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Machine learning: Implications for translator education

Abstract: Machines are learning fast, and human translators must keep pace by learning with, from and about them. Deep learning (DL) and neural machine translation (NMT) are set to change the reality of translation and the distributions of tasks. Although theoretical and practical courses on computer-aided and/or machine translation abound, less attention has been paid to DL and NMT in most translation programmes. The challenge for translation education is to give students the knowledge and toolkits to learn when and how to embrace the new technologies, and to exploit how and when the added value of human intuition, creativity and ethics can and should be deployed.

Keywords: Translator education, human translation, NMT, creativity, ethics

Introduction

The title of this paper is deliberately ambiguous, playing as it does with the dual concept of translation students, their educators and professional translators learning with, from and about machines as the machines themselves develop, or rather are afforded, deep learning (DL) capabilities. We do not claim to present a panacea or cure-all for the many challenges posed by DL to the translation profession. Instead, this paper attempts to sketch out some possible approaches to the education of translators in order to equip translation graduates for a future in which

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artificial intelligence (AI) and DL in general, and neural machine translation (NMT) in particular, will play an increasingly significant part.

Descriptions of DL vary, depending on the degree of domain knowledge expected of the target group. One of the more accessible definitions for a non-specialist audience, due to the conceptual metaphors it deploys, comes from the *MIT Technological Review* (Hof 2016):

> Deep-learning software attempts to mimic the activity [...] in the neocortex, the wrinkly 80 percent of the brain where thinking occurs. The software learns [...] to recognize patterns in digital representations of sounds, images, and other data.

Interestingly, it appears that NMT has become one of the preferred testing grounds for DL development, with a number of AI specialists and linguistics without any particular knowledge or experience of human translation *per se* turning their attention to what one language industry commentator has called a "proxy" (Marking 2016) for AI and DL innovation and development. The excitement generated by NMT's potential is unmistakeable, reflected, alongside a growing body of scientific contributions, in a number of popular science articles and news reports on recent developments in the field. In August 2016, SYSTRAN, best known for its rule-based MT systems, announced the launch of a "purely neural MT" engine (*Global Newswire* 2016). A little later that year, Google Translate claimed that its own NMT system could deliver more natural translations than its statistical MT (SMT) system (*Tech Times* 2016).

Indeed, research on the NMT performance has produced some very positive results over the relatively short period of its deployment. According to Wu et al. (2016), a human side-by-side evaluation of isolated simple sentences suggested that Google's NMT machine reduces translation errors by an average of 60 % over Google's own phrase-based system on out-of-domain data. In a separate study, Junczys-Dowmunt et al. (2016) showed NMT output to be as good as or better than that of a phrase-based (Moses) SMT engine[1], using test data comprising 4,000 randomly selected sentences of a maximum of 100 words in length from the United Nations Parallel Corpus in 30 different language versions. Impressively, clear improvements were evident especially in what have hitherto been MT-challenging language pairs involving Chinese. In other words, NMT already appears to have outperformed, or at least to have been equal to, phrase-based SMT, even when tested within specific domains. Other studies (e.g. Moorkens 2016) with different language pairs and translation versions seem to underpin these findings.

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1 As measured by BLEU scores.

It is against this background that the most recent *Translation Technology Landscape Report* predicts that, subject to continued unrestricted access to big data, "fully automatic useful translation" will become the generally accepted norm within the next two decades (Massardo et al. 2016:11). After a period of what the influential Translation Automation Users Society (TAUS) has labelled the "convergence" era (Massardo et al. 2016:10f.), dominated by NMT-driven cloud translation solutions and characterised by translation "available on every screen, in every app and on every signboard", MT will reach human translation quality levels. The prediction is in line with the onset of what futurologists and AI specialists (e.g. Kurzweil 2005) call the technological singularity – a hypothesised point in time when AI and other technological developments are so advanced that they will irreversibly transform human living and working as we know it.

