University of British Columbia
CPSC 111, Intro to Computation
2009W2: Jan-Apr 2010

Tamara Munzner

Loops II

Lecture 18, Mon Mar 1 2010

borrowing from slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/111-10

Reading

- This week: Chapter 6 all (6.1-6.4)
  - second edition: Chap 7

News

- Welcome back!
- Midterms returned last time
  - get yours after class if you didn't already
- Department news

Events this week

Resume & Cover Letter Drop-In Session

Date: Wed., Mar 3
Time: 12 – 3 pm (20 mins. sessions)
Location: Rm 255, ICICS/CS

Find a Job Fast! Info Session

Date: Thurs., Mar 4
Time: 12:30 – 1:45 pm
Location: DMP 201
Registration: Email dianejoh@cs.ubc.ca

Townhall Meting – 1st Year CS Students

Date: Thurs., Mar 4
Time: 12:30 - 2 pm
Location: DMP 310
Lunch will be provided!

Faculty Talk – Son Vuong

Title: Mobile Learning via LIVES
Date: Thurs., Mar 4
Time: 12:30 – 1:45 pm
Location: DMP 201

Events next week

Townhall Meeting – Combined Majors/Honours, BA, B.Comm in CS

Date: Thurs., Mar 11
Time: 12:30 – 2 pm
Location: DMP 310
Lunch will be provided!

CS Distinguished Lecture Series – Featuring David Parkes

Title: Incentive Mechanism Engineering in the Internet Age
Date: Thurs., Mar 11
Time: 3:30 – 4:50 pm
Location: DMP 110

CSSS Moive Night – "Zombieland" & "Iron Man"

Date: Thurs., Mar 11
Time: 6 – 10 pm
Location: DMP 310
Free pop & popcorn!

Recap: `While` Statement

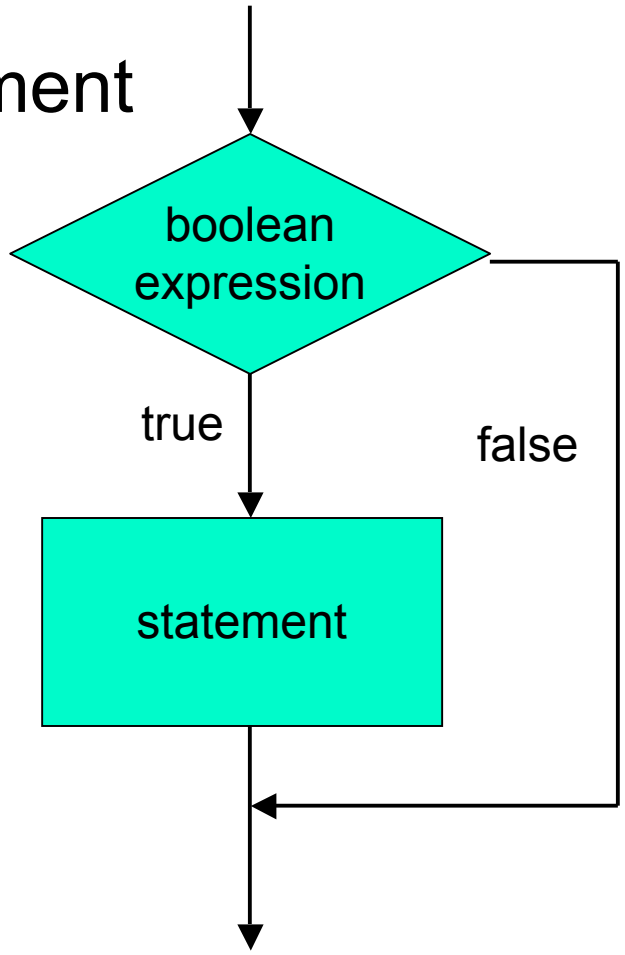
`while` (boolean expression)

