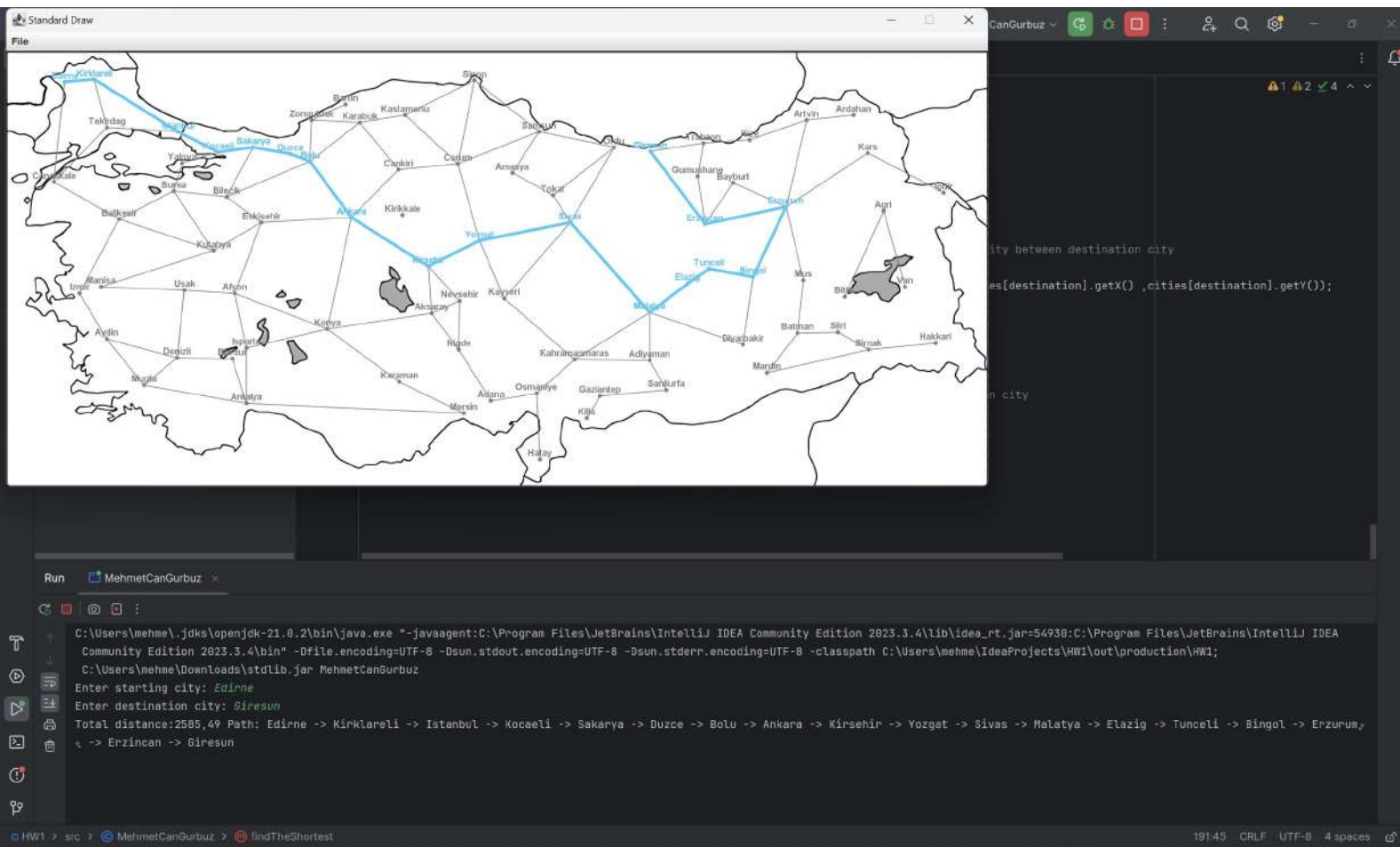


REPORT: Mehmet Can Gürbüz

CASE 1:



A valid case for two cities with connections

CASE 2:

The screenshot displays an IDE environment. On the left, a map of Turkey shows a network of cities connected by lines. A specific path is highlighted in blue, starting from Canakkale and ending at Makkeki. The path includes the following cities: Canakkale, Balıkesir, Kutahya, Eskişehir, Ankara, Kirsehir, Yozgat, Sivas, Malatya, Elazig, Tunceli, Bingol, Erzurum, Mus, Batman, Siirt, Sirnak, and Makkeki. On the right, a code editor shows a Java method `findTheShortest` that takes a starting city and a destination city as input and returns the shortest path. The terminal window at the bottom shows the execution of the program, with the starting city set to Canakkale and the destination city set to Makkeki. The output displays the total distance as 2780,87 and the path as Canakkale -> Balıkesir -> Kutahya -> Eskişehir -> Ankara -> Kirsehir -> Yozgat -> Sivas -> Malatya -> Elazig -> Tunceli -> Bingol -> Erzurum -> Mus -> Batman -> Siirt -> Sirnak -> Makkeki.

