Traffic Flow Modelling

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Main Aims and Challenges

Main aims:

- To develop a traffic flow modelling tool
- Capability of modelling complicated road networks
- Numerically solving a governing PDE using various methods/tools from CFD

Challenges:

- How can you unambiguously describe a traffic network as input for a computer program?
- Coupling a *numerical* PDE solver with a *probabilistic* method for governing flow through junctions
  - Interaction of junction boundary information on incoming and outgoing roads

Research Objectives

By addressing the previous aims and challenges, the following can be achieved:

- Assess the influence of numerical methods on microscale decisions relevant to applied problems
- Design a suitable test case to expose advantages and disadvantages in network traffic flow solvers
- Calibrate the model using empirical data on real roads

Methodologies

Existing methodologies:

- Microscopic - modelling individual cars
- Macroscopic - aggregate variables for density ρ, flow rate f, velocity u

My method:

- A Godunov numerical solver for the macroscopic Lighthill, Whitham, Richards (1955/56) conservation model:

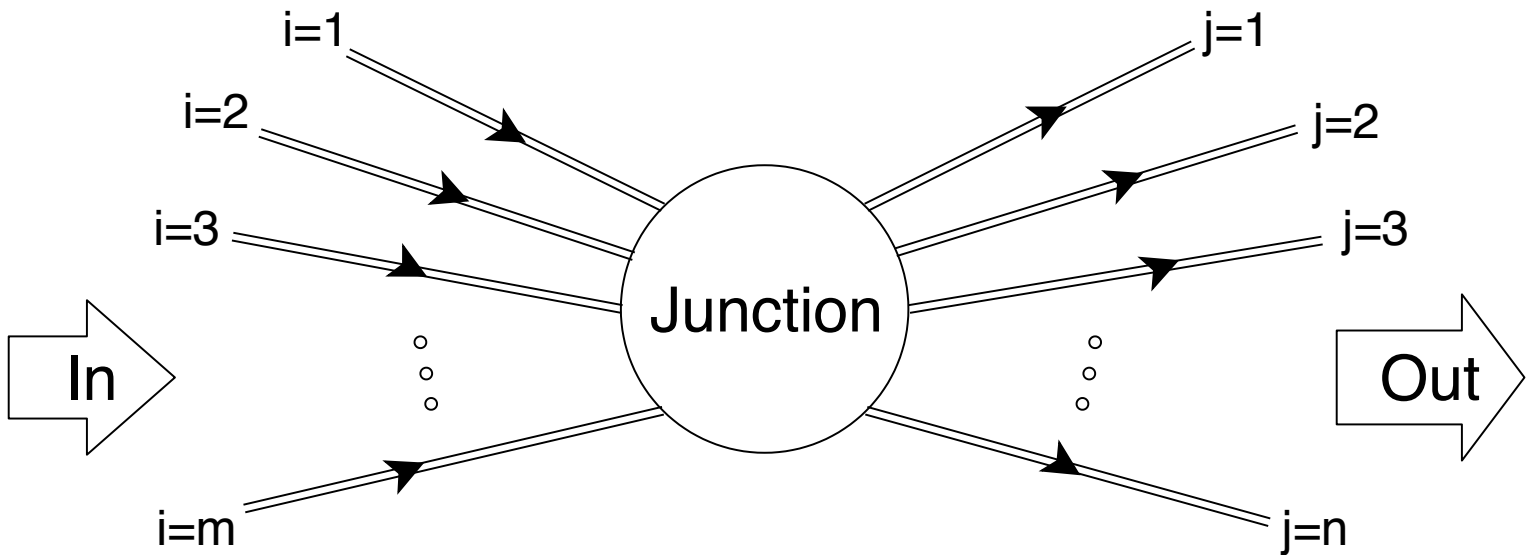
$$\frac{\partial \rho}{\partial t} + \frac{\partial f}{\partial x} = 0$$

- Traffic distribution matrix (TDM) (Shi-Guo, 2016) determines the flow decisions at junctions

Traffic Distribution Matrix

TDM elements, $A = (a_{ij})$, describe the proportion of traffic passing through a junction from incoming road i to outgoing road j,

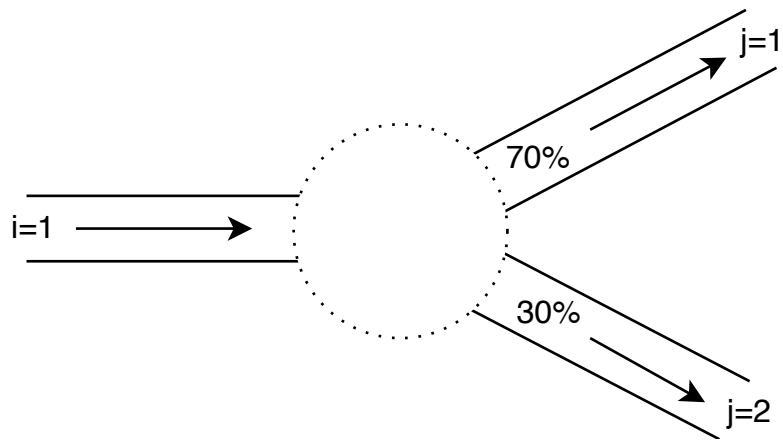
$$A = \begin{pmatrix} a_{1,1} & a_{1,2} & \cdots & a_{1,n} \\ a_{2,1} & a_{2,2} & \cdots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m,1} & a_{m,2} & \cdots & a_{m,n} \end{pmatrix}$$



Preliminary Simulation

- Simple network of a 1-2 split exercising a preferred route by the traffic distribution matrix (play movie)

$$A = [a_{1,1},\ a_{1,2}] = [0.7,\ 0.3]$$



Future Work

Next steps:

- Expand the capabilities and behaviour of the current program:
  - Junctions of m-incoming and n-outgoing roads
  - Network of many junctions
  - Introduce an input file for quicker test simulations of varying parameters (δx, CFL, etc.)
  - Add extra numerical method options: discretisation, gradient limiters, reconstruction
- Verify the numerical methods against test cases in current papers