    body

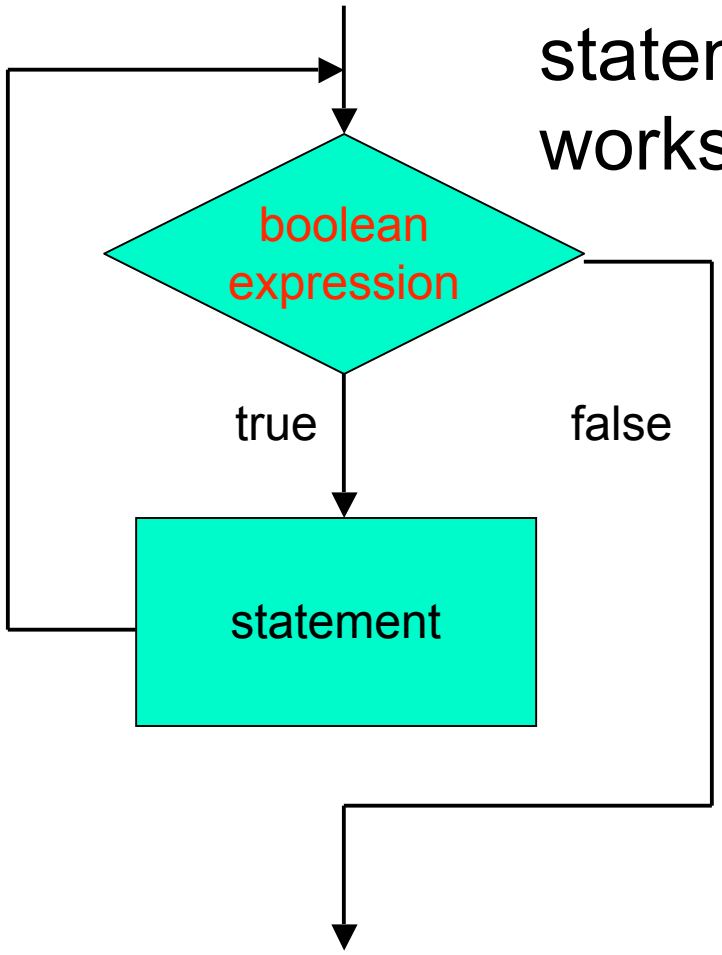
- Simplest form of loop in Java
- Body of loop can be
  - single statement
  - whole block of many statements in curly braces
- Control flow
  - body executed if expression is true
  - then boolean expression evaluated again
  - if expression still true, body executed again
  - repetition continues until expression false
  - then processing continues with next statement after loop

Recap: `If` Versus `While` Statements

how if statement works



how while statement works



- How can loop boolean change from false to true?

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- **`while`** statement

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- boolean expression

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- **`while`** statement body

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- statement after **`while`**
  - control flow resumes here when boolean is false

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- trace what happens when execute

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 1

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 1 Is counter <= limit? yes

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 1 Is counter <= limit? yes

"The square of 1 is 1" printed on monitor

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 2

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 2 Is counter <= limit? yes

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 2 Is counter <= limit? yes

"The square of 2 is 4" printed on monitor

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 3

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 3 Is counter <= limit? yes

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 3 Is counter <= limit? yes

"The square of 3 is 9" printed on monitor

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 4

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 counter 4 Is counter <= limit? NO!

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

limit 3 **counter** 4 **Is counter <= limit? NO!**

"End of demonstration" printed on monitor

Climbing Stairs Again

- Am I at the top of the stairs?
- No.
- Climb up one step.
- Am I at the top of the stairs?
- No.
- Climb up one step.
- Am I at the top of the stairs?
- No.
- Climb up one step.
- Am I at the top of the stairs?
- No.
- Climb up one step.
- ...and so on...

Climbing Stairs Again

```
while (I'm not at the top of the stairs)
{
    Climb up one step
}
```

- Climbing stairs is a while loop!

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter >= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- change termination condition

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter >= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- change termination condition
  - body of loop never executed

Using `while` Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter >= counter)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- change termination condition
  - always true

Infinite Loops

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter >= counter)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- if termination condition always true, loop never ends
  - infinite loop goes forever

Infinite Loops

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter - 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- good termination condition
- but process never gets closer to condition

Infinite Loops

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 9;
    int counter = 0;

    while (counter != limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 2;
    }
    System.out.println("End of demonstration");
  }
}
```

- process gets closer to termination condition
- but never satisfies condition, keeps going past it

Another `while` Example

```
public class PrintFactorials
{
  public static void main (String[] args)
  {
    int limit = 10;
    int counter = 1;
    int product = 1;

    while (counter <= limit)
    {
      System.out.println("The factorial of " + counter +
                         " is " + product'\);
      counter = counter + 1;
      product = product * counter;
    }
    System.out.println("End of demonstration");
  }
}
```

- accumulate product

Fun With Loops

```
public class BeerSong
{
  public static void main (String[] args)
  {
    int beerNum = 99;
    String word = "bottles";
    while (beerNum > 0)
    {
      if (beerNum == 1)
      {
        word = "bottle";
      }

