Quality of models and modeling languages

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Short background on me

- Master and PhD in Information Systems (1991, 1995), modeling techniques, quality of modeling in particular
- Employed 9 years in Andersen Consulting (Accenture)
- 2000-2005 SINTEF ICT (Oslo)
- Professor at IDI, NTNU, Trondheim, Norway 1.August 2005.
- Leader of Strategic Area ICT at NTNU, coordinate cross-disciplinary ICT research at the university (health informatics, eGovernment etc)
- Leader of IFIP WG 8.1 on Design and Evaluation of Information Systems (EMMSAD, POEM, BPMDS, ME...)
Overview of presentation

- What is quality?
- Overview presentation of semiotic model quality framework (SEQUAL)
  - Quality of models
  - Quality of modelling languages (briefly)
Different views on quality

- According to requirements (ISO 9000 – support stated or implied needs)
- The user is satisfied (Denning)
- Properties of the product (-ilities) (ISO/IEC 9126)
- Properties of a requirements specification or model (Davis/Pohl)
- Quality related to different semiotic levels (Lindland, Stamper, Price/Shanks, Nelson/Poels..)
- Product vs. Process quality (e.g. CMM)
SEQUAL – A framework for understanding and assessing quality of models based on semiotics

- For models as a knowledge representation in general
- Can be extended and specialised towards specific types of model and modelling languages
- Differentiate between quality of different levels based on semiotic theory
- Differentiate between goals of modelling (quality characteristics) and means to achieve these goals
- Set-oriented definition to enable a formal discussion of the different quality levels
- Takes into account that models are socially constructed
Main elements of a modelling activity

- Example of goal:
  Create a requirements specification for a travel agency on the net
Sets in the quality framework

- A: Actors that develops or has to relate to (parts of) the model. Can be persons or tools (technical actors).
- L: What can be expressed in the modelling language
- M: What is expressed in the model
- D: What can be expressed about the domain (area of interest)
- K: The explicit knowledge of the participating persons
- I: What the persons in the audience interpret the model to express
- T: What relevant tools interpret the model to say
- G: The goals of the modelling

All of these sets evolves as part of modelling
Usage of modeling and models
Model-based Development and Evolution of Information Systems - 2012

SEQUAL

G: Goals of modelling
D: Modeling Domain
K: Social actor explicit knowledge
M: Model externalization
T: Technical actor interpretation
L: Language extension

Q: Goals of modelling
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Perceived semantic
Social
Deontic (learning)
Physical
Pragmatic (human understanding)
Syntactic
Empirical
Pragmatic (tool understanding)

Deontic
Semantic
Empirical

Deontic (action)
Physical
Pragmatic (human understanding)
Syntactic
Empirical
Pragmatic (tool understanding)
Overall structure of framework

- Quality type (physical, empirical...)
  - One or more quality characteristics per quality type
    - Means to achieve the quality characteristics
      - Beneficial existing quality
      - Model properties
      - Language properties
      - Modeling activities
      - Tool-support
Model example to illustrate the different quality levels

- Language: ER
- Domain: Conference organizing
- Goal: Design of database solution to support conference organizing
Physical Quality

- Internalizability
  - Model persistence
  - Model availability
  - Currency

  -> Database functionality (model repository)
Empirical quality

- Look on aspects related to
  - Ergonomics
  - Graph and document layout
  - Readability

- The model must be externalised

- Language properties
  - Comprehensibility appropriateness

- Modelling and tool activities
  - (Automatic) graph-layout, readability index calculation, grammar checking, evaluation of use of colour.
Example of poor graph-layout
Syntactic quality

- Syntactic correctness: $M\setminus L = \emptyset$
- Two types of errors
  - Syntactic invalidity
  - Syntactic incompleteness
- The model must be externalised
- Language properties
  - Formal syntax
- Activities
  - Error prevention
  - Error detection
  - Error correction (automatically or by suggestion ("spellcheck"))
Example of syntactic invalidity

- Person
- Author-ship
- Paper
- Title
- Language
- JK
Example of syntactic incompleteness
Semantic quality

- Quality characteristics
  - Validity: $M \setminus D = \emptyset$
  - Completeness: $D \setminus M = \emptyset$

- Necessary/useful that the model is externalised and is syntactically correct

- Language properties: Formal semantics, domain appropriateness, modeller appropriateness

- Activities: Model testing (consistency checking), reuse of models, ’driving questions’, meta-model adaptation
Example of semantic invalidity (and incompleteness)
Pragmatic quality

- Quality characteristics
  - Comprehension, do the audience understand what the model express? (I=M)

- Useful that the model have high physical, empirical, and syntactic quality before evaluating pragmatic quality.

- Language properties:
  - Operational semantics
  - Executability
  - Explicit modelling of intention
  - Participant appropriateness

- Activities: Inspection, visualization, filtering/views, explanation generation, simulation, animation, reporting, execution/prototyping, model-generated solutions
Perceived semantic quality

- Quality characteristics
  - Perceived validity \( \mathbb{K} = \emptyset \)
  - Perceived completeness: \( \mathbb{K} \setminus \mathbb{I} = \emptyset \)

- Useful that the model has high physical, empirical, syntactic, and pragmatic quality before investigating perceived semantic quality

- Same means and activities as for semantic quality.
Social quality

- Quality characteristics: Agreement
  - Agreement in knowledge/interpretation/model
  - Relative vs. absolute agreement

- Important first to address physical, pragmatic and perceived semantic quality

- Language properties: Possibility to explicitly express inconsistencies based on disagreement.

- Activities: Model integration and conflict resolution
Deontic quality

- The deontic quality of the model relates to
  - that all statements in the model contribute to fulfilling the goals of modelling (goal validity)
  - that all the goals of modelling are addressed through the model (goal completeness)

- Language properties: Organizational appropriateness

- Deontic quality introduce a context that relax wanted quality for a model on the other levels (e.g. trade-off between completeness of the model relative to cost).

- Expressed with the notion of feasible quality (particularly on the levels of semantic, pragmatic, perceived semantic and social quality)

- Goals include also aspects relative to participant learning and domain improvement
SEQUAL – language quality

Goals of modelling

Modeling domain

Social actor explicit knowledge

Organizational appropriateness

Model externalization

Participant appropriateness

Language extension

Comprehensibility appropriateness

Modeller appropriateness

Technical actor interpretation

Participant appropriateness

Domain appropriateness

Tool appropriateness
SEQUAL specializations

- SEQUAL-IM
- SEQUAL-EM
- SEQUAL-Gen
  - SEQUAL-SRS
  - SEQUAL-DM
  - SEQUAL-Met
  - SEQUAL-DESIGN
  - SEQUAL-DQ
  - SEQUAL-BPM
  - SEQUAL-ONT
  - SEQUAL-SOA
  - SEQUAL-MDA
  - SEQUAL-UML
Usage of the SEQUAL

- E.g. in ATHENA (EU project)
  - Evaluation of a modeling language under development
  - Evaluation of the model of the modeling language (meta-model)
  - Evaluation of a modeling tool/environment
  - Evaluation of a modeling methodology
    - The methodology as a model
    - The way the methodology support development of models of high quality

- Evaluation and choice of modeling languages (UML, BPMN, EEML, others)

- Evaluation of models

- Methodology guidelines for developing good models

- Guidelines for developing new modeling languages (Domain specific models)

- Variants for other types of visual representations (MAPQUAL)
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