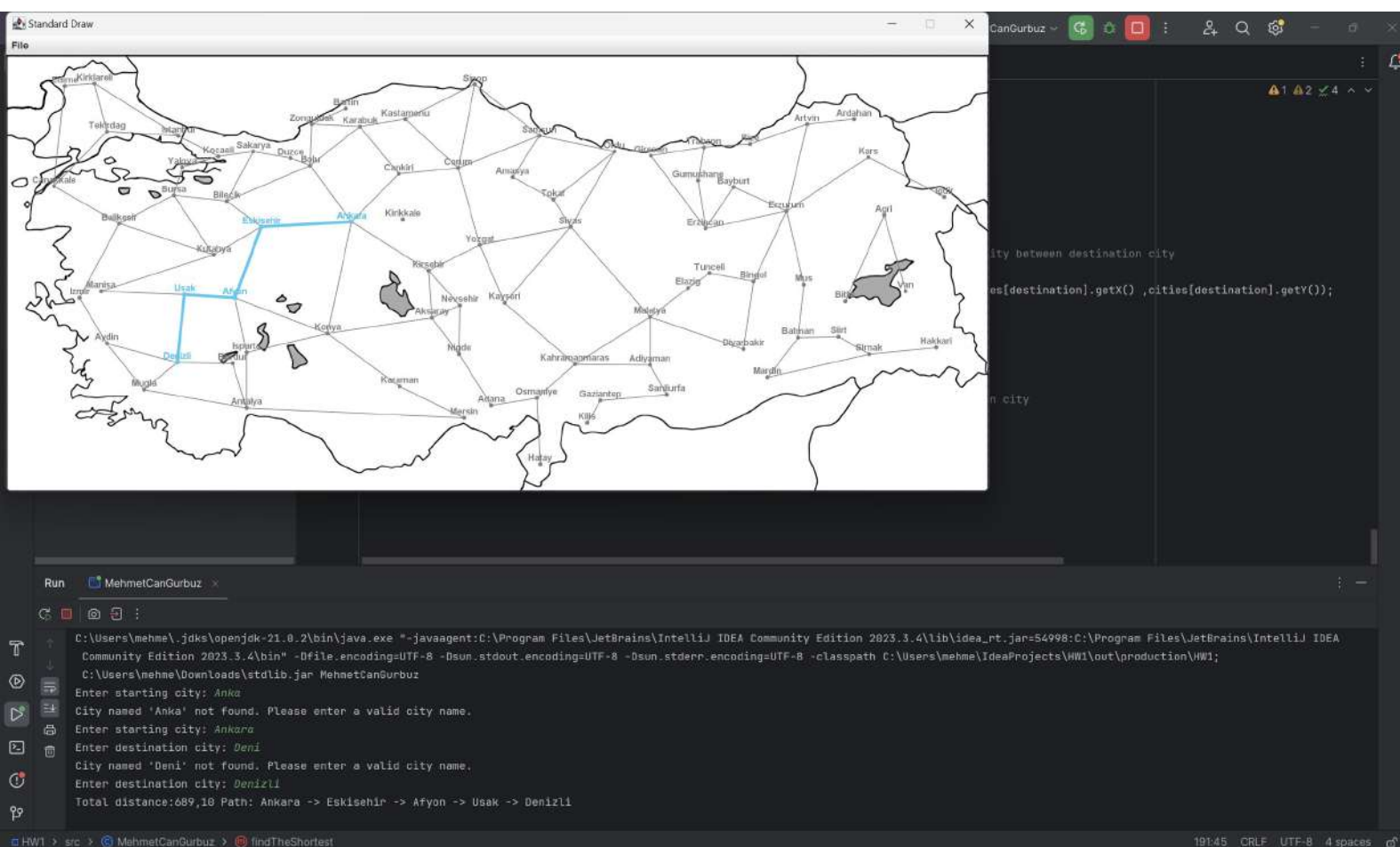
```
Run MehmetCanGurbuz x
```

```
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=54991:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\IdeaProjects\HW1\out\production\HW1; C:\Users\mehme\Downloads\stdlib.jar MehmetCanGurbuz
Enter starting city: Canakkale
Enter destination city: Makkeki
Total distance:2780,87 Path: Canakkale -> Balıkesir -> Kutahya -> Eskişehir -> Ankara -> Kirsehir -> Yozgat -> Sivas -> Malatya -> Elazig -> Tunceli -> Bingol -> Erzurum -> Mus -> Batman -> Siirt -> Sirnak -> Makkeki
```

HW1 > src > MehmetCanGurbuz > findTheShortest 19:45 CRLF UTF-8 4 spaces

A valid case for two cities with connections

CASE 3:



The screenshot displays an IDE environment. On the left, a map of Turkey is shown with a network of cities and roads. The cities are represented as nodes, and the roads as edges. The map is titled "Standard Draw" and "File".

