

Methodology

This section describes the implementation methodology and experimental setup used in the optimization project.

Algorithm Implementation

Gradient Descent Algorithm

The core algorithm implements the following iterative procedure for unconstrained optimization:

Input: Initial point $x_0 \in \mathbb{R}^d$, step size $\alpha > 0$, tolerance $\epsilon > 0$, maximum iterations $N_{\max} \in \mathbb{N}$

Output: Approximate solution $x^* \approx \arg \min f(x)$

Algorithm 1: Gradient Descent

***Input:** Initial point x_0 , step size α , tolerance ϵ , max iterations N_{\max}*

1. Initialize $k \leftarrow 0$
2. **While** $k < N_{\max}$ **do:**
 - ▶ Compute gradient $g_k = \nabla f(x_k)$
 - ▶ **If** $\|g_k\|_2 < \epsilon$ **then return** x_k (converged)
 - ▶ Update: $x_{k+1} \leftarrow x_k - \alpha \cdot g_k$
 - ▶ $k \leftarrow k + 1$