October 5

- Register to vote!
- Go to the State Fair! (15-24 October)
- Help with a user study! (Peter Parente parente@cs.unc.edu)
- How many struggling with Assignment 5.8.77?
- Questions?
- Chapter 4 – Multiplication/Division

Multiplication Facts

- N digit number TIMES a M digit number produces: ? an (N+M) digit number
- 32 bit number TIMES a 32 bit number produces: ? a 64 bit number

\[
\begin{array}{cc}
123 & 101 \\
45 & 11 \\
615 & 151 \\
492 & 101 \\
5535 & 1111 \\
\end{array}
\]

Multiplication: Implementation

Second Version

Example for second version

<table>
<thead>
<tr>
<th>Iteration</th>
<th>Step</th>
<th>Multiplier</th>
<th>Multiplicand</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>initial</td>
<td>0010</td>
<td>00000000</td>
<td>00000000</td>
</tr>
<tr>
<td>1</td>
<td>Test true left 0</td>
<td>0010</td>
<td>00000000</td>
<td>0001 0000</td>
</tr>
<tr>
<td>2</td>
<td>Test true right 0</td>
<td>0010</td>
<td>0011 0000</td>
<td>0000 1000</td>
</tr>
<tr>
<td>3</td>
<td>Test false right 0</td>
<td>0010</td>
<td>0010 1100</td>
<td>0001 0110</td>
</tr>
<tr>
<td>4</td>
<td>Test true right 0</td>
<td>0010</td>
<td>0010 1100</td>
<td>0001 0110</td>
</tr>
</tbody>
</table>

Final Version

The trick is to use the lower half of the product to hold the multiplier during the operation.
What about the sign?

- Positive numbers are easy.
- How about negative numbers?

Faster Multiply

See Booth coding in the book.

Division

1. Subtract Divisor from the Remainder leave the result in the Remainder
2. Test Remainder: if adding Divisor to the left set its rightmost bit = 1
3. Subtract Divisor from the Shift Quotient to the left set its rightmost bit = 0
4. Shift Quotient right 1 bit
5. Repeat 3 times