RWR 4015

Traffic Simulation for Planning Applications

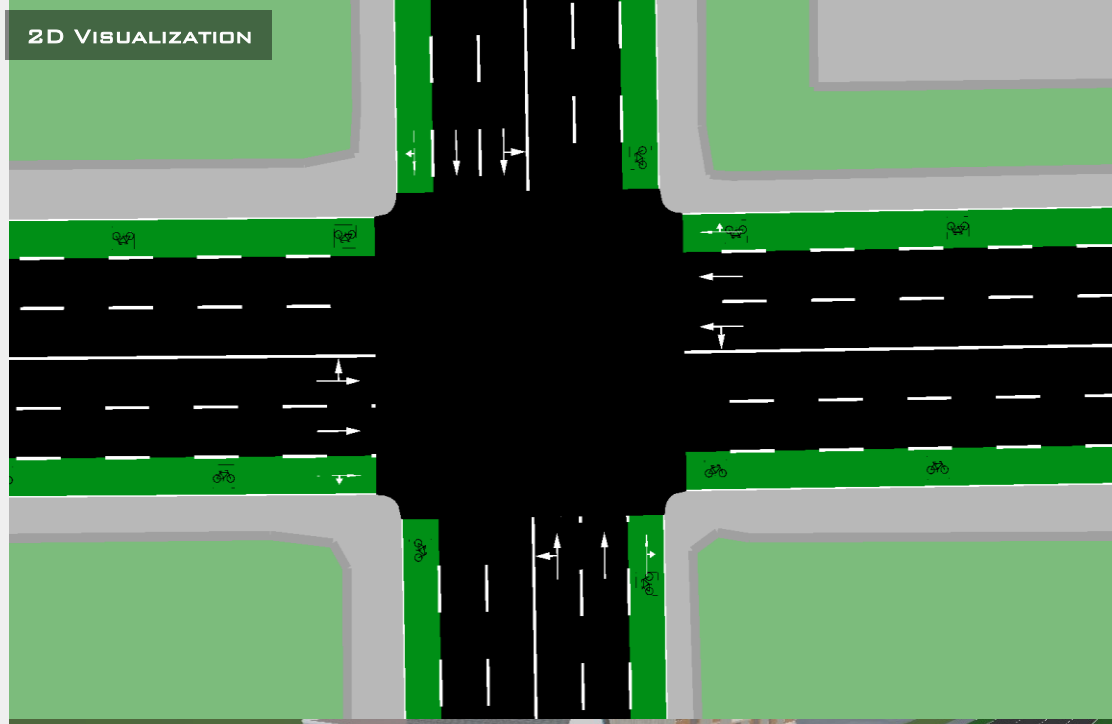
Dr. Ahmad Mohammadi

Week 10 | Hands-on:
3D Simulation in Planning I

Fall 2026

RoadwayVR

roadwayvr.github.io/TrafficSimulationforPlanningApplications



Agenda

- ❑ Install Sumo2Unity tool
- ❑ Install Unity Game Engine
- ❑ Visualize a Single Lane Road with one Unsignalized Intersection

Sumo2Unity Tool

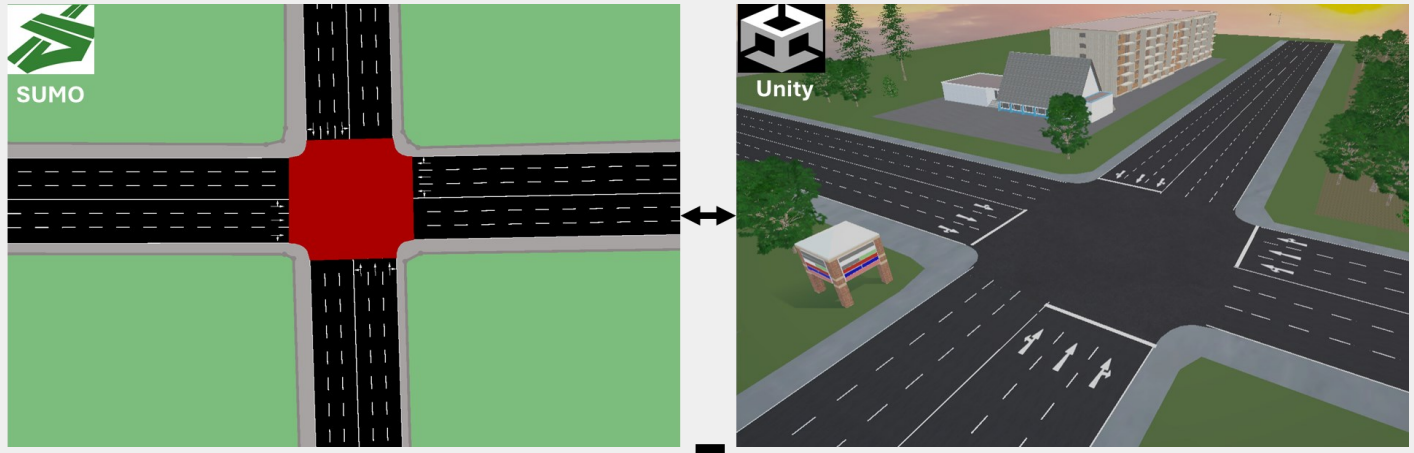
- ❑ Download Sumo2Unity V2.0.0
- ❑ SUMO Installation and Quit Start
- ❑ Unity VR Installation
- ❑ Visualize a Single Lane Road with one Unsignalized Intersection

Sumo2Unity Tool

Generate:

- ❑ Complex Road Network
- ❑ Complex Traffic System
- ❑ Performance Functions (Analytics)

1



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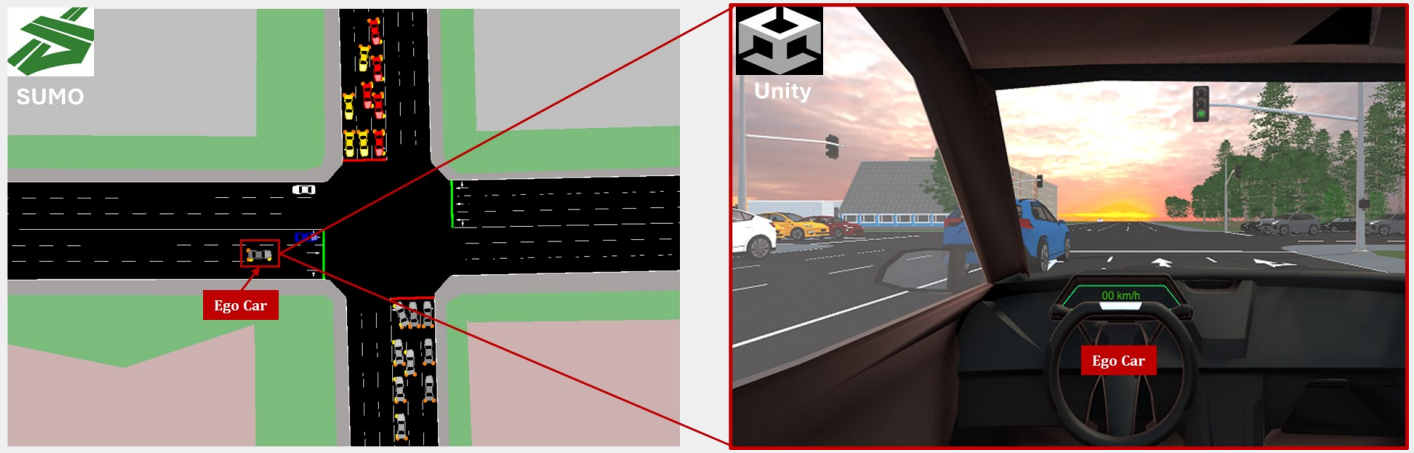

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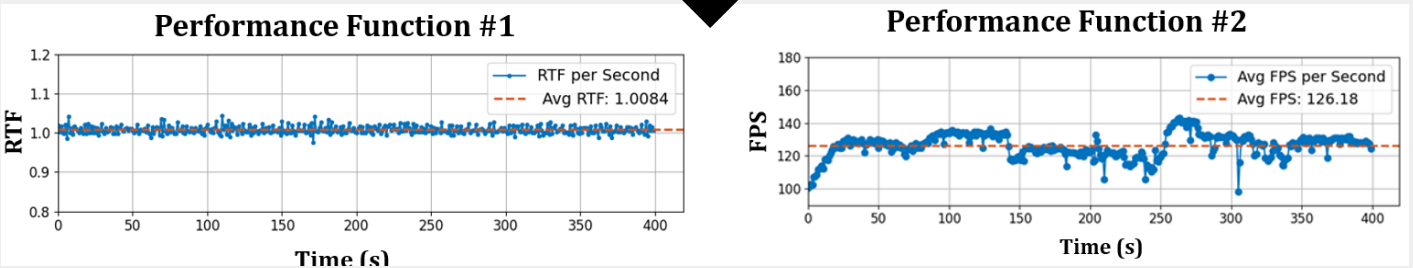


Unity Installation

1. Install Unity HUB

2. Install Unity Editor (Version 6000.0.53f1)

3. Install Visual Studio

4. Install Visual Studio Dependencies

Watch:
“Unity VR Tutorial Part 1.1. Install Unity HUB and Visual Studio”

https://youtu.be/ngccSGH3-_8

Sumo2Unity Tutorials

- ❑ Scenario 1 (Single Lane Road with one Unsignalized Intersection)
- ❑ Scenario 2 (Multi Lane Road with Signalized Intersection)
- ❑ Scenario 3 (Bicycle)
- ❑ Scenario 4 (Scooters)
- ❑ Scenario 5 (Different Traffic Density: Level of Service)

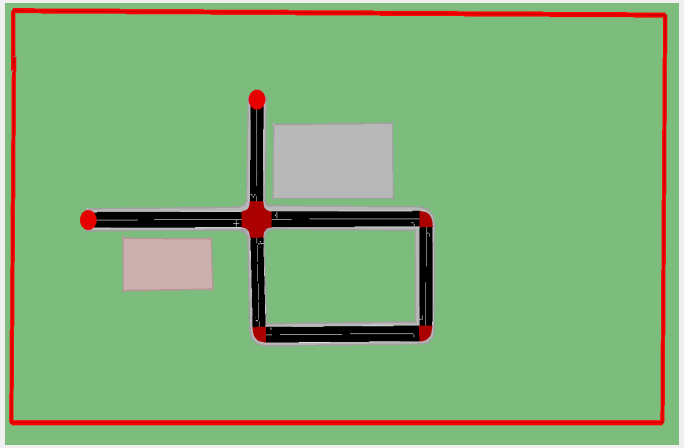
Scenario 1:
Single Lane Road with one Unsignalized Intersection

