Research Statement: Data Science for Smart Cities

My research passion lies in discovering real-world problems with authentic large-scale data and resolving these problems by creating solid solutions that transform science and daily life with interdisciplinary knowledge. My current research focuses on developing innovative Trustworthy Machine Learning, Data Science, Human-Centered Computing, and Cyber-Physical Systems, techniques to address real-world scientific and societal challenges related to *fairness, privacy, safety, scalability, resiliency*, and *sustainability* in different application domains including Mobility, Smart & Connected Community, Healthcare, Economy, and Climate Change.

In particular, I have developed a generic closed-loop research framework by integrating three thrusts, i.e., Spatio-temporal Data Mining, Trustworthy Decision-making, and Generative AI, with a special highlight in the closed loop. I consider this integration of the three thrusts as the core theme of my research, as shown in Fig. 1.
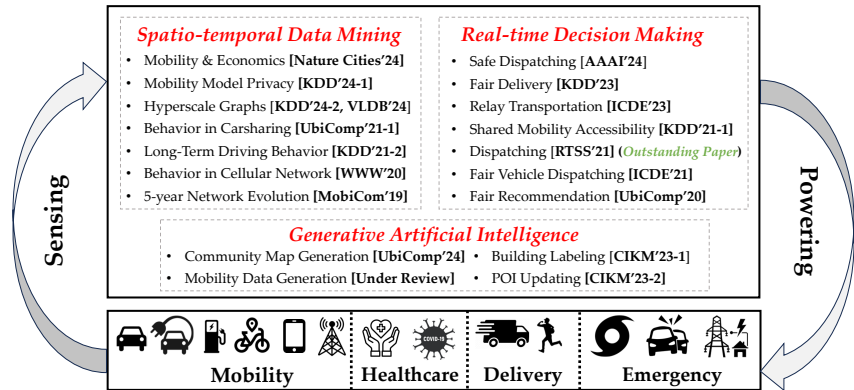

Fig 1: Research Overview

My research on data science for smart cities aligns closely with the mission of the Institute for Successful Longevity (ISL), which focuses on enhancing the quality of life and promoting well-being, particularly for aging populations. ISL's goals of fostering longevity through improved health and safer living environments can be supported by my work in domains such as mobility, healthcare, and emergency response.

One of the core themes of my research is the development of smart and connected communities that are inclusive and adaptable to the unique needs of elderly populations. By leveraging Spatio-temporal Data Mining, we can uncover patterns in mobility, healthcare access, and community engagement that are crucial for designing age-friendly cities. These cities would support independent living, allowing older adults to move about safely and easily while maintaining access to essential services like healthcare and social interaction. For example, by analyzing large-scale mobility data, we can propose solutions to optimize transportation accessibility and walkability, ensuring older adults can navigate their communities with ease and confidence.

Another critical aspect of our research is Trustworthy Decision-making, which is key to ensuring that the data and algorithms used in these smart systems are fair, secure, and aligned with the ethical considerations essential for ISL's mission. Our work in Trustworthy Machine Learning specifically addresses concerns about bias, privacy, and safety in data systems, which are paramount when designing solutions for vulnerable populations such as older adults. By ensuring that machine learning models are fair and privacy-preserving, our research helps protect personal data while providing actionable insights for improving the quality of life for seniors, such as through predictive health interventions or fall detection systems.

Our work also focuses on Generative AI, which allows for the creation of synthetic data that can be used to simulate various scenarios, such as healthcare resource distribution or emergency responses tailored to the elderly. This capability can enhance the resilience of urban infrastructure, ensuring it can adapt to both routine needs and crises such as pandemics or natural disasters, where the elderly are often the most affected. Moreover, Generative AI can facilitate the development of new technologies in smart healthcare, such as AI-powered diagnostics and personalized treatment plans, which can contribute to healthier and longer lives for aging populations.

In essence, our research provides a pathway to transform science into real-world solutions that directly contribute to the goals of the Institute for Successful Longevity. By integrating Spatio-temporal Data Mining, Trustworthy Decision-making, and Generative AI, we aim to create technological innovations that enhance urban life, improve healthcare, and support the well-being of older adults, thus aligning with ISL's vision of fostering a more inclusive and supportive world for the elderly.