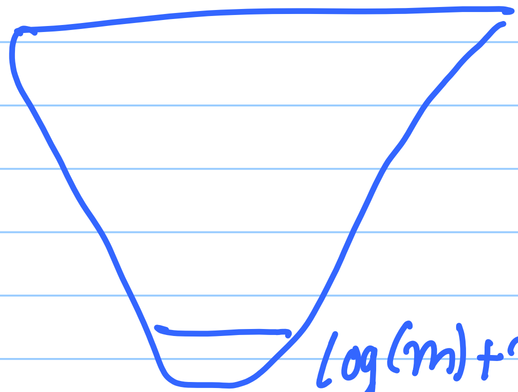
Sept-6

Note Title 06-09-2011

add m n-bit numbers.



$\log(m) * (\log(n + \log(m)))$

$\log(m) + n$

Faster multiply: $a + b + c = d + e$

sum carry

5 (1)
+3
+4

2
1 0

1 1 (2)
1 0

0 1 } Sum
1 0 0 } carry

a
+b

sum = $a \oplus b \oplus c$
carry = $ab + bc + ca$
1-bit case.

1 0 1 1
1 0 1 1

0 0 0 0 } Sum
1 0 1 1 0 } Carry

1 0 0 0
0 1 1 1
1 1 0 1

0 0 1 0 } sum

$$\begin{array}{r} 45 \\ 56 \\ \hline 9\;1 \\ +1\;0 \\ \hline 101 \end{array} \qquad \begin{array}{l} 40 + 5 \\ +50 + 6 \\ (1+10) \end{array}$$

$$\begin{array}{r} 11010 \\ \hline 11100 \end{array} \begin{array}{l} \} \text{ Carry} \\ \} \text{ final result.} \end{array}$$

$$\begin{array}{r} 63 \\ 45 \\ 56 \\ \hline 54 \\ 110 \\ \hline 164 \end{array} \begin{array}{l} \\ \\ \\ \} \text{ sum} \\ \} \text{ carry.} \\ \\ \end{array}$$

Basic Idea: Reduce a sum of three numbers to a sum of two numbers in $O(1)$ time.

$m = 30$

1 step: $m = 20$

2 step: $m = 14$

3 rd step: 10

⋮

$$\left.\begin{array}{l} \\ \\ \\ \end{array}\right\} \log_{3/2}(m)$$

At the end: sum of two numbers

Max. size of each number:

$n + \log(m)$

Time for the last addition: $\log(n + \log(m))$

Total Time: $\log(n + \log(m)) + \log(m)$

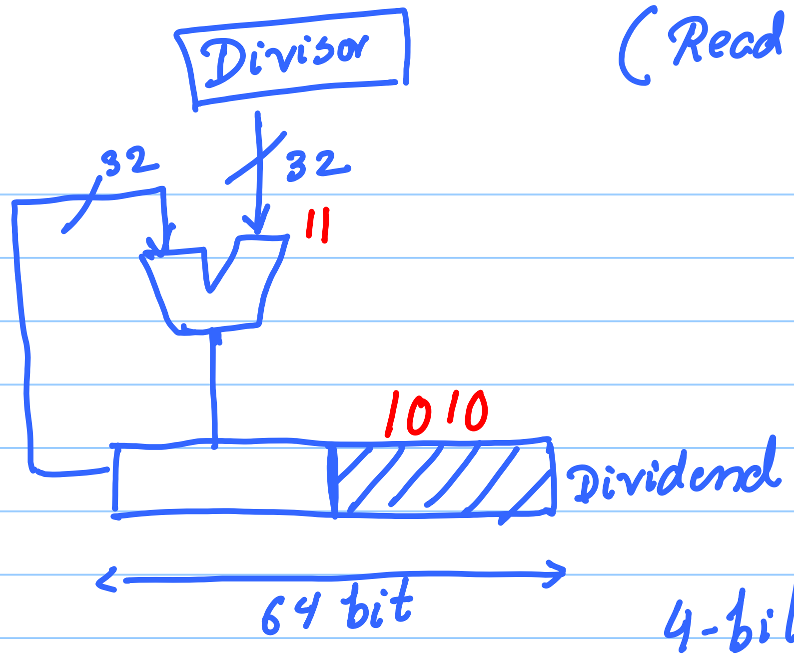
Carry save multiplier.

(Tree) multiplier.

Wallace Tree multiplier.

Division

$$
\begin{array}{r}
9\overline{)100}(011 \\
\underline{9} \\
10 \\
\underline{9} \\
1
\end{array}
$$



(Read this from the book)

4-bit division

$(10 \div 3)_d$

$1010 \div 11$

Step 1: 1 | 0100

Step 2: 10 | 1000

Step 3: 101 | 0001

−011

| 010 | 0001 |

Step 4: | 0100 | |

− 011

| 0001 | 0011 |

remainder. Quotient

Restoring division algorithm.

restoring division

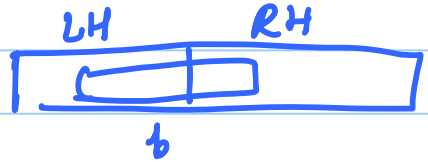
1) Every step:
   compare left half (LH) with divisor
   how!!
   subtract: (LH) − divisor
   see value of sign bit

non-restoring division

1) If it is negative don't care 🙂

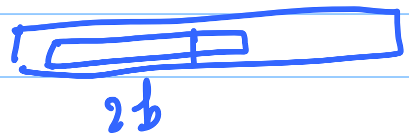
if negative:
add the divisor
to LH

step n:



$b-d$

step n+1:



$2b-2d.$

	non-restoring.	restoring
step 1:	$b-d.$	b
step 2:	$2b-2d$	$2b-d$

$$\begin{array}{r} 2b-2d \\ +d \\ \hline 2b-d \end{array}$$

Tomorrow: Example - non-restoring division
(Sept 7^{th}).

Floating point.