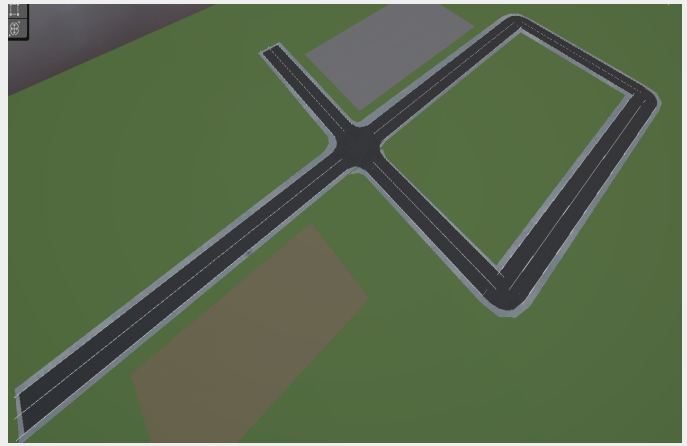
1. Create Road Network

2. Run Sumo2Unity Integration

3. Generate Performance Functions

1





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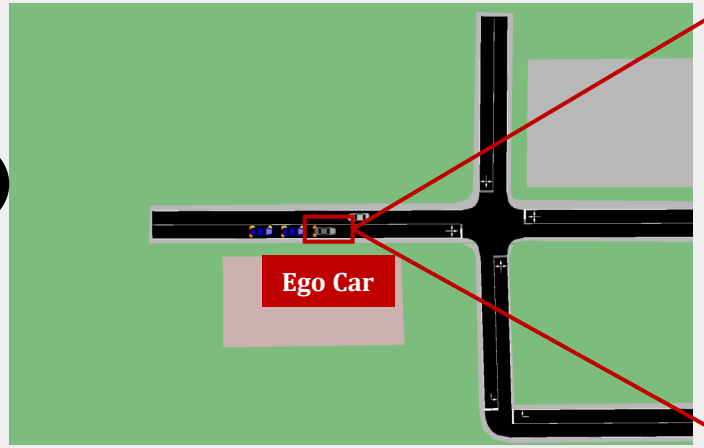

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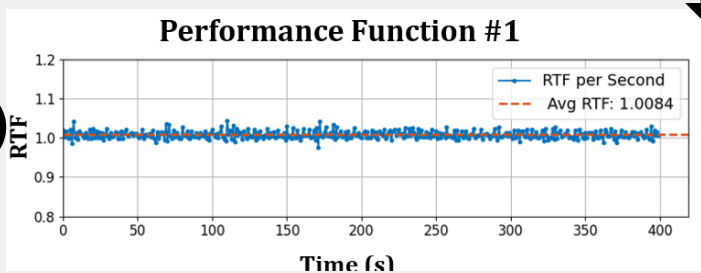
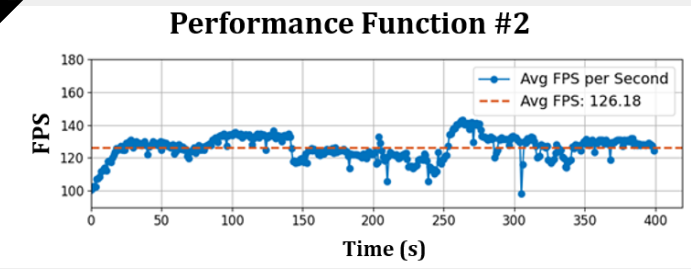




Step 1: Create Road Network

1.1. SUMO Steps

A) Adding Lane

B) Adding Terrain

C) Adding Roadside

D) Adding Residential

E) Adding Wood

1.2. Unity Steps

F) Import SUMO Road Network

G) Road Marking As Decals: Stamp an image on a 3D model

H) Add Stop Signs, and Navigation Arrow

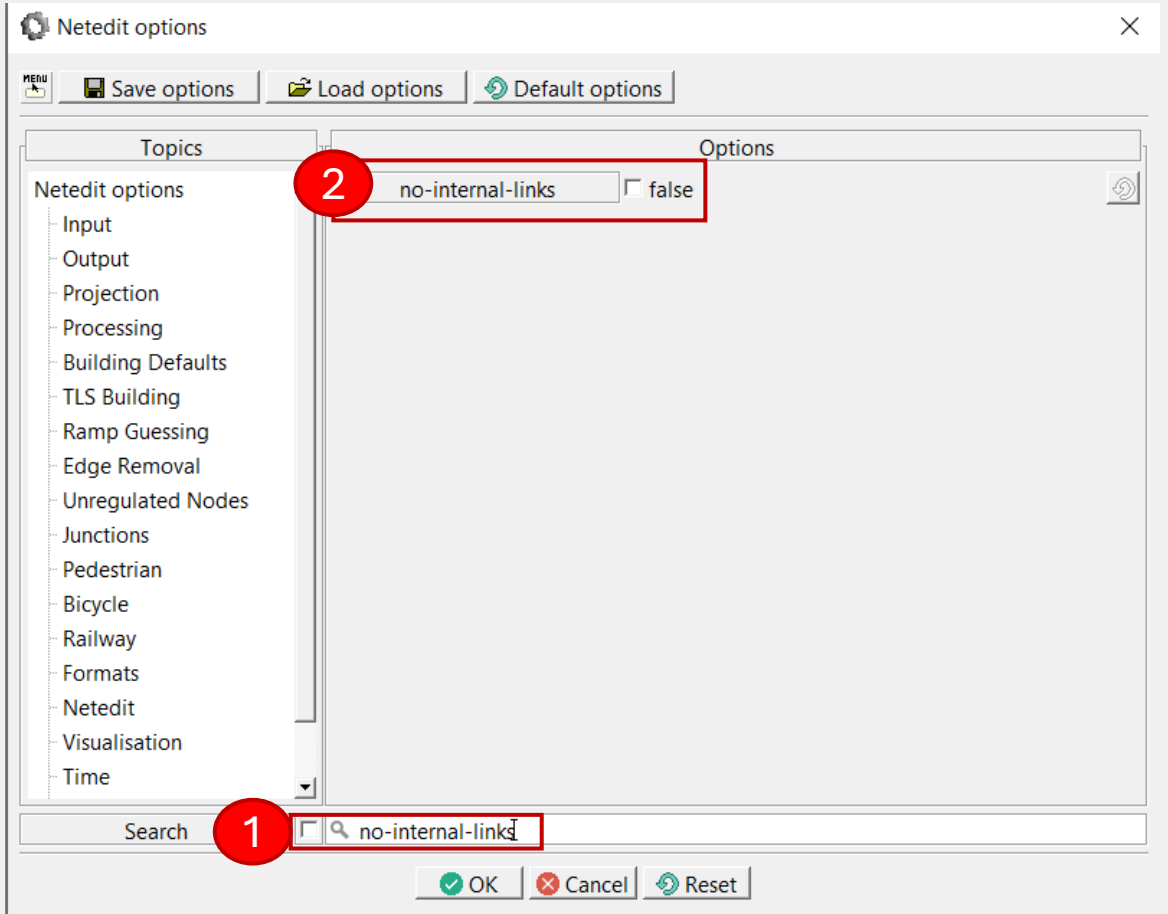
I) Add Trees, Buildings, and Road Signs

Step 1: Create Road Network

A) Adding Lanes

❑ Open netedit → Processing → Option → Search “no-internal-links”

→ Make sure it is like the image

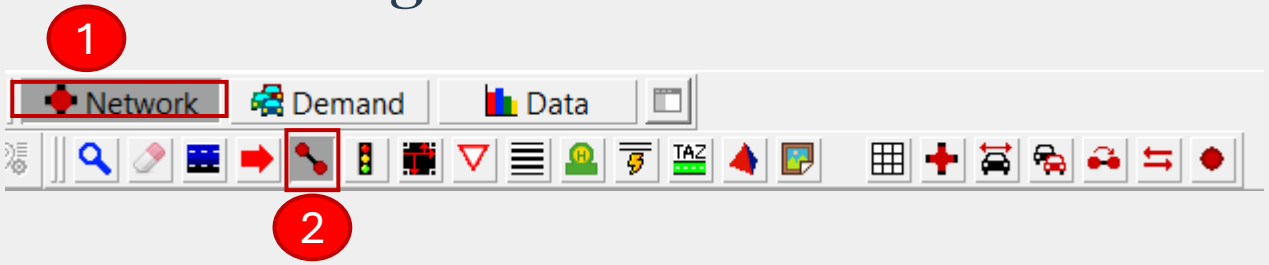


Step 1: Create Road Network

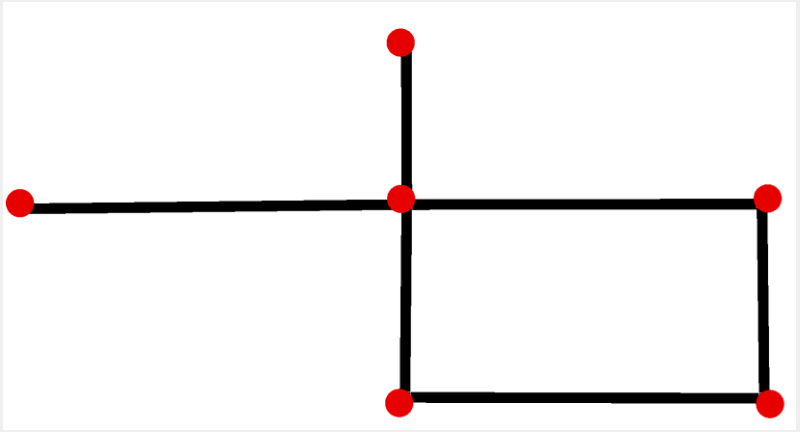
A) Adding Lanes

❑ netedit → File → New Network

❑ UI → Network → Select “Creating Junction and Edges Tool”



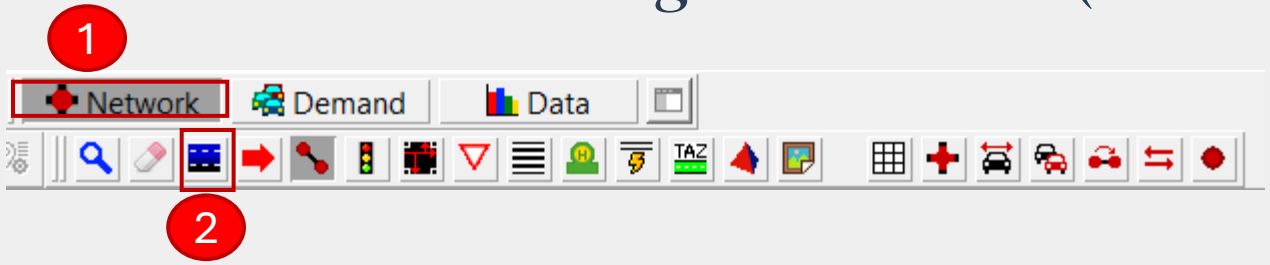
❑ Create a simple network like below



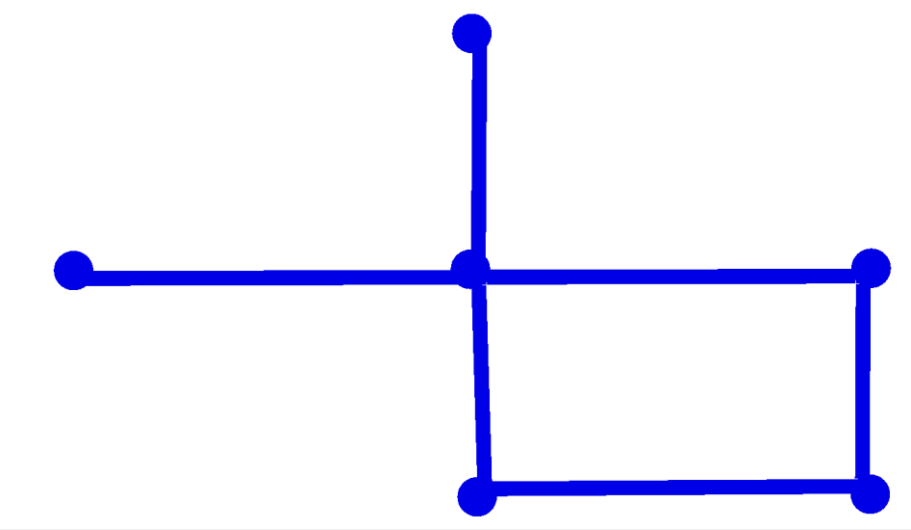
Step 1: Create Road Network

A) Adding Lanes

- ❑ UI → Network → Select “Selection Element” → Select All Edges and Nodes (roads & intersections)



