Playground

Abdelrahman

October 14, 2024

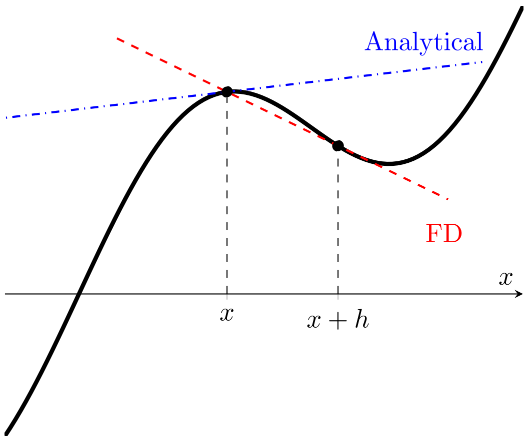

Figure 1: Forward Finite Difference

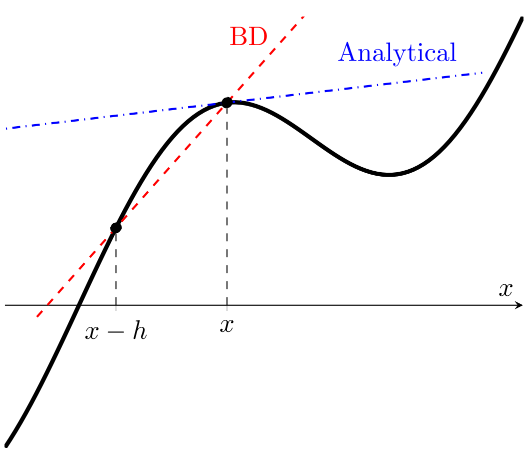

Figure 2: Backward Finite Difference

Algorithm 1: Hill Climbing Algorithm

```
Data: x_i
Result: x_n ← last solution candidate

x_0 ← starting solution candidate;

for i ∈ {0, ..., n} do
    x_neighbor ← select best neighbor from x_i neighborhood;
    Δ cost ← compute cost difference between x_neighbor and x_i;

    if cost(x_neighbor) is better than cost(x_i) then
        Accept x_{i+1} ← x_i;

    else if cost(x_neighbor) is worse than cost(x_i) then
        Terminate Search;
end
```

Algorithm 2: Simulated Annealing Algorithm

```
Data: T_i, x_i
Result: x_n ← last solution candidate

T_0 ← initial temperature of cooling schedule;
x_0 ← starting solution candidate;

for i ∈ {0, ..., n} do
    x_neighbor ← randomly sample a neighbor from x_i neighborhood
                 using uniform distribution;
    Δ cost ← compute cost difference between x_neighbor and x_i;

    if cost(x_neighbor) is better than cost(x_i) then
        Accept x_{i+1} ← x_i;

    else if cost(x_neighbor) is worse than cost(x_i) then
        if probability e^{-Δcost / T_i} then
            Accept x_{i+1} ← x_i;
        else
            Reject Do nothing;
        end
end
```

