

# Playground

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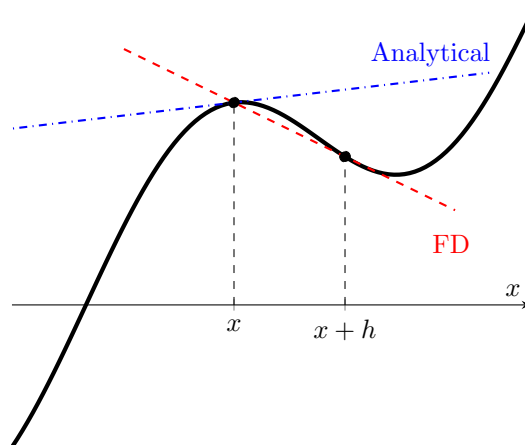


Figure 1: Forward Finite Difference

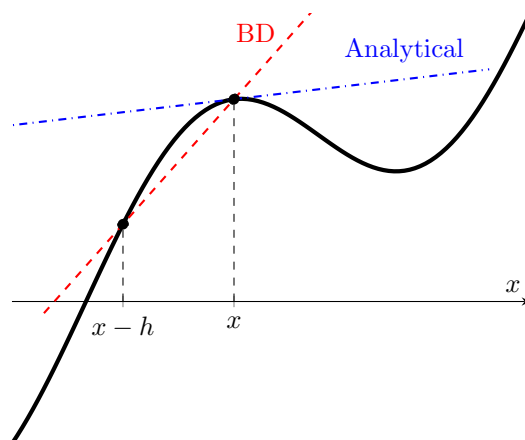


Figure 2: Backward Finite Difference

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**Algorithm 1:** Hill Climbing Algorithm

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**Data:**  $x_i$

**Result:**  $x_n \leftarrow$  last solution candidate

$x_0 \leftarrow$  starting solution candidate;

**for**  $i \in \{0, \dots, n\}$  **do**

$x_{\text{neighbor}} \leftarrow$  select best neighbor from  $x_i$  neighborhood;

$\Delta \text{cost} \leftarrow$  compute cost difference between  $x_{\text{neighbor}}$  and  $x_i$ ;

**if**  $\text{cost}(x_{\text{neighbor}})$  is better than  $\text{cost}(x_i)$  **then**

**Accept**  $x_{i+1} \leftarrow x_i$ ;

**else if**  $\text{cost}(x_{\text{neighbor}})$  is worse than  $\text{cost}(x_i)$  **then**

**Terminate** Search;

**end**

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**Algorithm 2:** Simulated Annealing Algorithm

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**Data:**  $T_i, x_i$

**Result:**  $x_n \leftarrow$  last solution candidate

$T_0 \leftarrow$  initial temperature of cooling schedule;

$x_0 \leftarrow$  starting solution candidate;

**for**  $i \in \{0, \dots, n\}$  **do**

$x_{\text{neighbor}} \leftarrow$  randomly sample a neighbor from  $x_i$  neighborhood  
        using uniform distribution;

$\Delta \text{cost} \leftarrow$  compute cost difference between  $x_{\text{neighbor}}$  and  $x_i$ ;

**if**  $\text{cost}(x_{\text{neighbor}})$  is better than  $\text{cost}(x_i)$  **then**

**Accept**  $x_{i+1} \leftarrow x_i$ ;

**else if**  $\text{cost}(x_{\text{neighbor}})$  is worse than  $\text{cost}(x_i)$  **then**

**if** probability  $e^{-\Delta \text{cost} / T_i}$  **then**

**Accept**  $x_{i+1} \leftarrow x_i$ ;

**else**

**Reject** Do nothing;

**end**

**end**

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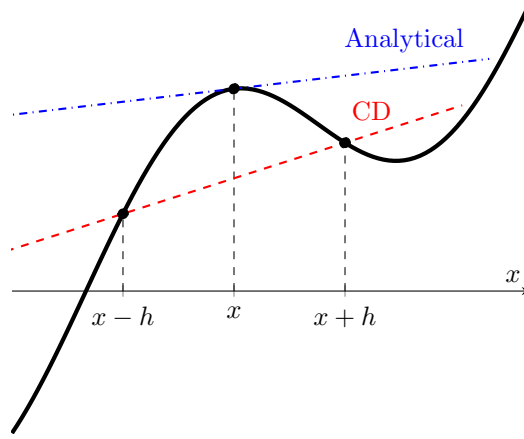


