COS 217: Introduction to Programming Systems

Aarti Gupta

Agenda

Course overview

- **Introductions**
- Course goals
- Resources
- Grading
- Policies
- Schedule

Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- C details (if time)

Introductions

Instructor-of-Record

- Aarti Gupta, Ph.D.
  - aartig@cs.princeton.edu

Lead Preceptors

- Robert Dondero, Ph.D.
  - rdondero@cs.princeton.edu
- Iasonas Petras, Ph.D.
  - ipetras@cs.princeton.edu

Introductions: Preceptors

Scott Karlin, Ph.D
scott@cs.princeton.edu

Huilian (Sophie) Qiu
hqiu@princeton.edu

Agenda

Course overview

- Introductions
- **Course goals**
- Resources
- Grading
- Policies
- Schedule

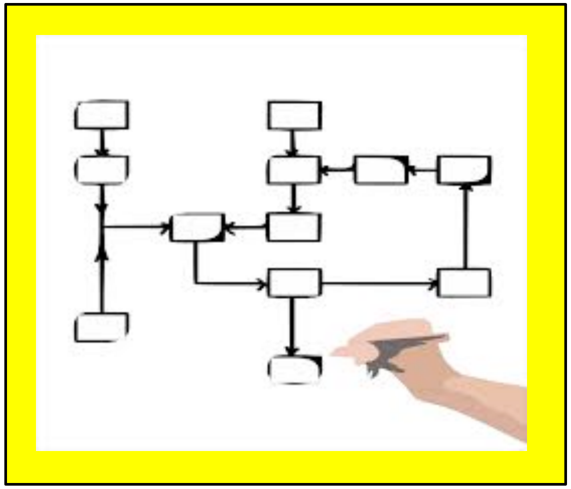
Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- C details (if time)

Goal 1: “Pgmming in the Large”

Goal 1: “Programming in the large”

- Help you learn how to compose large computer programs



Topics

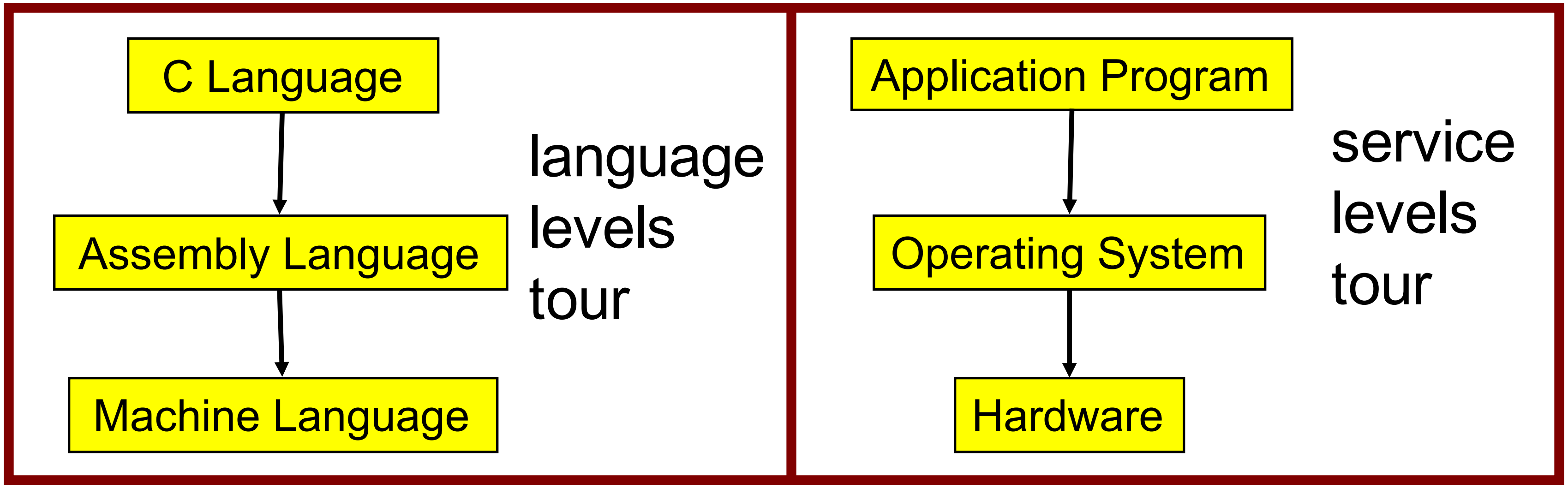
- Modularity/abstraction, information hiding, resource management, error handling, testing, debugging, performance improvement, tool support

Goal 2: “Under the Hood”

Goal 2: “Look under the hood”

- Help you learn what happens “under the hood” of computer systems

Downward tours



C Language

Assembly Language

Machine Language

language levels tour

Application Program

Operating System

Hardware

service levels tour

Goals: Summary

Help you to become a...

Power Programmer!!!

Goals: Why C?

Question: Why C instead of Java?

Answer 1: C supports Goal 2 better

Answer 2: C supports Goal 1 better

Goals: Why Linux?

Question: Why Linux instead of Microsoft Windows?

