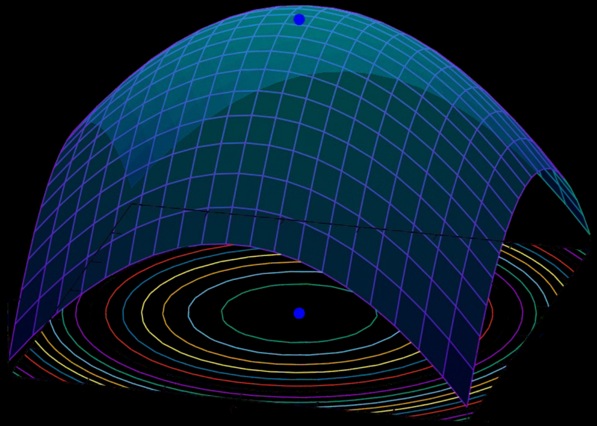
CH510- Self-Learning Group Project



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Why Do We Need Optimization Techniques?

1. Many real-world problems involve multiple variables and constraints that need to be balanced. Optimization techniques enable solutions to such complex problems.

2. Optimization helps in improving performance by maximizing efficiency in resource allocation, reducing time and costs.

3. By automating the decision-making process, optimization techniques can handle large-scale problems that would be impractical to solve manually.

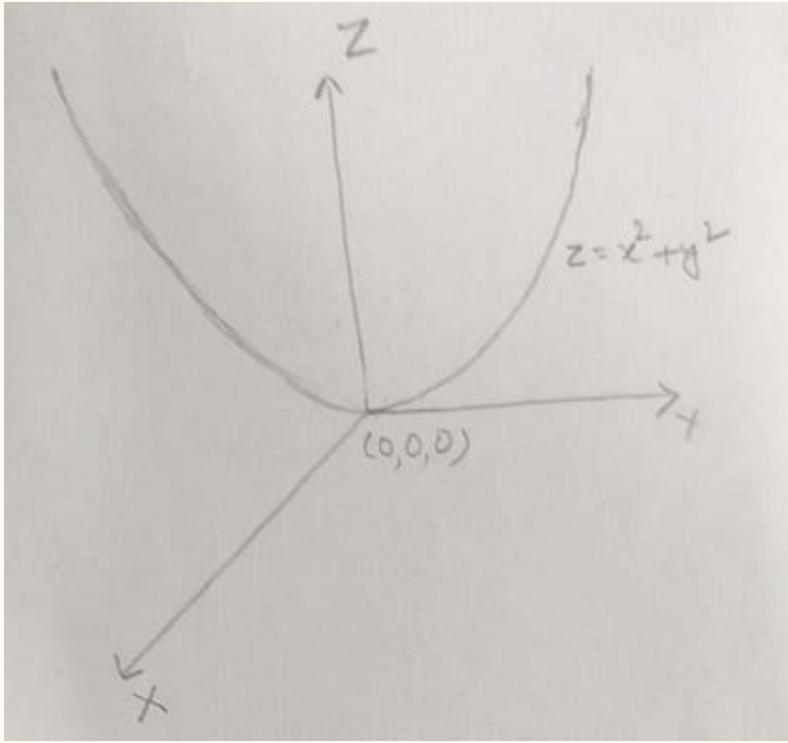
4. Essential in training algorithms, adjusting weights, and hyperparameter tuning to improve the performance of models.

Task 1

- Graphical Representation of a Surface
- Graphical Representation of Contours
- 3D Image of Objective Function and Constraint
- Contours of Objective Function and Constraint

Mathematical Function: Z=x^2+y^2

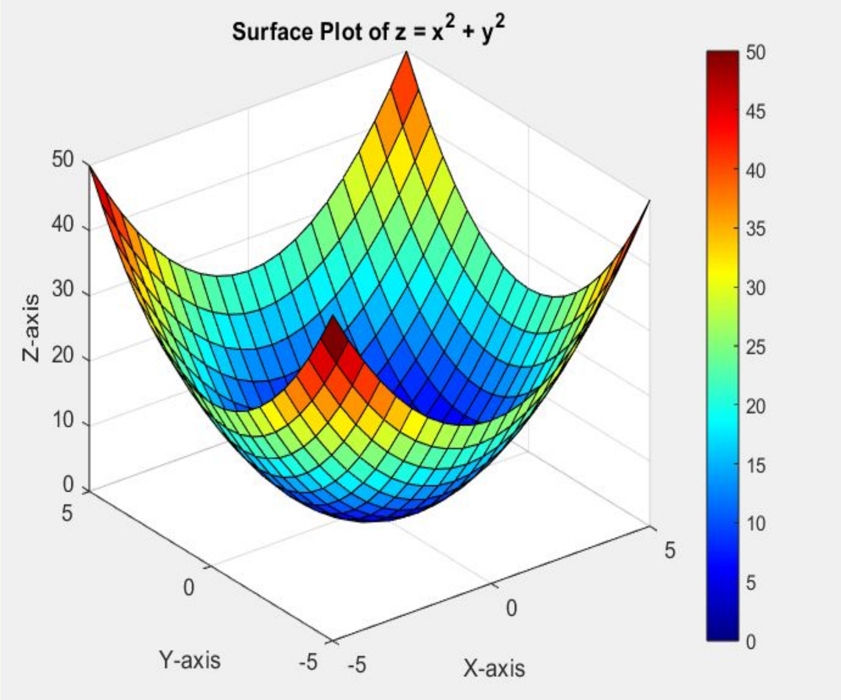
- We have used the above function to plot the tasks.The cross sections of above function are typically parabolas or hyperbolas and the surface is called Hyperbolic paraboloid.



