

MPCS 51040 – C Programming

Lecture 1

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Outline

Useful Information

- About me
- Student Resources
- Syllabus

Some ground rules. . .

- University Policy
- Assignments

Why C

Hello World

- Program
- Environment
- Secure Shell
- Version Control

Workflow

- Overview
- Preprocessing



Where you might have seen me...

Teaching C programming, Introduction to Computer Systems, Operating Systems, Parallel I/O, MPI (UChicago, UIC, KULeuven, UGent).

Currently Team Lead/Senior Software Engineer at KCG (securities trading firm).

Previously Assistant Computer Scientist at Argonne National Laboratory (working on parallel and distributed storage).

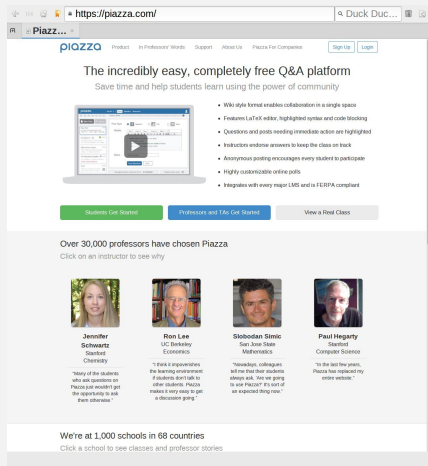
Community Service:

- ▶ Standard organizations: MPI, C++.
- ▶ Conference & workshops
- ▶ Journal review

Main research interests:

- ▶ High-Performance Computing and derived topics (networking, parallel computing, ...)
- ▶ Operating Systems
- ▶ Software Development (from a process point of view)





The screenshot shows the Piazza website homepage. At the top, there's a navigation bar with links for Product, In Professors' Words, Support, About Us, and Piazza For Companies, along with Sign Up and Login buttons. The main heading reads "The incredibly easy, completely free Q&A platform" with the subtext "Save time and help students learn using the power of community". Below this is a video player showing a Piazza interface. To the right of the video, a list of features is provided: Wiki style format for collaboration, LaTeX editor, highlighting, and code blocking; questions and posts needing immediate action are highlighted; instructors endorse answers to keep the class on track; anonymous posting encourages every student to participate; highly customizable online polls; and integration with major LMS and FERPA compliance. Below the features are three buttons: "Students Get Started", "Professors and TAs Get Started", and "View a Real Class". A section titled "Over 30,000 professors have chosen Piazza" includes a link to "Click on an instructor to see why" and four professor profiles with their photos, names, institutions, and fields of study. Each profile has a quote from a student praising the platform. At the bottom, it states "We're at 1,000 schools in 68 countries" with a link to "Click a school to see classes and professor stories".

https://piazza.com/ Duck Duc...

Piazza

The incredibly easy, completely free Q&A platform
Save time and help students learn using the power of community

- Wiki style format enables collaboration in a single space
- Features LaTeX editor, highlighted syntax and code blocking
- Questions and posts needing immediate action are highlighted
- Instructors endorse answers to keep the class on track
- Anonymous posting encourages every student to participate
- Highly customizable online polls
- Integrates with every major LMS and is FERPA compliant

Students Get Started Professors and TAs Get Started View a Real Class

Over 30,000 professors have chosen Piazza
Click on an instructor to see why

Professor	Institution	Field	Quote
Jennifer Schwartz	Stanford	Chemistry	"Many of the students who ask questions on Piazza just wouldn't get the opportunity to ask their classmates."
Ron Lee	UC Berkeley	Economics	"I think it improves the learning environment if students don't talk to other students. Piazza makes it very easy to get a discussion going."
Stobodan Simic	San Jose State	Mathematics	"Nevertheless, colleagues tell me that their students always ask. So we're going to use Piazza! It's sort of an expected thing now."
Paul Hegarty	Stanford	Computer Science	"In the last few years, Piazza has replaced my entire website."