- ❑ Result

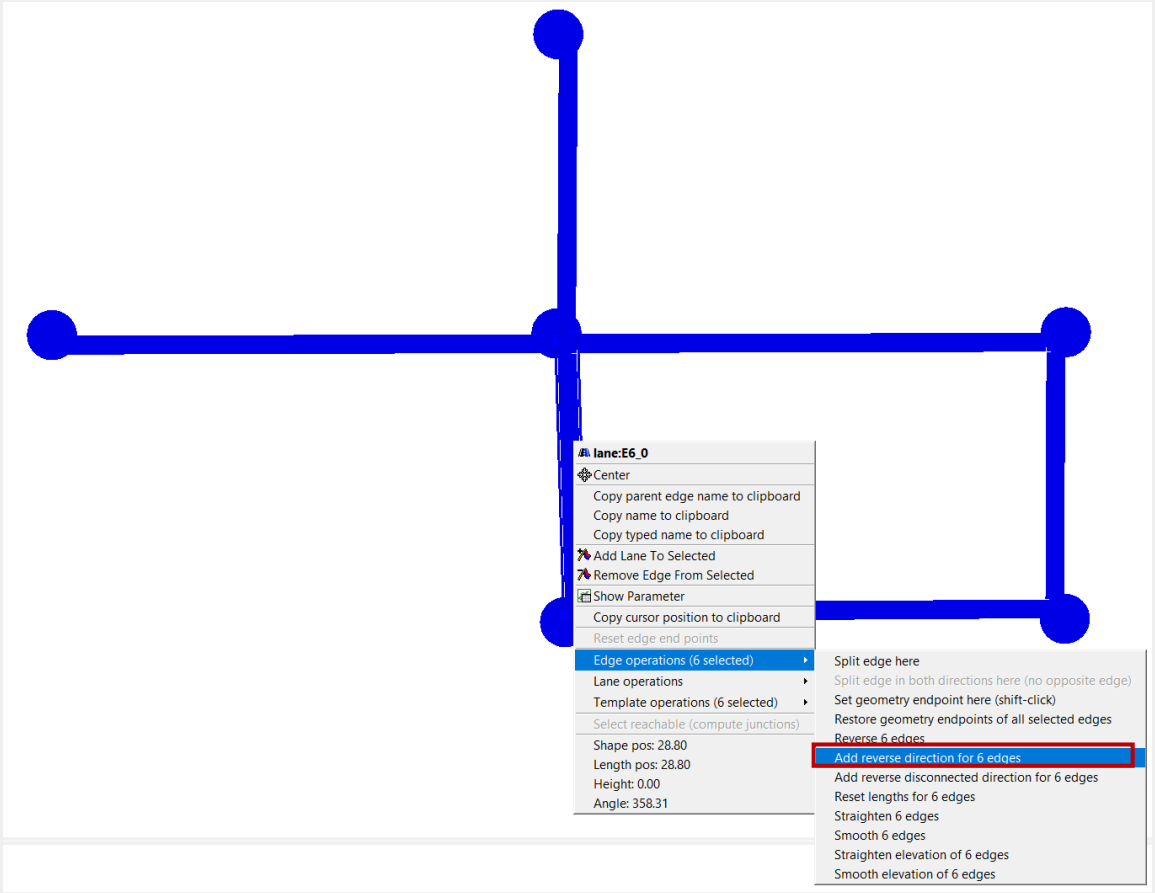


Step 1: Create Road Network

A) Adding Lanes

❑ Right Click On Roads → Add Reverse Direction for 6 Edges

❑ Processing → Compute Junctions

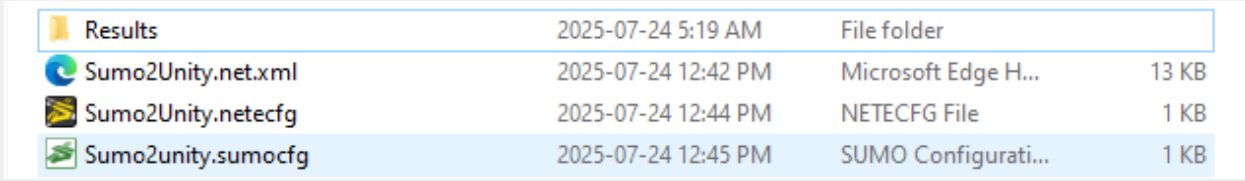


Step 1: Create Road Network

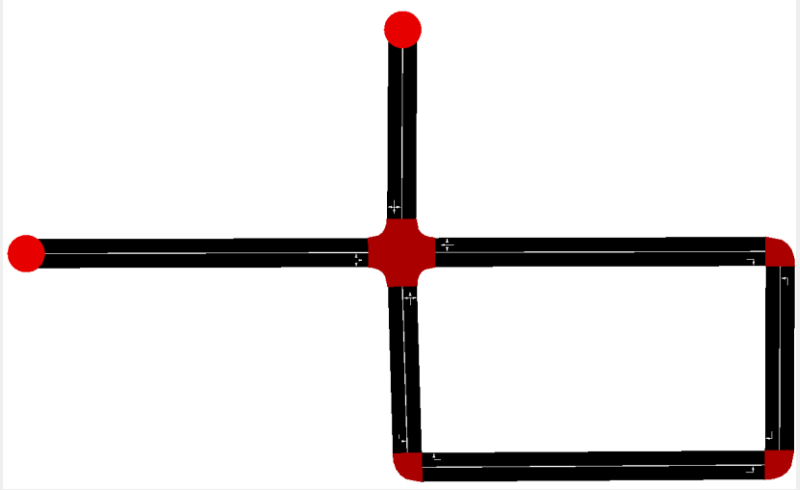
A) Adding Lanes

- ❑ File → Save Network → Save in Folder “SUMOData” → Name it Sumo2Unity
- ❑ File → Netedit config → Save in Folder “SUMOData” → Name it Sumo2Unity
- ❑ File → Sumo config → Save in Folder “SUMOData” → Name it Sumo2Unity

❑ You should have the below three files



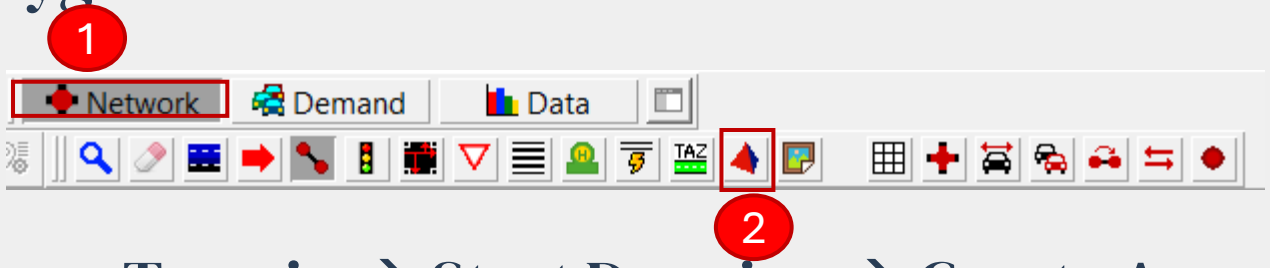
❑ Your network should look like this (processing → compute junction)



Step 1: Create Road Network

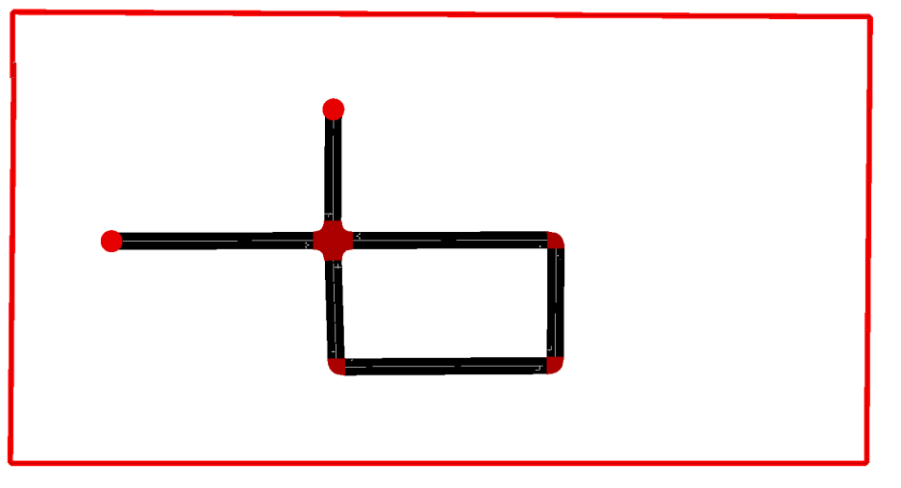
B) Adding Terrain

❑ UI → Network → Select “Creating Polygon”



❑ Zoom out → in Shapes Window → Type: Terrain → Start Drawing → Create A rectangle that serves as “terrain” → Stop Drawing

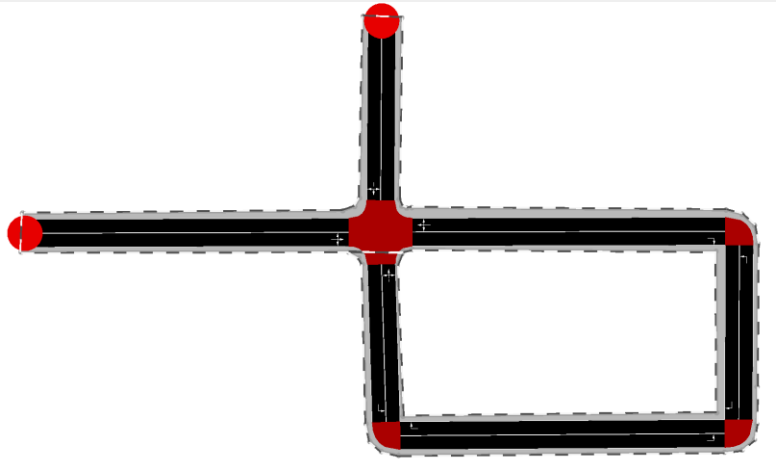
❑ File → Additionals and Shapes → Save Additional
→ File Filter: xml files → name as Sumo2Unity.Poly



