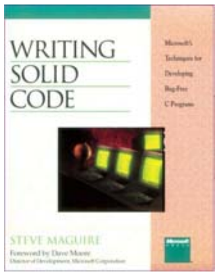
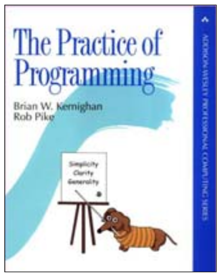
Robust Coding and Debugging

CSE 403

Lecture 26

Summer reading




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

Don’t do this

```
#include <stdio.h>
char *T="IeJKLMaYQCE]jbZRskc[SldU^V\\X\\|/_<[<:90!\"$434-./2>]s",
K[3][1000],*F,x,A,*M[2],*J,r[4],*g,N,Y,*Q,W,*k,q,D;X(){r [r [r[3]=M[1-
(x&1)][*r=W,1],2]=*Q+2,1]=x+1+Y,*g++=((((x& 7) -1)>>1)-
1)?*r:r[x>>3],(++x<*r)&&X();}E(){A||X(x=0,g =J ),x=7&(*T>>A*3),J[(x[F]-
W-x)^A*7]=Q[x&3]^A*(*M)[2 +( x&1)],g=J+((x[k]-W)^A*7)-
A,g[1]=(*M)[*g=M[T+=A ,1 ][x&1],x&1],(A^=1)&&(E(),J+=W);}l(){E(--q&&l
() );}B(){*J&&B((D=*J,Q[2]<D&&D<k[1]&&(*g++=1 ), !(D-W&&D-9&&D-
10&&D-13)&&(!*r&&(*g++=0) ,* r=1)||64<D&&D<91&&(*r=0,*g++=D-
63)||D >= 97&&D<123&&(*r=0,*g++=D-95)||!(D-k[ 3]
)&&(*r=0,*g++=12)||D>k[3]&&D<=k[ 1] -1&&(*r=0,*g++=D-47),J++));}j(
){ putchar(A);}b(){(j(A=(*K)[D* W+ r[2]*Y+x]),++x<Y)&&b();}t ()
{(j((b(D=q[g],x=0),A=W) ), ++q<(*(r+1)<Y?*(r+1): Y) )&&t();}R(){(A=(t( q=
0),'\n'),j(),++r [2 ]<N)&&R();}O() {( j((r[2]=0,R( )) ),r[1]-=q) && O(g-=-q) ;}
C(){( J= gets (K [1]))&&C((B(g=K[2]),*r=!(!*r&&(*g++=0)),(*r)[r]=g-
K[2],g=K[2 ],r[ 1]&& O()) );;} main (){C ((l( (J=( A=0) [K], A[M] =(F= (k=(
M[!A ]=(Q =T+( q=(Y =(W= 32)- (N=4 )))) +N)+ 2)+7 )+7) ),Y= N<<( *r=! -
A)) );;}
```

Assertions

- Don’t use assertions to check unusual conditions
  - You need explicit error code for this
- Only use them to ensure that illegal conditions are avoided

Memory

- The memcpy examples are from *Writing Solid Code: Microsoft’s Techniques for Developing Bug-Free C Programs*
- Although the book is general, lots of the guidelines focus on memory issues
  - Marking freed memory
  - Not accessing freed memory
  - Dealing with details of `realloc`
- These are real issues, but appear less frequently in other languages

Writing solid code

- Shred your garbage

```
void FreeMemory(void *pv){
        Assert(pv != NULL);
        memset(pv, 0xA3, sizeofBlock(pv);
        free(pv);
}
```

- Force early failure, increase determinism
- Why 0xA3?

Should debug code be left in shipped version

- Pro:
  - Debug code useful for maintenance
  - Removing debug code change behavior
    - Bugs in release but not debug versions
- Con:
  - Efficiency issues
  - Different behavior for debug vs. release
    - Early fail vs. recover

Step through your code

- Maguire
  - Step through new code in the debugger the first time it is used
    - Add code, set break points, run debugger
    - Add code, run tests, if failure, run debugger
- Knuth
  - Developed tool to print out first two executions of every line of code

Candy machine interfaces

- Error prone return values or arguments

```
char c;
c = getchar();
If (c == EOF) ...
```

- Classic bad example, getchar() returns an int!
- Alternate approach
  - bool fGetChar(char pch);
- Many bugs with malloc returning NULL

Another coding quiz

```
char tolower(char ch){




}
```

Handling out of range inputs

- Ignore
- Return error code
- Assert
- Redefine the function to do something reasonable
- Write functions that, given valid inputs, cannot fail

Debugging

- What are the key steps in debugging a program?

Kernigan and Pike's debugging wisdom

- Look for common patterns
  - Common bugs have distinct signatures
    - int n; scanf("%d", n);
- Examine most recent change
- Don't make the same mistake twice
- Debug it now, not later
- Get a stack trace
- Read before typing

K & P, II

- Explain your code to someone else
- Make the bug reproducible
- Divide and conquer
  - Find simplest failing case
- Display output to localize your search
  - Debugging with printf()
- Write self checking code
- Keep records

My favorite bugs (and stupidities)

- BI280 Business Basic Interpreter written in C for CP/M
- Sporadic failure of parsing
- Only happened when Basic program was changed (after being loaded)
- Parsing done by interpreter, each time a line was executed
- Adding printf's to code also changed behavior

The Bug

- Uninitialized variable
- Variable used by the parser to hold a character that would be either a binary operator or end of line
- Parsing algorithm looked at last character and tested if it was a binary operator to continue parsing

Don't do this

```
try {
        doSomething();
}
catch (Exception e){
}
```

- Can cover up very bad things
- Violates K&P: Debug it now, not later

Apocryphal (but still a good story)

- A program which fails only in the month of September

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- A program which fails only in the month of September

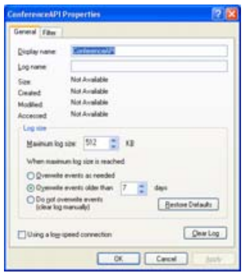
```
char monthName[9];

strcpy(monthName, "September");
```

ConferenceXP

- Video conferencing system would run (after initial install) for about an hour and then fail
- System would not work at all at this point
- In a week it would start working again (for an hour)
- Repeated recovery every week

Solution

- Install process (erroneously) set event log to "overwrite events older than 7 days
- Application was very verbose in logging
- Failure when log was full



ConferenceAPI Properties

Display name: ConferenceAPI
Log name:
Size: Not Available
Created: Not Available
Modified: Not Available
Accessed: Not Available

Log size
Maximum log size: 512 KB
When maximum log size is reached:
○ Overwrite events as needed
[✓ Overwrite events older than 7 days]
○ Do not overwrite events (clear log manually)

☐ Using a low-speed connection