

List of Publications

The publications that are found for each research question are listed based on their categories described in Section 5 of SLR.

Types of Counterexample Representation	Publications
Graphical Representation	[1–55]
Trace	[56–91]
Textual Representation	[92–107]
Graphical Representation and Tabular View	[108–112]
Tabular View	[113–117]
Total Count	116

Table 1: Counterexample representations.

Category	Publications
Minimized counterexample	[2, 7, 29–31, 40, 44, 46, 52, 55–57, 59, 60, 62–67, 69–71, 73–77, 81–83, 85–90, 96]
Witness and Counterexample	[12, 22, 41, 58, 68, 72, 79, 91, 106]
Multiple Counterexample	[39, 47, 54, 61, 80, 103, 105]
Total Count	54

Table 2: Counterexample processing

Categories in RQ12:	Publications
Additional information provided for enriching the counterexample representation	[1, 15, 53, 92–94, 97, 113]
Additional information by witness traces	[58, 64, 72, 103]

Table 3: Enriching counterexamples with additional information

Input domain	Publications
System model (State machine/Kripke/MDP/DTM-C/LTS)	[5, 6, 10–13, 20, 25, 30–33, 35, 39–41, 43, 44, 46–53, 55, 98, 101, 105, 109, 111, 114, 116, 117]
Programming Language	[2, 22, 26, 27, 29, 42, 45, 100, 102–104, 106, 107, 110, 115]
Function Block Diagram	[1, 8, 14, 17, 18, 37, 38]
Component diagram	[3, 7, 19, 112]
Structured English Language	[93, 94, 97, 99]
SCADE/Simulink Model	[15, 24, 34]
CNL	[95, 96]
Others	[4, 9, 16, 21, 23, 28, 36, 54, 92, 108, 113]
Total	81

Table 4: Publications for **RQ9**: - Input domain

Output Domain	Publications
Graph	[22, 23, 30–33, 40, 42–47]
State Machine	[2, 5, 6, 13, 25–27, 29]
Fault tree	[35, 48–52, 55]
Tabular view	[113–117]
Programming Language	[102–104, 106, 107]
Structured English Language	[93, 94, 97–99]
Function Block Diagram	[1, 14, 17, 18, 37, 38]
Trace Simulation of signal	[8, 12, 34, 53, 54]
Textual Representation	[10, 100, 101]
Others	[3, 4, 7, 9, 11, 16, 19–21, 28, 36, 39, 41, 92, 105, 108–112]
Total	81

Table 5: Publications for **RQ9**: - Output domain

Category	Sub-Category	Publications
Independent	Reference/Mapping	-
	Simulation	[13, 16, 26]
	Traceability	[3, 6, 8, 23, 29, 39, 40, 46–49, 51, 52, 55, 92–94, 96–99, 101, 113]
	No Reference/Mapping	[2, 5, 10–12, 20–22, 25, 27, 30–36, 41–45, 50, 53, 54, 100, 105, 109–111, 114–117]
Same	Reference/Mapping	[4, 7, 9, 15, 24, 28, 95, 102–104, 106, 107]
	Simulation	[1, 14, 17–19, 37, 38, 108, 112]
	Traceability	-
	No Reference/Mapping	-
Total		81

Table 6: Relations between input domains and output domains.

Specification	Publications
LTL	[1, 2, 6, 18–20, 25–28, 37, 38, 49, 53, 54, 56, 57, 59, 63, 64, 66, 68, 72, 75, 80, 85, 90, 101, 106–108]
CTL	[8, 12, 21, 39, 41, 87, 89, 110, 111, 116]
PCTL	[10, 40, 76, 77, 83]
CSL	[48, 50, 51, 55]
LTL, CTL	[14, 114, 115]
μ -calculus	[23, 42]
ACTL	[61, 82]
CL	[84, 96]
PSL	[11, 86]
Others	[3, 7, 9, 43, 46, 47, 58, 62, 93, 99]
Total	71

Table 7: Types of specification **RQ2**:

Property	Publications
Safety, Liveness	[1, 2, 4, 7, 8, 20, 21, 31, 38, 42, 45, 49, 53, 54, 58, 59, 63, 75, 91]
Safety	[18, 22, 29, 30, 39, 62, 64, 68, 69, 74, 79, 103, 105, 106]
Liveness	[11, 27, 85, 88]
Total	37

Table 8: Types of property specification.

