Spatio-Temporal Analysis of Network Data and Road Developments

Dr Tao Cheng
CEGE UCL
## Workshop today

### Session 1: Spatio-Temporal Data Infrastructures
- **Muhammad Adnan**: *Real time geodemographics: requirements and challenges*
- **Andrew Crooks**: *Developing operational urban models using London’s spatial data infrastructure*
- **Jonathan Turner**: *Data sources for monitoring road network performance in London*
- **Berk Anbaroglu (UCL CEGE)**: *Spatio-temporal outlier analysis*
- **Garavig Tanaksaranond (UCL CEGE)**: *Visualising traffic data*
- **Adel Bolbol (UCL CEGE)**: *Analyzing travel behaviour through geotagging*

### Session 2: Road Networks and Complex Systems
- **Andy Emmonds**: *Research challenges in understanding London’s road network performance*
- **Jingxi Dong**: *Performance evaluation of urban road network using GPS-equipped probe vehicles*
- **Tao Cheng**: *Integrated spatio-temporal data mining for network complexity*

### Session 3: Representation and Analysis of Network Data
- **Tomoki Nakaya**: *Visualising crime clusters in a space-time cube*
- **Chris Brunsdon**: *Visualising and modelling complex social systems*
- **Benjamin Heydecker**: *Analysing road traffic data*

### Session 4: STANDARD
- **Mike Batty**: *A land use transport model for greater London*
• Data
  - Synthesis (MA)
  - Measurement/re-use (AC)
  - Monitoring (JT)
  - Modelling (AB)

• Visualisation
  - Traffic flows (GT)
  - Outliers (BA)
  - 3D (TN)
  - Complexity (CB)

• Interaction
  - Networks (BH)
  - Performance (AE, JD)
  - ST Dynamics (MB, TC)
Background

• Large cities are increasingly crowded - population & mobility
• Traffic congestion affects both the economy and daily life.
• It is difficult and expensive to increase the capacity of the road network.
City of London

- cost of congestion
  - £3 billion per year
- Mayor’s traffic priorities
  - reduce congestion and smooth traffic flows
- Remove western extension of CC (27/11/2008)
- Olympic Game 2012
  - travel time to London Olympic sites
Challenge (1) - Network Complexity

1) Dynamics
2) Spatial dependence
3) Spatio-temporal interactions
4) Heterogeneity
Aim

• To quantitatively measure road network performance
• To understand causes of traffic congestion
  - association between traffic and interventions
    • traffic flow, speed/journey time
    • incidents, road works, signal changes and bus lane changes
• Case study - London
What’s new?

- data-driven, mining
- integrated space and time
  - ST associations
- combine regression analysis with machine learning
  - improve the sensitivity and explanatory power
- study the heterogeneity and scale of road performance
  - optimal scale for monitoring
London Road Networks

Cordons
Central, Inner, Outer

Screenlines
Thames, Northern, five radials, four peripherals

Cordon and screenline sites

- Central cordon
- Inner cordon
- Outer cordon
- Thames screenline
- Northern screenline
- Radial screenlines
- Peripheral screenlines
Challenge (2) - Data issues

- massive - 20GB monthly
- multi-sourced related to 5 different networks
- different scales (density & frequency)
- variable data quality
- contain conflicts, errors, mistakes and gaps
Traffic Flow Surveys

- NMC (National manual count annual data)
- ATC (Automatic Count) - 20 MB
- different time periods, intervals and accuracy
Traffic speed (and hence journey time) data

- **MCOS** *(Moving Car Observer Surveys)*
  - Centre, Inner, and Outer
  - least accurate of the datasets

- **ITIS** *(GPS vehicle tracking system)* - 2GB
  - major A roads and bus routes in town with 2000 probes
  - medium accuracy

- **ANPR** *(Automatic Number Plate Reading)* - 6 GB
  - main roads in the central and west extensions of CCZs
  - 5-minute intervals, 5 vehicle groups,
  - high accuracy
  - available since March 2008

- **At least 5 networks**
  - boundaries do not fully align
LTIS incident and event data - 20MB

- works, hazards, accidents, signal faults, special events, breakdowns, security, and other causes
- DfT have all these data as map or as text files

- Minimal, Moderate, Serious or Severe subjective?
- not recorded?
- not geocoded?

not broadcast on the traffic Link website, creating problems in analysis and reporting.

There are uncertainties and gaps in the intervention data
Methodology: some preliminary thoughts

• accommodate network structure (topology & geometry)
• model multi-variable spatio-temporal correlations
• investigate network heterogeneity
  - STWR
• model impacts of interventions
  - STARIMA & DRNN; hybrid; STANN
• Traffic pattern clustering and long-term prediction
  - STANN; STSVM
• sensitivity analysis and accuracy assessment
• simulate congestion in the short term
Figure 1: Main tasks and workflow of the project

**Key:** work conducted by \(F_1\) 1st research fellow; \(F_2\) 2nd research fellow; \(S\) research student.
Team (April 2009 – March 2012)

- **UCL**
  - Dr Tao Cheng (PI), Senior Lecturer in GIS
  - Prof. Benjamin Heydecker (Co-I), Professor of Transport Studies
  - Dr Jingxin Dong, Transport Modelling (F1)
  - Dr Jiaqiu Wang, GIS (F2)
  - RS, MSc in GIS - SVM/GWR
  - EngD, MSc in Transport - Simulation
  - 3 visiting scholars, each 2 months

- **Other PhDs**
  - Mr Berk Anbaroglu (RS), BSc in Computer Science - outlier detection
  - Ms Garavig Tanaksaranond (RS), MSc in GIS - dynamic visualization

- **TfL RNP&R**
  - Mr Andy Emmonds, Principal Transport Analyst
  - Mr Mike Tarrier, Head of RNP&R
  - Mr Jonathan Turner, Performance Analyst
Advisory Committee

• Prof. Harry Timmermans, GIS-T and transport, Eindhoven Technical University - ETU;
• Prof. Stewart Fotheringham, GRW, National University of Ireland (Maynooth) - NUIM;
• Prof. Mikhail Kanevski, SVM, Institute of Geomatics and Analysis of Risk (IGAR), University of Lausanne, Switzerland
• Prof. Peter Jones, CTS, UCL
• Dr Antony Steed, Computer Science, UCL
• Dr Katherine Blair, Directorate of Road Network Performance, TfL
• Mr Jason Robinson, Chief Engineer, Urban Traffic Control (UTC), TfL
Website

- news
- workshops
- publications
- sample data
- competitions
- discussion

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