Universal Multiplication Equation for Efficient and Faster Multiplication

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Abstract:

*In this paper, **"Universal Multiplication Equation"**- a new multiplication equation is proposed. This is called universal because of its wide application on all types of numbers. This works fine without any assumptions, no matter whatever the numbers are. It has evolved after continuous study on numbers; how the answers were generated, when different types of numbers underwent multiplication. Using the same equation, it has been proved why zero multiplied by any number is zero and why negative multiplied by negative is positive. This equation can be further used for fast mental calculations and calculations in competitive exams very efficiently. This can be also used in the field of math coprocessors in computers. Algorithms can be developed using this equation for faster multiplications in multiplier (FPGA's), reducing the processing time and power consumption hence increases the efficiency.*

Keywords: Universal Multiplication Equation, Multiplier, Algorithm, Coprocessor, FPGA (Field Programmable Gate Array).

Introduction:

We have been doing some of the things in our life since grade 1. Unfortunately we are unable to understand the origin of those basics. In fact we are just like the dumb driven cattle. One of those basic things is zero, which forms the foundation for mathematics. We have been using properties of zero in almost all applications in mathematics; for instance, zero multiplied by any number is zero. One more instance is, negative multiplied by negative is positive. Did we ever wonder why it is so? No, Never. We can prove all these after formulating "Universal Multiplication Equation". This equation is a universal equation for multiplication of all kinds of numbers. No matter whatever the numbers are; this equation works fine without any assumptions, which we usually do. This equation evolved after continuous study on numbers, how they occur when they undergo different types of multiplication [1, 2].

1.1 Universal Multiplication Equation:

The proposed equation is based on products that were formed when two numbers were multiplied. The relation was drawn into an equation. Secondly, the main advantage is that the whole multiplication process has been divided into two parts. This can be used to calculate mentally, more efficiently and faster [3]. There is a demand of increase in speed of processing in math coprocessor. This speed, power and area can be attained by developing an efficient architecture [4]. This can be only achieved by improvising the method of calculation.

To check the validity of this equation, firstly we will prove it by taking any two numbers. Later using this equation, we would prove why zero multiplied by any number is zero by taking one number as zero. We will also prove why negative multiplied by negative is positive by taking two negative numbers.

Universal Multiplication Equation consists of two sub equations. They are:

$$X - (10^{n} - Y) \qquad (1)$$

$$[Y - \{X - (10^{n} - Y)\}][\{10^{n} - Y\}] \qquad (2)$$

To solve multiplication using this Equation, some set of rules must be followed which is common for multiplication of all types of numbers.

1. X and Y are the two numbers to be multiplied.

   Example →you want to multiply

   988×982

   Here X=982

   Y=988

2. Y should be greater than or equal to X (Y≥X).
3. 10^{n} is known as the reference number.
4. ‘n’ is the number of digits in Y.

   Example →In the above example

   n=3 since there are 3 digits in Y.

5. ‘n’ has to be the same throughout the equation.
6. This calculation is divided into two parts.
7. Substitute the values of X and Y in Eq. (1) and Eq. (2).
8. To get the final answer, write the answer, which you get from Eq. (1) followed by the answer, which you get from Eq. (2).

   Example →you get the answer as 970 from Eq. (1) and 216 from Eq. (2). Therefore, the final answer is 970216.

9. Number of digits in the answer, which you get from Eq. (2) should be equal to ‘n’. This case is being illustrated through examples.

➢ 826×996

Here X=826

Y=996

n=3

Substituting the values of X and Y in Eq. (1).

$$X-(10^{n}-Y)$$

$$= 826-(10^{3}-996)$$
$$= 826-(1000-996)$$
$$= 826-4$$
$$= 822$$

We get the answer as 822.

Substituting the values of X and Y in Eq. (2).

$$[Y-\{X-(10^{n}-Y)\}][\{10^{n}-Y\}]$$

$$= [996-\{826-(10^{3}-996)\}][\{10^{3}-996\}]$$

$$= [996-\{826-(1000-996)\}][\{1000-996\}]$$

$$= [996-\{826-4\}]\ 4$$

$$= [996-822]4$$

$$= 174\times4$$

$$= 696$$

We get the answer as 696.

