Big Data Sources and Methodologies

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2018 SF Bay Area ITE/ITS CA Joint Transportation Workshop
Big Data for Automated Driving Technology, Transportation Planning, and Engineering
Thousands Use INRIX Real-time Traffic and Analytics

INRIX powers more country, state & city agencies than any other company

A History of ITS Public Sector Firsts

- Fusion of private and roadside sensor data on a country-wide basis
- Country-wide traffic services based exclusively on GPS probe data
- Innovative traffic analytics to understand origin and destination
- Corridor-wide multi-state traffic monitoring website
- Pay-for-performance contract with payments tied to data
- Exclusive sourcing deals and industry partnerships

Public Sector Customers & Partners
Mining Data On The Road

We use a connected network of sensors, devices, car and drivers to develop robust insights.
Global Scale and Impact

Powered by global relationships and coverage, INRIX takes on the big transportation and population movement challenges

<table>
<thead>
<tr>
<th>100B+</th>
<th>5M+</th>
<th>60+</th>
<th>1PB+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-time data points aggregated, processed and delivered each month</td>
<td>Miles of road we cover in 50 countries</td>
<td>Countries we are live in</td>
<td>Data analyzed every day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>350M+</th>
<th>15M+</th>
<th>450+</th>
<th>29M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-time vehicles and connected devices we crowdsource</td>
<td>Connected cars in the world powered by INRIX services</td>
<td>B2B/B2G customers we serve</td>
<td>Parking spots we cover</td>
</tr>
</tbody>
</table>
Movement Today & Tomorrow

Technology is fundamentally reinventing transportation, creating a unique opportunity

Smarter Transportation

The convergence of the connected car and smart cities

Use of Big Data for Decision Making

Urbanization, Sustainability, IoT, Analytics

Transformation of Automotive Industry

Autonomous, Connected, Electric, Shared
Industry Inflection Point: The ACES

**Autonomous**
- TESLA
- Google
- UBER
- Mobileye

**Connected**
- INRIX
- HERE
- TomTom

**Electric**
- NISSAN LEAF
- TESLA
- BMW VOLT

**Shared**
- UBER
- CAR2GO
- DiDi
- zipcar
- lyft

INRIX
Industry Inflection Point: The ACES

- Autonomous
- Connected
- Electric
- Shared
The Promise of Big Data

• Improved Intelligence
  • More Data (every day...)
  • Better Data/Relational/Location Based Databases
  • Better Spatial Granularity and Coverage

• Achilles Heel
  • DRIP (Data Rich Information Poor)
  • Drowning in Data
  • Don’t have the Staff/Resources/Tools to Effectively Store/Analyze/Communicate the Data

One day worth of Origins and Destinations in Seattle
WHAT IS BIG DATA?
You Can’t Handle the Data!!!

Big Data: /big/ /ˈdaːdə/: noun.
1. Too big to fit in Excel
Steady growth in global auto sales (units in Millions)

Rapid rise in car connectivity (new connected car penetration rate in %)

Source: IHS Automotive and internal sources
Connected Cars Require a Lot of Software

- Car Driving Sub-System
- Boeing 787
- Mars Probe “Curiosity”
- Drone
- Space Shuttle

* Lines of code (mn)

1. Own estimates
2. Boeing
3. Own estimates
4. Own estimates
5. Own estimates

References:
- [Source](https://www.evworld.com/2013/01/21/energy-efficiency-and-smart-plans)
- [Source](http://www.nasa.gov/centers/human-spaceflight/pioneeringarpa.html)
Connected Cars Use a Lot of Data

Exabytes of Data Produced By Global Connected Cars

1 Exabyte = 1 Billion Gigabytes

<table>
<thead>
<tr>
<th>Year</th>
<th>Exabytes</th>
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<tr>
<td>2013E</td>
<td>1,616</td>
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<tr>
<td>2014E</td>
<td>3,796</td>
</tr>
<tr>
<td>2015E</td>
<td>8,210</td>
</tr>
<tr>
<td>2016E</td>
<td>17,149</td>
</tr>
<tr>
<td>2017E</td>
<td>35,254</td>
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<tr>
<td>2018E</td>
<td>71,923</td>
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<tr>
<td>2019E</td>
<td>146,187</td>
</tr>
<tr>
<td>2020E</td>
<td>296,593</td>
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</tbody>
</table>

Source: Ford: 2013, BI Intelligence: 2015

Current AV’s generate 2 GIGs/second!
Data Mining the Connected Car

- Raw Data
- Machine Learning
- Self-tuning
- Contextual Services

- Temperature
- LiDAR Sensors
- Mirror Sensors
- Wipers Status
- Engine Diagnostics
- Fog Lights
- Fuel Level
- Camera
- Traction Control
- Speed Location
- Tire Pressure
There are More Mobile Devices Than People

Source: Cisco IBSG, April 2011
By 2020, More People Will Have Mobile Phones Than Electricity at Home

- People with mobile phones: 5.4 billion (69% of Global Population)
- People with electricity: 5.3 billion (68% of Global Population)
- People with bank accounts: 4.5 billion (58% of Global Population)
- People with running water: 3.5 billion (45% of Global Population)
- People with cars: 2.8 billion (36% of Global Population)
- People with landlines: 2.2 billion (28% of Global Population)
Data Privacy

