ECE/CS/ME 539 – Fall 2024 — Activity Solution 17

NOTE: The solution is not unique.

Solution

$$
\begin{aligned}
c_0 &= \text{Step}(\text{ReLU}(a_0 + b_0 - 0.5) - 2 * \text{ReLU}(a_0 + b_0 - 1)) \\
c_1 &= \text{Step}(\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 1.5) - 2\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 2.5) \\
&\qquad +4\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 5.0) - 6.5\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 6.5)) \\
c_2 &= \text{Step}(\text{ReLU}(2a_1 + a_0 + 2b_1 + b_0 - 3.5))
\end{aligned}
$$

where Step is step function:$Step(x) = 0$ if $x \leq 0$; otherwise 1.$ReLU(x) = 0$ if $x \leq 0$; otherwise x

Explanation

Since $c_0 = 1$ when $a_0 \oplus b_0 = 1$, we can express c_0 as:

$$\text{Step}(\text{ReLU}(a_0 + b_0 - 0.5) - 2 \times \text{ReLU}(a_0 + b_0 - 1))$$

The decimal number represented by $c_2c_1c_0$ can be computed as $2(a_1 + b_1) + a_0 + b_0$. The value $c_1 = 1$ when the decimal number is $2, 3$, or 6. Therefore, we can use the expression, which is shown in the figure 1

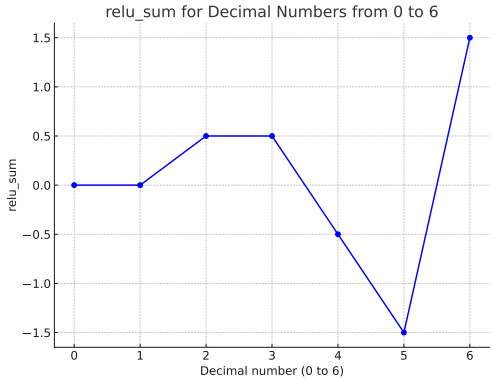

Figure 1: ReLU Sum for Decimal Numbers from 0 to 6

$$
\begin{aligned}
c_1 &= \text{Step}(\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 1.5) - 2\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 2.5) \\
&\qquad +4\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 5.0) - 6.5\text{ReLU}(2(a_1 + b_1) + a_0 + b_0 - 6.5))
\end{aligned}
$$

For c_2, which equals 1 when the decimal number is greater than 3, we use:

$$\text{Step}(\text{ReLU}(2a_1 + a_0 + 2b_1 + b_0 - 3.5))$$