What you know
- That Rob should never have tried to put a metaproducts problem on this homework...
- That middle-aged CAD faculty should ask their TAs before releasing their Powerpoint slides...
- That there is another bug on another BDD in the “More on Metaproducts” previous version of this explanation
- That you are really, really looking forward to getting on to HW3...

What you don’t know
- How to fix this bug
- If you’re actually going to read this, or just go watch another rerun of “Friends” on channel 9...

Suppose I have a Boolean function of 2 vars: F(x,y)
- If I want to consider writing an SOP equation for F(x,y), how many possible product terms could there be?

Can enumerate: there are $3^2 = 9$ terms:
- Every product has 2 “slots” for literals in it
- The first slot can be one of {ε, x, x'} where “ε” means “empty”
- The second slot can be one of {ε, y, y'} where “ε” also means “empty”
- Why 9 terms max? |{(ε, x, x')}| x |{(ε, y, y')}| = 3x3 = 9

Examples
- Term $xy' = (1^{st}$ slot is $x)(2^{nd}$ slot is $y'$)
- Term $x' = (1^{st}$ slot is $x')(2^{nd}$ slot is $ε$ -- empty)
Even More on Metaproducts

- Well, what are all 9 of these possible product terms?

<table>
<thead>
<tr>
<th>1st slot</th>
<th>2nd slot</th>
<th>Product Term Represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varepsilon$</td>
<td>$\varepsilon$</td>
<td>$\varepsilon = \text{empty}$</td>
</tr>
<tr>
<td>$x$</td>
<td>$\varepsilon$</td>
<td>$x$</td>
</tr>
<tr>
<td>$x'$</td>
<td>$\varepsilon$</td>
<td>$x'$</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>$y$</td>
<td>$y$</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>$y'$</td>
<td>$y'$</td>
</tr>
<tr>
<td>$x$</td>
<td>$y$</td>
<td>$xy$</td>
</tr>
<tr>
<td>$x$</td>
<td>$y'$</td>
<td>$xy'$</td>
</tr>
<tr>
<td>$x'$</td>
<td>$y$</td>
<td>$x'y$</td>
</tr>
<tr>
<td>$x'$</td>
<td>$y'$</td>
<td>$x'y'$</td>
</tr>
</tbody>
</table>

- OK, what does this have to do with metaproducts…?

Even More on Metaproducts

- A metaproduct is really a BDD that represents a set.
  - The set it represents is some arbitrary set of product terms, chosen from the complete set of 9 (in this 2-variable case) on previous slide.

- Example: $F(x,y) = x + y'$
Even More on Metaproducts

So, what really happens when you complement this BDD?

Complement it

This one is actually OK: kbdd says this

It’s the BDD for the set of all the OTHER product terms NOT in the original BDD...

(Also, its just the same BDD as at left, with the 1 and the 0 flipped)

Small bug – reversed labels on arrows in prev version
Subtle stuff

Interpreting what happens when you see missing variables

- x is here and negative, but no y occurrence var. Interpret as: all values of y are possible, including the empty \( \varepsilon \) y value. Result is: \( x', x'y, x'y' \)
- x is here and positive, y is here, but no y sign var. Interpret as: all “signed” values of y are possible, but not the empty \( \varepsilon \) y value. Result is: \( xy, xy' \)

So both original metaproduct BDD and its complement are just sets of stuff. They represent subsets of these 9 terms

- When you complement one of these, you don't get \( F'(\)\). You get a set that represents all the other terms you didn't represent originally

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<tr>
<th>1st slot</th>
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<th>Product Term Represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x' )</td>
<td>( y' )</td>
<td>( x'y' )</td>
</tr>
<tr>
<td>( x' )</td>
<td>( y )</td>
<td>( x'y )</td>
</tr>
<tr>
<td>( x )</td>
<td>( y )</td>
<td>( xy )</td>
</tr>
<tr>
<td>( x )</td>
<td>( y' )</td>
<td>( xy' )</td>
</tr>
</tbody>
</table>
About HW2 Problem 8

The part about “...complement it and explain it” was aimed at this, but with $F() = 4$ variables, it's just way too complicated to see. (Sorry...)

Do this instead of the complicated 4-variable function:

- Let $F(x,y) = x'y + xy'$
- Draw the BDD for the metaproduction form for $F()$
- Draw the complement BDD for this metaproduction BDD
- Like in these notes, show that the complement really does represent all of the other product terms not in the original BDD.