Sense Theory

(part 5)

Sense Space

[P-S Standard]

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Abstract.
A purely sense-to-sense connection between two arbitrary objects would allow trillions of other objects to be associated with each other by their specific sense.
The main benefit of the sense connection is still lost if an object of certain nature does not still have a property's association to even a single another object (-s).
We propose a *new paradigm of a mathematical space* that is sense-centered and AI-focused in its nature. One of the main purposes of this space is to create an informational sphere for a massive number of heterogeneous objects by the existed sense relationship between them.
It may be extremely useful if a life event (behavior) in the future of one person, say buying a car could be described by another life event (behavior) in the past of another person, say the baby's birthday celebration or the properties of physical phenomena in the past will trigger some actions in the future.

1. Introduction

Like the fundamental system of traditional mathematics, Zermelo–Fraenkel set theory, the Sense Theory has its basis - Sense Space. The main radical difference between traditional set theory and the sense theory is the nature of elements of the set and its properties.

Numeric characteristics of elements of the traditional set are only part of the possible characteristics of the Sense Set. For example, a function integration does describe the area bounded by the function curve. But it does not give information about the behavior or reasons for affecting the function curve.

A pure artificial intellect requires a minimum of two things existed, a sense association between two objects of different nature and the rule of creation of that associations. With some modesty, we believe that the Sense Theory might be a small step forward to the creation of a good-working AI.

2. Problem

$$f(x) \neq S_f(x) \; for \; x \in R \quad [1, 3].$$

Below we give a basic sense space description.

3. Solution

A sense space S_s is a set of sets No-Sense Sets (Object No-Sense Sets) with given operations inclusion, semantic union, exclusion and semantic disunion where there is at least one implementation of the inclusion operation with zero object.

In other words, the set $\not{S}_N$ ($\not{S}_{O(N)}$) contains at least one semantic function S_f [1] defined on the set $\not{S}_K$ (Object No-Sense Set $\not{S}_{O(K)}$) where K < N.

Basic elements of S_s: objects and independent properties.

<u>Setting the set No-Sense Set</u>

Finite No-Sense Set $\not{S}_N$ is defined and given if and only if the following expression is true [2]:

$$\lim_{S} \not{S}_N = \infty \qquad (1)$$

$$\not{S}_N = \{a_i\}_{i=1,\ldots N}$$

where

a_i – independent properties,

N – finite number.

Setting the set Object No-Sense Set

Finite Object No-Sense Set $\not{S}_{O(N)}$ is defined and given if and only if the following expression is true [2]:

$$\lim_{S} \not{S}_{O(N)} = \infty \qquad (2)$$

$$\not{S}_{O(N)} = \{O_i\}_{i=1,\ldots N}$$

where

O_i – zero objects,

N – finite number.

Setting the subset of $\not{S}_N$

Subset $Sub\not{S}_K$ of $\not{S}_N$ is defined and given if and only if the following expression is true:

$$\bigcup_{i=1\ldots N} \not{S}_i = \not{S}_N \qquad (3)$$

where K < N.

Expression $\lim_{S} \not{S}_N = \circledcirc$ **does not follow expression** $\lim_{S} Sub\not{S}_K = \circledcirc$

Setting the Object subset of $Ꞩ_{N}$

Subset $SubꞨ_{O(K)}$ of $Ꞩ_{O(N)}$ is defined and given if and only if the following expression is true:

$$\bigcup_{i=1...N} Ꞩ_{o(i)} = Ꞩ_{O(N)} \tag{4}$$

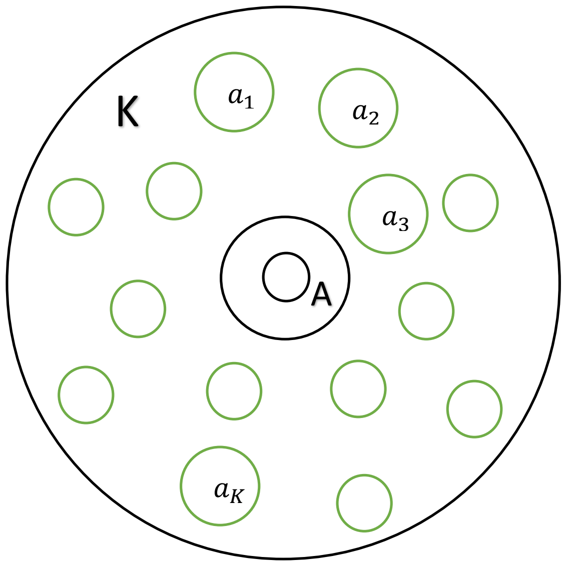
where K < N.

Expression $\lim_{S} Ꞩ_{O(N)} = ◎$ **does not follow expression** $\lim_{S} SubꞨ_{O(K)} = ◎$

Binary operations

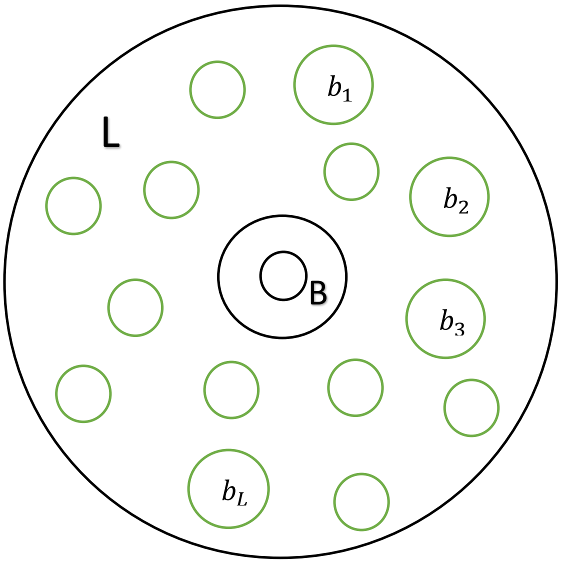
Given:

1. $O_{A(K)}$ – object A with K elements



pic.1.

