Basic Concepts

Base 2 integer encoding

- base 2 to base 10: 2 ways
  - Way 1: 1101 is really $1 \times 2^3 + 1 \times 2^2 + 1 \times 2^0 = 13$
  - Way 2:

<table>
<thead>
<tr>
<th>$2^7$</th>
<th>$2^6$</th>
<th>$2^5$</th>
<th>$2^4$</th>
<th>$2^3$</th>
<th>$2^2$</th>
<th>$2^1$</th>
<th>$2^0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

- base 10 to base 2: 2 ways
  - Way 1: 55 = 32 + 16 + 4 + 2 + 1 = 110111
  - Way 2: Divide the decimal by 2, write down the remainders, continue till the quotient reaches to 0. The binary is the remainders read from bottom up.
- range of positive values represented by N bits
  - $0 \sim 2^{N-1}$
- binary arithmetic: addition
  - 10111 + 1101 = 100100
- 2's complement

<table>
<thead>
<tr>
<th>$-2^7$</th>
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<th>$2^5$</th>
<th>$2^4$</th>
<th>$2^3$</th>
<th>$2^2$</th>
<th>$2^1$</th>
<th>$2^0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-1</td>
</tr>
</tbody>
</table>

- Convert negative values to binary strings: 2 ways
  - Way 1: -126 = -128 + 2 = 1000 000 + 0000 0010 = 1000 0010
  - Way 2: invert each bit and add one to the result
- range of values represented by N bits in 2's complement:
  - $-2^{(N-1)} \sim 2^{(N-1)} - 1$
- overflow