Recent advances in refutations and validations using Meth8 modal logic model checker

In applied and theoretical mathematics, assertions are categorized in alphabetical order as: axiom; conjecture; definition, entry; equation; expression; formula; functor; hypothesis; inequality; metatheorem; paradox; problem; proof; schema; system; theorem; and thesis. We evaluate 144 objects for 594 assertions to validate 174 as tautology and 420 as not (71%). We use Meth8 that is a modal logic checker in five models.

The semantic content or predicate basis of some expressions on their face does not disqualify them from evaluation by Meth8 in classical modal logic. However, the rules of classical logic, as based on the corrected Square of Opposition by Meth8, apply to virtually any logic system. Consequently some numerical equations are mapped to classical logic as Meth8 scripts.

The rationale for mapping quantifiers as modal operators is in the Appendix based on satisfiability and reproducability of validation of syllogisms.

A table lists what was tested with separated results. The names are numbered in alphabetical order. Test results are Invalidated as Not Validated Tautology (nvt) or Validated as Tautology (vt). For a paradox, invalidated means it is not validated as tautologous, that is, it is not a paradox or contradiction.

The experimental tests used variables for 4 propositions, 4 theorems, and 11 propositions. The size of truth tables are respectively for 16-, 256-, and 2048- truth values. One formula of Popper in 250-characters processed in 125-steps instantly due to recent advances in look up table indexing.

The Meth8 modal theorem prover implements the logic system variant VŁ4 which corrects the quaternary Ł4 of Łukasiewicz. There are two sets of truth values on the 2-tuple {00, 10, 01, 11} as respectively <contradictory for contradiction, Contingent for falsity, Non contingent for truth, Tautology for proof> and <Unevaluated, Improper, Proper, Evaluated>. The model checker contains recent advances in parsing technology and is U.S. Patent Pending.

The mapping of formulas into Meth8 script was performed by hand, checked, and tested for accuracy of intent. (A semi-automation of that process is underway.) The Meth8 script uses literals and connectives in one-character. Propositions are p-z, and theorems are A-B. The connectives for <and, or, imply, equivalent> are <&; +; >; =). The negated connectives for <nand; nor; not imply; exclusive-or> are <\; -; <; @>. The operators for <not; possibility ◇ ∃; necessity □ ∀> are <~; %; #>. Some expressions are adopted for clarity such as: (p=p) for tautologous; (p@p) for contradiction; and (x<y) for x∈y. The expression "x less than or equal to y" is rendered in the negative as ~(x>y).

Definition	Axiom	Symbol	Name	Meaning	2-tuple	Ordinal
1	p=p	T	Tautology	proof	11	3
2	p@p	F	Contradiction	absurdum	00	0
3	%p>#p	N	Non-contingency	truth	01	1
4	%p<#p	C	Contingency	falsity	10	2

The designated proof value is T tautology. Note the meaning of (%p>#p): a possibility of p implies the necessity of p; and some p implies all p. In other words, if a possibility of p then the necessity of p; and if some p then all p. This shows equivalence and interchangeability of respective modal operators and quantified operators, as proved in Appendix.

For Meth8 an immediate further application to "validate as tautologous" is mapping sentences of natural language into logical formulas. The approach identifies parts of speech as nouns, verbs, and modifiers. These translate into logical symbols for literals, connectives, and operators. For example: the conjunction "and" becomes the connective "&"; and the modifier articles "the" and "a" become the modal box # and lozenge %. Expressions for consecutive sentences are linked by the imply connective to build paragraphs to form requirements documents.

No.	Name of object	Type of object	Results with instances
1	ABC	Conjecture	Invalidated
2	Alcoholics Anonymous BB: We agnostics, p 53	Traditions	Invalidated
3	Alexandroff correspondence	Conditional	Invalidated (3)
4	Anderson division by zero as nullity	Theorem	Invalidated
5	Axiomatizing category theory in free logic	Axioms	Invalidated
6	Banach-Tarski	Paradox	Invalidated
7	Barcan	Formula	Validated
8	Bayes rule	Rule	Invalidated (11) Validated(11)
9	Bell / CHSH / Spekken toy model	Inequalities	Invalidated
10	Berkeley	Paradox	Invalidated
11	Biscuit conditionals	System	Invalidated (13)
12	Bogdanov map, 2D conjugate of Hénon map	Formula	Invalidated
13	Borsuk-Ulam	Theorem	Validated
14	Borsuk-Ulam extensible, non-invertive	Theorem	Validated (2)
15	Branching quantifier (Hintikka)	System	Invalidated
16	Buridan's Ass	Paradox	Invalidated
17	Caithin incompleteness and L constant	Theorem	Invalidated (3) Validated (1)
18	Cantor's diagonal argument	Proof	Invalidated (3)
19	Cantor pairing	Functor	Invalidated (2)
20	Category composition of morphisms	Definition	Invalidated (1)
21	Church	Thesis	Invalidated
22	Clifford tori 2D / Kanban cell neuron	Definition	Validated
23	(Lothar) Collatz	Conjecture	Validated
24	Constructivistic logic	System	Invalidated (14) Validated (2)
25	Creative theories in degrees of unsolvability	Theorem	Invalidated
26	D Ultrafilter contra continuum problem	Equation	Invalidated (1)
27	Dedekind lattice identity	Axiom	Validated
28	Density of all Turing and truth table degrees	Formula	Invalidated (2)
29	Description logic	System	Invalidated (2)