2. $O_{B(K)}$ – object B with L elements



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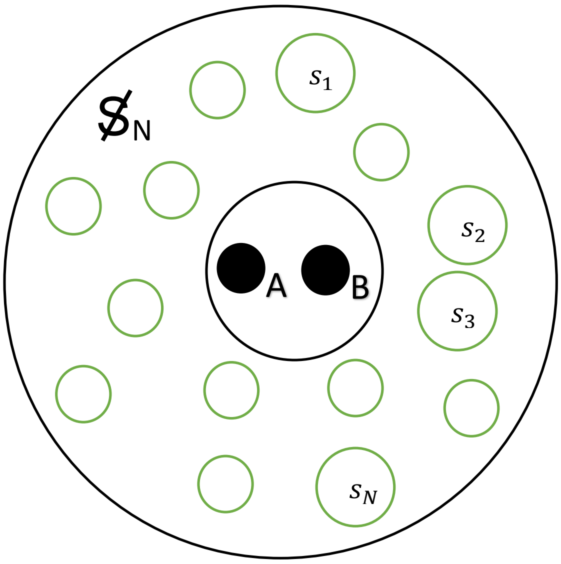
3. $S_{2(N)}$ – Sense Set with two zero objects A and B and N elements of No-Sense Set



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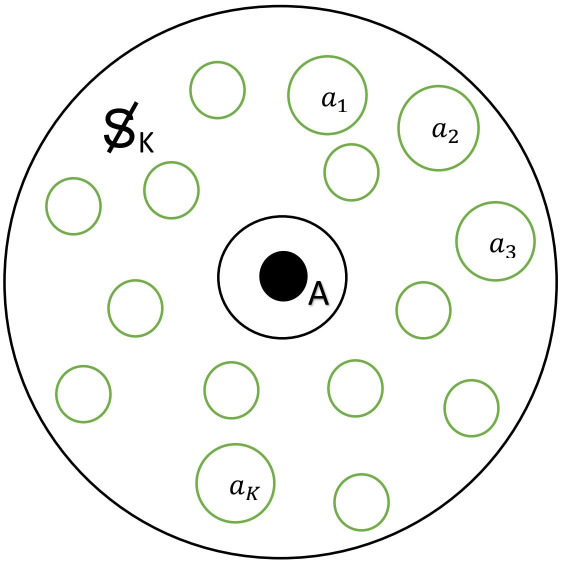
4. $S_{A(K)}$ – Sense Set with K elements of No-Sense Set



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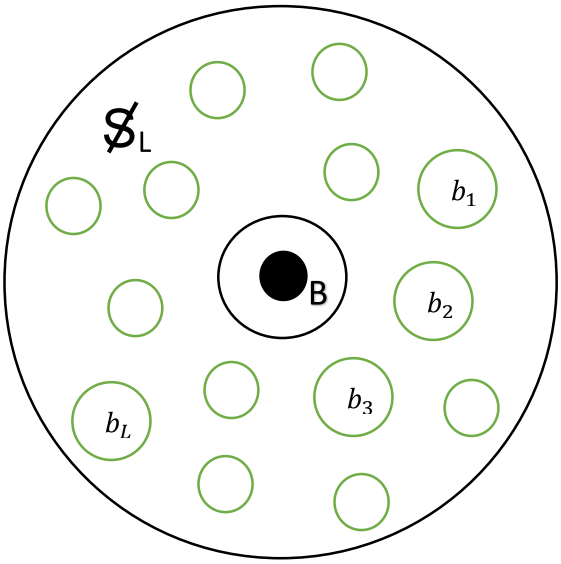
5. $S_{B(L)}$ – Sense Set with L elements of No-Sense Set



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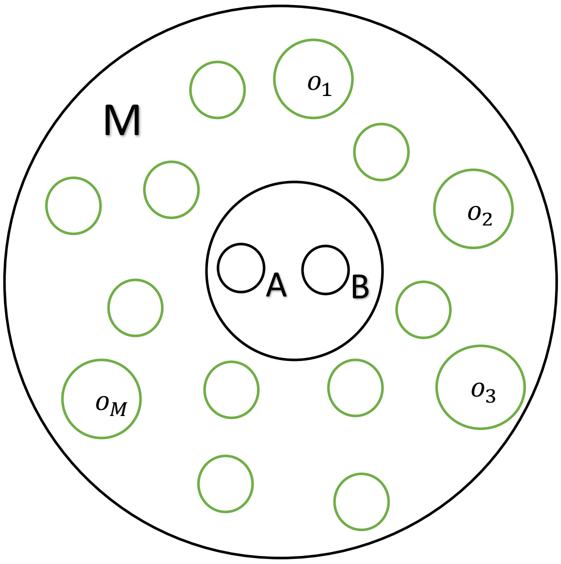
<u>Inclusion:</u>

1. $O_{A(K)} \Subset O_{B(L)} := \{O_{C(M)} | O_{C(O)} = \{O_{A(O)}, O_{B(O)}\}, O_C = \uplus_{M}$ a,b} , where

$O_A \stackrel{S}{=} O_B$

,

$a - elements\ of\ object\ A,$
$b - elements\ of\ object\ B,$
$M = K + L,$
$O_{A(O)} - key\ element\ of object\ A,$
$O_{B(O)} - key\ element\ of object\ B.$

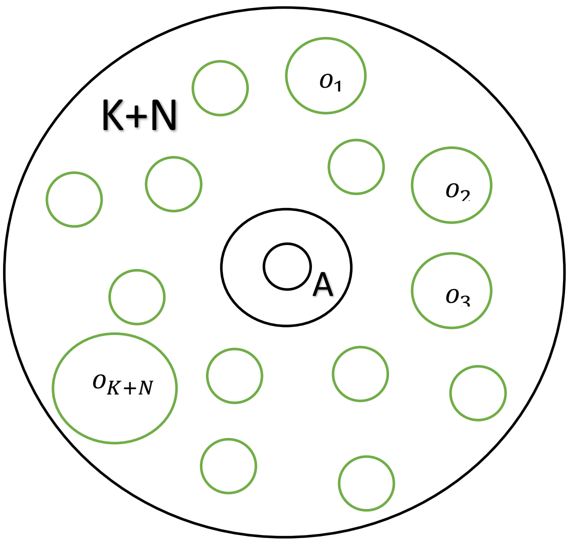


pic.6.

