Automation of Requirements-Based Testing (RQBT)

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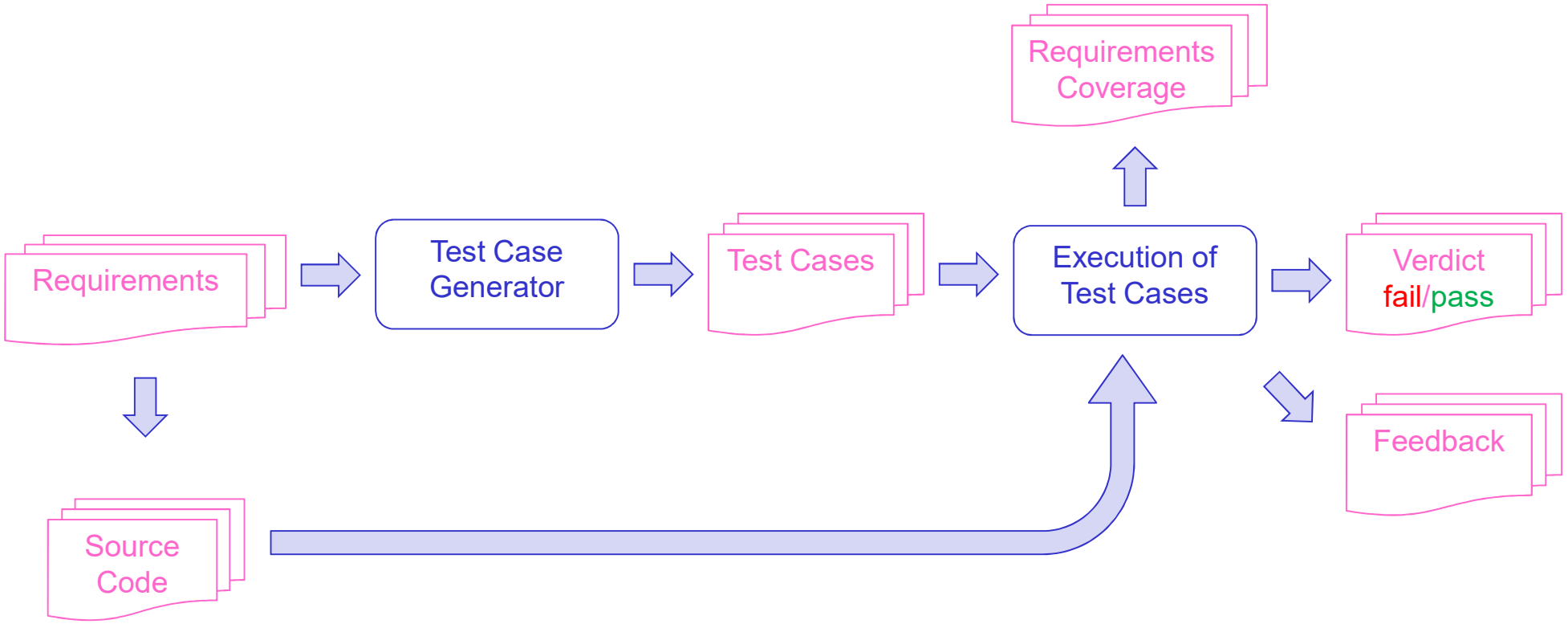
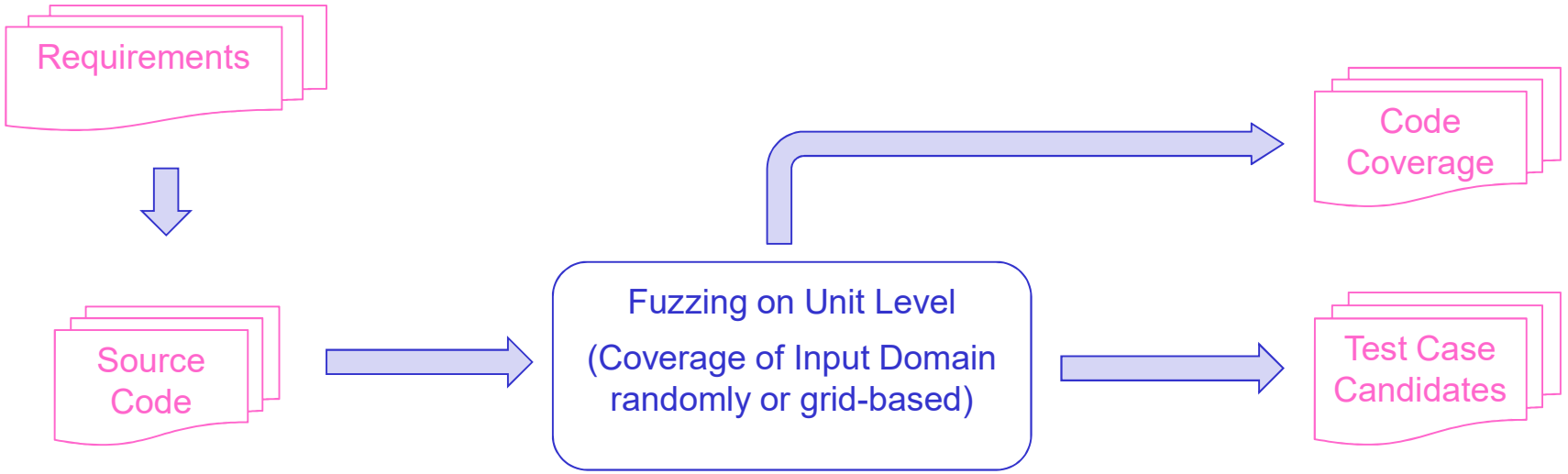
Agenda

