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AD 666444 A SEMANTIC ANALYSIS OF ENGLISH LOCATIVE PREPOSITIONS

Gloria S. Cooper

Contract No. F19628-68-C-0125
Project No. 8668
Task No. 866800
Work Unit No. 86680001

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Contract Monitor: Hans Zschirnt
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AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

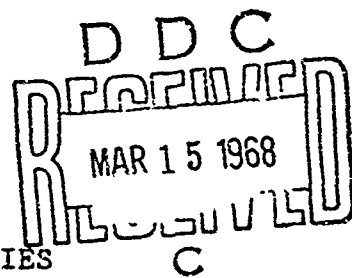
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ABSTRACT

Locative prepositions are members of a small closed class of English formatives. We present here an analysis of the thirty three English locative prepositions in the context of a theory which provides a basis for extracting semantic readings for phrases containing these words.

The meaning of a preposition is first analyzed with function concepts which pick out the relevant characteristics of objects to be related. Then a relation concept is specified which describes the special relation between the value of functions. The resulting complex relation marker will thus have the form $R(f(x),g(y))$ where f and g are function markers, R is a relation marker, and x and y are the objects to be related.

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SECTION I

INTRODUCTION

Locative prepositions are members of a small class of formatives which are difficult to define. For example, try to distinguish between "in the street" and "on the street" for a non-native speaker of English. One is hard put to clear up the confusion. It is interesting that native speakers, who often make all kinds of syntactic and semantic errors never use prepositions in prepositional phrases incorrectly; while foreign speakers master the proper use of prepositions with the greatest difficulty. It is also interesting that children learn to use prepositional forms as prepositions rather late in the language-learning game.

Prepositions may be viewed as linguistic representations of spatial objects which are unique to a given language community. Prepositions are differentiated from each other by mutually contrasting combinations of semantic markers.

A reading for a preposition consists of a complex semantic marker which itself consists of a relation marker and function markers operating on objects. The markers themselves are concepts relating to the perceptual space viewed and occupied by speakers of a language. As will be shown, the function markers extract, as it were, a part of an object as semantically salient.

In this sense, speakers of a language must learn to attend to a commonly shared inventory of perceptions. Speakers of the same language are in agreement about the visual components of the object world. The listener is immediately cued by the speaker to select one set of components for attention from a vast array

of possibilities. Prepositions represent a cognitive mapping of a culturally contingent set of visual percepts. Nothing is implied about how one learns to perceive; but, rather, what one learns to perceive is a cultural dependent.

The difficulties encountered by foreign speakers can be accounted for in two ways. First, the total set of locative markers is different from language community to language community, but a common core of such markers is found in all language communities. Secondly, the minimal combination of markers which differentiates one preposition from another within a given language, contains different markers in another language. Thus, there will be differences in the units themselves, and differences in combinatorial possibilities from language to language.

Prepositions, then, provide a linguistic mapping of the object world which is culturally habituated and thoroughly familiar to all members of the same language community. It is this characteristic of prepositions which can account for their later acquisition by children. The young child must first learn the cognitively significant semantic units for his own language. In other words, he must first learn the markers of the system before he can use the system. In this particular instance the markers are complex, so that the child's learning task is two-fold. He must learn the content of each marker in the total set of markers for the language, and he must learn the combinatorial possibilities of markers. How these two different learning tasks are mastered is not known.

This theory proposes the set of semantic markers by means of which English prepositions, as constituents of locative prepositional phrases, enjoin speakers to conceptualize objects and relations between objects. They are a set of learned discriminations which present a schema for perceiving and remembering.

This is not to say that the set of visual properties and relations which give meaning to English prepositions are the only ones available to English speakers. Obviously, English speakers can be articulate about and can make many more discriminations than the small set which mark prepositions. However, the difficulty with which foreign speakers master correct usage of prepositions in contrast to other parts of the grammar suggests that such speakers use a different set of semantic markers some of which are common to all languages. Much of the difficulty is semantic not syntactic. Foreign speakers are required to learn a somewhat different set of visual features as well as somewhat different combinations of such sets, some of which are very close to the sets and lists encoded in their native language. Because of this similarity, the learning task is very difficult.

