Intro, C refresher

CSE 333 Autumn 2025

Instructor: Naomi Alterman & Chris Thachuk

Teaching Assistants:

Ann Baturytski	Derek de Leuw	Blake Diaz
Rishabh Jain	Chendur Jayavelu	Lucas Kwan
Irene Xin Jie Lau	Nathan Li	Maya Odenheim
Advay Patil	Selim Saridede	Deeksha Vatwani
Angela Wu	Jiexiao Xu	

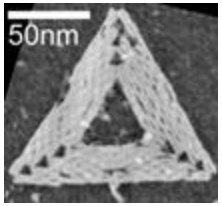
Introductions: Course Instructors

- ~~Professor Alterman~~ Naomi!
  - Electrical engineer by training
  - Bopped around Silicon Valley hacking on everything from OS kernels to internet backbone routers to LIDAR firmware to mobile graphics libraries
  - Discovered in industry that computers are boring
    - But *people* on the other hand…
  - Proud cat mom to Danni (aka Her Royal Majesty, Queen Baby)

Introductions: Course Instructors

- Chris (he/him)
  - From Canada (with lots of moving around)
    - Windsor (CA) → Toronto (CA) → Vancouver (CA) → Mexico City (MX) → Vancouver (CA) → Oxford (UK) → Pasadena (USA) → Seattle (USA)
  - I like: research, teaching, training, hiking with my dog, sci-fi
  - As a high school student (many years ago) I won a contest and was gifted a copy of "Visual Studio C++" and have been programming in C/C++ ever since
  - I research *systems programming* of molecules such as DNA!

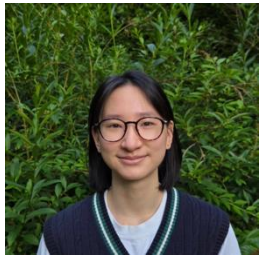
```
int main(int argc, char** argv) {
  make_triangle_from_DNA();
  return EXIT_SUCCESS;
}
```

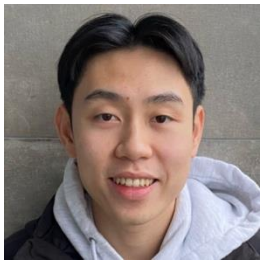


Introductions: Teaching Assistants












- Available in section, office hours, and discussion board

- More than anything, we want you to feel…
  - Comfortable and welcome in this space
  - Able to learn and succeed in this course
  - Comfortable reaching out if you need help or want change

Introductions: Students

- ~250 students registered
  - There are no overload forms or waiting lists for CSE courses
    - Majors must add using the UW system as space becomes available
- Expected background
  - **Prereq:** CSE 351 – C, pointers, memory model, linker, system calls
  - CSE 391 or Linux skills needed for CSE 351 assumed

Lecture Outline

- **Course Policies**
  - https://courses.cs.washington.edu/courses/cse333/25au/syllabus.html
  - Digest here, but you ***must*** read the full details online
- Course Introduction
- C Reintroduction

Communication

- **Website:** http://cs.uw.edu/333
  - Schedule, policies, materials, assignments, etc.
- **Discussion:** https://edstem.org/us/courses/87133/discussion/
  - Announcements made here
  - Ask and answer questions – staff will monitor and contribute
- **Office Hours:** spread throughout the week
  - Can fill out Google Form to schedule individual 1-on-1 appointments
- **Anonymous feedback**

Course Components

- Lectures (~28)
  - Introduce the concepts; take notes!!!
- Sections (10)
  - Applied concepts, important tools and skills for assignments, clarification of lectures, exam review and preparation
- Programming Exercises (18)
  - One due at 10am before every lecture (cannot accept late submissions)
  - We are checking for: correctness, memory issues, code style/quality
- Programming Projects (0+4)
  - Warm-up, then 4 "homework" that build on each other
- In Class Exams (2)
  - **Midterm** (tentatively evening of 10/27)
  - **Final**

Grading (tentative)

- **Exercises:** 30% total
  - Submitted via GradeScope (under your UW email)
  - Graded on correctness and style by autograders and TAs
- **Projects:** 40% total
  - Submitted via GitLab; must tag commit that you want graded
  - Binaries provided if you didn't get previous part working
  - Graded on test suite, manual tests, and style
- **Exams:** Midterm (12%) and Final (15%)
  - In-class midterm and final
- **Effort, Participation, Altruism:** 3%
  - Many ways to earn credit here, relatively lenient on this

