

calc_binary_example

Student Group

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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}{\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}{64} & \color{white}{32} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{2} & \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\$

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\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}{\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}{64} & \color{white}{32} & \color{white}{16} & \color{white}{8} & \color{white}{4} & \color{white}{2} & \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

$\quad$
$$\begin{aligned} & \text{\color{black}\{\text{\textnumeral:\}}\&\text{\color{black}\{\}}\&} \\ & \text{\color{black}\{1\}\&\text{\color{black}\{0\}\&\text{\color{black}\{0\}\&\text{\color{black}\{1\}\&\text{\color{black}\{1\}\&} } \\ & \text{\color{black}\{1\}\&\text{\color{black}\{0\}\&\text{\color{black}\{1\}\&\text{\color{black}\{\textindex{:}\}\&} } \\ & \text{\color{black}\{i\}\&\text{\color{black}\{7\}\&\text{\color{black}\{6\}\&\text{\color{black}\{5\}\&\text{\color{black}\{4\}\&} } \\ & \text{\color{black}\{3\}\&\text{\color{black}\{2\}\&\text{\color{black}\{1\}\&\text{\color{black}\{0\}\&} } \\ & \text{\color{blue}\{\textplace factor{:}\}\&\text{\color{blue}\{B^i\}\&\text{\color{blue}\{2^7\}\&\text{\color{blue}\{2^6\}\&} } \\ & \text{\color{blue}\{2^5\}\&\text{\color{blue}\{2^4\}\&\text{\color{blue}\{2^3\}\&\text{\color{blue}\{2^2\}\&} } \\ & \text{\color{blue}\{2^1\}\&\text{\color{blue}\{2^0\}\&\text{\color{white}\{\}\&\text{\color{white}\{\}\&} } \\ & \text{\color{white}\{128\}\&\text{\color{white}\{64\}\&\text{\color{white}\{32\}\&\text{\color{white}\{16\}\&} } \\ & \text{\color{white}\{8\}\&\text{\color{white}\{4\}\&\text{\color{white}\{2\}\&\text{\color{white}\{1\}\&} } \\ & \text{\color{white}\{\textdigits{:}\}\&\text{\color{white}\{z_i\}\&\text{\color{white}\{1\}\&\text{\color{white}\{0\}\&} } \\ & \text{\color{white}\{0\}\&\text{\color{white}\{1\}\&\text{\color{white}\{1\}\&\text{\color{white}\{1\}\&\text{\color{white}\{0\}\&} } \\ & \text{\color{white}\{1\}\&\text{\color{white}\{\textplace value{:}\}\&\text{\color{white}\{z_i\cdot B^i\}\&} } \\ & \text{\color{white}\{128\}\&\text{\color{white}\{0\}\&\text{\color{white}\{0\}\&\text{\color{white}\{16\}\&\text{\color{white}\{8\}\&} } \\ & \text{\color{white}\{4\}\&\text{\color{white}\{0\}\&\text{\color{white}\{1\}\&\text{\color{white}\{\textresult{:}\}\&} } \\ & \text{\color{white}\{\sum i\{ z_i\cdot B^i\}\}\&\&\&\text{\color{white}\{157\}\&\end{smallmatrix}\end{align}$$

3. calculate the place factor

(= ..., thousands, hundreds, tens, ones, tenths, ...)

$$\begin{aligned} & \begin{matrix} \text{numeral:} \\ \text{index:} \\ \text{place factor:} \\ \text{digits:} \\ \text{place value:} \\ \text{result:} \end{matrix} \\ & \begin{matrix} \text{B}^i \\ 2^7 \\ 2^6 \\ 2^5 \\ 2^4 \\ 2^3 \\ 2^2 \\ 2^1 \\ 2^0 \end{matrix} \\ & \begin{matrix} z_i \\ z_i \cdot B^i \end{matrix} \\ & \sum_i z_i \cdot B^i \end{aligned}$$

4. write down each digit of the numeral

$$\quad$$
$$\begin{aligned} & \text{\color{black}\{\text{text{numeral}:}\}} \& \text{\color{black}\{\}} \& \\ & \text{\color{black}\{1\}} \& \text{\color{black}\{0\}} \& \text{\color{black}\{0\}} \& \text{\color{black}\{1\}} \& \text{\color{black}\{1\}} \& \\ & \text{\color{black}\{1\}} \& \text{\color{black}\{0\}} \& \text{\color{black}\{1\}} \\\text{\color{blue}\{\text{text{index}:}\}} \& \\ & \text{\color{black}\{i\}} \& \text{\color{black}\{7\}} \& \text{\color{black}\{6\}} \& \text{\color{black}\{5\}} \& \text{\color{black}\{4\}} \& \\ & \text{\color{black}\{3\}} \& \text{\color{black}\{2\}} \& \text{\color{black}\{1\}} \& \text{\color{black}\{0\}} \\\ \\ & \text{\color{black}\{\text{text{place factor}:}\}} \& \text{\color{black}\{B^i\}} \& \text{\color{black}\{2^7\}} \& \\ & \text{\color{black}\{2^6\}} \& \text{\color{black}\{2^5\}} \& \text{\color{black}\{2^4\}} \& \text{\color{black}\{2^3\}} \& \\ & \text{\color{black}\{2^2\}} \& \text{\color{black}\{2^1\}} \& \text{\color{black}\{2^0\}} \\\text{\color{white}\{\}} \& \end{aligned}$$

```
\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*}
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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*}
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6. Add all place values

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\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*}
```

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