Answer 1: Linux is good for education and research

Answer 2: Linux (with GNU) is good for programming

Agenda

Course overview

- Introductions
- Course goals
- **Resources**
- Grading
- Policies
- Schedule

Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- C details (if time)

Lectures

Lectures

- Describe material at conceptual level
- Slides available via course website
- Suggestion: Bring hard copy of slides

Lecture etiquette

- Please don’t use electronic devices during lectures

Precepts

Precepts

- Describe material at physical (low) level
- Support your work on assignments
- Hard copy handouts distributed during precepts
- Handouts available via course website

Precept etiquette

- Attend your precept
- Use SCORE to move to another precept
  - Trouble: See Colleen Kenny-McGinley (CS Bldg 210)
    - But Colleen can’t move you into a full precept
- Must miss your precept: inform preceptors & attend another

Precepts begin Monday, February 1

Website

Website

- Access from http://www.cs.princeton.edu
  - Academics → Course Schedule → COS 217
  - Home page, schedule page, assignment page, policies page

Piazza

Piazza

- http://piazza.com/class#spring2016/cos217/
- Instructions provided in first precept

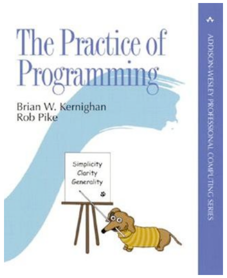
Piazza etiquette

- Study provided material before posting question
  - Lecture slides, precept handouts, required readings
- Read all (recent) Piazza threads before posting question
- Don’t show your code!!!
  - See course policies

Books

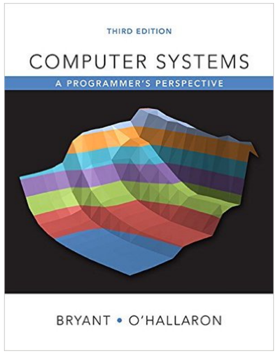
The Practice of Programming (recommended)

- Kernighan & Pike
- “Programming in the large”


The Practice of Programming
Brian W. Kernighan
Rob Pike
Simplicity
Clarity
Generality
ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES

Computer Systems: A Programmer's Perspective (Third Edition) (recommended)

- Bryant & O'Hallaron
- “Under the hood”



C Programming: A Modern Approach (Second Edition) (required)

- King
- C programming language and standard libraries

Manuals

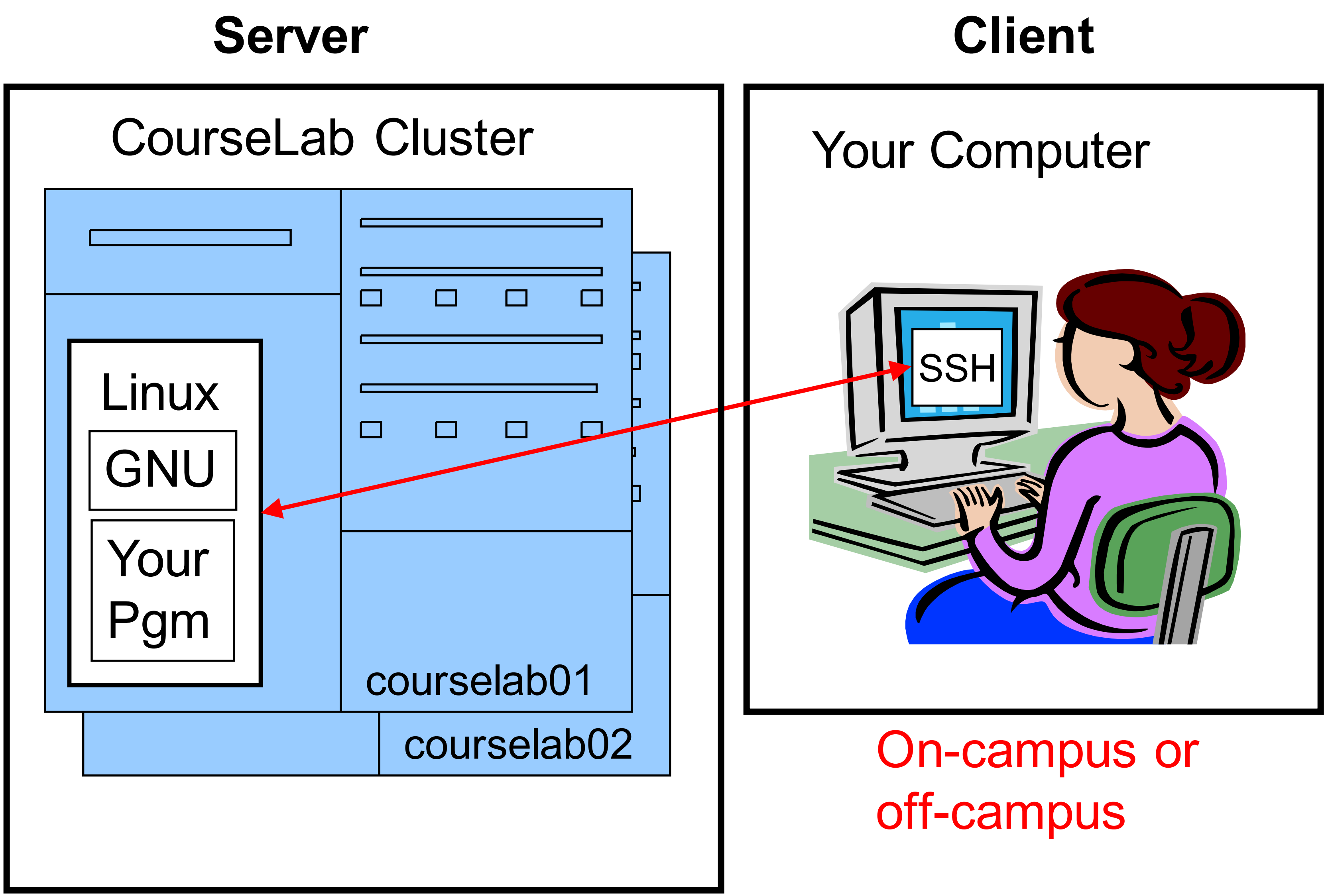
Manuals (for reference only, available online)

