

# Software Design and Analysis for Engineers

by

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*Simon Fraser University*

Slide Set: 0

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“Programming today is a race between software engineers striving to build bigger and better idiot-proof programs, and the Universe trying to produce bigger and better idiots. So far, the Universe is winning.”

- Author **Rick Cook**, *The Wizardry Compiled*

# Slide Set Overview

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- Course Motivation
- Logistical Details
- Course Lab Component
- Lecture Topics

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Why should you care about this course? In other words:

Why should you care about Software Design and Analysis?

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# Why care about this course?

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It's “*required*” – a core course for all options and a prerequisite for many other courses

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# Why care about Software Design & Analysis?

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Processors outnumber people (ARM alone has sold over 60 BILLION processor cores)

- Software is a key component of all commercial electronic systems

Anyone might be able to write simple software and it *might* work.

- But writing working, reliable, scalable, software for critical systems, heterogeneous systems, million line code bases, the cloud requires good design methodologies

# Why care about Software Design & Analysis?

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You are now seeking your first coop- these skills will be crucial to finding a good placement.

The software industry is one of the fastest growing industries

Even in other industries, software expertise will set you apart.



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Software is a key component of *all* electronic systems ...

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# Outer-Space

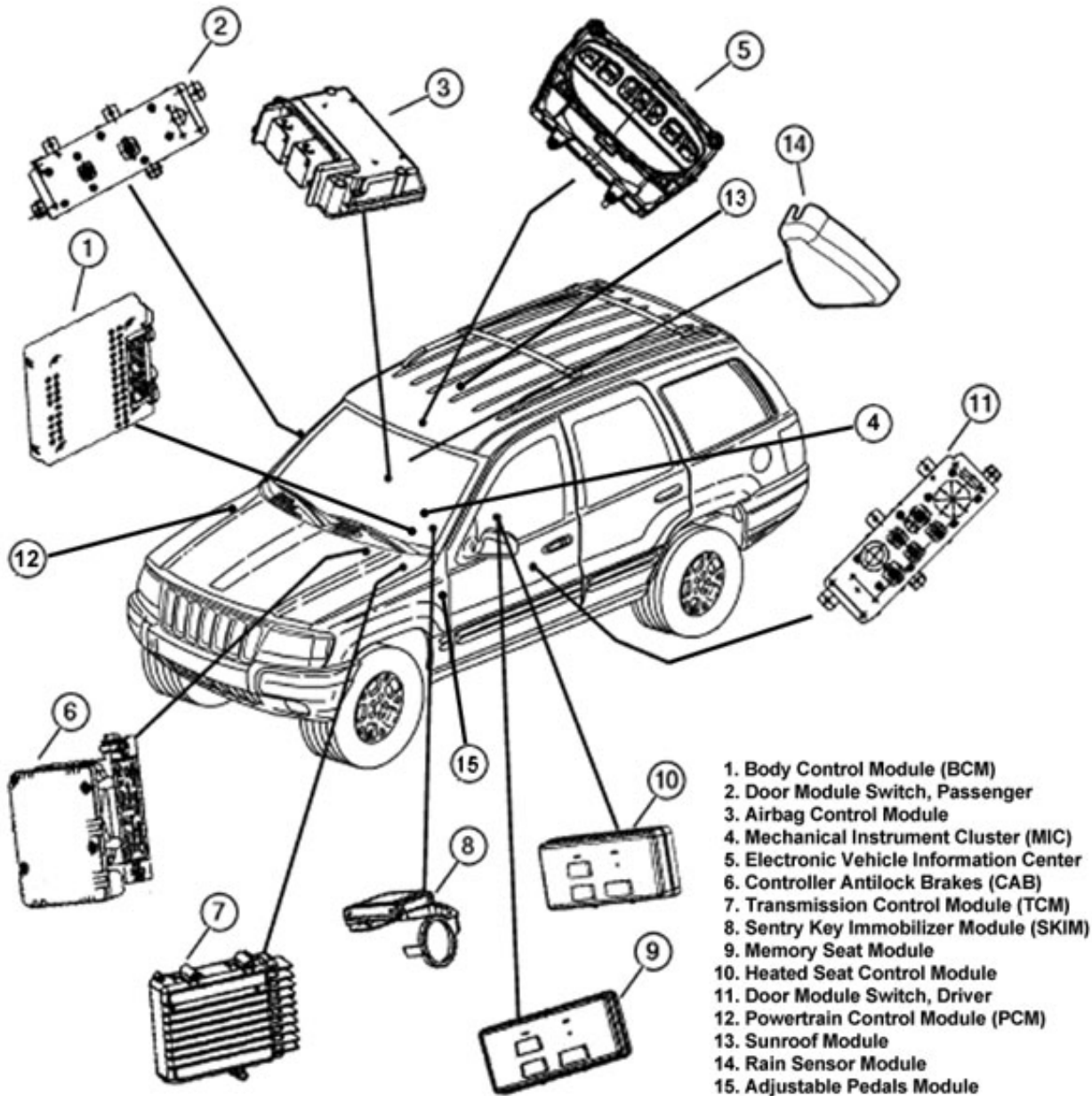


# Automotive Electronics

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# Automotive Electronics



7-Series BMW:  
63 Embedded  
Processors

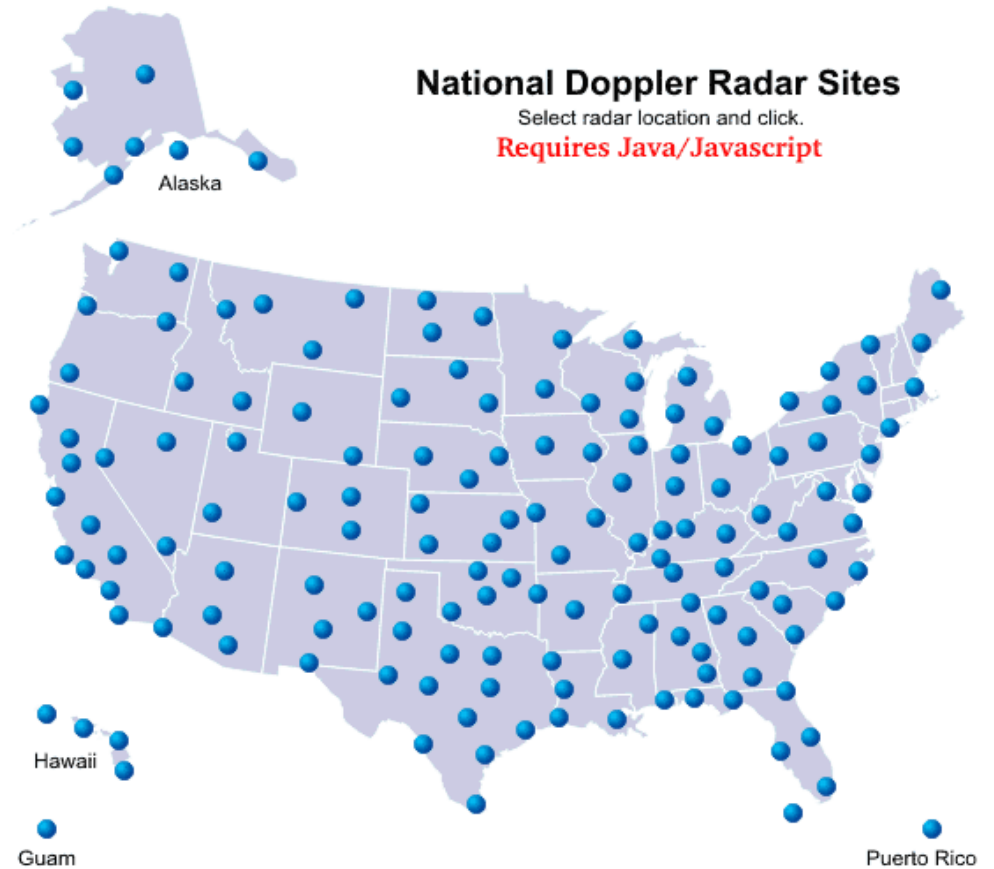
Mercedes S-Class  
65 Embedded  
Processors

More than 80% of  
the innovation in  
autos is from  
innovations in  
electronics  
- Daimler-Chrysler