Deadlines and Student Conduct

- Academic Integrity (**read** the full policy on the web)
  - We trust you implicitly and will follow up if that trust is violated
  - In short: don't attempt to gain credit for something you didn't do and don't help others do so either
  - This does ***not*** mean suffer in silence – learn from the course staff and peers, talk, share ideas; *but* don't share or copy work that is supposed to be yours

- If you find yourself in a situation where you are tempted to perform academic misconduct, please reach out to Chris & Naomi to explain your situation instead
  - See the Extenuating Circumstances section of the syllabus

Discipline?!?

- Cultivate good habits, encourage clean code
  - Coding style conventions
  - Unit testing, code coverage testing, regression testing
  - Documentation (code comments, design docs)
  - Code reviews

- Will take you a lifetime to learn
  - But oh-so-important, especially for systems code
    - Avoid write-once, read-never code

Deadlines & Late Policies

- Exercises: no late submissions accepted, due 10 am before class
  - Idea is to try out ideas introduced in lecture before the next class
- Projects: Late policy will be updated prior to HW0 release
- Need to get things done on time – difficult to catch up!
  - But we will work with you if unusual circumstances / problems

And off we go…

- This week: Goal is to figure out setup and computing infrastructure right away so we don't put that off and then have a crunch later in the quarter
- So:
  - First exercise out today, due Friday morning **10 am** before class
  - Warmup/logistics for larger projects in sections Thursday
    - HW0 (the warmup project) published and gitlab repos created before sections. OK to ignore details until then.
  - Poll Everywhere polls starting next lecture

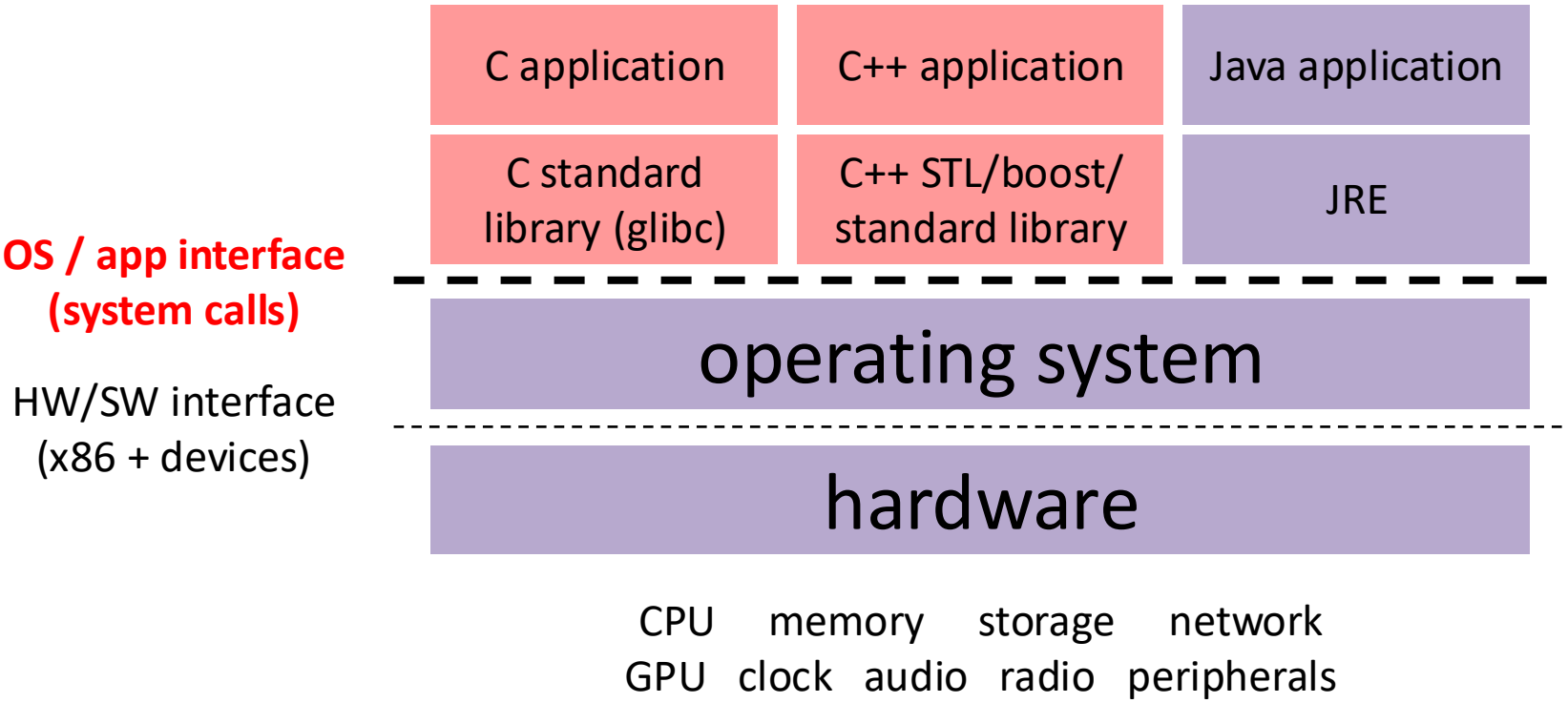
Deep Breath….