For example, Spanish speakers learning English find it very hard to differentiate between 'on' and 'over' or 'on' and 'above'. The one Spanish phrase "la lámpara sobre la mesa" would be used for the two events in English represented by "the lamp on the table" and "the lamp above the table".

The Spanish speaker has no intuitive grasp of the difference between English "in" and "at", since both concepts are combined in a single Spanish form.

English speakers learning German tend to say "Es gibt eine gute Oper bei Lincoln Center" instead of "Es gibt eine gute Oper in Lincoln Center". The semantic markers for "bei" and "in" are somewhat different from the markers for English "at" and "in".

A serious concern of the psychology of perception has been with understanding how modifications in some properties of contours determine shape. (Gibson, 1950) This too, is a separate problem to which this theory does not address itself. For the purposes of this analysis, the shape of a closed contour is denoted by the noun which refers to it. What this theory does propose is that all shapes that are named by nouns share some qualities in common.

A listener will make adjustments in his representation of the object to conform to the conceptualization of the object entailed by the preposition. This adaptability varies from speaker to speaker and is reflected in performance. Thus, some speakers will find a meaning for a seemingly bizarre phrase by accommodating to the requirements of the preposition.

SECTION II

DESCRIPTION OF THE VARIABLES

The semantic analysis presented here applies only to adverbials of place used as modifiers of nouns. We will assume that the meaning of these prepositions in other syntactic contexts (e.g., as sentential modifiers) will be predictable from the definitions we give here. The formal descriptions of locative prepositions are components of the dictionary entries for these lexical items. (Katz, 1966, p. 154). They are the "properties of the formatives that are relevant for semantic interpretation." (Chomsky, 1965, p. 87)

In any underlying structure containing the string

$$(- [\text{Det} + N_1]_{\text{NP}} + [\text{Prep} + (\text{Det} + N_2)]_{\text{Adv-p}} -)$$

we will let X be a variable for N_1 and Y a variable for N_2 . We assume that X and Y refer to objects, spaces or volumes that are perceived or conceptualized as spatial wholes.

We will let Z be a variable for a space perceived as a figure which stands in some relation to an X and Y . When Space is itself an object, it is a three-dimensional figure which replicates in reverse much of the contour of the concrete object to which it is contiguous. It is, as it were, a ghostly reflection of a concrete figure. Thus, the edges and sides which are contiguous to the concrete figure match in size the edges and sides of that figure. But the edges furthest from the concrete figure are less clearly specified and somewhat diffuse much as the reflection of a building in a lake tends to diffuse at the outer edges.

Locative prepositions describe the spatial relations of physical objects, areas, volumes, or spaces that are somehow perceived as single figures. Thus, locative uses include such expressions as "the book on the table", "the fly in the hole", or "the gap in the mountain". A locative seems to function semantically in the same way whether the referents of N_1 and N_2 are objects or spaces. It seems reasonable to assume that these referents all have the property of being unitary figures without concerning ourselves here with how this happens.

SECTION III

DESCRIPTION OF THE MARKERS

The nature of the semantic description to be used may be summarized as follows: a semantic marker is a formal symbol standing for a concept. A list of primitive semantic markers is given, together with a description indicating the intended interpretation of the primitives. The definition of a word is then given by specifying a complex semantic marker which is a combination of primitive markers. The method of combination also has an intended interpretation, so that the complex marker stands for a concept which is composed, in the way indicated, from the primitive concepts. For example, the marker (human) has as its intended interpretation the property of being human. The marker (young) has as its intended interpretation the property of being at the early part of a limited temporal existence. Juxtaposition of markers has as its intended interpretation conjunction of the properties of the markers juxtaposed. Thus ((human)(young)) represents a complex concept corresponding to the word "child". Semantic markers are of (at least) two sorts. The examples given indicate concepts of fixed properties. But a concept may also be of a relation with two or more arguments, and these arguments may themselves be concepts as well as other entities (e.g., physical objects or spatial configurations). Thus, the concept of location is a relation between two things, X and Y, and may be symbolized by the semantic marker L(X,Y). The intended interpretation is that Y is a place, X is a physical object or a spatial configuration, and Y is the location of X. As a special case of relation concepts we will use function concepts. For example, we will introduce the primitive semantic marker i(), which is intended to correspond to the

