

RWR 4013

Digital Twins for Smart Cities

Dr. Ahmad Mohammadi

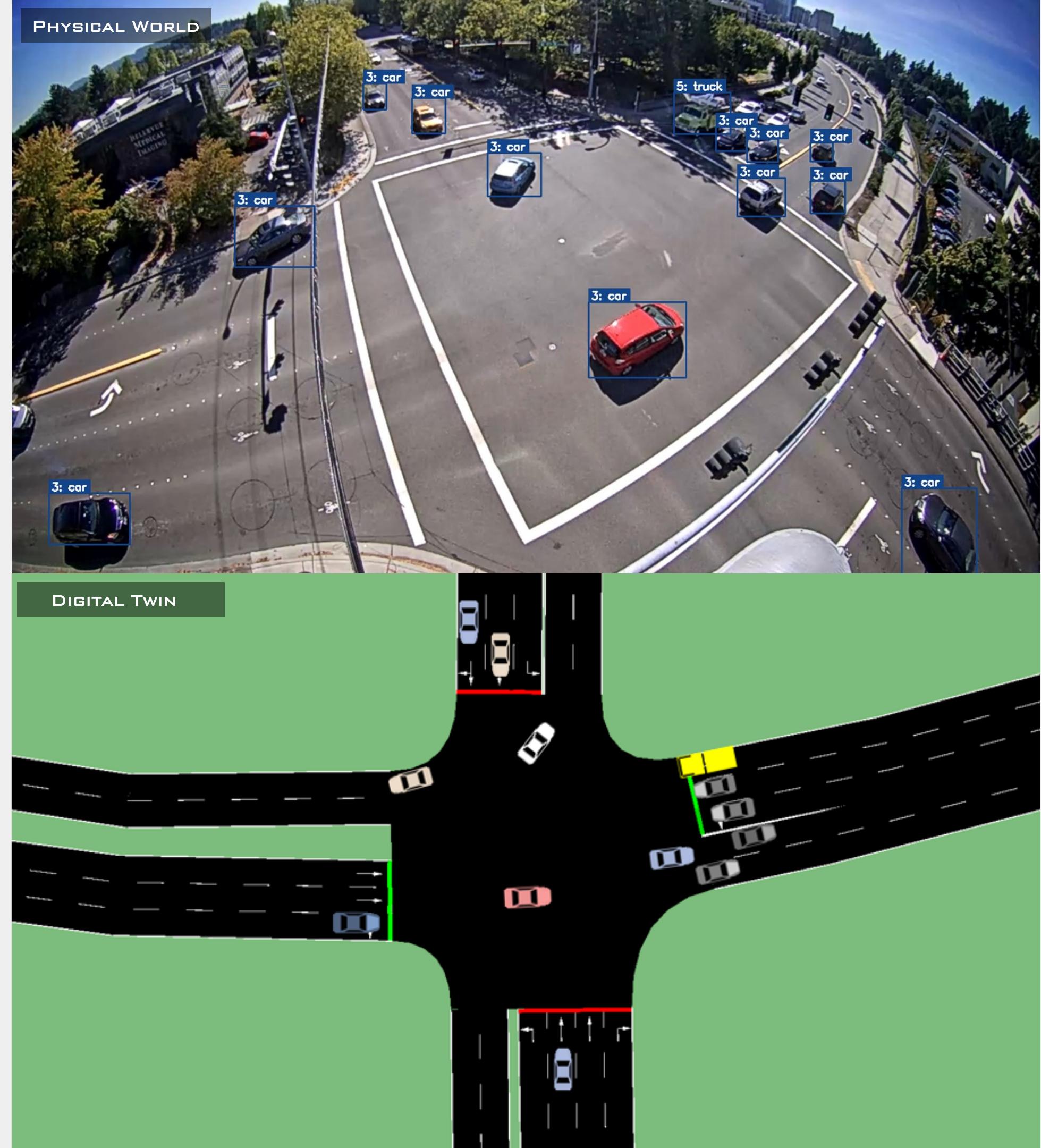
Week 4 | Session 2:
Introduction to Traffic Simulation

Fall 2026

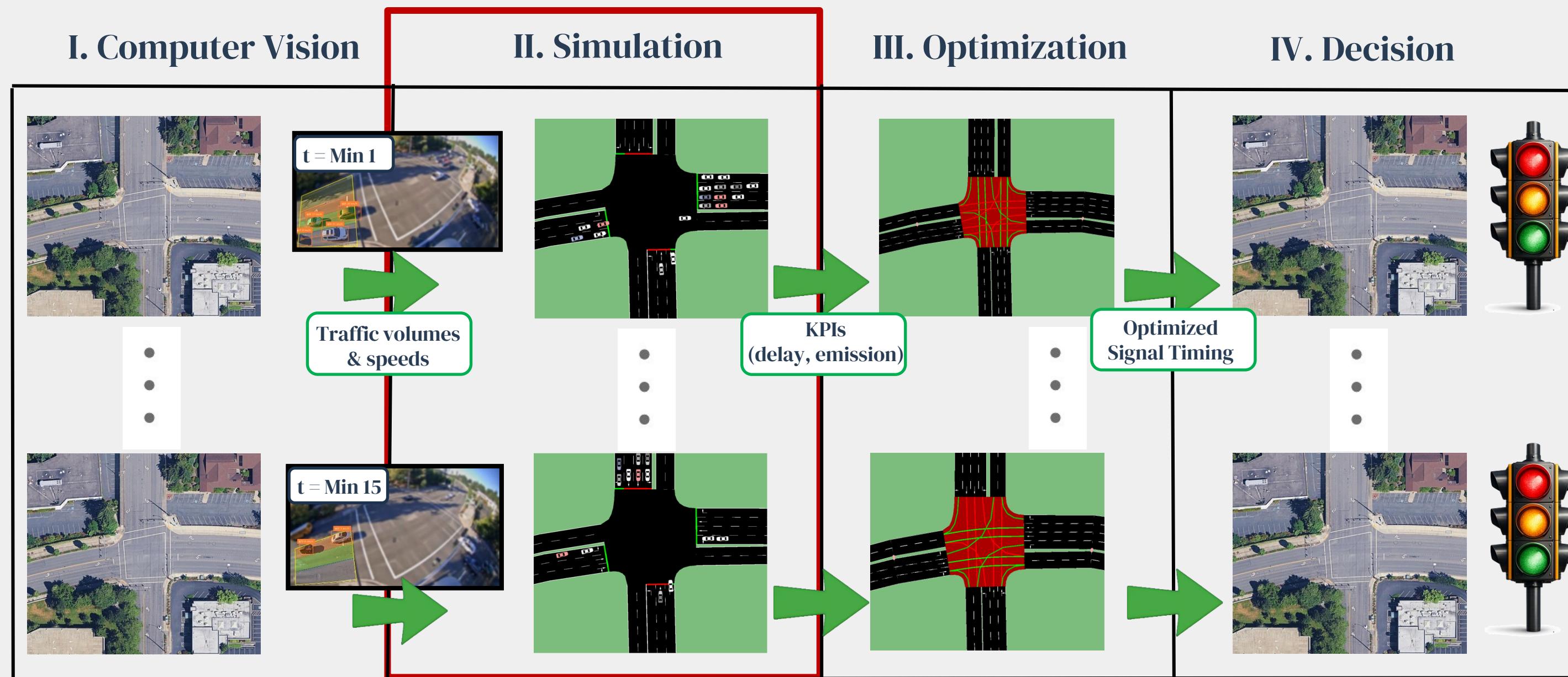
RoadwayVR



roadwayvr.github.io/DigitalTwinsforSmartCities

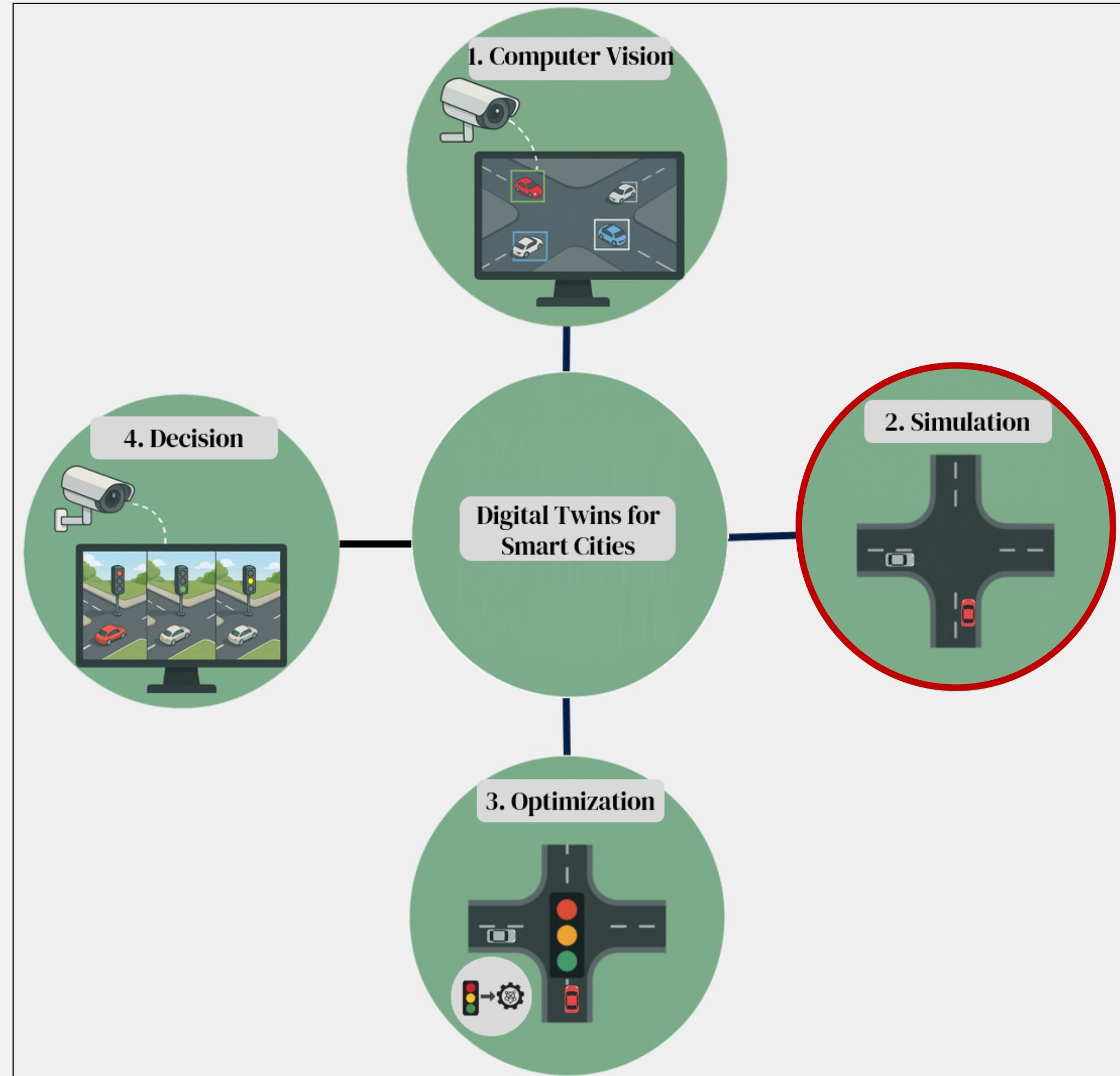


Overview of Course Syllabus in One Shot



Agenda

1. Install Simulation of Urban Mobility (SUMO)
2. Set Up SUMO Environment Variables
3. Install Notepad++
4. SUMO Files and User Interface
5. Create a Simple Network with Traffic Flow
6. Add Opposite Traffic Flow
7. Intersection - Unsignalized
8. Intersection - Signalized



1. Install Simulation of Urban Mobility (SUMO)

1. In Google, search “SUMO Installation”

2. Select sumo.dlr.de that contains sumo installing

3. Download SUMO as in the image

Installing

Windows

There are four different binary packages for Windows depending on the license and feature set (GPL vs. commercial) you want to do with SUMO. If you want to install it locally and have administrator rights on your machine you can use the Windows installer. If you do not have admin rights, use the correct zip, extract it into a desired folder using [7Zip](#), [Winzip](#), or similar extraction tools, and documentation in HTML format.

- Download 64-bit installer: [sumo-win64-1.25.0.msi](#)
- Download 64-bit zip: [sumo-win64-1.25.0.zip](#)
- Download 64-bit installer with all extras (contains GPL code): [sumo-win64extra-1.25.0.msi](#)
- Download 64-bit zip with all extras (contains GPL code): [sumo-win64extra-1.25.0.zip](#)

Within the installation folder, you will find a folder named "**bin**". Here, you can find the executables for the most common applications in **docs/examples**. All other applications (`dmarouter`, `dfrouter`, etc.) have to be run from the command line. If you feel unsure about the command line, please read [Running Programs from the Command Line](#).

If you want a bleeding edge nightly build or need tests or source files, you can download them from [GitHub](#).

For building SUMO from source see [building SUMO under Windows](#).

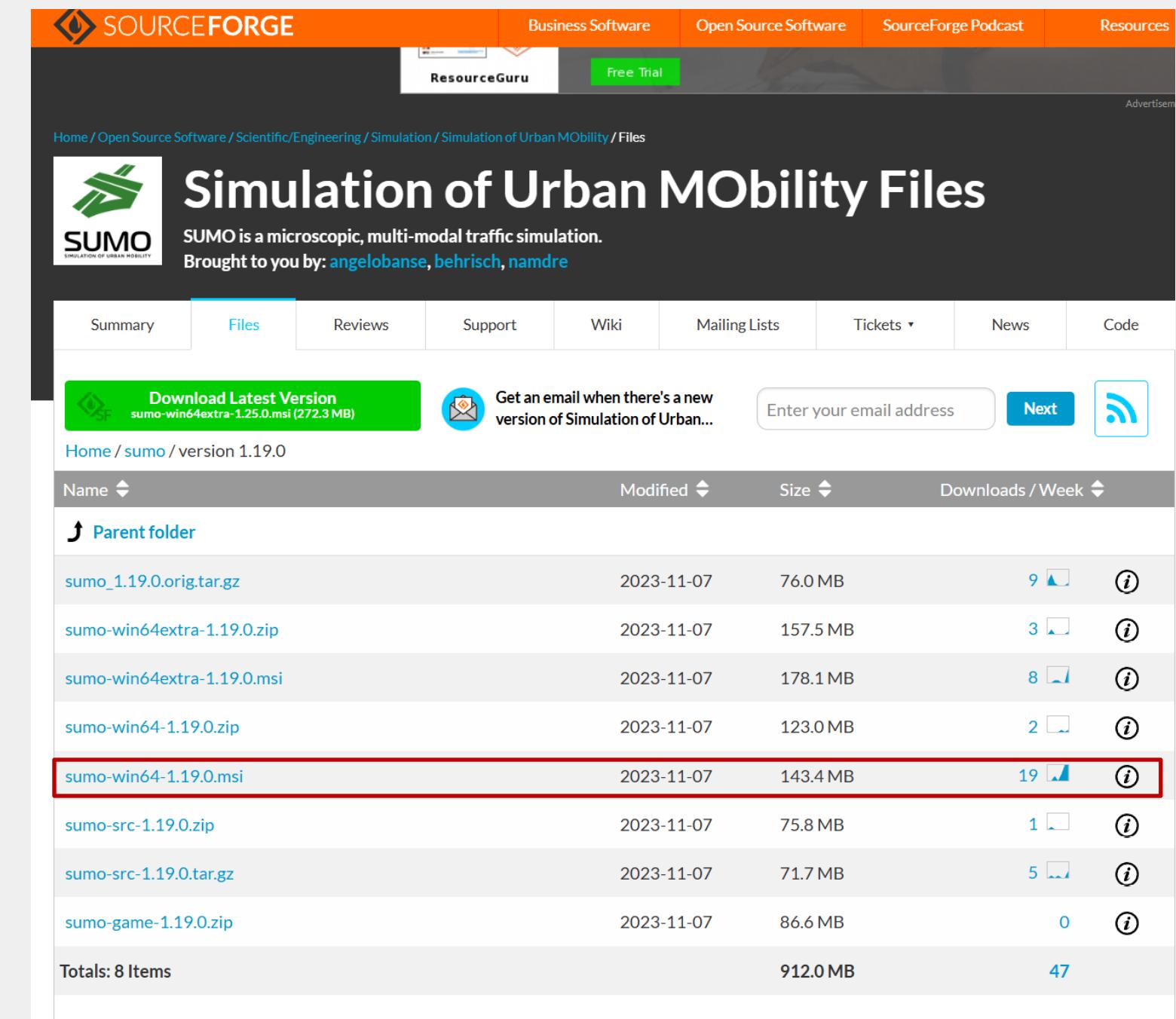
1. Install SUMO (Older Versions)