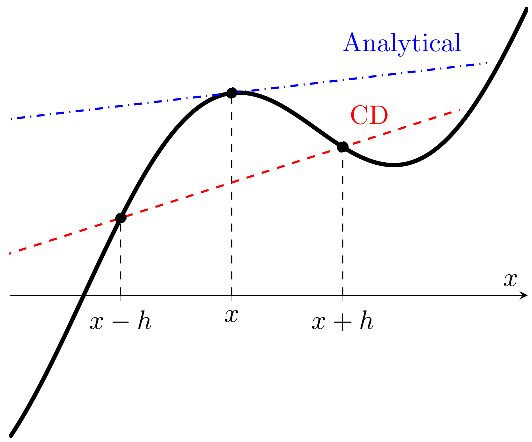

Figure 3: Central Finite Difference

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

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

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

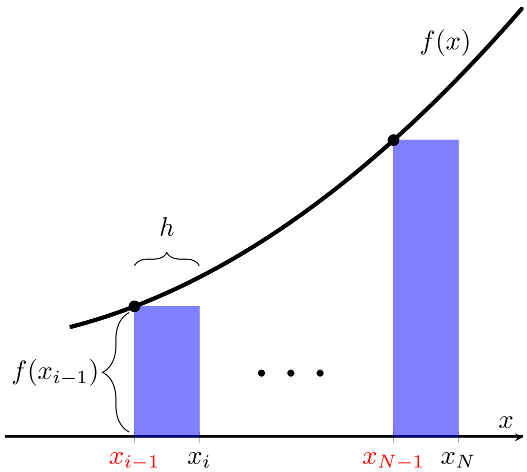

Figure 4: Rectangle Method Left Point Rule

References

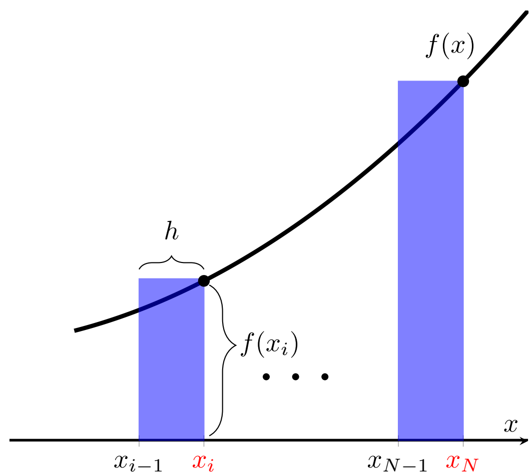

Figure 5: Rectangle Method Right Point Rule

