Control statements and operators

Lecture 2
CS 113 – Spring 2008

Announcements

- Add/drop deadline: next Monday 1/28
- Assignment #1 posted online
  - Due next Wednesday at 11:59pm on CMS
- C compilers
  - Check the website for information
  - You can download Dev-C++, or use it in the CIT labs
  - Or use another C compiler of your choice
- Office hours: W 11:00-12:00, F 1:30-2:30, 340 Upson

`if` statements

- Basic form: `if( condition ) statement;`
  - `statement` is executed iff condition is true
- Example:

```
if( 2 < 5 )
  printf("Surprise! 2 is less than 5\n");
```

- `statement` can also be multiple lines of code surrounded by braces, e.g.

```
if( 2 < 5 ) {
  printf("Surprise! 2 is less than 5\n");
  printf("What a shock!");
}
```

`if-else` statements

- `if(cond) statement1 else statement2;`
  - `statement1` is executed iff condition is true
  - `statement2` is executed iff condition is false
- Example:

```
if( a < 5 )
  printf("a < 5\n");
else
{
  if( a < 8 )
    printf("a < 8\n");
  else
    printf("a >= 8\n");
}
```

=

```
if( a < 5 )
  printf("a < 5\n");
else if( a < 8 )
  printf("a < 8\n");
else
  printf("a >= 8\n");
```

`if-else` statement pitfall

- What does this code do?

```
if( a > 70 )
  if( a < 80 )
    printf("grade = C");
else
  printf("grade < C ");
  printf("Fail.\n");

printf("done.");
```

=

```
if( a > 70 )
{
  if( a < 80 )
    printf("grade = C");
  else
    printf("grade < C ");
}
printf("Fail.\n");
printf("done.");
```

`if-else` statement pitfall

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  printf("grade < C ");
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printf("done.");
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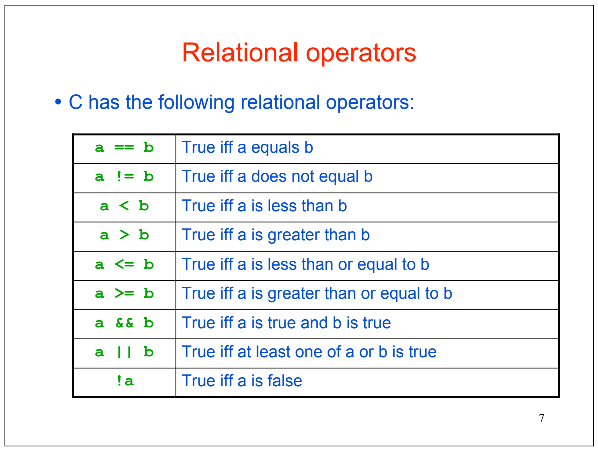
≠

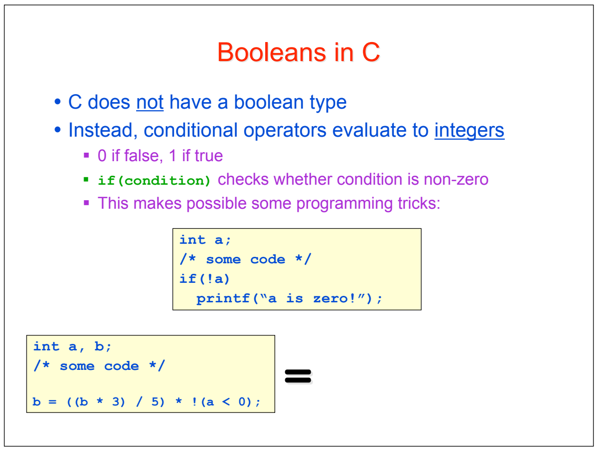
```
if( a > 70 )
{
  if( a < 80 )
    printf("grade = C");
}
else
{
  printf("grade < C ");
  printf("Fail.\n");
}

printf("done.");
```



Relational operators

- C has the following relational operators:

`a == b`	True iff a equals b
`a != b`	True iff a does not equal b
`a < b`	True iff a is less than b
`a > b`	True iff a is greater than b
`a <= b`	True iff a is less than or equal to b
`a >= b`	True iff a is greater than or equal to b
`a && b`	True iff a is true and b is true
`a || b`	True iff at least one of a or b is true
`!a`	True iff a is false



Booleans in C

- C does not have a boolean type
- Instead, conditional operators evaluate to integers
  - 0 if false, 1 if true
  - `if(condition)` checks whether condition is non-zero
  - This makes possible some programming tricks:

```
int a;
/* some code */
if(!a)
  printf(“a is zero!”);
```

```
int a, b;
/* some code */

b = ((b * 3) / 5) * !(a < 0);
```

