

Behind the scenes of machine translation: for a sustainable, ethical and collaborative use of machine translation in multilingual scholarly communication: a workshop report¹

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1. Introduction

In the age of artificial intelligence (AI), machine translation has become a mainstream tool, which has been widely embraced by users for the most diverse purposes. The scientific community has also started to look at AI-based translation tools as possible solutions for promoting multilingualism in scholarly communication and thus establishing a more linguistically inclusive landscape in research, both in terms of access and production of scientific publications (Di Bitetti and Ferreras 2017; Ramírez-Castañeda 2020; Taşkın et al. 2020; Tatsuya Amano et al. 2023). Despite being a millennial practice, translation was rarely considered in the past as a viable means of achieving language equality in scholarly communication due to a shortage of human and financial resources to support traditional translation processes. AI-based tools have therefore appeared as *the* way to provide easy access to scientific translation at lower costs. But what is the impact of these tools? On what foundations do they rely? Are they or can they be sustainable? The present contribution is a report of the workshop *Behind the scenes of machine translation: for a sustainable, ethical and collaborative use of machine translation in multilingual scholarly communication*. The workshop was held in Zadar during the OPERAS conference 2024 with the aim to explore AI-based translation tools, in particular neural machine translation (NMT) and generative AI (GenAI), as well as to suggest avenues to promote a sustainable use of these solutions. The content of the workshop was based on the results of the *Translations and Open Science project*², and inspired by the input of the OPERAS'

¹ The paper was originally presented at the OPERAS conference that was held in Zadar in April 2024.

² Fiorini, Susanna. 2024. Translations and Open Science: new reports released. OPERAS. Retrieved May 27, 2024, from <https://doi.org/10.58079/11nv4>

Special Interest Group for Multilingualism³. Some of the concepts were also leveraged as part of the TrustOn2024 Workshop and are therefore addressed in the corresponding report *Fostering trust in the digital age from the perspective of disinformation and trust in science* (OPERAS AISBL et, al. 2025). It should finally be noted that, although the workshop mainly focused on the translation features offered by these technologies (i.e. given a source text, a target text is generated), many of the points raised in the paper also apply to AI-based multilingual content generation (i.e. a tool is prompted to directly generate content in the target language).

2. Defining sustainability in relation to AI-based translation tools

Before getting to discuss AI-based translation tools and to assess their impact, the participants were initially asked to define the concept of sustainability. They were invited to express what sustainability means and what it encompasses for them, and how sustainability-related topics – for example, ethics, environment, justice and economic models, just to name some of the points raised by the audience – can be linked to AI-based translation tools.

In order to establish a framework to examine this relation, the Sustainable Development Goals (SDGs) set by the United Nations Department of Economic and Social Affairs (UNDESA)⁴ were used as a reference; specifically, some of the goals were discussed in order to answer the following question: “Can this sustainable development goal be linked to, supported by or compromised by AI-based translation tools (in particular neural machine translation and generative AI)?”

For each of the considered SDGs, both positive and negative correlations were identified in order to assess the impact of the tools on the achievement of the given goal. For example, the first goal analysed was SDG No. 4 *Quality education*, whose scope is to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all”. Therefore, the question was: do AI-based translation tools contribute to achieve inclusive and equitable quality education for all? For this SDG, the immediate answer could be yes, if we consider that these solutions can provide access to translated educational content (including research content) which otherwise would likely be available only in English. However, it should be noted that AI-based translation tools tend to offer more solid performances in high-resource languages, which are generally those that are spoken in the wealthiest countries, but do not work as well for low-resource languages, which inversely are often spoken by already marginalised communities. As a consequence, the improved access to educational content thanks to real-time translation risks to remain a privilege of some groups of people. In this context, with the advantage of providing real-time translation offset by the performance gap observed in many languages, the impact of AI-based translation tools on the achievement of a more inclusive and equitable education can hardly be considered as completely positive. The same questioning methodology was applied to other sustainable development goals, such as SDG No. 8 *Decent work and economic growth*. According to the United Nations, this goal consists in “promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”. In this

³ OPERAS Special interest group. Multilingualism. <https://operas-eu.org/special-interest-groups/multilingualism-2/>