- Any questions, comments, observations, before we go on to, uh, some technical stuff?

Lecture Outline

- Course Policies
  - https://courses.cs.washington.edu/courses/cse333/25au/syllabus/
  - Summary here, but you ***must*** read the full details online
- **Course Introduction**
- C Reintroduction

Course Map: 100,000 foot view



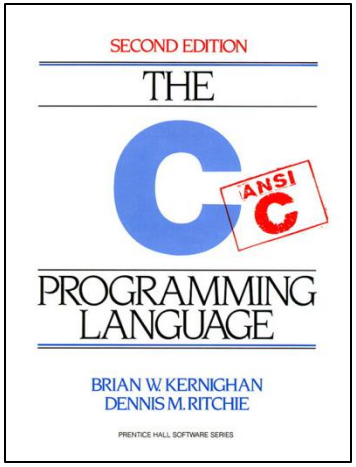
Systems Programming

- The programming skills, engineering discipline, and knowledge you need to build a system
  - **Programming:** C / C++
  - **Discipline:** testing, debugging, performance analysis
  - **Knowledge:** long list of interesting topics
    - Concurrency, OS interfaces and semantics, techniques for consistent data management, distributed systems algorithms, …
    - Most important: a deep(er) understanding of the "layer below"

Lecture Outline

- Course Introduction
- Course Policies
  - https://courses.cs.washington.edu/courses/cse333/25au/syllabus.html
- **C Intro**
  - **Workflow, Variables, Functions**

C



- Created in 1972 by Dennis Ritchie
  - Designed for creating system software
  - Portable across machine architectures
  - More recently updated in 1999 (C99) and 2011 (C11) and 2017 (C17) and 2023 (C23)
    - But core ideas have been stable for decades
- Characteristics
  - "Low-level" language that allows us to exploit underlying features of the architecture – but easy to fail spectacularly (!)
  - Procedural (not object-oriented)
  - Typed but unsafe (possible to bypass the type system)
  - Small, basic library compared to Java, C++, most others….

Generic C Program Layout

```
#include <system_files>
#include "local_files"

#define macro_name macro_expr

/* declare functions */
/* declare external variables & structs */

int main(int argc, char* argv[]) {
  /* the innards */
}

/* define other functions */
```

