Intro to Computation and Transportation

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Types of Transportation Systems

- Local Passenger Car
- Long Distance Passenger Car
- Local Commercial Vehicle Operations
- Regional Commercial Vehicle Operations
- Long Distance Commercial Vehicle Operations
- Passenger Airlines
- Air Cargo
- Transit (Bus, Subway, Regional Rail)
- Pedestrian
- Cyclist

All of These Types have been Impacted by Computing

- Huge Routing and Scheduling Problems Can be Solved for Trucking
- Intermodal Routing and Scheduling Problems can be Solved for Transit Operations
- Complex Optimization Problems Can be Solved to Develop Long and Sort Term Contracts (think Walmart, Amazon, Albertson's) with Trucking Companies
- Huge Routing, Scheduling and Crew Assignment Problems Can be Solved for Airline Operations
- Similar Routing, Scheduling and Crew Assignment Problems Can be Solved for Airline Operations under Disruptions
- Yield Management Problems for Airlines Can Be Solved (differential pricing within the same fare classes)
- Dynamic Traffic Assignment is a Possibility
- And of Course – Semi-Automated and Automated Vehicles are on the Horizon

Even Pedestrians, Cyclist and Travelers with Disabilities are Impacted by Technologies and Algorithms

- Routes (via googlemaps or other aps) can be presented to Cyclists and Pedestrians
- These can be tailored to the needs of individual pedestrians with disabilities (ongoing research at UCI, NYU, University College London)

A history of the Shortest Path Problem

- Googlemaps and the many related aps are fairly recent
- Algorithms for finding shortest paths were developed from the late 1950s onward and were fairly advanced in the 1990s.
- Computers were not able to solve these (fairly simple problems) quickly until about a decade ago..
- For large scale problems (simultaneously calculating paths for all vehicles in a network) we still have a ways to go for both algorithm development, implementation, and computing speed

Cell Phone 1987

Cell Phone 1997

Cell Phone 1997

A history of Routing and Scheduling Problems

- While we as individual consumers don't see the impact of Routing and Scheduling Algorithms
- The costs of logistics services such as UPS and Fedex, as well as Truckload Services which impact what we pay for groceries has dropped significantly
- UPS and FedEx (and later the major trucking companies) invested in developing computerised routing and scheduling systems in the 1980s
- Computer Systems were not able to solve large problems until the 1990's and not able to solve very large problems until after 2000

Revenue Management

- Broadly defined, revenue management is the process of maximizing revenue from a fixed amount of perishable inventory using market segmentation and demand management techniques.
- Fare-class (class): Each market segment is represented by a fare-class. Airline fare-classes such that a lower index refers to a higher-valued customer segment, i.e., fare-class 1 has the highest ticket price or fare of any class.
- Itinerary: The set of specific flights a traveler uses to fly between his/her origin and destination.
- Product: A combination of an itinerary and a fare-class.
- Booking limit: The maximum number of tickets (seats) that can be sold to each fare-class for a particular flight.
- Overbooking limit: The total number of tickets (seats) that can be sold for a particular flight; this limit is typically larger than the aircrafts capacity in anticipation of travelers canceling their reservations or not showing up for their flights.

Revenue Management

Each airline has a complex computer system based on algorithms that can maximize the profit on each flight based on the types of fares offered on that specific flight. On one flight, there could be as many as two dozen different fares based on different factors such as advance purchase or how many days you stay at the destination. The computer knows that, by releasing (for example) 5 seats at a very low price, 10 seats at a slightly higher price and 20 seats at a slightly higher price, it can maximize revenue as the flight fills up.

An Example – USDOT – Connected Vehicles Program

Sensors in Cars and Phones

How many sensors do you think are in cars today?

Sensors in Cars and Phones

Each car has 60-80 sensors ... manufacturers think that in the future there will be about 200

Sensors in Cars and Phones

How many sensors do you think are in typical smart phones today?

Sensors in Cars and Phones

I found a few... there are likely more

Proximity sensor (to turn the screen off when you are talking so you don't push the buttons with your face)

Motion sensor/accelerometer (to change the orientation of the screen)

Ambient Light sensor (to adjust the screen's brightness)

Moisture sensor

Gyroscope (apparently this helps with gaming, similar to the accelerometor but more accurate)

Compass

Magnetometer

Barometer (measures atmospheric pressure)

Pedometer (for health and fitness aps)

heart rate monitor

fingerprint sensors

Sensors in Cars and Trucks

Sensors in Cars and Trucks will allow for vehicle Platooning several years before we have self-driving cars

Grouping vehicles into platoons is a method of increasing the capacity of roads.

