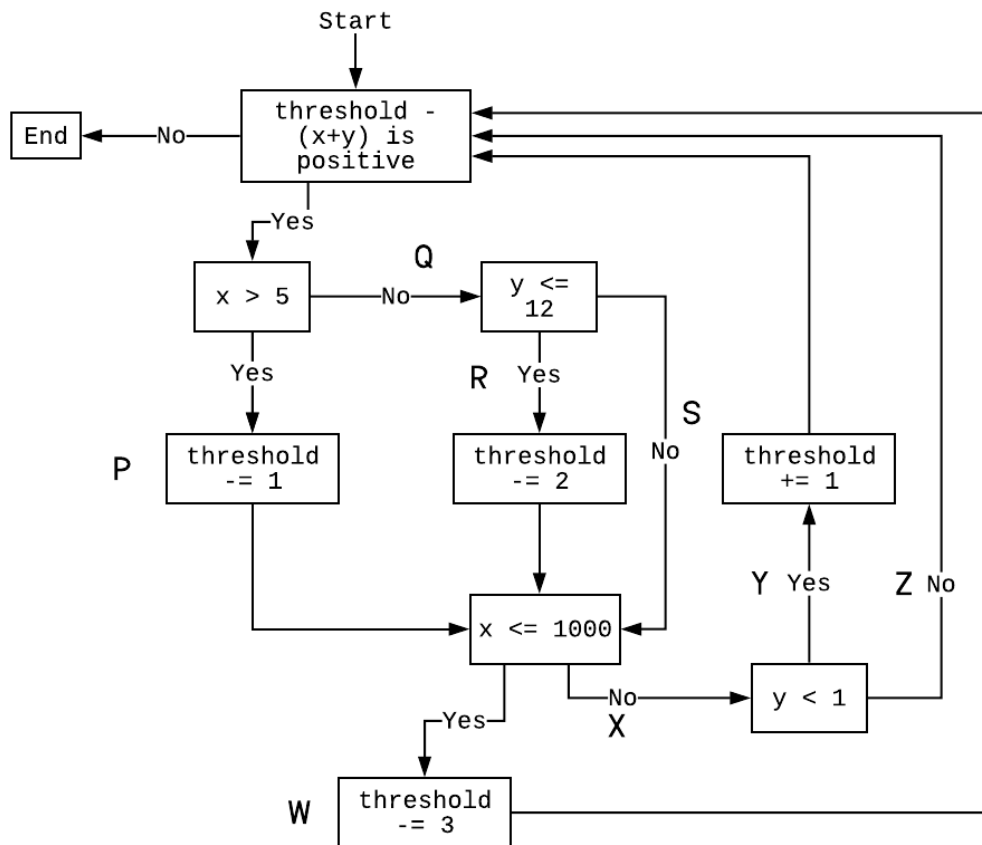
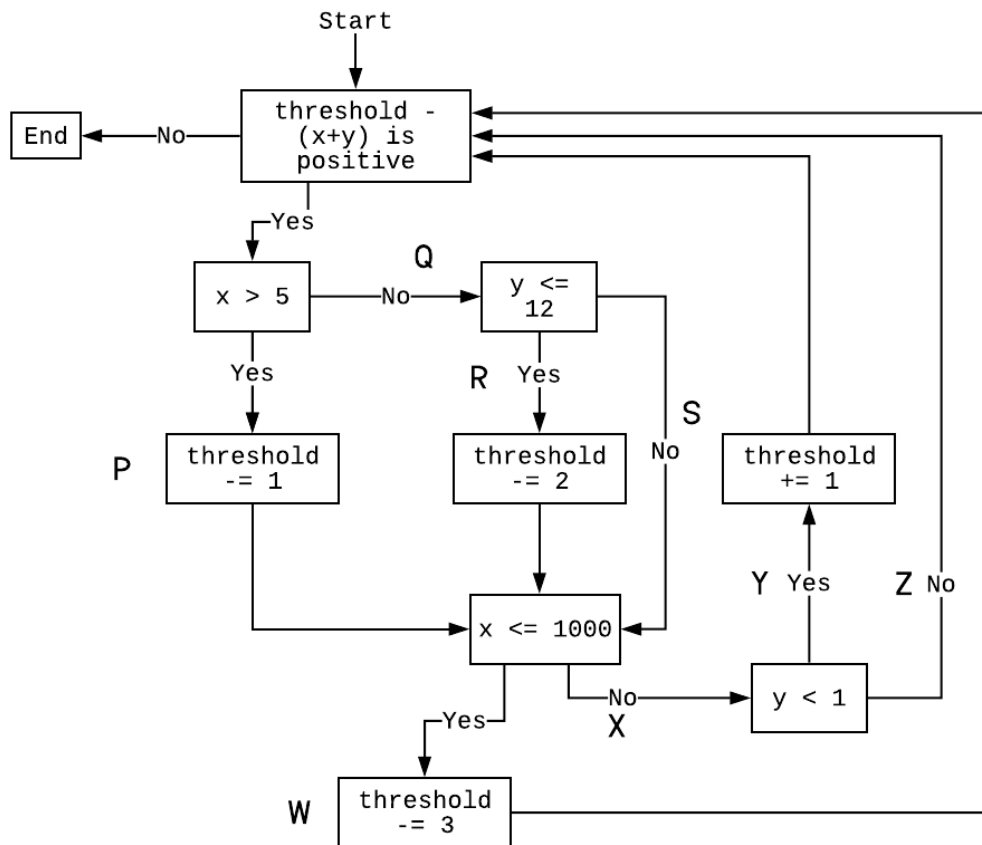


