Engineering Optimization

CE/IITG Bhattacharjya

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Course content

Basics of engineering analysis and design, need for optimal design, formulation of optimal design problems, basic difficulties associated with solution of optimal problems, classical optimization methods, necessary and sufficient optimality criteria for unconstrained and constrained problems, Kuhn-Tucker conditions, global optimality and convex analysis, linear optimal problems, Simplex method, Introduction to Karmarkar's algorithm; numerical methods for nonlinear unconstrained and constrained problems, sensitivity analysis, linear post optimal analysis, sensitivity analysis of discrete and distributed systems; introduction to variational methods of sensitivity analysis, shape sensitivity, introduction to integer programming, dynamic programming, stochastic programming and geometric programming, introduction to genetic algorithm and simulated annealing.

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Books

- K. Deb., Optimization for Engineering Design: Algorithms and Examples, PHI Pvt Ltd., 1998.
- J. S. Arora, Introduction to Optimum Design, McGraw Hill International Edition, 1989.
- S.S. Rao, Engineering optimization: Theory and Practice, New age international (P) Ltd. 2001
- D. E. Goldberg, Genetic Algorithms in search and optimization, Pearson publication, 1990.
- K. Deb, Multi-Objective Optimization Using Evolutionary Algorithms, Chichester, UK : Wiley

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Are you using optimization?

The word “optimization” may be very familiar or may be quite new to you. But whether you know about optimization or not, you are using optimization in many occasions in your day to day life.

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Assessment

- Assignment : 10
- Quiz : 15
- Mid semester exam : 25
- End semester exam : 40
- Project : 10

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What is Optimization?

- Optimization is the act of obtaining the best result under a given circumstances.

- Optimization is the mathematical discipline which is concerned with finding the maxima and minima of functions, possibly subject to constraints.

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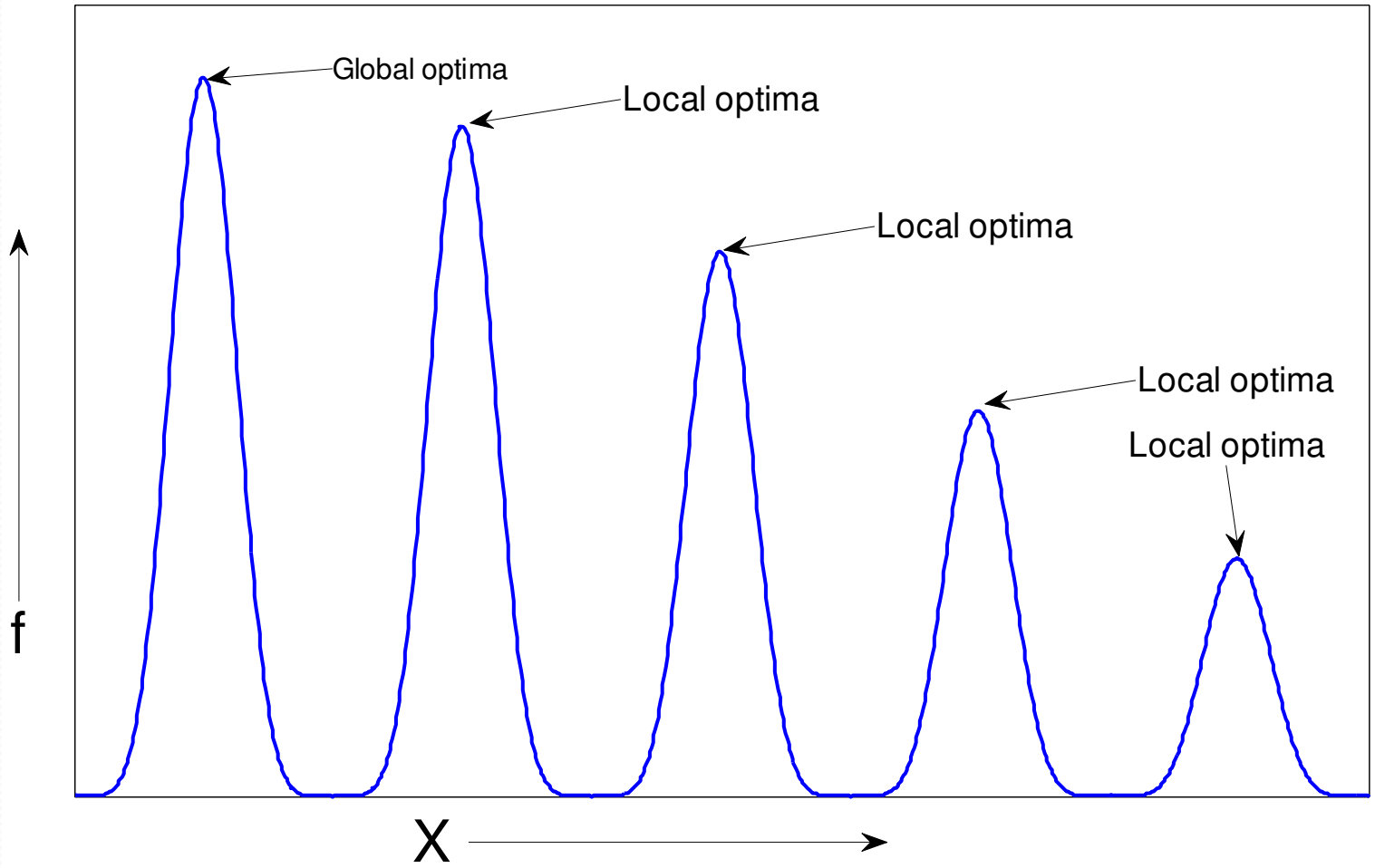
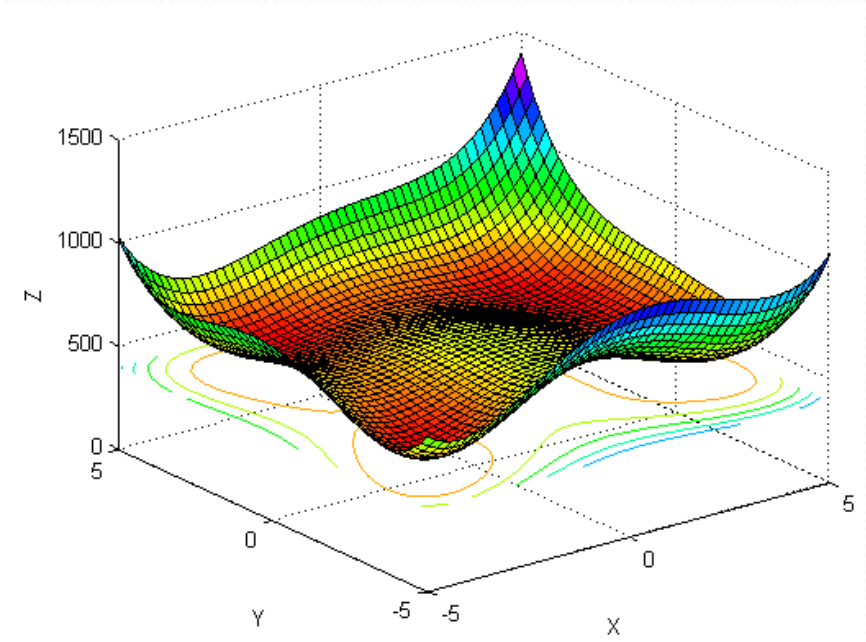
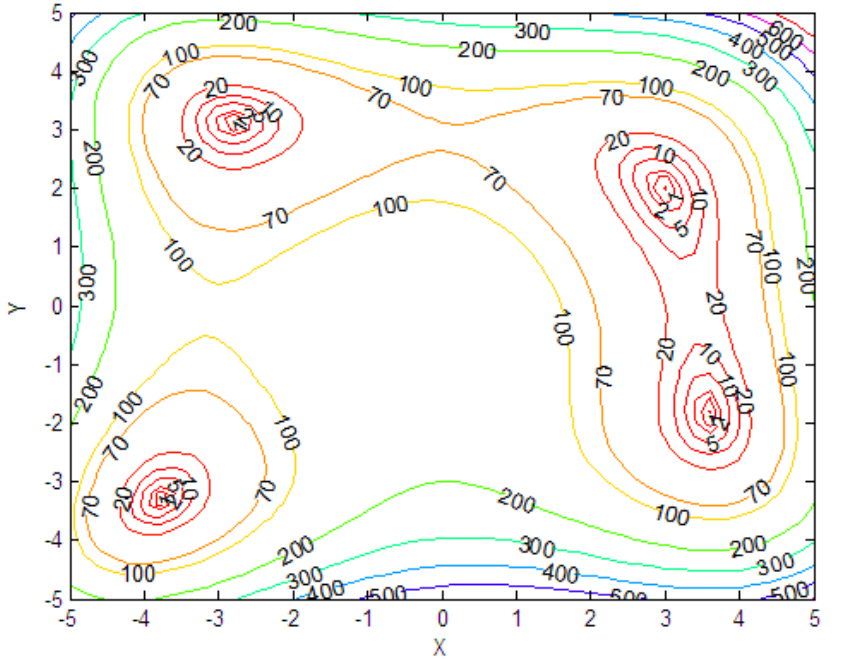
Introduction to optimization



