Model Based Testing for Agent Systems -

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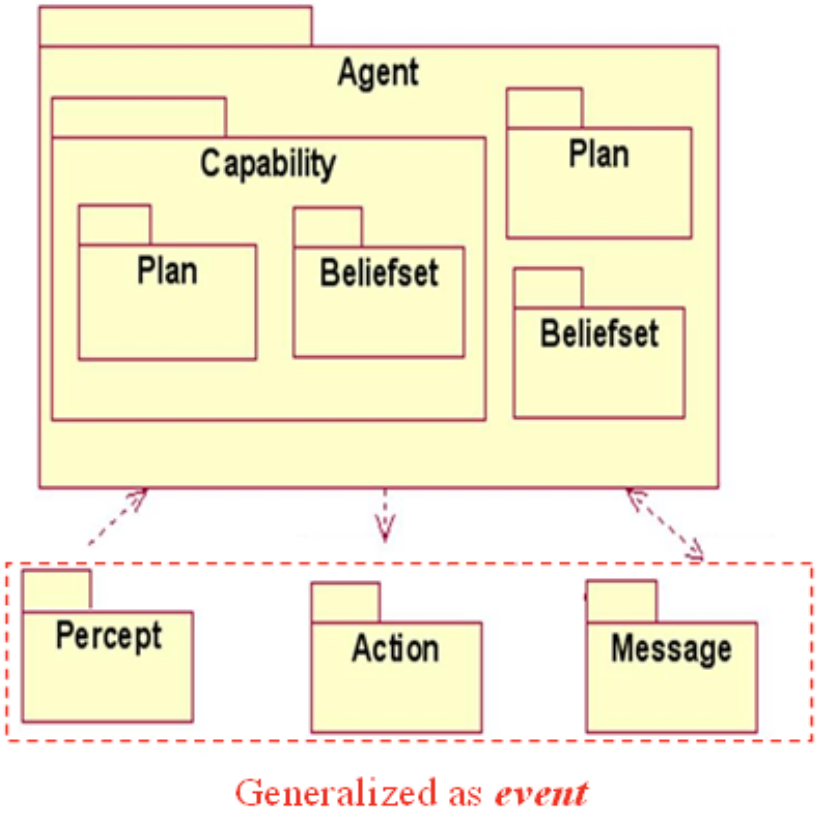
Model Based Testing – Units under test

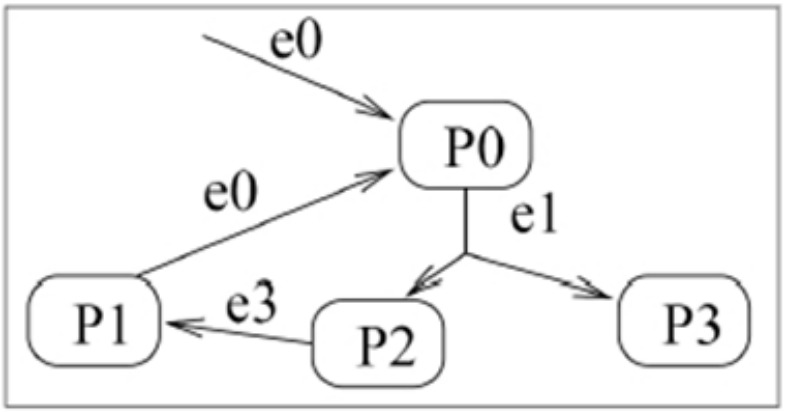
Model - The Prometheus Detailed Design Specification, typical of most BDI agent

- **event** (percept/action/message): is tested w.r.t coverage or overlap
- **plan**: is tested w.r.t event handling, context condition, event posting, completion of plan execution and plan cycle
- **Belief-set**: is tested w.r.t event posting



Hierarchy of Prometheus agent model

Testing Process



- Determine the testing order of units
  (paper at ENASE'07)
  - there may be dependencies
  - plan cycles
- Generate test cases
- Augment the source code to facilitate testing
- Execute test cases and generate report.
- Provide an analysis of testing report.

All the above are fully automated and can be applied to partial system.

Test Case Generation

- Extract variables specified in design

  e.g. [event-var, book.bookName, string, !=null],
  [agent-var, stock, int, ≥ 0, ≤ 200]

- Generate values for each variable
  - (Equivalence class partitioning, Boundary value analysis)
  - Allow for different levels for choice of values for variables

