Algorithm Design: Project 1

Problem 1

Design and implement your own algorithm that takes the array A with size m+n as input where:

- Subarray A[1], A[2],...A[m] sorted in ascending order
- Subarray A[m+1], A[m+2],...A[n] sorted in ascending order

and merges the two subarrays using an auxiliary array Aux of size min {m, n} back into array A sorted in ascending order. You must design and implement your own sorting function. Use of sorting functions in libraries is not permitted.

Test cases

Test Case 1: {} and {3, 7, 9}
Test Case 2: {2, 7, 9} and {1}
Test Case 3: {1, 7, 10, 15} and {3, 8, 12, 18}
Test Case 4: {1, 3, 5, 5, 15, 18, 21} and {5, 5, 6, 8, 10, 12, 16, 17, 17, 20, 25, 28}

Output Screenshots –

```
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'SubArraySort'
How many elements in first array
0
Enter sorted first subarray
How many elements in second array
3
Enter sorted second subarray
3
7
9
Sorted Array A of size m+n is [3, 7, 9]
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'SubArraySort'
How many elements in first array
3
Enter sorted first subarray
2
7
9
How many elements in second array
1
Enter sorted second subarray
1
Sorted Array A of size m+n is [1, 2, 7, 9]
PS C:\Users\Shusrita Venugopal\eclipse-workspace>
```

```
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'SubArraySort'
How many elements in first array
4
Enter sorted first subarray
1
7
10
15
How many elements in second array
4
Enter sorted second subarray
3
8
12
18
Sorted Array A of size m+n is [1, 3, 7, 8, 10, 12, 15, 18]
PS C:\Users\Shusrita Venugopal\eclipse-workspace>
```

```
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'SubArraySort'
How many elements in first array
7
Enter sorted first subarray
1
3
5
5
15
18
21
How many elements in second array
12
Enter sorted second subarray
5
5
6
8
10
12
16
17
17
20
25
28
Sorted Array A of size m+n is [1, 3, 5, 5, 5, 5, 6, 8, 10, 12, 15, 16, 17, 17, 18, 20, 21, 25, 2
8]
PS C:\Users\Shusrita Venugopal\eclipse-workspace>
```

Problem 2

Problem 2 (70 points)

Design and implement your own algorithms, one for Ala Carte Multiplication and one for Rectangle Multiplication. Your algorithms must allow for both positive and negative multiplicands and multipliers.

Test cases

Test Case 1: 7000 * 7294
Test Case 2: 25 * 5038385
Test Case 3: -59724 * 783
Test Case 4: 8516 * -82147953548159344
Test Case 5: 45952456856498465985 * 98654651986546519856

Test Case 6: -45952456856498465985 * -98654651986546519856

Output Screenshots –

I have used Python Language for this problem as Java Long primitive datatype supports only till third test case. After the third test case using Long will give us an error of stack overflow as we try to store a bigger number than long can hold. Long is of size 8byte and Stores whole numbers from -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807 I will include .java file for this problem too.

Output screenshots in Python –

```
PS D:\MSIS\python> & d:/MSIS/python/.venv/Scripts/python.exe d:/MSIS/python/AlaCarteMultiplicati
on.py
num1: 7000
num2: 7294
51058000
PS D:\MSIS\python> & d:/MSIS/python/.venv/Scripts/python.exe d:/MSIS/python/AlaCarteMultiplicati
on.py
num1: 25
num2: 5038385
125959625
PS D:\MSIS\python> & d:/MSIS/python/.venv/Scripts/python.exe d:/MSIS/python/AlaCarteMultiplicati
on.py
num1: -59724
num2: 783
- 46763892
PS D:\MSIS\python> & d:/MSIS/python/.venv/Scripts/python.exe d:/MSIS/python/AlaCarteMultiplicati
on.py
num1: 8516
num2: -82147953548159344
- 699571972416124973504
PS D:\MSIS\python> & d:/MSIS/python/.venv/Scripts/python.exe d:/MSIS/python/AlaCarteMultiplicati
on.py
num1: 45952456856498465985
num2: 98654651986546519856
4533423639104649634397093450504343098160
PS D:\MSIS\python> & d:/MSIS/python/.venv/Scripts/python.exe d:/MSIS/python/AlaCarteMultiplicati
on.py
num1: -45952456856498465985
num2: -98654651986546519856
4533423639104649634397093450504343098160
PS D:\MSIS\python>
```

Rectangle Multiplication –

```
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'RectangleMultiplic
ation'
Enter first big integer:
7000
Enter second big integer:
7294
The Product of Two Big Integers using Rectangle Method is 51058000
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'RectangleMultiplic
ation'
Enter first big integer:
25
Enter second big integer:
5038385
The Product of Two Big Integers using Rectangle Method is 125959625
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'RectangleMultiplic
ation'
Enter first big integer:
-59724
Enter second big integer:
783
The Product of Two Big Integers using Rectangle Method is -46763892
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'RectangleMultiplic
ation'
```

```
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'RectangleMultiplic
ation'
Enter first big integer:
8516
Enter second big integer:
-82147953548159344
The Product of Two Big Integers using Rectangle Method is -699571972416124973504
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'RectangleMultiplic
ation'
Enter first big integer:
45952456856498465985
Enter second big integer:
98654651986546519856
The Product of Two Big Integers using Rectangle Method is 45334236391046496343970934505043430981
60
PS C:\Users\Shusrita Venugopal\eclipse-workspace>  c:; cd 'c:\Users\Shusrita Venugopal\eclipse-w
orkspace'; & 'C:\Program Files\Java\jdk-20\bin\java.exe' '-XX:+ShowCodeDetailsInExceptionMessage
s' '-cp' 'C:\Users\Shusrita Venugopal\eclipse-workspace\AlgorithmDesign\bin' 'RectangleMultiplic
ation'
Enter first big integer:
-45952456856498465985
Enter second big integer:
-98654651986546519856
The Product of Two Big Integers using Rectangle Method is 45334236391046496343970934505043430981
60
PS C:\Users\Shusrita Venugopal\eclipse-workspace>
```