List of Figures

1.1	Theory structure	7
1.2	Family trees	11
2.1	Possible worlds	68
4.1	Inequalities as a DAG	148
4.2	Interval relations	149
4.3	Interval in a Partial Ordering	150
4.4	Scales	159
4.5	Pendulum	168
4.6	Mode Transition Networks	170
4.7	Mode Sequence for Spatial Curve	171
4.8	Two Pendulums	173
4.9	Block on a Spring	174
4.10	Envisionment Graph	177
4.11	Instantaneous Sequence of Events	177
4.12	Partial Orders as Sequences and Splits	183
5.1	Blocks World	194
5.2	Blocks-world example	199
5.3	Graph of situations and events	219
5.4	Tic-Tac-Toe Board	240
6.1	Two representations for a single shape	244
6.2	Criteria of approximation	245
6.3	Example Scenario: Calvin and his socks	24 8
6.4	Geometry of bedroom	250
6.5	Inside of an open box	256
6.6	Shape of shelf	257
6.7	Contact through a thin point	261
6.8	A common extended abutment implies an overlap \ldots .	262
6.9	An occupancy array	264
	Matching shapes in a simple occupancy array	
6.11	False evaluation of intersection	266

6.12	Occupancy array with partial/full occupancy	266
6.13	Loss of knowledge due to motion	267
6.14	Disjunction in occupancy arrays	267
6.15	Rotation applied to a Occupancy Array	268
6.16	Occupancy Array and Rigid Mapping	269
6.17	Quad tree	270
6.18	A human as the union of cylinders	271
6.19	Normalized set operations	272
6.20	Generalized Cylinders	273
6.21	MERCATOR representation	277
6.22	Maps matched by MERCATOR	279
6.23	World state in TOUR	280
6.24	Configuration of a joint	283
6.25	Meshed gears	284
6.26	Configuration space of a disk	285
6.27	Configuration space in quasi-static environments	286
6.28	Cart on a roller coaster	288
6.29	Track in NEWTON	290
6.30	Quadrants of directions	291
6.31	State transitions in NEWTON	294
6.32	Angle representations for a direction	296
6.33	Noncommutativity of three-dimensional rotations	299
6.34	Euler angles. $P_1 = X_1 - Y_1$ plane. $P_2 = X_3 - Y_3$ plane	301
6.35	Going through and coming back	303
6.36	Divided neighborhood	304
6.37	Positive and negative threadings	305
7.1	Scale	314
7.2	Schematic of scale	315
7.3	Constants of scale	319
7.4	Boiling water in a can	321
7.5	Kinematic systems	333
7.6	Dynamic systems	335
7.7	Point object in a funnel	339
7.8	Varying dimensionality of force	341
7.9	Predicates "bulk" and state "solid_coating"	344

7.10	Liquid in a cavity	•	•	•	•	•	•	•	•	•	346
9.1	Partially determined bindings		٠								399
9.2	Invalid partial plan										400
9.3	Successive states of the TWEAK planner										404
9.4	Hierarchy of tasks										425