Estimating Traffic Flows from Annual Average Daily Traffic and Third Party Speed Data

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Objective: Compute Delay

- Everybody wants delay and congestion measurements everywhere
  - We now have speeds everywhere via 3rd party speed (Inrix, HERE, TomTom), why not flows?
  - We just need flows and we’re home free

- Many methods
  - Use existing point detectors and fuse with 3rd party speeds
  - Just assume a constant value (eg: 1500 veh/lan/hour)
  - Develop flow estimates based solely on probes (can be done by current 3rd party providers)
  - Use existing AADT values (flow for a day)

- Goal: Estimate hourly vehicular flows for a large number of locations based on AADT
Inputs

- Annual Average Daily Traffic (AADT) values coming from the Federal Highway Performance Monitoring System (HPMS)
  - And the fact that it’s snapped to a GIS network (NHPN)
- Canonical hourly flow profiles
- Third party speed profiles
Flow estimation consists of 4 tasks:

1. Map HPMS links and 3rd party speeds onto common road network

2. Given HPMS AADT for a location, assign daily flow
   - Divide AADT by 2 => Assign to each direction
   - Adjust by annual growth, monthly, and day of week factors
   - End up with a flow per day

3. Generate canonical hourly flow profiles
   - Using available flow data from regional sources
   - Or just borrow a national profile

4. Pick the most probable hourly flow profile for the given link
   - Where the persistent slowdowns take place (eg: AM slowdown => AM peak flow)
   - Using third party speed data
Conflating PeMS, TMC and HPMS Maps

Detector Map

TMC Map

HPMS Map

PeMS Volumes

Speeds

AADT

Canonical Map
Matching Canonical Links with HPMS Link

- HPMS link geometry comes from National Transportation Atlas Database as ESRI shape files (updated annually)
- AADT values are included as attributes in the shape files
- Map matching between HPMS and canonical links is assigning AADT values to canonical links
- HPMS links are bidirectional, while canonical links are directed
Errors in Map Matching

- Errors occur when HPMS arterial links are too close to Canonical freeway links
- Wrong map matching results in huge errors in AADT assigned to Canonical links
- Sanity check:
  - Opposite canonical link must have the same AADT value
  - Either the nearest upstream or downstream neighbor must have the same AADT value
Computing Adjustment Factors

\[ \text{Total Daily Flow} = \frac{1}{2} \times \text{Annual Growth Factor} \times \text{Month Of Year Factor} \times \text{Day Of Week Factor} \times \text{AADT} \]

- Leverage regional data – looking for general trends
  - Use vehicle counts for an average day of the past 12 months to obtain annual growth factor
  - Use vehicle counts for an average day of every month to compute MoY adjustment factor
  - Use vehicle counts for an average Mon-Sun to compute DoW adjustment factor
- Each of these adjustment factors can be tagged by a geographic region – U.S. (default), state, county
- Each of these adjustment factors can be tuned for a particular daily volume range
Month of Year Factors

- Caltrans District 3 VDS 314013: average weekly volumes over 12 months

- Estimated MOY adjustment factor using data from 415 detectors in Caltrans District 3
Day of Week Factors

- Caltrans District 3 VDS 317213: Day of Week flows

- Estimated DOW adjustment factor using data from 415 detectors in Caltrans District 3
Computing Hourly Flow Profiles

- Need a small number of canonical flow profiles
- We’re going to assign one to each location
  - Function of day of week
- We decided on 4 basic patterns: AM peak, PM peak, midday peak and double peak
- Profiles can be also made by geographic region, daily volume range and season
- For each profile, find the mean and normalize
Grouping Hourly Flow Distributions

- Flow profiles of the same type (e.g. PM peak) are different for different daily volumes
- We did not find it useful maintaining different flow profile of the same type for different seasons or days of week (we still have a day of week factor, though)
Using Speed to Determine Flow Distribution

- Determine free flow speed by looking at speed profile between 5am and 11pm
- Find time intervals where average hourly speed drops below 90% of free flow: before 10 am = AM peak, after 3 pm = PM peak, 10 am – 3 pm = midday peak
- Presence of both AM and PM peaks = double peak
Challenges of Flow Classification

- Sometimes, it is impossible to infer anything from speed measurement.
- Sometimes, speed drop occurs due to accident and triggers wrong flow distribution choice.
Refinements of Speed Classification

- If nothing can be inferred from speed, use default flow distribution
  - Double peak for workdays
  - Midday peak for weekends and holidays
- For those links with default flow distribution, look at upstream and downstream neighbors and borrow from them
- If upstream and downstream neighbors have different flow distribution, look at the opposite link
  - AM peak on the opposite link implies PM peak on the current link
  - PM peak on the opposite link implies AM peak on the current link
  - Otherwise, use the same flow distribution
- Use speed data for multiple days to obtain a speed profile for a given Day of Week; and then work with that speed profile to determine flow distribution – this reduces the impact of incidents
Using Caltrans D3 Data for Evaluation

- Used Caltrans District 3 vehicle counts to
  - Determine annual growth factor (together with HPMS AADT)
  - Determine Month of Year and Day of Week adjustment factors
  - Create flow distributions
  - Evaluate the results

- Used 3rd party speed data for March 2014 to select flow distributions

- Built prototype that estimates flows on Caltrans District 3 freeways for March 2014
Example of Flow Estimation
Some Results on Flow Estimation Quality

- 415 vehicle detector locations
- Random date: Monday, March 24, 2014
- 4 experiments, each improving on the previous one:
  1. Initial try – simple map matching between HPMS and canonical links; links without speed data are considered to be without flow
  2. Use default values and flow distributions for canonical links without data
  3. Smear properly estimated flows to the nearest neighboring links without data
  4. Use mapping of HPMS links onto canonical links with sanity check; and refine speed classification for picking flow distribution

- Metrics
  - Number of correct flow distribution choices out of 415
  - Mean percentage error of hourly flows over 415 links with detectors
Computing Performance Measures

- 3.78 mile stretch of Interstate 5 South in Sacramento: from postmile 525.78 to postmile 522
- Compute hourly Vehicle Miles Traveled (VMT), Vehicle Hours Traveled (VHT) and Delay (vehicle-hours) in 3 ways
  1. Spot detectors (flows and speeds)
  2. Using spot flows and 3rd party speed data
  3. Using estimated flows and 3rd party speed data
- Delay is computed for free flow speed 50 mph
- Date: Monday, March 24, 2014
Computing Performance Measures (cont.)

- Estimate of delay for a single location
- Extending to many locations now
Summary

- (still a work in progress)
- Using AADTs and 3rd party speeds to estimate flow seems suitable for computing traffic performance measures
  - Might be useful for setting static ramp metering plans
  - It cannot replace traffic volume measurements for feedback traffic control