2. $O_{A(K)} \Subset S_{2(N)} := \{O_{A(K+N)} | O_A = \bigcup_{K+N} a, \not{S}_N \ \}$, where

$a - elements\ of\ object\ A,$

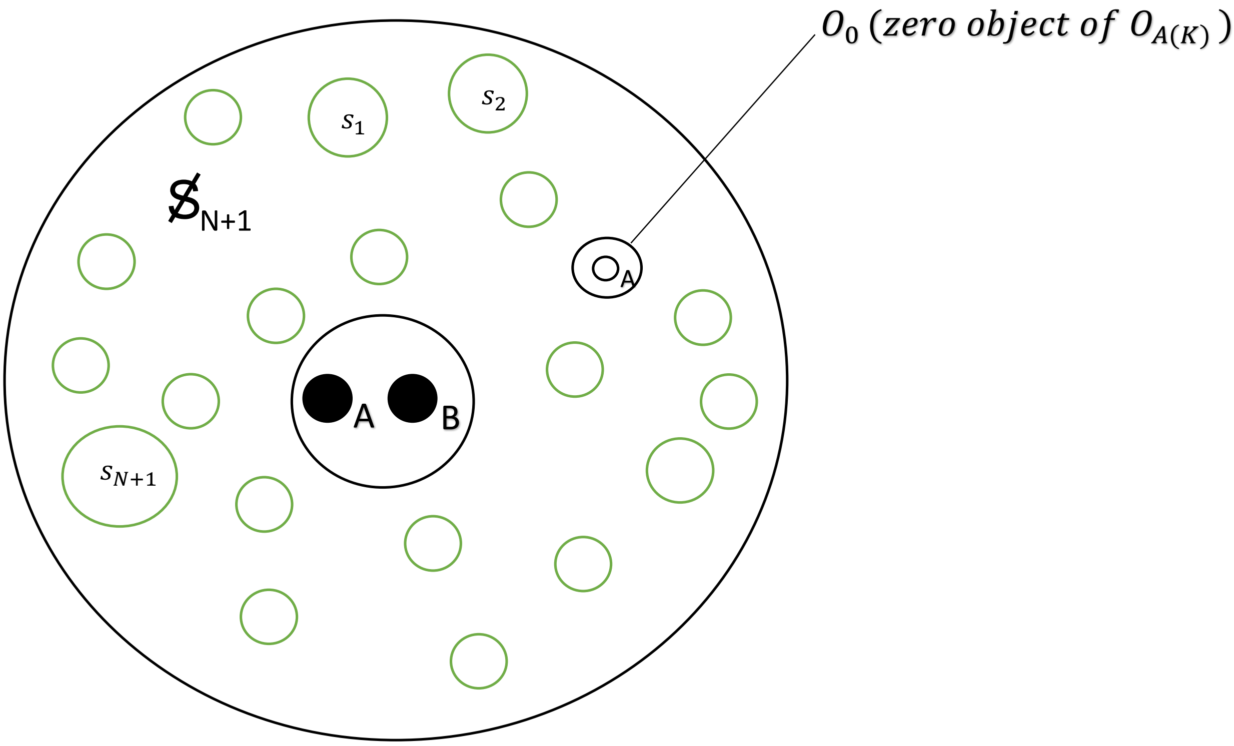
$\not{S}_N$ - No-Sense Set elements of S_2.



pic.7.

3.

$$S_{2(N)} \Subset O_{A(K)} := \{S_{2(N+1)} |\ \not{S}_{N+1} = \not{S}_{N} \Cup O_{A(K)}, \lim_{S} \not{S}_{(N+1)} = A, \lim_{S} \not{S}_{(N+1)} = B\}$$



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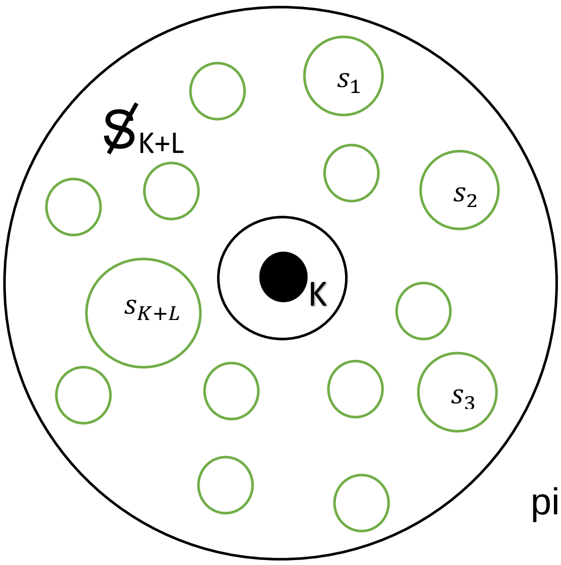
4.

$$S_{A(K)} \Subset S_{B(L)} := \begin{cases} S_{A(K+M)} |\ \not{S}_{K+M} = \not{S}_{K} \Cup \not{S}_{M}, \lim_{SE} \not{S}_{(K+M)} = A, M < L \\ S_{A,B(K)} \ |\ \not{S}_{K} = \not{S}_{K} \Cup \not{S}_{L}, \ \not{S}_{K} \Leftrightarrow \not{S}_{L} \end{cases}$$



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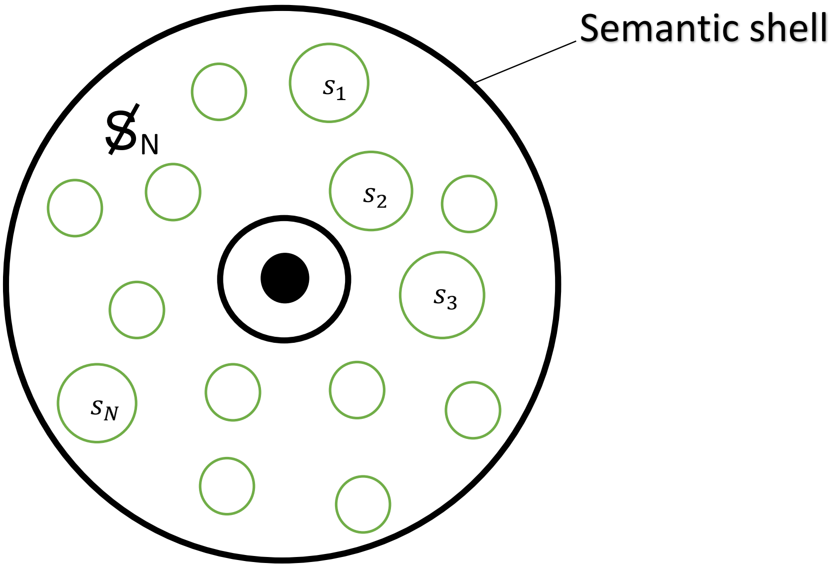
5. $\circledcirc \Subset \not{S}_N := \{S \mid \lim_{S} \not{S}_N = \circledcirc\}$

<u>Definition 1:</u>

Semantic shell of $\circledcirc$ in $\not{S}_N$ is existed and defined if and only if the following expression is true:

$$\circledcirc \Subset \not{S}_N = S \; [2] \qquad (5)$$



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<u>Definition 2:</u>

A Sense Set $S_{A(N)}$ is called *closed* if there is at least one sense derivative of S_f ($\not{S}_M$) on object O_0 on disunion,

$$\underset{\ominus}{\mathrm{diff}}\,(O_0)[S_f(\not{S}_N)]_M = \circledcirc = \mathrm{const} \;\; [3] \qquad (6)$$

and there is no 1-st order sense derivative of S_f ($\not{S}_M$) on object O_0 on union.

