A LEXICAL RELATION HIERARCHY

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Abstract

An extensive literature now exists documenting various lexical relations for representing information about words. This report summarizes the lexical relations recognized in a variety of sources. In addition, we claim that lexical relations themselves form not a class but a taxonomy, with a rich hierarchical structure. We present the outlines of this taxonomy, organize relations identified in a number of works under the taxonomy, and then give a condensed report of over 100 relations derived from the compendium, organized by their hierarchical status.

1. Introduction

Lexical relations provide a formal means for expressing relations among concepts. A wide study of lexical and semantic relationships was launched in the U.S.S.R. in connection with development of the Explanatory Combinatory Dictionary (ECD) [Apresyan, Mel´cuk and Zolkovshy 69]. Lexical relations were part of each entry in the unilingual Russion dictionary, and played a key role in the "meaning <=> text" model [Mel´cuk 73]. Mel´cuk has recently led a similar dictionary effort in Canada for French, carried out through the intellectual efforts of linguists. The ECD has influenced the work of Evens and of Fox, as can be seen below.

Evens and Smith [Evens and Smith 79] considered what knowledge would be needed in a lexicon to support question-answering. Their classification of relationships, along with that of the ECD, motivated an empirical study of the utility of lexical-semantic relationships in information retrieval [Fox 80]. Evens *et al.* used the same set of relations as in [Fox 80] in similar experiments with a different test collection [Evens 82]. It seems clear that lexical-semantic relations have applications in query expansion for information retrieval.

However, since no machine readable lexicon with lexical-semantic relations exists, these investigations all involved hand-constructed expanded queries. Evens investigated how such a lexicon might be prepared [Evens, Vandorpe and Wang 85], and using the Linguistic String Parser [Sager 81], she and Ahlswede developed a grammar for parsing adjective definitions in W7. After a number of problems were resolved, the grammar could handle a significant proportion of adjective entries [Ahlswede 83]. In addition, KWIC and frequency analysis tools helped identify a number of lexical-semantic relations and "defining formulae" that appear commonly in definitions to signal a particular relation. The overall process is discussed in [Ahlswede 85]; continuing work is described in [Fox, Nutter, Ahlswede, Evens and Markowitz 1988]. It became clear in the course of this work that the set of lexical-semantic relations is larger than suggested by Mel´cuk's group, especially if domain-specific relationships are considered as in [Ahlswede and Evens 84].

2. Selecting Relations

The question then arose of how to locate and identify lexical relations, so as to get a better sense of what relations appear in natural settings. There are two places to look: in the literature, and "in the wild", i.e. in natural language texts. Dictionaries are a particularly rich source of texts about words, albeit a less than fully natural one. The body of this report consists of two tables reflecting the results of our work. The first table contains a complete listing of relations culled from both sources; the second is derived from the first by extraction and condensation.

One of the primary results of this work is that the lexical relations we work with are themselves related, and form a rich hierarchy, which has not previously been developed, and which we intend to exploit. The hierarchy in its current form consists of over a hundred relations, classified at the top level as essentially semantic relations, morphological and syntactic relations, and factive relations. The hierarchy goes beyond a simple partition of relations; in many areas, the tree depth is around five. There is sufficient grouping of relations into natural families to allow for advantages in representing the relations hierarchically, and enough difference at the leaves not to want to collapse it. This hierarchy allows sophisticated representation of relationships among words that may not be immediately evident in the data from which relations are extracted.

In addition to the distinctions among lexical relations reflected by the hierarchy, there is a difference between those which routinely appear among terms from any domain, such as taxonomic relations, and those which are specific to a particular domain (such as specialized relations among substances in medical terminology. Our research indicates that no set of lexical relations can be considered complete, because most domains contain specialized relations of their own.

Comparing Mel'chuk's pioneering work on lexical relations arising from studies of Russian with work based on English reveals a large class of language independent lexical relations, and a much smaller class of language-dependent relations. An example of the latter is Mel'chuk's Perfective, which arises naturally in Russian because a distinction which most Indoeuropean languages make by inflection is made in Russian by using a different verb. Hence in Russian this relation often links words with different roots, and gives significant information about them. In English, on the other hand, examples which are not essentially instances of regular inflection rules are virtually nonexistent.

What is interesting is not that there are language dependent relations, but that there are so few. Mel'chuk's work can be transferred to representations of English meanings with very little substantive change. This suggests that the use of Lexical Relations for representing meanings does go beyond language barriers, and incidentally raises the question of its potential for applications in machine translation.

We therefore make absolutely no claim to comprehensiveness. Rather we believe that we have isolated a strong central set of relations which jointly cover many, though not all, of the relations among terms in general use. But just as we have not tried for comprehensiveness, neither have we enforced exclusivity. The big table includes most of the relations recognized in any of the works cited, including some relations such as the perfective relation, whose *raison d'être* seems to be a fact about Russian grammar. That is, it definitely reflects an important relation in Russian, where it will frequently link different roots which express the perfective and imperfective aspects of a single "verb concept". Examples in English, however, tend to be either trivial inflectional variants or highly contrived. In other words, while the main table does not include all possible lexical relations, neither does it exclude any discussed in the sources with which we worked.

3. Interpreting the tables

Appendix 1 holds the main table of lexical relations. Each entry in the table refers to a particular relation *as described in a particular source.* It follows that a single relation may have several entries (and the familiar ones do). The table has five columns: relation name, definition, citation, example, and notes. The relation name column holds the names of relations; in addition, for those whose which are not binary, the number of arguments the relation takes follows the relation name, separated from it by a slash. For instance, Genus-Species-Diff/3 indicates a relation named Genus-Species-Diff which takes three arguments. A slash followed by a question mark indicates that the number of arguments is not fixed.