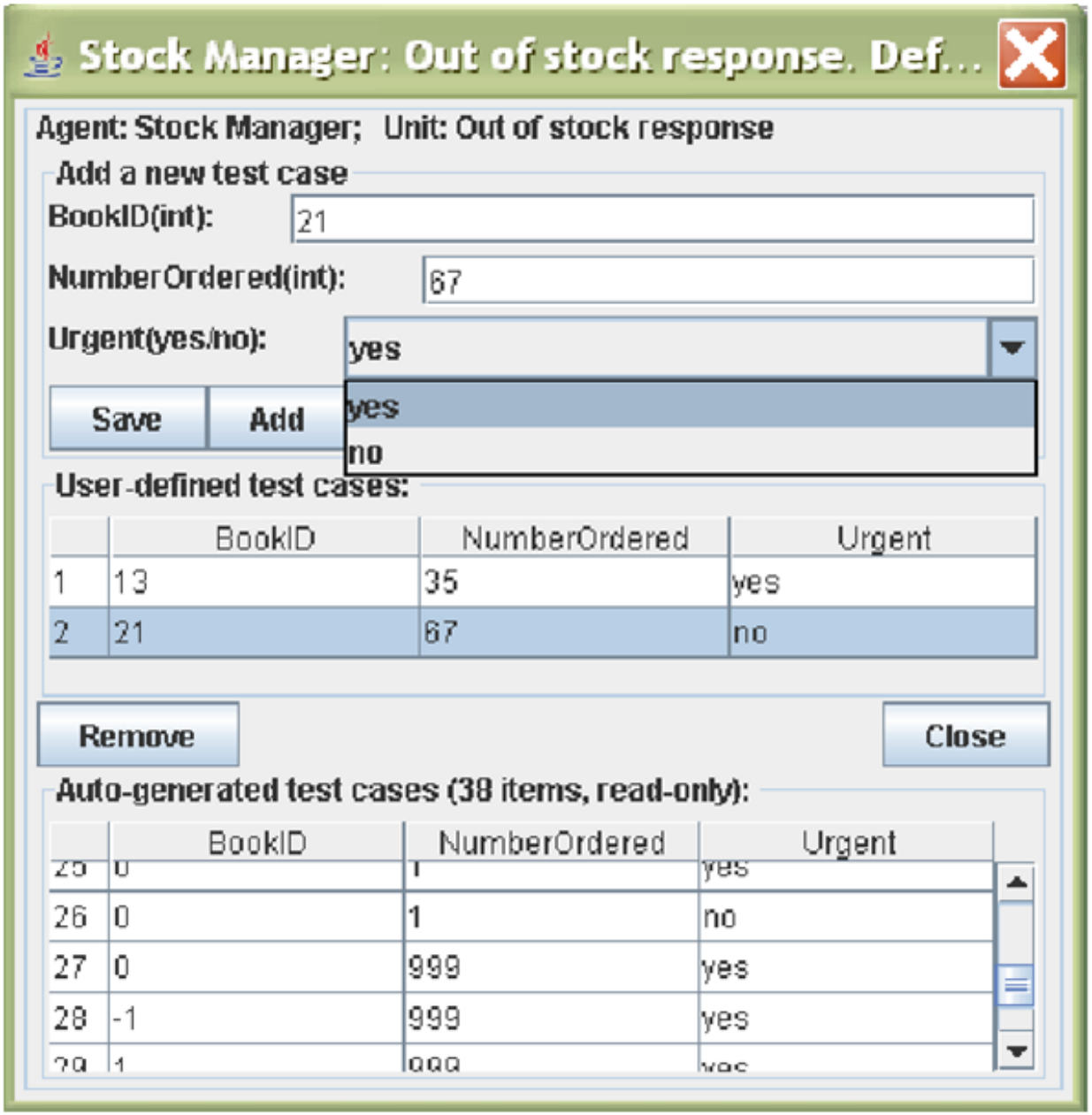
name	index	domain	valid	minimal	normal	compre-hensive
stock	EC-1	$(-\infty, 0)$	no	N/A	-1	-1
	EC-2	[0, 200]	yes	0, 200	0, 1, 199, 200	0, 1, 100, 199, 200
	EC-3	$(200, +\infty)$	no	N/A	201	201

  - use combinatorial Testing Service to reduce number of combinations, provide choice of thoroughness

- Allow user to manually enter test cases

Manual Testing Case Input

- The user can specify additional test cases using domain and design knowledge.



Test Case Execution - setup

- Initialization procedures – e.g. setting up connections servers, populating databases. Specified in the Unit Test Descriptor of each unit

order	owner object	is static	function call	comment
1	Stock Agent	yes	initBookDB()	method to populate the books database
2	BuyPlan	no	initConnAmazon(	sets up connection to Amazon.com

- Variable assignment - dependent on how variables are implemented, requires the specification of an assignment relation.

