A Visual Overview of the SSTSS-GenSim Tool Workflow

SSTSS-GenSim Tool Demo

The **SSTSS-GenSim Tool** facilitates scenario-based simulation and testing for ADS. SSTSS-GenSim comprises eight modules: (i) Scenario Selection Module, (ii) Scenario Implementation Module, (iii) Scenario Configuration Module, (iv) Simulator and ADS Integration Module, (v) Scenario Execution Module, (vi) Data Collection Module, (vii) Safety Evaluation Module, and (viii) Data Visualization and Report Module. Each module corresponds to a specific stage of the scenario-based safety testing pipeline, collectively forming a unified testing tool for evaluating the safety performance of ADS. In this tutorial, we provide a demo for using the SSTSS-GenSim tool. This demo provides detailed information that refers to Section 4 of the article.

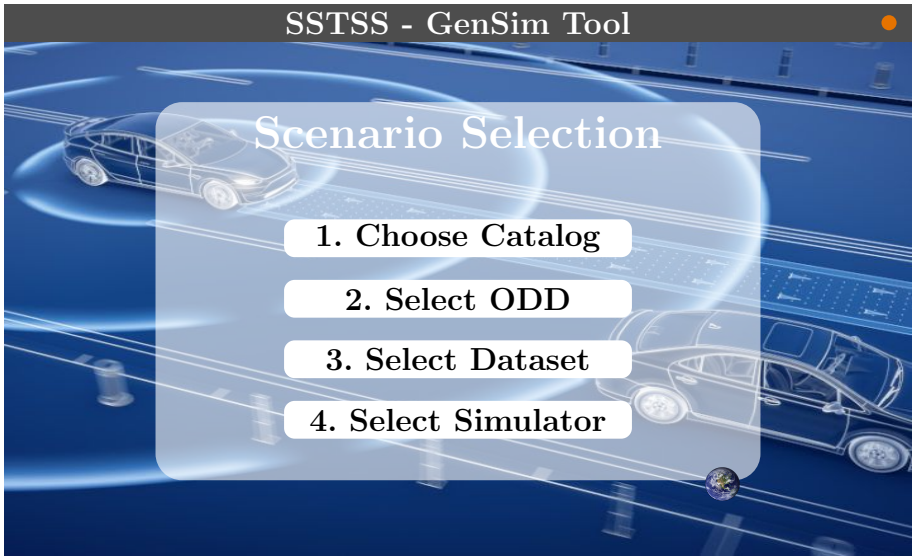


Figure 1: Graphical User Interface for the Scenario Selection Module

1 Scenario Selection Module

For Scenario Selection Module, users provide four inputs.

Step 1: Choose Catalog: Select the appropriate scenario catalog. The current version includes two default catalogs: *Singapore* and *NHTSA*. For demonstration, the Singapore Catalog is selected. Users can also add new scenarios by clicking the *Add Scenario* button and selecting the catalog to which the scenario should be added. Additionally, users have the option to create custom catalogs.