On the right, the code editor shows a Java program. The code is as follows:

```
city between destination city
es[destination].getX() , cities[destination].getY();
n city
```

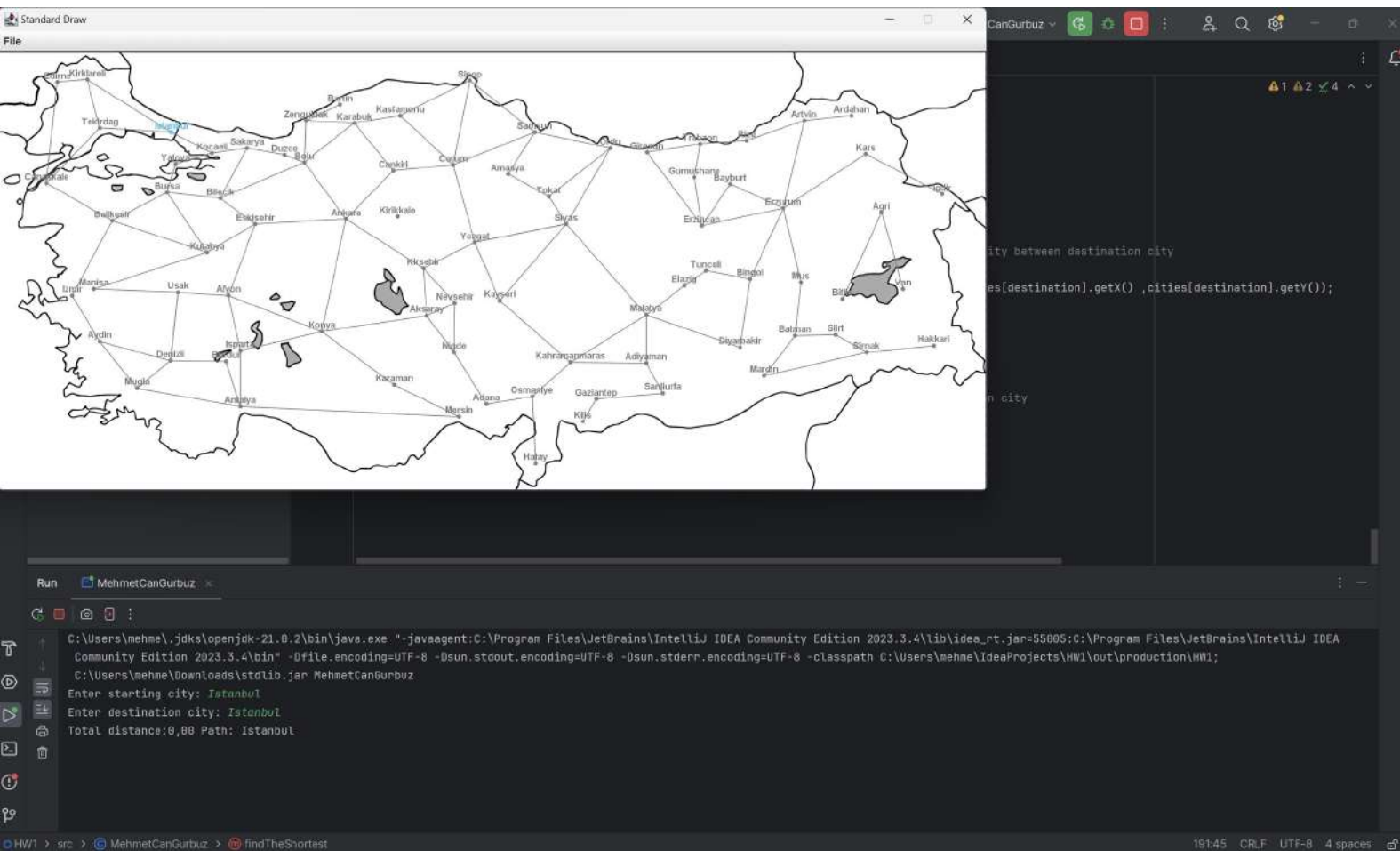
Below the code editor, the Run window shows the execution of the program. The output is as follows:

```
Run MehmetCanGurbuz x
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=54998:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\IdeaProjects\HW1\out\production\HW1; C:\Users\mehme\Downloads\stdlib.jar MehmetCanGurbuz
Enter starting city: Anka
City named 'Anka' not found. Please enter a valid city name.
Enter starting city: Ankara
Enter destination city: Deni
City named 'Deni' not found. Please enter a valid city name.
Enter destination city: Denizli
Total distance:689,18 Path: Ankara -> Eskisehir -> Afyon -> Usak -> Denizli
```