The definition column contains an abbreviated gloss on the meaning of the relation, in ordinary English. These are not intended as formal definitions; instead, they are intended to clarify what relation is meant.

The citation column gives bibliographic references for the origin of the table entry. The abbreviations in the citations column match up with entries in the bibliography as follows:

A	Ahlswede 1988
AM&Z	Apresyan, Mel´cuk and Zholkovsky 1973
C&H	Casagrande and Hale 1967
E&S	Evens and Smith 1979
F	Feifel 1949
E et al.	Evens, Litowitz, Markowitz, Smith and Werner 1983
IBM	Byrd, Calzolari, Chodorow, Klavans, Neff and Rizk 1987
J&W	Joshi and Weischedel 1973
M	Mel´chuk 1973
MA&E	Markowitz, Ahlswede and Evens 1986
P	Parks 1988
R	Riegel 1970
Ra	Raphael 1968
VT	The Virginia Tech lexicons group*
WV&E	Wang, Vandendorpe and Evens 1985

The examples taken from the source cited; the notes are either quotes from the original sources (in quotation marks) or annotations for clarification or cross reference.

The second appendix is essentially a stripped-down version of the large table, with multiple entries collapsed under a single name and with all information except the relation names and the nesting hierarchy eliminated. Its purpose is to give a more snapshot view of the universe of lexical relations.

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* This is not actually a bibliography reference. It refers instead to relations which we found at Virginia Tech while examining dictionary definitions. The responsible individuals, roughly speaking, are J. Terry Nutter and Robert France.

Appendix 1:

Lexical Relations Grouped by Apparent Meaning

Lexical Relations
Grouped by Apparent Meaning

Relation Name	Definition	Citation	Example	Notes
1. FUNDAMENTALLY SEMANTIC RELATIONS				
1.1 TAXONOMIC CLASSIFICATION RELATIONS				
1.1.1 Hierarchical Location				
Subclass/Superclass				
T	Taxonomy	E&S	lion - animal; dog - animal	
Taxonomy		P	green : color	(nouns & vbs only; parallel)
Class Inclusion		C&H	crane - a bird	
GENER	name of genus w/ respect to C_0	AM&Z	blue - color	
Gener	(note no differentia)	M		
Superordination		R	table - furniture	
$Y \supseteq X$	An X is a Y.	Ra	A boy is a person.	
Subordination		R	animal - zebra	
Gener	Taxonomy	A	liquid-substance	
Tax	taxonomy	WV&E	lion - animal	
Genus-Species-Diff/3	S is a subtype of G, with differentiating proposition D.	VT	<chess> is a <game> that is <played on a board>	
generic definition		R	eyelash - hair over the ey eor that protects you	
hypernymy	A's *hypernyms* are its taxon. superordinates; its *hyponyms*, its subords.	IBM	vehicle -> equipment	Gathered auto. by head finding (e.g. consider *state* to be a valide hypernym of *resemblance*
hyponymy		IBM	vehicle -> ambulance	
Function	classification by role	P	brooch : ornament	(nouns only)
Set membership				
$X \in Y$	X is a Y.	Ra	John is a person.	
class-member	object M is a member of class C.	F		
Hierarchical siblings				
Coordination		R	table - chair	
Coordination	X is the same kind as Y	P	foot : knee	

Relation Name	Definition	Citation	Example	Notes
Example-type				
E.G.	E is a prototypical example of G.	VT	<games> such as <football>	
Example	X is an instance/example of Y	P	soprano : high voice; New York : city	(nouns & vbs only; parallel)
Characteristic	X is a characteristic of Y	P	high voice : soprano	
1.1.2 Sameness and Likeness				
Synonyms				
S	Synonymy	E&S	amusing-funny	
Synonymy		C&H	amusing-funny	
SYN	synonym	AM&Z	to help-to aid	
Syn	A means the same as B	M		Syn=.
equiv[x;y]	x , y are two names for same thing	Ra		
Syn	Synonymy (same meaning)	A	help - aid	
Syn	synonymy	WV&E	speedy - fast	
Synonymy	X =Y	P	disaster : catastrophe	
synonymy	A is a synonym of B.	IBM	dense -> dull, stupid dense -> condensed, solid	Good discussion of assymmetry in synonymy on pp 235 & 239.
Negative synonymy	Y is a "negative" word for X	P	copy : plagiarize	
Cross-language synonymy				
translation	A is a (monosemous) translation of B from language L_1 into L_2.	IBM	anticipate -> aspettarsi say -> X -> orate	Can be extended back to L_1.
Similarity/near synonymity				
Synonymity/similars		R	zebra-horse	
Syn	A means the same as B	M		directed forms Syn<, Syn>
Feature similarity	X has the same major features as Y	P	rake : fork	
Specialized synonymity: idiomatic synonyms				
IMPER	irregular imperative	E&S	go ahead! - to talk; fire! - to shoot	
IMPER	idiomatic imperative	AM&Z	silence - to shut up	
Imper	Regular and irregular imperatives	A	shoot-fire; silence-shut up	
Imper	irregular imperative	WV&E	fire! - to shoot	
Imper	imper. used to elicit situation	M	to shoot -> fire!	