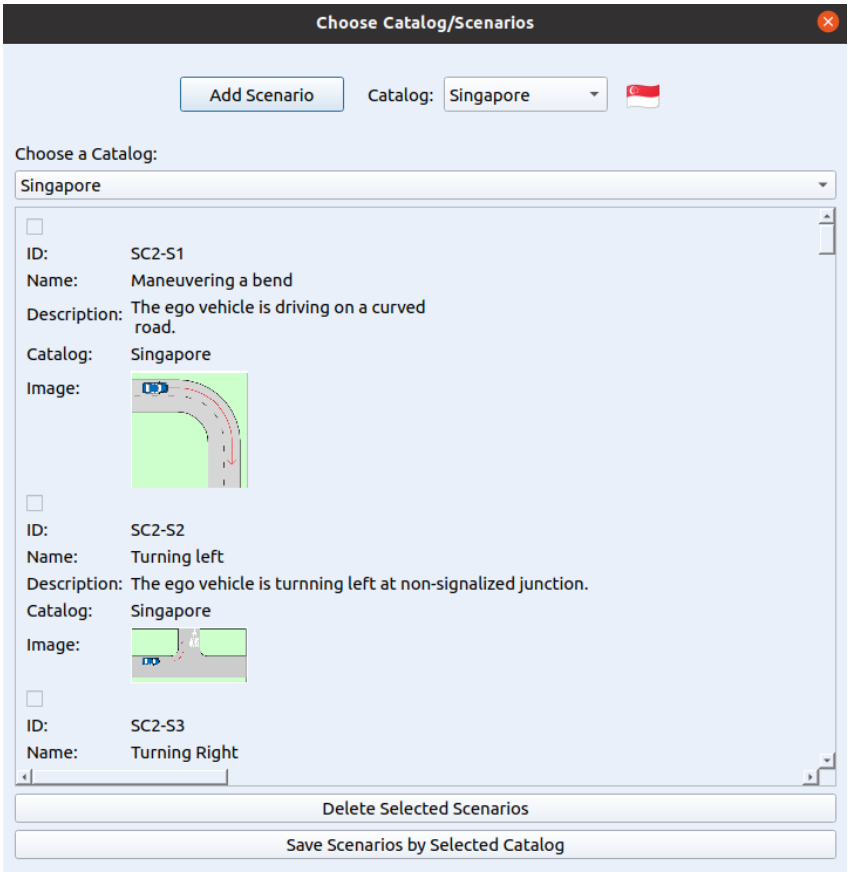


Figure 2: Choose Catalog window

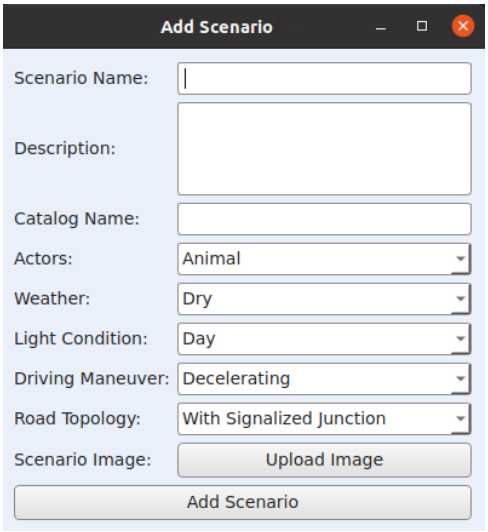
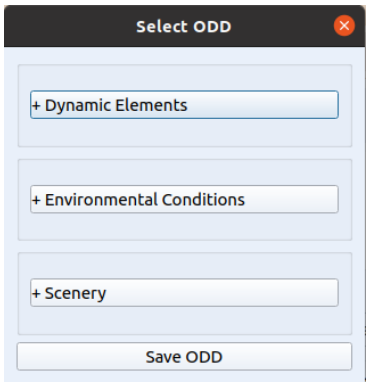
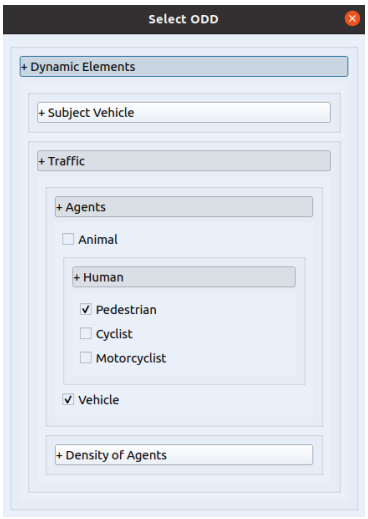


Figure 3: Add Scenario Interface

Step 2: Select ODD: Configure the Operational Design Domain (ODD). The ODD setup comprises three modules — *Dynamic Elements*, *Environment*, and *Scenery*. Each tab can be expanded to specify ODD elements. Each tab in the ODD configuration can be expanded to define specific ODD elements. For the demonstration, we select the ODD parameters based on the operational capabilities of the UT-ADS.