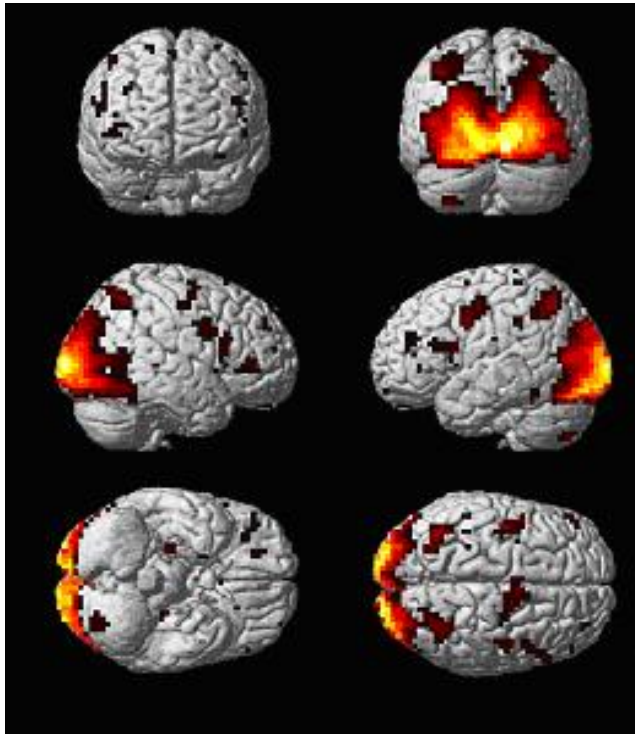
Automotive  
Semiconductor  
Market: US\$13.1  
billion / year

