Opposition is a kind of similarity

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Abstract

This article tries to discuss opposition fundamentally, synthetically, and logically. To achieve this, some prerequisite concepts such as lexical semantic relation, difference, sameness, and similarity are discussed at the beginning. Then this article argued opposition is a kind of similarity that also includes sameness, approximation, overlap, inclusion, and parallelism. These relations are obtained by analyzing sameness and differences among objects. Third, this article introduces three methods of analyzing opposition: difference reduction, transformation-state model, and verb-participant-state model. Fourth, a new classification of opposition is developed. There are three main kinds: small/big, X/not X, and AB/BA. In order to cover as many oppositions as possible, numerous examples in different areas are presented.

Keywords: lexical semantic relation, opposition, similarity, difference.

contexts

1 Extended lexical semantic relation and similarity

1.1 Extended lexical semantic relation.

Lexical semantic relation is the relation between lexical meanings. However, these relations also exist in the meanings of affixes, phrases, sentences, and texts, more or less. Moreover, these relations are not only linguistic but also cognitive. Therefore, it is necessary to translate these lexical terms into more general terms which are basic concepts of rational thinking. Lexical semantic relation and paradigmatic relation are almost the same. These relations are based on the comparing of terms that have something in common" (Saussure 1959:125). Murphy (2003, 2010), Chaffin and Herrmann (1984, 1988), and Saeed (1997) offered several systematic classifications of lexical semantic relations. In this article, a different and extended version is shown in Table 1. Overlap is a new relation for words. For example, *pet* and *cat* are overlapped since some cats are pets, some are not, and vice versa. Class inclusion and meronymy can be united into one kind: inclusion.

Table 1 Extended lexical semantic relation

	linguistic and cognitive terms	**lexical terms**
1	sameness	synonymy
2	approximation (almost same)	near-synonymy
3	inclusion(includer/includee)	class inclusion(hypernym/hyponym) meronymy(whole/part)
4	parallelism	co-hyponym
5	opposition	antonymy
6	overlapp	null

1.2 Sameness and difference.

Before discussing extended lexical semantic relation in detail, sameness and difference should be discussed first. If someone encounters two or more objects and wants to compare them, two questions will always emerge. Answering these two questions is a basic cognitive activity.

(i) What is the difference between them?

(ii) What do they have in common?

1.2.1 Question one: Difference.

What is the difference between A and B? Besides the answers "they are no different" and "they are completely different", the typical form of the answers is AX, BY. A and B are subjects; X and Y are predicates. There are two kinds of relation between X and Y: opposition (1) and parallelism (2).

(1) Opposite answers.

a. A likes coffee; B does not like coffee.

b. A is small, B is big.

c. A is the appointer, B is the appointee.

d. A is the attacker, B is the defender.

e. A is moving east, B is moving west.

f. A is melting. B is solidifying.

g. A is a surface-to-air missile, B is an air-to-surface missile.

(2) Parallel answers.

a. A likes coffee; B likes tea.

b. A is red, B is blue.

c. A is six years old, B is ten years old.

d. A is moving east, B is moving north.

e. A is a teacher, B is an entrepreneur.

f. A is an obligation, B is a right.

The answers of difference are based on sameness. We can find the similarities of every pair of A and B in (1) and (2) through the answers of difference. For example, *A is small, B is big* implies "Both A and B have the size".

These answers could turn into questions, and these questions could be asked in succession. For example, *what is the difference between small and big*? or *what is the difference between coffee and tea*? Finally, the question will be unanswerable, and some basic terms will be left. This method is very important for analyzing and classifying opposition and will be applied in Section 2.1.

1.2.2 Question two: Sameness.

What do they have in common? The typical forms of answers are (i) AX, and BX too(either), such as *A works in this factory, and B works in this factory too*. (ii) Both of A and B Y, such as *Both A and B work in this factory*, or (iii) A and B Z, such as *A and B work in the same factory.* X and Y is a normal predicate. Z is a predicate that includes the word "same".

It is impossible to find two objects that cannot answer this question. In other words, there are no two objects which are totally different when using "totally different" literally. However, some answers mean the similarity of these objects is on a very low level or they are almost totally different (ATD): (i) A negative form, such as *A is not red*, *and B is not red either*. (ii) A very broad description, such as *Both A and B exist (*or *are describable)*. (iii) Same attribute, not attribute value, such as *the Sun has weight*, *Hegel has weight too*. (vi) The form like "A and B are in the same system (or structure)", such as *sunlight and plants are in the same ecosystem*. S*unlight* and *plants* are ATD although they can answer the question of sameness.

1.3 Similarity and its classification.

Similar has three confused meanings. The narrow one is 'almost same' or 'approximate', and the broad one is 'partially same' or 'have something in common' which contains ATD. The third is between them which means 'partially same but not ATD'. To avoid confusion, *Similar* and *similarity* are used only in the third meaning in the article. *Approximate* and *partially same* will replace other meanings of *similar*.

If a cup is half full, it is also half empty. Accordingly, *partially same* also means 'partially different'. If A and B are partially same, there must be something to be said about their sameness and difference. Except for ATD, there are six types of similar relations: sameness, approximation, overlap, inclusion, opposition, and parallelism. This classification is the cognitive and logic source of lexical semantic relation.

Set model is not enough to express all six types (Cruse1986:87). An inaccurate but simple way to show these concepts is using a string model (Table 2). These relations can be between two objects or many objects except opposition.

Table 2 String model of classification of similarity

	type of similarity	**two objects**	**many objects**
1	same	A/A	A/A/A…
2	approximate (almost same)	A/a	A/a/**A**…
3	overlapped	AB/AC	AB/AC/AD…
4	inclusion(includer/includee)	A/AB	A/AB/ABC…
5	opposite	AB/BA	null
6	parallel	A/B	A/B/C…

Their detailed definitions are as follows:

(i) Sameness is a kind of similar relation between A and A or B and B, and so on. There is no difference between them.

(ii) Approximation is a kind of similar relation that the same part is far more important than the different part. For example, the letter "a" in uppercase, lowercase, and bold are approximate. In most cases, the different part is negligible, and the two approximate objects can be interchangeable. The criteria of approximation are not strict.

(iii) Overlap is a kind of similar relation that the same part is both of them include the same thing(s), the different part is one includes something that the other does not, and vice versa For example, both AB and AC have A; AB includes B that AC does not, and AC includes C that AB dose not.

(iv) Inclusion is a kind of similar relation between includer and includee. The includer includes the includee. The same part is both of them include the includee, and the different part is the includer includes other(s) that the includee does not. The includer is bigger than the includee in some sense. Includer and includee is the only type of similar relation that is asymmetric. It is a binary relation that can be extended. The includer can be other object's inculdee. Therefore, inclusion can be layered like an onion. For example, A is included by AB, AB is included by ABC, and so on. It includes but not limited to class inclusion and meronymy.

