Introduction

CS 205A:
Mathematical Methods for Robotics, Vision, and Graphics

Justin Solomon
Instructor

Justin Solomon

Office: Clark S297
Telephone: (650) 725-6521
Email: justin.solomon@stanford.edu
Office hours: W, 10am-12pm
Course Assistants

Joongyeub Yeo
Email: yeo@stanford.edu
Office hours: T, 1pm-3pm
Location: Gates B26A

Yang Zhao
Email: yzhao3@stanford.edu
Office hours: F, 2pm-4pm
Location: Gates B26A
Section

Fridays, 4:15pm-5:05pm
Hewlett 102
On the Web

Course website:
http://cs205a.stanford.edu

Piazza:
http://piazza.com/stanford/fall2013/cs205a

Office hours (GChat):
cs205a.ta
Texts

- **Official text:** *Scientific Computing*, Heath
- **Course notes:** On website
  - *Warning:* May contain typos!
  - Responsible for textbook material
  - Corrections, comments, and suggestions encouraged
Course Breakdown

- **Homeworks (approx. weekly):** 60%
- **Midterm:** 15%
- **Final exam:** 25%
- **Participation:** ±5%
  - Corrections or comments on notes
  - Participation in lecture, office hours, and Piazza
Course Topics I

1. **Numerics**
   - Stability and error analysis
   - Floating-point representations

2. **Linear algebra**
   - Gaussian elimination and LU
   - Column spaces and QR
   - Eigenproblems
   - Applications

3. **Root-finding and optimization**
   - Single-variable
   - Multivariable
   - Constrained optimization
Course Topics II

- Iterative linear solvers: Conjugate gradients and friends

4. **Interpolation and quadrature**
   - Approximating integrals
   - Approximating derivatives

5. **Differential equations**
   - ODEs: time-stepping, discretization
   - PDEs: Poisson equation, heat equation, waves
   - Techniques: Differencing, finite elements (time-permitting)
Two Roles

- **Client** of numerical methods
- **Designer** of numerical methods
Variational Viewpoint

Minimize objective subject to constraints

- \( A\vec{x} = \vec{b} \iff \min ||A\vec{x} - \vec{b}||^2 \)
- \( A^\top A\vec{x} = \lambda\vec{x} \iff \min ||A\vec{x}|| \text{ s.t. } ||\vec{x}|| = 1 \)
Official Prerequisites

Math 51 and CS 106B
Typical Linear Algebra

\[ \| A\vec{x} - \vec{b} \|^2 = (A\vec{x} - \vec{b}) \cdot (A\vec{x} - \vec{b}) \]
\[ = (A\vec{x} - \vec{b})^\top (A\vec{x} - \vec{b}) \]
\[ = (\vec{x}^\top A^\top - \vec{b}^\top)(A\vec{x} - \vec{b}) \]
\[ = \vec{x}^\top A^\top A\vec{x} - x^\top A^\top \vec{b} - \vec{b}^\top A\vec{x} + \vec{b}^\top \vec{b} \]
\[ = \| A\vec{x} \|^2 - 2(A^\top \vec{b}) \cdot \vec{x} + \| \vec{b} \|^2 \]
Necessary Calculus

- Gradient vector $\nabla f$ for $f : \mathbb{R}^n \to \mathbb{R}$
- Jacobian $Df$ for $f : \mathbb{R}^m \to \mathbb{R}^n$
- Lagrange multipliers for minimizing $f(\vec{x})$ subject to $g(\vec{x}) = \vec{0}$
Homework 0

Due one week from today!

To review:

- Linear algebra
- Calculus