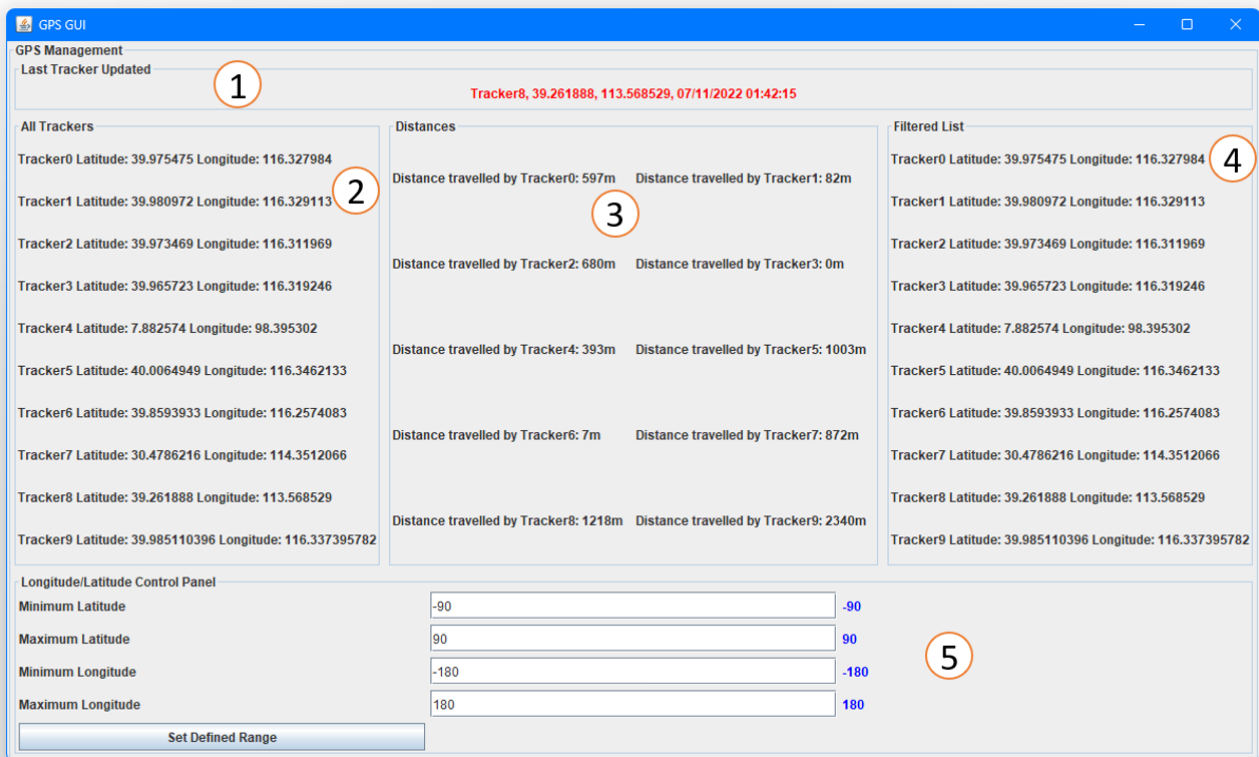


# Testing Report for EDC Assignment 3:

How to start:

1. Run the command to compile
  - a. `javac -cp ".;lib/sodium.jar;lib/swidgets.jar" GpsGUI.java GpsService.java GpsEvent.java`
2. Run the command to run the application
  - a. `java -cp ".;lib/sodium.jar;lib/swidgets.jar" GpsGUI`

Testing Report:



The user interface of the GPS GUI is divided into 5 distinct sections. According to the Expected GUI Display/ Output Format, the following are the points and the corresponding sections:

1. **SECTION 2** Ten tracker simplified displays. Simplified tracking data has its altitude data removed and this should be carried out with Sodium FRP operations. From this stream, display, in separate cells:
  - Tracker number
  - latitude

- longitude
- 2. **[SECTION 1]** A display field shows each event as it is passed to the GUI, at the time it occurs.
  - This is presented as a comma-delimited string of 4 items
  - Only a single entry is presented at a time, and cleared after 3 seconds if not overwritten.
- 3. **[SECTION 4 & 5]** A single (1) display that combines all input streams, and only outputs GPS events in the defined range of Latitude and Longitude.
  - The defined range is controlled by a control panel consisting of a latitude input field, a longitude input field, and a button to set the restriction.
    - The latitude and longitude restriction will probably require the use of the **snapshot** primitive.
  - Labels show the current setting of the restriction.
  - The GUI element displays the data in an identical form to the display field in (2), as long as the data is in the range.
- 4. **[SECTION 3 & 5]** A distance field for each tracker that outputs the total distance travelled over the last 5 minutes for each tracker.
  - Your GUI should display a label for each tracker, with the current distance travelled next to it.
  - This only includes events that are within the currently set Lat/Long range.
  - The value should be a distance in meters, rounded up to the nearest integer meter.
    - **Important: The tracker altitude data is in feet. You should use `map` to transform this data.**
  - Distance calculations may be calculated without considering the curvature of the Earth but must take the altitude into account.  
(See Latitude and Longitude section below)
  - **Hint:** You might want to look at the FRP primitive `snapshot`.
  - **Hint:** A sliding window of 5 minutes, however you implement it, will make this calculation easier. You only calculate distances between known positions, i.e. two distinct events

Your GUI should use framing and clear structure to group similar elements and make it easy to understand what is going on.

## Section 1 Last Tracker Updated (Point 2)

This section shows a display field of each event that happens as a comma-delimited string of 4 items that is cleared after 3 seconds if not overwritten.

