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ACADEMIC WRITING

The challenges of machine translation of academic publications

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Abstract: Clear translation remains a major challenge to better communication and understanding of the international academic literature, despite advances in Machine Translation (MT). Automatic translation systems which captured the detail and the sense of any manuscript in any language for a reader from any other linguistic background would find global applications.

In this article, we discuss the current opportunities and constraints to the wider use of machine translation and computer-assisted human translation (CAT). At the present stage of technology development, these instruments offer a number of advantages to specialists working with scientific texts. These include the facility to skim and scan large amounts of information in foreign languages, and to act as digital dictionaries, thesauri and encyclopedias. Word-to-word and phrase-to-phrase translation between many languages and scripts is now well advanced.

The availability of modern machine translation has therefore changed the work of specialist scientific translators, placing greater emphasis on more advanced text and sense editing skills. However, machine translation is still challenged by the nuances of language and culture from one society to another, particularly in the freestyle literature of the arts and humanities. Scientific papers are generally much more structured, but the quality of machine translation still largely depends on the quality of the source text. This varies considerably between different scientific disciplines and from one author to another.

The most advanced translation systems are making steady progress. It is timely to revisit traditional training programmes in the field of written translation to focus on the development of higher-level research competencies, such as terminology search, and so to make best use of evolving machine translation technologies.

More widely, we consider that there is a challenge across the higher education systems in all countries to develop a simple, clear and consistent "international" writing style to assist fast, reliable and low-cost machine translation and hence to advance mutual understanding across the global scientific literature.

Keywords: machine translation, academic English, academic writing, linguistic translation of scientific texts, English, scientific text editing, translation skills

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АКАДЕМИЧЕСКОЕ ПИСЬМО

Проблемы машинного перевода научных публикаций

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Резюме: В статье обсуждаются основные проблемы письменной научной коммуникации в условиях массового распространения машинного перевода текстов на различные языки мира. Точность машинного перевода на современном этапе развития технологий дает ряд преимуществ в работе с на-

учными текстами, среди которых возможность ознакомиться с большим количеством иноязычных материалов без дополнительного участия человека в процессе перевода. Однако следует учитывать, что адекватность машинного перевода всецело зависит от качества текста оригинала, а также варьируется в зависимости от принадлежности исследования к той или иной области научного знания. Доступность машинного перевода оказала влияние на роль переводчика в процессе научной коммуникации, сместив акцент в сторону навыков редактирования текстов, нежели собственно перевода. Таким образом, имеет смысл пересмотреть образовательные программы, готовящие современных переводчиков, и переориентировать их на обучение коммуникативным аспектам языка, а также развитие навыков осмысленного погружения в новую область знания. Не менее важно уделять внимание работе с терминологией и учиться эффективно использовать весь спектр возможностей машинного перевода, поскольку современные технологии на новом уровне аккумулируют ресурсы словарей, тезаурусов и энциклопедий.

Ключевые слова: машинный перевод, англоязычный научный текст, академическое письмо, лингвистический перевод научного текста, английский язык, редактирование научного текста, переводческие навыки

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Introduction

Science Fiction has long preceded and influenced Science Fact and technological evolution. In the 1960s, the original US Star Trek television series introduced the hand held "Universal Translator" as a tool to simplify story telling [1]. In 1978, the British Science Fiction writer Douglas Adams published "The Hitchhikers Guide to the Galaxy", in which he gave us the Babel Fish. The Babel Fish was a small creature that could immediately translate any language in the Galaxy into any other language[1]. Both of these imagined solutions challenged us to solve the universal problem of interpersonal communication across languages in the real world.

Languages and Writing Systems (Scripts) continue to present global challenges to efficient and seamless human communication, both in the written word and in the spoken word[2].

Effective translation from one language to another encompasses a series of intellectual and technical problems:

– in transliteration of one script (eg Cyrillic) to another (eg Latin);

– in translating the meaning of individual words from one language to another;

– in translating the meaning of phrases from one culture to another;

– in converting the grammatical structure of one language to another;

– in communicating accurately and sensitively the meaning of a sentence, paragraph or document from one reader to another.

