TUTORIAL

MULTI-MODAL AND TEMPORAL REPRESENTATION LEARNING FOR ELECTRONIC HEALTH RECORDS

Introduction

Electronic Health Records (EHRs) represent an unprecedented opportunity for data-driven discovery and precision medicine. However, this potential is locked within data that is notoriously complex: it is heterogeneous, mixing structured codes and labs (Matrix) with unstructured clinical notes (Text), all embedded within complex relational structures (Graph). Furthermore, this data is dynamic, evolving irregularly over time.

Traditional methods often fail, focusing on only one data type or struggling with temporality. This tutorial provides a guide to modern representation learning, the key to unlocking these complex datasets. We will systematically explore the three dominant paradigms for modeling EHRs—Matrix, Text, and Graph-based approaches. Participants will move from foundational concepts to advanced, state-of-the-art fusion strategies that create a single, holistic patient representation. Join us to gain the essential framework and techniques needed to transform messy clinical data into actionable, life-saving insights.

About the Lecturer

Yi-Ju Tseng is Professor at National Yang Ming Chiao Tung University (NYCU) Digital Health Lab with extensive experience in claims data and electronic medical records analysis and machine learning. Before joining NYCU as an associate professor in 2022, Tseng was an associate & assistant professor at NCU and CGU, and a postdoctoral research fellow at CHIP Boston Children's Hospital & Harvard Medical School.

Tseng and collaborators at CGMH have developed a clinically applicable system for rapidly predicting antibiotic susceptibility using MALDI-TOF data and AI. She has developed several models for diagnosis of infection, clinical outcome prediction, and risk assessment. Tseng also designed and developed a healthcare-associated infection surveillance system for NTUH. These systems have become indispensable tools for infection control programs at NTUH. Her group is developing a series of R packages for accelerating clinical data analysis.

Her work focuses on improving infection surveillance by using informatics techniques and applying machine learning technology to clinical research.

Objectives

This tutorial aims to equip researchers, students, and practitioners with a unified understanding and the practical skills needed to tackle multi-modal and temporal challenges in EHR data.

Participants will learn to:

- Understand the fundamental challenges of EHR data (e.g., irregularity, sparsity, multimodality).
- Master the principles of three core representation paradigms:
    i. Matrix/Tensor-based: For temporal structured data (labs, vitals) using deep representation learning.
    ii. Text-based: For unstructured clinical notes using modern Transformers (e.g., ClinicalBERT).
    iii. Graph-based: For relational data (e.g., medical ontologies, patient graphs) using GNNs.
- Analyze and compare different fusion strategies (e.g., early, late, cross-modal attention) to integrate these diverse data sources.
- Apply these methods in a practical context, from data preprocessing to model evaluation.

The tutorial is structured to build knowledge systematically. We will begin with a foundational overview of EHR data and its analytic challenges. We will then dedicate significant time to deep dives into each of the three representation paradigms (Matrix, Text, Graph), covering their core models and use cases. Finally, the session will conclude with a practical case study (e.g., mortality or sepsis prediction) using a public dataset like MIMIC-IV, covering crucial topics like cohort selection, evaluation metrics (AUROC vs. AUPRC), and model interpretability.

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