We're at 1,000 schools in 68 countries
Click a school to see classes and professor stories

We will be using Piazza for:

- ▶ Class announcements
- ▶ Forum discussion

Piazza will be the main communication venue – make sure to setup email notifications and to frequently check.

URL: <https://piazza.com/class/j0s8saq43wb42z>



Homework & Other Assignments

Homework assignments will be distributed using the `▶ class git repository` (more on this later). For handing in homework, you will be using your **personal** git repository.

- ▶ Clear timeline
- ▶ Can be used to show effort (recommended)
- ▶ Can handle multiple files easily



- ▶ Do not email homework to me or the TAs!
- ▶ We use automated tools to help with grading. Follow instructions **exactly**: filenames, upper/lower case, ...



Contact Information

In case the forum is not suitable don't hesitate to contact me (or TA) directly via email (or in person):

Lecturer Dries Kimpe <dries@cs.uchicago.edu >

TA Colin Hudler <chudler@cs.uchicago.edu>



Please use your official uchicago email address for class communication!



Office Hours



My office hours

- ▶ 1 hour before (appointment only) or after class.
- ▶ By appointment (both downtown or at the university).

TA Office Hours

To be determined; Please fill out <https://piazza.com/class/j0s8saq43wb42z?cid=6>.



Whenever possible email ahead of time (even if short notice)



Course Organization

Final Grade **approximate** weights

- ▶ Homeworks (and possibly final project): 60%–70%
- ▶ Quizzes: 30%–40%
- ▶ Class **and** **forum** participation: 5%–10%



Indication only!

Lectures

- ▶ 10 lectures
 - ▶ (possibly) optional exercise sessions (typically on Saturday morning)
- ▶ 8-9 homeworks, due **before** the next class
- ▶ 1-2 quizzes (≈ 90 min each)
- ▶ 20-30 min break during each lecture
- ▶ Active participation expected
 - ▶ Preferred: bring laptop to class for interactive exercise sessions



Syllabus



The screenshot shows the 'MPCS 51040 C Programming' page. It includes a navigation bar with links like 'About', 'Prospective Students', 'Current Students', 'Faculty', 'Admit', 'Career Resources', and 'Research'. The main content area has a 'Summary' section with a paragraph about the course: 'This is an accelerated introduction to the C (and C++) Programming Language designed for students with prior programming experience. C is in many ways the lingua franca of computing, and a broad range of programming languages and related technologies derive from the basic principles of C: memory management, control flow, and abstraction. Though there are many subdialects, C is not a big language, and it is expected that students will leave the course with a relatively deep understanding of the key concepts, which will then form a solid foundation for studying higher-level technologies. At the same time, C itself remains a very practical language, particularly so in areas such as scientific programming, high-performance computing, application-level library design, systems programming, network programming, multi-threaded programming, etc. Students who successfully complete the course will be well-prepared for subsequent MPCS courses in these areas. The course studies both fundamental and advanced C language constructs in the abstract and reinforces them through a range of...'. There are also links for 'Follow Us' (Facebook, Twitter), 'Quick Links' (2015-2016 Course Schedule, Online Applications, Computer Science Job Board, Computer Science Student Activities Committee, Course Request Form for Non-MPCS Students, myuchicago, Department of Computer Science, The University of Chicago), and a 'Search Search' box.

The syllabus can be found at
<https://mpcs-courses.cs.uchicago.edu/2016-17/spring/courses/51040>.



