

Smart Freeway – Modelling and Optimization of Traffic Flows

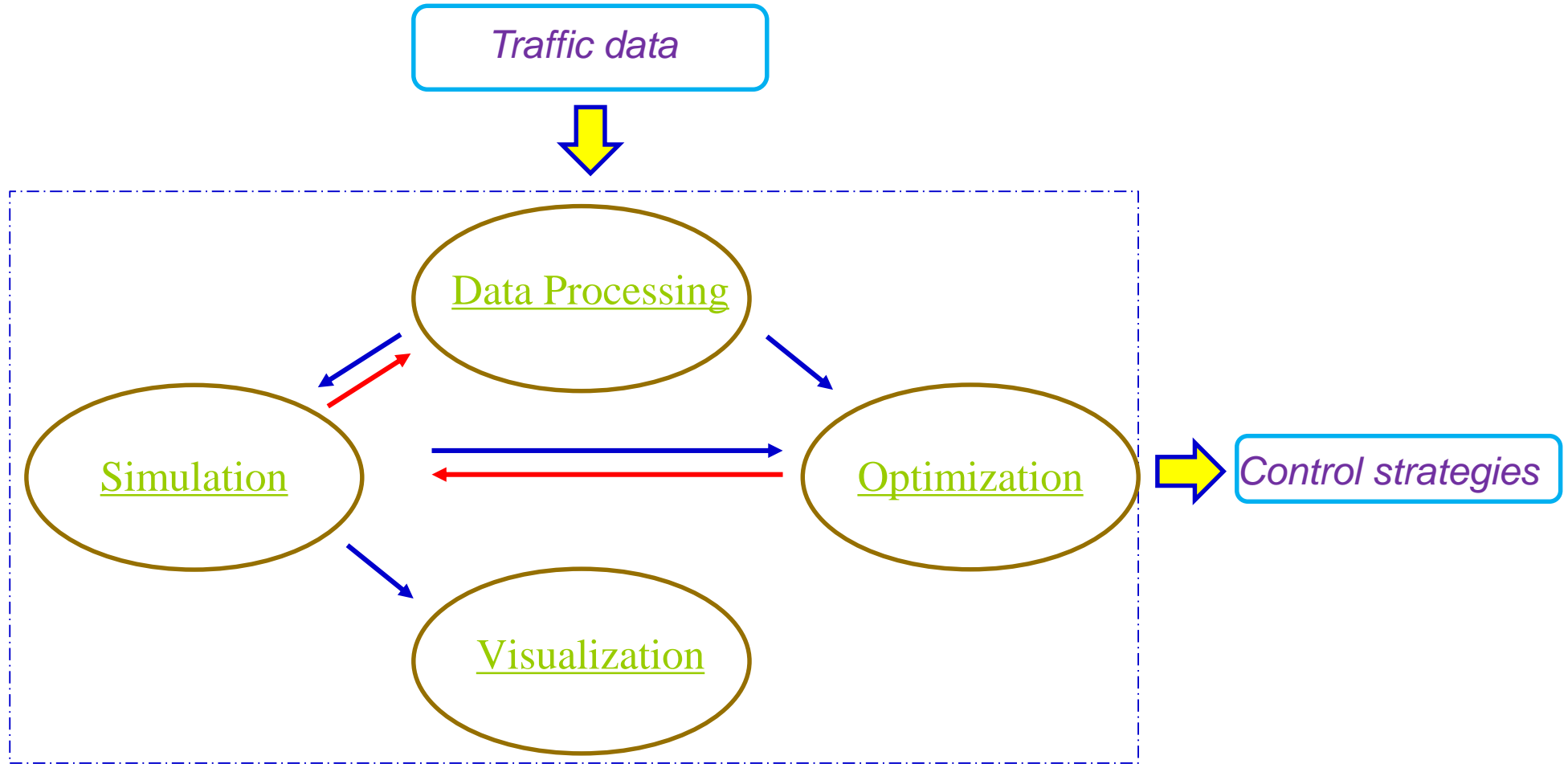
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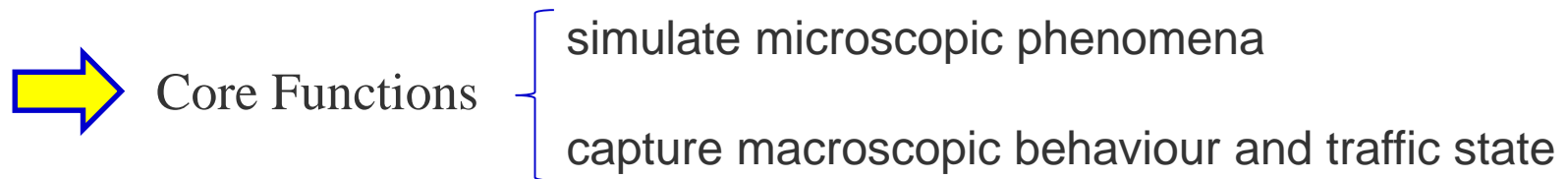
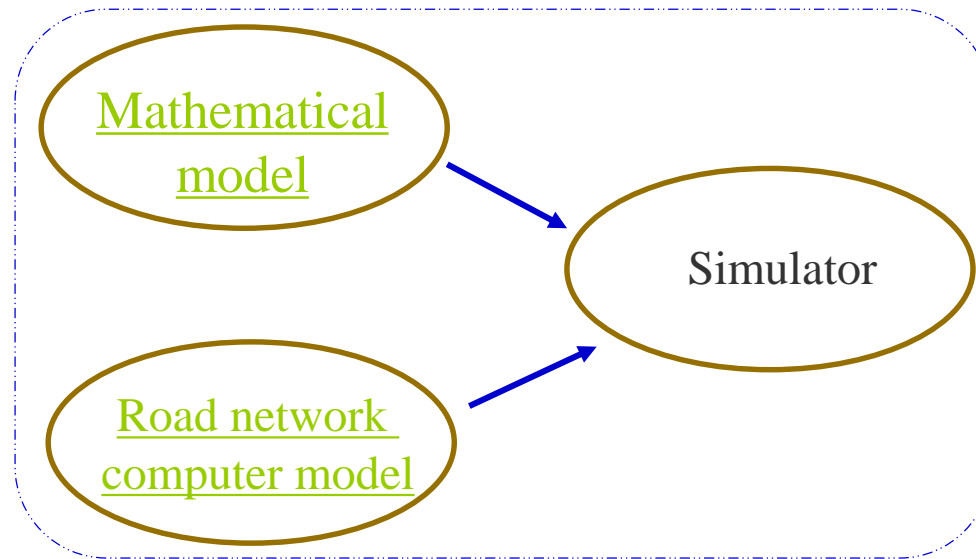
Content