The bottom status bar shows the file path: HW1 > src > MehmetCanGurbuz > findTheShortest. The encoding is UTF-8, and the line length is 191.45.

Invalid city names: User should be prompted again to enter a valid city name.

CASE 4:



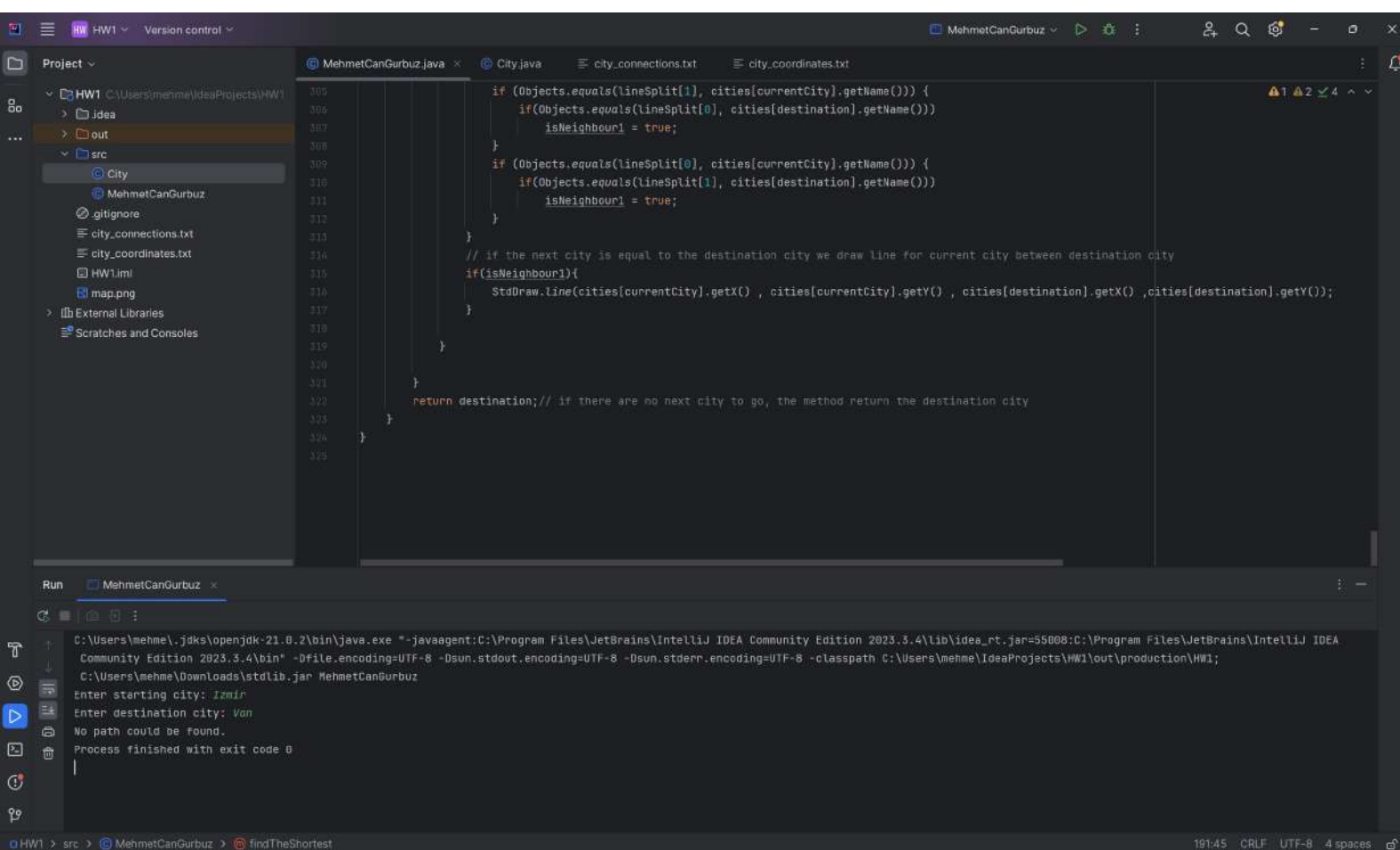
The screenshot displays a Java IDE with a map of Turkey on the left and a code editor on the right. The map shows a network of cities connected by roads, with Istanbul highlighted as the starting and ending point. The code editor shows a snippet of Java code for finding the shortest path between two cities. The terminal window at the bottom shows the execution of the program, which outputs the total distance and the path from Istanbul to Istanbul.

```
city between destination city
es[destination].getX() ,cities[destination].getY());
n city
```

```
Run MehmetCanGurbuz
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=55805:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\IdeaProjects\HW1\out\production\HW1; C:\Users\mehme\Downloads\stdlib.jar MehmetCanGurbuz
Enter starting city: Istanbul
Enter destination city: Istanbul
Total distance:0,00 Path: Istanbul
```