Figure 3: Central Finite Difference

Assumptions	
Steady & Fully developed $\Rightarrow 1$	$\frac{\partial}{\partial t} = 0$ , $\frac{\partial}{\partial x} = 0$
No-Slip Condition $\Rightarrow 2$	$\mathbf{u}(x, 0) = \mathbf{0}$ , $\mathbf{u}(x, d) = \begin{bmatrix} U \\ 0 \end{bmatrix}$
Constant Pressure $\Rightarrow 3$	$\frac{\partial p}{\partial x} = 0$ , $\frac{\partial p}{\partial y} = 0$
Newtonian Fluid	constant viscosity ( $\nu$ )
Incompressible	constant density ( $\rho$ )
Laminar & Purely axial	$v = 0$

Assumptions	
Steady & Fully developed $\Rightarrow 1$	$\frac{\partial}{\partial t} = 0$ , $\frac{\partial}{\partial x} = 0$
No-Slip Condition $\Rightarrow 2$	$\mathbf{u}(x, 0) = \mathbf{0}$ , $\mathbf{u}(x, d) = \mathbf{0}$
Constant Pressure $\Rightarrow 3$	$\frac{\partial p}{\partial x} = -G$ , $\frac{\partial p}{\partial y} = 0$
Newtonian Fluid	constant viscosity ( $\nu$ )
Incompressible	constant density ( $\rho$ )
Laminar & Purely axial	$v = 0$

Assumptions	
Steady & Fully developed $\Rightarrow 1$	$\frac{\partial}{\partial t} = 0$ , $\frac{\partial}{\partial x} = 0$
No-Slip Condition $\Rightarrow 2$	$\mathbf{u}(x, y, z) = \mathbf{0} \iff \sqrt{y^2 + z^2} = R$
Constant Pressure $\Rightarrow 3$	$\frac{\partial p}{\partial x} = -G$ , $\frac{\partial p}{\partial y} = 0$ , $\frac{\partial p}{\partial z} = 0$
Newtonian Fluid	constant viscosity ( $\nu$ )
Incompressible	constant density ( $\rho$ )
Laminar & Purely axial	$v = 0$ , $w = 0$