- ***Intel 64 and IA-32 Architectures Software Developer's Manual, Volumes 1-3***
- ***Intel 64 and IA-32 Architectures Optimization Reference Manual***
- ***Using as, the GNU Assembler***

See also

- Linux `man` command

Programming Environment



On-campus or off-campus

Agenda

Course overview

- Introductions
- Course goals
- Resources
- **Grading**
- Policies
- Schedule

Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- C details (if time)

Grading

Course Component	Percentage of Grade
Assignments *	50
Midterm Exam **	15
Final Exam **	25
Subjective ***	10

* Final assignment counts double; penalties for lateness

** Closed book, closed notes, no electronic devices

*** Did your involvement benefit the course as a whole?

- Lecture and precept attendance and participation counts

Programming Assignments

Programming assignments

- A “de-comment” program
- A string module
- A symbol table module
- Assembly language programs
- A buffer overrun attack (partner from your precept)
- A heap manager module (partner from your precept)
- A Unix shell

First assignment is available now

Start early!!!

Agenda

Course overview

- Introductions
- Course goals
- Resources
- Grading
- **Policies**
- Schedule

Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- C details (if time)

Policies

Study the course "Policies" web page!

Especially the assignment collaboration policies

- Violations often involve **trial by Committee on Discipline**
- Typical course-level penalty is **F for course**
- Typical University-level penalty is **suspension from University** for 1 academic year

Assignment Related Policies

Some highlights:

- You may not reveal any of your assignment solutions (products, descriptions of products, design decisions) on Piazza.
- **Getting help**: To help you compose an assignment solution you may use only authorized sources of information, may consult with other people only via the course's Piazza account or via interactions that might legitimately appear on the course's Piazza account, and must declare your sources in your readme file for the assignment.
- **Giving help**: You may help other students with assignments only via the course's Piazza account or interactions that might legitimately appear on the course's Piazza account, and you may not share your assignment solutions with anyone, ever, in any form.

Ask the instructor-of-record for clarifications

- Only the instructor-of-record can waive any policies (and not verbally)

Agenda

Course overview

- Introductions
- Course goals
- Resources
- Grading
- Policies
- **Schedule**

Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- C details (if time)

Course Schedule

Weeks	Lectures	Precepts
1-2	Number Systems C (conceptual)	Linux/GNU C (pragmatic)
3-6	“Pgmming in the Large”	Advanced C
6	Midterm Exam	
7	Recess	
8-13	“Under the Hood” (conceptual)	“Under the Hood” (pgmming asgts)
	Reading Period	
	Final Exam	

Any questions?

Agenda

Course overview

- Introductions
- Course goals
- Resources
- Grading
- Policies
- Schedule

Getting started with C

- **History of C**
- Building and running C programs
- Characteristics of C
- C details (if time)