Path to the same city

CASE 5:

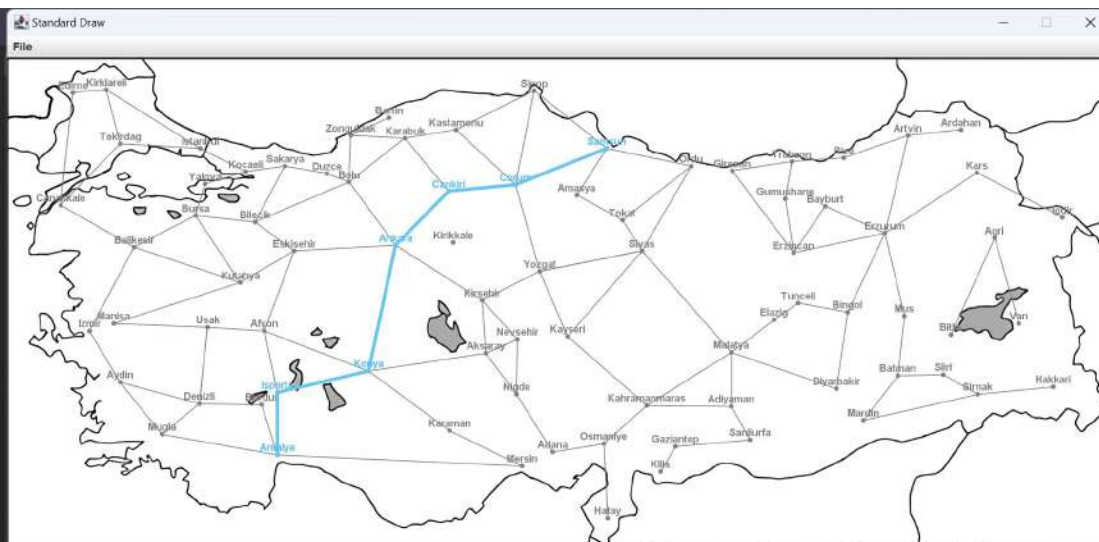


```
305     if (Objects.equals(lineSplit[1], cities[currentCity].getName())) {
306         if (Objects.equals(lineSplit[0], cities[destination].getName()))
307             isNeighbour1 = true;
308     }
309     if (Objects.equals(lineSplit[0], cities[currentCity].getName())) {
310         if (Objects.equals(lineSplit[1], cities[destination].getName()))
311             isNeighbour1 = true;
312     }
313 }
314 // if the next city is equal to the destination city we draw line for current city between destination city
315 if(isNeighbour1){
316     StdDraw.line(cities[currentCity].getX(), cities[currentCity].getY(), cities[destination].getX(), cities[destination].getY());
317 }
318 }
319 }
320 }
321 }
322 return destination; // if there are no next city to go, the method return the destination city
323 }
324 }
325 }
```

```
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=55008:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\IdeaProjects\HW1\out\production\HW1; C:\Users\mehme\Downloads\stdlib.jar MehmetCanGurbuz
Enter starting city: Izmir
Enter destination city: Van
No path could be found.
Process finished with exit code 0
```

Unreachable city pairs: There may be no path from the starting city to the destination city. In this case, no graphical output is produced and console output should be “No path could be found”.