      System.out.println(beerNum + " " + word + " of beer on the wall.");
      System.out.println(beerNum + " " + word + " of beer.");
      System.out.println("If one of the bottles");
      System.out.println("should happen to fall...");
      beerNum = beerNum - 1;

      if (beerNum < 1)
      {
        System.out.println("No more bottles of beer on the wall.");
      }
    }
  }
}
```

Fun With Loops

```
import java.util.Scanner;

public class BeerSong2
{
  public static void main (String[] args)
  {
    int beerNum = 99;
    String word = "bottles";

    boolean keepgoing = true;
    String answer;
    Scanner in = new Scanner(System.in);

    while ((beerNum > 0) && keepgoing)
    {
      if (beerNum == 1)
      {
        word = "bottle";
      }

      System.out.println(beerNum + " " + word + " of beer on the wall.");
      System.out.println(beerNum + " " + word + " of beer.");
      System.out.println("If one of the bottles");
      System.out.println("should happen to fall...");
      beerNum = beerNum - 1;
```

Fun With Loops

```
System.out.println("Continue? (y/n): ");
answer = in.nextLine();
if (answer.equals("n"))
{
  keepgoing = false;
}
```

```
      if (beerNum < 1)
      {
        System.out.println("No more bottles of beer on the wall.");
      }
    }
  }
}
```

Other Loop Statements

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- Equivalent to...

Other Loop Statements

```
public class ForDemo
{
  public static void main (String[] args)
  {

    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

- ...this loop using **`for`** statement

For Statement

```
public class ForDemo
{
  public static void main (String[] args)
  {
    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

- **`for`** statement

For Statement

```
public class ForDemo
{
  public static void main (String[] args)
  {

    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

- Header has three parts
  - separated by semicolons

For Statement

```
public class ForDemo
{
  public static void main (String[] args)
  {

    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

- Initialization: first part
  - executed only one time, at beginning

`For` Statement

```
public class ForDemo
{
  public static void main (String[] args)
  {

    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

- boolean expression: second part
  - evaluated just before loop body, like in **`while`**

