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NATURAL LANGUAGE AI AIDING THE "DECODING" OF HUMAN THOUGHT

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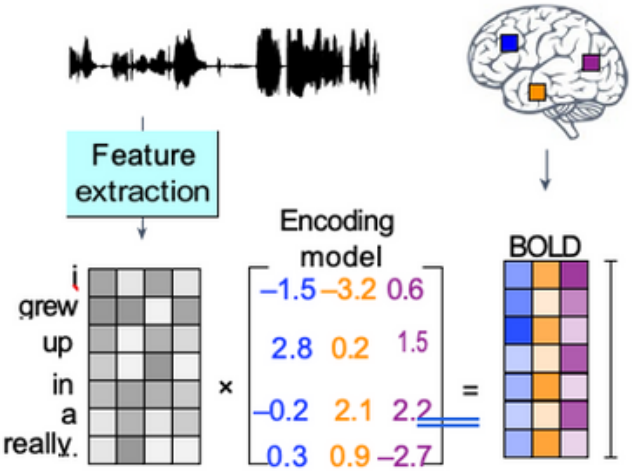
Published recently (2023) in the esteemed journal Nature Neuroscience, a team of researchers (J. Tang, A. LeBel, S. Jain & A. Huth) from the fields of computer science and neuroscience at the University of Austin (USA), unveiled an article titled "Semantic reconstruction of continuous language from non-invasive brain recordings". This represents a significant leap forward in harnessing artificial intelligence for "decoding" the internal thought contents of human beings.

Crafting a "semantic encryption key" for human verbal thought

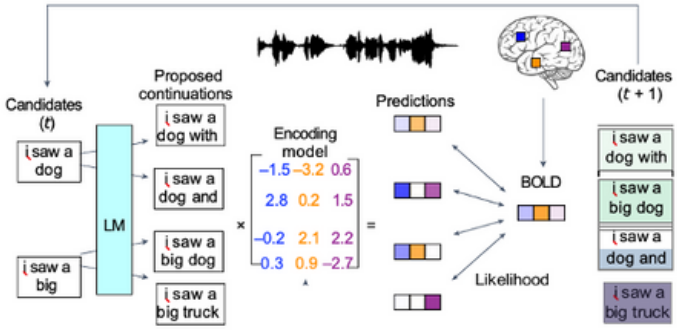
The researchers from North America exposed test subjects to a substantial number of word sequences embedded within narrative stories. Using the conventional functional magnetic resonance imaging (fMRI) technology, they captured specific variations in blood oxygen supply to the semantic language cortical regions activated during auditory perception of each verbal sequence. These recordings provide a digital representation, in the mathematical sense, of the neural activity that physiologically translates the semantic encoding of these word sequences.



Every word sequence stimulus was subsequently associated with the corresponding electrochemical brain activity generated by the test subjects. This process created a set of pairs (verbal sequence input, specific digital signature output). The language-digital function, thus defined, indirectly represents the semantic encodings performed by these individuals. This function, mathematically a correspondence matrix (input, output) processed through regression, can be interpreted as a decoding key for understanding the semantic encryption produced by human cognition (see the diagram from the original article).

Decoding Verbal Thoughts

If this encryption function enables a translation from word sequence to neuronal signature, its inverse function theoretically allows a decryption, in reverse, from neuronal signature back to word sequence. By extension, it could also decrypt neural activity to reveal the semantic content of verbal thought.



To explore this intriguing possibility, the researchers asked the participants in the experiment to generate new narrative discourses internally (i.e., without verbalizing them). Their specific brain activities during this task were once again recorded using fMRI, and these recordings were subjected to the reverse neuro-semantic decryption key (see the diagram from the article).

This decryption key, unsurprisingly, isn't a bijective function (i.e., doesn't provide a one-to-one correspondence). The procedure, therefore, yields a series of potential word sequences, only a few of which are likely from a strictly syntactic or semantic perspective. This is where generative language AI steps in, allowing an assessment of the linguistic plausibility of the large number of obtained candidates and retaining only the most probable one (the inferred content of the internally generated verbal thought).

The predicted verbal thoughts were then compared with the verbal thoughts actually reported by the participants post-experiment, using other language AI techniques to measure their semantic similarity. The obtained statistical results indicate that the meaning of these verbal thoughts has been significantly and accurately predicted by the neuro-semantic decryption key, moderated by the language AI (see the examples from the article).

With the need for stringent ethical precautions to be rigorously implemented for all major scientific innovations, the potential applications of this language AI technology are broad and promising. They range from the therapeutic field (for instance, the case of language production aphasia) to man-machine interface command. Undoubtedly, this area of research will witness robust and unexpected growth in the very close years to come.

Actual stimulus	Decoded stimulus	
¡got up from the air mattress and pressed my face against the glass of the bedroom window expecting to see eyes staring back at me but instead finding only darkness	¡just continued to walk up to the window and open the glass ¡stood on my toes and peered out ¡didn't see anything and looked up again ¡saw nothing	
¡didn't know whether to scream cry or run away instead ¡said leave me alone ¡don't need your help adam disappeared and ¡cleaned up alone crying	started to scream and cry and then she just said ¡told you to leave me alone you can't hurt me anymore i'm sorry and then he stormed off ¡thought he had left ¡started to cry	Exact
that night ¡went upstairs to what had been our bedroom and not knowing what else to do ¡turned out the lights and lay down on the floor	we got back to my dorm room ¡had no idea where my bed was ¡just assumed ¡would sleep on it but instead ¡lay down on the floor	Gist
¡don't have my driver's license yet and ¡just jumped out right when ¡needed to and she says well why don't you come back to my house and i'll give you a ride ¡say ok	she is not ready she has not even started to learn to drive yet ¡had to push her out of the car ¡said we will take her home now and she agreed	Error