

## SmartOpt — Simple AI-Powered Code Optimizer

### Overview

SmartOpt is a **prototype compiler optimization advisor** for **C, C++, and Rust** programs. It analyzes user-submitted code, compiles it with different optimization flags (like -O0, -O1, -O2, -O3, and -Os), and identifies which flag performs best based on **runtime, compile time, and binary size**.

This is a **simple, working prototype** — not a research-level mathematical optimizer. It focuses on **small code samples** and **basic loops, operations, or functions**, not on advanced workloads (like matrix multiplication, sin/cos, or heavy math libraries).

### Current Capabilities

- Supports **C, C++, and Rust**
- Benchmarks compile time, runtime, and binary size
- Provides **best optimization flag**
- Uses a simple **ML model** (RandomForest/XGBoost) for prediction
- Optional **LLM explanation** (Gemma-2B) for plain-language insights
- Automated deployment via **Jenkins + Cloud Run**

### Limitations (for prototype phase)

- Designed for **simple code snippets** only
- No mathematical or high-complexity workloads (e.g., sin, cos, matrix math)
- Binary sizes may appear similar for small programs
- Focused on functionality, not precision modeling

### Future Enhancements

- Add support for **mathematical and scientific workloads**
- Improve ML model using **code-level feature extraction**
- Introduce **GNN or RL-based learning** for better predictions
- Add advanced benchmarking and metrics visualization
- Integrate more languages and improve frontend UX

### Purpose

The goal of this version is to **demonstrate concept and workflow** — how DevOps automation (Jenkins + GCP) and Machine Learning can work together in compiler optimization.

It's not about mathematical depth — it's about building a **working, cloud-based AI compiler advisor**.