For Statement

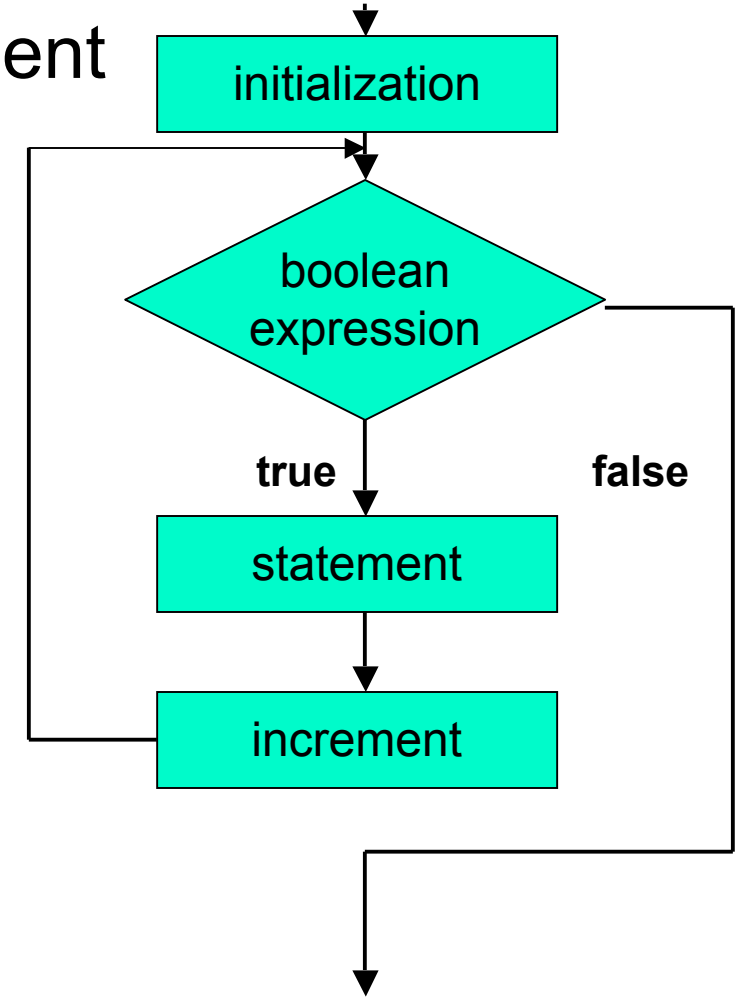
```
public class ForDemo
{
  public static void main (String[] args)
  {

    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

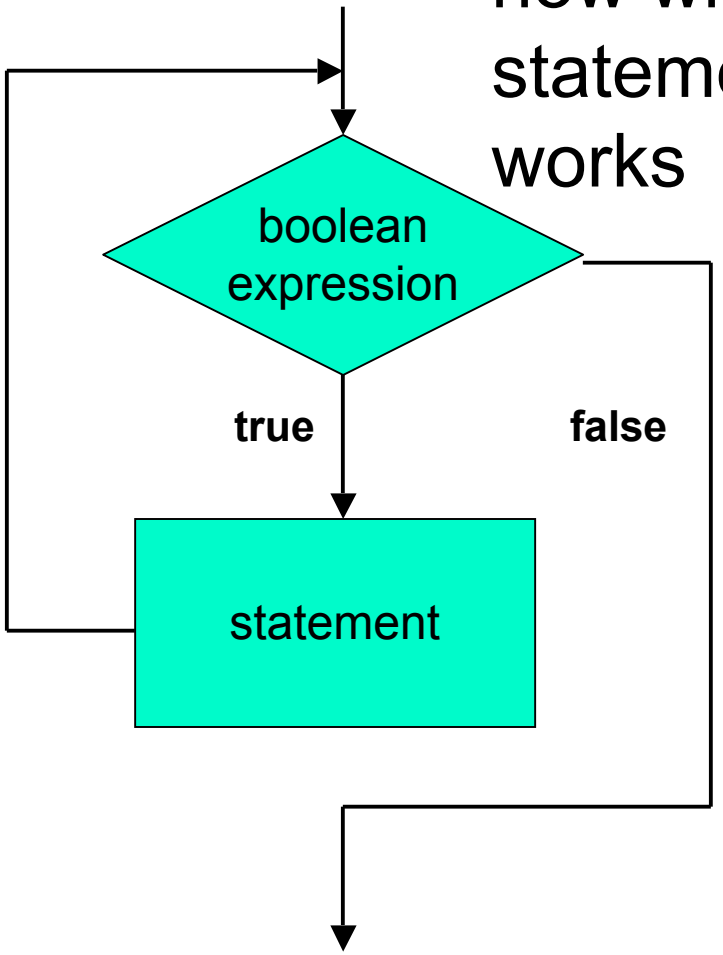
- Increment: third part
  - executed at end of loop body
- Despite name, arbitrary calculation allowed
  - could decrement, for example!

`For` Versus `While` Statement

how for statement works

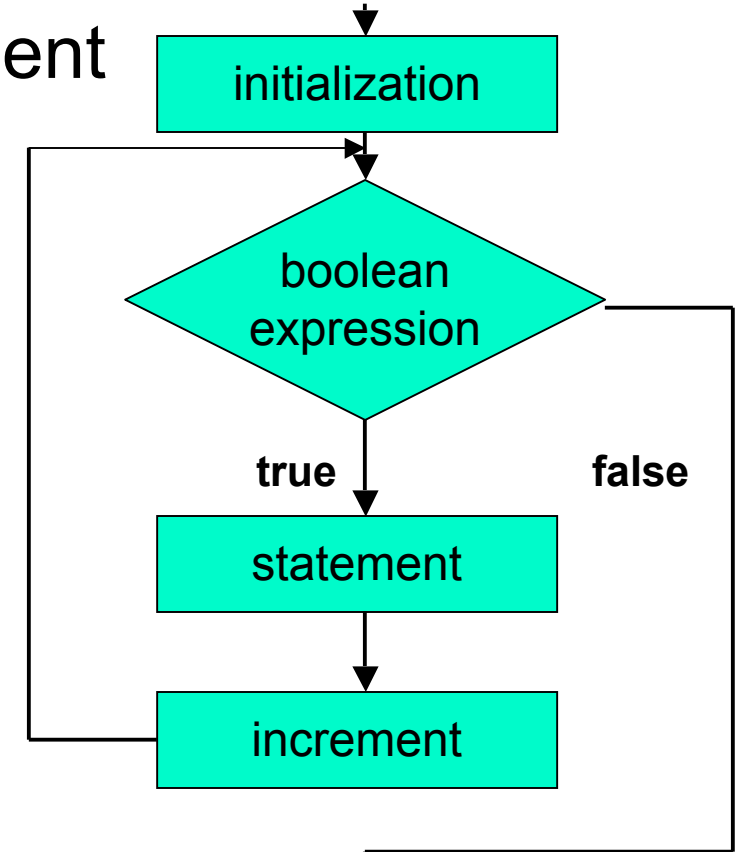


how while statement works

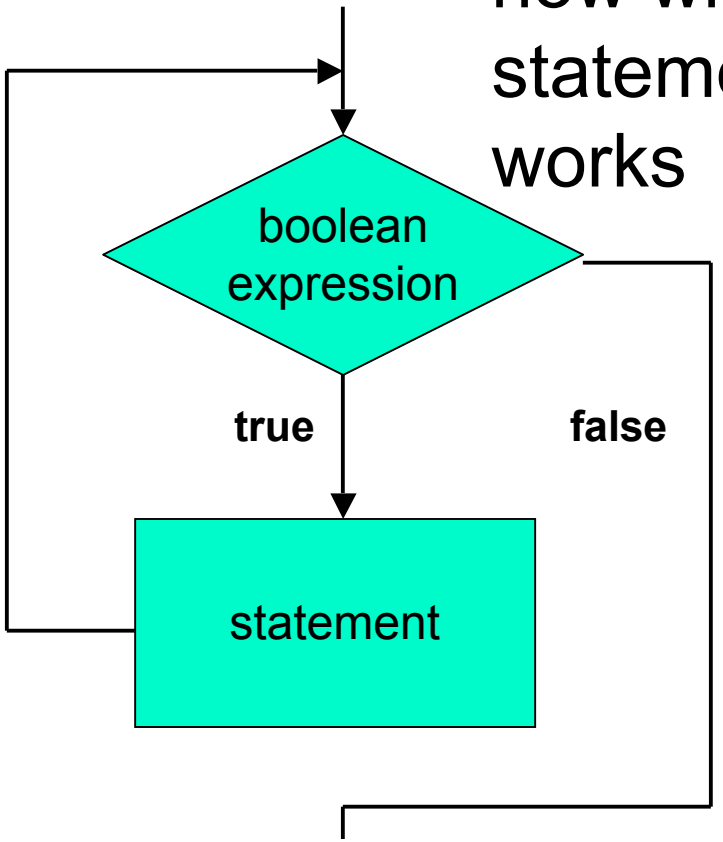


`For` Versus `While` Statement

