

Getting Started in C

CSC 230 : C and Software Tools

NC State Department of Computer
Science

Topics for Today

- C Overview
- Software Tools
- Building a program
- The common platform
- The C you already know

You **Want** to Learn C

- It's a lower-level language than Java
 - Can offer much better performance (often not that important)
 - Exposes more of what's going on underneath
 - this can make us more effective developers (even if we never program in C again)
- It will help prepare us for:
 - Operating Systems (CSC 246)
 - Assembly Language (CSC 236)



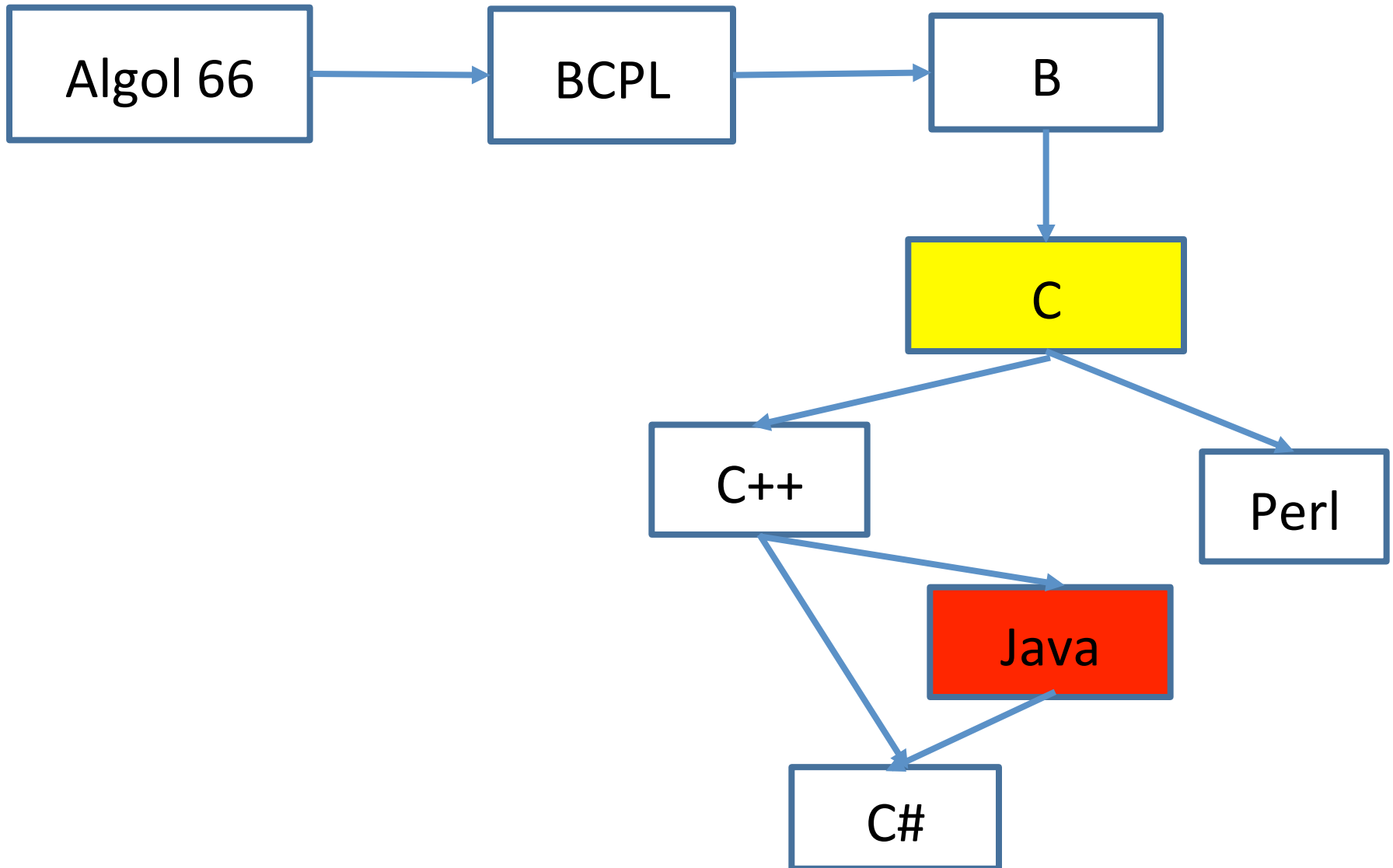
You Want to Learn C

- Someone has to be able to program in C
 - That operating system you like to use, what do you think it's written in?
 - Linux : Assembly and C
 - MS Windows : Assembly, C and C++
 - How about that JVM that lets you run your fancy, high-level programs?
 - Assembly, C and C++
 - Lots of other examples
 - Embedded systems (cars, calculators, appliances, etc.)
 - High performance applications (science/engineering)

