Practical Use of ADUS for Real-Time Routing and Travel Time Prediction

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Motivation

• Trip from Berkeley to Stanford
Overview

• Archived Data User Service (ADUS) system
• PeMS (Freeway Performance Measurement System)
• A prototype dynamic route guidance system
  – robust real-time and historical traffic content from PeMS
  – path finding and route guidance algorithm
• Advanced Traveler Information Systems (ATIS).
• Benefit of the real-time route guidance system
  – For a simplified freeway network in Los Angeles, which shows an average of 30~60% reduction in travel time for trips that last an hour or longer.
ADUS System and PeMS

• ADUS system
  – Archives ITS-generated operational data for such uses as
    • planning, performance monitoring, program assessment, policy evaluation, safety, and research.
  – Data stored in ADUS are typically characterized by
    • Huge quantity
    • Wide geographical coverage
    • Wide temporal coverage

• PeMS ([http://pems.eecs.berkeley.edu](http://pems.eecs.berkeley.edu))
  – The current state-of-the-art example of ADUS systems
  – On each day, PeMS archives 2 GB of data collected and processed from over 26,000 detectors in California in real-time.
  – It covers most urban freeways in California and spans about 5 years in duration.
Route guidance system

- Given a query consisting of the origin and destination (O-D), a route guidance system provides turn-by-turn directions as well as the duration of the trip for a traveler making the trip between the O-D
- Find (near-) optimal routes using a variant of shortest path algorithms applied to the road network database
- Such service is typically provided as a function of a geographic positioning system (GPS) unit or via web-based system such as Mapquest (2).
Dynamic route guidance system

• Currently, most route guidance systems use the nominal travel time based on the speed limit for path finding as well as for trip duration computation.
  – useful, but not satisfactory

• Little practical effort in implementing such a system that incorporates real-time traffic information in shortest path
  – Primarily due to the lack of available data
  – Our system is one of the first robust and mature web-based dynamic route guidance systems
System components

- **PeMS**
  - Coding freeway network in PeMS into segments (~1/2 mile).
  - Historical average travel time that is specific to the time of day and day of week.
  - Real-time travel time information
- **Shortest path algorithm**
  - The road network represented as a “weighted directed graph (di-graph)”
  - Dijkstra algorithm / A* (“A-star”) algorithm
- **Static or dynamic**
  - Static: Nominal travel time (speed limit)
  - Dynamic: Current travel times, updated in real-time
  - (Historic: Historical median travel times)
  - (Predicted: From our travel time prediction method; for longer routes only)
- **Web-based user interface and the map server**
Web-based user interface

- Similar to commercial web-based routing services such as Mapquest
- It receives the street addresses of O-D from the user and displays the best route found by the algorithm on the map and the turn-by-turn directions.
- Also shows nominal, historical average and predicted travel times, along with other information such as daily travel time predictions over the route and incidents.
Benefit of Dynamic Route Guidance

• “How much time a traveler saves using the dynamic route guidance system compared to when he/she uses the static one?”
• Study the LA freeway network
• Computed shorted paths for each of them for each departure time every 5-minute from 5 AM to 11 PM on October 4, 2004, using both static and dynamic route guidance systems
Los Angeles (Caltrans District 7) freeway network

- Screenshot from PeMS website
- Each dot corresponds to a loop detector station and the color of the dots show the current speed at each location
The simplified Los Angeles freeway network

- The directed graph with 21 nodes and 64 directed edges.
- There are 420 possible O-Ds.
The last plot shows an average of 30~60% reduction in travel time for trips that last an hour or longer.
Summary

• A prototype web-based dynamic route guidance system we developed
  – Uses the real time traffic information and historical data archive from PeMS
  – A sophisticated travel time prediction algorithm to report a realistic estimate of
  the trip duration, reflecting the possible change in the traffic condition during the
  trip.

• The benefit of the dynamic route guidance system compared to the static
  route guidance system.
  – An average of 30~60% reduction in travel time for trips that last an hour or
  longer.
  – Even when there’s no alternative route, the realistic travel times reported by the
  system benefit drivers in trip planning.

• To summarize, we developed a robust and mature web-based dynamic
  route guidance system that makes intelligent use of real-time and historical
  data in PeMS. Combined with realistic travel times computed using a travel
  time prediction algorithm, the system can benefit travelers in various ways.
References