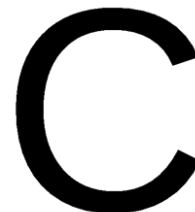


Lecture 1 - Introduction to C Programming Language

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iOS



Origins of C

- C is a **by-product of UNIX**, developed at Bell Laboratories by **Ken Thompson**, **Dennis Ritchie**, and others.
- Thompson designed a small language named **B**.
- B was based on **BCPL**, a systems programming language developed in the mid-1960s.



Ken Thompson
(1943-)



Dennis Ritchie
(1941-2011)

Origins of C (cont.)

- By 1971, Ritchie began to develop an extended version of B.
- He called his language **NB** (“**New B**”) at first.
- As the language began to diverge more from B, he changed its name to C.
- The language was stable enough by **1973** that UNIX could be rewritten in C.



Standardization of C

- *K&R C*
 - *The C Programming Language* (1978) (written by Kernighan and Ritchie)
 - De facto standard
- *C89/C90*
 - ANSI standard X3.159-1989
 - ISO/IEC 9899:1990
- *C99* ←
- *C11*
- *C18*

Features taught in this course are introduced/defined in C99.

ISO/IEC Documents

ISO/IEC 9899:1990

ISO/IEC 9899:1990/Amd 1:1995

ISO/IEC 9899:1990/Cor 1:1994

ISO/IEC 9899:1990/Cor 2:1996

ISO/IEC 9899:1999

ISO/IEC 9899:1999/Cor 1:2001

ISO/IEC 9899:1999/Cor 2:2004

ISO/IEC 9899:1999/Cor 3:2007

ISO/IEC 9899:2011

ISO/IEC 9899:2011/Cor 1:2012

ISO/IEC 9899:2018



Brian Kernighan
(1942-)

C-Based Languages

- **C++** includes **all the features of C**, but adds **classes** and other features to support **object-oriented programming**.
- **Java** is **based on C++** and therefore inherits many C features.
- **C#** is a more recent language **derived from C++ and Java**.
- **Perl** has **adopted many of the features** of C.
- **Carbon** is developed by Google for possible successor to C++.

Properties of C

- Low-level
- Small
- Permissive

Strengths of C

- Efficiency (low-level)
- Flexibility (small and permissive)
 - C imposes **very few restrictions** on the use of its features.
- **Integration with UNIX**
- Portability
 - C compilers are small and easily written.
- Power
 - C has large collection of data types and operators.
- Standard library

Weaknesses of C

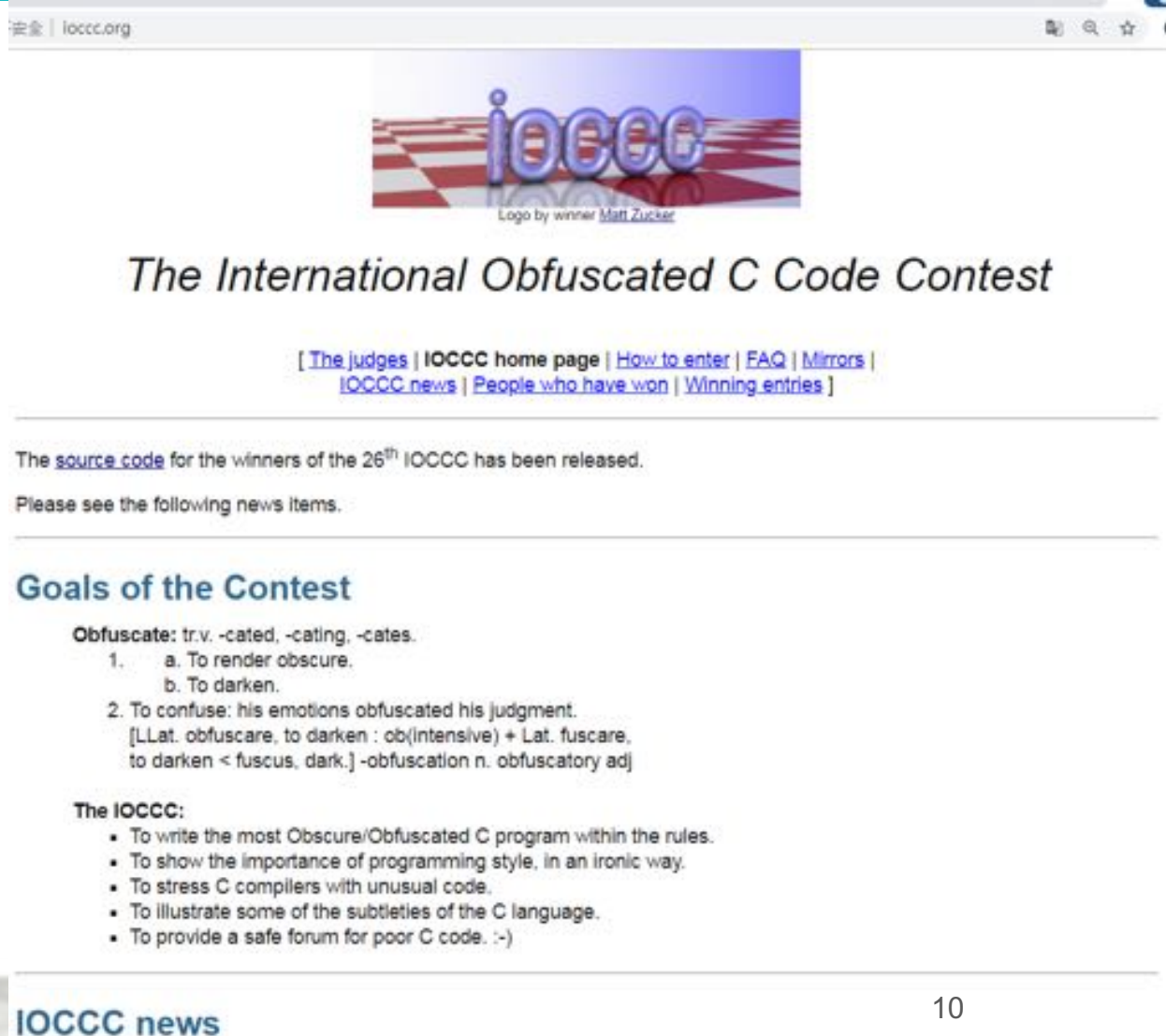
- Programs can be error-prone.
 - Programming mistakes that would be caught in many other languages cannot be detected by a C compiler.
- Programs can be difficult to understand.
 - Programmers who are too clever for their own good can make programs almost impossible to understand.
- Programs can be difficult to modify.
 - Large programs written in C can be hard to change if they haven't been designed with maintenance in mind.

