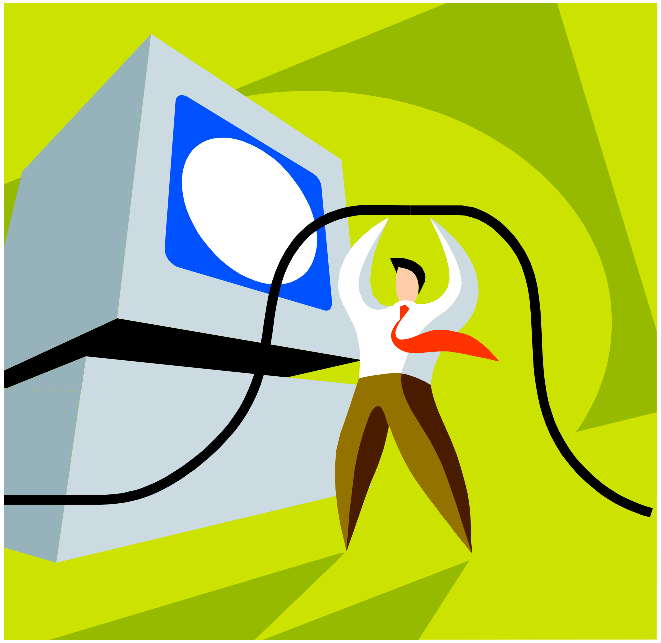
EE 209: Programming Structures for Electrical Engineering

Goals for Today’s Class

- Course overview
  - Introductions
  - Course goals
  - Resources
  - Grading
  - Policies

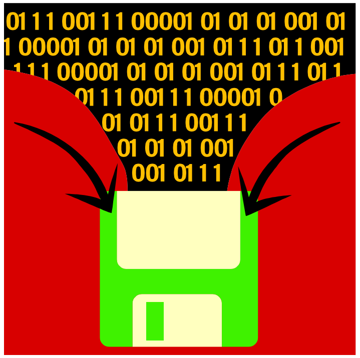


- Getting started with C
  - C programming language overview

Introductions

- Lecturer: KyoungSoo Park, Ph.D.
- TAs
  - Asim Jamshed (ajamshed@ndsl.kaist.edu)
  - Kabseok Go (ksko@cnr.kaist.ac.kr)
  - Hansung Leem (hsleem@cnr.kaist.ac.kr)
  - Chulmin Kim (cmkim@core.kaist.ac.kr)
- Modeled around Princeton COS 217
  - Slides and programming assignments borrowed and adapted from Princeton COS 217
  - Got permission to use the material

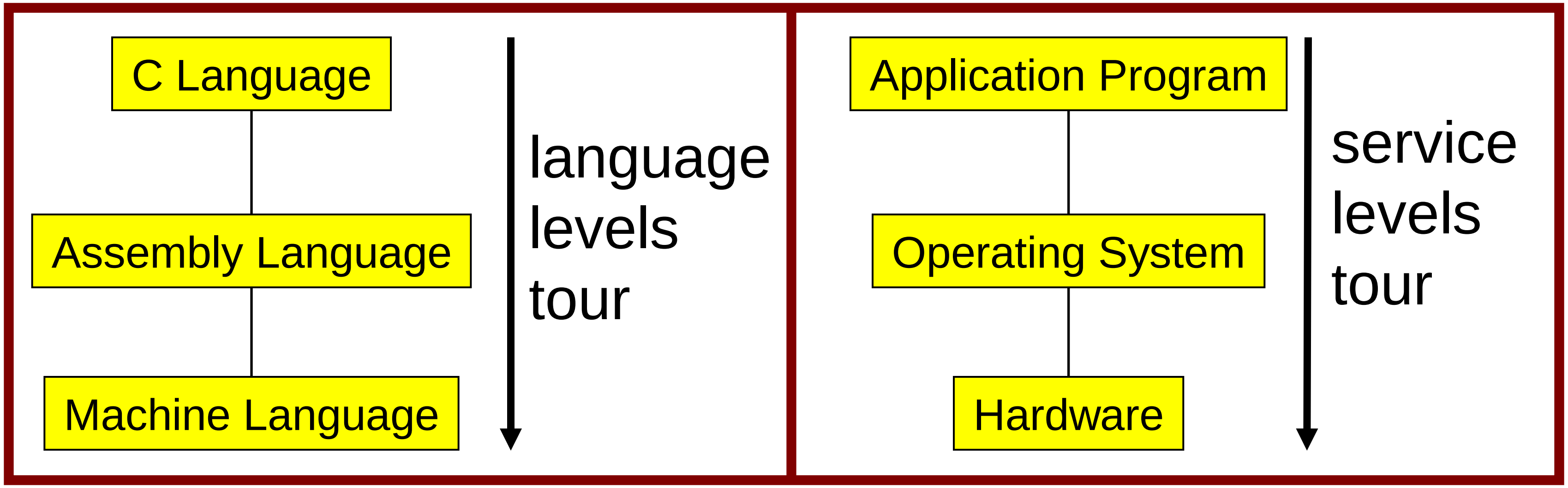
Course Goal 1: “Programming in the Large”



