Complete method `addClimb` below.

```
/** Adds a new climb with name peakName and time climbTime to the list of climbs.
 *  @param peakName the name of the mountain peak climbed
 *  @param climbTime the number of minutes taken to complete the climb
 *  Postcondition: The new entry is at the end of climbList;
 *                 The order of the remaining entries is unchanged.
 */
public void addClimb(String peakName, int climbTime)
```

Part (b) begins on page 6.

(b) Write an implementation of the `ClimbingClub` method `addClimb` that stores the elements of `climbList` in alphabetical order by name (as determined by the `compareTo` method of the `String` class). This implementation of `addClimb` should create a new `ClimbInfo` object with the given name and time and then insert the object into the appropriate position in `climbList`. Entries that have the same name will be grouped together and can appear in any order within the group. For example, consider the following code segment.

```
ClimbingClub hikerClub = new ClimbingClub();
hikerClub.addClimb("Monadnock", 274);
hikerClub.addClimb("Whiteface", 301);
hikerClub.addClimb("Algonquin", 225);
hikerClub.addClimb("Monadnock", 344);
```

When the code segment has completed execution, the instance variable `climbList` would contain the following entries in either of the orders shown below.

Peak Name	"Algonquin"	"Monadnock"	"Monadnock"	"Whiteface"
Climb Time	225	344	274	301

OR

Peak Name	"Algonquin"	"Monadnock"	"Monadnock"	"Whiteface"
Climb Time	225	274	344	301

You may assume that `climbList` is in alphabetical order by name when the method is called. When the method has completed execution, `climbList` should still be in alphabetical order by name.

Information repeated from the beginning of the question

```
public class ClimbInfo

public ClimbInfo(String peakName, int climbTime)
public String getName()
public int getTime()


public class ClimbingClub

private List<ClimbInfo> climbList
public void addClimb(String peakName, int climbTime)
public int distinctPeakNames()
```

Complete method `addClimb` below.

```
/** Adds a new climb with name peakName and time climbTime to the list of climbs.
 *  Alphabetical order is determined by the compareTo method of the String class.
 *  @param peakName the name of the mountain peak climbed
 *  @param climbTime the number of minutes taken to complete the climb
 *  Precondition: entries in climbList are in alphabetical order by name.
 *  Postcondition: entries in climbList are in alphabetical order by name.
 */
public void addClimb(String peakName, int climbTime)
```

Part (c) begins on page 8.

(c) The `ClimbingClub` method `distinctPeakNames` is intended to return the number of different names in `climbList`. For example, after the following code segment has completed execution, the value of the variable `numNames` would be 3.

```
ClimbingClub hikerClub = new ClimbingClub();
hikerClub.addClimb("Monadnock", 274);
hikerClub.addClimb("Whiteface", 301);
hikerClub.addClimb("Algonquin", 225);
hikerClub.addClimb("Monadnock", 344);
int numNames = hikerClub.distinctPeakNames();
```

Consider the following implementation of method `distinctPeakNames`.

```
/** @return the number of distinct names in the list of climbs */
public int distinctPeakNames()
{
  if (climbList.size() == 0)
  {
    return 0;
  }

  ClimbInfo currInfo = climbList.get(0);
  String prevName = currInfo.getName();
  String currName = null;
  int numNames = 1;

  for (int k = 1; k < climbList.size(); k++)
  {
    currInfo = climbList.get(k);
    currName = currInfo.getName();
    if (prevName.compareTo(currName) != 0)
    {
       numNames++;
       prevName = currName;
    }
  }
  return numNames;
}
```

Assume that `addClimb` works as specified, regardless of what you wrote in parts (a) and (b).

(i) Does this implementation of the `distinctPeakNames` method work as intended when the `addClimb` method stores the `ClimbInfo` objects in the order they were added as described in part (a)?

Circle one of the answers below.

YES NO

(ii) Does this implementation of the `distinctPeakNames` method work as intended when the `addClimb` method stores the `ClimbInfo` objects in alphabetical order by name as described in part (b)?

