2. Basic Program Structure

ENEE 140

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Today's Lecture

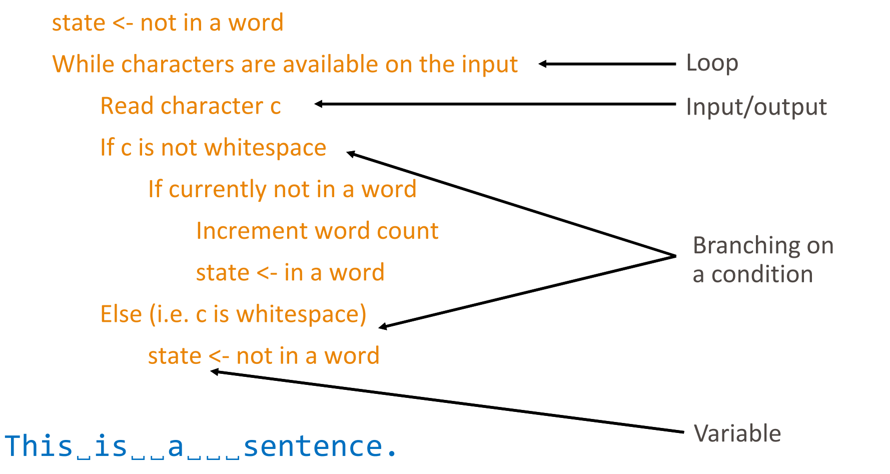
- Where we've been
  - Comments & documentation
  - First program in C
  - *Requirements*
  - *Using Eclipse*
- Where we're going today
  - Variables
  - Constants
  - Arithmetic operations
  - `while` loops
  - *Program design*
- Where we're going next
  - Character input/output

We’ve Seen: Requirements

Before you start programming,
you must understand the requirements
(you must **know what the program is supposed to do**)

