• Dennis Ritchie
• 1969 to 1973
• AT&T Bell Labs
• Close to Assembly
• Unix
• Standard
• Many languages based on C. (C++, Obj. C, C#)
• Many influenced by C (Java, Python, Perl)
C Lacks...

- Exceptions
- Garbage collection
- OOP
- Polymorphism
- But...
C Lacks…

• Exceptions
• Garbage collection
• OOP
• Polymorphism
• But… it is usually faster!
Good Reference

- Essential C, by Nick Parlante, Stanford U.  
  http://cslibrary.stanford.edu/101/EssentialC.pdf
Hello World!

• Library
• Strings
• Block-structured language
• main()

```c
#include <stdio.h>

void main() {
    printf("\nHello World\n");
}
```
• gcc Gnu compiler
• man gcc for help

```bash
[~/handout]$ gcc hello.c
[~/handout]$ ./a.out
Hello World

[~/handout]$ gcc -o hello hello.c
[~/handout]$ ./hello
Hello World
```
Files

[~/handout]$ ls -l
total 28
-rwx------ 1 352a 352a 6583 Oct 6 16:41 a.out*
-rwx------ 1 352a 352a 6583 Oct 6 16:48 hello*
-rw------- 1 352a 352a   66 Oct 6 16:41 hello.c
-rw------- 1 352a 352a   67 Oct 6 16:39 hello.c~
The GNU C Reference Manual

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• printf( “string with %-operators”, list of vars);
  • %d int
  • %f float
  • %s string
• Simple types

• No strings!

• No booleans (only 0 for \textit{false} and !0 for \textit{true})

• No classes, no objects!

\begin{itemize}
\item int \rightarrow \text{integer variable}
\item short \rightarrow \text{short integer}
\item long \rightarrow \text{long integer}
\item float \rightarrow \text{single precision real (floating point) variable}
\item double \rightarrow \text{double precision real (floating point) variable}
\item char \rightarrow \text{character variable (single byte)}
\end{itemize}
/*
programName.c
author

This is the header
*/
#include <stdio.h>
#include <string.h>

void main() {
    // line comment
    printf("Hello!\n");
}

Comments

Computer Science

Dominique Thiebaut
#include <stdio.h>
#include <string.h>

void main() {
    char hello[] = "hello";
    char world[] = "world!";
    char sentence[100] = "";

    strcpy( sentence, hello );  // sentence <- "hello"
    strcat( sentence, " " );    // sentence <- "hello "
    strcat( sentence, world );  // sentence <- "hello world!"

    printf( "sentence = %s\n", sentence );
}

[~/handout]$ gcc strings2.c

sentence = hello world!
[~/handout]
#include <stdio.h>
#include <string.h>

void main() {
    char sentence[100] = "Hello world!";

    printf( "sentence = %s\n", sentence );
    sentence[5] = '\0';
    printf( "sentence = %s\n", sentence );
}

~/handout]$ a.out
sentence = Hello world!
sentence = Hello
[~/handout]$
#include <stdio.h>
#include <string.h>

void main() {
    int a = 3;
    int b = 5;
    int c = 0;
    char firstName[] = "your first name here";
    char lastName[] = "your last name here";
    char fullName[100];
    ...
}

- make the program store the sum of a and b into c, and then print your full name and the value in c. Also, make it output the number of characters in your full name (it must count the number of chars using a string function (strlen))
```c
#include <stdio.h>
#include <string.h>

void main() {
    int a = 3;
    int b = 5;
    int c = 0;
    char firstName[] = "Mickey";  // First name
    char lastName[] = "Mouse";   // Last name
    char fullName[100];

    c = a + b;
    strcpy( fullName, firstName );  // Copy first name
    strcat( fullName, " " );      // Add space
    strcat( fullName, lastName );  // Concatenate last name

    printf( "\nc = %d  Full name = %s\n\n", c, fullName );
}
```
#include <stdio.h>

void main() {
    int i;
    int sum = 0;

    // compute the sum of all the numbers from 1 to 100
    for ( i=1; i<=100; i++ ) {
        sum += i;
    }

    printf( "\nsum = %d\n\n", sum );
}
#include <stdio.h>

void main() {
    int i;
    int sum = 0;

