IBRAHITHM:New effective and flexible Algorithm for the division of numbers and polynomials

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Abstract

For a long time we study the long division of numbers and polynomials and perform it from left to right as we know . In this paper we introduce new flexible and effective manual method for the division of numbers and polynomials which perform from right to left which we call it " IBRAHITHM Division" . The method is easy and it has done without any problems when we divide numbers on an odd number except five and its multiplies . But we have some obstacles when we divide numbers by even numbers or a number five and its multiplies in the decimal system . The method can be use for all number systems such as decimal, binary , octal and hexadecimal Systems . Also we use this method to divide numbers with decimal fractions . We can use it to find the square roots of numbers. Finally we have built IBRAHITHM polynomial division and IBRAHITHM synthetic division. Our method here is characterized by the fact that it performs division and test the divisibility at the same time.Finally we introduce the relation between the standard algorithm division method and IBRAHITHM division method .

Keywords and phrases: long division , Binary , Octal and Hexadecimal Systems, polynomial division,square roots

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1 Introduction and Preliminaries

The traditional long division algorithm is one familiar example that many students find particularly difficult to per-form with understanding. Some features of the traditional long division algorithm create more difficulties for students than any of the other algorithms for basic operations.[3]
The design of teacher education curricula or professional development interventions is founded on a conception that individual teacher's knowledge of mathematics teaching impacts their practice.[6]

Division is the opposite of multiplying. Division is one of the four basic operations of arithmetic, the ways that numbers are combined to make new numbers. The other operations are addition, subtraction, and multiplication (which can be viewed as the inverse of division). The division with remainder or Euclidean division of two natural numbers provides a quotient, which is the number of times the second one is contained in the first one, and a remainder, which is the part of the first number that remains, when in the course of computing the quotient, no further full chunk of the size of the second number can be allocated. All forms of division appear in various algebraic structures. Those in which a Euclidean division (with remainder) is defined are called Euclidean domains and include polynomial rings in one indeterminate . Those in which a division by all nonzero elements is defined are called fields and division rings. In a ring the elements by which division is always possible are called the units . Another generalization of division to algebraic structures is the quotient group, in which the result of 'division' is a group rather than a number.

Some previous manual division methods is often introduced through the notion of ”sharing out” a set of objects, for example a pile of lollies, into a number of equal portions. Distributing the objects several at a time in each round of sharing to each portion leads to the idea of ”chunking” — a form of division where one repeatedly subtracts multiples of the divisor from the dividend itself. By allowing one to subtract more multiples than what the partial remainder allows at a given stage, more flexible methods, such as the bidirectional variant of chunking, can be developed as well. More systematic and more efficient , a person who knows the multiplication tables can divide two integers with pencil and paper using the method of short division, if the divisor is small, or long division, if the divisor is larger. If the dividend has a fractional part (expressed as a decimal fraction), one can continue the algorithm past the ones place as far as desired. If the divisor has a fractional part, one can restate the problem by moving the decimal to the right in both numbers until the divisor has no fraction. A person can calculate division with an abacus by repeatedly placing the dividend on the abacus, and then subtracting the divisor the offset of each digit in the result, counting the number of divisions possible at each offset. A person can use logarithm tables to divide two numbers, by subtracting the two numbers' logarithms, then looking up the antilogarithm of the result. A person can calculate division with a slide rule by aligning the divisor on the C scale with the dividend on the D scale. The quotient can be found on the D scale where it is aligned with the left index on the C scale. The user is responsible, however, for mentally keeping track of the decimal point.

For a long time we study the long division of numbers and polynomials and perform it from left to right as we know . In this paper we introduce new flexible and effective manual method for the division of numbers and polynomails which perform from right to left .My method here is characterized by the fact that it performs division and test the divisibility at the same time.The method is effective and flexible when we divide numbers on an odd number except five and its multiplies . But we have some difficult when we divide numbers by even numbers or a number five and its multiplies in the decimal system . . The method can be use for all number systems such as Binary , Octal and Hexadecimal Systems . Moreover this new method is suitable for polynomial division.Finally we introduce some applications .
We call this new method “IBRAHITHM division” . The name has the same naming pattern as the known algorithm in order to attract attention to this new method that runs parallel the known standard algorithm division .
We have long been dealing and studying long division. One of the rules that we grew up with and that our students raise on them also is that division cannot take place from right to left. I think it is time for you to change this thinking when you read this paper. My method here is very flexible and wonderful and may be the great alternative to all kinds of division known and found so far.

It suffices to say that it is indispensable to write a marginal multiplication table for the divisor as it is known in the long division used to this day.
Moreover we know that there is many ways to test the divisibility of some numbers. But how do you do with the rest of the other numbers?. One of the advantages of my method here is that it strikes two birds with one stone, as we use it to test the divisibility and perform the division process for numbers simultaneously.
I hope that the method will be accepted by the mathematics community. I also hope that researchers interested in the topic will solve problems in the method and give more study and attention.
Now, we reminded here the previously well known standard algorithm division theorem .