4. Sometimes, you need older versions (for example version 1.19):

5. In Google, search “sumo archive download 1.19”

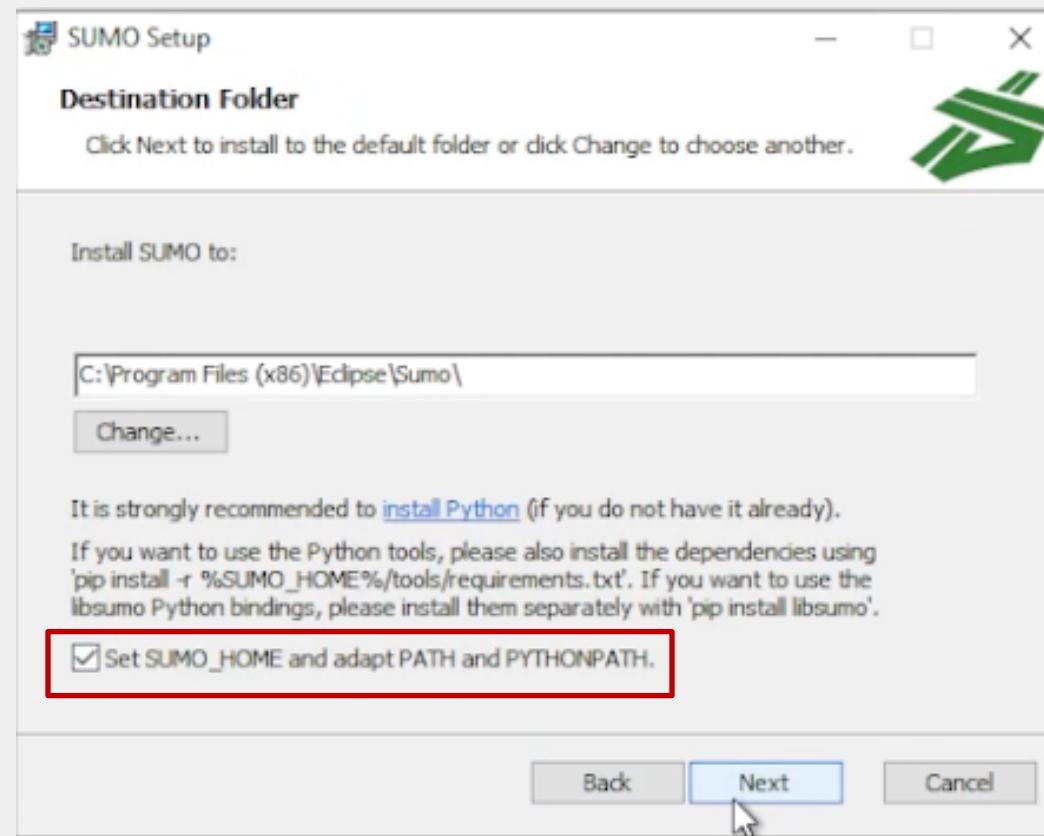
6. Select SourceForge.net that contains sumo archive

7. Download SUMO as in the image



1. Install SUMO

8. When you install, make sure the SUMO_HOME is checked



2. Set Up SUMO Environment Variables

1. SUMO has two only graphical users
2. All other programs must be called using codes! (But I provided all the codes in this course)
3. We set Environment Variables so we can avoid typing SUMO directory in codes (See Next Slides)



Sumo-gui



Simulation Visualization Interface



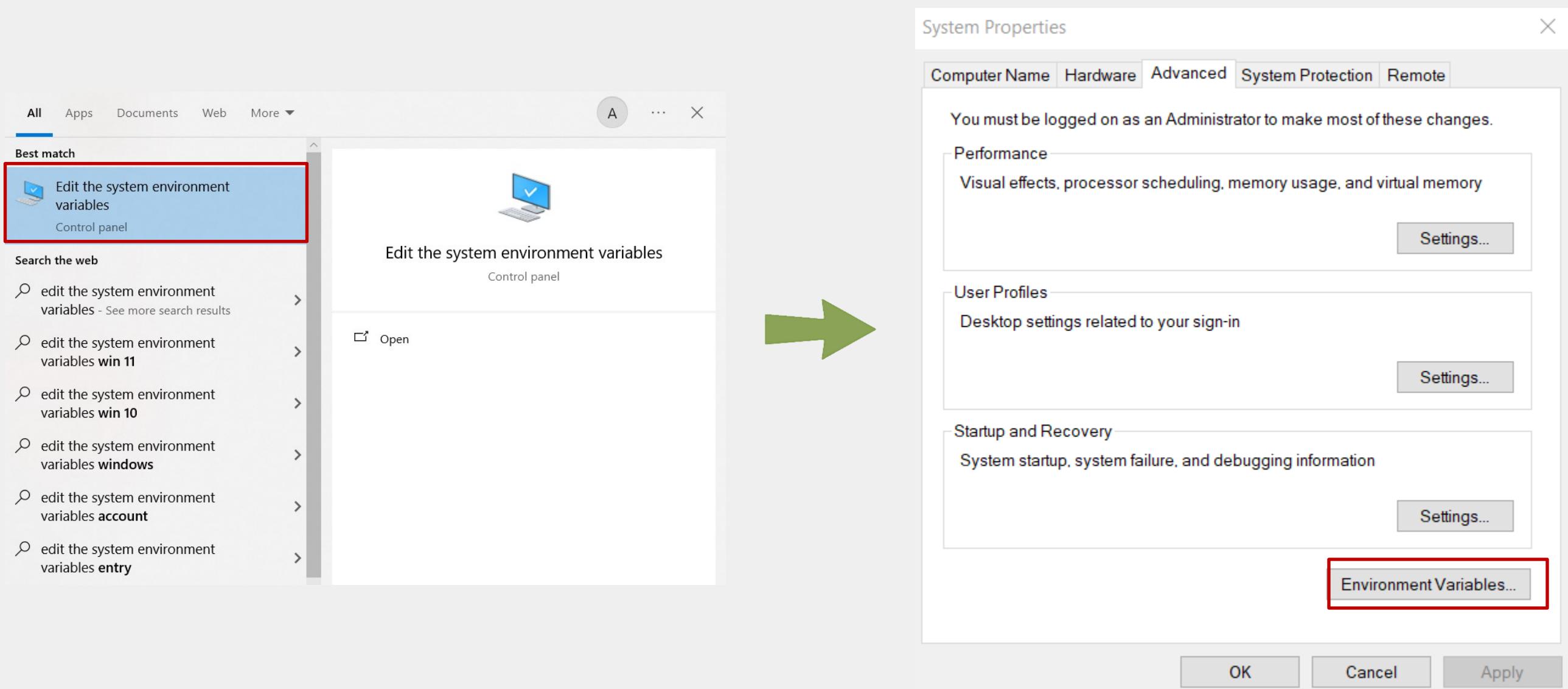
netedit



Simulation Creation Interface

2. Set Up SUMO Environment Variables

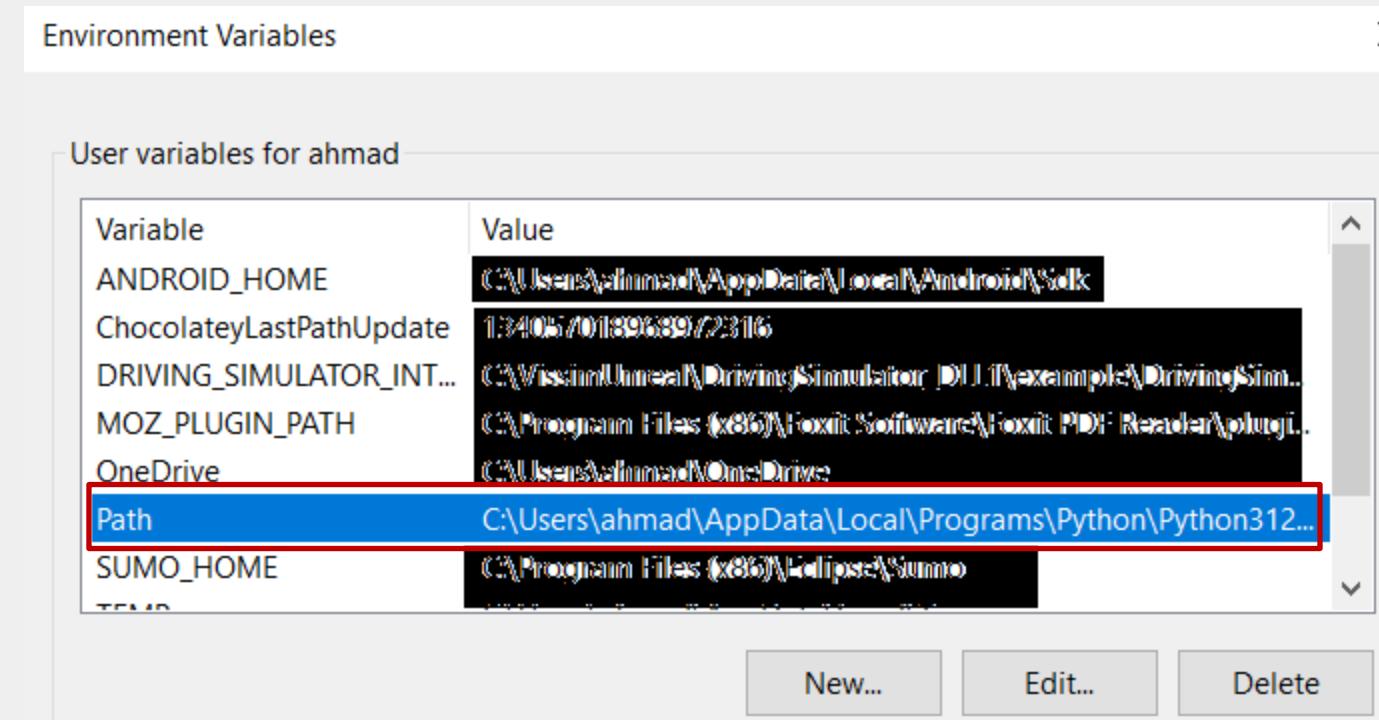
4. On the Windows search box (on the Taskbar) search for environment. The best match result should be the "Edit the system environment variables" option. Open it.



2. Set Up SUMO Environment Variables

5. Under user variables select PATH (or Path - Windows environment variables are case insensitive) and click Edit.

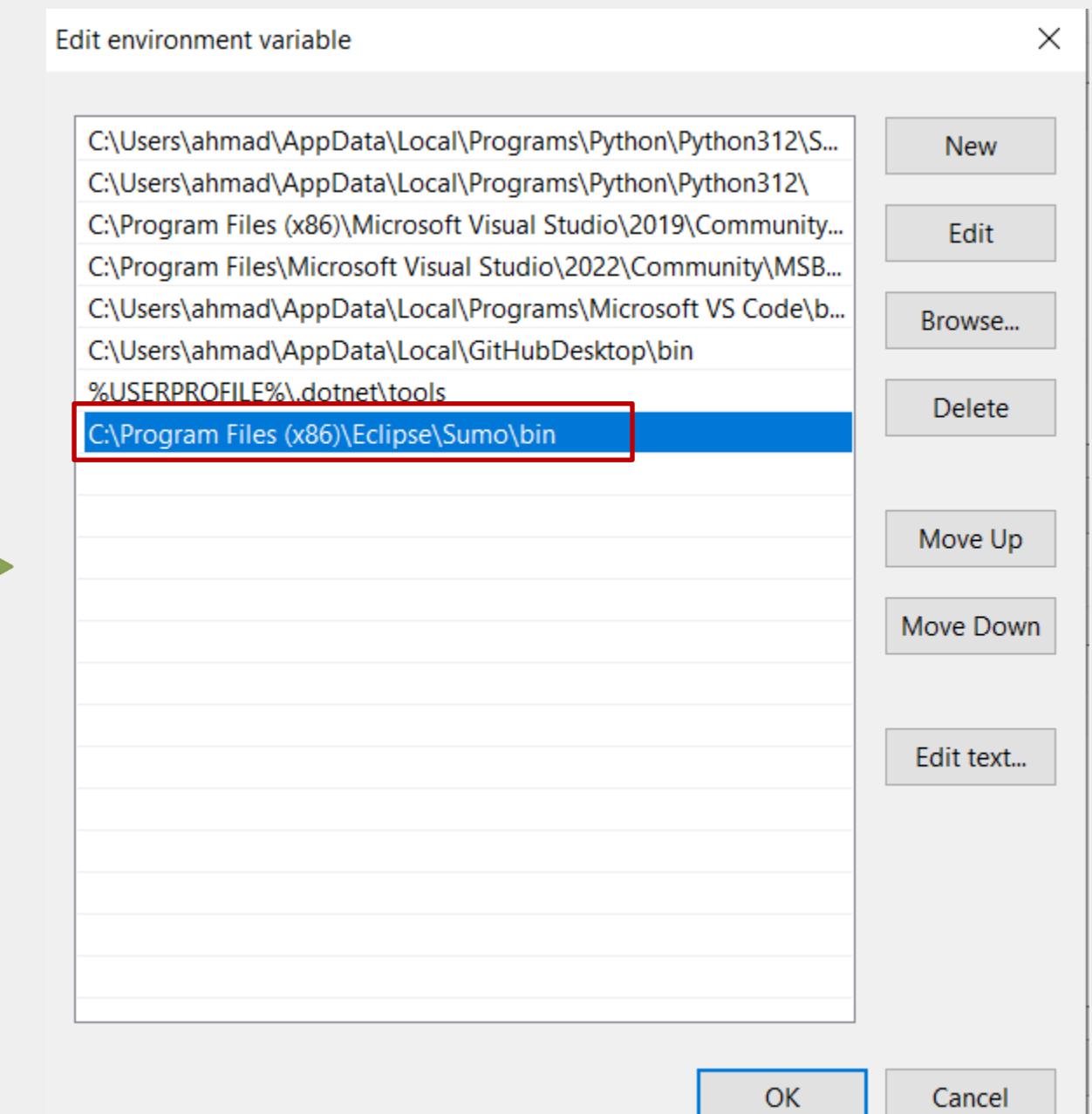
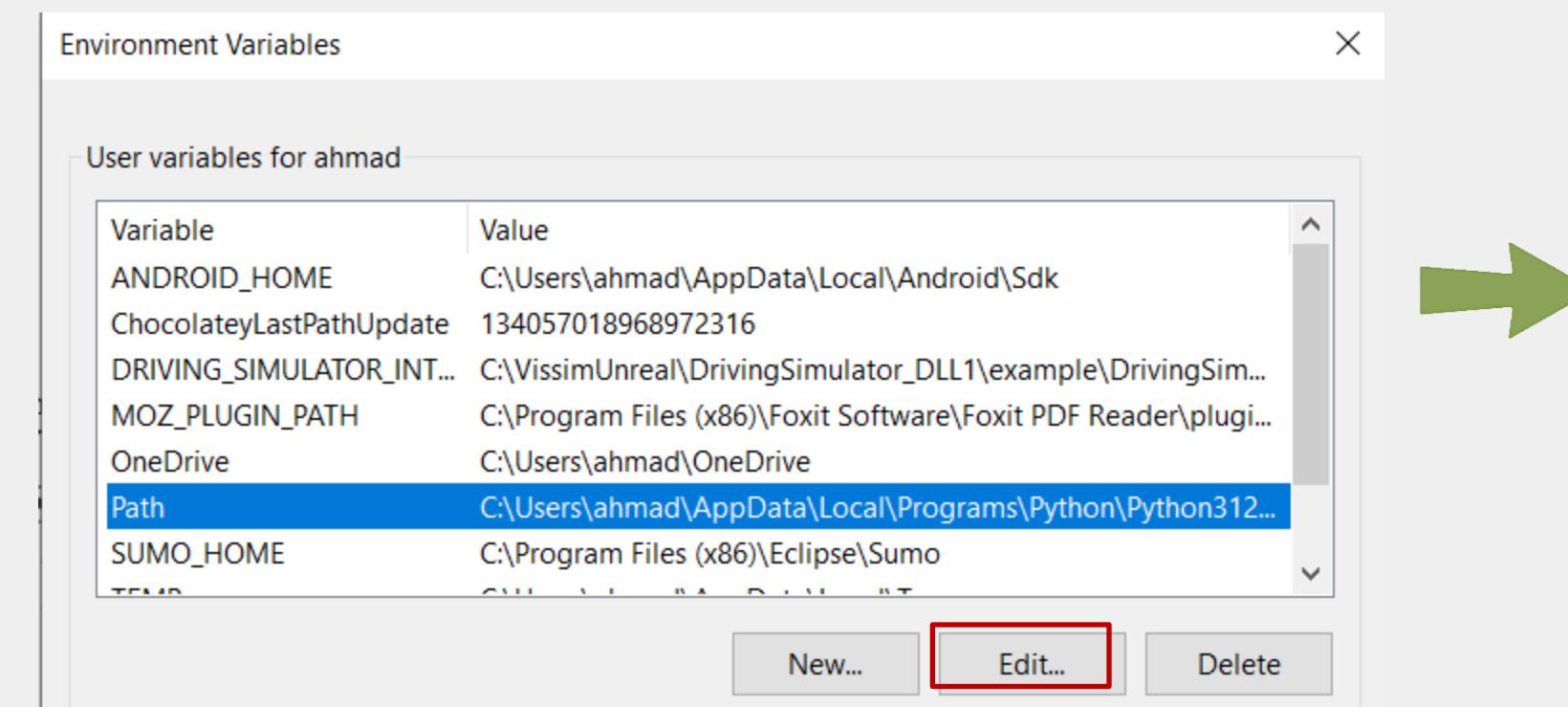
5.1. If no such variable exists, you must create it with the New-Button.



