

Contents

Part I. Knowledge Representation with MultiNet

1. Introduction	1
2. Historical Roots	13
3. Basic Concepts	17
3.1 General Remarks	17
3.2 Classificatory Knowledge	22
3.2.1 Sorts and Features	22
3.2.2 Multidimensional Layer Attributes	24
3.2.3 Immanent vs. Situational Components of Meaning ...	28
3.2.4 Classification of Questions	36
3.3 Structural Means of Representation	38
3.3.1 Relations and Functions	38
3.3.2 Inferential Relationships – Axiomatic Rules	40
4. Semantic Characterization of Objects	45
4.1 The Hierarchical Order of Objects	45
4.2 Material Characterization of Objects	52
4.3 Qualitative Characterization of Objects	57
4.3.1 General Remarks	57
4.3.2 Assignment of Properties to Objects	58
4.3.3 Attribute-Value Characterizations	64
4.3.3.1 Instances, Attributes, and Values	65
4.3.3.2 Generic Concepts and Their Attributes	67
4.4 Possession, Attachment, and Association	73
4.4.1 Possession	73
4.4.2 Assignment of Objects to Objects (Attachment)	75
4.4.3 Association	80

4.5	Different Manifestations of Objects	82
5.	Semantic Characterization of Situations	85
5.1	The General Structure of Situations	85
5.2	Events [Dynamic Situations]	90
5.2.1	Participants and C-Roles [Valency Frames]	90
5.2.2	Conceptual Subordination of Situations	96
5.2.3	Circumstances	103
5.3	States [Static Situations]	104
6.	The Comparison of Entities	113
6.1	Typical Relations of Comparison	113
6.2	The Semantic Treatment of Comparison	119
6.2.1	The Absolute or Positive	119
6.2.2	The Comparative	121
6.2.3	The Superlative	127
7.	The Spatio-temporal Characterization of Entities	131
7.1	General Remarks on Space and Time	131
7.2	Local Relations	133
7.3	Temporal Relations	145
7.4	Situations and Times	154
8.	Modality and Negation	163
8.1	The Modal Characterization of Situations	163
8.2	Negation	165
8.3	Modalities in a Narrower Sense	188
9.	Quantification and Pluralities	197
10.	The Role of Layer Information in Semantic Representations ...	219
10.1	General Remarks	219
10.2	Degree of Generalization: GENER	220
10.3	Facticity: FACT	221
10.4	Determination of Reference: REFER	223
10.5	Variability: VARIA	225
11.	Relations Between Situations	233
11.1	Semantic Interpretation of Conjunctions	233
11.1.1	General Remarks	233
11.1.2	Subordinating Conjunctions (Subordinators)	234

11.1.3	Coordinative Conjunctions (Coordinators)	238
11.2	Conditions and Reasons	247
11.2.1	Language Phenomena and Representational Means . . .	247
11.2.2	Causality	256
11.2.3	Conditional Relations	263
11.3	Counterfactuals	270
11.4	Contextual Restrictions and Situational Embedding	274
11.5	The Rhetorical Structure Theory (RST)	277
12.	Lexicon and Knowledge Representation	279
12.1	Linguistic Knowledge and World Knowledge	279
12.2	The Semantic Component of the Lexicon	282
13.	Question Answering and Inferences	305
13.1	Logical Principles	305
13.2	Classes of Questions and Inferential Answer Finding	317
13.3	Associatively Guided Question Answering	324
14.	Software Tools for the Knowledge Engineer / Sample Applications	331
14.1	Knowledge Management as an Engineering Task	331
14.2	MWR – the Workbench for the Knowledge Engineer	332
14.3	NatLink – A Semantic Interpreter for MultiNet	337
14.4	LIA – the Workbench for the Computer Lexicographer	345
14.5	VILAB – The Virtual Laboratory	353
15.	Comparison Between MultiNet and Other Semantic Formalisms	357
15.1	Introductory Remarks	357
15.2	MultiNet and Other Network Representations	358
15.2.1	Structured Inheritance Networks	358
15.2.2	The Semantic Network Processing System (SNePS) . .	364
15.2.3	Sowa’s Conceptual Structures (SCS)	367
15.2.4	Scripts and the Conceptual Dependency Theory	371
15.3	MultiNet and Logic-Oriented Semantic Formalisms	374
15.3.1	General Remarks	374
15.3.2	The Discourse Representation Theory	376
15.3.3	Description Logics	378
15.3.4	The Generalized Quantifier Theory	381
15.4	Comparison Between MultiNet and Frame Representations . . .	384
15.4.1	General Remarks	384
15.4.2	The Knowledge Representation Language KRL	384

