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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".



test

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 newly discovered cuneiform tablet preserves the mechanism for performing simple neural network calculations. These calculations, it seems, were used to calculate the lengths of triangles; a well known exercise preserved on the tablet known as Plimpton 322¹. It is remarkably that no historian of math or cuneiform scholar has ever consider this possibility. This paper presents the story of discovery, a description of the cuneogramming language, and includes a facsimile copy of the important tablet as an appendix.




2 Discovery



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
















¹And 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.²

3 Description of the Language

Programs in  follow a tabular structure with three main sections: (i) a header, denoted by 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 ). 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  denoting the radix point which separates the integer part from a following fraction. There is an explicit representation for zero (), making these tablets some of the earliest unambiguous examples of the mathematical concept of zero.

A register address is denoted by the phrase NID₂.KAS₇ *n*-KAM *n* ("thing.account *n*-th", "the item in the *n*-th place"), where *n* is any number.  expressions can be nested to perform a kind of pointer dereferencing: for example, if  (register 1) contains the value  (3), and  (register 3) contains the value  (7), then  will evaluate to 7 (the value in the register pointed to by ).

²github.com/MrLogarithm/emeszida

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 50×2 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 60×60 , 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.

4 Description of the Texts

The Sealand corpus contains numerous fragments implementing recognizable procedures such as bit-shifting, populating an array, computing dot products, and so on. However, only a single text is known to have been preserved in its entirety.³ Spanning close to 1700 lines, this impressive text is divided into five sections implementing what modern readers will immediately recognize to be a multi-layer perceptron. The first section straightforwardly defines a matrix-multiplication subroutine. This is called by a subroutine defined in section two, which applies each layer of the perceptron to a given input, and applies a ReLU-style activation between each pair of layers. Section three implements the tablet’s “main” method, which loads an input to memory, calls the perceptron subroutine, and prints the resulting

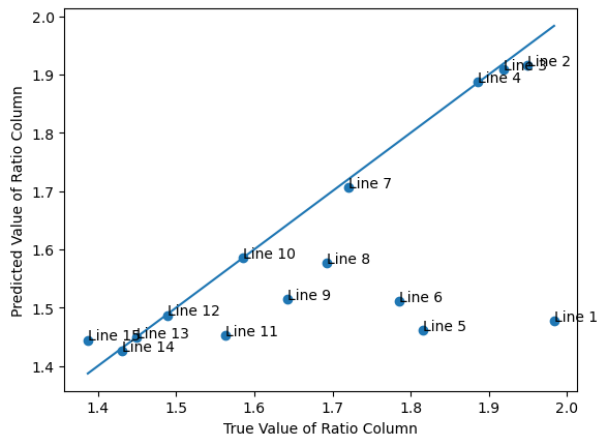


Figure 1

output. Section four loads the model parameters, which appear to comprise weight matrices of sizes 50×2 , 25×50 , and 1×25 , plus bias vectors of sizes 50, 25, and 1 respectively. The final section lists pairs of inputs, whose values (incredibly!) correspond to the second and third columns of Plimpton 322.

When the program is executed, it produces a single numeric output for each input pair. These outputs correspond remarkably closely to the values in the first column of Plimpton 322, as demonstrated in Figure ???. The correspondence is not perfect, however, and the values which should match lines 1, 5, and 6 of Plimpton 322 are significantly larger than expected. This implies that, although the code on this tablet is clearly *related* to Plimpton 322, it could not have been used to directly populate the table in that text. Perhaps the outputs from this model were refined in some later step to produce the more exact ratios in the Plimpton text, or perhaps the Babylonians were disillusioned by the imprecision of their machine learning models and simply abandoned them for tried-and-true manual methods. Given how miniscule the cuneigramming corpus is relative to the larger body of Babylonian administrative writing, we lean towards the latter explanation.

5 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

³All of the known texts are reproduced in github.com/MrLogarithm/emeszida/tree/main/programs

of ancient programming traditions.

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

Acknowledgments

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:

Figure 1	Figure 2	Figure 3

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