Circle one of the answers below.

YES NO

2. This question involves reasoning about the GridWorld case study. Reference materials are provided in the appendices.

A retro bug behaves like a regular bug. It also has the ability to revert to its previous location and direction. When a retro bug acts, it maintains information about its location and direction at the beginning of the act. The retro bug has a `restore` method that restores it to the location (if possible) and direction it faced at the beginning of its previous act. A retro bug only maintains information about its most recent act; therefore, multiple calls to `restore` that occur before its next act will use the same information. The `restore` method has no effect if it is called before a retro bug's first act.

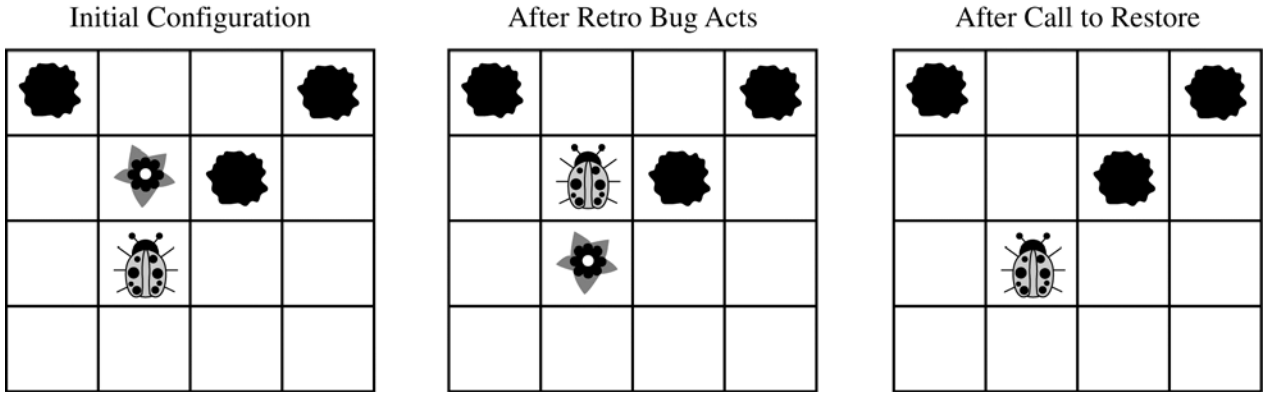
The `restore` method takes no parameters and does not return a value. The `restore` method has the following functionality.

- If the previous location of the retro bug is either unoccupied or contains a flower, the `restore` method places the retro bug in that previous location. The presence of any other type of actor in that location will prevent the retro bug from being placed in that location.
- The `restore` method always ends with the retro bug facing in the same direction that it had been facing at the beginning of its most recent act.

The following examples illustrate the behavior of the `restore` method.

Example 1

The retro bug acts once and later calls `restore`. Note that the flower that was originally in front of the retro bug is not replaced as a result of the call to `restore`. The retro bug is returned to its previous direction, which, in this case, is the same as the current direction.



Question 2 continues on the next page.

Complete method `findHorseSpace` below.

```
/** Returns the index of the space that contains the horse with the specified name.
 *  Precondition: No two horses in the barn have the same name.
 *  @param name the name of the horse to find
 *  @return the index of the space containing the horse with the specified name;
 *          -1 if no horse with the specified name is in the barn.
 */
public int findHorseSpace(String name)
```

Part (b) begins on page 16.

(b) Write the `HorseBarn` method `consolidate`. This method consolidates the barn by moving horses so that the horses are in adjacent spaces, starting at index 0, with no empty spaces between any two horses. After the barn is consolidated, the horses are in the same order as they were before the consolidation.

For example, assume a barn has horses in the following spaces.

0	1	2	3	4	5	6
"Trigger" 1340	null	"Silver" 1210	null	null	"Patches" 1350	"Duke" 1410

The following table shows the arrangement of the horses after `consolidate` is called.