Definition 3:

A Sense Set $S_{A(K)}$ is called *open* if there is at least one sense derivative of S_f ($\not{S}_L$) on object O_0 on union,

$$\underset{\circledcirc}{\mathrm{diff}}(O_0)[S_f(\not{S}_K)]_L = \circledcirc = \mathrm{const} \quad [3] \tag{7}$$

Definition 4:

Semantic shell of (N)-order of $\circledcirc_A$ is a sense derivative of S_f of n-order on $\circledcirc_A$ on union:

$$S_f^{diff(+N)}(\circledcirc_A) = \mathrm{const} \quad \textit{for } N = \{1,2,3,\ldots n\} \tag{8}$$

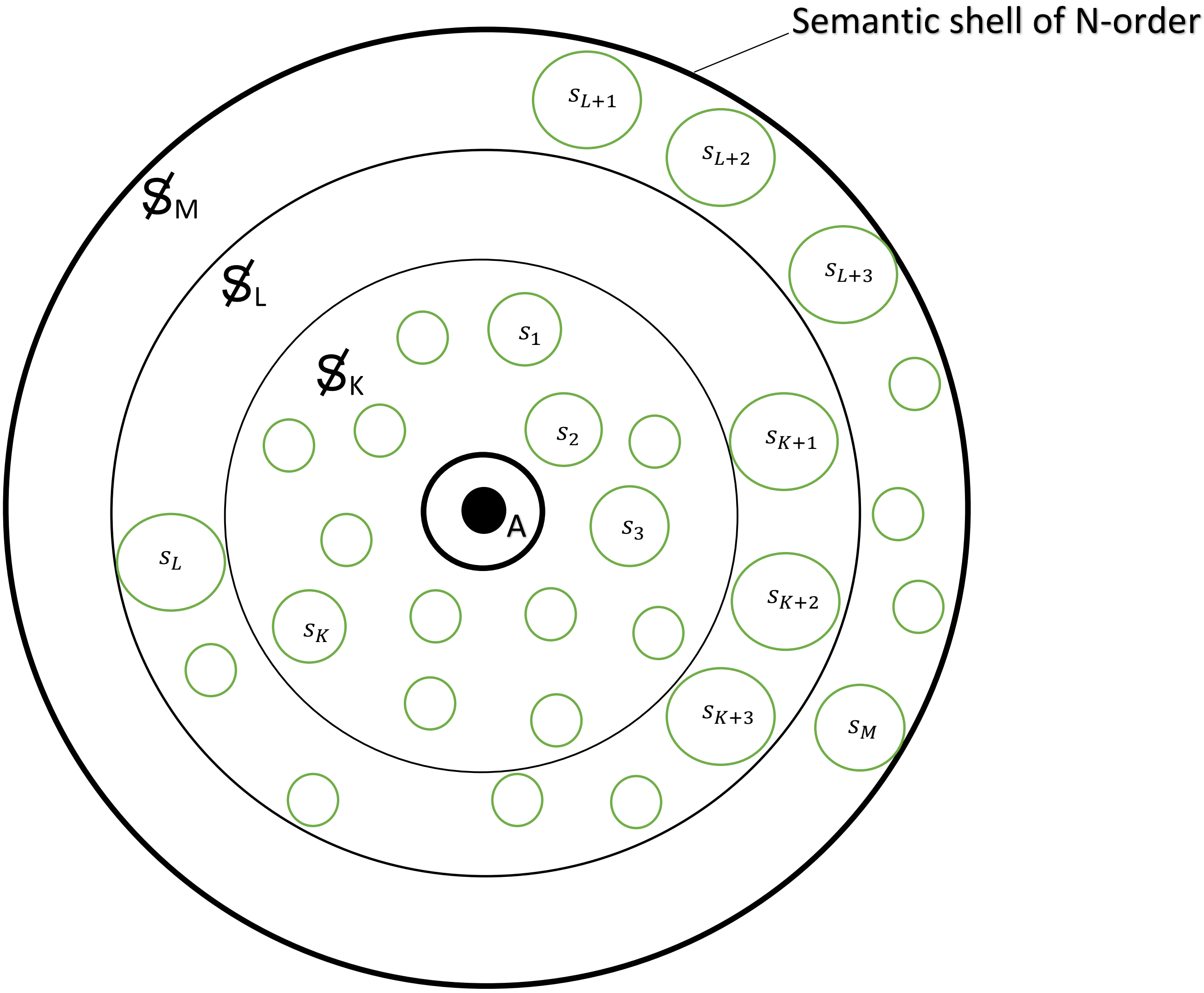
Definition 5:

Semantic shell of (-N)-order of $\circledcirc_A$ is a sense derivative of S_f of n-order on $\circledcirc_A$ on disunion:

$$S_f^{diff(-N)}(\circledcirc_A) = \mathrm{const} \quad \textit{for } N = \{1,2,3,\ldots n\} \tag{9}$$

The semantic shell describes *the properties of continuity* on the object of the sense function S_f and its area of semantic definition.

So, if $\not{S}_N$ is divided into three sense subsets $\not{S}_K$, $\not{S}_L$ and $\not{S}_M$ where N= K+L+M then $S_{A(K)} \overset{S}{\subset} S_{A(L)} \overset{S}{\subset} S_{A(M)}$ the sense function S_f defined on all three subsets and having a sense derivative on object in each of them is called a *continuous function* on $\not{S}_N$.



pic.11.

6.

