Patrick Luu - 300289974

Design	Advantages	Disadvantages
Design 1	● Easy to use either polar or cartesian coordinates	● Methods contain many if statements since either type of coordinates could be stored
Design 2	● Quick retrieval of polar coordinates	● Cartesian coordinates take time to calculate and must be calculated each time ● getDistance and rotatePoint methods run slower
Design 3	● Quick retrieval of cartesian coordinates ● getDistance and rotatePoint methods run quicker	● Polar coordinates take time to calculate and must be calculated each time
Design 5	● Code is easy to modify and scale (ie. adding other coordinate systems, adding common methods)	● More boilerplate code that may not be necessary for functionality

Methods	Design 1			Design 2			Design 3		
	Min	Med	Max	Min	Med	Max	Min	Med	Max
getX()	0	0.067	0.073	0.064	0.066	0.070	0	0	0.009
getY()	0	0.069	0.071	0.057	0.069	0.072	0	0	0.003
getRho()	0	0	0.002	0	0	0.003	0	0	0.009
getTheta()	0.003	0.005	0.380	0	0	0.002	0.374	0.582	0.588
getDistance()	0	0.271	0.275	0.263	0.271	0.280	0	0	0.003
rotatePoint()	0.541	0.689	0.708	1.263	1.286	1.311	0.539	0.550	0.562

Methods	Design 5 Sub2			Design 5 Sub 3		
	Min	Med	Max	Min	Med	Max
getX()	0.065	0.067	0.072	0	0	0.004
getY()	0.068	0.070	0.078	0	0	0.010
getRho()	0	0	0.003	0	0	0.003
getTheta()	0	0	0.002	0.375	0.582	0.592
getDistance()	0.266	0.270	0.277	0	0	0.003
rotatePoint()	1.264	1.287	1.307	0.539	0.551	0.558

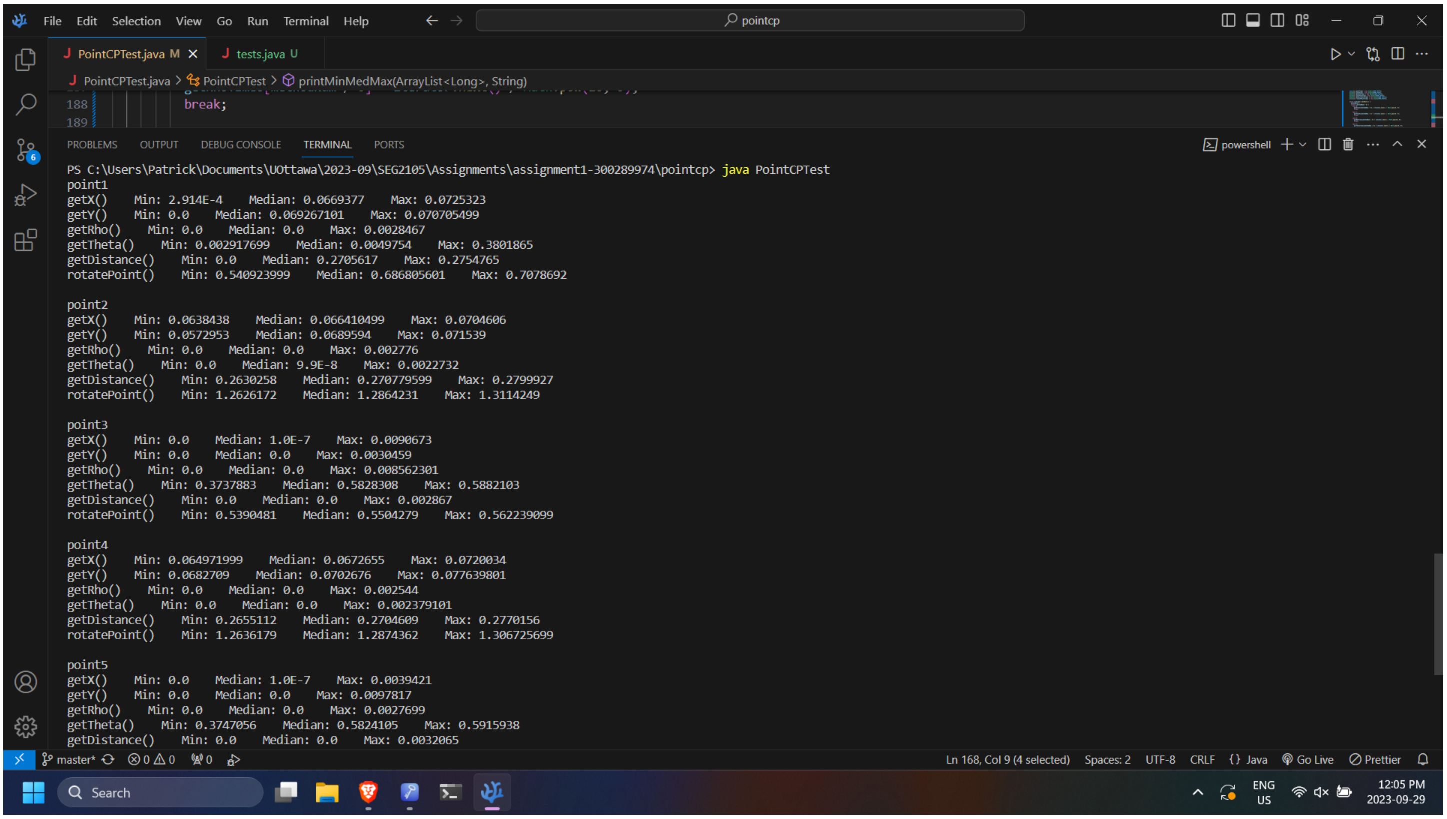
The tests were conducted 10 times with each test consisting of every design calling every method 10,000,000 and measuring the nanosecond runtime of each method. The larger number of calls was necessary to ensure that the runtime would be long enough to convert to seconds.