(v) Opposition is difficult to define in a unified form although there is also something to say about their difference and sameness. In general, opposition is a kind of similar relation that the same part is secondary, and the different part is primary (this is the reason that the relation between approximation and opposition is considered as a kind of opposition. However, the better opposite of approximation is ATD). Opposition is the only similar relation that has

fixed two members. AB/BA is one kind of opposition. There are other kinds that cannot be formalized. The detailed classification will be discussed in next section.

(vi) Parallelism is the result of dividing an object that includes many or countless objects. For example, 26 English letters are parallel. If the object is a class such as *animals*, we classify it; if the object is a structure such as *a car,* we disassemble it; if the object is a period or a series of events, we periodize it. The same part is all of them are included by the same includer, and they are in the same level of a hierarchical classification. For example, *dog* and *cat* are parallel, as well as *digestive system* and *respiratory system*, but *dog* and *ragdoll*, *digestive system* and *lung* are not parallel. They are similar indirectly. The different part is they are separated parts of the includer. The degree of similarity of parallelism is flexible. *Birman* and *ragdoll* are parallel; *animal* and *plant* are also parallel; even *matter* and *energy* are parallel.

Sameness and difference are a complex continuum. All the similar relations can be arranged on a scale of difference (Figure 2) although the distinction among similar relations is not clear. Sameness (no different) is at zero, approximation is next to it. Total difference is at infinity which means "total difference is impossible" since the question "What do they have in common?" is always answerable. ATD is next to it.

The other four are in a vast area between approximation and ATD. Their similarity is flexible. Parallelism is flexible as mentioned above. Overlap and inclusion are also flexible since the proportion of their different part and same part is flexible. Opposition under loose standards is also flexible. For example, the similarity between *artiodactyl* and *perissodactyl* is greater than that between *vertebrate* and *invertebrate,* since both *artiodactyl* and *perissodactyl* are *vertebrates.* Meanwhile, the other four also are intertwined.

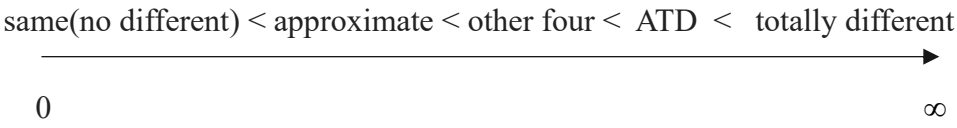


Figure 1 Scale of difference

2 Three methods of analyzing opposition.

2.1 Difference reduction and root difference.

This method is inspired by the concept "encapsulate" (Cruse 1986:198). In Section 1.2.1, the key parts of these opposite answers are opposite words or phrases that can be further reduced. The final results of reduction are root differences which are used to distinguish other differences and cannot be distinguished by any differences. The only three root differences are small/big, X/not X, and AB/BA. They still have something in common. It is impossible to remove all the same parts of two opposite objects and leave only the different parts. They are also root oppositions. All oppositions are based on one or more of them. There are four methods to reduce oppositions to root differences:

(i) Decompression. Some words are equivalent to phrases. Decompression is the process

that decompressing a complex word into a phrase that has several simple words. For example, after decompressing, *man* is 'adult male human'; *unreal* is 'not real'. The focus of decompression is meaning, not form. For example, *hardware* cannot decompress to "hard" and "ware". Decompression is not componential analysis (Leech 1981) since the result of decompression is a phrase, and the result of componential analysis is several independent words. Decompression is more like the descriptive definition. It at least has three problems. First, some words are too simple to decompress which are called "morpheme". Second, some words are too complex to decompress such as *book*, *conservatism*. Third, some function words can only be explained, not decompressed such as *in*, *of*.

(ii) Attributive analysis. This method is a supplement of decompression for analyzing meanings. Some objects can be decompressed, same cannot. However, all objects have attributives. According to bundle theory (Van Cleve 1985, Hume 1738), "a thing is nothing but a bundle of properties." An undecomposable object also has many attributes. We can find their differences through comparing their attributes. This method should be used with caution since it is difficult to determine how many attributes an object has and which attributes are important. For example, both *man* and *woman* have countless attributes, and they are different in countless ways.

(iii) Deleting unnecessary same parts. Deletion processes the results of two previous methods. For decompression, it is a kind of string processing of deleting all the same parts unless it is the only one left and keeping the different parts. Their forms are the only focus. For example, what is different between *adult male human* and *adult female human*? The answer is *male* and *female*. For attributive analysis, deletion means deleting the same attributes and keeping different attributes.

(iv) Formalizing necessary same parts. Formalization is the process of replacing the same and necessary parts of words or sentences with more general symbols or meaningless letters. The purpose is to raise the relation to a more abstract and general level. Root differences will be too many to classify without this step. For example, *Red* and *not red* have the same part *red.* We cannot delete *red* since it is the only one left. However, the relation of *red*/*not red* and *blue*/*not blue* are the same, they share the same form: X/not X. Other forms include AB/BA such as *surface-to-air/air-to-surface*, Ver/Vee such as *appointer/appointee*, V1er/V2er such as *attacker/defender*.

These four methods can be used in combination or separately. For example, *father/mother* can decompress to *male parent/female parent*, and delete to *male/female*, and decompress to *not give birth to babies/give birth to babies*, and delete to *not give birth / give birth*, and formalize to not X/X. Therefore, the root difference of *father/mother* is not X/X.

Difference reduction is a multi-step method. Therefore, it also produces many intermediate results. Some of these results (e.g. Ver/Vee) are basic oppositions that can be used to subdivide opposition.

2.2 Reversibility and transformation-state model.

Difference reduction is an effective and fundamental method of analyzing opposition, but it is not the only one. Reversibility (Cruse 1986: 226) is another important concept to analyze opposition. The united form includes two transformations and two states. Reversibility means the third state and the initial state are the same, as shown in (3a). If the states are not time-sensitive, the form also can be expressed as (3b).

(3) a. state X $\xrightarrow{\text{transformation A}}$ state Y $\xrightarrow{\text{transformation B}}$ state X

b. state X $\underset{\text{transformation B}}{\overset{\text{transformation A}}{\rightleftarrows}}$ state Y

Reversibility is the concept based on similarity. The relation between transformations could be same or opposite, and the relation between states could be same, opposite or parallel. Therefore, reversible transformations can be divided into six kinds (Table 3).

Table 3 A classification of reversibility

	relation of transformation A and B	**relation of state X and Y**
1	same	same
2		opposite
3		parallel
4	opposite	same
5		opposite
6		parallel

Mathematical functions are the most important instance of reversible transformation, as shown in (4). A function has one input and output. After two functions, the number returns to its initial value. The two functions are transforms; the inputs and outputs are states.

(4) a. input X $\xrightarrow{\text{function A}}$ output / input Y $\xrightarrow{\text{function B}}$ output X

If function A: $X \rightarrow Y$ and function B: $Y \rightarrow X$, then function A and B also could be same or opposite. The two functions are called self-inverse functions (Adams and Christopher 2008: 167) if they are the same; one is the other's inverse function if they are opposite. The numbers as input and output also can be same, opposite, and parallel. Many reversible transformations can be found their phototypes in mathematical functions. Reversible transformations also exist in other scientific areas, real world, and language. Some interdisciplinary examples are approximate. A comprehensive classification is shown in (5)-(10). These examples (11) are special in functions since they only apply to a specific number.