C Syntax: `main`

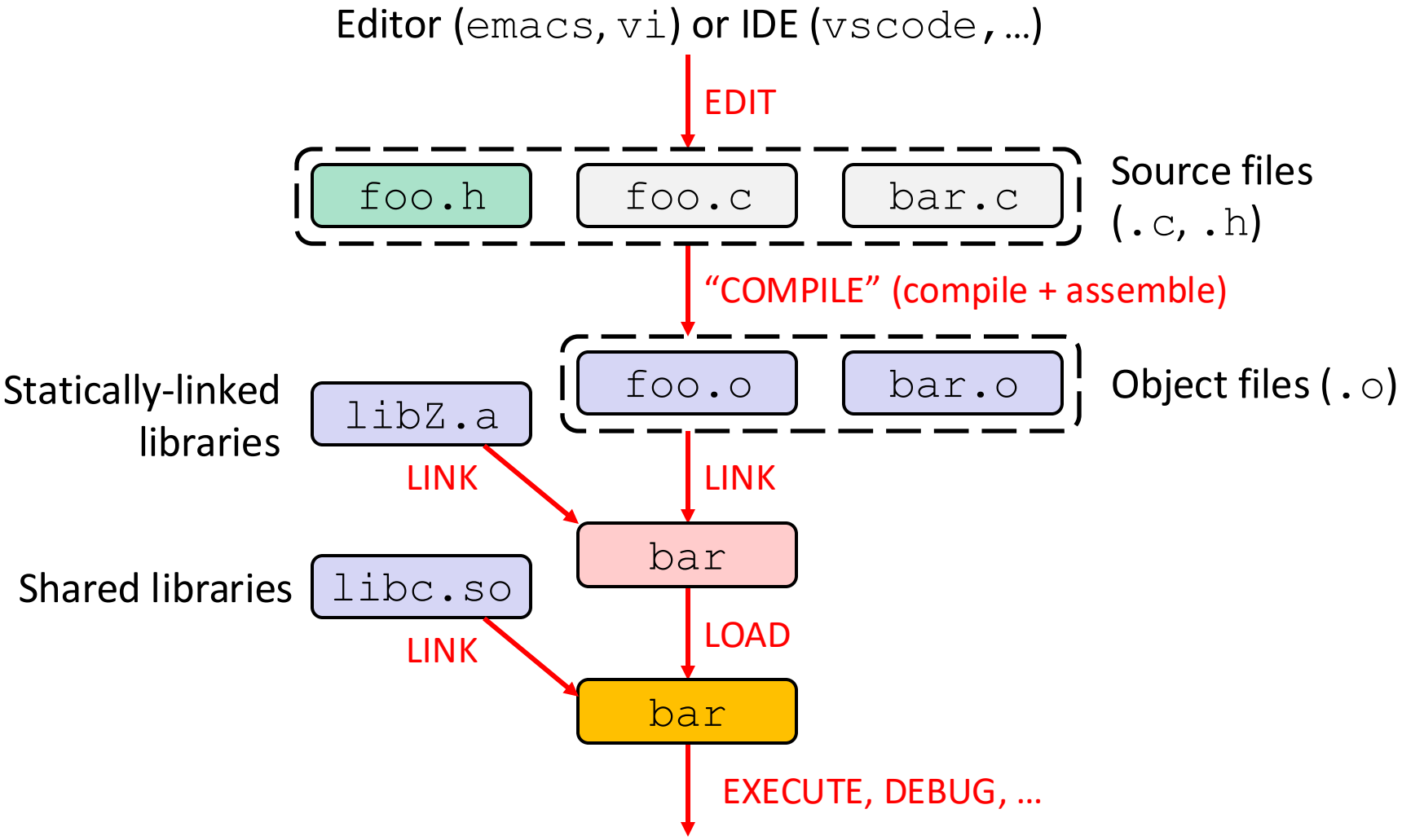
- To get command-line arguments in `main`, use:

```
int main(int argc, char* argv[])
```