The syllabus is a guideline – schedule & coursework is subject to change based on class progress



UNIX Bootcamp is strongly recommended!
(Not certain it will be organized this quarter)



Review syllabus



Academic Honesty & Plagiarism

*In brief, academic dishonesty (handing in someone else's work as your own, taking existing code and not citing its origin, etc.) will not be tolerated in this course. **Penalties for academic dishonesty can range from failing the class to expulsion from the Masters Program.** Even so, collaboration between students is certainly allowed (and encouraged) as long as you don't hand someone else's work as your own. You can discuss the high-level aspects of assignments with other students, but you should never share your solution to an assignment with other students. If you have discussed parts of an assignment with someone else, then make sure to say so. If you consulted other sources, please make sure you cite these sources. Unless you have written an assignment entirely on your own with no outside assistance, **always err on the side of caution and disclose every source you have consulted.** If you have any questions regarding what would or would not be considered academic dishonesty in this course, please don't hesitate to ask the instructor.*



University Policy

Academic Honesty & Plagiarism Policy

Please review <https://csmasters.uchicago.edu/page/rules-and-policies> for a full description.

- ▶ Academic dishonesty is a serious offense and there will be consequences even for first time offenders.
- ▶ Discussion is generally fine **if** you solve the assignment on your own **and** you disclose who you discussed the assignment with.
- ▶ Always err on the side of caution.
- ▶ When in doubt, **ask**.

Unlawful Discrimination and Sexual Misconduct policy

University policy [here](#).



Homework

Handing In

- ▶ In your personal git repository
 - ▶ *your responsibility* to ensure your work remains private
(i.e. don't push to public git repository, . . .)
- ▶ Make sure your files are **pushed to the server**
(Check by recloning or via the web interface)
- ▶ Use file- & directory names as specified!
(otherwise grading scripts might fail to find your work)
- ▶ **Email and other methods are not accepted.**

Late Policy

- ▶ Strict deadline will be enforced
(but see next point).
- ▶ Exceptions can be made on a case-by-case basis.
- ▶ Incomplete/non-functioning will still yield points
Commit early and often!



Do not wait until the last moment to request an exception!



Why would you be interested in C?




There are many languages to choose from (and more are invented every year). Why would somebody be interested in learning C?

- ▶ Good basis for learning C++ (and other imperative languages)
- ▶ Because C doesn't offer many built-in language features, one develops a good understanding of how those features are implemented in other languages.
 - ▶ ... and of their performance implications...
- ▶ Not much happens behind the scenes. This offers full control over:
 - ▶ Memory usage (important for embedded systems **and** high-performance computing/big data)
 - ▶ Code generation (important for OS development)
 - ▶ Performance guarantees/constraints (real-time systems)
- ▶ C exposes a fair amount of the underlying hardware architecture
- ▶ Some areas traditionally still use C
 - ▶ Embedded system development
 - ▶ OS kernel programming
 - ▶ ...
- ▶ Many other languages are modeled (or based) on C
- ▶ Depending on which source is consulted, C one of the most popular languages



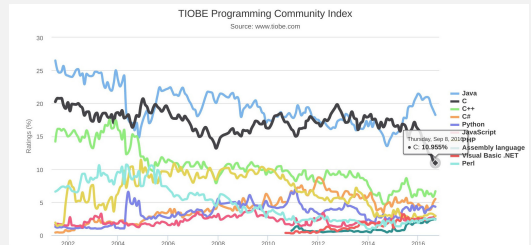
Recent examples

IEEE

Language Rank	types	Spectrum Ranking
1. C		100.0
2. Java		98.1
3. Python		98.0
4. C++		95.9
5. R		87.9
6. C#		86.7
7. PHP		82.8
8. JavaScript		82.2
9. Ruby		74.5
10. Go		71.9

Source: The Register "Plenty of Fish in the C", July 2016.
http://www.theregister.co.uk/2016/07/28/plenty_of_fish_in_the_c_ieee_finds_in_language_popularity_contest/

TIOBE



Source: TIOBE Programming Community Index, September 2016.
<http://www.tiobe.com/tiobe-index/>



First C Program

```
1 #include <stdio.h>
2 #include <stdlib.h>
3
4 int main (int argc, char ** args)
5 {
6     int ret = printf ("Hello, world!\n");
7     return EXIT_SUCCESS;
8 }
```

- ▶ 1,2: “module” concept
- ▶ 4: define (and declare) function
- ▶ 6: function call
- ▶ 6: note ‘\’ *character(string) escape*
- ▶ 6: variables (static typing)
- ▶ declarations, definitions, statements and expressions...