(5) same transformation and same state

a. m $\xrightarrow{\text{x*1}}$ m $\xrightarrow{\text{x*1}}$ m

b. $12\,\text{o'clock} \xrightarrow{\text{24 hour passed}} 12\,\text{o'clock} \xrightarrow{\text{24 hour passed}} 12\,\text{o'clock}$

(6) same transformation and opposite states

a. $+\text{m} \xrightarrow{x*-1} -\text{m} \xrightarrow{x*-1} +\text{m}$

b. $1(\text{boolean}) \xrightarrow{\text{negate}} 0(\text{boolean}) \xrightarrow{\text{negate}} 1(\text{boolean})$

c. $\text{AB} \xrightarrow{\text{exchange}} \text{BA} \xrightarrow{\text{exchange}} \text{AB}$

(7) same transformation and parallel states

a. $\text{m} \xrightarrow{8-x} 8-\text{m} \xrightarrow{8-x} \text{m}$

b. $\text{m} \xrightarrow{-x/(1+x)} -\text{m}/(1+\text{m}) \xrightarrow{-x/(1+x)} \text{m}$

(8) opposite transformations and same state

$\text{east} \xrightarrow{\text{rotate 360° clockwise}} \text{east} \xrightarrow{\text{rotate 360° anticlockwise}} \text{east}$

(9) opposite transformations and opposite states

$\text{the door is closed} \xrightarrow{\text{I open the door}} \text{opened} \xrightarrow{\text{I close the door}} \text{closed}$

(10) opposite transformations and parallel states

a. $\text{m} \xrightarrow{x+2} \text{m}+2 \xrightarrow{x-2} \text{m}$

b. $\text{m} \xrightarrow{x*2} 2\text{m} \xrightarrow{x/2} \text{m}$

d. $\text{solid} \xrightarrow{\text{melt}} \text{liquid} \xrightarrow{\text{solidify}} \text{solid}$

(11) special cases

a. $4 \xrightarrow{8-x} 4 \xrightarrow{8-x} 4$

b. $-1 \xrightarrow{x+2} +1 \xrightarrow{x-2} -1$

c. $0 \xrightarrow{x*2} 0 \xrightarrow{x/2} 0$

Opposition involves four kinds of reversible transformation (2, 4, 5, 6 in Table 3). Type 4 (opposite transforms and same state) is rare and unimportant. Therefore, the other three kinds can be used to analyze and classify opposition. In transformation-state model, there are two main kinds of opposition: states and transformations (Table 4).

Table 4 Opposition in reversible transformations

	relation of transformation A and B	relation of state X and Y
2	same	opposite (as state)
5	opposite (as transformation)	opposite (as state)
6	opposite (as transformation)	parallel

2.3 Verb-participant-state model.

Some instances of reversible transformation are complicated, especially when these transformations are events with more than one participant. Any reversible event pairs have three elements: verbs, participants, and states of the participant(s). These events can be classified further from the perspective of language expression. Some expressions of event pairs are simple since they are only different in verbs (12a, b). Some expressions are not only different in verbs, but also different in participants (12c, d). These events are interactions between participants. Some expressions have the same meaning, but different voices(12e).

(12) Simple transformation

a. state X of $P \xrightarrow{P\ V_1}$ state Y $\xrightarrow{P\ V_2}$ state X

b. state X of $P_2 \xrightarrow{P_1\ V_1\ P_2}$ state Y $\xrightarrow{P_1\ V_2\ P_2}$ state X

Interactive transformation

c. state X of $P_2 \xrightarrow{P_1\ V_1\ P_2}$ state Y $\xrightarrow{P_2\ V_2\ P_1}$ state X

d. state X of $P_3 \xrightarrow{P_1\ V_1\ P_3}$ state Y $\xrightarrow{P_2\ V_2\ P_3}$ state X

Verbs with opposite voices

e. state X of $P_2 \xrightarrow[P_2\ V_2(\text{be } V_1\text{ed by})\ P_1]{P_1\ V_1\ P_2}$ state Y

Many oppositions can be explained by these prototypes. V1 and V2 are opposite as verbs and all of them are different in AB/BA form. State X and Y are opposite or parallel as nouns or adjectives. P1 and P2 are opposite as nouns such as Ver/Vee or V1er/V2er.

2.4 A classification of opposition.

Words are the main objects of the classification of opposition since most other units can be simplified into words. Sentences are the longest units of opposition. Two articles can have opposite theories or titles. Two novels can have opposite ends or opposite narrative orders. However, as a whole, texts are too complex to be opposite. If every sentence of a text is opposite with the other text, then one of the texts will be ridiculous. If one or some sentence(s) of a text is opposite with the other text, the rest sentences are same, then there are some opposite sentences, not texts. Anyhow, there are no opposite texts.

There are too many opposite word pairs and therefore the use of a hierarchical classification is appropriate. The earliest classification probably came from Categories (Aristotle 1984:10-23). It was not until modern times that there was a more systematic classification. Lyons (1977:270-87) has four types (complementary, antonymy, converseness, and directional opposition) and some subtypes. Cruse (1986:197-264) has three types (complementary, antonym, and directional) and some subtypes.

Based on the traditional classification, difference reduction, and two models of reversibility, a new classification is developed. There are five kinds of opposition (Table 5). This classification is compatible with Lyons and Cruse's. According to their terminology, small/big is called "antonymy". X/not X is called "complementary". The rest parts have some differences. These concepts will be discussed and classified further in the following sections.

Table 5 A classification of opposition

type of opposition	**subtype of opposition**	**examples**
antonymy (small/big)	small/big in particular ways	*short/long*
	smallest/biggest	*empty/full*
	smaller/bigger than intermediate	*past/future*
	A<B/A> B	*understate/overstate*
X/not X	X/not X	*real/unreal* *pass/fail*
	X/U\X	*inside/outside*
AB/BA	as states	*clockwise/anti-clockwise*
	as simple transformations	*melt/solidify; lock/unlock*
	as interactive transformations	*attack/defend;* *throw/catch*
	as verbs with opposite voices	*appoint/be appointed by;* *own/belong to*
	as sentences	
AB/(OA)(OB)	AB/(OA)(OB)	*reward/punish*
polysemous opposition	all pairs are opposite	*subjective/objective*
	some pairs are opposite	*white/black*

3 Type one of opposition: antonymy.

If A and B are different in quantity such as 3 and 8, their similar relation is parallel since both of them are numbers, and their differences can be expressed by small and big: 3 is small, 8 is big. The similar relation of small and big are opposite. Small and big can distinguish the difference of 3 and 8, but their difference cannot be distinguished by others. Small/big have four subtypes. Difference reduction is the only mothed to analyze small/big.