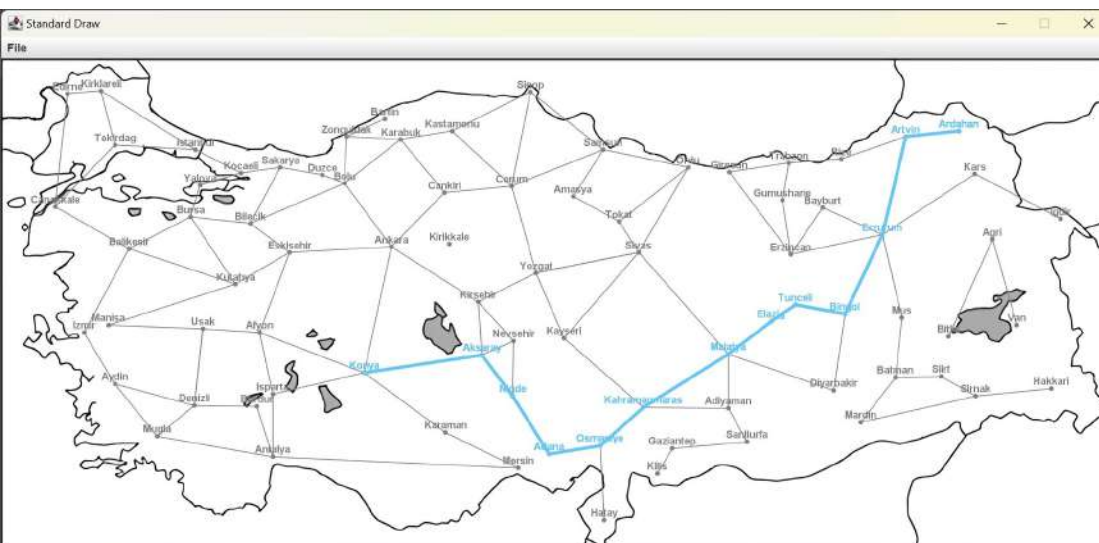
ADDITIONAL CASES:



```
cities[destination].getName());  
  
cities[nextCity].getX(), cities[nextCity].getY() );  
  
distance += distances[currentCity][nextCity] +  
  
if (Objects.equals(linesplit[1], cities[destination].getName()))  
    isNeighbour = true;  
}
```

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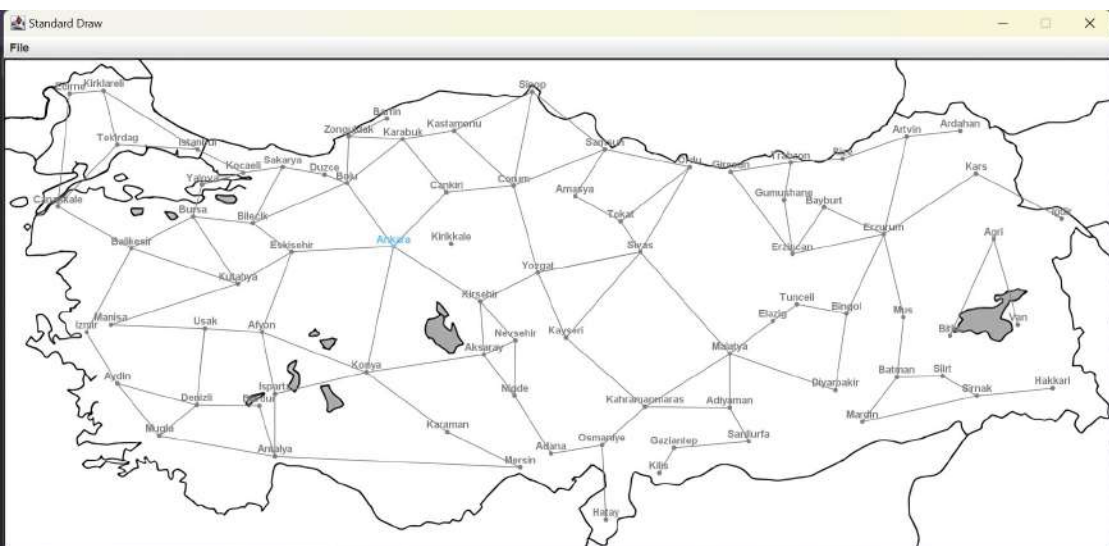
```
Run MehmetCanGurbuz  
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=55011:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\IdeaProjects\HW1\out\production\HW1; C:\Users\mehme\Downloads\stdlib.jar MehmetCanGurbuz  
Enter starting city: Samsun  
Enter destination city: Antalya  
Total distance:1129,76 Path: Samsun -> Corum -> Cankiri -> Ankara -> Konya -> Isparta -> Antalya  
HW1 > src > MehmetCanGurbuz > getNextCity 289:55 CRLF UTF-8 4 spaces
```



```
city between destination city  
cities[destination].getX(), cities[destination].getY();  
  
n city
```

```
Run MehmetCanGurbuz  
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=55015:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\IdeaProjects\HW1\out\production\HW1; C:\Users\mehme\Downloads\stdlib.jar MehmetCanGurbuz  
Enter starting city: Konya  
Enter destination city: Ardahan  
Total distance:1765,90 Path: Konya -> Aksaray -> Nigde -> Adana -> Osmaniye -> Kahramanmaraş -> Malatya -> Elazığ -> Tunceli -> Bingöl -> Erzurum -> Artvin -> Ardahan  
HW1 > src > MehmetCanGurbuz > findTheShortest 191:45 CRLF UTF-8 4 spaces
```