Introduction to optimization





Single variable optimization

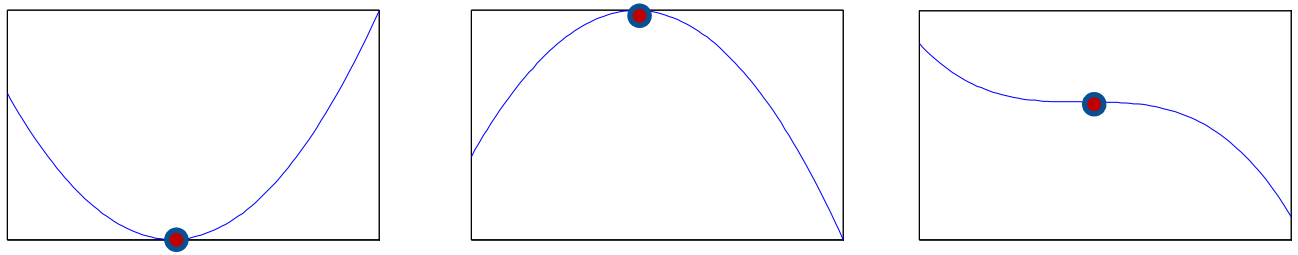
Objective function is defined as

Minimization/Maximization f(x)

Single variable optimization

Stationary points

For a continuous and differentiable function $f(x)$ *a stationary point* x^* *is a point at which the* slope of the function is zero, *i.e.* $f'(x) = 0$ *at* $x = x^*$,



Minima Maxima Inflection point

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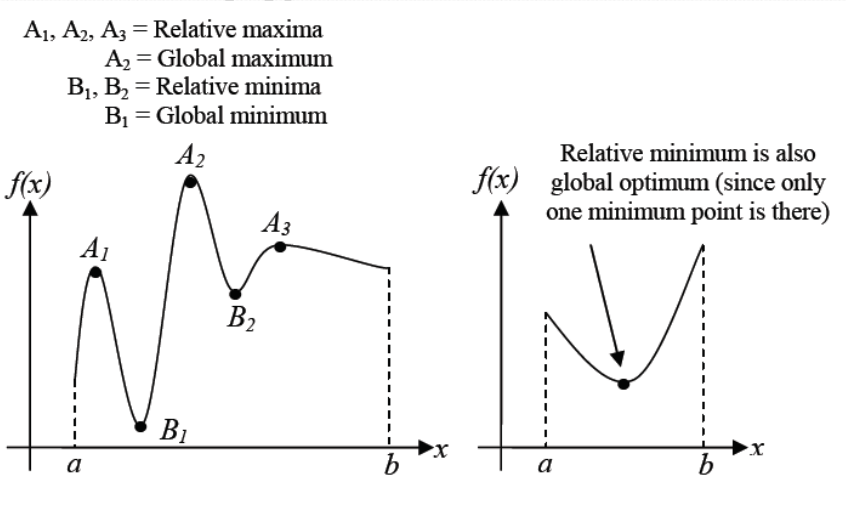
Global minimum and maximum

- A function is said to have a *global or absolute minimum at* $x = x^*$ *if* $f(x^*) \leq f(x)$ *for all* x *in the domain over which* $f(x)$ *is defined.*
- A function is said to have a *global or absolute maximum at* $x = x^*$ *if* $f(x^*) \geq f(x)$ *for all* x *in the domain over which* $f(x)$ *is defined.*



