Model-Based Specification in VDM

http://d3s.mff.cuni.cz

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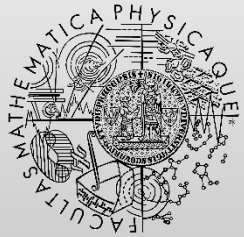

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Vienna Development Method (VDM)

- Formal specification languages
  - VDM-SL
  - VDM++
- Combination: model-based + algebraic
  - Abstract modeling (data + contracts)
  - Executable subset (prototyping implementation)
- Tools
  - validation, analysis, testing
  - code generation (Java, C++)

VDM-SL

- Syntax
  - ASCII text, graphical
- Features
  - Basic types: numeric, character, token, quote
  - Collections: set, sequence, map
  - Type constructors: union, cartesian product, record (composite)
  - Functions (pure, no side effects)
  - Operations (modify global state)

Example

- Management system for public transport

- Key concepts
  - Modules (import, export)
  - Implicit definition of functions/operations
    - Contracts (precondition, postcondition)
  - Explicit definition of functions/operations
    - Prototype implementation (algorithm)
  - Control-flow structures
    - imperative, functional

Proving correctness

Implicit definition

```
f(p:T_p)r:T_r
  pre pre-f(p)
  post post-f(p,r)
```

Explicit definition

```
f:T_p -> T_r
f(p) == ...
```

Proof obligation

```
forall p:T_p • pre-f(p) => f(p):T_r and post-f(p, f(p))
```

Refinement – another perspective

- Abstract data representation AR

- New concrete data representation CR
- Abstraction function α: CR → AR

- Proof obligations
  - $\forall$ a:AR • $\exists$ c:CR $\wedge$ a = α(c)
  - $\forall$ c:CR • pre-OpA(α(c)) => pre-OpC(c)
  - $\forall$ c~,c:CR • pre-OpA(α(c~)) $\wedge$ post-OpC(c~,c) => post-OpA(α(c~),α(c))

Case studies

- International conference on Rigorous State Based Methods: ABZ
  - https://abz2021.uni-ulm.de/
  - https://www.southampton.ac.uk/abz2018/participants/programme.page

Tools

- VDMTools
  - http://fmvdm.org/vdmtools/
  - Checks syntax, types, integrity
  - Interpreter (debugger)
  - Code generation (Java, C++)
- Overture
  - http://overturetool.org/

Literature

- C.B. Jones. Systematic software development using VDM. Prentice-Hall, 1990
  - https://www.amazon.com/Systematic-Software-Development-Prentice-hall-International/dp/0138807337
  - https://dl.acm.org/citation.cfm?id=94062