# Meteorological Applications (Predicting the Weather)

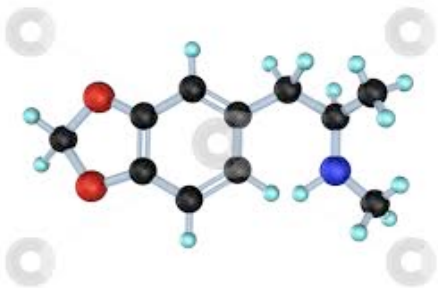
## Doppler Weather Radar



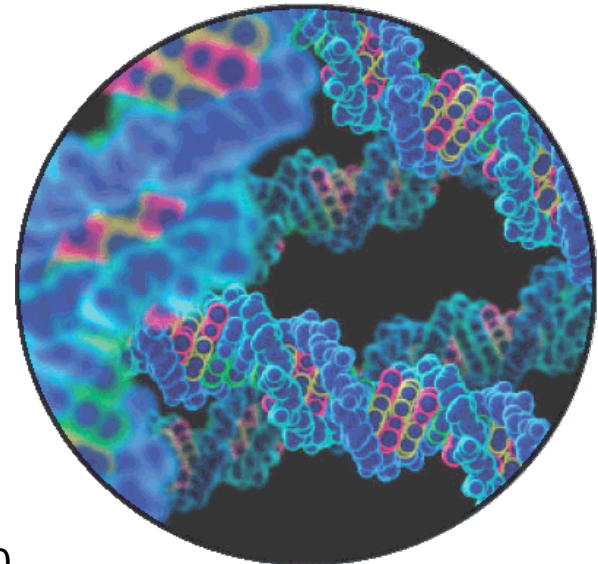
# Medical Applications



## Diagnostic Applications

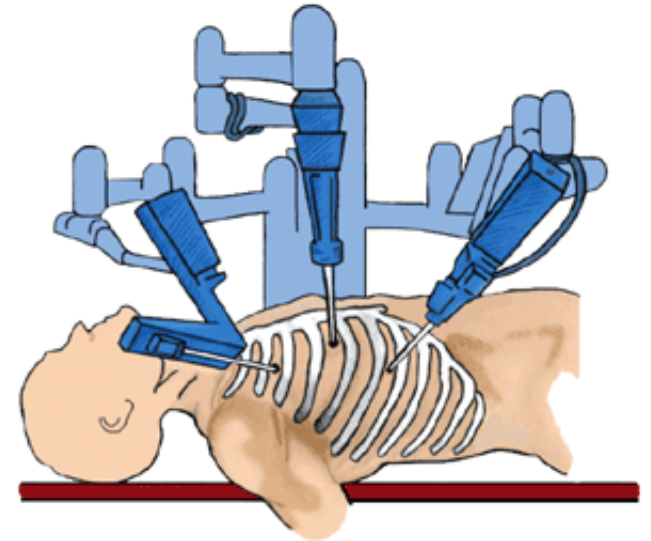


## Molecular Dynamics and Gene Mapping



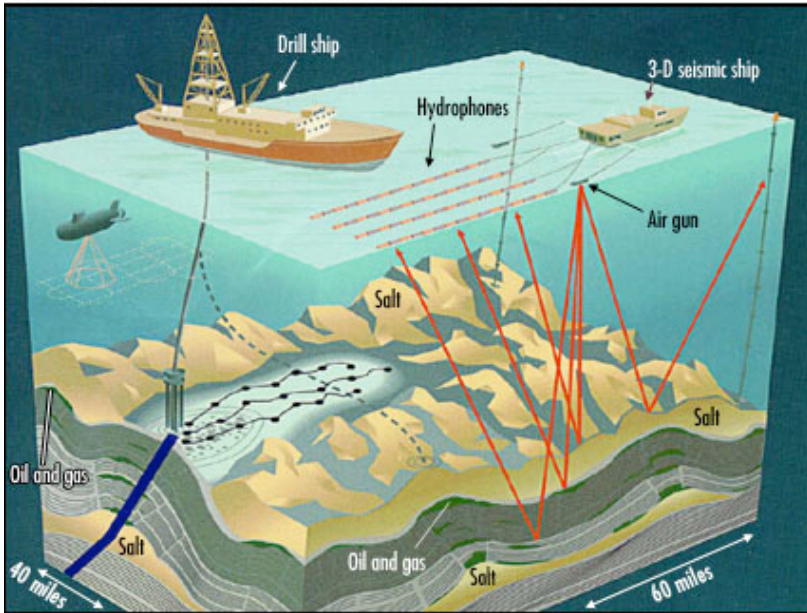