Thinking in C

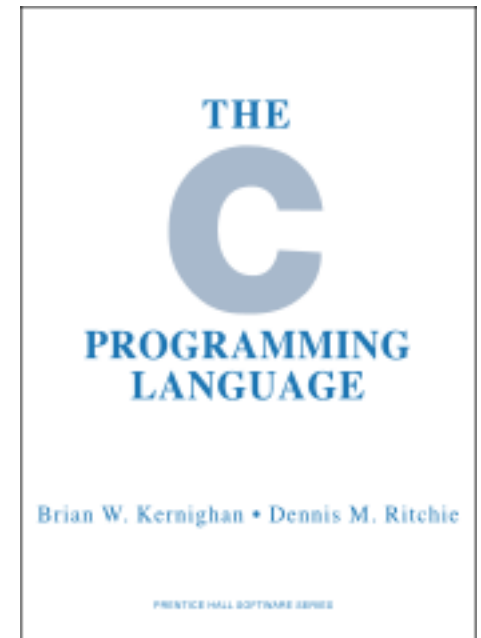
- C : Programming in a different Type of language
 - Like Java, it's an *imperative language*, focused on **how** a computation should be performed
 - C is *procedural*
 - A program is a collection of procedures (functions)
 - Focus on **actions** performed by these procedures
 - Instead of *object-oriented*
 - Where program is a collection of objects, each with state and operations
 - Focus on the **state** of these objects
- Of course, there are other ways we could go ...
 - *Declarative Languages* : focus on **what** the program should compute rather than **how** it should compute it
 - *Functional Languages*: Lisp, Scheme, Haskell
 - *Dataflow Languages*
 - *Logic* or *Constraint-Based*: Prolog
 - *Markup Languages*: HTML

C Family Tree



How We Got Here

- Developed along with the Unix operating system
 - An alternative to developing the OS in assembly
 - More portable
 - More readable/maintainable
- What's C
 - Informal standard for 10 years
 - C89 standard in 1989/1990
 - C99 standard in 1999
 - C11 standard in ... well 2011



C Strengths and Weaknesses

- Think of C as a thin veneer over the underlying assembly language
 - Lets us do some things we couldn't do in a higher level language 😊
 - Standard leaves some details implementation-defined, to better exploit the hardware 😊 and ☹
 - C has an int type, what's its range?
 - What will memory contain if your forget to initialize it?
- C programs and the compiler can be tiny and fast 😊
 - Example trivial C and Java programs
 - Example matrix multiplication

C Performance vs Java

- C is faster at nothing:

```
$ time java Nothing  
real    0m0.138s
```

```
$ time ./nothing  
real    0m0.002s
```

About 70 times faster.

- Also, faster at sorting 60,000 words

```
$ time java SortWords words.txt  
real    0m1.529s
```

```
$ time ./sortWords words.txt  
real    0m0.063s
```

About 24 times faster.

C Performance vs Java

- Or, multiplying 400 X 400 matrices.

```
$ time java Matrix ab.txt  
real    0m3.458s
```

```
$ time ./matrix  
real    0m0.601s
```

About 6 times faster.

- Why so much faster?
 - Well, C is compiled down to the hardware's native machine language.
 - And, there are a lot of things Java does that C doesn't

C Strengths and Weaknesses

- C offers very little in *protection* and *security* 😞
- C lacks some constructs for managing very large projects 😞

It's Not Just About C

- Software tools
 - To help write, build, analyze and maintain software
 - Coordinate contributions from a team
- Examples:
 - Editors, pretty printers
 - Compilers, linkers
 - Debuggers
 - Code generators
 - Performance analyzers
- Often, these are integrated into the IDE
 - But, there's some value in being able to run them directly

The Common Platform

- Different systems have different processors, line termination rules, compilers, language versions, etc.
- We need to agree on what system to target
- We call this is our *common platform*
 - 64-bit Intel PC
 - Linux OS
 - gcc compiler suite
- Readily available on campus and from home

Choice in Where you Develop

Environment	GUI Interface?	Access to AFS Files?
Unity Computer Lab (e.g., EB3 2108)	Yes	Yes
ssh to remote-linux.eos.ncsu.edu	No Well, Yes with X11	Yes
ssh to VCL reservation	No Well, Yes with X11	No (via sftp)
Use Mac OS X with developer tools	Yes	Via sftp
Use MS Windows with cygwin	Yes	Via sftp or ExpandDrive
Use Linux on your PC or Mac (Dual boot or virtual machine)	Yes	Via sftp, etc.
Try our ready-made Centos7.0 VM image	Yes	Via sftp, ExpandDrive, etc.

