Abstract

This module discusses modeling, especially aspects such as credibility, working range, and accuracy.
Abstract

We make models to facilitate decision making. These decisions range from business decisions, such as Service Level Agreements, to requirements, and to detailed design decisions. The space of decisions is huge and heterogeneous. The proposed modeling approach is to use multiple small and simple models. In this paper we discuss how to reason by means of multiple models.
How to use multiple models to facilitate decisions?
How to get from many fragments to integral insight?
How many models do we need?
At what quality and complexity levels?
Graph of Decisions and Models

usage context
enterprise & users
black box view
design

life cycle context

legend
a assumption
i input e.g. measurement
d decision
m model

Modeling and Analysis: Reasoning Approach
Gerrit Muller
version: 1.0
March 9, 2015
MAREgraph
Example Graph for Web Shop

usage context

enterprise & users
- customer interest
- #products
- market penetration
- market share
- customer behavior
- personnel
- financial
- salary
- workflow
- service cost

system

black box view
- load
- throughput
- information
- response time
- elapsed time
- budget

design
- transactions
- CPU load
- network load
- storage capacity
- CPU budget
- memory budget
- overhead
- picture cache
- access time

life cycle context

SLA
- running cost
- initial cost
- maintenance effort
- changes

legend
- a assumption
- i input e.g. measurement
- d decision
- m model

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MAREgraphWebShop
Relations: Decisions, Models, Inputs and Assumptions

- **Legend**
  - `a`: assumption
  - `i`: input e.g. measurement
  - `d`: decision
  - `m`: model

- **Diagram**
  - Inputs (`i`) feed into decisions (`d`). Decisions feed into models (`m`). Models influence assumptions (`a`). Assumptions trigger decisions.
  - Inputs also feed into models, calibrating them.

- **Graph Edges**
  - `facilitates`
  - `influence`
  - `triggers`
  - `feeds`
1. Explore usage context, life cycle context and system

2. Determine main Threads-of-Reasoning

3. Make main Threads-of-Reasoning SMART

4. Identify "hottest" issues

5. Model hottest, non-obvious, issues

6. Capture overview, results and decisions

7. Iterate and validate

**all steps time-boxed between 1 hour and a few days**

- early in project
- later in project

Learning cycle:
- b2a. "Play" with models
- b2b. Investigate facts
- b2c. Identify assumptions
- b3. Model significant, non-obvious, issues

Reasoning Approach
Frequency of Assumptions, Decisions and Modeling

- **Implicit (trivial?)**
- **Explicit**
- **Try-outs**
- **Very simple**
- **Small**
- **Key**
- **Substantial**

Legend:
- \(\text{a}\) Assumption
- \(\text{i}\) Input e.g. measurement
- \(\text{d}\) Decision
- \(\text{m}\) Model

Graph showing frequency on a logarithmic scale from \(10^0\) to \(10^6\).
Life Cycle of Models

- Understanding
- Exploration
- Optimization
- Verification

Try out models:
- Most try out models never leave the desk or computer of the architect!

Simple and small models:
- Many small and simple models are used only once;
- Some are re-used in next projects

Substantial models:
- Substantial models capture core domain know-how;
- They evolve often from project to project.
- Creation and evolution of intellectual property assets
Examples of Life Cycle of Models

- understanding
- exploration
- optimization
- verification

- try out models
  - load/cost
    - function mix
    - load/cost peak impact
  - simple and small models
    - customer global distribution
    - integral load model
    - global customer demographics
  - substantial models (IP assets)
    - load/stress test suite
    - web server performance
    - webshop benchmark suite
Identify a **chain of models** needed to support architecture development.

- models are related horizontally in the CAFCR model (across views), as well as vertically within a view

- models have various levels of detail; detailed models tend to feed/support less detailed models

- per model
  - formulate its purpose
  - indicate the main quantities that play a role
Abstract

Models only get value when they are actively used. We will focus in this presentation on analysis aspects: accuracy, credibility, sensitivity, efficiency, robustness, reliability and scalability.
What Comes out of a Model

- varying inputs
- varying circumstances
- varying design options
- varying realizations
- specification changes
- and ripple through

**model(s)**
- accuracy
- credibility
- working range
- working range
- worst case behavior
- exceptional behavior
- sensitivity
- robustness
- efficiency
- performance
- reliability
- scalability
- other system qualities

**design**
- applicability

**design quality**
- quality
- specification
- feasibility

**life cycle**
- use cases
- worst case exceptions
- change cases
- specification changes and ripple through
Applicability of the Model

+ $\varepsilon_1$
- $\varepsilon_2$

**input**
- accuracy
- credibility

**abstraction**
- credibility
- working range

**model(s)**
- accuracy
- credibility
- working range

**model realization**
- credibility
- propagation

**abstraction**
- usage context
- specifications
- designs
- realizations

**+**
- measurements
- assumptions
- facts

**-**

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MAANmodelApplicability
How to Determine Applicability

**try out models**
be aware of accuracy, credibility and working range

**simple and small models**

1. Estimate accuracy of results
   based on most significant inaccuracies of inputs and assumed model propagation behavior

2. Identify top 3 credibility risks
   identify biggest uncertainties in inputs, abstractions and realization

3. Identify relevant working range risks
   identify required (critical) working ranges and compare with model working range

**substantial models**

systematic analysis and documentation of accuracy, credibility and working range
Common Pitfalls

- **discrete events in continuous world**
  - discretization artefacts
  - e.g. stepwise simulations

- (too) **systematic input data**
  - random data show different behavior
  - e.g. memory fragmentation

- **fragile model**
  - small model change results in large shift in results

- **self fulfilling prophecy**
  - price erosions + cost increase (inflation) -> bankruptcy
Worst Case Questions

Which design assumptions have a big impact on system performance?

What are the worst cases for these assumptions?

How does the system behave in the worst case?

a. poor performance within spec

b. poor performance not within spec

c. failure -> reliability issue
FMEA-like Analysis Techniques

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<th>(systematic) brainstorm</th>
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Brainstorming Phases

wave 1: the obvious

wave 2: more of the same

wave 3: the exotic, but potentially important

don't stop too early with brainstorming!
Different Viewpoints for Analysis

usage context
- new product
  - e.g. WoW extension
- merger
- automated access

new functions
- new interfaces
- new media
- new standards

system
- cache/memory trashing
- garbage collection
- critical sections
- local peak loads
- intermittent HW failure

life cycle context
- power failure
- network failure
- new SW release
- roll back to old SW release

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Determine for a few models their credibility, accuracy, and working range.

- Identify top 3 credibility risks
  - identify biggest uncertainties in inputs, abstractions and realization
- Estimate accuracy of results; quantitative, e.g. order 1% or 50%
  - based on most significant inaccuracies of inputs and assumed model propagation behavior
- Identify relevant working range risks
  - identify required (critical) working ranges and compare with model working range
Modeling

From Chaos... to some Order

Many Light Models, few Substantial Models

Accuracy, Credibility, Working Range

Summary Module Architectural Reasoning Modeling

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