



DATA
61

Traffic Flow Modelling with Point Processes

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Why Model Traffic Flow?

Congestion in Sydney

- Economic Cost
 - Congestion costs Sydney \$4.6 billion a year.
- Business Impact
 - Lost productivity, higher operational cost, and lower business attractiveness.



How we Model Traffic Flow?



Modelling with Point Processes

- A point process models a series of events (e.g. traffic flow) that can be treated as a point in time (and space).
- Can capture the clustering effect of events (one excites another).
- We model the occurrence of traffic flows as modulated by external events such as news and tweets.

In the news



[Road Rage: Boxing brawl on busy Sydney road](#)

[9news.com.au](#) - 7 hours ago

A **Sydney** man has been recorded in broad daylight landing more than a dozen ...
Top News.

[Weather forecast: Rain for Sydney, Melbourne, Brisbane, Adelaide, Hobart](#)

[NEWS.com.au](#) - 23 hours ago

[Man punches tattooed driver a dozen times in Sydney road rage brawl](#)

[Yahoo7 News](#) - 4 hours ago

[More news for Sydney news](#)

[NSW News | Latest & Breaking News Sydney, NSW](#)

[www.smh.com.au/nsw](#) ▼

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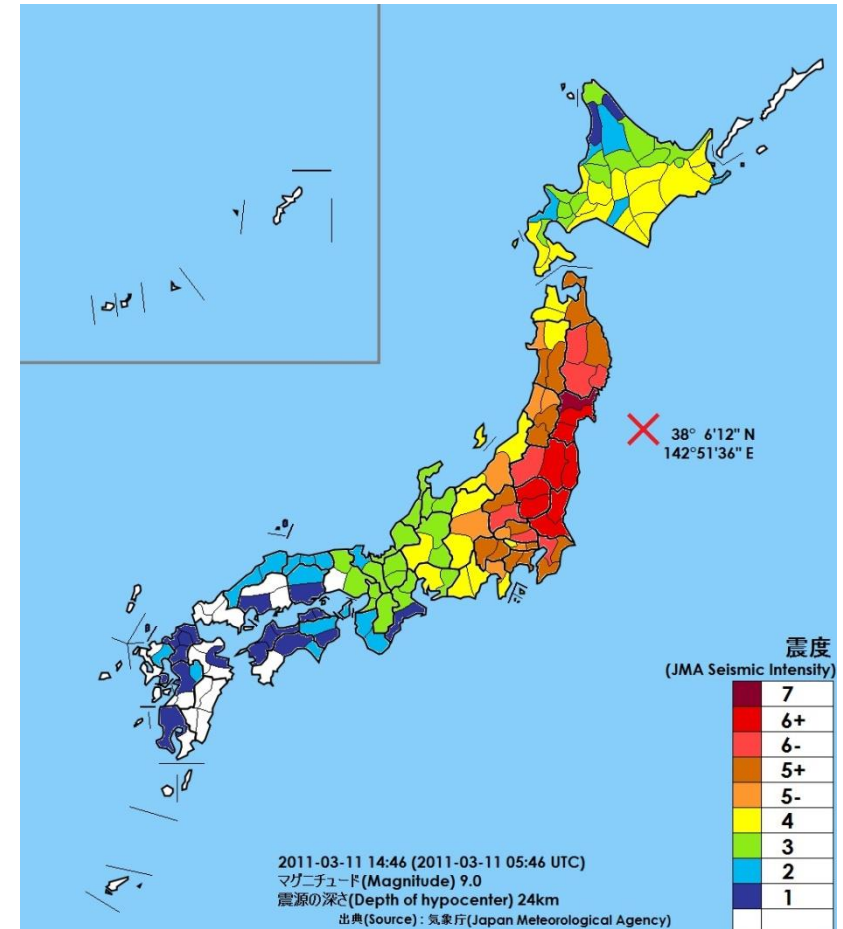
Point Process – Overview

Intensity Function

- Describes the rate of occurrence of an event.
- The higher the intensity at one point, the higher the chance of seeing an event at that point.
- We let the intensity of traffic flow to be 'excited' by an external event (such as news).

