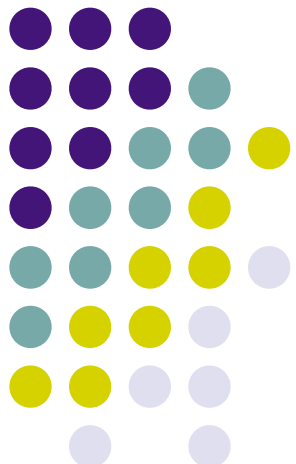
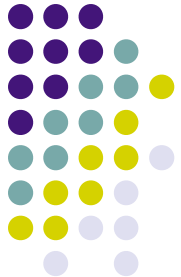
Relational and Logical Operators

CMSC 104, Spring 2014
Christopher S. Marron
(thanks to John Park for slides)



Relational and Logical Operators



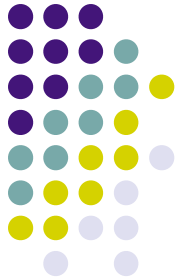
Topics

- Relational Operators and Expressions
- The if Statement
- The if-else Statement
- Nesting of if-else Statements
- Logical Operators and Expressions
- Truth Tables

Reading

- Sections 2.6, 4.10, 4.11

Relational Operators

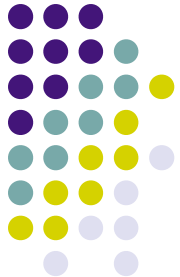


<	less than
>	greater than
<=	less than or equal to
>=	greater than or equal to
==	is equal to
!=	is not equal to

Relational expressions evaluate to the integer values 1 (true) or 0 (false).

All of these operators are called **binary operators** because they take two expressions as **operands**.

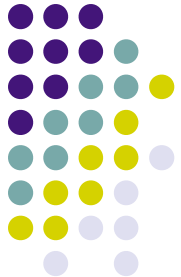
Practice with Relational Expressions



```
int a=1, b=2, c=3;
```

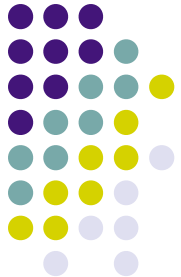
Expression	Value	Expression	Value
`a < c`		`a + b >= c`	
`b <= c`		`a + b == c`	
`c <= a`		`a != b`	
`a > b`		`a + b != c`	
`b >= c`			

Arithmetic Expressions: True or False



- **Arithmetic expressions** evaluate to numeric values.
- An arithmetic expression that has a value of zero is false.
- An arithmetic expression that has a value other than zero is true.

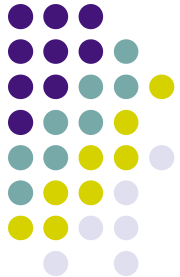
Practice with Arithmetic Expressions



```
int   a=1, b=2, c=3;
float x=3.33, y=6.66;
```

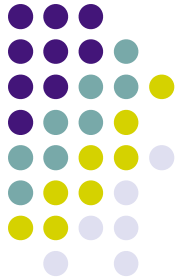
Expression	Numeric Value	True/False
`a + b`		
`b - 2 * a`		
`c - b - a`		
`c - a`		
`y - x`		
`y - 2 * x`		

Structured Programming



- All programs can be written in terms of only three control structures
  - The **sequence** structure
    - Unless otherwise directed, the statements are executed in the order in which they are written.
  - The **selection** structure
    - Used to choose among alternative courses of action.
  - The **repetition** structure
    - Allows an action to be repeated while some condition remains true.

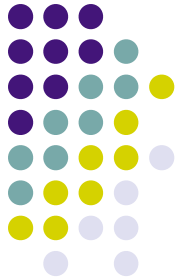
Selection: the if statement



```
if ( condition ) {
     statement(s)  /* body */
}
```

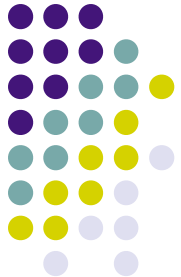
The braces are not required if the body contains only a single statement.