Theorem 1. *(Division Algorithm) Given any strictly positive integer d and any integer a, there exist unique integers q and r such that $a = qd + r$,and $0 \leq r \leq d$.*

The paper is divided into the following sections :

IBRAHITHM Division method

Using IBRAHITHM Division to divide numbers by an odd number .
Using IBRAHITHM Division to divide numbers by an even number .
Using IBRAHITHM Division to converting fractions numbers to decimals numbers
Using IBRAHITHM Division to divide numbers with decimal fractions
Using IBRAHITHM Division to divide Binary numbers
Using IBRAHITHM Division to divide Octal numbers
Using IBRAHITHM Division to divide Hexadecimal numbers
Using IBRAHITHM Division to find the square root of numbers
IBRAHITHM polynomial division
IBRAHITHM synthetic division
The Relation between Standerd ALGORITHM division method and IBRAHITHM division method

2 IBRAHITHM Division method

In this section we will introduce the general IBRAHITHM Division method of dividing real numbers or polynomials.We will use the symbol $x * y$ to express the regular multiplication of x and y , while we use the symbol xy to means that y is the Ones-digit of the number xy .

Theorem 2. ***(IBRAHITHM Division method)***

Let x_1 and d are integer numbers . we can divide the dividend x_1 on a divisor d by the following steps :

Step 1 : *choose an integer number q_n such that $q_n * d = m_1$.*
Step 2 : *subtract m_1 from x_1 to get an another integer say " $h_1 = x_2r_n$.*
Step 3 : *drop the ones of h_1 (say it r_n) to get an another integer say " x_2".*
Step 4 : *choose q_{n-1} such that $q_{n-1} * d = m_2$*
Step 5 : *subtract m_2 from x_2 to get an another integer say " $h_2 = x_3r_{n-1}$.*
Step 6 : *drop the ones of h_2 (say it r_{n-1}) to get an another integer say " x_3".*
Step 7 : *repeat the first three steps again and continue .*
Now we have two series $q_n, q_{n-1}, ...q_1$ and $r_n, r_{n-1}, ...r_1$ such that

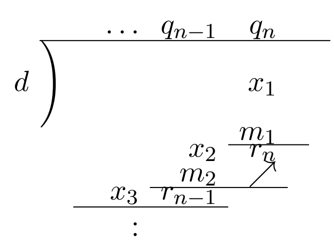
$$x_1 = d * Q_1 + R_1$$

where the quotient $Q_1 = q_1q_2...q_n$ and the remainder $R_1 = r_1r_2r_3.....r_n$ and we have two cases :
Case 1:
If the dropped numbers $\{r_1, r_2, ...r_n\}$ are all zeros then x_1 is divided by d .
Case 2: *If the dropped numbers $\{r_1, r_2, ...r_n\}$ are not all zeros we have to divide R_1 by d again by the previous method to get $R_1 = dQ_2 + R_2$. By continue by this method we have*

$$x_1 = d * Q_1 + R_1 = d * Q_1 + d * Q_2 + R_2 = d * Q_1 + d * Q_2 + d * Q_3 + ... + R_n$$

$$= d * (Q_1 + Q_2 + ...Q_n) + R_n = d * Q + R_n$$

where $Q = Q_1 + Q_2 + Q_3 + ... + Q_n$ is the quotient of x_1 on d and R_n is the remainder .



3 Using IBRAHITHM Division to divide numbers on an odd number

The method is simply that when dealing with odd numbers, we choose the suitable number which, if multiplied by the one's digit in divisor , give a number that begins with the one's digit of the dividend. For example, if the one's digit in dividend is 2, and the one's digit in divisor is 3, then the appropriate number here is 4 because when multiplying 4 by 3, it gives 12, which in turn begins with the number 2. The next step is to write the number 12 below the dividend and then subtract. Finally, we drop out first digit in the result , which in our case here is the number zero.We continue in this way and repeat the previous steps until we get the result of division.
In other words , we will build a special version of IBRAHITHM Division which suitable for all odd number except five and its multiplies in the following corollary .

Corollary 1. *Let the dividend be an integer number $X_1 = x_1x_2....x_{n_1}$ and the divisor is $Y = y_1y_2...y_n$ where both of x_{n_1} and y_n are the one's of X_1 and Y respectively . we can divide X_1 on Y by the following steps :*
Step 1 : *choose an integer number q_n such that $q_n * y_n = l_1x_{n_1} = m_1$.*
Step 2 : *subtract m_1 from X_1 to get an another integer say " h_1 " as follows :*

$$X_1 - m_1 = X_1 - l_1x_{n_1}$$

$$= x_1x_2....x_{n_1} - l_1x_{n_1} = x_1x_2....x_{n_2}0 = X_20 = h_1$$

Step 3 : *drop the ones "zero" of h_1 to get an another integer say " X_2".*
Step 4 : *choose q_{n-1} such that $q_{n-1} * y_n = l_2x_{n_2} = m_2$*
Step 5 : *subtract m_2 from X_2 to get an another integer say " h_2.*
Step 6 : *drop the ones "zero" of h_2 to get an another integer say " X_3".*
Step 7 : *repeat the first three steps again and continue .*
Now we have two series $q_n, q_{n-1}, ...q_1$ and $0, 0, ...r_1$ such that

$$X_1 = d * Q_1 + R_1$$

where the quotient $Q_1 = q_1q_2...q_n$ and the remainder $R_1 = r_1000...0$ and we have two cases :
Case 1:
If the dropped number r_1 is zero then X_1 is divide by d .
Case 2: *If the dropped number r_1 is not zero we have to divide R_1 on d again by the previous method to get $R_1 = d * Q_2 + R_2$. By continue by this method we have*

