$\Pi(\mathcal{SD})$ (ASP encoding of \mathcal{AL} system	answer set, 11
description), 172	formal definition, Part I, 21
Π^S (reduct), 26	formal definition, Part II, 26
$\Pi_c(\mathcal{SD})$, 168	intuition for, 16
Σ (signature), 11	of CR-Prolog, 105
σ_0 (initial state), 162	answer set planning, 197
σ_n (final state), 163	answer-set programming paradigm, 114
SD (system description), 167	Answer Set Prolog (ASP), 5, 11–35
$\mathcal{T}(\mathcal{SD})$ (transition diagram), 167	semantics, 16–29
	syntax, 11–16
abductive support, 105–108	answer set solver, 29, 114-115
aces in succession example, 250-251	arithmetic term, 12, 15
action languages, 165	arity, 11
agent, 1	ASP program, 14
agent action, 216	properties of, 31–35
agent architecture, 2	ASP solver, see answer set solver
agent loop, 3	ASPIDE, 310–313
AL, 165–187	atom, 13
statements of, 167	ground, 14
algorithm	attribute (P-log), 241
for answering queries, 148-149	autoepistemic logic, 44, 46-47
for computing answer sets, 131-150	Awareness Axiom, 225, 235
for computing answer sets of disjunctive	axiomatic method, 6-8
programs, 147–148	
for computing models of propositional	backtracking, 131, 281, 282
formulas, 131–136	Bayesian squirrel example, 260–263
resolution, 271	biased dice example, 245–246
SLD resolution, 276–282	blocks world domain, 154
SLDNF resolution, 282–284	concurrent actions in, 182-184
translation from AL to ASP,	first try in ASP, 152–162
172–174	modeling with AL , 179–182
unification, 271–276	planning, 195–199
algorithmic language, 3	body (of a rule), 14
all_clear(), 224	briefcase domain, 175-179
ancestor example, 68-71	recorded history in, 219-220

Cancellation Axiom, 88	Davis-Putnam procedure, 131–136
special case, 92	declarative language, 4
causal law, 157 , 163, 167, 173	default, 86 –108
causal probability, 247, 247	Contingency Axiom, 104
causal probability statement, 245	exception to, 87–108
choice rule, 118 , 124, 127, 193	priorities between, 95–98, 102
circuit diagnostic example, 217–218,	Reiter's, 47
221–223, 226–228, 325–329	default logic, 44, 47–49
circumscription, 44-46	default negation, 14, 49, 52
Clark's completion, 50, 49–53	example, 19, 26
Clark, Keith L., 49	removal, 26
ClaspD, 115	default rule, 88
classical planning, 192	default theory, 48
Clingo, 115 , 307	defined fluent, 162, 172, 173, 198
Closed World Assumption (CWA), 21, 32,	definite program, 140, 271
65–66, 86	dependency graph, 33
Colmerauer, Alain, 8	derivatives example (Prolog), 295–304
commonsense knowledge, 61, 74, 76, 125,	diagnose(), 226
126	diagnostic problem, 216
commonsense reasoning, 20, 86, 236–238	example, 217–218
complementary, 14	diagnostics, 216–231
concurrent planning, 208–209	dice example, 243–245
configuration (of a system), 220	DLV, 115 , 307
Cons(), 133	domain literal, 166
Cons1(), 137, 138	complete set of, 167
Cons2(), 144, 145	consistent set of, 167
consequence	domain properties, 166
ASP, 19	Doyle, Jon, 44
computation for ASP, 138–146	dynamic domain, 152
computation for FOL, 133-136	diagnostics, 216–231
FOL, 42	modeling, 152–188
well-founded, 54	planning, 192–213
consistent	dynamic range, 242
set of domain literals, 167	effect on possible worlds, 250–251
set of e-literals, 136	
set of ground literals, 21	elaboration tolerance, 5 , 80–81, 154, 184
constraint, 14, 34	electrical circuit example, 71–75
example, 18, 25	e-literal, see extended literal
removing, 35	encoding
Contingency Axiom, 104, 106	of a system description, 172
cowardly students example, 91-92	entailment, see also consequence
CR-Prolog, 103–108, 209–211, 228–229,	ASP, 19
263–266	FOL, 42
cr-rule, 104	minimal (circumpscription), 44
CRModels, 107	recorded history, 219
CWA, see Closed World Assumption	epistemic disjunction, 14
	example, 17–18, 24–25
Datalog, 8	Euclid, 7

