Maintainability and Readability

- elements of maintainability
- program readability
  - module structure
  - commenting
- coding standards
- code ownership

What makes code "understandable"?

- good architecture
  - intuitive components, well chosen interfaces
  - straight-forward hierarchical structure
- good specifications
  - good overview of system structure & operation
  - clear descriptions of each component
- good design
  - good modularity and cohesion
  - well abstracted interfaces
- readable code
  - it is relatively obvious how the code works

What makes code "readable"?

- module organization
  - order in which we describe/define routines, variables
- visual layout
  - use white-space to delimit functional units
  - use consistent visual metaphors to convey structure
- commenting
  - to further accentuate structure
  - to guide us though non-obvious parts of the code
- variable and routine naming conventions
  - to make meaning of code more obvious
- these aren't merely style; they involve technique

Understandable code

- Get together in groups of 3-4
  - each identify a personal experience of:
    - some very hard to understand code
    - some very easy to understand code
  - list the factors that made them so
  - reasons why they were done that way
  - prepare a summary of
    - your good/bad examples
    - your conclusions
- Be prepared to discuss them

General Module Structure

- standard preamble
  - copyrights, version, module overview
- include files, type definitions
- static global, then private data declaration
- routine pre-declarations (if required)
- constructors and destructors (if required)
- public, then private routine definitions
  - in some logical order (e.g. top-down, alphabetical order, temporal call order, etc)

General Routine Structure

- standard preamble
  - description of purpose, context, limitations
- routine declaration
  - return type, name, parameters & types
- local variables
  - by type, one per line, with descriptions
- blank-separated paragraphs of code
  - preceded, if necessary, with comments describing, in general, what each does

Explanations and Excuses

- often non-obvious code is bad
  - complexity results from a bad approach
  - it is usually better to fix it than to explain it
- some non-obvious approaches are good
  - eliminate problems, improve performance
  - explain problem and the novel approach
- sometimes we leave code incomplete
  - designed features that aren't yet required
  - work we plan to complete later
  - leave warning, excuse, advice, comment

Commenting Data Items

- we mostly talk about commenting code?
- many data items also need comments
  - who uses it for what purpose
  - units, range, and meanings of its values
  - **validity assertions**, **synchronization rules**
- can be true for all types of declarations
  - basic types, structures, bit-fields, unions, etc.
- associate comments with declarations
  - end-line comments for simple declarations
  - large block comments for complex items

non-Readability Comments

- mandatory module preambles
  - copyright notices, legal disclaimers
  - title, version, and authorship information
- information for use by CAD tools
  - semantic interface descriptions
    - for documentation and test generation tools
  - notes for static analysis tools
    - information that is not statically determinable
  - correctness assertions
    - for automated testing or run-time checking

Coding Standards - scope

- naming conventions
  - generation, use of case, prefixes, suffixes
- usage conventions
  - e.g. defines, include file processing
- commenting conventions
  - standard module preamble
  - standard routine preamble
- formatting conventions
  - indentation and commenting style

Code Ownership

- Get together in groups of 3-4
- Consider the following questions:
  - When is code "personal property"?
  - When is code "public property"?
  - Where is the line between "creators' prerogative" and "social responsibility"?
  - What should we do if we are writing "personal code" that might one day become "public"?
- Prepare positions
- Be prepared to discuss them

For Next Lecture

- McConnell, section 34.2
  - choose your process
- McConnell, section 34.9
  - eschew religious wars
- Wikipedia: Agile Software Development
- Wikipedia: SCRUM
  - Roles
  - Sprint
  - Meetings
  - Artifacts

Supplementary Slides

Product Documentation

- design documentation
  - architectural/design introduction/overview
  - component level design specifications
  - design rationale folders
- end-user documentation
  - manuals on how to use the product
- support documentation
  - installation/configuration guidelines
  - trouble-shooting guidelines
  - detailed technical descriptions

Architectural Overviews

- author - lead engineers
- audience - initially developers, later everyone
- form - eventually a polished report/presentation
- content
  - describe overall structure of product
  - goals, principles, components, interfaces
  - later, a technical introduction to the product
- role in code maintainability
  - lays conceptual foundations, intro to design

Design Rationale(s)

- author - architects & designers
- audience - other architects and designers
- form - usually just a collection of notes
  - some may eventually turn into white papers
- content
  - issues, problems, options, decisions
- role in code maintainability
  - explain non-obvious features of the design
  - keep important lessons from being forgotten

Installation/Configuration

- author - responsible engineers
- audience - support and customers
- form - external product documentation
- content
  - process for installing product
  - product configuration options
  - performance considerations and tuning
- role in code maintainability
  - explain how the product is managed

Trouble-Shooting Guidelines

- author - development and support engineers
- audience - technical support
- form - internal product documentation
- content
  - how to diagnose likely problems
  - how to fix or get around them
- role in code maintainability
  - direct how-to guidance for support engineers
  - acquaint maintenance engineers w/problems

Detailed Technical Descriptions

- author - responsible engineers
- audience - support/maintenance engineers
- form - internal product documentation
- content
  - detailed component design descriptions
    - may be at routine level, or even more detailed
- role in code maintainability
  - training for new code maintainers