Standard Draw



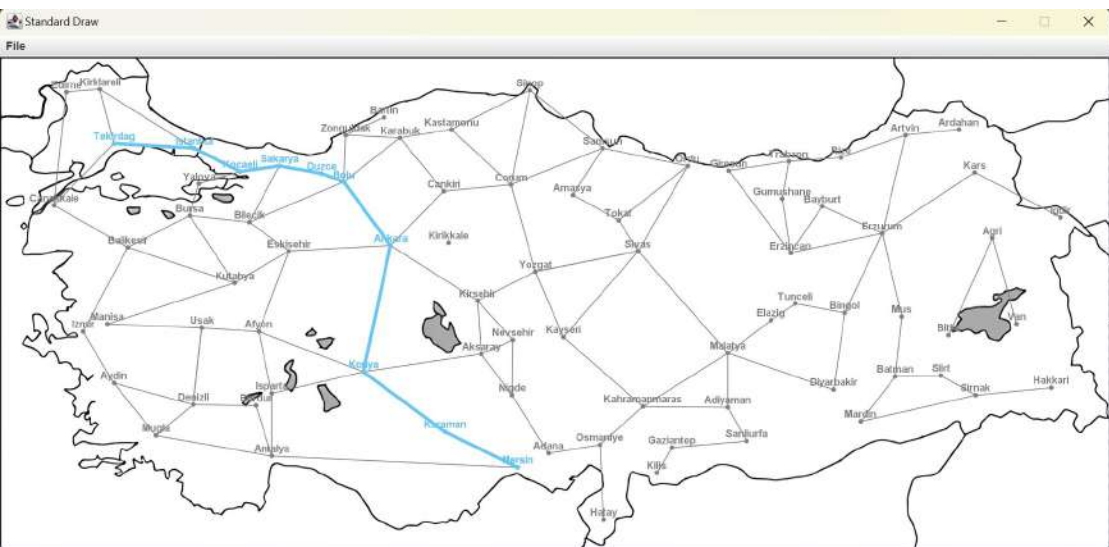
CanGurbuz

Run MehmetCanGurbuz

```
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=55042:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\Downloads\stdLib.jar MehmetCanGurbuz
Enter starting city: Ankara
Enter destination city: Ankara
Total distance:0,00 Path: Ankara
```

HW1 > src > MehmetCanGurbuz > findTheShortest 191:45 CRLF UTF-8 4 spaces

Standard Draw



CanGurbuz

Run MehmetCanGurbuz

```
C:\Users\mehme\jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=55032:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\Downloads\stdLib.jar MehmetCanGurbuz
Enter starting city: Tekir
City named 'Tekir' not found. Please enter a valid city name.
Enter starting city: Tekirdag
Enter destination city: Mers
City named 'Mers' not found. Please enter a valid city name.
Enter destination city: Mersin
Total distance:1344,34 Path: Tekirdag -> Istanbul -> Kocaeli -> Sakarya -> Duzce -> Bolu -> Ankara -> Konya -> Karaman -> Mersin
```

HW1 > src > MehmetCanGurbuz > findTheShortest 191:45 CRLF UTF-8 4 spaces

HW1 Version control MehmetCanGurbuz

Project HW1 C:\Users\mehme\IdeaProjects\HW1
> .idea
> out
> src
City
MehmetCanGurbuz
gignore
city_connections.txt
city_coordinates.txt
HW1.iml
map.png
External Libraries
Scratches and Consoles

MehmetCanGurbuz.java City.java city_connections.txt city_coordinates.txt


```
305 if (Objects.equals(lineSplit[1], cities[currentCity].getName())) {
306     if(Objects.equals(lineSplit[0], cities[destination].getName()))
307         isNeighbour1 = true;
308 }
309 if (Objects.equals(lineSplit[0], cities[currentCity].getName())) {
310     if(Objects.equals(lineSplit[1], cities[destination].getName()))
311         isNeighbour1 = true;
312 }
313 }
314 // if the next city is equal to the destination city we draw line for current city between destination city
315 if(isNeighbour1){
316     StdDraw.Line(cities[currentCity].getX(), cities[currentCity].getY(), cities[destination].getX(), cities[destination].getY());
317 }
318 }
319 }
320 }
321 }
322 return destination;// if there are no next city to go, the method return the destination city
323 }
324 }
325 }
```

