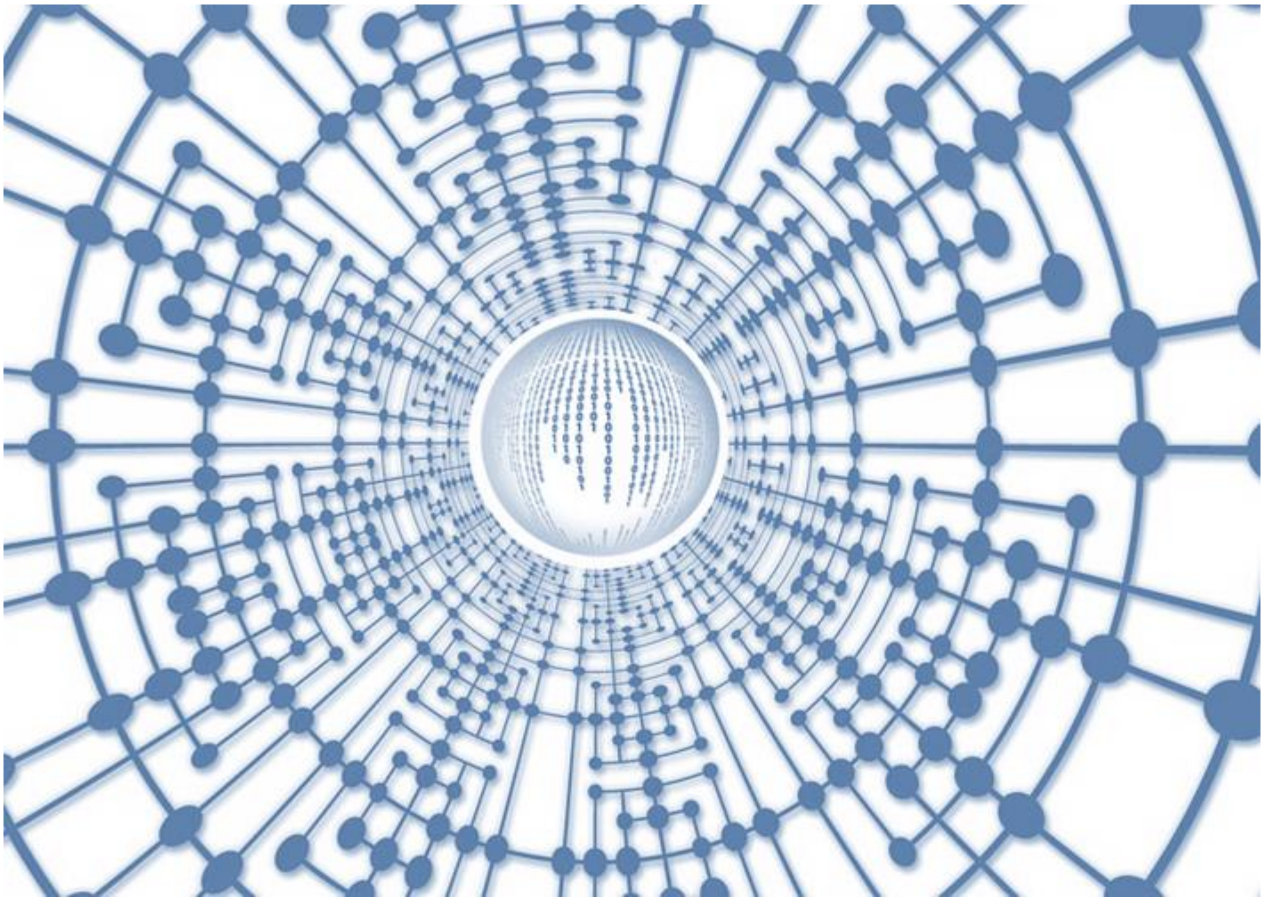
A Primer on:

Artificial Intelligence in Transportation and Public Administration



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Artificial Intelligence in Transportation & Public Administration

Advances in computing techniques, processing capacity, and data collection are enabling artificial intelligence applications in myriad real-world settings. Algorithms at the heart of artificial intelligence can provide decision support, ease labor-intensive operations, perform predictive analysis, and inform targeted outreach. In the transportation sector such applications could reduce the administrative burden at public agencies such as TxDOT, the Department of Motor Vehicles, and other state agencies with oversight of infrastructure, vehicles, and transportation services. The combination of improved hardware engineering and manufacturing and machine learning methods for image processing has enabled the collection of higher resolution traffic data with less infrastructure, thus enabling more detailed transportation planning models and improved traffic incident management. Artificial intelligence is also being used in a new wave of traffic control devices, and preliminary deployments have been promising. However, with the advent of advanced models and the significantly higher quantity of data they typically consume and produce, key challenges for stewards of data and technology will include managing complex data sources, ensuring their ethical application in decision-making, protecting the privacy of the public, and reducing cybersecurity risks.

Levels of Automation

Levels of automation range from complete human control to complete computer control. The degree to which a task is automated can be characterized by the levels defined below. Lower levels of automation enhance value by optimizing workforce productivity, while higher levels of automation reduce costs by reducing labor.

- **0** — **No Automation:** People-powered public services without automated applications
- **1** — **Task Augmentation:** Limited assistance in services, e.g., data entry, identifying clusters of activity, creating accounts, etc.
- **2** — **Close Supervision:** Routine administration of system monitoring with difficult decisions deferred to human discretion.
- **3** — **Semi-automated:** Computer systems monitoring and running simple programs, e.g., regulatory compliance monitoring.
- **4** — **Highly-automated:** Automated services except for edge cases where human intervention is required.
- **5** — **Fully-automated:** Fully automated system with no human intervention.

Application Areas

AI can provide benefits in many areas relevant to existing and emerging transportation and public agency tasks. Five applications are described below.

System & Service Planning

Comprehensive consideration of service and infrastructure development scenarios and strategies such as determining transit routes, added capacity needs, signal phasing and timing plans, funding allocation, etc. Application examples include using sensors and telecommunications to determine route choice, travel behavior, origins and destinations, transit wait times, etc.

Asset Management

Using sensors and data analytics to gather and predict insights about infrastructure and vehicle assets, their management and utilization strategies, long-term expenditure forecasts, and business management processes. Application examples include automated systems to identify pavement conditions such as cracks, ruts, and potholes and signage and striping conditions. Other applications include automated fleet vehicle diagnostics and predicative maintenance.

System Operations

Using technology and data to inform and automate strategies that optimize the safe, efficient, and reliable use of infrastructure for all modes. Application examples include intersection monitoring via camera, sensors, and telecommunications for conflict warning, pedestrian detection and notification, level-of-service monitoring, dynamic signal timing, and emergency response.

Communications & Information

Using machine learning and natural language processing to detect or respond to routine and exceptional scenarios which threaten public safety. Application examples include scanning Twitter feeds to target disaster and hurricane response efforts, identifying traffic patterns associated with dangerous road conditions or incidents, and forecasting dangerous levels of air pollution.

Business Administration

Using machine learning, data mining, and natural language processing and generation to optimize typical administrative functions such as sorting, formatting, cleaning data, populating forms, scheduling appointments, and responding to routine public inquiries. Application examples include machine vision that reads handwriting and automates sorting, software that can manage complex scheduling tasks, and chat bots that can engage in and respond to simple requests and questions from the public.

Supplemental Technologies and Systems

The following technologies, when alone or in combination, enable performance and capabilities of AI applications by serving as the backbone for data collection, efficient processing, storage, transfer, actuation, and security.