how for statement works



how while statement works

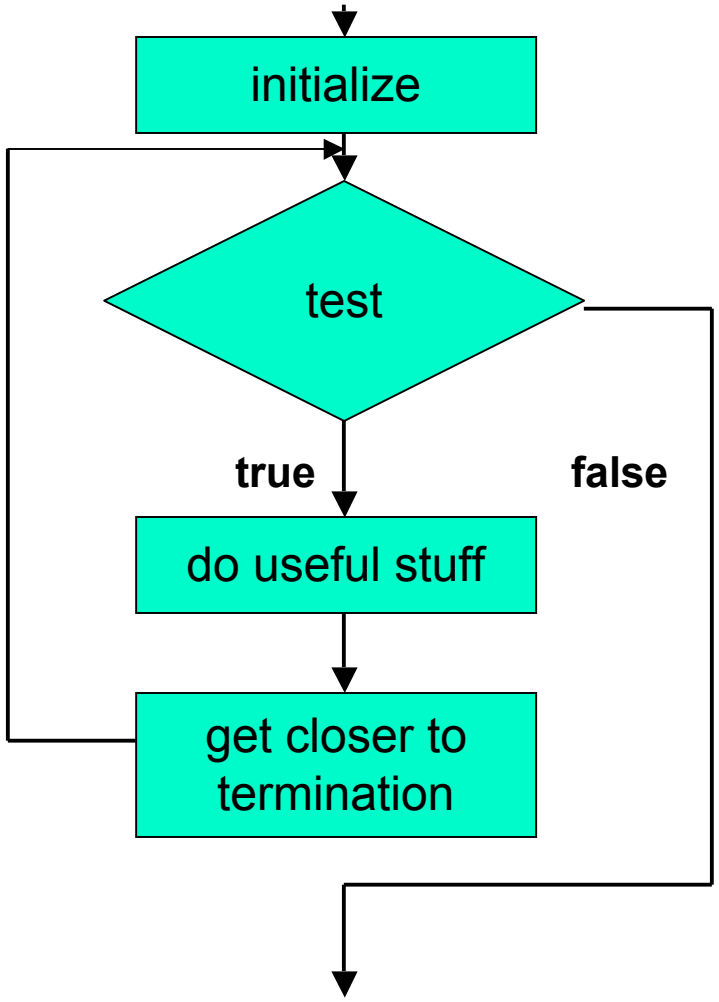


- flowcharts can be somewhat deceptive
  - need initialization and incrementing/modifying in while loop too
  - although syntax does not require it in specific spot

`For` Versus `While` Statement

- Anything that can be done with one type of loop can be done with another
  - `for` and `while` are equivalent
- `For` statement convenient when
  - loop should be executed specific number of times
  - number can be determined before loop starts
