Acknowledgments

- These slides reflect the order of presentation and the example presented in an MIT Open Courseware lecture:


Objectives

- Understand the method of Lagrange multipliers for optimization of multivariate functions.
- Prepare to apply the method to parameter estimation in categorical and multinomial probability models.

Lagrange Multipliers

\[
f(x_1, x_2, \ldots, x_n)\]

is our objective function

\[
\text{Wanted: } \frac{\partial f}{\partial x_i} = 0, \quad i = 1, 2, \ldots, n
\]

\[
\text{Subject to constraint } g(x_1, x_2, \ldots, x_n) = 0
\]

Condition: \( f \) and \( g \) must be continuously differentiable functions

Gradient

\[
\nabla f(x_1, x_2, \ldots, x_n) = \left( \frac{\partial f}{\partial x_1}, \frac{\partial f}{\partial x_2}, \ldots, \frac{\partial f}{\partial x_n} \right)
\]

Alternative notation:

\[
\left( f_1, f_2, \ldots, f_n \right)
\]
Using the method of Lagrange multipliers to find the Maximum Likelihood Estimate (MLE) of the parameters for a categorical or multinomial distribution.