Task 1 :MATLAB Results

1) Graphical Representation of a Surface:

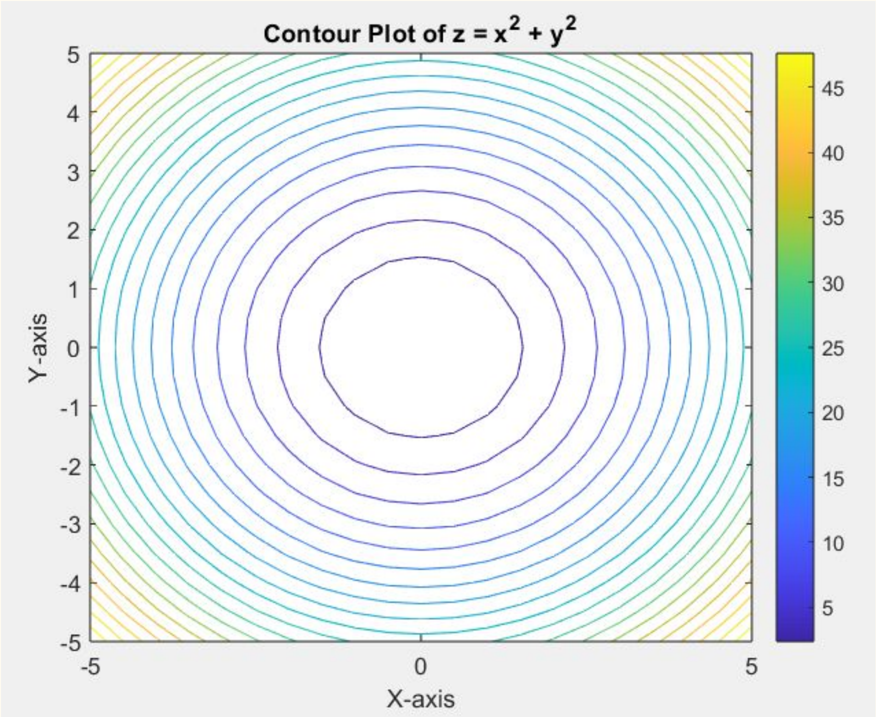
- **Graphical Surface Plot:** A 3D plot visualizes a function's behavior, mapping input variables (x, y) on the x and y axes, with the function's output (z) on the z-axis.
- **Visual Insights:** This helps identify peaks, valleys, and flat regions.
- **Purpose:** Used to understand the function's shape and locate critical points like minima, maxima, and saddle points.



Task 1

2) Graphical Representation of Contours:

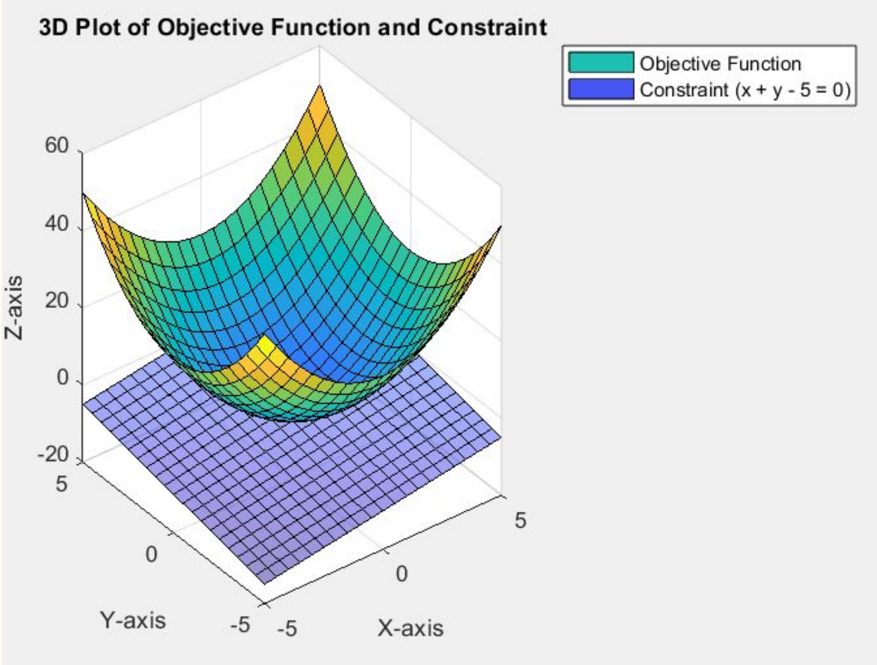
- **Contour Plot Overview**: A contour plot is a 2D visualization of a 3D surface, where contour lines connect points of equal value, forming “level sets.”
- **Purpose**: It reveals the behavior of functions with two variables, highlighting regions of high and low values.
- **Application**: Useful for optimization analysis, showing gradients and paths to optimal values (e.g., minimum or maximum).



