Programming Style

- Writing good programs is like writing good prose; the object is to ***communicate***
  - concise, straightforward, no unnecessary parts
- Principles of good programming style are ***language independent***
  - some languages have features that ***encourage*** good style, e.g. structured loops
  - some have features that ***discourage*** good style, e.g. gotos, anemic data types
  - modern block-structured languages are better than older unstructured languages
  - but ***bad*** programs can be written in ***any*** language
- Benefits of good style
  - code that is easy to ***understand***
  - code that is more likely to ***work***
  - code that is easy to ***maintain*** and change
- Method to develop good programming style
  - ***read*** code written by good programmers
  - Ask: Will I understand this program in two years?

Names

- Pick names that capture the use of the variable or function, e.g. **`addElement`**
  - nouns for variables
  - verbs for functions
  - adjectives for booleans, conditions, and some enumeration constants
- Use ***descriptive*** names for global variables and functions, e.g. **`elementCount`**
- Use ***concise*** names for local variables that reflect ***standard notation***

prefer

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

to

```
for (arrayindex = 0; arrayindex<arraysize;
                     arrayindex++)
    array[arrayindex] = 0;
```

- Use ***case*** judiciously
  - use all capitals for constants
  - do not rely on only case to distinguish names
- Use a consistent style for ***compound*** names

  `printword` **`PrintWord`** **`print_word`**
- Module-level prefixes help distinguish names, e.g. **`Strset_T, Strset_add`**
- Do not use nerdy abbreviations and acronyms

Layout and Indentation

- Use ***white space*** judiciously
  - separate code into “paragraphs”
  - make expressions more readable
- Use ***indentation*** to emphasize ***structure***
  - use editor “autoindent” facilities and a consistent amount of space
  - watch for extreme indentation — signals ***excessive*** nesting
- Line up parallel structures

```
alpha = angle(p1, p2, p3);
beta = angle(p2, p3, p1);
gamma = angle(p3, p1, p2);
```

```
alpha = angle(p1, p2, p3);
beta  = angle(p2, p3, p1);
gamma = angle(p3, p1, p2)
```

- One statement per line
- Be ***consistent***, but use ***variation*** for emphasis
- Break long lines at logical places, e.g. by precedence; indent continuations
- Use tabular input and output formats

Clear Expression

- Compare:

```
for(i=1; i<=n; i++)
for(j=1; j<=n; i++)
v[i-1][j-1] = (i/j)*(j/i);
```

vs.

```
/* make v the identity matrix */
for (i = 0; i < n; i++) {
    for (j = 0; j < n; j++)
        v[i][j] = 0.0;
    v[i][i] = 1.0;
}
```

- Rules:
  - be clever, but do notbe ***too clever***
  - say what you mean, simply and directly
  - use parentheses to emphasize precedence and braces to display structure
  - use white space and indentation to clarify structure
  - do notsacrifice clarity for “efficiency”

Clear Expression, cont'd

- Compare:

```
if (!(i > 10 || 0 > i)) ...
```

vs.

```
if (0 <= i && i <= 10) ...
```

- Compare:

```
for (neg = 0; *s1 == *s2++; )
    if (*s1++ == '\0')
        break;
neg = *s1 - (*--s2);
if (!neg) ...
```

vs.

```
while (*s1 == *s2 && *s1 != '\0') { s1++; s2++; }
if (*s1 == *s2) ...
```

vs.

```
if (strcmp(s1, s2) == 0) ...
```

- Rules:
  - avoid double negation
  - avoid temporary variables
  - use library functions
  - let the compiler do the dirty work

Clear Expression, cont'd

- Compare:

```
if (a > b)
    if (b > c)
        z = c;
    else
        z = b;
else
    if (a > c)
        z = c;
    else
        z = a;
```

vs.

```
if (a < b)
    if (a <= c)
        z = a;
    else
        z = c;
else    /* a >= b */
    if (b <= c)
        z = b
    else
        z = c;
```

better yet:

```
z = min(a, min(b, c));
```

- Rules:
  - lay out expressions according to standard conventions
  - rearrange logic so it is easy to understand
  - follow each decision with a matching action

