Recitation 6

Loop Invariants and Prelim Review

Four loopy questions

```
//Precondition
 Initialization;
// invariant: P
while ( B ) { S }
```

1. Does it **start** right?
Does initialization make invariant P true?

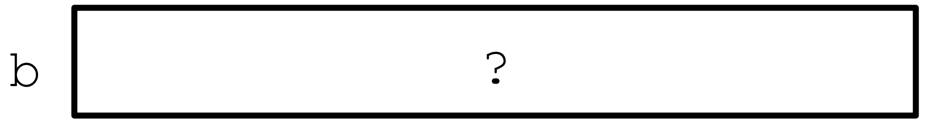
2. Does it **stop** right?
Does P and !B imply the desired result?

3. Does repetend S make **progress** toward termination?

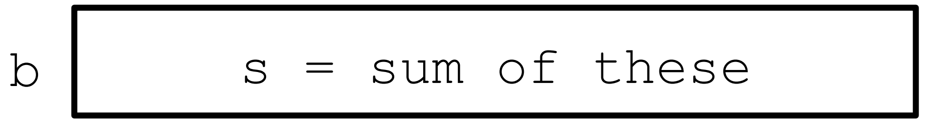
4. Does repetend S **keep** invariant P true?

Add elements backward

Precondition

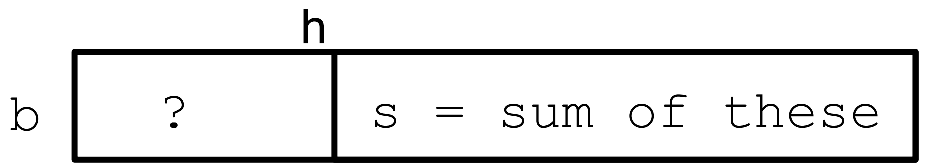


Postcondition

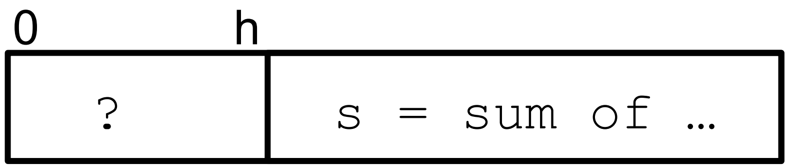


Get invariant by generalizing pre- and post-conditions

Invariant



Add elements backward

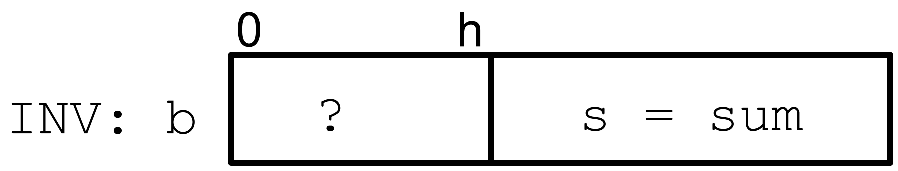
INV: b


```
int s= 0;
int h= b.length-1;
while (h >= 0) {
      s= s + b[h];
}
```

1. ✓ Does it **start** right?
2. ✓ Does it **stop** right?
3. ✓ Does it **keep** the invariant true?
4. ✗ Does it make **progress** toward termination?

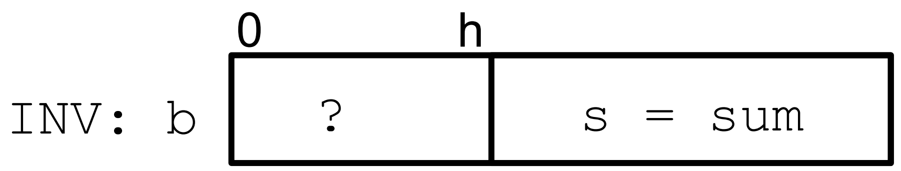
Add elements backward

```
int s= 0;
int h= b.length-1;
while (h > 0) {
        s= s + b[h];
        h--;
}
```



1. ✓ Does it **start** right?
2. ✗ Does it **stop** right?
3. ✓ Does it **keep** the invariant true?
4. ✓ Does it make **progress** toward termination?

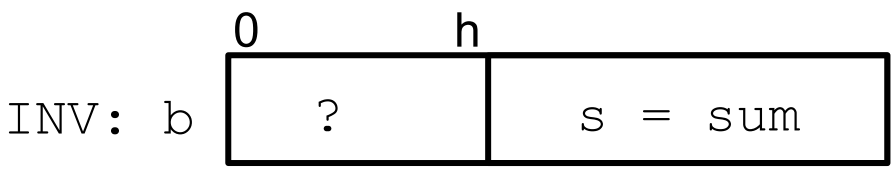
Add elements backward



```
int s= 0;
int h= b.length-1;
while (h >= 0) {
      s= s + b[h];
      h= h - 2;
}
```

1. ✓ Does it **start** right?
2. ✓ Does it **stop** right?
3. ✗ Does it **keep** the invariant true?
4. ✓ Does it make **progress** toward termination?

Add elements backwards

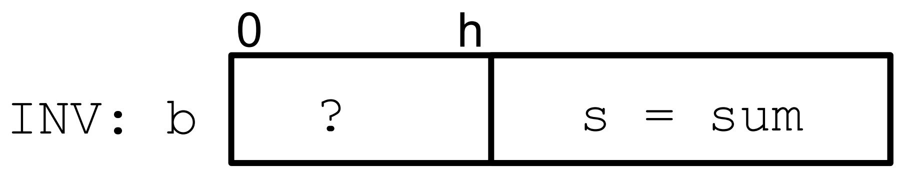


```
int s= 0;
int h= b.length-1;
while (h >= 0) {
      s= s + b[h];
      h--;
}
```

✓ 1. Does it **start** right?
✓ 2. Does it **stop** right?
✓ 3. Does it **keep** the invariant true?
✓ 4. Does it make **progress** toward termination?