Effective Use of C

- Learn how to **avoid pitfalls**.
- **Use software tools** (~~lint~~/splint/cppcheck, debuggers) to make programs more reliable.
- Take advantage of **existing code libraries**.
- Adopt a sensible set of **coding conventions**.
- **Avoid “tricks” and overly complex code**.
- Stick to the **standard**.


If you are bored with learning basic C skills...

Take a look at the IOCCC website to see how obfuscating C can be!



The screenshot shows the homepage of the International Obfuscated C Code Contest (IOCCC). At the top, the URL "ioccc.org" is visible in the browser's address bar. The main header features a logo with the word "ioccc" in a stylized, 3D blue font, set against a background of a red and white checkered floor. Below the logo, it says "Logo by winner Matt Zucker". The title "The International Obfuscated C Code Contest" is displayed in a large, black, serif font. A navigation bar contains several links: "[The judges | IOCCC home page | How to enter | FAQ | Mirrors | IOCCC news | People who have won | Winning entries]". A paragraph of text states: "The [source code](#) for the winners of the 26th IOCCC has been released. Please see the following news items." Below this, a section titled "Goals of the Contest" lists the objectives of the contest. The first goal is "Obfuscate: tr.v. -cated, -cating, -cates." followed by two sub-points: "1. a. To render obscure, b. To darken." and "2. To confuse: his emotions obfuscated his judgment." with a detailed etymology in brackets. The second goal is "The IOCCC:" followed by a bulleted list of four points: "• To write the most Obscure/Obfuscated C program within the rules.", "• To show the importance of programming style, in an ironic way.", "• To stress C compilers with unusual code.", and "• To illustrate some of the subtleties of the C language." and "• To provide a safe forum for poor C code. :-)". At the bottom left of the screenshot, there is a logo for "MSLab Since 2010" featuring a stylized figure and a lightning bolt. The text "IOCCC news" is visible at the bottom center of the screenshot.

ioccc.org



Logo by winner Matt Zucker

The International Obfuscated C Code Contest

[[The judges](#) | [IOCCC home page](#) | [How to enter](#) | [FAQ](#) | [Mirrors](#) | [IOCCC news](#) | [People who have won](#) | [Winning entries](#)]

The [source code](#) for the winners of the 26th IOCCC has been released.
Please see the following news items.

Goals of the Contest

Obfuscate: tr.v. -cated, -cating, -cates.