concept of the following operator: if X stands for a physical object or a spatial configuration, then $i(X)$ stands for the space or volume internal to X . A combination of relation markers and function markers will have the usual interpretation. For example, $L(X, i(Y))$ is to be interpreted as the relation L holding between X and the value of the function i operating on Y . Thus, $L(, i())$ is a complex semantic marker standing for the concept of a complex relation.

Locative prepositions, unlike nouns and adjectives, specify relation-concepts with two or more arguments. Thus, in general, the meaning of the prepositions must be given in terms of the relation markers and function markers instead of the sort of marker which specifies a property concept. Locative prepositions specify a spatial relation between a small subset of the characteristics of the objects indicated by the expressions which are connected by the preposition. Thus, the meaning of the preposition can be analyzed, first, with function concepts which pick out the relevant characteristics to be related, and second, with the relation concept describing the special relation between the values of the functions. The resulting complex relation marker will thus have the form $R(f(), g())$ where f and g are function markers and R is a relation marker. For example, the complex marker $L(, i())$ described above gives the meaning of the preposition "in".

R , f and g will either be primitive markers taken from the list given below or complex function and relation markers defined in terms of the primitives. Semantic markers indicating properties will be used only in selection restrictions which limit the domain of the relations.

SECTION IV

THE MARKERS

- 1) L(X,Y) (Y is the LOCATION of X). L(,) is a two place relation which holds when Y is the location of X. Y may be either a precise location, or it may be a volume, area, or line which delimits the exact location of X. Thus, L(,) is intended to be the general concept of exact location. In this sense we can say that Mr. Jones' home is located in Cambridge.
- 2a) C(X,Y) (X is CONTIGUOUS with Y). C is a two-place relation which holds between X and Y when they are in contact, when they are adjacent, very close or in juxtaposition. The concept is applicable when the contact or closeness is over a considerable portion of both figures and not when the contact or closeness is at one point only.
- 2b) Sep(X,Y) (X and Y are not contiguous but separated). The contrast between contiguity and separation will be used to make the distinction between such prepositions as "on" and "near", "on top of" and "above". For example, if a pencil were located in the space above a table and were in contact with that table along that pencil's length (the pencil is lying on the table and so is contiguous with it) we would say the pencil is on top of the table. But, if the pencil were located in the space above the table without touching it (say, the pencil were suspended from the ceiling), we would say the pencil is above, but not on top of the table.

- 3) S(X) (S(X) is the set of points, lines and surfaces marking the boundary of X). If X is a three dimensional figure (i.e., a volume), S(X) is the set of surfaces enclosing or marking off that figure. If X is two dimensional (i.e., a surface), S(X) is the set of lines or the contour marking the boundary or edge of the surface. And if X is one dimensional (i.e., a line), then S(X) is the set of endpoints of the line. In case X is a closed surface or closed line (and thus, not having an edge or endpoints, as for example, a spherical shell or a circle), then S(X) is empty. Clearly, S can be iterated. If X is a box-figure, then S(S(X)) is the set of lines forming the edge of the box. S(S(S(X))) is the set of corner points of the box.
- 3a) B(X) (B(X) is the boundary of X). If X is two dimensional B(X) = S(X). If X is three dimensional B(X) = S(S(X)). If X is one dimensional B(X) = nil. Thus, B(X) is the set of lines marking the boundary or edges of an object, be it two or three dimensional. It should also be noted that figures will be marked for dimensionality (see Bierwisch) so that B can actually be defined in terms of S as a function of X and its dimensionality, without introducing any new concepts.
- 3b) Sur(X) (Sur(X) is the surface of X).
 If X is three dimensional, Sur(X) = S(X)
 If X is two dimensional, Sur(X) = X
 If X is one dimensional, Sur(X) = X.
- 4) Side₁(X) (Side₁(X) $\equiv$ member of S(X)).