The following is an example of cultural rather than of technical mistranslation. The phrase: "*We will bury you*!" (Russian: «Мы вас похороним!», romanized: "My vas pokhoronim!") was famously attributed to Soviet First Secretary Nikita Khrushchev while addressing Western ambassadors at a reception in Moscow on November 18, 1956. However, in a recent letter in the Times of London (May 31st 2021) a correspondent asked whether Khrushchev actually said this. A different translation is merely: "*We will attend your funeral*." This can be paraphrased as "*Our system will outlive your system*." In the alternative translation, the meaning of his words is significantly softened and rendered less belligerent than in the Cold War cliché. Khrushchev used a Russian idiomatic expression, for which the interpreter failed to find an adequate equivalent on the spot.

[1] https://lynceans.org/tag/universal-translator/

[2] https://en.wikipedia.org/wiki/List_of_languages_by_writing_system

In academic communication, mistranslation may not have such immediate negative consequences. However, since scientific activity is always about standing on "*the shoulders of giants*", poor translation may have long-term implications which may be very damaging.

The Science of Language

The scientific study of language, Linguistics, encompasses a wide range of subjects. Some of these include:

– Conversation Analysis;

– Forensic Phonetics;

– Historical and Anthropological matters of language evolution;

– Phonetics and Phonology (the study and classification of sounds);

– Sociolinguistics (the effects of society upon language);

– Psycholinguistics (the study of processes involved in the use of language – language acquisition, etc.);

– Morphology (the study of word forms);

– Syntax (the rules governing the sentence structure in a language);

– Semantics (the study of the relationship between words);

– Pragmatics (describes the study of the practical nuances of language use which are not encoded in dictionaries and lexicons);

– Generative linguistics (aiming to prove the presence of universal innate grammatical structures);

– Computational Linguistics describes many theoretical and practical methods to apply computation to the study of the structure of language and to advance translation;

– Natural Language Processing (NLP) is the process of understanding and characterising the contents of documents, so as to extract information and insights.

Excellence in translation is never easy to achieve, because grammatical structures, syntax and semantics vary considerably from one language to another. For example:

– many of the evolved rules and practices of language are complex and change over time;

– many words can have different meanings, depending upon their context;

– many cultural references which are clearly understood in one language will not be familiar in another language and another culture;

For the purposes of this paper, our focus is not on the Transcription from one writing system to another, such as from Cyrillic to Latin script. We are also not discussing immediate translation, as (for example), using interpreters as intermediaries between politicians in international meetings. We are interested in this paper in the planned Translation of text and the written word from one language to another, as with Russian to and from English. We are particularly focused upon academic and scientific writing in journals, papers and textbooks, where the demand for translation has always exceeded the capacity of the translation profession.

Scientific translation is often thought to be easier than the translation of creative literature, because:

– scientific writing tends to take a standard form;

– individual scientific subject areas have standard vocabularies;

– many technical words are shared across many languages;

– many of the ideas being communicated have a logical structure and sequence of ideas;

– we are not concerned with the complexities and nuances of the spoken word.

however, upon deeper scrutiny, scientific translation faces a number of significant challenges, such as:

– science is part of culture, and different cultural systems have developed their specific ways of writing scientific texts;

– for social and political reasons, some scientific directions (particularly those related to national security and ideology – engineering, the humanities, etc.) have developed country-specific terminological units;

– scientific translation requires highly professional competences involving not only general linguistic skills but also deep subject-specific knowledge.

a Brief History of Machine Translation (MT) in Academic Writing

Traditionally, translation has been the "analogue" function of human interpreters who are multilingual, either from birth or through education. However, these skills are time-consuming to acquire and expensive to deploy, in circumstances of translation:

– of one language to another;

– or of one language to multiple languages;

– or of multiple languages to multiple languages.

Many benefits would flow from the efficient, accurate and autonomous Machine Translation (MT) of any one language to another language. Ideally, it would be possible to publish a text, book, journal or article in any language and to permit it to be read in any other language through a "Babel Fish" interface without any significant additional work by the publisher or by the reader.

Machine Translation is a product of the Computer Age [2; 3]. In 1954, an experiment between Georgetown University and IBM involved the automatic translation of sixty carefully selected Russian sentences into English. This led to further investment in computational linguistics, but the technology of the time was not up to the task and progress slowed.

