CS 136: Elementary Algorithm Design and Data Abstraction

Official calendar entry: This course builds on the techniques and patterns learned in CS 135 while making the transition to use of an imperative language. It introduces the design and analysis of algorithms, the management of information, and the programming mechanisms and methodologies required in implementations. Topics discussed include iterative and recursive sorting algorithms; lists, stacks, queues, trees, and their application; abstract data types and their implementations.

Welcome to CS 136 (Winter 2020)

Instructors: Tim Brecht, Navid Esfahani, Daniel Holtby, Adrian Reetz, Dave Tompkins

Web page:
http://www.student.cs.uwaterloo.ca/~cs136/

Other course personnel: ISAs (Instructional Support Assistants), IAs (Instructional Apprentices), ISC (Instructional Support Coordinator): see website for details

Lectures: Tuesdays and Thursdays
Tutorials: Wednesdays

Be sure to explore the course website: Lots of useful info!

About me (your instructor)
Main topics & themes

- imperative programming style
- elementary data structures & abstract data types
- modularization
- memory management & state
- introduction to algorithm design & efficiency
- designing “medium” sized, “real world” programs with I/O

Curriculum

Three of the most common programming paradigms are functional, imperative and object-oriented.

The first three CS courses at Waterloo use different paradigms to ensure you are “well rounded” for your upper year courses.

\[
\text{CS 135 } \Rightarrow \text{ CS 136 } \Rightarrow \text{ CS 246}
\]

\textit{functional} \hspace{1cm} \textit{imperative} \hspace{1cm} \textit{object-oriented}

Each course incorporates a wide variety of CS topics and is much more than the paradigm taught.

Programming languages

Most of this course is presented in the \texttt{C} programming language.

While time is spent learning some of the C syntax, this is not a “learn C” course.

We present C language features and syntax only as needed.

We occasionally use Racket to illustrate concepts and highlight the similarities (and differences) between the two languages.

What you learn in this course can be transferred to most languages.
Programming environment (Seashell)

We use our own customized “Seashell” development environment.

- browser-based for platform independence
- works with both C and Racket
- integrates with our submission & testing environment
- helps to facilitate your own testing

See the website and attend tutorials for how to use Seashell.

Course materials

Textbooks:

- “C Programming: A Modern Approach” (CP:AMA) by K. N. King. (strongly recommended)
- “How to Design Programs” (HtDP) by Felleisen, Flatt, Findler, Krishnamurthi (very optional)
  Available for free online: http://www.htdp.org

Course notes:

Available on the web page and as a printed coursepack from W Store | Course Materials + Supplies in SCH.

Several different styles of “boxes” are used in the notes:

- **Important information appears in a thick box.**
- Comments and “asides” appear in a thinner box. Content that only appears in these “asides” will **not appear on exams**.
- Additional **advanced** material appears in a “dashed” box.
  The advanced material enhances your learning and may be discussed in class and appear on assignments, but you are **not responsible for this material on exams** unless your instructor explicitly states otherwise.
In some terms, the course notes may be supplemented by online appendices that contain additional content and examples. You are not responsible for any material that appears in appendices.

Marking scheme

- 20% assignments (roughly weekly)
- 5% participation
- 25% midterm
- 50% final

To pass this course, you must pass both the assignment component and the weighted exam component.

Class participation

We use i>Clickers to encourage active learning and provide real-time feedback.

- i>Clickers are available for purchase at the bookstore
- Any physical i>Clicker can be used, but we do not support web-based clickers (e.g., i>Clicker Go)
- Register your clicker ID in Assignment 0
- To receive credit you must attend your registered lecture section (you may attend any tutorial section)

Using someone else's i>Clicker is an academic offense
Participation grading

- 2 marks for a correct answer, 1 mark for a wrong answer
- Your best 75% responses (from the entire term) are used to calculate your 5% participation grade
- For each tutorial you attend, we’ll increase your 5% participation grade 0.1% (up to 1.2% overall, you cannot exceed 5%)

To achieve a perfect participation mark

- answer 75% of all clicker questions correctly, or
- answer ≈ 40% of all clicker questions correctly, and attend every tutorial

Assignments

Assignments are weekly (approximately 10 per term).

Each assignment is weighted equally (except A0).

- read the assignment instructions carefully
- read the official piazza post frequently
- rules & requirements may change throughout the course

A0 does not count toward your grade, but must be completed before you can receive any other assignment marks.

Assignment questions are colour-coded as either “black” or “gold” to indicate if any collaboration is permitted.