$$\lambda_t = a + \sum_{j=1}^{J_t} X_j e^{-\delta(t-s_j)}$$

- (our intensity is a function over time)

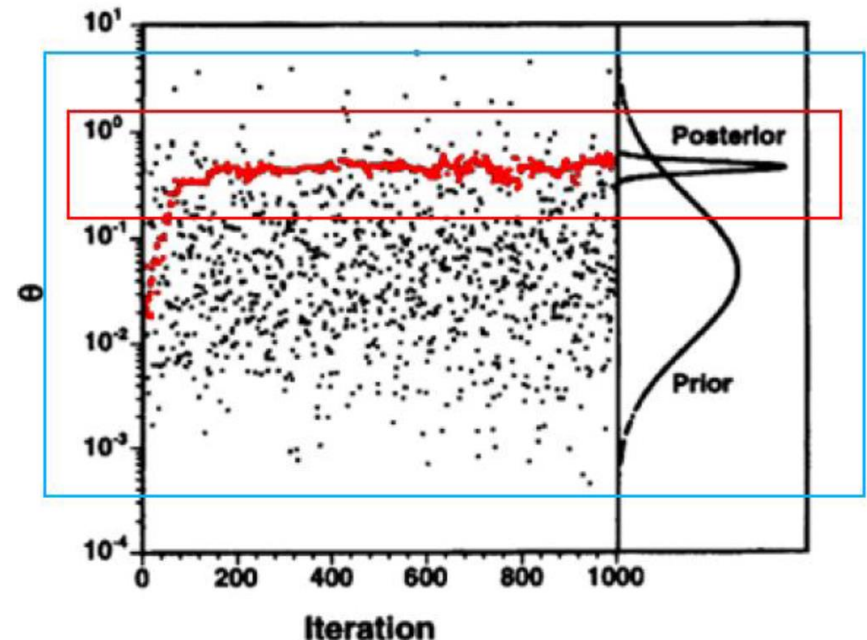


Learning the Intensity Function

Bayesian Inference

- A hybrid of Markov chain Monte Carlo methods.
 - Gibbs samplers.
 - Metropolis-Hastings algorithm.
- Find the posteriors of the parameters - i.e. what is the most probable given data and also prior information.
- Posterior = Likelihood x Prior

$$P(a, \mu, \delta, \alpha, \beta, \mathbf{X} | \mathbf{t}, \mathbf{s}) \propto P(\mathbf{t}, \mathbf{s} | a, \delta, \mathbf{X}) P(a, \mu, \delta, \alpha, \beta)$$

