AI for a Re-engineered Transportation System: *Opportunities And Challenges*

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AI for Transportation

Current Challenges

- Need to provide safe, efficient, and reliable transportation while minimizing impacts on the environment and communities

- Challenges include: congestion, traffic accidents, wasted energy, pollution, fiscal constraints, deteriorating infrastructure, response to natural disasters…etc…

Opportunity

- Our interest is primarily to utilize the tools and methods that the AI community has developed to address real transportation problems that have been quite challenging to solve using classical methods

What is AI?

Difference between Strong AI & Weak AI

- ***Strong AI:*** computer functions that have strong similarities with intelligent human reasoning

- ***Weak AI:*** computer applications that deal with limited application areas, contain practical knowledge and seem to have some intelligent features

Engineering applications of AI focus more on weak AI

AI versus Classical Approaches

- Problems involving both quantitative and qualitative data. The fact that we often have to deal with qualitative data
- Systems whose behavior hard to model with traditional approach because: (1) interactions among system components not fully understood; or (2) Significant uncertainty
- Hard optimization problems, where the relationships are hard to specify analytically or because of the problem size and its computational intractability
- Problem with emergent and complex behavior, which demands ***adaptability*** and ***learning***.

AI Limitations

A Black Box Solution
- Maps input to output
- Need for Explainable AI

No guarantee of "optimality"
- Combining Model-based and AI Methods

Little guidance on how to best apply AI
- Applying AI requires tuning several parameters

The Challenge of Liability
- The Case of AVs

Workforce Challenges
- Automation replacing human workers?
- Need for re-training the workforce

AI Application Domains

Sense & Perceive Environment

Applications that use AI and technologies such as cameras, sensors, remote sensing, and other devices to identify, detect, and track objects in the surrounding environment.

Reason & Analyze Information

Applications that use AI to analyze large quantities of data from different sources to make predictions, inferences, or categorize information in a meaningful way.

Learn from Experience & Adapt to New Situations

Applications that use AI to adjust their outputs (i.e. actions, recommendations, predictions, etc.) as they are exposed to new experiences and situations.

Make Decisions, Communicate, & Take Actions

Applications that use AI to provide information, recommendations, or automatically make changes based on the situation.

Source: Identifying Real-World Transportation Applications Using Artificial Intelligence (AI). Final Report – July 2020 Publication Number: FHWA-JPO-20-810

Sensing & Perception Examples

- Nevada and Florida DOT use an AI system (NN) for incident detection. The system fuses information from radar and loop detectors, and from the DOT's CCTV cameras

- Improvements in incident detection times of up to 12 min, along with a 17% reduction in accidents resulting from the proper positioning of assets.