⁴ Sustainable Development Goals. Division for Sustainable Development Goals (DSDG) in the United Nations Department of Economic and Social Affairs (UNDESA). <https://sdgs.un.org/goals>

respect, it can be argued that AI-based translation tools can improve the working conditions of some professionals, for example those who must communicate in a language which is not their mother tongue or a language which they do not master with ease – like the case of many researchers. However, these tools do not benefit all the professional profiles and categories: in fact, since the advent of AI-based translation tools, some professions – such as translators – have been threatened or devalued, not to mention the invisible, underpaid digital labour needed to train and maintain AI systems. Hence, AI-based translation tools do not always go hand in hand with better or decent work for all, nor with an inclusive and sustainable economic growth. Finally, the assessment appeared to be less nuanced for some SDGs, with AI-based translation tools having a clearer positive or negative impact depending on the goal. For example, in the case of SDG No. 13 *Climate action*, which appeals for “urgent action to combat climate change”, the impact of AI-based translation tools can be fairly considered as negative since these technologies are notoriously quite demanding in terms of resources and thus are not very environment-friendly; on the contrary, SDG No. 17 *Partnership for the goals*, which encourages multi-stakeholder collaboration, could benefit from the development of a transparent, open AI-based translation tool – dedicated to scholarly communication, for example – which could become a driver of scientific collaboration, mutual understanding and capacity building.

The conclusion of the first part of the workshop was therefore that AI-based translation tools might be sustainable – in the sense that they might have a positive impact on sustainable development goals or at least be compatible – provided that the whole picture is assessed, and the necessary precautions are taken (Illustration 1). On this point, it is interesting to cite the work of Vinuesa et al. (2020), whose conclusions regarding the relation between AI and SDGs explain that:

“Reported potential impacts of AI indicate both positive and negative impacts on sustainable development. [In other words] AI can either enable or inhibit the achievement of the Sustainable Development Goals recognized in the 2030 Agenda for Sustainable Development. [Therefore], the fast development of AI needs to be supported by the necessary regulatory insight and oversight for AI-based technologies to enable sustainable development. Failure to do so could result in gaps in transparency, safety, and ethical standards” Vinuesa et al. (2020).



Illustration 1. Overview of negative and positive impacts of AI-based translation tools on Sustainable Development Goals

3. Sustainability and AI-based translation tools: existing challenges and possible solutions discussed during the workshop

3.1 Data-driven training

The first challenge discussed in the workshop was the data-driven nature of AI-based translation tools, which are trained on millions of previously translated sentences in the case of NMT, or monolingual content for GenAI technologies. But what data do these corpora contain? How is this data collected? Starting from the second question, “data collection is basically performed on the Web via automated data collection techniques, which must be replicable on large scales and thus require substantial standardisation. While being core factors for efficient data collection, replicability and standardisation limit by their very nature the kind of data that can be collected” (Fiorini 2025, 61) and therefore determine a first challenge in the data-driven approach: the datasets used for AI training are “intrinsically biased, because their construction is affected by technical and legal constraints – for example, only content having given standardised formats and licences can be collected – and also reflects real-world forces – for instance, they are over-sampled by race, gender, or languages” (Fiorini 2025, 61). This lack of representation is not the only problem in datasets, which are also typically marked by a lack of transparency. “Unawareness of what data is used for training not only amplifies the “black-box effect” which makes predicting and interpreting the machine output more challenging but also makes it virtually impossible to know if copyrighted, protected or sensitive material was collected” (Fiorini 2025, 61). To make AI-based translation more sustainable – meaning more inclusive and transparent – the implementation of open solutions and RAG⁵ techniques should be encouraged, so that data transparency and diversification can also be improved. In other words, the ideal open-source solution – i.e. whose code, parameters and training data are known – should make it possible to retrieve information about the sources and the composition of the training datasets, so that their reliability, diversification and legal compliance can be assessed, and the necessary adjustments can be made. Such an approach could also be useful to ensure adequate visibility of the (human) knowledge used to train AI tools and thus to produce the machine-generated content; this point was further developed in the following section of the workshop about risk management and accountability.

3.2 Risk management and accountability

Making training data more transparent and diversified does not solve, however, another key challenge relating to AI and its sustainability: to manage the risk arising from the use of machine-generated content and to determine who is accountable for such a risk – for example, in the case of unreliable or misinformative translated content. The question is *who* is