To get the final answer, club both the answers.

Therefore, the final answer is <u>822696</u>.

➢ 9928×9992

Here X=9928

Y=9992

n=4

Substituting the values of X and Y in Eq. (1).

$$X-(10^{n}-Y)$$

$$= 9928-(10^{4}-9992)$$
$$= 9928-(10000-9992)$$
$$= 9928-8$$
$$= 9920$$

We get the answer as 9920.

Substituting the values of X and Y in Eq. (2).

$$[Y-\{X-(10^{n}-Y)\}][\{10^{n}-Y\}]$$

$$= [9992-\{9928-(10^{4}-9992)\}][\{10^{4}-9992\}]$$

$$= [9992-\{9928-8\}]\ 8$$
$$= [9992-9920]8$$
$$= 72\times8$$

$= 576$

We get the answer as 576.

(Point no.9 is being illustrated here)

NOTE: There should be ‘n’ number of digits in the answer obtained from Eq. (2). If it is less than ‘n’, so many zeroes are added to the left of the answer.

Here the answer obtained from Eq. (2) is 576 but n=4, so without affecting the answer, we add one zero to the Left of the answer obtained from Eq. (2). So the answer is 0576.

Therefore, the final answer is 99200576.

- 654×789

  Here X=654

  Y=789

  n=3

Substituting the values of X and Y in Eq. (1).

$$X-(10^{n}-Y)$$
$$= 654-(10^{3}-789)$$
$$= 654-(1000-789)$$
$$= 654-211$$
$$= 443$$

We get the answer as 443.

Substituting the values of X and Y in Eq. (2).

$$[Y-\{X-(10^{n}-Y)\}][\{10^{n}-Y\}]$$

$$= [789-\{654-(10^{3}-789)\}][\{10^{3}-789\}]$$

$$= [789-\{654-(1000-789)\}][\{1000-789\}]$$

$$= [789-\{654-211\}]\ 211$$
$$= [789-443]\ 211$$
$$= 346\times 211$$
$$= 73006$$

We get the answer as 73006.

(Point no.9 is being illustrated here)

NOTE: There should be ‘n’ number of digits in the answer obtained from Eq. (2). If it is more than ‘n’, then the extra digits from the left are added to the answer obtained from Eq. (1).

Here the answer obtained from Eq. (2) is 73006 but n=3, so we add 73 to 443 which is equal to 516.

443 ↕ 73 006
↓
Extra digits

443 ↕ 006
+73
516 ↕ 006

516006

Therefore, the final answer is 516006.

1.2 Why is zero multiplied by any number is zero?

Let us try with a small number.

- 0×8

Here X=0

Y=8

n=1

Substituting the values of X and Y in Eq. (1).

$$X-(10^{n}-Y)$$
$$=0-(10^{1}-8)$$
$$=0-(10-8)$$
$$=0-2$$
$$=-2$$

We get the answer as –2.

Substituting the values of X and Y in Eq. (2).

$$[Y-\{X-(10^{n}-Y)\}][\{10^{n}-Y\}]$$

$$=[8-\{0-(10^{1}-8)\}][\{10^{1}-8\}]$$
$$=[8-\{0-(10-8)\}][\{10-8\}]$$
$$=[8-\{0-2\}]\,2$$
$$=[8-\{-2\}]\,2$$
$$=[8+2]\,2$$
$$=10\times 2$$
$$=20$$

We get the answer as 20.

(Point no.9 is being illustrated here)

NOTE: There should be 'n' number of digits in the answer obtained from Eq. (2). If it is more than 'n', then the extra digits from the left are added to the answer obtained from Eq. (1).

Here the answer obtained from Eq. (2) is 20 but n=1, so we add 2 to –2which is equal to 0.

$$-2 \;\updownarrow\; \underline{2}\;0$$

$\downarrow$

Extra digit

$$\begin{array}{r}-2\\ \underline{+2}\\ 0\end{array}\quad\begin{array}{c}\updownarrow\\ \\ \updownarrow\end{array}\quad\begin{array}{c}0\\ \\ 0\end{array}$$

= 00

Therefore, the final answer is 0!

