2.7 Floating-point arithmetic

Adding decimal floating-point numbers

Adding two decimal floating-point numbers in normalized scientific notation can be done in three steps:

1. Make the exponents the same
2. Add the significands, applying the same exponent
3. If necessary, adjust the result to normalized scientific notation.

PARTICIPATION ACTIVITY 2.7.1: Adding decimal floating-point numbers.

Start 2x speed

$$\begin{array}{r} 4.3 \times 10^{6} \\ +\ 8.1 \times 10^{6} \\ \hline 12.4 \times 10^{6} \end{array}$$

$$= 1.24 \times 10^{7}$$

$$\begin{array}{r} 2 \times 10^{2} \\ +\ 3 \times 10^{4} \\ \hline \end{array} \quad \blacktriangleright \quad \begin{array}{r} 0.02 \times 10^{4} \\ +\ 3 \quad \times 10^{4} \\ \hline 3.02 \times 10^{4} \end{array}$$

PARTICIPATION ACTIVITY 2.7.2: Decimal floating-point addition.

Provide answers in normalized scientific notation. Use the letter x to express multiplication and the ^ symbol to express exponents. Ex: 3 x 10^2.

1) $4 \times 10^3 + 2 \times 10^3 =$ _____

Check Show answer

2) $5.4 \times 10^5 + 4.1 \times 10^5 =$ _____

Check Show answer

3) $6.2 \times 10^2 + 6.3 \times 10^2 =$ _____

Check Show answer

4) $8.5 \times 10^4 + 1.7 \times 10^4 =$ _____

Check Show answer

5) $2 \times 10^2 + 5.3 \times 10^4 =$ _____

Check Show answer

6) $4.7 \times 10^3 + 7.1 \times 10^6 =$ _____

Check Show answer

Adding binary floating-point numbers

To add together binary floating-point numbers represented using normalized scientific notation, the exponents must first b like in decimal notation. Then one can add together the significands. If the result is not in normalized scientific notation, the exponent and binary point location are adjusted.

If the exponents differ, the process is again similar to the decimal notation process. One value's exponent is adjusted to ma exponent by moving the location of the value's binary point before the significands are added.

Figure 2.7.1: Adding binary floating-point numbers.

$$\begin{array}{r} 1.110 \times 2^3 \\ +\ \ 1.000 \times 2^3 \\ \hline 10.110 \times 2^3 \end{array}$$

$$= 1.011 \times 2^4$$

1. The exponents are already the same.
2. Add the significands and apply the exponent.
3. Adjust to normalized scientific notation.

$$\begin{array}{r} 1.110 \times 2^2 \\ +\ \ 1.000 \times 2^4 \\ \hline \end{array} \quad \rightarrow \quad \begin{array}{r} 0.0111 \times 2^4 \\ +\ \ 1.000 \times 2^4 \\ \hline 1.0111 \times 2^4 \end{array}$$

1. Make the exponents the same.
2. Add the significands and apply the exponent.
3. Result is already adjusted to normalized scientific notation.

PARTICIPATION ACTIVITY 2.7.3: Binary floating-point addition.

Use the letter x to express multiplication and the ^ symbol to express exponents. Ex: 1.0 x 2^2. Remove trailing 0s from the results.

1) $1.0 \times 2^2 + 1.1 \times 2^2 =$ _____

Check Show answer

2) $1.11 \times 2^4 + 1.01 \times 2^4 =$ _____

Check Show answer

3) $1.101 \times 2^1 + 1.011 \times 2^3 =$ _____

Check Show answer

4) $1.0 \times 2^2 + 1.001 \times 2^5 =$ _____

Check Show answer

5) $1.1 \times 2^4 + 1.1 \times 2^5 =$ _____

Check Show answer

6) $1.11 \times 2^7 + 1.11 \times 2^8 =$ _____

Check Show answer

Multiplying binary floating-point numbers

Multiplying floating-point numbers can be done in three steps:

1. Multiply the significands.
2. Add the exponents.
3. Adjust to normalized scientific notation.

Note that the exponents need not be the same. Ex: For decimal, given $(3.1\times10^5) \times (4.0\times10^2)$, then

1. 3.1 × 4.0 is 12.4
2. 5 + 2 is 7
3. Adjusting 12.4×10^7 yields 1.24×10^8

The steps for binary are the same.

PARTICIPATION ACTIVITY 2.7.4: Multiplying binary floating-point numbers.

Start 2x speed

1. Multiply significands

$$\begin{array}{r} 1.01 \\ \times\ 1.11 \\ \hline 101 \\ 101 \\ +\ 101 \\ \hline 10.0011 \end{array}$$

$$\begin{array}{r} 1.01 \times 2^2 \\ \times\ 1.11 \times 2^1 \\ \hline 10.0011 \times 2^3 \end{array}$$

2. Add exponents

$$\begin{array}{r} 2 \\ +\ 1 \\ \hline 3 \end{array}$$

3. Adjust to normalized scientific notation

$= 1.00011 \times 2^4$

PARTICIPATION ACTIVITY 2.7.5: Binary floating-point multiplication.

1) $(1.01 \times 2^4) \times (1.1 \times 2^4) = ? \times 2^8$

Check Show answer

2) $(1.01 \times 2^3) \times (1.01 \times 2^4) = 1.1001 \times 2^?$

Check Show answer

3) For the following questions, use the letter x to express multiplication and the ^ symbol to express exponents. Ex. 1.0x2^2. Remove trailing 0s from the significands.

$(1.1 \times 2^6) \times (1.0 \times 2^3) = ?$

Check Show answer

4) $(1.101 \times 2^3) \times (1.1 \times 2^3) = 10.0111 \times 2^6 = ?$

Check Show answer

5) $(1.1\times2^5) \times (1.1\times2^3) = ?$

Check Show answer

CHALLENGE ACTIVITY 2.7.1: Floating-point arithmetic.

Start

Enter the exponent of the normalized scientific notation result.

Use ^ for exponents. Ex: 2^3 for 2^3.

$$\begin{array}{rl} & 1.010 \times 2^5 \\ + & 1.001 \times 2^5 \\ \hline & 1.0011\times 2 \end{array}$$

Ex: 2

1	2	3	4	5	6

Check Next

1 2 3 4 5 6

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