1

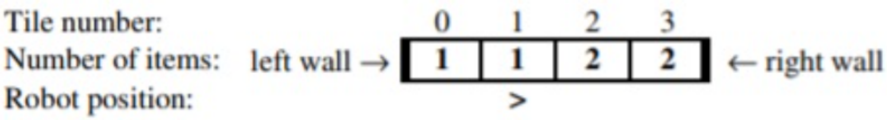
The PR2004 is a robot that automatically gathers toys and other items scattered in a tiled hallway. A tiled hallway has a wall at each end and consists of a single row of tiles, each with some number of items to be gathered.

The PR2004 robot is initialized with a starting position and an array that contains the number of items on each tile. Initially the robot is facing right, meaning that it is facing toward higher-numbered tiles.

The PR2004 robot makes a sequence of moves until there are no items remaining on any tile. A move is defined as follows.

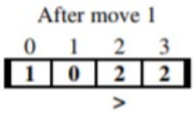
1. If there are any items on the current tile, then one item is removed.
2. If there are more items on the current tile, then the robot remains on the current tile facing the same direction.
3. If there are no more items on the current tile
    a. if the robot can move forward, it advances to the next tile in the direction that it is facing;
    b. otherwise, if the robot cannot move forward, it reverses direction and does not change position.

In the following example, the position and direction of the robot are indicated by "<" or ">" and the entries in the diagram indicate the number of items to be gathered on each tile. There are four tiles in this hallway. The starting state of the robot is illustrated in the following diagram.



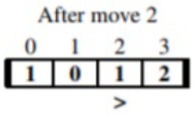
Tile number:		0	1	2	3	
Number of items:	left wall →	1	1	2	2	← right wall
Robot position:			>			

The following sequence shows the configuration of the hallway and the robot after each move.