- Review of traffic flow models and optimization strategies
- A Computational framework for smart freeway modelling and optimization
- Simulation module
- Optimization module
- Data processing module
- Visualization module

A computational framework for smart freeway modelling and optimization



Simulation Module



Simulation Module - *Mathematical Model*

■ Generalized car following model

$$\frac{dv_i}{dt} = f(v_i, \Delta x_i, \Delta v_i, \alpha_1 \dots), \quad i=1,2,\dots$$

- *optimal velocity model*
- *full velocity difference model*
- *full velocity/acceleration difference*
- *intelligent driver model*
- ...

■ Generalized macroscopic model

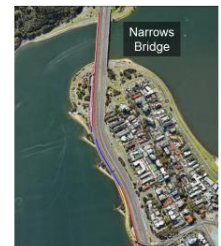
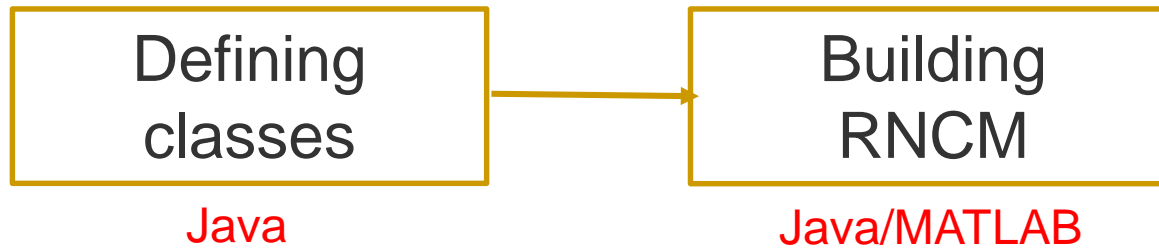
$$\frac{dv}{dt} + \frac{\partial f}{\partial x} = g(t, x)$$

$$\frac{dv}{dt} + v \frac{\partial v}{\partial x} = a \left(\rho, v, \frac{\partial \rho}{\partial x}, \frac{\partial v}{\partial x}, v_e, \beta_1, \dots \right)$$

- *LWR model (the 1st equation with $f = \rho v_e(r)$)*
- *density gradient models (eg Payne)*
- *speed gradient models*
- *model with varying road conditions*
- ...