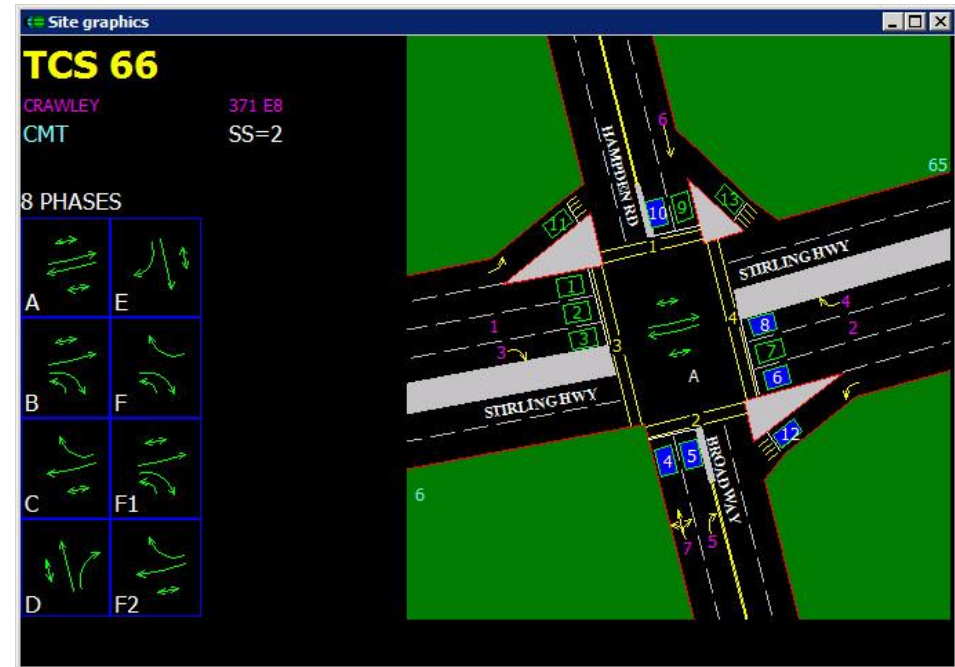


Getting the Data

Traffic Flow Data

SCATS - Intelligent Traffic Management

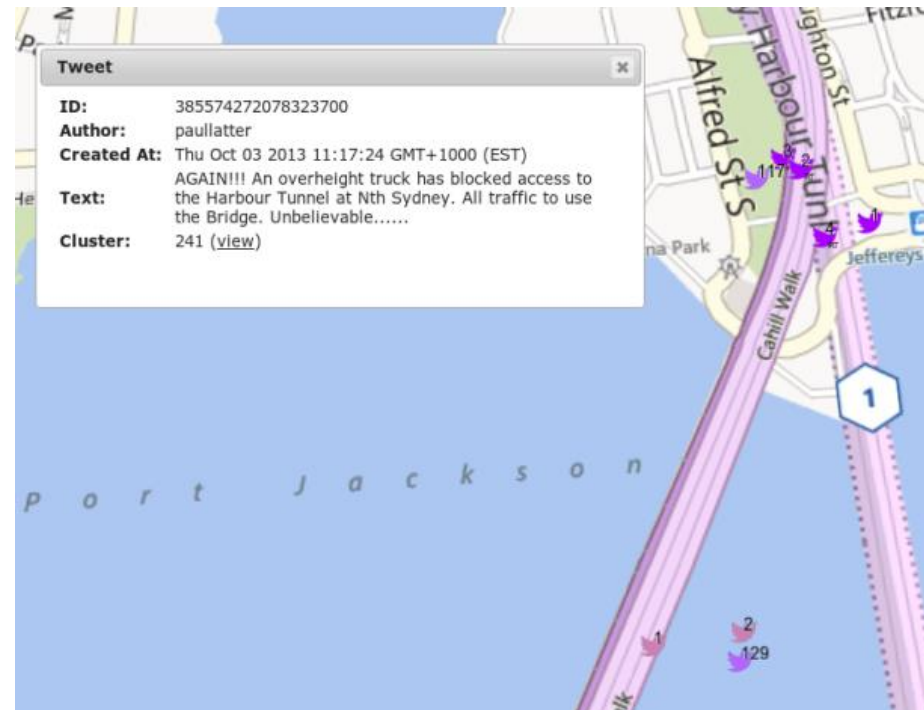
- Data from SCATS (Sydney Coordinated Adaptive Traffic System).
- Vehicles passing through intersections are observed by detectors (numbered in figure).
- We process the data and treat each vehicle passing as an 'event' for the point process.



Tweets on Traffic

Traffic Watch

- Tweets are collected and are categorised to be traffic related or not using the Traffic Watch system.
- Traffic related tweets are treated as 'external events' for the point process.



Traffic Watch Annotation System



More Examples

- Name entity recognition (NER) is used to detect type of roads and the parties involved.
- SVM classifier is used to determine whether a tweet is relevant to traffic or not.

The screenshot displays the Traffic Watch Annotation System interface. The main window shows a list of tweets with various entities highlighted and labeled. The labels include Street, Suburb, Accident, Vehicle, Direction, Status, Queue, Lane, Breakdown, and People. The tweets are numbered 33 to 50. A sidebar on the right, titled 'Edit Annotation', contains a 'Text' field, a 'Vehicle' link, a 'Search' field with 'Google, Wikipedia' entered, and a list of 'Entity type' categories. The categories are Location (State, Suburb, Street, POI, Place), Entity (People, Vehicle, Stationary_object), Incident_type (Queue, Accident, Breakdown, Hazard, Special_event, Police, Roadwork), Incident_properties (Lane, Direction, Time, Status), Non-relevant, and Duplicate. At the bottom of the sidebar are 'Add Frag.' and 'Delete' buttons.

