Mathematical laws of boolean arithmetic:  AND

- Commutative: $AB = BA$
- Associative: $ABC = (AB)C = A(BC)$
- Distributive: $A(B+C) = AB + AC$
- Identity: $A1 = A$
- Complement: $AA' = 0$

Mathematical laws of boolean arithmetic:  OR

- Commutative: $A+B = B+A$
- Associative: $A+B+C = (A+B) + C = A + (B+C)$
- Distributive: $A + BC = (A+B)(A+C)$
- Identity: $A+0 = A$
- Complement: $A+A' = 1$

DeMorgan's laws

- Equivalent boolean expressions for NAND and NOR
  - $(AB)' = A' + B'$
  - $(A+B)' = A'B'$
Examples of DeMorgan's Laws

- \((AB + BC)' = (AB)'(BC)' = (A'+B')(B'+C')\)
- \((A+B)'(C+D)' = (A'B')(C'D) = A'B'C'D\)
- \((A'B + (B+C)')' = (A'B)'(B+C) = (A+B')(B+C)\)

Deriving boolean equations from a truth table

- Q: Suppose you are given a truth table, with no circuit or equation accompanying it. How do you figure out what boolean equation corresponds to that truth table?

Example

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
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<tr>
<td>1</td>
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<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

X is true if either:
- A is false and B is true
- A is true and B is true

We can write this as:
- \(X = A'B + AB\)
- \(A'B = 1\) if A is 0 and B is 1
- \(AB = 1\) if A is 1 and B is 0

Example (cont.)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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</tr>
</tbody>
</table>

\(X = A'B + AB\)

Simplify:
- \(X = B(A'+A)\)
- \(= B(1)\)
- \(= B\)