Testing this section was just corresponding to the last events that were printed in the terminal with the tracker that was showing as the 'last event'. This test shows that it works:

The screenshot displays a code editor on the left and a GUI application titled 'GPS GUI' on the right. The code editor shows a Java-like script with a loop that updates a 'Last Tracker Updated' field every 3 seconds. The GUI application has a 'GPS Management' tab with a 'Last Tracker Updated' field showing 'Tracker8, 39.226196, 113.577249, 07/11/2022 01:47:09'. Below this, there are sections for 'All Trackers', 'Distances', and 'Filtered List'. The 'All Trackers' section lists 10 trackers with their coordinates. The 'Distances' section shows the distance travelled by each tracker. The 'Filtered List' section shows a list of trackers with their coordinates. The 'Tracker8' entry is highlighted in red in the 'All Trackers' section.

```
621 // ZonedDateToTime.now().toInstant().toEpochMilli(), updatedDistance);
622
623 rollingWindow.add(rolled);
624
625
626 double tempDistTravelled = 0.0;
627 for (int i = 0; i < rollingWindow.size(); i++) {
628     if (rollingWindow.get(i).getTimestamp() < (System.currentTimeMillis() - 300000)) {
629         tempDistTravelled -= rollingWindow.get(i).getDistance();
630     }
631 }
632 distTravelled[0] = tempDistTravelled;
633 int intDistance = (int) tempDistTravelled;
634
635 // Add data to a map for processing
636 latitudes[0] = ev.getLatitude();
637 longitudes[0] = ev.getLongitude();
638 altitudes[0] = ev.getAltitude();
639
640 // Replace tracker component
641 buffer0.setText(input0.getText() + "Distance travelled by " + Tracker8.getLatitude() + ", " + Tracker8.getLongitude() + ", " + Tracker8.getAltitude() + ", " + Tracker8.getDistance() + "m\n");
642 input0.selectAll();
643
644 // Add data to a map for processing
645 latitudes[0] = ev.getLatitude();
646 longitudes[0] = ev.getLongitude();
647 altitudes[0] = ev.getAltitude();
648
649 // Replace tracker component
650 buffer0.setText(input0.getText() + "Distance travelled by " + Tracker8.getLatitude() + ", " + Tracker8.getLongitude() + ", " + Tracker8.getAltitude() + ", " + Tracker8.getDistance() + "m\n");
651 input0.selectAll();
```

Tracker3 lat:39.966293 lon:116.345105 alt:144.0  
Tracker6 lat:39.8639 lon:116.2700283 alt:141.1  
Tracker5 lat:40.808448 lon:116.3800183 alt:173.9  
Tracker8 lat:39.226196 lon:113.576889 alt:387.0  
Tracker7 lat:30.4792199 lon:114.3399166 alt:134.5  
Tracker3 lat:39.966296 lon:116.345329 alt:144.0  
Tracker6 lat:39.863883 lon:116.2701615 alt:137.8  
Tracker8 lat:39.226373 lon:113.57787 alt:387.0  
Tracker1 lat:39.980714 lon:116.329225 alt:66.0  
Tracker0 lat:39.983628 lon:116.327524 alt:242.0  
Tracker9 lat:39.98722549 lon:116.406310061 alt:139.58435367454  
Tracker3 lat:39.966299 lon:116.345553 alt:148.0  
Tracker6 lat:39.8638766 lon:116.2702966 alt:137.8  
Tracker5 lat:40.8084749 lon:116.3801299 alt:177.2  
Tracker8 lat:39.226196 lon:113.577249 alt:387.0

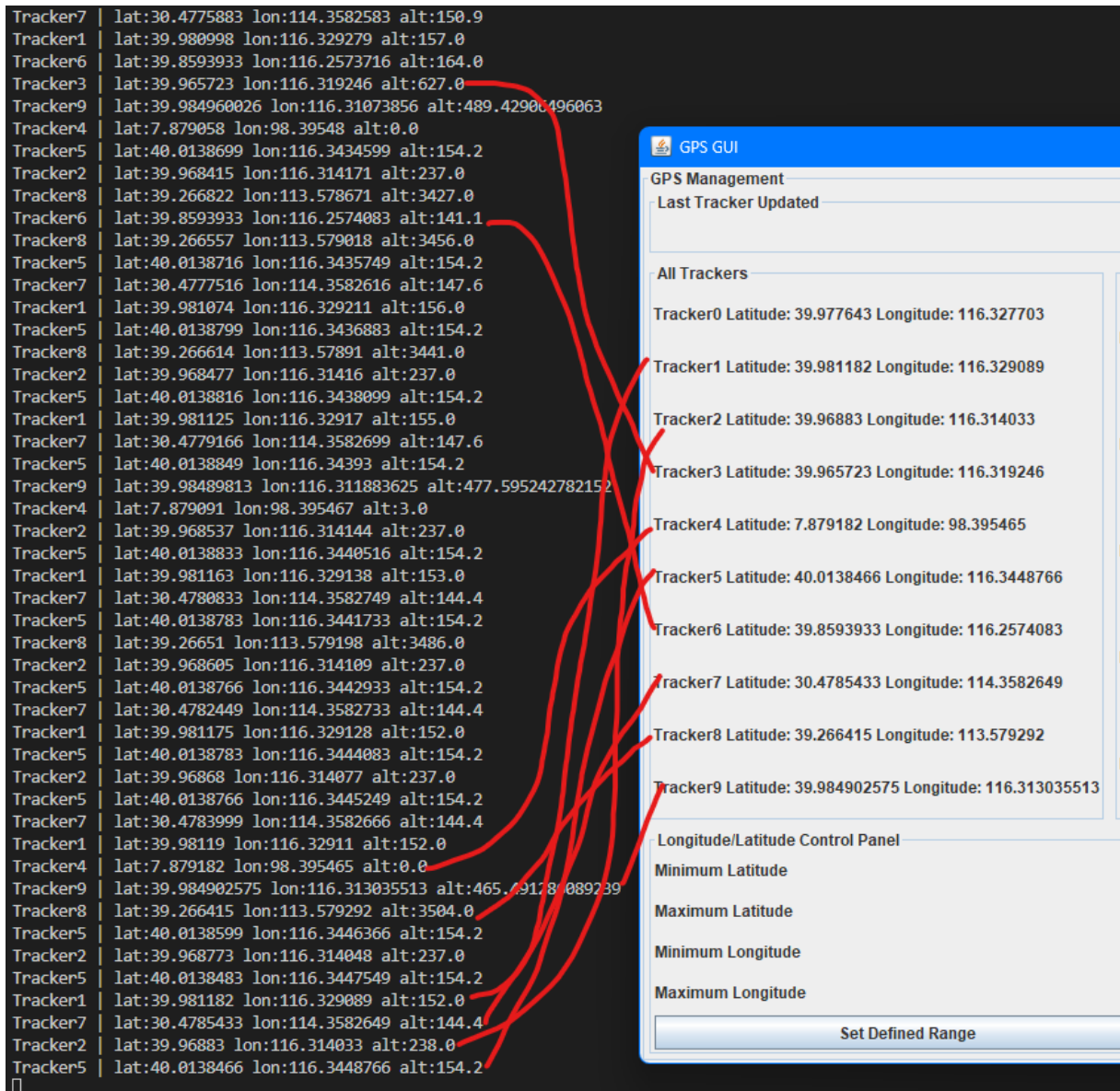
GPS GUI  
GPS Management  
Last Tracker Updated  
Tracker8, 39.226196, 113.577249, 07/11/2022 01:47:09  
All Trackers  
Tracker0 Latitude: 39.983628 Longitude: 116.327524  
Tracker1 Latitude: 39.980714 Longitude: 116.329225  
Tracker2 Latitude: 39.978405 Longitude: 116.311211  
Tracker3 Latitude: 39.966299 Longitude: 116.345553  
Tracker4 Latitude: 7.883777 Longitude: 98.392853  
Tracker5 Latitude: 40.0084749 Longitude: 116.3801299  
Tracker6 Latitude: 39.8638766 Longitude: 116.2702966  
Tracker7 Latitude: 30.4792199 Longitude: 114.3399166  
Tracker8 Latitude: 39.226196 Longitude: 113.577249  
Tracker9 Latitude: 39.98722549 Longitude: 116.406310061  
Distances  
Distance travelled by Tracker0: 1130m Distance travelled by Tracker1: 103m  
Distance travelled by Tracker2: 1025m Distance travelled by Tracker3: 2259m  
Distance travelled by Tracker4: 710m Distance travelled by Tracker5: 2919m  
Distance travelled by Tracker6: 1561m Distance travelled by Tracker7: 1263m  
Distance travelled by Tracker8: 5243m Distance travelled by Tracker9: 6097m  
Filtered List  
Tracker0 Latitude: 39.983628 Longitude: 116.327524  
Tracker1 Latitude: 39.980714 Longitude: 116.329225  
Tracker2 Latitude: 39.978405 Longitude: 116.311211  
Tracker3 Latitude: 39.966299 Longitude: 116.345553  
Tracker4 Latitude: 7.883777 Longitude: 98.392853  
Tracker5 Latitude: 40.0084749 Longitude: 116.3801299  
Tracker6 Latitude: 39.8638766 Longitude: 116.2702966  
Tracker7 Latitude: 30.4792199 Longitude: 114.3399166  
Tracker8 Latitude: 39.226196 Longitude: 113.577249  
Tracker9 Latitude: 39.98722549 Longitude: 116.406310061  
Longitude/Latitude Control Panel  
Minimum Latitude -90 Maximum Latitude 90  
Minimum Longitude -180 Maximum Longitude 180  
Set Defined Range