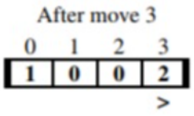
After move 1

0	1	2	3
1	0	2	2
		>	



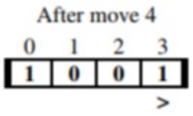
After move 2

0	1	2	3
1	0	1	2
		>	



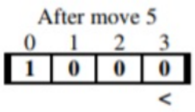
After move 3

0	1	2	3
1	0	0	2
			>



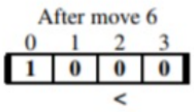
After move 4

0	1	2	3
1	0	0	1
			>



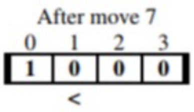
After move 5

0	1	2	3
1	0	0	0
			<



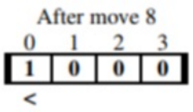
After move 6

0	1	2	3
1	0	0	0
		<	



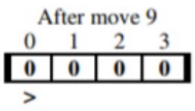
After move 7

0	1	2	3
1	0	0	0
	<		



After move 8

0	1	2	3
1	0	0	0
<			

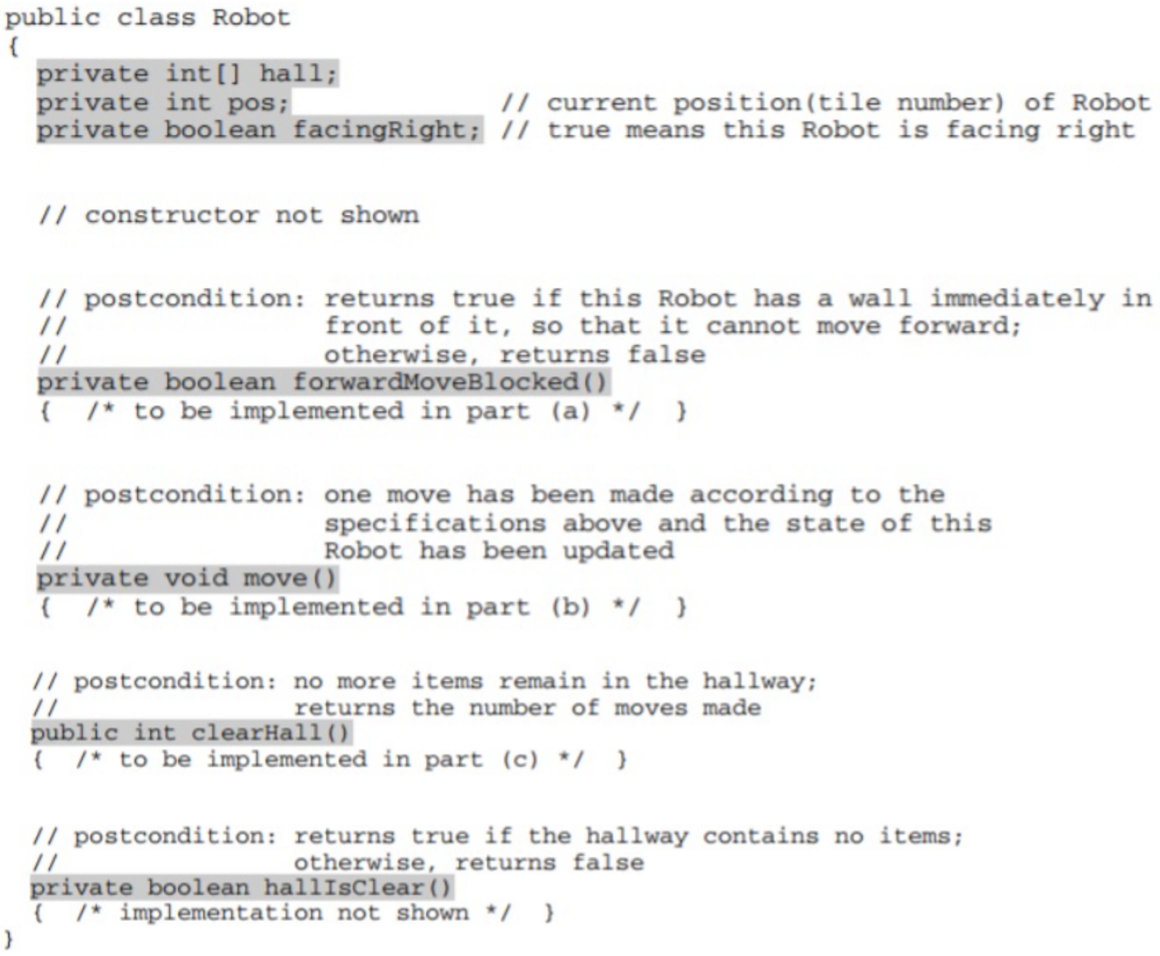


After move 9

0	1	2	3
0	0	0	0
>			

After nine moves, the robot stops because the hall is clear.

The PR2004 is modeled by the class Robot as shown in the following declaration.

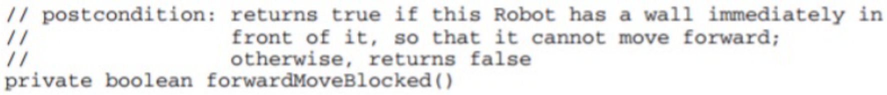


```
public class Robot
{
  private int[] hall;
  private int pos;             // current position(tile number) of Robot
  private boolean facingRight; // true means this Robot is facing right

  // constructor not shown

  // postcondition: returns true if this Robot has a wall immediately in
  //                front of it, so that it cannot move forward;
  //                otherwise, returns false
  private boolean forwardMoveBlocked()
  {  /* to be implemented in part (a) */  }

  // postcondition: one move has been made according to the
  //                specifications above and the state of this
  //                Robot has been updated
  private void move()
  {  /* to be implemented in part (b) */  }

  // postcondition: no more items remain in the hallway;
  //                returns the number of moves made
  public int clearHall()
  {  /* to be implemented in part (c) */  }

  // postcondition: returns true if the hallway contains no items;
  //                otherwise, returns false
  private boolean hallIsClear()
  {  /* implementation not shown */  }
}
```

In the Robot class, the number of items on each tile in the hall is stored in the corresponding entry in the array hall. The current position is stored in the instance variable pos. The boolean instance variable facingRight is true if the Robot is facing to the right and is false otherwise.

a. Write the Robot method forwardMoveBlocked. Method forwardMoveBlocked returns true if the robot has a wall immediately in front of it, so that it cannot move forward. Otherwise, forwardMoveBlocked returns false.

   Complete method forwardMoveBlocked below.



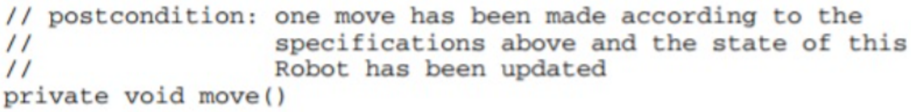
```
// postcondition: returns true if this Robot has a wall immediately in
//                front of it, so that it cannot move forward;
//                otherwise, returns false
private boolean forwardMoveBlocked()
```

b. Write the Robot method move. Method move has the robot carry out one move as specified at the beginning of the question. The specification for a move is repeated here for your convenience.

   1. If there are any items on the current tile, then one item is removed.
   2. If there are more items on the current tile, then the robot remains on the current tile facing the same direction.
   3. If there are no more items on the current tile
      a. if the robot can move forward, it advances to the next tile in the direction that it is facing
      b. otherwise, if the robot cannot move forward, it reverses direction and does not change position.

In writing move, you may use any of the other methods in the Robot class. Assume these methods work as specified, regardless of what you wrote in part (a). Solutions that reimplement the functionality provided by these methods, rather than invoking these methods, will not receive full credit.

Complete method move below.



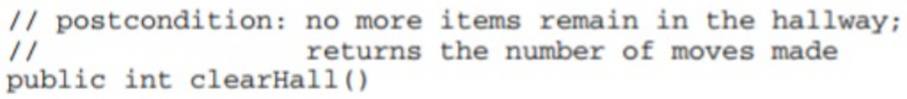
```
// postcondition: one move has been made according to the
//                specifications above and the state of this
//                Robot has been updated
private void move()
```

c. Write the Robot method clearHall. Method clearHall clears the hallway, repeatedly having this robot make a move until the hallway has no items, and returns the number of moves made.

In the example at the beginning of this problem, clearHall would take the robot through the moves shown and return 9, leaving the robot in the state shown in the final diagram.

In writing clearHall, you may use any of the other methods in the Robot class. Assume these methods work as specified, regardless of what you wrote in parts (a) and (b). Solutions that reimplement the functionality provided by these methods, rather than invoking these methods, will not receive full credit.

Complete method clearHall below.



```
// postcondition: no more items remain in the hallway;
//                returns the number of moves made
public int clearHall()
```