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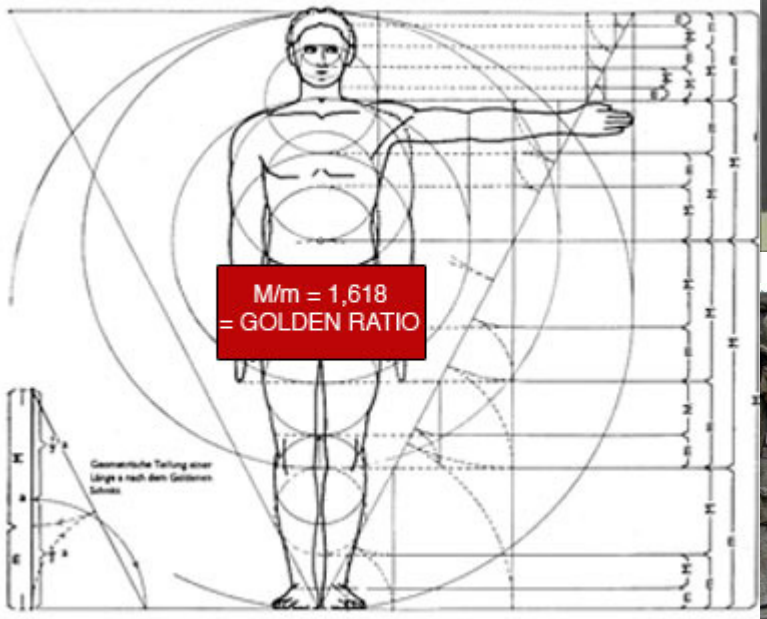
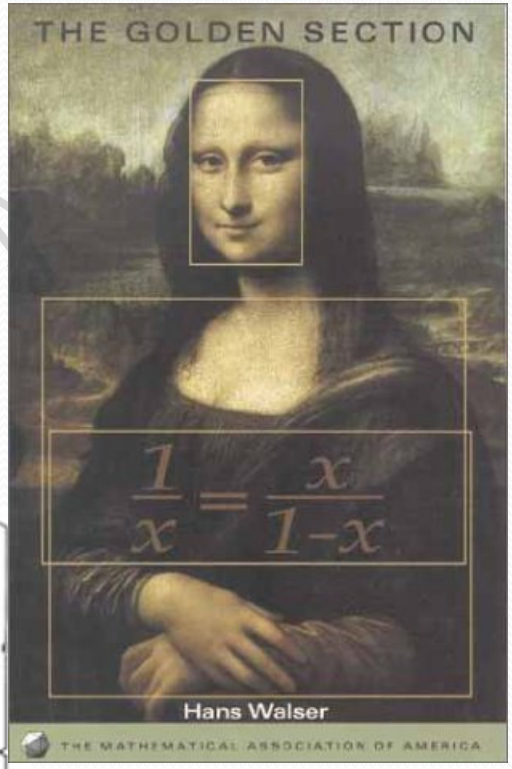
Golden ratio

0.618=1/1.618





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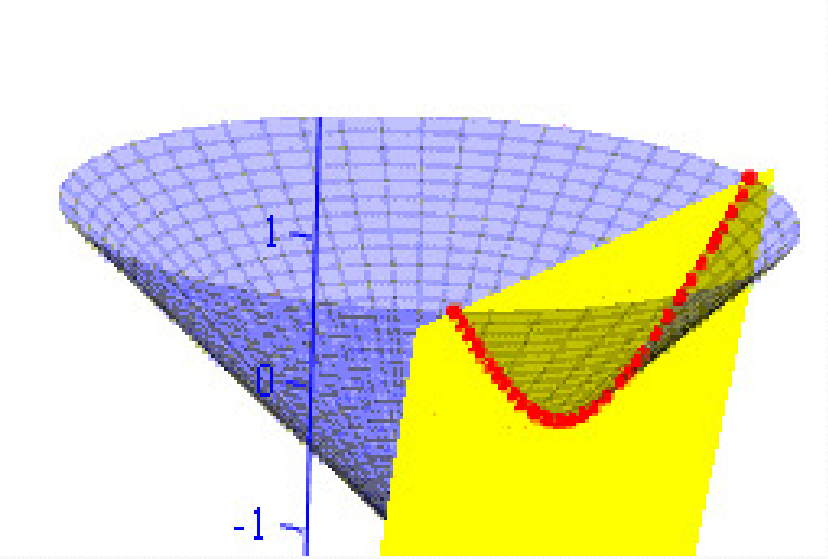
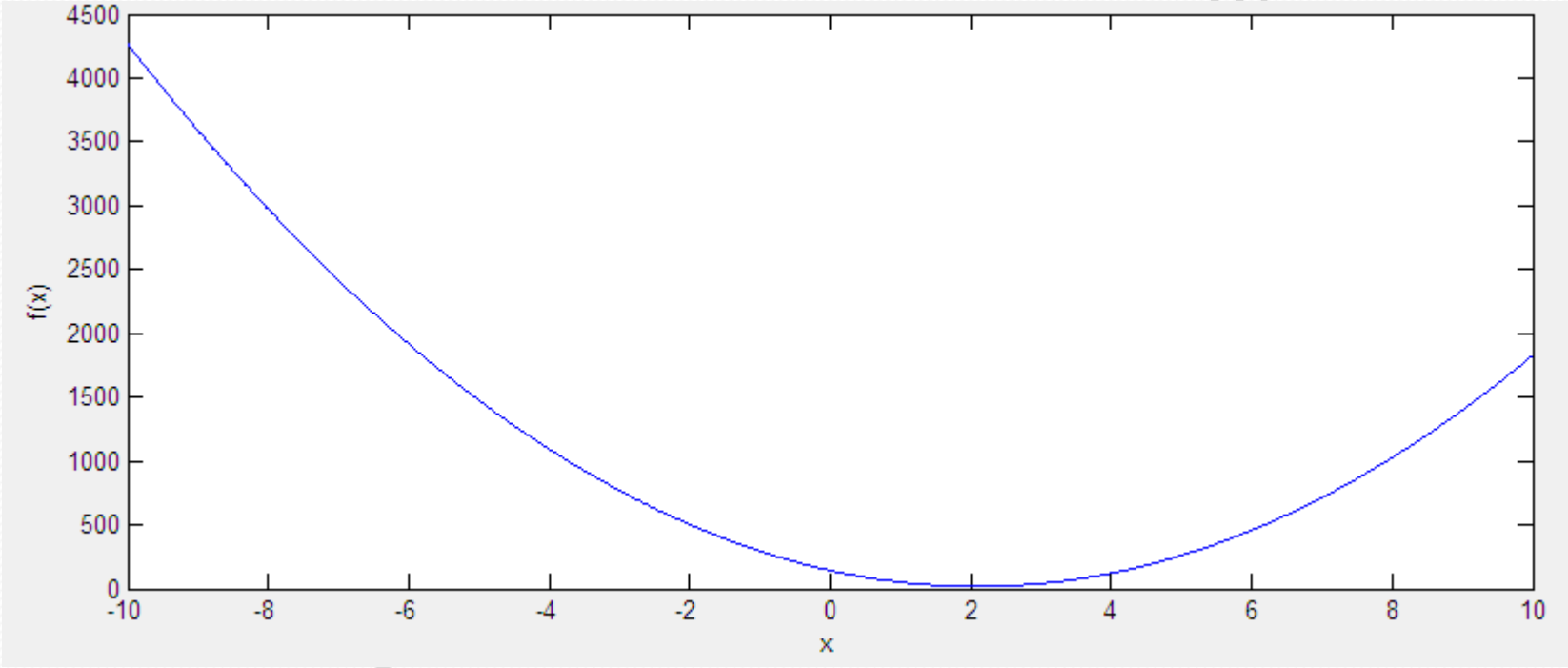
Multivariable optimization problem