In 1966, the US ALPAC (Automatic Language Processing Advisory Committee) Report articulated the limitations of MT and raised serious doubts about its future progress. At that time, the report actually put an end to the MT boom and led to a drastic cut in funding for MT research [3].

From the 1980s onwards, computer technology advanced rapidly, and more powerful mathematical approaches were adopted to linguistic analysis. For example, Michael Zarechnak of Georgetown University described the principles of design, development, and implementation of the Intermediary Language Programming for Machine Translation across a set of major languages [4]. Interlingua investigations were continued all over the world, eventually leading to the appearance of more sophisticated corpus-based (benefitting from rapid access to large databanks of text corpora) and memory-based (relying on finding or recalling of analogous examples) methods (Natalia to provide reference [5]).

Well-written scientific texts which have common terminology can now be reliably translated by MT without additional human intervention. However, for the present, the mechanical machine substitution of words in one language for words in another rarely produces a satisfactory translation. Some words in one language have no equivalent in another language, and many words have more than one meaning, according to context. This condition is known as Ambiguity.

Huge computing power now underpins the world's major search engines. As but examples, Google, Wikipedia, Bing, Skype, Twitter and Facebook (US), Yandex (Russia-Netherlands) Baidu (China) and other familiar Internet services build continuously and innovatively upon machine translation technologies.

To minimise Ambiguity, number crunching statistical techniques permit the interpretation of the meaning of words and phrases from the context of their use. This approach is leading to continuous improvement in the quality of contextual machine translation across a wide range of applications. However, the goal of a wholly autonomous translation system is still a long way off, and machine-assisted translation remains in evolution.

The current research in MT is encompassing a large range of problems, to list just a few:

– dealing with translation units bigger than single sentences;

– taking into account contextual or real-world knowledge;

– developing dialogue MT environments where the interaction with the machine is aimed at disambiguating the input text [2].

Computer-assisted translation (CAT) and Human-Machine teamwork

The human brain remains a very powerful tool in many of the most complex computational challenges, and the effective teaming of computers and human specialists remains a very effective strategy to optimise translation. In sim-

ple terms, the computer does the basic work in transliteration and translation of words and simple phrases, while the trained interpreter sense checks the document, identifies obvious errors and refines and polishes the final text. In addition, modern MT systems function as versatile research tools, combining the potential of dictionaries, thesauri and encyclopaedias.

An interesting pedagogical experiment was conducted by one of the authors of this study (Natalya Popova, personal communication) to demonstrate this process with two groups of native Russian PhD students. One group were advanced students of English, while the other group members were clearly struggling with English. Both groups were asked to translate a scientific abstract from Russian to English. The first group had to use their pre-existing skills, while the other group had to first formulate Russian sentences in an 'English' manner and then use Google Translate or any other MT system. Although the experiment cannot be considered scientifically robust due to a non-representative sample, the results were informative in that students in the second group, who hardly knew any English, produced much better English Language texts.

Chon and colleagues [6] have recently reported developments in machine translation, such as in Google Translate, that may help second language (L2) writers produce texts in the target language according to their intended meaning. Their results indicate that MT narrowed the difference of writing ability between the skilled and less skilled learners, facilitated learner use of lower frequency words, and produced syntactically more complex sentences. Error analysis showed a reduction in the quantity of grammatical errors when MT was used to aid L2 writing. However, MT-translated compositions contained more mistranslations and a greater number of poor word choices.

Interpreters and translators now have access to computer-assisted tools (CAT), such as WordFast Anywhere, WFA, (also known as FreeTM) are now widely available for public and specialist use, and they support a wide range of document file types. Translation memory (MT) systems incorporated in CAT assist human translators in dealing with subject-specific texts when previously translated fragments and units are available [7]. Such databases will automatically propose a relevant translation from the translation memory whenever similar sentences re-occur. The MT of professional translators can reach thousands of translation units, increasing immensely the productivity and consistency of the entire process.

The Human Translator "in the Loop" remains a very important element to "sense check" machine product and to correct significant errors in translation for a long time to come. Today, with the advent of CAT and MT, most professional translators and their work is pivoting to editing rather than translation competences.