15.4.3 The Knowledge Base Project CYC 387

Part II. The Representational Means of MultiNet

16. Overview and Representational Principles 395

16.1 MultiNet Within the Context of Knowledge Processing 395

16.2 The Paradigm of Multilayered Extended Semantic Networks . 398

16.3 Conventions of Description. 400

17. Means for Expressing Classification and Stratification 409

17.1 Sorts and Features 409

17.2 Layers 417

17.2.1 General Remarks on the Typology of Layer Attributes 417

17.2.2 Degree of Generality (Attribute **GENER**) 418

17.2.3 Determination of Reference (Attribute **REFER**) 421

17.2.4 Variability (Attribute **VARIA**) 423

17.2.5 Facticity (Attribute **FACT**) 425

17.2.6 Quantification (**QUANT**) vs. Cardinality (**CARD**) ... 427

17.2.7 Type of Extensionality (Attribute **ETYPE**) 429

17.2.8 The Classification of Nominal Concepts 430

17.3 Encapsulation of Concepts 433

18. Relations and Functions 439

18.1 Overview 439

18.2 Relations 446

18.2.1 AFF: C-Role – Affected Object 446

18.2.2 AGT: C-Role – Agent 447

18.2.3 ANLG2/3: Similarity Between Entities 449

18.2.4 ANTE: Relation of Temporal Succession 450

18.2.5 ANTO: Antonymy Relation 451

18.2.6 ARG1/2/3: Argument Specification at the Metalevel .. 452

18.2.7 ASSOC: Association 454

18.2.8 ATTCH: Attachment of Objects 455

18.2.9 ATTR: Assignment of Attributes to Objects 456

18.2.10 AVRT: C-Role – Averting from an Object 457

18.2.11 BENF: C-Role – Beneficiary 459

18.2.12 CAUS: Causality, Relation Between Cause and Effect 460

18.2.13 CHEA: Sortal Change: Event – Abstract Concept 462

18.2.14 CHPA: Sortal Change: Property – Abstract Concept .. 463

18.2.15 CHPE: Sortal Change: Property – Event 465

18.2.16 CHPS: Sortal Change: Property – State 466

18.2.17 CHSA: Sortal Change: State – Abstract State 467

18.2.18 CHSP1/2/3: Sortal Change Between Situational
 Concepts and Properties 468

18.2.19 CIRC: Relation Between a Situation and a
 Concomitant Situation 472

18.2.20 CNVRS: Lexical Relation Between Converse Concepts 473

18.2.21 COMPL: Complementarity 474

18.2.22 CONC: Relation Expressing a Concession 475

18.2.23 COND: Conditional Relation 476

18.2.24 CONF: Relation Expressing the Conformity
 with an Abstract Frame 478

18.2.25 CONTR: Relation of Contrast 479

18.2.26 CORR: Qualitative or Quantitative Correspondence .. 480

18.2.27 CSTR: C-Role – Causator 481

18.2.28 CTXT: Relation Specifying a Restricting Context 482

18.2.29 DIRCL: Local Destination or Direction 484

18.2.30 DISTG/2/3: Relations Specifying a Difference 485

18.2.31 DPND: Dependency Relation 486

18.2.32 DUR: Relation Specifying a Temporal Extension 488

18.2.33 ELMT: Element Relation 489

18.2.34 EQU: Equivalence Relation 491

18.2.35 EXP: C-Role – Experiencer of an Event 492

18.2.36 EXT: Relation Between Intension and Extension 494

18.2.37 FIN: Temporal End 495

18.2.38 GOAL: Generalized Goal 496

18.2.39 HSIT: Constituents of a Hypersituation 497

18.2.40 IMPL: Implication Relation Between Situations 498

18.2.41 INIT: Initial Situation or Entity 500

18.2.42 INSTR: C-Role – Instrument 501

18.2.43 JUST: Justification of a Situation 502

18.2.44 LEXT: Relation Specifying a Local Extent 503

18.2.45 LOC: Location of a Situation 504

18.2.46 MAJ/MAJE: ‘Greater than (or Equal to)’-Relation ... 505

18.2.47 MANNR: Relation Specifying the Manner 506

18.2.48 MCONT: C-Role – Relation Between a Mental
 Process and Its Content 507

18.2.49 MERO: Meronymy Relation 508

18.2.50 METH: C-Role – Method	509
18.2.51 MEXP: C-Role – Mental Experiencer	510
18.2.52 MIN/MINE: ‘Smaller than (or Equal to)’-Relation . . .	512
18.2.53 MODE: Generalized Mode of a Situation	512