3.1 Small/big in particular ways.

This family is huge. For example, *minority/majority* are small/big in quantity; *short/long* are in length or time; *simple/complicate* are in complexity; *occasionally/often* are in frequency;

slightly/very are in degree; *unknown/well-known* are ‘known about by few people’/‘known about by many people’; *democratic/autocratic* are ‘ruled by majority’/‘ruled by minority’.

3.2 Smallest/biggest.

Its noun form is *minimum/maximum*. Its verbal form is *minimize/maximize*. *Lowest/highest* are smallest/biggest in height. *Bottom/top* are the lowest part/ highest part. Some derivatives are smallest/biggest in specific ranges.

(i) Smallest/biggest in (0, Infinite] and [0, Infinite]. *Infinitesimal* and *infinite* can be decompressed into ‘limitless small’ and ‘limitless big’. They are also the smallest and biggest ones in (0, Infinite] (zero is not included). *Zero and Infinite* are smallest and biggest in [0, Infinite] (zero is included). *Short circuit* means ‘the resistance of the loop is zero or infinitesimal’; *open circuit* means ‘the resistance is extremely big or infinite’. Therefore, the basic opposition of *short circuit* and *open circuit* are also smallest/biggest.

(ii) Smallest/biggest in {1/N,2/N…N/N}. For example, *first/last*, *beginning/end*, *initial/final*, *one/all*.

(iii) Smallest/biggest in {0/N,1/N…N/N} or [0%, 100%]. This subtype is most canonical among the three, such as *none/all*, *never/always*, *impossible/inevitable*, and *empty/full*.

3.3 Smaller/bigger than intermediate.

Two quantitative objects can compare with each other. One is smaller; the other is bigger. They also can be compared with the third object. As a reference, the third object is intermediate such as *zero*, *now*, and *current position*. The reference and two antonyms are a useful trichotomy: smaller/intermediate/bigger, such as *negative/zero/positive*, *acute angle/right angle/obtuse angle*, *concave/flat/convex*. Time stream can be considered as a process of becoming bigger, such as *early/on time/late*, *past/now/future*.

3.4 A is smaller than B/A is bigger than B.

This subtype is not between two quantitative objects, but between two structures that have two comparable objects. There are two examples as follows: (i) *Understate* means ‘to say something that makes it seem less important than it really is’. *Overstate* means ‘to say something that makes it seem more important than it really is’. In short, *understate is* ‘a statement is less important than the fact’. *Overstate is* ‘a statement is more important than the fact’. (ii) There are two governing ways: *rule of law* and *rule of man*. The difference between them is not *law* and *man*. *Man* means ‘ruler’ in this phrase. *Rule of man* means ‘a governing way that the ruler has more power than the law’. *Rule of law* means ‘a governing way that the ruler has less power than the law’. Their basic opposition are also A is smaller than B/A is bigger than B.

4 Type two of opposition: X/not X as states.

As states, the examples in (6) that have same transformation and opposite states can be classified further by three root differences (13). The root difference of +m/-m

(*negative/positive*) is big/small (Section 3.3). It seems an isolated type without approximate instances. Small/big as one of root differences cannot be reversed by self-inverse transformation directly. On the contrary, X/not X and AB/BA can and have many instances in different areas.

(13) small/big

a. $+\mathrm{m} \xrightarrow{x^*-1} -\mathrm{m} \xrightarrow{x^*-1} +\mathrm{m}$

X/not X

b. $\mathrm{m} \xrightarrow{100\%-x} 100\%-\mathrm{m} \xrightarrow{100\%-x} \mathrm{m}$

c. $\text{set A} \xrightarrow{\text{univeral set}-x} \text{complement of set A} \xrightarrow{\text{univeral set}-x} \text{set A}$

d. $\text{self} \xrightarrow{\text{all people except x}} \text{others} \xrightarrow{\text{all people except x}} \text{self}$

e. $1(\text{boolean}) \xrightarrow{\text{negate}} 0(\text{boolean}) \xrightarrow{\text{negate}} 1(\text{boolean})$

f. $\text{adj(or verb) X} \xrightarrow{\text{add negative marker}} \text{not X} \xrightarrow{\text{add negative marker}} \text{X}$

AB/BA

g. $\mathrm{m/n} \xrightarrow{1/x} \mathrm{n/m} \xrightarrow{1/x} \mathrm{m/n}$

h. $\text{A side faces up} \xrightarrow{\text{turn}-\text{over}} \text{B side faces up} \xrightarrow{\text{turn}-\text{over}} \text{A side faces up}$

i. $\text{left(as a direction)} \xrightarrow{\text{rotate}\,180^\circ} \text{right} \xrightarrow{\text{rotate}\,180^\circ} \text{left}$

j. $\mathrm{AB} \xrightarrow{\text{exchange}} \mathrm{BA} \xrightarrow{\text{exchange}} \mathrm{AB}$

This section will discuss these states whose root difference is X/not X. Besides Boolean number 0 and 1, there are two main kinds: one has an explicit “not”; another has an implicit “not”.

4.1 Complementarity I (X/not X).

Complementary represents the relation of X/not X in linguistics. X and not X are separated and make a whole naturally. Negative prefixes (e.g. a-, in-, un-) and *not* have the same meaning. They can be collectively called negative marker. Adding a negative marker can negate the meaning, and adding another negative marker can return the meaning to its original state. Negative marker can modify verbs, adjectives, and a few adverbs and nouns.

Verb/not verb. Most of these types are simple. For example, after decompression, *pass/fail* become ‘pass/not pass’; *hit/miss* become ‘hit/not hit’; *accept/refuse* become ‘accept/not accept’; *obey/disobey* become ‘follow the order/not follow the order’. A few of them are a

little bit complicated. For example, *believe/doubt* become 'to think something is true/to think something is not true'; *sincere/insincere* become 'showing and thinking are consistent/showing and thinking are not consistent'.

Adj/not adj. Most complementary adjectives can reduce to verbs. For example, *true/false* become 'correspond to the facts/not correspond to the facts'; *odd/even* become 'divisible by two/indivisible by two'; *constant/variable* become 'unchanging/changing'. A few adjectives cannot reduce to verbs, such as *small/not small*, and *red/not red*.

Scale and gradability. Logically, small/big are gradable (Sapir 1944); X/not X are ungradable; *negative/positive* have an intermediate: *zero*; X/not X do not have any intermediate. However, in daily life X/not X also can be gradable (e.g. *same/different*) and have intermediates. For example, Likert Scale (Likert 1932) is based on *agree/disagree* that include "strongly disagree", "disagree", "was undecided", "agree", "strongly agree". The model behind the scale is {big not X, small not X, zero (neutral), small X, big X}.

4.2 Complementarity II (X/U\X).

In set theory, the complement of A is defined as (O'Leary 2015):

$$\overline{A} = U \setminus A = \{x : x \in U \wedge x \notin A\}$$

Therefore, if A and B are complementary, then U\A=B; U\B=A. Although U\X hides "not", the root difference of X/U\X is X/not X. Complementarity in set theory can be applied to other fields such as space, pronoun, percentage, and natural numbers.