The C Programming Language

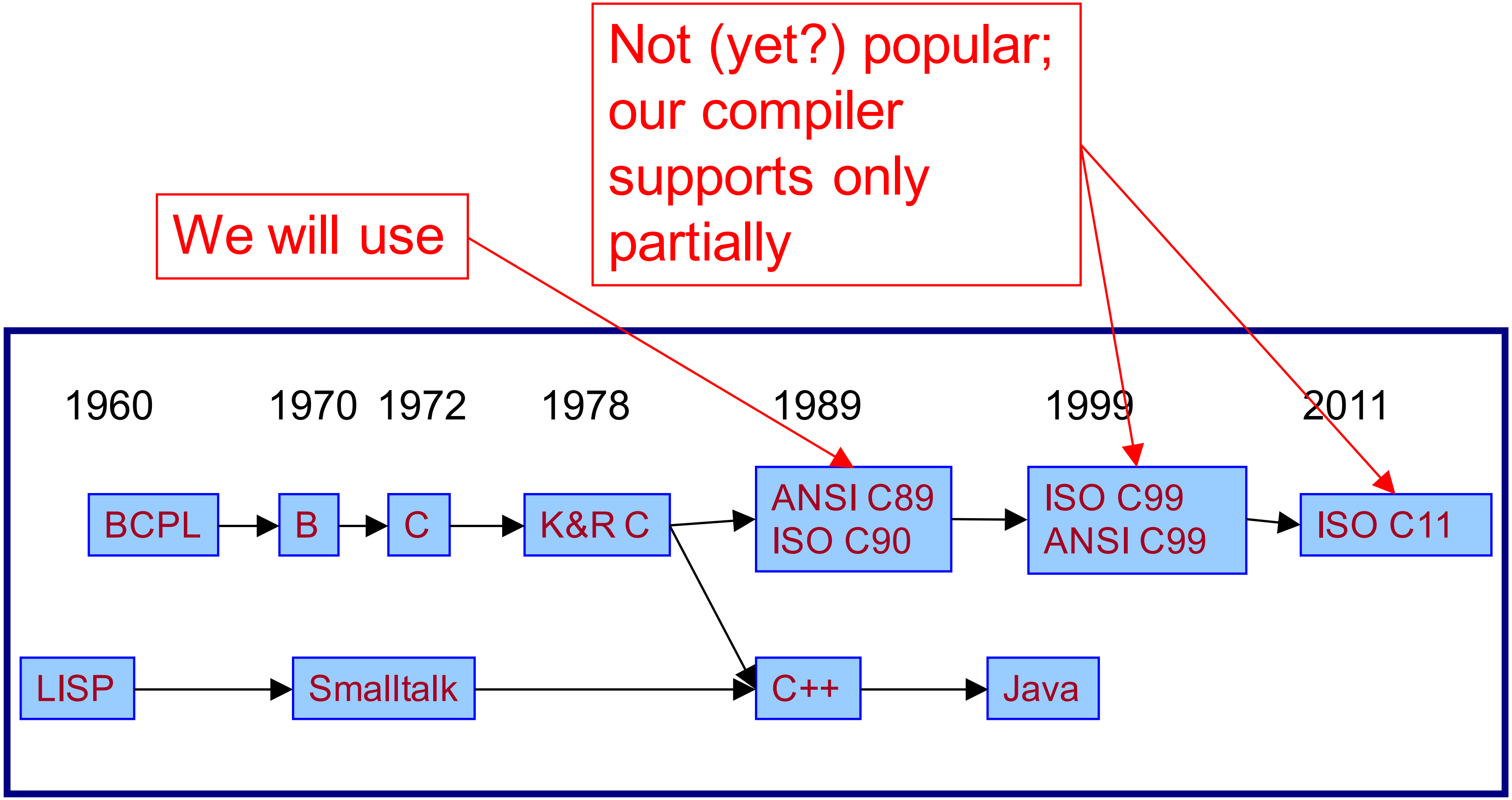
Who? Dennis Ritchie

When? ~1972

Where? Bell Labs

Why? Compose the Unix OS

Java vs. C: History



Java vs. C: Design Goals

Java Design Goals	C Design Goals
Language of the Internet	Compose Unix
High-level; insulated from hardware and OS	Low-level; close to HW and OS
Good for application-level programming	Good for system-level programming
Support object-oriented programming	Support structured programming
Look like C!	

Agenda

Course overview

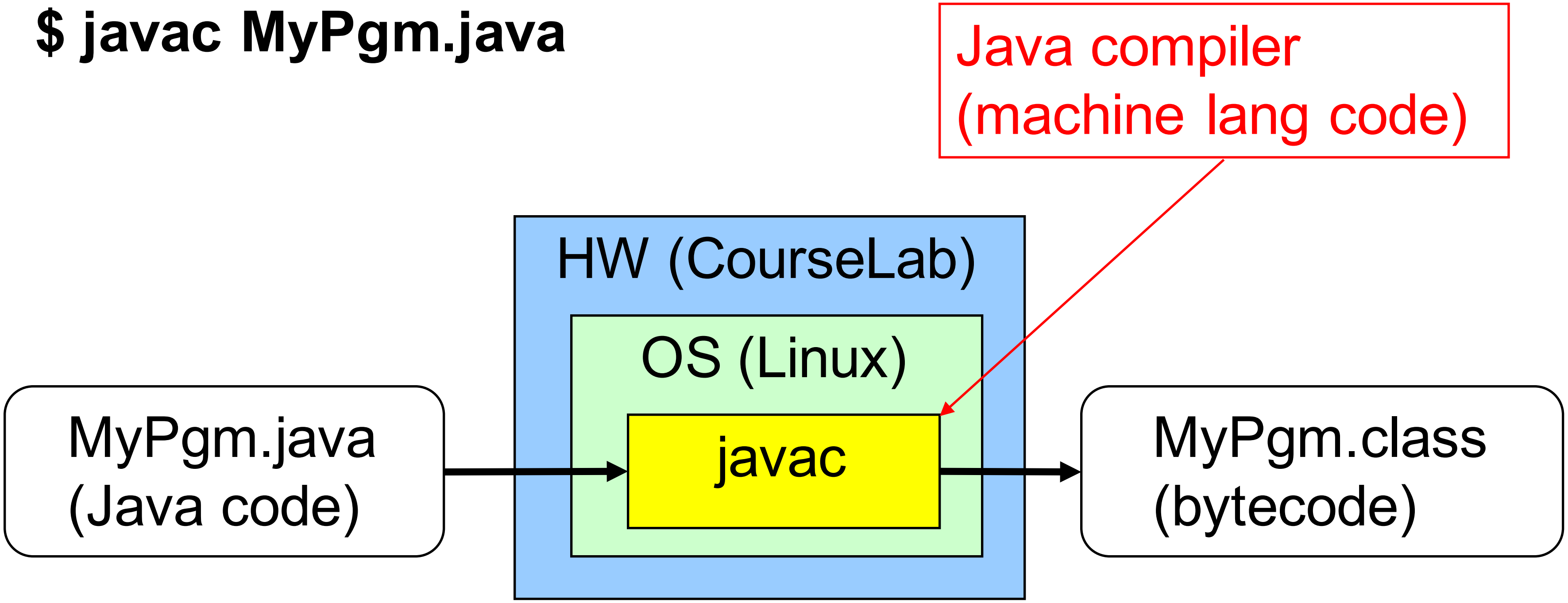
- Introductions
- Course goals
- Resources
- Grading
- Policies
- Schedule

Getting started with C

- History of C
- **Building and running C programs**
- Characteristics of C
- C details (if time)