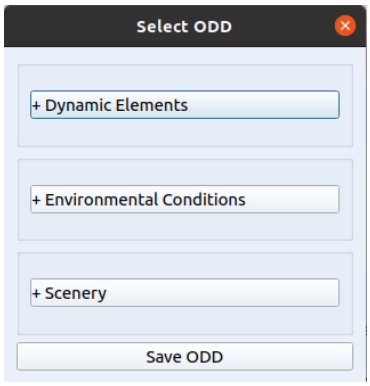


(a) ODD Input

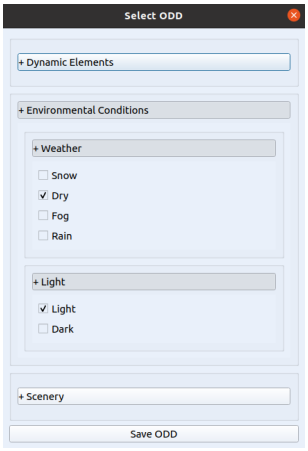


(b) Dynamic Elements

Dynamic Elements: Under **Dynamic Elements**, we selected *pedestrians* and *vehicles*, as the UT-ADS is capable of detecting and interacting with both.



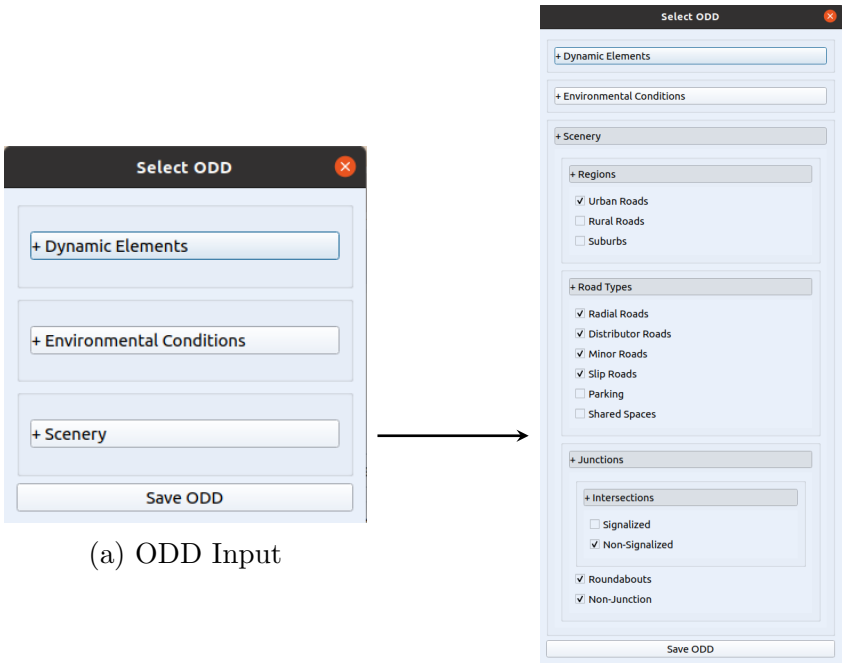
(c) ODD Input



(d) Environmental Conditions

Environmental Conditions: We configured the scenario for *daytime* with *dry weather*.

Figure 4: Process flow for ODD configuration across Dynamic Elements and Environmental Conditions.



(a) ODD Input

(b) Scenery Elements

Scenery Elements: We selected an *urban road environment*. The road type was defined as *radial*, including slip roads, minor, and distributed roads.

Figure 5: Process flow for ODD configuration (continued): Scenery Elements.

Step 3: Select Dataset: The tool allows users to select a dataset.The dataset is required to prioritize and select test scenarios. Currently, two datasets are supported. For demonstration, the US Accident Dataset is selected.