Run MehmetCanGurbuz

```
C:\Users\mehme\.jdk\openjdk-21.0.2\bin\java.exe "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_rt.jar=55039:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\bin" -Dfile.encoding=UTF-8 -Dsun.stdout.encoding=UTF-8 -Dsun.stderr.encoding=UTF-8 -classpath C:\Users\mehme\IdeaProjects\HW1\out\production\HW1; C:\Users\mehme\Downloads\stdlib.jar MehmetCanGurbuz
Enter starting city: Kars
Enter destination city: Kirikkale
No path could be found.
Process finished with exit code 0
```

HW1 > src > MehmetCanGurbuz > findTheShortest 10:45 CRLF UTF-8 4 spaces

PSEUDOCODE:

 *Pseudocode - Not Defteri

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```
function findTheShortest(cities, distances)
    // Read the file to determine the number of cities
    num_cities = countCities()

    // Initialize distances using Floyd-Warshall algorithm
    for k = 0 to num_cities
        for i = 0 to num_cities
            for j = 0 to num_cities
                if dist[i][k] ≠ ∞ and dist[k][j] ≠ ∞
                    newDistance = dist[i][k] + dist[k][j]
                    if newDistance < dist[i][j]
                        dist[i][j] = newDistance

    // Prompt user to input starting and destination cities
    first_city, last_city = getCityInput(cities, num_cities)

    // If a path exists between the cities
    if dist[first_city][last_city] ≠ ∞
        print "Total distance: " + dist[first_city][last_city] / 1000
        drawMap(cities, num_cities, distances)
        printShortestPath(cities, distances, first_city, last_city)
    else
        print "No path could be found."

function printShortestPath(cities, distances, source, destination)
    Draw starting city on the map
    Print "Path: " + source city name

    while source ≠ destination
        nextCity = getNextCity(cities, distances, source, destination)
        Print " -> " + nextCity city name
        source = nextCity

function getNextCity(cities, distances, currentCity, destination)
    for each nextCity in distances
        if nextCity is not currentCity and not destination
            if distances[currentCity][destination] == distances[currentCity][nextCity] + distances[nextCity][destination]
                if nextCity is a neighbor of currentCity
                    Draw points, lines, and city names on map
                    Draw line between currentCity and nextCity
                    return nextCity

    if destination is a neighbor of currentCity
        Draw line between currentCity and destination
    return destination
```

Explanation Of The Algorithm:

Reading city coordinates and initializing distances:

The code starts by reading city coordinates from a file named "city_coordinates.txt" to determine the number of cities. It initializes a 2D array dist to represent the distances between each pair of cities. The array is initialized based on road distances between cities.

Floyd-Warshall Algorithm:

The Floyd-Warshall algorithm is used to find the shortest distances between all pairs of vertices (cities) in the graph. Three nested loops iterate over all vertices (cities) to consider each vertex as a possible intermediate vertex in the paths being examined. For each pair of vertices (a, b), if the shortest path from a to b passing through the current intermediate vertex k is shorter than the previously known shortest path, the algorithm updates the shortest distance.

Input of starting and destination cities:

The user is prompted to input the starting city and destination city. The input is validated to ensure that the entered city names exist in the list of cities.

Finding the shortest path:

If a path exists between the starting and destination cities (i.e., `dist[first_city][last_city] != Double.POSITIVE_INFINITY`), the algorithm proceeds to visualize the shortest path. The total distance of the shortest path is printed, converted from meters to kilometers. The StdDraw library is used to create a map visualization. City names and their coordinates are plotted on the map. The connections between cities are read from the file "city_connections.txt" and drawn on the map as lines. Printing the shortest path:

The printShortestPath function is called to print the shortest path on the map. It starts by setting the pen color and drawing the starting city on the map. While the current city is not equal to the destination city, it iteratively finds the next city in the shortest path using the getNextCity function. The names of the cities along the shortest path are printed, separated by arrows, and their positions are marked on the map. Finding the next city in the shortest path:

The getNextCity function is responsible for finding the next city in the shortest path. It iterates over all possible next cities and checks if the distance from the current city to the destination city equals the sum of the distances from the current city to the next city and from the next city to the destination city. If the next city is a neighbor of the current city, it is considered a valid candidate for the shortest path. The function returns the index of the next city along the shortest path. Overall, the algorithm efficiently finds the shortest path between two cities on the map and visualizes it using the StdDraw library.

Sources that I used for learning Floyd Warshall :

- [geeksforgeek.org](https://www.geeksforgeek.org/)
- chat.openai.com