**Efficient Solubility Prediction of Polymers in Gases, Vapors, and Supercritical Fluids Using Light Gradient Boosting Machine Framework**

**ABSTRACT**

This project focuses on predicting the solubility of Polymers in gases, vapors, and supercritical fluids using Light Gradient Boosting Machine (LightGBM) framework. The solubility behaviour of these substances in polymers plays a critical role in various industrial processes, including material design and optimization. Traditional methods for predicting solubility rely on experimental data, which can be time-consuming and costly. This study employs LightGBM, which exhibits high performance in predicting the intricate relationships between molecular structure and solubility.By training the model on a diverse dataset of polymers and solvent values, this approach generalizes and predicts solubility for new, uncharacterized materials. This work aims to accelerate the design of polymer-based materials for specialized applications by providing accurate, efficient, and scalable solubility predictions without the need for extensive experimental testing.