CS100J Lab 10 11-12 November 2003

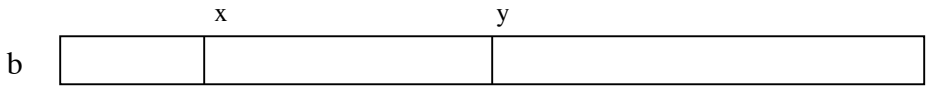
This lab is designed to give you practice with developing loops from invariants and with the array algorithms that you have to know for prelim III. We give a series of exercises for you to do. Your lab instructor and any consultants that are present will help you. Answers are at the end of this document, but don't look at an answer until you have done an exercise.

In our sample answers, we don't draw all the pictures that are required. If you need help with them, ask our A or consultant.

Finally, if you finish these ahead of time and you want something else to do. Start on assignment 7. If you don't have the assignment, look on the web page.

When you are finished, show your TA what you have done.

1. Give a formula for the number of values in the segment b[x..y-1]:



2. Draw an array that satisfies these conditions b[0..i] >= 5, b[i+1..j] = 6, b[j+1..] <= 5.

3. Below is a precondition and postcondition for the algorithm to find the min of an array b[h..k]. Below that are four different loop invariants for the problem. Write a loop (with initialization) for each one.

Precondition: h <= k

Postcondition R: b[x] is the minimum of b[h..k]

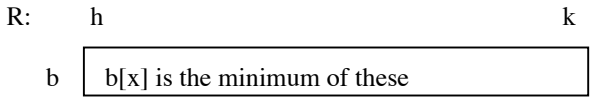
(a) invariant P1: b[x] is the minimum of b[h..t]

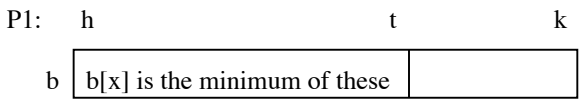
(b) invariant P2: b[x] is the minimum of b[h..s–1]

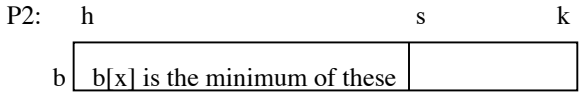
(c) invariant P3: b[x] is the minimum of b[r..k]

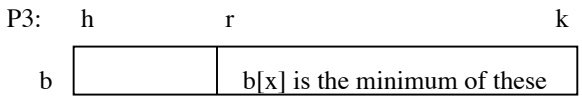
(d) invariant P4: b[x] is the minimum of b[w+1..k]

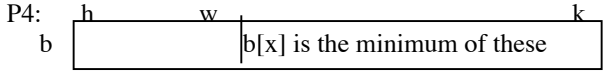
Below are the postcondition and invariants drawn as pictures. Use either the text versions or the pictures.











4. Below is a postcondition for an algorithm and several different loop invariants. Write a loop (with initialization) for each one. The array is not necessarily sorted. Before you begin, write the precondition (b[0..b.length–1] = ?, meaning that we know nothing about the values in the array), the postcondition, and the invariant as a picture.

Postcondition R: b[0..k] <= 6 and b[k+1..] > 6

(a) invariant P1: b[0..h] <= 6 and b[k+1..] > 6

(b) invariant P2:...b[0..k] <= 6 and b[t..] > 6
(c) invariant P3: .. b[0..s–1] <= 6 and b[k+1..] > 6

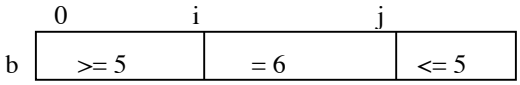
5. Write selection sort, to sort array segment b[h..k], in several ways, using the invariants provided below. Before you do each one, write the invariant as a picture.

postcondition: b[0..b.length–1] is sorted (in ascending order)
(a) invariant P1: b[0..k–1] is sorted, and b[0..k–1] <= b[k..]
(b) invariant P2: b[0..h] is sorted, and b[0..h] <= b[h+1..]
(c) invariant P3: b[s+1..b.length–1] is sorted, and b[0..s] <= b[s+1..]

Answers to questions.

1. y – x

2.



3. (a)
```
t= h; x= t;
while (t != k) {
   if (b[t+1] < b[x]) x= t+1;
   t= t + 1;
}
```

(b)
```
s= h+1; x= h;
while (s-1 != k) {
   if (b[s] < b[x]) x= s;
   s= s + 1;
}
```

(c)
```
r= k; x= r;
   while (r != h) {
      if (b[r–1] < b[x]) x= r–1;
      r= r–1;
}
```

(d)
```
w= k–1; x= k;
   while (w+1 != h) {
      if (b[w] < b[x]) x= w;
      w= w–1;
   }
```

4. (a)
```
h= –1; k= b.length–1;
   // invariant: P1
   while (h != k) {
      if (b[h+1] <= 6) h= h+1;
      else { Swap b[h+1] and b[k]; k= k–1; }
   }
```

(b)
```
k= –1; t= b.length;
   // invariant: P2
   while  (t != k+1) {
      if (b[k+1] <= 6) k= k+1;
      else { Swap b[k+1] and b[t–1]; t= t–1; }
   }
```

(c)
```
s= 0; k= b.length–1;
  // invariant: P3
  while (s–1 != k) {
      if ( b[s] <= 6) s= s+1;
      else { Swap b[s] and b[k]; k= k–1; }
  }
```

5. (a)
```
k= 0;
// invariant: P1
while (k != b.length] {
   Set t to the index of the minimum
      of b[k..b.length–1];
   Swap b[k] and b[t];   k= k+1;
}
```

(b)
```
h= –1;
// invariant: P2
while (h != b.length–1]) {
  Set t to the index of the minimum
     of b[h+1..b.length–1];
        Swap b[h] and b[t];   h=  h+1;
}
```

```
s= b.length–1;
// invariant: P3
while (s != –1) {
  Set t to the index of the minimum of b[0..s]
  Swap b[t] and b[s];      s= s–1;
}
```