- Goal 1: “Programming in the large”
  - How to write large computer programs
  - Abstraction; Interfaces and implementations
- Specifically, help you learn how to:
  - Write modular code
    - Hide information
    - Manage resources
    - Handle errors
  - Write portable code
  - Test and debug your code
  - Improve your code’s performance (and when to do so)
  - Use tools to support those activities

Course Goal 2: “Under the Hood”

- Goal 2: “Look under the hood”
  - Help you learn what happens “under the hood” of computer systems
- Specifically, two downward tours



- Goal 2 supports Goal 1
  - Reveals many examples of effective abstractions

Course Goals: Why C?

Q: Why C?

A: C supports Goal 1 better

- C is a lower-level language
  - C provides more opportunities to create abstractions
- C has some flaws
  - C's flaws motivate discussions of software engineering principles

A: C supports Goal 2 better

- C facilitates language levels tour
  - C is closely related to assembly language
- C facilitates service levels tour
  - Linux is written in C

Course Goals: Why Linux?

Q: Why Linux instead of Microsoft Windows?

A: Linux is good for education and research

- Linux is open-source and well-specified

A: Linux is good for programming

- Linux is a variant of Unix
- Unix has GNU, a rich open-source programming environment

Lectures and Precepts

- Lectures
  - Describe concepts at a high level
  - Slides available online at course Web site
- Precepts
  - Support lectures by describing concepts at a lower level
  - Support your work on assignments
  - Divided into A and B
    - Check your class (A or B) at the course homepage

Website and Mailing List

- Course Website
  - http://www.ndsl.kaist.edu/~kyoungsoo/ee209/
    - Accessible from KAIST IP block (143.248.*)
- Course mailing list
  - ee209@list.ndsl.kaist.edu
  - Subscription is required (look at course website)
  - Urgent announcements (e.g., cancelling class)
- Course Moodle
  - Used to submit your programming assignments
  - Linked to course website

