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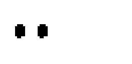
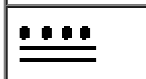
The Mayan Number System

The Mayan number system dates back to the fourth century and was approximately 1,000 years more advanced than the Europeans of that time. This system is unique to our current decimal system, which has a base 10, in that the Mayan's used a vigesimal system, which had a base 20. This system is believed to have been used because, since the Mayan's lived in such a warm climate and there was rarely a need to wear shoes, 20 was the total number of fingers and toes, thus making the system workable. Therefore two important markers in this system are 20, which relates to the fingers and toes, and five, which relates to the number of digits on one hand or foot.

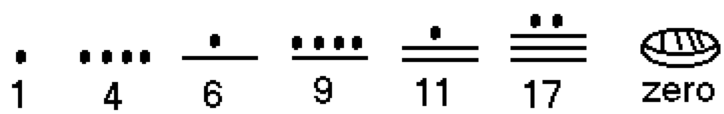
The Mayan system used a combination of two symbols. A dot (.) was used to represent the units (one through four) and a dash (-) was used to represent five. It is thought that the Mayan's may have used an abacus because of the use of their symbols and, therefore, there may be a connection between the Japanese and certain American tribes (Ortenzi, 1964). The Mayan's wrote their numbers vertically as opposed to horizontally with the lowest denomination on the bottom. Their system was set up so that the first five place values were based on the multiples of 20. They were 1 (20^0), 20 (20^1), 400 (20^2), 8,000 (20^3), and 160,000 (20^4). In the Arabic form we use the place values of 1, 10, 100, 1,000, and 10,000. For example, the number 241,083 would be figured out and written as follows:

Mayan	Place Value	Decimal Value

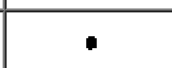
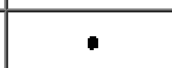
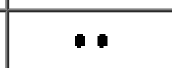
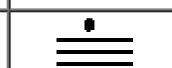
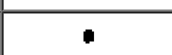
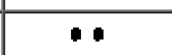
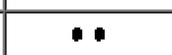
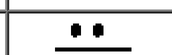
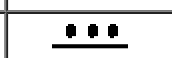
Numbers		
	1 times 160,000	= 160,000
	10 times 8,000	= 80,000
	2 times 400	= 800
	14 times 20	= 80
	3 times 1	= 3

This number written in Arabic would be 1.10.2.14.3 (McLeish, 1991, p. 129).

The Mayan's were also the first to symbolize the concept of nothing (or zero). The most common symbol was that of a shell ( ) but there were several other symbols (e.g. a head). It is interesting to learn that with all of the great mathematicians and scientists that were around in ancient Greece and Rome, it was the Mayan Indians who independently came up with this symbol which usually meant completion as opposed to zero or nothing. Below is a visual of different numbers and how they would have been written:



In the table below are represented some Mayan numbers. The left column gives the decimal equivalent for each position of teh Mayan number. Remember the numbers are read from bottom to top. Below each Mayan number is its decimal equivalent.

8,000						
400						
20						
units						
	20	40	445	508	953	30,414

It has been suggested that counters may have been used, such as grain or pebbles, to represent the units and a short stick or bean pod to represent the fives. Through this system the bars and dots could be easily added together as opposed to such number systems as the Romans but, unfortunately, nothing of this form of notation has remained except the number system that relates to the Mayan calendar.

For further study: The 360 day calendar also came from the Mayan's who actually used base 18 when dealing with the calendar. Each month contained 20 days with 18 months to a year. This left five days at the end of the year which was a month in itself that was filled with danger and bad luck. In this way, the Mayans had invented the 365 day calendar which revolved around the solar system.

Contributed by Mikelle Mercer

References.

1. McLeish, J. (1991). The story of numbers. New York, NY: Fawcett Columbine.
2. Ortenzi, E. C. (1964). Numbers in ancient times. Portland, ME: J. Weston Walch.
3. Roys, R. L. (1972). The Indian background of colonial Yucatan. Norman, OK: University of Oklahoma Press.
4. Thompson, J. E. S. (1967). The rise and fall of Maya civilization. Norman, OK: University of Oklahoma Press.
5. Trout, L. (1991). The Maya. New York, NY: Chelsea House Publishers.

