\( f(w, x, y, z) \)

\[
= w'x'y'z' + w'x'y'z + w'x'yz' + wx'y'z' + wx'y'z + wxy'z'
\]

Goal: Simplify or minimize this function.

6x4 = 24 literals \( \downarrow \)

6 terms \( \downarrow \)

\[
= \sum (0, 3, 4, 8, 12, 14)
\]

Alternative 1: Algebraic simplification

Alternative 2: K-map simplification

Design choices.

K-map 4 variable map \( \Rightarrow \)
K-map

K-map

2^4 = 16 cells

\( f(w, x, y, z) = \Sigma 0, 3, 4, 8, 12, 14 \)

1. Empty K-map
2. Fill up the function in K-map
3. Group the terms:
   - As large a group as possible
   - All 1's covered by minimal number of groups

Group of 16 1's? No

Group of 8 1's? No

Group of 4 1's? Yes 1 group. \( \Rightarrow Y'Z' \)

Are all the 1's covered? No

16 1's? No 8 1's? No 4 1's? No more? 2 1's? Yes

Group of 2 1's \( \Rightarrow wxz' \)

Are all the 1's covered? No

16 1's? 8 1's? 4 1's? 2 1's? No

Singleton 1's \( \Rightarrow w'x'y'z \)

Are all the 1's covered? Yes

\( f(w, x, y, z) = Y'Z' + wxz' + W'X'Y'Z \)

NAND gates implementation

Sum of products "Standard form"
\[ f(a, b, c, d) = \ \Sigma \{0, 3, 8, 10, 17, 15, 2\} \]

4 variable K-map

Group of 4 1's?

\[ b'd' \]

Group of 2 1's?

\[ b'cd' \]

Group of 2 1's?

\[ a'b'c \]

Alternative simplified function is

\[ f(a, b, c, d) = b'd'+bcd+ab'c \]

\[ f(a, b, c, d) = 5'd'+bcd+a'ed \]

= Let's apply these concepts to a real world problem.

Seven segment LED display
Truth Table

<table>
<thead>
<tr>
<th>Inputs</th>
<th>0 0 0 0 1</th>
<th>4 inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 0 0 0</td>
<td>a b c d e f g</td>
</tr>
</tbody>
</table>

2 true & 9, 5, 4, 1, 6, 3
1 rest are 0.