

## First Author

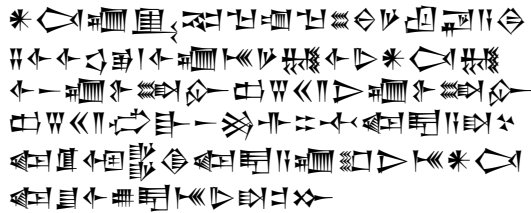
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## Abstract

This paper announces the discovery of the use of neural nets almost 4,000 years before their use in the modern era. Newly discovered tablets preserve a perceptron used for calculating the numbers on Plimpton 322, the most important object in the history of mathematics. The native programming language used by the ancient Babylonian "cuneogrammers" uses sexagesimal numbering leading to some "weirdness".



## 1 Introduction

The history of math is long, but the history of programming is longer. Cuneiform, arguably the first writing in the world, is known for its sheep receipts and beer ration lists as well as copper complaints (Oppenheim, 1954). This article adds neural network programming to that vaunted list of human achievements. A set of newly discovered cuneiform tablets preserve the mechanism for performing simple neural network calculations. These methods, it seems, were used to calculate the lengths of triangles; a well known exercise preserved on the tablet known as Plimpton 322<sup>1</sup>. It is remarkable that no historian of math or cuneiform scholar has ever consider this possibility. This paper covers the background, a description of the cuneogramming language, and includes a facsimile copy of the most important tablet as an appendix.

<sup>1</sup>And important and real introduction into this interesting object is found in Robson (2002).

Unfortunately, the hardware required to execute these programs (i.e. a living Babylonian mathematician) has not been adequately preserved, but we have managed to write a Python library which emulates it.<sup>2</sup> The assumption is that these calculations were done by hand in their copious free time between inventing the wheel and the concept of zero. While the actual output of these tablets is relatively simple by modern standards, the implications of this discovery are profound. Future work will explore how these techniques could have been used in the realm of astronomical calculation and elucidate the full extent of the Babylonian's computational prowess.

## 2 Description of the Language

Programs in 𒂗𒍪𒍪𒍪 (EME.ŠID.A "language of counting") follow a tabular structure with three main sections: (i) a header, denoted by 𒂗𒍪 (DUB "tablet"), (ii) a sequence of instructions, and (iii) a colophon detailing the tablet's authorship. Each instruction spans four columns, which we have taken to calling the *arguments*, *opcode*, *destination*, and *line number*. These columns are usually tab-separated, though in a few documents they are TAB-separated (using the cuneiform sign TAB 𒂗). Instructions are grouped into blocks by means of horizontal lines.

**Arguments** An instruction's arguments may be numbers, register addresses, or a combination of the two. Numbers are encoded following standard Babylonian conventions (?), with 𒌦 denoting the radix point which separates the integer part from a following fraction. There is an explicit representation for zero (𒌦), making these tablets some of the earliest unambiguous examples of the mathematical concept of zero.

<sup>2</sup>[github.com/MrLogarithm/emeszida](https://github.com/MrLogarithm/emeszida)





Figure 1: BM 34580, courtesy of the Trustees of the British Museum, CC BY-NC-SA 4.0

parameters are stored in addresses with integer part 1; the program inputs all have integer part 2; the matrix multiplication subroutine uses addresses with integer part 3; and so on. The fractional parts of register addresses also appear to follow some standard conventions, with the X;0 register typically storing a subroutine's return address, while X;1 onward were used for its arguments.

The perceptron tablet also uses fractional register addresses to perform a kind of multi-dimensional array indexing. As an example, the first layer of the perceptron has a  $50 \times 2$  weight matrix, and this is stored in registers 1;0,0,0 through 1;0,49,1. The integer part of these addresses denotes the "data" portion of memory; the first digit after the radix point identifies this as the 0th model parameter; and the second and third digits can be treated as a pair of indices ranging from 0–49 and 0–1 respectively. To access a specific element in this matrix, the scribes use repeated division by 60 to implement a kind of "bit-shift" instruction, in order to shift integer indices into the correct positions after the radix point. By adding the bit-shifted element indices (e.g. 0;0,4,7 for the element in row 5, column 8) to a pointer to the top corner of the matrix (1;0,0,0) they obtain the address of the desired element (1;0,4,7).

Notably, this practice limits the size of their model parameters to at most  $60 \times 60$ , as for larger values the addresses would carry over to higher digits and thus begin to overwrite one another. This limitation may explain why AI never made waves in Babylonian society, as their models were all too small to be truly

revolutionary.

### 3 Description of the Texts

The tablets preserve a number of methods for performing simple neural network calculations. Simple array operations as well as the calculation of the dot product are included in the corpus. All of this comes together in the large perceptron tablet. It is clear that the cuneogrammers were slowly developing their skills as some of the earlier and simpler methods date as far back as the Old Akkadian period (c. 2300–2150 BCE) while the perceptron tablet is from the Old Babylonian period (c. 1900–1600 BCE). The longest tablet, included in the appendix, shows a fully featured perceptron ADD MORE HERE Interestingly, the long weights at the end of the tablet very closely resemble the parameters of later astronomical calculations (see Figure 1).

- add graph plotting perceptron output vs true trigonometric ratios from Plimpton

### 4 Implications

This completely rewrites the history of modern computing...

Other ancient corpora which have resisted decipherment, and which boast a similar numeric component, may represent additional examples of ancient programming traditions.

- compare the table of params at the end of the file to tables of astronomical parameters from genuine tablets

## Acknowledgments

The search for these tablets and our effort to understand them was inspired by Ramsey Nasser’s **قلب** programming language (<https://github.com/nasser/—>).

## References

- A. L. Oppenheim. 1954. [The seafaring merchants of ur](#). *Journal of the American Oriental Society*, 74(1):6–17.
- Eleanor Robson. 2002. [Words and pictures: New light on plimpton 322](#). *The American Mathematical Monthly*, 109(2):105–120.

## A Example Appendix

- reproduce entire perceptron-full.eme in the text, without comments:

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*[The page contains dense vertical Chinese text arranged in columns.]*

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**THE**

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