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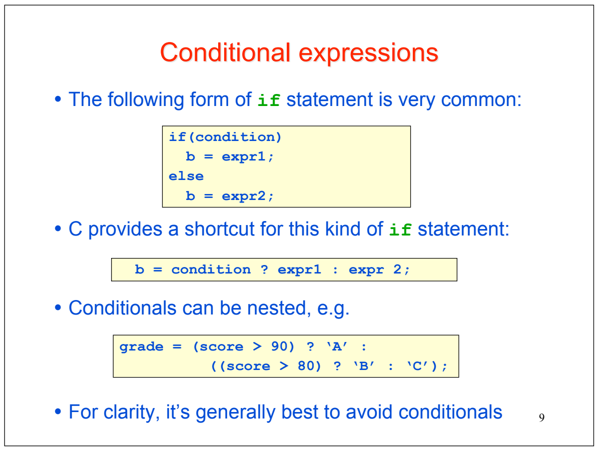


Conditional expressions

- The following form of `if` statement is very common:

```
if(condition)
  b = expr1;
else
  b = expr2;
```

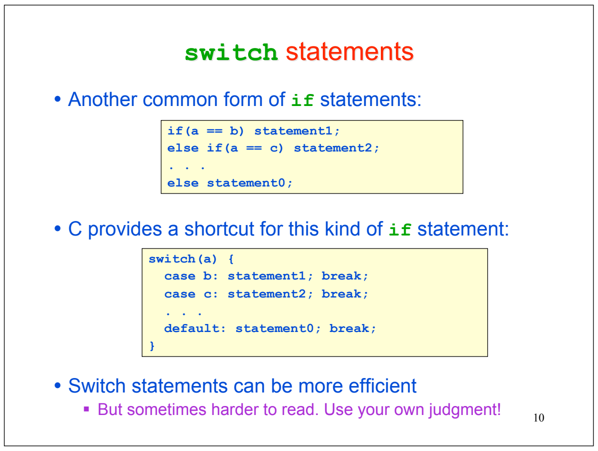
- C provides a shortcut for this kind of `if` statement:

```
  b = condition ? expr1 : expr 2;
```

- Conditionals can be nested, e.g.

```
grade = (score > 90) ? ‘A’ :
          ((score > 80) ? ‘B’ : ‘C’);
```

- For clarity, it’s generally best to avoid conditionals



`switch` statements

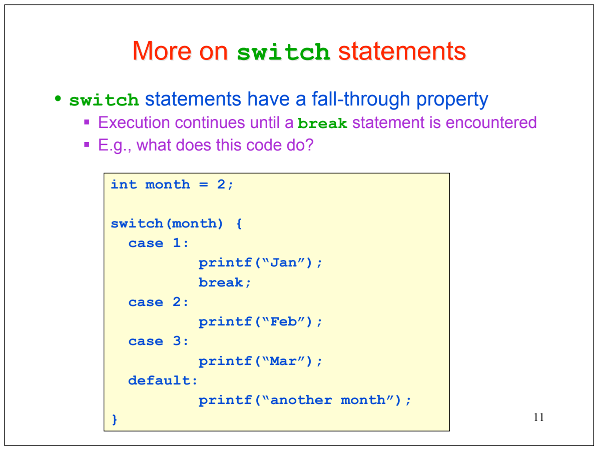
- Another common form of `if` statements:

```
if(a == b) statement1;
else if(a == c) statement2;
. . .
else statement0;
```

- C provides a shortcut for this kind of `if` statement:

```
switch(a) {
  case b: statement1; break;
  case c: statement2; break;
  . . .
  default: statement0; break;
}
```

- Switch statements can be more efficient
  - But sometimes harder to read. Use your own judgment!

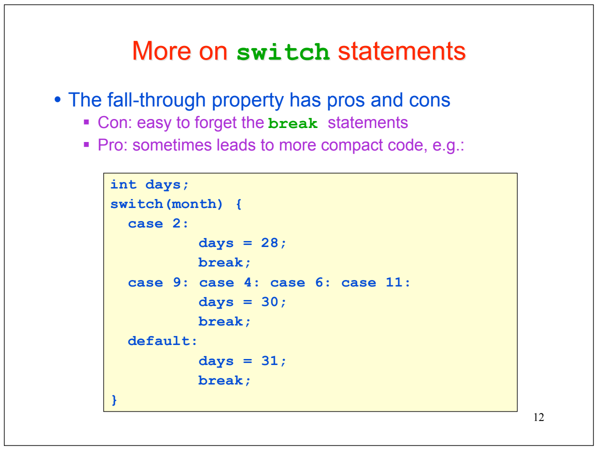


More on `switch` statements

- `switch` statements have a fall-through property
  - Execution continues until a `break` statement is encountered
  - E.g., what does this code do?

```
int month = 2;

switch(month) {
  case 1:
          printf(“Jan”);
          break;
  case 2:
          printf(“Feb”);
  case 3:
          printf(“Mar”);
  default:
          printf(“another month”);
}
```



