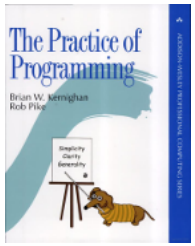
Programming Style

Kurt Schmidt

Dept. of Computer Science, Drexel University

March 31, 2016

Examples are taken from Kernighan & Pike, *The Practice of Programming*, Addison-Wesley, 1999



Intro

Programming Style

Objective: For students to appreciate the importance of good programming style and to develop good programming style themselves

> *Well-written programs are better than badly-written ones – they have fewer errors and are easier to debug and to modify – so it is important to think about style from the beginning.*

Motivation

- Good code should read like a book
  - Straight-forward
  - Concise
  - Easy to look at
- Much easier to debug and maintain
- Don’t irritate Jobu

Themes

- **Consistency!**
- Code should be clear and simple:
  - Straightforward logic
  - Natural expression
  - Conventional (idiomatic) language use
  - Meaningful names
  - Neat formatting
  - Helpful comments
  - Avoid clever tricks and unusual constructs

Consistency

Oh, yeah...

Did I mention consistency?

Names

Choose Good names


```
if( country==SG || country==BN || country==PL )
{
...
}
```

So, maybe ISO country codes aren't all that clear to everybody.

```
if( country==SINGAPORE || country==BRUNEI || country==POLAND )
{
   ...
}
```

Keep Comments in Synch


```
if( country==SINGAPORE || country==BRUNEI
     || country==POLAND || country==ITALY )
{
   /*
    * If the country is Singapore, Brunei, or Poland, the current
    * time is te answer time, rather than the off-hook time.
    * Reset answer time and set day of week.
    */
   ...
}
```

- Update comments when code gets updated
- Better still, write legible code, skip silly comments

Names

- Use descriptive name for globals, short names for locals
  - The smaller the scope, the shorter the name
- Namespaces
  - Use them to avoid clashes, and contrived-sounding names
- Follow consistent conventions
  - You'll develop your own style, over time
  - Larger projects should have their own style guides

Names *(cont.)*

- Use active names for functions
  - Make it clear what the function does
  - Make the meaning of the return value easy to infer
- Be accurate
- Comment units

Use Meaningful Names


```
#define ONE 1
#define TEN 10
#define EIGHT 16
```

Much more helpful:

```
#define INPUT_MODE 1
#define INPUT_BUFSIZE 10
#define WORD_BITS 16
```

Descriptive Names for Globals, Shorter for Local


```
int nPending = 0 /* current length of input queue */
```

```
for( theElementIndex = 0 ;
     theElementIndex < numberOfElements ;
     ++theElementIndex )
```

```
for( i=0; i<nelemens; ++i )
   elem[i] = i
```

Conventions

These are simply examples you *might* follow:

- Use camelcase, or underscores
  - `leastRightDesc` vs. `least_right_desc`
- Decorate pointers, globals
  - `p_head`, `gName`
- Initial capital letter for types, or for globals
- All caps for constants
- Be Consistent!

Use Namespaces

Don't be silly

```
class UserQueue {
  public:
   int noOfItemsInQ, frontOfTheQueue, queueCapacity ;
   int noOfUsersInQueue() {...}
}

queue.queueCapacity ;
```

```
class UserQueue {
  public:
   int nItems, front, capacity ;
   int nUsers() {...}
}
```

Use Active Names for Functions


```
now = date.getTime() ;
putchar( '\n' ) ;
```

Name should make sense of the return value:

```
if( checkoctal( c )) ...
```

Okay. Sure. Yes. I checked it.
Better:

```
if( isoctal( c )) ...
```

Accuracy

Use Active Names for Functions

This may stray outside of "programming style" a bit, but, worth mentioning

```
#define isoctal( c ) ((c) >= '0' && (#c) <= '8')
```

```
#define isoctal( c ) ((c) >= '0' && (#c) <= '7')
```

```
public boolean inTable( Object obj )
   int j = this.getIndex( obj ) ;
   return( j == nTable ) ;
}
```

```
public boolean inTable( Object obj )
   int j = this.getIndex( obj ) ;
   return( j < nTable ) ;
}
```

Expressions and Statements

Expression and Statements

- Use indentation to show structure
- Use the natural form of an expression
- Parenthesize to resolve ambiguity
- Break up complex expressions
- Mind those side effects!