Other forecasts go further. In a recent survey conducted by members of the Future of Humanity Institute at Oxford University and of the Department of Political Science at Yale University (Grace et al. 2017), 352 leading machine learning researchers, the largest population to participate in a study of this kind, responded to questions eliciting their predictions about the progress of AI. On the basis of the responses, a timeline of median estimates for AI achieving human performance in various tasks with 50 % probability intervals was generated. Overall, aggregate forecasts for "high-level machine intelligence" predicted it occurring in 45 years, although the 50 %-probability forecast for full automation of human labour was much later, at 122 years in the future. The translation-related milestones were much closer in time (Grace et al. 2017:14): machines were predicted to be able to "perform translation about as good as a human who is fluent in both languages but unskilled at translation, for most types of text, and for most popular languages" in eight years (that is by 2024) and to exceed human performance in translating "speech in a new language given only unlimited films with subtitles in the new language" by 2026; only six years later, by 2032, AI systems were predicted to be able to "translate a text written in a newly discovered language into English as well as a team of human experts [could]". The optimism of these predictions echoes those made in the early days of MT but also makes abundantly clear the challenges that may soon be facing the translation market as we know it today.

While human translation may appear to be under threat, economic research suggests that the impact is likely to be uneven, depending in large part on the type of translation tasks being performed. A diachronic United States employment study by the Federal Reserve Bank of St. Louis (Dvorkin 2016) shows that automation seems above all to jeopardise routine work, revealing a stagnation in routine cognitive and routine manual employment levels between 1983 and 2014, but a steady rise in employment in non-routine cognitive (and non-routine

manual) jobs over the same period. Complementary information on the unemployment rate shows a very similar pattern, with "occupations requiring a higher degree of cognitive skills [having], on average, a lower unemployment rate" (Dvorkin 2016). The phenomenon of polarisation (Canon/Marifian 2013) underlying this trend, i.e. the growth in both high-skill and low-skill occupations as the medium-skilled, medium-wage job market wanes, is ascribed largely to technological automation and, to a lesser extent, offshoring (Canon/Marifian 2013:10; Dvorkin 2016). It is this that prompts Canon and Marifian (2013:11) to recommend that "while educational achievement is undoubtedly important as demand continues to increase for college-educated, high-skilled (and high-wage) workers, it also may be useful to emphasise development and training for non-routine skills since they will grow ever more valuable as technology automates routine work". Given that technological automation (like offshoring) are global developments by no means isolated to the United States, this appears to be advice worth heeding in all industrialised economies. What is more, continued advances in DL seem likely to exacerbate the future impact on routine jobs, manual and cognitive alike.

When applied to translation, the development of employment trends away from routine activities towards adaptive cognitive tasks suggests that NMT will challenge human translators primarily in those segments where their work requires little more than routine cognitive activities. Interestingly, this has also been touched on in the popular press, with a recent edition of *The Economist* (2017) reporting that, while "translators in the bulk and middle markets will inevitably be doing more editing, or will be squeezed out" as a result of MT, there will be a place for those who go beyond the language and writing skills needed for repeatable language work to "gain clients' trust and learn their minds". In short, translators will be in demand in those areas where human translation provides clients with the added values of intuition, creativity and ethical judgement.

That demand is already acknowledged among language industry players. The TAUS content pyramid (Massardo et al. 2016:10) depicts the current state of translation demand, dividing it into the larger segments of user-generated content, messaging, internal documentation and maintenance and support content in the broader bottom half, and user documentation, user interfaces, marketing and brand content in the narrowing top half. Much of the content in the bottom half of the metaphorical pyramid is already being covered by MT, often representing new markets and large volumes that have never been or ever would be handled by human translators.

