MIPS Assembly Program : Area Under The Curve

Strategy And Approach Used:

The first input that the program takes in sets the value of the variable length, which represents the number of points that the curve constitutes of. An input of 0 as the number of points, prints "The Curve Has No Points", and an input of 1 results in an area of 0.00000000 .

What we do is, compute the area under the curve between each pair of consecutive points and keep them adding to the total area until we reach the last point. So for each point after the first we run a loop till we reach the last point of the curve. Each iteration of the loop with index = k, takes an input of k^{th} point on the curve and computes the area under the curve made by joining a straight line from the $(k-1)^{th}$ point (with its integer valued X coordinated loaded in $t2 and the integer valued Y coordinate loaded in $t3) to k^{th} point (with its integer valued X coordinate loaded in $t4 and the integer valued Y coordinate loaded in $t5) say $a_{k-1..k}{}^{*}$, and adds this value to the total area of the curve. At the end of each iteration we load the X and Y coordinate values of point k to $t2 and $t3 to be used for next iteration of the loop.

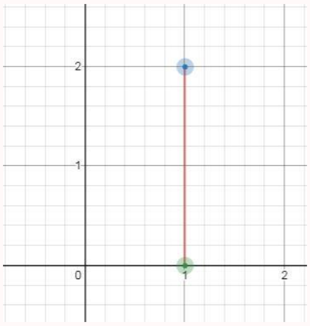
As the loop iterates till the index n, what we finally get as the total area of type float under the curve is equal to $a_{1..2} + \ldots + a_{k-1..k} + \ldots + a_{n-1..n}$. Thus the total area under the curve is reported as a floating point number.

Test Cases And Corner Cases Handled:

*This area under the curve made by joining a straight line from the $(k-1)^{th}$ point to k^{th} point is computed taking in consideration the exhaustive set of cases as follows.

Case 1: $X_{k-1} = X_k$

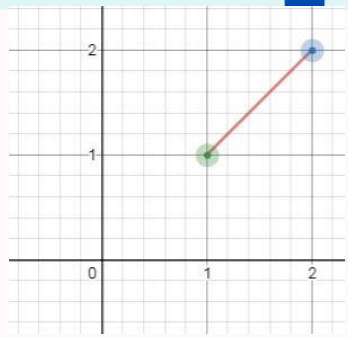
Then, $a_{k-1..k} = 0.00000000$



$(K-1)^{th}$ point : (X_{k-1}, Y_{k-1}) :Blue Color

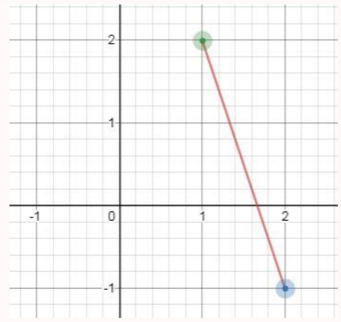
K^{th} point : (X_k, Y_k) :Green Color

Case 2: $Y_{k-1} >= 0$ and $Y_k >= 0$



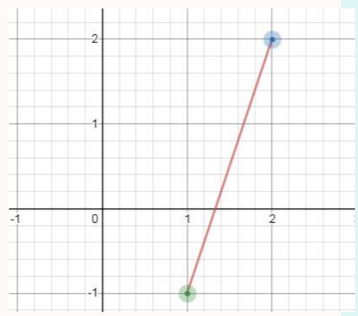
Then , $a_{k-1..k}$ is given by the area of the trapezium under the straight line
$a_{k-1..k} = 0.5*(X_k - X_{k-1})*(Y_k + Y_{k-1})$

Case 3: $Y_{k-1} > 0$ and $Y_k < 0$



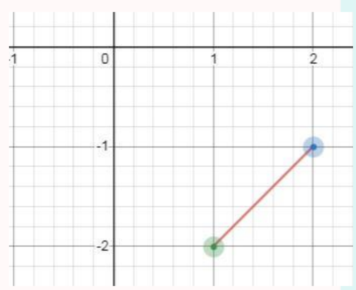
Then , $a_{k-1..k}$ is given as the sum of areas of triangles formed between (k-1)th point to the x intercept and that formed between the x intercept and kth point
$xinter = ((Y_k \times X_{k-1})-(X_k \times Y_{k-1}))/(Y_k - Y_{k-1})$
$a_{k-1..k} = ((0.5x(X_k -xinter) \times Y_k)+((-0.5)x(xinter- X_{k-1}) \times Y_{k-1}))$

Case 4: $Y_{k-1} < 0$ and $Y_k > 0$



Then , $a_{k-1..k}$ is given as the sum of areas of triangles formed between (k-1)th point to the x intercept and that formed between the x intercept and the kth point
$xinter = ((Y_k \times X_{k-1})-(X_k \times Y_{k-1}))/(Y_k - Y_{k-1})$
$a_{k-1..k} = (((-0.5)x(X_k -xinter)x Y_k)+(0.5 \times (xinter- X_{k-1}) \times Y_{k-1}))$

Case 5: $Y_{k-1} <=0$ and $Y_k <=0$



Then , $a_{k-1..k}$ is given by the area of the trapezium above the straight line bounded by the X - axis
$a_{k-1..k} = 0.5 \times (X_k - X_{k-1}) \times (Y_k + Y_{k-1})$

Other Test Cases And Corner Cases Handled:
An input of 0 as the number of points, prints "The Curve Has No Points"
An input of 1 as the number of points, results in an area of 0.00000000
An occurrence of overflow at any point of computation raises an Arithmetic Overflow Exception.

$(K-1)^{th}$ point : (X_{k-1}, Y_{k-1}) :Blue Color
K^{th} point : (X_k, Y_k) :Green Color