Control Structure

- Flow of control should be written for human understanding

```
for (i = 0; i < n; i++) {
    if (strcmp(table[i].word, word))
        continue;
    table[i].count++;
}
```

better:

```
for (i = 0; i < n; i++)
    if (strcmp(table[i].word, word) == 0)
        table[i].count++;
```

- Avoid **`continue; break`** is OK, but use it sparingly; "breaking" out of functions is OK, if used with care

```
func(a) {
    if (isbad(a))
        return;
    ...
}
```

- Rules:
  - use structured control constructs
  - do not make the reader jump around or decrypt convoluted flow of control
  - avoid long blocks
  - avoid complicated, nested blocks
  - minimize the use of **`return`** and **`break`**

Control Structure, cont'd

- "Comb" structures

compare:

```
if (x < v[mid])
    high = mid - 1;
else if (x > v[mid])
    low = mid + 1;
else
    return mid;
```

vs:

```
if (x < v[mid])
    high = mid - 1;
    else if (x > v[mid])
        low = mid + 1;
        else
            return mid;
```

- Ditto for **`switch`**
- Rules:
  - implement multiway branches with **`if ... else if ... else`**
  - emphasize that only one of the actions is performed
  - avoid empty **`then`** and **`else`** actions
  - handle default action, even if it "canot happen;" use **`assert(0)`**
  - avoid nesting

Program Structure

- Rules:
  - modularize; use interfaces
  - every function/interface should do ***one*** thing well
  - every function/interface should ***hide*** something
  - replace repetitious code with calls to functions
  - let the data structure drive the program
  - make sure your code “does nothing” gracefully
  - do not patch bad code — rewrite it
  - do not strain to reuse code — reorganize it
  - watch for “off-by-one” errors

Documentation

- Best program documentation includes
  - clean structure
  - consistent programming
  - good mnemonic identifiers
  - smattering of enlighting comments
- Comments should add new information

```
i = i + 1;   /* add one to i */
```

- Comments and code must ***agree***; if they disagree, odds are they are both wrong
- Do not comment bad code — rewrite it
- Comment algorithms, not coding idiosyncracies
- Comment procedural interfaces and data structures liberally
- Master the language and its ***idioms***; let the code speak for itself

Program Organization

- Good, consistent organization makes programs easier to read and modify
- Pick a consistent program layout style for
  - functions
  - statements
  - expressions
  - comments
- ***Small*** programs (~ few ***hundred*** lines, maximum) can fit into one file
  - opening explanatory comments
  - purpose
  - author and history (handled better by tools like RCS)
  - **`#includes`** (i.e. imports)
  - **`#defines`** (i.e. constants)
  - type definitions (e.g. **`typedef`**, **`struct`**, etc.)
  - global variables
  - **`main`**
  - functions in alphabetical or logical order
- Maximize “data ink”

Program Organization, cont’d

- Divide medium-size programs (~ few ***thousand*** lines, maximum) into modules
- Use established interfaces and implementations
- Implementations
  - organized around data or function
  - organize each implementation as a “small” program
- Interfaces
  - use separate headers for separate interfaces, but do not ***over-modularize***
  - permit multiple inclusion
  - do ***not*** define variables
- Global variables and functions
  - ***declared*** in interfaces, so all clients see the same declaration
  - ***defined*** and ***initialized*** in an implementation
- What about ***large*** programs, say, more than 50,000 lines? another course...

Efficiency and Style

- If a program does not ***work***, it does not matter how fast it is!
- Rules:
  - make it clear before you make it faster
  - make it correct before you make it faster
  - see if it is fast enough before you make it faster
  - keep it correct while you make it faster
  - ill-conceived attempts to increase efficiency usually lead to bad code; gains are usually small or non-existent
- Make performance improvements ***only***
  - if they are really needed, and
  - if there are objective ***measurements*** that identify the sources of inefficiency
  - intuitions are notoriously bad; they are not"objective measurements"
- Rules:
  - keep it simple to make it faster
  - let the compiler do the simple optimizations
  - do not diddle code to make it faster — find a better algorithm

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