Introduction to Machine Learning

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Overview

Part 05

Urban Applications

Opportunities for Machine Learning

Machine Learning Opportunities:

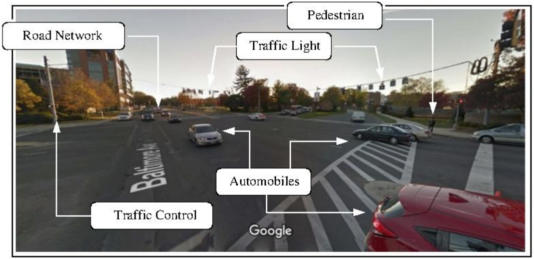
- Predicting system response and performance.
- Interpreting data and formulating models to predict component and subsystem-level properties.
- Information retrieval from images and text.
- Recognizing patterns in streams of sensed data.

Economic Considerations:

- Urban infrastructure is permanent/semi-permanent and very expensive to build and maintain.
- Prioritize improvements to efficiency by identifying and removing bottlenecks in performance.
- Use AI-ML for design of actions that enhance behavior/system performance.

Small Scale: Traffic Intersection at UMD

Goal. How to traverse a traffic intersection safely and without causing an accident?

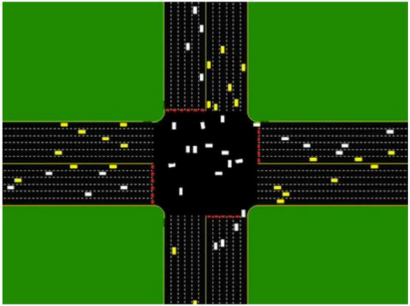


Required Capability. Observe, evaluate, reason, take actions.

Challenges. Multiple types of data, event-driven behavior, dynamic, time critical. Too much traffic congestion.

Self-Driving Cars

Goal. Improve performance by removing bottlenecks → no human driver; no traffic lights.



Remark: 95% of the requirements are for the system software.

Source: ISR visitor from GM Research.

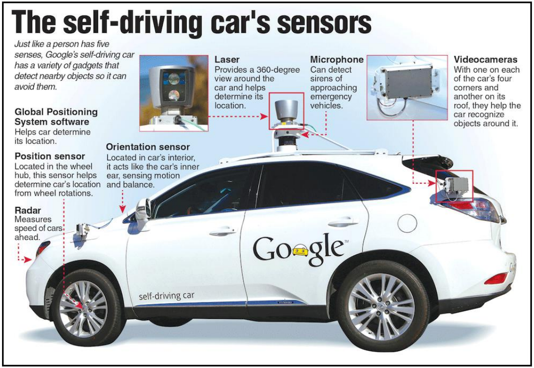
Remark: Tesla will produce self-driving cars by 2016.

Source: Elon Musk.

Stop signs and traffic lights are replaced by mechanisms for vehicle-to-vehicle communication (Adapted from http:citylab.com).

Google Self-Driving Car

Essentially: A network of sensors and computers on wheels.



Today: Modern automobiles → 100 million lines of code.
Tomorrow: Self-driving automobiles → 300 million lines of code.

Navigating a Busy Traffic Intersection

Step-by-Step Procedure:

- Identify various kinds of objects (e.g., vehicles, crosswalk).
- Predict what objects will do next.
- Conduct safety assessment.
- Take action.

Google DeepMind (2018-2020)

Teach Self-Driving Cars to Navigate a City without a Map

Test Cities: London, Paris, New York.

Research at PEER

ML Research at PEER

PEER Hub ImageNet (2018): Classification of Structural Engineering images:

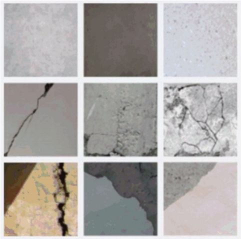


Fig 1a Pixel Level Samples

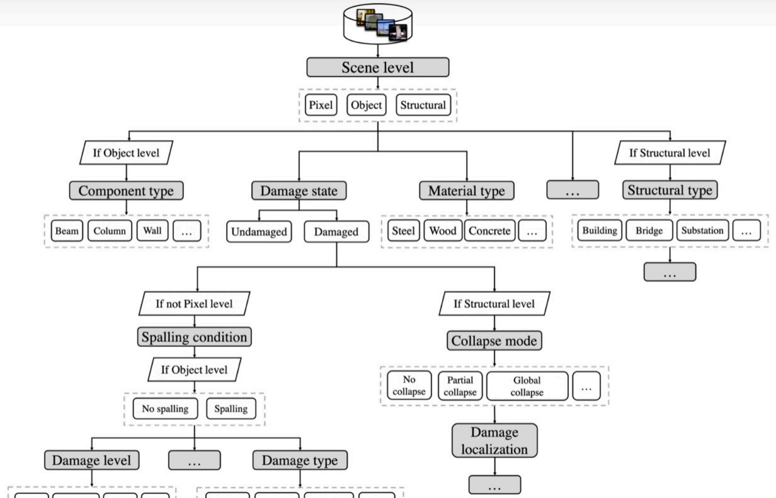
Fig 1b Object level Samples

Fig 1c Structure Level Samples

Source:
https://apps.peer.berkeley.edu/phichallenge/detection-tasks/

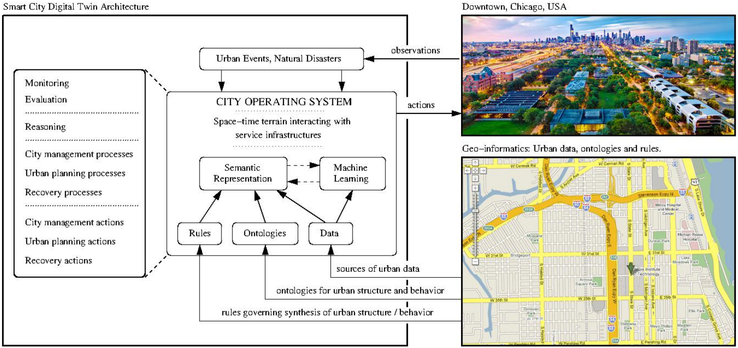
ML Research at PEER

Future Work: Create pathway from image classification to decision making:



Research at UMD

Large Scale: Management of City Operations

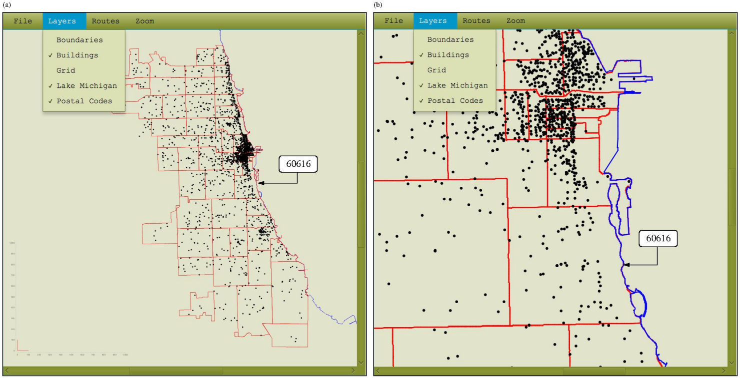


Required Capability. Modeling and Control of Urban Processes.

Challenges. Distributed system behavior/control. Decision making covers a wide range of temporal and spatial scales.

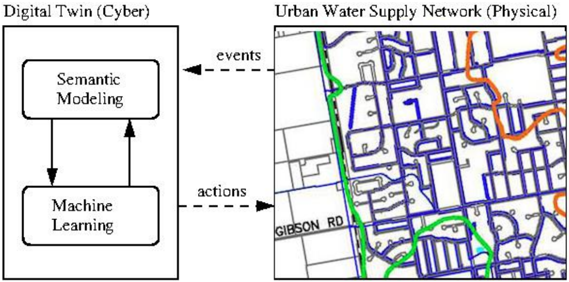
Large Scale: Management of City Operations

Case Study A (2019): Mine publically available data to understand Energy Consumption in 2,500 Buildings in Chicago.



Large Scale: Management of City Operations

Case Study B (2020): Can we teach a machine to understand the structure and behavior of water supply networks?



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References

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