## Prosthetics

## Remote Surgery



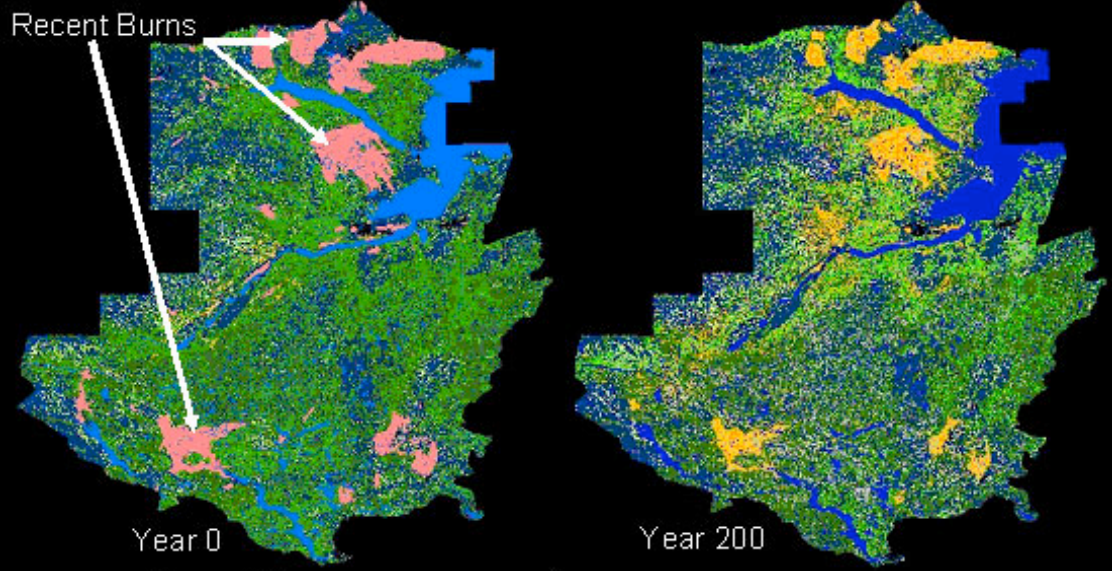
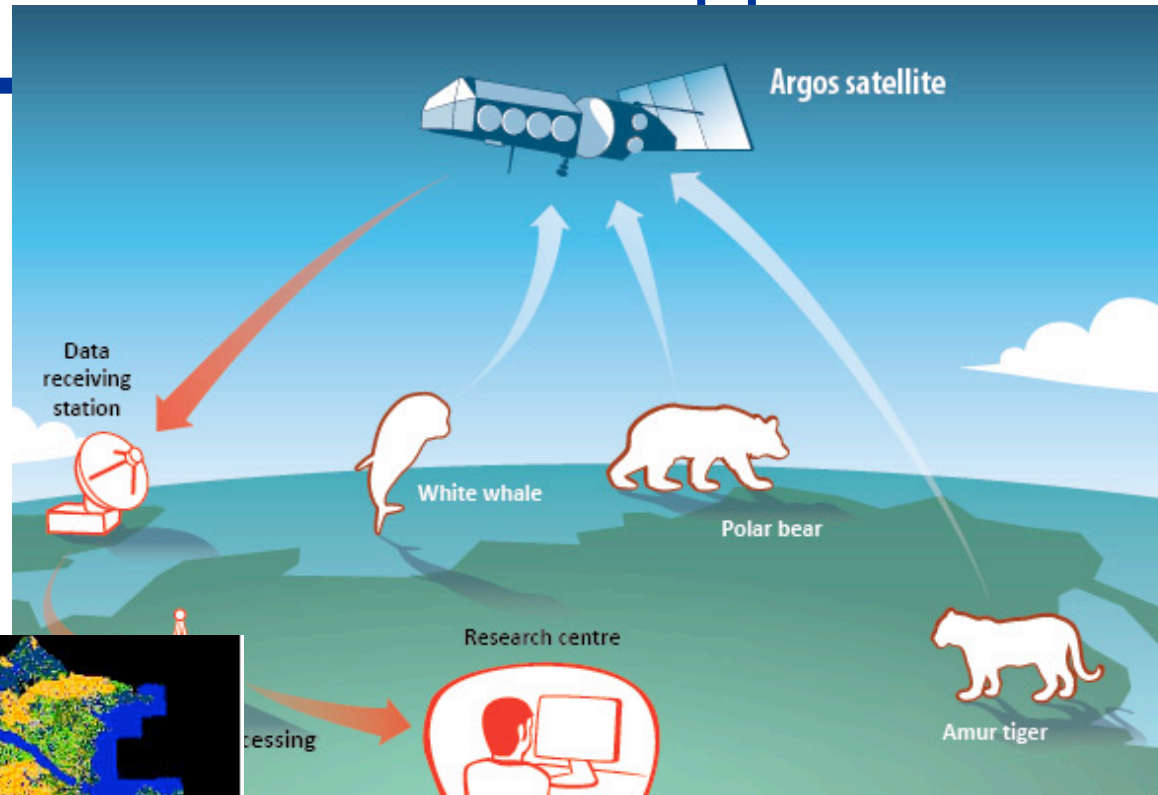
## 3-D Seismic Imaging At Work

Hydrophones streaming from a 3-D seismic ship record the reflection of sound waves as they bounce back from subsalt surfaces.



Credit: Hutchins, A.E. and Anderson, R.M. (Eds.), World Oil's 4-D Seismic Handbook, Gulf Publishing, 1997

