

Monday January 28
Lecture 7

- Lab 2 Tutorial Videos 20 ~ 24

~ Loops

~ Debugger

- Quiz 2 Week of Feb 4

~ guide

Logical Law: Negation of Relation Operation

Relation	Negation	Equivalence
$i > j$	$!(i > j)$	$i \leq j$
$i \geq j$	$!(i \geq j)$	$i < j$
$i < j$	$!(i < j)$	$i \geq j$
$i \leq j$	$!(i \leq j)$	$i > j$

Test 1: $i = 17$
 $j = 3$

Test 2: $i = -4$
 $j = 13$

```

if (i > j) {
    /* Action 1 */
}
else {
    /* Action 2 */
}
    
```

Handwritten annotations: $i <= j$ above the else block, -4 and 13 above the code.

equivalent to

```

if (i <= j) {
    /* Action 2 */
}
else {
    /* Action 1 */
}
    
```

Handwritten annotations: $i > j$ above the else block, -4 and 13 above the code.

boolean P ;
boolean q ;

$$!(P \ \&\& \ q) = !P \ || \ !q$$

$$!(\check{P} \ || \ \check{q}) = \check{P} \ \&\& \ \check{q}$$

Logical Laws: De Morgan

B_1	B_2
true	true
true	false
false	true
false	false

$\neg(B_1 \ \&\& \ B_2)$
false

$\neg B_1 \ \ \neg B_2$
false

T

B_1	B_2
true	true
true	false
false	true
false	false

$\neg(B_1 \ \ B_2)$

$\neg B_1 \ \&\& \ \neg B_2$

De Morgan Law: Application 1

```
if (0 <= i && i <= 10) { /* Action 1 */ }  
else { /* Action 2 */ }
```

$\underline{!(0 \leq i \ \&\& \ i \leq 10)}$

• When is **Action 2** executed?

$i < 0 \ || \ i > 10$

```
if (i < 0 && false) { /* Action 1 */ }  
else { /* Action 2 */ }
```

• When is **Action 1** executed?

false

• When is **Action 2** executed?

true (i.e., $i \geq 0 \ || \ true$)

```
if (i < 0 && i > 10) { /* Action 1 */ }  
else { /* Action 2 */ }
```

• When is **Action 1** executed?

false

• When is **Action 2** executed?

true (i.e., $i \geq 0 \ || \ i \leq 10$)



→ if ($i < 0 \ \&\& \ \text{false}$) {

}
elsef /* ??? */ → $!(i < 0 \ \&\& \ \text{false})$
} _____ == $!(i < 0)$ || $!\text{false}$
== $i \geq 0$ (||) true
== true .

!

$\neg (0 \leq i \ \&\& \ i \leq 10)$

...

$\} \text{ else } \{$

$\quad \text{ /* ?? */ }$

$\} \dots$

$\neg (0 \leq i \ \&\& \ i \leq 10)$

$= \neg (0 \leq i) \ \parallel \ \neg (i \leq 10)$

$= \underline{0 > i \ \parallel \ i > 10}$

De Morgan Law: Application 2

```
if (i < 0 || i > 10) { /* Action 1 */ }  
else { /* Action 2 */ }
```

• When is *Action 2* executed?

$$0 \leq i \ \&\& \ i \leq 10$$

```
if (i < 0 || true) { /* Action 1 */ }  
else { /* Action 2 */ }
```

• When is *Action 1* executed?



• When is *Action 2* executed?

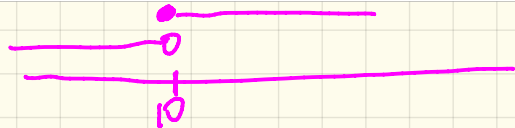


```
if (i < 10 || i >= 10) { /* Action 1 */ }  
else { /* Action 2 */ }
```

• When is *Action 1* executed?



• When is *Action 2* executed?



if (i < 0 || i > 10) {

...

}
else { /* ... */

!(i < 0 || i > 10)

== ! (i < 0) && ! (i > 10)

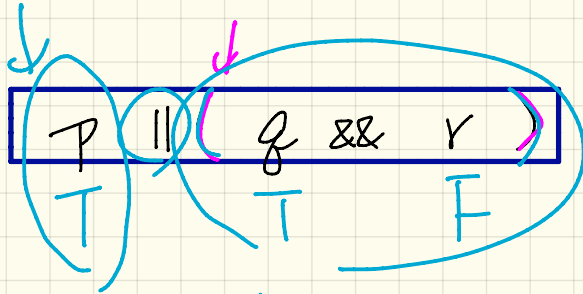
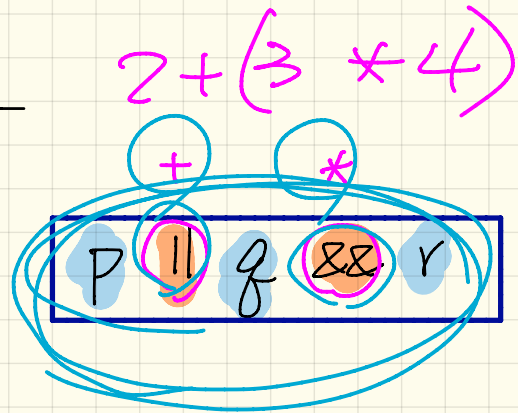
...