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4000
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f(x)
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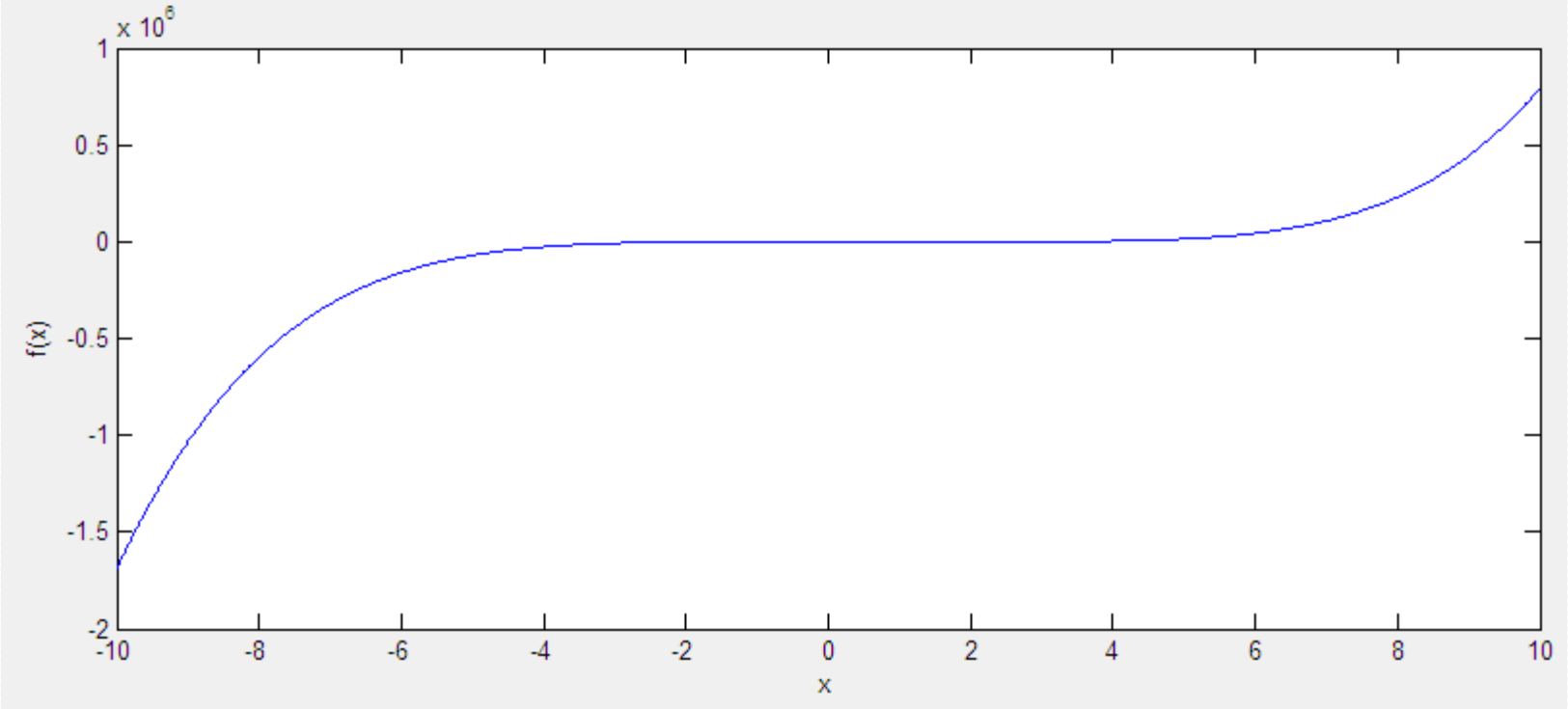
x 10^6
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f(x)