- Introduction/Current Status
- Our Approach
- Examples
- Open Challenges
- Conclusions

Our Goal


Requirements
Coverage
Requirements
Test Case
Generator
Test Cases
Execution of
Test Cases
Verdict
fail/pass
Feedback
Source
Code

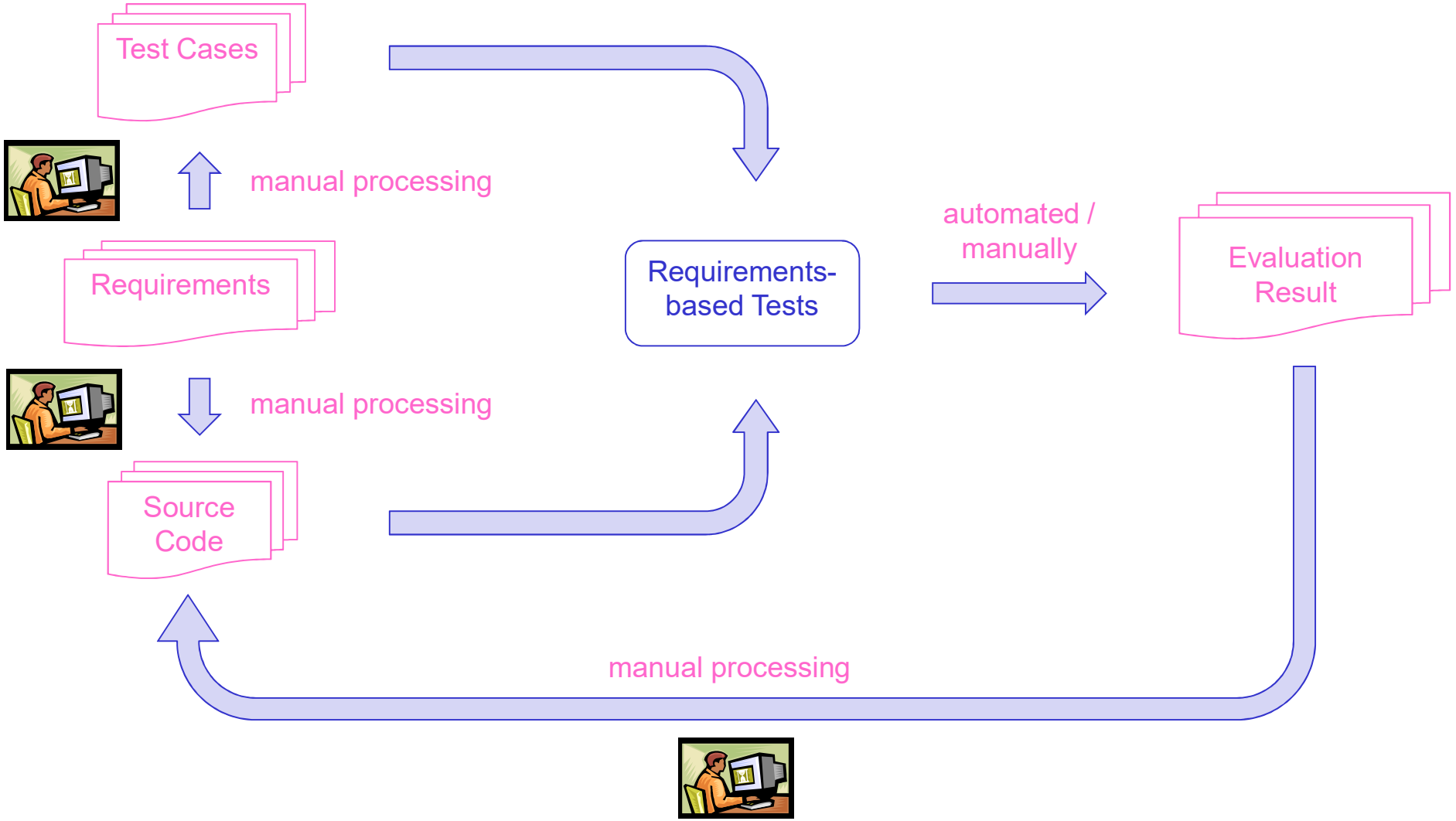
Current Status



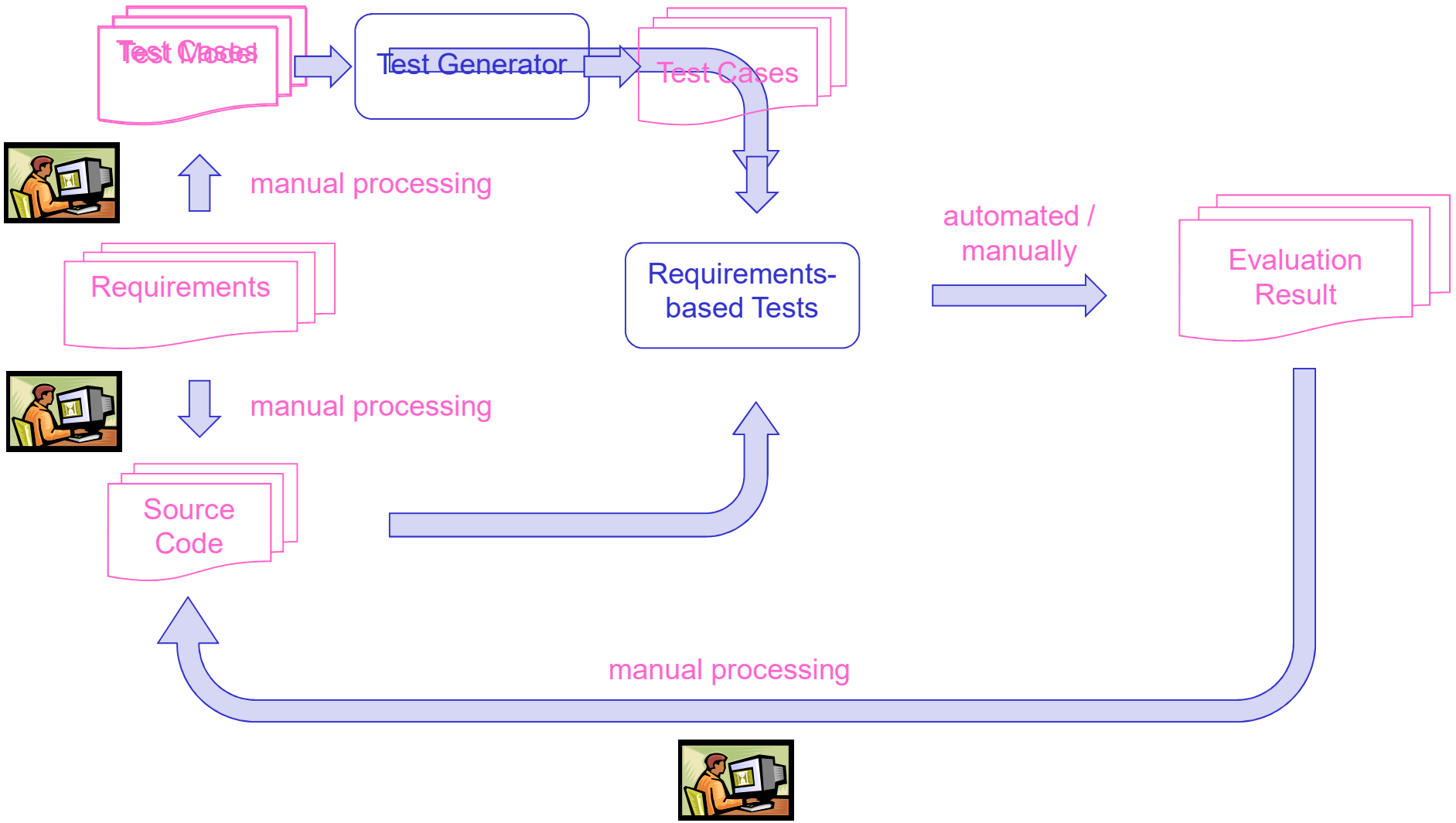
Goal for Automation of RQBT

- Benefitting from automated massive stimulation
- Automated correlation of unit tests with requirements
- Automated evaluation of test results w.r.t. requirements
- Automated propagation of verification results (pass/fail) bottom-up in the hierarchy of requirements