30	Dialetheism	System	Invalidated (4)
31	Dialetheism: inconsistent	System	Invalidated (2)
32	Dichotomy of selection	System	Invalidated
33	Diverse double compiling	Schema	Invalidated
34	Doxastic logic	System	Invalidated (8) Validated (13)
35	Ehrenfeucft-Mostowski indiscernables	Theorem	Invalidated (1)
36	Epistemic coalition	Perfect recall	Invalidated (4) Validated (3)
37	Epistemic dynamic reasoning	System	Invalidated (2)
38	Epistemic Hilbert substructure	System	Invalidated (5)
39	Epistemic navigation	System	Invalidated (8)
40	Epistemic quantifiers over agents	Conjecture	Invalidated (8) Validated (12)
41	Erdös-Strauss	Conjecture	Invalidated
42	FOL disjunctive normal forms (DNF): minimize	FOL Optimizer	Invalidated (2) Validated (1)
43	Gentzen proof of sequent System G-M	System	Invalidated (6) Validated (2)
44	Gettier (Justified tautologous belief)	Conjecture	Validated
45	Gödel compactness	Theorem	Invalidated (6) Validated (2)
46	Gödel completeness	Theorem	Invalidated
47	Gödel first incompleteness	Theorem	Invalidated (4)
48	Gödel incompleteness	Equations	Invalidated (14) Validated (1)
49	Gödel incompleteness FOL	Contradicitions	Invalidated (14) Validated (1)
50	Gödel incompleteness theorem	Assistant tools	Invalidated (2) Validated (2)
51	Gödel incompleteness theorem	Refutation	Invalidated (7)
52	Gödel-Löb	Axiom	Invalidated
53	Gödel recursion	Theorem	Validated
54	Gödel-Scott on God	Theorem schema	Invalidated
55	Goldbach's conjectures	Conjectures	Invalidated
56	Grassmannian (*recently discovered*)	Paradox	Invalidated
57	Henkin cyclic algebra and first order logic	System	Invalidated (9) Validated(6)
58	Applications to logic	Axioms	Invalidated (8) Validated(6)
59	Permutation model nonrepresentable	Assertion	Invalidated (1)
60	Herbrand semantics	System	Invalidated (6)
61	Heyting-Brouwer intuitionistic logic	Systems	Invalidated (9) Validated (1)
62	Hilbert #10 Diophantine universal solution	Formulas	Invalidated
63	Hilbert generalization	System	Invalidated
64	Huhn 2-distributive lattice identity	Formula	Invalidated