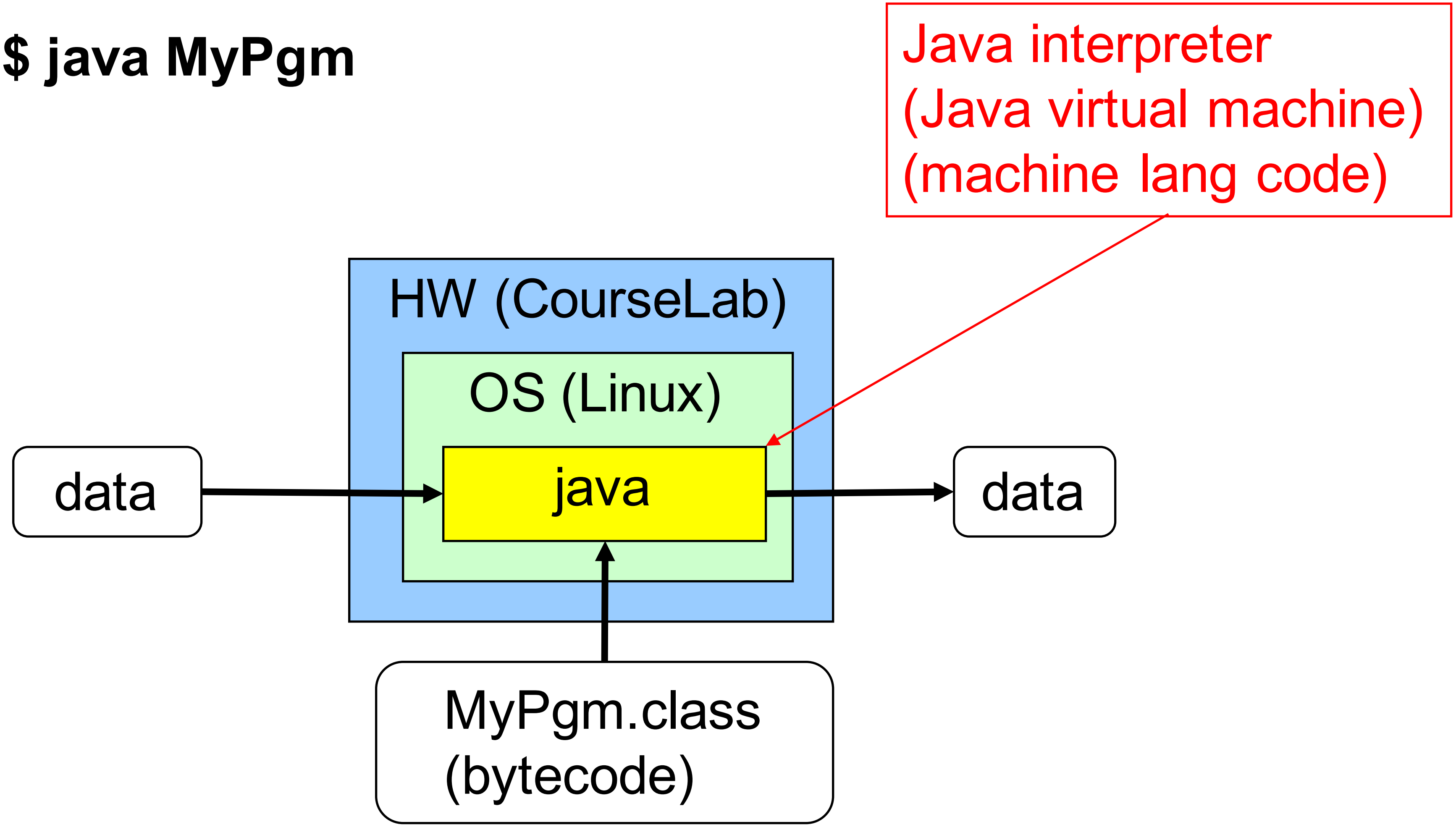
Building Java Programs

```
$ javac MyPgm.java
```