- Interaction with external entities –
  - External to the system (user controlled)
  - Other agents within the system (use mock agents to simulate)

Variable types

- Simple (public variable)
- Complex (part of a nested structure)
- Belief (part of a belief-set)
- Function (variables realised by a function, e.g. avg. price)

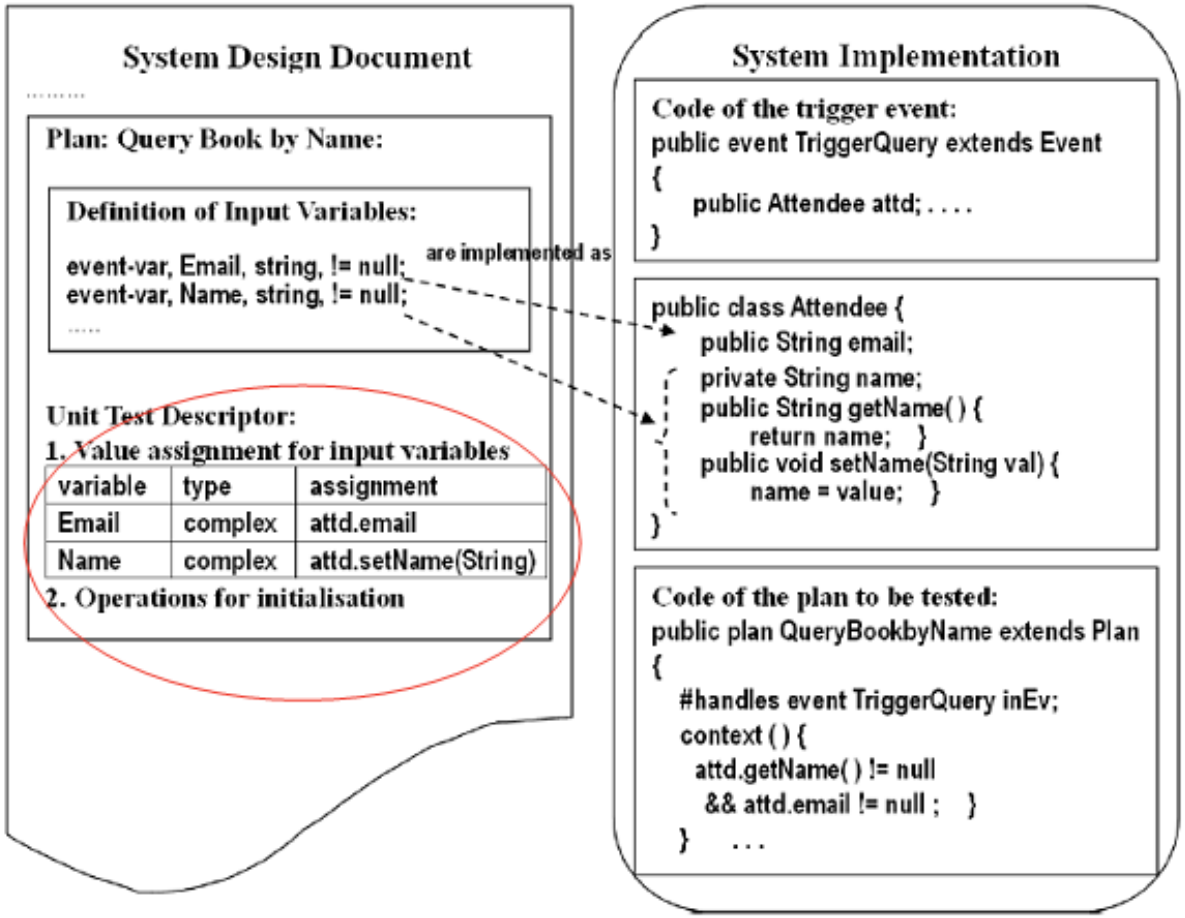


Illustration of complex variables

Value combinations:

Index	SD.bookID	SO.bookID	SD.inStock	SO.required
1	1	1	5	30
		.....		
12	0	0	0	31

Assigned by the following records

StockDB:

bookID	inStock	time
1	5	random

StockOrders:

bookID	required	supplier
1	30	random

Illustration of belief variables

Mock Agents

- Functionality of a Mock Agent
  - Simulates the message send-reply logic of the interactee agent that it replaces.
  - Any message from the plan-under-test to an interactee agent will be received by the replacement mock agent.

- Implementing a Mock Agent
  - The mock agents are automatically created when the testing framework builds the testing code for a plan:
    - All outgoing messaged are extracted from the plan under test.
    - For each message, the interactee agent type that receives the message is identified.
    - For each of the identified interactee agent type, the testing framework generates the code of a mock agent type that replaces this interactee agent type.

Summary

- Provide a model based unit testing framework that is automated.
- Implemented within PDT (The Prometheus Design Tool www.cs.rmit.edu.au/agents/pdt)
- Based on previous work - Zhiyong Zhang, John Thangarajah and Lin Padgham, **Automated Unit Testing For Agent Systems.** 2nd International Working Conference on Evaluation of Novel Approaches to Software Engineering (ENASE-07).
- Full paper at AOSE 2009 : Zhiyong Zhang, John Thangarajah and Lin Padgham, **Model based Testing for Agent Systems** (AOSE-09).

Future Work

- Testing Agent Interactions .
- Testing requirements.