Indent to Show Structure


```
for( n++; n<100; field[n++]='\0' );
*i = '\0'; return( '\n' );
```

Make it clear the body is empty:

```
for( n++; n<100; field[n++]='\0' )
  ;
*i = '\0';
return( '\n' );
```

Better still – idiomatic use of for loop

```
for( n++; n<100; ++n )
   field[n]='\0' ;
*i = '\0' ;
return( '\n' ) ;
```

Use Natural Form for Expressions


```
if( !(block_id < actblks)
    || !(block_id >= unblocks) )
```

```
if( block_id >= actblks
    || block_id < unblocks )
```

Remember DeMorgan's Laws

```
if( !( r=='n' || r=='N' ))
```

```
if( r!='n' && r!='N' )
```

Use Parentheses to Resolve Ambiguity

Even if parentheses aren't strictly necessary.

```
if( x & ( MASK==BITS )) /* Incorrect */
if( x & MASK == BITS ) /* Correct (maybe) */
```

```
if( (x&MASK) == BITS )
```

```
leap_year = y%4 == 0 && y%100 != 0 || y%400 == 0 ;
```

```
leap_year = y%400==0 || (( y%4==0 ) && ( y%100!=0 )) ;
```

Break up Complex Expressions


```
*x += (*xp=(2*k < (n-m) ? c[k+1] : d[k--]))
```

```
if( 2*k < n-m )
   *xp = c[k+1] ;
else
   *xp = d[k--] ;
*x += *xp ;
```

Be Clear


```
subkey = subkey >> (bitoff - ((bitoff >> 3) << 3)) ;
```

We can clean the logic up, make it easier to read:

```
subkey = subkey >> (bitoff & 0x7) ;
subkey >>= bitoff & 0x7 ;
```

Here are some acceptable uses of the ternary operator:

```
max = a>b ? a : b ;
```

```
printf( "The list has %d item%s\n"
        n, (n==1)?"":"s" ) ;
```

Save “clever” for your design.

Don't Abuse Coercion

Don't treat pointers as booleans

```
child=( !LC&&!RC )? 0 : (!LC?RC:LC) ;
```

Expanded out:

```
if( LC==0 && RC==0 )
   child = 0 ;
else if( LC==0 )
   child = RC ;
else
   child = LC ;
```

Better, simplify the logic:

```
if( LC==0 )
   child = RC ;
else
   child = LC ;
```

Mind the Side Effects

Assignment associates right-to-left; however, the order in which the operands are evaluated is **not** defined.

```
str[i++] = str[i++] = ' ' ;
```

```
str[i++] = ' ' ;
str[i++] = ' ' ;
```

Actually, no harm in the above. Consider this one:

```
array[i++] = i ;
```

```
array[i] = i ;
i++ ;
```

Mind Evaluation

- Order in which arguments to a function are evaluated is not defined
- **All** arguments to a function are evaluated before the function is called

Here, `profit[yr]` is evaluated before `yr` is read:

```
scanf( "%d %d", &yr, &profit[yr] );
```

Must read `yr` first:

```
scanf( "%d", &yr );
scanf( "%d", &profit[yr] );
```

Consistency and Idioms

Use Consistent Indentation and Brace Style


```
if( month==FEB ) {
   if( isLeap( yr ))
      if( day>29 )
         legal = FALSE ;
      else
   if( day > 28 )
   {
      legal = FALSE ;
   }
}
```

- Generally, braces are recommended, even if not needed
- If omitted for small scopes, be careful

```
if( month==FEB ) {
   if( isLeap( yr )) {
      if( day>29 )
         legal = FALSE ;
      else if( day > 28 )
         legal = FALSE ;
   }
}
```

Consistent Indentation and Brace Style

Rearrange the logic the improve the legibility of the previous example:

```
if( month==FEB ) {
   int nday = 28 ;

   if( isLeap( yr ))
      nday = 29 ;
   if( day > nday )
      legal = FALSE ;
}
```

Use Idioms for Consistency

Each of these loops does the same:

```
i = 0 ;
while( i <= n-1 )
   array[i++] = 1.0 ;
```

```
for( i=n; i>=0; --i )
   array[i] = 1.0 ;
```

```
for( i=0; i<n; )
   array[i++] = 1.0 ;
```

```
for( i=0; i<n; ++i )
   array[i] = 1.0 ;
```

- A non-standard construct will catch the eye
- If the loop is doing something non-standard (going right-to-left through the array) it **should** catch the eye
- Otherwise, it shouldn't

Use Idioms for Consistency

Standard for walking a linked list:

```
for( p=list; p!=NULL; p=p->next )
   ...
```

A couple infinite loops (I prefer the latter, though industry seems to favor the former).

```
for( ;; )
   ...
```

```
while( 1 )
```

- Unless the loop *actually* is meant to run forever, this is lazy design
- It is handy to be able to look at the first line, have an idea of the loop's purpose

Use Idioms – Avoid Sprawl

- Sprawling layouts also force code onto multiple screens
- General rule of thumb: A function, loop body, etc., should fit on a screen

```
for (
   ap = arr ;
    ap < arr + 128 ;
    ++ap
    )
{
   *ap = 0 ;
}
```