Step 1: Create Road Network

B) Adding Roadside

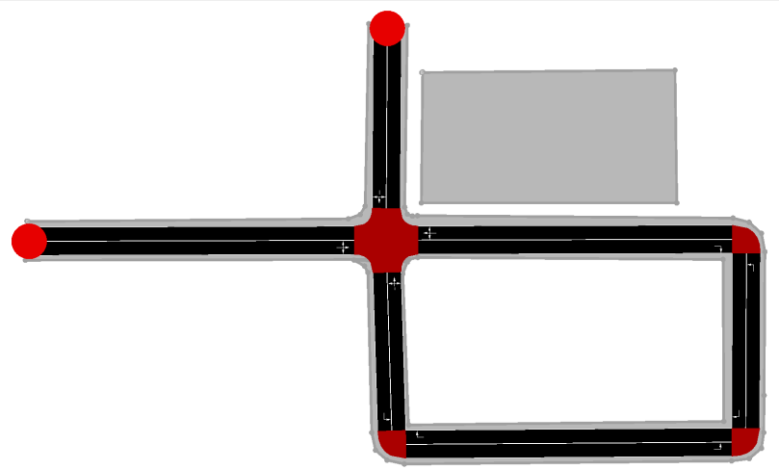
- ❑ UI → Network → Select “Creating Polygon”
- ❑ in Shapes Window → Type: Roadside → Start Drawing → Create A roadside area that serves as “roadside” → Stop Drawing
- ❑ in Shapes Window → Fill: true → color: 122,122,122 (grey)
- ❑ File → Additionals and Shapes → Save Additional



Step 1: Create Road Network

B) Adding Residential

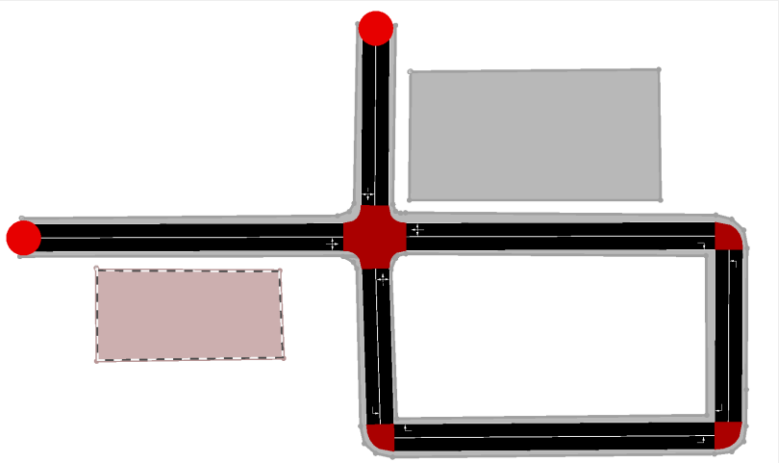
- ❑ UI → Network → Select “Creating Polygon”
- ❑ in Shapes Window → Type: Residential → Start Drawing → Create A rectangular that serves as “residential” area → Stop Drawing
- ❑ in Shapes Window → Fill: true → color: 122,122,122 (grey)
- ❑ File → Additionals and Shapes → Save Additional



Step 1: Create Road Network

B) Adding Wood

- ❑ UI → Network → Select “Creating Polygon”
- ❑ in Shapes Window → Type: Residential → Start Drawing → Create A rectangular that serves as “wood” area → Stop Drawing
- ❑ in Shapes Window → Fill: true → color: 154,110,110
- ❑ File → Additionals and Shapes → Save Additional



Step 1: Create Road Network

1.2. Unity Steps

Note: Rename the Existing Scene to Scenario1

F) Import SUMO Road Network

G) Road Marking As Decals (Stamp an image on a 3D model)

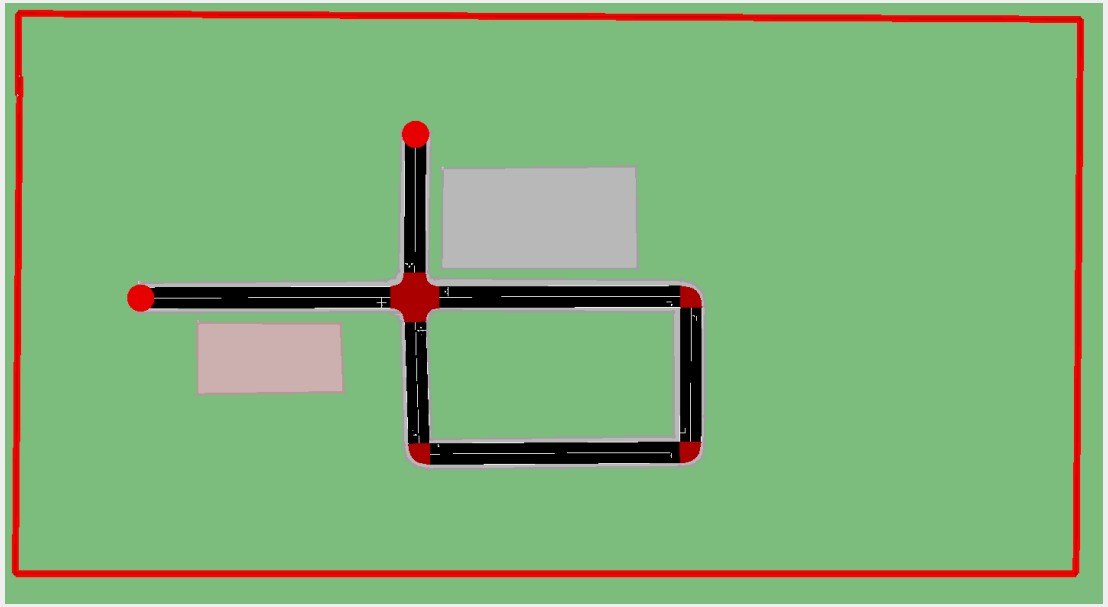
H) Add Stop Signs, and Navigation Arrow

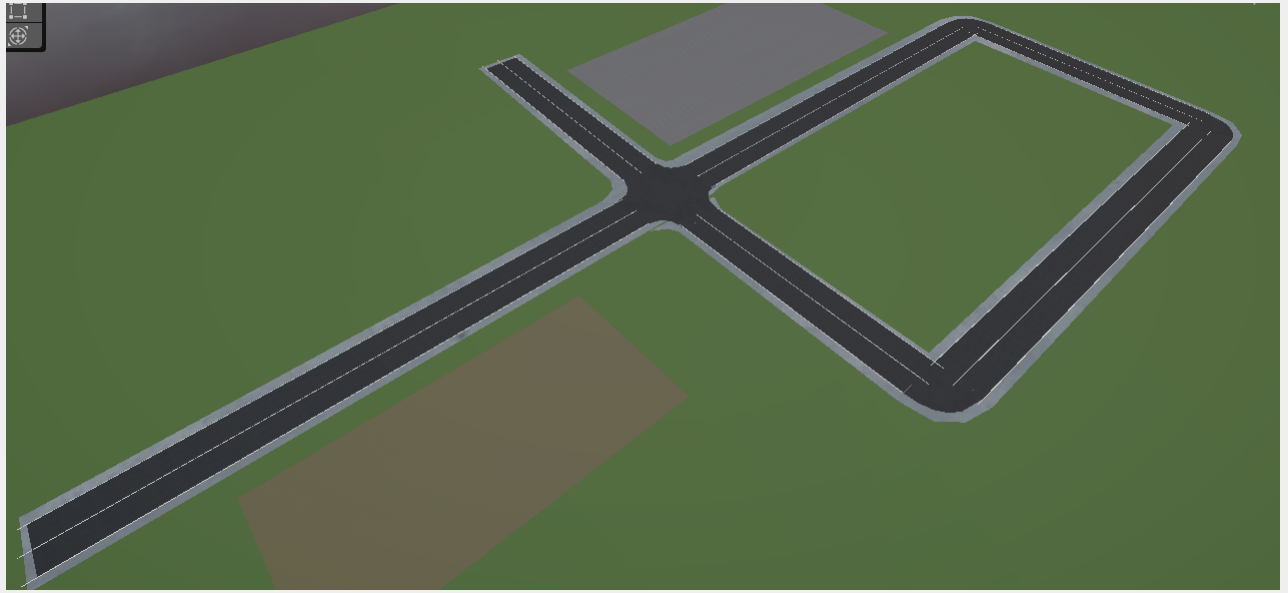
I) Add Trees, Buildings, and Road Signs

Step 1: Create Road Network

F) Import SUMO Road Network

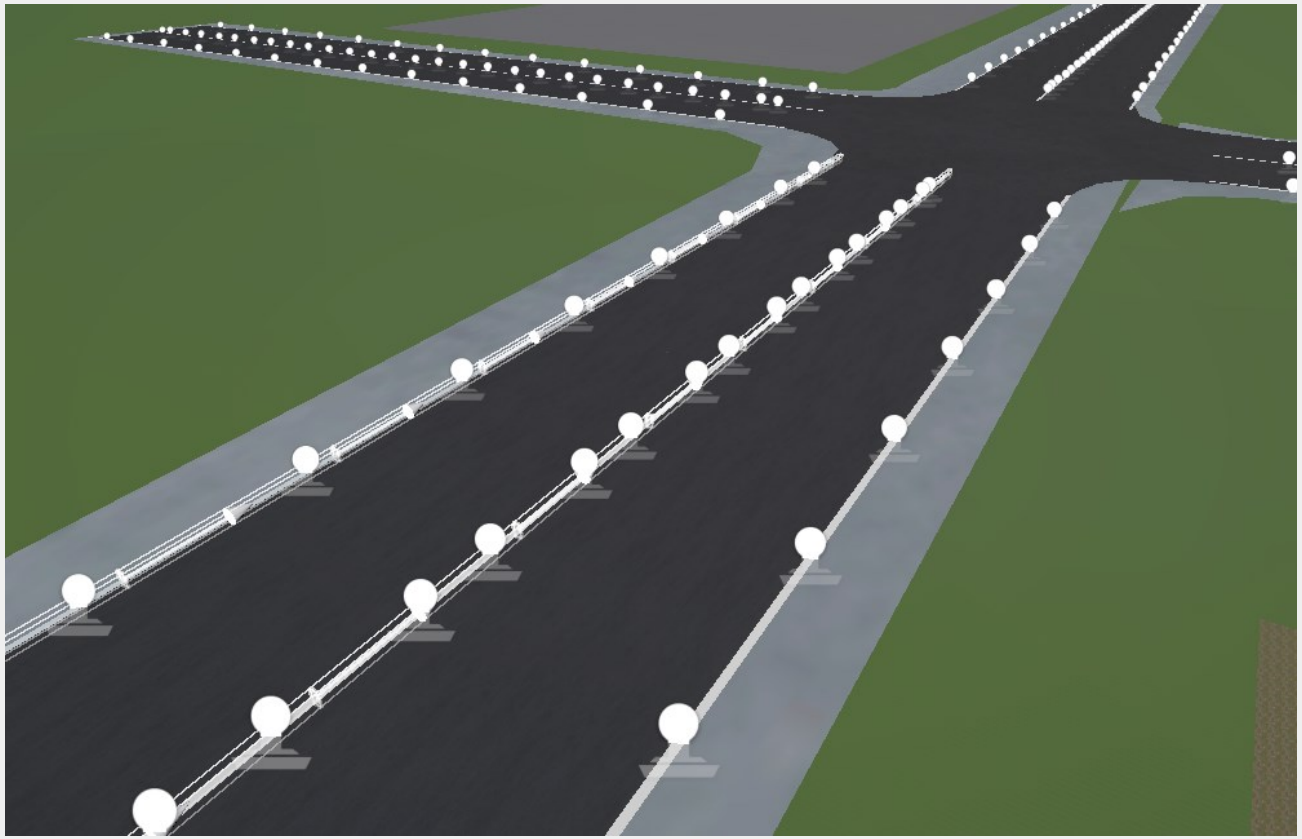
❑ Menu Bar → Sumo2Unity → 1. Create Road Network → Set SUMO Files Folder as Directory\SUMO2Unity\Scenario1 → Start