Add elements backward

```
int s= 0;
int h= 0;
while (h >= 0) {
        s= s + b[h];
        h--;
}
```

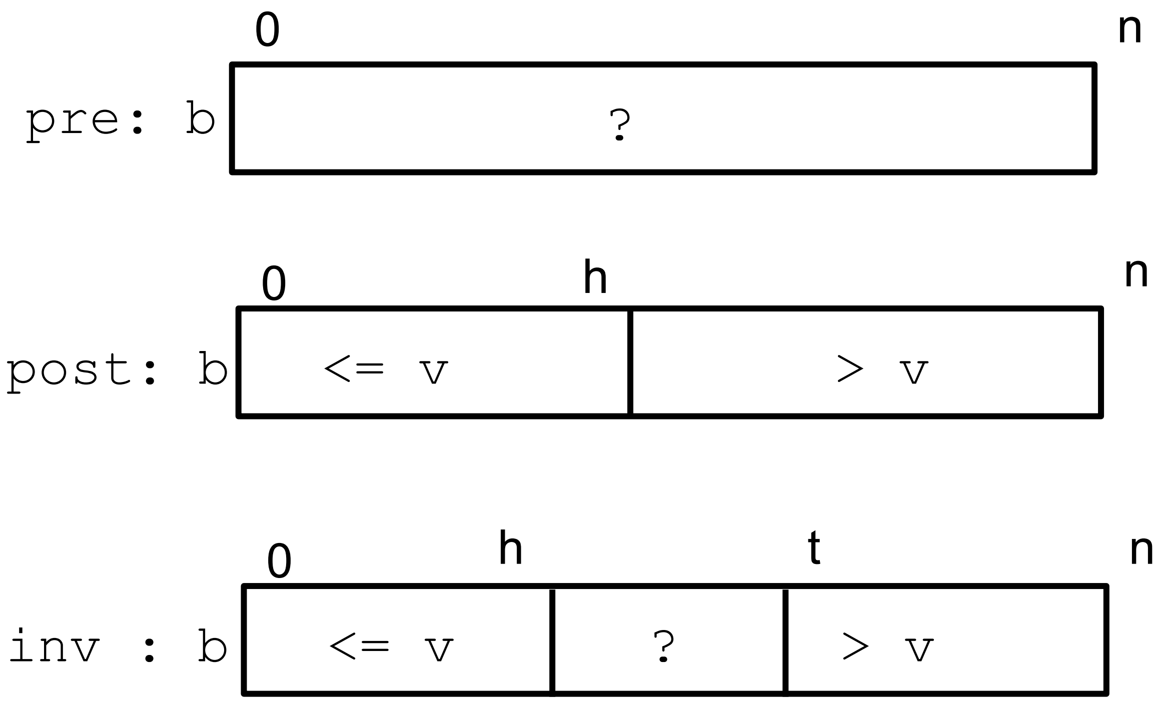


1. ✗ Does it **start** right?
2. ✓ Does it **stop** right?
3. ✓ Does it **keep** the invariant true?
4. ✓ Does it make **progress** toward termination?

Binary search in sorted b[0..n-1]

Given this precondition and a value v, store a value in h to truthify:

Find invariant by generalizing pre and post



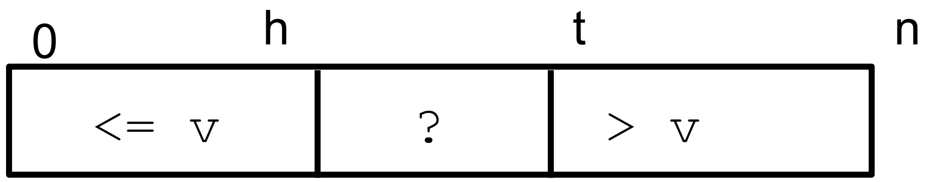
Binary search time (b[0..n-1] is sorted)

```
h= -1; t= n;
// invariant: P (below)
while (h < t-1) {
    int e= (h+t)/2;
    if (b[e] <= v) h= e;
    else  t= e;
}
// b[0..h] <= v < b[h+1..]
```

b[h+1..t-1] starts out with n elements in it.

Each iteration cuts size of b[h+1..t-1] in half.

worst-case and expected case time: log n

inv P: b


(some) things to know for the prelim

- Can you list the steps in evaluating a new-expression? Can you do them yourself on a piece of paper?
- Can you list the steps in executing a method call? Can you do them yourself on a piece of paper?
- Do you understand exception handling? E.g. What happens after a catch block has been executed?
- Can you write a recursive method or understand a given one?
- Abstract class and interfaces
- ArrayList, interface Comparable
- Loops invariants

Exception handling

```
private static double m(int x) {
        int y = x;
        try {
            y = 5/x;
            return 5/(x+2);
        } catch (NullPointerException e) {
                System.out.println("null");
        } catch (RuntimeException e) {
            y = 5/(x+1);
        }
        return 1/x;
}
```

What happens when:

```
x =  0
x =  1
x = -1
x = -2

x = null(?)
```

What method calls are legal

```
Animal an; …  an.m(args);
```

The … is computation. stores something in an.

legal ONLY if Java can guarantee that method m exists. How to guarantee?

m must be declared in Animal or inherited. Why?

Someone might write a subclass C of Animal that does not have m declared in it, create an object of C, store it in an. Then method m would not exist

You know already from lecture 4 on class Object, overriding toString(), and the bottom-up/overriding rule that the overriding method is called