Relation Name	Definition	Citation	Example	Notes
Similarity + Difference				
Comparison		C&H	wolf - they are rather like coyotes, but they are big	
Attributive		C&H	burrowing owl - but they are small; and they act like mice; they live in holes.	
1.1.3 Opposites				
Undistinguished opposition				
Anti	Undistinguished antonymy	A	beautiful - plain; beautiful - ugly; friend - enemy; love - hate; science - ignorance; hack - racing	
Logical opposites				
Antonymy		C&H	low-not high	
Binary antonymy	Mutually exclusive & exhaustive	P	fertile : sterile	
Item/Non-attribute		P	harmony : discordant	
Attribute/Non-attribute			P	inconsolable : comforted
Item/Descripive act		P	recluse : socialize	
Attribute/action		P	reticent : talk	
Contrasting extremes				
Anti	antonymy	WV&E	hot - cold	
Asymmetric contrase		P	hot - cool	
Contradictory	one is negation of other	E	perfec t- imperfect	
Contrasted	one presents sharp contrast to other	E	dry - moist	
ANTI	Antonymy	E&S	hot - cold; big - small	
ANTI	antonym	AM&Z	beautiful - ugly; friend - enemy; to love - to hate	
N-ary Antonymy	X and Y are opp. ends of spectrum	P	genius : idiot	
Anti	antonynm	M		including directed forms as for Syn.
Contrary	both cannot be true	E	superiority-inferiority	
Incompatible	differing in small part of meaning; usually cannot apply to same thing	E	abstruse-superficial	
Complements				
COMP	complementarity	E&S	single-married; male-female	
Comp	complementarity	WV&E	single-married	
Antonymity/contrasts		R	black-white	
Complementary	one is reciprocal to the other; one is imcomplete unless the other follows	E	attack-defend	

Relation Name	Definition	Citation	Example	Notes
Inverse operations				
CONV	converseness	E&S	to buy - (3-2-1-4) to sell	
CONV	conversive	AM&Z	to buy-to sell	
Converse		P	buyer : seller	
Conv	Verb A is the converse of verb B	M	to precede -> to follow	
Conv	converseness	WV&E	to buy - to sell	
Conv	Converse	A	build - be built	These look like a misunderstanding
Conv*	(Inverse of above; this is odd)	A	build - to cause to be constructed	of Mel'chuk.
Reversing operations				
Reverse	one reverses or undoes the quality, act, or state of the other	E	destructive - constructive	
Reciprocality				
RECK	reciprocal kinship	E&S	husband - wife	
Relative	one is inverse or converse of other	E	parent-child	
Reck	reciprocal kinship	WV&E	husband-wife	

1.2 PARTS, WHOLES AND AGGREGATES

Aggregate name				
SET	set-element	E&S	flock - sheep; pride - lions; gaggle - geese	
Set	set-element	WV&E	flock - sheep	
MULT	totality or aggregate	AM&Z	sheep - flock	
Mult	collection of the item	M	flowers -> bunch	
Mult	Group of	A	sheep - flock; dog - pack	
Sing	Instance of (but see SING below)	A	violence - act; fury - fit; furlong - distance	
set_of	(Of nouns)	IBM		Mentioned but not discussed.
set/2-3	S is a set of (exactly N) objects of type M.	VT	a <cricket team> consists of <11> <players>	
Singular collective		P	medecine : aspirin	
Plural collective		P	dishes : cups	

Relation Name	Definition	Citation	Example	Notes
Part-Whole				
PART	part - whole	E&S	horn - cow; finger - hand; carburetor - car	
Part	part-whole	WV&E	horn - cow	
CONSTITUENT	X is a constituent of part of Y.	E et. al.	A *cheek* is part of the face.	
Parts		R	zebra - stripes; table - leg	
Wholes		R	horn - cow	
partg[x;y]	An x is part of a y.	Ra		
part[x;y]	An x is part of y.	Ra		
Component/Object	X is a part of Y	P	sentence : paragraph	
Member/Collection	Xs make up Y	P	trees : forest	
Head-Organization				
CAP	head - organization	E&S	chief - tribe	
CAP	name of head	AM&Z	tribe - chief	
Cap	title of a head or commander	M	tribe -> chief	
Cap	Organizational head of	A	tribe - chief	
Cap	head-organization	WV&E	chief - tribe	
Staff-Staffed				
EQUIP	personnel - object	E&S	crew - gun; crew - ship	
EQUIP	name of staff or personnel	AM&Z	gun - crew	
Equip	name of the staff of an organization	M	cloister –> monks	
Equip		A	cloister - monks; gun - crew	
Equip	personnel-object	WV&E	crew - gun	
Mass-Portion				
PIECE	count - mass	E&S	lump - sugar; item - news	
Piece	count-mass	WV&E	lump - sugar	
Sing	member of the class	M	news -> item	
SING	single item or instance of C_O	AM&Z	news - item	
Sing	Instance of (see also SET above)	A	violence - act; fury - fit; furlong - distance; armor - gorget; statement - specification	
Portion/Mass	X is a portion of Y	P	slice : pie	
Ingredient/Mass	X makes up part of the mass Y	P	flour : wheat	
Instance	X is a "lump" of Y	P	item : news	

Relation Name	Definition	Citation	Example	Notes

1.3 ORDERING AND MEASURING RELATIONS

1.3.1 Ordering

Sequence

Q	queuing	E&S	Monday - Tuesday	
Q	queuing	WV&E	Monday - Tuesday	
Grading		C&H	Monday - the one following Sunday	
Preceding, contemporaneous, succeeding events		R	crash - hospital	
SEQUENTIAL	Word-association stimulus-response	E et. al.	whistle - stop; wish - bone	

Temporal association

Time/action		P	summer : harvest	
Time/item		P	retirement : pension	
Stage/activity		P	buying : shopping	
Plan	X is a plan for Y	P	itinerary : journey	