The authors of the present paper predict that NMT will gradually push the dividing line between machine solutions and human translation further up the pyramid. Repetitive, controlled content such as user documentation and user

interfaces will be increasingly covered by MT as it improves. However, marketing and brand content will remain the preserve of human translation. The reason has to do with the growing need for quality differentiation concomitant with the greater role that users have in deciding what languages, which content and what level of quality is important to them. TAUS has clearly indicated that translation is acquiring a strategic function in organisations (Massardo et al. 2016:10), which of course means that it must be integrated into corporate communication strategies (cf. Argenti 2016; Cornelissen 2014; Holtzhausen/Zerfass 2015).

With increasing globalisation, companies are being confronted with the challenge of managing communication strategically not only among stakeholders in the company's country of origin, but also across all cultures in which the organisation operates. This necessarily foregrounds multi-layered audience and stakeholder design as part of overarching communications plans, calling for a degree of adaptability, risk awareness and trustworthiness that MT on its own will be hard-pressed to provide in the foreseeable future. These traits are eminently human, but traditionally-trained translators might need to be empowered to exploit them fully in their work and to see themselves as creative agents in the multilingual text production chain. In the following sections, we explore the extent to which today's translators are equipped for this role and consider what might be done to prepare future members of the profession for it.

Technology and the added value of adaptive expertise

At this point, it is worth recalling that computer-assisted translation (CAT) systems have been supporting translators in their work for well over two decades. Translation memory (TM) systems, which have increasingly integrated MT to broaden the range of translation solutions offered, and other CAT tools have already been able to relieve translators of many of the tedious, repetitive aspects of their work. It is reasonable to assume that technology will continue to expand its assistive impact. Technological advances have brought about a noticeable shift in translators' principal tasks, which can be defined as a specific form of human-computer interaction (O'Brien 2012) involving the extended cognition (Pym 2011) provided by TM, MT and terminology management systems. Going a little further, we claim that translation represents a fascinating instance of situated cognition, done by the mind in conjunction with the complex physical environments and socio-technical systems in which the act of translation takes place (cf. Risku 2002:529; 2010:103). Those systems, environments and their

cultural and technological artefacts not only support translation *per se* but can also be regarded as affordances that feed into a process of emergent learning and competence development, which is why current translator education places so much emphasis on authentic experiential learning (e.g. Kiraly 2012; Kiraly et al. 2016). In other words, translators can and do learn with and from the machines that assist them.

Yet, technologies also impose constraints, with effects on translators' working conditions, working practices and output quality that are not always beneficial. Research on translators' responses to technology (Olohan 2011) and other aspects of organisational ergonomics (Ehrensberger-Dow/Massey 2017) reveal a certain resentment of technologies arbitrarily imposed by clients or organisations and of what many translators consider to be the inadequate pay they receive for certain services, especially in the area of post-editing (Guerberof Arenas 2013). There are also indicators from cognitive and ergonomic research on translation processes that translators subject themselves to the constraints imposed by the technology, with a detrimental impact on their creativity and sense of autonomy (e.g. Ehrensberger-Dow/Massey 2014a, 2014b, 2017). In an experiment comparing the quality of post-edited machine-translated marketing texts with those produced by human translators working in a TM environment, the post-edited output came off slightly better (Läubli et al. 2013). Although the participants in that study were MA students and not professional translators, this does suggest that there might be a negative impact of working within a constrained TM environment on text types that would normally demand a high degree of creativity and that students might actually use MT output to kick-start their creative process.

However, it is reasonable to assume that an increasing reliance on technology and tools might well encourage translators to deploy more routines and unconsciously adopt greater automaticity in their work. While superficially increasing productivity, this can lead to what has been called "fixation" (Dodds/Smith 1999) or "over-routinisation" (Massey/Brändli 2016:181), which process researchers have identified as a barrier to creative problem solving and as a risk to the acceptability of translation products (Bayer-Hohenwarter 2010:108, 2011:71). Other findings from cognitive process research show that fixation can also be an impediment to strategic decision making and reflective problem solving in professional translators' information behaviour and knowledge integration (Prassl 2010, 2011). Indeed, professional translators participating in the University of Graz's *TransComp* project (see Göpferich 2009, 2010, 2012; Göpferich et al. 2011) were generally observed to lag behind the research team's expectations of their strategic competence, perhaps as a result of fixation. The apparent stagnation in their development prompted the conclusion that "a considerable amount of specific training would be needed to help them overcome this state" (Göpferich 2013:72).