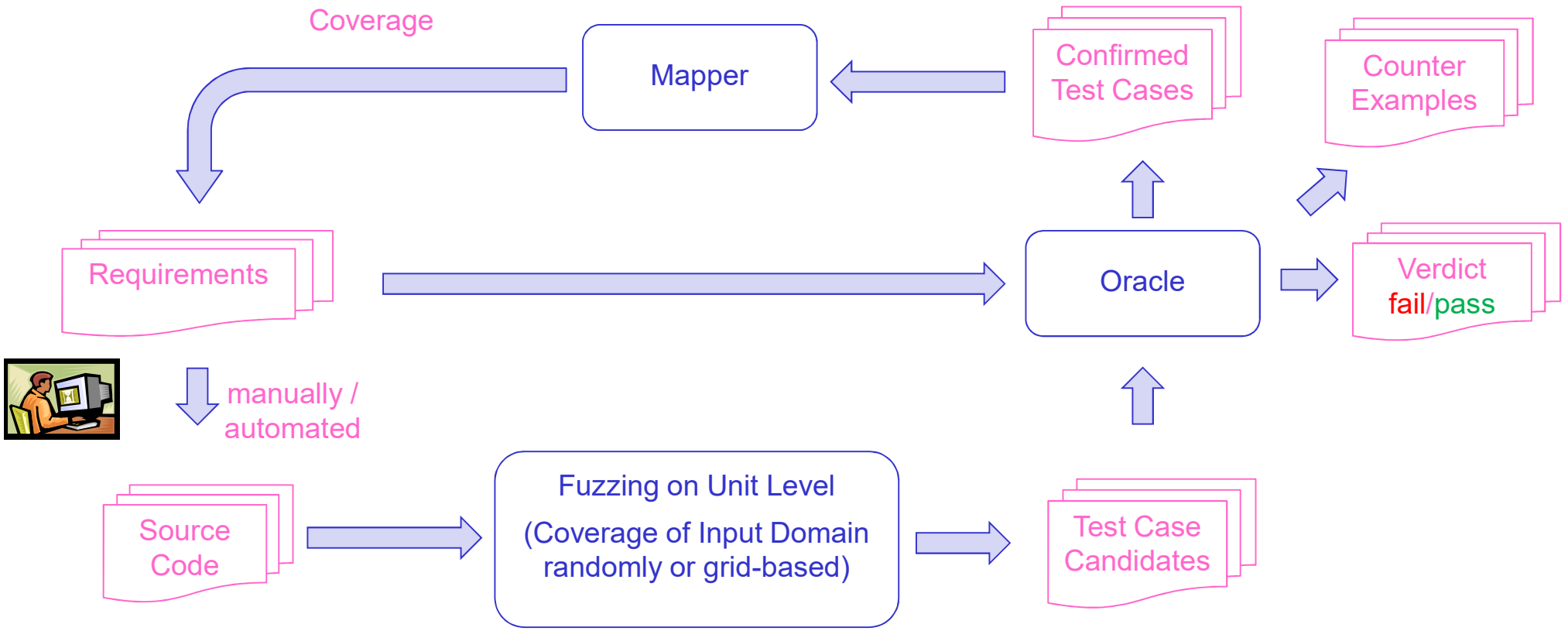
The Manual Procedure for RQBT



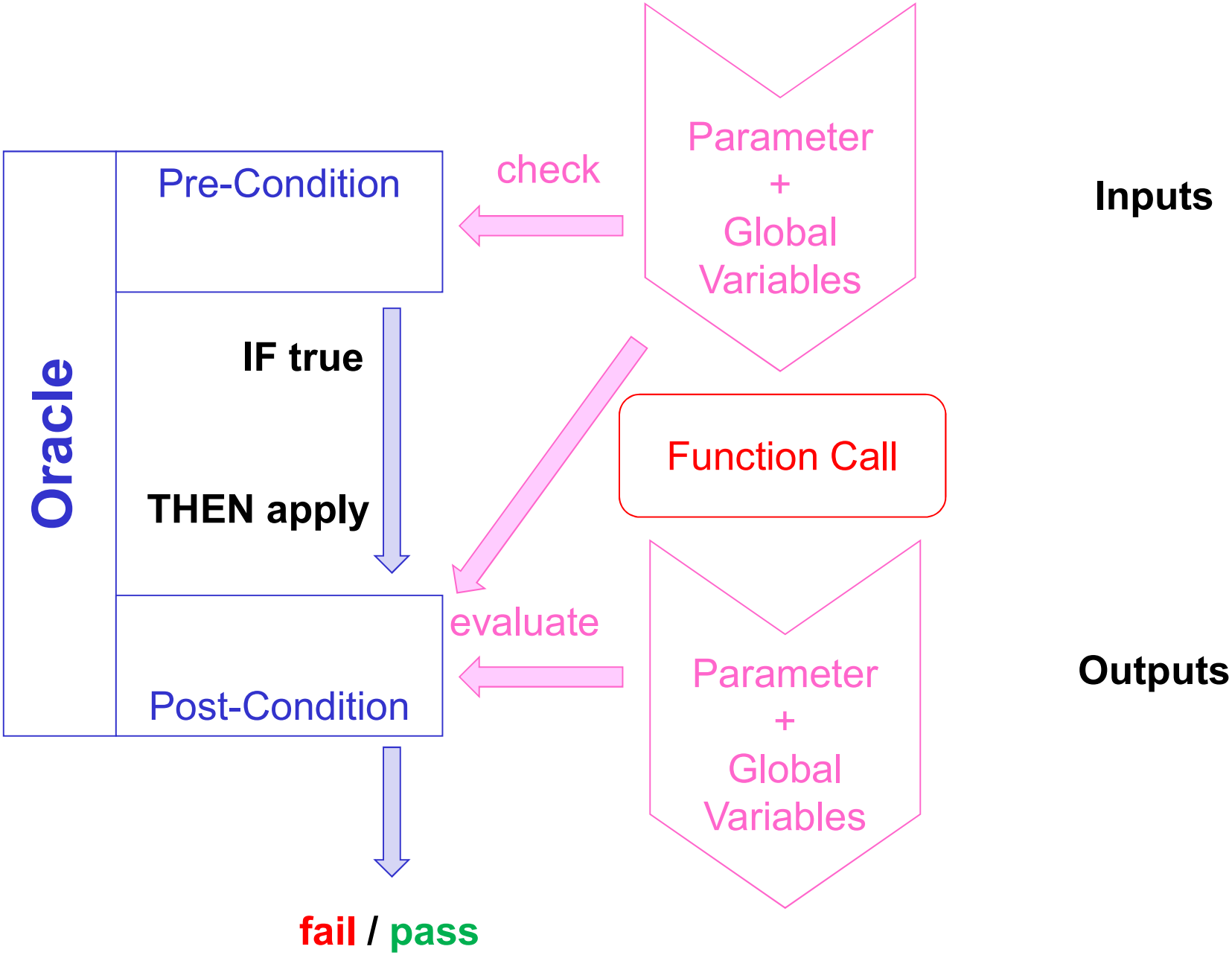
Model-Based Testing



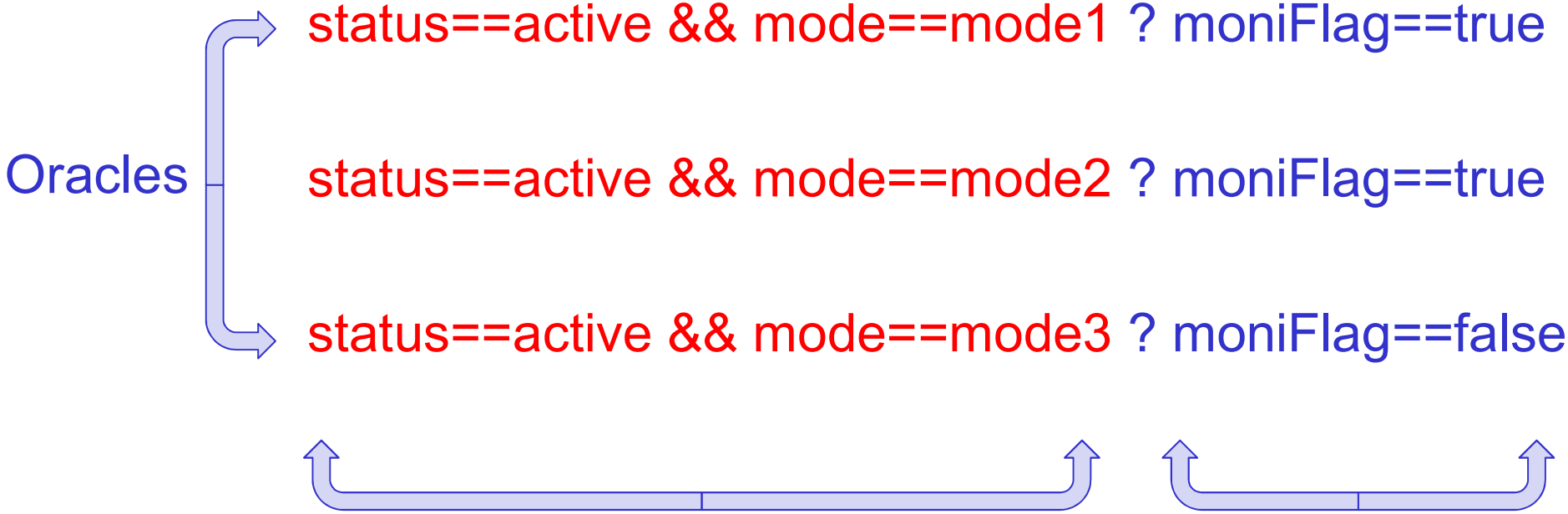
Our Approach



Oracle Structure



Example: Status Monitoring



Some Mathematical Examples and Results of Implementation