For BLACK questions, moderate collaboration is permitted:

- You can discuss assignment strategies openly (including online)
- You can search the Internet for strategies or code examples
• You can discuss your code with individuals, but **not** online or electronically
  (piazza, facebook, github, email, IM, etc.)

• You can show your code to others to help them (or to get help), but copying code is not allowed
  (electronic transfer, copying code from the screen, printouts, etc.)

If you submit any work that is not your own, you must still cite the origin of the work in your source code.

For **GOLD** questions, **no collaboration** is permitted:

• **Never share or discuss your code** with other students

• Do not discuss assignment **strategies** with fellow students

• Do not search the Internet for strategies or code examples

You may always discuss your code **with course staff**.

Academic integrity is strictly enforced for gold questions.

**Assignments: second chances**

Assignment deadlines are strict, but some assignment questions may be granted a “second chance”.

• Second chances are granted automatically by an automated “oracle” that considers the quantity and quality of the submissions

• Don’t ask in advance if a question will be granted a second chance; we won’t know

• Second chances are (typically) due 48 hours after the original

• Your grade is: \( \max \left( \text{original}, \frac{\text{original} + \text{second}}{2} \right) \)
  (there is no risk in submitting a second chance)
Marmoset

Assignments are submitted to the Marmoset submission system:
http://marmoset.student.cs.uwaterloo.ca/

There are two types of Marmoset tests:

- **Public** *(basic / simple)* test results are available immediately and ensure your program is “runnable”.

- **Private** *(comprehensive / correctness)* test results are available after the deadline and fully assess your code.

**Public tests do not thoroughly test your code.**

Marmoset uses the best result from all of your submissions (there is never any harm in resubmitting).

For questions that are *hand-marked*, we mark the submission with the highest score that was submitted closest to the deadline.

You can *submit* your assignments via Seashell and view *public* test results.

Every submission is stored (backed up) for your convenience.

**You must log into Marmoset to view your private test results (after the deadline).**

Design recipe

In CS 135 you were encouraged to use the *design recipe*, which included: contracts, purpose statements, examples, tests, templates, and data definitions.

The design recipe has two main goals:

- to help you *design* new functions from scratch, and

- to aid *communication* by providing *documentation*.

In this course, you should already be comfortable designing functions, so we focus on *communication* (through documentation).
Documentation

In this course, every function you write must have:

- a **purpose** statement, and
- a **contract** (including a **requires** section if necessary).

Unless otherwise stated, you are **not** required to provide:
templates, data definitions or examples.

Later, we extend contracts to include **effects** and **time** (speed / efficiency).

Hand-marking

Questions that are hand-marked for “style” may be evaluated for:

- documentation and comments
- code readability
- whitespace and indentation
- identifiers (variable & function names)
- appropriate use of helper functions
- testing methodology

The purpose of hand-marking is not to “punish” or “torture” you.
It is **formative feedback** to improve your learning.

Unfortunately, we do not have the resources (staff) to hand-mark all assignment questions.

Well formatted and documented code is still expected, even if it is not hand-marked.

We will not provide assistance (office hours or piazza) if your code is poorly formatted or undocumented.

View your formative feedback on MarkUs.
Getting help

- office hours (see website)
- lab hours (see website)
- tutorials (see website)
- textbook
- piazza

Course announcements made on piazza are mandatory reading (including official assignment and exam posts).

Piazza etiquette

- read the official assignment post before asking a question
- search to see if your question has already been asked
- use meaningful titles
- ask clarification questions for assignments
  (do not ask leading questions for GOLD questions)
- do not discuss strategies for GOLD questions
- do not post any of your assignment code publicly
- you can post your commented code privately, and an ISA or Instructor may provide some assistance.

At the end of each Section there are learning goals for the Section (in this Section, we present the learning goals for the entire course).

These learning goals clearly state what our expectations are.

Not all learning goals can be achieved just by listening to the lecture. Some goals require reading the text or using Seashell to complete the assignments.
Course learning goals
At the end of this course, you should be able to:

• produce well-designed, properly-formatted, documented and tested programs of a moderate size (200 lines) that can use basic I/O

• use imperative paradigms (e.g., mutation, iteration) effectively

• explain and demonstrate the use of the C memory model, including the explicit allocation and deallocation of memory

• explain and demonstrate the principles of modularization and abstraction

• implement, use and compare elementary data structures (structures, arrays, lists and trees) and abstract data type collections (stacks, queues, sequences, sets, dictionaries)

• analyze the efficiency of an algorithm implementation