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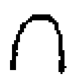
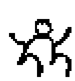
The Egyptian Number System

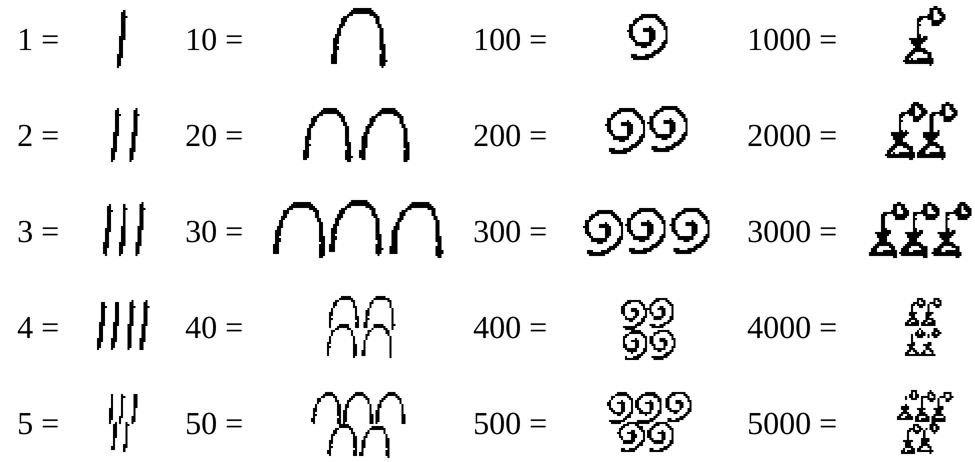
How do we know what the Egyptian language of numbers is? It has been found on the writings on the stones of monument walls of ancient time. Numbers have also been found on pottery, limestone plaques, and on the fragile fibers of the papyrus. The language is composed of heiroglyphs, pictorial signs that represent people, animals, plants, and numbers.

The Egyptians used a written numeration that was changed into hieroglyphic writing, which enabled them to note whole numbers to 1,000,000 . It had a decimal base and allowed for the additive principle. In this notation there was a special sign for every power of ten. For I, a vertical line; for 10, a sign with the shape of an upside down U; for 100, a spiral rope; for 1000, a lotus blossom; for 10,000 , a raised finger, slightly bent; for 100,000 , a tadpole; and for 1,000,000, a kneeling genie with upraised arms.

Decimal Number	Egyptian Symbol	
1 =		staff
10 =		heel bone
100 =		coil of rope
1000 =		lotus flower
10,000 =		pointing finger
100,000 =		tadpole
1,000,000 =		astonished man

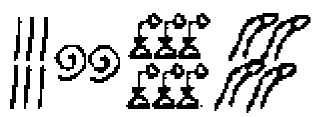
This hieroglyphic numeration was a written version of a concrete counting system using material objects. To represent a number, the sign for each decimal order was repeated as many times as necessary. To make it easier to read the repeated signs they were placed in groups of two, three, or four and arranged vertically.

Example 1.

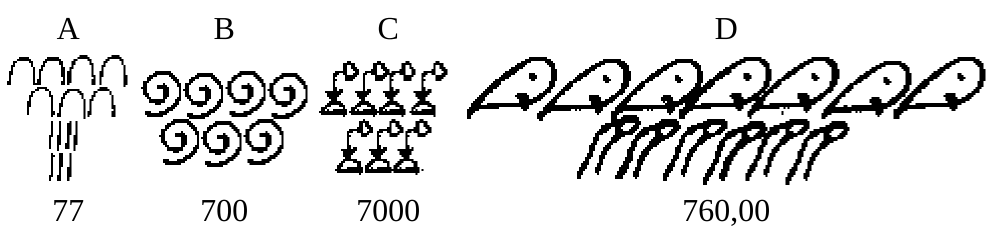


In writing the numbers , the largest decimal order would be written first. The numbers were written from right to left.

Example 2.

46,206 = 

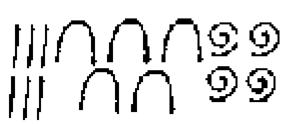
Below are some examples from tomb inscriptions.



