Lecture Notes 0: Introduction

CPSC 302: Numerical Computation for Algebraic Problems

Jessica Bosch
jbosch@cs.ubc.ca
http://www.cs.ubc.ca/~jbosch

University of British Columbia
Department of Computer Science

2017/2018 Winter Term 1

Outline

1. Motivation
2. Introduction of Your Instructor
3. Syllabus
4. Group Activity
   - Common Ground
   - Team Presentation
5. Reflection

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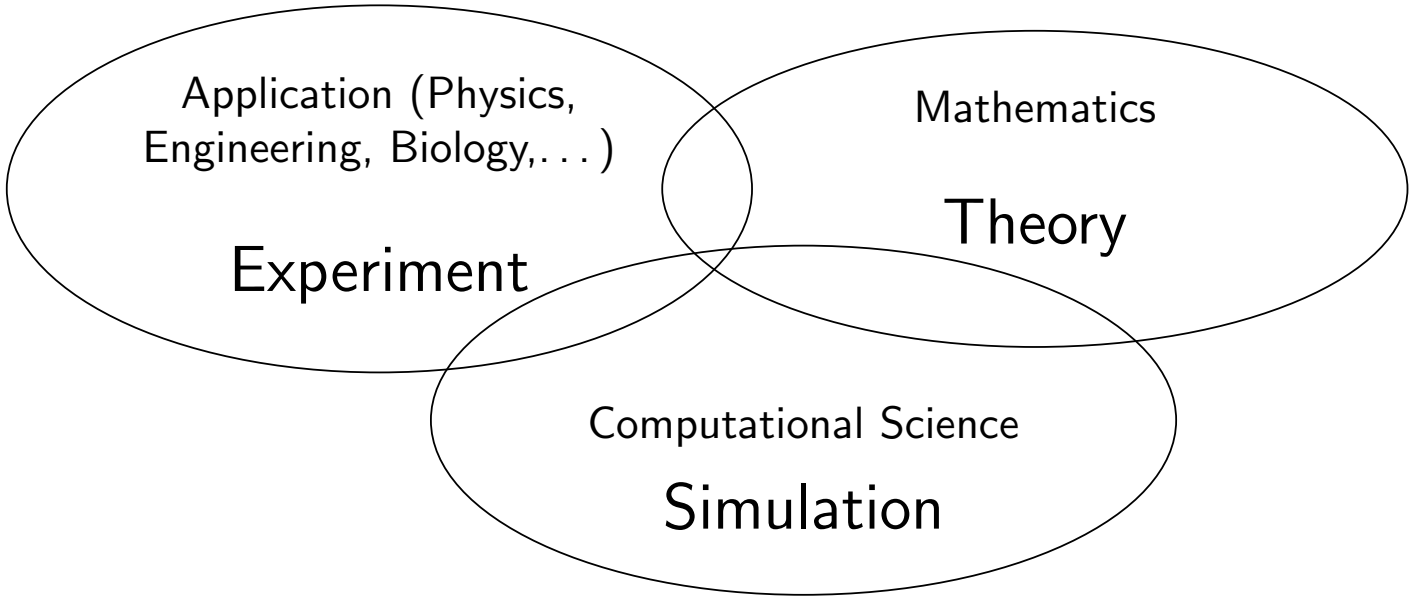
Scientific Computing

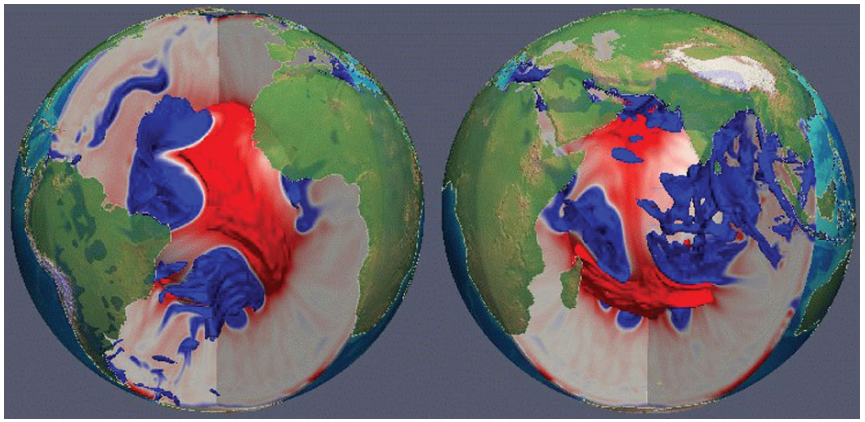
- Development & study of numerical algorithms for solving mathematical problems.
- Numerical analysis is the theory behind.



