

Metrics for defining transformations properties

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- 1 Introduction of Software Metrics
- 2 Metrics for measuring ATL model transformations
- 3 UML models measurements with ATL
- 4 Typing ATL Model in Global Model Management
- 5 White-box coverage criteria for model transformations
- 6 Higher Order Model Transformation
- 7 Performance in model transformations:ATL and QVT
- 8 Using metrics for assessing the quality of ASF+ SDF model
- 9 Using metrics for assessing the quality of ATL
- 10 Conclusion and Future Scope
- 11 References

- This is a human desire to measure the unknown like height of mountain, depth of ocean, even our destiny.
- We can measure either quality or quantity. The International System of Units (SI Units) is the current international standard metric system used to measure quantity.
- Although, there is no international standard metric system to measure quality as SI system exist to measure quantity.
- Measuring ATL model transformation is mainly dependent on measure of quality in terms of metrics associated with ATL model transformation.

- There are more than 100 different metrics discussed in 9 different papers.
- Reference [1] defines 81 metrics, which is more in compare to number of metrics defined in [2-9].

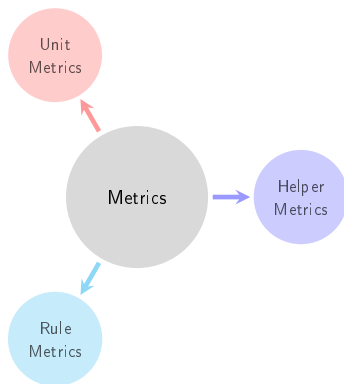
Reference	Classification of Metrics
[1]	3 Classes: Unit, Rule, Helper
[2]	3 Classes: Basic, Chidamber & Kemer, Fernando Brito e Abreu
[5]	Transformation Metrics
[6]	3 Classes: Model Transformation, QVTo Model Transformation, QVTr Model Transformation
[7]	4 Classes: Size, Function, Module, Consistency
[8]	4 Classes: Dependency, Helper, Miscellaneous, Rule
[9]	2 Classes: Simple, Aggregated

- These metrics need to be related to quality attributes like Completeness, Complexity, Consistency, Conciseness, Modularity, Modifiability, Performance, Reusability, Reuse, and Understandability for assessing quality of ATL model transformation.

Table: Quality Attributes Used in Quality Assessment

Abbreviation	Quality Attributes
Co	Completeness, Consistency, Conciseness, Complexity
Mo	Modularity, Modifiability
Pe	Performance
R	Reusability, Reuse
U	Understandability

Metrics for measuring ATL model transformations [1]



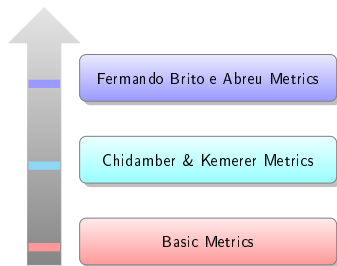
- The first Unit Metrics further divide into module metrics and library metrics.
- Another Rule Metrics cover the matched rule, lazy matched rule, and called matched rule metrics, the last Helper Metrics doesn't have any sub categories.

Relation between Quality Attribute and Metrics

Table: Quality Attributes and Distribution of Metrics

Quality Attribute	Relation to metrics
Complexity	77 %
Understandability	72%
Modifiability	52%
Reuse	25%
Performance	15%
Conciseness	14%
Consistency	11%
Reusability	10%
Completeness	5%
Modularity	4%

There are 46 Unit metrics, 13 Rule metrics, 23 helper metrics, 82 total metrics and 10 quality attributes used to define size and complexity of the ATL metamodel.



- ATLAS Transformation Language (ATL) for Models to Models (M2M) transformation, Kernel Meta Meta Model (KM3) for Writing Meta Model and Textual Concrete Syntax (TCS) Language for Domain Specific Language used in UMLQualityAnalysis.
- These 3 metrics are defined in following 3 contexts: Class (C), Package (P) and Model (M). There are 8 basic metrics, 4 CM metrics and 4 FBA metrics.

Basics Metrics

Basics metrics are the simplest design to enumerate the basic UML element. TN stands for Total Number of.

Table: Basics Metrics

Acronym	Description	Context
TNP	Packages	M
TNC	Classes	P/C
TNA	Attributes	P/C
TNAI	Attributes Inherited	P/C
TNM	Methods	P/C
TNMI	Methods Inherited	P/C
TNAs	Associations	P/C
TNA _s I	Associations Inherited	P/C

$\langle X, Y, Z \rangle$. X, Y are number of attributes in class and package that hold class. Z is average attributes per classes in package.

Chidamber & Kemerer metrics

Chidamber & Kemerer metrics are designed to measure the complexity and difficulty to maintain them.

Table: Chimamber & Kemerer metrics

Acronym	Description	Context
WMC	Weighted Methods per Class	C
DIT	Depth Inheritance Tree	P/C
NOC	Number of Children	P/C
CBO	Couplage Between Objects	P/C

Brito e Abreu metrics are going to evaluate the whole system in term of percentage for interpretation.

Table: Brito e Abreu metrics

Acronym	Description	Context
AIF	Attribute Inheritance Factor	P/C
MIF	Methods Inheritance Factor	P/C
AHF	Attribute Hiding Factor	P/C
MHF	Methods Hiding Factor	P/C

Typing ATL Model in Global Model Management [3]

- All transformations have almost everything in common, except for the header and some other fixed parts.
- Therefore, generator is defined in place of manually developing all transformation [3].
- Template embodies one single implementation of the metrics. Main ATL module and the four ATL libraries (FLAME4KM3, MOOD4KM3, QMOOD4KM3, and EMOOSE4KM3) are used to compute metrics on KM3 metamodels and that's why they are prefixed by Lib(KM3).