Don't sacrifice legibility for compactness, either.

```
i=0;while(i<12){if(i%2==0)printf("%d\n",i*i);++i;}
```

Use `do-while` Loops Sparingly

Only use a `do-while` loop when the loop must be exectued at leat once.

```
do {
   c = getchar() ;
   putchar( c ) ;
} while( c != EOF ) ;
```

```
while( (c=getchar()) != EOF )
   putchar( c ) ;
```

Non-Standard Constructs Catch the Eye

Consistent use of idioms draws attention to non-idiomatic constructs, a frequent source of trouble.

```
iArray = (int*) malloc( nmemb * sizeof( int )) ;
for( i=0; i<=nmemb; ++i )
   iArray[i] = i ;
```

Use `else-if` for Multi-Way Decisions


```
if( argc==3 )
   if( (fin=fopen( argv[1], "r" )) != NULL )
      if( (fout=fopen( argv[2], "w" )) != NULL ) {
         while( (c=getc( fin )) != EOF )
            putc( c, fout ) ;
         fclose( fin ) ;
         fclose( fout ) ;
      } else
         printf( "Can't open output file %s\n", argv[2] ) ;
   else
      printf( "Can't open input file %s\n", argv[1] ) ;
else
   printf( "Usage: cp inputfile outputfile\n" ) ;
```

- Marches across the screen
- Point of the mess is buried in the middle of the mess
- The alternative is not near the consequent

Use `else-if` for Multi-Way Decisions

- Flip the tests in the antecedent
- Leave the `else-if` at the same indent

```
if( argc!=3 )
   printf( "Usage: cp inputfile outputfile\n" ) ;
else if( (fin=fopen( argv[1], "r" )) == NULL )
   printf( "Can't open input file %s\n", argv[1] ) ;
else if( (fout=fopen( argv[2], "w" )) == NULL ) {
   printf( "Can't open output file %s\n", argv[2] ) ;
   fclose( fin ) ;
} else {
   while( (c=getc( fin )) != EOF )
      putc( c, fout ) ;
   fclose( fin ) ;
   fclose( fout ) ;
}
```

Don't Be Clever With Switch Statements

- Avoid fall-throughs in switch statements
- Comment, if you must

```
switch( c ) {
   case '-':  sign = -1 ;
   case '+':  c = getchar() ;
   case '.':  break ;
   default:
      if( !isdigit( c ))
         return 0 ;
}  /* switch c */
```

- Saves duplicating one line of code

```
switch( c ) {
   case '-':
      sign = -1 ;
      /* fall through */
   case '+':
      c = getchar() ;
      break ;
   case '.':
      break ;
   default:
      if( !isdigit( c ))
         return 0 ;
}  /* switch c */
```

- Longer, but much clearer

Switch Statements

- Might be better to express using `else-if`

```
if( c == '-' ) {
    sign = -1 ;
    c = getchar() ;
} else if( c == '+' ) {
    c = getchar() ;
} else if( c != '.' && !isdigit(c))
    return 0 ;
```

- Example of acceptable fall-throughs
- No comment needed

```
switch( c ) {
   case 'h':
   case 'H':
   case '?':
      usage() ;
      break ;
   ...
}
```

Function Macros

Avoid Function Macros

- Macros have been used to avoid the overhead of function calls
  - No longer necessary
  - In C99, C++, we have inline functions
- Note, actual arguments might be evaluated more than once
  - Again, side effects become a problem

Read 2 characters:

```
#define isUpper(c) ( 'A'<=(c) && (c)<='Z' )
...
while( isUpper( c=getchar()))
   ...
```

Correct, but, inefficient:

```
#define round_to_int(x) ( (int)( (x)+( (x)>0 ? 0.5 : -0.5 )))
size = rounded_to_int( sqrt( dx*dx + dy*dy ))
```

Parenthesize Macro Body and Argument

Each occurrence of a macro argument should be put in parentheses:

```
1 #define square(x) x * x
2 i=3 ; j=4 ;
3 k = square( i+j ) ;
```

- Line 3 expands to `3+4*3+4`
- `k` has value 19, rather than 49

Entire macro definition should be enclosed in parentheses:

```
1 #define square(x) x * x
2 f = 3 ;
3 g = 1.0/square(i)
```

- Line 3 expands to `1.0/3*3`
- `k` has value 1.0, rather than 0.111

Magic Numbers

Avoid *Magic Numbers*

- Unnamed, meaningful, numerical constant
- Obscures developer's intent in choosing that number
- Increases opportunities for subtle errors
  - Is 3.14159265358979 correct?
  - Is it equal to 3.14159265359?
- Easier to alter the number's value

```
x = 12 * d ;
   /* mo/yr? eggs/dozen? */
f = 6.672e-11 * 5 * 8 / (7*7)
   /* force due to gravity? G might change */
```