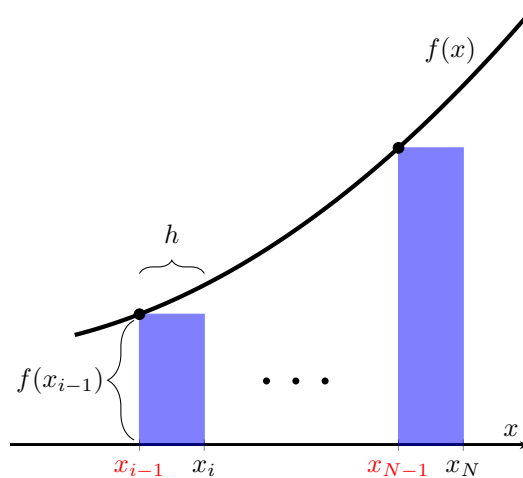


Figure 4: Rectangle Method Left Point Rule

## References

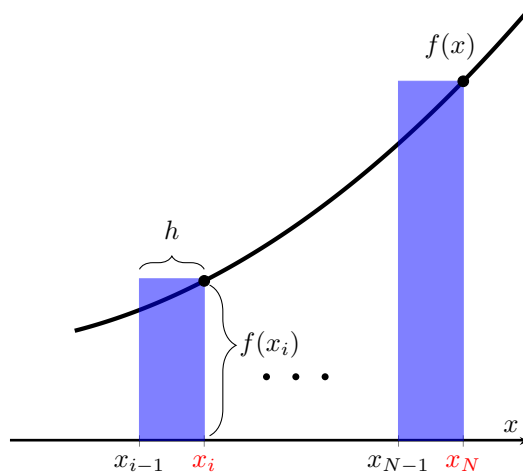


Figure 5: Rectangle Method Right Point Rule

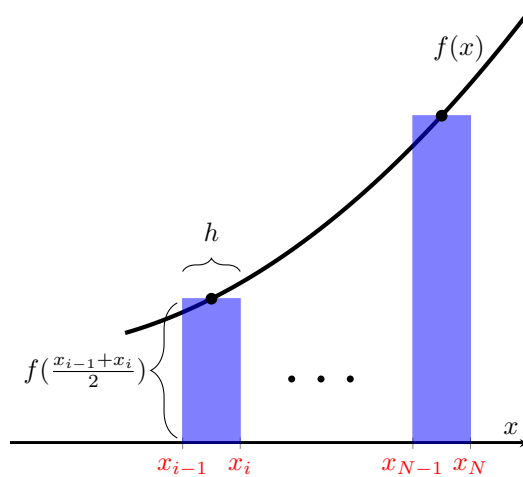


Figure 6: Rectangle Method Midpoint Rule

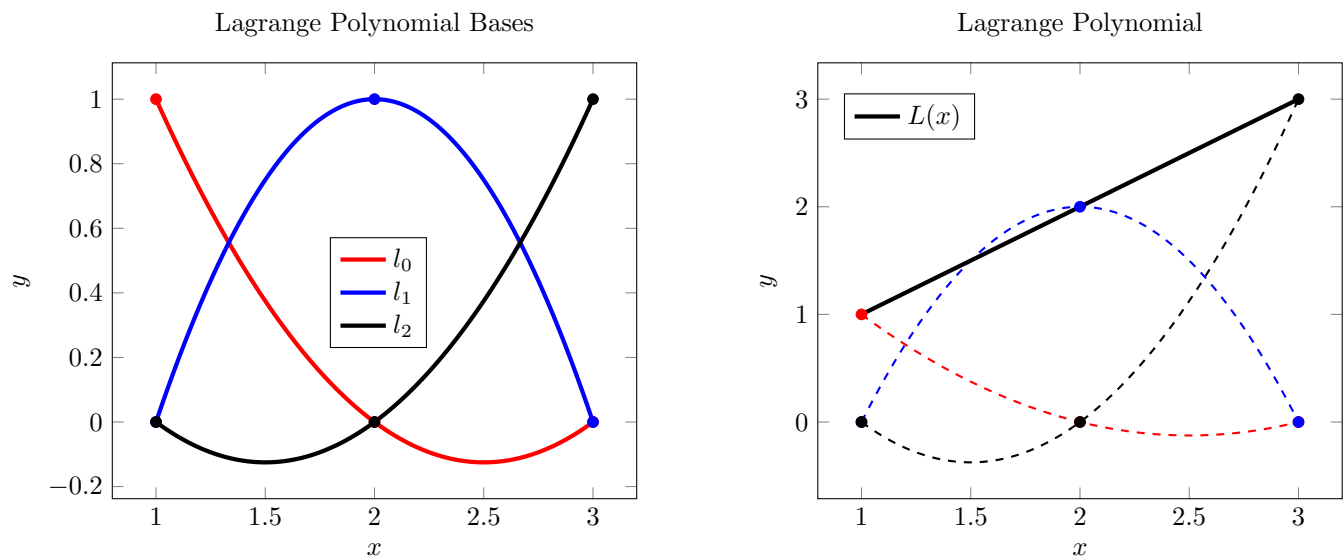


Figure 7: Lagrange Polynomial and its Bases

