Virginia Tech
ECE 4500: Fundamentals of Computer Systems

Example of Multiplication Using Booth's Algorithm

Consider multiplying +34 by -26 assuming 8-bit two's complement representation for the two numbers. We will use Booth's algorithm. A product of two eight-bit numbers may require as many as 16 bits for its representation, so we will use 16-bit two's complement representation for the product.

- +34 in two's complement representation is: 0010 0010
- -26 in two's complement representation is: 1110 0110

Sometimes we will need to subtract 34. To accomplish this, we will add -34. -34 is 1101 1110.

The computation is shown below. At each step we either merely shift if the current and previous bits are "11" or "00," add the multiplier if the current and previous bits are "01," or subtract the multiplier if the current and previous bits are "10." To subtract the multiplier (for the "10" bit pair), we actually add the negative of the multiplier. For the first step of Booth's algorithm, we assume the preceding bit was a "0."

After each step, we compute the partial product by adding the previous partial product with the value derived for the step. The addition to computer the partial product is trivial if the bit pair is "11" or "00."

									0	**0**	**1**	**0**	**0**	**0**	**1**	**0**	(+34)
								×	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**0**	×(-26)
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	00 ⇒ simple shift
+	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0		10 ⇒ subtract 34 (add -34), extend sign
	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	Partial product (-68)
+	0	0	0	0	0	0	0	0	0	0	0	0	0	0			11 ⇒ simple shift
	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	Partial product (-68)
+	0	0	0	0	0	0	0	1	0	0	0	1	0				01 ⇒ add 34, extend sign
	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	Partial product (204)
+	0	0	0	0	0	0	0	0	0	0	0	0					00 ⇒ simple shift
	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	Partial product
+	1	1	1	1	1	0	1	1	1	1	0						10 ⇒ subtract 34, extend sign
	1	1	1	1	1	1	0	0	1	0	0	0	1	1	0	0	Partial product
+	0	0	0	0	0	0	0	0	0	0							11 ⇒ simple shift
	1	1	1	1	1	1	0	0	1	0	0	0	1	1	0	0	Partial product
+	0	0	0	0	0	0	0	0	0								11 ⇒ simple shift
	1	1	1	1	1	1	0	0	1	0	0	0	1	1	0	0	-884

We can test our result to verify that the product is 34 ×(-26) = -884. Does "1111110010001100" represent -884? First, negate this value by performing the two's complement operation.

1111 1100 1000 1100 → 0000 0011 0111 0011 + 1 = 0000 0011 0111 0100.

Then verify that the result is +884.

0000 0011 0111 0100 = $2^9 + 2^8 + 2^6 + 2^5 + 2^4 + 2^2$ = 512 + 256 + 64 + 32 + 16 + 4 = 884.

So, 1111 1100 1000 1100 = -884 assuming two's complement representation.