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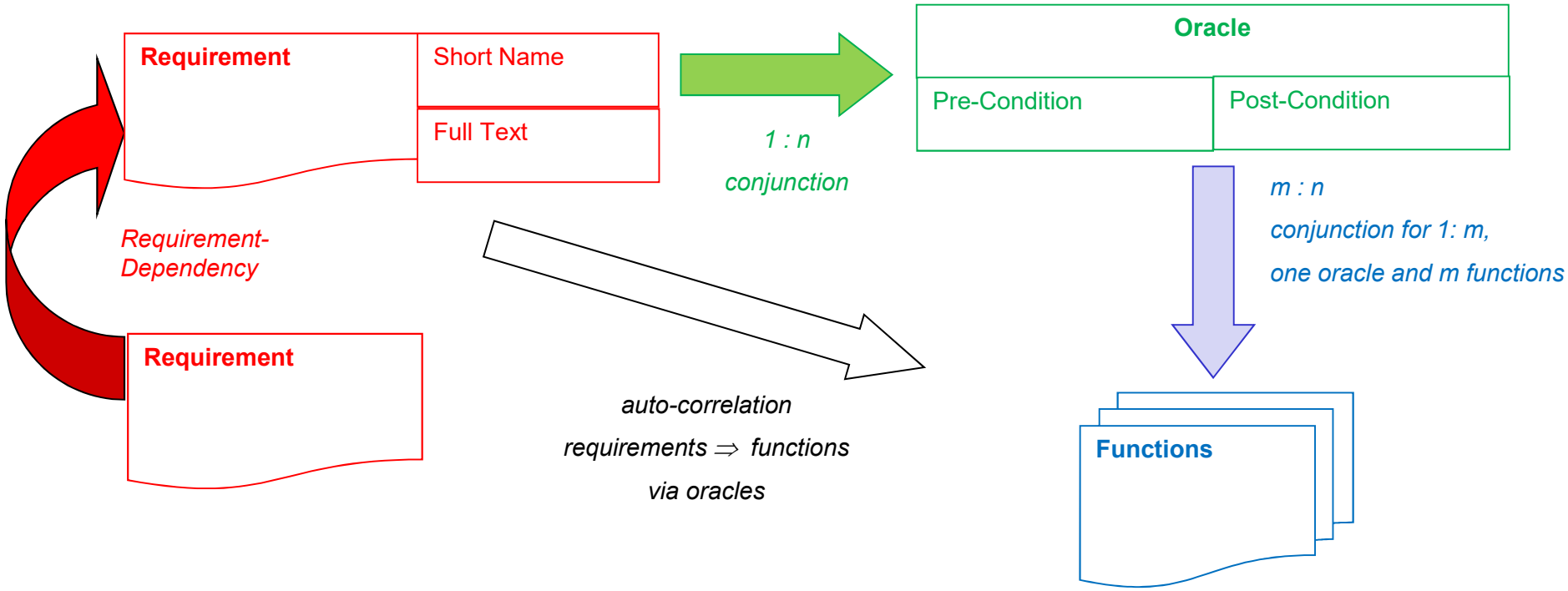
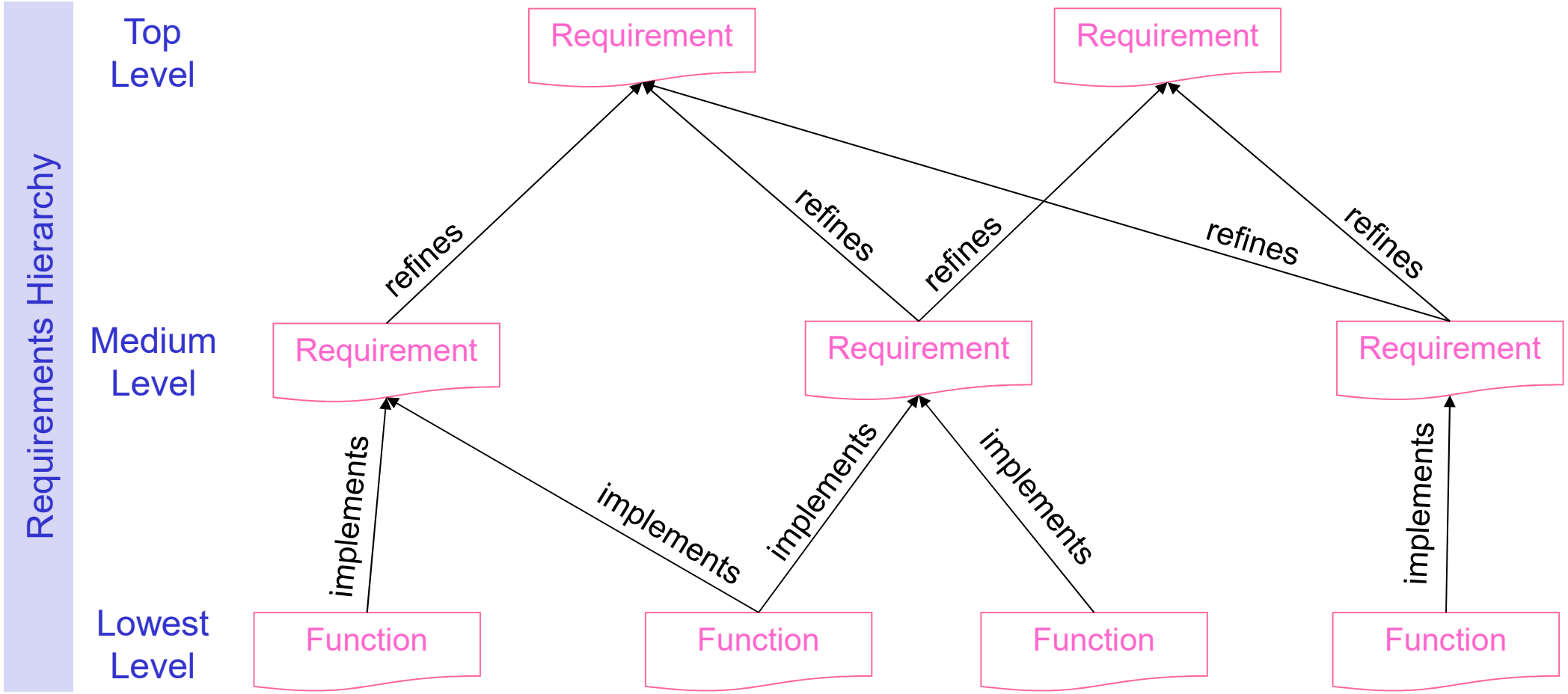
Function	Requirement	Oracle		Number of Tests	Oracle Output			RQ fully covered	RQ verified
		Pre-Condition	Post-Condition		Coverage	true	false		
x*x	$\forall x \in \{double\}\ \sqrt{x^2}$ shall not differ from $\|x\|$ more than ε	x normalised	`(fabs(fabs(x)-sqrt(retVal))/x)<eps`	302	299	225	74	yes	no
		x denormalised	`fabs(fabs(x)-sqrt(retVal))<eps`		3	3	0		
abs(x)	$\forall x \in \{sint\}$ abs(x) shall be ≥ 0	`true`	retVal>=0	302	302	301	1	yes	no