- 4a) Top(X) ($\text{Top}(X) \equiv \text{member of } S(X) \text{ and } (+\text{vert}(X)) \text{ and } (+\text{ext}(X))$).
(+ vert) marks the axis perpendicular to the side.
The distinction between opposing sides which are considered a contrasting pair is indicated by a pair of markers called (+ext) and (-ext). (see Teller)
- 4b) Bottom(X) ($\text{Bottom}(X) \equiv \text{member of } S(X) \text{ and } (+\text{vert}(X)) \text{ and } (-\text{ext}(X))$).
- 4c) Front(X) ($\text{Front}(X) \equiv \text{member of } S(X) \text{ and } (-\text{vert}(X)) \text{ and } (+\text{ext}(X))$).
- 4d) Back(X) ($\text{Back}(X) \equiv \text{member of } S(X) \text{ and } (-\text{vert}(X)) \text{ and } (-\text{ext}(X))$).
- 4e) Side₂(X) ($\text{Side}_2(X) \equiv \text{member of } S(X) \text{ and } (-\text{vert}(X))$).
- 5a) Distal(S(X)) $\text{Distal}(S(X))$ is a distance measure marking the farther S(X) of two opposing S(X)'s from the point of view of a third referent, the speaker.
- 5b) Proximal(S(X)) $\text{Proximal}(S(X))$ is a distance measure marking the nearer S(X) of two opposing S(X)'s from the point of view of a third referent, the speaker.
- 6) Sp(Z) Z is a space defined by some relationship(s) to X and/or Y, the arguments of the prepositional relation.

SECTION V

DEFINITIONS OF THE PREPOSITIONS

1.) X above Y

X and Y are separate.

1) Sep(X,Y)

X is located internal to

2) Sp(Z)

the space Z, a bottom

3) L(X,i(Z))

boundary of which is

4) C(bottom(B(Z)),top(Y)) .

contiguous with the top of Y.

This definition accounts for a range of positions an X may occupy relative to a Y. It also accounts for differences which may depend on changes in the visual field of the speaker. Since the only condition on the relation between Z and Y is that any bottom boundary of Z be contiguous with the top of Y, the bottom side of the figural space Z may or may not coincide with the top side of Y.

In any stacked series of objects, the stack itself becomes the space for any single object in it. Thus, one can talk about "the stratum of oil above the other stratum", or "the red book above the blue one." etc.

It is a fact of the world that objects which are gases and liquids conform to the shape of the containers which confine them, or else spread across the surface of another object. That is, their contours are not inherently fixed. (This feature is syntactically marked by mass nouns.) We view such objects as air, water, oil, mist, fog, and the like, as filling the space Z such that they may or may not be separate from the figure Y. Thus, phrases such

as "the air above the surface", "the mist above the trees", and "the fog above the road" fit the definition given above.

Examples:

the plane above the city
the shelf above the desk
the floor above this one
the moon above the trees
the mesa above the city

the water above this level
the pressure above the surface
the atmosphere above the earth
the mist above the water

2.) X below Y

X and Y are separate
X is located internal to the
space Z, the top boundary of
which is contiguous with the
bottom of Y.

- 1) Sep(X,Y)
- 2) Sp(Z)
- 3) L(X,1(Z))
- 4) C(top(B(Z)),bottom(Y))

Examples:

the city below the plane
the valley below the clouds
the desk below the shelf
the floor below this one

the water below the surface
the oil below this level
the book below the red one
the pressure below the earth's
crust

3.1) X over₁Y

- 1) Sep(X,Y)
- 2) Sp(Z)
- 3) L(X,1(Z))
- 4) C(bottom(B(Z)),top(Y))

Over₁ is a synonym of above.

