Boolean Algebra

Lab 10

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George Boole

George Boole's work is considered by many the starting point of Boolean Algebra. His work is also considered as a beginning of sorts for Comp Sci.

Alice in Wonderland

Lewis Carroll

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What is a boolean?

A boolean is any condition or variable that can be evaluated to true or false.

```
boolean stop = false;
boolean go = true;

if(x>10) {  }

while(z<20) { }
```

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Operator Precedence

()	HIGH
! ++ --	
* / %	
+ -	
<< >> (bitwise shifts)	
< <= > >=	
== !=	
& (bitwise and)	
^ (bitwise xor)	
| (bitwise or)	
&& (logical and)	
|| (logical or)	
= += -= *= /= %=	
,	LOW

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Common Boolean Symbols

Name	Boolean Symbol	Java Counterpart
and	$\wedge$ logical and	&&
or	$\vee$ logical or	| |
not	$\neg$ logical not	!

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AND

&&

all conditions must be true

```
if (total==17 && 92==num)
{
  do something 1;
  do something 2;
}
```

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AND

Engineering Symbol

$I = C \wedge S$

C	S	I
0	0	0
0	1	0
1	0	0
1	1	1

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OR

||

any condition can be true

```
if (total==9 || num==31)
{
   do something 1;
   do something 2;
}
```

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OR

Engineering Symbol

$I = C \vee S$

C	S	I
0	0	0
0	1	1
1	0	1
1	1	1

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Fundamental Boolean Logic

true and false = false
false and true = false
false and false = false
true and true = true

false or true = true
true or false = true
true or true = true
false or false = false

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NOT

!

true (if condition is false)

```
if (! pass.equals("pass"))
{
   do something 1;
   do something 2;
}
```

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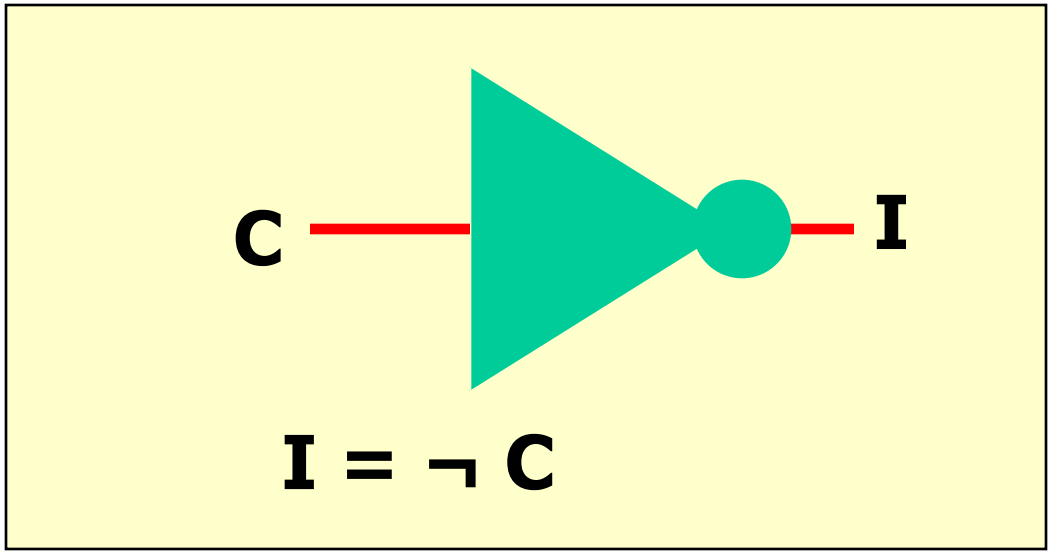
NOT

Engineering Symbol



C	I
0	1
1	0

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XOR

^

true if only one condition is true

```
if (total==34 ^ num==23)
{
   do something 1;
   do something 2;
}
```

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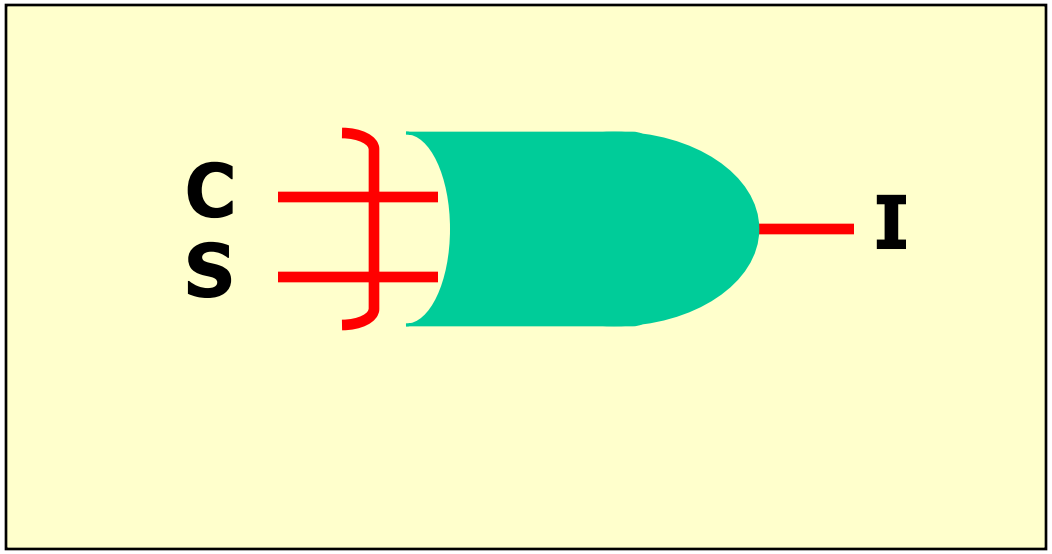
XOR

Engineering Symbol



C	S	I
0	0	0
0	1	1
1	0	1
1	1	0

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Open logical.java

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Open dowhile.java password.java

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Common Boolean Laws

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Absorption Law

$C \wedge (C \vee S) = C$	Law of Absorption
$C \vee (C \wedge S) = C$	Law of Absorption

c&&(c||s)	Java Code
c||(c&&s)	Java Code

This is used now and again by AP and UIL!