33 Bruce Highway, Narangba Crash Multivehicle Southbound 200m south of Boundary Rd. Delays expected, Proceed

34 VIC Glen Iris Burke Rd all lanes blocked Burke Rd emergency vehicles attending Avoid area if possible | 51504294

35 Warradale slow traffic bothways Morphett Road at Oaklands Road | 515042978398613000 | GetTrafficSA

36 Greenacres roadworks bothways A17 Hampstead Road at Sandville Ave CLEAR | 515043160280400000 | GetTrafficS

37 Western Freeway, Mount CootTha Stationary Vehicle Outbound Left lane blocked after Miskin Street, Delays e http://t

38 Man dies after Kewdale accident http://t.co/F4EetYxv6 #Australia #news | 515043486664368000 | tuitAustralia

39 RT @HoldYour_Heart: I swear to god I want nothing more than to watch ISIL crash and burn. | 515043536064901000 |

40 Bradfield Highway, Fortitude Valley Congestion Southbound Congestion from Fortitude Valley to Greenslopes, http://t

41 Minden accident bothways Lowood Minden Rd near Warrego Hwy CLEAR | 515043690486583000 | GetTrafficQLD

42 The 5.08pm Roma Street to Shorncliffe train delayed 18 minutes. http://t.co/GT8GNTYyEx #qr | 515043806706946000 |

43 RT @TransLinkSEQ: The 5.08pm Roma Street to Shorncliffe train delayed 18 minutes. http://t.co/GT8GNTYyEx #qr

44 NSW CLYDE M4 Mwy at James Ruse Dr BREAKDOWN Car (Site cleared) Started today 4:51pm, last checked tod

45 Flying with jetstar tomorrow night: let's start placing bets with how delayed I'll be and if they actually inform passengers r

46 Oxley accident eastbound Ipswich Motorway at Blunder Road | 515044003134186000 | GetTrafficQLD

47 Smith Street, Molendinar Congestion Westbound is now CLEARED | 515044005361369000 | 131940_NCSC

48 #goldcoast Report of Road Traffic Crash Pymont Street, Robina #gctrffic | 515044075045536000 | QLDincidents

49 #goldcoast Report of Road Traffic Crash Pymont Street, Robina #gctrffic | 515044197506642000 | SEQincidents

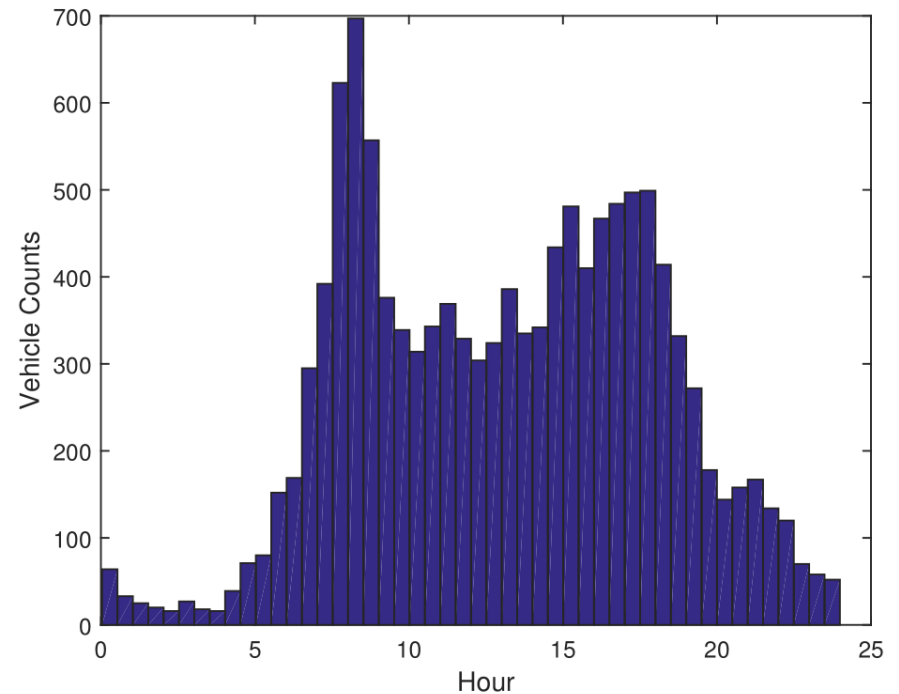
50 I'm having a breakdown http://t.co/VKtHa6vJKv | 515044230377402000 | 5s4ucenary

