Title: Data Analytics for Enhancing Power Distribution System Monitoring

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Abstract: As the penetration of distributed energy resources (DERs) increases, the distribution system is gradually shifting from a traditional grid to a smart grid. This calls for developing advanced real-time monitoring frameworks to ensure reliable and resilient electricity supply. However, there have been several challenges in achieving effective grid monitoring in actual distribution systems, including limited real-time sensors, incomplete or outdated system models, and uncertainty in data quality. Researchers and practitioners are exploring a variety of strategies to address these challenges. Recently, the deployment of advanced metering infrastructure (AMI) in distribution systems provides a unique opportunity to extend the monitoring capability to grid edges. This dissertation demonstrates a comprehensive grid monitoring framework that permits unlocking the untapped potential of AMI data using machine learning, graph theory, and optimization. More precisely, we will present multiple novel data-driven approaches to implement distribution system modeling, real-time distribution state estimation, and outage detection and location in this presentation.