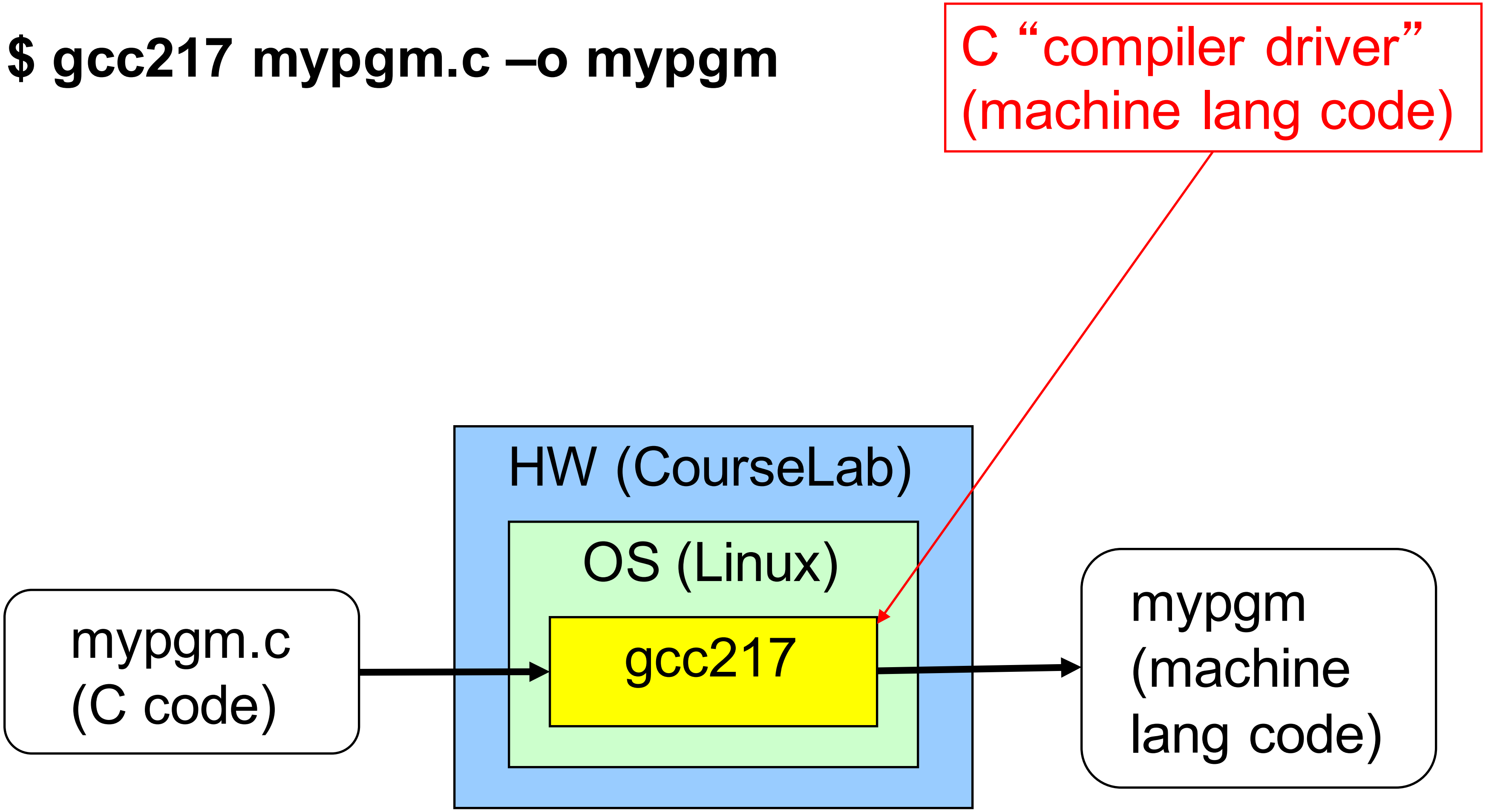
Running Java Programs

$ java MyPgm



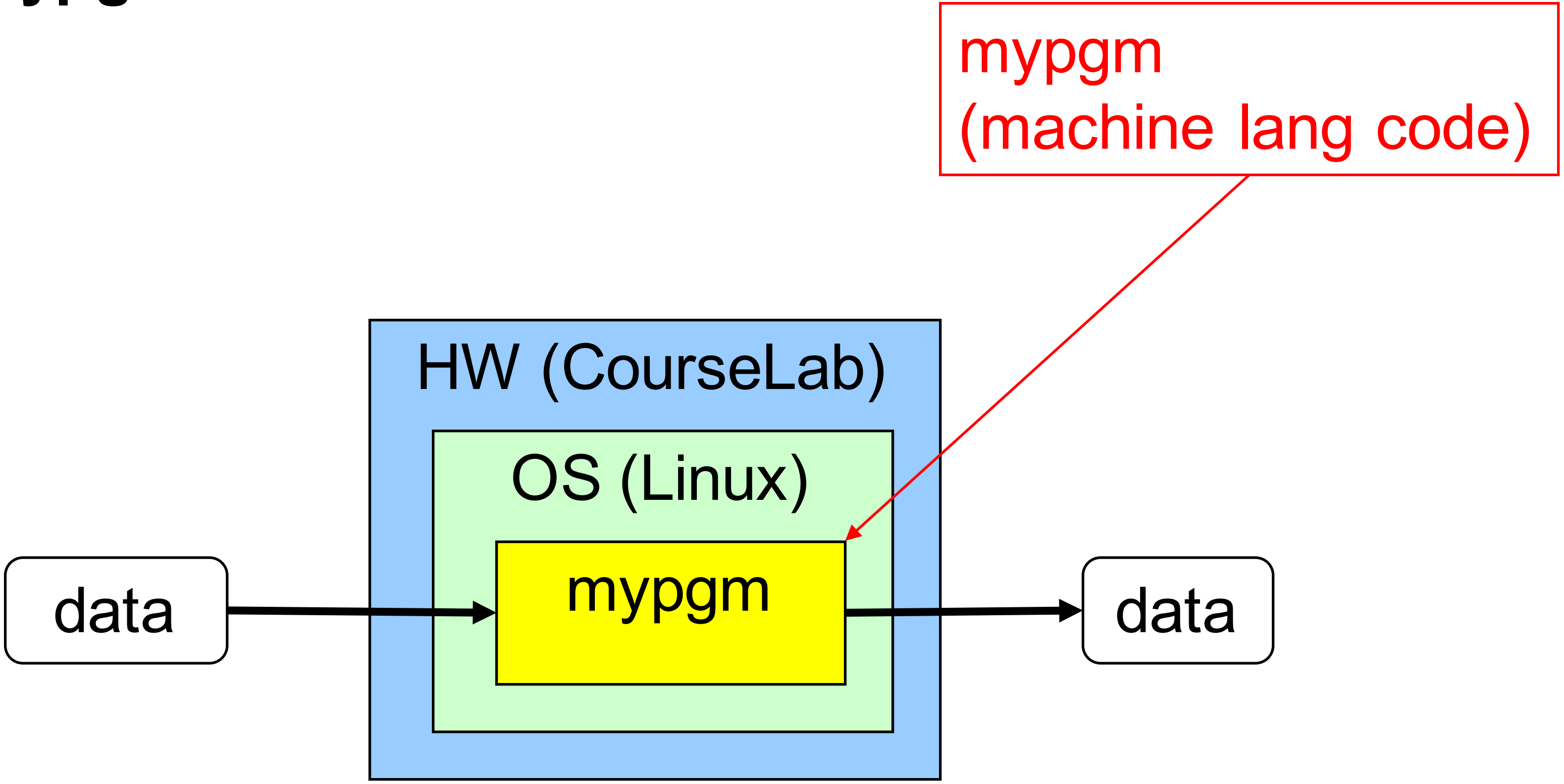
Building C Programs

```
$ gcc217 mypgm.c –o mypgm
```