Some Results

Sydney Traffic Flow

Traffic Flow Data (from SCATS)

- Traffic flow on south of NSW, far away from city, on 30th March 2015.
- About 12k events observed.
- Histogram shows that the traffic flow volume is not uniform through time.



Modelling Results

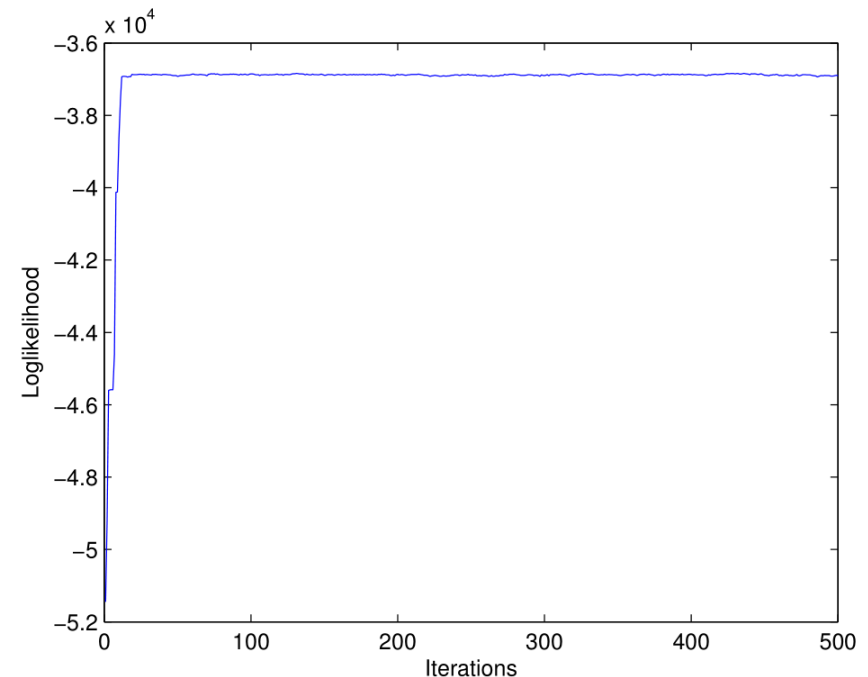
Parameters Learning

- Learned parameter values:

$$\hat{a} = 0.1440 \quad \hat{\mu} = 0.0005$$

$$\hat{\delta} = 3.0334 \quad \hat{\beta} = 3.4104$$

- What does this mean?
 - We expect on average 0.144 vehicle per second, or about 9 vehicles per minute.
 - Each tweet generates an expected number of 0.09666 vehicle.