- To render obscure,
 - To darken.
- To confuse: his emotions obfuscated his judgment.
[LLat. obfuscare, to darken : ob(Intensive) + Lat. fuscare, to darken < fuscus, dark.] -obfuscation n. obfuscatory adj

The IOCCC:

- To write the most Obscure/Obfuscated C program within the rules.
- To show the importance of programming style, in an ironic way.
- To stress C compilers with unusual code.
- To illustrate some of the subtleties of the C language.
- To provide a safe forum for poor C code. :-)

IOCCC news

IOCCC 1986/holloway

It just prints “Hello, world!”

```

← → ↺ ① 不安全 | loccc.org/1986/holloway/holloway.c

#include "stdio.h"
#define e 3
#define g (e/e)
#define h ((g+e)/2)
#define f (e-g-h)
#define j (e*e-g)
#define k (j-h)
#define l(x) tab2[x]/h
#define m(n,a) ((n&(a))==(a))

long tab1[]={ 989L,5L,26L,0L,88319L,123L,0L,9367L };
int tab2[]={ 4,6,10,14,22,26,34,38,46,58,62,74,82,86 };

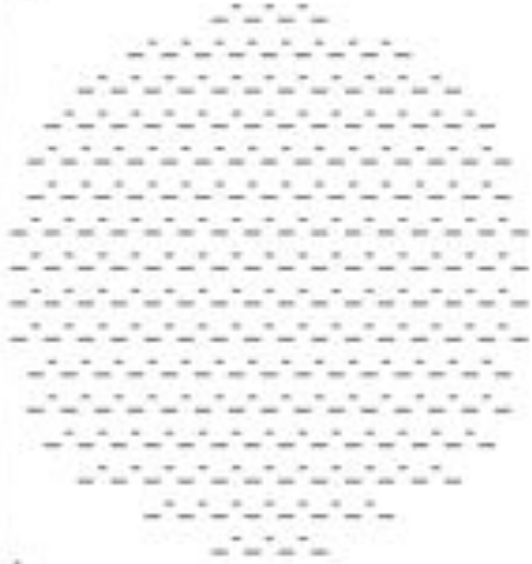
main(m1,s) char *s; {
    int a,b,c,d,o[k],n=(int)s;
    if(m1==1){ char b[2*j+f-g]; main(l(h+e)+h+e,b); printf(b); }
    else switch(m1-h){
        case f:
            a=(b=(c=(d=g)<<g)<<g)<<g;
            return(m(n,a|c)|m(n,b)|m(n,a|d)|m(n,c|d));
        case h:
            for(a=f;a<j;++a)if(tab1[a]&&!(tab1[a]%((long)l(n))))return(a);
        case g:
            if(n<h)return(g);
            if(n<j){n-=g;c='D';o[f]=h;o[g]=f;}
            else{c='\r'-' '\b';n-=j-g;o[f]=o[g]=g;}
            if((b=n)>=e)for(b=g<<g;b<n;++b)o[b]=o[b-h]+o[b-g]+c;
            return(o[b-g]%n+k-h);
        default:
            if(m1==e) main(m1-g+e+h,s+g); else *(s+g)=f;
            for(*s=a=f;a<e;) *s=(s<<e)|main(h+a++,(char *)m1);
    }
}

```

They both print out the π value.

← → ↻ ① 不安全 | ioccc.org/1988/westley.c

```
#define _ -F<00||--F-00--;  
int F=00,00=00;main(){F_00();printf("%1.3f\n",4.*-F/00/00);}F_00()  
{
```



→ ↻ ① 不安全 | ioccc.org/1989/roemer.c

```
char  
_3141592654[3141  
],_3141[3141];_314159[31415],_3141[31415];main(){register char*  
_3_141,*_3_1415,*_3_1415;register int _314,_31415,_31415,*_31,  
_3_14159,_3_1415;*_3141592654=_31415=2,_3141592654[0][_3141592654  
-1]=1[_3141]=5;_3_1415=1;do{ _3_14159+_314=0,_31415++;for( _31415  
=0;_31415<(3,14-4)*_31415;_31415++)_31415[_3141]=_314159[_31415]= -  
;_3141[*_314159+_3_14159]=_314;_3_141=_3141592654+_3_1415;_3_1415=  
_3_1415+_3141;for( _31415=_3141-  
_3_1415;_31415--  
,_3_141++,  
+_314<<2;  
*_3_1415;_31  
if(!(*_31+1)  
_31415,_314  
_31415;*(  
)+*_3_1415  
_3_1415>=  
_3_1415+=-  
)++;_314=_314  
_3_14159&&*_  
=1,_3_1415=  
_314+(_31415  
while( ++*  
)*_3_141--=0  
);{char*  
write((3,1),  
,(_3_14159  
3.1415926;}  
_31415<3141-  
31415%314-({  
_31415 }+  
[3]+1)-_314;  
_3141592654))
```

Source: <http://www.ioccc.org/1989/roemer.c>

Source: <http://www.ioccc.org/1988/westley.c>

IOCCC 1998/banks

It is a flight simulator in
1536 bytes! (X11 needed)