⁵ Acronym of Retrieval-Augmented Generation, a technology that “enhances LLMs by retrieving relevant document chunks from external knowledge bases through semantic similarity calculation. By referencing external knowledge, RAG effectively reduces the problem of generating factually incorrect content.” See Gao Y. *et al.* (2023). Retrieval-Augmented Generation for large language models: A Survey. <https://doi.org/10.48550/arXiv.2312.10997>

accountable: the interrogative pronoun clarifies straight away that machines cannot be deemed responsible for their output, a human must take responsibility. Who is the accountable person? The user who prompted the tool to generate the content? The owner of the AI tool? The hosting platform or even the reader of the machine-translated content? Although these questions might sound trivial, they are all the more relevant since a recent research found that “a shocking amount of the Web is [already] machine translated” (Thompson et al. 2024) and that “it is generally difficult to find information about the origin of a translation – for example, determining if the translation is machine-generated, if a human was involved in the process and in this case, which level of supervision was ensured” (Fiorini 2025, 60). If there is no such information for the translations published on the Web – which is basically the case in the current context – “not only it is hard to determine who is accountable for the reliability of such translations, but also the essentially human knowledge which is the foundation of the translating process becomes invisible and therefore loses value” (Fiorini 2025, 61). It should be remembered that, even when translation is a technical transcoding process performed by a machine, this process is only possible thanks to the millions of previously translated sentences used for training purposes and mentioned in the section above (see point 1 “Data-driven training”). This is an aspect that the real-time AI-generated output tends to hide. As some experts point out, AI is a “stochastic parrot” that generates plausible content based on the data it was trained on. And this data is quite often human work, or at least it has to be (qualitative) human work in order to enable the continuous improvement of the output – on this point, some researchers came to question the sustainability of training models on large-scale data scraped from the Web, since their bad quality could cause a “model collapse” effect (Shumailov et al. 2023). Therefore, qualitative human translation must be preserved and valued, since failure to do so could put the whole AI system at risk.

What could be done to improve process traceability, clarify accountability and promote the value of translation? A starting point could be to make the translators more visible in the content creation process: in too many cases, the name of the translator is not mentioned, nor translation is acknowledged as a value-added activity – for example, the CRediT Taxonomy⁶ for scholarly contributions does not include a “Translation” contributor role. If the translator’s name is associated with a given translation, it is easier to determine who is accountable for its reliability, as well as to make it visible – or even reward it – as a human work used, among other purposes, to train AI systems. Clear legal and ethical frameworks could also be implemented at a decision-making level, like in the case of the European AI Act which provides common obligations in terms of risk management, general transparency and copyright compliance. Once these principles were established, the workshop continued to identify the scholarly communication scenarios in which machine-translated content could be reasonably used.

3.3 (Un)realistic expectations

One of the main challenges associated with AI-based translation tools is to critically assess their performance and output usability by considering different communication contexts and requirements. There are several methods to evaluate machine translated content,

which can essentially be divided into two main categories: automatic metrics which rely on different types of algorithms, and human evaluation methods which require manual assessment performed by user personas. Each with their own advantages and pitfalls (automatic metrics tend to be cheaper but less reliable than human evaluation, which is in turn more expensive and time-consuming), both approaches require expert skills that can make it difficult for non-specialist users to conduct this assessment. Yet it remains a crucial step before deciding to adopt and use machine-generated translations, especially in sensitive and/or specialised contexts like scholarly communication. This part of the workshop consisted in presenting results from one of the studies carried out as part of the Translations and Open Science project, focussing on machine translation evaluation in the context of scholarly communication. The participants were presented with the general evaluation methodology and the main results enabling informed decision-making for a sustainable use of machine-generated translation in different scenarios of scholarly communication (professional translation, writing assistance, general comprehension, content discoverability). The images below (Illustration 2) show some of the presented samples.

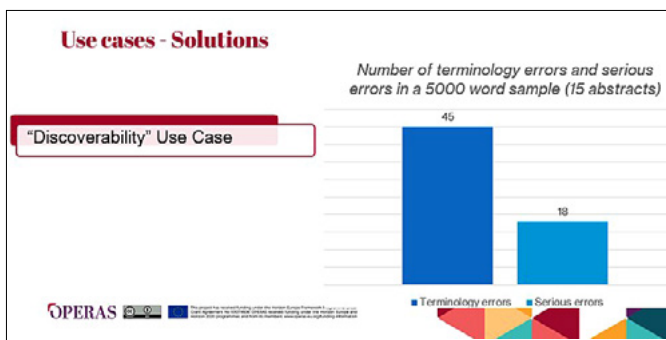


Illustration 2. Result samples from the machine translation evaluation task on error annotation for discoverability purposes

Detailed data and results can be found in the general report of the exploratory studies conducted in the Translations and Open Science project (Fiorini 2024), as well as in the full report of the study *Machine Translation evaluation in the context of scholarly communication* (Vanallemeersch et al. 2024) (Illustration 3).