Addition and Subtraction

The techniques used by the Egyptians for these are essentially the same as those used by modern mathematicians today.The Egyptians added by combining symbols. They would combine all the units (|) together, then all of the tens (∩) together, then all of the hundreds (∩), etc. If the scribe had more than ten units (|), he would replace those ten units by ∩. He would continue to do this until the number of units left was les than ten. This process was continued for the tens, replacing ten tens with ၅ , etc.

For example, if the scribe wanted to add 456 and 265, his problem would look like this


(= 456)


(= 265)

The scribe would then combine all like symbols to get something like the following

He would then replace the eleven units () with a unit () and a ten (). He would then have one unit and twelve tens. The twelve tens would be replaced by two tens and one one-hundred. When he was finished he would have 721, which he would write as

Subtraction was done much the same way as we do it except that when one has to borrow, it is done with writing ten symbols instead of a single one.

Multiplication

Egyptians method of multiplication is fairly clever, but can take longer than the modern day method. This is how they would have multiplied 5 by 29

*1	29
2	58
*4	116
1 + 4 = 5	29 + 116 = 145

When multiplying they would began with the number they were multiplying by 29 and double it for each line. Then they went back and picked out the numbers in the first column that added up to the first number (5). They used the distributive property of multiplication over addition.

$$29(5) = 29(1 + 4) = 29 + 116 = 145$$

Division

The way they did division was similar to their multiplication. For the problem 98/7 , they thought of this problem as 7 times some number equals 98. Again the problem was worked in columns.

1	7
2	*14
4	*28
8	*56
2 + 4 + 8 = 14	14 + 28 + 56 = 98

This time the the numbers in the right-hand column are marked which sum to 98 then the corresponding numbers in the left-hand column are summed to get the quotient.
So the answer is 14. 98 = 14 + 28 + 56 = 7(2 + 4 + 8) = 7*14

Contributed by Lloyd Holt

References:

1. Boyer, Carl B. - A History of Mathematics, John Wiley, New York 1968
2. Gillings, Richard J. - Mathematics in the Time of the Pharaohs, Dover, New York, 1982
3. Jason Gilman, David Slavit, - Ancient Egyptian Mathematics., Washington State University, 1995

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The Greek Number System

The Greek numbering system was uniquely based upon their alphabet. The Greek alphabet came from the Phoenicians around 900 B.C. When the Phoenicians invented the alphabet, it contained about 600 symbols. Those symbols took up too much room, so they eventually narrowed it down to 22 symbols. The Greeks borrowed some of the symbols and made up some of their own. But the Greeks were the first people to have separate symbols, or letters, to represent vowel sounds. Our own word "alphabet" comes from the first two letters, or numbers of the Greek alphabet -- "alpha" and "beta." Using the letters of their alphabet enabled them to use these symbols in a more condensed version of their old system, called Attic. The Attic system was similar to other forms of numbering systems of that era. It was based on symbols lined up in rows and took up a lot of space to write. This might not be to bad, except that they were still carving into stone tablets, and the symbols of the alphabet allowed them to stamp values on coins in a smaller, more condensed version.

Attic symbols

𐅅	=	500
Η	=	100
Δ	=	10
Γ	=	5
Ι	=	1

For example, 𐅅ΗΗΗΔΔΔΔΓΙΙΙΙ represented the number 849

The original Greek alphabet consisted of 27 letters and was written from the left to the right. These 27 letters make up the main 27 symbols used in their numbering system. Later special symbols, which were used only for mathematics vau, koppa, and sampi, became extinct. The New Greek alphabet nowadays uses only 24 letters.

1	α	alpha	10	ι	iota	100	ρ	rho
2	β	beta	20	κ	kappa	200	σ	sigma
3	γ	gamma	30	λ	lambda	300	τ	tau
4	δ	delta	40	μ	mu	400	υ	upsilon
5	ϵ	epsilon	50	ν	nu	500	ϕ	phi
6	ϛ	vau*	60	ξ	xi	600	χ	chi
7	ζ	zeta	70	ο	omicron	700	ψ	psi
8	η	eta	80	π	pi	800	ω	omega
9	θ	theta	90	ϟ	koppa*	900	ϡ	sampi

*vau, koppa, and sampi are obsolete characters

If you notice, the Greeks did not have a symbol for zero. They could string these 27 symbols together to represent any number up to 1000. By putting a comma in front of any symbol in the first row, they could now write any number up to 10,000.

