# Lagrange Multipliers

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# Constrained Optimization Problem

- We have a problem of the form
  - Find the maximum and minimum values of the function f(x,y) for (x,y) on the curve $g(x,y) = 0$
- where
  - f(x,y) is the objective function
  - g(x,y) is the constraint function

# Lagrange Multipliers

- Let f(x,y,z) and g(x,y,z) have continuous first partial derivatives in a region of $R^3$ that contains the surface S given by the equation g(x,y,z) = 0. Further assume that $\nabla g(x, y, z) \neq 0$ on S.
- If f, restricted to the surface S, has a local extreme value at the point (a,b,c) on s, then there is a real number $\lambda$ such that
  - $\nabla f(a, b, c) = \lambda \nabla g(a, b, c)$
- that is
  - $f_x(a, b, c) = \lambda g_x(a, b, c)$
  - $f_y(a, b, c) = \lambda g_y(a, b, c)$
  - $f_z(a, b, c) = \lambda g_z(a, b, c)$
- The number $\lambda$ is called a Lagrange Multiplier