Alternate form

STAGE	manifestation	E&S	ice - water	

1.3.2 Measuring

Unit - Dimension

[+unit] / 1	A is a unit of measurement.	IBM	acre	Useful in handling what would otherwise be syntactic irregs.
[+currency] / 1	" " " " " " currency.	IBM	dollar	

Intensifying verb

INC	increase verb	E&S	to mount - tension; to grow - child	
PLUS	attr. 'more, in a greater degree'	AM&Z	tension - to mount	
Plus	more	M		used only in combinations
Plus	Compound function	A	agression CausPlus escalate	
Inc	increase verb	WV&E	to mount - tension	

Relation Name	Definition	Citation	Example	Notes
Reducing verb				
DEC	decrease verb	E&S	to shrink - cloth	
MINUS	opposite of plus	AM&Z	temperature - to drop	
Minus	less	M		used only in combinations
Minus	Compound function	A	value IncepMinus shrink	
Dec	decrease verb	WV&E	to shrink - cloth	
"Very"/"A big"				
MAGN	attr. for 'very', to a great extent	AM&Z	to frighten - to terrify	
Magn	"very'	M		used only in combinations
Degree	X is a different degree than Y	P	cut : gash	exchange
Size	X is a different size than Y	P	mansion : hut	exchange
Magn	A magnitude of	A	fever - high; rock - boulder; deep - bottomless; bright - brilliant; cloud burst - rainfall	This seems to combine "what is a big X called?" with "the usual term for extremely X"

1.3.2 Figurative Measure

Culmination				
CENTR	name of central, culminating part	AM&Z	life - prime	
Centr	central part of object or process	M	crisis -> peak	
Centr		A	glory - summit; life - prime	
"Correct"				
VER	attribute meaning right, proper	AM&Z	pride - justifiable	
Ver	assoc. adj. conveying *right* or *proper*	M	reason -> valid	
Ver	Collocational	A	reason Ver valid	
"Positive quality"				
BON	attribute meaning good	AM&Z	aim - lofty	
Bon	assoc. adj. conveying *good*	M	proposal -> tempting	
Bon	Collocational	A	aim Bon lofty	

Relation Name	Definition	Citation	Example	Notes
1.4 SEMANTIC MARKERS				
1.4.1 Object property markers				
Is-the-male-of				
MALE	male - unmarked term	E&S	drake - duck; gander - goose	
Male	male-unmarked term	WV&E	drake - duck	
Denotes a male				
[+male] / 1	A is a noun which names a male.	IBM	husband, Pope	
Is-the-female-of				
FEMALE	female - unmarked term	E&S	lioness - lion	
Female	female-unmarked term	WV&E	lioness - lion	
Denotes a female				
[+female] / 1	A is a noun which names a female.	IBM	wife, aviatrix	
Is-the-young-of				
CHILD	juvenile - parent	E&S	calf - cow; puppy - dog; kitten - cat	
Child	offspring-parent	WV&E	kitten - cat	
Material-object				
MADEOF	substance	E&S	ski - wood	
Madeof	substance	WV&E	ski - wood	
Substance		R	table - wood	
made_of	(Of nouns)	IBM		Mentioned but not discussed.
Composition	X is made of Y	P	flour : wheat	
Composition	X is a material for making Y	P	wheat : flour	
Property-object				
Quality		R	table - hard	
which-adj	object O has quality A.	VT		
Item/attribute		P	beggar : poor	
Item/Descriptive cond.			P	beggar : poverty

Relation Name	Definition	Citation	Example	Notes
Object/Designation				
Expressive designation		P	smile : friendliness	
Representative desig.		P	portrait : person	
Use-Object				
use/3	U is used in V for doing	VT	a <board> is used in <cribbage>	
(or accomplishing) P			for <keeping score>	
Function		C&H	tongue - with which we speak	
functional definition		R	staw - hay that cattle eat	
Operational		C&H	bread - which we eat	
use and description		R	banana - yellow and you eat it	
Use-function	X is a use for Y	P	baking : oven	
Instrument/goal	X is used for Y	P	gun : shooting	
User-Object				
Agent/Instrument	X uses Y	P	carpenter : hammer	
Object/Instrument	Y is used on X	P	patient : stethoscope	

1.4.2 Selectional markers

Selects for human				
[+human] / 1	A can only apply to human beings.	IBM		
[+nonhuman] / 1	" " " " " non-human " .	IBM		
Selects for male/female				
[+male] / 1	A can only apply to male beings.	IBM	husband, Pope	"*happiness* is both [-m] and [-f]
[+female] / 1	" " " " " female " .	IBM	wife, aviatrix	whereas *author* could be either [+m] or [+f]."
Selects for animate/inanimate				
[+animal] / 1	A can only apply to animate beings.	IBM		
[+nonanimal] / 1	" " " " " non-animate ".	IBM		
Selects for abstract/concrete				
[+abstract] / 1	A can only apply to abstract things.	IBM		
[+concrete] / 1	" " " " " concrete " .	IBM		