Running C Programs

```
$ mypgm
```



Agenda

Course overview

- Introductions
- Course goals
- Resources
- Grading
- Policies
- Schedule

Getting started with C

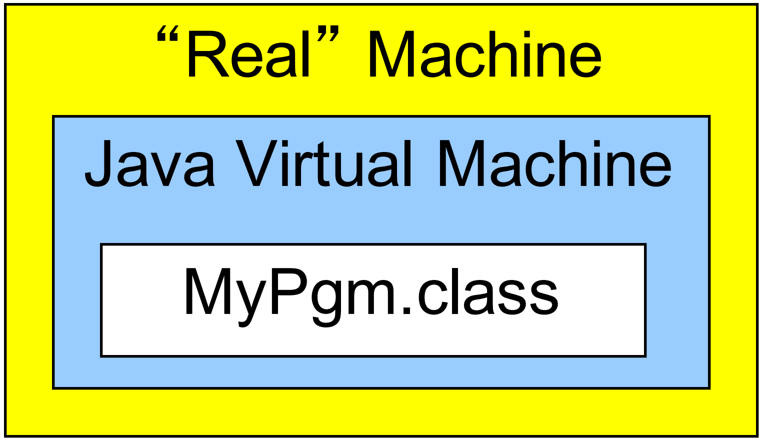
- History of C
- Building and running C programs
- **Characteristics of C**
- C details (if time)

Java vs. C: Portability

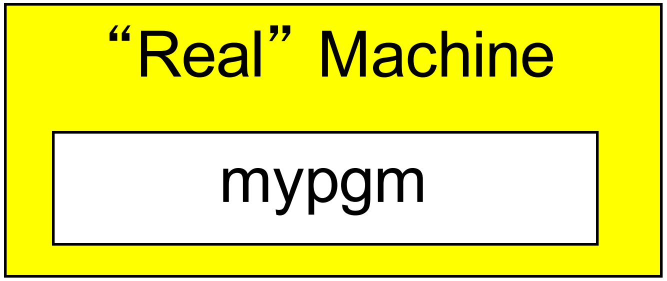
Program	Code Type	Portable?
MyPgm.java	Java source code	Yes
mypgm.c	C source code	Mostly
MyPgm.class	Bytecode	Yes
mypgm	Machine lang code	No
javac (Java compiler)	Machine lang code	No
java (Java interpreter)	Machine lang code	No
gcc217 (C compiler driver)	Machine lang code	No

Conclusion: Java programs are more portable

Java vs. C: Efficiency



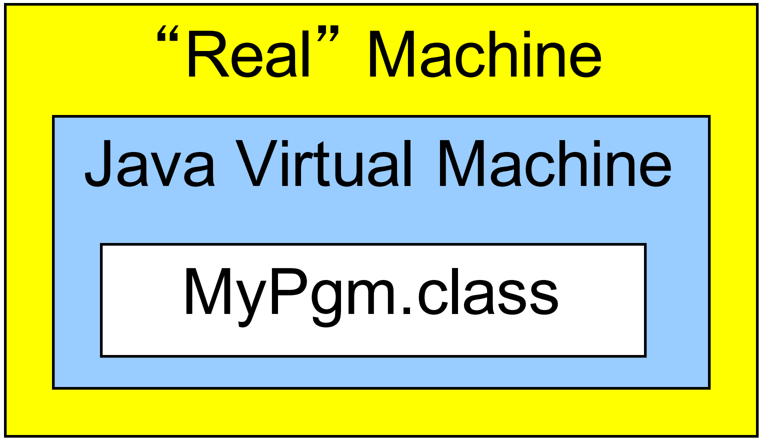
Java programs run on "virtual" machine which runs on "real" machine



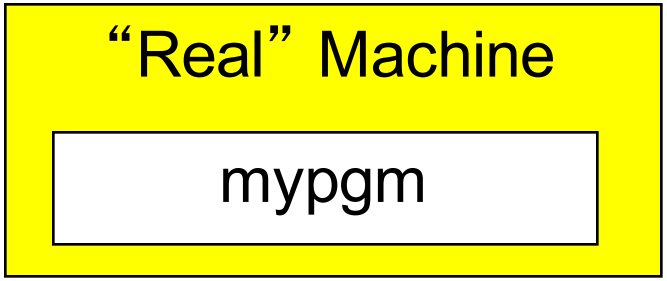
C programs run on "real" machine

Conclusion: C programs are faster

Java vs. C: Safety



Java programs run on "virtual" machine defined by interpreter; can provide safe environment
(e.g. array bounds checks)



C programs run directly on "real" machine

Conclusion: Java programs are safer

Java vs. C: Characteristics

	Java	C
Portability	+	-
Efficiency	-	+
Safety	+	-

Java vs. C: Characteristics

If this is Java…

Java vs. C: Characteristics

Then this is C

Agenda

Course overview

- Introductions
- Course goals
- Resources
- Grading
- Policies
- Schedule

Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- **C details (if time)**

Java vs. C: Details

Remaining slides provide some details

Use for future reference

Slides covered now, as time allows…

Java vs. C: Details

	Java	C

Overall Program Structure	Hello.java:
	
	public class Hello
	{ public static void main
	        (String[] args)
	    { System.out.println(
	            "hello, world");
	    }
	}
		hello.c:
		