We can inspect that every 3 seconds if not updated it will clear itself by placing a print statement and modifying the code in the loop to stop events from happening. From this it has been verified that the timer every 3 seconds works.

## Section 2 All Trackers (Point 1)

This section shows ten simplified tracker displays. The altitude of this data has been removed with Sodium FRP operations.

Testing this section was just corresponding to the events that were printed in the terminal with the tracker that was showing as the 'last event'. This test shows that it works:



## Section 3 Distances (Point 4)

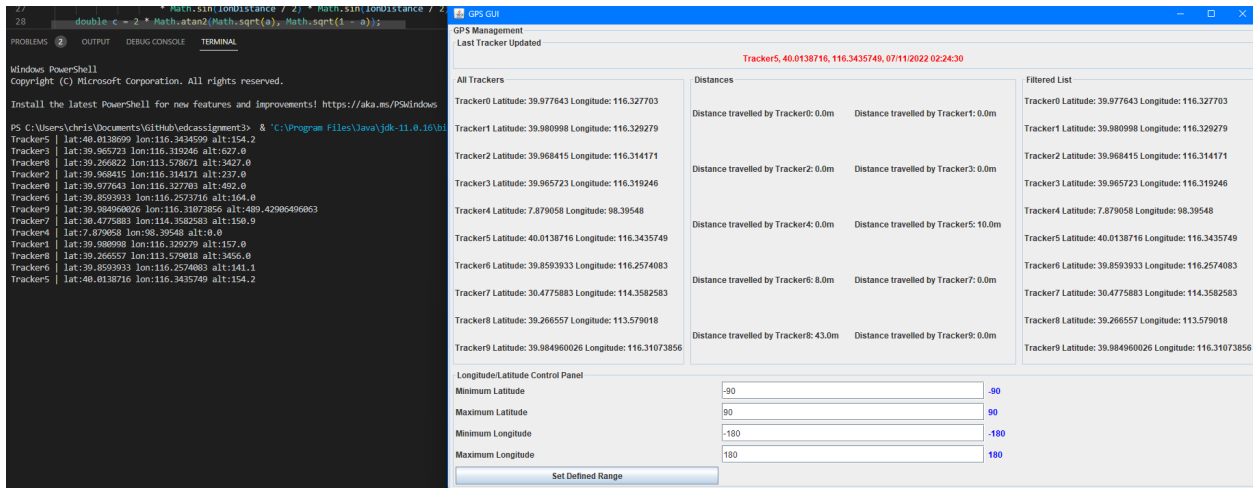
This section shows ten tracker labels with their corresponding distance traveled.

It only includes events that are within the Lat/Long range from Section 5.

The value should be in meters (rounded up).

To test this section, I first just looked at the values of the distances traveled in correspondence to what was displayed on the output of the GPS Service.