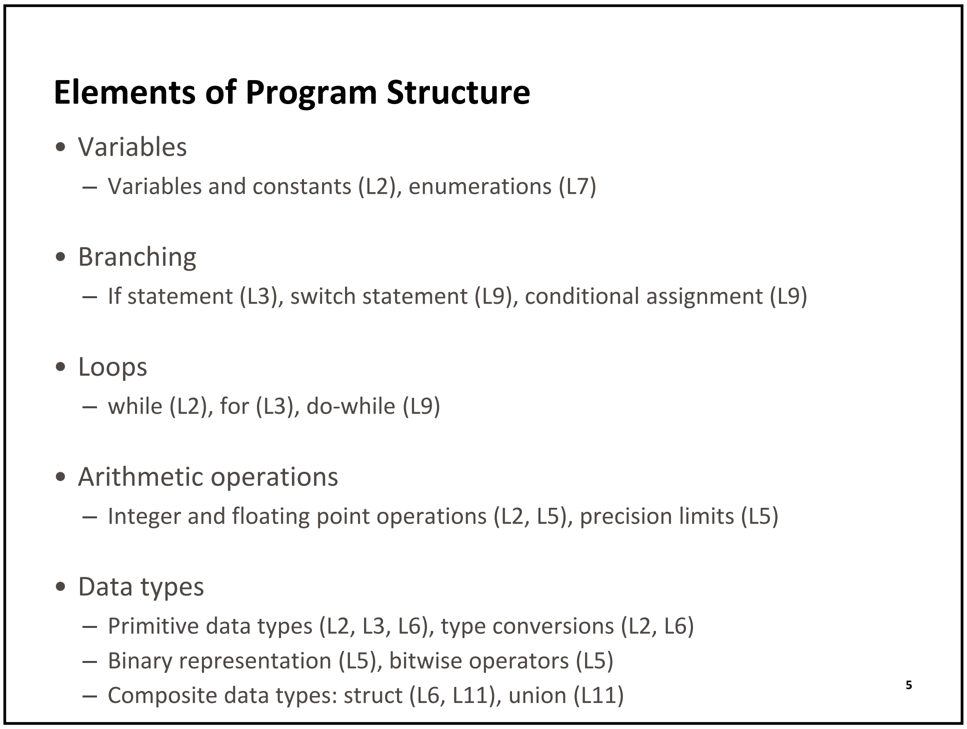
Program Design

- Write a program that counts the number of words from its input



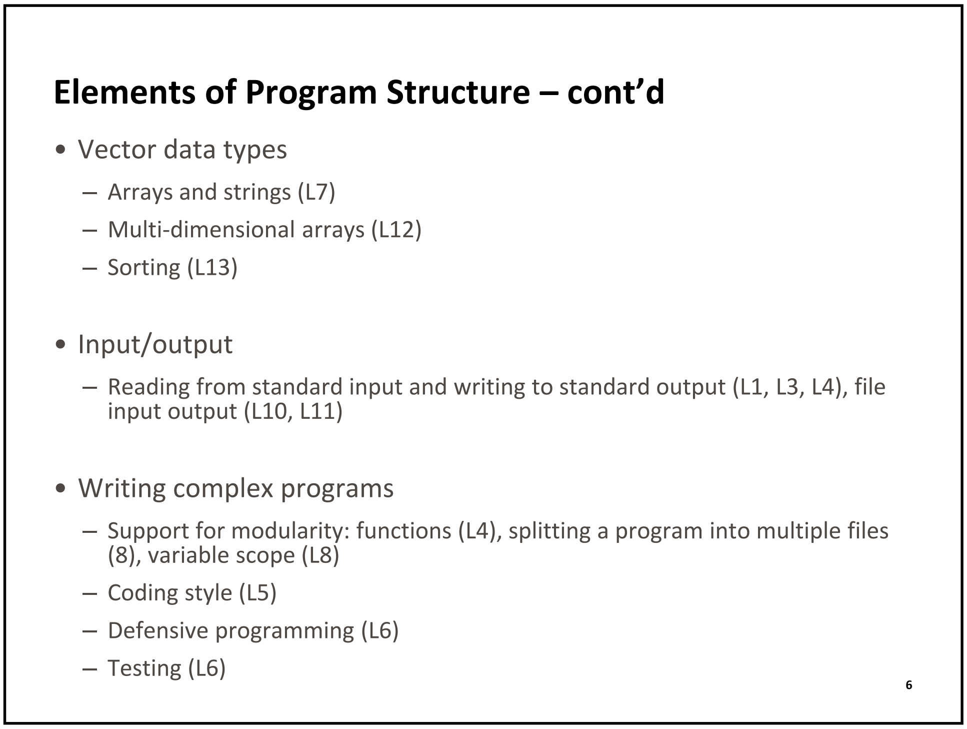
```
state <- not in a word
While characters are available on the input
    Read character c
    If c is not whitespace
        If currently not in a word
            Increment word count
            state <- in a word
    Else (i.e. c is whitespace)
        state <- not in a word
```