Textbooks

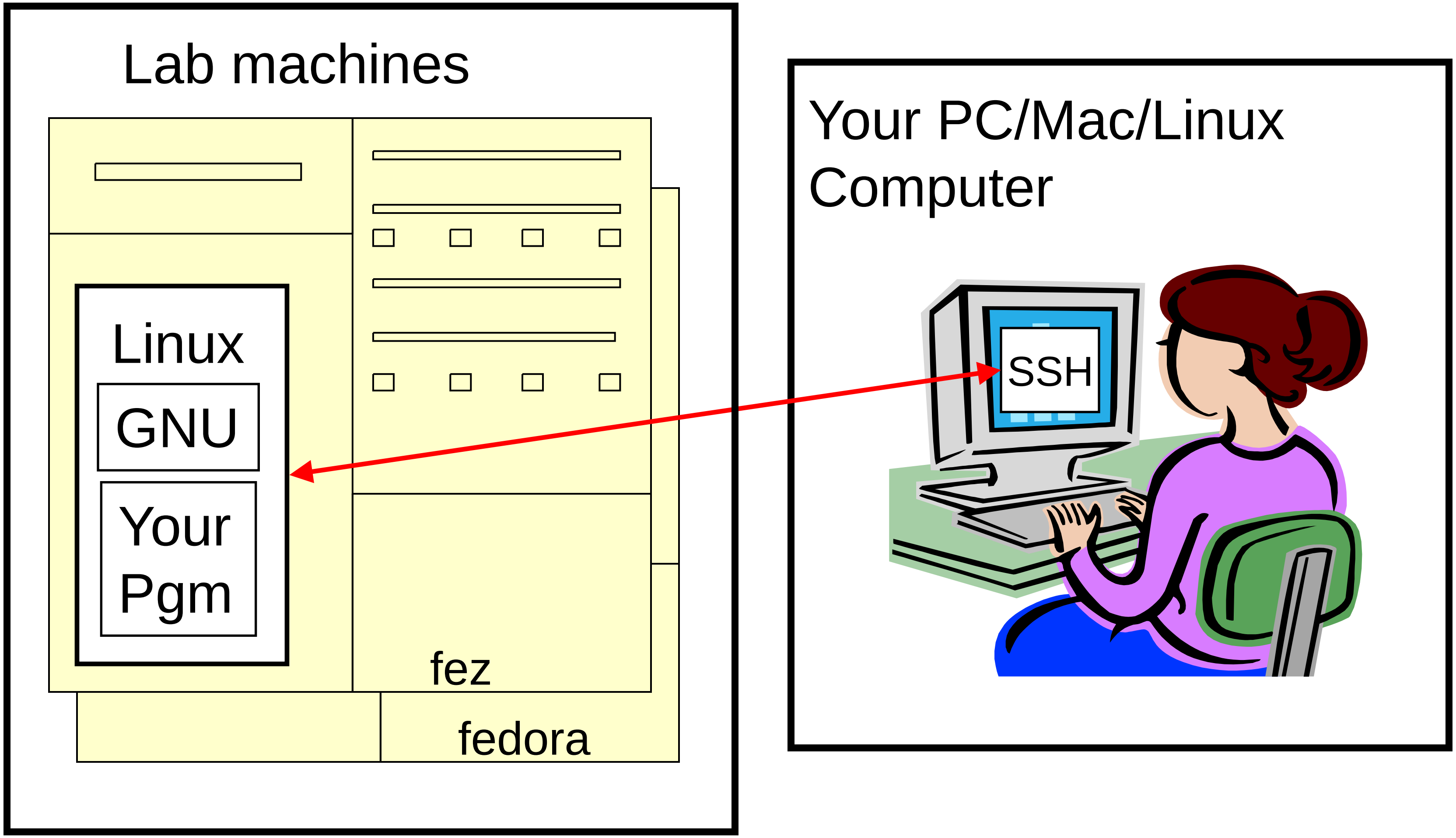
- Required book
  - *C Programming: A Modern Approach (Second Edition),* King, 2008.
    - Covers the C programming language and standard libraries
    - First edition is not quite so good, but is sufficient
  - *Computer Systems: A Programmer's Perspective*, Bryant and O'Hallaron, 2010.
    - Covers "under the hood"
- Highly recommended books
  - *The C Programming Language,* Kernighan and Ritchie, 1988.
    - Covers the C programming language
  - *The Practice of Programming,* Kernighan and Pike, 1999.
    - Covers "programming in the large"
  - *Programming with GNU Software*, Loukides and Oram, 1997.
    - Covers tools
- *All books are on reserve in the Library*

Manuals

- Manuals (for reference only, available online)
  - *Intel Architecture Software Developer's Manual, Volumes 1-3*
  - *Tool Interface Standard & Executable and Linking Format*
  - *Using as, the GNU Assembler*

- See also
  - Linux **`man`** command
    - **`man`** is short for “manual”
    - For more help, type **`man man`**