Simulation Module – *Road Network Computer Model (RNCM)*

Create the Kwinana Fwy road network model: **From Farrington to Narrows Bridge**



Optimization Module

➤ **Multiple objective function** $J(\alpha, u) = \beta_1 J_1(\alpha, u) + \dots + \beta_n J_n(\alpha, u)$

where $\alpha = (\alpha_1, \alpha_2, \dots, \alpha_m)$: system parameters

$u = (u_1, u_2, \dots, u_l)$: control variables/parameters

β_i : weighting coefficient

J_i : objective i

➤ Investigation problems

- Optimal strategy for maximum flow on freeways with a bottleneck
- Dynamic speed control for maximum flow on freeways under non-recurrent events
 - ┌ Closure of 1 lane
 - └ Reduction of road capacity
- Optimal strategy for maximum flow on freeways by real time traffic information
- Optimal strategy for maximum flow on freeways by historical data

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Data Processing Module

Flow – density
analysis



FD - Road capacities

Real time traffic data
Processing



Real time traffic state

Parameter calibration

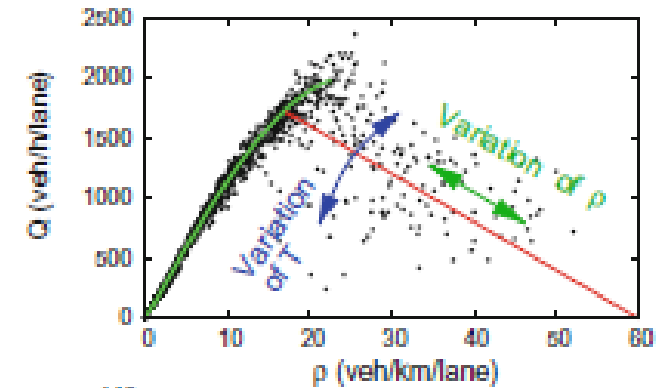


Model parameters

Model validation

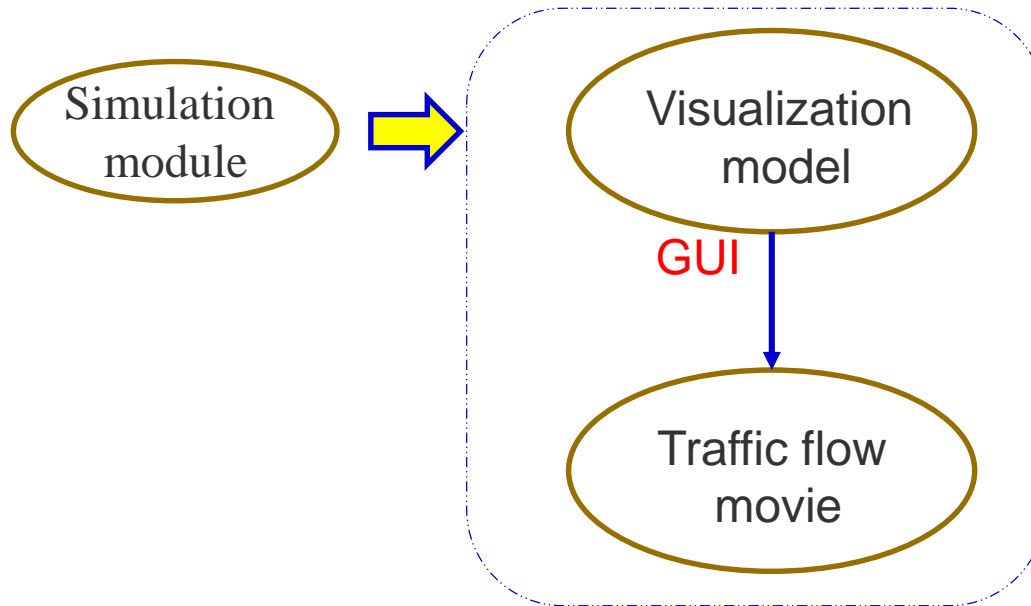


Model reliability

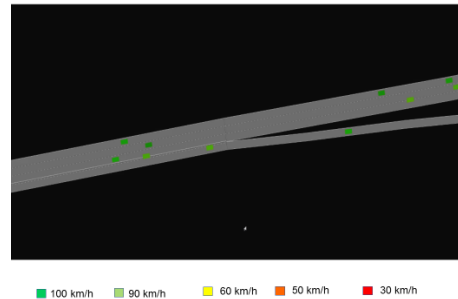


(source: M. Treiber et al)