Verification Tool	Publication
NuSMV/SMV/nuXmv	[1, 3, 14, 17, 18, 28, 37, 38, 41, 46, 47, 59, 61, 68, 74, 80, 82, 86, 90, 108, 109, 111–114, 116]
PRISM	[10, 44, 48, 51, 62, 71, 76, 83, 98]
SPIN	[6, 20, 56, 57, 63, 65, 75, 105]
Maude	[2, 13, 25–27]
ACL2	[92–94, 97]
VIS	[12, 21, 60, 110]
Others	[11, 15, 16, 19, 22, 23, 35, 49, 58, 81, 96, 100, 103, 115, 117]
Total	90

Table 9: Verification tools.

Framework	Publications	URL
DiPro	[10, 44, 55, 83]	http://www.uni-konstanz.de/soft/dipro/download.php
AutoFocus3	[3, 19, 112]	https://www.fortiss.org/veroeffentlichungen/software/autofocus-3
MODCHK	[1, 14, 18, 38]	https://github.com/igor-buzhinsky/nusmv_counterexample_visualizer
SpinCause	[49, 50, 52]	http://www.uni-konstanz.de/soft/tools/spincause/
KEGVis	[39, 41, 43]	http://www.drawsvg.org/
CLEAR	[30, 31]	https://github.com/gbarbon/clear/
FRET	[34]	https://github.com/NASA-SW-VnV/fret
RailComplete	[99]	https://www.railcomplete.com/en/downloads/
IBM RoseRT	[11]	https://www.ibm.com/support/pages/ibm-rational-rose-realtime-7001-ifix001
Ivy	[5]	https://www.cs.tau.ac.il/~odedp/ivy/
COMICS	[40]	https://www-i2.informatik.rwth-aachen.de/i2/comics/
DSValidator	[100]	https://ssvlab.github.io/dsverifier/dsvalidator/index.html
FASTEN	[108]	https://sites.google.com/site/fastenroot/
PLCverif	[115]	https://readthedocs.web.cern.ch/display/ICKB/PLCverif/
PyNuSMV	[47]	https://pypi.org/project/pynusmv/
VIS	[110]	https://ptolemy.berkeley.edu/projects/embedded/research/vis/
AMASE	[4]	https://github.com/afrl-rq/OpenAMASE/wiki/About-AMASE
Arcade.PLC	[29]	https://arcade.embedded.rwth-aachen.de/doku.php?id=arcade.plc
[Mc]SQUARE	[79]	https://arcade.embedded.rwth-aachen.de/
RuleBase PE	[53]	http://www.research.ibm.com/haifa/Workshops/rulebase2010/index.shtml
MechatronicUML	[7]	http://www.mechatronicuml.org/en/index.html
ELARVA	[84]	http://www.cs.um.edu.mt/svrg/Tools/ELARVApplus/
NuSeen	[114]	http://nuseen.sourceforge.net/
SpinRCP	[20]	http://lms.uni-mb.si/spinrcp/

Table 10 continued from previous page

Framework	Publications	URL
FLAVERS/Ada	[70]	http://laserweb.cs.umass.edu/verification-examples/chiron/original/2a2e/source/ada_flavors/index.html
GraphML	[22]	http://graphml.graphdrawing.org/
OERITTE	[37]	https://github.com/ShakeAnApple/cxbacktracker/
ASSERT	[92–94, 97]	-
A2G2V	[32, 33]	-
IFADIS	[109, 116]	-
STANCE	[15, 24]	-
FaultCAT,CX2FT	[48, 51]	-
AnaCon	[96]	-
Pseudo-merge	[23]	-
EOFM	[101]	-
ProofProd	[72]	-
Evidence Explorer	[42]	-
SMART	[87, 89]	-
Alfi	[80]	-
Theseus	[16]	-
MACEMC	[45]	-
QuantUM	[35]	
ATL	[36]	
Total		62

Table 10: Counterexample explanation frameworks.

Application Domain	Publications
Protocol	[2, 5, 26, 27, 33, 40, 45, 63, 71, 73, 75–77, 87]
Hardware	[10, 12, 16, 29, 37, 44, 51, 54, 74, 81, 83, 105, 111, 115]
Automotive	[21, 24, 35, 36, 43, 48, 52, 55, 80, 90]
Robotics	[4, 8, 19, 46, 98, 100]
Avionics	[91–94, 97]
Nuclear	[1, 14, 18, 38]
Railway	[95, 99, 113]
Others	[6, 7, 9, 13, 15, 28, 42, 49, 50, 64, 96, 106, 112]
Total	69