White-box coverage criteria for model transformations [4]

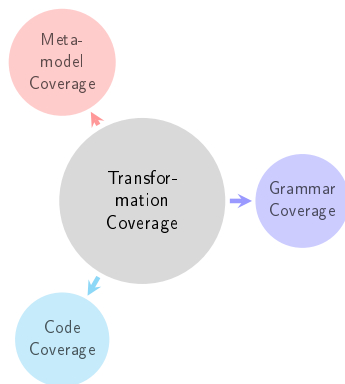
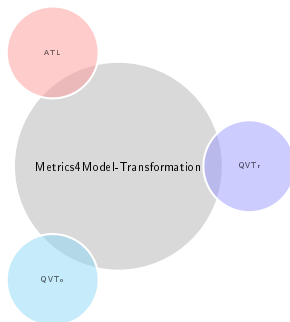


Figure: Classification of Metrics [4]

Coverage measures should be derived from (a) metamodel coverage measures, (b) research on grammar coverage, and (c) analogy with code coverage [4].

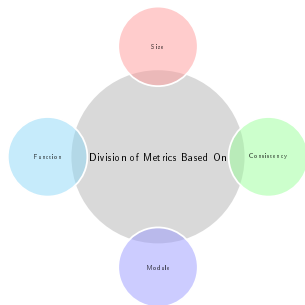
Higher Order Model Transformation [5]

- Model is an integral part of software engineering process.
- Focus of researcher is now on transformation in order to automate other tasks.
- This reference [5] also contribute in development of library of transformation as well as evaluation, testing, and generation of documentation.
- Higher-Order Transformations (HOTs) is applied in the analysis of model transformations for deriving metric values. However, there is an research gap using HOTs for transformation metrics generation [5].



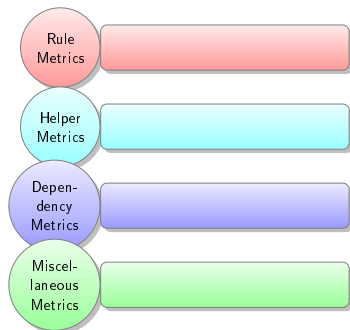
- Among 3 engine, declarative ATL is the fastest [6].
- 25 metrics extracted from ATL model transformation and 17 with QVTo model transformation.
- QVT-Operational is imperative for unidirectional transformations.
- QVT-Relations is declarative that permit both unidirectional and bidirectional transformations.

Metrics for assessing the quality of ASF+ SDF model[7]



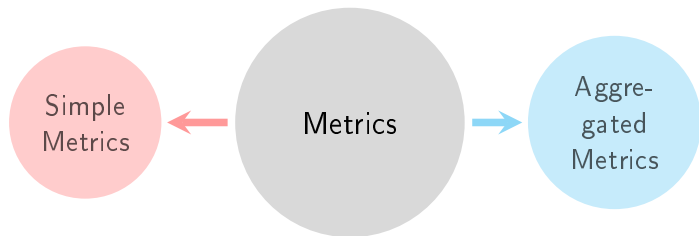
- Size metrics measure size of transformation.
- Function metrics measure complexity of functions.
- Module metrics deals with complexity of module
- Consistency covers transformation covers conflicting information.
- 6 quality attributes and 27 metrics evaluate quality of SDF (Syntax Definition Formalism) and ASF (Algebraic Specification Formalism) based model transformations.

Quality assessment of ATL model transformations using metrics [8]



Metrics can be divided into following four types: Dependency metrics, Helper metrics, Miscellaneous metrics, and Rule metrics [8].

Using metrics for assessing the quality of ATL model transformations [9]



- Simple metrics has single value for entire transformation. Whereas, aggregated metrics have multiple value for entire transformation [9].
- Therefore, simple metrics measured over the entire transformation and aggregated metric measured on a smaller scale.

Tools for Metrics Extraction

- The ATL files are parsed by the ATL parser. ATL models generated by parser.
- ATL models are the input for the metrics extractor.
- This metrics model is used as input for a pretty printer (Model2Text).
- The output of the pretty printer is comma separated value (CSV).

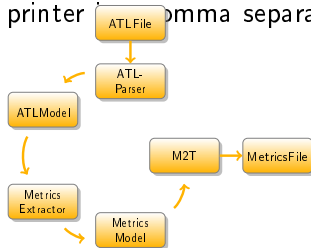


Figure: Block Diagram of Metrics Extractor Tool

- We have studied Unit Metrics, Rule Metrics, Helper Metrics [1], Basic Metrics, Chidamber & Kemer Metrics, Fernando Brito e Abreu Metrics [2], Transformation Metrics [5], Metrics for Model Transformation, Metrics for QVTo Model Transformation, Metrics for QVTr Model Transformation [6], Size Metrics, Function Metrics, Module Metrics, Consistency Metrics [7], Dependency Metrics, Helper Metrics, Miscellaneous Metrics, Rule Metrics [8], and Simple Metrics, Aggregated Metrics [9].
- All these metrics have some advantages and disadvantages.
- Reference [1] defines 81 metrics, which is more in compare to number of metrics defined in [2-9].

- But, there is option remain open to upgrade existing metric set and addition of more metrics for evaluation of quality of transformation.
- There is also scope of addition of more quality attribute other than 10 discussed in this presentation.

Acknowledgment

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