• Changes (like winter) are coming...
• Who owns what data?
• Impact of recent events/legislation
  • Numerous private sector data breaches
  • Russian hacking
  • Facebook Congressional hearings
  • Europe’s GDPR (General Data Protection Regulation)
  • etc., etc...
Traditional Transportation Data Sources

- Speed/Travel Time Data
  - Lane by lane
- Volume Data (ADT/AADT)
- Origin-Destination Data/Trip Purpose
- Full Modal Split/Occupancy Data
- Incidents
- Construction
- Weather
- Events
- etc.
New/Expanding/Non-Traditional Data Sources

• CV/AV Data
  • Numerous Safety Applications: Windshield Wipers, ABS, Air Bags, etc.
• User Generated Information (UGI)
• Socio-Economic Data
• Land Use Data
• Location Based Services (LBS) Data
  • Provides Context/Trip
• Snow Plow Data
• etc.
Data “Layer Cake”

- Speed Data
- Volume/ADT/AADT
- Socio-Economic Data
- Land Use Data
- Transit Service Data
- Const./Incident/Weather
- Origin-Destination Data
- Modal Data

“Cut Through” Data Layers

- Delay Impacts
- Trip Purpose
- Toll Feasibility Study
The Power of Multiple Data Sets

- Speed Data
- Land Use Data
- Origin-Destination Data
- Social Data
- Economic Data
- Volume Data
- Freight Data
- CV/AV Data
- Mode Split Data
- Future Source

EVERYBODY LIES
BIG DATA, NEW DATA, AND WHAT THE INTERNET CAN TELL US ABOUT WHO WE REALLY ARE

Seth Stephens-Davidowitz
Foreword by Steven Pinker
Impact of the Digital Economy: NYC Freight Data Sample - Selection Area

- Selected all trips the start, end or pass through the box
- Only selected fleet data and only freight profiles (i.e., no taxis)
- Selected all weight classes
OSM Map Layer Only
One Day of Freight Data in New York City
One Week of Freight Data in New York City
One Week of Freight Data in New York City – Zoomed Detail
One month of Freight Data in New York City
San Francisco Water Authority

- **Problem**: Water Main Breaks Throughout the City
- **Approach**: Assess Impacts of Heavy Trucks on Water Main Breaks
- **Data Used**: Combine Freight O-D Data with Water Main Locations and Break Locations
Return to Normal Analyses for Incident Management Programs

• Important for TSM&O/ICM Applications
  • New Performance Measurement

• Important for Toll Road Operators
  • Possible Insurance Claim for Insured Toll Authorities for Revenue Loss
Driver jumps median on US 183 near MoPac, kills 2

By: Jerry Becker

Updated: Nov 11, 2017 10:03 AM CST

AUSTIN (KXAN) - Two people were killed and three people were taken to the hospital in a three-vehicle crash Saturday afternoon in north Austin, said Austin-Travis County EMS. At least one victim was thrown from a vehicle.

Austin police said that around 3:30 p.m. a Jeep jumped the median on US 183 near MoPac, hitting two vehicles head-on in the southbound lanes.

Medics said two people - a woman in her 30s and young man under 18 - were pronounced dead at the scene. Both of the deceased victims were in a Fiat. A man and teenage girl in the same car were both taken to Dell Seton Medical Center in critical condition, along with a man in a BMW.

The freeway was closed for several hours while police cleared the crash.

Investigators are trying to figure out exactly what happened, and are asking drivers who saw it happen to call and relay details to the vehicular homicide unit at 512-974-4422.

Just a few hours later, two more people died in a crash after a driver slammed into a billboard in...
SH 183 Accident Near MOPAC – November 11, 2017

Accident occurs 3:30 pm

Return to normal ~10:30 pm
Georgia Dome Origin-Destination Assessment

- Looked at December 2017 due to Atlanta Falcons Home Schedule
- Three Home Games
  - December 3, 7 and 31
  - Vikings, Saints, Panthers

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<th>Result</th>
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<th>Score 1</th>
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<td>FALCONS</td>
<td>22</td>
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</tbody>
</table>
Georgia Dome December 2017 Waypoint Data
Georgia Dome December 2017 Waypoint Data

Number of Waypoints By Hour in Timezone: America/New_York

Driving Profile

- Consumer
- Taxi/shuttle/town car
- Field Service/Local Delivery
- For hire/private trucking

Trip Count

2017-12-30 2017-12-31 2017-12-01 2017-12-02 2017-12-03 2017-12-04 2017-12-05 2017-12-06 2017-12-07 2017-12-08 2017-12-09 2017-12-10 2017-12-11 2017-12-12 2017-12-13 2017-12-14 2017-12-15 2017-12-16 2017-12-17 2017-12-18 2017-12-19 2017-12-20 2017-12-21 2017-12-22 2017-12-23 2017-12-24 2017-12-25 2017-12-26 2017-12-27 2017-12-28 2017-12-29 2017-12-30 2017-12-31 2018-01-01
Oroville Dam Mandatory Evacuation

- Approximately 70 miles north of Sacramento
- Approximately 180,000 people evacuated
- Impacted three counties Butte, Sutter and Yuba
- Mandatory evacuation lasted three days
Mandatory evacuation order given at 4:58 pm 2/12/17
Questions?

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