`This␣is␣␣a␣␣␣sentence.`



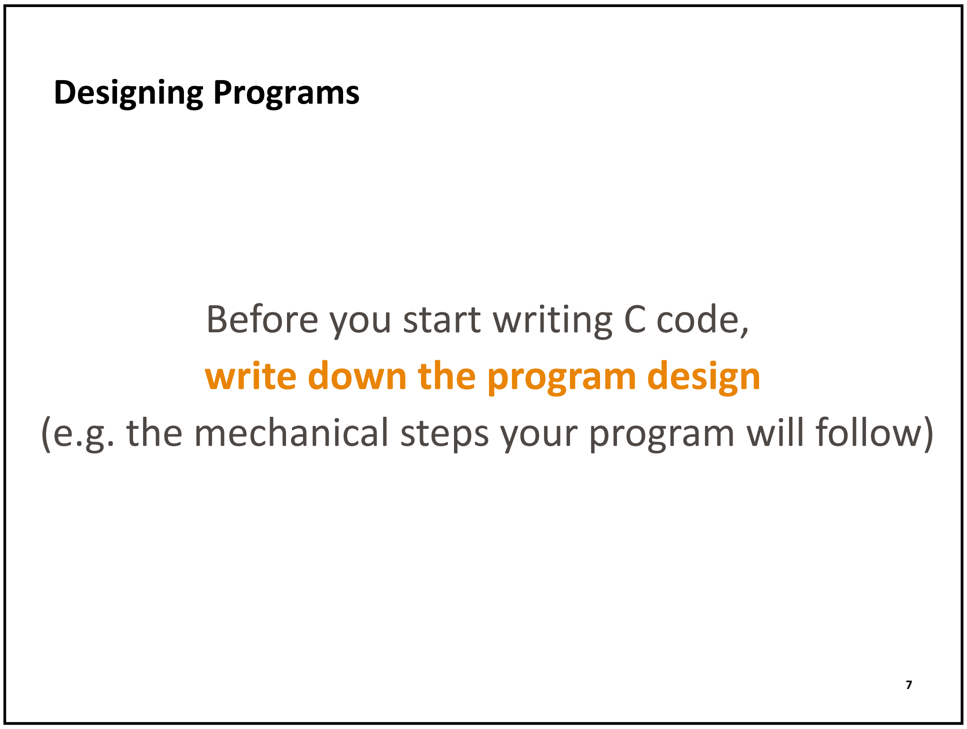
Elements of Program Structure

- Variables
  - Variables and constants (L2), enumerations (L7)
- Branching
  - If statement (L3), switch statement (L9), conditional assignment (L9)
- Loops
  - while (L2), for (L3), do-while (L9)
- Arithmetic operations
  - Integer and floating point operations (L2, L5), precision limits (L5)
- Data types
  - Primitive data types (L2, L3, L6), type conversions (L2, L6)
  - Binary representation (L5), bitwise operators (L5)
  - Composite data types: struct (L6, L11), union (L11)



Elements of Program Structure – cont’d

- Vector data types
  - Arrays and strings (L7)
  - Multi-dimensional arrays (L12)
  - Sorting (L13)
- Input/output
  - Reading from standard input and writing to standard output (L1, L3, L4), file input output (L10, L11)
- Writing complex programs
  - Support for modularity: functions (L4), splitting a program into multiple files (8), variable scope (L8)
  - Coding style (L5)
  - Defensive programming (L6)
  - Testing (L6)

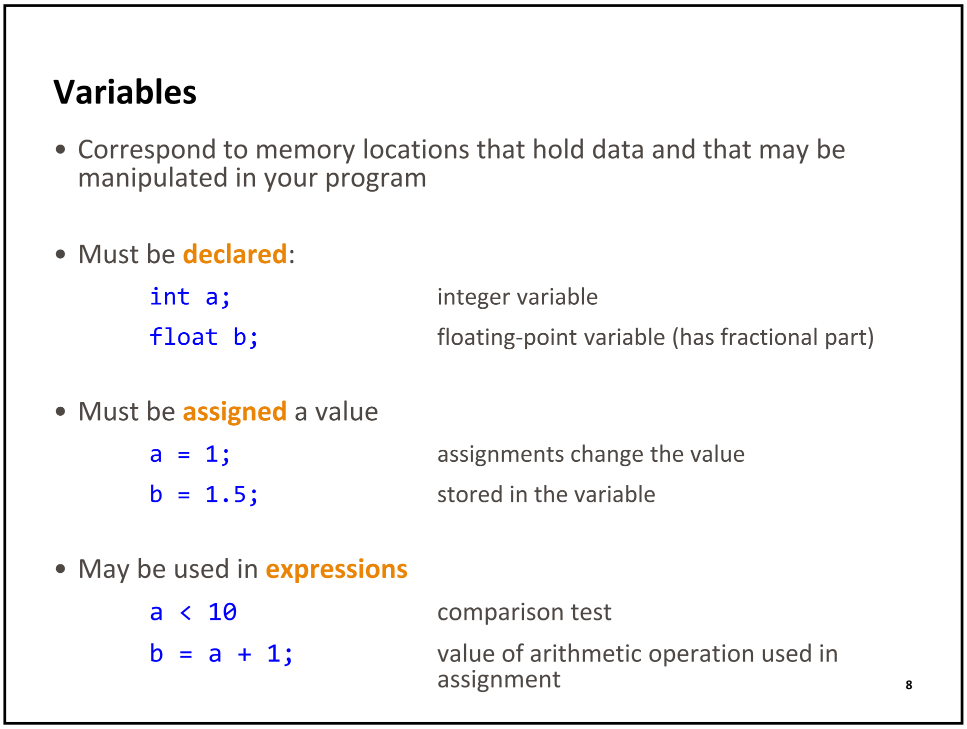


Designing Programs

Before you start writing C code,

write down the program design

(e.g. the mechanical steps your program will follow)