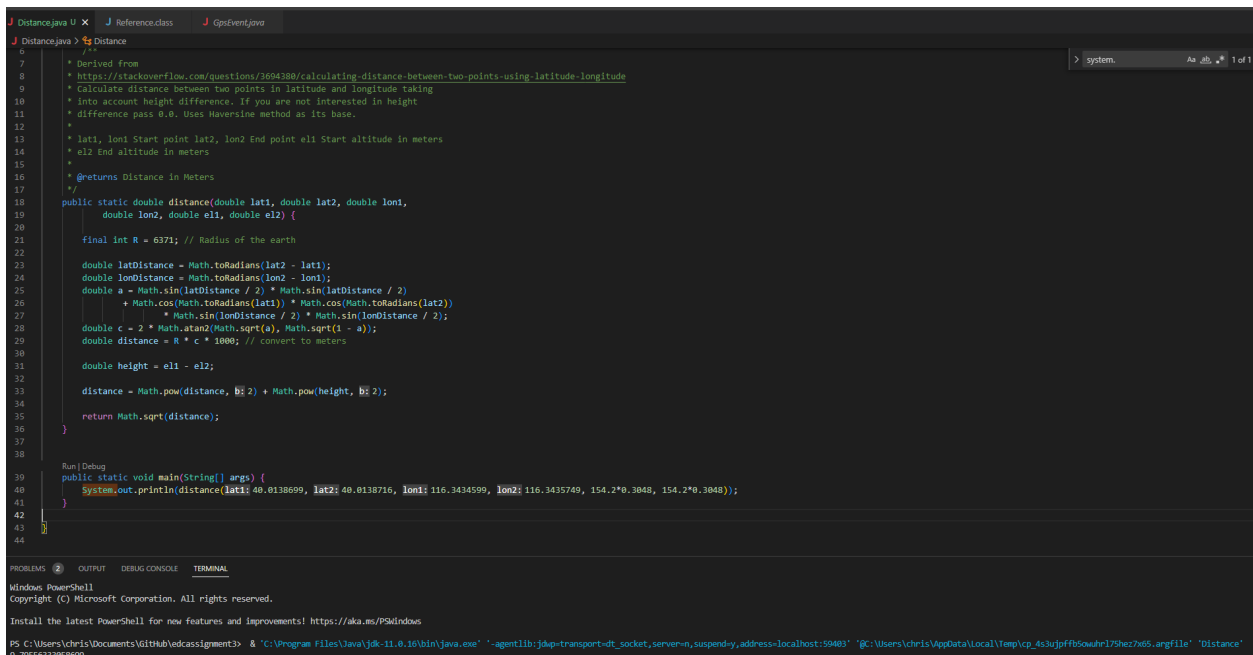


I then looked at the two strings that were shown highlighted at the beginning:

Tracker5 | lat:40.0138699 lon:116.3434599 alt:154.2

Tracker5 | lat:40.0138716 lon:116.3435749 alt:154.2

With the altitude multiplied by 0.3048 to convert to meters



Which gives us 9.79556333058699 ~ 10 m

Therefore the rounding and distance calculation is correct. I repeated this for a few other strings.

Note this uses the distance formula from

<https://stackoverflow.com/questions/3694380/calculating-distance-between-two-points-using-latitude-longitude>

Now to test that it only registers events that are within the range we set.

We quickly set the minimum latitude to 40 so that only tracker 5 meets the requirements

The screenshot shows a Java application window titled "GPS GUI" with a "GPS Management" tab. The window displays a list of trackers and their coordinates. The "All Trackers" section lists 10 trackers with their latitude, longitude, and altitude. The "Distances" section shows the distance travelled by each tracker. The "Filtered List" section shows the trackers that are currently within the defined range. The "Longitude/Latitude Control Panel" at the bottom allows the user to set the minimum and maximum latitude and longitude. The minimum latitude is set to 40, and the maximum latitude is set to 90. The minimum longitude is set to -180, and the maximum longitude is set to 180. The "Set Defined Range" button is visible at the bottom.

After a few seconds we find that everything else has remained the same except for tracker 5, which has gone from 91 m to 168m. Therefore we know that the filter is working and it only updates if the tracker is in range. We can also see from the terminal all the other events that are happening which do update on the All Trackers part of the program but does not register on the distance - which is a clear separation of both modules.

The screenshot shows a Java application window titled "GPS GUI" with a "GPS Management" tab. The window displays a list of trackers and their coordinates. The "All Trackers" section lists 10 trackers with their latitude, longitude, and altitude. The "Distances" section shows the distance travelled by each tracker. The "Filtered List" section shows the trackers that are currently within the defined range. The "Longitude/Latitude Control Panel" at the bottom allows the user to set the minimum and maximum latitude and longitude. The minimum latitude is set to 40, and the maximum latitude is set to 90. The minimum longitude is set to -180, and the maximum longitude is set to 180. The "Set Defined Range" button is visible at the bottom.



# Section 4 + 5 Filtered List and Control Panel (Point 3)

Section 4 and 5 correspond to point 3 where the requirements for testing were that the defined range is controlled by a control panel consisting of a latitude input field and a longitude input field and a button to set this restriction.

As we can see there are the input fields of the minimum and maximum latitude and longitudes. The labels show the current setting of the restriction.

The screenshot shows a window titled "GPS GUI" with a menu bar containing "GPS Management" and a status bar showing "Last Tracker Updated". The main content area is divided into three panels:

- All Trackers:** A list of 10 trackers with their coordinates. Tracker8 is highlighted in red.
- Distances:** A table showing the distance travelled by each tracker.
- Filtered List:** A list of trackers that match the current filter criteria. Tracker8 is highlighted in red.

Below the panels is a "Longitude/Latitude Control Panel" with input fields for Minimum Latitude, Maximum Latitude, Minimum Longitude, and Maximum Longitude. The current values are -90, 90, -180, and 180 respectively. A "Set Defined Range" button is at the bottom.

Tracker	Latitude	Longitude
Tracker0	39.97541	116.329522
Tracker1	39.98099	116.329158
Tracker2	39.969906	116.313603
Tracker3	39.965723	116.319246
Tracker4	7.881982	98.395303
Tracker5	40.0090199	116.3461016
Tracker6	39.8593933	116.2574083
Tracker7	30.4786783	114.3551716
Tracker8	39.265255	113.574234
Tracker9	39.984522857	116.323522032

Tracker	Distance
Tracker0	456.0m
Tracker1	72.0m
Tracker2	245.0m
Tracker3	0.0m
Tracker4	328.0m
Tracker5	722.0m
Tracker6	8.0m
Tracker7	490.0m
Tracker8	581.0m
Tracker9	1157....