More on `switch` statements

- The fall-through property has pros and cons
  - Con: easy to forget the `break` statements
  - Pro: sometimes leads to more compact code, e.g.:

```
int days;
switch(month) {
  case 2:
          days = 28;
          break;
  case 9: case 4: case 6: case 11:
          days = 30;
          break;
  default:
          days = 31;
          break;
}
```

`while` statements

- Simple loop construct:

```
while(condition) statement;
```

  - If condition is initially false, statement is never executed

- A variant: `do-while` loops

```
do statement while(condition);
```

  - Statement is executed at least once
  - Equivalent to:

```
statement;
while(condition) statement;
```

`for` statements

```
for(statement1; condition; statement2)
   statement;
```

- `for` statements are more complicated loop constructs
  - `statement1` is executed first (and exactly once)
  - `condition` is evaluated. If true, `statement` is executed, then `statement2`. `condition` is evaluated. If true …
  - Equivalent to:

```
statement1;
while(condition) {
  statement;
  statement2;
}
```

- Typically,
  - `statement1` is some initialization code (e.g. set a counter to 0)
  - `condition` is a stopping condition for the loop
  - `statement2` increments/decrements a counter

Loops

- Any loop can be written with a while, do-while, or for loop
  - Usually one type of loop is more natural
  - E.g. the following three are equivalent

```
i=0;
while(i<N) {
  printf("%d\n", i);
  i++;
}
```

```
i=0;
do {
  if(i < N) {
    printf("%d\n", i);
    i++;
  }
} while(i < N);
```

```
for(i=0; i<N; i++) {
  printf("%d\n", i);
}
```

Loops

- Any loop can be written with a while, do-while, or for loop
  - Usually one type of loop is more natural
  - E.g. the following three are equivalent

```
int n;
do {
  printf("enter a number:");
  n = read_int();
} while(n <= 0);
```

```
int n;
printf("enter a number:");
n = read_int();
while(n <= 0) {
  printf("enter a number:");
  n = read_int();
}
```

```
int n;
printf("enter a number:");
for(n = read_int(); n <= 0 ; n = read_int()) {
  printf("enter a number:");
}
```

break and continue

- A `break` inside a loop causes the loop to terminate immediately

```
int n = 10;
while( 1 ) {
  if(n == 0) break;
  n--;
}
```

- A `continue` statement causes the loop to immediately begin executing the next iteration

```
int n;
for(n=0; n < 10; n++) {
  if(n == 0) continue;
  printf("%d\n", n);
}
```

Common pitfalls

- What do these code fragments do?

```
int i;
for(i=0; i<10; i++);
  printf("%d\n", i);
```

```
int i=1;
while( i = 1 ) {
  printf("%d\n", i);
  i = 3;
}
```

Reserved words in C

- We've already covered half of the language!

break	case	char
continue	default	do
double	else	enum
extern	float	for
goto	if	int
long	register	return
short	sizeof	static
struct	switch	typedef
union	unsigned	void
while		

More on printf

- Syntax: `printf(format_string, val1, val2, …);`
  - `format_string` can include *placeholders* that specify how the arguments `val1`, `val2`, etc. should be formatted
  - `%c` : format as a character
  - `%d` : format as an integer
  - `%f` : format as a floating-point number
  - `%%` : print a `%` character

```
int i = 90;
float f = 3.0;
printf("%d roads\n", 42);
printf("i = %d%%, f = %f\n", i, f);
```

More on printf

- Placeholders can also specify widths and precisions, e.g.
  - `%10d` : add spaces to take up at least 10 characters
  - `%010d` : add zeros to take up at least 10 characters
  - `%.2f` : print only 2 digits after decimal point
  - `%5.2f` : print 1 decimal digit, add spaces to take up 5 chars

```
int i = 90;
float f = 3.0;
printf("%5d roads\n", 42);
printf("i = %06d, f = %5.2f\n", i, f);
```

```
   42 roads
i = 000090, f =  3.00
```

- Printf has many other features! Check API online.

Warning about printf

- `printf` is powerful, but potentially dangerous
  - What does this code do?

```
int i = 90;
float f = 3.0;

printf("i = %d, f = %f\n", i);
printf("%d roads\n", 42, f);
printf("i = %d, f = %f\n", f, i);
```