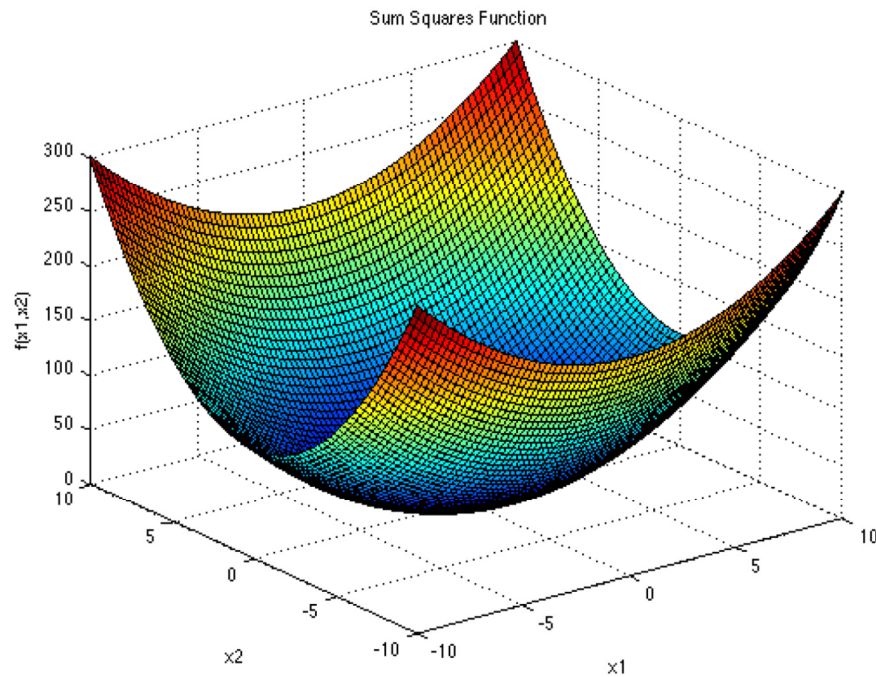


## **Project-Phase-2 Questions**

### **Instructions:**

- All problems are minimization-type.
- Some problem can be scaled to many number of variables. I have mentioned number of variables in the yellow box.
- The program should be generic so that any variable problem can be solved. I will ask you to run the examples with different number of variables.
- No. of variables for a given problem should be read from the input file.
- The codes developed in Project Phase-1 should be used for unidirectional searches
- Include linear independency check between two search directions. Also, include option of restart.
- Make slides and include your results (Table, convergence plots, etc.). You may change initial guess and/or input parameters to see their effect on the results.
- **Make a zip file of your codes and ppt file, and name it as “G\_group\_number” and upload on TEAMS.**

# SUM SQUARES FUNCTION



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

## Description:

*Dimensions:  $d$*

The Sum Squares function, also referred to as the Axis Parallel Hyper-Ellipsoid function, has no minimum except the global one. It is continuous, convex and unimodal. It is shown here in its two dimensional form.

## Input Domain:

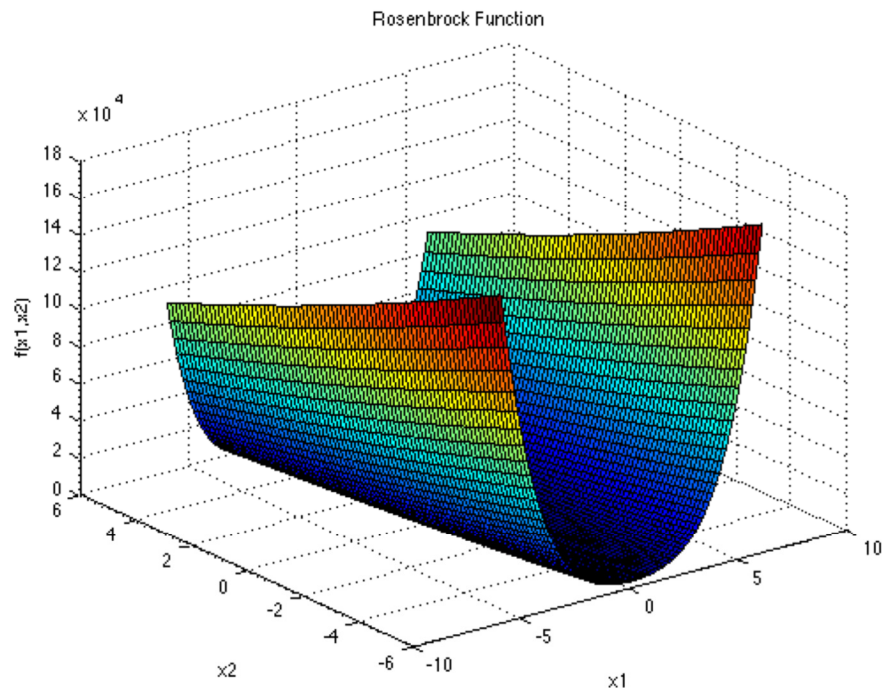
The function is usually evaluated on the hypercube  $x_i \in [-10, 10]$ , for all  $i = 1, \dots, d$ , although this is restricted to the hypercube  $x_i \in [-5.12, 5.12]$ , for all  $i = 1, \dots, d$ .