Variables

- Correspond to memory locations that hold data and that may be manipulated in your program

- Must be **declared**:

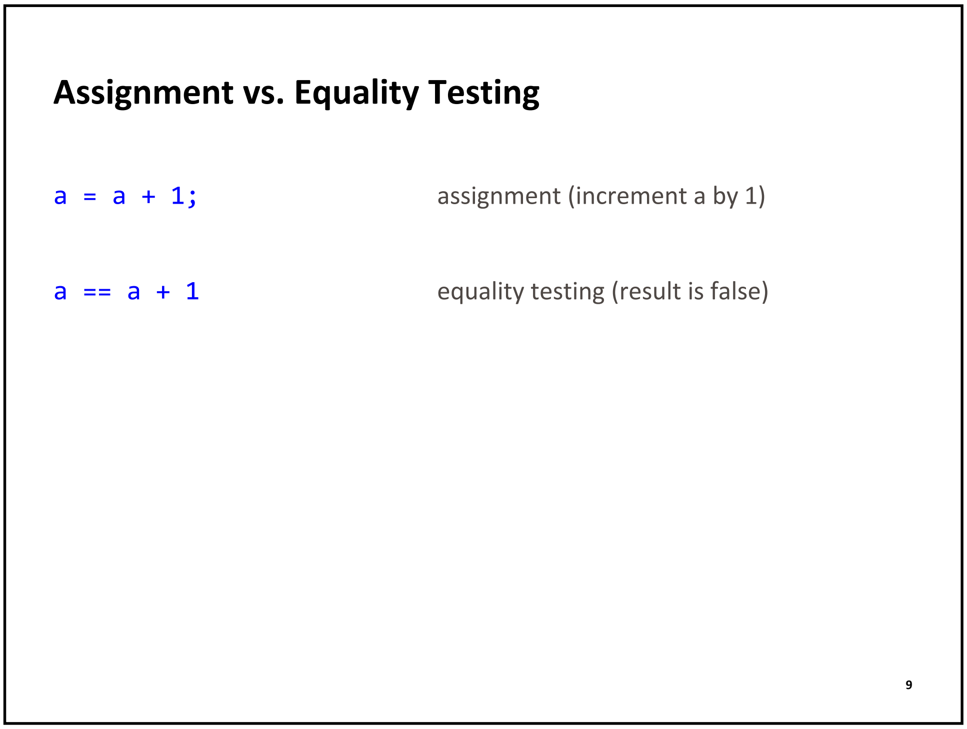
`int a;`	integer variable
`float b;`	floating-point variable (has fractional part)