Step 1: Create Road Network

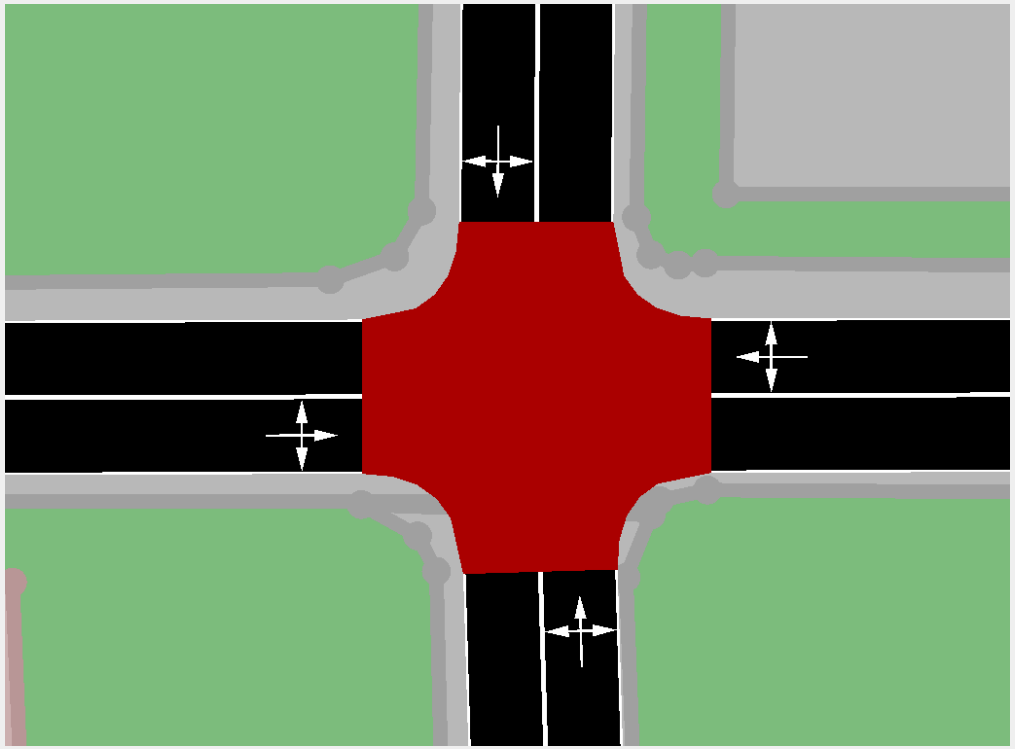
G) Road Marking As Decals (Stamp an image on a 3D model)



Step 1: Create Road Network

H) Add Stop Sign and Navigation Arrow

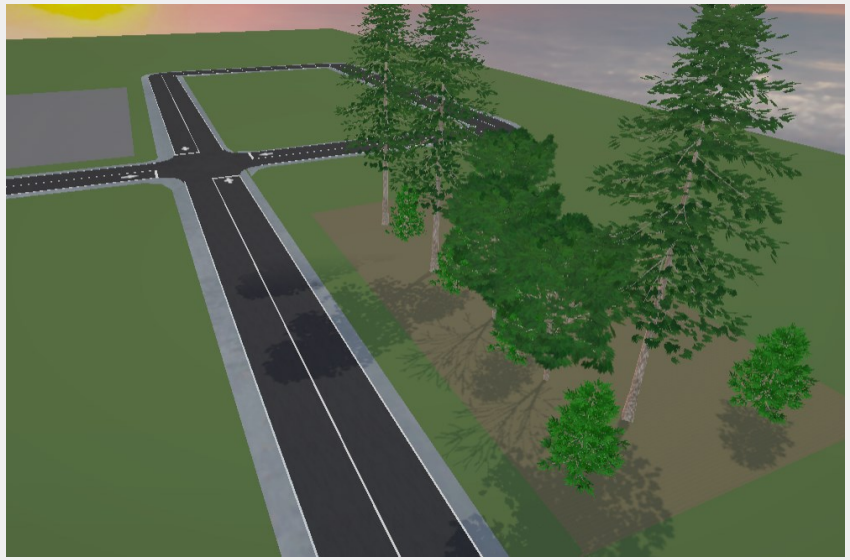
❑Hierarchy Window → Rendering → URP Decal Projector



Step 1: Create Road Network

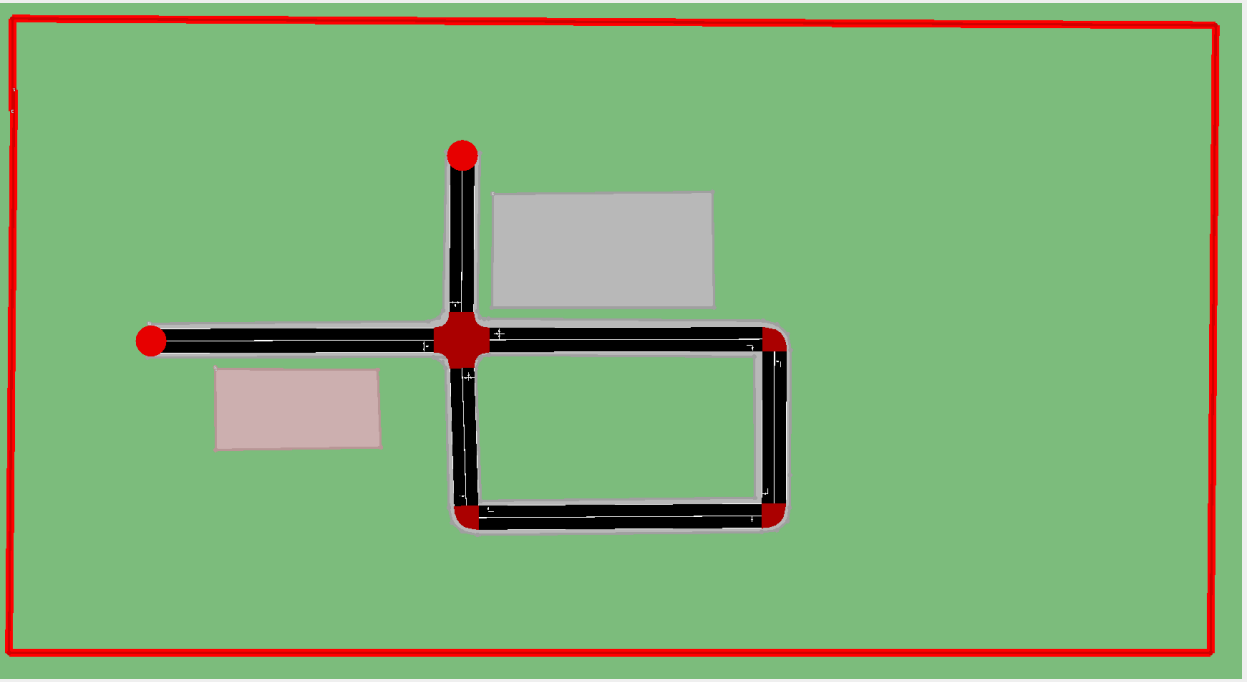
H) Add Trees, Buildings, and Road Signs

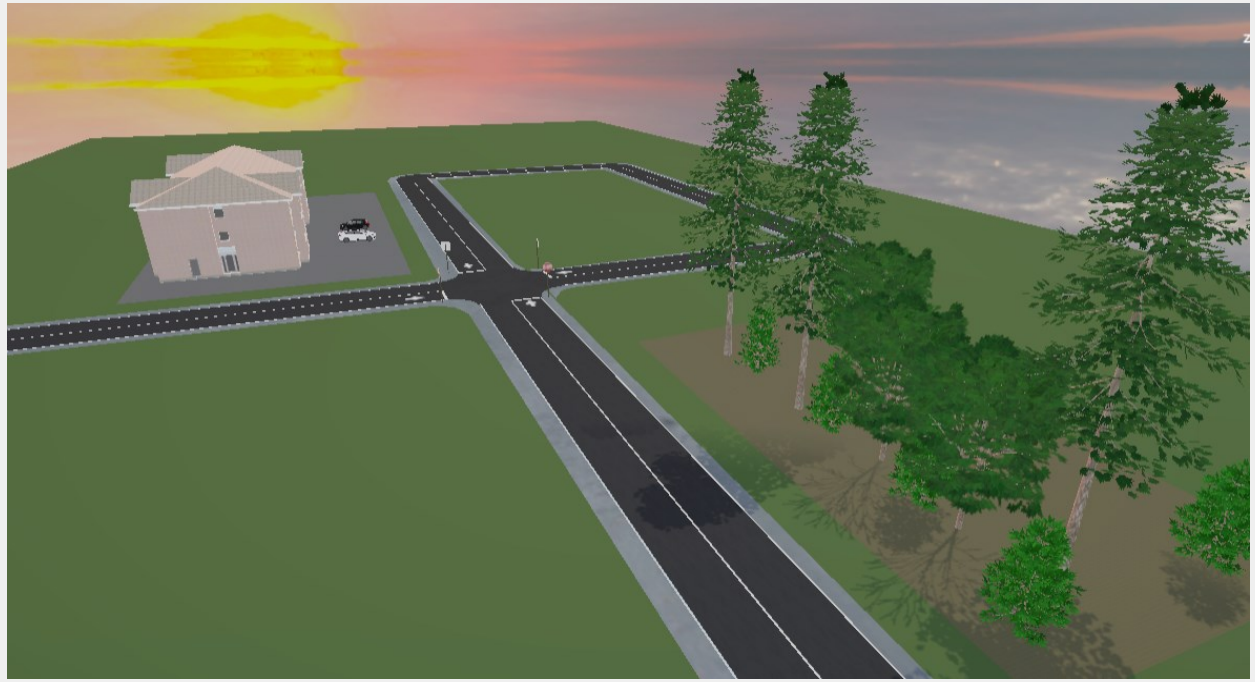
- ❑ Project Window → Resources → Trees → Drag and Drop Some Trees in Wood Area
- ❑ Project Window → Resources → Buildings → Drag and Drop Some Buildings in Residential Area
- ❑ Project Window → Resources → Road Signs → Drag and Drop Some Road Signs in Road Signs Area



Step 1: Create Road Network

❑ Final Output





Step 2: Run Sumo2Unity Integration

2.1. SUMO Steps

A) Add Ego Vehicle:

A.1. Create Vehicle Type for EgoCar

A.2. Add Vehicle To Network

B) Add Traffic Volume

B.1. Create Vehicle Types for Traffic Cars

B.2. Add Vehicles To Network

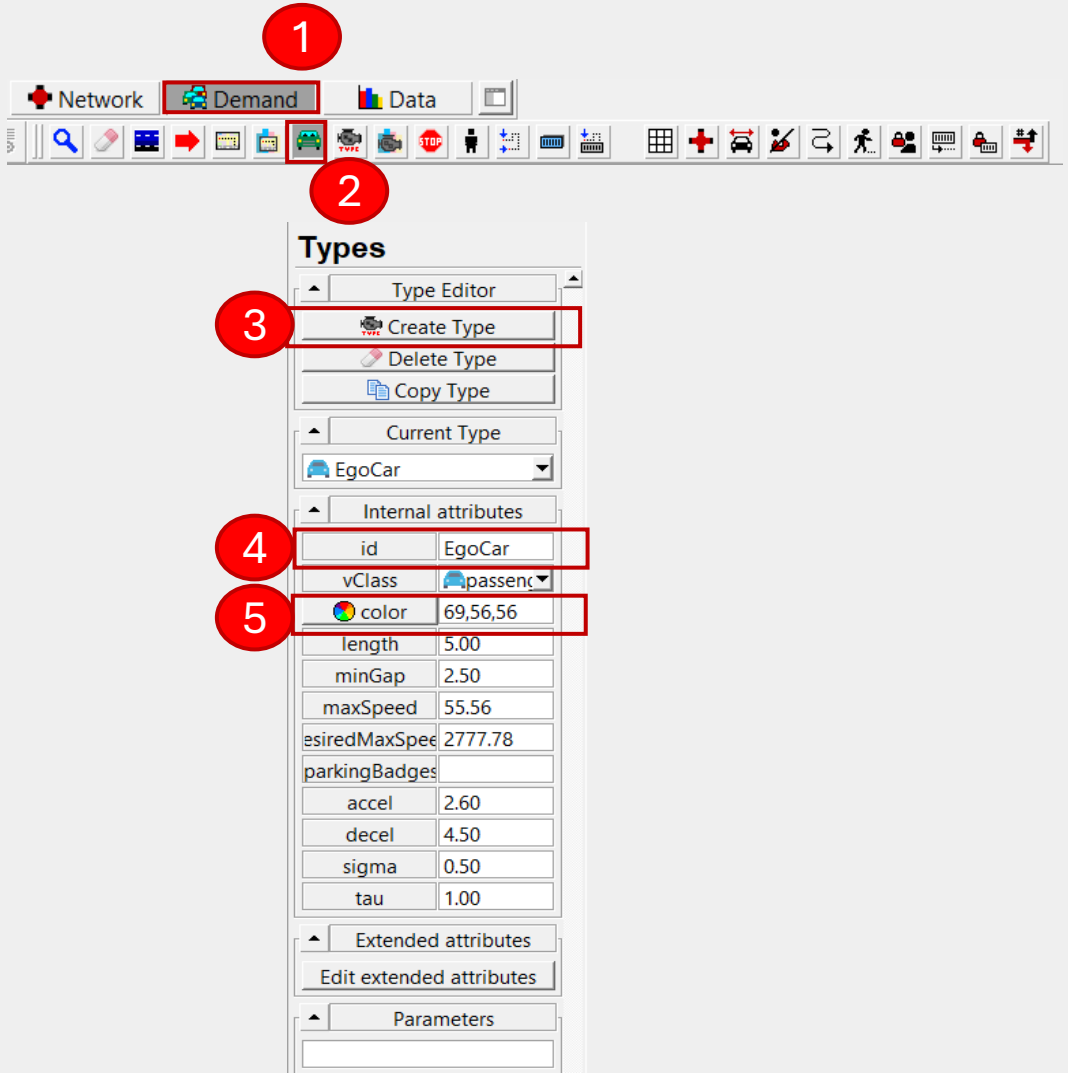
C) Assign Ego Vehicle and Traffic Volume in Unity

D) Prepare and Run Python Code (Sumo2Unity.py)

Step 2: Run Sumo2Unity integration

A) Add Ego Vehicle (A.1. Create Vehicle Type for EgoCar)

- ❑ UI → Demand → Select “Creating Vehicles”
- ❑ Create vehicle types EgoCar (Black) (69,56,56) – Follow Steps in the Image

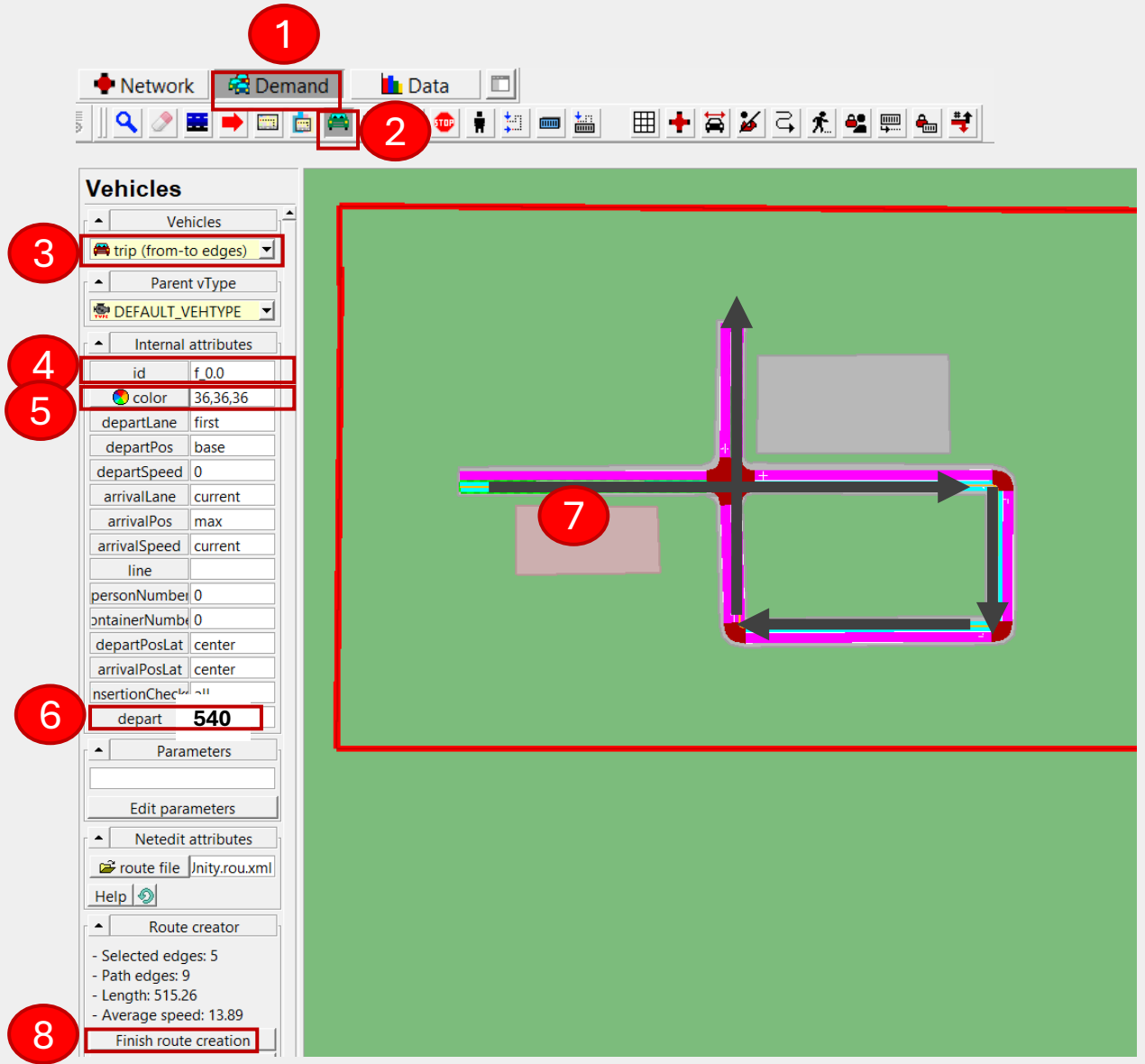


- ❑ File → Demand Element → Save Demand Element → Name it as Sumo2Unity

Step 2: Run Sumo2Unity integration

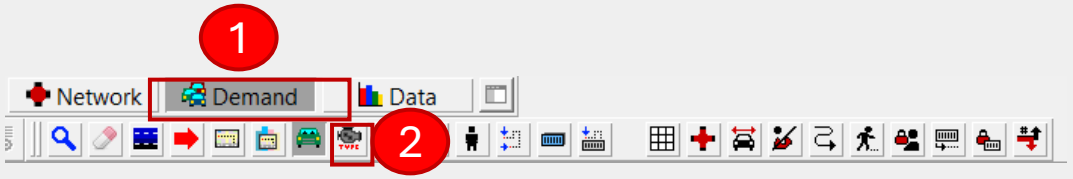
A) Add Ego Vehicle (A.2. Add Vehicle To Network)

- ❑ UI → Demand → Select “Creating Vehicles”
- ❑ Follow steps in Image

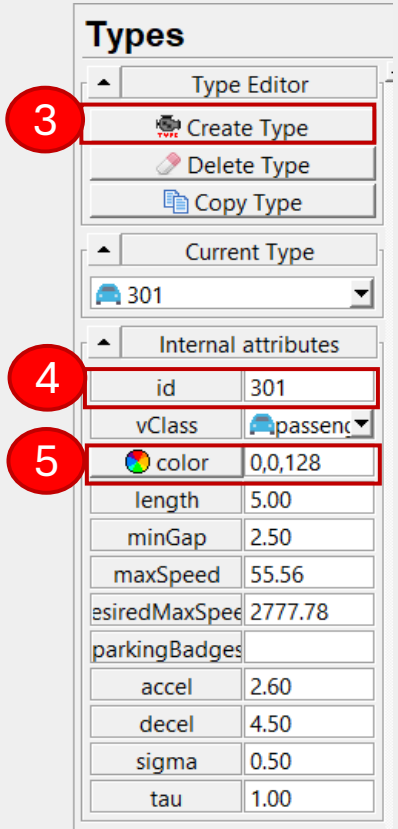


Step 2: Run Sumo2Unity integration

B) Add Traffic Volume (B.1. Create Vehicle Types for Traffic Cars)