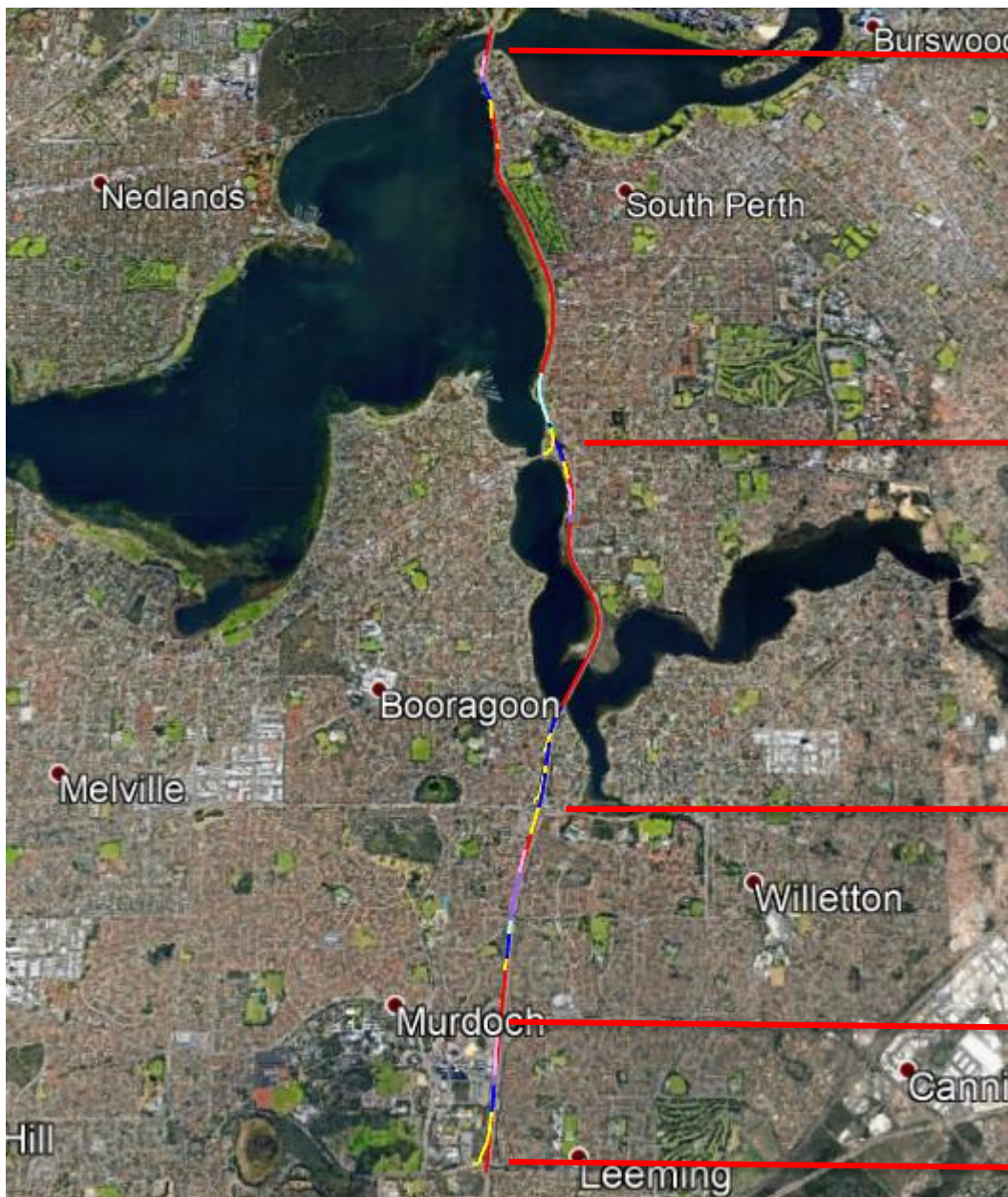
Visualization Module



movie



THANK YOU



Narrows Bridge

Canning Bridge

Bull Creek

