## CS100J 7 March 2006

**About wrapper classes and class Vector**
**More on loops. Reading: Secs 7.1–7.3**
**Do the self-review exercises on pp. 235 and 242!!!**

**Quotes for the Day:**

**Instead of trying out computer programs on test cases until they are debugged, one should prove that they have the desired properties.**
John McCarthy, 1961, A basis for a mathematical theory of computation.

**Testing may show the presence of errors, but never their absence.**
Dijkstra, Second NATO Conf. on Software Engineering, 1969.

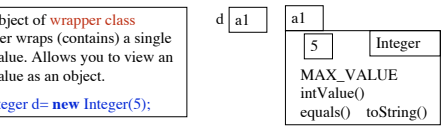
**A week of hard work on a program can save you 1/2 hour of thinking.**
Paul Gries, CS, University of Toronto, 2005.



## Wrapper classes and Java 1.5

An object of wrapper class Integer wraps (contains) a single **int** value. Allows you to view an **int** value as an object.

Integer d= **new** Integer(5);




| Primitive type | Wrapper class |
|---|---|
| **byte** | Byte |
| **int** | Int |
| **short** | Short |
| **long** | Long |
| **double** | Double |
| **char** | Character |
| **boolean** | Boolean |

**Two purposes of wrapper class:**

1. An instance wraps a value of the primitive type.
2. The wrapper class provides several instance methods and static methods/fields to manipulate values of the primitive type.



## Wrapper classes and Java 1.5
## Java 1.5 makes it easier to deal with the wrapper classes

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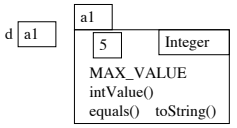
Integer d= **new** Integer(5);




**Java 1.4**

**int** i= d; illegal
Have to write:
**int** i= d.intValue();

Integer f= 5; illegal
Have to write:
Integer f= **new** Integer(5);

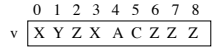
**Java 1.5**

**int** i= d; legal
It does the equivalent of:
**int** i= d.intValue();

Integer f= 5; legal
It does the equivalent of:
Integer f= **new** Integer(5);



## About class Vector (in lab today)




This is a Vector of Characters

**Java 1.4:**
Vector v= **new** Vector();

An object of class Vector contains a list of objects, all of the are Objects

v.add(ob) add object obj to v
v.get(0) = first object in v
v.get(1) = second object in v
v.size() = no. of objects in v

If you know v.get(0) is of class Character, can do

(Character) v.get(0)

**Java 1.5:**
Vector<Character> v=
**new** Vector<Character>();

The objects in v have to be of type Character.

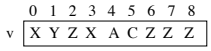
v.add(ob) add object obj to v
v.get(0) = first object in v
v.get(1) = second object in v
v.size() = no. of objects in v

If you know v.get(0) is of class Character, can do

Character c= v.get(0); this works

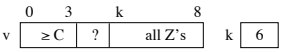


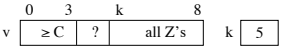
## Understanding assertions

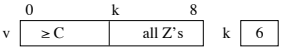


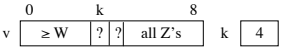

This is a Vector of Characters

This is an assertion about v and k. It is **true** because chars of v[0..3] are greater than 'C' and chars of v[6..8] are 'Z's.




Indicate whether each of these 3 assertions is true or false.



## The while loop

```
x= 0;
x= x + 2*2;
x= x + 3*3;
x= x + 4*4;
```

```
x= 0;
int k= 2;
while ( k != 5) {
    x= x + k*k;
    k= k+1;
}
```

To execute the while loop:

(1) Evaluate condition k != 5;

if false, stop execution of loop.

(2) Execute the repetend.

(3) Repeat again from step (1).