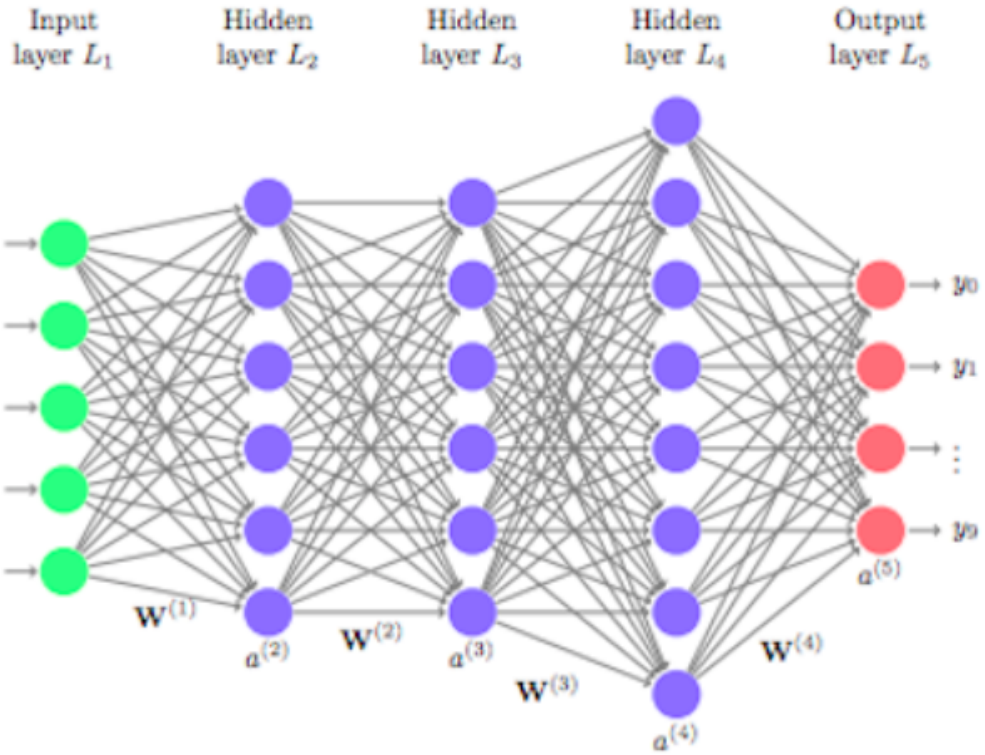
Sensing & Perception

- CMU researchers developed an AI-based image processing system for detecting and counting pedestrians at intersections

- System improved pedestrian crossing safety, and enabled increasing the walk time by 50%.

Reason & Analyze Data

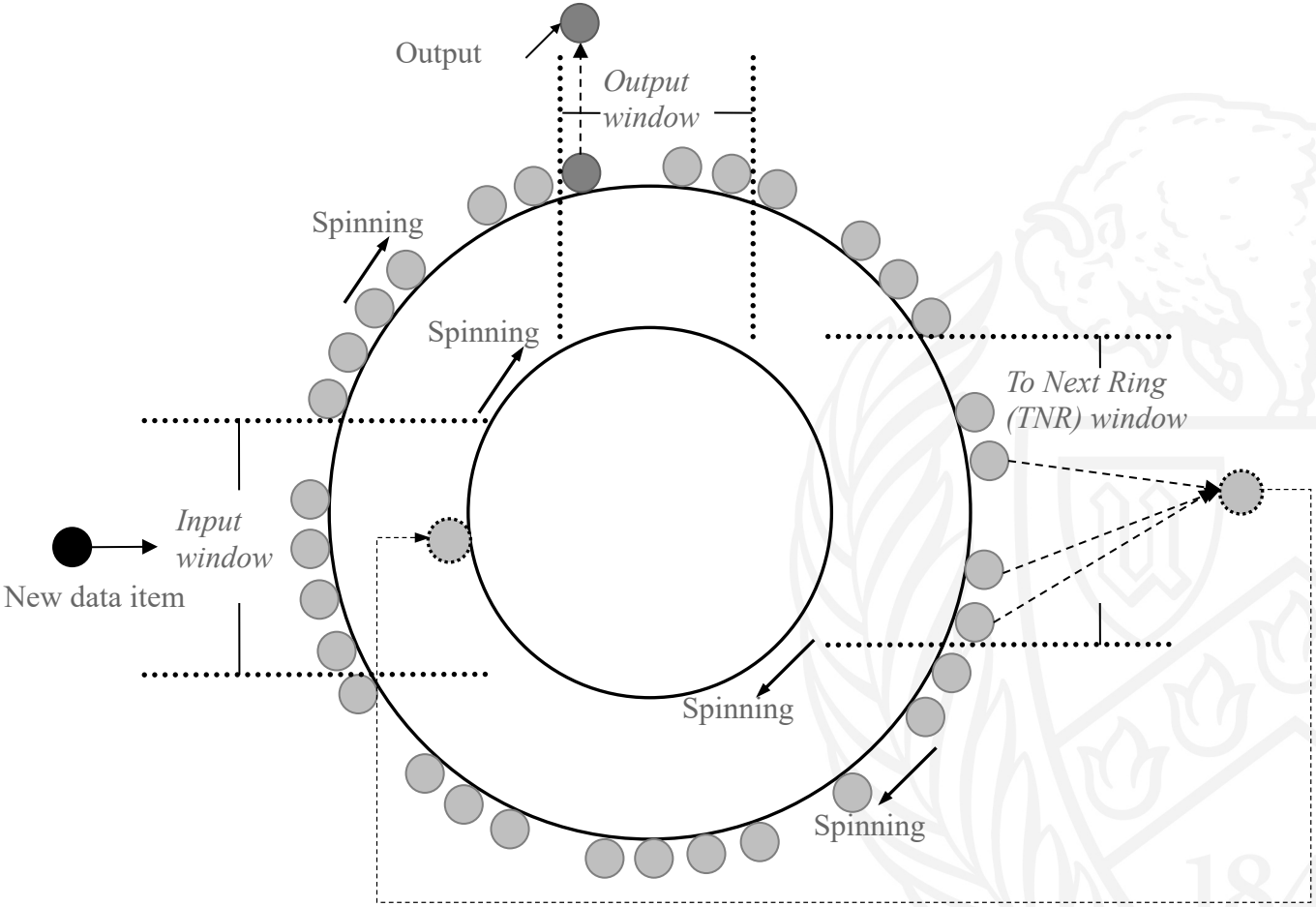
- Deep Learning Methods proposed for detecting pavement hazards (e.g., potholes), and recommending maintenance.