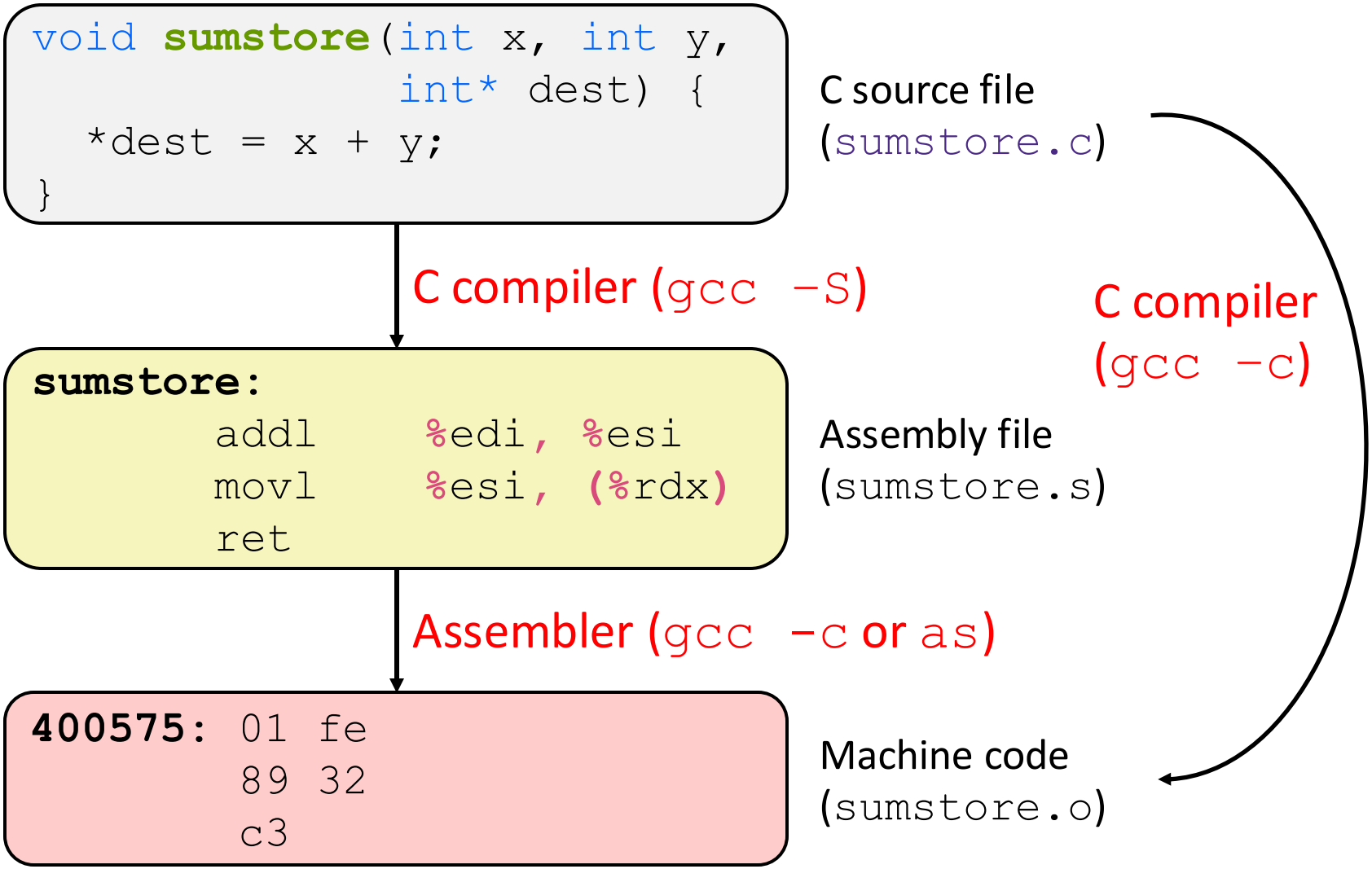
- What does this mean?
  - `argc` contains the number of strings on the command line (the executable name counts as one, plus one for each argument).
  - `argv` is an array containing *pointers* to the arguments as strings (more on pointers later)

- Example: `$ ./foo hello 87`
  - `argc = 3`
  - `argv[0]="./foo", argv[1]="hello", argv[2]="87"`

C Workflow


Editor (emacs, vi) or IDE (vscode, …)
EDIT
foo.h
foo.c
bar.c
Source files (.c, .h)
"COMPILE" (compile + assemble)
foo.o
bar.o
Object files (.o)
Statically-linked libraries
libZ.a
LINK
LINK
bar
Shared libraries
libc.so
LINK
LOAD
bar
EXECUTE, DEBUG, …

C to Machine Code



When Things Go South…

- Errors and Exceptions
  - C does not have exception handling (no `try`/`catch`)
  - Errors are returned as integer error codes from functions
  - Because of this, error handling is ugly and inelegant

- Processes return an "exit code" when they terminate
  - Can be read and used by parent process (shell or other)
    - In main: return EXIT_SUCCESS; or return EXIT_FAILURE; (e.g., 0 or 1)

- Crashes
  - If you do something bad, you hope to get a "segmentation fault" (believe it or not, this is the "good" option)

Java vs. C (351 refresher)

- Are Java and C mostly similar (S) or significantly different (D) in the following categories?