Task 1

3) 3D Image of Objective Function and Constraint:

- **3D Visualization of Optimization**: Shows the objective function as a surface and constraints as boundaries, illustrating the search space.
- **Purpose**: Demonstrates optimization within constrained spaces, where feasible regions intersect the objective function.
- **Insight**: Helps understand how constraints limit the optimum search, highlighting feasible regions for solution evaluation.



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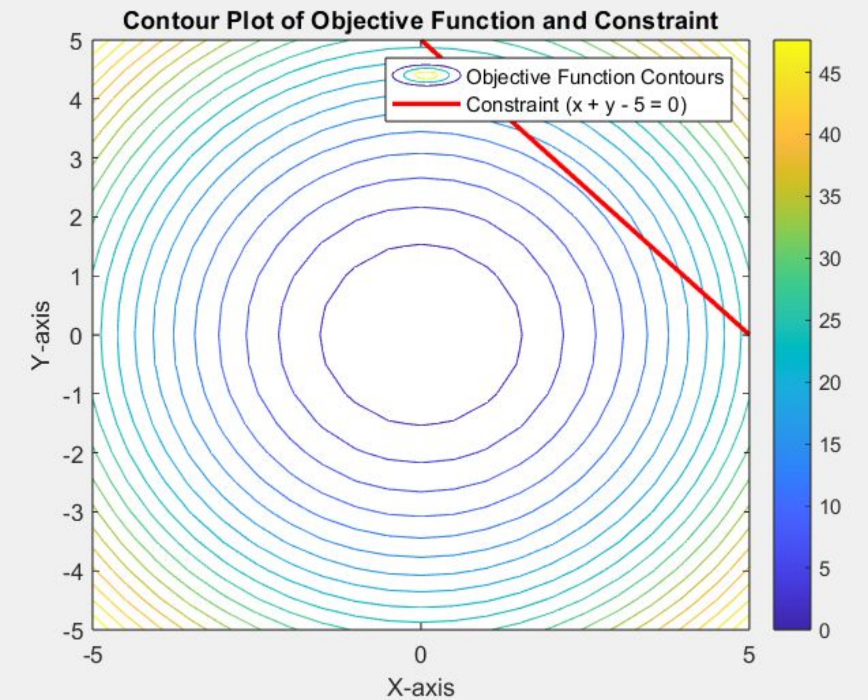
Task 1

4) Contours of Objective Function and Constraint:

- **Visualization of Optimization**: The contour plot displays both the objective function and constraints, illustrating levels of equal values and boundaries of feasible regions.
- **Purpose**: This plot visualizes the relationship between objectives and constraints, helping to identify the optimal solution within the feasible region.
- **Insights**: By observing intersecting contours, we can pinpoint the optimal point effectively