Spatial complementarity. A plane can be dichotomized in two ways. One is by a line, such as *left side/right side*, *west side/east side*; the other is by a circle, such as *inside/outside*, *central/peripheral*, and *indoor/outdoor*. Although there is a boundary between them, it can be ignored in most cases. For example, *someone is not inside the house* means *someone is outside the house*.

Pronoun complementarity. The relation of *this/that*, *this/other*, *this/the rest* are approximate. They are like two parts of one set. Meanwhile, they also can be decompressed into 'something that has been mentioned/ something that has not been mentioned'.

Self/other is another important instance of pronoun since *self* is always the most special one in any agent's perspective, and it is necessary and useful to distinguish *self* from *others*. *self/other* have some derivatives, such as *selfish/altruistic*, *domestic/foreign*, and *local/outside*. The underlying difference between *automatic transmission* and *manual transmission* is *self-shifting* and *other-shifting*. *Manual* is not a precise adjective in this case. Motorcycles shift gears with the foot, but it is still called "manual transmission".

Percentage complementarity. 100% is a whole. It can be divided into two parts. The two percentages represent two parts of a whole. X and 100%-X are complementary. For example, *30% of the land is his* and *70% of the land is not his* are the same.

[0%, 100] is also a whole. It also can be divided into two parts. The two intervals represent two parts of a whole. 0% and (0%, 100%] (14a), [0%, 100) and 100% (14c) are

complementary since both of them can combine to [0%, 100]. Meanwhile, 0% and (0%, 100%] correspond to *non-existent* and *existent* (14b). [0%, 100) and 100% correspond to *not all* and *all* (14d). This example also shows the two kinds of complementarity are approximate.

(14) a. $0\% \xleftarrow{[0\%,100\%]-x} (0\%,100\%]$ b. non-existent $\xleftarrow{\text{add 'not'}}$ existent

c. $[0\%,100\%) \xleftarrow{[0\%,100\%]-x} 100\%$ d. not all $\xleftarrow{\text{add 'not'}}$ all

Numerical complementarity. *Many*, *multi-,* and *poly-* are approximate and have two meanings. The first one is the opposite of *few,* and the second one is the complement of *minimum.* The most common minimum is one, the second most common is two, and so on. The bigger the rarer. (i) {1, 2, …N} = {1}∪{2, …N} = *minimum* and *others* = *one* and *many* (15a). *One/many* are the basic opposition of *proper/common*, *singular/plural*, and *elementary/compounded*. (ii) {2, …N} = {2}∪{3, …N} = *minimum* and *others* = *two* and *many* (15b). *Two/many* are the basic opposition of *bilateral/multilateral, dichotomy/multichotomy.* (iii) *Three/many* are the basic opposition of *triangle/polygon*. Overall, *one/many*, *two/many*, and *three/many* are complementary in particular contexts. Complementarity is not an arbitrary dichotomy. The pattern is the most special(smallest) one and others. For example, {1,2} and {3, …N} are complementary. {2} and {1,3, …N} are also complementary. However, we do not use these dichotomies since {1,2} or {2} are not special.
(15) one/many

a. $\{1\} \xleftarrow{\{1,2,...N\}-x} \{2,3,...N\}$

two/many

b. $\{2\} \xleftarrow{\{2,3,...N\}-x} \{3,...N\}$

5 Type three of opposition: AB/BA.

5.1 AB/BA as states.

Besides number such as 2/3 and 3/2, other instances exist mainly in directional adjectives (16). Any line has and only has two directions which can turn to other by the operation "rotating 180°", such as *left/right*, *east/west*, *clockwise/anti-clockwise*, *centrifugal/centripetal*. If X is the direction from point A to B, then Y is the direction from point B to A. Therefore, X/Y are reversible and their root difference is AB/BA. Accordingly, *air-to-surface* and *surface-to-air* are also two reversible directions.

(16) a direction from A to B $\xleftarrow{\text{rotate } 180°}$ a direction from B to A

5.2 AB/BA as simple transformations.

From the perspective of morphology, some verbal pairs can be reduced to the form: Verb/Verb + reverse marker. For example, *centralize/decentralize*, *lock/unlock*, and *connect/disconnect*.

If Verb X means ‘make sth from state A to B’, then Verb X+ reverse marker meaning ‘make sth from state B to A’. Although there are no double reversals, it is conceivable that “Verb X+ reverse marker+ reverse marker” means Verb X. Some verbal pairs cannot reduce to this form such as *melt/solidify*. Their root differences are AB/BA. Normally, the relation between state A and B is parallel. In particular cases, A and B are opposite.

5.2.1 Two parallel states (AB/BA).

Some substances have many states: s*olid, liquid* and *gaseous* (17a). *Melt* means ‘make the solid substance into liquid’. *Solidify* means ‘make the liquid substance into solid’. *Melt/solidify* can reverse two parallel states, and so does *advance/retreat* (17b).

(17) a. solid $\underset{\text{solidify}}{\overset{\text{melt}}{\rightleftarrows}}$ liquid

b. position X $\underset{\text{retreat}}{\overset{\text{advance}}{\rightleftarrows}}$ position Y

5.2.2 Two opposite states(A(OA)/(OA)A).

Some alterable objects only have two opposite states such as *a lock*. Therefore, a typical group has two verbs and two adjectives. The simple examples are *lock/unlock-unlocked/locked* (18a)*, join/quit-outside/inside* (18b), *annihilate/create-existent/nonexistent* (18c), and *kill/resurrect-alive/dead*.

(18) a. unlocked $\underset{\text{unlock}}{\overset{\text{lock}}{\rightleftarrows}}$ locked

b. outside $\underset{\text{quit}}{\overset{\text{join}}{\rightleftarrows}}$ inside

c. existent $\underset{\text{create}}{\overset{\text{annihilate}}{\rightleftarrows}}$ nonexistent

The complicated examples are as follows: *discourage/encourage* switch somebody’s psychological state between ‘more likely to do something’ and ‘more likely not to do something’ (19); *slander/rehabilitate* switch an indeed-good people’s reputation between ‘good’ and ‘bad’ (20a); *whitewash/anti-whitewash* switch an indeed-bad people’s reputation between ‘bad’ and ‘good’ (20b); *slander/whitewash* are not opposite. The four words are parallel in a higher perspective.

(19) B more likely to do sth $\underset{\text{A encourage B}}{\overset{\text{A discourage B}}{\rightleftarrows}}$ B more likely to not do

(20) a. B have good reputation $\underset{\text{A rehabilitate B(good person)}}{\overset{\text{A slander B(good person)}}{\rightleftarrows}}$ bad reputation

b. B have bad reputation $\underset{\text{A anti−whitewash B(bad person)}}{\overset{\text{A whitewash B(bad person)}}{\rightleftarrows}}$ good reputation

Some events not only change the state of the patient, but also the agent such as *borrow/return* (21a), and *buy/sell* (21b).