Relation Name	Definition	Citation	Example	Notes
1.4.3 Physical properties and relations				
General description				
phys-desc/?	object O has physical description D.	VT		Slots include shape, size, color, material, pattern & character.
Characteristic sound				
SON	characteristic sound - producer	E&S	bark - dog; roar - lion; meow - cat; choo-choo - train	
Son	Characteristic sound	A	lion - roar; dog - bark	
Son	characteristic sound	WV&E	bark - dog	
SON	typical sound produced by C_O	AM&Z	dog - to bark	
Son	typical sound	M	dog -> to bark	
Relative spatial location				
right[x;y]	x is to the right of y	Ra		
jright[x;y]	x is just to the right of y.	Ra		
Location				
Spatial Container		C&H	bucket - in which we get water	
Location	X is located in Y	P	jelly : jar	
		P	country : continent	
1.5 GENERIC TYPICAL CASE FRAME FILLERS				
1.5.1 Act-slot relations				
All purpose slot relation				
S_i	generic name of the first, second, third, fourth participant in C_O	AM&Z	to sell - seller; to sell - goods; to sell - buyer; to sell - customer; to sell - price.	S_1 = Tagent; S_2 = Tobject; etc.
S_i	gen. subj. (1), obj. (2), indobj (3)	M		
S_i	generic slot relations	A		

Relation Name	Definition	Citation	Example	Notes
Act/actor				
TAGENT	typical agent	E&S	conqueror - to conquer; baker - to bake	
Tagent	typical agent	WV&E	conqueror - to conquer	
Action	X does Y	P	professor : teaching	
(Subj. selection)	Selects for subj of X type (of verbs)	IBM		X is some set of +/- markers (?).
S_1	generic subject relation	A	employ - employer	
Agent/Action		P	professor - teach	
Act/object				
TOBJECT	typical object	E&S	dinner - to dine; food - to eat	
Tobject	typical object	WV&E	loser - to beat	
TCAGENT	typical counter agenet	E&S	loser - to beat	
Process	X happens to Y	P	incarceration : criminal	
Process	X is subject to Y	P	criminal : incarceration	
S_2	generic object relation	A	employ - employee	
Action/Dir. Obj.		P	baste : chicken	
Act/recipient				
Action/Indir. obj.		P	bequeath : heir	
Dir. Obj./ Indir Obj.		P	inheritance : heir	
Act/product				
TRESULT	typical result	E&S	hole - to dig; bag - to hunt	
Tresult	typical result	WV&E	hole - to dig	
S_{res}	noun denoting the resultof C_o	AM&Z	to hunt - bag	
S_{res}	result	M	talks -> results	
S_{res}	result of X	A	hunt - bag	
Act/instrument				
TINST	typical instrument	E&S	needle - to sew; brain - to think	
Tinst	typical instrument	WV&E	needle - to sew	
S_{instr}	noun denoting the instrument of C_o	AM&Z	to think - brain	
S_{instr}	instrument	M		
S_{instr}	Typical instrument	A	think - brain; seal - batten	

Relation Name	Definition	Citation	Example	Notes
Act/location				
TSOURCE	typical source	E&S	earth - to sprout	
Tsource	typical source	WV&E	earth - to sprout	
Location/Action		P	school : learning	
Act/experiencer				
TEXPER	typical experiencer	E&S	lover - to love	
Texper	typical experience	WV&E	lover - to love	
Act-thing/typical setting				
TLOC	typical location	E&S	kitchen - to bake	
Tloc	typical location	WV&E	kitchen - to bake	
Sloc	noun denoting the place of C_o	AM&Z	arrow - quiver; action - scene	
Sloc	location	M		
Sloc	Typical location	A	arrows - quiver; action - scene	
Locations		R	zebra - Africa	
Source	X comes/is obtained from Y	P	stone : quarry	
1.5.2 Object-object relations				
Thing/container				
Container	X is contained in Y	P	jelly : jar	
Thing/producer				
COMESFROM	provenience	E&S	milk - cow	
Comefrom	provenience	WV&E	milk - cow	
Provenience		C&H	milk - we get it from a cow	
Thing/habitat				
Home	habitat-object (see also Tloc)	WV&E	Africa - hyena	
HOME	habitat - object	E&S	Africa - lion	See also Tloc, Provenience

Relation Name	Definition	Citation	Example	Notes
1.5.3 Situation/verb relations				
Situation/slot-verb				
$OPER_i$	verb connecting first, second, ... participant with name of situation	AM&Z	support - to lend; support - to receive	
$Oper_i$	verb connect. S_i to sit. (=$V_0(C_0)$)	M	(1) support -> to lend	
$Oper_i$	Collocational verb of operation	A		
$Oper_1$	Y = provide X		support - lend	
$Oper_2$	Y = be provided with X		support - receive; aid - receive	
Situation (subj) + verb				
$FUNC_i$	verb connecting name of situation and name of participant	AM&Z	silence - to reign; blow - to fall	
$Func_i$	verb denoting the basic action of the situation on S_i	M	(0) silence -> to reign	
		M	(1) anxiety -> to grow; (2) blow -> to fall	
$Func_i$	More collocations	A		
$Func_1$			silence - reign	
$Func_2$			anxiety - gnaw	
$Func_3$			blow -fall	
Verb + situation (obj)				
$LABOR_{ij}$	verb connecting ith partic. in func. of subj. with jth partic. in func. of obj.	AM&Z	torture - to put to	
$Labor_i$	verb connecting S_i to S_j	M		
$Labor_{ij}$	Collocational	A		
$Labor_{12}$			torture - put to	
1.5.4 Miscellaneous case-frame relations				
Act/manner				
S_{mod}	noun denoting the mode of action	AM&Z	to write - handwriting; to write - style	
S_{mod}	"mode of action" (=action modifier?)	M	to write -> handwriting	
S_{mod}	Collocational or paradigmatic	A	write - handwriting; write - style	
Agent/product				
Agent/product	X makes Y	P	baker : bread	passive