Table 11: Publications for **RQ8**: application domain

Use-Case	Publications
Reference to non-industrial use-case	[5, 10, 23, 26, 27, 30, 31, 33, 40, 42, 44, 49, 50, 53, 58, 59, 62, 63, 71, 73, 76, 77, 80, 81, 83, 87–89, 92, 100, 105]
Reference to industrial use-case	[7, 21, 24, 28, 29, 35, 36, 48–50, 52, 55, 62, 64, 80, 90, 91, 105–107, 111, 115]
Example Use-Case	[2, 8, 11–13, 22, 32, 37, 39, 43, 45, 56, 74, 75, 79, 84, 101–103]
Non-Industrial Use-Case	[4, 9, 19, 51, 95, 96, 98]
Industrial Use-Case	[1, 6, 14–16, 18, 38, 46, 51, 54, 93, 94, 97, 99, 112, 113]
Total	89

Table 12: Publications for **RQ8**: use-case

Evaluation Aspects	Publications
Efficiency, Performance	[11, 12, 21, 22, 29–31, 35, 36, 38, 40, 42–46, 48–54, 56, 58–60, 62, 63, 65, 66, 68–71, 73–77, 79–82, 86, 87, 90, 91, 95, 98–100, 103, 105, 106]
Effectiveness	[1, 2, 4–10, 13–16, 18, 19, 22–24, 26–28, 30–33, 37, 38, 44, 54, 55, 64, 83, 84, 88–90, 92–94, 96, 97, 99, 102, 105, 107–109, 111–113, 115]
Scalability	[35, 53, 58, 62, 65, 66, 71, 80, 81, 89, 91, 98, 103]
Total	97

Table 13: Publications for **RQ8**: evaluation aspects

Evaluation Method	Publications
Use-Case(s)	[1, 2, 4–11, 13–16, 18, 19, 21–24, 26–33, 35–38, 40, 42–46, 48–55, 58, 59, 62–64, 71, 73–77, 79–81, 83, 84, 87–100, 102, 103, 105–107, 111–113, 115]
Benchmark	[12, 40, 43, 52, 56, 60, 63, 65, 66, 68–71, 74, 75, 77, 82, 86, 87, 89, 98]
User-Study	[30, 31, 108, 109, 111, 113]
Total	97

Table 14: Publications for **RQ8**: evaluation methods

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Acronyms

ACL2 A Computational Logic for Applicative Common Lisp.

AMASE Aerospace Multi-agent Simulation Environment.

ASSERT Analysis of Semantic Specifications and Efficient generation of Requirements-based Tests.

BDD Binary Decision Diagrams.

BFL Brute Force Lifting.

BFS Breath-First Search.

BPMN Business Process Model and Notation.

Butramin BUg TRAcE MINimization.

CAD Computer-aided Design.

CBD Contract-Based Design.

CBMC C Bounded Model Checker.

CL Contract Language.

CLAN Contract Language ANalyser.

CNL Controlled/Constrained Natural Language.

COMICS Computing Minimal Counterexamples.

CSL Continuous Stochastic Logic.

CTL Computation Tree Logic.

CTMC Continuous-Time Markov Chain.

DFS Depth-First Search.

DiPro Directed Probabilistic Counterexample Generation Tool.

DSL Domain-Specific Language.

DTMC Discrete-Time Markov Chain.

FASTEN FormAl SpecificaTion ENvironment.

FMEA Failure Mode and Effect Analysis.

FTA Fault Tree Analysis.

GF Grammatical Framework.

GraphML Graph Markup Language.

GUI Graphical User Interface.

HAZOP Hazard and Operability.

KEGVis Kounterexample generator and visualizer.

LTL Linear Temporal Logic.

MDP Markov Decision Processes.

MILP Mixed Integer Linear Programming.

MPS Meta Programming System.

MRMC Markov Reward Model Checker.

MSC Message Sequence Chart.

NuSMV New Symbolic Model Verifier.

PCTL Probabilistic Computation Tree Logic.

PLC Programmable Logic Controller.

PRISM Probabilistic Symbolic Model Checker.

PROMELA Process or Protocol Meta Language.

PSL Property Specification Language.

RAE Requirements Analysis Engine.

RTCTL Real Time Computation Tree Logic.

SAT Satisfiability.

SMT Satisfiability Modulo Theories.

SMV Symbolic Model Verifier.

SPIN Simple PROMELA Interpreter.

STANCE Structural Analysis of Counter-Examples.

SysML Systems Modeling Language.

TCTL Timed Computational Tree Logic.

UAV Unmanned Aerial Vehicle.

UML Unified Modeling Language.

VIS Verification Interacting with Synthesis.

XBF eXtended Best-First.

XChek Multi-valued Model-Checker.