calc_binary_example

Student Group

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Table of Contents

Calculation example for binary value

Idea: The numeral 10011101 is only the representation with the digits $[0,1]$, but what is the value behind it?

so lets start

1. Put space between the digits
$\quad$

\begin{align*} \begin{smallmatrix} \color{black}{\text{numeral}:} & \color{black}{} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{white}{\text{index}:} & \color{white}{i} & \color{white}{7} & \color{white}{6} & \color{white}{5} & \color{white}{4 } & \color{white}{3} & \color{white}{2} & \color{white}{1} & \color{white}{0} \\ \color{white}{\text{place factor}:} & \color{white}{B^i} & \color{white}{2^7} & \color{white}{2^6} & \color{white}{2^5} & \color{white}{2^4} & \color{white}{2^3} & \color{white}{2^2} & \color{white}{2^1} & \color{white}{2^0} \\ \color{white}{} & \color{white}{} & \color{white}{128} & \color{white}{64} & \color{white}{32} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{2} & \color{white}{1} \\ \color{white}{\text{digits }:} & \color{white}{z_i} & \color{white}{1} & \color{white}{0} & \color{white}{0} & \color{white}{1 } & \color{white}{1} & \color{white}{1} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{place value}:} & \color{white}{z_i \cdot B^i} & \color{white}{128} & \color{white}{0} & \color{white}{0} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & & \color{white}{157} \\ \end{smallmatrix} \end{align*}

2. Write down the index for each position.
$\quad$

\begin{align*} \begin{smallmatrix} \color{black}{\text{numeral}:} & \color{black}{} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{blue}{\text{index}:} & \color{blue }{i} & \color{blue }{7} & \color{blue }{6} & \color{blue }{5} & \color{blue }{4 } & \color{blue }{3} & \color{blue }{2} & \color{blue }{1} & \color{blue }{0} \\ \color{white}{\text{place factor}:} & \color{white}{B^i} & \color{white}{2^7} & \color{white}{2^6} & \color{white}{2^5} & \color{white}{2^4} & \color{white}{2^3} & \color{white}{2^2} & \color{white}{2^1} & \color{white}{2^0} \\ \color{white}{} & \color{white}{} & \color{white}{128} & \color{white}{64} & \color{white}{32} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{2} & \color{white}{1} \\ \color{white}{\text{digits }:} & \color{white}{z_i} & \color{white}{1} & \color{white}{0} & \color{white}{0} & \color{white}{1 } & \color{white}{1} & \color{white}{1} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{place value}:} & \color{white}{z_i \cdot B^i} & \color{white}{128} & \color{white}{0} & \color{white}{0} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & & \color{white}{157} \\ \end{smallmatrix} \end{align*}

3. calculate the place factor

$\quad$

\begin{align*} \begin{smallmatrix} \color{black}{\text{numeral}:} & \color{black}{} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{black}{\text{index}:} & \color{black}{i} & \color{black}{7} & \color{black}{6} & \color{black}{5} & \color{black}{4 } & \color{black}{3} & \color{black}{2} & \color{black}{1} & \color{black}{0} \\ \color{blue}{\text{place factor}:} & \color{blue }{B^i} & \color{blue }{2^7} & \color{blue }{2^6} & \color{blue }{2^5} & \color{blue }{2^4} & \color{blue }{2^3} & \color{blue }{2^2} & \color{blue }{2^1} & \color{blue }{2^0} \\ \color{white}{} & \color{white}{} & \color{white}{128} & \color{white}{64} & \color{white}{32} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{2} & \color{white}{1} \\ \color{white}{\text{digits }:} & \color{white}{z_i} & \color{white}{1} & \color{white}{0} & \color{white}{0} & \color{white}{1 } & \color{white}{1} & \color{white}{1} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{place value}:} & \color{white}{z_i \cdot B^i} & \color{white}{128} & \color{white}{0} & \color{white}{0} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & \color{white}{157} \\ \end{smallmatrix} \end{align*}

3. calculate the place factor
(= ..., thousands, hundreds, tens, ones, tenths, ...)

\begin{align*} \begin{smallmatrix} \color{black}{\text{numeral}:} & \color{black}{} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{blue}{\text{index}:} & \color{black}{i} & \color{black}{7} & \color{black}{6} & \color{black}{5} & \color{black}{4 } & \color{black}{3} & \color{black}{2} & \color{black}{1} & \color{black}{0} \\ \color{blue }{\text{place factor}:} & \color{blue }{B^i} & \color{blue }{2^7} & \color{blue }{2^6} & \color{blue }{2^5} & \color{blue }{2^4} & \color{blue }{2^3} & \color{blue }{2^2} & \color{blue }{2^1} & \color{blue }{2^0} \\ \color{white}{} & \color{blue }{} & \color{blue }{128} & \color{blue }{64} & \color{blue }{32} & \color{blue }{16} & \color{blue }{8} & \color{blue }{4} & \color{blue }{2} & \color{blue }{1} \\ \color{white}{\text{digits }:} & \color{white}{z_i} & \color{white}{1} & \color{white}{0} & \color{white}{0} & \color{white}{1 } & \color{white}{1} & \color{white}{1} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{place value}:} & \color{white}{z_i \cdot B^i} & \color{white}{128} & \color{white}{0} & \color{white}{0} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & \color{white}{157} \\ \end{smallmatrix} \end{align*}