18.2.54 MODL: Relation Specifying the Modality of a Situation	514
18.2.55 NAME: Assignment of a Name to an Object	515
18.2.56 OBJ: C-Role – Neutral Object as Participant	517
18.2.57 OPPOS: C-Role – Relation Specifying an Opposition .	519
18.2.58 ORIG: Mental or Informational Origin	520
18.2.59 ORIGL: Relation Specifying the Local Origin	521
18.2.60 ORIGM: Relation Specifying the Material Origin	522
18.2.61 ORNT: C-Role – Orientation to an Object	524
18.2.62 PARS: Relation Between Part and Whole	525
18.2.63 POSS: Relation of Possession	527
18.2.64 PRED/PREDR/PREDS: Predicative Concept Governing a Plurality	528
18.2.65 PROP: Relation Between Object and Property	530
18.2.66 PROPR: Relation Between a Plurality and a Semantically Relational Property	531
18.2.67 PURP: Relation Specifying a Purpose	532
18.2.68 QMOD: Quantitative Modification	533
18.2.69 REAS: General Reason for a Situation	534
18.2.70 RPRS: Representational Form or Manifestation of an Object	535
18.2.71 RSLT: C-Role – Result	537
18.2.72 SCAR: C-Role – Carrier of a State (Passive)	538
18.2.73 SETOF: Relation Between the Extensional of a Plurality and the Governing Predicative Concept	539
18.2.74 SITU: Situational Embedding or Abstract Location . . .	541
18.2.75 SOURC: Generalized Source or Origin	542
18.2.76 SSPE: C-Role – Entity Specifying a State	543
18.2.77 STRT: Relation Specifying the Temporal Beginning . .	544
18.2.78 SUB: Subordination of Concepts Representing Objects	546
18.2.79 SUB0: Generalized Subordination Relation	547
18.2.80 SUBM/SUBME: Subsumption of Sets (Set Inclusion)	548
18.2.81 SUBR: Metarelation for the Description of Relations .	549
18.2.82 SUBS: Subordination of Situations	551
18.2.83 SUBST: Relation Specifying a Substitute for an Entity	553
18.2.84 SUPPL: Supplement Relation	555

18.2.85	SYNO: Synonymy Relation	556
18.2.86	TEMP: Relation Specifying a Temporal Frame	557
18.2.87	VAL: Relation Between Attribute and Value	558
18.2.88	VALR: Relation Between Attributes and Their Value Restriction	561
18.2.89	VIA: Relation Specifying a Spatial Path	562
18.3	Functions	565
18.3.1	*ALTN1/2: Construction of Alternative Pluralities	565
18.3.2	*COMP: Function for the Comparison of Properties	566
18.3.3	*DIFF: Set Difference	568
18.3.4	*FLP _J : Functions Generating Locations	570
18.3.5	*INTSC: Intersection of Sets	572
18.3.6	*ITMS/*ITMS-I: Function for Enumerating Sets and Its Counterpart at the Intensional Level	573
18.3.7	*MODP: Function for the Modification of Properties	575
18.3.8	*MODQ: Function for the Modification of Quantities	577
18.3.9	*MODS: Modification of a Situational Concept	577
18.3.10	*NON: Family of Functions Specifying Negation	579
18.3.11	*OP _J : Arithmetic Operations	581
18.3.12	*ORD: Function Defining Ordinal Numbers	582
18.3.13	*PMOD: Modification of Objects by Associative Properties	583
18.3.14	*QUANT: Function Generating Quantities	585
18.3.15	*SUPL: Function Characterizing the Superlative	585
18.3.16	*TUPL: Function Generating Tuples	587
18.3.17	*UNION: Union of Sets	588
18.3.18	*VEL1/2: Disjunctive Composition of Situations	590
A.	Table of Abbreviations	593
B.	Overview of the Representational Means	595
C.	Semantic Templates for the Meaning of Relations	601
D.	Characterization of Arcs with Regard to Their Knowledge Type	605
E.	Classes of Typical Axioms	609
E.1	R-Axioms (Categorical Knowledge)	609
E.2	R-Axioms (Default Knowledge)	610
E.3	R-Axioms (Definitions of Relations)	611

E.4	Axioms Concerning the Preextensional Level	612
E.5	B-Axioms (Categorical Knowledge)	612
E.6	R-Axioms and B-Axioms (Spatio-temporal Relations)	614
E.7	Axiom Schemata (B-Axioms)	615
E.8	Axiom Schemata (R-Axioms)	616
Bibliography		617
List of Figures		629
Index		637