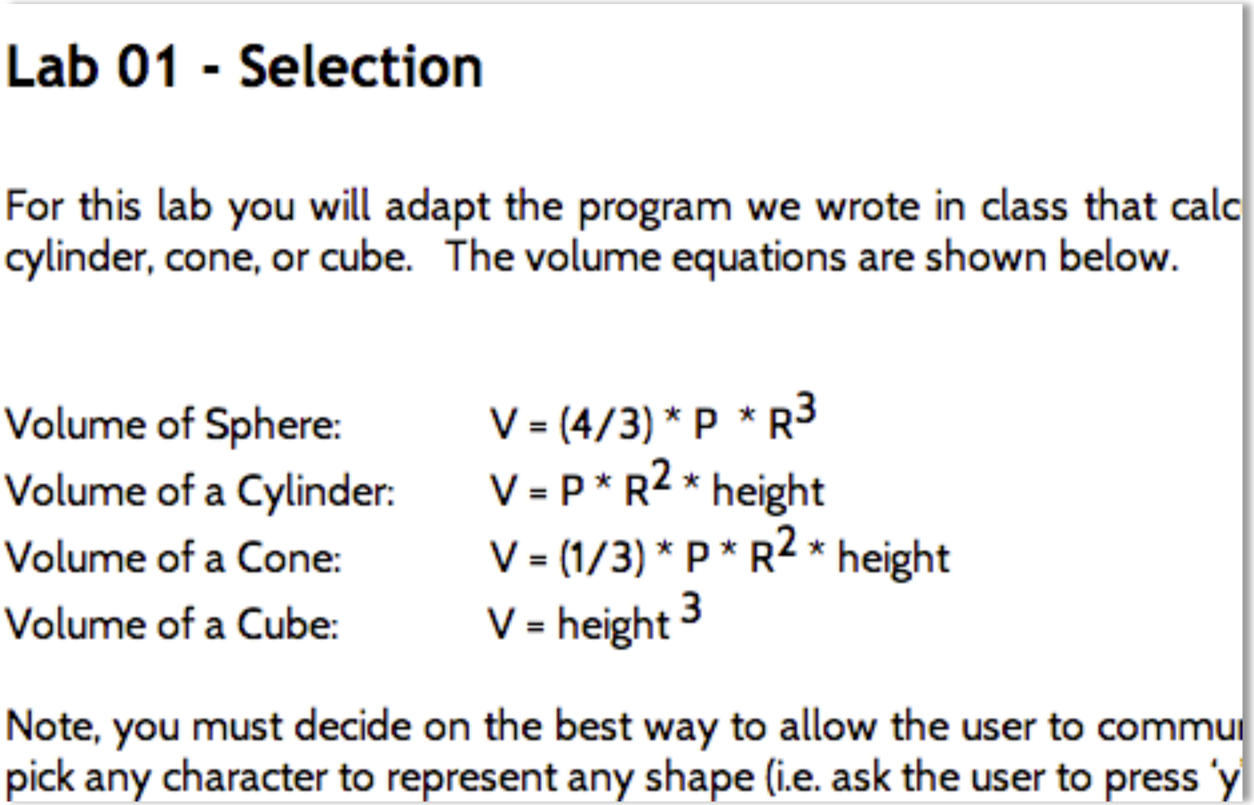
LOOPS

Lab 1 - Recap



Lab 01 - Selection

For this lab you will adapt the program we wrote in class that calc
cylinder, cone, or cube. The volume equations are shown below.

Volume of Sphere:	$V = (4/3) * P * R^3$
Volume of a Cylinder:	$V = P * R^2 * \text{height}$
Volume of a Cone:	$V = (1/3) * P * R^2 * \text{height}$
Volume of a Cube:	$V = \text{height}^3$

Note, you must decide on the best way to allow the user to commu
pick any character to represent any shape (i.e. ask the user to press 'y

while Loop Syntax

```
while ( boolean expression ) {
    statements to execute….
}
```

Designing While Loops

- while loops run **<u>until</u>** a condition **<u>fails</u>**
  - Step 1: Determine Ending condition
    - Expressed as a boolean expression
  - Step 2: Initialization
    - Determine what, if any, steps are needed to make sure the "first" execution works as expected.
  - Step 3: Ensure statements within loop will eventually meet end condition
    - Statements inside while loop **must** make some change to to the variables in the boolean expression!

Pre-Test

- A while loop is a **pre-test** loop:
  - Before executing any statements within the loop, the boolean expression is checked.

- Often, we will want to execute **at least** once…
  - Execute the statements, *then* test to see if we should repeat…

Post-Test

- Do - While Loop

```
do {
    statements…
} while ( boolean expression ) ;
```

- Always executes at least 1 **iteration**.