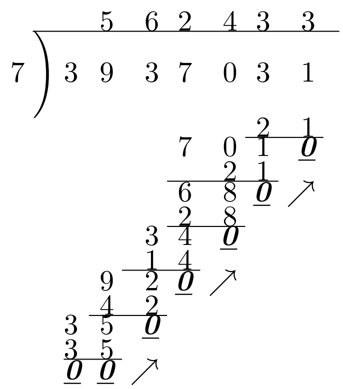
$$X_1 = d * Q_1 + R_1 = d * Q_1 + d * Q_2 + d * Q_3 + ... + R_n = d * Q + R_n$$

where $Q = Q_1 + Q_2 + Q_3 + ... + Q_n$ is the quotient of X_1 on d and R_n is the remainder .

$$\begin{array}{r|cccccc}
 & & & \cdots & q_{n-1} & q_n & \\ \hline
y_1y_2....y_n & x_1 & x_2 & & \cdots & x_{n_1} & \\
 & & & & l_1 & x_{n_1} & \\ \cline{4-7}
 & x_1 & & \cdots & x_{n_2} & 0 & \\
 & & & l_2 & x_{n_2} & & \nearrow \\ \cline{4-6}
 & & & \vdots & & &
\end{array}$$

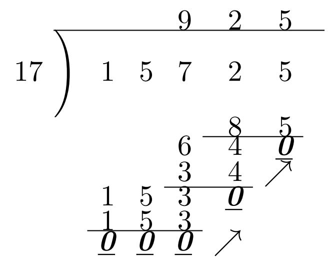
Remark 1. *It is worth noting here that this method is an adequate and easy way to test the divisibility of all odd numbers.*

Example 1.

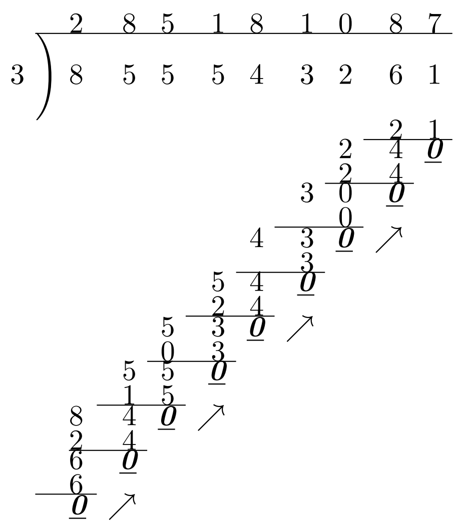


The quotient Q=562433 ,and with remainder R=0 .

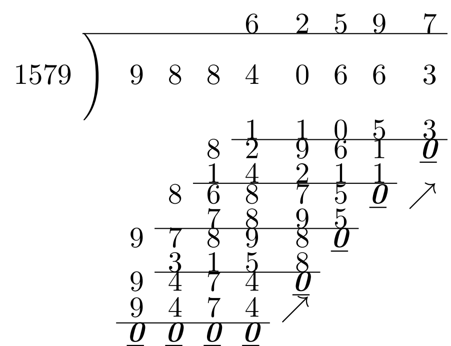
Example 2.



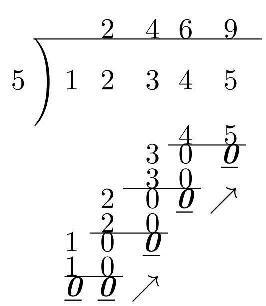
Example 3.



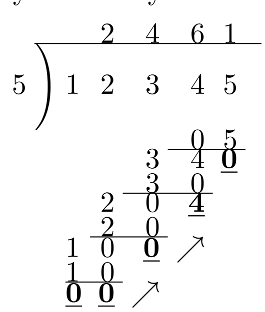
Example 4.



Example 5. *As we have said before , when we divide on five or its multiplies we can solve the division by many ways .*

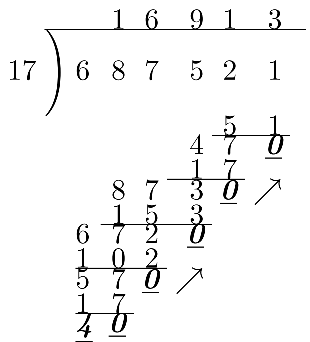


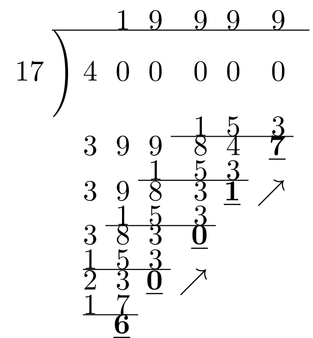
This example can be perform by many other ways. we will solve it by an another way as follows:

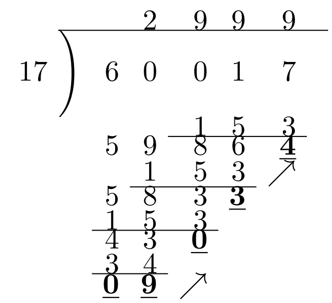


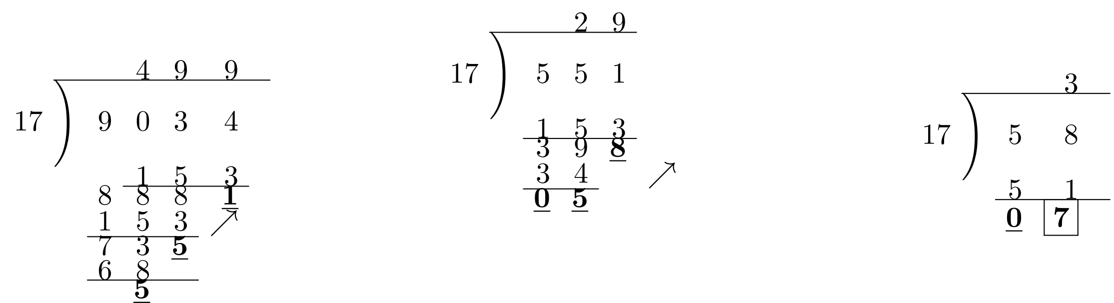
So the quotient is $Q_1 + Q_2 = 2461 + \frac{40}{5} = 2469$ and the remainder is 0 .

Example 6.







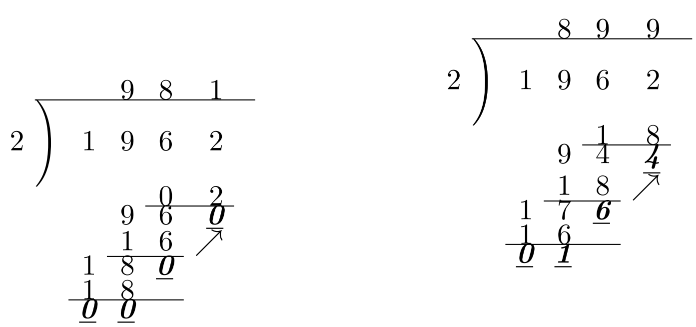


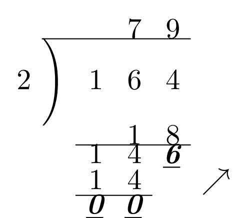
Then the quotient of 687521 on 17 is $Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 = 16913 + 19999 + 2999 + 499 + 29 + 3 = 40442$ with remainder $R = 7$.

4 Using IBRAHITHM Division to divide numbers on an even number

As we have said before , the dealing with even numbers has some difficults .This thing happens because every even number has two probabilities to give the first digit of dividend .For example , when we divide the number 23**4** on 2 ,we have two suitable numbers 7 and 2 in which we get the first digit 4.In others words , $2 * 2 = \mathbf{4}$ and $7 * 2 = 1\mathbf{4}$. But in general we can use the IBRAHITHM Division.

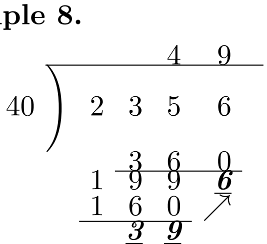
Example 7. *We will divide 1962 on 2 using IBRAHITHM Division method by two different ways .*

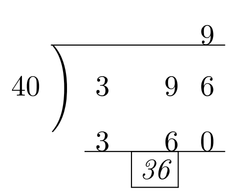




$Q = Q_1 + Q_2 + Q_3 = 899 + 79 + \frac{6}{2} = 981, R = 0$

Example 8.



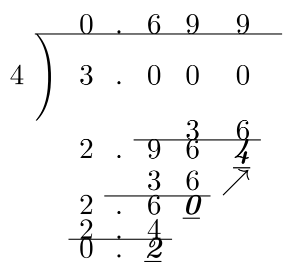


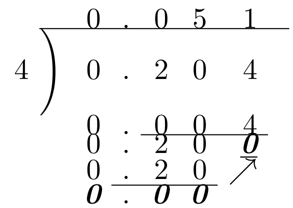
$Q = Q_1 + Q_2 = 49 + 9 = 58$ *and with remainder* $R = 36$

5 Using IBRAHITHM Division to Converting fractions to decimals

As we know , every one can be used the standard algorithm division to convert fractions to decimal . In this section we use IBRAHITHM division to do the same thing .

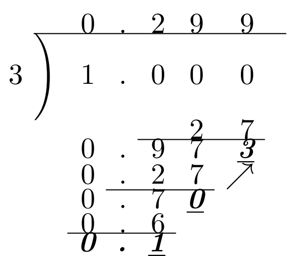
Example 9. *In this example we will covert the fraction* $\frac{3}{4}$ *to decimal .*

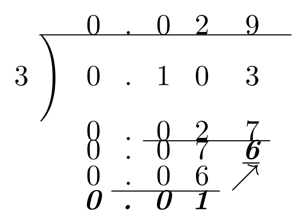


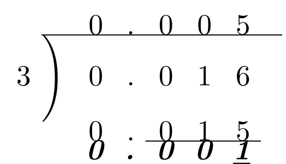


$Q = Q_1 + Q_2 = 0.699 + 0.051 = 0.750$ *and with remainder* $R = 0$

Example 10. *In this example we will covert the fraction* $\frac{1}{3}$ *to decimal .*





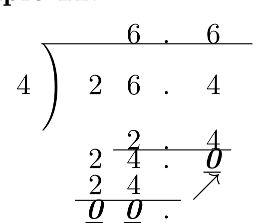


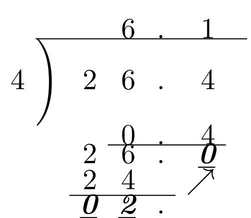
$Q = Q_1 + Q_2 + Q_3 = 0.299 + 0.029 + 0.005 = 0.333$ *and with remainder* $R = 0.001$

6 Using IBRAHITHM Division to divide numbers with decimal fractions

As in the standard algorithm division , we will use IBRAHITHM Division to deal with decimal fractions.