Examples:

the plane over the city
the shelf over the desk
the floor over this one
the moon over Manhattan

the gas over the surface
the mist over the water
the moon over the trees

3.2) X over₂Y

SR: <X flexible solid or liquid> 1) SR: <X(flexible
the back of X is contiguous solid-liquid)>
with at least the top of Y 2) C(back(X),top(Y))

Note that over₂ is not synonymous with above. SR indicates
a selective semantic restriction.

Examples:

the blanket over the bed
the blood over his hand
the ivy over the fence

the coat over the book
the frosting over the cake
the water over the floor

Note that this definition optionally allows for the contiguity of the back side of X with both the top and any other sides of Y. Whether this is so or not depends upon the facts of the world concerning X. If X is a flexible object, depending on its size it may be folded in half, thirds or quarters, lengthwise, or it may not. It may be small or very large. However to meet the condition of the definition that the back side of X be contiguous with at least the top side of Y, X must be similar in size to Y, and can be larger.

At this juncture, we are not able to account for phrases such as "the curtain over the window" meaning the curtain covering the window. We can claim that it is a fact of the world that windows do not have top sides, but are objects embedded in other surfaces such as a wall or ceiling and are viewed as a part of such a surface.

4.1) X under₁ Y

X and Y are separate.
X is located internal
to the space Z, a top
boundary of which is
contiguous with the
bottom of Y.

- 1) Sep(X,Y)
- 2) Sp(Z)
- 3) I.(Y,1(?))
- 4) C(top(B(Z)),bottom,(Y))

Under₁ is a synonym of below and antonymous to over₁ and above.

Examples:

the city under the clouds
the desk under the shelf
the floor under this one
the chest under the mirror

the water under the surface
the gas under the earth's
crust
the book under the red one
the table under the umbrella

4.2) X under₂Y

SR: <Y is a flexible solid or liquid>
 a surface of X is contiguous with
 an internal surface of Y
Under₂ is an antonym of Over₂
 and is not antonymous with any
 reading of Above.

1) SR: <Y(flexible solid v
 liquid)>

2) C(Sur(X), Sur(1(Y)))

Examples:

the bed under the blankets

the streets under the flood-
 waters

the book under his coat

the tick under his skin

the vest under his jacket

the meat under the casing

the cut under the bandage

the face under the veil

the man under the sheets

the mummy under the bindings

5.1) X underneath₁Y

X and Y are separate.

1) Sep(X,Y)

X is located internal to the

2) Sp(Z)

Space Z, the top of which is

3) L(X,1(Z))

contiguous with the bottom of Y.

4) C(top(Z), bottom(Y))

Examples:

the desk underneath the shelf

the water underneath the
 surface

the chest underneath the mirror

the pressure underneath the
 earth's crust

the floor underneath this one

the trunk underneath the bed

Note that underneath₁ is almost synonymous with under₁. They differ by the markers on Z. Underneath₁ selects the top of Z as salient and under₁ selects a boundary of Z as salient. Thus, for underneath₁ the space Z always coincides with the boundaries of the bottom of Y, where this is not so for under₁.

5.2) X underneath₂Y

SR: <Y is a flexible solid
or liquid>
a surface of X is contiguous
with the internal surface of Y

- 1) SR:<Y(flexible solid v
liquid>
- 2) C(Sur(X), Sur(1(Y)))

Examples:

the bed underneath the blanket
the book underneath his coat

the boy underneath the sheets
the cake underneath the
frosting

6.) X beneath Y

X is located internal to the
space Z, the top of which is
contiguous with the bottom of Y.

- 1) Sp(Z)
- 2) L(X, 1(Z)) and
- 3) C(top(Z), bottom(Y))

Examples:

the desk beneath the shelf
the floor beneath this one
the city beneath the clouds
the book beneath the coat
the cake beneath the frosting

the chest beneath the mirror
the trunk beneath the bed
the boy beneath the sheets
the vest beneath his jacket
the cut beneath the bandage

Note that this is almost synonymous with underneath₁. Beneath₂ does not mark separation of X and Y, so that X and Y could be contiguous or not.