Mapping Scheme

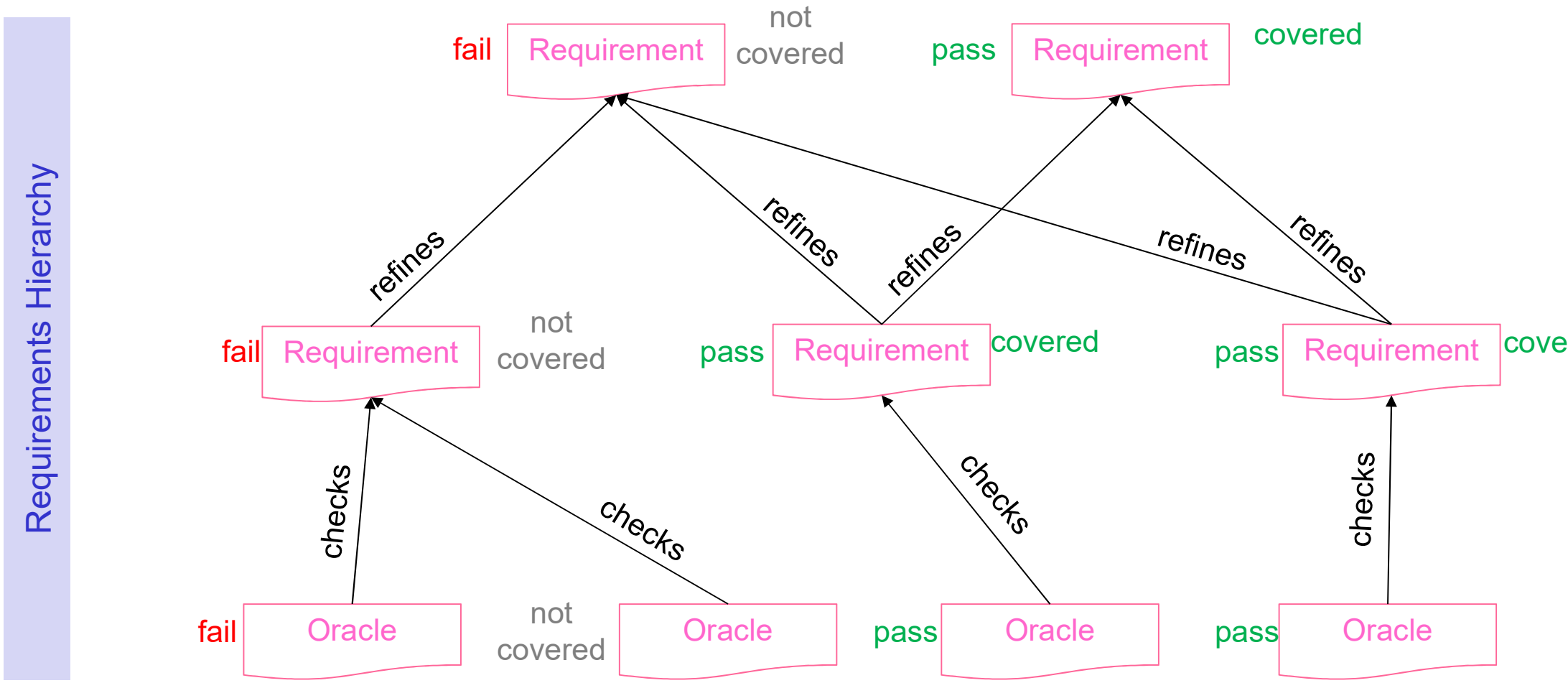


Goal / Challenge:
automated derivation
supported by some
formalised (an)notation
of requirements

