

## **Explainable Machine Learning For Healthcare Cost Optimization: A Time-Driven Approach**

Efficient cost and resource allocation in healthcare is essential for the sustainability of hospital operations and patient-centered initiatives. However, this can be a complex issue due to the extensive scope of work and the difficulty in maintaining economic models designed for these evaluations. In recent years, machine learning (ML) has been increasingly adopted to support healthcare decision-making, but despite its predictive power, a major limitation remains: the lack of interpretability in many models, which hinders trust and usability by medical personnel.

In this study, we use the electronic medical records of 2800 cardiothoracic surgery patients of Santa Marta's Hospital and propose a novel approach that integrates ML with mathematical optimization to provide interpretable insights for healthcare cost analysis. Our methodology incorporates set covers within a clustering algorithm to identify representative patient cohorts, addressing the explainability gap in current ML approaches. Subsequently, we apply the Time-Driven Activity-Based Costing model to estimate the cost of each patient type by mapping clinical activities to time-based resource consumption. By combining optimization techniques with interpretable machine learning, our approach provides a transparent framework for healthcare cost analysis. This supports more informed decision-making, aligns with the growing demand for explainable ML in healthcare, and enhances communication between technical and clinical stakeholders.

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**Session Classification:** Session 2.5 - AI and OR in healthcare

**Track Classification:** Session 2.5 - AI and OR in healthcare