Sensors

The Internet of Things (IoT) refers to an ecosystem of discrete computing devices that have internet-connected sensors. In Smart City applications, strain gauge sensors can be used for infrastructure health monitoring, air quality sensors can provide a granular picture of pollution through time and region, and in-ground vehicle detection sensors can paint a realistic picture of parking availability and demand. Artificial intelligence applications to interpret these sensor-collected data streams are synergistic with the benefits already unlocked from the higher granularity and greater scope of information, enabling real-time control, such as demand-responsive parking pricing, road and weather condition alerting, and informative, real-time air quality advisories.[1]

Telecommunications

Certain artificial intelligence applications require low latency, or low delay, communications networks to function properly and safely. Connected and automated vehicle-to-vehicle applications are a classic example of an automated system that demands low latency communications. 5G networks will provide lower latency, higher bandwidth, and more reliable communications than present 4G-LTE networks can, enabling the implementation of increasingly sophisticated AI applications which depend on near-instantaneous data transfers, high volumes of data, or secure and reliable networks.[2]

Backhaul

Legacy information technology (IT) infrastructure may not be capable of gathering program data at scale, hindering AI applications for streamlined business administration. They may also not be interoperable across multiple databases, limiting the breadth of data that could be used to train sophisticated AI algorithms. Public IT systems need to be critically evaluated to identify how to replace, modify, and retire systems to accommodate modern systems that provide a platform to develop and deploy memory-intensive AI applications.

Storage

Cloud-based data management and computing can enable public agencies to store data remotely rather than through on-premise storage resources, reducing system maintenance costs.[3] Some cloud-computing vendors such as Amazon Web Services and Google Cloud are also packaged with AI-based bot services which some public agencies have already employed for customer service applications.[4]

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[1] http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/
[2] http://www.gtigroup.org/d/file/Resources/rep/2018-02-22/a97b3970bb0111fa348e833074251de8.pdf
[3] https://www.komprise.com/glossary_terms/cloud-data-management/
[4] https://www.datamation.com/cloud-computing/artificial-intelligence-as-a-service-ai-meets-the-cloud.html

Blockchain

Just as increased environmental sensing through the Internet of Things enables advanced AI application, cybersecurity of data transmission and control systems enables IoT. IoT systems are uniquely challenging to secure because sensors may not individually possess great processing power and thus are not designed with attention to cybersecurity. However, a system of sensors that IoT and AI applications demand could transmit valuable and sensitive information. Blockchain-based systems are being researched for their application in securing internet-connected devices while requiring little processing power, memory, and hardware; securing IoT smart city applications will be paramount to their success in implementing advanced AI solutions.[5]

Opportunities & Next Steps

With AI adoption (as with any emerging technology), there is some risk of failure which must be balanced against the risk of enterprise obsolescence or non-competitiveness in the present era of technological and analytical innovation. Successful agencies can mitigate risk by integrating AI programs incrementally and developing a vision and committing resources for a long-term strategy. Developing that strategy starts with a fundamental understanding of capabilities and limitations. Outlining viable paths to incremental inclusion of proven AI applications will help public agencies achieve benefits such as cost reduction, increased productivity, improved resource availability and reliability, and optimal performance.

Next steps include:

- **Developing a Portfolio of Applications:** Provide a scan of literature, industry, and media to develop a comprehensive list of applications grouped by category (transportation planning, maintenance, operations, communications, and administration).
- **Present & Prioritize:** Provide a presentation of preliminary findings and seek feedback on critical application areas of interest to down select 3-5 applications for deep-dive investigation.
- **Subject Matter Expert Interviews:** Conduct deep-dive interviews with software and technology developers as well as with public agencies with implementation experience to understand lessons learned, setup and utilization requirements, needed data, cost, etc.
- **Tech Memos:** Develop technical memorandums on priority applications with lessons learned by deploying agencies on data and hardware requirements and other technical considerations.
- **Full Report:** Develop final report with recommendations on paths forward for application integration and continued application discovery.

[5] https://www.scientificamerican.com/article/using-blockchain-to-secure-the-internet-of-things/