Tracker	Latitude	Longitude
Tracker0	39.97541	116.329522
Tracker1	39.98099	116.329158
Tracker2	39.969906	116.313603
Tracker3	39.965723	116.319246
Tracker4	7.881982	98.395303
Tracker5	40.0090199	116.3461016
Tracker6	39.8593933	116.2574083
Tracker7	30.4786783	114.3551716
Tracker8	39.265255	113.574234
Tracker9	39.984522857	116.323522032

Longitude/Latitude Control Panel

Field	Value
Minimum Latitude	-90
Maximum Latitude	90
Minimum Longitude	-180
Maximum Longitude	180

Set Defined Range

To test the normal use of this application, we can choose a tracker to filter out. For example, choosing to filter by latitude to show tracker4 as it is around 7 compared which is different from the others:

GPS GUI

GPS Management

Last Tracker Updated

Tracker5, 40.0084366, 116.36931, 07/11/2022 02:37:36

All Trackers

Tracker0 Latitude: 39.981118 Longitude: 116.327676

Tracker1 Latitude: 39.980954 Longitude: 116.329165

Tracker2 Latitude: 39.977755 Longitude: 116.310714

Tracker3 Latitude: 39.966233 Longitude: 116.325571

Tracker4 Latitude: 7.883777 Longitude: 98.392853

Tracker5 Latitude: 40.0084366 Longitude: 116.36931

Tracker6 Latitude: 39.86359 Longitude: 116.25997

Tracker7 Latitude: 30.4783849 Longitude: 114.3443683

Tracker8 Latitude: 39.23975 Longitude: 113.56449

Tracker9 Latitude: 39.986524521 Longitude: 116.384629129

Distances

Distance travelled by Tracker0: 964.0m Distance travelled by Tracker1: 108.0m

Distance travelled by Tracker2: 1046.0m Distance travelled by Tracker3: 0.0m

Distance travelled by Tracker4: 394.0m Distance travelled by Tracker5: 2718.0m

Distance travelled by Tracker6: 143.0m Distance travelled by Tracker7: 1451.0m

Distance travelled by Tracker8: 2749.0m Distance travelled by Tracker9: 4539.0m

Filtered List

Tracker4 Latitude: 7.882574 Longitude: 98.395302

Longitude/Latitude Control Panel

Minimum Latitude

6

6

Maximum Latitude

8

8

Minimum Longitude

-180

-180

Maximum Longitude

180

180

Set Defined Range

We can see the other trackers disappear as they are not in the range of the control panel.

If we want to filter based on longitude, we can choose the trackers that fit in the 116 range.

GPS GUI

GPS Management

Last Tracker Updated

Tracker6, 39.8640149, 116.2675833, 07/11/2022 02:38:42

All Trackers

Tracker0 Latitude: 39.983062 Longitude: 116.327696

Tracker1 Latitude: 39.980699 Longitude: 116.329225

Tracker2 Latitude: 39.978389 Longitude: 116.311217

Tracker3 Latitude: 39.96629 Longitude: 116.341363

Tracker4 Latitude: 7.883777 Longitude: 98.392853

Tracker5 Latitude: 40.0084399 Longitude: 116.3798883

Tracker6 Latitude: 39.8640149 Longitude: 116.2675833

Tracker7 Latitude: 30.4790833 Longitude: 114.3403016

Tracker8 Latitude: 39.229432 Longitude: 113.573953

Tracker9 Latitude: 39.987052903 Longitude: 116.400773349

Distances

Distance travelled by Tracker0: 964.0m Distance travelled by Tracker1: 74.0m

Distance travelled by Tracker2: 1017.0m Distance travelled by Tracker3: 1894.0m

Distance travelled by Tracker4: 394.0m Distance travelled by Tracker5: 2950.0m

Distance travelled by Tracker6: 1185.0m Distance travelled by Tracker7: 1319.0m

Distance travelled by Tracker8: 4810.0m Distance travelled by Tracker9: 6097.0m

Filtered List

Tracker0 Latitude: 39.983062 Longitude: 116.327696

Tracker1 Latitude: 39.980699 Longitude: 116.329225

Tracker2 Latitude: 39.978389 Longitude: 116.311217

Tracker3 Latitude: 39.96629 Longitude: 116.341363

Tracker5 Latitude: 40.0084399 Longitude: 116.3798883

Tracker6 Latitude: 39.8640149 Longitude: 116.2675833

Tracker9 Latitude: 39.987052903 Longitude: 116.400773349

Longitude/Latitude Control Panel

Minimum Latitude

-90

-90

Maximum Latitude

90

90

Minimum Longitude

115

115

Maximum Longitude

117

117

Set Defined Range

As can be seen, this example test shows that the control panel works.

## Edge Case / Error Handling:

To test that the values do not go over the minimum and maximum values of -90, 90 and -180, 180 for latitude and longitude respectively, we try setting the defined range over.

GPS GUI

GPS Management

Last Tracker Updated

Tracker2, 39.973312, 116.312039, 07/11/2022 02:34:09

All Trackers

Tracker0 Latitude: 39.975442 Longitude: 116.328011

Tracker1 Latitude: 39.980975 Longitude: 116.329108

Tracker2 Latitude: 39.973312 Longitude: 116.312039

Tracker3 Latitude: 39.965723 Longitude: 116.319246

Tracker4 Latitude: 7.882574 Longitude: 98.395302

Tracker5 Latitude: 40.0064949 Longitude: 116.3462133

Tracker6 Latitude: 39.8593933 Longitude: 116.2574083

Tracker7 Latitude: 30.4786266 Longitude: 114.3513233

Tracker8 Latitude: 39.262215 Longitude: 113.568993

Tracker9 Latitude: 39.985068614 Longitude: 116.336193258

Distances

Distance travelled by Tracker0: 553.0m Distance travelled by Tracker1: 80.0m

Distance travelled by Tracker2: 470.0m Distance travelled by Tracker3: 0.0m

Distance travelled by Tracker4: 394.0m Distance travelled by Tracker5: 992.0m

Distance travelled by Tracker6: 8.0m Distance travelled by Tracker7: 767.0m

Distance travelled by Tracker8: 976.0m Distance travelled by Tracker9: 1996....

Filtered List

Longitude/Latitude Control Panel

Minimum Latitude -9012389 -90

Maximum Latitude 2948924 90

Minimum Longitude -394084 -180

Maximum Longitude 893434 180

Set Defined Range

We can see that it doesn't register anything because it goes over the limit. Only registering the -90, 90, -180, and 180.