Example 11.

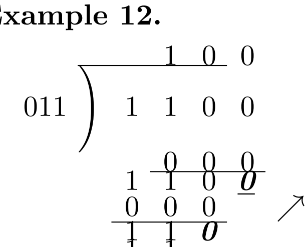




$Q = Q_1 + Q_2 = 6.1 + \frac{2}{4} = 6.6$ *and with remainder* $R = 0$

7 Using IBRAHITHM Division to divide Binary numbers

Example 12.



$Q = 100 \quad , R = 0$

Example 13.

$$
\begin{array}{r|l}
 & 0\;1\;0\;\;1 \\ \hline
1011 & 1\;\;1\;\;0\;\;1\;\;1\;\;\;1 \\
 & \underline{\;\;1\;\;0\;\;1\;\;1} \\
 & 1\;\;0\;\;1\;\;1\;\;0\;\;\underline{\mathit{0}} \\
 & \underline{0\;\;0\;\;0\;\;0} \\
 & 1\;\;0\;\;1\;\;1\;\;\underline{\mathit{0}}\;\nearrow \\
 & \underline{1\;\;0\;\;1\;\;1} \\
 & \mathit{0}\;\;\mathit{0}\;\;\mathit{0}\;\;\underline{\mathit{0}}
\end{array}
\qquad Q = 0101 \quad , R = 0
$$

Example 14.

$$
\begin{array}{r|l}
 & 1\;\;\;1 \\ \hline
111 & 1\;\;0\;\;1\;\;1\;\;\;0 \\
 & \underline{\;\;1\;\;1\;\;1} \\
 & 0\;\;1\;\;1\;\;1\;\;\underline{\mathit{1}} \\
 & \underline{1\;\;1\;\;1}\;\nearrow \\
 & \mathit{0}\;\;\mathit{0}\;\;\mathit{0}\;\;\mathit{0}
\end{array}
\qquad Q = 011 \quad , R = 01
$$

Example 15.

$$
\begin{array}{r|l}
 & 0\;.\;0\;0\;\;1 \\ \hline
111 & 1\;.\;0\;0\;\;0 \\
 & 0\;:\;\underline{1\;\;1\;\;1} \\
 & 0\;:\;0\;\;0\;\;\underline{\mathit{1}} \\
 & \underline{0\;.\;0\;\;0}\;\nearrow \\
 & \mathit{0}\;.\;\mathit{0}\;\;\mathit{0}
\end{array}
\qquad Q = 0.001, R = 0.001
$$

8 Using IBRAHITHM Division to divide Octal numbers

Example 16.

$$
\begin{array}{r|l}
 & 1\;\;2\;\;\;3 \\ \hline
451 & 6\;\;0\;\;1\;\;1\;\;\;3 \\
 & \underline{\;\;1\;\;5\;\;7\;\;3} \\
 & 5\;\;6\;\;3\;\;2\;\;\underline{\mathit{0}} \\
 & \underline{1\;\;1\;\;2\;\;2}\;\nearrow \\
 & 4\;\;5\;\;1\;\;\mathit{0} \\
 & \underline{4\;\;5\;\;1} \\
 & \mathit{0}\;\;\mathit{0}\;\;\mathit{0}
\end{array}
\qquad Q = 123, R = 0
$$

Example 17.

$$
\begin{array}{r|l}
 & 0\;.\;0\;3\;\;7 \\ \hline
222 & 1\;1\;.\;0\;0\;\;0 \\
 & 1\;:\;\underline{7\;\;7\;\;6} \\
 & 7\;:\;0\;\;0\;\;\underline{\mathit{2}} \\
 & 0\;\;\underline{6\;.\;6\;\;6} \\
 & \mathit{0}\;.\;\underline{\mathit{1}}\;\;\underline{\mathit{2}}\;\nearrow
\end{array}
\qquad Q = 0.037, R = 0.122
$$

Example 18.

$$
\begin{array}{r|l}
 & 3\;\;\;6 \\ \hline
7 & 4\;\;2\;\;\;2 \\
 & \underline{\;\;5\;\;\;2} \\
 & 3\;\;5\;\;\mathit{0} \\
 & \underline{2\;\;5} \\
 & \mathit{1}\;\;\mathit{0}\;\nearrow
\end{array}
\qquad
\begin{array}{r|l}
 & 1\;\;\;1 \\ \hline
7 & 1\;\;0\;\;\;0 \\
 & \underline{\;\;\;\;\;\;\;7} \\
 & 0\;\;7\;\;\mathit{1} \\
 & \underline{0\;\;7} \\
 & \mathit{0}\;\;\mathit{0}\;\nearrow
\end{array}
$$

$Q = Q_1 + Q_2 = 36 + 11 = 47$ *and with remainder* $R = 1$

9 Using IBRAHITHM Division to divide Hexadecimal numbers

Example 19.