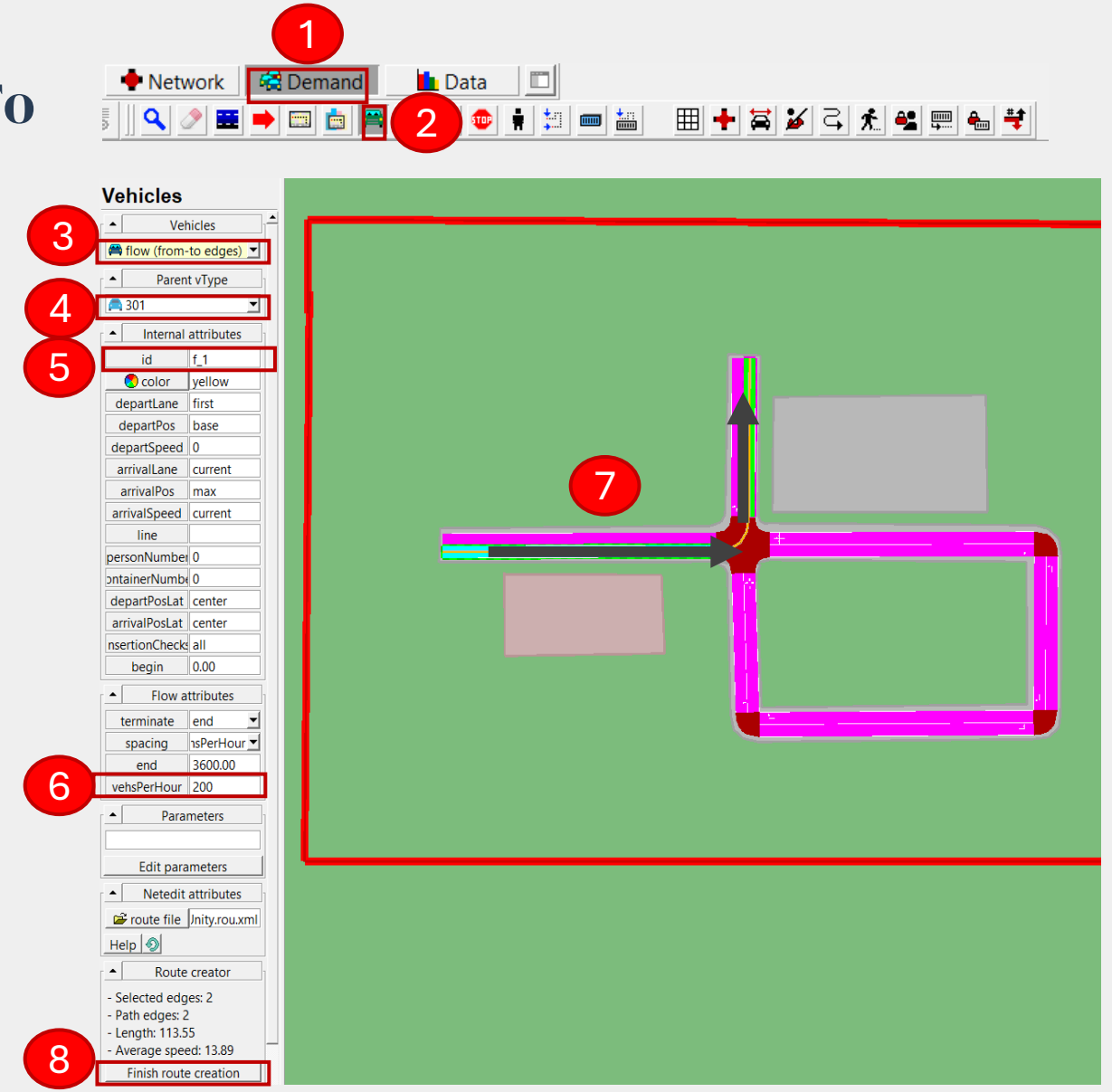
- ❑ UI → Demand → Select “Creating Vehicles”
- ❑ Create vehicle types 301 (blue), 302 (grey), 303(black), 304 (red), 305(gold), 306(white)
- ❑ See 301 (blue as an example)
- ❑ File → Demand Element → Save Demand Element → Name it as Sumo2Unity



Step 2: Run Sumo2Unity integration

B) Add Traffic Volume (B.2. Add Vehicle To Network)

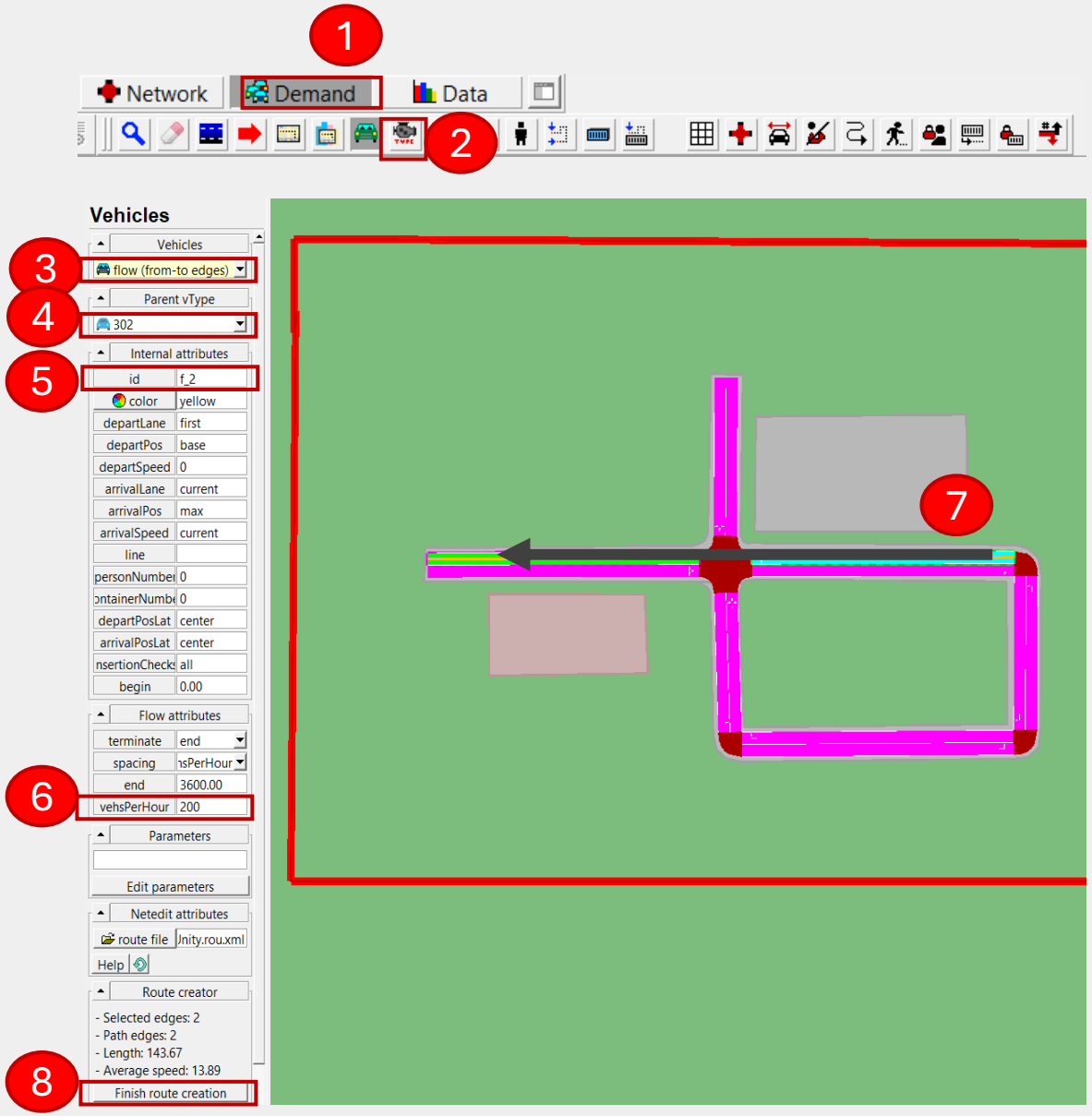
- ❑ UI → Demand → Select “Creating Vehicles”
- ❑ Follow Steps



Step 2: Run Sumo2Unity Integration

B) Add Traffic Volume (B.2. Add Vehicle To Network)

- ❑ Do this for 302



Step 2: Run Sumo2Unity integration

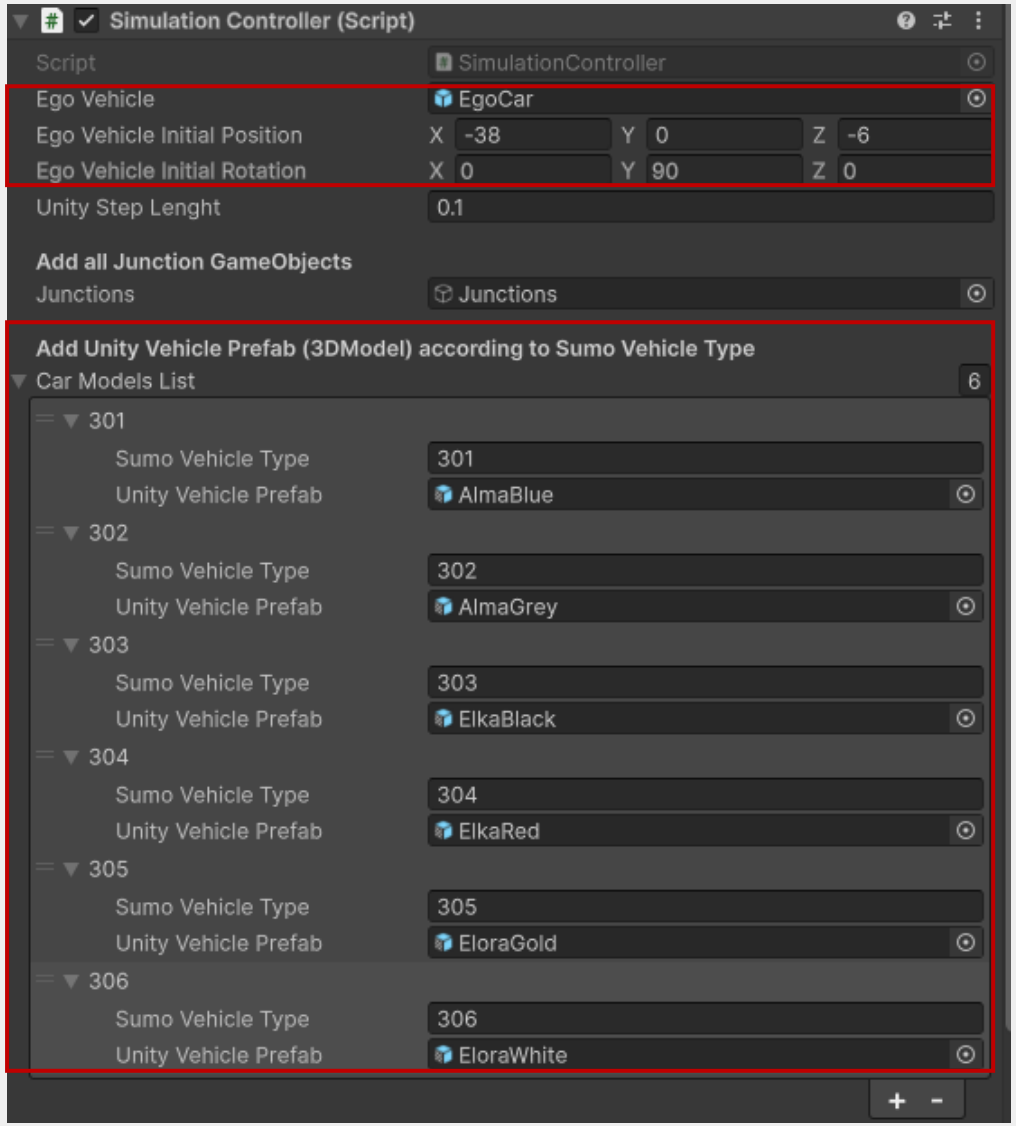
2.1. Unity Steps

C) Assign Ego Vehicle and Traffic Volume in Unity

D) Prepare and Run Python Code (Sumo2Unity.py)

