INTELLIGENT TRANSPORTATION SYSTEMS

Lecture 1 (8 Sep 2021)
Introduction to ITS

Mozhgan Pourmoradnasseri, PhD
Mozhgan PourmoradNasseri

- 2017 - PhD in Theoretical Computer Science (Tartu)
- 2018 - Postdoc in Enumeration Algorithms (France)
- 2019 - A Deep-Tech Startup
- 2019 - Researcher with ITS Labs (Tartu)
- 2021 - Assistant Professor

  - Research interests: Human Mobility, Spatiotemporal data analysis, Mobile data, Optimization, Probabilistic Modeling
Lectures:

• Wednesdays 10:15 - 12:00, Delta (1019) & Teams (online)
  Mozhgan Pourmoradnasseri (mozhgan@ut.ee)

Labs:

• Fridays 10:15 - 12:00, Teams (online)
  Artjom Lind

Info:

• https://courses.cs.ut.ee/2021/ITS/fall
Course organization

Important dates:
Midterm exam: 27 Oct
Final exam: 8 Dec

Homework:
Every week, one week to submit.

Grading policy:
Participation(15%) + Homework(20%) + Project(25%) + Midterm Exam(20%) + Final Exam(20%) =100
- Attendance and participation (15%)
- Midterm exam (20%)
- Final exam (20%)
- Projects and presentations: (25%) (two choices)
  - Research paper (individual)
    - Critical review of selected ITS literature
    - Analysis on some topic of interest to you related to ITS
  - Creating a small application (individual or group)
    - Possible applications will be discussed during the lab sessions
- Labs: (20%)
  - First part is related to image processing and computer vision in ITS
  - Second part is about traffic simulation and working with GIS
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When has it started?

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Thousands of migrants moved westward to take advantage of new land and new economic opportunities using the National Road.

The Casselman River Bridge in western Maryland, completed in 1814.
When has it started?

Creation of Model T (1920s)

"Put America on wheels, created mass mobility, revolutionized mass production, established the American middle class and eventually reshaped the country's physical landscape with suburban sprawl." (ref: WSJ)
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Federal-Aid Highway Act of 1956

$25 billion for the construction of 41,000 miles (66,000 km) of the Interstate Highway System.

The largest public works project in American history through that time
The first motorway ever built in the world was opened in Sep 1924.
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Motorway construction in European nations by 2012.
Connecting Europe: The new EU core transport network

- safer and less congested travel
- smoother and quicker journeys
- increasing efficiency
- reducing CO2 emissions
- ...

Note: the nine TEN-T core network corridors are based on the CEF and TEN-T Regulations (1316/2013 & 1315/2013); they have been created as a coordination instrument to facilitate the completion of major parts of the core network of strategic importance.

Source: European Commission, Directorate-General for Mobility and Transport. TEN-tc Information System
In Estonia?

Estonian national route network
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Estonian national route network
1,602 kilometers of road, amounting to 10% of the total road network

Estonian international E-roads
994 kilometers
Estonian national route network
1,602 kilometers of road, amounting to 10% of the total road network

Random fact: how many km of ice roads exist in Estonia?

994 kilometers
Why transportation system is so important?

The volume of goods and people transported follows the growth of the GDP (EU - Delphy Study on Future and Mobility).
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“mobility is perhaps the single greatest global force in the quest for equality of opportunity.”

Martin Wachs, Professor of Urban Planning at UCLA
Transportation system is an indispensable part of human activities...
**Forecasts:** 68% of the world population and 84% of Europe will live in urban areas in 2050. People above 60 will make up one-third of the population.

Requirements for transportation capability rise annually, it is increasingly difficult for the highway system to provide high-quality travel services.
Some of transport problems:

- Traffic congestion
- Delays
- Environmental impacts
- Energy consumption
- Accidents and safety
- High maintenance costs
- Land consumption
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Traditional solutions:

- Restrictions in some areas
- Increasing the fuel costs
- Fines
- ...

...
Re-think about transportation philosophy by:

- emphasizing operations and instead of a sole emphasis on conventional infrastructure;
- focusing on both mobility and sustainable transportation instead of a sole focus on mobility.
Information and communication technologies are filling the gaps.

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What is ITS?

ITS combines high technology and improvements in information systems, communication, sensors, controllers, and advanced mathematical methods with the conventional world of transportation infrastructure in order to improve transportation safety and mobility, reduces environmental impact, promote sustainable transportation development, and enhances productivity.

source: The future of Intelligent Transport Systems (ITS)
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An interdisciplinary research field; difficult to have a clear picture of the whole system.

*source: The future of Intelligent Transport Systems (ITS)*
ITS Elements

ITS Elements


The key characteristic is interconnectivity.
Architecture of ITS

**Architecture of ITS**

**Physical layer:** Nearly anything can be seen as a kind of agent, which can (1) perceive their environment; (2) have some control over their actions; (3) interact with other agents. This provides the capability to collect basic traffic data and react to environmental changes. The data in physical layer is collected by the generalized sensors and their platforms, such as roadside sensors, onboard sensors, and online social media platforms.

Architecture of ITS

**Communication layer:** provides for the accurate and timely exchange of information between ITS subsystems. It provides the protocol stacks needed to implement an information flow between the physical world and supports:

(a) data exchange inside physical layer;
(b) data exchange between physical layer and operation layer.
Architecture of ITS

Operation layer: Collects and translates data into information and knowledge. Information gathered from all elements of transportation system will be disposed or distributed. Those result of data disposal will be feedback to physical layer in the form of services in service layer.

There are three fundamental components in operation layer as follows:

- Advanced Traffic Management Systems (ATMS)
- Advanced Traveler Information Systems (ATIS)
- Advanced Vehicle Control Systems (AVCS) (also known as Advanced Driver Assistance System (ADAS))
Architecture of ITS

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**Architecture of ITS**

**Service Layer**: where services are deployed and run. The result of operation layer will be combined in order to provide better transportation services. The user of it might be **public authorities** (local, regional and national), **passenger/freight transport operators** and service providers (public and private), **fleet operators** (e.g. emergency vehicles or commercial vehicle operators). This classification may not cover every requirement, but it meets the demand of daily travel.
ITS is highly interdisciplinary.
A Future with fewer cars