Software Maintainability

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What is Software Maintainability?

- Short answer - The ease with which a software system or component can be modified to correct faults, improve performance or other attributes, or adapt to a changed environment.[1]
- How do we measure maintainability?

Measurement Approaches

“Lexical Level” Approaches, or complexity (based on program code)[2]

- Individual and average lines of code (LOC), number of commented lines, executable statements, blank lines, tokens, and data declarations
- Source code readability (ratio of LOC to commented LOC)
- Halstead Metrics - Halstead Length, Halstead Volume, Halstead Effort, purity ratio
- McCabe's Cyclomatic Complexity
- Control structure nesting level
- Number of knots (number of times control flow crosses, not as relevant with OOP)

Measurement Approaches

“Psychological Complexity” measures, or difficulty (based on understandability and user)[3]

- Nature of the file and the difficulty experienced by those working with the file

Other factors

- Documentation existence and understandability

Important Halstead Metrics Overview

Implementation Length

- n_1 = number of unique or distinct operators appearing in a program.
- n_2 = number of unique or distinct operands
- N_1 = the total number of operators
- N_2 = the total number of operands
- Program Length: $N = N_1 + N_2$

Volume

- $V = N * \log_2(n_1 + n_2)$

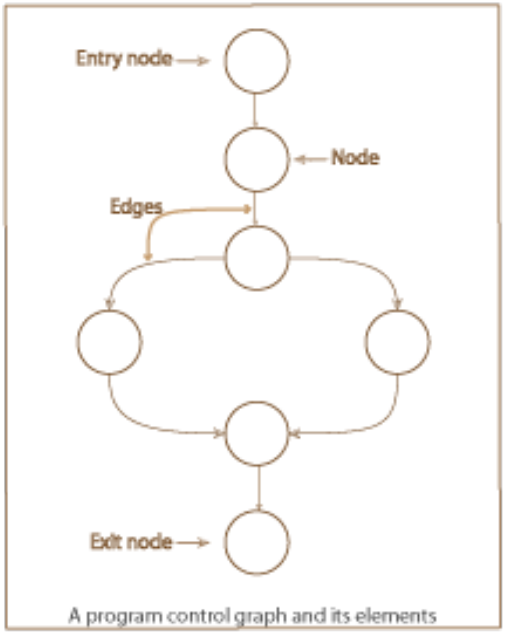
Effort

- Difficulty: $D = (n_1/2) * (N_2/n_2)$
- Effort: $E = D * V$

Cyclomatic Complexity Overview

$v(G) = e - n + 2*p$

- e = number of edges
- n = number of nodes
- p = number of modules



Automated VSCADA Code Maintainability Results

Used radon Python package to automatically calculate A - F maintainability “grade” based on Cyclomatic Complexity on all VSCADA source files

- Most files received an A, roughly 10% received a B, and three files received a C

Automated VSCADA Code Maintainability Results

Also used radon to automatically calculate A - C “maintainability index”

- A: 20 - 100, B: 10 - 19, C: 0 - 9
- All files received an A
- Results such as these illustrate the limits of automated maintainability metrics

Algorithmic Measurement Drawbacks

Q: Is the data returned from algorithmic maintainability measurements statistically meaningful/have the various approaches been thoroughly verified and well correlated?

A: According to at least one study which systematically reviewed various methodologies, no; more research needs to be done/published.[6]

- Most studies also fail to mention the maintenance method(s) which their measurements cover.

Maintenance Methods

IEEE describes three general maintenance method types[7]

- Corrective
- Adaptive
- Perfective

Practical Guidelines

Helpful NASA JPL guidelines[8]

- Early planning, account for future modifications
- Modular design (one overall task/function)
- Object-oriented design
- Uniform conventions (naming conventions, coding standards, comments, style, documentation standards)
- Common tool sets
- Configuration Management

Configuration Guidelines

Even well configured code can have many problems; the following guidelines can help[9]

- Not everything should be configured
- Having as few configuration files as possible helps with complexity
- Optional configurable items should have default values
- Documentation in the configuration resource is preferable, should be thorough and cover configurable setting relationships if there are any

How this relates to VSCADA

- Software design does not include all requirements in current state
- Therefore code needs to be easily understandable, configurable, and maintainable for easy modification in upcoming years
- Want to avoid the scrapheap

References

1 - Software Maintainability Definition: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=159342

2 - Lexical Level Metrics: http://www.artes.uu.se/events/gsconf02/papers/Land_Maintainability.pdf

3 - Psychological Complexity, Other metrics: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=312036&tag=1

4 - Halstead Metrics: http://asetechs.com/NewSite2014/Products/Interpreting_Halstead_metrics.htm#BOTTOM

5 - McCabe's Cyclomatic Complexity: http://asetechs.com/NewSite2014/Products/Interpreting_McCabe_metrics.htm#BOTTOM

6 - Maintainability Measurement Drawbacks: https://www.rose-hulman.edu/Users/faculty/young/CS-Classes/csse575/Resources/maintainabilityMeas05314233.pdf

7 - Maintenance Methods: http://www.pitt.edu/~ckemerer/CK%20research%20papers/TowardsDetailedClassificationScheme_BarryKemererSlaughter99.pdf

8 - Practical Guidelines: https://oce.jpl.nasa.gov/practices/dfe6.pdf

9 - Configurability Pitfalls: https://msdn.microsoft.com/en-us/library/bb896744.aspx#anchor5