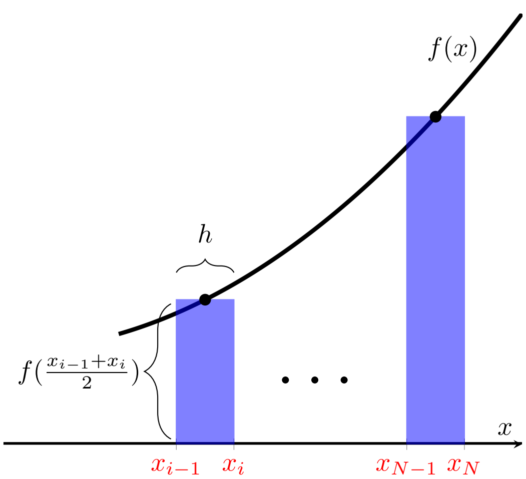

Figure 6: Rectangle Method Midpoint Rule

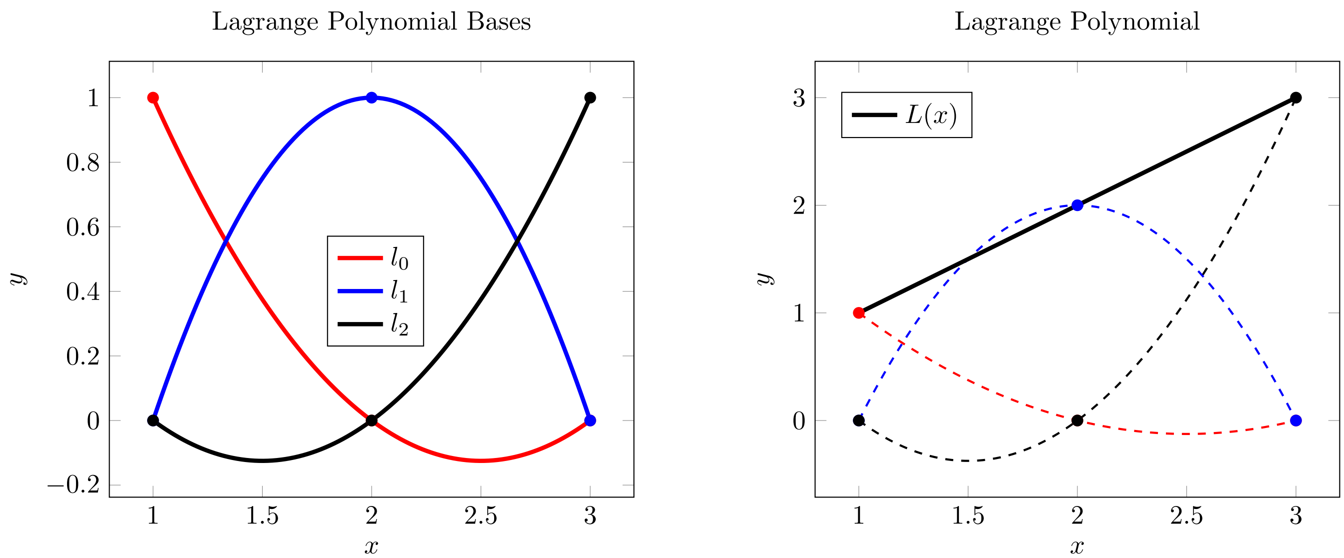

Figure 7: Lagrange Polynomial and its Bases

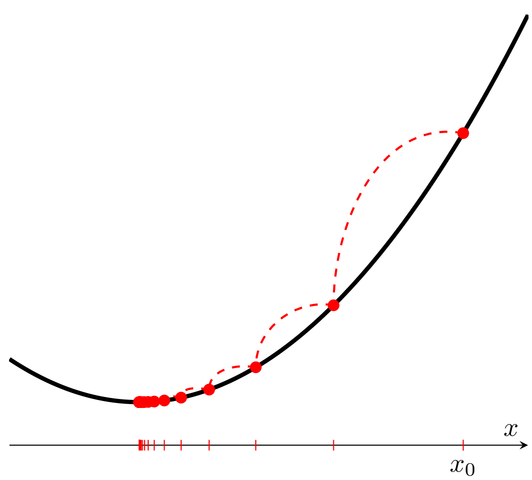

Figure 8: Gradient Decent Steps

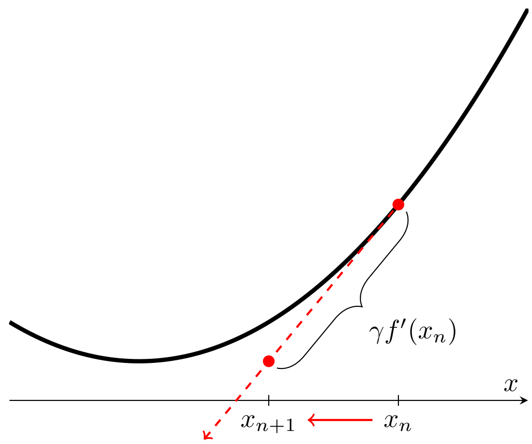

Figure 9: Gradient Decent Step

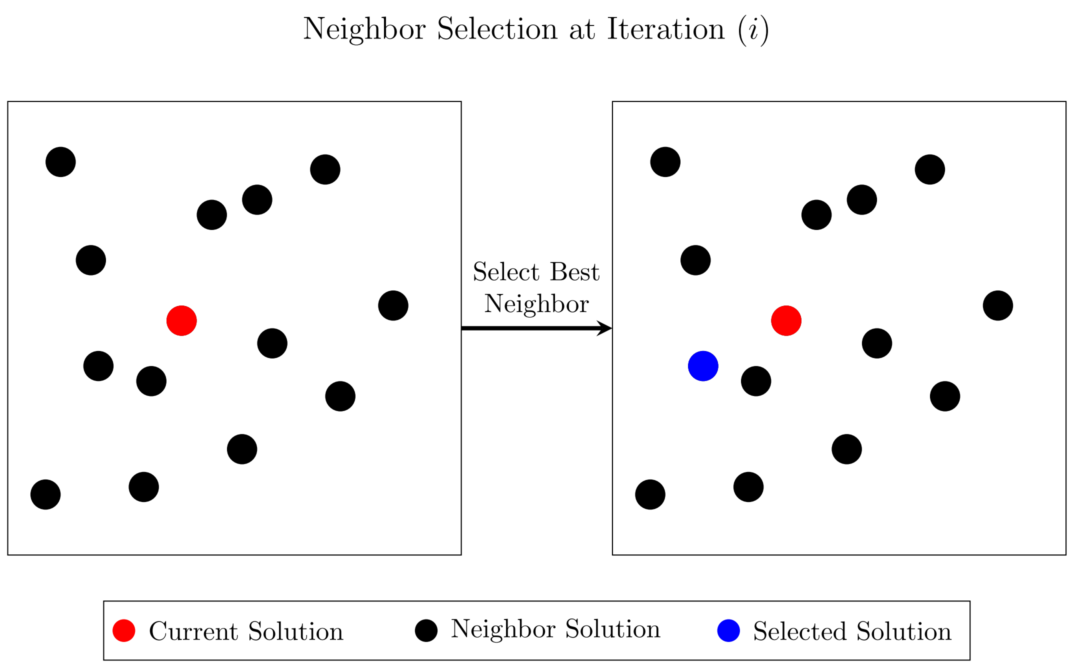

Figure 10: Hill Climbing Neighbor Selection