Repetend: the thing to be repeated. The block:

```
    {
  …
}
```

## Develop loop to store in x the sum of 1..100.

We'll keep this definition of x and k true:
**x = sum of 1..k–1**

**1. How should the loop start?** Make range 1..k–1 empty: **k= 1; x= 0;**

**2. When can loop stop?** What condition lets us know that x has result? When **k == 101**

**3. How can repetend make progress toward termination?** **k= k+1;**

**4. How do we keep def of x, h, k true?** **x= x + k;**

Four loopy questions

```
k= 1;  x= 0;
// invariant: x = sum of 1..(k–1)
while ( k != 101) {
    x=  x + k;
    k= k + 1;
}
// { x = sum of 1..100 }
```



## Develop loop to store in x the sum of 1..100.

This time, we'll keep this definition of x and k true:
**x = sum of h..100**

**1. How should the loop start?** Make range h..100 empty: **h= 101; x= 0;**

**2. When can loop stop?** What condition lets us know that x has result? When **h == 1**

**3. How can repetend make progress toward termination?** **h= h – 1;**

**4. How do we keep def of x, h, k true?** **x= x + (h – 1);**

Four loopy questions

```
h= 101;  x= 0;
// invariant: x = sum of h..100
while ( h != 1) {
    x=  x + (h – 1);
    h= h – 1;
}
// { x = sum of 1..100 }
```



## Develop a loop (with initialization) to store in x the minimum of p*p – p for p in the range h..k.

E.g. for h..k the range –2..0, it's min of
(–2)*(–2) – 2, (–1)*(–1) – 1, 0*0 – 0

We'll keep this definition of x, h, and k true:

**x = minimum of p*p – p for p in the range h..i**

**1. How should the loop start?**
**i= h; x= h*h – h;**

**2. When can loop stop?** What condition lets us know that x has result? **i == k**

**3. Make progress toward termination?** **i= i + 1;**

**4. How do we keep def of x, h, k true?**
**if ((i+1)*(i+1) – (i+1) < x)**
**x= ((i+1)*(i+1) – (i+1);**

Four loopy questions



## Develop a loop (with initialization) to store in x the minimum of p*p – p for p in the range h..k.

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**if ((i+1)*(i+1) – (i+1) < x)**
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Four loopy questions

```
i= h;  x= h*h – h;
// invariant: x = min of p*p – p  for p
//                in the range h..i
while ( i != k) {
    if ((i+1)*(i+1) – (i+1) < x)
        x= ((i+1)*(i+1) – (i+1);
    i=  i + 1;
}
// x = min of p*p – p for p in the range h..k
```



## Roach infestation!

```
/** = number of weeks it takes roaches to fill the apartment --see p 244 of text*/
public static int roaches() {
    double roachVol= .001;    // Space one roach takes
    double aptVol= 20*20*8;  // Apartment volume
    double growthRate= 1.25; // Population growth rate per week

    int w= 0;       // number of weeks
    int pop= 100; // roach population after w weeks

    // inv: pop = roach population after w weeks   AND
    //       before week w, volume of the roaches < aptVol
    while (aptVol > pop * roachVol ) {
        pop= (int) (pop * growthRate);
        w= w + 1;
    }
    return w;
}
```



## Develop loop to count the number of 'e's in String s.

We'll keep this definition of c and k true:
**c = number of 'e's in s[0..h-1]**

**1. How should the loop start?** Make range h..100 empty: **h= 0; c= 0;**

**2. When can loop stop?** What condition lets us know that x has result? When **h == s.length**

**3. How can repetend make progress toward termination?** **h= h + 1;**

**4. How do we keep def of x, h, k true?** **x= x + (h – 1);**

Four loopy questions

**if (s.charAt[h] == 'e')**
**c= c + 1;**

```
h= 0;  c= 0;
// invariant: c = no. of 'e's in s[0..s.length–1]
while ( h != s.length) {
    if (s.charAt[h] == 'e')   c= c + 1;
    h= h + 1;
}
// { c = no. of 'e's in s[0..h–1] }
```