Programming Environment



Lab machines

Linux

GNU

Your Pgm

fez

fedora

Your PC/Mac/Linux Computer

SSH

Programming Environment

- Other options
  - Use your own PC/Mac/Linux computer; run GNU tools locally; run your programs locally (e.g., VMWare Player on Windows)
  - Use your own PC/Mac/Linux computer; run a non-GNU development environment locally; run your programs locally (e.g., Visual C++)
  - Etc.
- Notes
  - Other options cannot be used for some assignments (esp. timing studies)
  - Instructors cannot promise support of other options
  - My recommendation: use local environment for development and lab environment for testing & debugging
  - First precept provides setup instructions

Grading

- Six programming assignments (50%)
  - Working code
  - Clean, readable, maintainable code
  - On time (penalties for late submission)
  - Final assignment counts more (12.5%)
- Exams (40%)
  - Midterm (20%)
  - Final (20%)
- Class participation (10%)
  - Attendance + random quiz(?)
- Lecture and recitation attendance is ***mandatory***

Programming Assignments

- Tentative programming assignments
  1. A "de-comment" program
  2. A regular expression module
  3. A symbol table module
  4. IA-32 assembly language programs
  5. A heap manager module
  6. A Unix shell
- Key part of the course
- Due (typically) Sundays at 9:00PM
- First assignment is available now
- Advice: Start early to allow time for debugging …

Why Debugging is Necessary…

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Course Policy

Study the course “Policy” web page!!!

- Especially the assignment and exam Policy
  - Violation is automatic failure (F) of this course.
  - We’ll use MOSS to check plagiarism
- Some highlights:
  - Don’t view anyone else’s work during, before, or after the assignment time period
  - Don’t allow anyone to view your work during, before, or after the assignment time period
  - In your assignment “readme” file, acknowledge all resources used
- Ask your preceptor for clarifications if necessary