- `While` statement convenient when
  - don't know yet how many times to execute loop body
  - but can check if it's time to end loop as you go

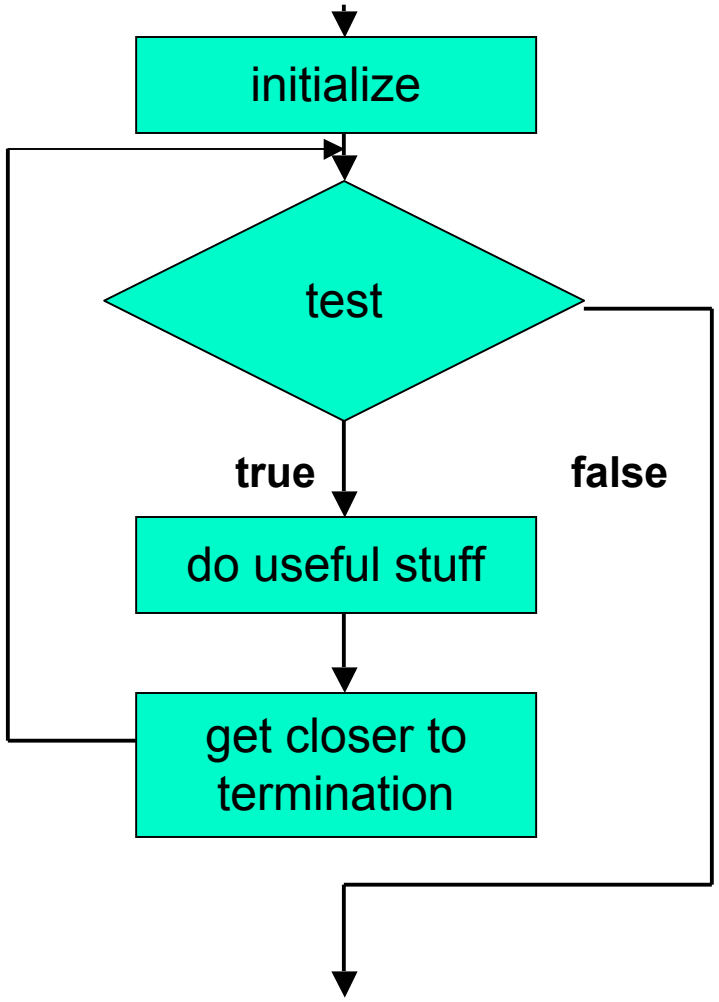
Four Things Needed In Any Loop



- Give starting values to one or more variables used in loop

how loops work in general

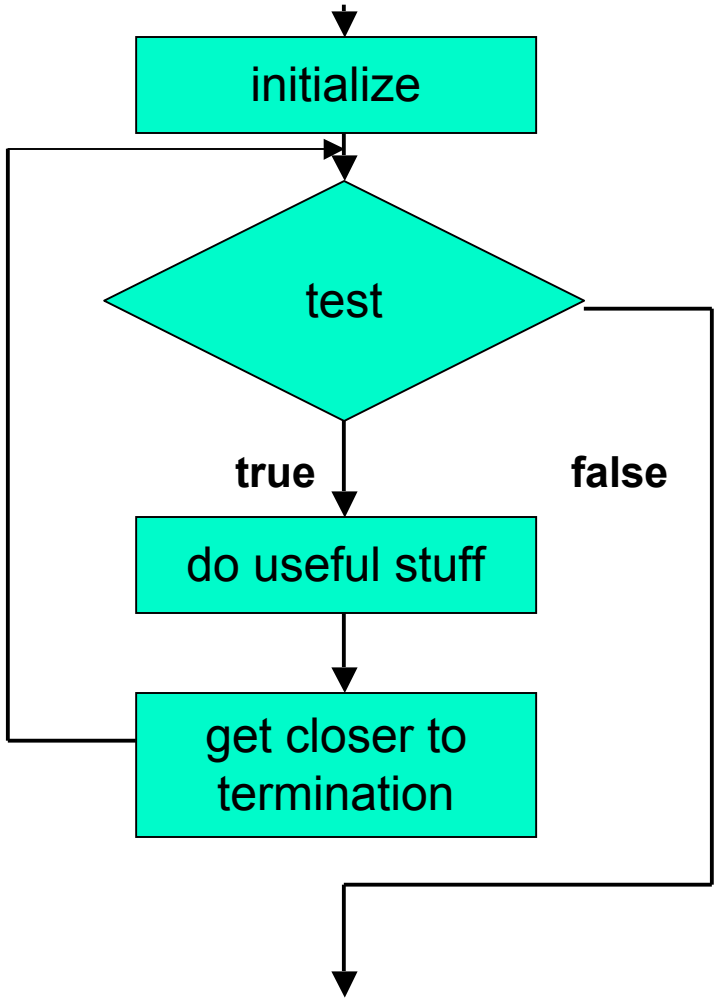
Four Things Needed In Any Loop



- Give starting values to one or more variables used in loop
- Test to see when looping stops

how loops work in general

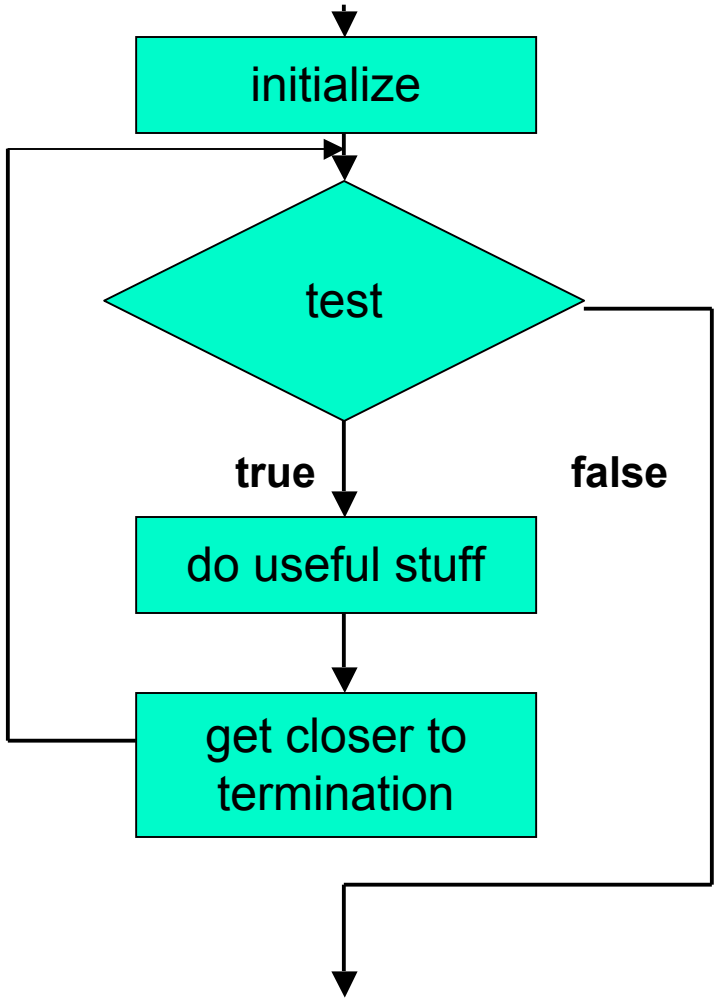
Four Things Needed In Any Loop



- Give starting values to one or more variables used in loop
- Test to see when looping stops
- One or more useful operations here

how loops work in general

Four Things Needed In Any Loop



- Give starting values to one or more variables used in loop
- Test to see when looping stops
- One or more useful operations here
- Change something to move process closer termination

how loops work in general

Yet Another Loop Statement

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- **`while`** version

Yet Another Loop Statement