## Environmental Applications

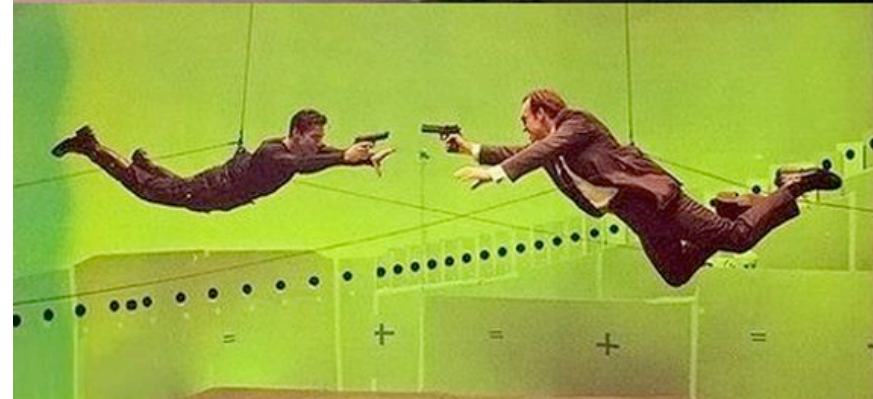


### Forest Type

- |                 |             |            |
|-----------------|-------------|------------|
| Black Spruce    | Pin Cherry  | Non-Active |
| Spruce-Fir      | White Birch | Water      |
| Balsam Fir      | Birch-Aspen | Unoccupied |
| Lichen Woodland | Spruce Bog  |            |



# Financial & Entertainment Applications





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To build these types of systems, you need specialized software (*and sometimes hardware*) to work in concert

In this course, we'll only be looking at the **software** ...

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What should you already know?

# Everything you covered in CMPT 128

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- Fundamentals of Programming
  - Basic algorithms, Basic Approach and Design, and Commenting, etc.
- Fundamentals of C/C++ syntax
  - Basic data types, control structures, and I/O, etc.
- Basics of Debugging, Testing, etc.
- How Application Executables are generated
- Numbers and Arithmetic
  - Base 2 and 16, floating point/fixed point, masking, etc.

# Concerns about previous material from CMPT 128

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I know that some people found CMPT128 challenging.

Don't be afraid- you can do better in this course!

But you are going to need to work very hard:

- Review the first nine chapters of the textbook (as a reference)
- Attend **one** of the review tutorials I will be running on Thursday (the 10<sup>th</sup>), Wednesday (the 16<sup>th</sup>), and Thursday (the 17<sup>th</sup>)
- Ask questions on the bulletin board and in my office hours, and...
- **PRACTICE** your coding skills (do the example problems from the textbook)

# Keep in Mind

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Programming languages have **families** like oral languages (e.g. Romance, Scandinavian, etc.)

- Each family has a common structure
- This course will focus on objected oriented languages using C++ to make it concrete

Once you learn the structure for a family of languages, you can quickly & easily pick up related languages quickly (like learning Italian after learning French)

# What will you learn?

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- Fundamentals of Object Oriented Programming
  - Using C++ syntax
- Proofs and Complexity Analysis
- Custom and Complex Data types
- Pointers and Linked Lists
- Recursion
- Profiling

# What will you learn?

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- Software Design
  - Working in design teams
  - Code robustness & error handling
  - Unit tests & code coverage
  - Good software design & testing practices
    - Agile Programming Techniques (e.g. Extreme Programming)

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By the end of this course, you should be able to take a customer specification for a software system:

- create a set of testing criteria, testbenches, and unit tests
- identify objects and divide the software into separate tasks
- identify and/or create appropriate data types
- apply Agile software development techniques to your design process.
- profile/analyze your program's execution and determine its scalability
- effectively work as a member of a large software design team



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# Important Logistics

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# Lectures

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## Guest Lectures:

- Attendance of all guest lectures is **mandatory**.
- You will be required to sign in to indicate your attendance
- Failure to attend (without a medical note) will result in a 3% deduction off your final grade

# Lab Equipment

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- Your SFU login will give you access to the machines in the lab
  - But first you need to form a lab group (pair)
- ***You are responsible for the well being and proper care of the equipment in the lab***
  - ***Destruction/vandalism will result in FAILURE of the class***

**NOTE:** You will have to sign a statement of expected professional integrity standards and consequences before any of your labs will be marked.