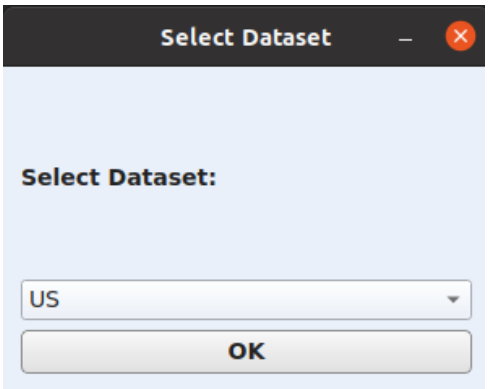


Figure 6: Dataset selection interface

Step 4: Select Simulator: The tool allows users to select a simulator; the current version supports CARLA.

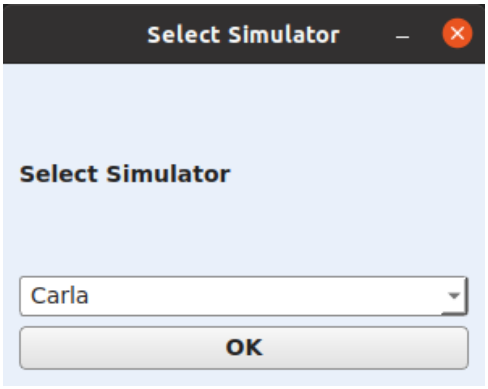


Figure 7: Simulator selection interface

Final Output: Upon giving four inputs, the tool generates a structured list of selected scenarios, including their IDs, names, descriptions, and preview images.

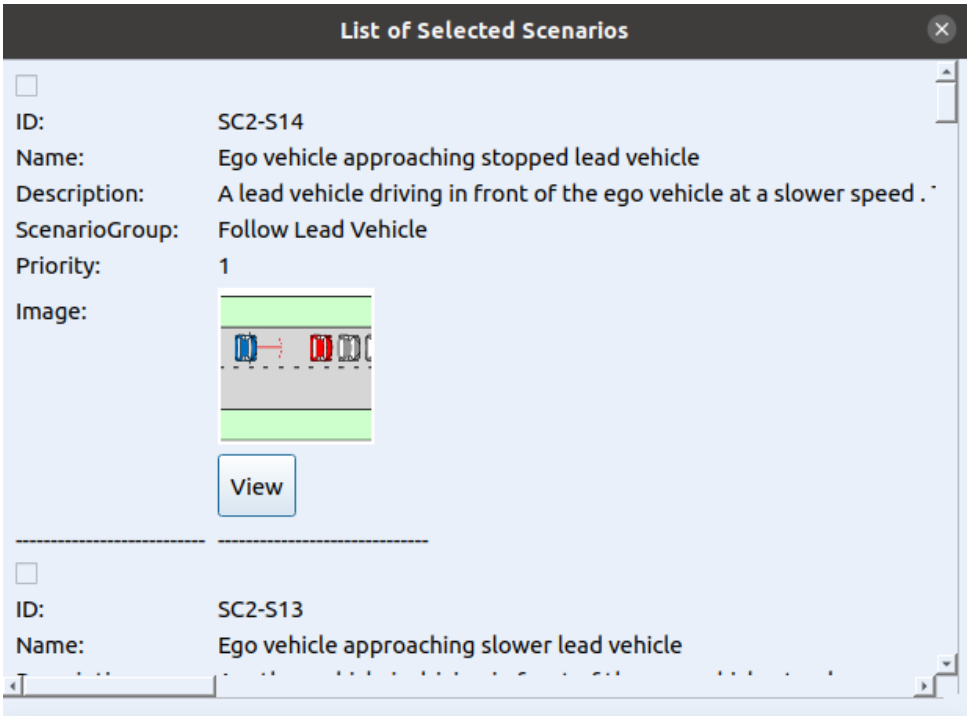


Figure 8: Final list of selected scenarios

2 Scenario Implmentation Module

Once the scenarios are selected, the tool automatically converts the top-prioritized scenario into executable `FollowLeadVehicle.py` files for the simulator. No user interaction is required for this step.