For $O_{A(K)} \overset{S}{\neq} O_{B(L)}, O_{A(K)} \Subset O_{B(L)} := \{\overline{O_{C(M)}} \mid \overline{O_{C(0)}} = \{O_{A(0)}, O_{B(0)}\}, O_C = \bigcup_{M} a, b\}$

where

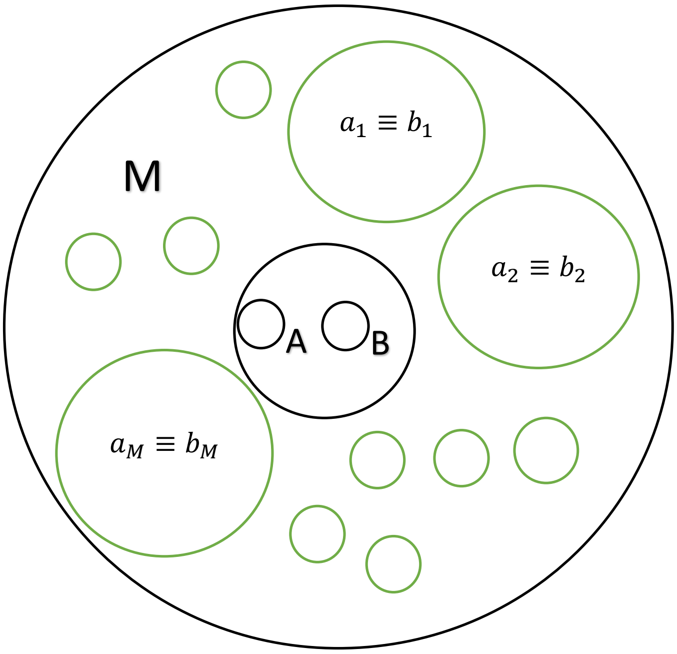
$a - elements\ of\ object\ A,$

$b - elements\ of\ object\ B,$

$O_{A(O)} - key\ element\ of object\ A,$

$O_{B(O)} - key\ element\ of object\ B,$

$M = K + L, K = L.$



pic.12.

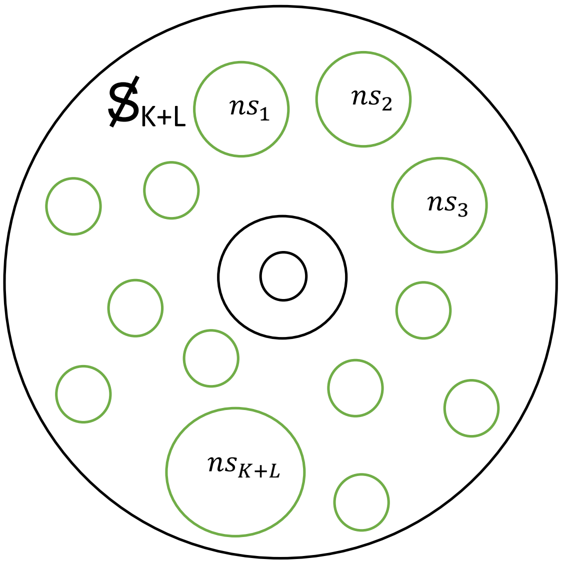
7.

$$S_{A(N)} \Subset \overline{O_{C(M)}} := \begin{cases} S_{A(N+R)} | \not{S}_{N+R} = \not{S}_N \uplus \not{S}_K \text{ , R = K or R} \neq \text{K, } \not{S}_K = \not{S}_M \ominus \not{S}_L \text{, } \lim \not{S}_{N+R} = A \\ S_{C(N+R+1)} | \not{S}_{N+R+1} = \not{S}_N \uplus \not{S}_K \uplus O_{B(L)} \text{ , R = K or R} \neq \text{K, } \not{S}_K = \not{S}_M \ominus \not{S}_L \text{, } \lim_{S} \not{S}_{N+R+1} = C \\ O_{C(N+2)} | O_{N+2} = O_N \uplus O_{A(0)} \uplus O_{B(0)} \end{cases}$$

This property is called ***the displaced core effect*** (DCE). In other words, under the condition $O_{A(K)} \overset{E}{\Leftrightarrow} O_{B(L)}$ and $O_{A(K)} \overset{S}{\neq} O_{B(L)}$, we have a situation when the semantic core $\circledcirc_A$ changes to another semantic core $\circledcirc_C$ or becomes undefined.

<u>Semantic Union:</u>

1. $\not{S}_K \uplus \not{S}_L := \{\not{S}_M \mid \not{S}_M = \not{S}_K \uplus \not{S}_L \text{ ,K=L or K} \neq \text{L, M = K + L}\}$



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<u>Definition 6:</u>

Attribute Set (A_S) is a set each element of which is the quantitative and/or qualitative characteristic of a zero object O_0,

$$\forall a \in A_{S(M)} \rightarrow a \in O_{A(K)} \tag{10}$$

2.

$$O_{A(K)} \uplus \not{S}_L := \begin{cases} O_{A(K+L)} \mid O_A = \mathop{\uplus}\limits_{K+L} a, \not{S}_L, \forall a_i \in O_A(a_i \in A_S(O_{A(0)}), i = \{1, \ldots K + L\} \\ \not{S}_M \mid \not{S}_M = \not{S}_K \uplus \not{S}_L, K=L \text{ or } K \neq L, M = K + L, \exists p \in \not{S}_L \ (p \notin A_S(O_{A(0)})) \end{cases}$$

<u>Definition 7:</u>

Coherent Sense Set (C_S) is a sense set at least two elements of which are being connected to each other by a *semantic synapse*,

$$\exists c \in S_{A(N)}(c \in \not{S}_N \wedge c = \uplus a, b; \ a, b \in \not{S}_{N+1}) \tag{11}$$

Definition 8:

Semantic Synapse (S_{SY}) of two arbitrary elements a and b is a semantic union $c = \uplus a,b$ where $c \underset{S}{\in} \not{S}_N$,