Exposure to increasingly autonomous, self-learning DL technologies, with all the potential constraints on human creativity and autonomy that this brings, is likely to impact increasingly on professional translators. The tried and tested routines of professionals within constraintive technological environments undoubtedly work well with predictable tasks, familiar or conventionalised text types and, most importantly, within stable economic and ecological conditions in the language industry. But the cognitive effects on creativity of fixed routines could render translators incapable of adapting their approaches to the re-positioning needed to confront the challenges presented by the progressive encroachment of machine translation onto increasingly broad sections of the translation market.

The requisite adaptivity is inexorably linked to expertise and its development. As the "product of [...] maximal efforts to improve performance in a domain through an optimal distribution of deliberate practice" (Ericsson et al. 1993:363), expertise is achieved through a combination of proceduralisation and metacognitive self-regulation, developed through deliberate practice (Shreve 2006:29). Only then will translators acquire the adaptive expertise needed to cope with the idiosyncratic, ill-defined problems translation involves (Muñoz Martín 2014:9).

The conditions under which adaptive competence and expertise can evolve is predicated on a high degree of autonomy, self-empowerment and a conceptualisation of the translator's role and responsibilities, or self-concept, that must go beyond that of a "text processor" (Tirkkonen-Condit/Laukkanen 1996:45f.). An adequate self-concept entails a broadened perception of the translator's role away from the "copier" or "wordsmith" (Katan 2016:366) to one akin to that of a writer (Tirkkonen-Condit/Laukkanen 1996:45f.; Gross 2003:91) or "transcreator" (Katan 2016:377). For as Katan (2016:377) cogently points out in his forecast of the future course of the professions, "technical, low-risk, low ambiguity translating and interpreting can be safely delivered with minimum human intervention" but it is only the (professionally trained) translator as an intercultural communicator who is "uniquely placed to intervene and mediate between contexts to ensure optimum communication".

The pre-conditions to develop such a self-concept are not necessarily given in the current language profession and industry. The increasing segmentation of translation processes and the growing technologisation of the translator's workplace seem to have been undermining translators' self-concept and identity, leading to a perception among the professionals themselves, reflected in strong indicators from a large-scale survey, that they are pursuing a low autonomy profession (LAP) (Katan 2009, 2011, 2016). This situation can and will be exacerbated by the newest developments in translation technologies if the role and position of human translation is not redefined and not adequately addressed by

translator education. In short, if translators "are to survive, they must make the transcreational turn" (Katan 2016:378).

The demand for an extended, adaptable mediatory role for translators has been recognised in many quarters. Some language services have already incorporated the new added-value needs into their competence profiles. A good example is provided by the European Parliament's Directorate-General for Translation (DG-TRAD), which is now looking for translators not only with advanced TM skills able to work in technological translation environments and to perform post-editing tasks, but also with the capacity to analyse, draft, edit and adapt texts in a variety of (social) media as well as to provide linguistic advice to writers (Juriené 2017). Such a profile fits extremely well into the broader conception of translation as a strategic, co-creative activity, which is precisely where future demand for high-quality human translation and translators seems likely to grow.

Implications for translator education

As a situated activity, translation involves interactions of environmental and socio-technical factors beyond the specific cognitive act of interlingual or intralingual transfer. It therefore seems wholly appropriate that preparing students for such a professional reality should be based on the authentic experiential learning now flourishing in translator education (cf. Kiraly et al. 2016). It is at this interface that educators have responded most obviously to the challenge of narrowing the graduate employability gap, which in the context of translation technologies means sustained authentic exposure to the systems deployed in the translator's current and future workplace.