The importance of Good Writing of the Source Texts for Machine Translation

Machine translation is therefore a very complex science with many elements and solutions. The quality of source texts is an important issue. Many authors in many languages still write using long, incomprehensible sentences, in the mistaken belief that complexity conveys evidence of intelligence, when the opposite is in fact the case. This complexity of writing confounds machine translation of publishable quality.

Michaela Panter [8] has explained how "poor sentence construction, syntax, and terminology use may decrease the readability of a text, leading to unclear or even lost meaning. These issues increase the likelihood of subsequent rejection by professional language editors and journal editors alike. The four most obvious mistakes in machine translation appear to be sentence fragmentation; long sentences; the illogical ordering of phrases; and literal instead of context-dependent translation".

Determinants of the quality of texts for Machine Translation include:

– common and internationally accepted terminologies;

– the absence of metaphors, idiomatic expressions and wordplay. For example, Cricket is a gladiatorial sport which is widely played in cur-

rent and former British Commonwealth countries. It generates many terms and metaphors for human behaviour which would not be understood elsewhere (eg he bowled a maiden over; he hit me right out of the ground");

– proximity of language pairs (such as German and English) in terms of sentence structure.

There are AI tools which measure the complexity of text, as for example Lexile Analyser. Such systems measure the number of words in a sentence, and the frequency with which particular words are used, which in turn provide a "readability score". The lower the score, the easier is the text to read, and we can speculate that the linguistic quality of the text of an academic document or journal may become another marker of academic quality.

Automated Intelligence (AI) therefore works particularly well in fields where the source texts are of sufficient clarity and simplicity. In the case of Russian <–> English translation, the "machine-friendly fields" include Medicine, Maths and Information Technology (IT), as well as fundamental Chemistry and Physics, where the terminologies are common to Russian- and English-speaking communicants.

However, AI is of less value in those disciplines which developed distinctive terminologies in relative isolation from global trends during the 20th Century. This particularly concerns applied science, such as Engineering, Agriculture or Geology, as well as the Humanities and Social Sciences. Translation of scientific texts in these fields requires specific professional competences, including deep subject and extra-linguistic knowledge.

The Relevance of Machine Translation to Russian Scientific Editorship

The world is moving steadily to a much more integrated ecosystem of scientific publication and communication. Globally influential academic information aggregation and citation systems such as Google Scholar, SCOPUS and the Web of Science are creating far greater global transparency of open source and public facing scientific output.

This in turn shares benefits and insights around a global audience, and it helps to drive up international standards in scientific activity and publishing. The open Internet has resolved many of the fundamental challenges in international communication, and it has dramatically reduced the speed and costs of reaching this global audience for any academic journal.

At this point, the challenges of content translation become a significant impediment and cost to further information exchange across the academic community. The challenge before us as a global academic community is to help select and develop those MT and AI systems which most confidently and efficiently translate academic texts in Any Language to Any Other Language.

This challenge is made much easier, because most journals and other forms of academic output, including Theses, Dissertations and Textbooks have moved from analogue to digital formats at source.

Moreover, high speed image capture systems and AI enhanced optical character recognition systems allow the backloading of historic (pre-digital) papers, documents and pictures into modern digital systems. This makes it much easier to capture content and to process it through translation systems than in the past.

We therefore felt that this was an appropriate time to widen the discussion on Machine- and AI-assisted translation, and to consider:

– whether this is a field where international and open standards should apply;

– how competing commercial translation systems would be validated and policed;

– where should machine translation systems sit in the academic publishing process;

– who should take responsibility for the accuracy of the translation between competing commercial systems;

– which output would be the version of record in any translation;

– what role would translation systems play when under the direct control of the information consumer (the reader or researcher) rather than of the publisher or distributor;

– to which subjects and disciplines would the rules and validation apply;

– what "Human in the Loop" principles would need to be applied, and

– how would translation errors be captured, classified and fed back into further refinement of the systems?

In terms of the criteria for acceptability of a translated article in an international journal, it is reasonable to ask whether we should always require the native-speaker level? In the world of scientific publishing, there is a growing tendency to support and promote linguistic diversity. This mandates high quality MT to ensure that the national characteristics and authorial voice of the authors are preserved from one language to another. Under such an approach, the basic principles of publishability become the clarity, academic style and grammatical accuracy of writing.