We can also test that the minimum can't go over the maximum and will be limited.

For example, in this case:

GPS GUI

GPS Management

Last Tracker Updated

Tracker1, 39.980906, 116.329071, 07/11/2022 02:35:54

All Trackers

Tracker0 Latitude: 39.977563 Longitude: 116.327712  
Tracker1 Latitude: 39.980906 Longitude: 116.329071  
Tracker2 Latitude: 39.976139 Longitude: 116.310998  
Tracker3 Latitude: 39.965723 Longitude: 116.319246  
Tracker4 Latitude: 7.883777 Longitude: 98.392853  
Tracker5 Latitude: 40.0081066 Longitude: 116.3621966  
Tracker6 Latitude: 39.8594983 Longitude: 116.2581566  
Tracker7 Latitude: 30.4783099 Longitude: 114.3456299  
Tracker8 Latitude: 39.254969 Longitude: 113.556287  
Tracker9 Latitude: 39.985836004 Longitude: 116.359494582

Distances

Distance travelled by Tracker0: 821.0m    Distance travelled by Tracker1: 101.0m  
  
Distance travelled by Tracker2: 1026....    Distance travelled by Tracker3: 0.0m  
  
Distance travelled by Tracker4: 394.0m    Distance travelled by Tracker5: 2373....  
  
Distance travelled by Tracker6: 77.0m    Distance travelled by Tracker7: 1420....  
  
Distance travelled by Tracker8: 2567....    Distance travelled by Tracker9: 4225....

Filtered List

Tracker0 Latitude: 39.977563 Longitude: 116.327712  
Tracker1 Latitude: 39.980906 Longitude: 116.329071  
Tracker2 Latitude: 39.976139 Longitude: 116.310998  
Tracker3 Latitude: 39.965723 Longitude: 116.319246  
Tracker4 Latitude: 7.882574 Longitude: 98.395302  
Tracker5 Latitude: 40.0081066 Longitude: 116.3621966  
Tracker6 Latitude: 39.8594983 Longitude: 116.2581566  
Tracker7 Latitude: 30.4783099 Longitude: 114.3456299  
Tracker8 Latitude: 39.254969 Longitude: 113.556287  
Tracker9 Latitude: 39.985836004 Longitude: 116.359494582

Longitude/Latitude Control Panel

Minimum Latitude

-90

-90

Maximum Latitude

50

50

Minimum Longitude

-180

-180

Maximum Longitude

180

180

Set Defined Range

If we try and set minimum latitude to be larger than 51, we are capped at 50 instead.

GPS GUI

GPS Management

Last Tracker Updated

Tracker7, 30.4785266, 114.3454616, 07/11/2022 02:36:11

All Trackers

Tracker0 Latitude: 39.978636 Longitude: 116.327796  
Tracker1 Latitude: 39.980958 Longitude: 116.329098  
Tracker2 Latitude: 39.976287 Longitude: 116.310974  
Tracker3 Latitude: 39.965723 Longitude: 116.319246  
Tracker4 Latitude: 7.883777 Longitude: 98.392853  
Tracker5 Latitude: 40.0082549 Longitude: 116.3664616  
Tracker6 Latitude: 39.8596299 Longitude: 116.2589083  
Tracker7 Latitude: 30.4785266 Longitude: 114.3454616  
Tracker8 Latitude: 39.253431 Longitude: 113.5573  
Tracker9 Latitude: 39.98600197 Longitude: 116.364494719

Distances

Distance travelled by Tracker0: 964.0m    Distance travelled by Tracker1: 108.0m  
  
Distance travelled by Tracker2: 1046.0m    Distance travelled by Tracker3: 0.0m  
  
Distance travelled by Tracker4: 394.0m    Distance travelled by Tracker5: 2718.0m  
  
Distance travelled by Tracker6: 143.0m    Distance travelled by Tracker7: 1451.0m  
  
Distance travelled by Tracker8: 2749.0m    Distance travelled by Tracker9: 4539.0m

Filtered List

Longitude/Latitude Control Panel

Minimum Latitude

51

50

Maximum Latitude

50

50

Minimum Longitude

-180

-180

Maximum Longitude

180

180

Set Defined Range

With the filter list not updating due to the invalid format.

## Testing the 5 minute Window: Quick Test

A quick test can be performed to see if there is indeed a window by seeing if there is a fluctuation both upwards and downwards of the distances after 5 minutes.

GPS GUI

GPS Management  
Last Tracker Updated

Tracker3, 39.967101, 116.388015, 07/11/2022 02:43:34

All Trackers

Tracker0 Latitude: 39.991152 Longitude: 116.327038  
Tracker1 Latitude: 39.980802 Longitude: 116.329071  
Tracker2 Latitude: 39.989014 Longitude: 116.309623  
Tracker3 Latitude: 39.967101 Longitude: 116.388015  
Tracker4 Latitude: 7.908411 Longitude: 98.391283  
Tracker5 Latitude: 40.0204799 Longitude: 116.4259133  
Tracker6 Latitude: 39.82927 Longitude: 116.2873149  
Tracker7 Latitude: 30.4935549 Longitude: 114.3342333  
Tracker8 Latitude: 39.188761 Longitude: 113.616594  
Tracker9 Latitude: 39.980934418 Longitude: 116.446302328

Distances

Distance travelled by Tracker0: 1109.0m      Distance travelled by Tracker1: 96.0m  
Distance travelled by Tracker2: 1319.0m      Distance travelled by Tracker3: 4148.0m  
Distance travelled by Tracker4: 394.0m      Distance travelled by Tracker5: 5838.0m  
Distance travelled by Tracker6: 5021.0m      Distance travelled by Tracker7: 1319.0m  
Distance travelled by Tracker8: 6141.0m      Distance travelled by Tracker9: 4328.0m

Filtered List

Tracker0 Latitude: 39.991152 Longitude: 116.327038  
Tracker1 Latitude: 39.980802 Longitude: 116.329071  
Tracker2 Latitude: 39.989014 Longitude: 116.309623  
Tracker3 Latitude: 39.967101 Longitude: 116.388015  
Tracker4 Latitude: 7.882574 Longitude: 98.395302  
Tracker5 Latitude: 40.0204799 Longitude: 116.4259133  
Tracker6 Latitude: 39.82927 Longitude: 116.2873149  
Tracker7 Latitude: 30.4789433 Longitude: 114.3413466  
Tracker8 Latitude: 39.188761 Longitude: 113.616594  
Tracker9 Latitude: 39.980934418 Longitude: 116.446302328