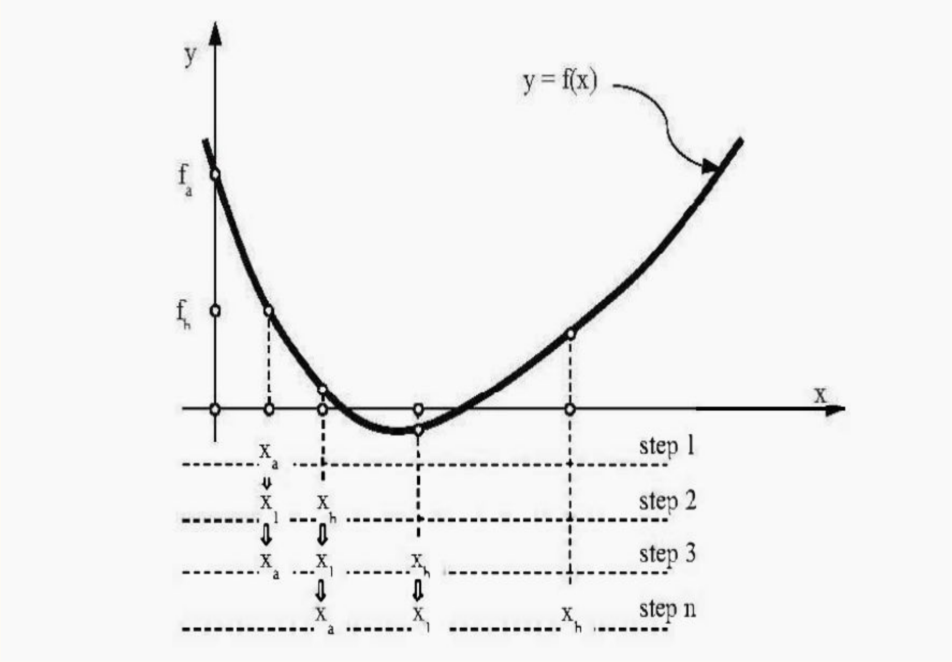


Task 2

- Graph represents a unimodal function searching for boundaries of the interval containing single minima.

Mathematical Function : **f(x)=x2−5x+6**

➔ We have used method inspired by Golden-section search to locate the interval around the minimum of Unimodal function.



History of iterations to find boundaries

Xa	Xb	Fa	Fb
0.00	0.38	6.00	4.24
0.00	0.53	6.00	3.64
0.38	0.88	4.24	2.39
0.52	1.41	3.64	0.94
0.87	2.28	2.39	0.20
1.41	3.70	0.94	1.18

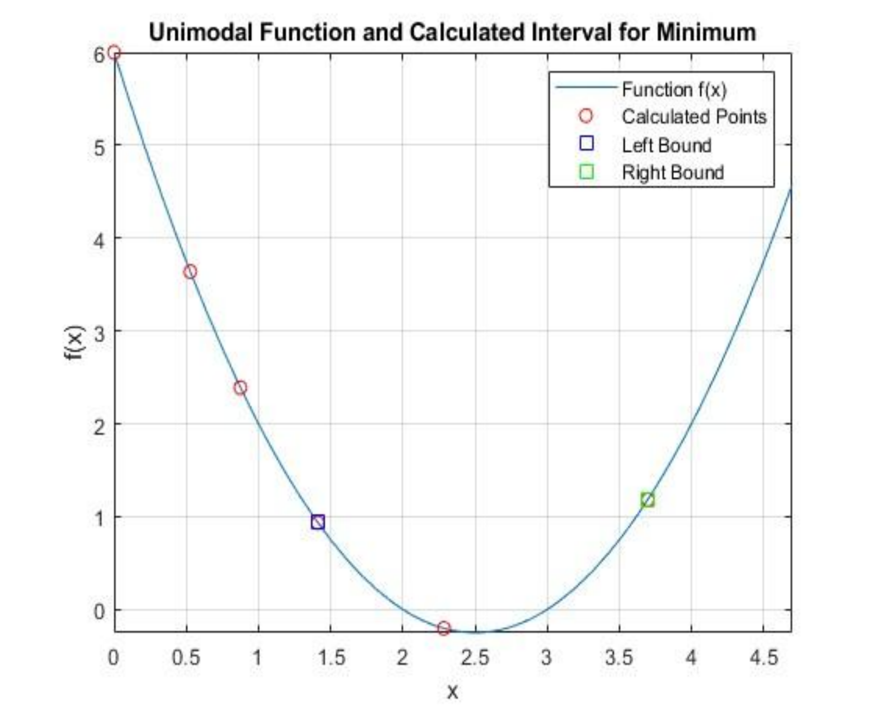
Task 2 :MATLAB Results

1)Graphical Representation of a Surface:

Graphical Surface Plot: A 2D plot visualizes a behavior, shape and The minimum of the function.

Visual Insights: Parabolic Shape: The function x^2 -5x+6 is quadratic, creating a parabola that opens upward. This shape clearly indicates a single minimum point at 2.5, reinforcing that the function is unimodal.

Purpose: It is designed to minimize the number of function evaluations when searching for a minimum of a unimodal function.



Conclusion

In this assignment, we successfully explored and implemented various MATLAB programs to visualize and solve optimization problems using different numerical methods.

These tasks provided a deeper understanding of the visualization and analysis of functions in MATLAB and the application of optimization techniques to solve real world problems. By implementing and comparing these methods, we learned about the efficiency, convergence, and approach in finding optimal solutions.