

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}{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}{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*}
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2. Write down the index for each position.

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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}{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}{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

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

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

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

```
\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*}
```

5. calculate the place value

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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{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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