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2
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6
8
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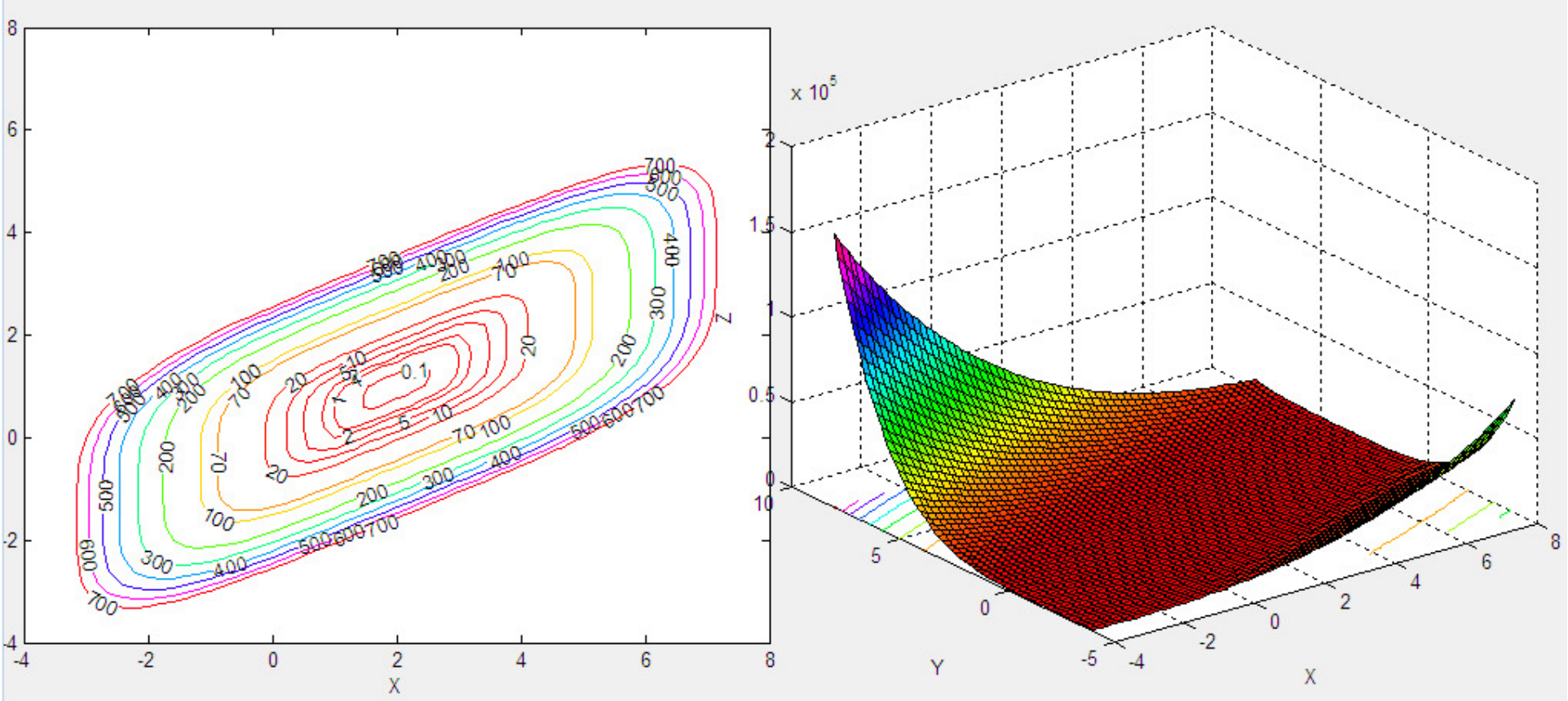
x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x 10^5
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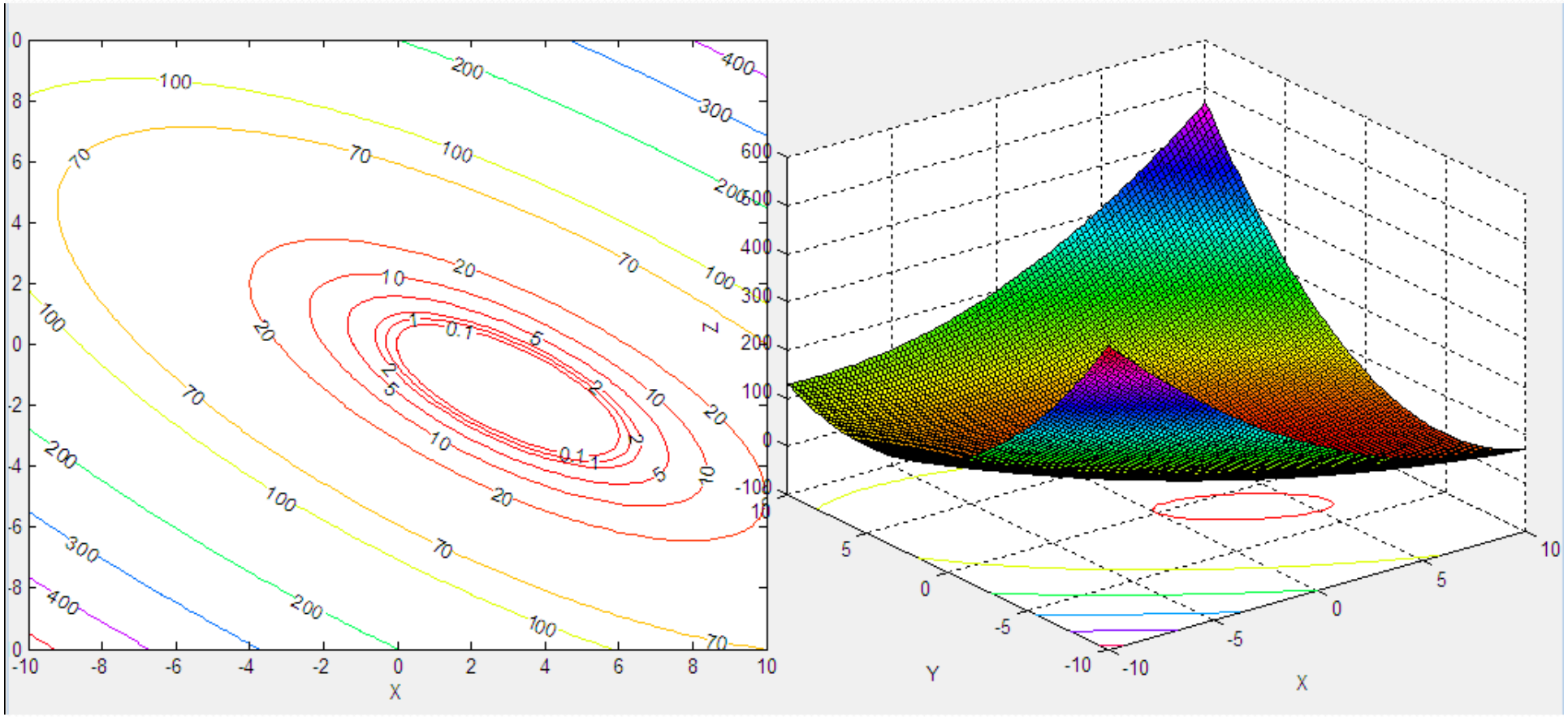