Step 2: Run Sumo2Unity Integration

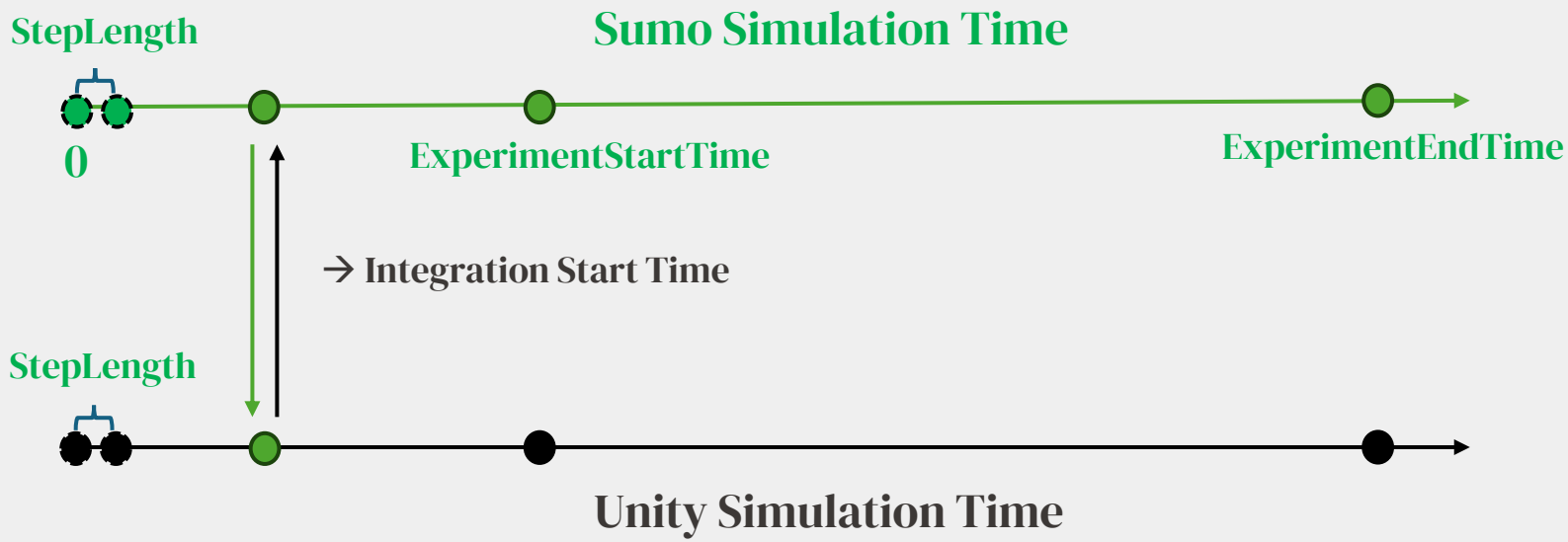
C) Assign Ego Vehicle and Traffic Volume in Unity



Step 2: Run Sumo2Unity integration

D) Prepare and Run Python Code (Sumo2Unity.py)

```
15   #Initial Variables
16   IntegrationStartTime = 540 #
17   ExperimentStartTime = 600 #E
18   ExperimentEndTime = 720 #Exp
19   steplength = 0.1 #Sumo step
```



Step 2: Run Sumo2Unity Integration

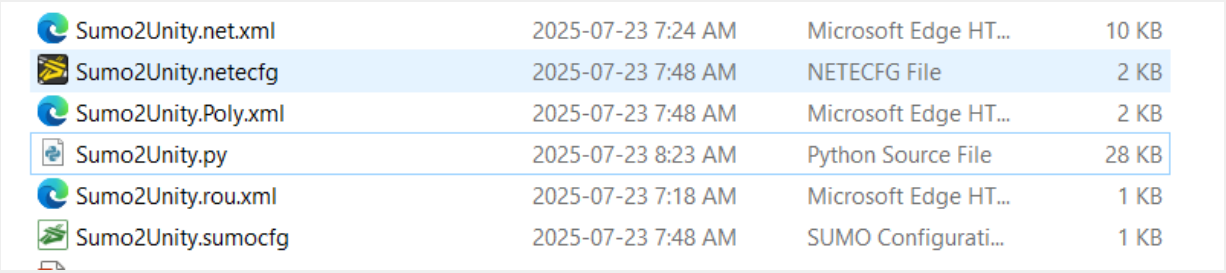
D) Prepare and Run Python Code (Sumo2Unity.py)

- **IntegrationStartTime:** The time when both SUMO and Unity run.
- **ExperimentStartTime:** Normally 10 min (600 Seconds) for the simulation to run before putting ego vehicle into simulation. This is called warm-up period.
- **ExperimentEndTime:** The time you want to put the participant in the simulation, for example, if your experiment is 2 min, then end time is 600 +120 second = 780 seconds
- **Step length:** is data exchange rate between SUMO and Unity. Default value is 0.1 second. Lower value means more exchanging, and higher accuracy, but it takes a lot of resources. This value should be always equal to Unity Step Length in Unity in Simulation Controller inspector.

Step 2: Run Sumo2Unity Integration

D) Prepare and Run Python Code (Sumo2Unity.py)

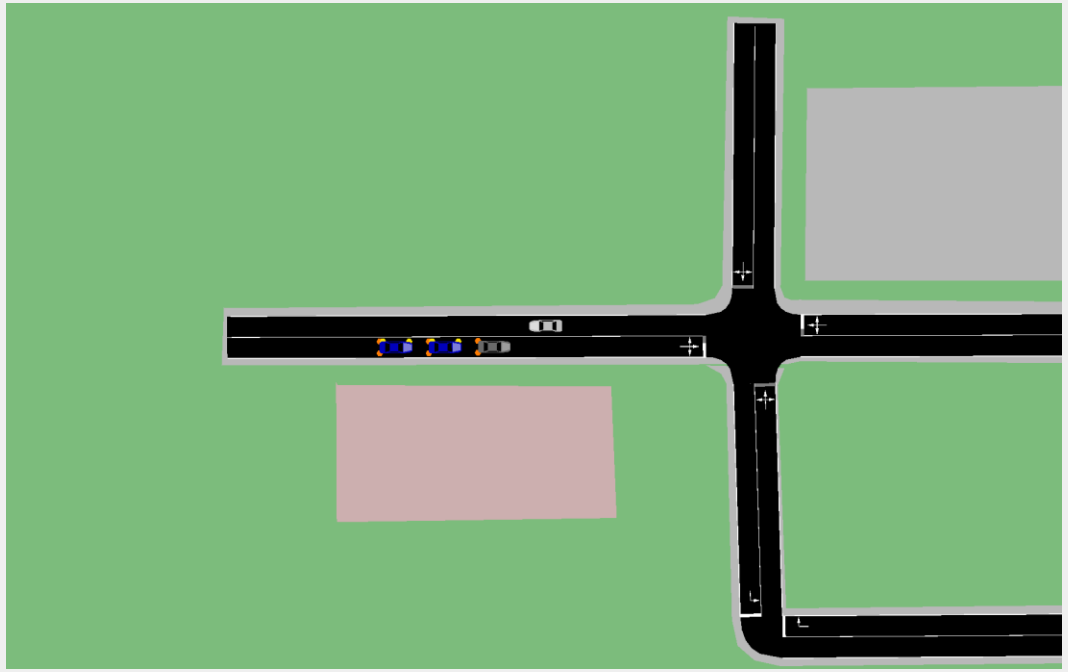
❑ Make sure you have below files including Sumo2Unity.sumofg in the proper folder "SUMO2Unity\Scenario1"



Step 2: Run Sumo2Unity integration

D) Prepare and Run Python Code (Sumo2Unity.py)

- ❑ Run Python
- ❑ When it reaches second 540, ego car is added to SUMO, then Run Unity.



Step 3: Generate Performance Functions

- **RTF(Real time Factor):** Sumo simulation time/Unity simulation time: Always should be 1

- **FPS (Frame Rate per Second):** number of frames (images render in each second): Recommended more than 90

Conduct the experiment multiple times and generate RTF

and FPS before inviting people.

Python Installation and Dependencies

1. Visual Studio Code → Download Python Extension

2. Install Python 3.12 (Recommended)

3. During install check “Add Python to PATH” and choose “Install for all users”

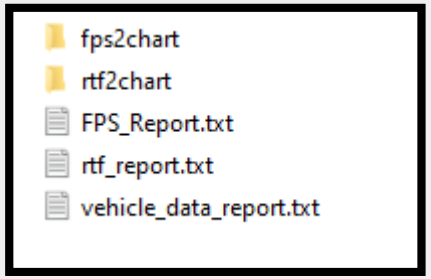
4. Cmd → python –version

5. pip list → To show all Python dependencies

6. pip install matplotlib

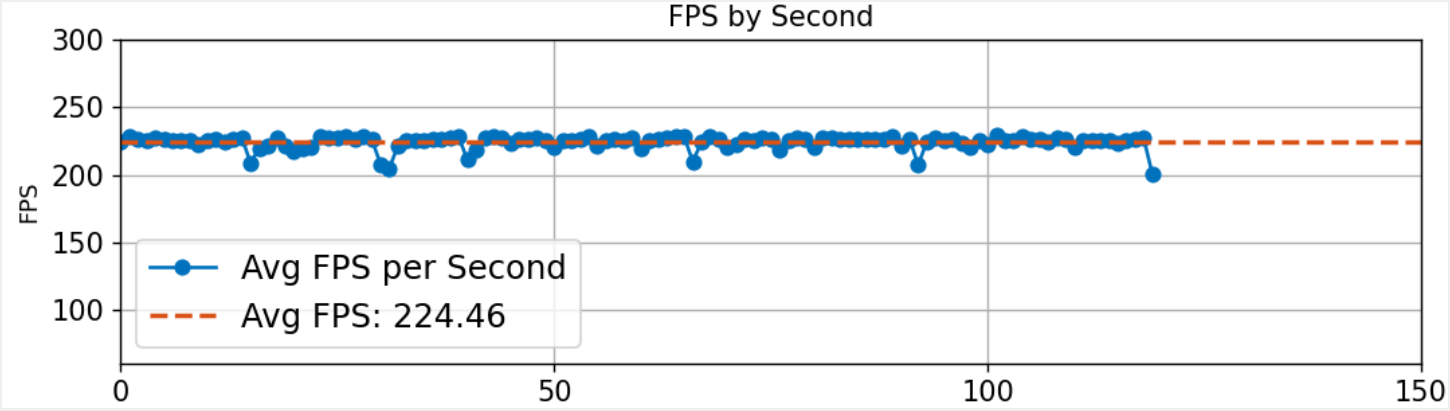
Step 3: Generate Performance Functions

❑ Folder Results →



❑ Copy and Paste FPS_Report.txt → Folder “fps2chart” → Replace with “FPS_Report.txt”

❑ Run fps2chart.py →



Step 3: Generate Performance Functions

❑ Copy and Paste rtf_report.txt → Folder “rtf2chart” → Replace with “rtf_report.txt”

❑ Run rtf2chart.py →