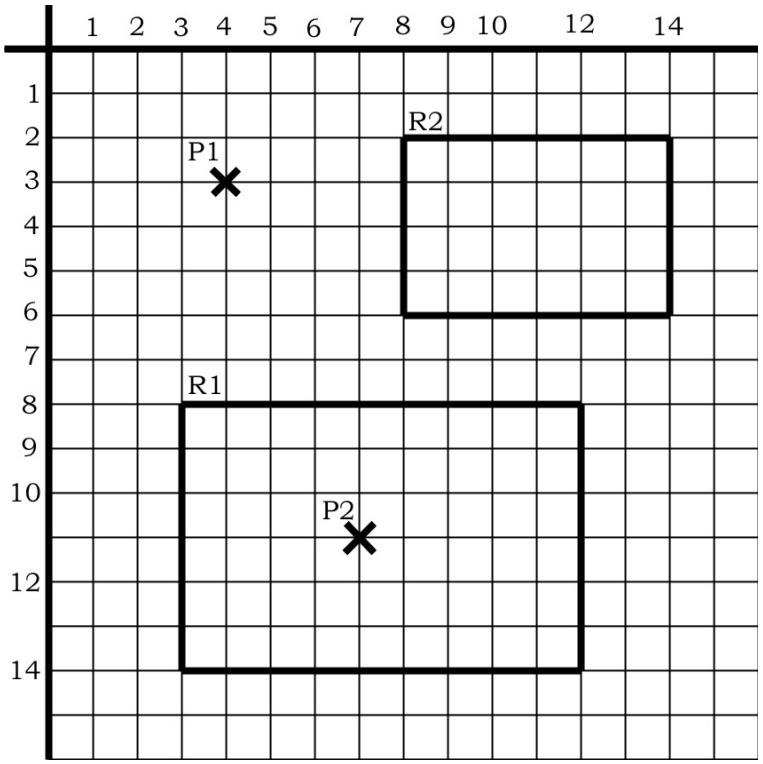
5.

A rectangle is represented by four numbers:
the x and y co-ordinates of its top left corner,
and its width and height.
A point is represented by two numbers:
its x and y co-ordinates.

a. Give C++ definitions of the structs to represent rectangles and points, and the functions make_rect, make_pt, and area that would work with this sample code

```
rectangle R1 = make_rect(3, 8, 9, 6);     // x, y, w, h
rectangle R2 = make_rect(8, 2, 6, 4);
point P1 = make_pt(4, 3);                 // x, y
point P2 = make_pt(7, 11);
cout << area(R2);                  // this should print 24
```



b. Define a function called is_inside, which takes a rectangle and a point as its parameters, and returns true if the point is inside the rectangle, false if it is not.

c. Define a function called grow_to_include, which takes a rectangle and a point as its parameters, and modifies the rectangle, making it just big enough to include the point.

If the point is already inside the rectangle, nothing needs to be done.

If the point is to the right of the rectangle, it will have to be made wider to cover the point.

and so on.

d. Define a function called merge, which takes two rectangles as its parameters. It doesn't change those rectangles, but it creates a new one which is returned as the result.

The new rectangle must be big enough to cover both of the original rectangles, but no bigger than it needs to be.

6.

Billy Stoat's Very Exciting Circus has a lot of animals, and all the important information about them is kept in a file called "animals.txt". In that file, each line describes one animal, and contains

1. its name (no spaces ever appear in names),
2. its species (no spaces ever appear in the species),
3. its cost when it was purchased (in dollars),
4. its weight (in pounds), and
5. the number of children it has successfully eaten, squashed, mangled, or otherwise killed.

This is the beginning of the file:

```
Lenny lion 3000 350 0
Lolita lion 3200 324 0
Sammy seal 699 130 1
Gummy clown 50 220 0
Flossie horse 625 1261 7
Twinkle horse 700 1154 15
Oinky seal 347 150 0
Henrietta hippopotamus 79 3261 5
```

but it is thousands of lines long

a. Write a function (or functions) that read this file, and perform the following tasks:

1. Create another file called "dull.txt", that contains all the details of the animals who have never killed any children, but their prices should be increased by 10%. These animals are going to be sold to another less exciting circus.
2. Create another file called "tubbyhippos.txt", that contains the names only for all of the hippopotamusses that weigh more than 5000 pounds.
3. Keep count of the total number of clowns, and print that number at the end.
4. Find the animal that gave the best value for money (number of children eaten divided by purchase price), and print its name at the end.

7.

Just to be sure you haven't forgotten, a prime number is a whole number that has no divisors except for 1 and itself, and by convention 1 is considered not to be prime. So the first ten prime numbers are 2, 3, 5, 7, 11, 13, 17, 19, 23, and 29.

There are exactly 78,498 prime numbers that are less than a million. Can we find them all?

For a number N to be prime, none of the numbers between 2 and N-1 (inclusive) must divide into it exactly, without leaving a remainder. So when N is big, that requires a lot of checking. Fortunately, it is not necessary to check *all* the numbers between 2 and N-1, you really only have to check the other prime numbers.

Here is the method:

i. Create an array that would be big enough to hold all the primes that are less than 1,000,000. Initially there are no numbers in that array.
ii. Check each number starting with 2 and going up to 1,000,000, to see if they are divisible by any of the primes that are already in the array.
iii. If a number is divisible by one of those primes, ignore it and go on to the next number in turn.
iv. If a number is not divisible by any of those primes, put it in the array, and carry on checking the rest of the numbers.

a.

Write a whole C++ program that uses exactly that method to produce an array containing all the prime numbers that are less than a million, then check that there really are 78,498 of them, and then prints them all out.