Source: <http://www.ioccc.org/1998/banks.c>



```
← → ↺ ① 不安全 | loccc.org/1998/banks.c

#include <math.h>
#include <sys/time.h>
#include <X11/Xlib.h>
#include <X11/keysym.h>

double l, o, p,
dt, t, z, d=1, d,
s[999], e, h= 0, i,
j, k, v[999], m, m, o,
n[999], j=33e-3, i=
1E3, r, t, u, v, w, s=
74.3, l=221, x=7.26,
a, b, A=32.2, c, f, H;
int N, q, C, y, p, U;
Window z; char f[52];
; GC k; main(){ Display *e=
XOpenDisplay( 0); z=RootWindow(e,0); for (XSetForeground(e,k=XCreateGC (e,z,0,0),BlackPixel(e,0))
; scanf("%l%l%l%l%l",y +n,w+y, y+s)+1; y ++); XSelectInput(e,z= XCreateSimpleWindow(e,z,0,0,400,400,
0,0,WhitePixel(e,0) ),KeyPressMask); for(XMapWindow(e,z); ; T=sin(O)){ struct timeval G= { 0,dt*1e6}
; K= cos(j); N=1e4; M+= M*_; Z=O*K; F+=_P; r=E*K; W=cos( O); m=K*W; H=K*T; O+=O*_F/ K+d/K*E*_; B=
sin(j); a=B*T*D-E*W; XClearWindow(e,z); t=T*E+ O*B*W; j+=d*_O-_F*E; P=W*E*B-T*D; for (o+=(I=O)*H+E
*T*B,E*d/K *B+v+B/K*f*O)*_; p<y; ){ T=p[s]+i; E=-p[w]; O=n[p]-L; K=O*m-B*T*H*E; if(p [n]+u[ p]*p[s
j]== 0|K <fabs(W=T*r-I*E +O*P) |fabs(D=t *D+Z *T-a *E)> K)N=1e4; else{ q=W/K *4E2+2e2; C= 2E2+4e2/ K
*D; N-1E4&& XDrawLine(e ,z,k,N ,U,q,C); N=q; U=C; } +=p; } L+=_ (X*t +P*H+m*1); T=X*X+ 1*1+M *M;
XDrawString(e,z,k ,20,380,f,17); D=v/l*15; i+=(B *l-M*r -X*Z)*_ for(; XPending(e); u *=CS!N){
XEvent z; XNextEvent(e ,&z);
++*{(N=XLookupKeysym
(&z.xkey,0))-1?
N-1? U-P-N?& E:&
3:& u &h); --*{
DN -N? N-DT ?N+=
RT?&u: & h:&h:&3
}; } m=15*f/l;
ce=(I=H/ 1,1*M
+I*M+a*X)*_ ; H
=A*r+v*X-F*1e{
E=.1+X*4.0/l,t
=T*m/32-I*f/24
}/5; K=f*M+{
h* 1e4/l-(T+
E*3*T*E)/3e2
}/5-X*d-B*A;
a=2.63 /l*d;
X+={ d*1-T/5
*(.19*E +a
*.64+3/1e3
)-H* v +A*
Z)*_ 1 +=
K *_; W=d;
printf(f,
"%5d %3d"
"%7d",p +1
/1.7,(C=0E3+
0*57.3)%0550,(int)1); d+=T*(.45-14/l*
X-a*130-3* .14)*_/125e2+f*_v; P=(T*(47
*I-m 52+E*94 *D-t*.38+u*.21*E) /1e2+W*
179*v)/2312; select(p=0,0,0,0,&); v+={
H*f-T*(.63*m-I*-.086+m*E*19-D*25-.11*u
)/107e2)*_ ; D=cos(o); E=sin(o); } }
```

Does it deserve to learn C?

Jun 2022	Jun 2021	Change	Programming Language		Ratings	Change
1	2			Python	12.20%	+0.35%
2	1			C	11.91%	-0.64%
3	3			Java	10.47%	-1.07%
4	4			C++	9.63%	+2.26%
5	5			C#	6.12%	+1.79%
6	6			Visual Basic	5.42%	+1.40%
7	7			JavaScript	2.09%	-0.24%
8	10			SQL	1.94%	+0.06%
9	9			Assembly language	1.85%	-0.27%
10	16			Swift	1.55%	+0.44%

Does it deserve to learn C? (cont.)

Very Long Term History

To see the bigger picture, please find below the positions of the top 10 programming languages of many years back. Please note that these are average positions for a period of 12 months.

Programming Language	2022	2017	2012	2007	2002	1997	1992	1987
Python	1	5	8	7	12	28	-	-
C	2	2	2	2	2	1	1	1
Java	3	1	1	1	1	13	-	-
C++	4	3	3	3	3	2	2	5
C#	5	4	4	8	18	-	-	-
Visual Basic	6	15	-	-	-	-	-	-
JavaScript	7	7	10	9	9	20	-	-
Assembly language	8	10	-	-	-	-	-	-
SQL	9	-	-	-	7	-	-	-
PHP	10	8	6	5	6	-	-	-