7.) X against Y

SR: <Y is a solid>

a vertical side of X is
contiguous with a vertical
side of Y

1) SR:<Y(solid)>

2) C(side₂(X),side₂(Y))

Examples:

the desk against the wall
the ladder against the house
the car against the curb
the rose hedge against the fence
the puddle against the wall
*the wall against the puddle

the chair against the desk
the board against the fence
the book against the back of
the shelf
* the ladder against the water
* the cliff against the fog

* = not permissible, because X does not meet the SR restriction

8.1) X is across₁Y

X is located in the space
which is contiguous with the
distal boundary of Y

- 1) $Sp(Z)$
- 2) $L_1(X, Z)$
- 3) $C(X, d(B(Y)))$

Examples:

the room across the hall
the house across the park
the man across the street
the land across the sea
the town across the river

the chair across the room
the room across the house
the boat across the lake
the letter across the table
the shoe across the floor

Across is ambiguous for location inside or outside a figure Y. Location internal to a figure has to do with facts of the world rather than a specification by the definition. For example, "the ball across the pool" is unspecified as to placement of the ball within the pool or outside the pool. All that is marked is that the ball is near the distal boundary of the pool from the point of view of the speaker.

It is a fact about the nature of houses that rooms are within them. This is not specified by the reading for the preposition.

8.2) X is across₂Y

SR: <A magnitude of X is equal to 1) SR:< $\geq$ (mag.(X),mag.(Y))>
 or larger than a magnitude 2) C(X,d(B(S(Y))))
 of Y> 3) C(X,p(B(S(Y))))
 X is contiguous with the
 distal and proximal boundaries
 of a side of Y

Examples:

the rope across the bridge
 the log across the stream
 the saucer across the cup
 the bridge across the canyon

the cable across the ocean
 the bridge across the river
 the crack across the wall

9.) X by Y

syntactic restriction	1) Sp(Z)
<Y is not an object pronoun>	2) L(X,i(Z))
X is located internal to the	3) C(Z,side ₂ (Y))
space Z which is contiguous	
to a vertical side of Y	

Examples:

the boy by my side
 the car by the road
 the table by the door
 the tree by the house
 the house by the road
 the trunk by the bed
 the lamp by the side of my head

*the boy by me

This definition is not marked for separation of X and Y.
Thus X and Y may or may not be contiguous.

10.) X in back of Y This contrasts with X in the back of Y.

X and Y are separate.

1) Sep(X,Y)

X is located internal to the
space which is contiguous with
the back of Y

2) Sp(Z)

3) L(X,i(Z))

4) C(Z,back(Y))

Examples:

the man in back of the house

in contrast:

the man in the back of the
house

the opening in back of the house

the opening in the back of
the house

the thread in back of the dress

the thread in the back of
the dress

11.) X in front of Y

X and Y are separate.

1) Sep(X,Y)

X is located internal to the
space which is contiguous with
the front of Y

2) Sp(Z)

3) L(X,i(Z))

4) C(Z,front(Y))

Examples:

the man in front of the house

in contrast:

the man in the front of the
house

the tree in front of me

*the tree in the front of me

the car in front of the house

the car in the front of the
house

Examples: (cont.)

the yard in front of the school

the yard in the front of the
school

the desk in front of the classroom

the desk in the front of the
classroom

the glasses in front of the cups

the glasses in the front of
the cups

12.) X beyond Y

X and Y are separate

1) $Sep(X,Y)$

X is located internal to the
space which is contiguous to
the distal boundary of Y

2) $Sp(Z)$

3) $L(X,i(Z))$

4) $C(X,d(B(Y)))$

Examples:

the street beyond this one

the road beyond the house

the man beyond the house

the car beyond the trees

the traffic-lights beyond the
turn-off

the turn-off beyond the
traffic-lights

13.) X in Y

<X is smaller than Y>

X is located internal to Y

1) SR:<smaller(X,Y)>

2) L(X,1(Y))

