Nature Inspired Algorithms

Outline

- Introduction
- Benchmark Functions
- Genetic Algorithm
- Particle Swarm Optimization
- Differential Evolution
- Demonstration of optimizing benchmarks by GA, PSO, DE
- Application of NIA
  - Segmentation in Image processing
  - Clustering in wireless sensor networks
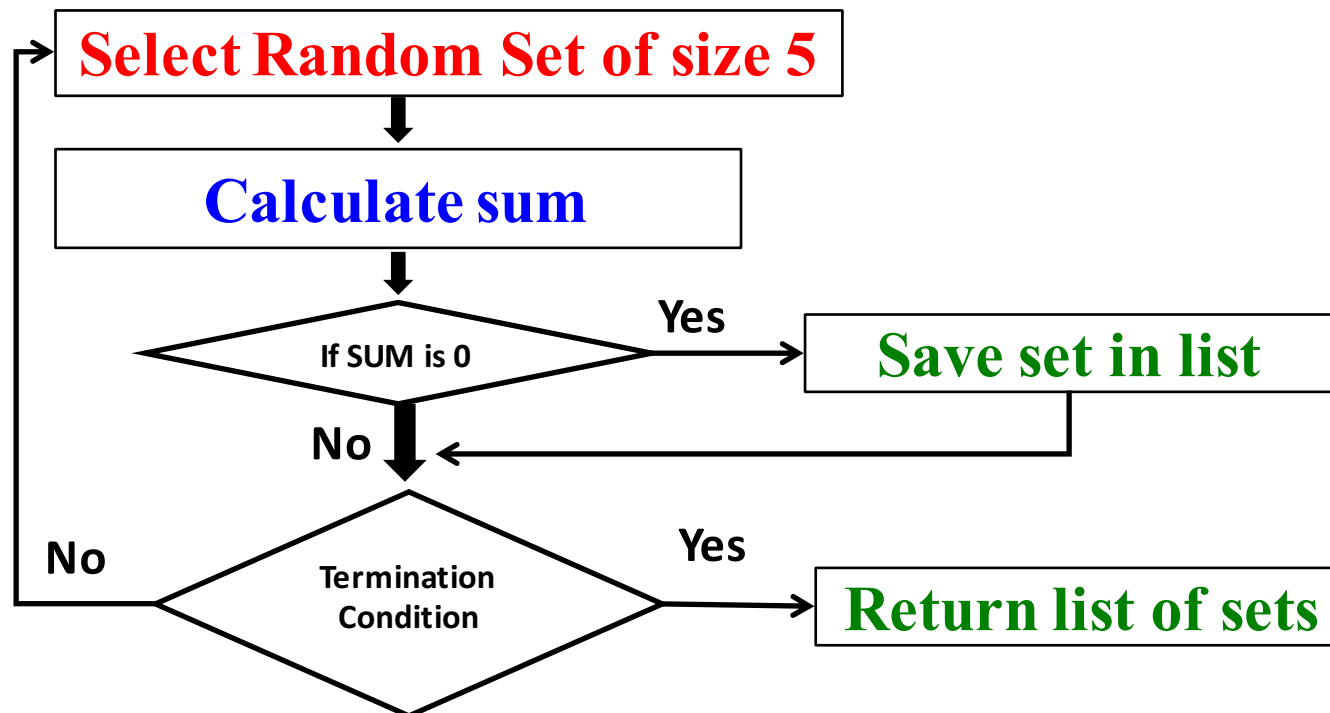
Introduction

Sub Set Problem

Problem Statement

Find <u>all the subset</u> from a set of numbers whose sum is zero.

Constraint: **Subset size must be 5**.

A={-12,-3,-6,7,2,-2,6,3,9,-7,-5,-8,1,11,-9,-4}

Subset Problem
Heuristics Approach

Select Random Set of size 5

Calculate sum

If SUM is 0 — Yes → Save set in list

No

Termination Condition — Yes → Return list of sets

No

Application of
Sub Set Problem

Combo Offer by online portal
e.g. – Flipcart, Amazon, Snapdeal, etc.

Assignment
Sub Set Problem

Web application to find combo offer.

