

Mathematics, language and AI

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Are machines and AI eroding our relationship with language?

- Several young translators spontaneously told me that they are worrying that AI could replace them.
- Many teachers worry that school children and teenage pupils have less incentive to learn to write well (which requires many years of patient work) because they experience that LLM's produce texts which seem better written than their own.
- Even university professors I know, both in China and Europe, say that they are gradually becoming less capable of hand-writing because they use all the time computers as word processors and even mobile phones as typewriters.

Why this question matters

- The human family, considered as a concert of all cultures, is interconnected in a way which is unprecedented in History. It opens wonderful possibilities of mutual fertilization.
- In particular, Chinese civilization and European civilization, which have developped independently for several millenia, are at the beginning of the process of their mutual discovery.
 - Deep knowledge of another culture requires learning its language or languages.
 - Machines cannot spare us the effort needed to really learn to know another culture.
- Even more deeply:
 - Language and writing are key elements of our very nature as human persons. They are not mere tools.
 - Hand-writing is possibly even more essential in Chinese culture than in European cultures.

The relationship with hand-writing and hand-correcting of mathematician Alexandre Grothendieck

- He carried out the most ground-breaking work of XXth century mathematics on the basis of his extremely deep relationship with language, especially written language

« Il est important pour moi de garder un contact direct et intime avec le support matériel du travail – en l'occurrence, la feuille de papier couverte d'écriture. J'ai besoin de voir les ratures que j'y ai portées. Quand il y en a un bon peu, c'est un signe clair qu'il me faut retaper toute la page. Or "retaper" ce n'est nullement reproduire le texte en tenant compte des ratures qu'il y faut incorporer (le travail donc que la machine ferait mieux que moi). La page raturée me sert de point de départ pour reprendre tout le texte, souvent avec des modifications notables. Cela fait partie du "travail d'approfondissement" par l'écriture, et est un travail créateur au même titre que le premier jet de l'écriture, qu'on ne songerait pas plus à confier à une machine (pas moi, du moins...). »

« It is important for me to maintain direct and intimate contact with the physical medium of my work – in this case, the sheet of paper covered with writing. I need to see the corrections I have made. When there are quite a few, it is a clear sign that I need to retype the entire page. However, 'retyping' does not mean reproducing the text, taking into account the corrections that need to be incorporated (the work that a machine would do better than me). The crossed-out page serves as a starting point for me to rework the entire text, often with significant modifications. This is part of the 'in-depth work' involved in writing, and is a creative task in the same way as the first draft, which one would not dream of entrusting to a machine (at least, I wouldn't...). »

The distinction between “information” and “knowledge” according to Grothendieck

« Une [...] information, alors même qu'elle resterait gravée dans la psyché de façon durable, ne mérite pas le nom de "connaissance" au sens où je l'entends. Elle reste au fond étrangère à notre être profond, telle une nourriture simplement ingérée et non encore digérée, comme un repas qui "reste sur l'estomac". Les "processus créateurs" [...] sont ceux qui "digèrent et qui assimilent". Ce sont eux qui transforment information et "connaissance brute" en connaissance plénière, en la chair de notre être, et nous font grandir mentalement et spirituellement. »

« Information, even if it remains engraved in the psyche for a long time, does not deserve to be called 'knowledge' in the sense that I understand it. It remains fundamentally foreign to our inner being, like food that has been ingested but not yet digested, like a meal that 'lies heavy on the stomach'. 'Creative processes' are those that 'digest and assimilate'. They are what transform information and 'raw knowledge' into full knowledge, into the flesh of our being, and make us grow mentally and spiritually. »

The 3 main ingredients of present AI

(1) Huge computing power of hardware systems:

- This is engineer work.
- It is based on modern physics.
- Modern physics is mathematical physics.
- Just as any theory, mathematics and physics mainly consist in language.

(2) The use of huge quantities of data to parametrized the systems:

- Huge data can be stored and processed thanks to the huge memory and computing power of hardware systems.
- For LLM's, these data consist in all texts previously written by real human beings.

(3) New math-inspired algorithms based on

- statistics or "probability theory",
- the idea of approximation, and approximation methods (in particular Newton's method),
- the idea to construct approximating "functions" no more by "superposition" but by "composition":


A little more about the birth of probability theory

- Probability theory is the only branch of mathematics which, unlike geometry, algebra or even analysis, is purely modern, without any ancient origin.
- It is generally considered that probability theory was born in year 1654, in letters exchanged by Pierre de Fermat and Blaise Pascal.

→ Blaise Pascal (1623-1662) was a universal genius who

- did ground-breaking work in mathematics and physics,
- designed and built the first automatic computing machines (which of course were mechanical, not electronic),
- introduced for the first time in Paris the idea of public transport running on regular schedules,
- became one of the most important French thinkers (who really lived his own thoughts),
- became one of the most important French writers, possibly the most important French writer in History as it can be considered that he created modern French language.

Concluding remarks

- The greatest French mathematicians I can think about had all a special relationship

{ – to language (French, Latin, Ancient Greek, ...)
– to literary classics.

- Most striking examples:

René Descartes (1596-1650)

Blaise Pascal (1623-1662)

Evariste Galois (1811-1832)

Henri Poincaré (1854-1912)

André Weil (1906-1998)

Alexandre Grothendieck (1928-2014)

- France is a literary country

which has been especially creative in mathematics.

- China is just as literary as France.

The special relationship of China with language,

especially written language in a form which is less “linear”, more “spatial”,

will necessarily inspire a special way to do mathematics.