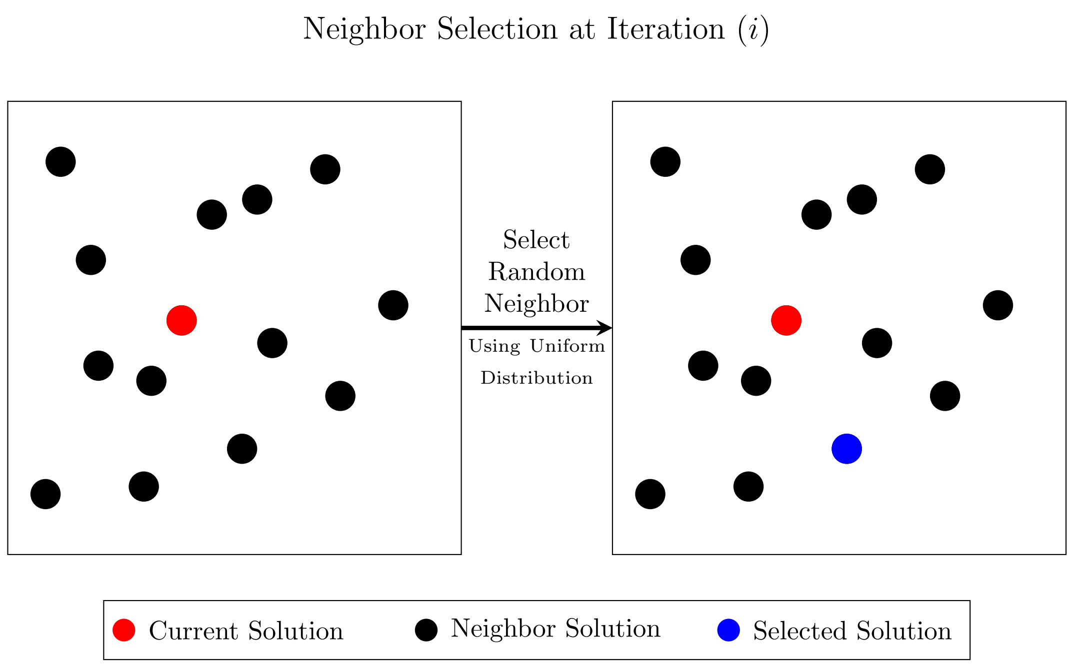

Figure 11: Simulated Annealing Neighbor Selection

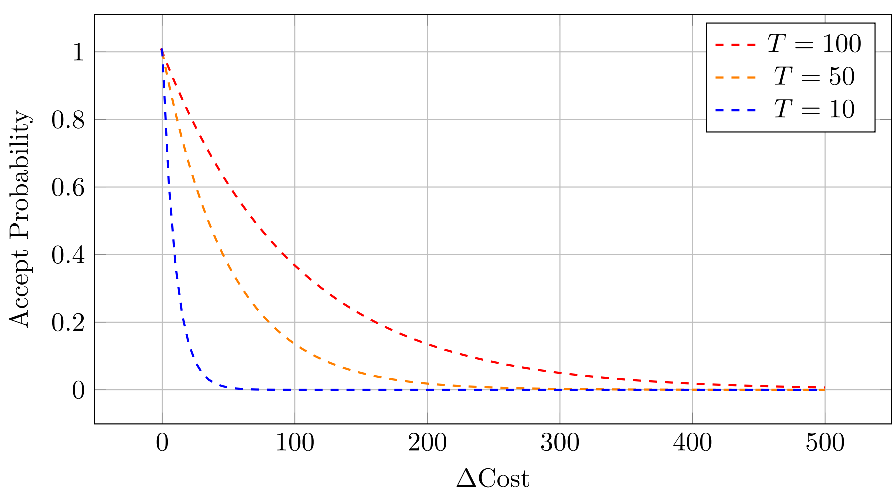

Figure 12: Simulated Annealing Temperature

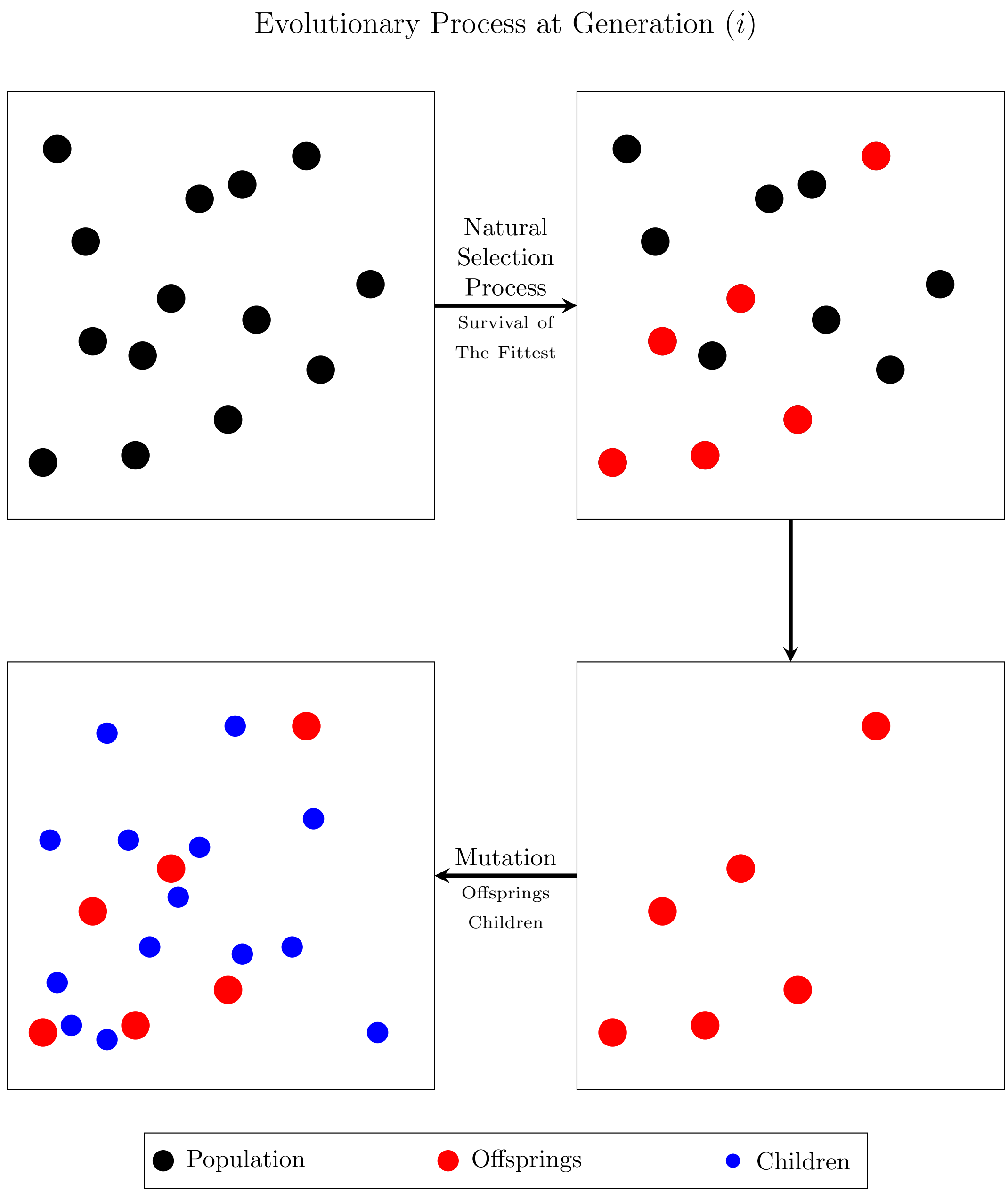

Figure 13: Evolutionary Process in Evolutionary Strategies Algorithm

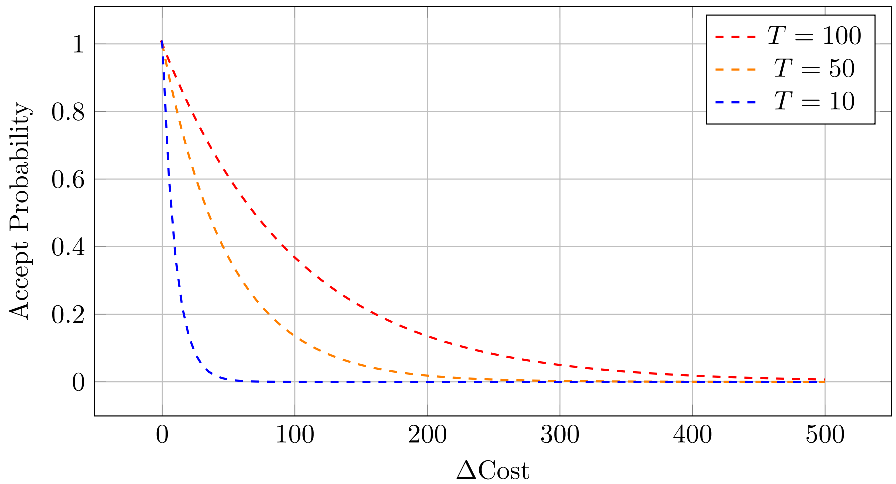

Figure 14: Simulated Annealing Temperature

Algorithm 3: Simulated Annealing Algorithm