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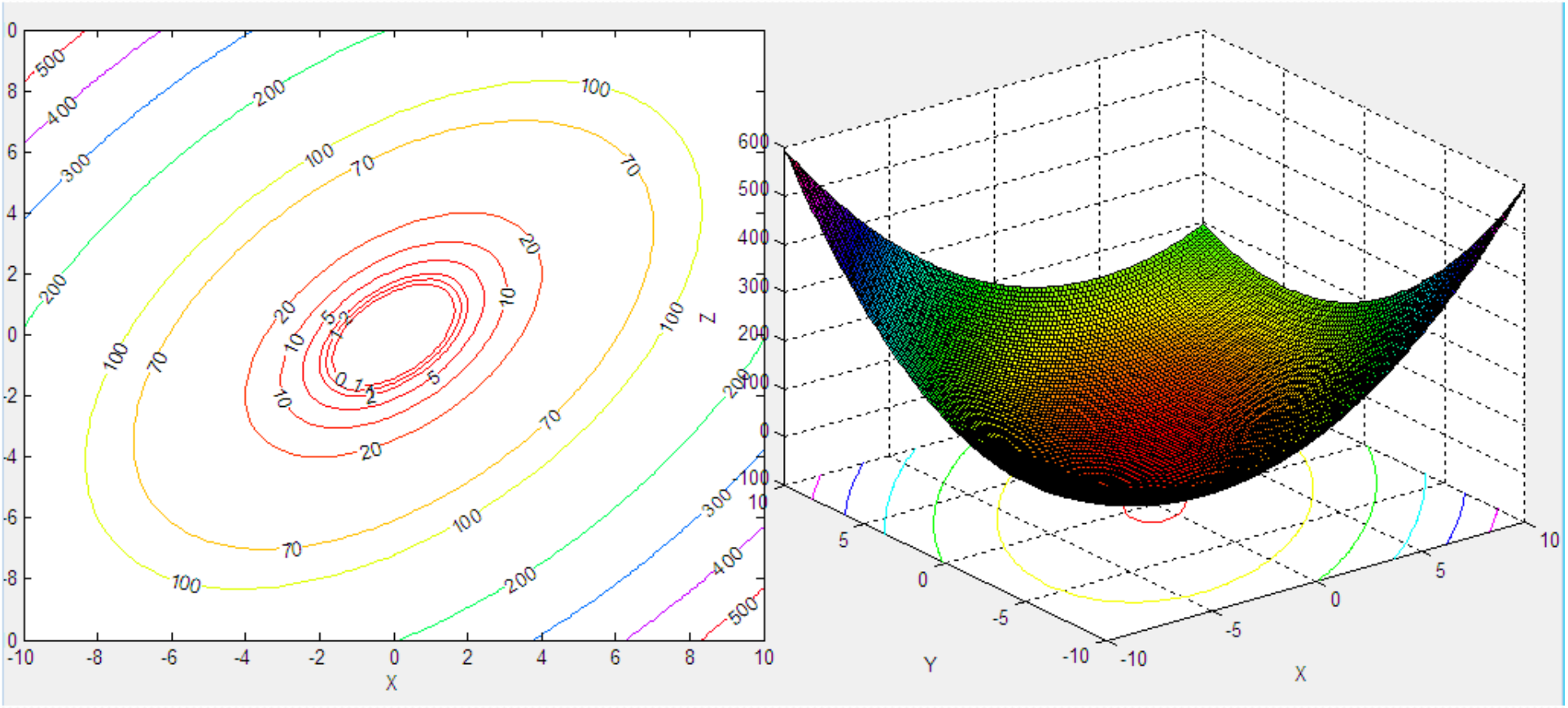
X
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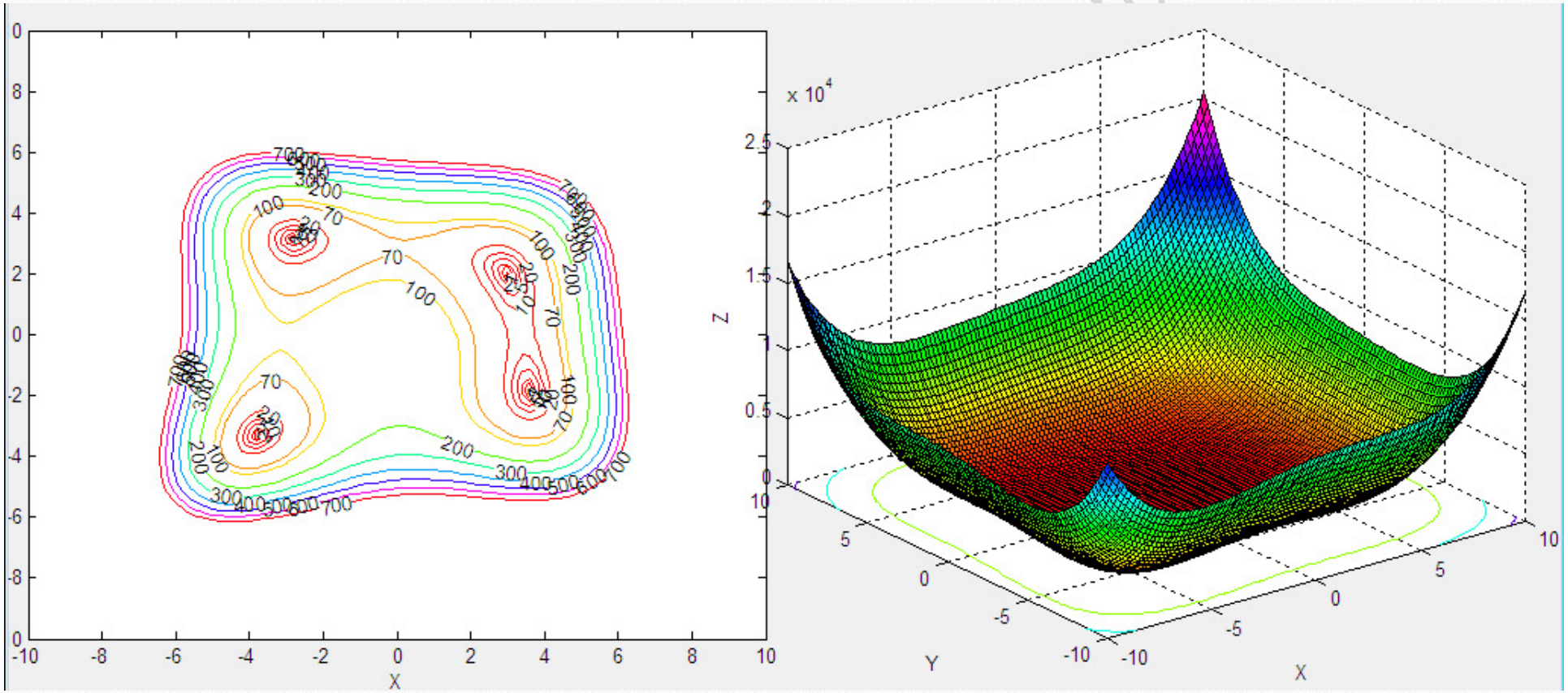
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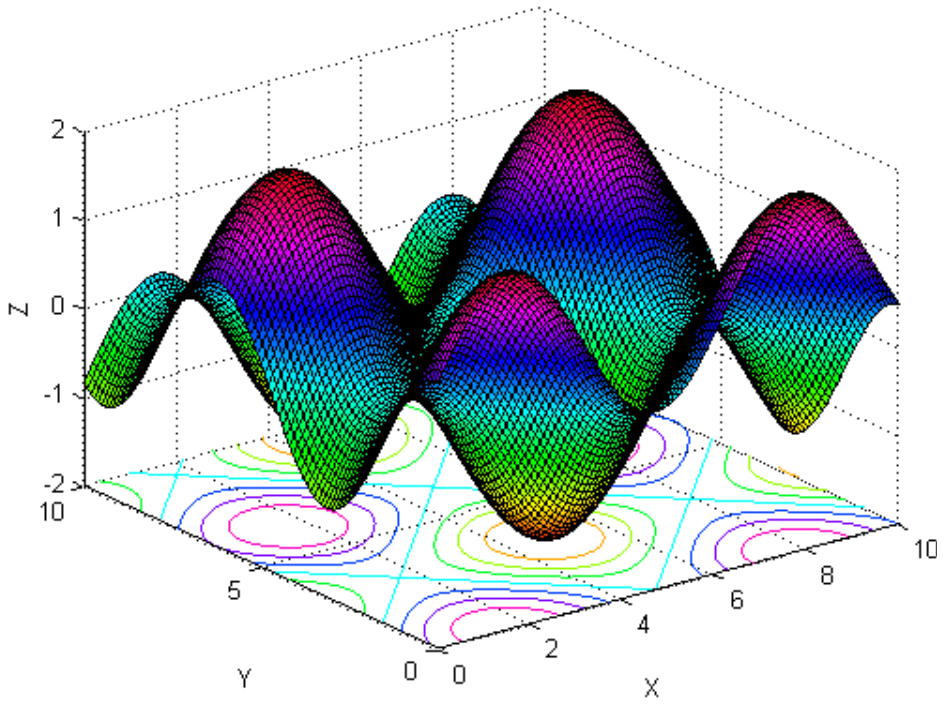