# The Lab

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## Final Notes on the lab:

- Everyone will be tested ***INDIVIDUALLY***,
- Relying on your lab partner to do all the work is ***NOT*** a viable option
- If it is determined that you do not understand the code being evaluated (and therefore did not contribute), you will be awarded ***zero*** on that assignment/final project

# Canvas and Piazza Course Webpage

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- We will only be using Canvas to post marks.
- We will be using Piazza for Discussion board postings
  - Do **NOT** send technical email to me or the TAs;

*I have over 6000 emails in my inbox and 3000 of them are unread: chances are your email will simply get lost.*

- A Course Mailing List has been created for last minute updates ENSC251
  - You **cannot** send to it, so please use the bulletin board to contact each other

# Course Discussion Board Policy and Disclaimer

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Please do not use these forums to post any material that is knowingly false and/or defamatory, abusive, vulgar, hateful, obscene, threatening, invasive of a person's privacy, or otherwise in violation of any law. Do not post any copyrighted material unless the copyright is owned by you. I reserve the right to remove any messages posted and to reveal your identity (or whatever information is known about you) in the event of a complaint or legal action arising from any message posted by you.

By posting your message, you agree to indemnify me, my employees, agents and representatives, and to hold them harmless from any and all claims and liabilities (including lawyers' fees) resulting from any material posted to these forums, or from any acts resulting from participants' use of these forums.

# Course Grade Breakdown

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- 15% Lab Assignments
- 10 % Lab Project
- 25 % Midterm
- 50 % Final Exam
- 5 % Class Participation **Bonus**

# Class Participation *Bonus*

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- 5% Class Participation:
  - This course requires team work, and it will be rewarded:
    - Making and responding to posts on the course bulletin board
    - In-lecture participation
    - Helping “the team” (fellow classmates) in the lab:
      - This means reviewing their code for bugs- NOT giving them a copy of your own
  - Conversely, ANY forms of cheating will in no way be accepted or tolerated



# Grade Award Breakdown

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- $\geq 93\%$  A+
- 85 – 92% A
- 80 – 84% A-
- 75 – 79% B+
- 70 – 74% B
- 65 – 69% B-
- 60 – 64% C+
- 55 – 59% C
- 50 – 54% D
- $< 50\%$  F

# Final comment on grades:

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- I don't scale
  - Pro: If everyone does well, everyone gets a good mark
  - But there's always the flip side ...

# Evening Review Tutorials

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- I've scheduled three 2-hour tutorials to review material you should know from CMPT 128:
  - Thursday (the 10<sup>th</sup>), [LA01, LA04]
  - Wednesday (the 16<sup>th</sup>), [LA02, LA05]
  - Thursday (the 17<sup>th</sup>), [LA03, LA06]

Please attend **one** of the review tutorials I will be running on these days as the rooms only hold ~100 people and I'll be reviewing the same material on each day.

# Next Lecture & Tutorial

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We're going to:

- Review how a computer operates
- Review programming paradigms
- Discuss Creating Custom Data Types:
  - Structures
  - Unions, and
  - Classes

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# Additional info

(for your reference)

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# Other Logistics

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# Contact Info

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- Office:
  - ASB8819
- Email:
  - [Ishannon@ensc.sfu.ca](mailto:Ishannon@ensc.sfu.ca)
- Homepage:
  - <http://www.ensc.sfu.ca/~Ishannon/>
- Office Hours:
  - Mondays: 12:50pm-2:30pm
  - Wednesdays: 11:45am-12:30pm; 3:45-4:30pm
- Teaching Assistants (Office Hours: TBA)
  - Eric Matthews (Head TA), Mohammad Akbari, Veronica Cojocaru, Yawar Khan, Rui Wang

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# Lecture Topics for the Course

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# Lecture Topics

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- Object Oriented Programming with C++
- Dynamic Memory Allocation
- Debugging, Testing and Verification
- Introduction to Set Theory and Complexity of Algorithms
- Recursion
- Proofs

# Lecture Topics

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- Pointers and Linked Lists
- Custom Data Types
- Code Robustness and Error Handling
- Functions and Relations
- Profiling and Code Performance
- Unit Tests, Code coverage

# Lecture Topics

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- Non-traditional I/O
- Abstraction and Inheritance
- As time permits:
  - Intro to Complex Data Structures (Trees and Graphs)
  - Fundamentals of Compilers
  - ...