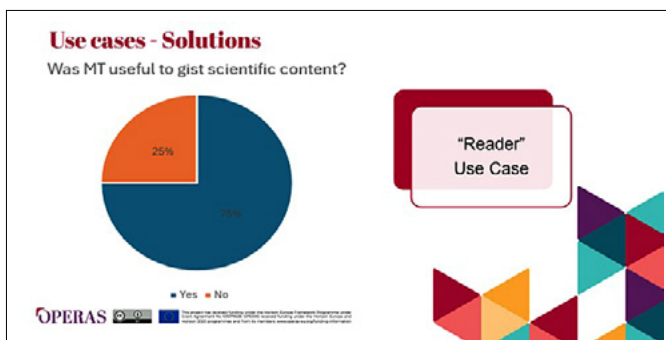


Illustration 3. Result samples from the machine translation evaluation task on self-paced reading of unsupervised machine translation output to get the gist of a scientific publication

Performance and output usability, however, are not the only factors to be evaluated when deciding whether to use machine-translated content. Other key factors must be assessed especially with a view to promoting a sustainable use of AI. The last part of the workshop focussed on a key point raised by most participants regarding AI sustainability, that is to say ethical and economic viability.

3.4 Ethical and economic viability

Developing and maintaining AI systems necessitates a substantial investment of resources, including vast amounts of data, powerful computational hardware, and skilled human expertise. The quantity of resources and the associated costs are so exorbitant that it could be argued that any economic model of this kind could hardly be considered as sustainable by its very nature. In this context, it is not surprising that most of the AI companies in the current landscape are profit-driven, which does not contribute to improving the sustainability-related dimensions described in the previous points of the workshop (transparency, inclusiveness, work recognition, etc.). Is it realistic to imagine an alternative model making it possible to ensure a fair but also efficient approach to AI development and maintenance? Which conditions could encourage users and stakeholders to contribute to an AI-based translation tool dedicated to scholarly communication? These were the questions submitted to participants for the last part of the workshop. Most of the respondents endorsed the proposal of a non-for-profit, community-led AI, operating based on collaboration and shared mutual interests among different stakeholders (for example publishers, researchers and professional translators), but still serving individual practices and needs which can vary considerably according to user profiles and preferences. Illustration 4 shows a simplified representation of such a multi-stakeholder alliance, inspired by the idea conveyed by the United Nations’ SDG No. 17 *Partnership for the goals*. Detailed information about individual, general and common interests, as well as possible funding mechanisms, can be found in the general report of the exploratory studies conducted in the Translations and Open Science project (Fiorini 2024), as well as in the full report of the study *Operating model for a technology-aided collaborative translation service dedicated to open scholarly communication* (Talbot and Torres 2024).

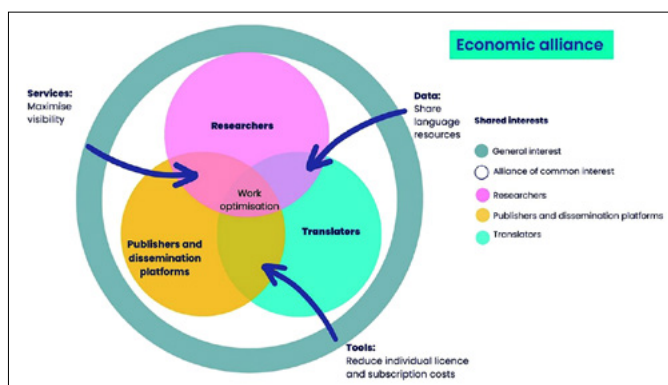


Illustration 4. Symbolic representation of an economic alliance based on common interests between stakeholders

4. Conclusions

AI-based translation technologies hold potential to empower users, enhance multilingual communication, and facilitate global collaboration. However, to make this potential sustainable and ensure a fully positive impact on society, it is crucial to support the use of these technologies with well-informed policies and approaches. Such measures should address considerations on transparency, accountability, inclusiveness, usability, environmental impact, economic models, and any other dimension relating to the concept of sustainability. If this principle applies to the use of AI in general, it is even more relevant in scholarly communication, a context in which information reliability and integrity are crucial to foster progress across all levels of society. The workshop was therefore intended to be a starting point for open discussion and collective action to tackle the challenge of AI sustainability within the scientific community. To pursue these efforts, further activity should be encouraged so as to foster skill-sharing and multi-stakeholder collaboration.

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