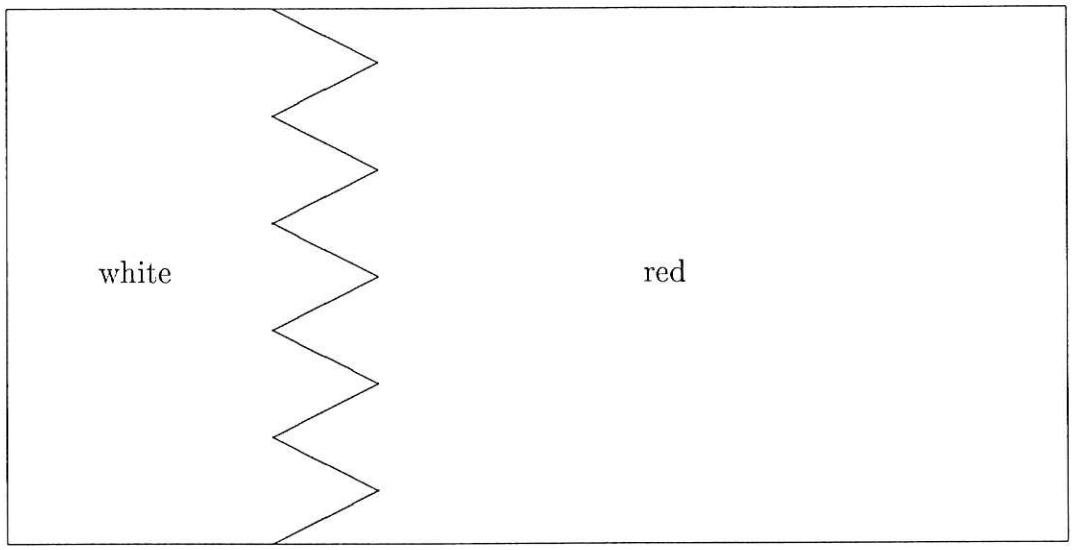
1.

The Bahrain national flag is a rectangle with a width:height ratio of 2:1 and showing the following pattern:



Write a method

```
public void drawBahrain(int n)
```

that draws the Bahrain flag on the screen with a height of `n` pixels. Your method should create and use a `SimpleCanvas` (as used in lectures and laboratories) to draw on. Both of the colours needed are pre-constructed Color objects.

(Do not worry about the precise positions and angles of the jagged bits: draw something approximately right.)

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2.

(a) Write a method

```
public int countSmaller(int x, int[] a)
```

that returns the number of elements of a that are smaller than x.

(5 marks)

(b) Write a method

```
public int median(int[] a)
```

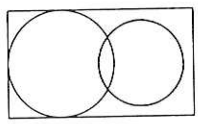
that returns the median of `a`. The median of an array is the value `k` such that half of the elements in the array are smaller than `k`, and half are bigger than `k`. You may assume that `a` has odd length and that its elements are all distinct.

(5 marks)

3.

We wish to estimate the area of the intersection of two overlapping circles with diameters `d1` and `d2`, whose centres are separated by `x`. We can do this by a simple sampling procedure.

Imagine the two circles are enclosed in a rectangle with width `d1+d2` and height `dk`, where `dk` is the greater of `d1` and `d2`:



Generate `n` points randomly in this rectangle, and count how many points sit in the intersection (i.e. inside both circles). The proportion of points that sit in the intersection approximates `A/B`, where `A` is the area of the intersection, and `B` is the area of the rectangle. From this we can estimate `A`. Clearly the precision of the estimate increases with the number of samples.

Write a method

```
public double area(double d1, double d2, double x, int n)
```

that implements the above procedure.

You should use an object from the library class `java.util.Random` to generate a sequence of random points inside the rectangle, and you will need the following method from that class.

```
public double nextDouble()

    Returns the next pseudorandom, uniformly-distributed double
    between 0.0 and 1.0 from this random number generator's sequence.
```

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4.

Consider the class `BankAccount`, for use in a bank's account record system:

```
public class BankAccount {

  // The accName is the username of the account holder
  // such as BillGates or JackSmith

  private String accName;
  private int accNumber;
  private int balance;

  public String getName()
  {return accName;}

  public int getBalance()
  {return balance;}

  // constructor and other details omitted
}
```

The records are sorted in alphabetical order by the account names. Write a method

```
public int accountBalance(BankAccount[] accList, String accName)
```

that uses an efficient search technique to search the sorted account list `accList` for the bank account with the account name `accName`, and returns its balance. If `accName` is not in `accList`, the method should throw a suitable exception.

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5.

Sudoku is a number placement puzzle: a 9×9 grid made up of 3×3 subgrids. Some cells already contain numbers, known as "givens", for example:

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8			7	9

The goal is to fill in the empty cells, one number in each, so that each column, row, and subgrid contains the numbers 1 – 9 exactly once.

A player often needs to determine which numbers can be placed in a particular cell location. Given a partially filled game `grid` with 0s for empty cells, write a method

```
public boolean[] findPossible(int[][] grid, int i, int j)
```

that returns a 9-element boolean array indicating whether each number is possible in the cell ith across and jth down from the top left corner (0,0). For example, if *1* is possible at the specified location, the *first* element of the boolean array should be `true`, otherwise `false`.

Factor out the subtasks into separate methods to make your code easier to understand.

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6.

(a) An array `a` is said to *dominate* an array `b` of the same length if every value in `a` is at least as big as the corresponding value in `b`, and at least one value in `a` is bigger than the corresponding value in `b`. For example, `{1,2,3}` dominates `{1,0,3}`, but it does not dominate `{1,0,4}`.

Write a method

```
public boolean dominates(int[] a, int[] b)
```

that returns `true` if `a` dominates `b`, and `false` otherwise.

(5 marks)

(b) The *rank* of an element `a[i]` in a 2D array is equal to the number of elements of `a` that dominate `a[i]`. (Note that multiple elements of `a` can have the same rank.)

Write a method

```
public int[] rank(int[][] a)
```

that returns an array containing the rank of each element of `a`.

(5 marks)