}

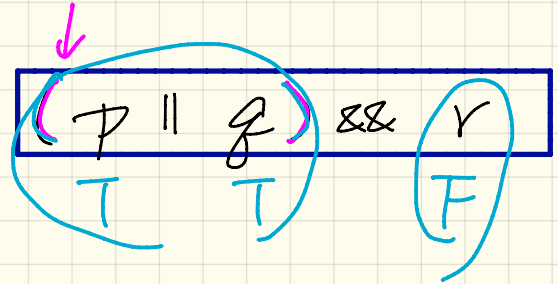
== i >= 0 && i <= 10

Precedence of Logical Operators

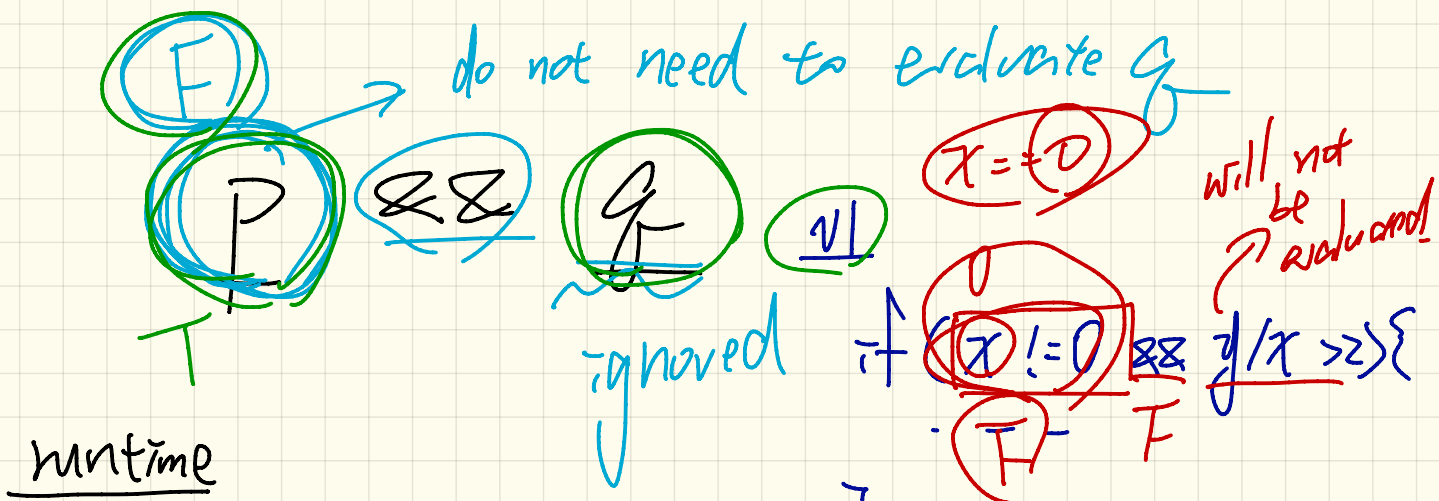
```
boolean p = true;
boolean q = true;
boolean r = false;
```



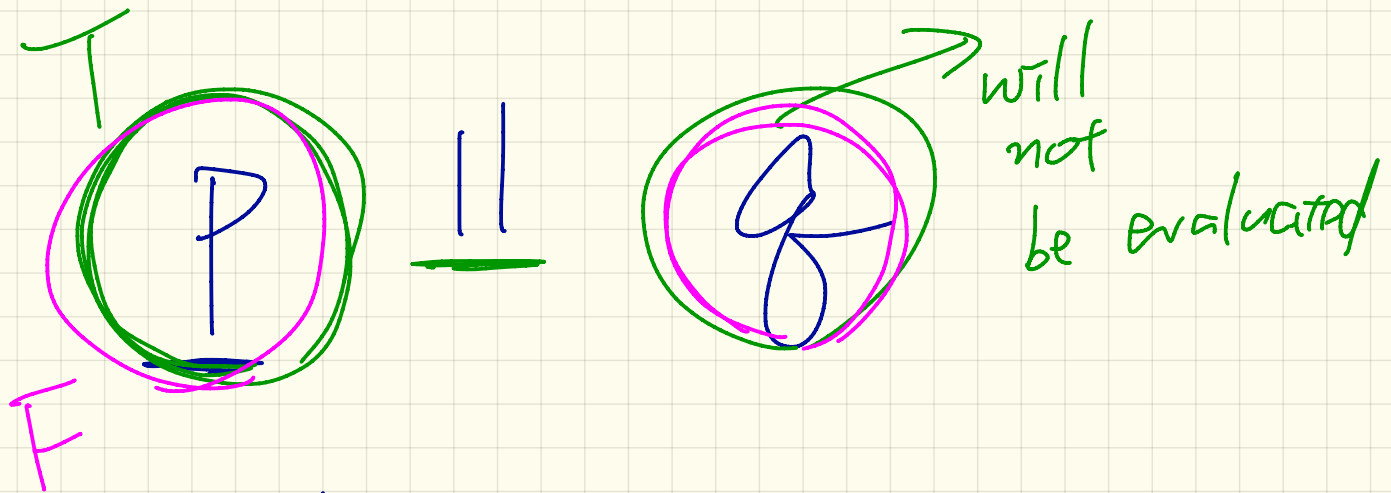
↓ - p && q
T - q && p



↓
F



1. Evaluate P
2. "If necessary", evaluate g



1. Evaluate P

2. If necessary, evaluate Q.