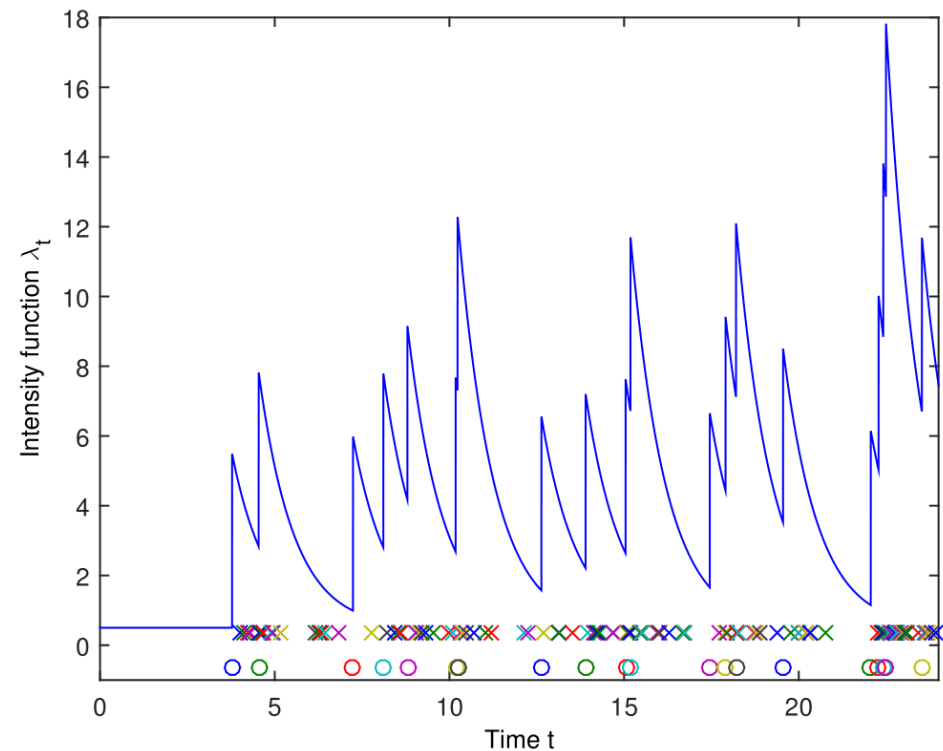


Loglikelihood Trace – algorithm
converged quickly

Simulations of Traffic Flow

Using Learned Parameter Results

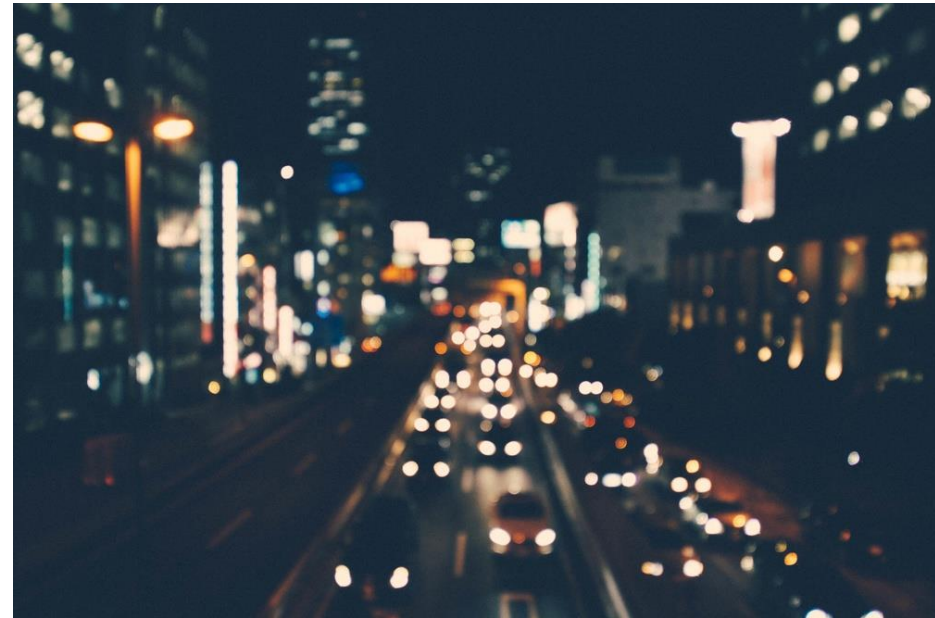
- The learned parameters are used to forecast and predict future traffic flows in Sydney.
- A simulation example is shown on the right.
 - Circles are external events that 'excite' traffic flows.
 - Crosses are traffic flow 'events'.
 - Each occurrence of external events triggers an increase of 'intensity' which in turn leads to traffic flows.



Our Aims

Intelligent Transport System

- To incorporate traffic flow modelling for intelligent transport system as part of smart cities management.
- Smart planning and optimisation to reduce economic cost and business impact from congestion.
- To lower stress in drivers and pedestrians caused by traffic conditions.



Future Work

Improving Traffic Flow Modelling

- Incorporate other type of event data:
 - Calendar events, e.g. festivals.
- Use Natural Language Processing (NLP) to understand text and its influence.
- Stochastic excitations
 - Model the 'excitations' as a stochastic process – events that come first have greater influence.

