Introduction

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

Doug James
Instructor

Prof. Doug James

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Course Assistants

Qifeng Chen
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Christina Lee
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  ● Th 10:30am-12:30pm (Lathrop Tech Lounge)

Michela Meister
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Section

Fridays, 11:30am-12:20pm
Location TBD
Optional
On the Web

Course website:  
http://graphics.stanford.edu/courses/cs205a-16-spring

Piazza:  
https://piazza.com/stanford/spring2015/cs205a/

Gradescope: (Registration code: MG6YG9)  
https://gradescope.com/courses/3035

Online office hours:  
Google Hangout
Texts

▶ **Text:** *Numerical Algorithms*, Justin Solomon
  - Book available online (PDF), in print, or as an electronic reader
  - Check course web page...
  - Contact Justin with typos

▶ **Optional text:** *Scientific Computing*, Heath
Course Breakdown

- **Homeworks (approx. weekly):** 60%
  
  Submit with *gradescope*

- **Midterm:** 15%

- **Final exam:** 25%

- **Participation:** ±5%
  
  - Corrections or comments on text
  - Participation in lecture, office hours, and/or Piazza
  - Extra credit on homework
Quick Survey

- Program?
- Department?
- Math background?
Two Roles

- **Client** of numerical methods
- **Designer** of numerical methods
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)
Studying for 205A

Be creative!

- Try simple examples
- Write some code
- Re-derive on paper
- Draw pictures
- Ask questions
Official Prerequisites

Math 51 and CS 106B
Typical Linear Algebra

\[ \| A\vec{x} - \vec{b} \|_2^2 = (A\vec{x} - \vec{b}) \cdot (A\vec{x} - \vec{b}) \]
\[ = (A\vec{x} - \vec{b})^\top (A\vec{x} - \vec{b}) \]
\[ = (\vec{x}^\top A^\top - \vec{b}^\top)(A\vec{x} - \vec{b}) \]
\[ = \vec{x}^\top A^\top A\vec{x} - \vec{x}^\top A^\top \vec{b} - \vec{b}^\top A\vec{x} + \vec{b}^\top \vec{b} \]
\[ = \| A\vec{x} \|_2^2 - 2(A^\top \vec{b}) \cdot \vec{x} + \| \vec{b} \|_2^2 \]
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:

$$\min_{\vec{x} \in \mathbb{R}^n} f(\vec{x})$$

subject to $g(\vec{x}) = 0$
Homework 0

Due one week from today!

To review (Chapter 1):

- Linear algebra
- Calculus

Make **ample use** of Piazza & office hours.
Submit online using **gradescope**.