Longitude/Latitude Control Panel

Minimum Latitude: -90      -90  
Maximum Latitude: 90      90  
Minimum Longitude: -180      -180  
Maximum Longitude: 180      180  
Set Defined Range

GPS GUI

GPS Management  
Last Tracker Updated

Tracker3, 39.967156, 116.389785, 07/11/2022 02:43:43

All Trackers

Tracker0 Latitude: 39.991236 Longitude: 116.327038  
Tracker1 Latitude: 39.980792 Longitude: 116.329067  
Tracker2 Latitude: 39.989218 Longitude: 116.309724  
Tracker3 Latitude: 39.967156 Longitude: 116.389785  
Tracker4 Latitude: 7.908411 Longitude: 98.391283  
Tracker5 Latitude: 40.0204099 Longitude: 116.4284666  
Tracker6 Latitude: 39.829245 Longitude: 116.2892683  
Tracker7 Latitude: 30.4941733 Longitude: 114.3343833  
Tracker8 Latitude: 39.186807 Longitude: 113.617516  
Tracker9 Latitude: 39.980774646 Longitude: 116.446556576

Distances

Distance travelled by Tracker0: 1097.0m      Distance travelled by Tracker1: 95.0m  
Distance travelled by Tracker2: 1344.0m      Distance travelled by Tracker3: 4116.0m  
Distance travelled by Tracker4: 394.0m      Distance travelled by Tracker5: 6029.0m  
Distance travelled by Tracker6: 5067.0m      Distance travelled by Tracker7: 1830.0m  
Distance travelled by Tracker8: 6372.0m      Distance travelled by Tracker9: 4133.0m

Filtered List

Tracker0 Latitude: 39.991236 Longitude: 116.327038  
Tracker1 Latitude: 39.980792 Longitude: 116.329067  
Tracker2 Latitude: 39.989218 Longitude: 116.309724  
Tracker3 Latitude: 39.967156 Longitude: 116.389785  
Tracker4 Latitude: 7.882574 Longitude: 98.395302  
Tracker5 Latitude: 40.0204099 Longitude: 116.4284666  
Tracker6 Latitude: 39.829245 Longitude: 116.2892683  
Tracker7 Latitude: 30.4941733 Longitude: 114.3343833  
Tracker8 Latitude: 39.186807 Longitude: 113.617516  
Tracker9 Latitude: 39.980774646 Longitude: 116.446556576

Longitude/Latitude Control Panel

Minimum Latitude: -90      -90  
Maximum Latitude: 90      90  
Minimum Longitude: -180      -180  
Maximum Longitude: 180      180  
Set Defined Range

Which can be observed as so, with multiple trackers going down and some going up.

## Complex Test

A more complex test would be to create a modification to the application as follows:

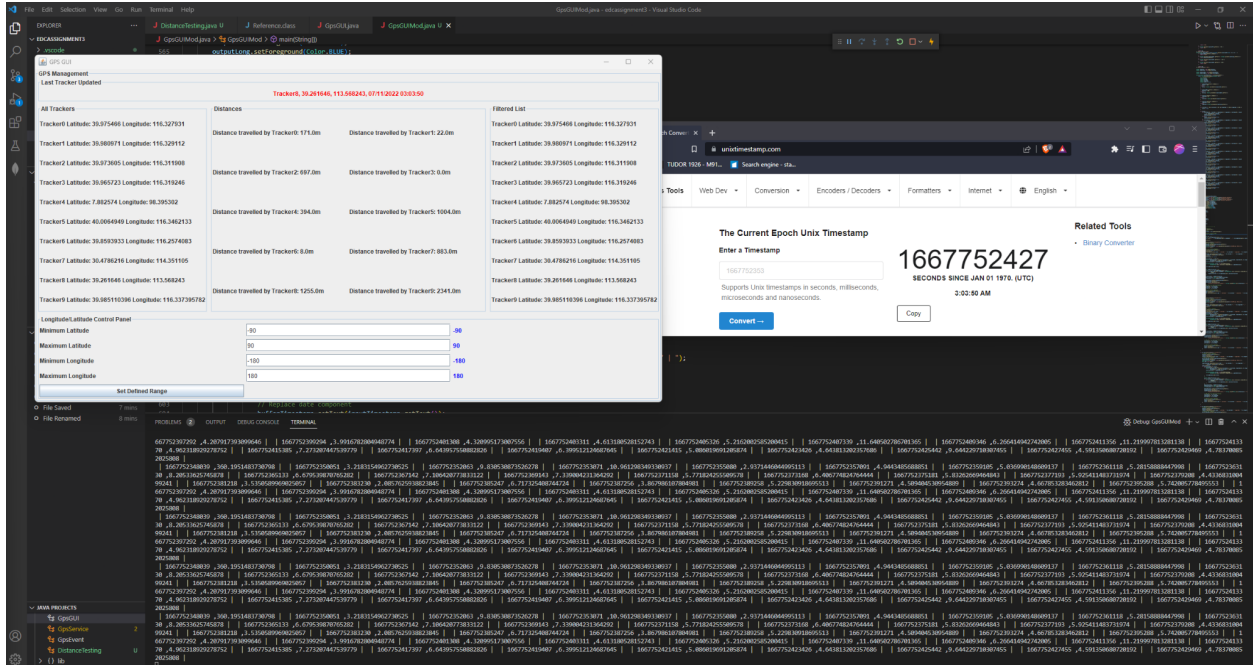
```
double tempDistTravelled = 0.0;
for (int i = 0; i < rollingWindow0.size(); i++) {
    if (rollingWindow0.get(i).timeAdded > ((ZonedDateTime.now().toInstant().toEpochMilli()
        - 60000)) {
        tempDistTravelled += rollingWindow0.get(i).distanceTravelled;
    }
}
```

Time window only 1 minute

```
s.listen((GpsEvent ev) -> {
    for (int i=0; i < rollingWindow0.size(); i++) {
        System.out.print("(" + rollingWindow0.get(i).timeAdded+ " , " + rollingWindow0.get(i).distanceTravelled + " | ");
    }
    System.out.println();
}
```

And a different output for tracker 0

The screenshot shows a Java application running in an IDE. The main window displays a list of trackers and their distances traveled. The trackers are listed in a table with columns for Tracker ID, Latitude, Longitude, and Distance traveled. The distances are shown in meters. The application is running on a Windows operating system, and the IDE is showing the source code of the application. The console output window displays a large list of coordinates and distances, which are the output of the application's logging. The output is formatted as a list of strings, each containing a tracker ID, its latitude, longitude, and distance traveled, separated by commas. The output is displayed in a scrollable text area.