# Lectures, Tutorials, and Tests

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Lectures: Monday 10:30-11:20pm, AQ 3182  
Wednesday 10:30-11:30am, AQ 3182  
2:30-3:20pm, SWH 10081

Tutorial: Monday 11:30-12:20pm AQ 3182

One 2-hour Midterm (25%)

– Date: Monday, October 19<sup>th</sup> (in class)

• One Final Exam (50%)

– Date: December 14<sup>th</sup>, 3:30-6:30pm (Room: TBD)

# Labs (ESIL and ASB 10802)

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## Lab Sections

- LA01: Tuesday 12:30-2:30pm
- LA02: Thursday 10:30-12:30pm
- LA03: Thursday 2:30-4:30pm
- LA04: Friday 10:30-12:30pm
- LA05: Friday 2:30-4:30pm
- LA06: Thursday 10:30-12:30pm (in ASB 10802)

Please show up at your assigned lab section as there is limited seating available.

# Labs (ESIL and ASB 10802)

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## Lab Assignments (15%)

- Students will be required to work in teams to complete 3-4 lab assignments.
- Student are required to demonstrate their work in *their* lab session. Electronic submission of their code is also required as part of the evaluation.
- Information on each lab will be posted on the course home page

# Labs (ESIL and ASB 10802)

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## Lab Project (10%)

- Students will work in teams
- Each group will be required to demonstrate their project in the lab session (including additional features).  
Electronic submission of their code is also required as part of the evaluation.
- Information on the course project will be posted on the course home page at a later date

# Course Webpage

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- Course Webpage:
  - <http://www.ensc.sfu.ca/~lshannon/courses/ensc251/>.
- Course Handouts will be posted here.
- Lecture Slides will also be posted before each class.
- Information on the labs and final project will be posted here



# Course Webpage

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- We will only be using Canvas to post marks.
- We will be using Piazza for Discussion board postings
  - Do ***NOT*** send technical email to myself or the TAs; technical emails will not be answered
- A Course Mailing List has been created for last minute updates ENSC251
  - You ***cannot*** send to it, so please use the bulletin board to contact each other

# Course Discussion Board Policy

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All students ***must*** regularly check the course bulletin board.

All course related questions ***must*** be posted to the bulletin board.

- You should also post any answers you know

Postings are set to be anonymous (you can sign your name if you like).

- Please note that they are anonymous to the other students only (I will know who made the posting).

# Course Discussion Board Policy

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Announcements and hints regarding the labs, the project, and tests will be posted here.

Please observe appropriate bulletin board etiquette (***be respectful***).

Good citizenship in this course is expected and will be rewarded.

# Course Discussion Board Policy and Disclaimer

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Please do not use these forums to post any material that is knowingly false and/or defamatory, abusive, vulgar, hateful, obscene, threatening, invasive of a person's privacy, or otherwise in violation of any law. Do not post any copyrighted material unless the copyright is owned by you. I reserve the right to remove any messages posted and to reveal your identity (or whatever information is known about you) in the event of a complaint or legal action arising from any message posted by you.

By posting your message, you agree to indemnify me, my employees, agents and representatives, and to hold them harmless from any and all claims and liabilities (including lawyers' fees) resulting from any material posted to these forums, or from any acts resulting from participants' use of these forums.

# Course Discussion Board

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- The different Discussion Board Categories are:
  - Course Work Related Topics
    - Lectures
    - Administrative details
    - Tests
    - Labs (Lab Assignments & Project)

# Course Reference Material

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## Course Textbook:

- Walter Savtitch. Problem Solving with C++. 9<sup>th</sup> Edition Pearson.

## Other recommended books:

- Ralph P. Grimaldi. Discrete and Combinational Mathematics: An Applied Introduction. 5<sup>th</sup> Edition Pearson Education Inc.
- Robert Sedgewick. Algorithms in C. Addison Wesley.
- William H. Press, Brian P. Flannery, Saul A. Teukolsky and William T. Vetterling. Numerical Recipes in C: The Art of Scientific Computing. Cambridge University Press (There's also *a Numerical Recipes in C++*)

# Course Reference Material

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- Other recommended references are:
  - Google “Agile Programming”
  - Extreme Programming:  
<http://www.extremeprogramming.org/>
  - EETimes:  
<http://www.eetimes.com/>