2. Set Up SUMO Environment Variables

6. First, find where you installed SUMO, likely,
C:\Program Files (x86)\Eclipse\Sumo\bin
Once you find it, then copy the directory and

16. Select PATH → Edit → New → paste the “C:\Program Files (x86)\Eclipse\Sumo\bin” → Select Okay

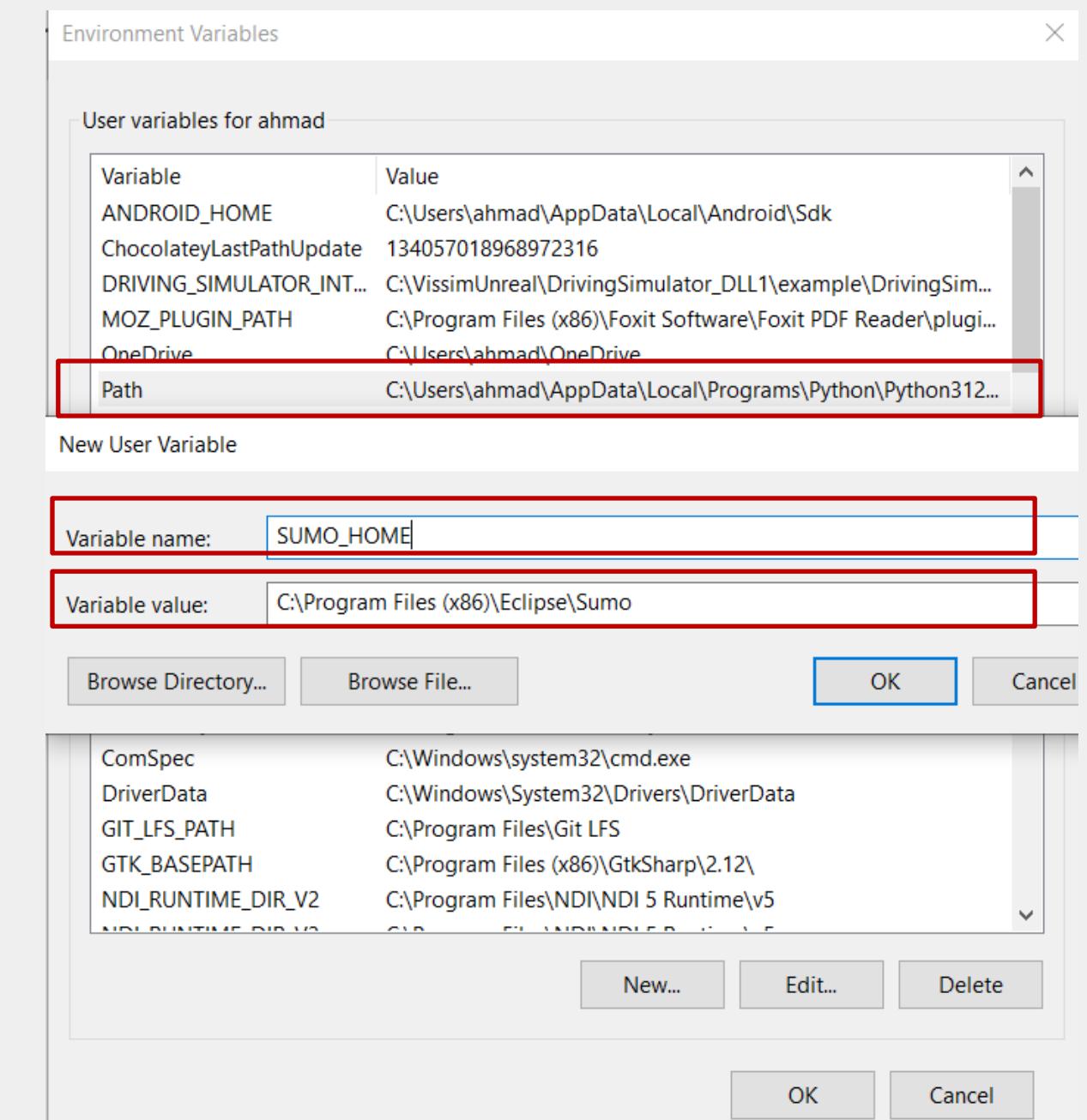


2. Set Up SUMO Environment Variables

17. Select Path → New → fill variable name and variable value as in the image

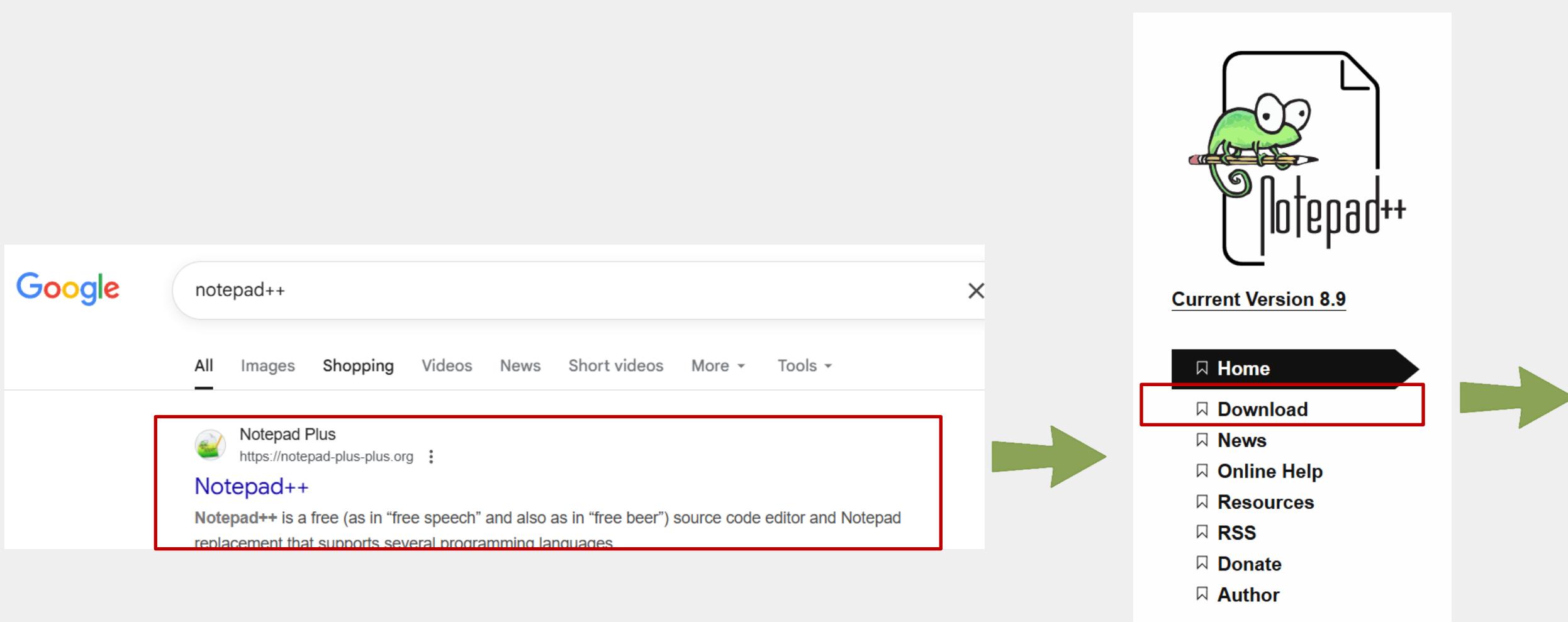
Variable name: **SUMO_HOME**

Variable value: **C:\Program Files (x86)\Eclipse\Sumo**



3. Install Notepad++

1. In Google, Search Notepad ++



Download most recent version
(version is not important)

Downloads

- Download Notepad++ v8.9: security enhancements
- Download Notepad++ v8.8.9: vulnerability-fix
- Download Notepad++ v8.8.8 (stable: auto-update triggered)
- Download Notepad++ v8.8.7 - Authenticity Guaranteed
- Download Notepad++ v8.8.6: Clarifying the CVE-2025-56383 Non-Issue

4. SUMO Files and User Interfaces

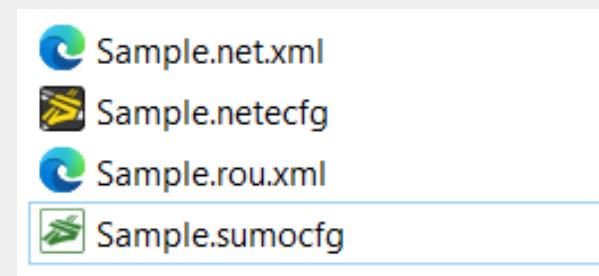


4.1. Simulation Visualization Interface (SUMO GUI)

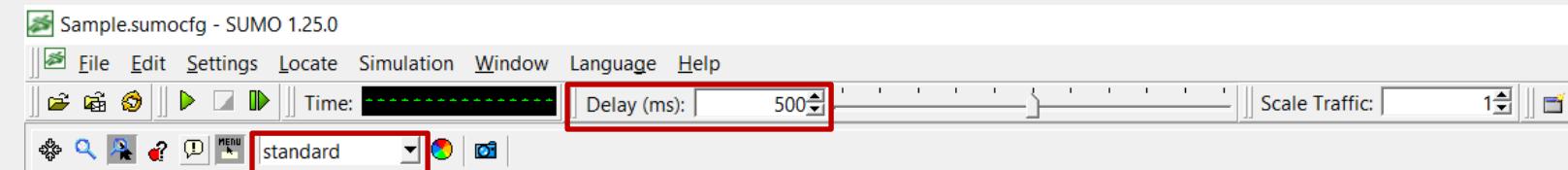
1. Download Folder “Week4b.Material.zip”

2. Extract the folder in Download folder

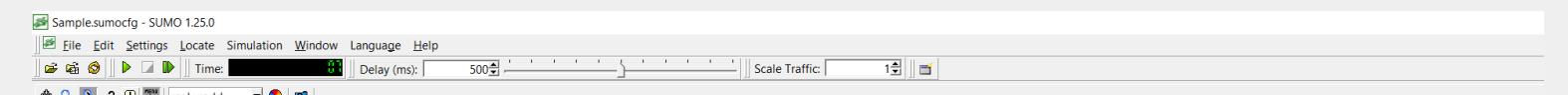
3. You should have four files as below



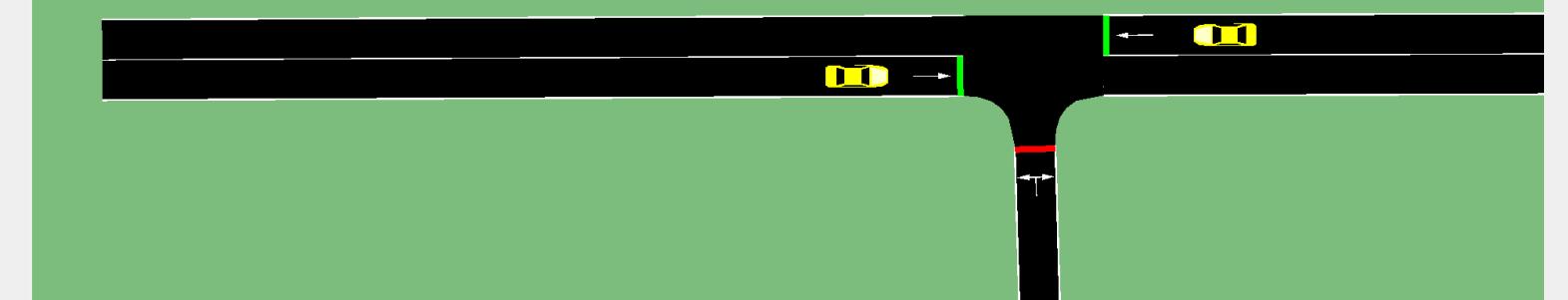
4. Run Sample.sumocfg → Increase delay to 500