We see tracker0's value go from 177 to 171 from unix timestamp 1667752416 to 1667752427.  
 $1667752427 - 60 = 1667752367$ .

If we look closely at the output of the timestamp to distance:

```
1667752348039,360.1951483730798 | 1667752350051,3.2183154962730525 | 1667752352063,9.830530873526278 | 1667752353071,10.961298349330937 | 1667752355080,2.9371446044995113 | 1667752356108,4.9443485688851 | 1667752357115,5.77182455509578 | 1667752358168,6.40677482476444 | 1667752359105,5.036990148609137 | 1667752360118,5.28158888447998 | 1667752361130,8.20533625745878 | 1667752362133,6.679530870765282 | 1667752363142,7.106420773833122 | 1667752364143,7.339004231364292 | 16677523651158,5.77182455509578 | 1667752366168,6.40677482476444 | 1667752367181,5.83262669464843 | 1667752368193,5.925411483731974 | 1667752369208,4.433683100499241 | 1667752370218,3.5350589969025057 | 1667752371230,2.0857625938823845 | 1667752372247,6.717325408744724 | 1667752373256,3.867986107804981 | 1667752374258,5.229830918695513 | 1667752375271,4.509404530954889 | 1667752376236,4.667853283462812 | 1667752377288,5.742005778495553 | 1667752378292,4.207917393099646 | 1667752379294,3.9916782804948774 | 1667752401308,4.320995173007556 | 1667752403311,4.613180528152743 | 1667752405326,5.2162002585200415 | 1667752407339,11.640502786701365 | 1667752409346,6.266414942742005 |
```

And we add up the corresponding amount that is higher than 1667752367:

```
1667752348039,360.1951483730798 | 1667752350051,3.2183154962730525 | 1667752352063,9.830530873526278 | 1667752353071,10.961298349330937 | 1667752355080,2.9371446044995113 | 1667752356108,4.9443485688851 | 1667752357115,5.77182455509578 | 1667752358168,6.40677482476444 | 1667752359105,5.036990148609137 | 1667752360118,5.28158888447998 | 1667752361130,8.20533625745878 | 1667752362133,6.679530870765282 | 1667752363142,7.106420773833122 | 1667752364143,7.339004231364292 | 16677523651158,5.77182455509578 | 1667752366168,6.40677482476444 | 1667752367181,5.83262669464843 | 1667752368193,5.925411483731974 | 1667752369208,4.433683100499241 | 1667752370218,3.5350589969025057 | 1667752371230,2.0857625938823845 | 1667752372247,6.717325408744724 | 1667752373256,3.867986107804981 | 1667752374258,5.229830918695513 | 1667752375271,4.509404530954889 | 1667752376236,4.667853283462812 | 1667752377288,5.742005778495553 | 1667752378292,4.207917393099646 | 1667752379294,3.9916782804948774 | 1667752401308,4.320995173007556 | 1667752403311,4.613180528152743 | 1667752405326,5.2162002585200415 | 1667752407339,11.640502786701365 | 1667752409346,6.266414942742005 |
```

+1667752348039,360.1951483730798 | +1667752350051,3.2183154962730525 | +1667752352063,9.830530873526278 | +1667752353071,10.961298349330937 | +1667752355080,2.9371446044995113 | +1667752356108,4.9443485688851 | +1667752357115,5.77182455509578 | +1667752358168,6.40677482476444 | +1667752359105,5.036990148609137 | +1667752360118,5.28158888447998 | +1667752361130,8.20533625745878 | +1667752362133,6.679530870765282 | +1667752363142,7.106420773833122 | +1667752364143,7.339004231364292 | +16677523651158,5.77182455509578 | +1667752366168,6.40677482476444 | +1667752367181,5.83262669464843 | +1667752368193,5.925411483731974 | +1667752369208,4.433683100499241 | +1667752370218,3.5350589969025057 | +1667752371230,2.0857625938823845 | +1667752372247,6.717325408744724 | +1667752373256,3.867986107804981 | +1667752374258,5.229830918695513 | +1667752375271,4.509404530954889 | +1667752376236,4.667853283462812 | +1667752377288,5.742005778495553 | +1667752378292,4.207917393099646 | +1667752379294,3.9916782804948774 | +1667752401308,4.320995173007556 | +1667752403311,4.613180528152743 | +1667752405326,5.2162002585200415 | +1667752407339,11.640502786701365 | +1667752409346,6.266414942742005 |

1667752411356 ,11.219997813281138 | | 1667752413370 ,4.962318929278752 | |  
 1667752415385 ,7.273207447539779 | | 1667752417397 ,6.643957550882826 | |  
 1667752419407 ,6.399512124687645 | | 1667752421415 ,5.086019691205874 | |  
 1667752423426 ,4.643813202357686 | | 1667752425442 ,9.644229710307455 | |  
 1667752427455 ,4.591350680720192 | | 1667752429469 ,4.78370085

This meant these sections were the ones added up they would equal ~171

5.7718243		
6.4067748		
5.8326267		
5.9254115		
4.4336831		
3.535059		
2.0857626		
6.7173254		
3.8679861		
5.2298309		
4.5094045		
4.6678533		
5.7420058		
4.2079174		
3.9916783		
4.3209952		
4.6131805		
5.2162003		
11.640503		
6.2664149		
11.219998		
4.9623189		
7.2732074		
6.6439576		
6.3995121		
5.0860197		
4.6438132		
9.6442297		
4.5913507	SUM	
4.7837009	170.2305	

Which is correct when rounding up 170.2305



Meaning that the 1 minute = 60,000 UNIX millisecond window works, which can be generalized to the  $5 * 60,000 = 30,000$  UNIX millisecond time window.