(21) a. B have sth $\underset{\text{A return sth to B}}{\overset{\text{A borrow sth from B}}{\rightleftarrows}}$ B have no sth (A also changed)

b. B have sth, no money $\underset{\text{A sell sth to B}}{\overset{\text{A buy sth from B}}{\rightleftarrows}}$ B have money, no sth (A also changed)

Verb pairs such as *increase/decrease* (22)*, zoom in/zoom out, strengthen/weaken* are special since they can reduce in two ways. They can reduce to *make sth smaller/make sth bigger* (small/big). They also can reduce to *make sth from small to big/ make sth from big to small* (AB/BA).

(22) small $\underset{\text{decrease(zoom out)}}{\overset{\text{increase(zoom in)}}{\rightleftarrows}}$ big

5.3 AB/BA as interactive transformations.

This subsection will introduce the third kind of AB/BA: act/reversely react. The discussion in this subsection is based on the study of Cruse (1986:198-202). Before discussing act/reversely react, some distinctions should be introduced first.

Act/react. The prefix *re-* in *react* is not an opposite marker. Act/react and *stimulus*/*response* (Cruse 1986:201) are approximate. In most cases, act/react are time-sensitive. The action is earlier than the reaction. If one action happened, there are many ways to react. For example, the response to *attack* could be *defend*, *surrender*, *do nothing*, *run away*, *play dead*, and so on. These verbs (reactions) can be transitive or intransitive (23). The final state Z is uncertain. It could be the initial state or any other state. Overall, act/react are not two reservable transformations.

(23) state X of $P_2 \xrightarrow{P_1\ V_1\ P_2\text{(act)}}$ state Y $\xrightarrow{P_2\ V_2\ P_1 \text{ or } P_2\ V_2\text{ (react)}}$ state Z

Two/three participants. Some interactions have two participants, the agent of the early event is the patient of the later event, and vice versa (24a). Some interactions have three participants, one participant is the shared patient of the other two participants (24b).

(24) two participants

a. state X of $P_2 \xrightarrow{P_1\ V_1\ P_2(act)}$ state Y $\xrightarrow{P_2\ V_2\ P_1(react)}$ state Z

three participants

b. state X of $P_3 \xrightarrow{P_1\ V_1\ P_3(act)}$ state Y $\xrightarrow{P_2\ V_2\ P_3(react)}$ state Z

Process/result. Some verbs represent the processes of intentional actions. The results of processes can fulfill the intent or not. Some verbs represent the results of intentional actions. For example, *search* is a process; *find* or *not find* is a result. Both action and reaction are more like processes, not results. For example, both *attack* and *defend* could be successful or unsuccessful. Contrastively, *unlock* and *lock* are more like results of intentional actions. This dichotomy and accomplishment/achievement (Vendler 1967:97-121) are approximate. The state that marks with * in the following examples means the state is an intent that maybe happens or not.

Competitive/cooperative/neutral interaction. Interactions can be classified by winning and losing: (i) competitive (or antagonistic) interaction. Two agents are competitors such as a match. There are one winner and one loser among them (A win or B win); (ii) cooperative interaction. Two agents are cooperators such as a communication task. If the sender fails to send the message, the receiver also fails to receive the message. If the receiver succeeds, the sender also succeeds. There are two winners or two losers among them (they win or they lose); (iii) neutral interaction. Two agents are neither competitors nor cooperators. There are no winners or losers. The two actions of neutral interaction are not opposite.

reverse/other reaction. Obviously, a reverse reaction means the reaction that initializes the state (25). In a competitive interaction, the reverse reaction resists the previous action. In a cooperative interaction, the reverse reaction caters to the previous action.

(25) state X of $P_2 \xrightarrow{act}$ state Y $\xrightarrow{reversely\ react}$ state X

Overall, act/reversely react can be subdivided by competitive/cooperative interaction and two/three participants.

5.3.1 Competitive interaction.

In (26a), the two participants are *attacker* and *defender*. The attack tris to hurt the defender. The defender tries not to get hurt. In (26b), the three participants are *sun*, *suncream*, and *skin*. The approximate example is *killer, bodyguard*, and *target*.

(26) two participants

a. B is uninjured $\xrightarrow{\text{A attack B}}$ *injured $\xrightarrow{\text{B defense A}}$ *uninjured

three participants

b. skin is not sunburnt $\underset{\text{suncream protect skin}}{\overset{\text{sun burn skin}}{\rightleftarrows}}$ *skin is sunburnt

5.3.2 Cooperative interaction.

Most cooperative interactions are not reversible even if the reverse reaction caters to the previous action. For example, A car could be made by two (27a), three(27b), or more cooperators like a relay race.

(27) a. car not exist $\xrightarrow{\text{act}}$ semi finished $\xrightarrow{\text{react}}$ exist(finished)

b. car not exist $\xrightarrow{\text{act}}$ 30% finished $\xrightarrow{\text{react 1}}$ 70% $\xrightarrow{\text{react 2}}$ 100%

The perfect examples are *produce*/*consume* (28a) and *ask/answer* (28b). The most common but imperfect kind is called point-to-point transmission. There are always three participants in this cooperative interaction. P1 and P2 are transmitters, and P3 is the thing that the transmitters transmit. P3 can be explicit or implicit since some verbs (e.g. *teach*, *send*) are transitive or ditransitive. The whole pattern is shown in (29a). The most typical example (29b) is *throw/catch*. If ignoring the difference between the transmitters P1 and P2, P3 returns to the initial state (29c). The approximate examples (29d) are *teach/learn.*

(28) a. product not exist $\xrightarrow{\text{P1 produce product}}$ exist $\xrightarrow{\text{P2 consume product}}$ not exist

b. no question $\xrightarrow{\text{P1 ask P2}}$ question exist $\xrightarrow{\text{P2 answer P1}}$ no question

(29) a. P3 is in P1 $\xrightarrow{\text{P1 V1 P2 P3}}$ on the way $\xrightarrow{\text{P2 V2 P1 P3}}$ in P2

b. ball is in P1 $\xrightarrow{\text{P1 throw ball to P2}}$ on the way $\xrightarrow{\text{P2 catch ball from P1}}$ in P2

c. ball is in transmitter $\xrightarrow{\text{throw}}$ on the way $\xrightarrow{\text{catch}}$ in transmitter

d. knowledge in teacher $\xrightarrow{\text{teach}}$ on the way $\xrightarrow{\text{learn}}$ in learner

5.4 AB/BA as verbs with opposite voices.

5.4.1 Verbs.

A few transitive verbs or verb phrases are not directional. SVO and OVS with these verbs have the same meaning such as *A equals B* and *B equals A, A makes a deal with B* and *B makes*

a deal with A. However, most transitive verbs are directional. If exchanging the subject and object, two sentences will have different meanings or the exchanged sentences will be ridiculous. Some directional and transitive verbs have a derivative verb with the united form "verb + passive marker". They are used to describe an event in two ways: active voice and passive voice. The passive marker is "be -ed by" in English. The function of passive marker is also exchanging A and B. Sentences SVO and O(V+ passive marker)S have the same meaning (30a). It is hard to tell whether the difference between V and V+ passive marker is in meaning or syntax. This is a purely linguistic phenomenon that should be a separate type.