Examples:

the elephant in the zoo

the flowers in my room

the drawer in my desk

the crack in the wall

a bee in my bonnet

the papers in my desk

the cigarettes in my pocket

the hole in his head

14.) X out of Y

<X is smaller than Y>

X and Y are separate

1) SR:<smaller (X,Y)>

2) Sep(X,1,(Y))

Examples:

elephants out of the zoo

the flowers out of my room

the cigarettes out of my pocket

the coat out of the closet

the flowers out of my room

the papers out of my desk

the coat is out of the closet

15.) X beside Y

Beside derives from "by the side of" so that the readings for each of the morphemes are combined. However, this is to say that the construct side(Y) is to be read as side(SIDE). In this analysis, the side of SIDE is equivalent to side.

Examples:

the boy beside me = the boy by my side
the car beside the road
the table beside the door
the tree beside the house
the house beside the road
the trunk beside the bed
the lamp beside my head = the lamp by the side of my head

16.) X near Y

X and Y are separate	1) Sep(X,Y)
X is located internal to the	2) Sp(Z)
space Z which is contiguous	3) L(X,i(Z))
with Y	4) C(Z,Y)

Examples:

the boy near me	the car near the road
the table near the door	the house near the road
the trunk near the bed	the lamp near my head

17.) X behind Y

X and Y are separate
X is located internal to the
space which is contiguous
with the back of Y

- 1) Sep(X,Y)
- 2) Sp(Z)
- 3) L(X,i(Z))
- 4) C(Z,bk(Y))

Examples:

the road behind the house
the chair behind the desk
the trunk behind the bed
the shed behind the house

the man behind the curtain
the table behind the door
the faucet behind the house

18.) X on Y

SR: <Y supports X>
a surface of X is contiguous
with a surface of Y

- 1) SR<supports (Y,X)>
- 2) C(Sur(X),Sur(Y))

Examples:

the nose on his face
the desk on the floor
the book on the table
the fly on the ceiling

the picture on the wall
the car on the street
the blood on his hands
the paint on the wall

19.) X off Y

the surface of X is separate Sep(Sur(X),Sur(Y))
from the surface of Y

Examples:

the picture off the wall
the book off the desk
the paint off the wall, etc.

20.) X at Y

selective restrictions:

<X is portable relative to Y, and Y is not a geopolitical area>
at = near or in

Note that the selective restrictions exclude the following:

*The history book at the mystery book but The history book
near the mystery book.

*The man at New York but The man in New York.

21.) X between Y_1 and Y_2

X is located internal to the space Z which is contiguous with a boundary of Y_1 and a boundary of Y_2

- 1) $Sp(Z)$
- 2) $L(X,1(Z))$
- 3) $C(Z,B(Y_1))$
- 4) $C(Z,B(Y_2))$

Examples:

the chair between the desk and the chest
 the plane between New York and Boston
 the hall between the bedroom and the bathroom
 the book between the bookends
 the river between St. Louis and New Orleans

Note that separation of X and Y's is not marked, so that X in the space Z could be in contact with one or both Y's as in the last three examples.

22.) X among Y_1 , Y_2 and Y_n

X is located internal to the space Z which is contiguous with a boundary of Y_1 , a boundary of Y_2 and a boundary of Y_n

- 1) $Sp(Z)$
- 2) $L(X,1(Z))$
- 3) $C(Z,B(Y_1))$
- 4) $C(Z,B(Y_2))$
- ...
- n) $C(Z,B(Y_n))$

Examples:

the girl among the flowers
 the papers among the books
 the weeds among the grass

the men among the boys
 the flowers among the trees

23.) X inside (of) Y

SR: <X is smaller than Y>

X is located internal to a
vertical side of Y

1) SR.<smaller(X,Y)>

2) L(X,1(side₂(Y)))

Examples:

the man inside the room

the letters inside the mailbox

the train inside the station

the papers inside the drawer

the car inside the garage

the crack inside the wall

24.) X outside (of) Y

X and Y are separate

X is located internal to the

space Z which is contiguous

with a vertical side of Y

1) Sep(X,1(Y))

2) Sp(Z)

3) L(X,1(Z))

4) C(Z,side₂(Y))

Note that the first statement of the definition of outside is antonymous to the reading for inside. This means that all phrases containing inside may use the antonym outside, but not the converse, i.e., not all instances of outside may substitute the antonym inside, unless they meet the conditions of the selective restriction for inside.

