Transfer Learning for Time Series Forecasting in Integrated Energy Systems

Motivation and Background

The rapid expansion of integrated energy systems (IES) underscores the need for highly accurate time series forecasting to support effective energy planning and scheduling. However, various IESs differ in both focus and stage of development, it can be challenging to assemble the necessary data for these forecasts. This challenge necessitates the robust forecasting models that can leverage existing knowledge from related tasks and adapt to varying data availability.

This thesis focuses on transfer learning for time-series forecasting in tasks that exhibit different yet closely related characteristics, such as PV power generation and load forecasting. Both are driven by time-dependent factors and are strongly influenced by weather conditions, as illustrated in Fig. 1. We aim to transfer Temporal Fusion Transformer (TFT)-based forecasting models from data-rich source tasks to target tasks with limited data, as shown in Fig. 2.

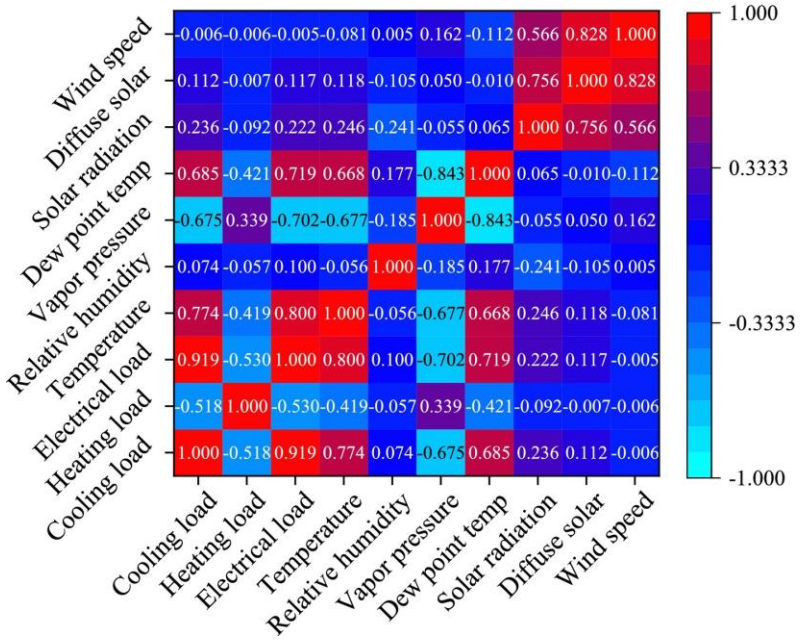

Fig. 1 Coupling relationships between multi-energy loads and weather conditions

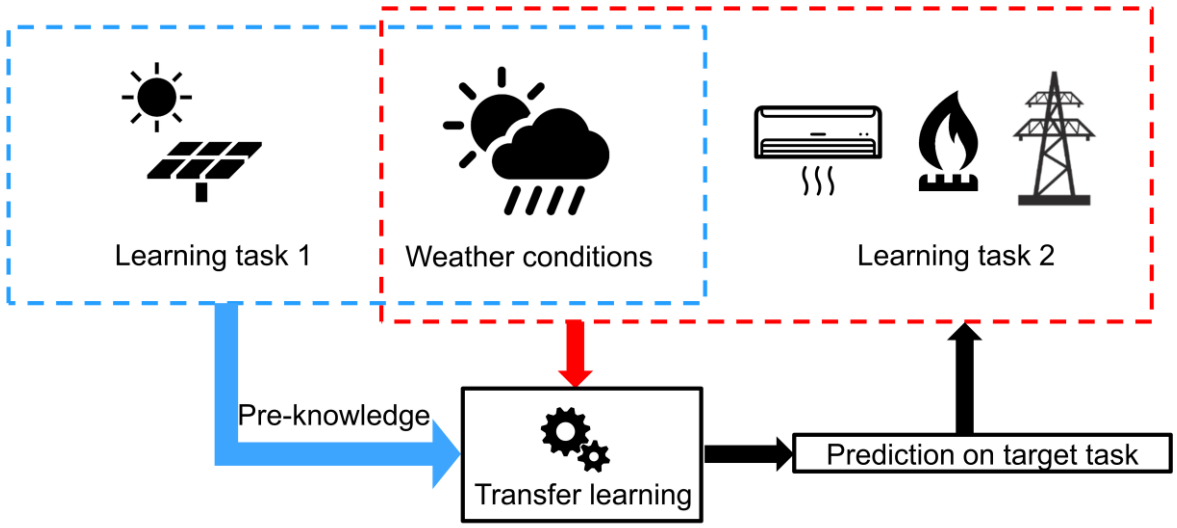

Fig. 2 Transfer learning between tasks exhibiting different yet closely related characteristics

Tasks and expected outcomes

This research seeks to develop a transfer learning framework for time series forecasting in IES domain, enabling adaptive knowledge transfer between source and target tasks. The main objectives include:

- Investigate the TFT architecture and TL-related knowledge for time-series prediction.
- Design and conduct model transfer experiments leveraging the TFT architecture.
- Implement transfer learning approaches across various tasks to reduce data dependence while improving accuracy.
- Evaluate and analyze the impact of different transfer strategies on forecasting performance, and enhance model adaptability through online learning.

Requirements

We are looking for a highly motivated student with the following qualifications:

- Basic knowledge of Integrated Energy Systems desirable and strong interest in time series prediction and transfer learning.
- Basic understanding of machine learning, ideally with experience in transformer-based models or similar architectures (e.g., RNN/LSTM).
- Experience in Python and familiarity with deep learning frameworks such as TensorFlow or PyTorch (optional).
- Strong problem-solving skills and the ability to work independently in a structured manner.

Application

If you are interested in working on this or a related topic, please contact Kun Fu and state your motivation as well as your relevant prior knowledge and qualifications.

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