Language Feature	S/D	Differences in C
Control structures	S	
Primitive datatypes	S/D	Similar but sizes can differ (char, esp.), unsigned, no boolean, uninitialized data, …
Operators	S	Java has >>>, C has ->
Casting	D	Java enforces type safety, C does not
Arrays	D	Not objects, don't know their own length, no bounds checking
Memory management	D	Manual (malloc/free), no garbage collection

Primitive Types in C

- Integer types
  - `char`, `int`
- Floating point
  - `float`, `double`
- Modifiers
  - `short` [int]
  - `long` [int, double]
  - `signed` [char, int]
  - `unsigned` [char, int]

C Data Type	32-bit	64-bit	printf
char	1	1	%c
short int	2	2	%hd
unsigned short int	2	2	%hu
int	4	4	%d / %i
unsigned int	4	4	%u
long int	4	8	%ld
long long int	8	8	%lld
float	4	4	%f
double	8	8	%lf
long double	12	16	%Lf
pointer	4	8	%p

Typical sizes – see `sizeofs.c`

C99 Extended Integer Types

- Solves the conundrum of "how big is an `long int`?"

```
#include <stdint.h>

void foo(void) {
  int8_t  a;  // exactly 8 bits, signed
  int16_t b;  // exactly 16 bits, signed
  int32_t c;  // exactly 32 bits, signed
  int64_t d;  // exactly 64 bits, signed
  uint8_t w;  // exactly 8 bits, unsigned
  ...
}
```

Use extended types in most cse333 code

```
void sumstore(int x,     y, int* dest) {
```

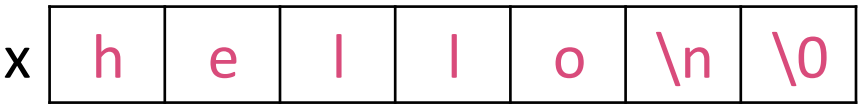
But int is usually fine for simple ints

```
void sumstore(int32_t x, int32_t y, int32_t* dest) {
```

Basic Data Structures

- C does not support objects!!!
- **Arrays** are contiguous chunks of memory
  - Arrays have no methods and do not know their own length
  - Can easily run off ends of arrays in C – security bugs!!!
- **Strings** are null-terminated char arrays
  - Strings have no methods, but `string.h` has helpful utility functions

```
char* x = "hello\n";
```



- **Structs** are the most object-like feature, but are just collections of fields – no "methods" or functions
  - (but can contain pointers to functions!)

Function Definitions

- Generic format:

```
returnType fname(type param1, …, type paramN) {
    // statements
}
```

```
// sum of integers from 1 to max
int sumTo(int max) {
  int i, sum = 0;

  for (i = 1; i <= max; i++) {
    sum += i;
  }

  return sum;
}
```

Function Ordering

- You *shouldn't* call a function that hasn't been declared yet

sum_badorder.c

```c
#include <stdio.h>

int main(int argc, char** argv) {
  printf("sumTo(5) is: %d\n", sumTo(5));
  return 0;
}

// sum of integers from 1 to max
int sumTo(int max) {
  int i, sum = 0;

  for (i = 1; i <= max; i++) {
    sum += i;
  }
  return sum;
}
```

Solution 1: Reverse Ordering

- Simple solution; however, imposes ordering restriction on writing functions (who-calls-what?)

sum_betterorder.c

```c
#include <stdio.h>

// sum of integers from 1 to max
int sumTo(int max) {
  int i, sum = 0;

  for (i = 1; i <= max; i++) {
    sum += i;
  }
  return sum;
}

int main(int argc, char** argv) {
  printf("sumTo(5) is: %d\n", sumTo(5));
  return 0;
}
```

Solution 2: Function Declaration

- Teaches the compiler arguments and return types; function definitions can then be in a logical order
  - We will use this for all functions – either local or libraries

sum_declared.c

Hint: code examples from slides are on the course web for you to experiment with

```c
#include <stdio.h>

// = sum of integers from 1 to max
int sumTo(int max);  // func prototype

int main(int argc, char** argv) {
  printf("sumTo(5) is: %d\n", sumTo(5));
  return 0;
}

int sumTo(int max) {
  int i, sum = 0;
  for (i = 1; i <= max; i++) {
    sum += i;
  }
  return sum;
}
```

Function Declaration vs. Definition

- C/C++ make a careful distinction between these two

- Definition: the thing itself
  - *e.g.* code for function, variable definition that creates storage
  - Must be **exactly one** definition of each thing (no duplicates)

- Declaration: description of a thing defined elsewhere
  - *e.g.* function prototype, external variable declaration
    - Often in header files and incorporated via `#include`
    - Should also `#include` declaration in the file with the actual definition to check for consistency
  - Needs to appear in **all files** that use the thing
    - Should appear before first use