In most cases, V + passive marker is a phrase, not a word (30a). In a few cases, there are two verbs such as *borrow/lend* (30b). "B lend sth to A" equals "*B is borrowed sth by A". *Buy/sell* seems an interesting example since they are opposite in two ways: (i) they can represent two reversible events (30b); (ii) they also can be used to describe a deal in two ways (30c).

(30) a. B is not appointed $\xrightarrow[\text{B is appointed by A}]{\text{A appoint B}}$ B is appointed

b. B have sth $\xrightarrow[\text{B lend sth to A(*B is borrowed sth by A)}]{\text{A borrow sth from B}}$ B have no sth

c. B have sth, no money $\xrightarrow[\substack{\text{B sell sth to A}\\ \text{(*B is buyed sth by A)}}]{\text{A buy sth from B}}$ B have money, no sth

These verbs in previous examples are dynamic verbs that make an obvious change. However, some stative verbs also fit the pattern such as *own/belong to* (31).

(31) B is unowned $\xrightarrow[\text{B belong to A(B is owned by A)}]{\text{A own B}}$ B is owned

5.4.2 Nouns.

Some verbs can derive nouns that represent participants. Their ideal form is Ver, Vee, V1er, and V2er, although the realistic forms are usually irregular. Roughly, the deriving rules are as follows (Table 6): (i) If the verb is intransitive, it only can derive Ver since there is only one participant. (ii) If the verb is transitive and not directional, it also only can derive Ver since the two participants are unordered. (iii) If the verb is transitive and directional, and the event that the verb represents is not reversible. For example, an appointment is an irreversible event. Therefore, "appoint+ reverse marker" is an invalid combination. These verbs can derive Ver and Vee. (iv) If the verb is transitive and directional, and the event that the verb represents is reversible, the verb has a reverse companion. The two verbs can derive V1er and V2er. V1ee and V2ee are unnecessary since V1ee is V2er, V2ee is V1er. This rule also applied to verbs in previous section, such as *attacker/defender*. The root differences of Ver/Vee and V1er/V2er

are also AB/BA.

Table 6 Verbs and their derived nouns

verb	**noun**	**example**
intransitive	Ver	*dancer/dance, worker/work*
transitive, not directional	Ver	*dealer/deal/dealer*
transitive, directional, not reversible	Ver/Vee	*appointer/appoint/appointee* *doctor/treat/patient* *premise/infer/conclusion*
transitive, directional, reversible	V1er/V2er	*borrower/lender, buyer/seller* *attacker/defender*

5.5 AB/BA as sentences.

Two sentences are opposite for two reasons: one is they have two opposite words or phrases, especially, the link verbs, verbs, and predicative adjectives; the other is they include two nouns or noun phrases that have reversible positions, such as *A is bigger than B/B is bigger than A*, *A kills B/B kills A*, and *A is B's boss/B is A's boss*.

6 Type four of opposition: dual opposition (AB/(OA)(OB)).

Most opposition follows the rule of minimal difference rule (Murphy 2003:45). The smaller the quantity of differences between two opposite objects, the stronger their oppositeness. Most canonical oppositive pairs are different in one way. For example, *man* means 'male adult human'; *woman* means 'female adult human'; *girl* means 'female nonadult human'. *Man* and *woman* are opposite. *Man* and *girl* are not opposite since they are different in two ways. However, there are some special cases in verbs. In AB/(OA)(OB), there are two differences: A and OA are opposite, and so do B and OB. For example, *reward* means 'to give the benefit to somebody because somebody did well'; *punish* means 'to deprive the benefit from somebody because somebody did not do well'. After decompression and formalization, their difference is *do A for B* and *do OA for OB*. Meanwhile, A and B, or OA and OB show some kind of causal relationship. Both *do A for OB* and *do OA for B* seem illogical. Other examples are *praise/criticize*.

There is a more complex and special example. All of these six events can happen (32) since humans are not always rational. Some of them can be expressed by words or idioms, some cannot. *Requite/revenge* are dually opposite like *reward*/*punish*. The rest of the verbs belong to the catch-all type: parallelism or the gray area of opposition and parallelism.

(32) GE return good for evil
EG return evil for good bite the hand that feeds one
GG return good for good requite
EE return evil for evil revenge
NG return nothing for good be ungrateful
NE return nothing for evil forgive

7 Type five of opposition: polysemous opposition.

7.1 All meaning pairs are opposite.

Word pairs discussed above only have one meaning. However, some word pairs are polysemous, especially adjectives, such as *positive/negative*, *good/bad*. All meaning pairs are opposite and have their respective reduction paths to root difference. The meanings of most polysemes have been listed in dictionaries (Diana and Jennifer 2020), but some have not. They have several disputed and tricky meanings. There are two examples as follow:

Subjective/objective. (i) A person can be observed by self or others. The self (first-person) perspective is subjective. The other (third-person) perspective is objective. Therefore, the basic opposition is *self/other*. (ii) In the event "a person observes or thinks a thing", the person is the observer or subject, and the thing is the observee or object. Thus Ver/Vee is their basic opposition. (iii) Some judgments of an event or object are made by the person who is involved in the event or related to the object, some are not. The former judgments are biased or subjective, and the latter are unbiased or objective. Thus X/not X is their basic opposition. (iv) Some judgments are based on a person's body, belief, or conjecture which differ from person to person. Some judgments are based on a person's observation, contemplation, or inference which has few or no individual differences. The former is subjective, the latter is objective. Roughly speaking, their basic opposition is *having individual differences/not having individual differences* (X/not X).

Concrete/abstract. They can reduce to (i) *sensible/unsensible* from the human perspective, (ii) *detectable/undetectable* from the instrumental or physics perspective, and (iii) *non-symbolic/symbolic* from the symbolic perspective.

Both of them can be modified with *very*. Therefore, they can be projected to a scale (Section 4.1). The above explanations may not be accurate. The main purpose is to argue that no matter how many explanations they have, their root differences remain the only three.

7.2 Some meaning pairs are opposite.

Some word pairs are also polysemous, but not all meaning pairs are opposite. The examples are as follow:

Pain/pleasure. There are two physical feelings: *uncomfortable*/*comfortable* which are approximate to *pain*/*pleasure.* Therefore. the root difference of *pain/pleasure* is not X/X. On the other hand, there are many psychological feelings or emotions: *sad (pain)*, *fear*, *anger*, *boredom*, *happiness (pleasure)*, *tranquility*, and so on. *Pain* and *pleasure* are parallel with others. They also have no root difference.

Black/white. (i)*White* can be a color or a light. *black* is only a color. There is no black light. Therefore, *black* and *white* are not opposite as a light. (ii) As a color, on the one hand, *white*, *black*, and other colors are parallel. (iii) On the other hand, *black* does not reflect any visible light in the spectrum; *white* reflects all visible light. Their basic opposition is none/all or 0%/100%. Therefore, *white* and *black* are opposite.