Course Schedule

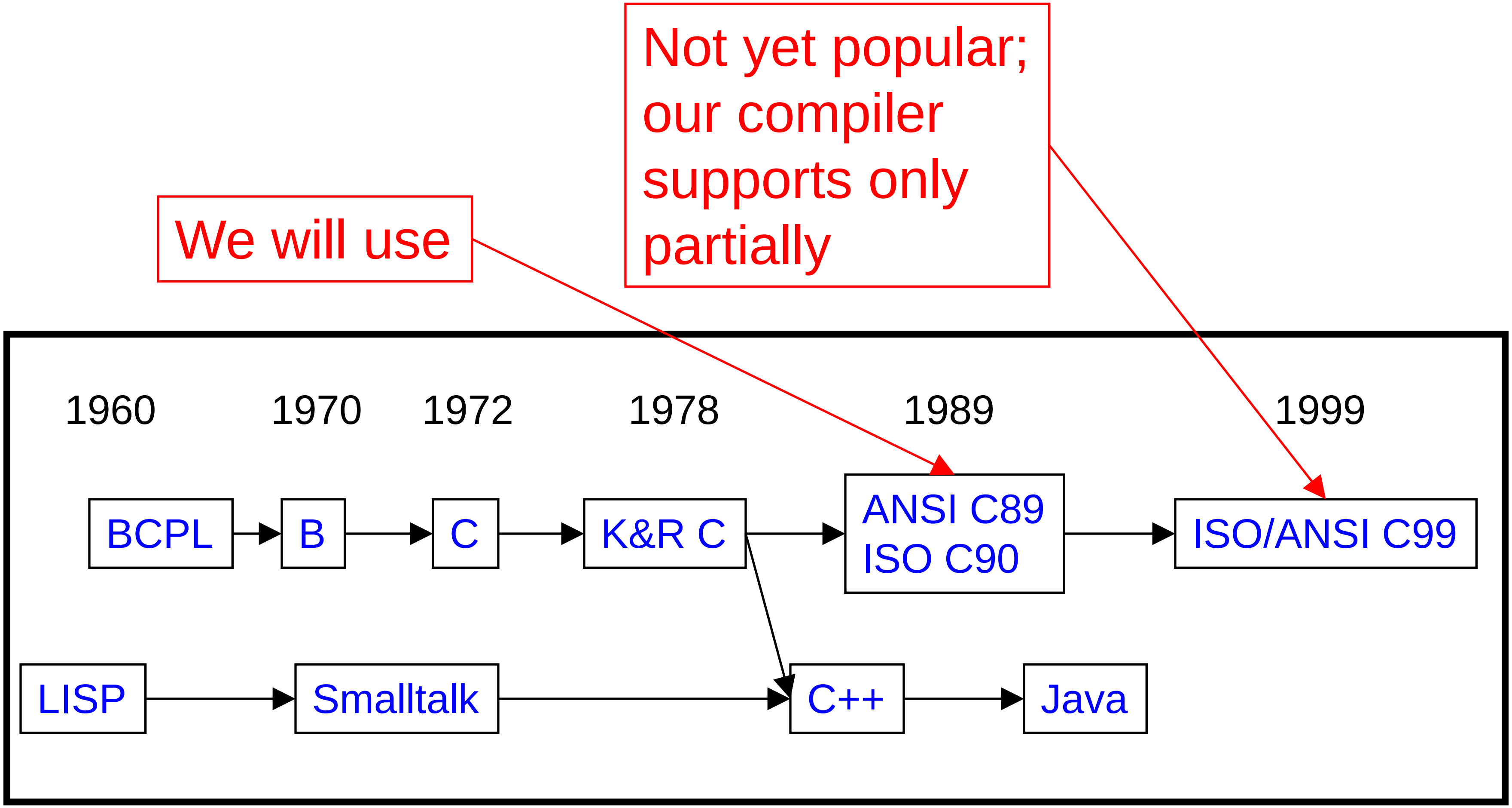
- Tentatively…

Weeks	Lectures	Precepts
1-2	Intro to C (conceptual)	Intro to Linux/GNU Intro to C (mechanical)
3-6	“Pgmming in the Large”	Advanced C
7	Midterm Exam	
8-14	“Under the Hood”	Assembly Language Pgmming Assignments
15	Final Exam	

- See course “Schedule” web page for details

Any questions before we start?

C : History


Not yet popular; our compiler supports only partially
We will use
1960
1970
1972
1978
1989
1999
BCPL
B
C
K&R C
ANSI C89
ISO C90
ISO/ANSI C99
LISP
Smalltalk
C++
Java

C vs. Java: Design Goals

- C design goals
  - Support structured programming
  - Support development of the Unix OS and Unix tools
    - As Unix became popular, so did C
- Implications for C
  - Good for system-level programming
    - But often used for application-level programming – sometimes inappropriately
  - Low-level
    - Close to assembly language; close to machine language; close to hardware
  - Efficiency over portability
  - Efficiency over security
  - Flexibility over security

C vs. Java: Design Goals

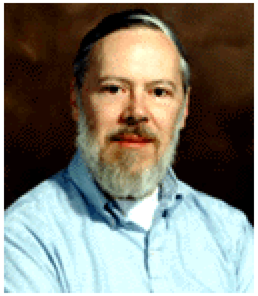
- Java design goals
  - Support object-oriented programming
  - Allow same program to be executed on multiple operating systems
  - Support using computer networks
  - Execute code from remote sources securely
  - Adopt the good parts of other languages (esp. C and C++)
- Implications for Java
  - Good for application-level programming
  - High-level
    - Virtual machine insulates programmer from underlying assembly language, machine language, hardware
  - Portability over efficiency
  - Security over efficiency
  - Security over flexibility

C vs. Java: Design Goals

- Differences in design goals explain many differences between the languages
- C's design goal explains many of its eccentricities

  – We'll see examples throughout the course

C vs. Java: Overview



- Dennis Ritchie on the nature of C:
  - "C has always been a language that never attempts to tie a programmer down."
  - "C has always appealed to systems programmers who like the terse, concise manner in which powerful expressions can be coded."
  - "C allowed programmers to (while sacrificing portability) have direct access to many machine-level features that would otherwise require the use of assembly language."
  - "C is quirky, flawed, and an enormous success. While accidents of history surely helped, it evidently satisfied a need for a system implementation language efficient enough to displace assembly language, yet sufficiently abstract and fluent to describe algorithms and interactions in a wide variety of environments."