    // compute the sum of all the numbers from 1 to 100
    i = 1;
    while ( i<=100 ) {
        sum += i;    // could have also used i++
        i += 1;
    }

    printf( "\nsum = %d\n\n", sum );
}

#include <stdio.h>

void main() {
    while ( 1 ) {
        printf( "hello!\n" );
    }
}

#include <stdio.h>

void main() {
    for ( ;; ) {
        printf( "hello!\n" );
    }
}
Exercise

• Write a program that writes your full name underlined (line of dashes below). The underline length must be computed and the number of characters equal to the number of characters in your full name.

Hints: strlen() returns # of chars

man strlen
Symbolic Constants

#include <stdio.h>

#define NAME "Mickey"
#define HEIGHT 5
#define YEARBORN 1928

void main() {
    printf( "%s is %d inches high, and was created in %d
\n\n", NAME, HEIGHT, YEARBORN );
}
#include <stdio.h>

void main() {
    int a = 5;
    int b = 3;
    int c = 7;

    if ( a <= b && a <= c )
        printf( "%d is the smallest\n\n", a );
    else if ( b <= a && b <= c )
        printf( "%d is the smallest\n\n", b );
    else
        printf( "%d is the smallest\n\n", c );
}
switch ( ordinal_expression ) {
    case ordinal_value: {
        // ...
        break;
    }
    case ordinal_value: {
        // ...
        break;
    }
    default: { 
        // ...
    }
}
Pointers
float x = 6.5;
float* px = &x;
#include <stdio.h>
#define SIZE 10

int main() {
    float A[SIZE];
    float* p;
    int i;

    p = A;
    for (i=0; i<SIZE; i++) {
        *p = i;
        p++;
    }

    p = A;
    for (i=0; i<SIZE; i++) {
        printf("p=%p A[%d] = %1.2f *p = %1.2f\n", \\
            p, i, A[i], *p);
        p = p + 1;
    }
}

Example: Initialize an Array
a.out
p=0x7fff88d54560 A[0] = 0.00 *p = 0.00
p=0x7fff88d54564 A[1] = 1.00 *p = 1.00
p=0x7fff88d54568 A[2] = 2.00 *p = 2.00
p=0x7fff88d5456c A[3] = 3.00 *p = 3.00
p=0x7fff88d54570 A[4] = 4.00 *p = 4.00
p=0x7fff88d54574 A[5] = 5.00 *p = 5.00
p=0x7fff88d54578 A[6] = 6.00 *p = 6.00
p=0x7fff88d5457c A[7] = 7.00 *p = 7.00
p=0x7fff88d54580 A[8] = 8.00 *p = 8.00
p=0x7fff88d54584 A[9] = 9.00 *p = 9.00
Arrays

```c
TYPE v[DIM];
TYPE* pv;

pv = v;
```
Arrays

- The name of an array is a pointer to the first cell of the array.

```c
char name[DIM];
```

- `name` is the same as `*(name + 0)`
• * has two meanings, depending on context
  • “Pointer to”
  • “Contents of”
• & means “the address of”
* and &

```c
int A[DIM];
int* p = A;    // "int pointer p"
int *q = &A[0]; // "int pointer q"

*p = 3;        // what p is pointing to gets 3
*(q+1) = 5;    // what q is pointing to gets 5
```
Functions

- Functions are always declared before they are used.
- Functions can return values of simple types (int, char, floats), and even pointers.
- Functions get parameters of simple types, and pointers.
- Passing by value is automatic. Passing by reference requires passing a pointer.
```c
#include <stdio.h>

int sum( int a, int b ) {
    return a+b;
}

void main() {
    int x = 10;
    int y = 20;
    int z;

    z = sum( x, y );
    printf( "z = %d\n", z );

    z = sum( 3, 8 );
    printf( "z = %d\n", z );

    printf( "sum( 11, 22) = %d\n", sum( 11, 22 ) );
}
```

```
z = 30
z = 11
sum( 11, 22) = 33
```
Functions