x 10^4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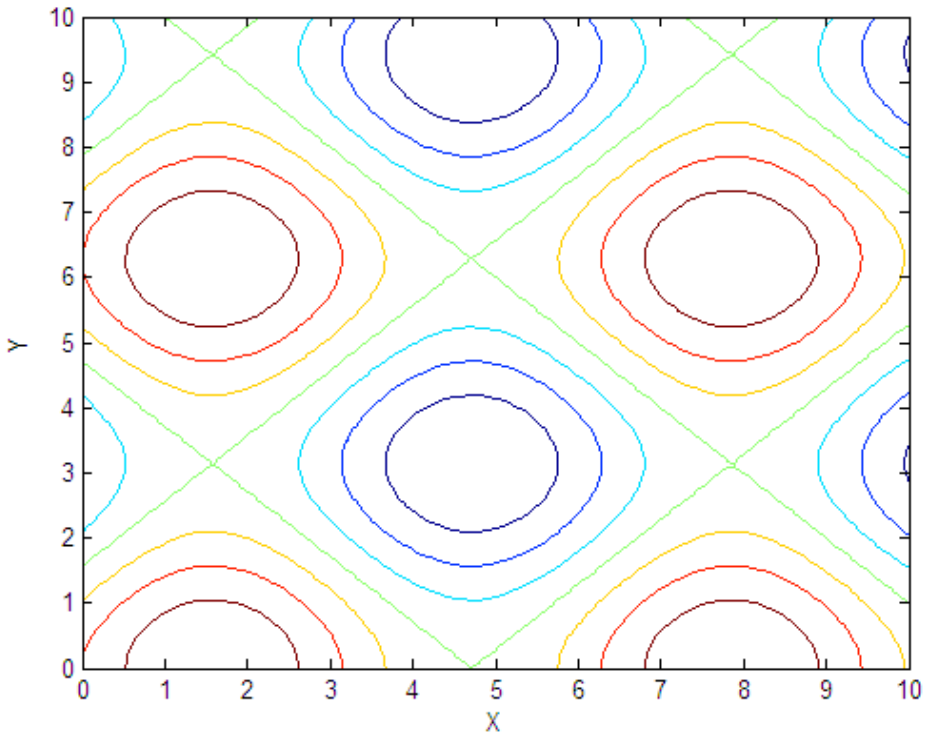
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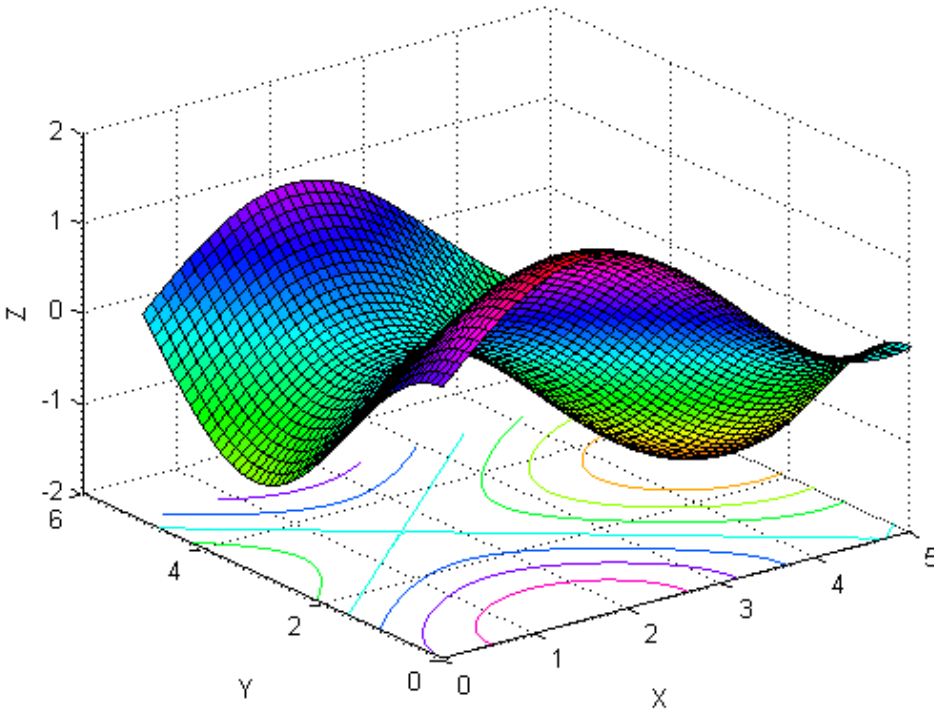
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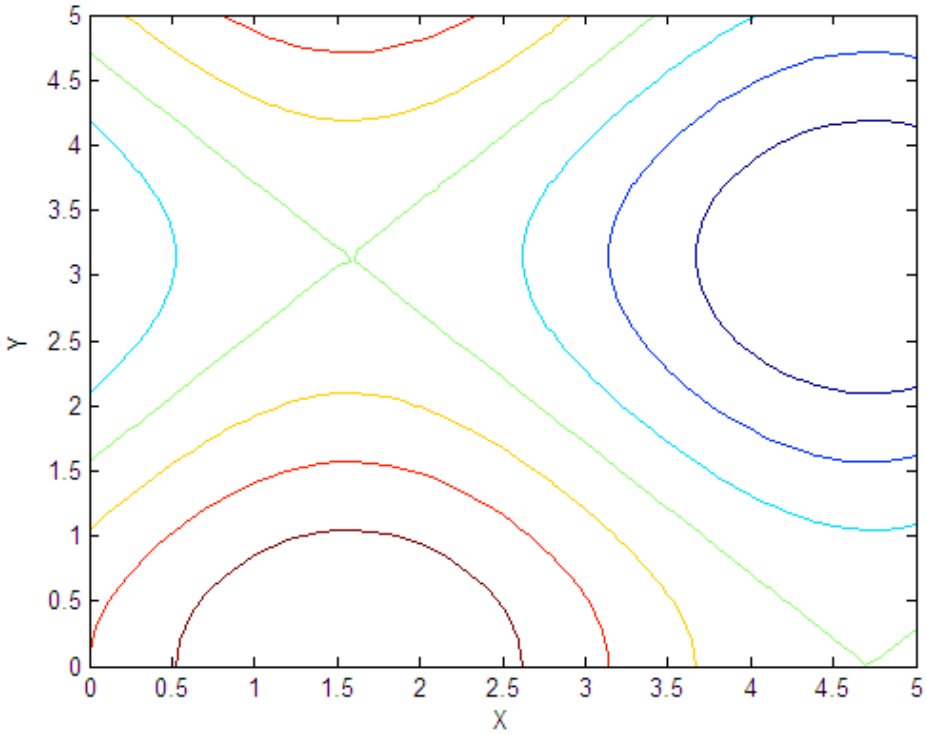