3 Scenario Configuration

Selecting *View* opens a configuration window where users can modify scenario parameters before execution. For demonstration, we configure the parameter shown in the figure below.

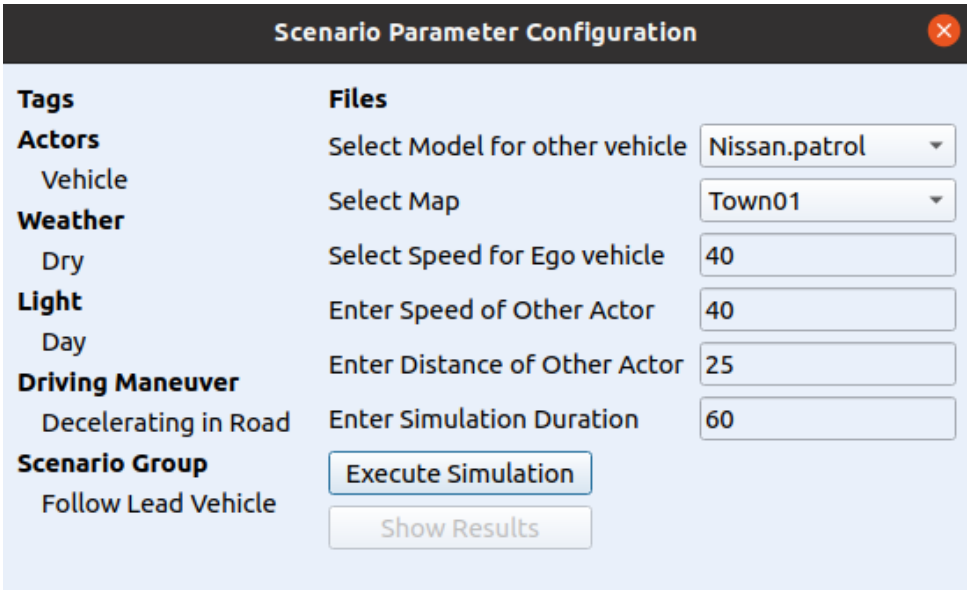


Figure 9: Scenario parameter configuration interface

Once the parameters are configured, the tool generates `FollowLeadVehicle.xml` files for the simulator and updates the `FollowLeadVehicle.py` with user-configured parameters. No user interaction is required for this step.

4 Simulator and ADS Integration Module

Upon pressing *Execute Simulation*, the CARLA starts, then the ADS stack, and then the scenario runner. The environment is set up, and the actors are initialized.

5 Scenario Execution

The driving path is configured for the ADS in green colour, and the scenario starts execution. The system visualizes both the CARLA simulation view and the RViz perception view.

(a) CARLA view (b) RViz view

Figure 10: Scenario execution in CARLA and RViz

Once the simulation is finished,`FollowLeadVehicle.log` and `FollowLeadVehicle.json` are generated. No user interaction is required for this step

6 Data Collection

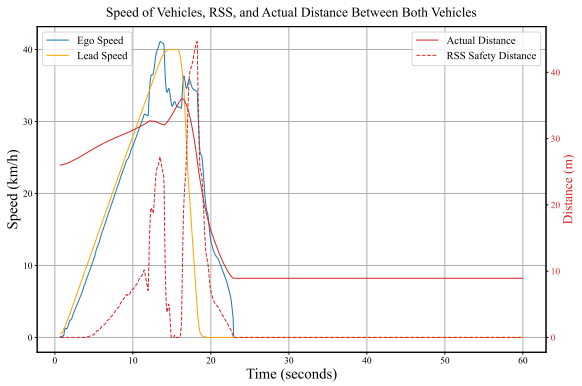
The tools convert `FollowLeadVehicle.log` to `FollowLeadVehicle_data`.csv. No user interaction is required for this step