Relation Name	Definition	Citation	Example	Notes
Agent/goal				
Agent/goal	X wants Y	P	hunter : quarry	
Agent/material				
Agent/material	X works in/with Y	P	baker : flour	
All-purpose case frame				
case/?	standard case frame for actions	VT		

1.6 OTHER PARADIGMATIC RELATIONS

1.6.1 Causal Relations

Situation/Cause (collocational)				
CAUSE	cause - thing or action affected	E&S	to send - to go;	
Caus	Causation; collocational	A	crisis - bring about	
Cause	cause-action effected	WV&E	to send - to go	
CAUS	act in such a way that C_o comes into being (collocational)	AM&Z	crisis - to bring about	
Caus	verb expressing cause for C_o	M	crisis -> to bring about	
Situation/Cause (non-collocational)				
PERM	permit, to make it possible to	AM&Z	to fall - to drop	
Perm	verb express. that which permits C_o	M	terror -> to let loose	
Perm	Non-collocational causality	A	fall - drop; hobble - limp; elect - selection	
State/Cause (non-collocational)				
Cause/Effect	X causes Y	P	eclipse : darkness	
Causation-Predic.	X induces Y	P	stress : headache	
Effect/Result	X results in Y	P	war : grief	
State/Action				
Cause/Action	X leads to doing Y	P	hunger : eat	
Affector/Affected				
Influence	X influences Y	P	lawyer : jury decision	

Relation Name	Definition	Citation	Example	Notes
Activity/Outcome				
RESULT	the resultative	AM&Z	To study - to know	
Result	verb for resulatant state of C_o	M	used only in combinations	
Result	Cause-effect between verbs	A	study - know	
Action/Goal	X is done to achieve Y	P	eat : satiation	
Action/Result. Attrib.	X is done to make something Y	P	pasteurize: sterile	
Preventative	X is done to prevent Y	P	baste : dryness	

1.6.2 Paradigmatic verb relations

State/verb expressing state				
BE	be + predicate	E&S	to neighbor - near	
Be	verb-adjective	WV&E	to neighbor - near	
PRED	Copul(C_o) + C_o	AM&Z	near - to neighbor	
Pred	[= Copula(C_o) + C_o]	M	near -> to neighbor	
Pred	Y = to be X	A	near - neighbor; similar - agree; consistent - agree	
State/copular verb used with state				
COPUL	special copula verb	E&S	to fall - victim	
COPUL	copula, link verb	AM&Z	victim - to fall	
Copul	assoc. copula	M	victim -> to fall	
Copul	Copular verb used with a noun	A	pale - look; victim - fall	
Copul	special copula verb	WV&E	to fall - victim	
State/verb to achieve state				
BECOME	become + adj	E&S	to redden - red; to clean - clean	
Become	verb-adjective	WV&E	to redden - red	
Object/verb to make ready				
PREPAR	verb which means prepare	E&S	to lay - table; to make - bed; to load - gun	
PREPAR	verb meaning to prepare	AM&Z	table - to lay	
Prepar	verb expressing preparing for C_o	M	table -> to lay	
Prepar	Collocation; verb to make X ready	A	gun - load	
Prepar	verb which means prepare for use	WV&E	to lay - table	

Relation Name	Definition	Citation	Example	Notes
Object/verb to destroy or remove				
LIQU	destroying verb	E&S	to correct - mistake; to wipe out - traces	
Liqu	destroying verb	WV&E	to correct - mistake	
LIQU	to act in such a way that C_o ceases; Liqu=AntiCaus	AM&Z	mistake - to correct	
Liqu	verb expressing destruction of C_o	M	ban –> to lift	
Liqu	Collocational; to reverse or nullify	A	mistake - correct; exhaust - fertility	
Object/verb to deteriorate				
DEGRAD	verb to deteriorate	E&S	to decay - teeth; to wear out - clothes	
DEGRAD	very meaning to deteriorate	AM&Z	teeth - to decay	
Degrad	verb expressing deterioration of C_o	M	teeth -> to decay	
Degrad	Collocation; verb to deteriorate X	A	teeth - decay; house - dilapidate	
Degrad	deterioration verb	WV&E	to decay - tooth	

1.6.3 Dispositional relations

Generic dispositional				
ABLE	used in comb. w/ case relations only	E&S	combustible - burn; understandable - understand	
Able	adjective-verb	WV&E	combustible - to burn	
$ABLE_i$	generic definition of first, second, º potential participant	AM&Z	to burn - combustible; to eat - edible	
$Able_i$	generic definition of S_i	M	to burn -> combustible	
$Able_i$	Adj-vb dispositions	A		
Act/Disposition to act				
$Able_1$	Can X	A	burn (intrans) - combustible	
Act/Disposition to be acted on				
$Able_2$	Can be Xed	A	eat - edible	
Act/poss. result. act	Can be Xed	P	drink : potable	
Miscellaneous dispositions				
Attribute/res. attr.	Being X tends toward being Y	P	taciturn : silent	
Attribute/res. action	Being X tends toward doing Y	P	viable : live	
Object/act	Xs tend to Y	P	glass : break	