5. Change Gui shape from “Standard” to “Real-World”



6. Hit “Play Button”

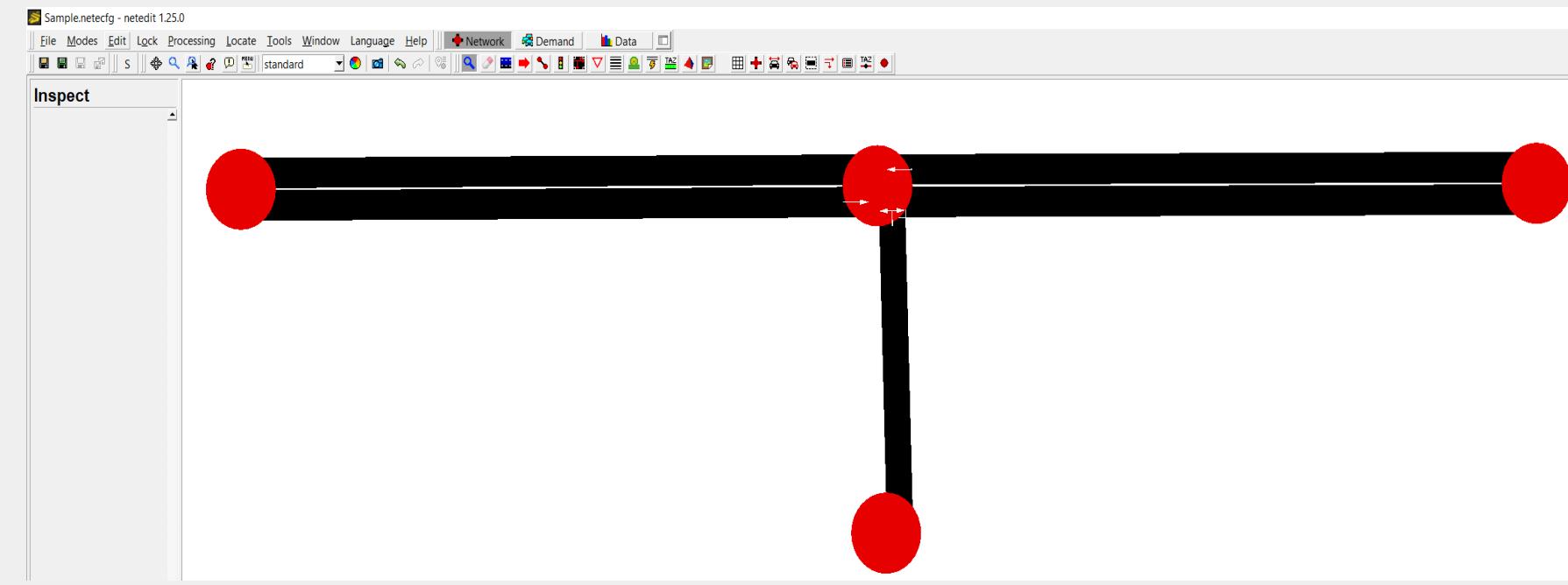


4.2. Simulation Creation Interface (SUMO netedit)

7. Run Sample.netecfg

8. Open netedit → this is interface we can change road

network and add/modify traffic light, add cars



5. Create a Simple Network with Traffic Flow

1. Create a Folder called “Exercise1”

2. On the Windows search box (on the Taskbar) search for “netEdit” and open it

3. In netEdit → File → New Network

4. Select Network

5. Select “Creating junctions and edges”

6. Create below road (left click)

7. If Mistaken, use eraser



5. Create a Simple Network with Traffic Flow

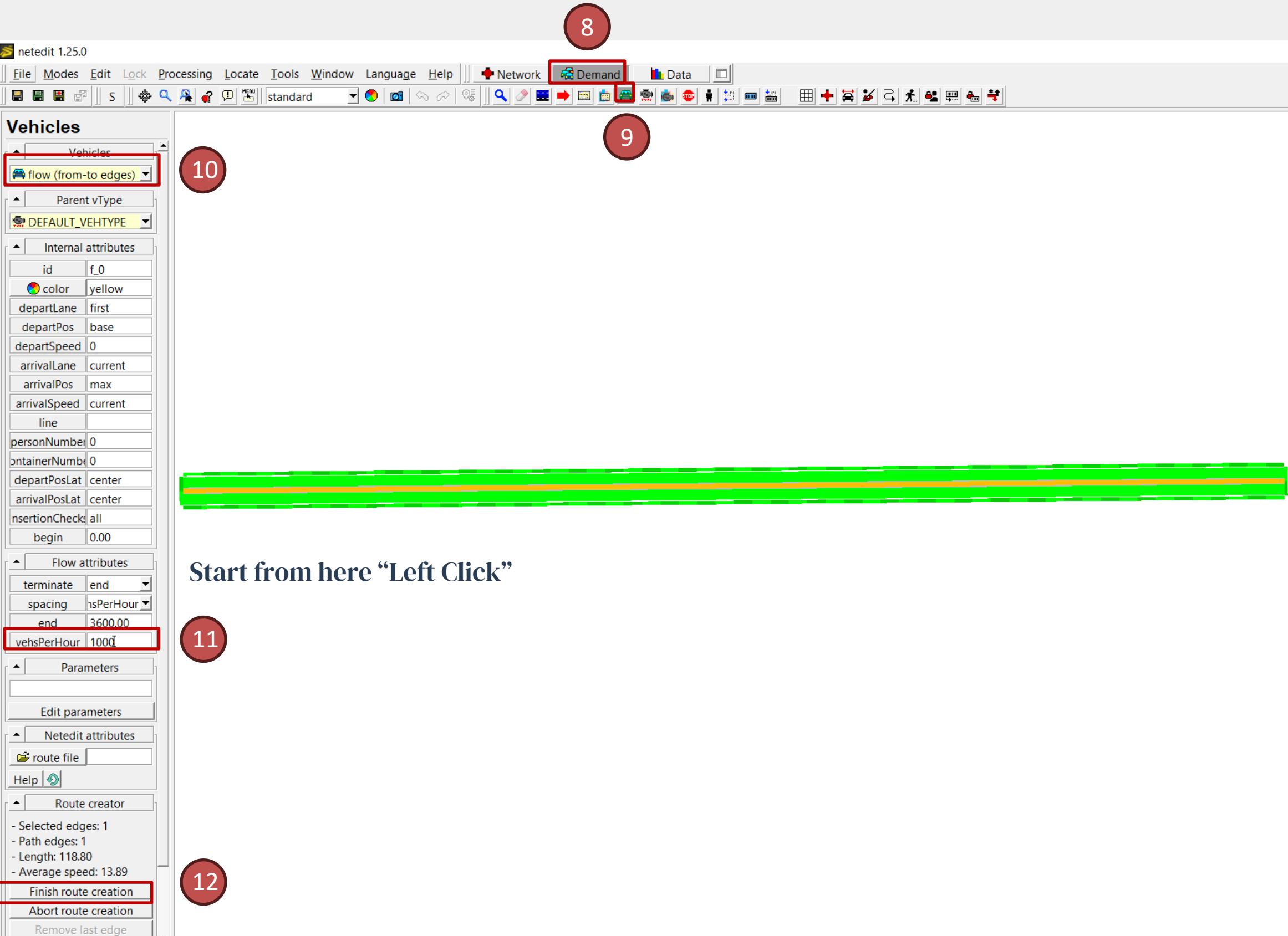
8. Add Traffic Volume by Selecting Demand

9. Select Vehicle

10. Change “trip” to “flow”

11. Change the Volume per Hour to “1000”

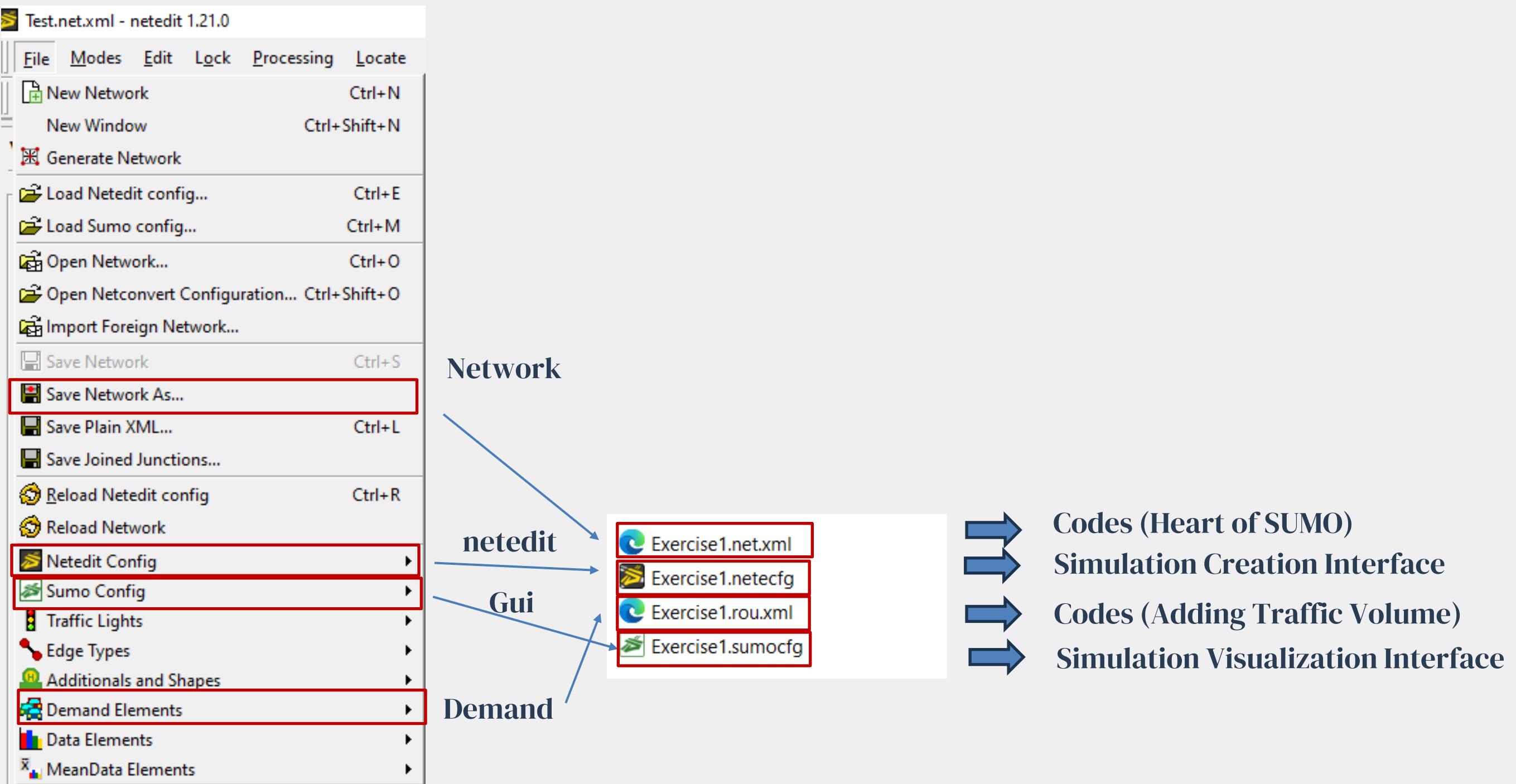
12. Finish Route Creation



Start from here “Left Click”

5. Create a Simple Network with Traffic Flow

13. Save SUMO Files in Folder “Exercise1” as below (name each file as “Exercise1”)

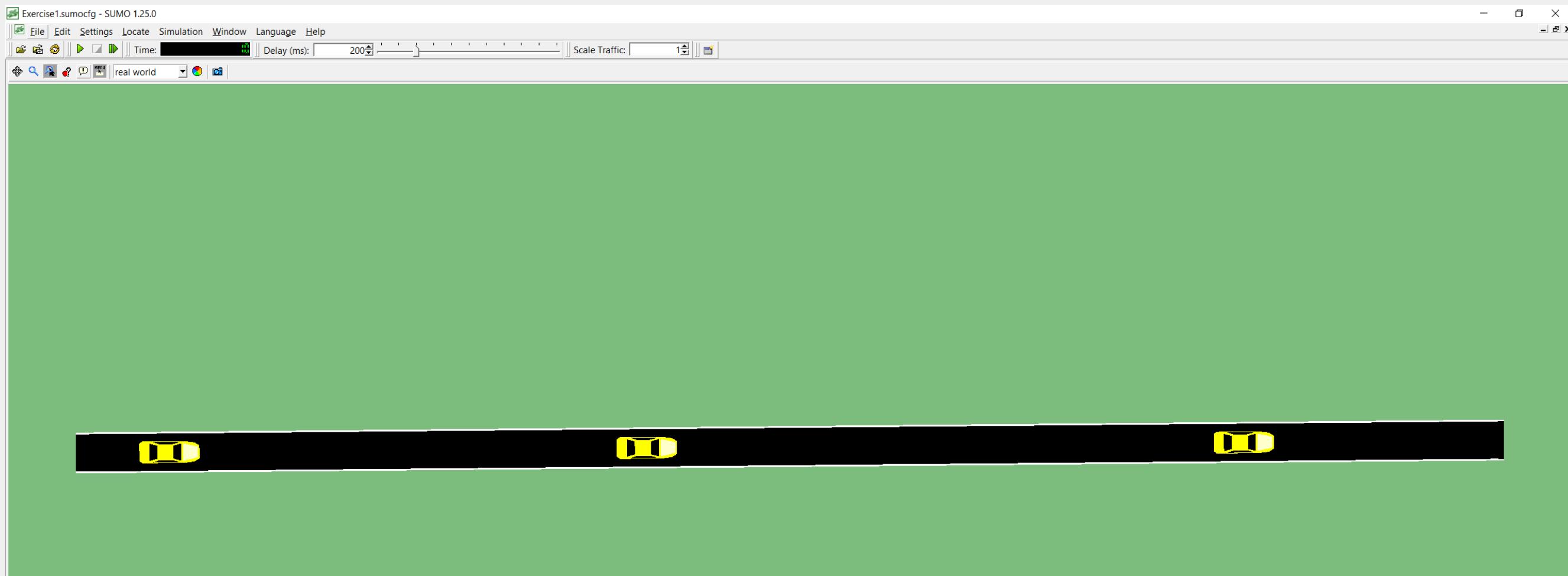


5. Create a Simple Network with Traffic Flow

14. Run SUMO Gui (Exercise1.sumocfg)

15. Increase delay to 200

16. Gui shape from “Standard” to “Real-World”





6. Add Opposite Traffic Flow

□ Open netedit (Exercisel.netecfg) and do the following actions:

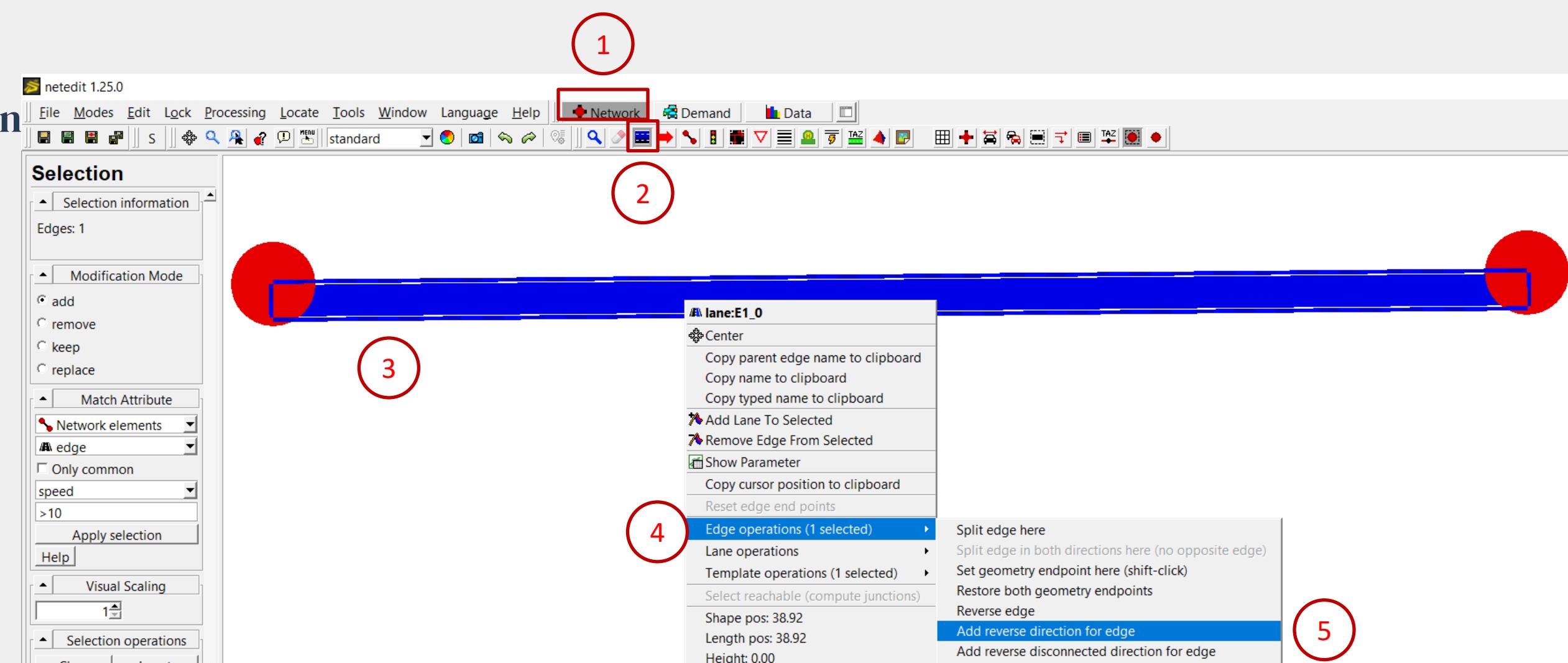
1. Select Network

2. Select “Selecting element”

3. Left click on the road

4. Right click and select Edge operation

5. Add reverse direction for edge





6. Add Opposite Traffic Flow

6. The output should look like this

7. In fact, you added a reverse lane



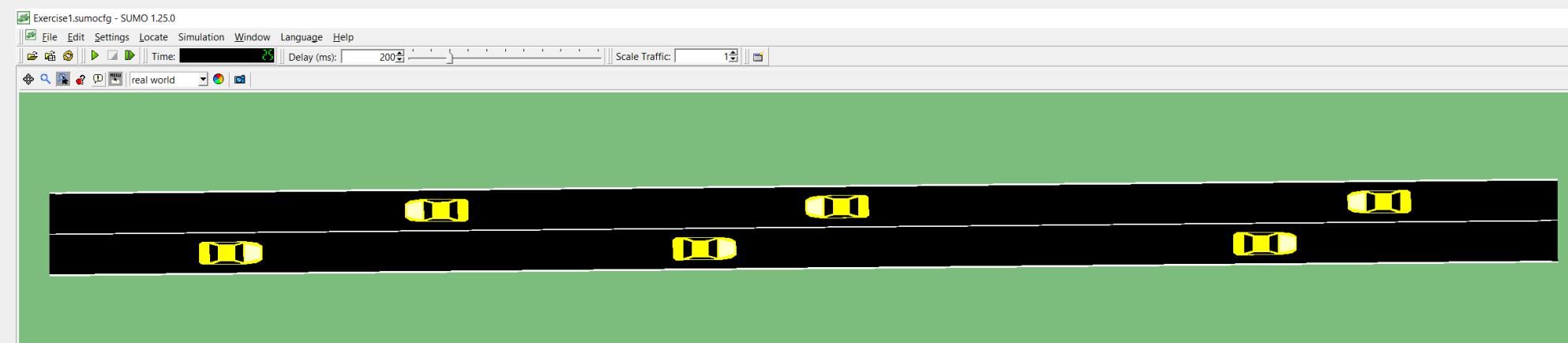
8. Add opposite traffic flow input to the

reverse direction with traffic volume of 1000

9. Save the files

10. Run SUMO Gui

11. The output should look like below:





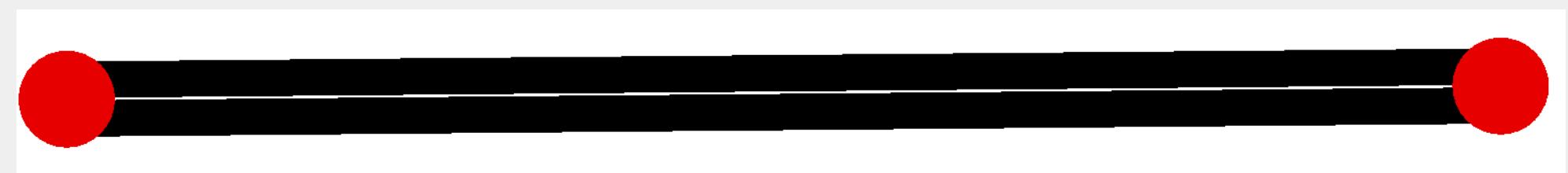
6. Add Opposite Traffic Flow

- For Deselecting a lane, do the following:

1. Select Network

2. Select “Selecting element”

3. Press “Escape”



Intersection – Unsignalized

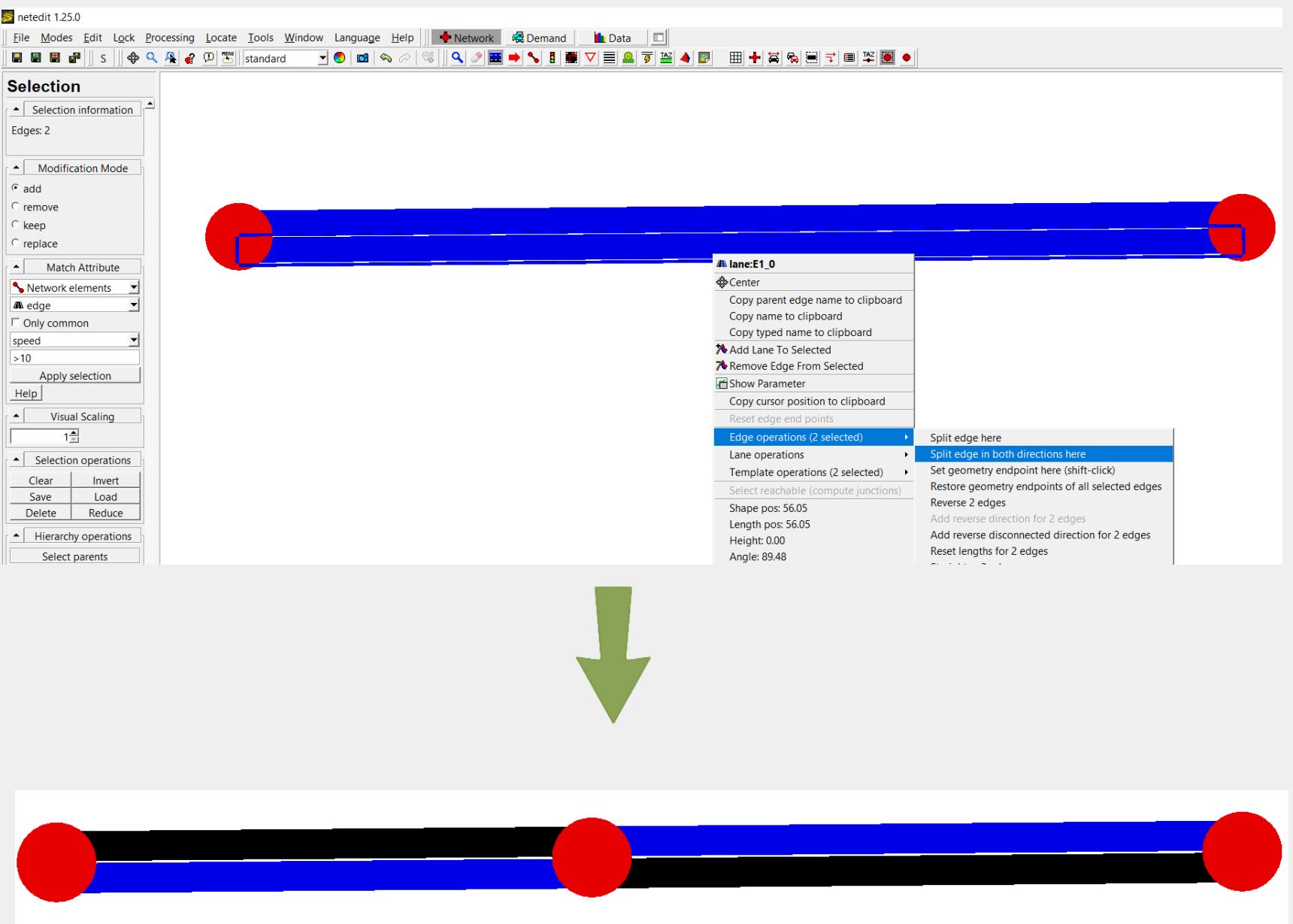
- Open netedit (Exercisel.netecfg) and do the following actions:

1. Select “Selecting element”

2. Select both edges → and in the middle of it →

Right Click → Split edge in both direction

3. Output would be the image

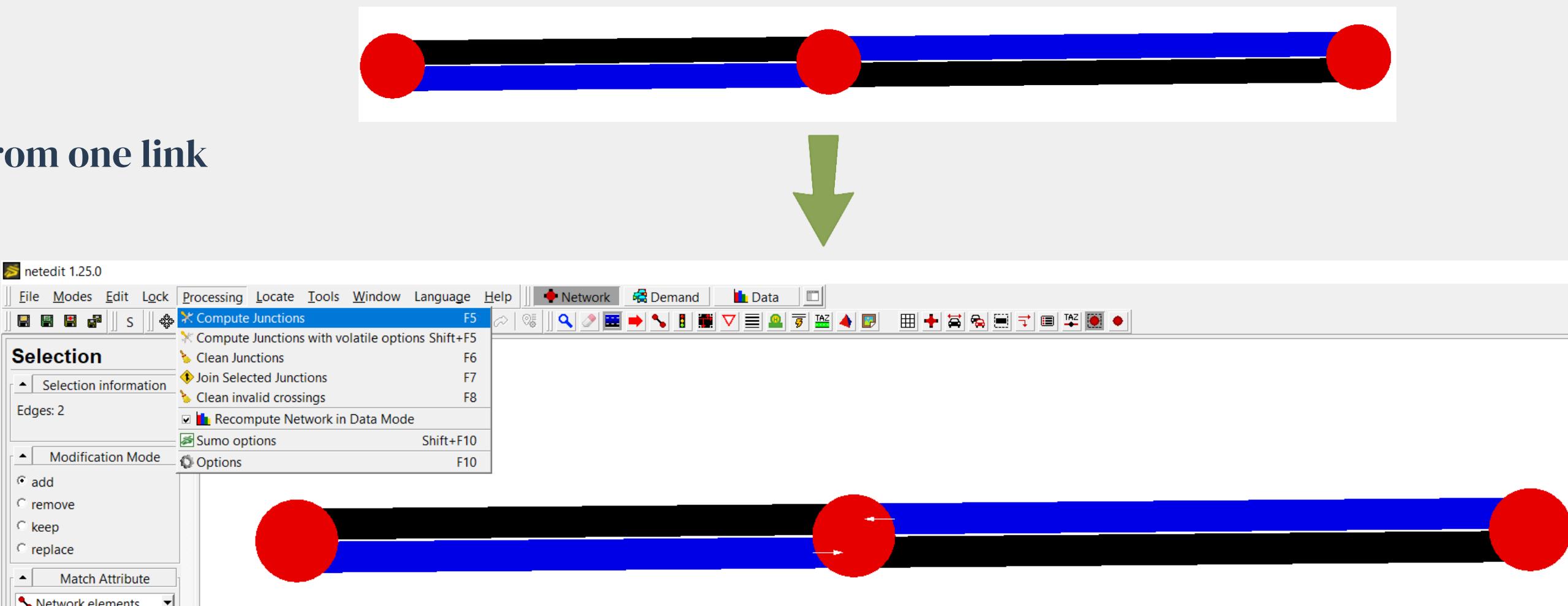




Intersection – Unsignalized

4. Processing → Compute Junctions

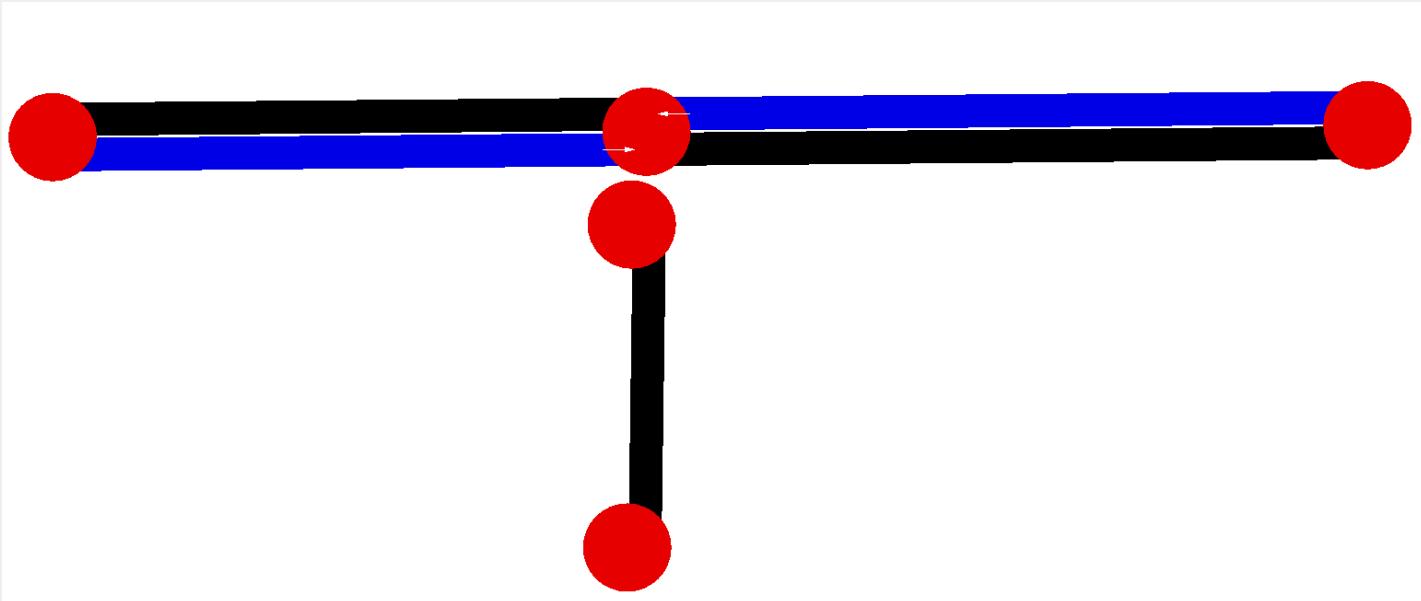
Now you will see two white arrows from one link
to another link