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Boolean Example 1

```
boolean c = true;
boolean s = false;
boolean i = c || (c&&s);
System.out.println(i);
```

c	s	i
1	1	1
1	0	1
0	1	0
0	0	0

OUTPUT

true

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Boolean Example 2

```
boolean c = false;
boolean s = true;
boolean i = c && (c||s);
System.out.println(i);
```

c	s	i
1	1	1
1	0	1
0	1	0
0	0	0

OUTPUT

false

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open

absorptionlaw.java

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Distributive Law

$C \wedge (S \vee I) = (C \wedge S) \vee (C \wedge I)$ **Distributive**

$C \vee (S \wedge I) = (C \vee S) \wedge (C \vee I)$ **Distributive**

```
c&&(s||i)
is the same as
(c&&s)||(c&&i)
```

This is used now and again by AP and UIL!

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Boolean Example 3

```
boolean c=true,s=true,i=false,ans;
ans=((c||(s&&i))==((c||s)&&(c||i)));
System.out.println(ans);
```

OUTPUT

true

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open

distributivelaw.java

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Start work on Lab 10

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More Boolean Laws

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DeMorgan's Law

$\neg(C \vee S) = \neg C \wedge \neg S$ DeMorgan's Law

$\neg(C \wedge S) = \neg C \vee \neg S$ DeMorgan's Law

```
!(c||s) == !c&&!s        Java Code
!(c&&s) == !c||!s        Java Code
```

This is always used by AP and UIL!

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AND

&&

all conditions must be true

```
if (c==true && s==true)
{
  do something 1;
  do something 2;
}
```

C	S	I
0	0	0
0	1	0
1	0	0
1	1	1

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Boolean Example 4

```
boolean c = true;
boolean s = true;
boolean i = !(c&&s);
System.out.println(i);
```

c	s	i
1	1	0
1	0	1
0	1	1
0	0	1

OUTPUT

false

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Boolean Example 5

```
boolean c = false;
boolean s = true;
boolean i = !(c||s);
System.out.println(i);
```

c	s	i
1	1	0
1	0	0
0	1	0
0	0	1

OUTPUT

false

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open

demorganslaw.java

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Boolean Example 6

Which statement is represented by the truth table at right?

A. i = !(c&&s)&&(c||s);
B. i = c||s&&s;
C. i = c&&s;
D. i != c&&s;

c	s	i
0	0	0
0	1	1
1	0	1
1	1	1

b

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Boolean Example 7

Which statement is represented by the truth table at right?

A. i = !(c&&s) && c||s;
B. i = c||s&&s;
C. i = c&&s;
D. i = !(c&&s) &&(c||s);

c	s	i
0	0	0
0	1	1
1	0	1
1	1	0

d

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Short Circuit Evaluation

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Short Circuit Evaluation

Java evaluates boolean expressions from left to right in most situations and stops the evaluation process once a condition is found that can complete the expression.

&& - and
|| - or

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Short Circuit Evaluation || or

```
int total=9;
boolean flipper = false;

if(flipper || total>4)
{
  out.println("short");
}
out.println("check");
```

OUTPUT

```
short
check
```

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Short Circuit Evaluation || or

```
int total=2;
boolean flipper = true;

if(flipper || total>4)
{
  out.println("short");
}
out.println("check");
```

OUTPUT

```
short
check
```

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Short Circuit Evaluation || or

```
int total=2;
boolean flipper = false;

if(flipper || total>4)
{
  out.println("short");
}
out.println("check");
```

OUTPUT

```
check
```

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Short Circuit Evaluation || or

```
int total=9, num=13;

if (total<4 || ++num<15)
{
    out.println("short");
}
out.println(num);
```

OUTPUT

```
short
14
```

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Short Circuit Evaluation && and

```
int total=9, num=13;

if (total>4 && ++num>15)
{
    out.println("short");
}
out.println(num);
```

OUTPUT

14

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Short Circuit Evaluation && and || or

```
int total=9, num=13;

if (total>4 ||++num>15 && total>0)
{
    out.println("short");
}
out.println(num);
```

OUTPUT

```
short
13
```

The && never happens!

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open
shortone.java
shorttwo.java
shortthree.java
shortfour.java

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Random Numbers

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Math.random()

```
double decOne;
decOne = Math.random() * 10;
int intOne;
intOne = (int)(Math.random() * 10);

System.out.println(decOne);
System.out.println(intOne);
```

OUTPUT

8.44193167660682
6

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Random Instantiation

reference variable

```
Random rand = new Random();
```

object instantiation

Always make Random vars instance vars!

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Random

frequently used methods

Name	Use
nextInt(x)	returns a random int 0 to x(exclusive)
nextInt()	returns a random int MIN to MAX(exclusive)
nextDouble()	returns a random int 0.0 to 1.0(exclusive)

```
import  java.util.Random;
```

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Random

```
Random rand = new Random();
int intOne = rand.nextInt(10);        //0-9
System.out.println(intOne);
intOne = rand.nextInt(50)+1;          //1-50
System.out.println(intOne);
intOne = rand.nextInt(20)+20;         //20-39
System.out.println(intOne);
```

OUTPUT

```
7
29
37
```

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open

randomone.java

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Continue work on Lab 10

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