NOTE: these are not common

Detailed Technical Descriptions

- often mandated by large organizations
  - with very long maintenance commitments
    - e.g. aerospace, government
  - when many maintainers will be trained
    - e.g. military, telecommunications
  - they do improve product maintainability
- they are very expensive to produce
  - documentation takes longer than the code
  - they have to change whenever the code does
- easier just to make code more readable

javadoc

- A commenting discipline and tool for automatically generating documentation from the code.
- A set of standard tags
  - @param, @return, @throws, @serial
  - @link, @see, @version, @since, @author
- A convention for descriptions

```
/**
 * stuff for javadoc
 */
```


choosing good names

- well chosen routine names ...
  - describe what the routine does
  - suggest the meaning of their return value
- well chosen variable names ...
  - tell us what the variable means
  - suggest its scope and general class
- good names are better than comments
  - because they take up much less space
  - because they appear on every usage

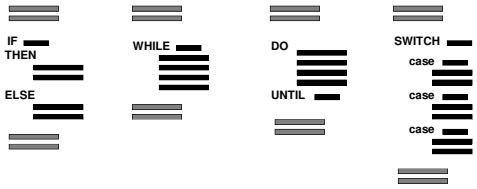
mnemonic naming conventions

- describe the entity/action they represent
  - integer: linesPerPage
  - boolean: outOfSpace
  - routine: pushStack()
- follow recognizable patterns
  - scoreMax, scoreMin, scoreMean, …
  - addStudent(), dropStudent(), ...
- are long enough to make sense
  - but short enough to be manageable
    - easy to type, don't take up the whole line

syntactic naming conventions

- can suggest general variable classes
  - UpperMixed classes and defined types
  - lowerMixed locals and parameters
  - UPPERCASE constants and macros
- can suggest scope
  - m_mixedCase member-private data
  - G_mixedCase global data
- can suggest class from which they come
  - base_Value enumerated types

white-space & program structure



- blank lines make block separation clear
- indentation makes block nesting clear
- visually clearer than keywords or braces

standard (K&R) C indentation

- most braces on same line as keyword
- closing braces, un-indented, on own line
- motivation - ease of editing

```
If (condition) {
    statement;
    statement;
} else {
    statement;
    statement;
}
```

```
while (condition) {
    statement;
    statement;
}
```

```
do {
    statement;
    statement;
} until (condition);
```

```
switch (var) {
  case 1:
    statement;
    statement;
    break;
  case 2:
    statement;
    statement;
    break;
}
```


Indentation Guidelines

- use consistent indentations for all ...
  - lines within a single loop, block, or sub-case
  - loops, blocks or sub-cases at the same level, (especially siblings within a larger block)
  - labels are allowed to hang to the left
- avoid excessively large indentations
  - no more than 50-75% of a line
  - use a smaller indent (e.g. 4 vs 8)
  - put the sub-block into a sub-routine
  - as a last resort, shift whole block left

Line Formatting

- expressions
  - use parens to make precedence explicit
  - use spaces to make sub-expressions obvious

```
((x>4) && ((y/10) > 0))
```
vs.
```
x>4&&y/10>0
```

- continuation lines
  - break line at an argument/operand boundary
  - indent each continuation to same level

```
fprintf( stderr,    "Free space %d entries (%02d\% full)\n",
                    cache.totsize - cache.current,
                    (cache.current * 100) / cache.totsize );
```


simpler code: boolean exprs

```
If (errors > MAX_ERRORS)
    return( TRUE);
else
    return(FALSE);
```

```
return (errors > MAX_ERRORS);
```

```
If (personType == STUDENT)
    salesTax = 0;
else
    salesTax = 0.085;
```

```
salesTax = (PersonType==STUDENT) ? 0 : 0.085;
```

```
if (((index+1) % tablesize) == 0)
    xxx;
…
if (((index+1) % tablesize) == 0)
yyy;
…
```

```
wrap = ((index+1) % tablesize) == 0;

if (wrap)
    xxx;
…
if (wrap)
    yyy;
```


Useful Code Commenting

- prose or pseudo-code summaries
  - explain the purpose of the code that follows
  - high level overview of the algorithm
  - enumerate pre-conditions that must hold
- rationale and references
  - remind reader of important issues
  - explain non-obvious choices
  - refer reader to more detailed discussions
- draw attention to module sub-sections
  - start of a new class or routine

Labels for non-obvious targets

```
if (queue.numEntries > 0) {
        …
    } else      /* (queue.numEntries <= 0) */




    …
        if (request.status == ERR_FATAL)
                break;          /* NextRequest */
        …
    }
    /* NextRequest: */
        …
```


Standards - tools

- static analysis tools (e.g. lint)
  - stricter checking than the C compiler
- style checkers (e.g. cstyle, hdrchk, libchk)
  - audit code against specified standards
- pretty-printers (e.g. indent, C beautifier)
  - reformat code w/standard indents/spacing
- auto-documenters (e.g. javadoc)
  - generate routine documents from comments
- code browsers (e.g. cxref, source navigator)