Choice in Where you Develop

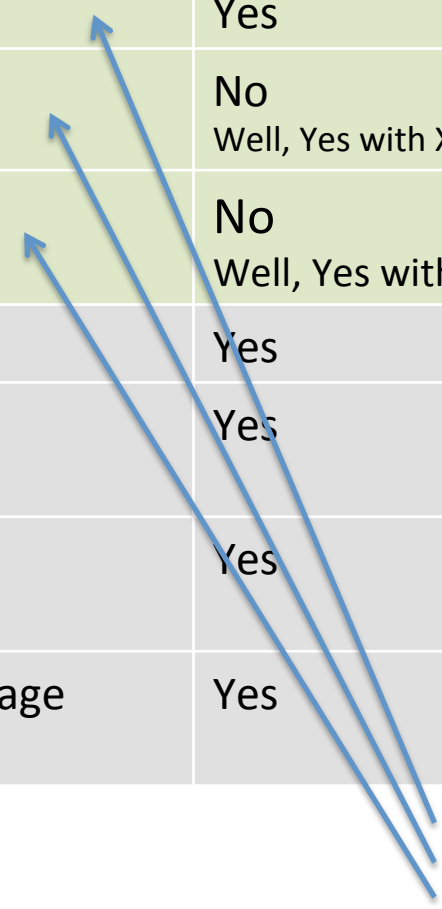
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It's fine to develop here

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**But, you should test
here before you submit**

Meet C

```
/**
 * @file hello.c
 * @author David Sturgill (dbsturgi)
 * A program that prints: Hello World
 */
#include <stdio.h>

/**
 * Starting point for the program.
 * @return exit status
 */
int main()
{
    printf( "Hello World\n" );
    return 0;
}
```

Meet C

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```

Compile like this

```
$ gcc -Wall -std=c99 hello.c -o hello
$ ./hello
```

Execute like this

What are You Looking At?

```
/**
  @file hello.c
  @author David Sturgill (dbsturgi)
  A program that prints: Hello World
 */
#include <stdio.h>

/**
  Starting point for the program.
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}
```

A Comment, part of our style requirements

Telling the compiler about library components we use below (just printf).

A main function, where your program starts (see, it's not inside a class).

A call to the printf function to, well, print something out.

We're all done. Exit with success.

Building C Programs

- Here's a recipe for building any simple C program:

Name of your source file

Don't use the default output file name.

```
$ gcc -Wall -std=c99 X.c -o X
```

Enable lots of warnings.

Use the C99 Standard

Name of the resulting executable

The C You Already Know

- Some parts of the C language look a lot like Java
 - Variable declarations look the same

```
int main()
{
    int a = 25;
    double x = 3.14;
    char c = '*';
    .
    .
}
```

Before the C99 standard, local variables had to be declared at the top of a function or block.
Some people still code that way.

- We have most of the same built-in types, including **char**, **short**, **int**, **long**, **float** and **double**
- No **byte** and **boolean** types, though.

We use **char** instead.

We have **bool** (sort of)

The C You Already Know

- C has many of the operators you remember from Java ... and they mostly work the same.

Arithmetic	+, -, *, /, %
Logical	!, &&,
Pre-increment, etc.	++, --
Relational	==, !=, <, >, <=, >=
Assignment	=, +=, *=, etc.

Looks just like good old Java.

But, C has some operators
Java doesn't have.

```
int a = 25;  
double x = a * 1.5;  
  
a++;  
x = x / 2;  
x += a % 3;  
  
int *p = &a;
```

The C You Already Know

- Flow of control
 - C has an if statement that looks a lot like Java:

```
if ( a > 25 ) {  
    a /= 2;  
}
```

- ... and a for loop (that looks a lot like Java):

```
for ( int i = 0; i < 25; i++ ) {  
    x += i;  
}
```

The C You Already Know

- ... and a while statement (that looks a lot like Java):

```
while ( x < 100.0 ) {  
    x *= 1.05;  
}
```

- ... and a do/while:
(that's basically the same as Java)

```
do {  
    x = getchar();  
} while ( x != '\n' );
```


The C You Already Know


- ... and a switch statement:
(that's more restrictive than Java's switch)

```
switch ( i ) {  
    case 0:  
        print( "it's zero!\n" );  
        break;  
    case 1:  
        ...;  
    default:  
        ...;  
}
```

This has to be an integer.


The C You Already Know

- Flow of control
 - And C has break and continue statements



.. that you should avoid using when you can.

- ... and one other thing Java doesn't have.



.. that will help you appreciate why you should avoid break & continue.

The C You Already Know

- Functions

- C has functions, with parameters and return types

```
double power( double x, int p )  
{  
    double result = 1;  
    for ( int i = 0; i < p; i++ )  
        result *= x;  
    return result;  
}
```

Here's a
function
definition.

```
y = power( 3.25, j + 1 );
```

Here's a
function call.

- Like static methods in Java

The C You Already Know

- Some things are different.
 - C functions aren't part of a class, they are defined at *file scope*

```
double power( double x, int p )
{
    double result = 1;
    for ( int i = 0; i < p; i++ )
        result *= x;
    return result;
}
```

```
y = power( 3.25, j + 1 );
```

And, C99 wants to see the function definition (or declaration) **before** you try to call it.

Not Quite Java

- C doesn't force you to initialize your local variables.
- ... and, it doesn't initialize them for you.

```
double power( double x, int p )  
{  
    double result;  
    for ( int i = 0; i < p; i++ )  
        result *= x;  
    return result;  
}
```

Oops.
What value will this
variable have?
Whatever was in that
region of memory.

```
y = power( 3.25, j + 1 );
```

What will this return?
Probably garbage.