Multi-file C Programs

C source file 1 (sumstore.c)

```
void sumstore(int x, int y, int* dest) {
  *dest = x + y;
}
```

definition

C source file 2 (sumnum.c)

```
#include <stdio.h>

void sumstore(int x, int y, int* dest);

int main(int argc, char** argv) {
  int z, x = 351, y = 333;
  sumstore(x,y,&z);
  printf("%d + %d = %d\n",x,y,z);
  return 0;
}
```

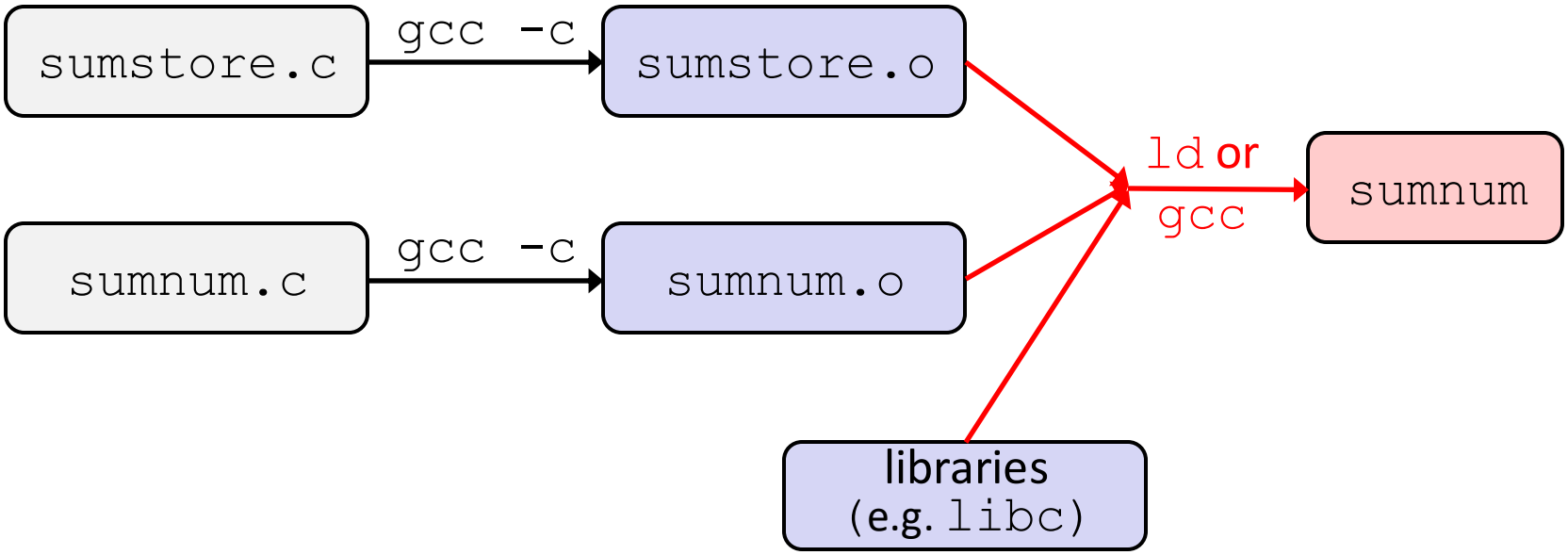
declaration

Compile together:

```
$ gcc -o sumnum sumnum.c sumstore.c
```

Compiling Multi-file Programs

- The **linker** combines multiple object files plus statically-linked libraries to produce an executable (details later)
  - Includes many standard libraries (*e.g.* `libc`, `crt1`)
    - A *library* is just a pre-assembled collection of `.o` files



To-do List

- Explore the website *thoroughly*: http://cs.uw.edu/333
- Computer setup: CSE labs, attu, or CSE Linux VM
- Exercise 0 is due 10 am **sharp** Friday before class
  - Find exercise spec on website, submit via Gradescope
  - Sample solution will be posted Wednesday after class
  - Give it your best shot and be sure to finish and submit on time
- Gradescope accounts created
  - Userid is your uw.edu email address
  - Exercise submission: find CSE 333 25au in gradescope, click on the exercise, drag-n-drop file(s)! That's it!!
    - See resources page on course web for how to transfer files from attu / vscode / etc. to your local laptop to do drag-n-drop
- Project repos created and hw0 out before sections this week
  - All will become clear in sections this week!