## Global Minimum:

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

Solve for five variables:  $\mathbf{x} = (x_1, x_2, x_3, x_4, x_5)^T$

# ROSENBROCK FUNCTION



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

## Description:

*Dimensions:  $d$*

The Rosenbrock function, also referred to as the Valley or Banana function, is a popular test problem for gradient-based optimization algorithms. It is shown in the plot above in its two-dimensional form.

The function is unimodal, and the global minimum lies in a narrow, parabolic valley. However, even though this valley is easy to find, convergence to the minimum is difficult (Picheny et al., 2012).

## Input Domain:

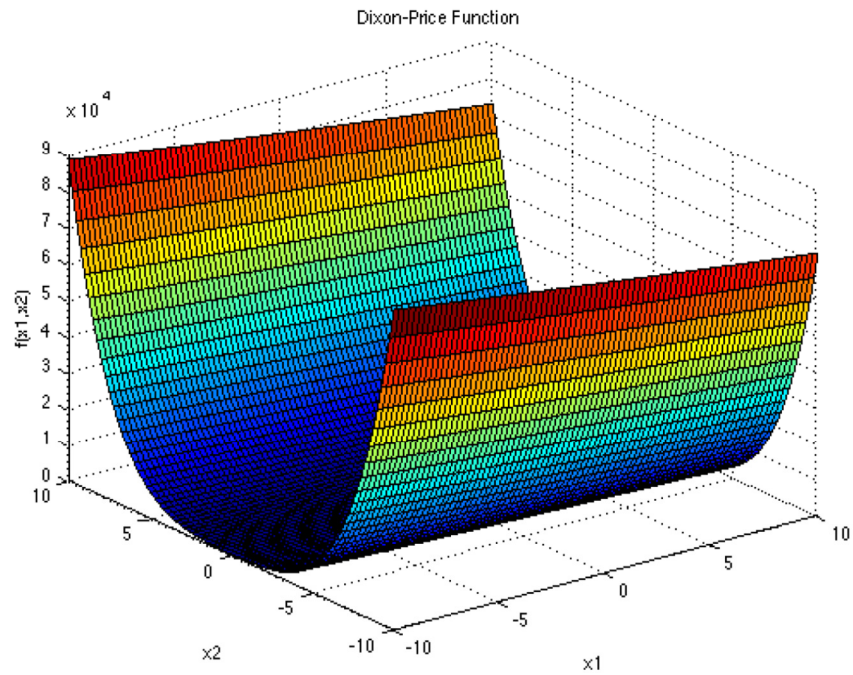
The function is usually evaluated on the hypercube  $x_i \in [-5, 10]$ , for all  $i = 1, \dots, d$ , although it may also be restricted to the hypercube  $x_i \in [-2.048, 2.048]$ , for all  $i = 1, \dots, d$ .

