Method of Lagrange Multipliers
Reminders

• Homework 2: Linear Algebra + Calculus
  – Out: Tue, Sep. 25
  – Due: Tue, Oct. 2 at 11:59pm

• Quiz 1: Linear Algebra
  – In-class, Wed, Oct. 3

• Homework 3: Calculus + Probability
  – Out: Wed, Oct. 3
  – Due: Wed, Oct. 10 at 11:59pm

• Quiz 2: Matrix Calculus + Probability
  – In-class, Wed, Oct. 10
MATRIX CALCULUS
Method of Lagrange Multipliers

Chalkboard

– Motivation: Constrained Optimization
– Method of Lagrange Multipliers
– Extending to multiple constraints
– Extending to inequality constraints
Method of Lagrange Multipliers

\[ f(x, y) = x^2 - 2y \]
Method of Lagrange Multipliers

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Method of Lagrange Multipliers

\[ g(x, y) = x^2 + y^2 \]
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Method of Lagrange Multipliers
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Figure from http://tutorial.math.lamar.edu/Classes/CalcIII/LagrangeMultipliers.aspx
DIMENSIONALITY REDUCTION
PCA Outline

• **Dimensionality Reduction**
  – High-dimensional data
  – Learning (low dimensional) representations

• **Principal Component Analysis (PCA)**
  – Examples: 2D and 3D
  – Data for PCA
  – PCA Definition
  – Objective functions for PCA
  – PCA, Eigenvectors, and Eigenvalues
  – Algorithms for finding Eigenvectors / Eigenvalues

• **PCA Examples**
  – Face Recognition
  – Image Compression
High Dimension Data

Examples of high dimensional data:

– High resolution images (millions of pixels)
High Dimension Data

Examples of high dimensional data:

– Multilingual News Stories
  (vocabulary of hundreds of thousands of words)
High Dimension Data

Examples of high dimensional data:

– Brain Imaging Data (100s of MBs per scan)

Image from (Wehbe et al., 2014)
High Dimension Data

Examples of high dimensional data:
– Customer Purchase Data