mark Coeckelbergh, Wolfgang Gross, Paolo Campigotto, Craig Lincoln

Artificial Intelligence (AI) is increasingly being used to solve global problems, and its use could potentially solve challenges relating to climate change, but the creation of AI systems often requires vast amounts of, up front, computing power, and, thereby, it can be a significant contributor to greenhouse gas emissions. In 2015, the United Nations (UN) set their 'Sustainable Development Goals' (SDGs) as key global priorities for a better world by 2030. One of the key goals (Goal 13) is 'to take urgent action to combat climate change and its impacts'. More recently, at the 2021 World Climate Summit (a global conference aimed at addressing climate change), a worldwide pledge was made for countries to do more to reduce their carbon footprints. Achieving this aim: utilising 'Sustainability Budgets', in analogy with Privacy Budgets in Differential Privacy, it develops a procedure that empowers developers, allows management to have sufficient oversight and provides a governance framework towards achieving Goal 13 of the 'Sustainable Development Goals'.

Keywords: AI ; artificial intelligence ; sustainability

1. 'Gamify!': Gamification Techniques to Manage Sustainability

Gamification—a notion taken from the gaming industry—is the enrichment of products, services and information systems with game style elements in order to positively influence the productivity, motivation and behaviour of users ^[1]. An early example was the Nike+ running application ^[2], which encouraged individuals to engage in physical activity by making a 'game' out of running. Users were encouraged to compete against other runners for positions on leader boards, 'fastest course completions' or simply 'most runs that week'. More recently, other exercise applications such as Strava and Peloton make use of the gamification technique, and this can be extended to other areas.

Sustainability Budgets lend themselves very well to gamification techniques, with 'Sustainability Scores' or Limits usable to drive competition between developers. Therefore, a developer might be incentivised to develop their system in the most efficient way, because they are part of a 'game' with other developers, where there is a benefit for 'winning' (whether this be financial or otherwise).

As well as lending itself to competition between developers, moving one abstraction level away, look at how this might also translate to operating at an organisational level first.

Many organisations are motivated to reduce their carbon footprints, but this often seems to weigh against certain costs, meaning that there often has to be a compromise on sustainability in order to drive down the costs of development. However, if gamification were used as a technique to not only incentivise developers, but also to audit how systems were developed and their efficiency (through a Gamification management system), it would be easier for organisations to understand and explain the added time and costs for the delivery of projects. Ultimately, gamification systems would not only be instrumental in incentivising developers, but they could also be used by organisations to show why they are particularly sustainable

It could also be applied from an executive management perspective, and it could even be used at a national and global governance level. There could be competitions between teams of an organisation or even across different organisations or countries.

Utilising the 'Sustainability Budgets' methodology, there will be a mechanism to plan for and log the amount of energy expended per development task and also information for developers to provide explanations at a management level for different components of the development process. For example, a developer would be able to articulate why they chose a particular training step or method over another, in terms of the balance between sustainability and effectiveness, and there would be oversight as to how much energy was expended per process. The developer would be incentivised to be more energy efficient in their development approach, and there could be incentivised competitions between different developers to find the most 'energy efficient', effective approach.

The incentivisation could be extended to include ‘games’ between different developers. From a management level, this would give the chance to reward more sustainable development through a points/score-based system. There would need to be a balance between sustainability and effectiveness of the algorithms, but a score-based system would allow visibility of the compromises and management accordingly. For example, as a manager, I might decide to increase my sustainability budget (i.e., the amount of energy a development project expends), because the project is particularly pertinent (from a business perspective) or because having a lower budget would make the system unsafe (i.e., in a medical context). Equally, I might decide to lower my budget because, from a resource perspective, the project allows for this. Gamification would encourage developers to create their systems in the most energy efficient ways, being rewarded for creative technical solutions.

2. Using Sustainability Budgets to Achieve the SDGs

Eventually, the proposed method might also contribute to wider political and societal goals. At the beginning of this paper, the Sustainable Development Goals (SDGs) were discussed, in particular, Goal 13 and the drive for countries to achieve carbon neutrality, or at least reduce their carbon footprints. As well as offering a mechanism for incentivisation through Gamification (or similar) approaches, at either a developer, management or governance level, what Sustainability Budgets ultimately provide is a mechanism for ‘Energy Consciousness’ insofar as not only do developers become more aware of the amount of energy the development of their system expends, but managers can translate this into development action, and governments can reward/recognise organisations who offer more sustainable solutions or govern organisations to be more sustainable.

Strategically, those systems that offer the greatest benefit/cost ratio would be the systems that are invested in the most. Where previously it was difficult to determine this ratio in the early phases of a project because there was no mechanism to quantify it beforehand, there can be effective management of energy expenditure at all levels of an organisation: a company, for example, but also a sector and even a nation.

For example, energy budgets could be set on an industry basis, based upon the needs of the industry. There could be regulation to ensure that industries did not go beyond their allowance, and the different levels could be managed at a political level. Organisations could be incentivised to be sustainable through energy ratings that would ensure that standards were being maintained. An organisation might receive an ‘A’ energy rating for particularly energy efficient processes and a lower rating (‘B’) for a lower energy efficiency. As with energy efficiency levels used to rate buildings and appliances (ref), the energy expended for each project would need to be measured against the size and utility of the project.

A strong contribution of the Sustainability Budget approach is to provide a way to embed the topic of environmental sustainability into ML practices and organisations from the beginning. The urgent need to address climate change is injected directly in the project development phase of machine learning and AI applications. Whereas most of the time such topics are managed purely in an abstract way with review processes that are being applied after the fact and that are followed or not, sustainability budgets put this matter at the heart of the development process itself. With the aforementioned gamification implementation, there is a direct and accessible way to address these problems.

And most of all: sustainability budgets raise awareness about this topic. Next to incentivisation, sustainability budgets and the related gamification strategies are likely to raise awareness of energy consumption and sustainability issues, which may influence the behaviour of individuals and the organisation. Just like privacy budgets in differential privacy, sustainability budgets need to be handled before starting a training run of a machine learning task and, because of that, they force developers, project managers and policy makers to think about the impact of the project early on and continuously. It does matter if a machine learning task is solved by using the next best large network trained on all available next best data or rather designed and developed with energy consumption and sustainability in mind, carefully selecting the optimal network architecture, data subset and iterative development approach. Being aware, after all, is the first and most important step when trying to change and influence things. Sustainability budgets help raise awareness of the climate change impacts Machine Learning development can have at and before the development process itself.

References

1. Deterding, S.; Dixon, D.; Khaled, R.; Nacke, L. From game design elements to gamefulness: Defining “gamification”. In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, New York, NY, USA, 28–30 September 2011; pp. 9–15.

Retrieved from <https://encyclopedia.pub/entry/history/show/57859>