The results of the test were mostly as expected. Design 2 and Design 5 Sub 2 had negligible runtimes for getRho and getTheta. While Design 1 and Design 5 Sub 3 had negligible runtimes for getX and getY. This is because those methods required no calculations and simply returned the specific attribute of the method.

The getX and getY methods for designs that had to calculate them were still relatively fast since those methods did not require large calculations. On the other hand, the getTheta method was the longest getter, most likely because of the complex equation involved. What surprised me was the runtime for getRho which despite involving a complex equation, had negligible runtime.

For similar reasons as above, the getDistance and rotatePoint methods were the fastest when the design stored cartesian coordinates since those methods only use the getX and getY methods. However, overall the rotatePoint method is very slow, most likely due to the complex equation involved.

Since the runtimes for getRho() were not what I expected, I debugged the code to double-check that the runtime calculations were correct. I noticed a spike in runtime whenever I put a breakpoint anywhere in a test method even if it was after the runtime calculations. I concluded this was most likely due to it using more system resources. In the end, all the code and runtime calculations seemed to be working correctly and the log files generated after each test support this conclusion. As such, I believe that the Math.sqrt and Math.pow functions used in calculating rho are significantly faster than the Math.toDegrees and Math.atan2 used to calculate theta.


File Edit Selection View Go Run Terminal Help
pointcp
PointCPTest.java M
tests.java U
PointCPTest.java > PointCPTest > printMinMedMax(ArrayList<Long>, String)
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powershell
master* 0 0 0
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```
break;
```

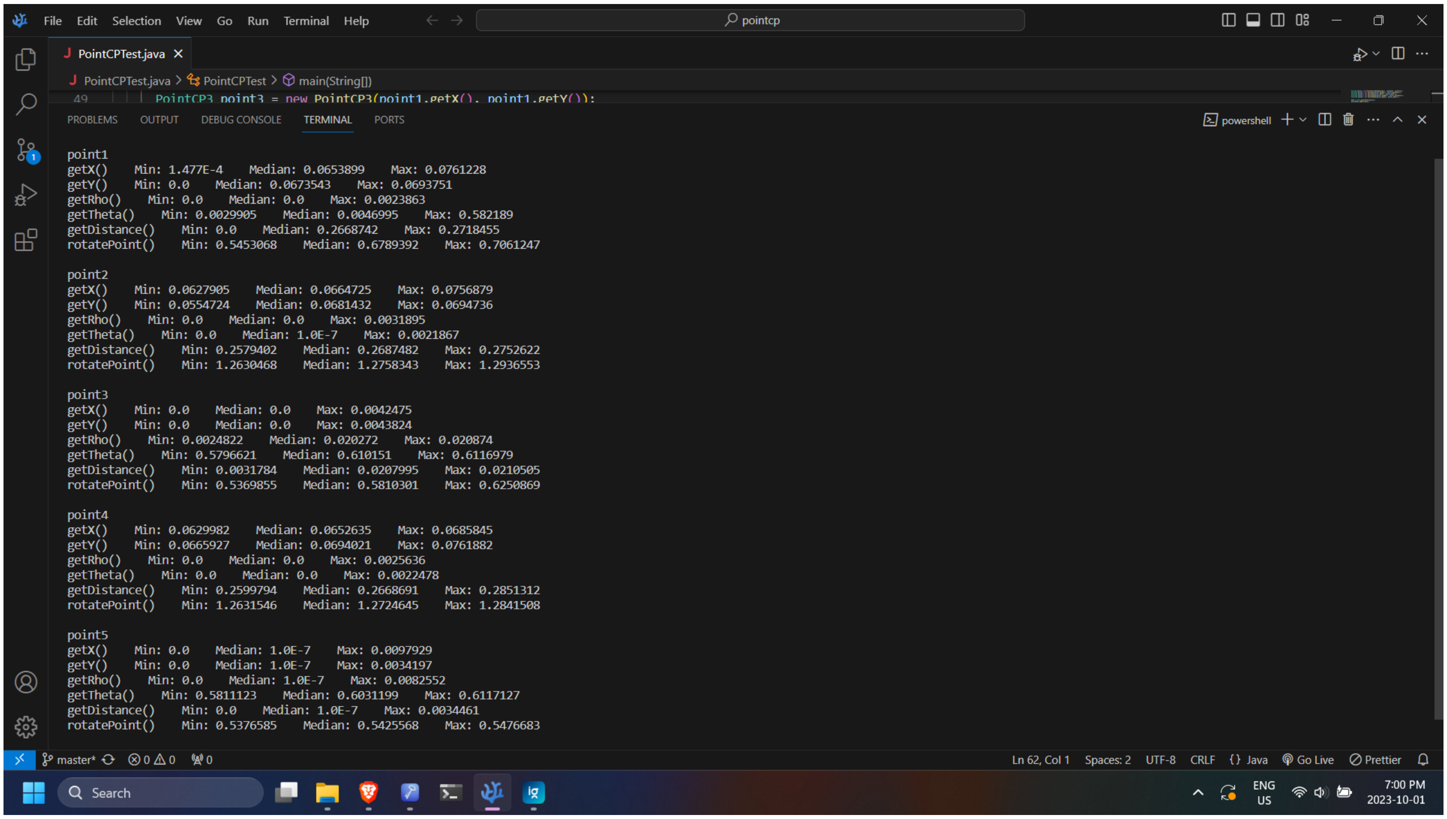
```
PS C:\Users\Patrick\Documents\UOttawa\2023-09\SEG2105\Assignments\assignment1-300289974\pointcp> java PointCPTest
point1
getX()    Min: 2.914E-4    Median: 0.0669377    Max: 0.0725323
getY()    Min: 0.0    Median: 0.069267101    Max: 0.070705499
getRho()    Min: 0.0    Median: 0.0    Max: 0.0028467
getTheta()    Min: 0.002917699    Median: 0.0049754    Max: 0.3801865
getDistance()    Min: 0.0    Median: 0.2705617    Max: 0.2754765
rotatePoint()    Min: 0.540923999    Median: 0.686805601    Max: 0.7078692