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 $i \in \{0, \ldots, n\}$ **do**
  $x_{\text{neighbor}} \leftarrow$ randomly sample a neighbor from x_i neighborhood
    using uniform distribution;
  $\Delta\, cost \leftarrow$ compute cost difference between x_{neighbor} and x_i;
  if cost(x_{neighbor}) is better than cost(x_i) **then**
    Accept $x_{i+1} \leftarrow x_i$;
  else if cost(x_{neighbor}) is worse than cost(x_i) **then**
    if probability $e^{-\Delta cost\,/\,T_i}$ **then**
      Accept $x_{i+1} \leftarrow x_i$;
    else
      Reject Do nothing;
    end
end

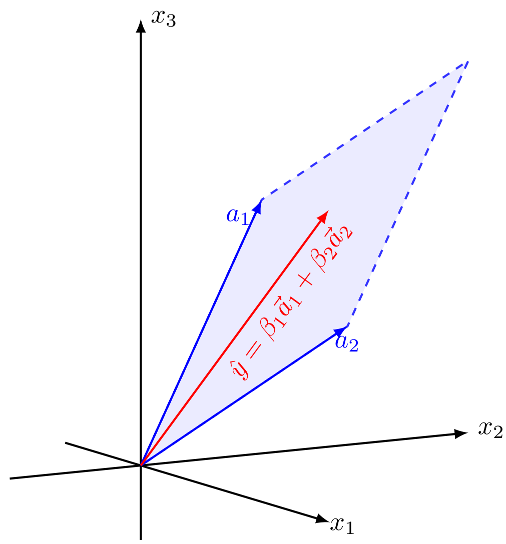

Figure 15: Least Square Problem - Linear combination of column vectors

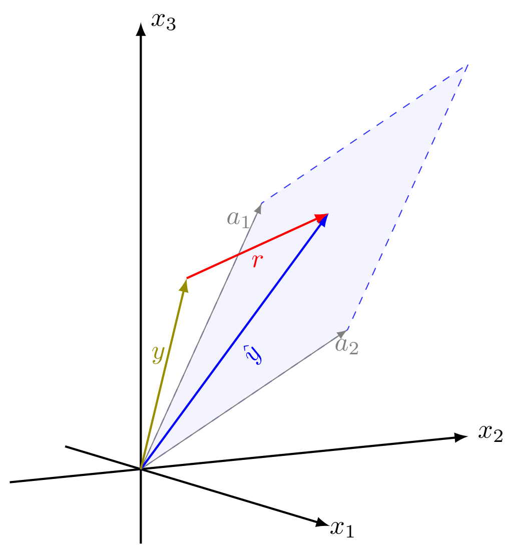

Figure 16: Least Square Problem

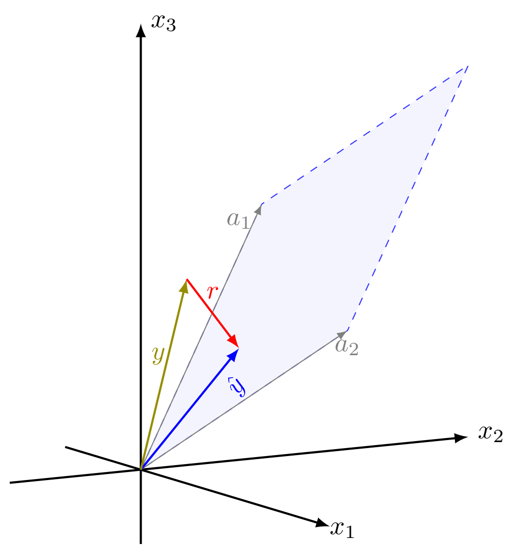

Figure 17: Least Square Problem