ASSIGNMENT 4
## *DUE DATE: 9 NOVEMBER 2021*

**NOTE:** This is an individual assignment.

Benchmark functions are often used in the field of Evolutionary Computation in order to compare the effectiveness and scalability of optimization algorithms. Below, five commonly used benchmark functions are depicted in 2 dimensions within the range [-5, 5]. Some of these functions may appear simple, but in higher dimensions (30 is a common value) optimization becomes much more complicated.
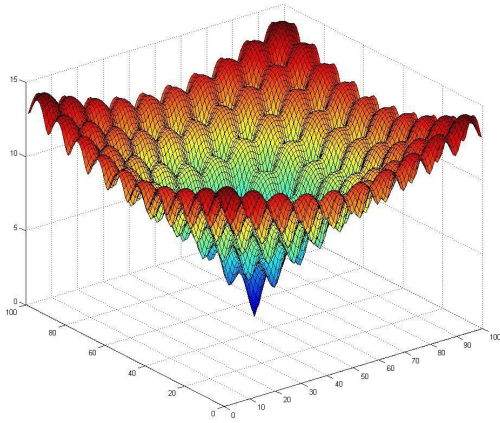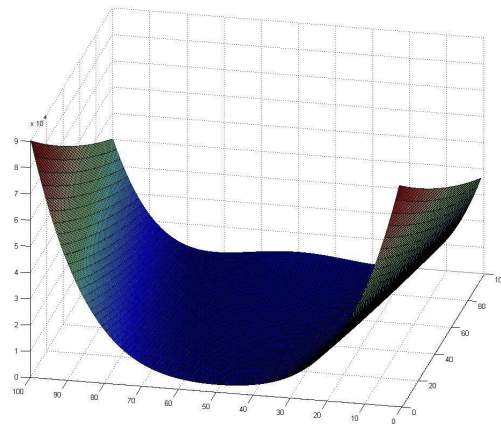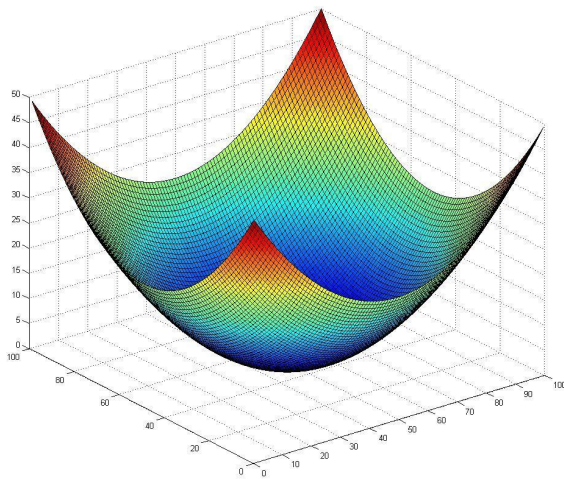

Ackley
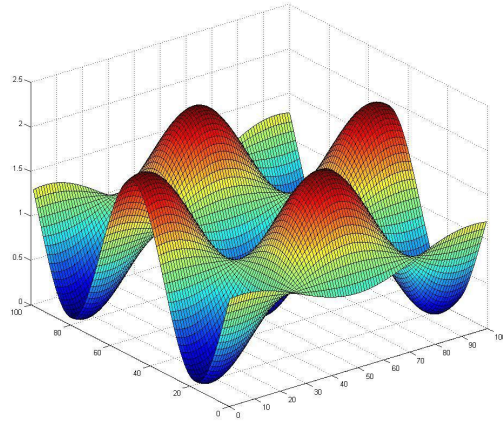
Griewank
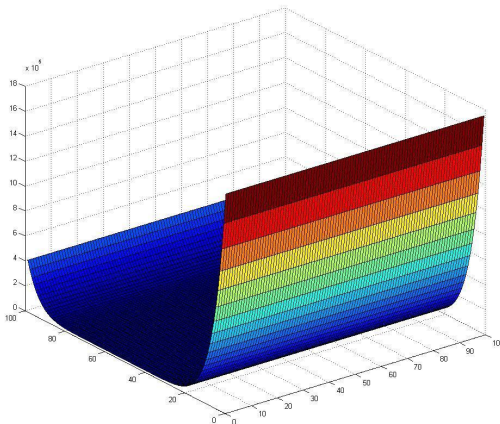
Whitley

Rosenbrock

Spherical

Java and Matlab implementations of the above functions are provided.

<u>JAVA</u>

Each of the supplied classes implements the abstract class ContinuousFunction (also supplied), given below:

```java
public abstract class ContinuousFunction
{
    private int Dimension = 1;

    public void setDimension(int d)
    {
        Dimension = d;
    }

    public int getDimension()
    {
        return Dimension;
    }


    public double getMinimum()
    {
        return 0;
    }

    public abstract double evaluate(ArrayList<Double> x);
}
```

Each class implements the method `evaluate`. This method takes as input an array of double values representing a point in n-dimensional space, and returns the value of the function at that point. The goal is to find the function minimum (i.e. the point for which the `evaluate` method returns the lowest value). Please note that all benchmark functions as supplied are implemented in 30-dimensional space and it is suggested that all experiments are carried out on these 30-dimensional functions.

MATLAB

Five .m files have been provided, one for each of the benchmark functions in this assignment.   Each of these functions simply takes as input a one-dimensional Matlab matrix (a row or column vector) containing 30 values (by default, these functions are implemented in 30-dimensional space).   These 30 values represent a point in 30-dimensional space, and each Matlab function returns the value of the relevant benchmark function at that point. The goal is to find the function minimum.

Tasks

The objective of this assignment is to use an optimization algorithm to find the minimum for each function.

Three different optimization algorithms are to be investigated:

- Adapt your **Genetic Algorithm (GA)** from Assignment 3
- Also evaluate the optimization ability of the **Differential Evolution (DE)** algorithm, as well as that of the
- **Particle Swarm Optimization (PSO)** algorithm

To clarify: minimize each of the benchmark functions using each of the three algorithms listed above.

Write a report that clearly contrasts the performance of the GA, DE and PSO algorithms, per function. Also discuss parameter values used in each algorithm with motivation for your choice of these values, e.g. mutation and crossover probability, scaling factor etc.

Further Reading

The supplied benchmark functions are well-known in the optimization community and you can easily obtain more information on them on the internet.