iCity - ITSoS Integrative Platform

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iCity Research Day 2019
Agenda

- **iCity-ITSoS as a Platform:**
  - iCity-ITSoS Architecture
  - iCity-ITSoS Linked Data and Data Lake
  - iCity-ITSoS Software Development Kit

- **iCity-ITSoS Applications**
  - Semantic Advanced Traveler Information System
  - Highway Traffic Estimation using Deep Convolutional Neural Network
  - Comparative Study of Web Service Architectures for Software Development Kit of Transportation Application

- **iCity-ITSoS Team**

- **Next Year Plan**
Objective:

- Create a platform to facilitate/enable the process of building transport applications

Challenges:

1. Data variety and heterogeneity
2. Multiple siloed services
3. Difficult re-usability

Approach: ITSoS Integrative platform
iCity-ITSoS as a Platform
iCity-ITSSoS Architecture

Application Layer

Services Layer

Data Lake Layer

Infrastructure as a Services (Multi-Could Strategy)

Traffic Camera Data
Traffic Travel Time Data
GFTS Data
Loop Detectors Data
Travel Demand Data
Weather Data

Applications
Visualization
Application Programming Interface (APIs)
Analytics Engine
Software Development Kit
Multi-Layers Data
UofT*
Azure

*UofT Cloud: in-house and secure cloud service by UofT, to host confidential data.

Traffic Camera Data
Loop Detectors Data
Travel Demand Data
Weather Data

Infrastructure as a Services

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Transportation Research Institute
Challenge (1): Data Heterogeneity

- Integrating new datasets is a challenging task
- Heterogeneity in
  - Access methods
  - Data formats
  - Schema

- Data Types
- MTO Loop Detectors
  - Microwave
- Traffic Cameras - MTO & CoT
- GIS / Maps
- Travel Time
  - HERE/ Google/ Tomotom
- Weather
Data processing and data ingestion:

Processing Flow

RAW Data

- Python process .csv files and generate new files usable for insert
- Store files on local disk
- Run SQL command on server to insert entries
- Store entries in database

Example: MTO Data (2010-2018)

RAW Data => Rows/Month = 265,549,166 rows

Version 1
- Avg. speed 375 rows/s
- 8.2 days/month
- 2 Years All Data

Version 2
- Avg. speed 1200 rows/s
- 2.7 days/month
- 9 months All Data

Version 3
- Avg. speed 113,434 rows/s
- 40min/month
- 5 Days (2010-2018)

Testing and Optimization

MTO Data processing procedure – flowchart
Analytics Platform
Linked Data & iCity Ontology
Challenge 2: Siloed Services

iCity-ITSoS SDK Architecture:

- iCity-ITSoS
- Software Development Kit (SDK)
- Azure API Manager
- Traffic APIs
- Transit APIs
- GIS APIs
iCity-ITSoS Applications
iCity-ITSoS Applications

1. **Application 1.0** : Semantic Advanced Traveler Information System

2. **Application 2.0** : Highway Traffic Estimation using Deep Convolutional Neural Network

3. **Application 3.0** : Comparative Study of Web Service Architectures for Software Development Kit of Transportation Application
Application 1.0: Semantic Advanced Traveler Information System

- Traffic representation on OTP by using loop detector data

- Using **iCity Ontology** to map loop detector data

- Test for 207 way-segments on 401 highway express. (LD data linked to OSN’s WayID)

- Two tests: Direct integration with the LD data and the 2<sup>nd</sup> by using the ontology
Semantic ATIS Architecture

SQL DB

Use Interface

Ontology Engine

OTP Server

Data

wfs:GetFeature service
Application 2.0 Highway Traffic Characteristics Estimation using Deep CNN:

- Develop a separate data stream for validation macroscopic flow characteristics
- Leverage existing data in the form of traffic camera images
- Train model that supplements loop detectors, especially where loop detectors are broken
- Work with static images instead of video – greatly reduces inference time, with trade-off of granularity
Application 2.0 Highway Traffic Characteristics Estimation using Deep CNN:

- Large corpus of existing loop detector data
- Preprocess loop detector data to extract macroscopic traffic characteristics, serve as ground truth for images
- Train detector that is robust to road dimensions, camera angle
- Centralizes processing of image data from traffic cameras with computational constraints
Application 3.0: Comparative Study of Web Service Architectures for SDK of Transportation Applications

- Define a performance metrics to compare different styles of web services
- Develop the APIs defined by the ITS researchers in RESTful format.
- Re-Develop the same service in SOAP-based web services
- Compare the performance of these APIs using the API Manager to measure the performance of these APIs in terms of speed, resources used, and reliability.
Team Structure

ITSoS Portal
Next Year Plan

1. Big Data Processing

2. High Performance Application