Pid	Price
P1	64
P2	88
P3	152
P4	93
P5	76
-	-
-	-
-	-
-	-

upload →
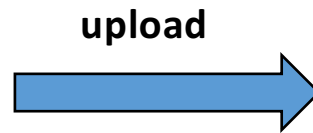
{P2,P5,P7}
{P1,P3,P6,P7}
{P2,P6,P9}
{P3,P7,P9,P12}

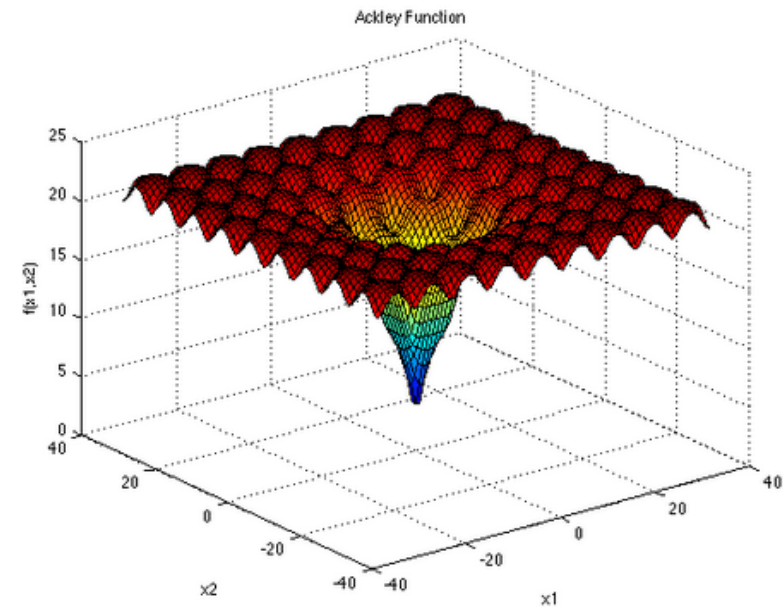**Product List**

Product Sets

Objective Function

Function used find the optimal solution among feasible solutions.

Ackley

$$f(\mathbf{x}) = -a \exp\left(-b\sqrt{\frac{1}{d}\sum_{i=1}^{d} x_i^2}\right) - \exp\left(\frac{1}{d}\sum_{i=1}^{d}\cos(cx_i)\right) + a + \exp(1)$$

Global Minimum:

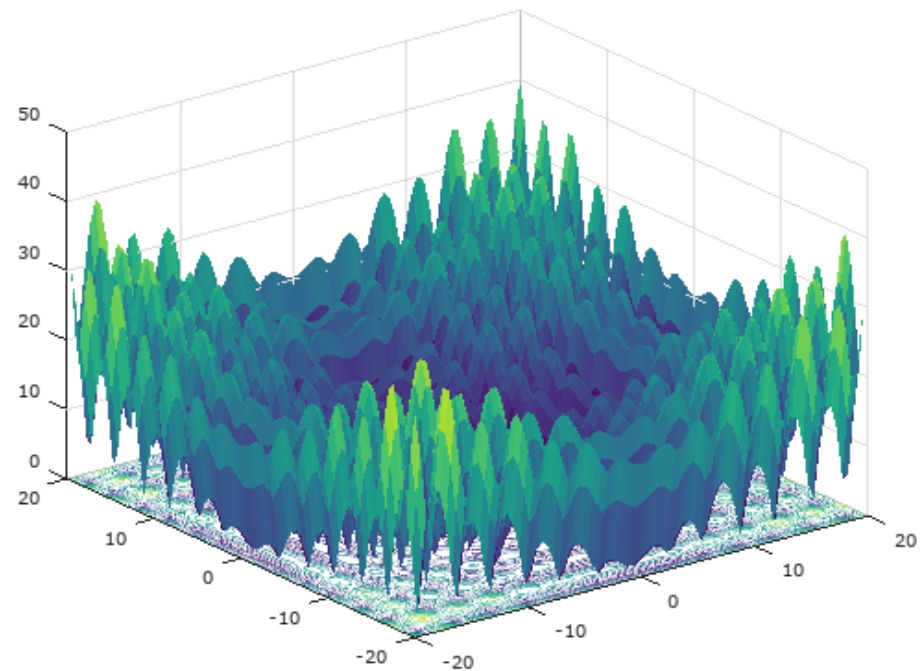$$f(\mathbf{x}^*) = 0, \text{ at } \mathbf{x}^* = (0,\ldots,0)$$

Ackley Function

Apline

$$f(\pmb{x}) = \sum_{i=1}^{D} \left| x_i \sin(x_i) + 0.1 x_i \right|$$

Global Minimum:

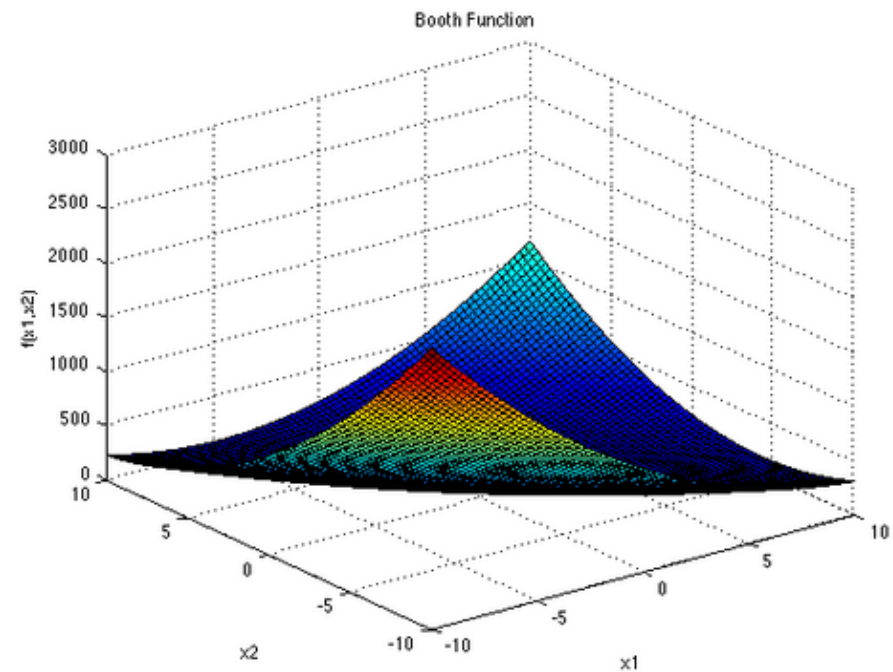$$f(\mathbf{x}^*) = 0, \text{ at } \mathbf{x}^* = (0, \ldots, 0)$$

Booth

$$f(\mathbf{x}) = (x_1 + 2x_2 - 7)^2 + (2x_1 + x_2 - 5)^2$$

Global Minimum:
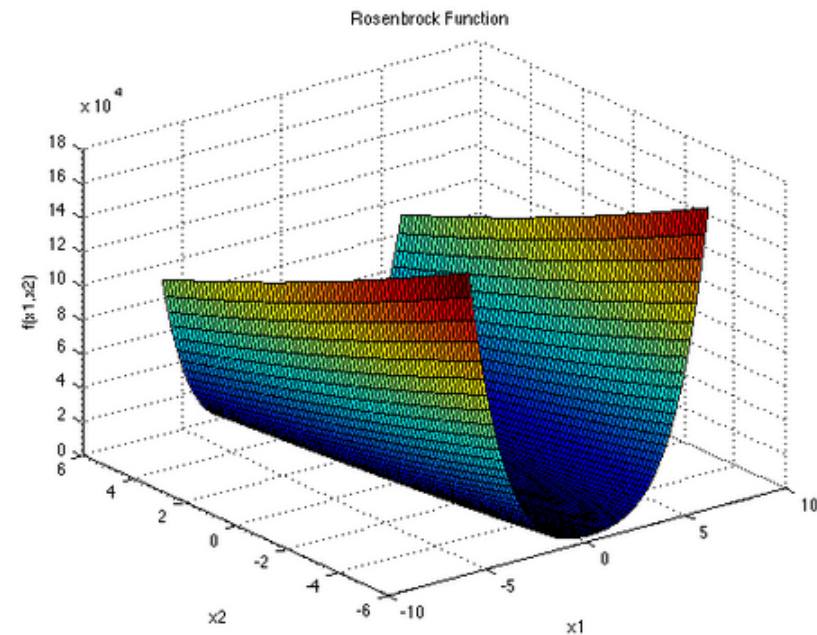
$f(\mathbf{x}^*) = 0$, at $\mathbf{x}^* = (1, 3)$

Booth Function

Rosenbrock

$$f(\mathbf{x}) = \sum_{i=1}^{d-1} \left[100(x_{i+1} - x_i^2)^2 + (x_i - 1)^2 \right]$$

Global Minimum:

$f(\mathbf{x}^*) = 0$, at $\mathbf{x}^* = (1, \dots, 1)$

Rosenbrock Function

Sphere

$$f(\mathbf{x}) = \sum_{i=1}^{d} x_i^2$$

Global Minimum:

$$f(\mathbf{x}^*) = 0, \text{ at } \mathbf{x}^* = (0, \dots, 0)$$

Sphere Function