point2
getX()    Min: 0.0638438    Median: 0.066410499    Max: 0.0704606
getY()    Min: 0.0572953    Median: 0.0689594    Max: 0.071539
getRho()    Min: 0.0    Median: 0.0    Max: 0.002776
getTheta()    Min: 0.0    Median: 9.9E-8    Max: 0.0022732
getDistance()    Min: 0.2630258    Median: 0.270779599    Max: 0.2799927
rotatePoint()    Min: 1.2626172    Median: 1.2864231    Max: 1.3114249

point3
getX()    Min: 0.0    Median: 1.0E-7    Max: 0.0090673
getY()    Min: 0.0    Median: 0.0    Max: 0.0030459
getRho()    Min: 0.0    Median: 0.0    Max: 0.008562301
getTheta()    Min: 0.3737883    Median: 0.5828308    Max: 0.5882103
getDistance()    Min: 0.0    Median: 0.0    Max: 0.002867
rotatePoint()    Min: 0.5390481    Median: 0.5504279    Max: 0.562239099

point4
getX()    Min: 0.064971999    Median: 0.0672655    Max: 0.0720034
getY()    Min: 0.0682709    Median: 0.0702676    Max: 0.077639801
getRho()    Min: 0.0    Median: 0.0    Max: 0.002544
getTheta()    Min: 0.0    Median: 0.0    Max: 0.002379101
getDistance()    Min: 0.2655112    Median: 0.2704609    Max: 0.2770156
rotatePoint()    Min: 1.2636179    Median: 1.2874362    Max: 1.306725699

point5
getX()    Min: 0.0    Median: 1.0E-7    Max: 0.0039421
getY()    Min: 0.0    Median: 0.0    Max: 0.0097817
getRho()    Min: 0.0    Median: 0.0    Max: 0.0027699
getTheta()    Min: 0.3747056    Median: 0.5824105    Max: 0.5915938
getDistance()    Min: 0.0    Median: 0.0    Max: 0.0032065
```


File Edit Selection View Go Run Terminal Help
pointcp
PointCPTest.java
PointCPTest.java > PointCPTest > main(String[])
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
powershell
master* 0 0 0
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```
PointCP3 point3 = new PointCP3(point1.getX(), point1.getY());
```

```
point1
getX()    Min: 1.477E-4    Median: 0.0653899    Max: 0.0761228
getY()    Min: 0.0    Median: 0.0673543    Max: 0.0693751
getRho()    Min: 0.0    Median: 0.0    Max: 0.0023863
getTheta()    Min: 0.0029905    Median: 0.0046995    Max: 0.582189
getDistance()    Min: 0.0    Median: 0.2668742    Max: 0.2718455
rotatePoint()    Min: 0.5453068    Median: 0.6789392    Max: 0.7061247

point2
getX()    Min: 0.0627905    Median: 0.0664725    Max: 0.0756879
getY()    Min: 0.0554724    Median: 0.0681432    Max: 0.0694736
getRho()    Min: 0.0    Median: 0.0    Max: 0.0031895
getTheta()    Min: 0.0    Median: 1.0E-7    Max: 0.0021867
getDistance()    Min: 0.2579402    Median: 0.2687482    Max: 0.2752622
rotatePoint()    Min: 1.2630468    Median: 1.2758343    Max: 1.2936553

point3
getX()    Min: 0.0    Median: 0.0    Max: 0.0042475
getY()    Min: 0.0    Median: 0.0    Max: 0.0043824
getRho()    Min: 0.0024822    Median: 0.020272    Max: 0.020874
getTheta()    Min: 0.5796621    Median: 0.610151    Max: 0.6116979
getDistance()    Min: 0.0031784    Median: 0.0207995    Max: 0.0210505
rotatePoint()    Min: 0.5369855    Median: 0.5810301    Max: 0.6250869

point4
getX()    Min: 0.0629982    Median: 0.0652635    Max: 0.0685845
getY()    Min: 0.0665927    Median: 0.0694021    Max: 0.0761882
getRho()    Min: 0.0    Median: 0.0    Max: 0.0025636
getTheta()    Min: 0.0    Median: 0.0    Max: 0.0022478
getDistance()    Min: 0.2599794    Median: 0.2668691    Max: 0.2851312
rotatePoint()    Min: 1.2631546    Median: 1.2724645    Max: 1.2841508

point5
getX()    Min: 0.0    Median: 1.0E-7    Max: 0.0097929
getY()    Min: 0.0    Median: 1.0E-7    Max: 0.0034197
getRho()    Min: 0.0    Median: 1.0E-7    Max: 0.0082552
getTheta()    Min: 0.5811123    Median: 0.6031199    Max: 0.6117127
getDistance()    Min: 0.0    Median: 1.0E-7    Max: 0.0034461
rotatePoint()    Min: 0.5376585    Median: 0.5425568    Max: 0.5476683
```