Relation Name	Definition	Citation	Example	Notes
1.7 COLLOCATIONAL RELATIONS				
1.7.1 Case-based attributive collocations				
Generic attribute relations by virtue of act				
A_i	generic attribute of *i*th partic.	AM&Z	to know - aware; to know - known;	
A_i	Adjective-verb patent relations	A		
Act/attribute of subject by virtue of act				
A_1	syn for pres. participle	A	to burn (intrans) - on fire	
A_2		A	to know - aware	(account does not match example)
Act/attribute of object by virtue of act				
A_3	syn for past participle	A	to know - known; familiar	
Generic attribute relations enabling act				
$QUAL_i$	name of qual. involving participants	AM&Z	to surprise - unusual; to understand - obvious	
$Qual_i$		A		
Act/attribute of subject enabling act				
$Qual_1$	Causes X	A	surprise - unusual	
Act/attribute of object enabling act				
$Qual_2$	Promotes X	A	understand - natural; understand - obvious	
1.7.2 Other collocations				
Object/selected preposition				
PREPOS	preposition-object	E&S	on - list	
LOC	appropriate preposition for noun C_o	AM&Z	list - on	
Loc	assoc. prep. indicating location	M	capitalism -> under	
Loc	Prep used locationally with term	A	capitalism - under; list - on	
Prep	preposition-object	WV&E	on - list	

Relation Name	Definition	Citation	Example	Notes
Discipline/object				
Field of study	X is the study of Y	P	anatomy : human body	
Study	X is the subject of (the field of) Y	P	human body : anatomy	
Object/figurative description				
FIGUR	standard figurative designation of C_o	AM&Z	passion - flame	
Figur	standard figurative description	M	passion -> flame	
Figur	figurative collocation	A	passion - flame; night - cover	
Figurative designation		P	flame : passion	
Practically based association				
COORDINATE	Word-association stimulus-response	E et. al.	bread - butter; needle - thread	
Phonetically based association				
CLANG	Word-association stimulus-response	E et. al.	table - stable; mutton - cotton	
Phrasally based association				
Completion	X completes Y	P	San : Francisco	passive

2. *FUNDAMENTALLY MORPHOLOGICAL AND SYNTACTIC RELATIONS*

2.1 MORPHOLOGICAL RELATIONS

State/verb (nominalized verb/verb)			
NOMV	process noun - verb	E&S	death-to die
S_o	noun coinciding with C_o in meaning	AM&Z	to move-movement
S_o	related noun	M	
S_o	Verbal or adjectival noun	A	move-movement; [to be]white-whiteness
V_o	verb coinciding with C_o in meaning	AM&Z	death-to die
V_o	related verb	M	
V_o	Inverse of S_o for verbal nouns	A	attack-attack; death-die
Nomv	process noun-verb	WV&E	death-to die

Relation Name	Definition	Citation	Example	Notes
Noun/related adjective				
ADJN	adjective-noun	E&S	solar-sun	
Adjn	adjective-noun	WV&E	solar-sun	
A_o	Related adjectives	A	Islam-Islamic; sun-solar; time-temporal	
A_n	adj. coinciding with C_O in meaning	AM&Z	sun-solar	
A_i	generic attribute of S_i	M	to burn -> fire	
A_i	generic quality associated with S_i	M	to surprise -> unusual	
A_o	related adjective	M		
Adjective/related adverb				
ADV_o	adv. coinciding with C_o in meaning	AM&Z	critical-critically; meaning-in meaning	
Adv_o	related adverb	M		
Adv_o	Adj + ly	A	critical-critically; civil-civilly	
2.2 INFLECTIONAL RELATIONS				
Past/inf				
PAST	past tense - infinitive	E&S	went-to go; sang-to sing	
Past	perfect-infinitive	WV&E	went-to go	
Past participle/inf				
PP	past participle - infinitive	E&S	gone-to go; sung-to sing	
PP	past participle-infinitive	WV&E	gone-to go	
Plural/singular				
PLURAL	plural - singular	E&S	men-man; children-child	
Plural	plural-singular	WV&E	men-man	
2.3 ASPECTIVE RELATIONS				
Is-state				
[+stative] / 1	A represents being in a state	IBM	resemble	They claim experimental evidence that this distinction is *not* lexical.
Is-action				
[+active] / 1	participating in a process or action.	IBM	classify	

Relation Name	Definition	Citation (also MA&E)	Example	Notes
Object/realization				
FACT	verb meaning to become a fact	AM&Z	dream-to come true	
Fact	verb express. the coming true for C_o	M	clothes -> to wear well	
Fact	Collocational	A	clothes-wear well; dream-come true	
$REAL_i\ j$	verb meaning make real	AM&Z	program-to adopt; program-to carry out	subj. is *i*th participant
Real	verb express. the making real for C_o	M	program -> to adopt	
Real	Collocational	A		
$Real^{I}_1$			program - adopt	
$Real^{II}_1$			program - fulfill	
Event/initiation				
INCEP	verb meaning to begin,	AM&Z	war-to break out	used only in combinations
Incep	verb expressing beginning of C_o	M		used only in combinations
Incep	"Inflection" of other functions	A	war $IncepFunc_o$ break out; influcence $IncepOper_2$ fall under	
Event/maintaining				
CONT	verb meaning to continue	AM&Z	silence-to keep	
Cont	verb expressing continuation of C_o	M		used only in combinations
Cont	"Inflection" of other functions	A	silence $ContOper_1$ preserve	
Event/termination				
FIN	verb meaning to cease, to stop	AM&Z	love-to fall out of	
Fin	verb expressing completion of C_o	M		used only in combinations
Fin	"Inflection" of other functions	A	patience $FinOper_1$ lose	
Perfective				
PERF	the perfective, standard expression is	AM&Z	to study-to have mastered	
perfect aspect of verb				used only in combinations
Perf	Associated w/ Russian perfective	A	study-have mastered	
Perf	verb expressing perfection of C_o	M		

