



# USER MANUAL

Railway Control System

Group 1

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## System Overview

The railway control system is a simulator with an automated control algorithm. It accepts a schedule of all trains on the one-direction railway with five stations. During the simulation, the trains are controlled by the automated control algorithm, which avoids the collision and minimizes the delay for each train as far as possible. The user is able to input some commands manually to control the trains during the simulation. After the simulation, the system can output a real schedule for each train.

## Environment Setting

The stations' layout settings are shown in the table below:

Station Name	Location	Standby Rail Number
Start	0	-
S1	4800	2
S2	7200	1
S3	10200	3
S4	12000	1
S5	19200	3
Terminal	21600	-

The time for switching rail is 1s.

The trains' settings are shown in the table below:

Train Type	Cruising Speed ( $v_1$ )	Maximum Speed ( $v_2$ )	Max Acceleration (0 to $v_1$ )	Max Acceleration ( $v_1$ to $v_2$ )	Max Deceleration ( $v_1$ to 0)	Max Acceleration ( $v_2$ to $v_1$ )	Max Delay
G	300	350	60	25	-100	-25	10
D	200	250	50	25	-100	-25	15
K	100	120	20	10	-50	-20	30

## Standard Input Format

Since the system needs to accept a input schedule, we make a standard input format for users. Here is an example input schedule:

Train Name (Start Time)	S1 (in/out)	S1 (in/out)	S1 (in/out)	S1 (in/out)	S1 (in/out)	Terminal (in)
K1 (0)	55/60	90/100	-	160/180	270/290	320
D1 (30)	-	70/80	100/110	-	170/180	210
G1 (40)	-	-	75/80	-	105/110	120

The symbol '-' means that the train doesn't stop at this station.

The standard input format for the schedule above is:

K1 0 55 60 90 100 - - 160 180 270 290 320

D1 30 - - 70 80 100 110 - - 170 180 210

G1 40 - - - 75 80 - - 105 110 120

The standard input should be written into a .txt file, such as 'test.txt'. The system can be started by:

```
>> System("test.txt")
```

The system architecture is shown below:



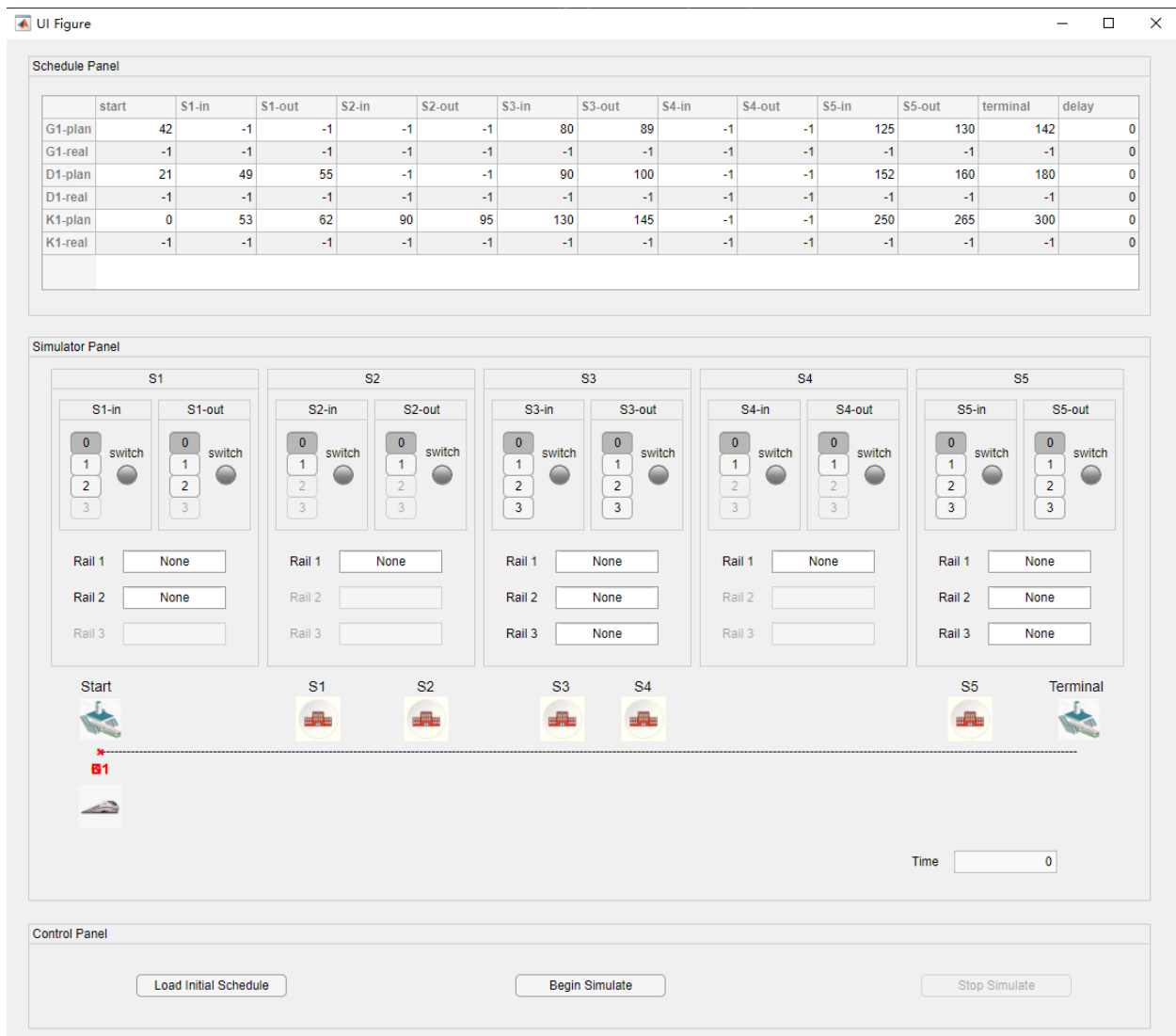
## User Interaction: Display Panel

The screenshot shows a window titled "UI Figure" with a standard macOS-style title bar (minimize, maximize, close buttons). The window is divided into three main horizontal panels:

- Schedule Panel:** Located at the top, it contains a table with 13 columns: "start", "S1-in", "S1-out", "S2-in", "S2-out", "S3-in", "S3-out", "S4-in", "S4-out", "S5-in", "S5-out", "terminal", and "delay". The table body is currently empty.
- Simulator Panel:** The middle section, containing five identical sub-panels labeled S1 through S5. Each sub-panel has:
  - Two columns of buttons: "S1-in" and "S1-out" (for S1), "S2-in" and "S2-out" (for S2), etc. Each column has four buttons labeled 0, 1, 2, and 3. A "switch" label is positioned between the columns.
  - Three input fields labeled "Rail 1", "Rail 2", and "Rail 3".
- Control Panel:** The bottom section, containing three buttons: "Load Initial Schedule", "Begin Simulate", and "Stop Simulate".

At the bottom right of the Simulator Panel, there is a "Time" label followed by an input field containing the value "0".

After booting the system, the user will be shown with a blank Display Panel. It contains Schedule Panel, Simulator Panel and Control Panel. The user should first press the 'Load Initial Schedule' button in the control panel to prepare for simulation.



After pressing 'Load Initial Schedule' button, the display panel shows all information for simulation.