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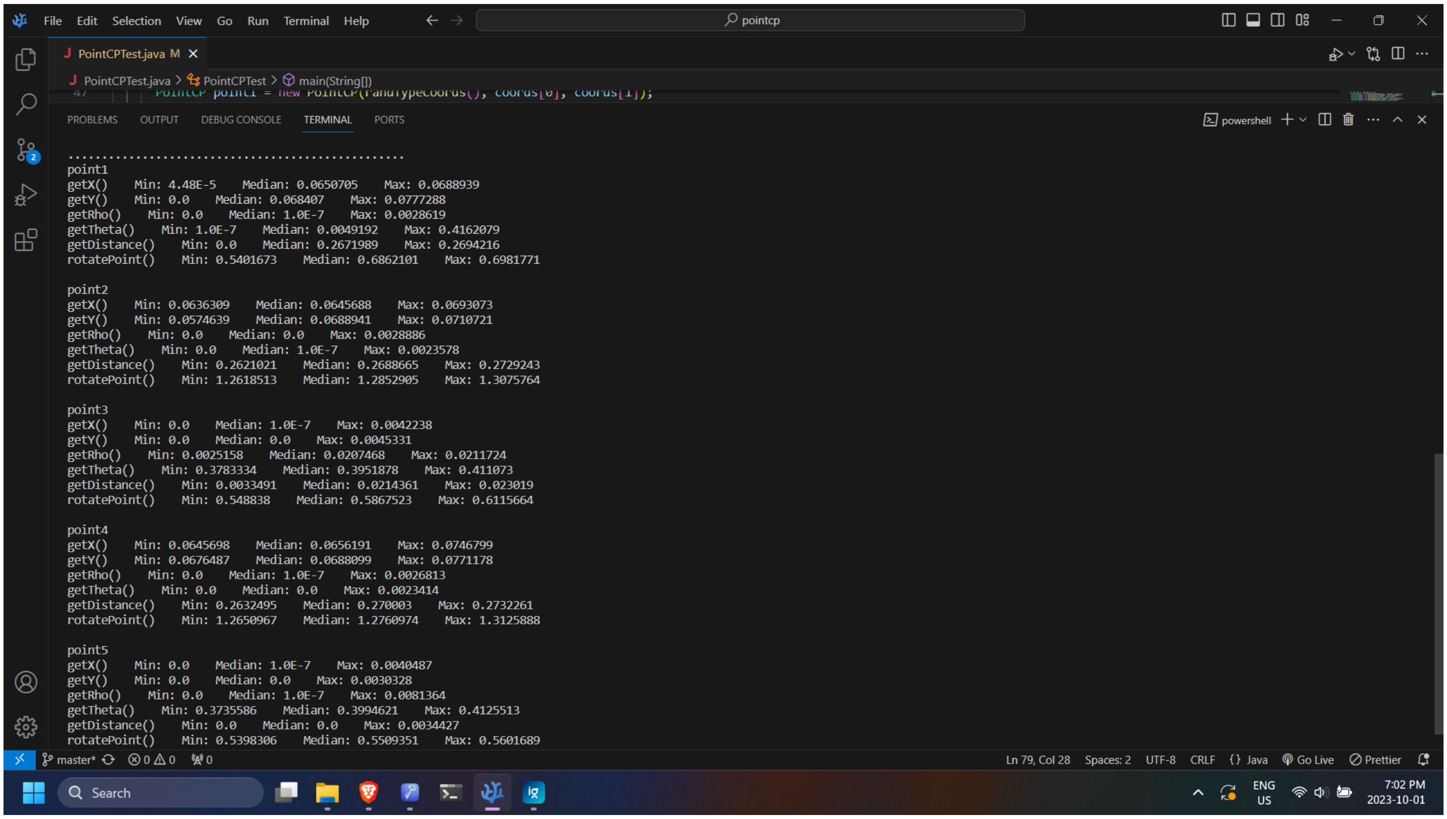