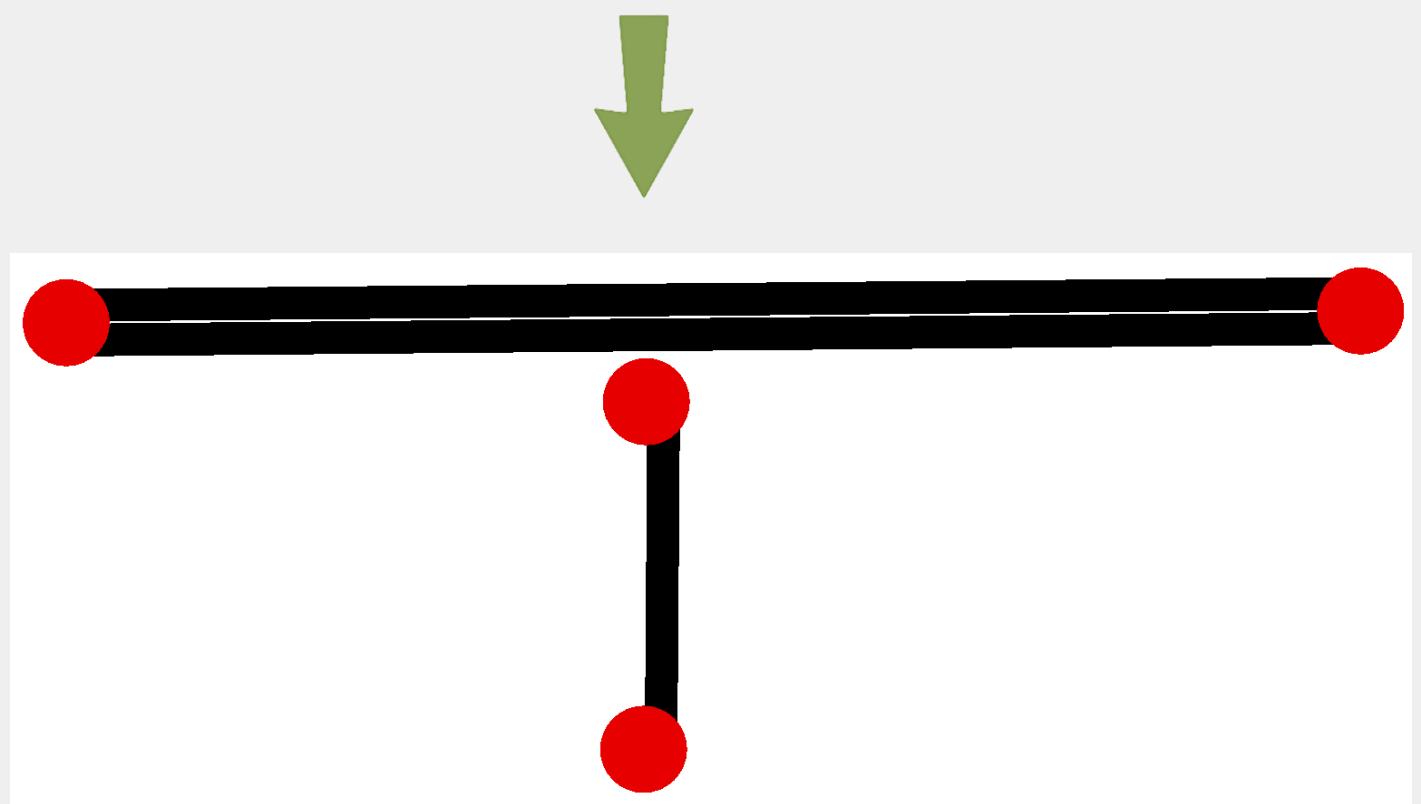
Intersection – Unsignalized

5. Now, create another road vertically



6. Select “Selecting elements”

7. Press “Escape”



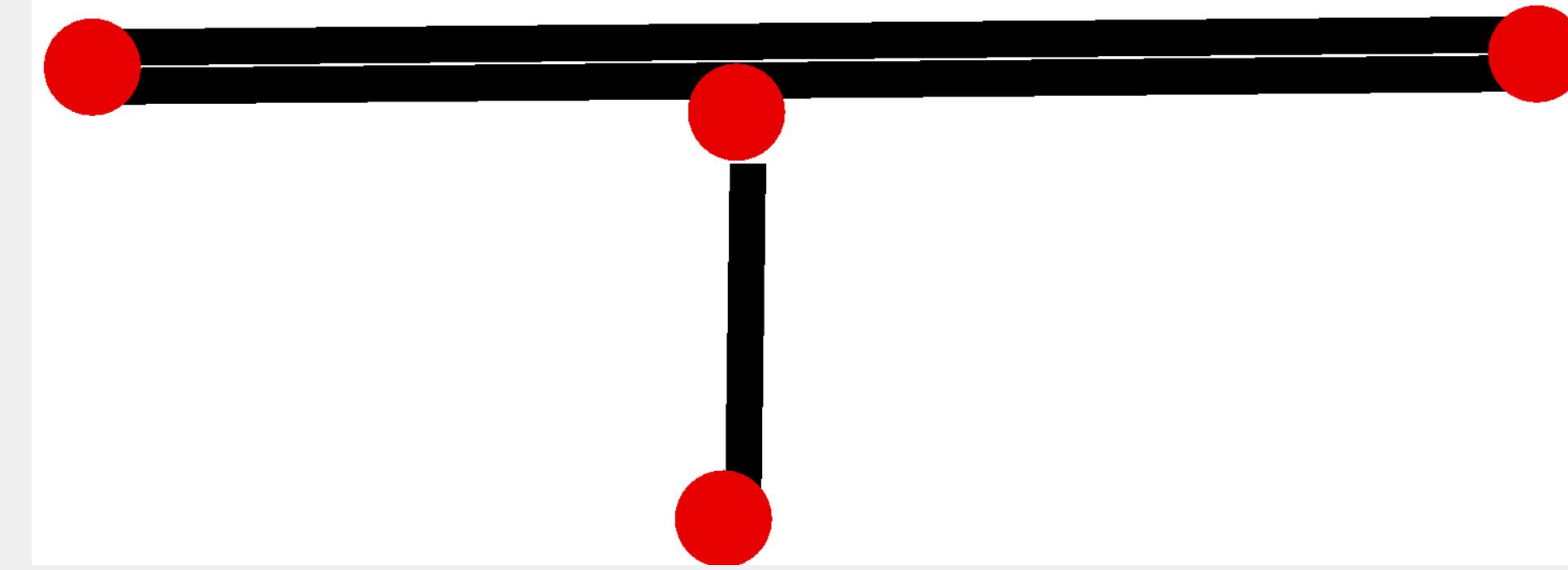
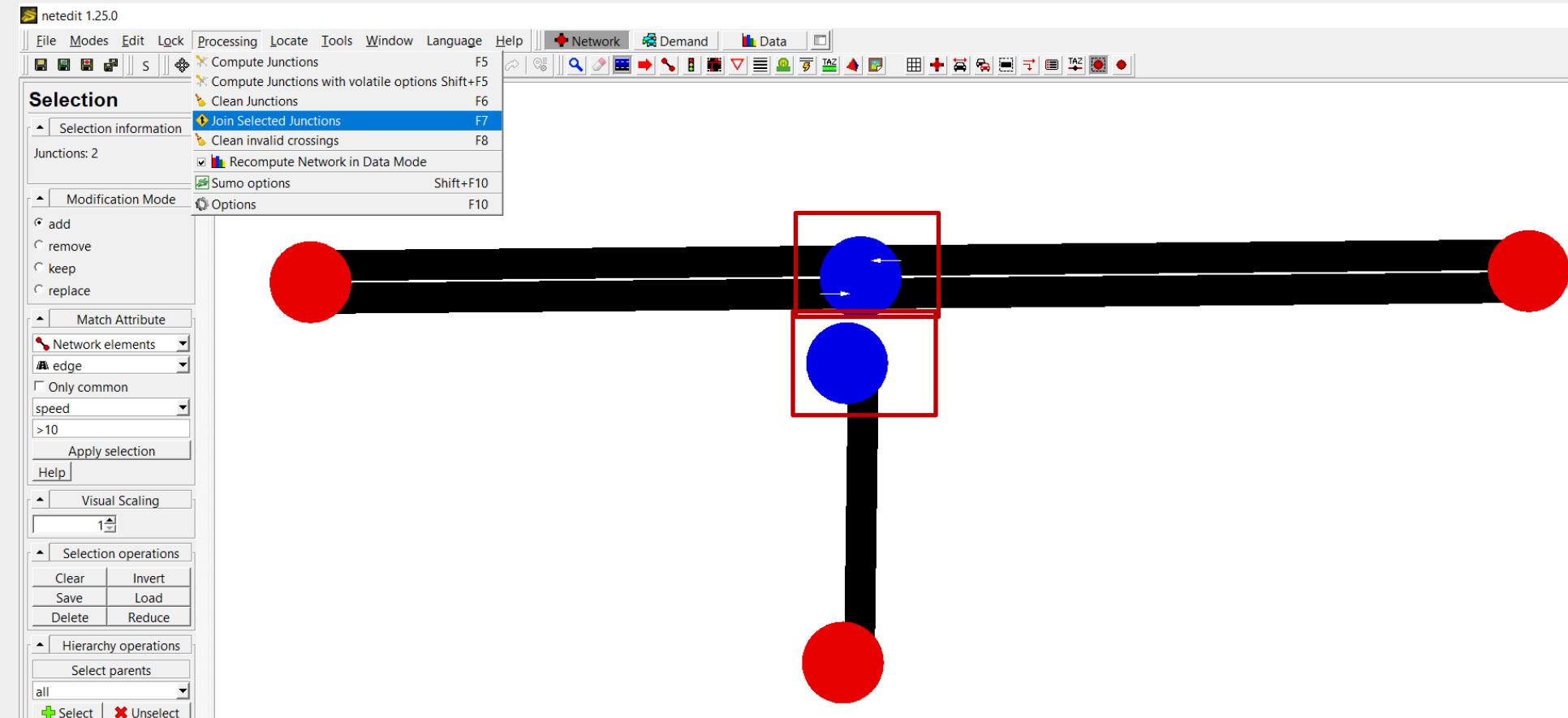
Intersection – Unsignalized

8. Select “Selecting elements”

9. Select both nodes to create an intersection

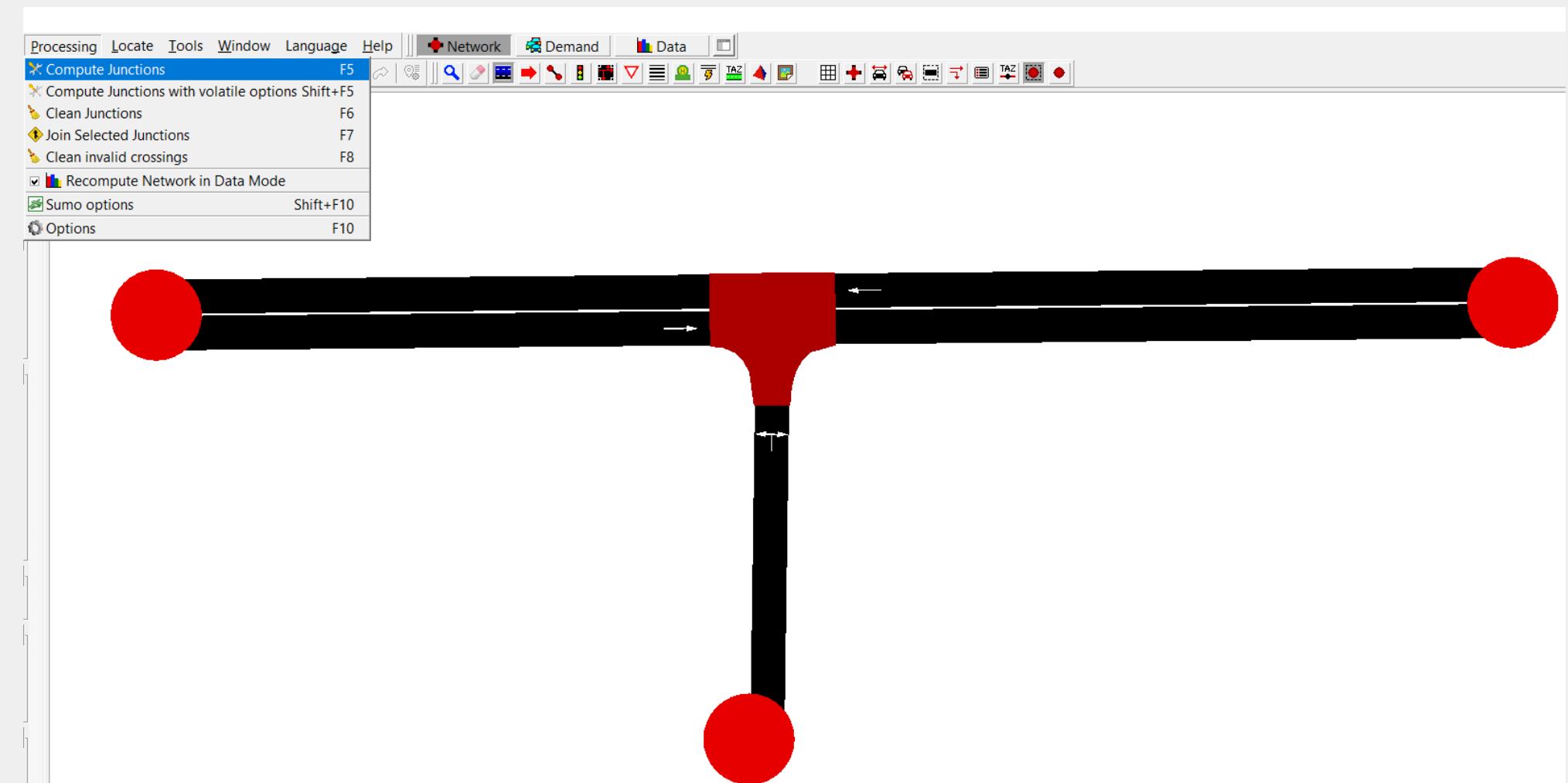
10. Processing → Join selected Junctions