The introduction of secondary Natural Language Processing (NLP) tools for writing better grammar, for example Grammarly and Ginger, may further help to improve the readability of translated text. Nevertheless, the quality of the recommendations provided by such systems also require human control.

Clarity in Writing as a Key Educational Challenge

The quality of the source text critically influences the ability of a computer to produce a meaningful translation. Writing in any language can be an exercise in beauty, elegance and simplicity in the communication of an idea, and all languages and cultures have their great literary exponents, whether Shakespeare in English or Pushkin in Russian. However, writing can also be an exercise in obfuscation, confusion and incomprehensibility for the reader and for the machine translator.

Clarity in writing in one's native language is a skill and an art form which develops throughout life, and with its own rules. Clarity in the flow of ideas and precision in the use words is as important in scientific writing as it is in any form of human communication. This idea is well summarised in the phrase "Less is More" in terms of the number of words used to communicate ideas. Very often, fewer words have greater impact, as is well understood by newspaper headline writers.

Unfortunately, there are many writers of scientific papers in English and Russian who revert to such complex text, poor sentence and grammatical structure, that the meaning is wholly lost on the reader.

It is therefore a key responsibility on teachers and educational planners at all levels in any national education system to impart the skills of clear writing in the native language. In particular,

– words should be chosen for their clarity, simplicity and lack of ambiguity of meaning;

– sentence and paragraph structure should be short, logical and clear;

– the writer of an article which is likely to be translated should avoid metaphors, phrases and references which may not translate well in other languages [9].

Within the scientific writing community, science writers, editors, translators and other communications professionals should have the confidence to engage with authors and to modify text structure where it is necessary or advisable to simplify complexity. This will both improve readability for the native language reader, and it will simplify the process of securing high quality machine translations.

The role of science translators will evolve with machine assistance, but it will remain an important element of the scientific communication process. Lisa Saffran, writing in a Scientific American Blog3 reminds us that all translation is interpretation. The ability to communicate both the words and the meaning of a text, demands a rich understanding of both the donor and the recipient language. Therefore, the importance of professional education and training will increase.

[3] https://blogs.scientificamerican.com/observations/the-art-of-translating-science/

In Summary

1. Machine Translation and AI as applied to scientific texts are technologies in rapid evolution. For browsing and search purposes around technical documents, MT can be used to convey the general gist of a paper without human editing, and it has largely superceded Professional word-for-word translators.

2. For publication level purposes, professional editing remains indispensable, from minimal "tweaking" to tighten terminology; or full editing of sentence structure, formatting, and general sense. The human translator needs to understand the overall context, meaning and direction of the text, as well as the individual words and phrases. There is a growing demand for professional editors and proof-readers, particularly native speakers of English, who are adept at supporting their work with MT tools.

3. Machine translation is advancing rapidly as a key technology in academic publication. The translation of language A to language B is not a simple word exchange transaction. Effective translation requires a full understanding of the complexities of the donor and recipient languages in every transaction. MT works best in subject areas with standard vocabularies and standard publication formats.

4. MT remains imperfect when compared to the art of the specialist translator. For the foreseeable future, Human-Machine teaming will offer the best solution for high quality scientific translation.

5. At this point, it seems unlikely that MT will ever fully replace human specialists in the fields requiring high-quality texts. However, MT systems such as Google Translate, are powerful referencing and research tools. They function as dictionaries, language corpora and thesauri; and this raises questions as to what new skills should we teach, and where in the educational pipeline.

6. This also challenges us to consider how the "communicability" of language and meaning should systematised and taught in national educational systems. It seems quite possible that within a generation, machine translation will be so advanced that school level education may need to pivot from the teaching of individual languages to the teaching and understanding of the technologies which will allow children and adults from any national or cultural background to communicate in all languages on a global basis.

7. Specifically in the matter of high-quality machine translation of scientific texts, we are approaching the point that AI can be inserted into the academic publication pipeline to simplify comprehension of a text in many languages, even if the translation is "impure".

Finally, high quality, clear and communicative science writing and editing in the author's native language will remain the foundation of machine translation for the foreseeable future. The enduring skills of translators are now evolving in "human-machine teaming" [10].

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