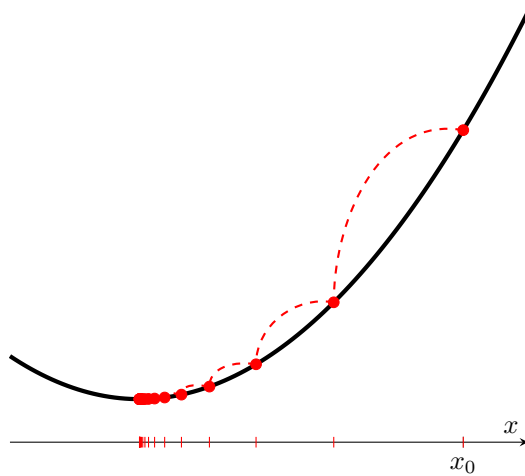


Figure 8: Gradient Decent Steps

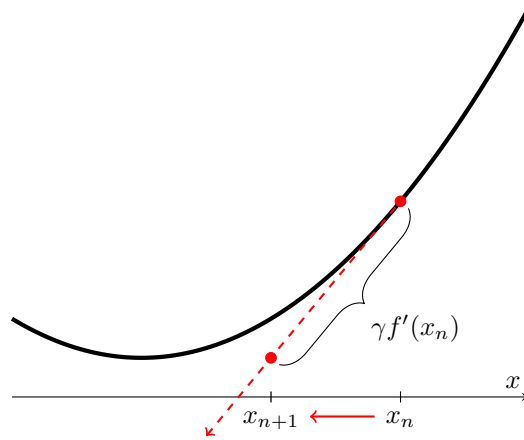


Figure 9: Gradient Decent Step

### Neighbor Selection at Iteration ( $i$ )

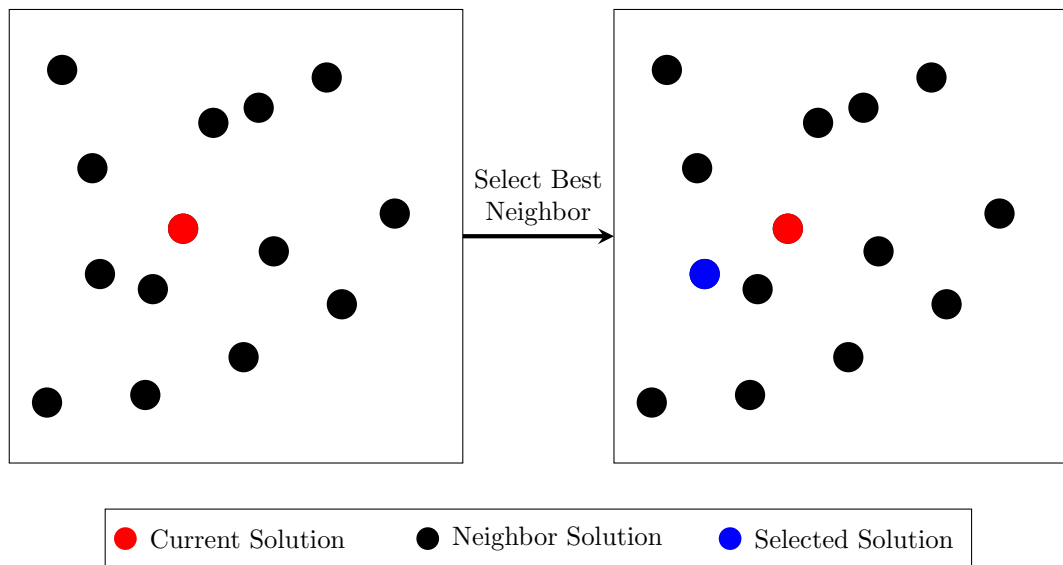


Figure 10: Hill Climbing Neighbor Selection

Neighbor Selection at Iteration ( $i$ )