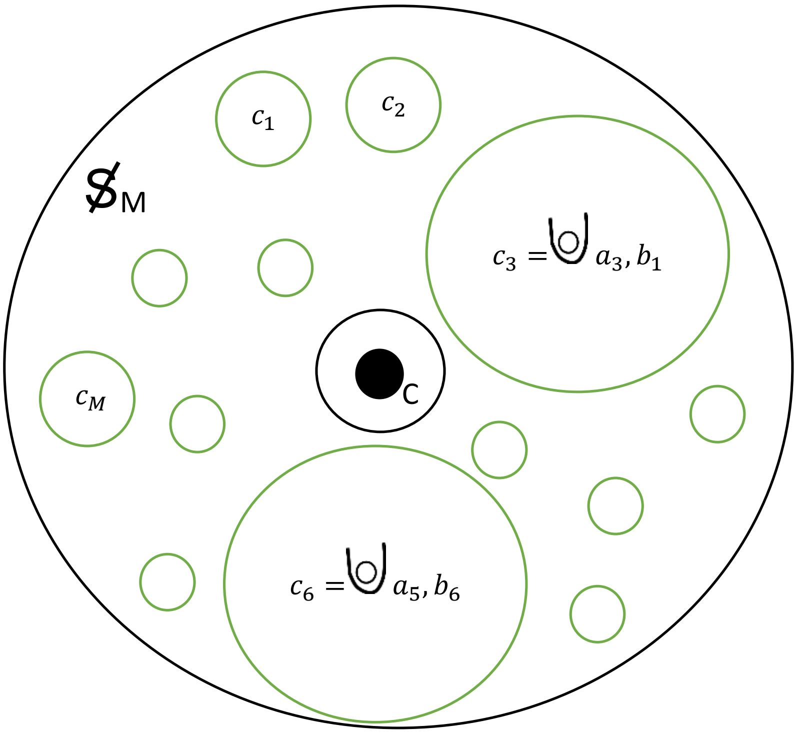
$$S_{SY}(a,b) = \uplus a, b \tag{12}$$

3.

$$O_{A(K)} \uplus O_{B(L)} := \begin{cases} O_{C(M)} \mid \forall c \in O_C(c_i \in A_S(O_{C(0)}), i = \{1, \dots M\} \\ \not{S}_M \mid \not{S}_M = \not{S}_K \uplus \not{S}_L \text{ , } \not{S}_M \notin A_S \end{cases}$$

4.

$$S_{A(K)} \uplus O_{B(L)} := \begin{cases} S_{d(K+M)} \mid \lim_{S} \not{S}_{K+M} = \circledcirc_d \\ C_{S(M)} \mid \lim_{S} \not{S}_M = \circledcirc, \exists a, b \in \not{S}_M \, (c \in \not{S}_M, c = \uplus a, b), M < K + L \end{cases}$$



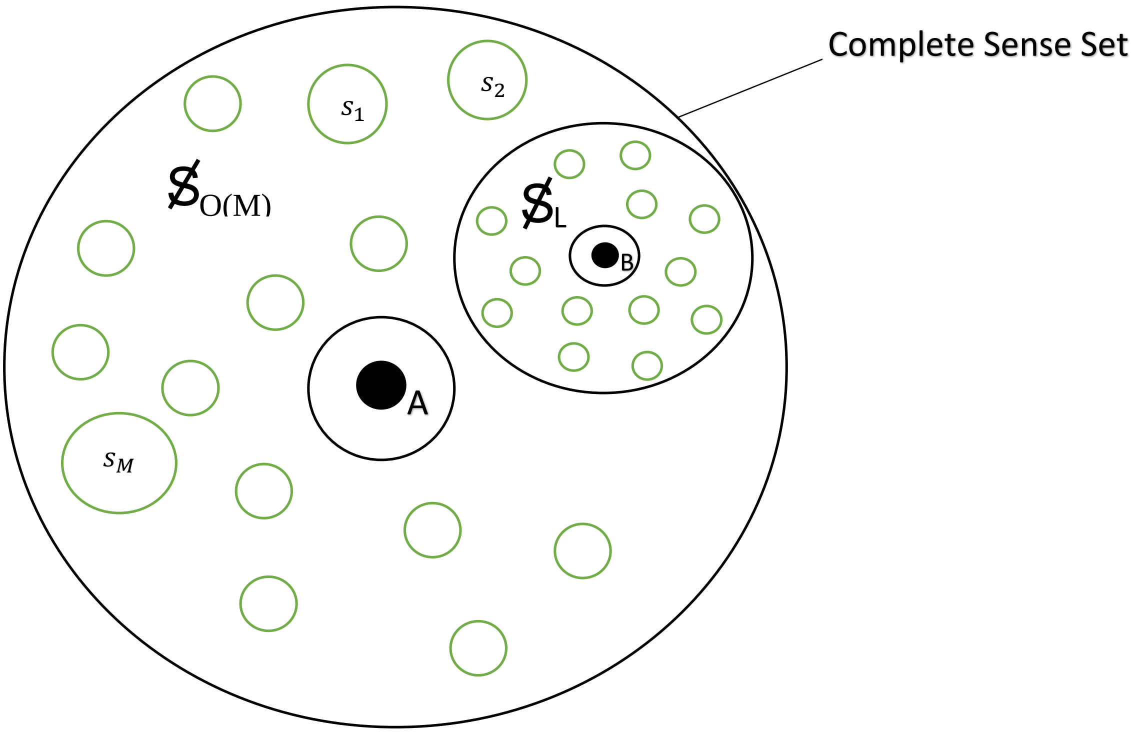
pic.14.

5.

$$S_{A(K)} \mathbin{\dot\cup} \not{S}_{L} := \{ S_{A(K+L)} \mid \not{S}_{K+L} = \not{S}_{K} \mathbin{\dot\cup} \not{S}_{L},\ \lim_{S} \not{S}_{K+L} = \circledcirc_{A} \}$$

6.

$$S_{A(K)} \mathbin{\dot\cup} S_{B(L)} := \begin{cases} S_{C(M)} \mid \not{S}_{O(M)} = \not{S}_{K} \mathbin{\dot\cup} S_{B(L)},\ \lim_{S} \not{S}_{O(M)} = \circledcirc_{C} \\ \not{S}_{O(M)} \mid \not{S}_{O(M)} = \not{S}_{K} \mathbin{\dot\cup} S_{B(L)},\ \lim_{S} \not{S}_{O(M)} \neq \circledcirc \end{cases}$$