Exercise

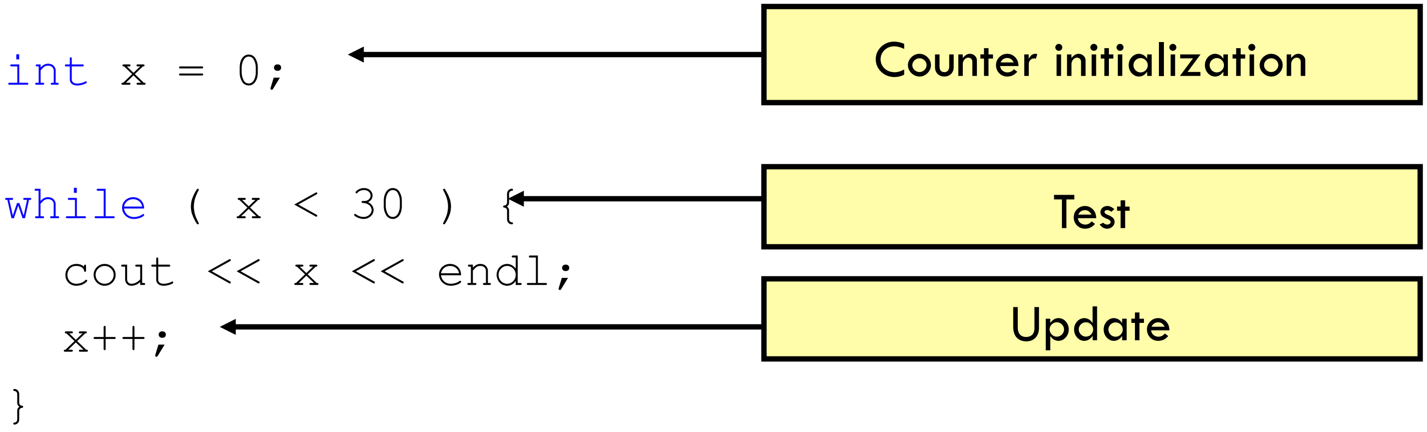
- Ask the user to enter a series of numbers
- They can stop by entering “-1”
- Compute and display the sum of all the numbers entered.

Counting v.s. Conditional Loops

- Conditional Loops: We do not know how many times we will loop…
  - *Sentinel (number entered != -1)*
  - *Continue? (y/n)*
  - *Input validation*

Counting Loops

- Counting: We will loop some set number of times, known *before* loop is entered



```
int x = 0;

while ( x < 30 ) {
   cout << x << endl;
   x++;
}
```

Counter initialization

Test

Update

- All counting loops share common features.

for Loops

```
for ( initialization; test; update) {
            statements…
}
```

```
for ( int i = 0; i < 30; i++) {
   statements…
}
```

Estimating PI

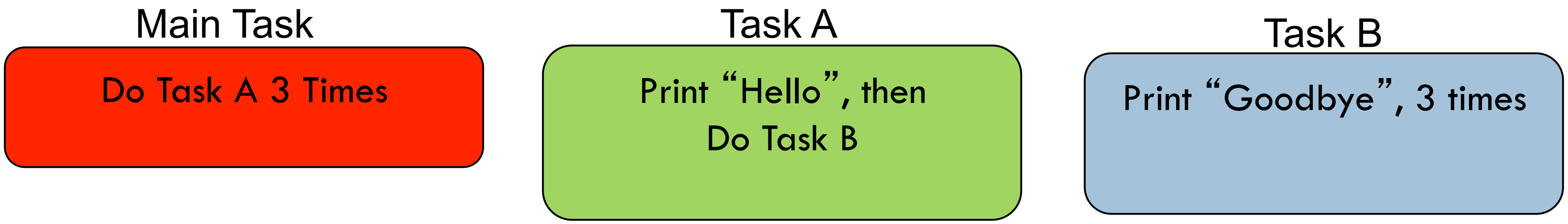
- PI can be estimated by computing an *infinite* series…

PI = 4 * (1 - 1/3 + 1/5 - 1/7 + 1/9 -1/11 +…)

Write a program to estimate PI…

How long does it take to get to 3.14159?

Nested for-loops



Main Task

Do Task A 3 Times

Task A

Print “Hello”, then
Do Task B

Task B

Print “Goodbye”, 3 times

```
// Main Task
for ( int i = 0; i < 3; i++ ) {
   // Task A
   cout << “Hello” << endl;
   // Task B
   for ( int j = 0; j < 3; j++ ) {
     cout << “Goodbye” << endl;
   }
}
```

```
Hello
Goodbye
Goodbye
Goodbye
Hello
Goodbye
Goodbye
Goodbye
Hello
Goodbye
Goodbye
Goodbye
```

Prime Numbers

- Ask the user to enter a positive number between 1 and 50 (input validation) -> N
- Then find the first N prime numbers
  - A number is prime if it is not divisible by any numbers between 1 and the number
  - `do-while` loop for validation
  - `while` loop for computing enough prime numbers
  - `for` loop for checking if the number is prime

Lab #2

- The constant "e" is approximately 2.718 and has been calculated to 869,894,101 decimal places.
- e^x is approximated by the following series.

$$e^x = x^0/0! + x^1/1! + x^2/2! + x^3/3! + x^4/4! + \ldots + x^n/n!$$

- Write a program that asks the user for a **positive** value for X. Display e^x based on the above approximation where N is 1, 5, 25, and 125.

```
e^5 (2 iterations) = 6.0000000000
e^5 (6 iterations) = 91.4166666667
e^5 (26 iterations) = 148.4131590981
e^5 (126 iterations) = 148.4131591026
```

I used `setprecision(10)` and `fixed`

http://ncalculators.com/number-conversion/e-x-calculator.htm

Important Tips for the lab

- This can be a tough problem, since you will end up with 3 levels of nesting (at least)
- For each N (N = 1, 5, 25, 125 …. *N*=5*)
  - **EX** = 0;
  - For each **i** = 0 to **N** (inclusive)
    - Calculate A = $\mathbf{x}^{i}$ (use pow function)
    - Calculate B = **i!** (this will be another loop)
    - Add A/B to **EX**
- I highly recommend you do N = 5 **first**, without using any looping for N. Get that number to be correct.
- Print out **i** on each iteration – along with $\mathbf{x}^{i}$ and **i!**. Make sure they are individually correct on each iteration.
- Then wrap your calculation in a loop for N = 1, 5, 25, 125

Next Class

- Please read chapter 5 in the text (FUNCTIONS)
  - We'll cover functions for the next week or so.
  - Remember to complete the lab for next class (upload to appiversity **before** class starts.