11. Output would be



Intersection – Unsignalized

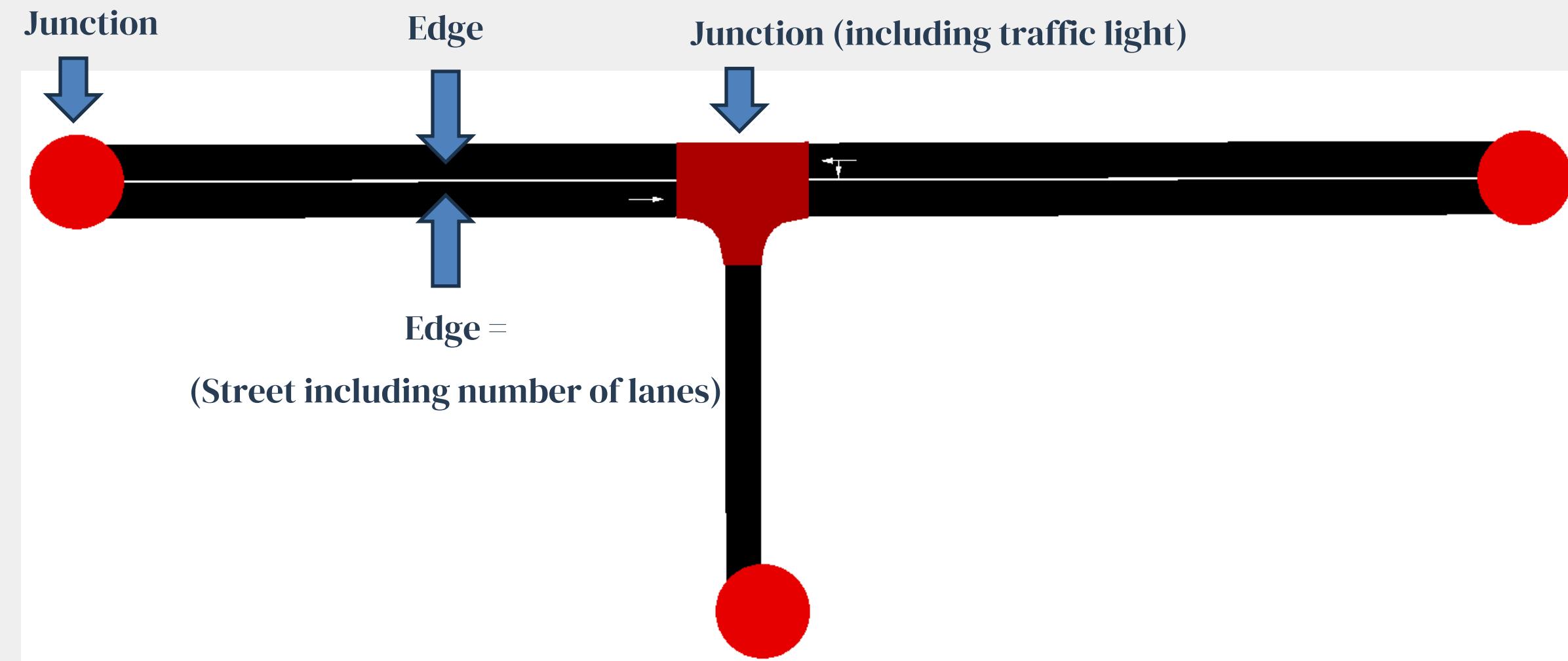
12. Processing → Compute Junction



13. Output would be an Intersection - Unsignalized



Edge vs Junction





Intersection – Signalized

Traffic Light

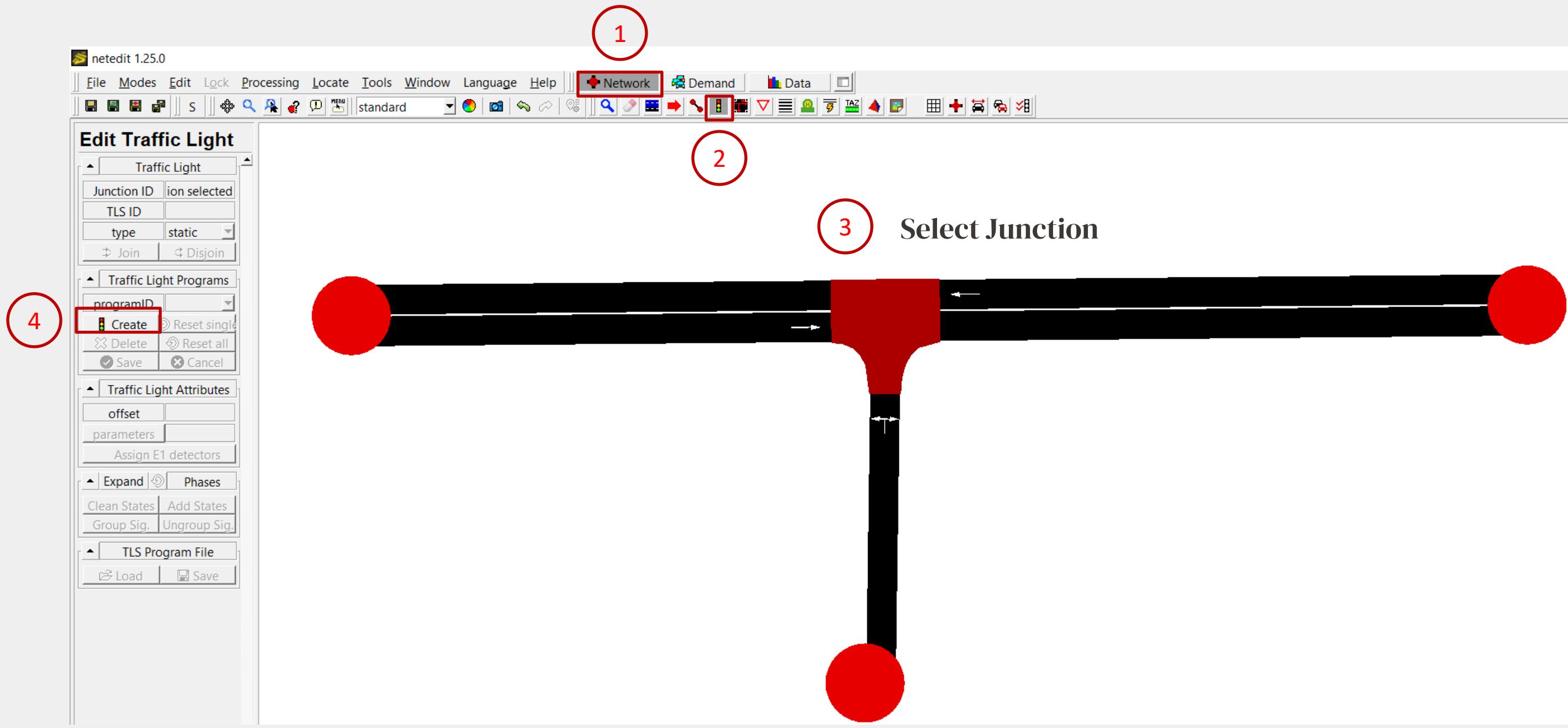
- Open netedit (Exercisel.netecfg) and do the following actions:

1. Select Network

2. Select Traffic Light

3. Select Junction

4. Create Traffic light



Intersection – Signalized

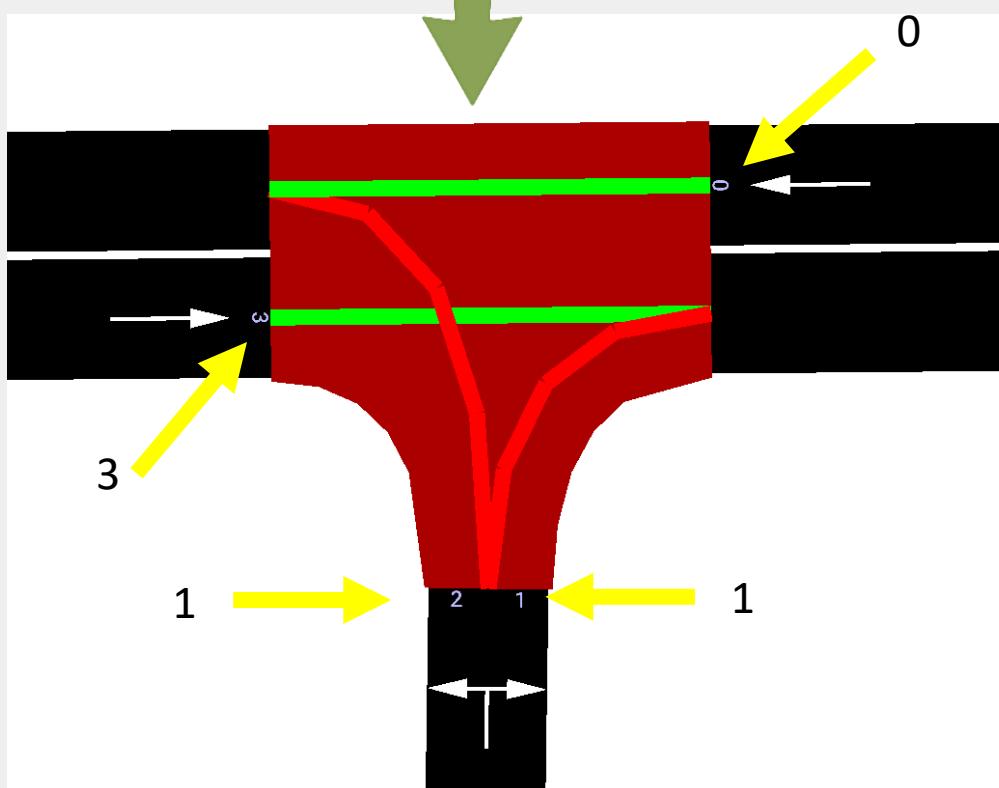
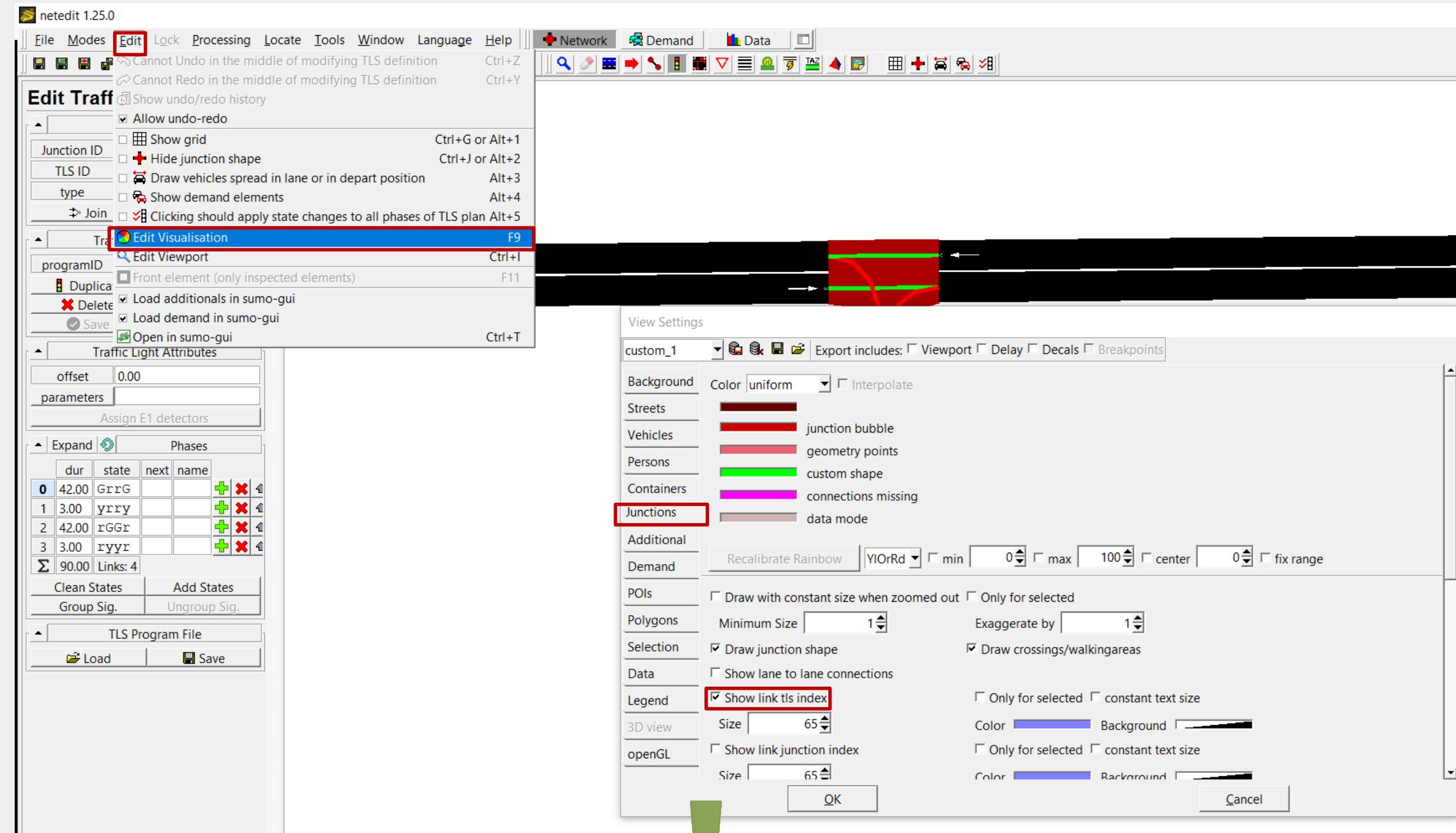
5. Edit → Edit Visualization

6. Select Traffic Light

7. Select Junction

8. Show link tls index

9. See each traffic signal head number



Intersection – Signalized

10. Observe the Four phases on the left Side in Window “Edit Traffic Light”

- Phase 1: 42 second
- Phase 2: 3 second
- Phase 3: 42 second
- Phase 4: 3 second

11. State:

G mean Green

y means yellow

r means red

In phase 0:

GrrG



0,1,2,3

In phase 1:

yrry



0,1,2,3

In phase 3:

rGGr



0,1,2,3

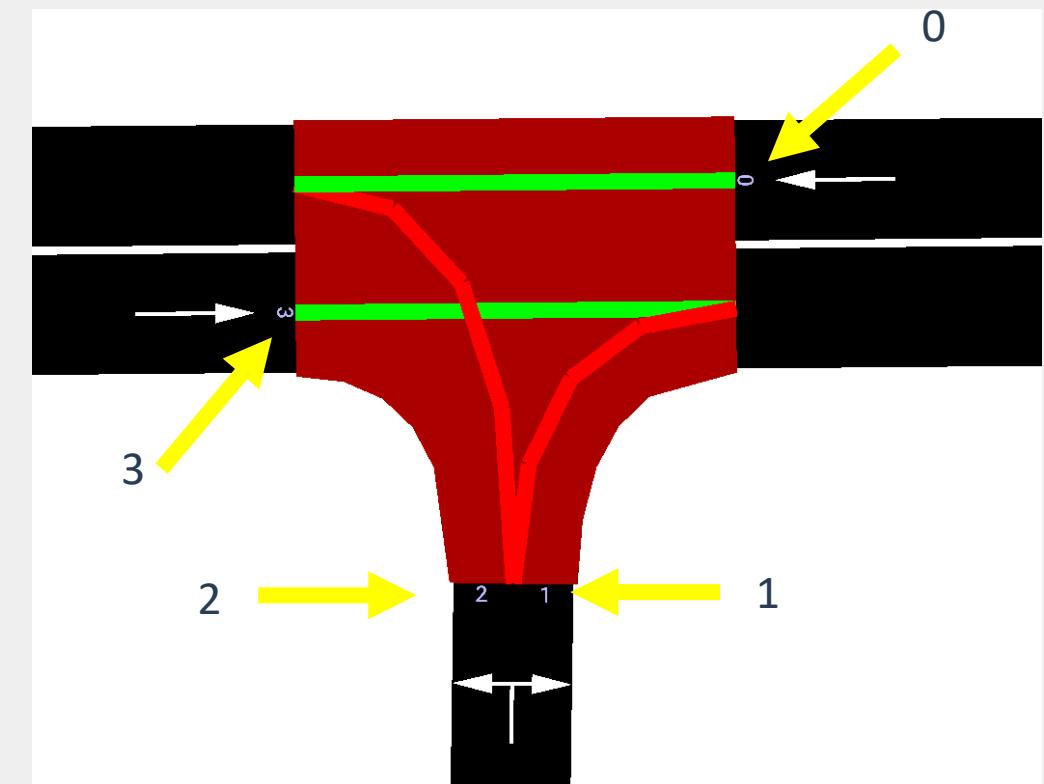
In phase 4:

ryyr



0,1,2,3

	dur	state	next	name		
0	42.00	GrrG			+ X 1	
1	3.00	yrry			+ X 1	
2	42.00	rGGr			+ X 1	
3	3.00	ryyr			+ X 1	
Σ	90.00			Links: 4		



