Assessment of Geant4 Maintainability with respect to Software Engineering References
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Questions
1. Can we use software metrics references to effectively assess the maintainability of a large scale physics software system?
2. Can statistical methods drive us to select proper software metrics for Geant4?

Background
- We adopted software quality standard, ISO/IEC 25010:2011 (former ISO/IEC 9126) [1], to identify software characteristics related to the maintainability factor.
- We identified and assessed software metrics tools to collect a large number of measurements of software characteristics [2].
- We exploited a set of product metrics to assess the code status [2].

Methodology

STEP 1 get access to the Geant4 web site
https://geant4.web.cern.ch/geant4-support/download.html

STEP 2 loading of the Geant4 source code into Imagix 4D

STEP 3 saving of all the collected data at different levels of granularity

STEP 4 addition and removal of fields in the cvs files

STEP 5 application of different statistical methods using R packages, such as lme4 and randtests

STEP 6 selection of references among relevant peer-reviewed papers, conference proceedings and technical reports [3]

STEP 7 comparison of the Geant4 measures with the references

A sample of results

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Ref.</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIT (Depth of Inheritance Tree)</td>
<td>6</td>
<td>M. Lorenz and J. Kidd, Object-Oriented Metrics, Englewood, NJ: Prentice Hall, 1996</td>
</tr>
<tr>
<td>RFC (Response for a Class)</td>
<td>2.58</td>
<td>R. Malhotra and A. Jain Bansal, Fault prediction considering threshold effects of object-oriented metrics</td>
</tr>
<tr>
<td>WMC (Weighted Methods per Class)</td>
<td>3</td>
<td>L. H. Rosenberg, Applying and Interpreting Object-Oriented Metrics, Proc. Software Technology Conf.</td>
</tr>
<tr>
<td>CB (Coupling Between Object class)</td>
<td>5</td>
<td>L. H. Rosenberg and T. Hammer and J. Shaw, Software Metrics and Reliability</td>
</tr>
<tr>
<td>NC (Number of Children)</td>
<td>3</td>
<td>McCabe</td>
</tr>
<tr>
<td>NMM (Number of Member Methods)</td>
<td>&lt;20</td>
<td>McCabe</td>
</tr>
<tr>
<td>MM (Maintainability Index)</td>
<td>&gt;60 poor maintainability &gt;50, 64, fair maintainability &gt;45, excellent maintainability</td>
<td></td>
</tr>
<tr>
<td>MDC (McCabe’s Maximum Cylomatic Complexity)</td>
<td>&lt;5</td>
<td>McCabe</td>
</tr>
</tbody>
</table>

Conclusion
- The use of metrics references contributes to interpret the internal quality of Geant4 software.
- Further investigation is in progress to identify appropriate ranges of metric values for scientific software.
- Statistical methods are valuable to identify the set of metrics that are most significant for a given Geant4 package.
- In future work we are going to explore other econometric/ecology concepts and techniques for the analysis of metrics data.

References

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