- Must be **assigned** a value

`a = 1;`	assignments change the value
`b = 1.5;`	stored in the variable

- May be used in **expressions**

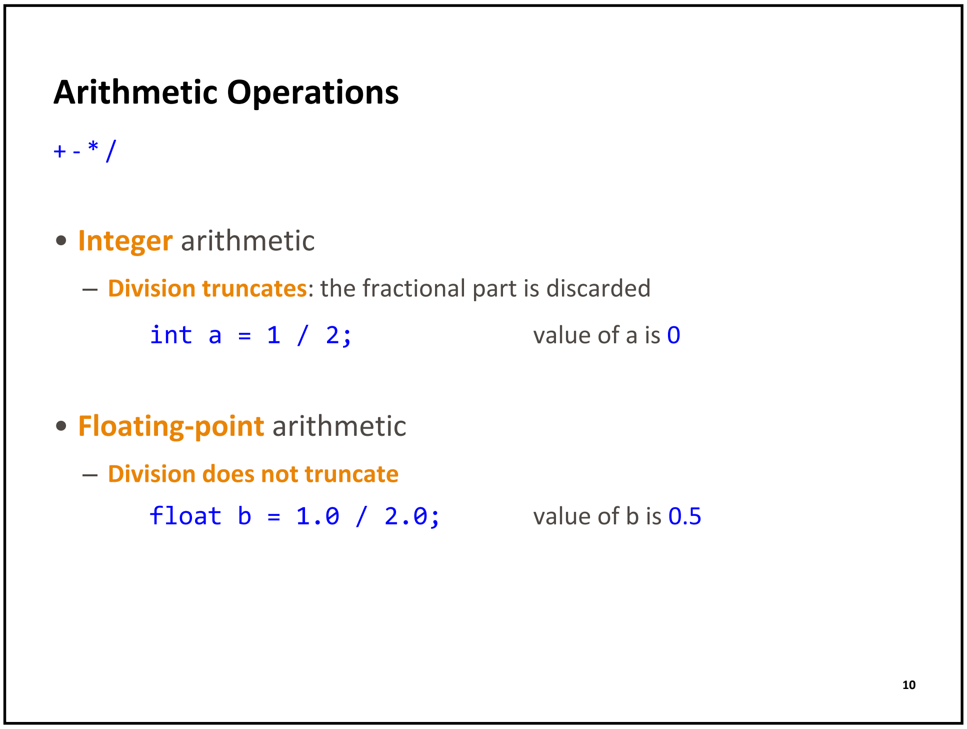
`a < 10`	comparison test
`b = a + 1;`	value of arithmetic operation used in assignment



Assignment vs. Equality Testing

```
a = a + 1;
```
assignment (increment a by 1)

```
a == a + 1
```
equality testing (result is false)



Arithmetic Operations

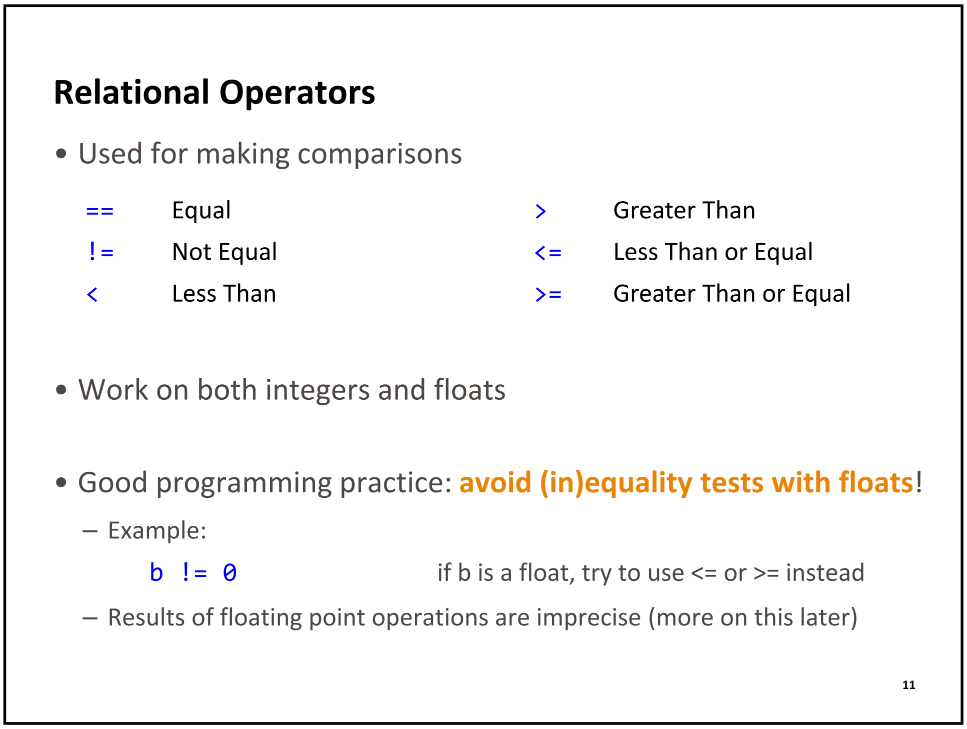
`+ - * /`

- **Integer** arithmetic
  - **Division truncates**: the fractional part is discarded