C vs. Java: Overview (cont.)

- Bad things you **can** do in C that you **can't** do in Java
  - Shoot yourself in the foot (safety)
  - Shoot others in the foot (security)
  - Ignore wounds (error handling)
- Dangerous things you **must** do in C that you **don't** in Java
  - Explicitly manage memory via **`malloc()`** and **`free()`**
- Good things you **can** do in C, but (more or less) **must** do in Java
  - Program using the object-oriented style
- Good things you **can't** do in C but **can** do in Java
  - Write completely portable code

C vs. Java: Details

- Remaining slides provide some details
  - Suggestion: Use for future reference

- Slides covered briefly now, as time allows…

C vs. Java: Details (cont.)

	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`
	`% ls`
	`Hello.class`
	`Hello.java`
	`%`
		`% gcc209 hello.c`
		`% ls`
		`a.out`
		`hello.c`
		`%`

Running	`% java Hello`
	`Hello, world`
	`%`
		`% a.out`
		`Hello, world`
		`%`

C vs. Java: Details (cont.)

	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};

C vs. Java: Details (cont.)

	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;`
		`}`

C vs. Java: Details (cont.)

<table>
<tr><th></th><th>Java</th><th>C</th></tr>
<tr><td>Strings</td><td>String s1 = "Hello";
String s2 = new
String("hello");</td><td>char *s1 = "Hello";
char s2[6];
strcpy(s2, "hello");</td></tr>
<tr><td>String concatenation</td><td>s1 + s2
s1 += s2</td><td>#include <string.h>
strcat(s1, s2);</td></tr>
<tr><td>Logical ops</td><td>&&, ||, !</td><td>&&, ||, !</td></tr>
<tr><td>Relational ops</td><td>=, !=, >, <, >=, <=</td><td>=, !=, >, <, >=, <=</td></tr>
<tr><td>Arithmetic ops</td><td>+, -, *, /, %, unary -</td><td>+, -, *, /, %, unary -</td></tr>
<tr><td>Bitwise ops</td><td>>>, <<, >>>, &, |, ^</td><td>>>, <<, &, |, ^</td></tr>
<tr><td>Assignment ops</td><td>=, *=, /=, +=, -=, <<=,
>>=, >>>=, =, ^=, |=, %=</td><td>=, *=, /=, +=, -=, <<=,
>>=, =, ^=, |=, %=</td></tr>
</table>

C vs. Java: Details (cont.)

	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;`

C vs. Java: Details (cont.)

	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 */

C vs. Java: Details (cont.)

	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);

Example C Program

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

const double KMETERS_PER_MILE = 1.609;

int main(void) {
   int miles;
   double kmeters;
   printf("miles: ");
   if (scanf("%d", &miles) != 1) {
      fprintf(stderr, "Error: Expect a number.\n");
      exit(EXIT_FAILURE);
   }
   kmeters = miles * KMETERS_PER_MILE;
   printf("%d miles is %f kilometers.\n",
      miles, kmeters);
   return 0;
}
```

Summary

- Course overview
  - Goals
    - Goal 1: Learn “programming in the large”
    - Goal 2: Look “under the hood”
    - Goal 2 supports Goal 1
    - Use of C and Linux supports both goals
  - Learning resources
    - Lectures, precepts, programming environment, course mailing list, textbooks
    - Course Web site: access via http://www.ndsl.kaist.edu/~kyoungsoo/ee209/

Summary

- Getting started with C
  - C was designed for system programming
    - Differences in design goals of Java and C explain many differences between the languages
    - Knowing C design goals explains many of its eccentricities
  - Knowing Java gives you a head start at learning C
    - C is not object-oriented, but many aspects are similar

Getting Started

- Check out course Web site **soon**
  - Study "Policy" page
  - First assignment is available

- Establish a reasonable computing environment **soon**
  - Instructions given in first precept