Define Numbers as Constants, not Macros

- C preprocessor changes the lexical structure of the program
  - We lose type info
  - Symbols don't appear in debugger
- Use the C `enum` for integer constants

```
enum { MAXROW=24, MAXCOL=80 } ;
```

- C++ provides the `const` keyword

```
const int MAXROW=24, MAXCOL=80 ;
```

- Java has `final`

```
static final int MAXROW=24, MAXCOL=80 ;
```

Use Character Constants, not Ordinals


```
if( 65<=c && c<=90 )
   ...
```

This is more legible:

```
if( 'A'<=c && c<='Z' )
   ...
```

But, still dependent upon a representation.
These always work:

```
if( isupper( c ))
   ...
```

```
if( Character.isUpperCase( c ))
   ...
```

Use the Language to Calculate Size of an Object

- Use `sizeof` operator in C/C++:

```
char buf[1024] ;
fgets( buf, sizeof(buf), stdin ) ;
```

- Java arrays have a `length` attribute:

```
char [] buf = new char[1024];
for( int i=0; i< buf.length; ++i )
   ...
```

- Idiom for finding length of array in C/C++ (in scope):

```
#define NELEMS(array) ( sizeof(array) / sizeof(array[0]) )
double dbuf[100] ;
for( i=0; i<NELEMS(dbuf); ++i )
   ...
```

Comments

Comments

- Don’t belabor the obvious
- Comment functions and global data
- Don’t comment bad code – rewrite it
- Don’t contradict the code
- Clarify, don’t confuse

Don’t Belabor the Obvious


```
 /*
  * default
  */
default :
   break ;
```

```
  /* return SUCCESS */
return SUCCESS ;
```

```
zerocount++ ; /* Increment zero entry counter */
```

```
   // Inialise totoal to number_received
node->total = node->number_received ;
```

Page Header Comments

Minimally, comments should include

- Filename
- Purpose
- Your name
- Date
- Platform information
- Usage notes (if it's a client-facing file)
- Change log

Page Header Comments (*cont*)


```
/**-*-C-*-*****
 * myHeader.h -- example interface file
 *
 * Kurt Schmidt
 * MAR 2016
 *
 * gcc (Ubuntu 4.8.4-2ubuntu1~14.04.1) 4.8.4 on
 * Linux 3.16.0-67-generic
 *
 * EDITOR: tabstop=3, cols=80
 *
 * NOTES:
 *  - Have fun
 *  - Watch that sine function
 */
```

Comment Global Data


```
struct State {          /* prefix & suffix list */
   char *pref[NPREF] ; /* prefix words */
   Suffix *suf ;        /* list of suffices */
   State *next ;        /* next State in list */
} ;
```

Supply units, where appropriate!

```
double weight ; /* Pounds? Newtons? */
double radius ; /* Inches? Furlongs? Light years? */
```

Comment Function Header

- These should serve as a user guide.
- Describe *inputs*, *outputs*, and *side-effects*
  - Alternatively, *preconditions* and *postconditions*
- Warn client of side-effects
- Units!

```
  /* mySine - computes sine of an angle
   * Requires: global PI, x in radians
   * Ensures: sine(x) returned; all your chocolate is gone
   */
double mySine( x ) {
   rv = magic( x, PI ) ;
   stealChocolate() ;
   return( rv ) ;
}
```

Don’t Comment Bad Code...


```
/* If ‘result’ is 0 a match was found so return
true (non-zero). Otherwise, ‘result’ is non-zero
so return false (zero). */
#ifdef DEBUG
printf( "*** isword returns !result=%d\n", !result ) ;
fflush( stdout ) ;
#endif
return( !result ) ;
```

. . . rewrite it

```
#ifdef DEBUG
printf( "*** isword returns matchFound=%d\n", matchFound ) ;
fflush( stdout ) ;
#endif
return( matchFound ) ;
```

Clarify, Don't Confuse


```
int strcmp( char *s1, char *s2 )
 /* string comparison routine returns -1 if s1 is above s2 */
 /* in ascending order list, 0 if equal, 1 if s1 below s2 */
{
   while( *s1==*s2 ) {
      if( *s1=='\0' )
         return( 0 ) ;
      ++s1 ; ++s2 ;
   if( *s2 > *s1 ) return( 1 ) ;
   return( -1 ) ;
}
```

```
/* strcmp: return <0 if s1<s2, >0 if s1>s2, 0 if equal */
/*   ANSI C, section 411.4.2 */
```

Summary

- Your code should be legible
- “Good style should be a matter of habit.”