Examples



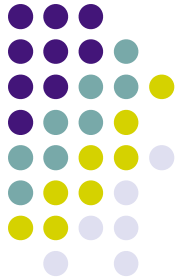
```
if (age >= 18) {
    printf("Go Vote!\n");

}


if (value == 0) {
    printf("The value you entered was zero.
\n");
}
```

Good Programming Practice



- Always place braces around the body of an if statement.
- Advantages:
  - Easier to read
  - Will not forget to add the braces if you go back and add a second statement to the body
  - Less likely to make a semantic error
- Indent the body of the if statement 3 to 4 spaces - be consistent!

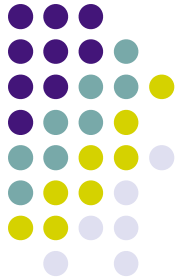
Selection: the if-else statement



```
if (condition){
      statement(s) /* if clause */
} else {
      statement(s) /* else clause */
}
```

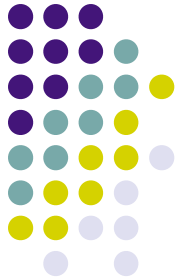
Note that there is no condition for the else.

Example



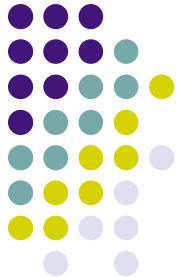
```
if ( age >= 18 ) {
    printf("Go Vote!\n") ;
} else {
    printf("Maybe next time!\n") ;
}
```

Another Example



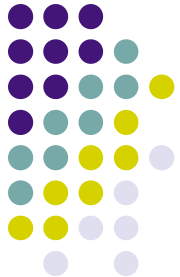
```
if (value == 0) {
   printf("The value you entered was
zero.\n") ;
} else {
   printf ("Value = %d.\n", value);
}
```

Good Programming Practice



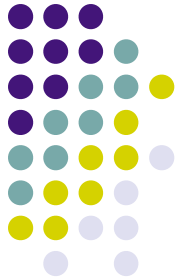
- Always place braces around the bodies of the if and else clauses of an if-else statement.
- Advantages:
  - Easier to read
  - Will not forget to add the braces if you go back and add a second statement to the clause
  - Less likely to make a semantic error
- Indent the bodies of the if and else clauses 3 to 4 spaces - be consistent!

Nesting **of if-else Statements**



```
if (condition1) {
      statement(s)
} else if (condition2)  {
    statement(s)
}

   /* more else if clauses may be here */

} else {
    statement(s)      /* the default case */
}
```

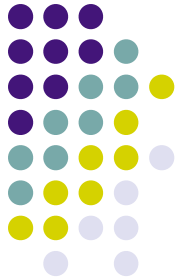
Nesting of if-else Statements



```
if (x == 1) {
    statement(s)
} else if (x == 2) {
    statement(s)
} else if (x == 3) {
    statement(s)
} else {
    statement(s)
}
```

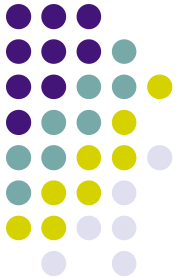
```
if (x == 1) {
    statement(s)
} else
    if (x == 2) {
        statement(s)
    } else
        if (x == 3)  {
            statement(s)
        } else {
            statement(s)
        }
```

Example



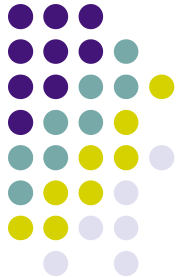
```
if (value == 0) {
   printf("You entered zero.\n");
} else if( value < 0 )  {
   printf("%d is negative.\n", value);
} else {
   printf("%d is positive.\n", value);
}
```

Gotcha! = versus ==



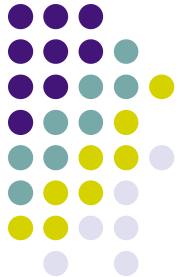
```
int a = 2;

if (a = 1) {     /* semantic (logic) error! */
    printf ("a is one\n") ;
} else if (a == 2) {
    printf ("a is two\n") ;
} else {
    printf ("a is %d\n", a) ;
}
```

Gotcha (con't)



- The statement `if (a = 1)` is syntactically correct, so no error message will be produced. (Some compilers will produce a warning.) However, a semantic (logic) error will occur.
- An assignment expression has a value - the value being assigned. In this case the value being assigned is 1, which is "true."
- If the value being assigned was 0, then the expression would evaluate to 0, which is false.
- This is a VERY common error. So, if your if-else structure always executes the same, look for this typographical error.