```
public class ForDemo
{
  public static void main (String[] args)
  {
    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

- `for` version

Yet Another Loop Statement

```
public class DoDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    do
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    } while (counter <= limit);

    System.out.println("End of demonstration");
  }
}
```

- **do** version

Do Statement

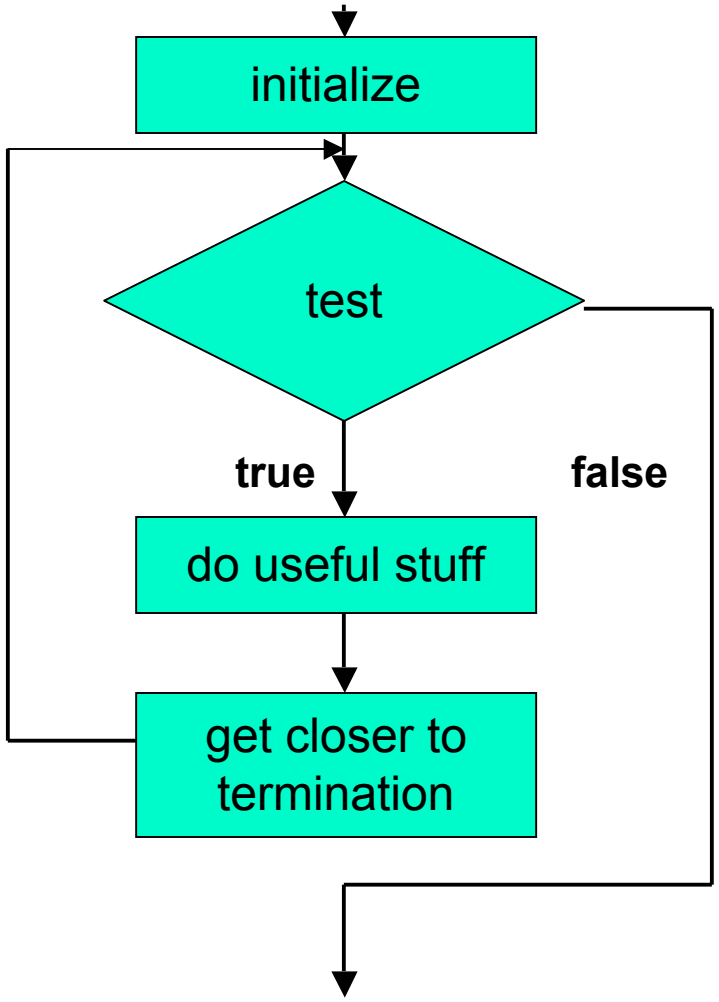
```
public class DoDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    do
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    } while (counter <= limit);

    System.out.println("End of demonstration");
  }
}
```

- **do** version: not quite equivalent
  - termination test at end, so body executed at least once

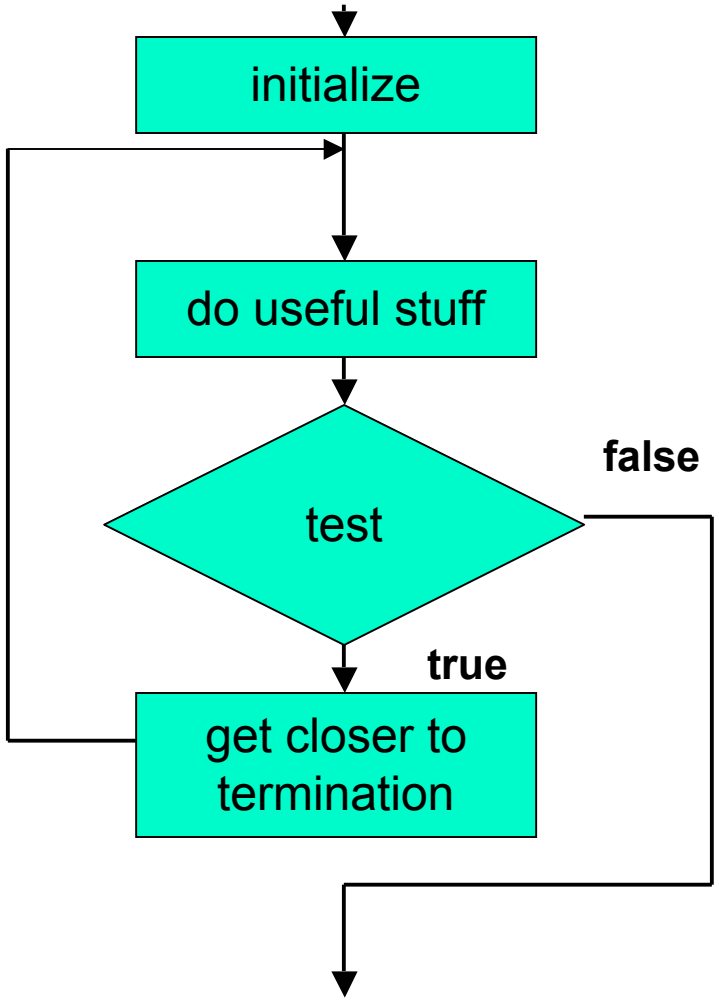
Four Things Needed In Any Loop



- Give starting values to one or more variables used in loop
- Test to see when looping stops
- One or more useful operations here
- Change something to move process closer termination

how loops work in general

Do Statement



- Body always executed at least once

order of four things can change, but need them all