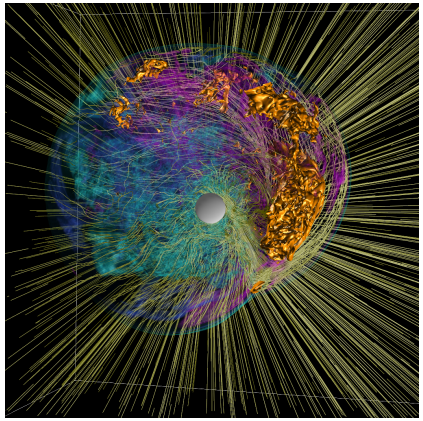
Why Numerical Simulations?

Experiments are often impossible.

- Geophysics: thermal structure of the Earth's mantle [1]

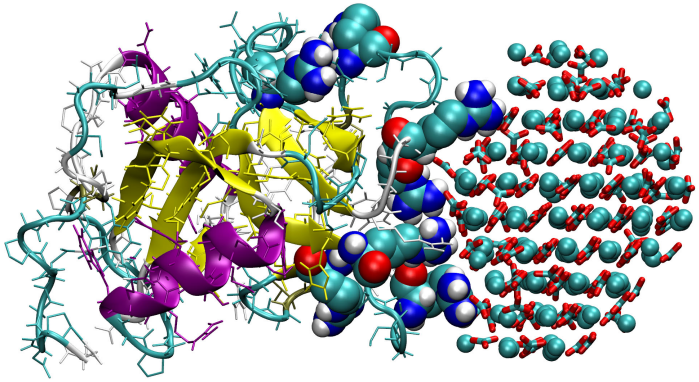


- Astrophysics: supernova simulations [2]

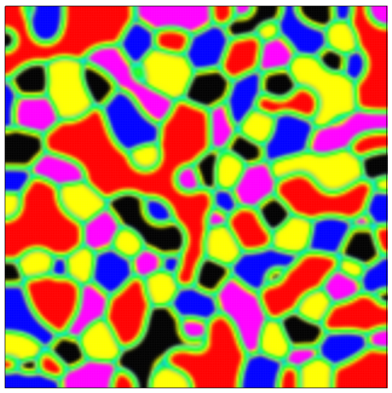


Why Numerical Simulations?

- Experiments are often costly: analysis and study of proteins [3]



- Simulations are often cheaper and faster: phase separation and coarsening in alloys [4]



Why Numerical Methods?

- Practical applications often require solving enormous systems of equations, millions or even billions of variables.

- Many practical problems – optimization, differential equations, signal processing, etc. – boil down to solving linear systems, even when the original problems are non-linear. Finite element software, for example, spends nearly all its time solving linear equations.

- The heart of Google is an enormous linear algebra problem. PageRank is essentially an eigenvalue problem.

To Prevent Disasters

Collapse of the Tacoma Narrows bridge on November 7, 1940

`http://eigenvaluesandbridges.weebly.com/tacoma-narrows-bridge.html`

A suspension bridge should be built so that the lower eigenvalues of vibrations in the bridge are not close to possible wind-induced frequencies.

CPSC 302

- We study **basic numerical methods** for solving:
  - Linear systems
  - Linear eigenvalue problems
  - Linear least squares problems
  - Nonlinear equations

- Many of the algorithms we will learn are already implemented...
- Why studying them?
  - They provide the **basis for more complex tasks**.
  - To **detect, understand, and correct errors**.
  - To **modify or create software** appropriate to a particular problem.
  - To **formulate the problem** in a manner appropriate to the problem.

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My Home


Sign in
Germany
Poland
Netherlands
Belgium
Czechia
Slovakia
Austria
Hungary
Switzerland
Liechtenstein
Amsterdam
The Hague
Hamburg
Bremen
Berlin
Hanover
Wolfsburg
Brunswick
Magdeburg
Dortmund
Essen
Cologne
Antwerp
Brussels
Lille
Leipzig
Dresden
Frankfurt
Mannheim
Karlsruhe
Stuttgart
Nuremberg
Augsburg
Munich
Strasbourg
Zürich
Salzburg
Graz
Vienna
Bratislava
Budapest
Debrecen
Prague
Brno
Ostrava
Katowice
Kraków
Rzeszow
Lviv
Львів
Ternopil
Тернопіль
Ivano-Frankivsk
Івано-Франківськ
Košice
Zakopane
Wrocław
Łódź
Poznań
Warsaw
Lublin
Kielce
Brest
Брэст
Grodno
Гродна
Białystok
Olsztyn
Gdańsk
Gdynia
Kaliningrad
Калининград
Vilnius
Szczecin
Bydgoszcz
Rostock
Lübeck
Kiel
Odense
Paris
Tours
Oxford
London
Cambridge
Brighton
Satellite
Google

Today's Goals

- Start the term on a positive note
- Gain your interest
- Communicate key elements and expectations for the course
- Actively involve you

Another Passion

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Contact Your Instructor

How to reach me?