Relation Name	Definition	Citation	Example	Notes
2.4 *OTHER SYNTACTIC RELATIONS*				
SComp				
[+thatcomp] / 1	(Of verbs) A takes *that* as a complementizer.	IBM	acknowledge, admit	Assembled by hand (from published lists ?)
Reflex				
[+reflexive] / 1	(Of verbs)	IBM		
Recip				Mentioned but not discussed.
[+reciprocal] / 1	(Of verbs)	IBM		"
3. *PROPOSITIONAL ATTITUDE RELATIONS*				
Factive	R(S)⊃S ~R(S)⊃S	J&W	R: realize; S: Meg baked the cake Jerry *realized* that Meg baked the cake.	
Implicatvie	R(S)⊃S ~R(S)⊃~S	J&W	We *managed* to finish the job.	
Only-if	~R(S)⊃~S	J&W	They *allowed* Jim Jim *had an opportunity* to visit China.	
If	R(S)⊃S	J&W	Larry *persuaded/forced* Bill to accept the job.	
Negative-if	R(S)⊃~S	J&W	Larry *prevented* Bill from winning the game.	
Negative-implicative	R(S)⊃~S ~R(S)⊃S	J&W	John *failed* to go. Hugh *refrained* from smoking.	
Counter-factive	R(S)⊃~S	J&W	Mary *pretended* that Ben went went home.	
Dull	No implications	J&W	Jerry *wanted* Meg to elope with him.	

Relation Name	Definition	Citation	Example	Notes
4. TRULY MISCELLANEOUS RELATIONS				
explanations		F	priceless-worth a lot of money	
repetitions				
Circularity		VT	puddle-puddle of water	
		C&H	near-when something is sitting nearby we say *near*	
owng[x;y]	Every y owns an x.	Ra		
own[x;y]	y owns an x.	Ra		
Contingency				
		C&H	to get angry-when we do not like something we get angry.	
Exemplification				
illustrations		C&H	sweet-as sugar	
		F	priceless-gem	

Appendix 2:

Outline of the Lexical Relations Hierarchy

Outline of the Lexical Relations Hierarchy

FUNDAMENTALLY SEMANTIC RELATIONS

TAXONOMIC CLASSIFICATION RELATIONS

Hierarchical Location
- Subclass/Superclass
- Set membership
- Hierarchical siblings
- Example-type

Sameness and Likeness
- Synonyms
- Cross-language synonymy
- Similarity/near synonymity
- Specialized synonymity: idiomatic synonyms
- Similarity + Difference

Opposites
- Undistinguished opposition
- Logical opposites
- Contrasting extremes
- Complements
- Inverse operations
- Reversing operations
- Reciprocality

PARTS, WHOLES AND AGGREGATES

- Aggregate name
- Part-Whole
- Head-Organization
- Staff-Staffed
- Mass-Portion

ORDERING AND MEASURING RELATIONS

Order
- Sequence
- Alternate form

Measure
- Unit - Dimension
- Intensifying verb
- Reducing verb
- "Very"/"A big"
- Figurative measure
- Culmination
- "Correct"
- "Positive quality"

SEMANTIC MARKERS

Object property markers
- Is-the-male-of
- Denotes a male
- Is-the-female-of
- Denotes a female
- Is-the-young-of
- Material/object
- Property/object
- Object/designation
- Use/Object
- User/Object

Selectional markers
- Selects for human
- Selects for male/female
- Selects for animate/inanimate
- Selects for abstract/concrete

Physical properties and relations
- General description
- Characteristic sound
- Relative spatial location
- Location

GENERIC TYPICAL CASE FRAME FILLERS

Act-Slot Relations
- All purpose slot relation
- Act/actor
- Act/object
- Act/recipient
- Act/product
- Act/instrument
- Act/location
- Act/experiencer
- Act-thing/typical setting

Object-object relations
- Thing/container
- Thing/producer
- Thing/habitat
- Agent/product

Situation-verb relations
  Situation/slot-verb
  Situation (subj) + verb
  Verb + situation (obj)

Miscellaneous
  Act/manner
  Agent/product
  Agent/goal
  Agent/material
  All-purpose case frame

Other Paradigmatic Relations

Causal Relations
  Situation/Cause (collocational)
  Situation/Cause (non-collocational)
  State/Cause (non-collocational)
  State/Action
  Affector/Affected
  Activity/Outcome

Paradigmatic verb relations
  State/verb expressing state
  State/verb to achieve state
  State/copular verb used with state
  Object/verb to make ready
  Object/verb to destroy or remove
  Object/verb to deteriorate

Dispositional relations
  Generic dispositional
  Act/Disposition to act
  Act/Disposition to be acted on

Collocational Relations

Case-based attributive collocations
  Generic attrib. rels. by virtue of act
  Act/attrib. of subject by virtue of act
  Act/attrib. of object by virtue of act
  Generic attrib. relations enabling act
  Act/attribute of subject enabling act
  Act/attribute of object enabling act

Other collocations
  Object/selected preposition
  Discipline/object
  Object/figurative description
  Practically based association
  Phonetically based association
  Phrasally based association

FUNDAMENTALLY MORPHOLOGICAL AND SYNTACTIC RELATIONS

Morphological Relations

State/verb (nominalized verb/verb)
Noun/related adjective
Adjective/related adverb

Inflectional Relations

Past/inf
Past participle/inf
Plural/singular

Aspective Relations

Is-state
Is-action
Object/realization
Event/initiation
Event/maintaining
Event/termination
Perfective

Other Syntactic Relations

SComp
Reflex
Recip

PROPOSITIONAL ATTITUDE RELATIONS

Factive
Implicative
Only-if
If
Negative-if
Negative-implicative
Counter-factive
Dull

TRULY MISCELLANEOUS RELATIONS

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