avantian to a default 97 109	haldan 156
exception to a default, 87–108	holds(), 156
given complete information, 92 indirect, 103 –108	horizon (of a planning problem), 192 <i>hpd()</i> , 219, 229–230
,	npu(), 219, 229–230
strong, 88 –93 weak, 88 –93	igniting the burner example, 200–201,
executability condition, 160, 167, 173	317–320
exogenous action, 216	inconsistent program, 27
expert knowledge, 61, 74	indirect exception, 103
expl(), 226	Inertia Axiom, 159
explin, 226 explanation, 216	encoding, 173
best, 224	Frame Problem, 163
computation of, 224–228	inertial fluent, 162 , 172
generation rule, 226	inheritance hierarchy, 76 , 75–81
minimal, 228–229	with defaults, 99–103
possible, 221	interpretation
explanation generation rule, 226	first-order, 41
extended literal, 14, 136	logic programming, 136
extension of a default theory, 48	partial (logic programming), 136
extension of a deladit meory, 40	partial (propositional), 132
fact, 15	propositional, 132
Fages, François, 53	is_a(), 78, 100–103
family example, 4–6, 62–66	IsAnswerSet(), 140
findall (Prolog built-in), 290	is_subclass(), 77, 100–101
first-order logic, 40–43	15 25 16 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
fixpoint, 53	jungle example, 238–240
floundering, 284, 289	J. 8
fluent, 155 , 166	knowledge base, 4-6, 14, 61-81
defined, 162, 172, 173, 198	with null values, 93–94
inertial, 162 , 172	Kowalski, Robert, 8
fluent dependency graph, 170	
fluent literal, 166	l-polynomial, 297
FOL, see first-order logic	law of the exclusive middle, 14
Frame Problem, 163	LB(), 138
	Least(), 141
goal, 192 , 193	Leibniz Dream, 8
Gringo, 115	Leibniz, Gottfried Wilhelm, 7
ground	level mapping, 31–32
atom, 14	list (in Prolog), 287–291
instantiation, 15	literal, 13
literal, 14	domain, 166
term, 12	extended, 14
grounding, 15	ground, 14
	negative, 14
Hamiltonian cycle example, 115-120	removing, 34
head (of a rule), 14	locally stratified, 32, 34
heuristic for ASP solvers, 147	logic program, see ASP program
heuristics for planning, 204-207	logic-based approach to agent design,
hierarchical information, 75-81, 99-103	3 –8

logic-based approach to AI, 8	null value, 93–94
lower bound, 138	nun varae, 25 21
Lparse, 115	obs(), 219, 229–230
1,	observation, 218
McCarthy, John, 8, 44, 163	occurs(), 156
McDermott, Drew, 44	orphan example, 66
member(), 78–79, 100–101	with incompleteness, 98
mgu, see most general unifier	overspecification, 184
minimal explanation, 228–229	· · · · · · · · · · · · · · · · · · ·
minimal plan, 209–211	P-log, 238 , 235–270
minimize statement, 211, 229	parts inventory example (Prolog), 291–295
missionaries and cannibals example,	Pearl, Judea, 246
201–204, 320–325	plan, 192
mkatoms, 308	planning, 192–213
mode (of a Prolog predicate), 288	concurrent, 208–209
model	heuristics, 204–207
FOL, 42	minimimal plan, 209–211
mathematical model of an intelligent	planning problem, 192
agent, 2	possible world, 236
minimal (FOL), 44	pr-atom, 245
of a recorded history, 219	predicate, 11
probabilistic, 236	preference relation (CR-Prolog), 104
propositional, 132	Principle of Indifference, 238
supported, 51	probabilistic measure, 237, 238, 245,
well-founded, 53	246–247
monotonic, 20	unnormalized, 247
monotonicity, 20	probabilistic model, 236
Monty Hall example, 252–255	probabilistic reasoning, 6, 235–270
Moore, Robert, 44	probability function, 237
most general unifier (mgu), 272	probability of a proposition, 243
mystery puzzle, 125–127	Prolog, 8, 271–306
	interpreter, 271–284
Narwhal example, see submarine example	programming, 284–304
natural language (translation into ASP),	Przymusinski, Teodor, 56
30–31	, ,,
negation as failure, see default negation	query, 20
negation as finite failure, 52, 283	ASP answer to, 20
negative information, 76, 94	SLD resolution answer to, 276
negative literal, 14	SLDNF resolution answer to, 282
removing, 34	Query(), 148
nlp, see normal logic program	query rule, 277
nondeterminism in AL , 184–186	1 2
nonmonotonic, 20 , 49, 88	Ramification Problem, 164
nonmonotonic logics, 20, 49	random attribute, 239
nonmonotonic logics, 43	random selection rule, 239
normal logic program, 49 , 54, 271	rat example, 255–257
tight, 52	Rationality Principle, 16 , 19, 35
<i>5</i> /	V 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