It is therefore clear that translator education institutes should continue to keep abreast of technological developments, giving students as much direct experience as possible with the tools, processes and practices with which they are likely to be confronted in their professional lives. This can only be achieved by regular and sustained use of CAT tools and TM in practical translation courses and not just in translation technology courses. Students should also learn with and from technologies to develop information literacy skills, to assess the opportunities and risks of the internet, and to work effectively with (parallel) corpora and digital language data, which still form the basic component of today's language technology.

At the same time, students should be encouraged to develop the metacognitive capacity to reflect on the deployment of language technologies, by learning about the capabilities and limitations of the machines and tools with which they are and will be working. To mitigate the constraints and the physical and cognitive ergo-

nomic risks presented by their TM systems and CAT tools, they should receive early and repeated training in ergonomics and in customising and adapting the technology to meet their own needs – and not the other way around. Finally, a basic introduction to MT in its various forms, from rule-based MT through phrase-based MT to NMT, is indispensable. Only with such knowledge can informed judgements be made as to when (e.g. with what genres and quality expectations) and how (e.g. system training and TM integration) the potential of MT might be used to the best effect, and when high-quality human translation will be needed instead.

Yet, all of the above presupposes that students are aware of the added value of human translation and are able to deliver it. An over-emphasis on technology in translator education, and the risk of dependence and routinisation that goes with it, must be avoided at all costs. Training programmes should encourage and foster the development of the human dimensions of intuition, creativity, and ethical judgement in order to ensure that graduates can deliver high-quality human translation when needed. This can be done by focusing, or re-focusing, on: writing and transcreational skills; user-centered, intersemiotic, multilingual text production; intercultural communication and conceptual transfer; ethics and risk; quality assurance and management, with a particular emphasis on post-editing and revision skills; and consultancy and extended (project) management skills.

In curricular terms, this means above all devising learning opportunities that tap the creative and ethical dimensions of human translation. In addition to building an awareness of what DL and NMT can do, education should prepare for future challenges to the profession by reaching out to related disciplines such as organisational communication. Re-defining the translator's primary tasks as writing and transcreation sets the stage for developing the skills necessary for adaptation and multilingual user-centred text production. On the MA at our institute, for instance, we have developed authentic collaborative projects integrating our translating, interpreting and organisational communication specialisations in the design and application of corporate communications concepts. The main objectives of such projects are to sensitise the students to the exigencies of their core tasks, break down traditional disciplinary boundaries between them and, by pooling cross-disciplinary competences, develop an extended role perception amongst the three student groups. Complementary input on marketing, PR and branding basics would also prove beneficial to translation students. Familiarity with the essentials of intercultural communication, as already offered at a number of institutes, and with the cognitive semantics of conceptual transfer, forcefully recommended as a potential mainstay of translator education by those researching the field (e.g. Nicaise 2011; Tabakowska 2014; Vandaele/Lubin 2005), would serve to stimulate and reinforce student awareness of audience design and user-centred translation.

Although routine translation work can and will increasingly be done by automated solutions such as NMT, the responsibility still lies with humans to decide in each case whether the risks of mistranslations and other errors are ethically acceptable. Students therefore need to be familiarised with risk and quality management concepts applied to translation (cf. Canfora/Ottmann 2015; Pym 2015) and to receive systematic training in translation ethics and, wherever feasible, the legal ramifications of the work translators do. Training programmes should equip students to handle the ethical and legal demands of those high-risk texts that no client should ever entrust to cloud-based MT solutions. Above all, it is time to redress some of the imbalances of recent shifts in the translator education curriculum by re-humanising key aspects of translator education. Only then will future translators be fully empowered to assume higher-autonomy, strategically oriented roles as adaptors, editors, transcreators and language consultants for the clients and organisations that employ them.

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