#include <stdio.h>

void sum2( int a, int b, int c ) {
    c = a+b;
}

void main() {
    int x = 10;
    int y = 20;
    int z;

    sum2( x, y, z );
    printf( "z = %d\n", z );

    sum2( 3, 8, x );
    printf( "x = %d\n", x );
}

z = 30
x = 11
```c
#include <stdio.h>

void main() {
    int age;
    float myPi;
    char name[80];

    printf( "Enter your name, please: " );
    gets( name ); // could be dangerous
    // if more than 80 chars entered

    printf( "Enter your age: " );
    scanf( "%d", &age );

    printf( "Enter your version of pi: " );
    scanf( "%f", &myPi );

    printf( "%s is %d years old, and thinks pi is %1.10f\n\n", name, age, myPi );
}
```
Enter your name, please: Mickey
Enter your age: 21
Enter your version of pi: 3.14159
Mickey is 21 years old, and thinks pi is 3.1415901184
#include <stdio.h>
#include <stdlib.h>

#define N 10

// functions go here...

void main() {
    int A[N] = { 3, 2, 1, 0, 6, 5, 9, 8, 7 };
    // your code goes here
}

- Write a C program (no functions) that finds the smallest, the largest, and computes the sum of all the ints in A.

- Write another program that does the same thing but uses functions. Only passing by value is allowed.
Exercises

• Write another program that does the same thing but uses functions, but this time passing by reference is required.
Dynamic Variables
#include <stdio.h>
#include <stdlib.h>

void main() {
    int *A, N, i, smallest;

    printf( "How many ints? " );
    scanf( "%d", &N );
    A = (int *) malloc( N * sizeof( int ) );

    for ( i=0; i<N; i++ ) {
        printf( "> " );
        scanf( "%d", &(A[i]) );
    }

    smallest = A[0];
    for ( i=1; i<N; i++ )
        if ( A[i] < smallest )
            smallest = A[i];
    free( A );

    printf( "The smallest = %d\n", smallest );
}
Exercise

• Same as previous exercises (finding the smallest, largest, sum of some array), but this time you allocate the array dynamically from the user input, i.e. ask the user for number of ints, then the ints.
#include <stdio.h>

void main() {
    FILE *fp;
    int i;
    char name[] = "Smith College";

    fp = fopen("hello.txt", "w"); // open file for writing
    fprintf(fp, "\nHello "); // write constant string
    fprintf(fp, "%s\n\n", name); // write string
    fclose(fp); // close file
}
#include <stdio.h>

void main() {
    FILE *fp;
    char line[80];

    fp = fopen( "fgets2.c", "r" ); // open file for reading

    while ( !feof( fp ) ) { // while not eof
        fgets( line, 80, fp ); // get at most 80 chars
        if ( feof( fp ) ) // if eof reached stop
            break;
        line[79] = '\0'; // truncate line to be safe
        printf( "%s", line ); // print it
    }

    close( fp ); // close file
}
File I/O: Input Numbers

[~handout] cat fileOfInts.txt

4
1 2 3
4 5 6
7 8 9
10 11 12
```c
#include <stdio.h>

void main() {
    FILE *fp;
    char line[80];
    int N, n1, n2, n3;

    fp = fopen("fileOfInts.txt", "r"); // 1st number is # of lines
    // then 3 ints per line

    if ( feof(fp) ) {
        printf("Empty file!\n\n");
        return;
    }

    // get the number of lines
    fscanf(fp, "%d", &N );

    while ( !feof(fp) ) {
        fscanf(fp, "%d %d %d", &n1, &n2, &n3 );
        if ( feof(fp) )
            break;
        printf("%d, %d, %d\n", n1, n2, n3 );
    }

    close(fp);
}
```
<table>
<thead>
<tr>
<th>File I/O: Input Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>![handout] a.out</td>
</tr>
<tr>
<td>1, 2, 3</td>
</tr>
<tr>
<td>4, 5, 6</td>
</tr>
<tr>
<td>7, 8, 9</td>
</tr>
<tr>
<td>10, 11, 12</td>
</tr>
</tbody>
</table>
Exercise

• Same as last exercise, but this time the array is stored in a text file. The first number on the first line (only one number on first line) is the dimension of the array. Then there is one number per line. Program stores all the numbers in the array and prints the smallest.