Here are representations for 1000, 2000 and the number we gave above 849.

, α = 1000 , β = 2000 etc. ωμθ = 849

This works great for smaller numbers, but what about larger numbers? Here the Greeks went back to the Attic System, and used the symbol M for 10,000. And used multiples of 10,000 by putting symbols above M.

Mωμθ = 10,849

,ζρoε
M ,εωoε = 71,755,875

Contributed by Erik Sorum

References:

Burton, David M. The History of Mathematics - An Introduction. Dubuque, Iowa: William C. Brown, 1988.

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The Babylonian Number System

The Babylonians lived in Mesopotamia, which is between the Tigris and Euphrates rivers. They began a numbering system about 5,000 years ago. It is one of the oldest numbering systems. The first mathematics can be traced to the ancient country of Babylon, during the third millennium B.C. Tables were the Babylonians most outstanding accomplishment which helped them in calculating problems.

One of the Babylonian tablets, Plimpton 322, which is dated from between 1900 and 1600 BC, contains tables of Pythagorean triples for the equation $a^2 + b^2 = c^2$. It is currently in a British museum.

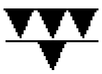
Nabu - rimanni and Kidinu are two of the only known mathematicians from Babylonia. However, not much is known about them. Historians believe Nabu - rimanni lived around 490 BC and Kidinu lived around 480 BC.

The Babylonian number system began with tally marks just as most of the ancient math systems did. The Babylonians developed a form of writing based on cuneiform. Cuneiform means "wedge shape" in Latin. They wrote these symbols on wet clay tablets which were baked in the hot sun. Many thousands of these tablets are still around today. The Babylonians used a stylist to imprint the symbols on the clay since curved lines could not be drawn.

The Babylonians had a very advanced number system even for today's standards. It was a base 60 system (sexigesimal) rather than a base ten (decimal). Base ten is what we use today.

The Babylonians divided the day into twenty-four hours, each hour into sixty minutes, and each minute to sixty seconds. This form of counting has survived for four thousand years.

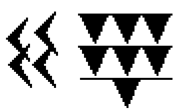
Any number less than 10 had a wedge that pointed down.

Example: 4 

The number 10 was symbolized by a wedge pointing to the left.

Example: 20 

Numbers less than 60 were made by combining the symbols of 1and 10.

Example: 47 

As with our numbering system, the Babylonian numbering system utilized units, ie tens, hundreds, thousands.

Example: 64 

However, they did not have a symbol for zero, but they did use the idea of zero. When they wanted to express zero, they just left a blank space in the number they were writing.

When they wrote "60", they would put a single wedge mark in the second place of the numeral.

When they wrote "120", they would put two wedge marks in the second place.

Following are some examples of larger numbers.

Example: 79883

$(22*602^2)+(11*60)+23$

Example: 5220062

$(24*60^3) + (10*60^2) + (1*60) + 2$

Contributed by Jeremy Troutman

References:

1. URL:http://www-groups.dcs.st-and.ac.uk/~history/HistTopics/Babylonian_and_Egyptian.html 6-12-00 6:00 pm
2. URL:http://www.angelfire.com/il2/babylonianmath/mathematicians.html 6-12-00 6:00 pm
3. Boyer, Merzbach. A History of Mathematics. John Wiley & Sons, 1989. Second Edition.
4. Bunt, Jones, and Bedient. The Historical Roots of Elementary Mathematics. Dover Publications. 1988.