65	Imperative logic	System	Invalidated (3) Validated (4)
66	Ignorance of first choice	System	Invalidated
67	Inconsistent theory	Theorem	Invalidated
68	Extending the monad to a triad	Formulas	Invalidated
69	Kunen inconsistency	Theorem	Invalidated
70	Independence-friendly logic (Kreiselization)	System	Invalidated (2)
71	Indicative conditionals	Encyclopedia entry	Invalidated
72	Induction: Black raven (swan); Kripkenstein	System	Invalidated (3)
73	Inequality: 'arbitrarily' vs 'sufficiently large	Conjecture	Invalidated (2) Validated (1)
74	Infinite set theory	Theorem	Invalidated
75	Jonsson positive logic: retromorphism	System	Invalidated (3)
76	Immanuel Kant: falsity of syllogistic figures	Theorems	Invalidated (8) Validated (2)
77	Karpenko, S.A.	System K-Ł4	Invalidated
78	Kuratowski–Zorn lemma (Zorn's lemma)	Lemma	Invalidated
79	Lachlan problem solution	Problem	Invalidated (4)
80	Leibniz' ontological proof	Proof	Invalidated (1) Validated (1)
81	Briefest known ontological proof of God	Proof	Validated (2)
82	Lemmon D	Axiom	Invalidated
83	Liar	Paradox	Invalidated
84	Prior rendition	Paradox	Invalidated
85	Kripke rendition	Paradox	Invalidated
86	Löb original, corrected	Theorem	Invalidated (1) Validated (1)
87	Löwenheim–Skolem, Hilbert style	Metatheorem	Invalidated
88	Luce model (general)	Definitions/Axioms	Validated (5)
89	Marjorana's 'root'	Equations	Invalidated (5)
90	Meth8 versus Prover9 via Lifshitz	Problem	Validated
91	Modified divine command	Theory	Invalidated
92	Necessitation: **K**,**T**,**4**,**B**,**D**,**5**; *D*,*M*,*S4*,*B*,*S5*	Axiom	Invalidated (10) Validated (7)
93	Leonard Nelson's criticism of epistemology	System	Invalidated
94	von Neuman-Bernays-Gödel [NBG]	Theory	Invalidated (2) Validated (3)
95	Neutrosophic logic	Theorems	Invalidated (5)
96	Neutrosophic sets	Properties	Invalidated (3)
97	Unification of other logics	Axioms / Rules	Invalidated (2)
98	P=NP	Conjecture	Invalidated
99	Paraconsistency, machine-assisted view	Axioms	Invalidated

100	Paraconsistent contradiction	Conext	Invalidated
101	Peano arithmetic 9, 1-8	Axioms	Invalidated (1) Validated (8)
102	Karl Popper on God	Proof	Validated
103	PowerEpsilon mathematical induction	Axiom	Validated (1)
104	Prover9 vs Meth8 differences	System	Invalidated
105	Ramsey's theorem for the 2-color case	Theorem	Validated (2)
106	Ranjan, A.	Problem	Validated
107	Realizability semanics for QML	Theorems	Invalidated (3)
108	Reichenbach common cause / event-splitting	Principle	Invalidated
107	Riemann: only zeroes at 0, 1/2	Hypothesis	Invalidated
108	Roman Catholic Church (RCC)	(Dogma)	Invalidated (7)
109	Erasmus contra Luther	Controversy	Validated
110	Infallibility and the Historic Church	Pius IX	Invalidated (2)
111	Magisterium	Paul VI	Invalidated (1)
112	Tradition above scripture	Pius IX	Invalidated (4)
113	Rota lattice theory, distributive	Axiom	Invalidated
114	Russell	Paradox	Invalidated
115	S5Π+ propositional quantification	System	Invalidated
116	Schrödinger's cat	Paradox	Invalidated
117	Self-equilibrium	Law / Paradox	Invalidated
118	Sorites	Paradox	Invalidated
119	Square of Opposition Meth8 Corrected	System	Validated
120	Square of Opposition Modern Revised	System	Invalidated
121	Square of Opposition	Proportions	Invalidated (3)
122	Stone space type lattice logic model	Theory	Invalidated (2)
123	Stone-Wales rotation transform reversibility	Theorem	Invalidated (2) Validated (1)
124	Time as God	Conjecture	Validated
125	Topological manifold transition	Function	Invalidated (1)
126	Universal finite set	Theorem	Invalidated (2)
127	Veblen (corrected)	Axiom	Invalidated (1) Validated(1)
128	Veronoï regions (with "nonempty sets")	Definition	Invalidated
129	W (K4W)	Theorem	Invalidated
130	Well ordering property	Axiom	Invalidated
131	Wittgenstein's ab-notation	System	Invalidated (3)
132	Yalcin logic	Axioms	Invalidated (2)

133	Zadeh first operators on fuzzy logic	System	Invalidated (5)
134	Zermello-Fraenkel (ZFC):	(Axioms)	Invalidated (10) Validated (1)
135	ZFC Choice	Axiom	Invalidated
136	ZFC Empty set	Axiom	Invalidated
137	ZFC Extensionality	Axiom	Invalidated
138	ZFC Infinity	Axiom	Invalidated
139	ZFC Pairing	Axiom	Invalidated
140	ZFC Power set	Axiom	Invalidated
141	ZFC Regularity or foundation	Axiom	Invalidated
142	ZFC Schema of replacement	Axiom	Invalidated
143	ZFC Specification	Axiom	Validated
144	ZFC Union	Axiom	Invalidated
145	ZFC Well ordering	Axiom	Invalidated
146	Zero knowledge proof	Theorem	Invalidated

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