Compiling: `gcc -Wall -pedantic -std=c11 -o hello hello.c`



Demo on `linux.cs.uchicago.edu`



Programming Environment

Recommended to work on `linux.cs.uchicago.edu`:

- ▶ That is where projects will be graded
(unless explicitly noted otherwise)
- ▶ Can connect from any OS
- ▶ Available 24/24

However, if for some reason, you can't use `linux.cs.uchicago.edu`
(for example due to no connectivity or firewall restrictions), *the recommended approach is to run Ubuntu in a virtual machine.*

- ▶ Free Virtual Machine host software available: ▶ VirtualBox
- ▶ Will protect your machine against mistakes
(such as using up all memory ...)
- ▶ Avoids system differences and allow reproducing issues
- ▶ Careful: might have different compiler version!



Regardless of which method you choose, it is *your* responsibility to test and validate your solution on `linux.cs.uchicago.edu`!



The use of IDEs is strongly discouraged!



Virtualbox



- ▶ Homepage: <https://www.virtualbox.org/>
- ▶ Download: <https://www.virtualbox.org/wiki/Downloads>
 - ▶ Download platform package for your system
 - ▶ Download and install extension pack as well
 - ▶ No need for software developer kit
- ▶ Suitable VirtualBox image: <https://goo.gl/rBewQI>
 - ▶ Import in VirtualBox as appliance (ctrl-I)
 - ▶ Check box 'Randomize MAC'
 - ▶ Username: student, password: Random99



Secure Shell

A protocol for connection to a remote terminal (where terminal is a device generating (text) output and taking keyboard input).

Unix-based systems

- ▶ Mostly provided as part of the base system
- ▶ Look for 'ssh' command

Windows/Mac GUI Client

- ▶ Putty: <http://www.chiark.greenend.org.uk/~sgtatham/putty/>
- ▶ Many others available...



Since we will generally not be generating graphical output, a terminal is all we need to create, compile and execute the programs we will write for this course.



- ▶ Connect to `linux.cs.uchicago.edu`
- ▶ Demonstrate key-based authentication



- ▶ Keybased-authentication for linux:
<https://www.digitalocean.com/community/tutorials/how-to-configure-ssh-key-based-authentication-on-a-linux-server>



Version Control

Why version control?

- ▶ Ubiquitous everywhere
- ▶ Serves as backup and shows how code evolved
- ▶ Helps *collaborate* on code

Important repositories

- ▶ GitLab server: `https://mit.cs.uchicago.edu`
- ▶ Class Repository:
`https://mit.cs.uchicago.edu/groups/mpcs51040-spr-17/mpcs51040-spr-17/`
- ▶ Personal Repository: (differs for everybody, likely
`https://mit.cs.uchicago.edu/groups/mpcs51040-spr-17/yourcnetid`)



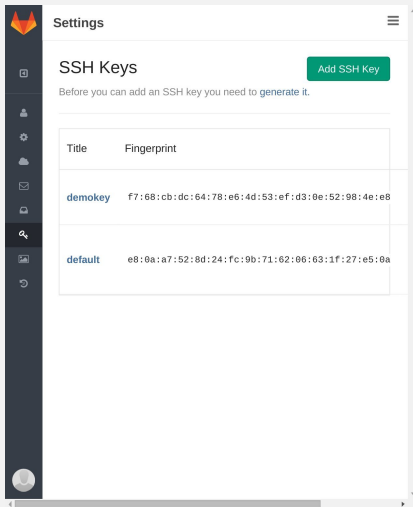
Please let me know immediately if you do not have access to both the class repository or your personal repository!