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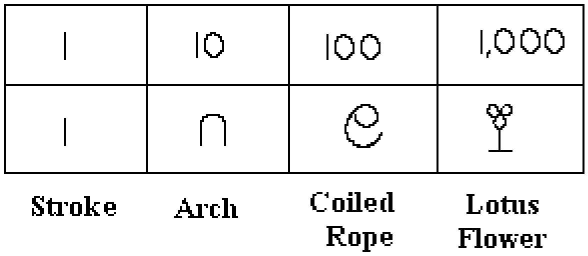
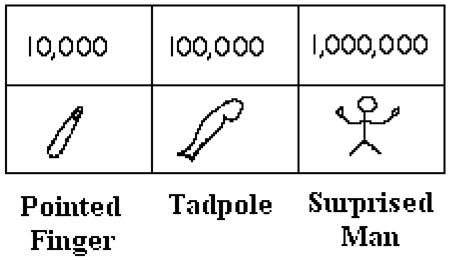
Where Did Numbers Originate?

Thousands of years ago there were no numbers to represent 'two' or 'three'. Instead fingers, rocks, sticks or eyes were used to represent numbers. There were neither clocks nor calendars to help keep track of time. The sun and moon were used to distinguish between 1 PM and 4 PM. Most civilizations did not have words for numbers larger than two so they had to use terminology familiar to them such as 'flocks' of sheep, 'heaps' of grain, or 'lots' of people. There was little need for a numeric system until groups of people formed clans, villages and settlements and began a system of bartering and trade that in turn created a demand for currency. How would you distinguish between five and fifty if you could only use the above terminology?

Paper and pencils were not available to transcribe numbers. Other methods were invented for means of communication and teaching of numerical systems. Babylonians stamped numbers in clay by using a stick and depressing it into the clay at different angles or pressures and the Egyptians painted on pottery and cut numbers into stone.

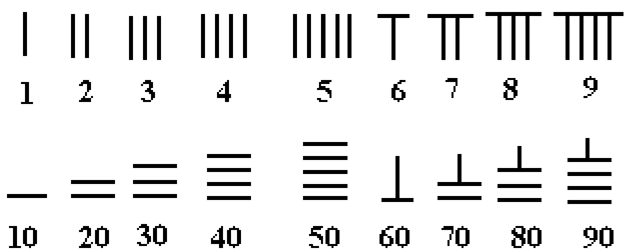
Numerical systems devised of symbols were used instead of numbers. For example, the Egyptians used the following numerical symbols:





From Esther Ortenzi, Numbers in Ancient Times. Maine:
J. Weston Walch, 1964, page 9.

The Chinese had one of the oldest systems of numerals that were based on sticks laid on tables to represent calculations. It is as follows:



From David Smith and Jekuthiel Ginsburg, Numbers and Numerals.
W. D. Reeve, 1937, page 11.

From about 450 BC the Greeks had several ways to write their numbers, the most common way was to use the first ten letters in their alphabet to represent the first ten numbers. To distinguish between numbers and letters they often placed a mark (/ or ') by each letter:

A′ B′ Γ′ Δ′ E′ F′ Z′ H′ Θ′

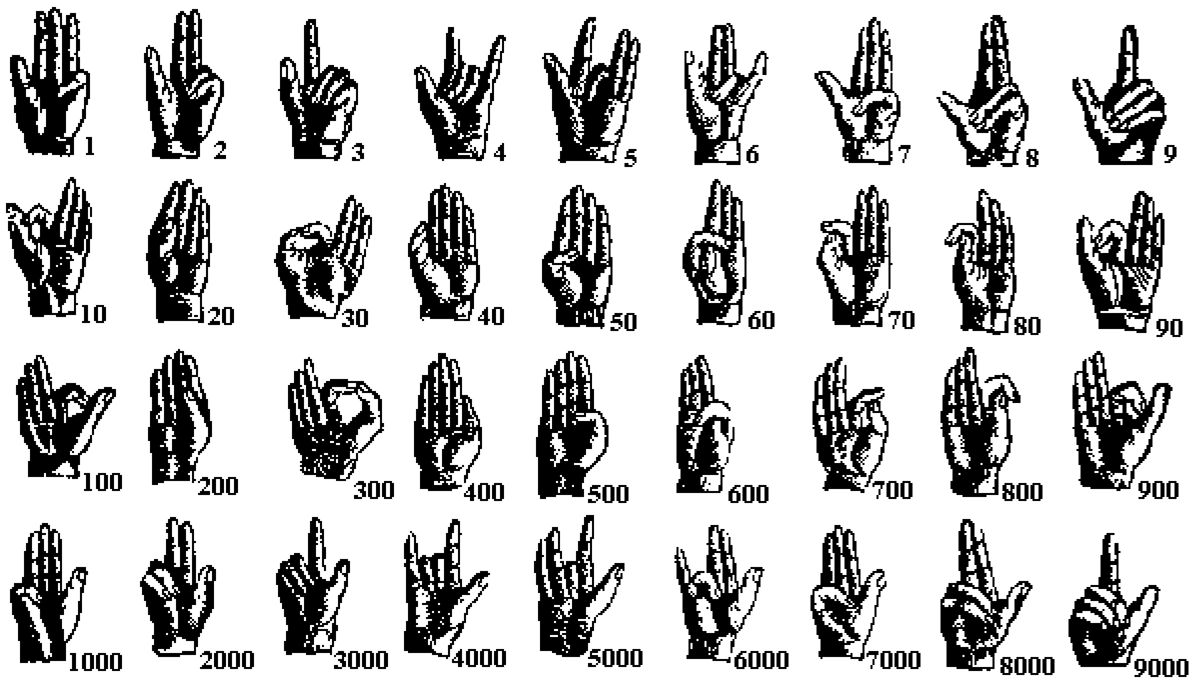
From David Smith and Jekuthiel Ginsburg, Numbers and Numerals.
W. D. Reeve, 1937, page 12.

The Roman numerical system is still used today although the symbols have changed from time to time. The Romans often wrote four as IIII instead of IV, I from V. Today the Roman numerals are used to represent numerical chapters of books or for the main divisions of outlines. The earliest forms of Roman numeral values are:

I	V	X	L	C	D	M
1	5	10	50	100	500	1000

From David Smith and Jekuthiel Ginsburg, Numbers and Numerals.
W. D. Reeve, 1937, page 14.

Finger numerals were used by the ancient Greeks, Romans, Europeans of the Middle Ages, and later the Asiatics. Still today you can see children learning to count on our own finger numerical system. The old system is as follows:



FINGER SYMBOLS
(From a manual published in 1520)

From Tobias Dantzig, Number: The Language of Science.
Macmillan Company, 1954, page 2.

From counting by means of 'flocks' to finger symbols our current numerical system has evolved from the Hindu numerals to present day numbers. The journey has taken us from 2400 BC to present day and we still use some of the old numerical systems and symbols. Our system of numerics is ever changing and who knows what it will look like in 2140 AD. Will we still count using our fingers or will mankind invent a new numerical tool?

Sanscrit letters of the 11. Century A.D.		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Apices of Boethius and of the Middle Ages	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8	9	[illegible]
Gubar-numerals of the West Arabs	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8	[illegible]	o
Numerals of the East Arabs	I	[illegible]	[illegible]	[illegible] or [illegible]	o or β	[illegible]	V	Λ	9	•
Numerals of Maximus Planudes.	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	V	Λ	9	o
Devangari-numerals.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	[illegible]	[illegible]	o
From the *Mirror of the World*, printed by Caxton, 1480	1	2	3	[illegible]	[illegible]	6	[illegible]	8	9	0
From the Bamberg Arithmetic by Wagner, 1488.	1	z	3 or 3	[illegible] or 4	[illegible] or 5	6	Λ or 7	8	9	0
From *De Arts Supp-urtandi* by Tonstall, 1522	1	2	3	4	5	6	7	8	9	10
This chart shows the change of numbers from their ancient to their present-day forms.										

This Chart was reconstructed from Esther Ortenzi, Numbers in Ancient Times.
Maine: J. Weston Walch, 1964, page 23.

Contributed by Carey Eskridge Lybarger

References:

1. David E. Smith and Jekuthiel Ginsburg. Numbers and Numerals. W. D. Reeves, 1937
2. Esther C. Ortenzi. Numbers in Ancient Times. J. Weston Walsh, 1964.
3. Tobias Dantzig. Number: The Language of Science. Macmillan Company, 1954.

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