Examples:

the man outside the room

the car outside the garage

the elephant outside the window

the light outside the house

the grass outside the yard

*the elephant inside the window

25.) X within Y

X "inside of" Y

- 1) S.R.<smaller(X,Y)>
- 2) L(X,i(sd₂(Y)))

Examples:

the man within the room
the furniture within the house
the children within the house

26.) X around₁ Y

SR: <X is a closed line or surface,
or a collection of objects
which forms a closed line or
surface>
Y is located in the space
which is inside (the closed
line or surface) X

- 1) Sp(Z)
- 2) X = S(Z)
- 3) L(Y,i(Z))

Examples:

the fence around the yard
the ring around her finger
the blanket around the boy
the moisture around the dust particle

the belt around his waist
the people around the table
the wrapping around the box

Note that the reading for around₁ does not mark whether or not X and Y are separate, so that X and Y may be in contact as in the last three examples.

27.) X up Y

- SR: <Y has a non-horizontal side>
- 1) SR<Y has non-hside>
- 2) $C_p(X, S(\text{non-hside}(Y)))$
- X is contiguous proximal to
the top of a non-horizontal
side of Y

This definition does not account for phrases such as:

the man up the street
the house up the road
the boat up the river, etc.

Since the marking of this use of 'up' seems to involve markers other than those used for this analysis, such as (direction one faces) or (path one traverses) namely markers of movement, it is not being considered here. This definition will cover examples such as:

- 1) the cat up the tree (has been howling all day)
- 2) the crack up the wall (is unsightly)
- 3) the house up the hill
- 4) the room up the stairs
- 5) the pennant up the pole

Note this definition excludes bizarre phrases such as:

- *1) the cat up the floor
- *2) the dirt up the ceiling
where Y is horizontal

28.) X down Y

SR: <Y has non-horizontal side>
 X is contiguous proximal
 to the bottom of a non-
 horizontal side of Y.

1) SR:<Y has non-hside>
 2) $C_p(X, S(\text{non-hside}(Y)))$

Examples:

the hole down the tree	the room down the stairs
the crack down the wall	the house down the hill
the pennant down the pole	

The following five prepositions are prepositions of direction rather than locatives. They use a different set of markers for which formal definitions have not yet been defined. They are included here as an addendum even though their descriptions are intuitive.

29.) X around₂ Y

there is a pathway W that extends from one side of Y to at least one other side of Y and X is an endpoint on that pathway

Examples:

the store around the corner
 the wagon around the back (of the house)
 the house around the bend
 the tree around the curve in the road

30.) X around₃ Y

there is a collection of places where X is located, which are an indefinite number of points in the vicinity of Y

Examples:

the cats around the house
the children around the yard
the weeds around the garden

31.) X about Y

= around₃

Examples:

the cats about the house
the children about the house, etc.

32.) X from Y

There is a pathway W that has an origin point which is the location of Y, and another point which is the location of X. If X is a pathway, then $X \equiv W$. Otherwise, X and Y are separate.

One reading of nouns such as, 'road', 'path', 'ray', 'corridor', and 'beam' must be semantically marked for (pathway).

Examples:

the light from the beacon

the book from the store

Examples: (cont.)

the paper from the cabinet
the path from the house
that man from England

the road from town
the bus from New York

33.) X to₁ Y

There is a pathway W that has a terminal point which is the location of Y, and another point which is the location of X. If X is a pathway, then $X \equiv W$.

SR: <if X is a vehicle then it is the customary means of transportation for a given pathway>

Note that the following are bizarre:

- *the roller-skates to New York
- *the bicycle to Second Street
- *the scooter to my house

but

the bus to town
the train to New York
the plane to Chicago
the steamboat to New Orleans
the boat to England

are acceptable.

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