Reality Check Axioms, 225, 230	stable expansion, 46
recorded history, 218	stable model, 11n1, see also answer set
briefcase domain, 219–220	stable model semantics, 53
circuit diagnosis example, 222	connection to autoepistemic logic, 47
semantics, 219	state, 169 , 167–171
syntax, 218	state constraint, 158, 167, 173
recursive definition, 70	static domain, 152
reduct, 26 , 26	static literal, 166
reification, 77, 76-81, 103, 156n4	statics, 155, 166
Reiter's default theory, 48	stratification, 32–34
Reiter, Raymond, 44	stratified, 33 , 47, 56
resolution, 43, 271 , 284	locally, 32 , 34
SLD, 8, 271 , 276–282	strong exception, 88 –93
SLDNF, 49, 52, 56, 272 , 282–284	STUDENT, 5 , 29–30, 310–313
SLS, 56	subclass relation, 76–81, 100–101
resolvent, 278	submarine example, 75–81
Ross, Kenneth A., 53	substitution, 272 , 276
Roussel, Philippe, 8	Sudoku puzzle, 121–125
rule (of ASP), 14	supported model, 51
(),	symptom, 216 , 221
safety, 64, 315	symptom checking, 225
Sat(), 133	system configuration, 220
satisfiability (of a rule), 15	system description, 167 –186
satisfiability solver, 120 –121, 131–136	system description, 107 100
schema, 175	Tarski, Alfred, 8
Schlipf, John S., 53	temporal projection, 186
signature, 11	term, 12
\mathcal{AL} , 166, 172	ground, 12
FOL, 132	tight normal logic program, 52
P-log, 238	Touretzky, David S., 102
sorted, 13	transition, 174 , 162–187
simple planning module, 193 –194	transition diagram, 162
SLD derivation, 279	=
*	transition diagram, 162–187
SLD resolution, 8, 271 , 276–282	nondeterministic, 184–186
SLD resolution inference rule, 278	Tweety example, 100–103
SLDNF resolution, 49, 52, 56, 272 ,	1100 144
282–284	<i>UB()</i> , 144
SLS resolution, 56	uncaring John example, 86–91
Smodels, 115	unification, 271 , 272–276
Solver(), 136	unifier, 272
Solver1(), 136, 137	Unique-Name Assumption (UNA),
Solver2(), 136	65
sort, 12	unit propagation, 133
sorted signature, 12–13	unnormalized probabilistic measure,
SPARC, 65, 108, 314–316	247
specificity principle, 102 , 100–103	unsafe rule, see safety
spider bite example, 257–260	upper bound, 144

Van Gelder, Allen, 53 variant, **279**

wandering robot example, 263–266 weak acyclicity, **171** weak exception, **88**–93 well-founded consequence, 54 model, 53–**54** semantics, 53–56 system description, **170**

XSB, 56, 282