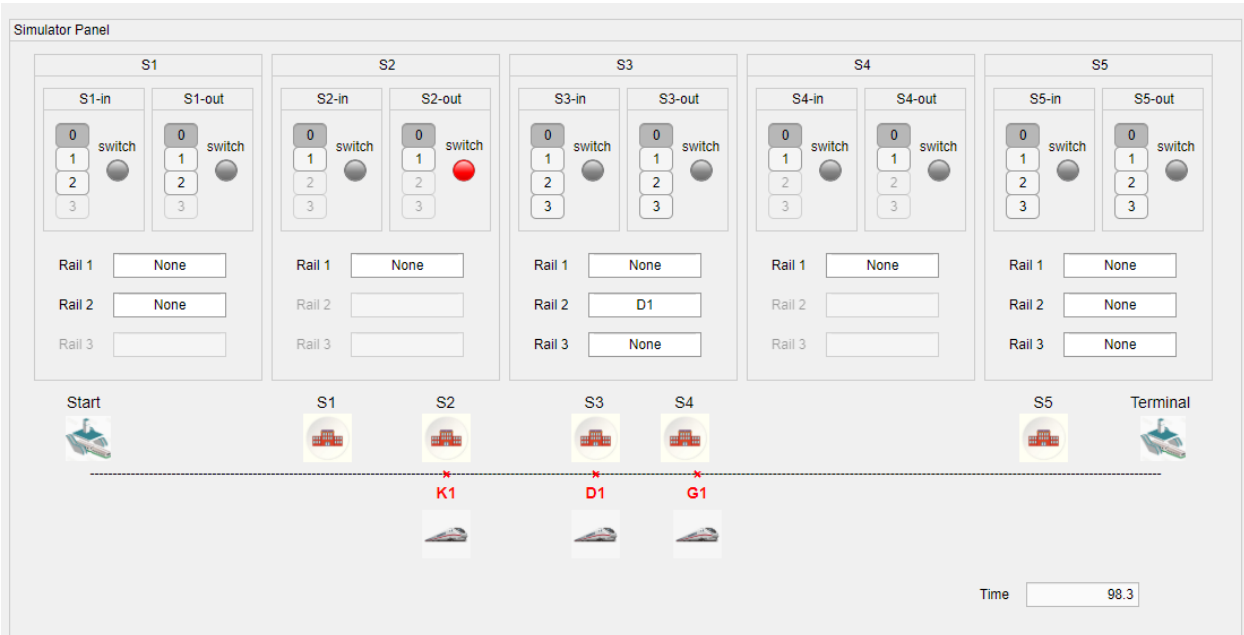
### Schedule Panel

The Schedule Panel shows the input schedule and real schedule for each train. '-1' means that the train doesn't stop at this station or the time is undefined. The real schedule and the delay information are updated in real time during the simulation. Here is an example for Schedule Panel in simulation:

Schedule Panel													
	start	S1-in	S1-out	S2-in	S2-out	S3-in	S3-out	S4-in	S4-out	S5-in	S5-out	terminal	delay
G1-plan	42.0000	-1.0000	-1.0000	-1.0000	-1.0000	80.0000	89.0000	-1.0000	-1.0000	125.0000	130.0000	142.0000	0
G1-real	42.0000	-1.0000	-1.0000	-1.0000	-1.0000	80.0000	89.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	0
D1-plan	21.0000	49.0000	55.0000	-1.0000	-1.0000	90.0000	100.0000	-1.0000	-1.0000	152.0000	160.0000	180.0000	0
D1-real	21.0000	57.2000	64.9000	-1.0000	-1.0000	90.5000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	8.7000
K1-plan	0	53.0000	62.0000	90.0000	95.0000	130.0000	145.0000	-1.0000	-1.0000	250.0000	265.0000	300.0000	0
K1-real	0	51.5000	68.2000	92.6000	97.6000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	2.6000

### Simulator Panel

The Simulator Panel is the core panel of the system, displaying the running process of the trains and the station information. Here is an example for Simulator Panel in simulation:



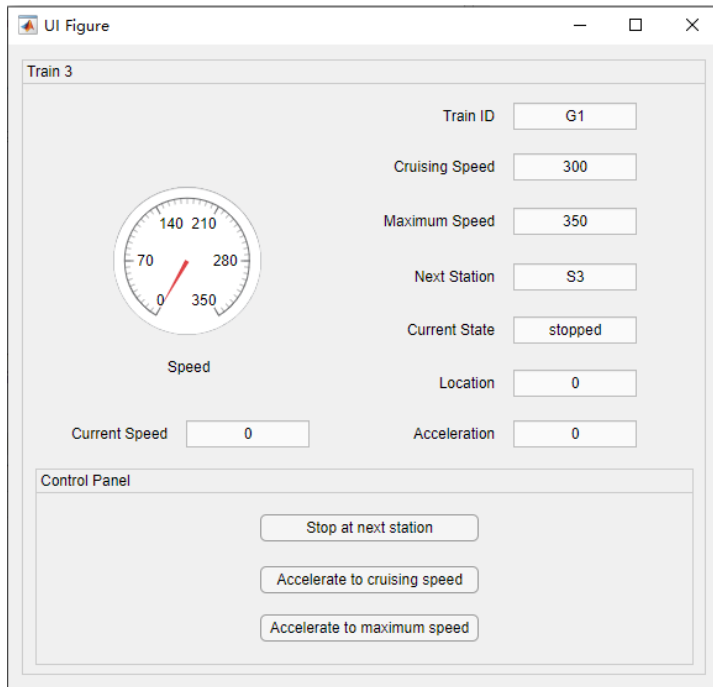
- The station information is shown on top side of panel. The button with number '0', '1', '2', '3' represents the rail at the entry and exit of each station. '0' represents the main rail. Users can press the number button to switch the rail.
- The lamp labeled with 'switch' is red when a rail is switching. When the lamp is on, the new switching rail request will be rejected. In the example above, the exit rail of  $S_2$  is switching back to rail 0.
- The text fields under the rail buttons show the stopping train on each rail. In the example above, train  $D_1$  is stopping on the rail 2 of  $S_3$ .
- The railway and moving trains are shown below the stations. In the example above, the train  $K_1$ ,  $D_1$  and  $G_1$  are moving along the railway.
- The time of the simulator is shown at the bottom right corner.

## Control Panel

The Control Panel contains 3 buttons for user.

- 'Load Initial Schedule' button is pressed after booting the system. The schedule and layout are shown on the panel.
- 'Begin Simulate' button is pressed to start the simulation. It will start the timer of the system.
- 'Stop Simulate' button is pressed to stop the simulation. It will stop the timer of the system.

## User Interaction: Train Panel

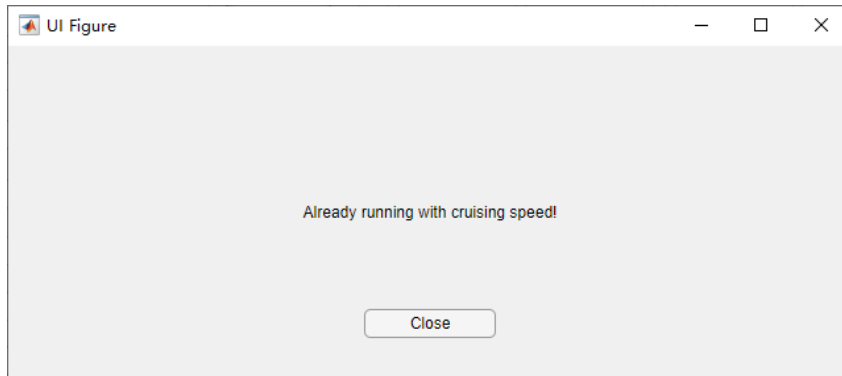


Each train has its own Train Panel, showing its information during the simulation. The user can send some commands to the train as well.

- 'Train ID' shows the name of the train, 'Cruising Speed' and 'Maximum Speed' show two standard speeds of the train, 'Next Station' shows the next destination of the train, 'Current State' shows the running state, 'Location' shows the train's position, 'Acceleration' shows the train's acceleration value, 'Current Speed' and the dashboard above show the speed of the train.
- 'Stop at next station' button is pressed if user wants the train to stop at next station. In the example above, the train will pass  $S_1$  and stop at  $S_3$ . After pressing the button, it will stop at  $S_1$ .
- 'Accelerate to cruising speed' button is pressed if user wants the train to accelerate to cruising speed. The train will execute the command when the environment is available, otherwise it will reject it and send an error message.
- 'Accelerate to maximum speed' button is pressed if the user wants the train to accelerate to maximum speed. The train will execute the command when the environment is available, otherwise it will reject it and send an error message.



## User Interaction: Message



The Message window pops out when user input is invalid or other unexpected situation occurs.

- When the Message pops out, the timer of the system is stopped so the simulation is stopped as well.
- When the user press 'Close' button, the Message will be closed and the simulation will continue.