1.3 Why negative multiplied by negative is positive?

Let us try with small numbers.

- -2×-4

Here X= -4

Y= -2

n=1

Substituting the values of X and Y in Eq. (1).

$X-(10^n-Y)$

$= -4-\{10^1-(-2)\}$

$= -4-(10+2)$

$= -4-12$

$= -16$

We get the answer as –16.

Substituting the values of X and Y in Eq. (2).

$[Y-\{X-(10^n-Y)\}][\{10^n-Y\}]$

$= [-2-\{-4-(10^1-(-2))\}][\{10^1-(-2)\}]$

$= [-2-\{-4-(10-(-2))\}][\{10-(-2)\}]$

$= [-2-\{-4-(10+2)\}][\{10+2\}]$

$= [-2-\{-4-12\}]\ 12$

$= [-2-\{-16\}]\ 12$

$= [-2+16]\ 12$

$= -14\times 12$

$= -168$

We get the answer as –168.

(Point no.9 is being illustrated here)

<u>NOTE</u>: There should be 'n' number of digits in the answer obtained from Eq. (2). If it is more than 'n', then the extra digits from the left are added to the answer obtained from Eq. (1).

Here the answer obtained from Eq. (2) is –168 but n=1, so we add –16 to 16 which is equal to 0.

$16 \updownarrow \underset{\substack{\downarrow\\ \text{Extra digit}}}{\underline{-16}}\ 8$

$16 \updownarrow\ 8$

$\underline{-16}$

$0 \updownarrow\ 8$

$= 08$

Therefore, the final answer is 8!

So you might be thinking that to prove

(—) × (—) is (+), we used the fact that

(—) x (—) is (+). We are not violating the rule. Using this fact, we are proving the fact ultimately.

Even now if it is not satisfied, $X-(10^n-Y)$ can be written as $X+Y-10^n$ and substitute this in place of $X-(10^n-Y)$, answer remains the same!

Here the main advantage is that the single calculation has been divided into two parts. We can use this advantage for cross checks.

Suppose in exams, where we have objective type questions and we get a question where we need to multiply two numbers. No matter whether its chemistry, physics, mathematics, accounts etc. Maths is applicable throughout the domain because Maths is the queen of all sciences.

We can do any one part and compare the answer obtained with the options given.

Example → we come across a question where you need to multiply

8564×9544

Ultimately, you have the options as:

a) 48694816 b) 87173481

c) 81734813 d) 81734816

Here both the numbers are ending with 4, and 4×4 can never end with 3 or 1. Therefore, options b) and c) are ruled out.

Here X=8564

Y=9544

n=4

Substituting the values of X and Y in Eq. (1).

$$X-(10^{n}-Y)$$

$$= 8564-(10^{4}-9544)$$

$$= 8564-(10000-9544)$$

$$= 8564-456$$

$$= 8108$$

So check the option starting with 81. So option a) is ruled out. Hence option d) is the right answer!

Here it is not necessary to do the second part of the equation. Once we get used to this equation, It is not necessary to substitute the numbers instead we can do it mentally. By using this method we can solve calculations in competitive exams in flawlessly within no time.

Results:

We could prove many facts using the proposed equation like why zero multiplied by any number is zero, negative multiplied by negative is positive. We saw that any kind of multiplication could be done using this equation. Similarly this equation can be used to multiply fraction, method remains to be the same. We have even seen how this method can be used efficiently in competitive exams.

Conclusion:

It can be concluded that the "Universal multiplication equation" is an efficient method of multiplication because there is no equation to multiply two numbers. We generally multiply numbers using traditional method which is time consuming and there are chances of making mistakes unlike this equation. The main advantage of this method is that the whole of multiplication is divided into two parts, hence chances of making mistakes is less. Not only in the field of calculation but also in the field of math coprocessor, it has a wide application for its efficiency. Results can be synthesised by using this method and can be compared with the results of array multiplier and booth multiplier [5]. This equation should be used developed for different applications for faster and efficient output.

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