Intersection – Signalized

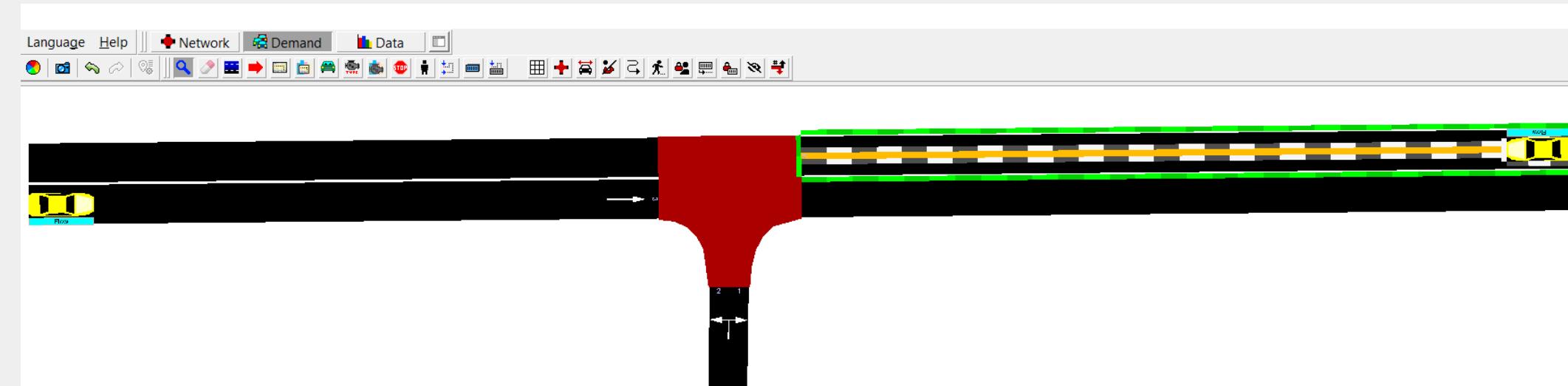
12. Run SUMO and Observe Changing Traffic Lights

13. What do you notice?

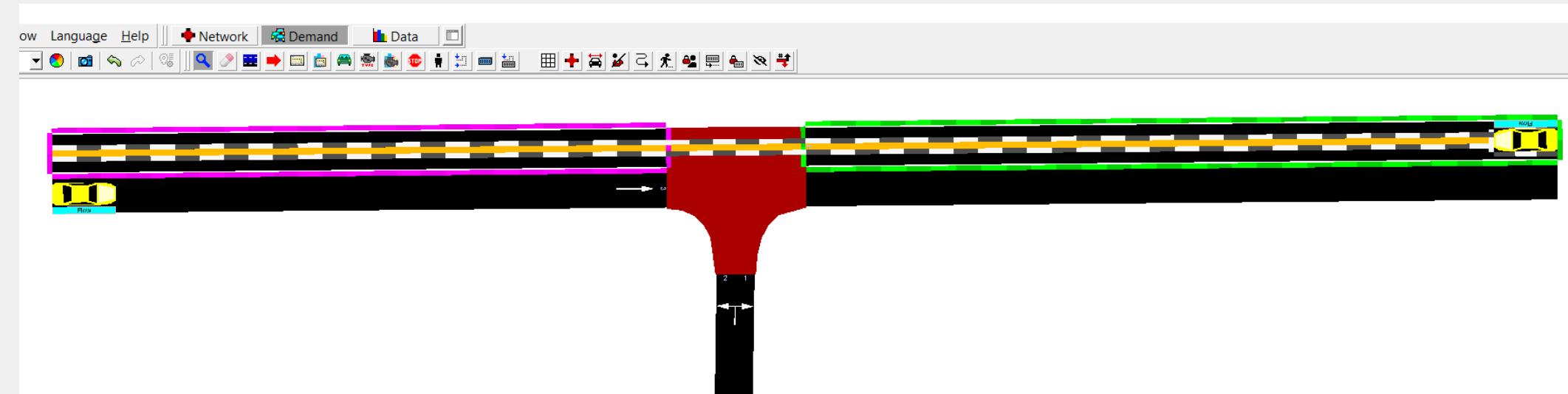
Intersection – Signalized

14. SUMO cars are disappearing before traffic light because we first add traffic light then modify the road network. So, we need to again check the traffic flow route

15. Open Netedit → Select Demand → Select Magnifier → Select Car → Notice the route is finished before intersection



16. Remove the traffic flow in both direction and add new traffic flows with complete route

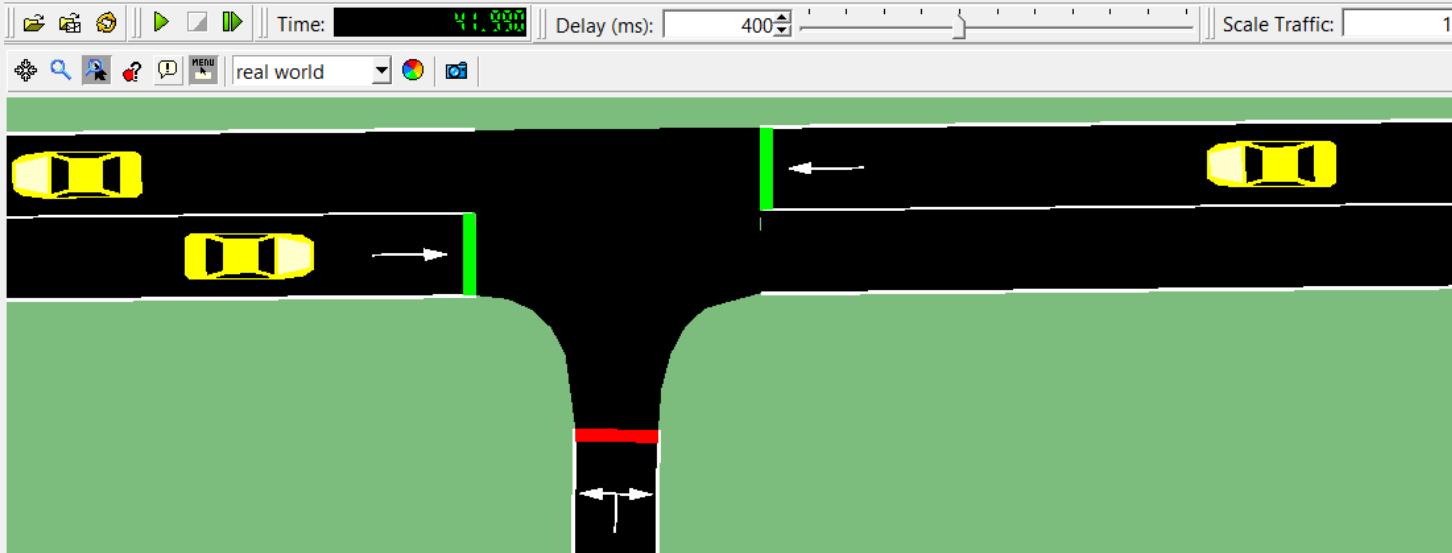


Intersection – Signalized

17. Run SUMO

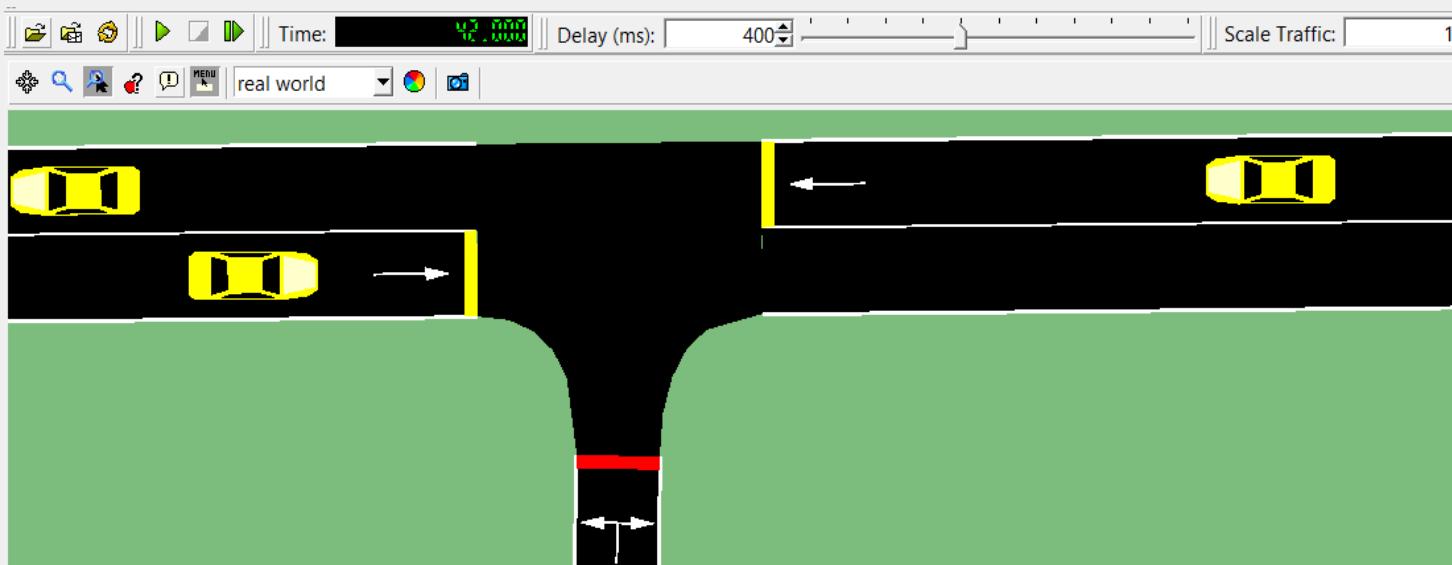
From Second 0 to 41.99,
it is phase 1

	dur	state
0	42.00	GrrG
1	3.00	yrry
2	42.00	rGGr
3	3.00	ryyr
Σ	90.00	Links: 4



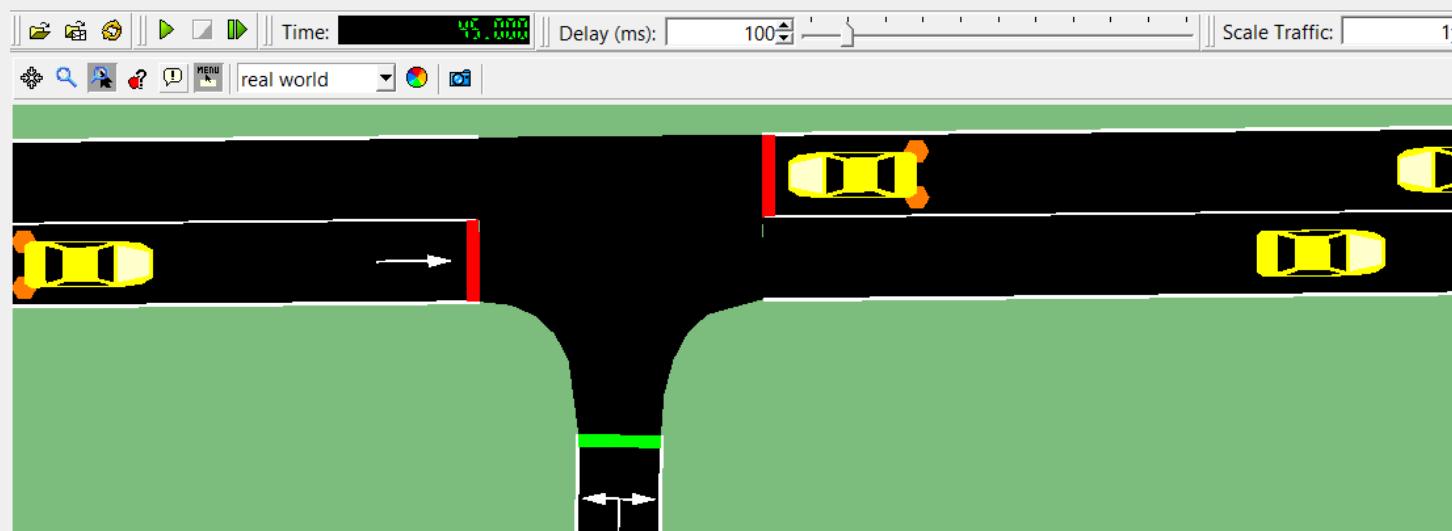
From Second 42 to 44.99,
it is phase 2

	dur	state
0	42.00	GrrG
1	3.00	yrry
2	42.00	rGGr
3	3.00	ryyr
Σ	90.00	Links: 4



From Second 45 to 86.99,
it is phase 3

	dur	state
0	42.00	GrrG
1	3.00	yrry
2	42.00	rGGr
3	3.00	ryyr
Σ	90.00	Links: 4

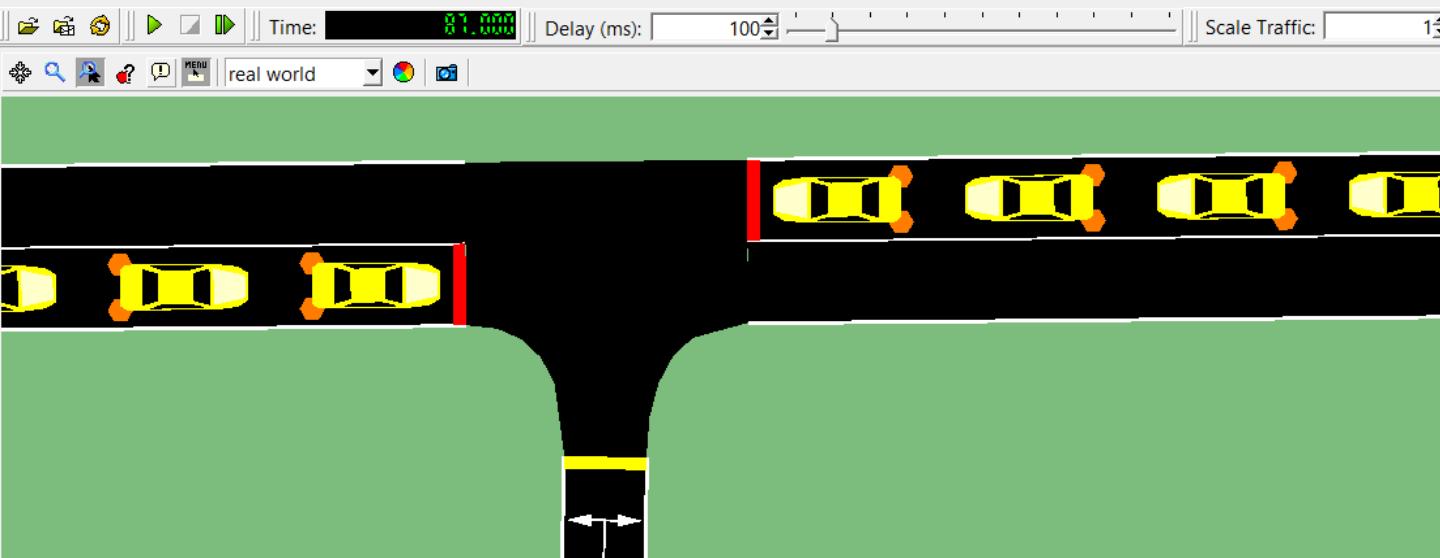


Intersection – Signalized

Run SUMO

From Second 87 to 79.99,
its phase 4

	dur	state
0	42.00	GrrG
1	3.00	yrry
2	42.00	rGGr
3	3.00	ryyr
Σ	90.00	Links: 4



It repeats