    `int a = 1 / 2;` value of a is 0

- **Floating-point** arithmetic
  - **Division does not truncate**

    `float b = 1.0 / 2.0;` value of b is 0.5



Relational Operators

- Used for making comparisons

`==`	Equal	`>`	Greater Than
`!=`	Not Equal	`<=`	Less Than or Equal
`<`	Less Than	`>=`	Greater Than or Equal

- Work on both integers and floats

- Good programming practice: **avoid (in)equality tests with floats**!
  - Example:

    `b != 0` if b is a float, try to use <= or >= instead
  - Results of floating point operations are imprecise (more on this later)

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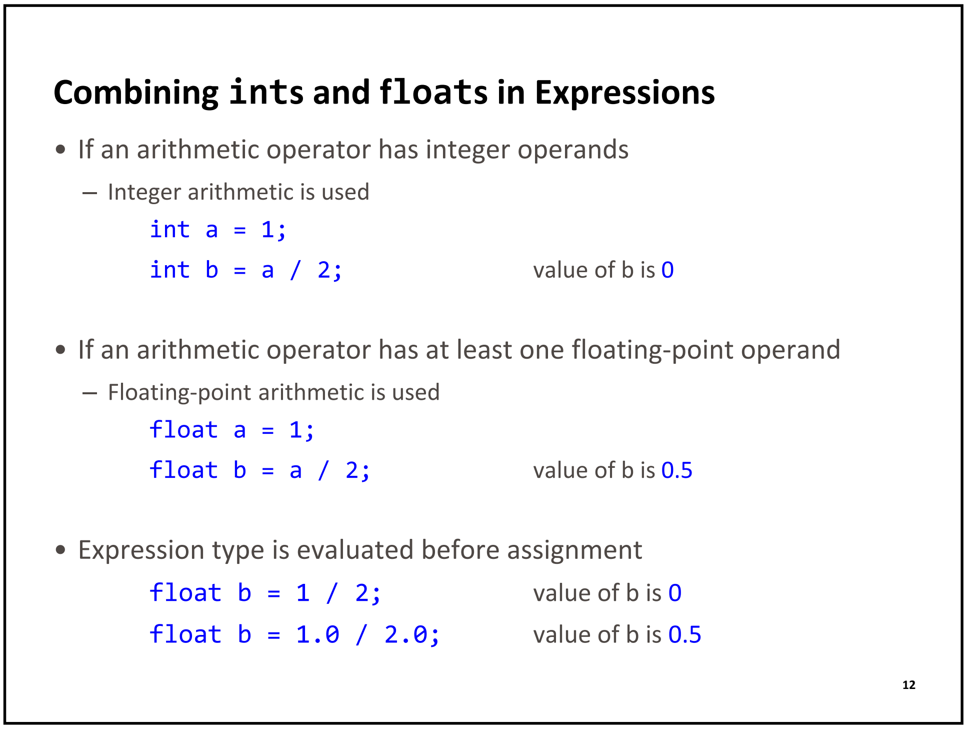

Combining `int`s and `float`s in Expressions

- If an arithmetic operator has integer operands
  - Integer arithmetic is used

```
int a = 1;
int b = a / 2;
```

value of b is 0

- If an arithmetic operator has at least one floating-point operand
  - Floating-point arithmetic is used

```
float a = 1;
float b = a / 2;
```