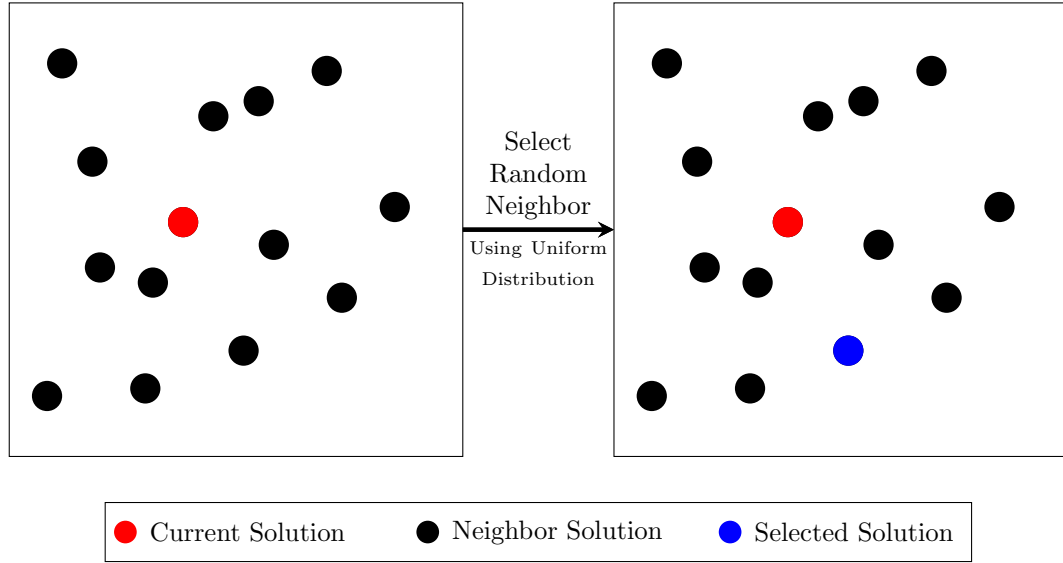


Figure 11: Simulated Annealing Neighbor Selection

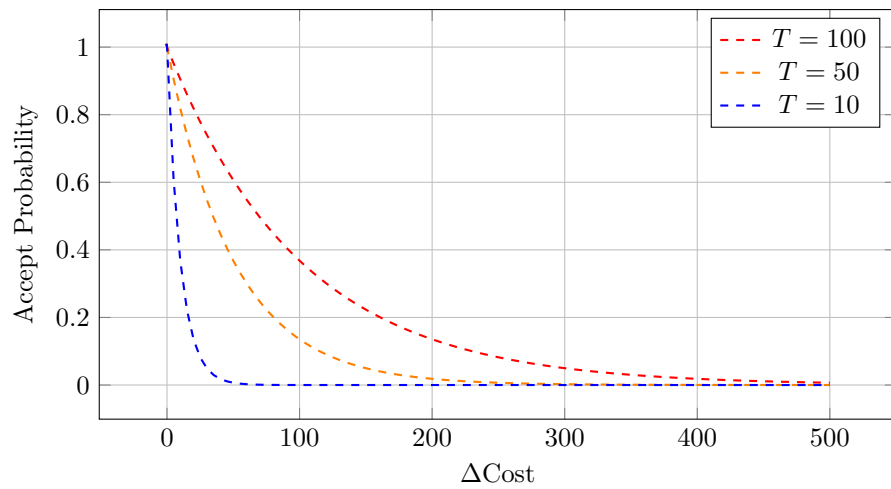


Figure 12: Simulated Annealing Temperature



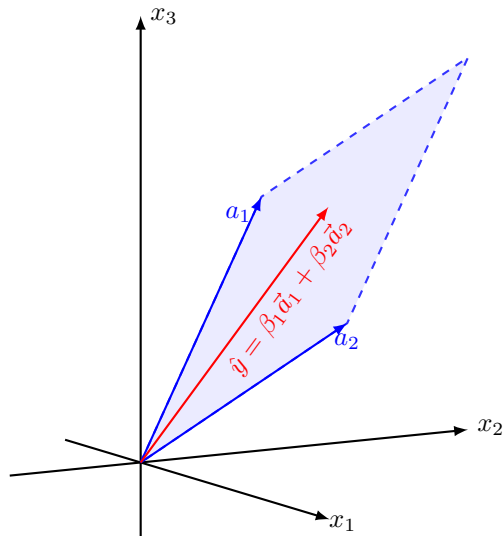


Figure 13: Least Square Problem - Linear combination of column vectors

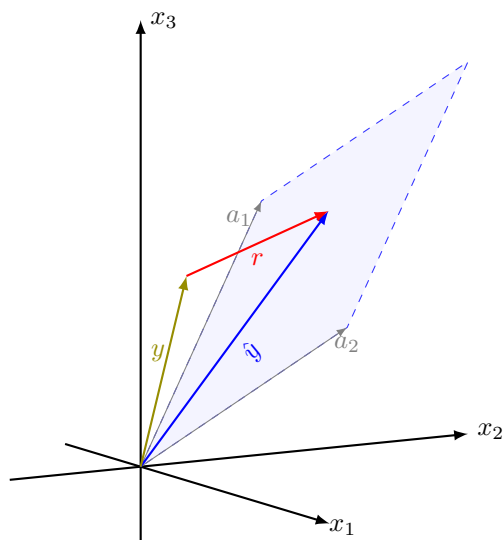


Figure 14: Least Square Problem

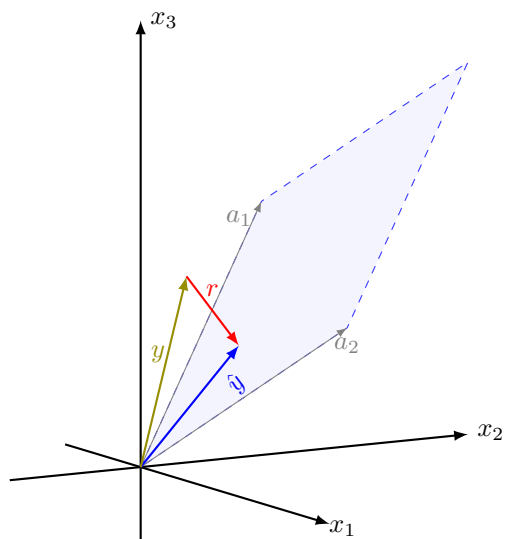


Figure 15: Least Square Problem