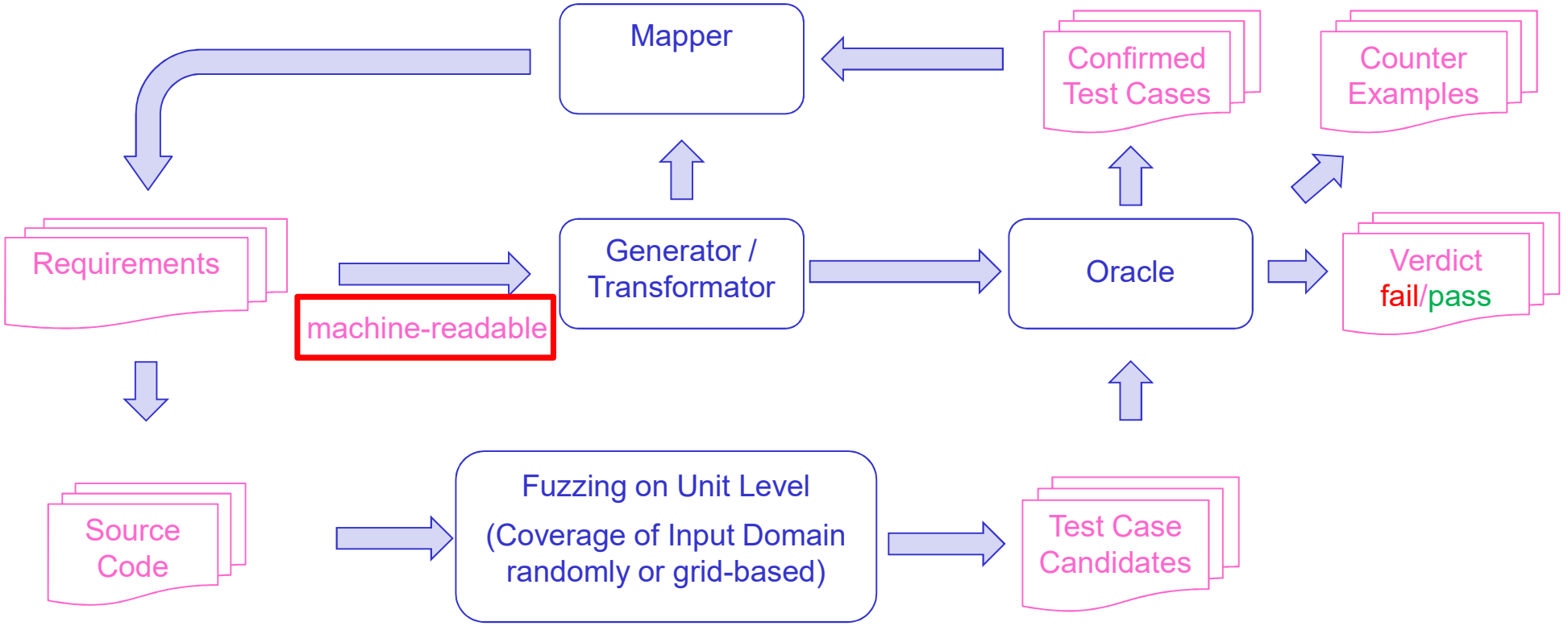
Functions vs. Requirements



Oracles vs. Requirements and pass / fail Inheritance



THE Challenge: machine-readable requirements (an)notation



Currently:
Requirements as pure text (Word, DOORS)
Automated extraction of oracles is difficult/impractical

Challenge:
Suitable and acceptable notation for requirements / oracles

Suggestions from users required!

Aspects of Quality Assurance

- The same measures for quality assurance as for the source code to be verified also apply to the oracles.
- This is similar to measures for manual verification.
- In addition, suitable automated checks can be applied in case of automated derivation of oracles.
- In contrast to manual processing the measures are consistently applied for every verification step.
- Improvement in the quality of requirements also expected.

Status

- Oracle notation defined
- Implementation available for integration of oracles with fuzzing / massive stimulation
- Reporting available with bottom-up propagation of pass/fail results
- Identification of counter examples confirmed
- Support for identification of source of failing oracles

Outlook

- Identification of user-acceptable machine-readable notations
- Analysis of current requirements
- Classification of requirements
  - top-level / low-level
  - functional
  - non-functional
  - quantifiable
- Proof-of-concept

Acknowledgement

The presented approach is an outcome of the ESA-project "Automated Source-code-based Testing, Continued" (FAST II) for the European Space Agency (ESA) (ESA Contract No. 4000116014) as part of the General Support Technology Programme (GSTP).

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