Logical Operators



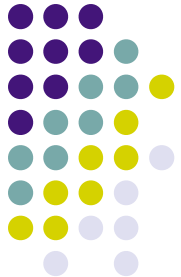
- So far we have seen only **simple conditions**.

```
if (count > 10) ...
```

- Sometimes we need to test multiple conditions in order to make a decision.
- **Logical operators** are used for combining simple conditions to make **complex conditions**.

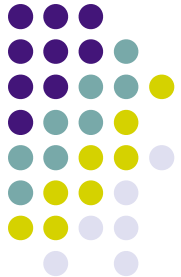
`&&`	is AND	`if (x > 5 && y < 6)`
`||`	is OR	`if (z == 0 || x > 10)`
`!`	is NOT	`if (! (bob > 42)`

Example Use of &&



```
if (age < 1 && gender == 'f') {
   printf ("You have a baby girl!\n");
}
```

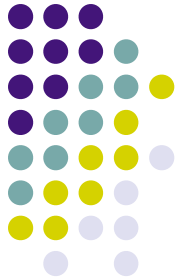
Truth Table **for &&**



$Expression_1$	$Expression_2$	$Expression_1$ && $Expression_2$
0	0	0
0	nonzero	0
nonzero	0	0
nonzero	nonzero	1

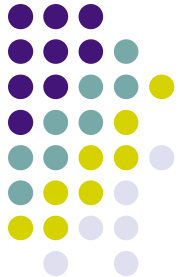
Exp_1 && Exp_2 && … && Exp_n will evaluate to 1 (true) only if ALL **subconditions** are true.

Example Use of ||



```
if (grade == 'D' || grade == 'F') {
   printf ("See you next semester!\n");
}
```

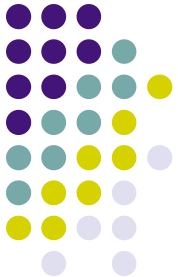
Truth Table for ||



$Expression_1$	$Expression_2$	$Expression_1$ || $Expression_2$
0	0	0
0	nonzero	1
nonzero	0	1
nonzero	nonzero	1

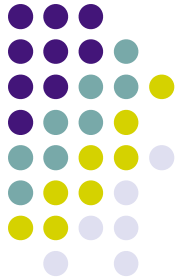
Exp_1 && Exp_2 && … && Exp_n will evaluate to 1 (true) if only ONE subcondition is true.

Example Use of !



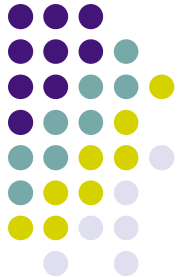
```
if (!(x == 2) ) { /* same as  (x != 2) */
    printf("x is not equal to 2.\n");
} else {
    printf("x is equal to 2.\n");
}
```

Truth Table for !



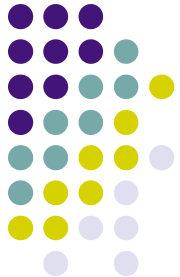
Expression	! Expression
0	1
nonzero	0

Operator Precedence and Associativity



Precedence	Associativity
( )	left to right/inside-out
* / %	left to right
+ (addition) - (subtraction)	left to right
< <= > >=	left to right
== !=	left to right
&&	left to right
||	left to right
=	right to left

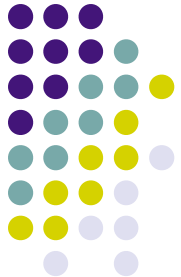
Some Practice Expressions



```
int a = 1, b = 0, c = 7;
```

Expression	Numeric Value	True/False
a		
b		
c		
a + b		
a && b		
a || b		
!c		
!!c		
a && !b		
a < b && b < c		
a > b && b < c		
a >= b || b > c		

More Practice



Given

```
int a = 5, b = 7, c = 17;
```

evaluate each expression as True or False.

1. `c / b == 2`
2. `c % b <= a % b`
3. `b + c / a != c - a`
4. `(b < c) && (c == 7)`
5. `(c + 1 - b == 0) || (b = 5)`