Cloning class repository, index, adding file



Key-based authentication for mit.cs.uchicago.edu



- ▶ A git repository can be accessed using multiple transport protocols.
supported by mit.cs.uchicago.edu: HTTPS and SSH
- ▶ The authentication method of the transport is used
⇒ we can reuse the public-key pair we created earlier

Installing the key:

- ▶ Login to mit.cs.uchicago.edu
- ▶ Click on the profile setting (upper right corner)
- ▶ Click on the key icon in the sidebar on the left
- ▶ Click 'add ssh key' and paste the contents of the *public* key file in the field.

An easy test:

- ▶ SSH (using your key for authentication) to git@mit.cs.uchicago.edu (i.e. username git)
- ▶ You should see 'Welcome to GitLab, <yourusername>'



Git Clients & more...



Setting up key-based authentication

Other useful resources

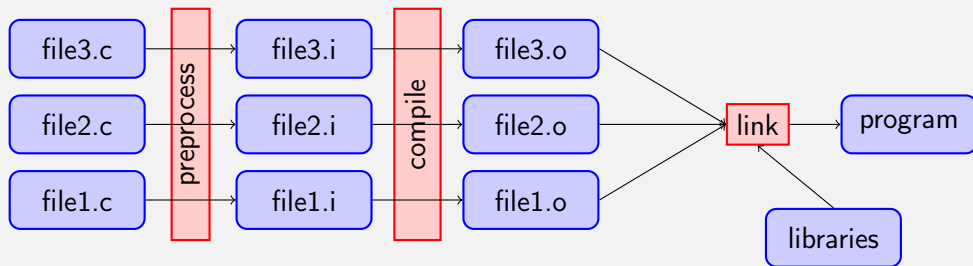


- ▶ Free git book: <http://git-scm.com/book/en/v2>
- ▶ GitLab documentation:
<https://about.gitlab.com/documentation/>
- ▶ Write-up of using git+ssh on windows:
<http://guides.beanstalkapp.com/version-control/git-on-windows.html>



From code to executable...

A processor can only execute a fixed set of binary instructions. How do we get from a set of files containing C code to a file which the OS (and processor) can execute?



Every file is preprocessed and compiled *separately*



Preprocessor

Preprocessor?

- ▶ Completely different “language”
- ▶ Independent from C
- ▶ Its **output** is fed into compiler
- ▶ *text* manipulation language



- ▶ *The preprocessor does not understand C!*
- ▶ Avoid side-effects (unpure functions)
- ▶ Precedence



Invoke using `cpp -pedantic -std=c11` or
`gcc -std=c11 -pedantic -E`



`#define, #ifdef, #include, max problem`

What is it used for?

- ▶ Implement “module” concept
- ▶ Reduce repetition (for example constants)
- ▶ Conditional compilation



This week...



- ▶ Fill out class survey
(<https://goo.gl/forms/15yZxdUxJwjJdlIg2>)
- ▶ Warm-up homework (will put on Piazza/emailed)
- ▶ Read chapter 1–3 of K&R book

Checklist

1. Verify access to class piazza page and ensure you receive email notifications
2. Remember to read or forward your @uchicago.edu address
3. Verify `mit.cs.uchicago.edu` access to both the class repository
(<https://mit.cs.uchicago.edu/groups/mpcs51040-spr-17/mpcs51040-spr-17/>) as well as
to your personal repository
(<https://mit.cs.uchicago.edu/groups/mpcs51040-spr-17/yourcnetid>)
4. Fill out survey (<https://goo.gl/forms/15yZxdUxJwjJdlIg2>)
5. Complete TA office hour scheduling poll
<https://piazza.com/class/j0s8saq43wb42z?cid=6>

If you do not have access to Piazza or to gitlab, please email Colin Hudler
<chudler@cs.uchicago.edu>(CC me) to request access.