Murdoch

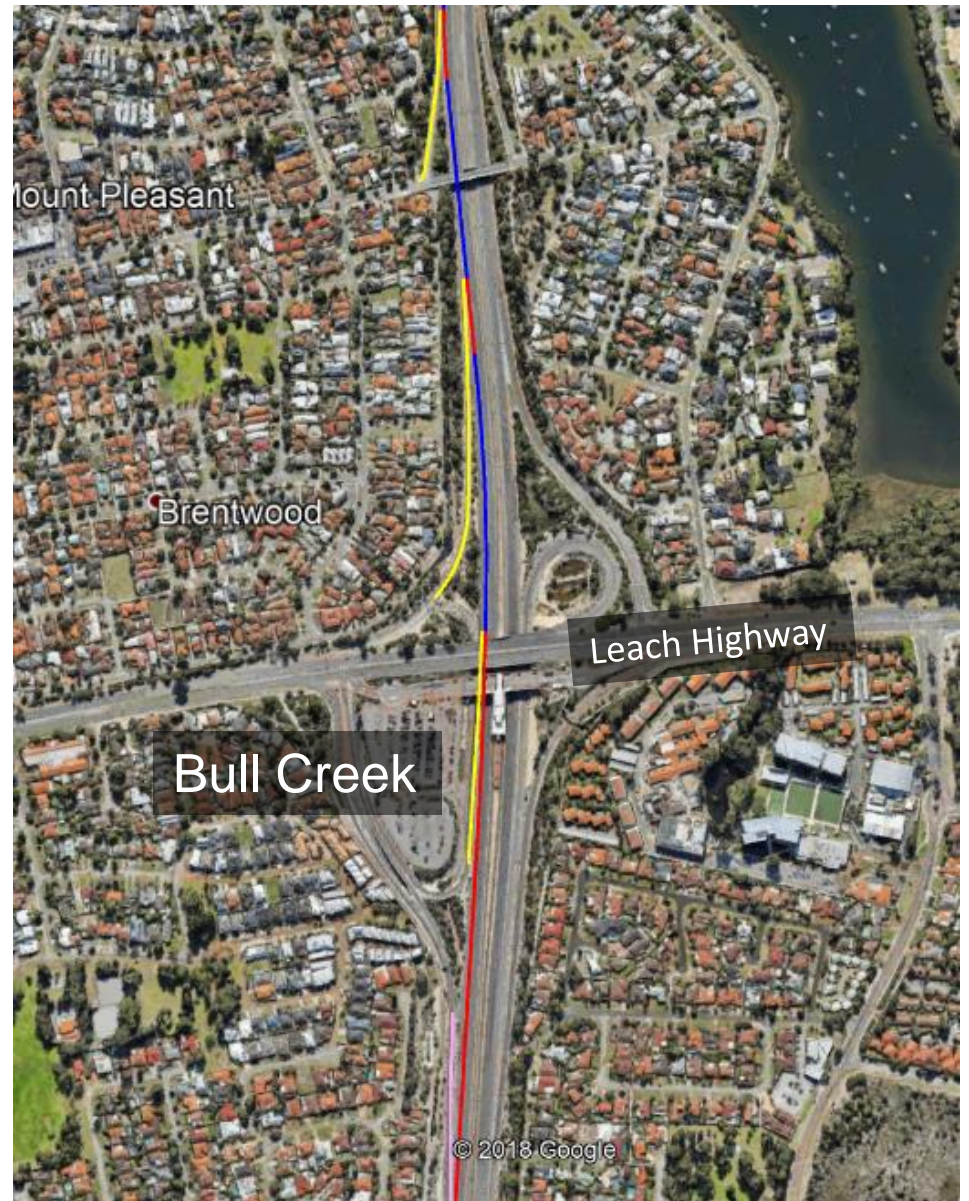
Farrington Road



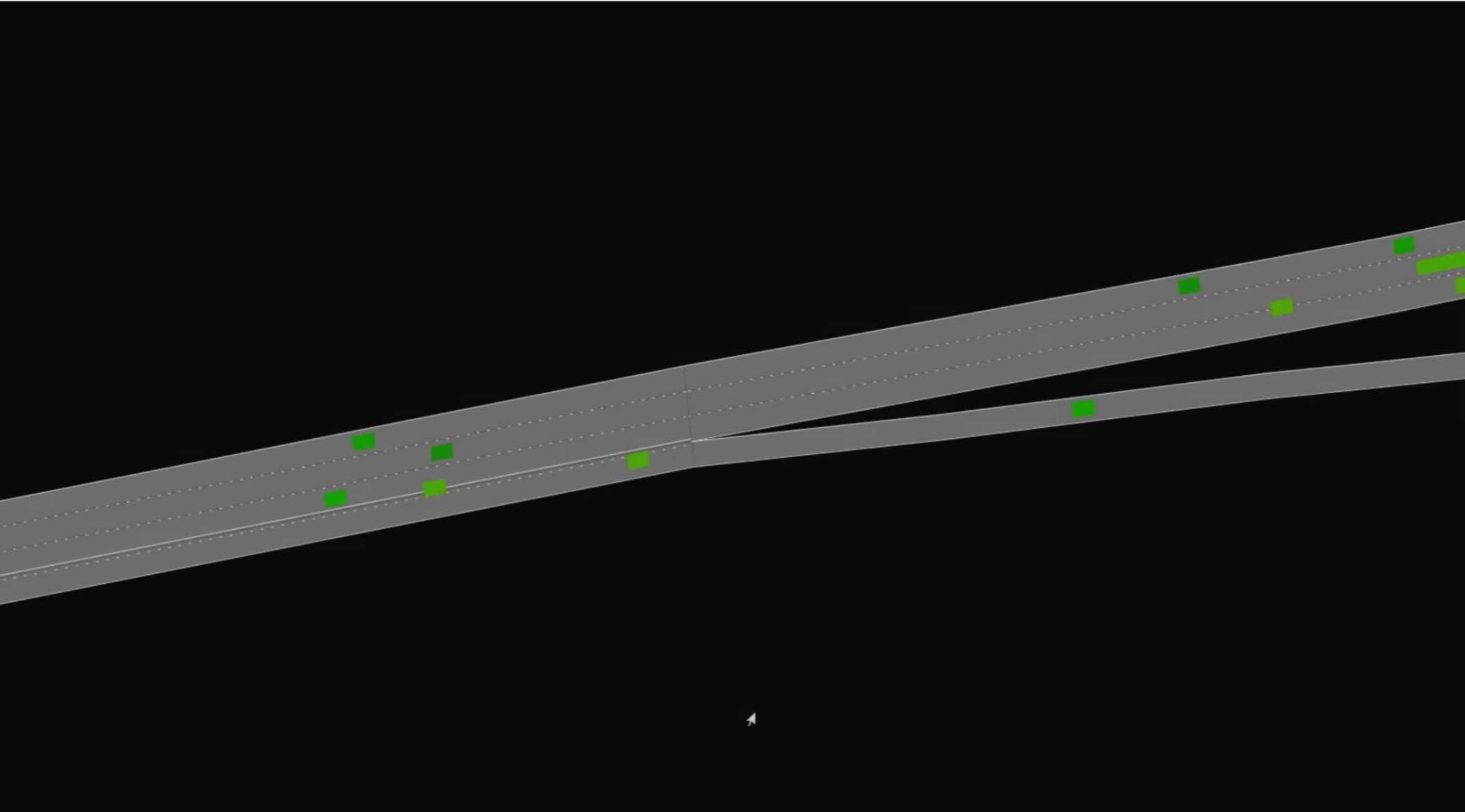
3
vlim: 100
lanes: n:n:n:n
up: 1,2
down: 4

2
vlim: 60
lane: n
down: 3

1
vlim: 100
lanes: n:n:n
down: 3







■ 100 km/h ■ 90 km/h ■ 60 km/h ■ 50 km/h ■ 30 km/h