0	1	2	3	4	5	6
"Trigger" 1340	"Silver" 1210	"Patches" 1350	"Duke" 1410	null	null	null

Information repeated from the beginning of the question

```
public interface Horse

String getName()
int getWeight()

public class HorseBarn

private Horse[] spaces
public int findHorseSpace(String name)
public void consolidate()
```

WRITE YOUR SOLUTION ON THE NEXT PAGE.

Complete method `consolidate` below.

```
/** Consolidates the barn by moving horses so that the horses are in adjacent spaces,
 *  starting at index 0, with no empty space between any two horses.
 *  Postcondition: The order of the horses is the same as before the consolidation.
 */
public void consolidate()
```

4. A grayscale image is represented by a 2-dimensional rectangular array of pixels (picture elements). A pixel is an integer value that represents a shade of gray. In this question, pixel values can be in the range from 0 through 255, inclusive. A black pixel is represented by 0, and a white pixel is represented by 255.

   The declaration of the `GrayImage` class is shown below. You will write two unrelated methods of the `GrayImage` class.

```
public class GrayImage
{
  public static final int BLACK = 0;
  public static final int WHITE = 255;


  /** The 2-dimensional representation of this image. Guaranteed not to be null.
   *  All values in the array are within the range [BLACK, WHITE], inclusive.
   */
  private int[][] pixelValues;


  /** @return the total number of white pixels in this image.
   *  Postcondition: this image has not been changed.
   */
  public int countWhitePixels()
  {  /* to be implemented in part (a) */  }


  /** Processes this image in row-major order and decreases the value of each pixel at
   *  position (row, col) by the value of the pixel at position (row + 2, col + 2) if it exists.
   *  Resulting values that would be less than BLACK are replaced by BLACK.
   *  Pixels for which there is no pixel at position (row + 2, col + 2) are unchanged.
   */
  public void processImage()
  {  /* to be implemented in part (b) */  }
}
```

   (a) Write the method `countWhitePixels` that returns the number of pixels in the image that contain the value `WHITE`. For example, assume that `pixelValues` contains the following image.

	0	1	2	3	4
0	**255**	184	178	84	129
1	84	**255**	**255**	130	84
2	78	**255**	0	0	78
3	84	130	**255**	130	84

   A call to `countWhitePixels` method would return 5 because there are 5 entries (shown in boldface) that have the value `WHITE`.

AP® COMPUTER SCIENCE A
2012 CANONICAL SOLUTIONS

Question 3: Horse Barn

Part (a):

```
public int findHorseSpace(String name) {
   for (int i = 0; i < this.spaces.length; i++) {
      if (this.spaces[i]!=null && name.equals(this.spaces[i].getName())) {
         return i;
      }
   }
   return -1;
}
```

Part (b):

```
public void consolidate() {
   for (int i = 0; i < this.spaces.length-1; i++) {
      if (this.spaces[i] == null) {
         for (int j = i+1; j < this.spaces.length; j++) {
            if (this.spaces[j] != null) {
               this.spaces[i] = this.spaces[j];
               this.spaces[j] = null;
               j = this.spaces.length;
            }
         }
      }
   }
}
```

Part (b): Alternative solution (auxiliary with array)

```
public void consolidate() {
   Horse[] newSpaces = new Horse[this.spaces.length];
   int nextSpot = 0;
   for (Horse nextHorse : this.spaces) {
      if (nextHorse != null) {
         newSpaces[nextSpot] = nextHorse;
         nextSpot++;
      }
   }
   this.spaces = newSpaces;
}
```

Part (b): Alternative solution (auxiliary with `ArrayList`)

```
public void consolidate() {
   List<Horse> horseList = new ArrayList<Horse>();
   for (Horse h : this.spaces) {
      if (h != null) horseList.add(h);
   }
   for (int i = 0; i < this.spaces.length; i++) {
      this.spaces[i] = null;
   }
   for (int i = 0; i < horseList.size(); i++) {
      this.spaces[i] = horseList.get(i);
   }
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.