Source:
UC Business Analytics – R-Programming Guide

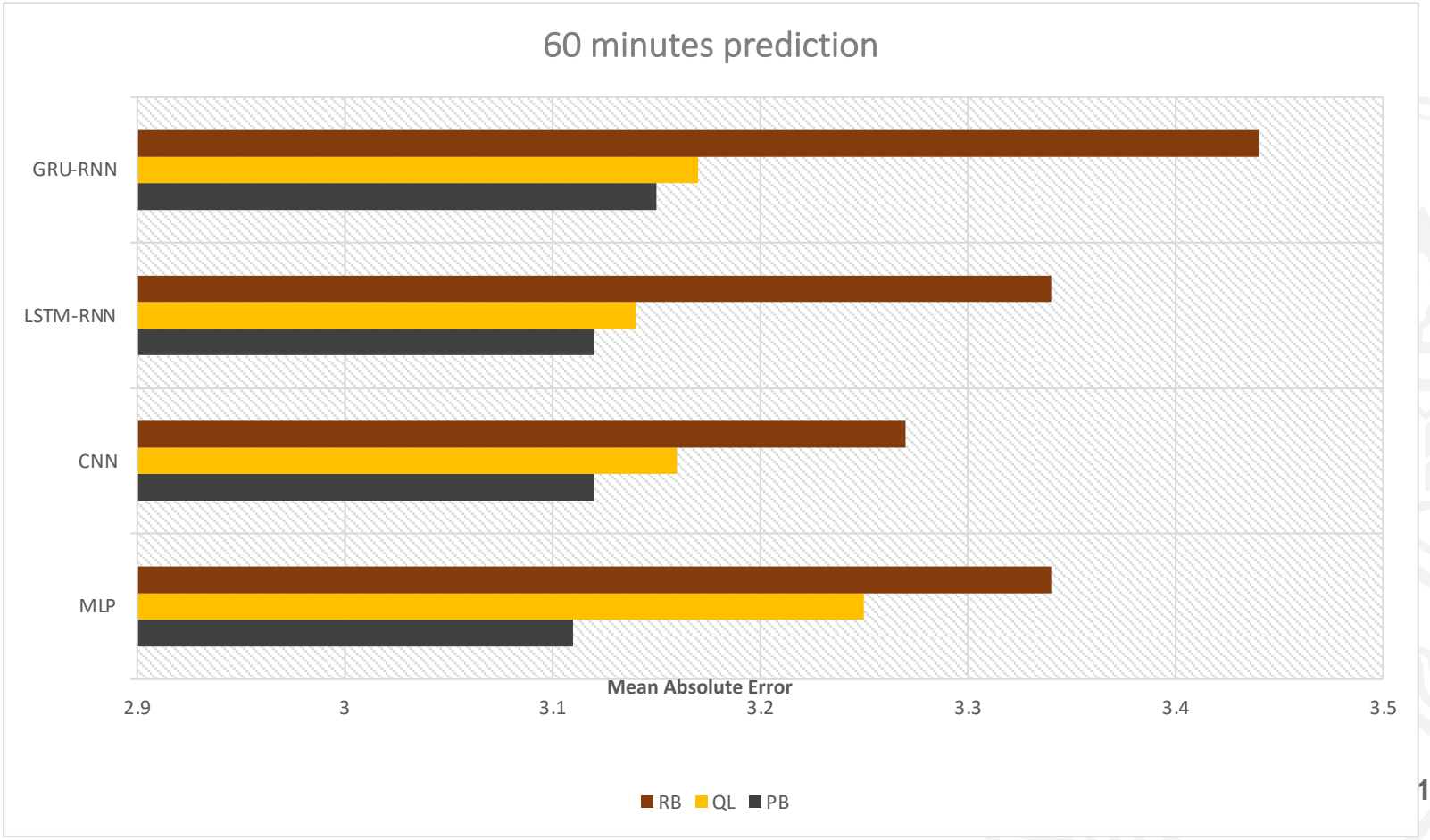
Reason & Analyze

- Short-term Traffic Prediction using Spinning Network



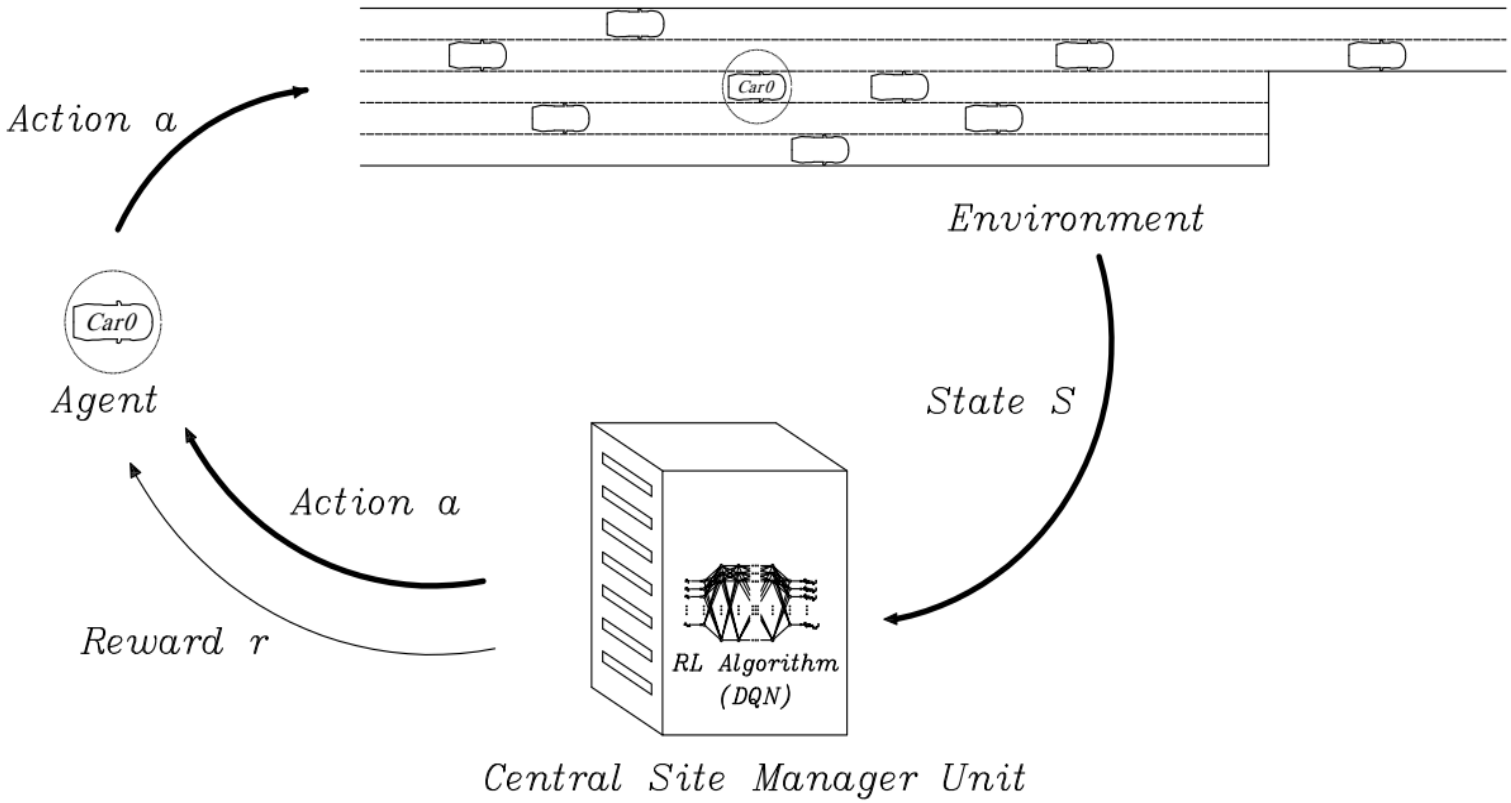
Reason & Analyze Data

Border Crossing Delay Prediction using Deep Learning



Learn from Experience & Adapt to New Situations

Reinforcement Learning for lane-change and speed control



Make Decision, Communicate & Take Actions

DelDOT is leveraging AI for traffic prediction, incident detection, and traveler info dissemination.

Using Reinforcement Learning to train NNs to manage traffic control systems as a “game” by predicting the impacts of traffic control actions and selecting the most effective

Discussion & Questions