Platoons decrease the distances between cars or trucks using electronic coupling.

This capability would allow many cars or trucks to accelerate or brake simultaneously.

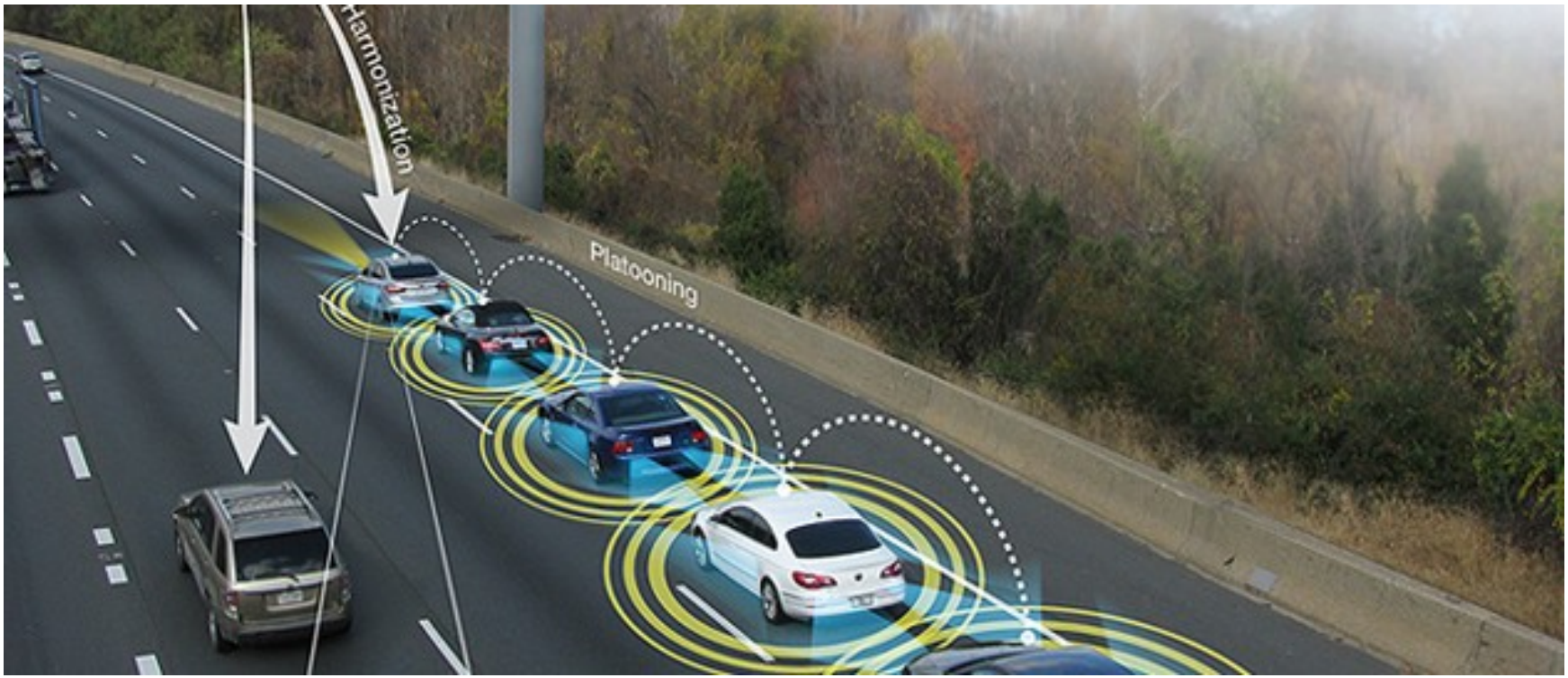
This increases the throughput and efficiency of highways and improves fuel efficiency because of reduced drag

Platooning

Platooning

California PATH

Platooning



Summary

Algorithms

Sensors

Computational Systems

Are important to all forms of Transportation

Their importance will increase over time

The promise of Intelligent Transportation Systems has come later than expected... but finally it is coming