7 Safety Evaluation for ADS Module

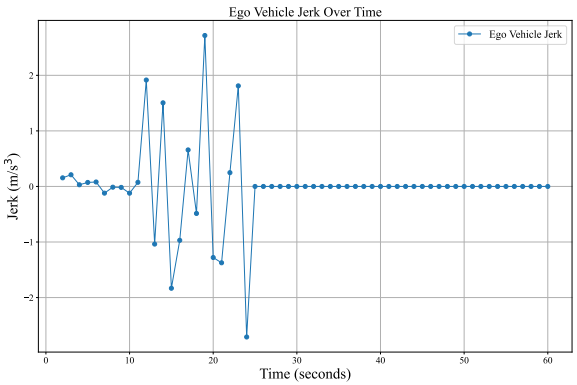
The tools generate `FollowLeadVehicle_metrices`.csv and calculate three safety metrics: (i) Collision Avoidance,(ii) RSS Minimum Safe Distance, and (iii) Jerk. No user interaction is required for this step

8 Data Visualization

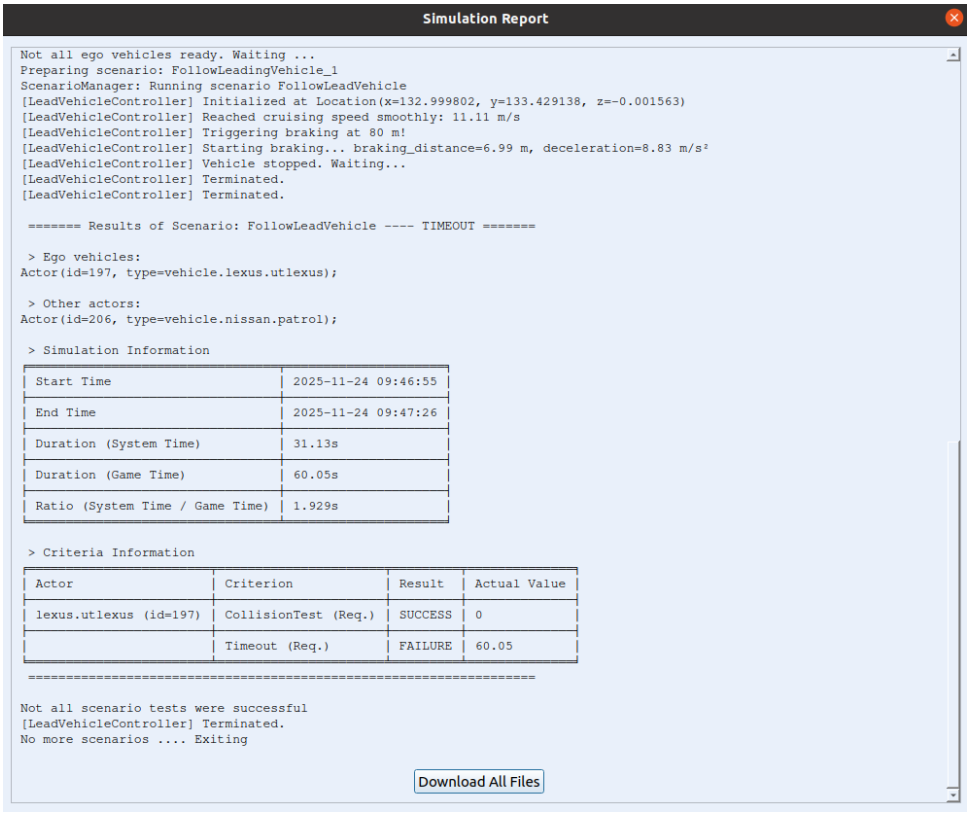
. Selecting *Show Results* displays the graphs for safety metrics and the simulation Report shown below. The user can download all the files in the folder.



(a) RSS Minimum Safe Distance



(b) Jerk



(c) Simulation Report

Figure 11: Visualization of simulation results showing (a) RSS minimum safe distance, (b) jerk, and (c) simulation report.