

Binary Subtraction

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These slides introduce subtraction with Binary Numbers

Binary Subtraction

- Elementary school concepts
 - Subtract columns of numbers and keep track of how much is borrowed from the next column

$$\begin{array}{r} 245 \text{ minuend} \\ - 189 \text{ subtrahend} \\ \hline 56 \text{ difference} \end{array}$$

$$\begin{array}{r} 245 \\ - 189 \\ \hline \end{array} \Rightarrow \begin{array}{r} 3^{15} \\ \cancel{2}45 \\ - 189 \\ \hline 6 \end{array} \Rightarrow \begin{array}{r} 235 \\ - 189 \\ \hline 6 \end{array} \Rightarrow \begin{array}{r} 1^{13} \\ \cancel{2}35 \\ - 189 \\ \hline 56 \end{array} \Rightarrow \begin{array}{r} 1^{13} \\ 135 \\ - 189 \\ \hline 056 \end{array} \Rightarrow \begin{array}{r} 245 \\ - 189 \\ \hline 56 \end{array}$$

- This is very difficult to implement in hardware

Binary Subtraction


- Binary Subtraction

- Used with signed (2's complement) numbers
- Negate the subtrahend and add
 - $a - b \rightarrow a + (-b)$
- Overflow – same rule as addition for signed numbers

$$\begin{array}{r} 71 \\ - 29 \\ \hline \end{array} \Rightarrow \begin{array}{r} 71 \\ + -(29) \\ \hline \end{array} \Rightarrow \begin{array}{r} 71 \\ + (-29) \\ \hline \end{array}$$


$$\begin{array}{r} 7 \\ - (-99) \\ \hline \end{array} \Rightarrow \begin{array}{r} 7 \\ + -(-99) \\ \hline \end{array} \Rightarrow \begin{array}{r} 7 \\ + 99 \\ \hline \end{array}$$

$$\begin{array}{r} 0\ 1\ 0\ 0\ 0\ 1\ 1\ 1 \\ - 0\ 0\ 0\ 1\ 1\ 1\ 0\ 1 \\ \hline \end{array} \quad \begin{array}{r} 71 \\ - 29 \\ \hline \end{array}$$



$$\begin{array}{r} \boxed{1} \quad 1 \qquad \qquad \qquad 1\ 1\ 1 \\ 0\ 1\ 0\ 0\ 0\ 1\ 1\ 1 \\ + 1\ 1\ 1\ 0\ 0\ 0\ 1\ 1 \\ \hline 0\ 0\ 1\ 0\ 1\ 0\ 1\ 0 \end{array} \quad \begin{array}{r} 71 \\ + (-29) \\ \hline 42 \end{array}$$

$$\begin{array}{r} 0\ 0\ 0\ 0\ 0\ 1\ 1\ 1 \\ - 1\ 0\ 0\ 1\ 1\ 1\ 0\ 1 \\ \hline \end{array} \quad \begin{array}{r} 7 \\ - (-99) \\ \hline \end{array}$$



$$\begin{array}{r} \boxed{0} \qquad \qquad \qquad 1\ 1\ 1 \\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 1 \\ + 0\ 1\ 1\ 0\ 0\ 0\ 1\ 1 \\ \hline 0\ 1\ 1\ 0\ 1\ 0\ 1\ 0 \end{array} \quad \begin{array}{r} 7 \\ + 99 \\ \hline 106 \end{array}$$