- In person after class
- Office hour: Mondays 4:30–5:30pm in ICCS 215
- Piazza
- Email: jbosch@cs.ubc.ca

Contact Your TAs

- Michael Wathen
  - Office hour: Tuesdays 09:30-10:30 in ICCS X337
  - Piazza
  - Email: mwathen@cs.ubc.ca
- Nicholas Hu
  - Office hour: Tuesdays 11:30-12:30 in Demco Learning Centre (ICCS X150), Table 3
  - Piazza
  - Email: nicholas.hu@alumni.ubc.ca
- Sarah Elhammadi
  - Office hour: Wednesdays 11:30-12:30 in Demco Learning Centre (ICCS X150), Table 3 (start: Sept 20)
  - Piazza
  - Email: shammadi@cs.ubc.ca

Outcomes

Main Objective

By the end of this course, you should be able to
choose, analyze, implement, and evaluate
appropriate numerical methods for solving a variety of mathematical problems.

Further outcomes include:

- Improve or continue on being an intentional learner.
- Identify the interactions between numerical computation and other realms of knowledge such as history, economics, science, ...
- Get excited!

Course Structure

	Monday		Wednesday		Friday	
In-class activities		Lecture		Lecture		Group Exercise
Out-of-class activities	Prior Knowledge Quiz		Assignment		Pre-Class Readings Quiz	

Lectures

- we'll use clickers $\rightsquigarrow$ register your clicker on Connect
- receive an extra 1% after good performance

Required Reading

- check "Schedule" on course website regularly
- for Friday classes: complete readings before class
- pre-class quizzes (Connect) on these readings
- in-class group exercises on these readings

Assignments

- bi-weekly
- uploaded ≈ 2 weeks before the due date
- hardcopy and electronic submission
- 1 bonus assignment at the end, up to an additional 3%

Course grade:

- 30% – Assignments
- 5% – Prior Knowledge Quizzes
- 5% – Pre-Class Readings Quizzes
- 5% – In-Class Group Exercises
- 15% – Midterm Exam
- 40% – Final Exam

You must have a pass standing in the assignment component of the course.

Course Structure

	Monday		Wednesday		Friday	
In-class activities		Lecture		Lecture		Group Exercise
Out-of-class activities	Prior Knowledge Quiz		Assignment		Pre-Class Readings Quiz	

Prior Knowledge Quizzes

- in Connect
- weekly, due by Monday at 1pm
- 5 graded quizzes among them

Pre-Class Readings Quizzes

- in Connect
- weekly, due by Friday at 1pm
- 5 graded quizzes among them

In-Class Group Exercises

- weekly
- 6 graded exercises among them

Course grade:

- 30% – Assignments
- 5% – Prior Knowledge Quizzes
- 5% – Pre-Class Readings Quizzes
- 5% – In-Class Group Exercises
- 15% – Midterm Exam
- 40% – Final Exam

You must have a pass standing in the assignment component of the course.

Suggestion Box

You can provide me with
anonymous suggestions regarding my teaching or the course in general.

You are encouraged to submit *typed* suggestions if you are concerned.

Course Details: Getting Started

- **Find the course website:**
  `http://www.cs.ubc.ca/~jbosch/courses/2017-18/CPSC302/`
- Read through the syllabus on the first page.
- Log into Connect and register your i>clicker.
  Clicker bonus questions start Sept 20.
- Register into Piazza site for the course:
  `http://www.piazza.com/ubc.ca/winterterm12017/cpsc302/`
- Get access to MATLAB.
- Do the assigned reading for Friday and answer the pre-class reading quiz.
  This Friday, each group should bring a laptop with MATLAB access.
- Interest Inventory Survey (Connect) due by Monday, 1pm

Note for Waiting List Students

- I will copy a PDF of the quizzes/surveys into Piazza until Sept 19.
- Students are admitted from wait lists until the add/drop deadline according to the department's standard priority scheme: `https://www.cs.ubc.ca/students/undergrad/courses/waitlists`

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Common Ground

Form groups of 4 students.

Common Ground

Form groups of 4 students.

Discuss and write down the following on a piece of paper:

- Everyone's name
- Come up with 6 things that you all share
- Create a team name
- Try to find a volunteer that is keen to present your team to the class
- If you have time: choose a team song, design a team mascot

Team Presentations

Who wants to present the team to the whole class?

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Reflection

On a piece of paper, write down the following:

- Your name
- The best way to contact you
- Answer the following question:

  What have teachers and professors done in the past that helped you to learn?

Submit the paper to your instructor.

References

[1] "Thermal versus elastic heterogeneity in high-resolution mantle circulation models with pyrolite composition: High plume excess temperatures in the lowermost mantle" by Schuberth, B. S. A.; Bunge, H. P.; Steinle-Neumann, G.; et al Geochemistry Geophysics Geosystems 10(1) Article Q01W01; Published January 8, 2009.

[2] `http://www.csm.ornl.gov/astro/`

[3] `http://www2.warwick.ac.uk/newsandevents/pressreleases/researchers_apply_computing/`

[4] "Fast Iterative Solvers for Cahn–Hilliard Problems" by J. Bosch; PhD thesis, Faculty of Mathematics, Otto-von-Guericke-Universität Magdeburg, June 2016.