8 Conclusion and extensions.

This article has developed a formalized methodology for analyzing and classifying opposition. It also has tried to cover all kinds of opposition by detailed classification and plentiful examples. In the big picture, opposition is a kind of similarity; similarity is a kind of relation.

This article is the first step of the discussion on extended lexical semantic relations. There is much work to do. An incomplete list is as follows:

First, the gray areas of extended lexical semantic relation. Some word pairs have confused semantic relations such as *rise/raise, emigrate*/*immigrate, product*/*by-product*, and *proof/disproof*;

Second, the classification of parallelism, especially some binary parallelisms such as *arrow/bow, mind/body, necessary/sufficient, interesting/interested, right/obligation*;

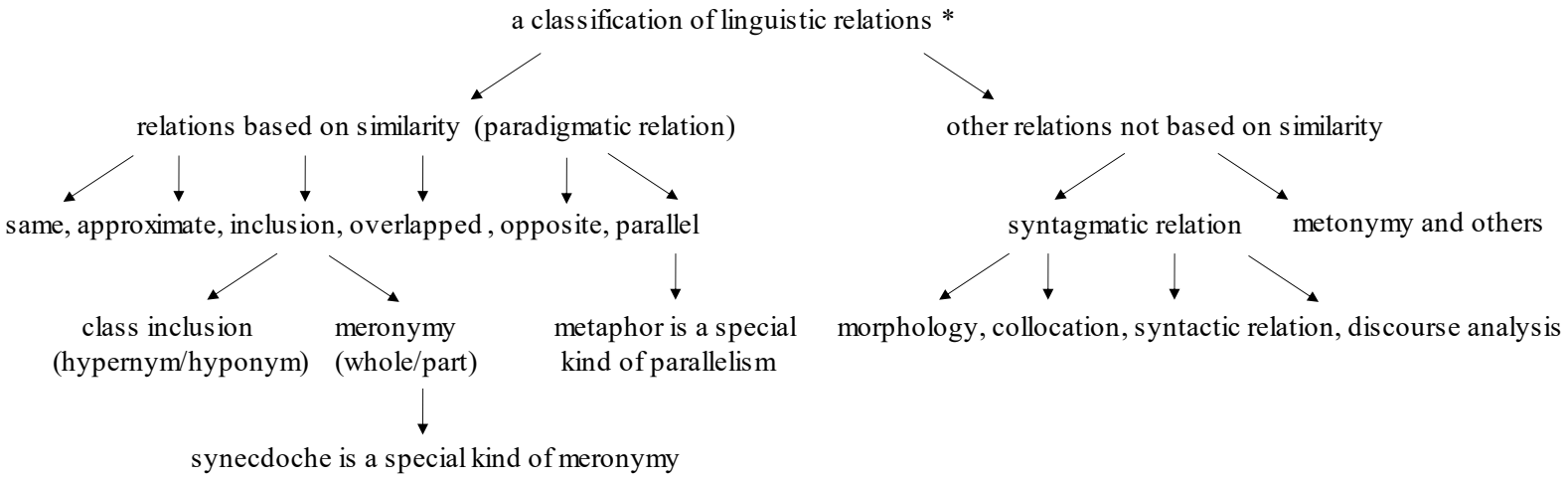
Third, the difference between parallel word pairs. For example, what is the difference between *east* and *south* (or *red* and *blue*, *written* and *spoken)?* It seems that only opposition has root differences, and parallelism does not have;

Fourth, metaphor (Lakoff and Johnson 1980) such as *way/method*, *target/purpose*, *bridge/connection*, or more poetically, *time/money*, *life/stage*. It is a special kind of parallelism that is neither close to approximation in the scaler of difference nor close to ATD. Metaphor and opposition are two of the most subtle similarities. By analyzing the differences and similarities between the tenor and the vehicle, we might be able to explain and categorize metaphor better.

Fifth, the similar relation between sentences. The relations between two sentences also can be same, approximate, inclusion, parallel, opposite, or overlapped. And sentences are more complicated than words. We can express a story, fact, or opinion in a straightforward way, or in a rhetorical way such as allegory, hyperbole, or irony. These sentences with different rhetoric are similar. For example, irony and straightforward are opposite in literal meanings and are the same in rhetorical meanings. The rhetorical meaning of *what a nice day*! and the literal meaning of *what a terrible day*! are the same.

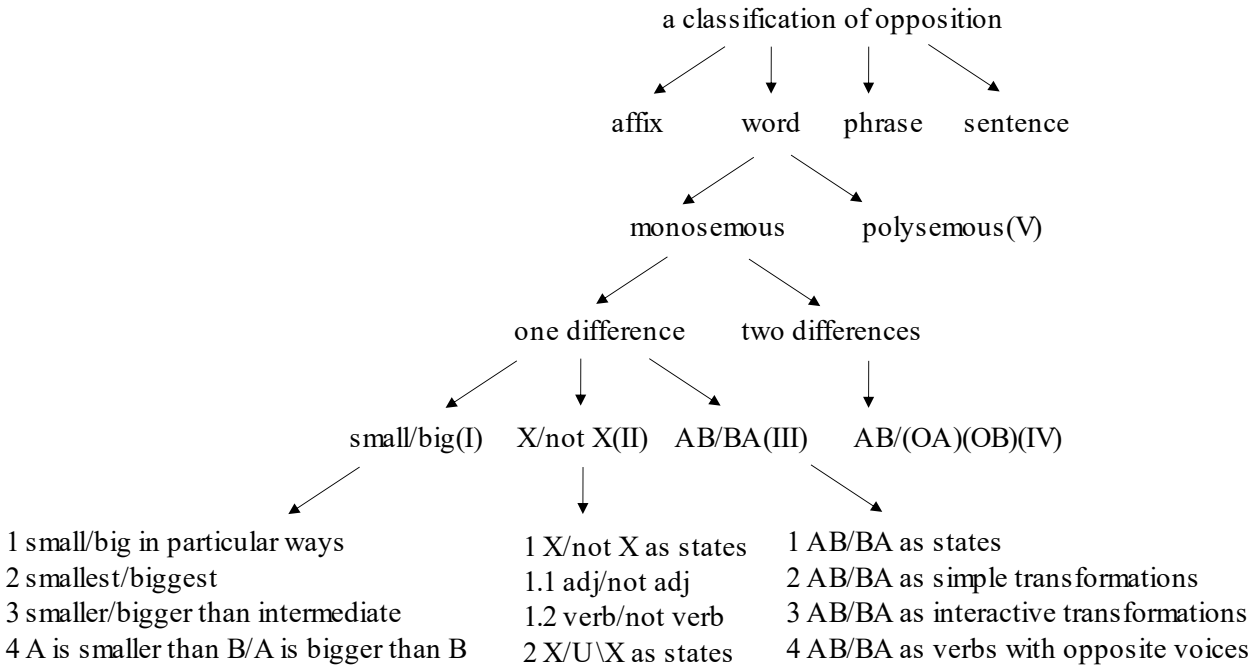
APPENDIX

A. A classification of linguistic relations



* these relations exists between affixes, words, phrases, sentences, and texts (more or less)

B. A classification of opposition



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