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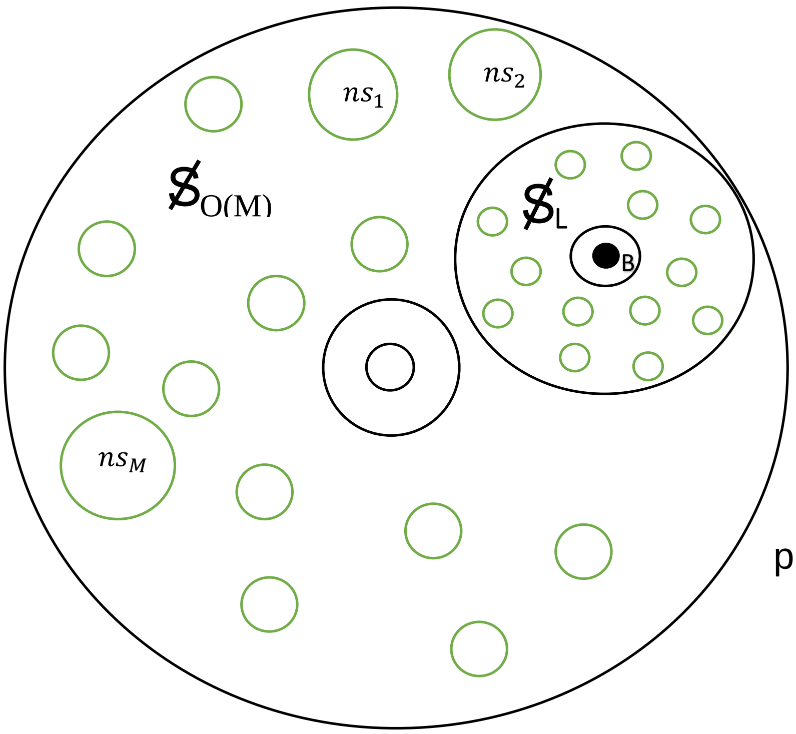

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Exclusion:

1.

$$O_{C(M)} \mathrel{\ominus\!\!\!\subset} O_{B(L)} := \{\, O_{A(K)} \mid \forall a_i \in O_{A(K)}\big(a_i \notin O_{B(L)}\big), O_{B(0)} \notin O_{A(0)}, M = K + L\}$$

2.

$$S_{A(K)} \mathrel{\ominus\!\!\!\subset} O_{B(L)} := \{\, S_{A(K-1)} \mid \not{S}_{K-1} = \not{S}_{K} \mathrel{\ominus\!\!\!\cup} O_{B(L)}, \lim_{S} \not{S}_{K-1} = \circledcirc_A\}$$

3.

$$S_{A(N)} \mathrel{\ominus\!\!\!\subset} \not{S}_N := \{\, S_{A(0)} \mid S_{A(N)} = S_{A(0)} \mathrel{\circ\!\!\!\subset} \not{S}_N\}$$

4.

$$S_{A(N)} \mathrel{\ominus\!\!\!\subset} S_{A(0)} := \{\not{S}_N \mid S_{A(N)} = S_{A(0)} \mathrel{\circ\!\!\!\subset} \not{S}_N\}$$

Semantic Disunion:

1.

$$\not{S}_K \mathrel{\ominus\!\!\!\cup} \not{S}_L := \begin{cases} \not{S}_M \mid \forall c_i \in \not{S}_M(c_i \notin \not{S}_L), a_j = b_k, a_j \in \not{S}_K, b_k \in \not{S}_L, \mathrm{i} > \mathrm{j}, \mathrm{j} \le k \\ \overline{\emptyset_S} \mid a_j = b_k, a_j \in \not{S}_K, b_k \in \not{S}_L, \mathrm{j} = k, \mathrm{j}=\{1,\dots,K\}, \mathrm{k}=\{1,\dots,L\} \\ \not{S}_K \mid \forall a_j \in \not{S}_K, \forall b_k \in \not{S}_L \ (\nexists a_j, b_k \mid a_j = b_k) \end{cases}$$

2.

$$O_{A(K)} \mathrel{\ominus\!\!\!\cup} \not{S}_L := \begin{cases} O_{A(K-M)} \mid O_A = \mathrel{\ominus\!\!\!\cup} a, \not{S}_L, \forall a_i \in O_A\left(a_i \in A_S\big(O_{A(0)}\big)\right), \mathrm{i} = \{1, \dots, \mathrm{K} - \mathrm{M}\}, \mathrm{K} > \mathrm{L}, \mathrm{M} \le L \\ \overline{\emptyset_S} \mid \forall a \in O_{A(K)}, \forall b \in \not{S}_L (a = b, K = L) \\ O_{A(K)} \mid \forall a \in O_{A(K)}, \forall b \in \not{S}_L (\nexists a, b \mid a = b) \end{cases}$$

3.

$$O_{A(K)} \mathrel{\ominus\!\!\!\cup} O_{B(L)} := \begin{cases} O_{A(K-M)} \mid \forall a_i \in O_{A(K-M)} \left(a_i \notin O_{B(L)}\right), \mathrm{M} \le L \\ \overline{\emptyset_S} \mid \forall a \in O_{A(K)}, \forall b \in O_{B(L)} (\mathrm{a} = \mathrm{b}, \mathrm{K} = \mathrm{L}) \end{cases}$$

4.

$$S_{A(K)} \ominus O_{B(L)} := \begin{cases} S_{A(K-M)} \mid \lim\limits_{S} \not{S}_{K-M} = \circledcirc_A, M \leq L, K \neq L \\ \circledcirc_A \mid \forall a \in \not{S}_K, \forall b \in O_{B(L)} (a = b, K = L) \end{cases}$$

5.

$$S_{A(K)} \ominus S_{B(L)} := \begin{cases} S_{d(M)} \mid \lim\limits_{S} \not{S}_M = \circledcirc, O_{B(0)} \in \not{S}_K \\ O_{C(M)} \mid \forall c_i \in O_C \, (c_i \in A_S(O_{C(0)})) \\ \not{S}_M \mid \exists p \in \not{S}_M (p \notin A_S), \not{S}_M = \not{S}_K \ominus S_{B(L)}, M = K - 1 \end{cases}$$

There are ***four basic axioms of a sense space*** that determine the basic relations between the elements of a given space and their properties.

<u>The Axiom of Structure of Sense Set:</u>

Every element of Sense Set $S_{A(N)}$ consists of two parts, zero object $O_{A(0)}$ and sense sequence $\not{S}_N$, where the first one is a sense limit of the second one:

$$\lim_{S} \not{S}_N = O_{A(0)} \tag{13}$$

The following two expressions are equivalent:

$$S_{A(N)} = \lim_{S} \not{S}_N \Subset \not{S}_N \tag{14}$$

$$S_{A(N)} = \not{S}_N \Subset \lim_{S} \not{S}_N \tag{15}$$

<u>The Axiom of Sense Conformity:</u>

The sense conformity of No-Sense Set (Object No-Sense Set) $\not{S}_N$ ($\not{S}_{O(N)}$) to a zero object O_o exists and defined if and only if there is a semantic derivative S_f($\not{S}_N$) on object O_o on disunion for any N:

$$\forall a_k \in \not{S}_{\mathrm{N}}(\underset{\ominus}{\mathrm{diff}}\,(O_0)\left[S_f(\not{S}_{\mathrm{N}})\right]_{N-1} = S_f\left(\not{S}_{\mathrm{N}} \ominus \underset{\mathrm{S}}{PN}\left(\not{S}_{\mathrm{N}}(a_k)\right)\right) = O_0) \qquad (16)$$