value of b is 0.5

- Expression type is evaluated before assignment

```
float b = 1 / 2;
```

value of b is 0

```
float b = 1.0 / 2.0;
```

value of b is 0.5

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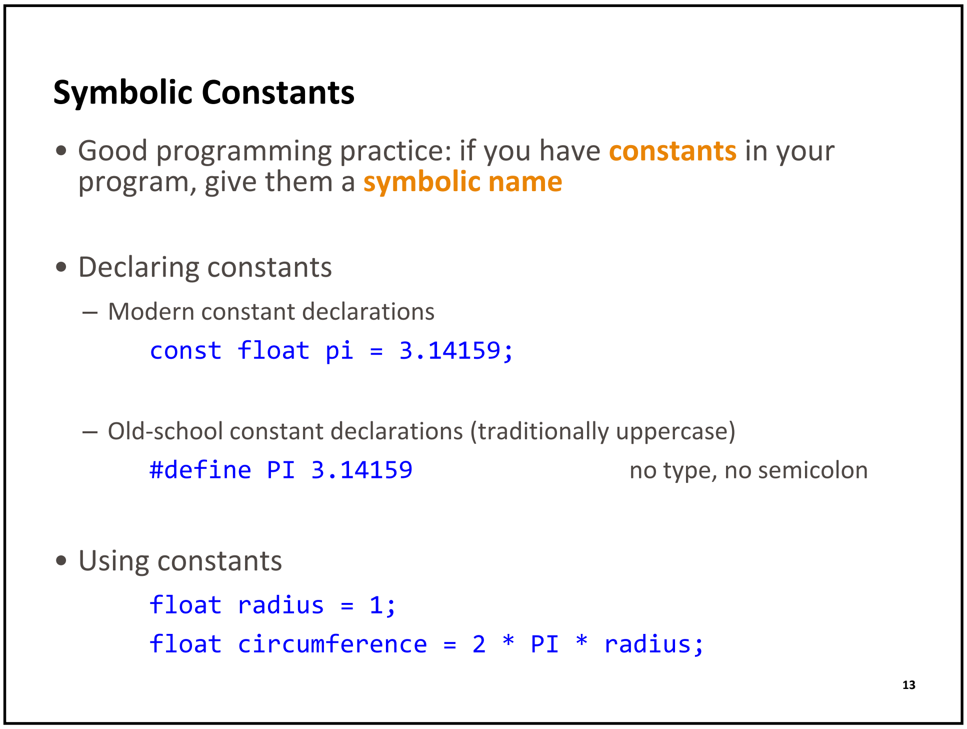


Symbolic Constants

- Good programming practice: if you have **constants** in your program, give them a **symbolic name**