$$
\begin{array}{r|l}
 & F\;\;A \\ \hline
C3 & B\;\;E\;\;6\;\;E \\
 & \underline{\;\;7\;\;9\;\;E} \\
 & B\;\;6\;\;D\;\;\underline{\mathit{0}} \\
 & \underline{B\;\;6\;\;D}\;\;\nearrow \\
 & \mathit{0}\;\;\mathit{0}\;\;\mathit{0}
\end{array}
\qquad Q = FA, R = 0
$$

Example 20.

$$
\begin{array}{r|ccccccc}
 & & & 5 & 7 & E & 6 & D \\
\hline
B9 & 3 & F & 8 & 5 & C & C & 5 \\
 & & & & & 9 & \cancel{6} & \cancel{5} \\
 & & & 8 & 5 & 3 & 6 & \underline{\boldsymbol{0}} \\
 & & & & \cancel{4} & \cancel{5} & \cancel{6} & \\
 & & F & 8 & 0 & E & \underline{\boldsymbol{0}} & \nearrow \\
 & & & \cancel{A} & \cancel{1} & \cancel{E} & & \\
 & 3 & E & D & F & \underline{\boldsymbol{0}} & & \\
 & & \cancel{5} & \cancel{0} & \cancel{F} & & & \\
 & 3 & 9 & D & \underline{\boldsymbol{0}} & \nearrow & & \\
 & \cancel{3} & \cancel{9} & \cancel{D} & & & & \\
 & \boldsymbol{0} & \underline{\boldsymbol{0}} & \underline{\boldsymbol{0}} & \nearrow & & &
\end{array}
$$

Example 21.

$$
\begin{array}{r|ccccc}
 & 0 & . & 0 & 0 & 8 \\
\hline
123D & A & . & 0 & 0 & 0 \\
 & 9 & . & \cancel{1} & \cancel{E} & \cancel{0} \\
 & \boldsymbol{0} & \boldsymbol{.} & \boldsymbol{E} & \boldsymbol{2} & \underline{\boldsymbol{0}}
\end{array}
\quad Q = 0.008, R = 0.E20
$$

Example 22.

$$
\begin{array}{r|ccccc}
 & & & D & 5 & F \\
\hline
CD & A & B & 5 & C & D \\
 & & & \cancel{C} & \cancel{0} & \cancel{3} \\
 & A & A & 9 & C & \underline{\boldsymbol{A}} \\
 & & \cancel{4} & \cancel{0} & \cancel{1} & \\
 & A & 6 & 9 & \underline{\boldsymbol{B}} & \\
 & \cancel{A} & \cancel{6} & \cancel{9} & \nearrow & \\
 & \boldsymbol{0} & \boldsymbol{0} & \underline{\boldsymbol{0}} & &
\end{array}
\quad Q = D5F, R = BA
$$

Example 23.

$$
\begin{array}{r|ccccc}
 & & 2 & 7 & F & 8 \\
\hline
32 & A & B & C & D & E \\
 & & & \cancel{1} & \cancel{9} & \cancel{0} \\
 & A & B & B & 4 & \underline{\boldsymbol{E}} \\
 & & \cancel{2} & \cancel{E} & \cancel{E} & \\
 & A & 8 & C & \underline{\boldsymbol{6}} & \\
 & \cancel{1} & \cancel{5} & \cancel{E} & & \\
 & 9 & 2 & \underline{\boldsymbol{E}} & & \\
 & \cancel{6} & \cancel{4} & \nearrow & & \\
 & \boldsymbol{2} & \underline{\boldsymbol{E}} & & &
\end{array}
\qquad
\begin{array}{r|ccccc}
 & & & E & F & F \\
\hline
32 & 2 & E & E & 6 & E \\
 & & & \cancel{2} & \cancel{E} & \cancel{E} \\
 & 2 & E & B & 8 & \underline{\boldsymbol{0}} \\
 & & \cancel{2} & \cancel{E} & \cancel{E} & \\
 & 2 & B & C & \underline{\boldsymbol{A}} & \\
 & \cancel{2} & \cancel{B} & \cancel{C} & \nearrow & \\
 & \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{0} & &
\end{array}
\qquad
\begin{array}{r|cc}
 & & 3 \\
\hline
32 & A & 0 \\
 & \cancel{9} & \cancel{6} \\
 & \boldsymbol{0} & \boldsymbol{A}
\end{array}
$$

The quotient $Q = Q_1 + Q_2 + Q_3 = 27F8 + EFF + 3 = 36FA$ *, and the remainder* $R = A$.

10 Using IBRAHITHM Division to get the square root of numbers

Example 24.

		$\boxed{2}$	$\boldsymbol{3}$
$\boldsymbol{3} + 3$	5	2	9
$= 6$			9
$\boxed{2}6 + 20$	5	2	$\underline{\boldsymbol{0}}$
$= 46$	5	2	
	$\boldsymbol{0}$	$\boldsymbol{0}$	

Example 25.

			$\boxed{6}$	$\boldsymbol{4}$
$\boldsymbol{4} + 4$	4	0	9	6
$= 8$			1	6
$\boxed{6}8 + 60$	4	0	8	$\underline{\boldsymbol{0}}$
$= 128$	4	0	8	
	$\boldsymbol{0}$	$\boldsymbol{0}$	$\boldsymbol{0}$	

Example 26.

