A Unified Model for Smart Meter Data Applications

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Making adequate utilization of smart meter data is conducive to improving the energy efficiency of the power system from demand side, especially with booming artificial intelligence (AI) technology. However, most existing AI-based methods are highly incompatible to each other due to unique designs based on their respective tasks. Low compatibility will lead to duplicate modeling among similar tasks and skyrocketing implementation costs, which is not suitable for diverse and changing demand-side tasks. Although large language models provide a promising way to build the general-purpose models, they either need substantial resources for pre-training or case-by-case design for fine-tuning. Hence, there are practically rare task-generic models available for power systems. In this paper, we propose a novel unified model for smart meter data applications. Specifically, we first propose a unified model with mixture-of-expert layers to ensure sufficient model capacity in a cost-effective manner, which makes the training from scratch affordable. Then, we design an information bottleneck-based training scheme to facilitate the unified model to efficiently learn the generic knowledge. Moreover, we develop a general framework based on pre-training paradigm to formulate a uniform objective function and provide a consistent workflow for different tasks. Finally, the effectiveness and superiority of our proposed method are validated on public datasets, where the proposed unified model can be applied to load forecasting, data imputation as well as anomaly detection, and realizes comparable performance to state-of-the-art task-specific methods.

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