		#include <stdio.h>
		
		int main(void)
		{ printf("hello,
		world\n");
		    return 0;
		}

Building	$ javac Hello.java	$ gcc217 hello.c -o hello
Running	$ java Hello hello, world $	$ hello hello, world $

Java vs. C: Details

	Java	C
Character type	char // 16-bit Unicode	char /* 8 bits */
Integral types	byte // 8 bits short // 16 bits int // 32 bits long // 64 bits	(unsigned) char (unsigned) short (unsigned) int (unsigned) long
Floating point types	float // 32 bits double // 64 bits	float double long double
Logical type	boolean	/* no equivalent */ /* use integral type */
Generic pointer type	// no equivalent	void*

Constants	final int MAX = 1000;	#define MAX 1000
		const int MAX = 1000;
		enum {MAX = 1000};

Java vs. C: Details

	Java	C

Arrays	`int [] a = new int [10];`
	`float [][] b =`
	`    new float [5][20];`
		`int a[10];`
		`float b[5][20];`

Array bound checking	`// run-time check`	`/* no run-time check */`

Pointer type	`// Object reference is an`
	`// implicit pointer`
		`int *p;`

Record type	`class Mine`
	`{   int x;`
	`    float y;`
	`}`
		`struct Mine`
		`{   int x;`
		`    float y;`
		`};`

Java vs. C: Details

	Java	C

Strings	`String s1 = "Hello";`
	`String s2 = new`
	`   String("hello");`
		`char *s1 = "Hello";`
		`char s2[6];`
		`strcpy(s2, "hello");`

String concatenation	`s1 + s2`
	`s1 += s2`
		`#include <string.h>`
		`strcat(s1, s2);`

Logical ops *	`&&, ||, !`	`&&, ||, !`
Relational ops *	`=, !=, >, <, >=, <=`	`=, !=, >, <, >=, <=`
Arithmetic ops *	`+, -, *, /, %, unary -`	`+, -, *, /, %, unary -`
Bitwise ops	`>>, <<, >>>, &, |, ^`	`>>, <<, &, |, ^`
Assignment ops	`=, *=, /=, +=, -=, <<=, >>=, >>>=, =, &=, ^=, |=, %=`	`=, *=, /=, +=, -=, <<=, >>=, =, &=, ^=, |=, %=`

* Essentially the same in the two languages

Java vs. C: Details

	Java	C

if stmt *	`if (i < 0)`
	`   statement1;`
	`else`
	`   statement2;`
		`if (i < 0)`
		`   statement1;`
		`else`
		`   statement2;`

switch stmt *	`switch (i)`
	`{  case 1:`
	`      ...`
	`      break;`
	`   case 2:`
	`      ...`
	`      break;`
	`   default:`
	`      ...`
	`}`
		`switch (i)`
		`{  case 1:`
		`      ...`
		`      break;`
		`   case 2:`
		`      ...`
		`      break;`
		`   default:`
		`      ...`
		`}`

goto stmt	`// no equivalent`	`goto someLabel;`

* Essentially the same in the two languages

Java vs. C: Details

	Java	C

for stmt	`for (int i=0; i<10; i++)`
	    `statement``;`
		`int i;`
		`for (i=0; i<10; i++)`
		    `statement``;`

while stmt *	`while (i < 0)`
	    `statement;`
		`while (i < 0)`
		    `statement;`

do-while stmt *	`do`
	    `statement``;`
	`while (i < 0)`
		`do`
		    `statement``;`
		`while (i < 0);`

continue stmt *	`continue;`	`continue;`
labeled continue stmt	`continue` *`someLabel`*`;`	`/* no equivalent */`
break stmt *	`break;`	`break;`
labeled break stmt	`break` *`someLabel`*`;`	`/* no equivalent */`

* Essentially the same in the two languages

Java vs. C: Details

	Java	C

return stmt *	`return 5;`
	`return;`
		`return 5;`
		`return;`

Compound stmt (alias block) *	`{`
	`    statement1;`
	`    statement2;`
	`}`
		`{`
		`    statement1;`
		`    statement2;`
		`}`

Exceptions	`throw, try-catch-finally`	`/* no equivalent */`

Comments	`/* comment */`
	`// another kind`
		`/* comment */`

Method / function call	`f(x, y, z);`
	`someObject.f(x, y, z);`
	`SomeClass.f(x, y, z);`
		`f(x, y, z);`

* Essentially the same in the two languages

Example C Program

```
#include <stdio.h>
#include <stdlib.h>

int main(void)
{  const double KMETERS_PER_MILE = 1.609;
   int miles;
   double kMeters;

   printf("miles: ");
   if (scanf("%d", &miles) != 1)
   {  fprintf(stderr, "Error: Expected a number.\n");
      exit(EXIT_FAILURE);
   }

   kMeters = (double)miles * KMETERS_PER_MILE;
   printf("%d miles is %f kilometers.\n",
      miles, kMeters);
   return 0;
}
```

Summary

Course overview

- Introductions
- Course goals
  - Goal 1: Learn “programming in the large”
  - Goal 2: Look “under the hood”
  - Use of C and Linux supports both goals
- Resources
  - Lectures, precepts, programming environment, Piazza, textbooks
  - Course website: access via http://www.cs.princeton.edu
- Grading
- Policies
- Schedule

Summary

Getting started with C

- History of C
- Building and running C programs
- Characteristics of C
- Details of C
  - Java and C are similar
  - Knowing Java gives you a head start at learning C

Getting Started

Check out course website **soon**

- **Study "Policies" page**
- First assignment is available

Establish a reasonable computing environment **soon**

- Instructions given in first precept