				$\underline{5}$	$\boxed{4}$	$\boldsymbol{3}$
$\boldsymbol{3} + 3$	2	9	4	8	4	9
$= 6$						9
$\boxed{4}6 + 40$			4	8	4	$\underline{\boldsymbol{0}}$
$= 86$			1	8	4	
$\underline{5}86 + 500$	2	9	3	0	$\boldsymbol{0}$	
$= 1086$	2	9	3	0		

Remark 2. *We know that there is a way to find the cubic root of a setting using known long division. As a conjecture , I think it can be used IBRAHITHM division method to find the cubic root of numbers and this is an open problem . that needs to be studied.*

11 IBRAHITHM polynomial division

In algebra, polynomial long division is an algorithm for dividing a polynomial by another polynomial of the same or lower degree, a generalised version of the familiar arithmetic technique called long division. It can be done easily by hand, because it separates an otherwise complex division problem into smaller ones . olynomial long division is an algorithm that implements the Euclidean division of polynomials, which starting from two polynomials A (the dividend) and B (the divisor) produces, if B is not zero, a quotient Q and a remainder R such that$A = B * Q + R$,and either $R = 0$ or the degree of R is lower than the degree of B. [1]
In this section , we introduce "IBRAHITHM polynomial division" to perform the steps from right to left . I think that the method here needs more further studies in order to be more intuitive and easier.

Example 27.

$$
\begin{array}{r|rcrcr}
 & & & 3x & - & 4 \\
\cline{2-6}
2x+5 & 6x^2 & + & 7x & - & 20 \\
 & & & -8x & - & 20 \\
\hline
 & 6x^2 & + & 15x & & \\
 & 6x^2 & + & 15x & & \\
\hline
 & \boldsymbol{0} & + & \boldsymbol{0} & &
\end{array}
$$

Example 28.

$$
\begin{array}{r|rcrcrcr}
 & & & x^2 & + & x & - & 2 \\
\cline{2-8}
x-3 & x^3 & - & 2x^2 & - & 5x & + & 6 \\
 & & & & & -2x & + & 6 \\
\hline
 & x^3 & - & 2x^2 & - & 3x & & \\
 & & & x^2 & - & 3x & & \\
\hline
 & x^3 & - & 3x^2 & & & & \\
 & x^3 & - & 3x^2 & & & & \\
\hline
 & \boldsymbol{0} & + & \boldsymbol{0} & & & &
\end{array}
$$

Example 29.

$$
\begin{array}{r|rcrcrcrcr}
 & & & & & -25x^2 & - & 8x & - & 6 \\
\cline{2-10}
x-3 & x^4 & - & 2x^3 & + & 3x^2 & - & 4x & + & 6 \\
 & & & & & -6x^2 & - & 12x & + & 6 \\
\hline
 & x^4 & - & 2x^3 & + & 9x^2 & + & 8x & & \\
 & & & -8x^3 & - & 16x^2 & + & 8x & & \\
\hline
 & x^4 & + & 6x^3 & + & 25x^2 & & & & \\
 & -25x^4 & - & 50x^3 & + & 25x^2 & & & & \\
\hline
 & 26x^4 & + & 56x^3 & \nearrow & & & & &
\end{array}
$$

$$
\begin{array}{r|rcrcrcrcr}
 & & & & & 18 & + & 4x & + & 26x^2 \\
\cline{2-10}
x-3 & & & & & & & 56x^3 & + & 26x^4 \\
 & & & & & -26x^2 & + & 52x^3 & + & 26x^4 \\
\hline
 & & & & & 26x^2 & + & 4x^3 & & \\
 & & & -4x & + & 8x^2 & + & 4x^3 & & \\
\hline
 & & & 4x & + & 18x^2 & & & & \\
 & -18 & + & 36x & + & 18x^2 & & & & \\
\hline
 & \boldsymbol{18} & \text{-} & \boldsymbol{32x} & & & & & &
\end{array}
$$

$Q = Q_1 + Q_2 = (-25x^2 - 8x - 6) + (18 + 4x + 26x^2) = x^2 - 4x + 12$ *with remainder* $R = 18 - 32x$

Example 30.

$$
\begin{array}{r|rcrcrcrcr}
 & & & & & x & + & 2xy & - & 3y \\
\cline{2-10}
x+y & x^2 & + & 2x^2y & - & 2xy & + & 2xy^2 & - & 3y^2 \\
 & & & & & -3xy & & & - & 3y^2 \\
\hline
x+y & x^2 & + & 2x^2y & + & xy & + & 2xy^2 & & \\
x+y & & & 2x^2y & & & + & 2xy^2 & & \\
\hline
x+y & x^2 & & & + & xy & & & & \\
x+y & x^2 & & & + & xy & & & & \\
\hline
x+y & \boldsymbol{0} & & & + & \boldsymbol{0} & \nearrow & & &
\end{array}
$$

12 IBRAHITHM synthetic division

Ruffini's rule a shortcut method for dividing a polynomial by a linear factor of the form which can be used in place of the standard long division algorithm. This method reduces the polynomial and the linear factor into a set of numeric values. After these values are processed, the resulting set of numeric outputs is used to construct the polynomial quotient and the polynomial remainder. Note that Ruffini's rule is a special case of the more generalized notion of synthetic division in which the divisor polynomial is a monic linear polynomial. Confusingly, Ruffini's rule is sometimes referred to as synthetic division, thus leading to the common misconception that the scope of synthetic division is significantly smaller than that of the long division algorithm. ([4] ,[5])
We introduce here a similar method but we perform the calculations from right to left .