Exercise 7



Exercise 8

3 tests which cover Paths PW ($x > 5 \ \&\& \ x \leq 1000$), QRW ($x \leq 5 \ \&\& \ y \leq 12$), and the PXY infinite loop ($x > 1000 \ \&\& \ y < 1 \ \&\& \ x + y < 1000$). This seems to be the minimum number of tests that provide full statement coverage as it is impossible to traverse paths P & Q together (they are an if-else if pair), as well as Q & X (for Q to execute, x must be less than 5, hence W will always execute). Therefore the PXY pairing (which would result in an infinite loop as threshold is always kept constant) is the only case in which X will execute. Therefore 3 tests should be the minimum.



Exercise 9

4. To achieve branch coverage, we need to add test(s) that cover Paths S and Z. This cannot be done by including a single test $(x > 1000 \ \&\& \ y > 12)$ because the condition $(\text{threshold} - (x+y) > 0)$ will not hold and the program will not enter the loop. However, we observe that Path Z can never be traversed, because it simultaneously requires y to be greater or equal to 1, and x to be greater than 1000. The Path traversing S will be QSW $(x < 5 \ \&\& \ y > 12)$. A program will never execute through Branch Z (which is essentially the 'else' branch), but excluding this and since Branch Z does not contribute statements, branch coverage is achieved.

Exercise 10

201 paths. Without any loop counting restrictions, there are 4 possible paths (PW, PXY, QRW, QSW). Immediately, PXY is invalid as it executes forever. For the remaining paths (PW, QRW, QSW), the corresponding changes in threshold value per loop are $(-4, -5, -3)$. The loop can only execute if the difference between the threshold and the sum of x and y is positive. Therefore, given the program executes at most 100 loops, the maximum changes in threshold value are $(-400, -500, -300)$. For the difference to remain positive for all 100 iterations, the sum of x and y must be $1000 +$ the change in threshold value. Hence the sums of x and y for each path are at least $(600, 500, 700)$.

For PW, any parameters x and y can result in at most 100 loops as long as $x > 5$ and $600 \leq x+y < 1000$. For QSW, any x and y can result in at most 100 loops as long as $x \leq 5$ and $700 \leq x+y < 1000$. However for QRW, to result in at most 100 loops, the conditions $x \leq 5$ and

$y \leq 12$ must be fulfilled. This will never lead to a situation where the sums are greater than 500, so QSW is never executed in at most 100 loops. Therefore, there are two possible paths where each loop can run up to 100 times depending on the values of x and y, giving $2 \times 100 = 200$. Additionally, the case where the program exits when $x + y > 1000$ is also considered a path, bringing the total to 201 paths

Exercise 11

The test cases do not provide condition coverage, simply because condition coverage for this particular program is impossible, as Path Z, `(y < 1 == false)` is never executed.

Exercise 12

This bug is demonstrated in the PXY loop as implemented in both `DiskStatementCoverage.java`, `DiskBranchCoverage.java`, and explained in the answers to Exercise 8 and 10.