Milestones in Machine Translation

Part 1 – How it all began in 1947 and 1948

Episodes from the history of computers and translation

by
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It is appropriate that this series on 'milestones' in machine translation should begin with the event, exactly 50 years ago, that can be said to mark the very beginning of ideas for using computers to translate natural languages.

Electronic computers were developed during World War II to satisfy the urgent need for large-scale mathematical calculations to support military actions of many kinds. In the United States, the previously secret research on computers came to the attention of the general public in the late 1940s. There was great excitement about the huge potential of these 'electric brains', as they were generally referred to by journalists. The possibilities for applications beyond 'number crunching' became increasingly obvious to many people, and among the first of the possibilities to be suggested was translation. In fact, the idea of 'machine translation' occurred independently to a number of people at this time.

The first, however, was almost certainly Warren Weaver, director of the Natural Sciences Division of the Rockefeller Foundation. Weaver had been closely involved in the development of electrical and mechanical devices for aiding the US military in the war. His background in mathematics - before going to the Foundation, he had been professor at the University of Wisconsin from 1920 to 1932 - and his long administrative experience made him a natural choice to head the Applied Mathematics Panel of the Office of Scientific Research and Development. The task of this unit was to provide the mathematical expertise to improve the effectiveness of bombing and torpedo attacks, firing anti-aircraft missiles, testing rocket propellants, and much more. Weaver's involvement brought him into contact with many of those building the earliest digital computers, scientists such as Howard Aiken, George Stibitz, Herman Goldstine and John von Neumann.

His work at the Rockefeller Foundation had shown him the vital importance of the diffusion of scientific information, particularly the spread of technical expertise from the more industrialised countries to the poorer developing countries in Central and South America - it was during the war that Weaver instigated the successful Rockefeller Foundation programme for improving agricultural production in Mexico. Furthermore, Weaver shared the widespread desire in the immediate post-war atmosphere, to improve international understanding. However, as the United Nations and its organisations such as UNESCO soon discovered, the language barriers were considerable.

It was, as he himself put it, "natural" that he should think of the possibility of applying the newly invented computers to the urgent task of translation. On March 4, 1947, he wrote to Norbert Wiener, the cyberneticist whom he knew from many wartime contacts. Wiener was also a linguist and knew a great deal about the potentials of the computer:

"Recognizing fully, even though necessarily vaguely, the semantic difficulties because of multiple meanings, etc., I have wondered if it were unthinkable to design a computer which would translate. Even if it would translate only scientific material (where the semantic difficulties are very notably less), and even if it did produce an inelegant (but intelligible) result, it would seem to me worth while.

"Also knowing nothing official about, but having guessed and inferred considerable about, powerful new mechanized methods in cryptography - methods which I believe succeed even when one does not know what language has been coded - one naturally wonders if the problem of translation could conceivably be treated as a problem in cryptography. When I look at an article in Russian, I say 'This is really written in English, but it has been coded in some strange symbols. I will now proceed to decode.'

"Have you ever thought about this? As a linguist and expert on computers, do you think it is worth thinking about?"

Wiener's reply was unexpectedly disappointing for Weaver.

"...as to the problem of mechanical translation, I frankly am afraid the boundaries of words in different languages are too vague and the emotional and international connotations are too extensive to make any quasi mechanical translation scheme very hopeful."

But Weaver was not deterred, and he continued to reflect on how translation might be done by machine. His mention of cryptography as a possible method had been prompted by an experience during the war. Professor Prager at Brown University had told him about a computer program for decipherment devised by one of his colleagues (R.E.Gilman). Prager had invented a code and written in it a message in Turkish. Gilman came back the next day, believing he had failed since he could not read the result. In fact Gilman's cyptography program had correctly reproduced the original Turkish message.

This was an impressive demonstration of the power of computers and suggested that foreign languages could be treated easily. As it happens, the system had been based on frequencies of letters and letter-pairs in English; fortunately, the frequencies were much the same in Turkish. However, cryptography was a false analogy, and it was recognised as such fairly soon after MT research began in earnest. The reason is, of course, that decipherment does not involve different languages, it is monolingual. The confusion arises whenever the two activities of decipherment and translation are carried out by the same person.

Two days after writing to Wiener, Weaver had met a British scientist from Birkbeck College London, who was in America to investigate the newly invented electronic computers. Dr. Andrew D. Booth had been able to come thanks to financial support from the Rockefeller Foundation which his department head Professor J. D. Bernal had received. It was natural, then, that he should visit Warren Weaver. They spoke about the possibilities of the Rockefeller Foundation or some other American institution providing funds for a British computer. Weaver did not think funds would be forthcoming for numerical applications, but he did believe that support for non-numerical uses might be possible. He suggested the use of computers for translation.

It is quite possible that Booth had had some such ideas before meeting Weaver since he knew Alan Turing, the computer genius at the National Physical Laboratory (NPL), who had designed the electronic decoder Colossus at Bletchley Park (Weaver would not have known about this secret activity in Britain despite his close contacts with British military experts). In an internal report for the NPL in September 1947 Turing specifically mentioned the possibility of using computers for translation - as a demonstration of their 'intelligence'. Booth may well have spoken to Turing about this possibility in 1946 or 1947.

Weaver's comments were the instigation for the practical work which began after Booth's return to England. At this stage he had in mind simply the storage and look-up of a mechanical dictionary, and had investigated some possibilities while he had been in the United States. However, he then met Richard H. Richens, assistant director of the Commonwealth Bureau of Plant Breeding and Genetics in Cambridge. Richens had independently had the idea of mechanically translating titles and abstracts of scientific articles, and had tested his ideas using punched card equipment. Essentially the method was simple word for word substitution, with all alternatives given for every word and some standard indication of grammatical function (noun, verb, adjective, etc.). The word order remained as the original language, and the results were difficult but not impossible to understand.

Weaver visited Booth next year in May 1948 and heard about his collaboration with Richens. He was, however, rather disappointed:

"So far, it turns out, they have not considered at all the problem of multiple meaning (!), and have been concerned only with the mechanics of looking up words in a dictionary. First, you sense the first letter of a word, and then have the machine see whether or not the memory contains precisely the word in question. If so, the machine simply produces the translation (which is the rub; of course 'the' translation doesn't exist) of this word. If this exact word is not contained in the memory, then the machine discards the last letter of the word, and tries over. If this fails, it discards another letter, and tries again. After it has found the largest initial combination of letters which is in the dictionary, it 'looks up' the whole discarded portion in a special 'grammatical annex' of the dictionary. Thus confronted by 'running', it might find 'run' and then find out what the ending (n)ing does to 'run'.

Weaver was feeling the need to explain more fully how he conceived translation by computer. He knew that statistical methods could be applied to identify specific meanings of words, which in isolation might be ambiguous; he knew about the potential of Claude Shannon's information theory; and he knew about notions of language universals. There was more to translation than just a mechanical dictionary. The following year, in July 1949, he wrote a memorandum, circulated to some 20 or 30 acquaintances, which was to stimulate the beginnings of research on machine translation in the United States. It will be the topic of the next article in this series. ■