- Declaring constants
  - Modern constant declarations

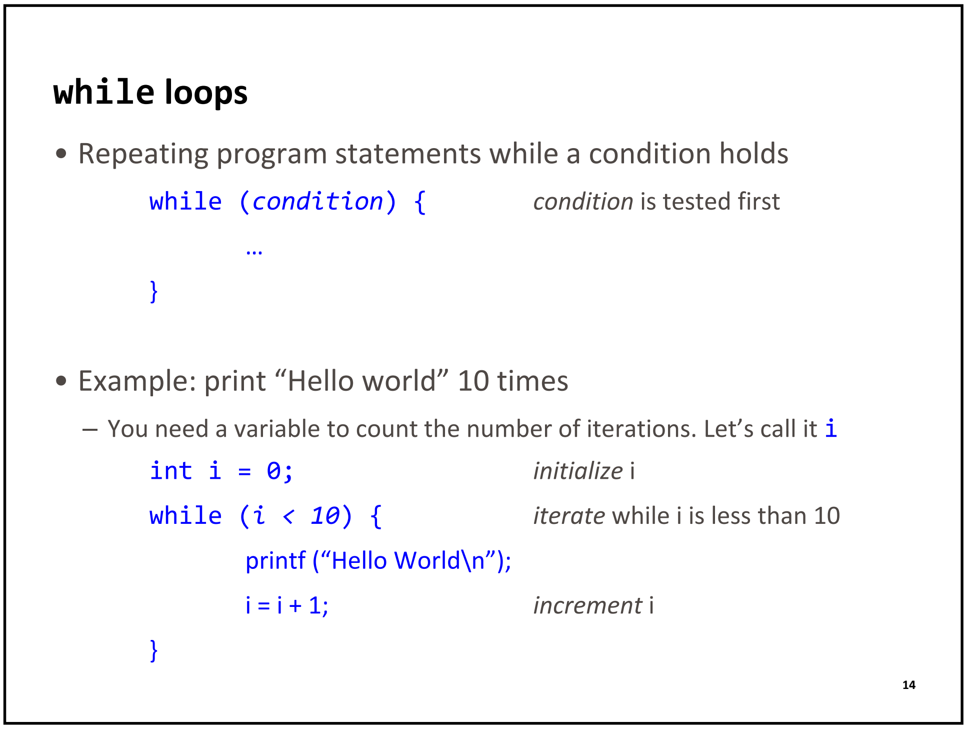
```
const float pi = 3.14159;
```

  - Old-school constant declarations (traditionally uppercase)

```
#define PI 3.14159                no type, no semicolon
```

- Using constants

```
float radius = 1;
float circumference = 2 * PI * radius;
```



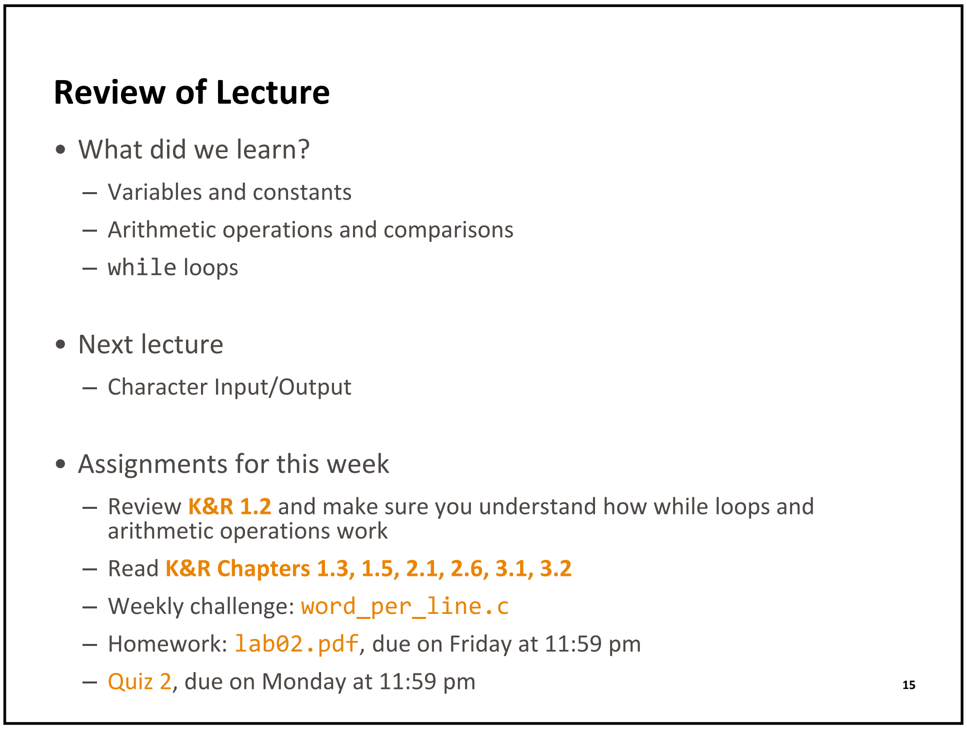
while loops

- Repeating program statements while a condition holds

```
while (condition) {          condition is tested first
        …
}
```

- Example: print “Hello world” 10 times
  - You need a variable to count the number of iterations. Let’s call it i

```
int i = 0;                   initialize i
while (i < 10) {             iterate while i is less than 10
        printf (“Hello World\n”);
        i = i + 1;           increment i
}
```



Review of Lecture

- What did we learn?
  - Variables and constants
  - Arithmetic operations and comparisons
  - `while` loops
- Next lecture
  - Character Input/Output
- Assignments for this week
  - Review **K&R 1.2** and make sure you understand how while loops and arithmetic operations work
  - Read **K&R Chapters 1.3, 1.5, 2.1, 2.6, 3.1, 3.2**
  - Weekly challenge: `word_per_line.c`
  - Homework: `lab02.pdf`, due on Friday at 11:59 pm
  - Quiz 2, due on Monday at 11:59 pm