<u>The Axiom of Sense Constancy:</u>

The semantic union (disunion) of a Sense Set S_N and empty set $\overline{\emptyset}_S$ is constantly Sense Set S_N:

$$S_N \uplus \overline{\emptyset}_S = \overline{\emptyset}_S \uplus S_N \overset{\mathrm{S}}{=} \mathrm{const} \qquad (17)$$

$$(S_N \ominus \overline{\emptyset}_S = \overline{\emptyset}_S \ominus S_N \overset{\mathrm{S}}{=} \mathrm{const})$$

<u>The Axiom of Power of Sense Set:</u>

The power of Sense Set S_N is always more than the power of their Coherent Sense Set C_{S_N}:

$$P_A > P_{C_A} \quad (A - S_N) \qquad (18)$$

<u>Definition 9:</u>

Sense direct bijection (SDB) between two arbitrary sets A and B is defined when each element of A (B) belongs to A_S for a single element of B (A):

$$\forall a_i \in A\left(b_j \in O_0 \,\middle|\, a_i \in A_S \; for \; b_j, i = j\right) \qquad (19)$$

$$(\forall b_i \in A\left(a_j \in O_0 \,\middle|\, b_i \in A_S \; for \; a_j, i = j\right))$$

The power of A is not equal to the power of B [2].

There is also a *sense reverse bijection* with the same property.

<u>Definition 10:</u>

Sense reverse bijection (SRB) between two arbitrary sets B and A is defined when each element of B (A) belongs to $O_{0(N)}$ for a single element of A (B):

$$\forall b_i \in B\left(a_j \in A_S \,\middle|\, b_i \in O_{0(N)} \; for \; a_j, i = j\right) \qquad (20)$$

$$(\forall a_i \in B(b_j \in A_S \mid a_i \in O_{0(N)}\ for\ b_j, i = j))$$

("O/NS" commutativity).

The power of B is not equal to the power of A [2].

Definition 11:

Sense direct surjection (SDS) between two arbitrary sets A and B is defined when each element of A semantically tends at least to one element of zero object set B:

$$\forall a \in A(\exists b \in B \mid \lim_{S} a = b \vee a \in O_{B(0)}) \tag{21}$$

Definition 12:

Sense reverse surjection (SRS) between two arbitrary sets B and A is defined when each element of zero object set B has at least one element of A as its property:

$$\forall b \in O_{B(0)}(\exists a \in A \mid a \in A_S \vee a \in \not\subset_{B(N)}) \tag{22}$$

Definition 13:

Dimension of Sense Space (D_S) is the maximum number of all elements that are members of any sense sequence (-es) and/or attribute set A_S (-s):

$$s_i \in A \quad \text{and/or} \quad s_i \in A_S \tag{23}$$

$$i = \{1, \ldots, D_S\}, A - sense\ sequence$$ [2]

Simple properties:

1. $D_S(S \uplus \overline{\emptyset}_S) = D_S(S \uplus \overline{\emptyset}_S)$
2. $D_S(S_f(\not\subset_N)) = N$
3. $S_{S(1)}$ – a singe sense space where the sense set (sense function) is the only element.
4. $S_f(\not\subset_1)$ - a single sense function (N=1)
5. $S_{S(1)} \setminus_S S_{A(1)} = undefined\ (S_{A(1)} \subseteq S_{S(1)})$

6. $D_S(S_S) \geq D_S(S)$

By analogy with the concept of the *degree of freedom* in physics, in a sense space, the concept of *dimension* describes the semantic state of a given space at a certain moment in time. In other words, what kind of object (-s) and what nature are described in sense space.

4. Conclusion

In this article, we presented the primary description of Sense Space S_S of Sense Theory. The Sense Space is a vast area of ***new mathematics*** that allows you to look at problems in the field of big data, machine learning and artificial intelligence from a different sense side.

We hope that our decent work will help other AI researchers in their life endeavors.

To be continued.

APPENDIX

$\underset{A}{\setminus}$ - “attribute complement”, binary operation

The attribute complement of $\not{S}_L$ ($O_{B(L)}$) in $\not{S}_K$ ($O_{A(K)}$) is the No-Sense Set $\not{S}_M$ ($O_{C(M)}$) of all elements that are members of $\not{S}_K$ ($O_{A(K)}$) but not members of $\not{S}_L$ ($O_{B(L)}$):

$$\not{S}_K \underset{A}{\setminus} \not{S}_L = \not{S}_M \left(O_{A(K)} \setminus O_{B(L)} = O_{C(M)}\right)$$

$\overline{\emptyset}_S$ - “empty set”

The empty set is a set that includes neither zero object nor No-Sense Set:

$$\overline{\emptyset}_S := \text{“ ”}\{\ \}$$

$\underset{S}{\in}$ - “sense membership sign”, binary operation

$a_1 \underset{S}{\in} \not{S}_N$ if and only if the following condition is met:

$$S = \{\circledcirc_K \Subset \not{S}_N\}, N \geq K, a_1 - element\ of\ \not{S}_N$$

$\underset{\not{S}}{\in}$ - “no-sense membership sign”, binary operation

$a_1 \underset{\not{S}}{\in} \not{S}_N$ if and only if $\not{S}_N$ is not a sense sequence [2]

$\underset{S}{\notin}$ - “sense no-membership sign”, binary operation

$a_1 \underset{S}{\notin} \not{S}_N$ where a_1 is not an element of $\not{S}_N$ for which the following condition is met:

$$S = \{\circledcirc_K \Subset \not{S}_N\}, N \geq K$$

$\underset{\not{S}}{\notin}$ - “no-sense no-membership sign”, binary operation

$a_1 \underset{\not{S}}{\notin} \not{S}_N$ where a_1 is not an element of $\not{S}_N$ which is not a sense sequence

$\underset{S}{\setminus}$ - “semantic complement”, binary operation

The semantic complement of S_M in S_N is the Sense Set S_K of all elements that are members of $\not{S}_N$ but not members of $\not{S}_M$:

$$S_N \underset{S}{\setminus} S_M = S_K, where\ a_k \underset{S}{\in} \not{S}_N, a_k \underset{S}{\notin} \not{S}_M, S_M \overset{S}{\not\subset} S_K$$

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