Example 31.

$$\frac{x^3+3x^2-x-3}{x-1}$$

$$\begin{array}{rrrrr|r}
 & 1 & 3 & -1 & -3 & 1 \\
\curvearrowleft & -1 & -4 & -3 & & \\
\hdashline
 & \boldsymbol{0} & -1 & -4 & -3 &
\end{array}$$

The quotient $Q = x^2 + 4x + 3$ *and the remainder* $R = 0$ *.*

Example 32.

$$\frac{2x^4-x^3-7x^2-3x+10}{x-2}$$

$$\begin{array}{rrrrrr|r}
 & 2 & -1 & -7 & -3 & 10 & 2 \\
\curvearrowleft & -2 & -3 & 1 & 5 & & \\
\hdashline
 & \boldsymbol{0} & -4 & -6 & 2 & 10 &
\end{array}$$

The quotient $Q = 2x^3 + 3x^2 - x - 5$ *and the remainder* $R = 0$ *.*

Remark 3. *Ruffini's synthetic division has already generalized to divide a polynomial by another polynomial of any degree .(see [2]) . As a conjecture , I think we can generalize "IBRAHITHM synthetic division " to more generalized situation to get "IBRAHITHM generalized synthetic division" and this is an open problem . .*

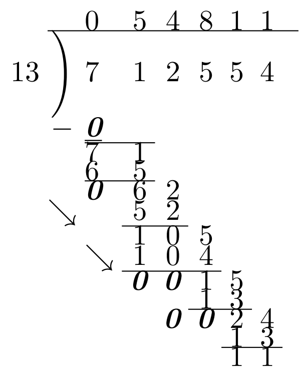
13 The Relation between Standerd ALGORITHM division method and IBRAHITHM division method

In order to know the relation between Standerd ALGORITHM division method and IBRAHITHM division method ,we need to read carefully the following example :

Example 33. *In this example we divide the number* 712554 *by* 13 *by many ways , using the Standerd ALGORITHM division method and IBRAHITHM division method .*

Case 1 : Using Standerd ALGORITHM division method:
Every one know that there is only one way to divide integer numbers by Using Standerd ALGORITHM division method . The ***surprise*** *here is ,for many people ,that the same method can be used to solve*

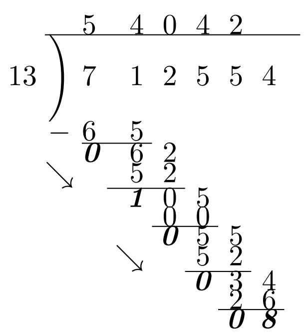
the example in different ways as follows:

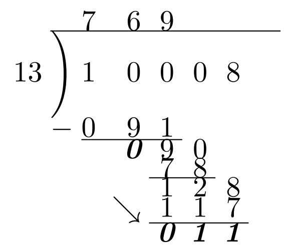


$$Q = 54811, R = 11$$

.

Another way :

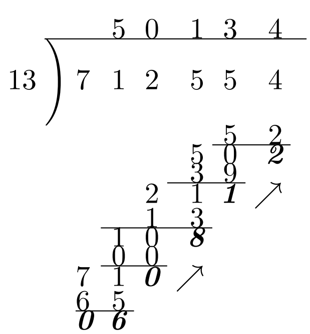


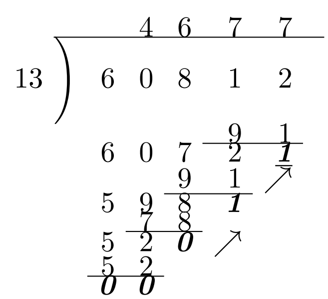


$$Q = Q_1 + Q_2 = 54042 + 769 = 54811$$

with remainder $R = 11$

Case 2 : *Using IBRAHITHM division method:*





$$Q = Q_1 + Q_2 = 50134 + 4677 = 54811$$

,with remainder $R = 11$

Remark 4. *It is clear from the previous example that the trend of arrows in the two methods always means the remainder of the division.*

14 Conclusions

In this paper, we study a new efficacious and resilient method which is corresponding to the standard algorithm division , We use it to divide numbers in some number systems such as decimal , binary , octal and hexadecimal systems .We give some applications of this method such as finding the square root of integer numbers , polynomial division and synthetic division .

15 Future Work

The method used in our paper when dividing on an even number is the same as for the odd numbers. But there is a problem here because we have two options at a time. For example, if the dividend starts with the number 2 and the dividend starts with the number 2, then we have two options: 1 and 6. Both numbers 1 and 6, if multiplied by number 2, give 12, which begins with the number 2, as is clear. So what is the solution here? . Indeed, there is a solution to the problem to complete the using of our method “IBRAHITHM”, but it takes some time to find the result of division, so the division on even numbers needs further study for those interested in the topic. In other words is there a method or rule that can be used to choose the appropriate number when we deal with even numbers. This is an open problem that needs further research.Also we can try to solve the open problems included in remark(2) and remark(3) .

Acknowledgements

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