4. write down each digit of the numeral
$\quad$

\begin{align*} \begin{smallmatrix} \color{black}{\text{numeral}:} & \color{black}{} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{blue}{\text{index}:} & \color{black}{i} & \color{black}{7} & \color{black}{6} & \color{black}{5} & \color{black}{4 } & \color{black}{3} & \color{black}{2} & \color{black}{1} & \color{black}{0} \\ \color{black}{\text{place factor}:} & \color{black}{B^i} & \color{black}{2^7} & \color{black}{2^6} & \color{black}{2^5} & \color{black}{2^4} & \color{black}{2^3} & \color{black}{2^2} & \color{black}{2^1} & \color{black}{2^0} \\ \color{white}{} &

$$\color{black}{} & \color{black}{128} & \color{black}{64} & \color{black}{32} & \color{black}{16} & \color{black}{8} & \color{black}{4} & \color{black}{2} & \color{black}{1} \\ \color{blue }{\text{digits }:} & \color{blue }{z_i} & \color{blue }{1} & \color{blue }{0} & \color{blue }{0} & \color{blue }{1 } & \color{blue }{1} & \color{blue }{1} & \color{blue }{0} & \color{blue }{1} \\ \color{white}{\text{place value}:} & \color{white}{z_i \cdot B^i} & \color{white}{128} & \color{white}{0} & \color{white}{0} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{0} & \color{white}{1} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & \color{white}{157} \\ \end{smallmatrix} \end{align*}$$

5. calculate the place value
$\quad$

$$\begin{align*} \begin{smallmatrix} \color{black}{\text{numeral}:} & \color{black}{} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{blue}{\text{index}:} & \color{black}{i} & \color{black}{7} & \color{black}{6} & \color{black}{5} & \color{black}{4 } & \color{black}{3} & \color{black}{2} & \color{black}{1} & \color{black}{0} \\ \color{black}{\text{place factor}:} & \color{black}{B^i} & \color{black}{2^7} & \color{black}{2^6} & \color{black}{2^5} & \color{black}{2^4} & \color{black}{2^3} & \color{black}{2^2} & \color{black}{2^1} & \color{black}{2^0} \\ \color{white}{} & \color{black}{} & \color{black}{128} & \color{black}{64} & \color{black}{32} & \color{black}{16} & \color{black}{8} & \color{black}{4} & \color{black}{2} & \color{black}{1} \\ \color{black}{\text{digits }:} & \color{black}{z_i} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{blue }{\text{place value}:} & \color{blue }{z_i \cdot B^i} & \color{blue }{128} & \color{blue }{0} & \color{blue }{0} & \color{blue }{16} & \color{blue }{8} & \color{blue }{4} & \color{blue }{0} & \color{blue }{1} \\ \color{white}{\text{result}:} & \color{white}{\sum_i{ z_i \cdot B^i }} & & & \color{white}{157} \\ \end{smallmatrix} \end{align*}$$

6.Add all place values
$\quad$

$$\begin{align*} \begin{smallmatrix} \color{black}{\text{numeral}:} & \color{black}{} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{blue}{\text{index}:} & \color{black}{i} & \color{black}{7} & \color{black}{6} & \color{black}{5} & \color{black}{4 } & \color{black}{3} & \color{black}{2} & \color{black}{1} & \color{black}{0} \\ \color{black}{\text{place factor}:} & \color{black}{B^i} & \color{black}{2^7} & \color{black}{2^6} & \color{black}{2^5} & \color{black}{2^4} & \color{black}{2^3} & \color{black}{2^2} & \color{black}{2^1} & \color{black}{2^0} \\ \color{white}{} & \color{black}{} & \color{black}{128} & \color{black}{64} & \color{black}{32} & \color{black}{16} & \color{black}{8} & \color{black}{4} & \color{black}{2} & \color{black}{1} \\ \color{black}{\text{digits }:} & \color{black}{z_i} & \color{black}{1} & \color{black}{0} & \color{black}{0} & \color{black}{1 } & \color{black}{1} & \color{black}{1} & \color{black}{0} & \color{black}{1} \\ \color{black}{\text{place value}:} & \color{black}{z_i \cdot B^i} & \color{black}{128} & \color{black}{0} & \color{black}{0} & \color{black}{16} & \color{black}{8} & \color{black}{4} & \color{black}{0} & \color{black}{1} \\ \color{blue }{\text{result}:} & \color{blue }{\sum_i{ z_i \cdot B^i }} & & & \color{blue }{157} \\ \end{smallmatrix} \end{align*}$$