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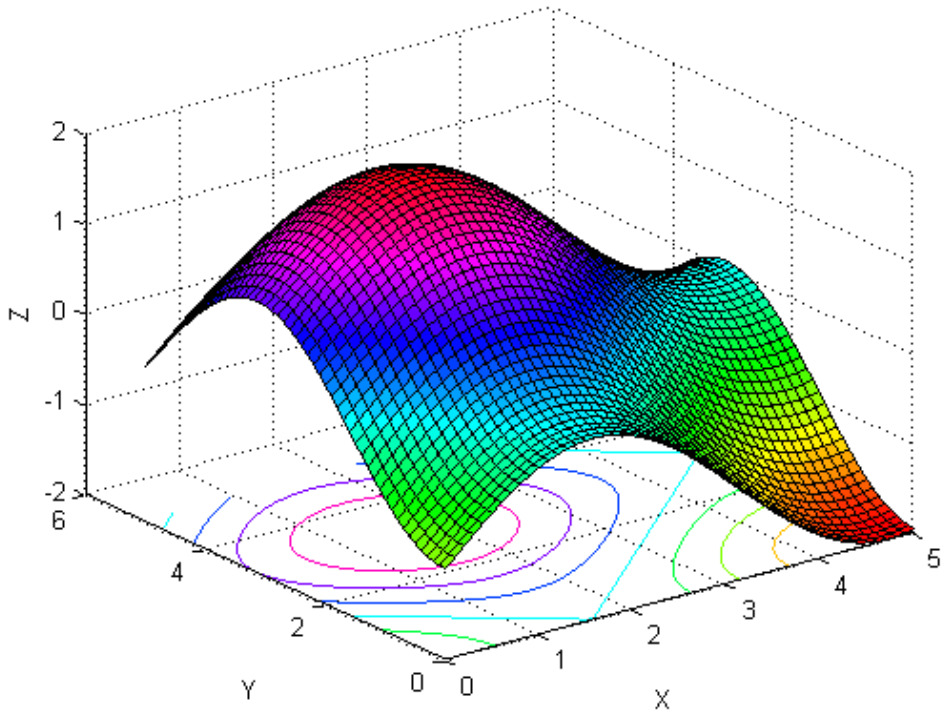
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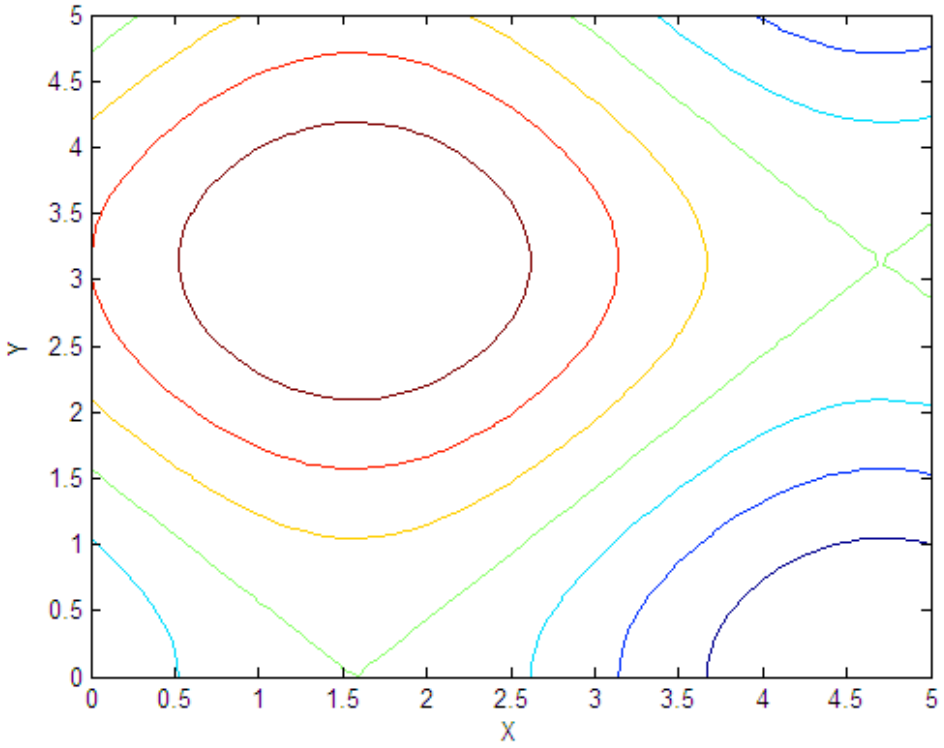
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THANKS

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