## Global Minimum:

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

Solve for three variables:  $\mathbf{x} = (x_1, x_2, x_3)^T$

# DIXON-PRICE FUNCTION



$$f(\mathbf{x}) = (x_1 - 1)^2 + \sum_{i=2}^d i (2x_i^2 - x_{i-1})^2$$

## Description:

*Dimensions: d*

## Input Domain:

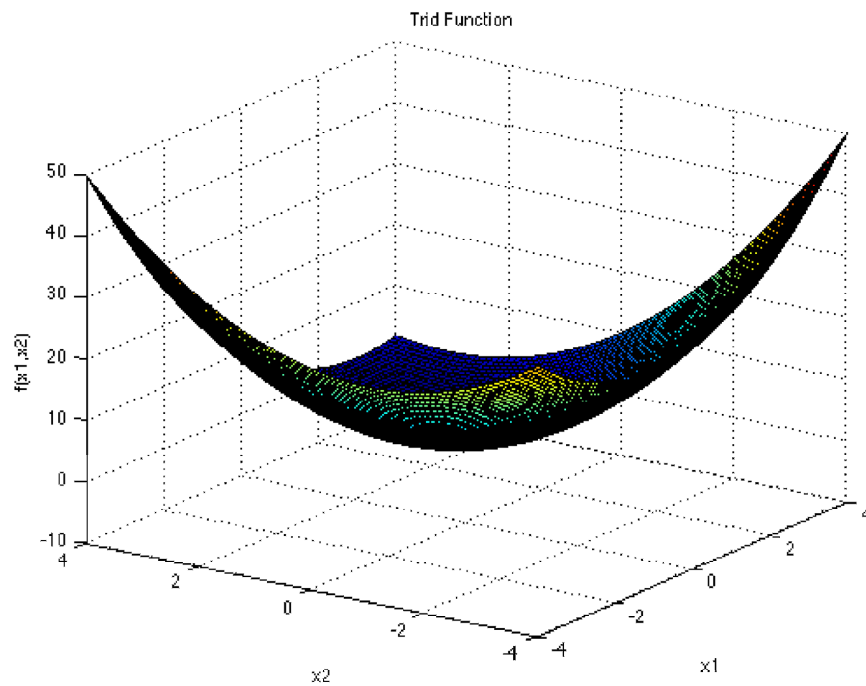
The function is usually evaluated on the hypercube  $x_i \in [-10, 10]$ , for all  $i = 1, \dots, d$ .

## Global Minimum:

$$f(\mathbf{x}^*) = 0, \text{ at } x_i = 2^{-\frac{2^i - 2}{2^i}}, \text{ for } i = 1, \dots, d$$

Solve for four variables:  $x = (x_1, \dots, x_4)^T$

# TRID FUNCTION



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

## Description:

*Dimensions:  $d$*

The Trid function has no local minimum except the global one. It is shown here in its two-dimens:

## Input Domain:

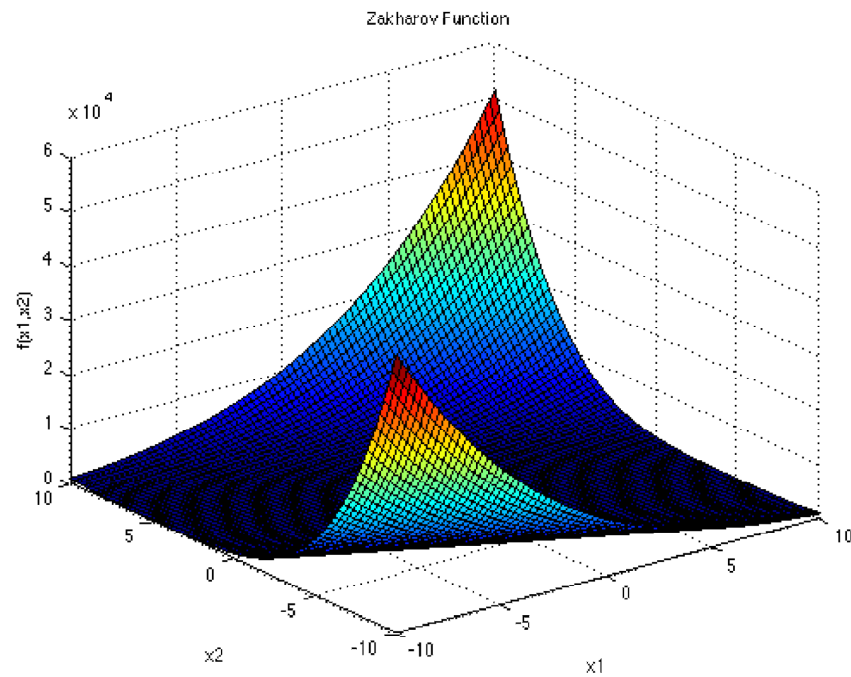
The function is usually evaluated on the hypercube  $x_i \in [-d^2, d^2]$ , for all  $i = 1, \dots, d$ .

## Global Minimum:

Solve for six variables:  $x = (x_1, \dots, x_6)^T$

$f(\mathbf{x}^*) = -d(d+4)(d-1)/6$ , at  $x_i = i(d+1-i)$ , for all  $i = 1, 2, \dots, d$

# ZAKHAROV FUNCTION



$$f(\mathbf{x}) = \sum_{i=1}^d x_i^2 + \left( \sum_{i=1}^d 0.5ix_i \right)^2 + \left( \sum_{i=1}^d 0.5ix_i \right)^4$$

## Description:

*Dimensions: d*

The Zakharov function has no local minima except the global one. It is shown here in its two-dim form.

## Input Domain:

The function is usually evaluated on the hypercube  $x_i \in [-5, 10]$ , for all  $i = 1, \dots, d$ .

## Global Minimum:

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

Solve for two variables:  $x = (x_1, x_2)^T$