File Edit Selection View Go Run Terminal Help
pointcp
PointCPTest.java M
PointCPTest.java > PointCPTest > main(String[])
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
powershell
master* ⊗ 0 ⚠ 0 0
Ln 79, Col 28 Spaces: 2 UTF-8 CRLF {} Java Go Live Prettier
Search
ENG US
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```
..................................................
point1
getX()    Min: 4.48E-5    Median: 0.0650705    Max: 0.0688939
getY()    Min: 0.0    Median: 0.068407    Max: 0.0777288
getRho()    Min: 0.0    Median: 1.0E-7    Max: 0.0028619
getTheta()    Min: 1.0E-7    Median: 0.0049192    Max: 0.4162079
getDistance()    Min: 0.0    Median: 0.2671989    Max: 0.2694216
rotatePoint()    Min: 0.5401673    Median: 0.6862101    Max: 0.6981771

point2
getX()    Min: 0.0636309    Median: 0.0645688    Max: 0.0693073
getY()    Min: 0.0574639    Median: 0.0688941    Max: 0.0710721
getRho()    Min: 0.0    Median: 0.0    Max: 0.0028886
getTheta()    Min: 0.0    Median: 1.0E-7    Max: 0.0023578
getDistance()    Min: 0.2621021    Median: 0.2688665    Max: 0.2729243
rotatePoint()    Min: 1.2618513    Median: 1.2852905    Max: 1.3075764

point3
getX()    Min: 0.0    Median: 1.0E-7    Max: 0.0042238
getY()    Min: 0.0    Median: 0.0    Max: 0.0045331
getRho()    Min: 0.0025158    Median: 0.0207468    Max: 0.0211724
getTheta()    Min: 0.3783334    Median: 0.3951878    Max: 0.411073
getDistance()    Min: 0.0033491    Median: 0.0214361    Max: 0.023019
rotatePoint()    Min: 0.548838    Median: 0.5867523    Max: 0.6115664

point4
getX()    Min: 0.0645698    Median: 0.0656191    Max: 0.0746799
getY()    Min: 0.0676487    Median: 0.0688099    Max: 0.0771178
getRho()    Min: 0.0    Median: 1.0E-7    Max: 0.0026813
getTheta()    Min: 0.0    Median: 0.0    Max: 0.0023414
getDistance()    Min: 0.2632495    Median: 0.270003    Max: 0.2732261
rotatePoint()    Min: 1.2650967    Median: 1.2760974    Max: 1.3125888

point5
getX()    Min: 0.0    Median: 1.0E-7    Max: 0.0040487
getY()    Min: 0.0    Median: 0.0    Max: 0.0030328
getRho()    Min: 0.0    Median: 1.0E-7    Max: 0.0081364
getTheta()    Min: 0.3735586    Median: 0.3994621    Max: 0.4125513
getDistance()    Min: 0.0    Median: 0.0    Max: 0.0034427
rotatePoint()    Min: 0.5398306    Median: 0.5509351    Max: 0.5601689
```