Sense Theory

(Part 4)
Sense Antiderivative

[P-S Standard]

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Abstract.
Like each neuron of the human brain may be connected to up to 10,000 other neurons, passing signals to each other via as many as 1,000 trillion synaptic connections, in Sense Theory there is a possibility for connecting over 1,000 trillion heterogeneous objects. An object in Sense Theory is like a neuron in the human brain. Properties of the object are like dendrites of the neuron. Changing object in the process of addition or deletion of its properties is like forming a new knowledge in the process of synaptic connections of two or more neurons. In Sense Theory, we introduced a mechanism for determining possible semantic relationships between objects by connecting-disconnecting different properties. This mechanism is Sense Integral.

In this article, we describe one of the instruments, *sense antiderivative*, that sheds light on the nature of forming new knowledge in the field of Artificial Intelligence.

1. Introduction

In traditional mathematics, the antiderivative of a function of a single variable, for example, measures the area under the curve of the function. In Sense Theory, the antiderivative of a sense function [2] determines a possible new knowledge (or describing current one more deeply) by addition or deletion of the properties. It also clearly shows sense associations between properties of different objects.

2. Problem

Unlike traditional integral calculus where infinitesimals used, in Sense Theory, we operate sets (finite or infinite) of possible properties of No-Sense Set (Object No-Sense Set) for zero-object ('s).

For a sense function S_f defined on A_i, a sense integral $\oint$ of the function will determine the following three possible cases:

1. $$\oint [S_f(A_i)] = \underset{S}{\text{const}}$$, for any subset B_j ($B_j \subseteq A_i$) or set B'_j ($B'_j \notin A_i$) **(I)**

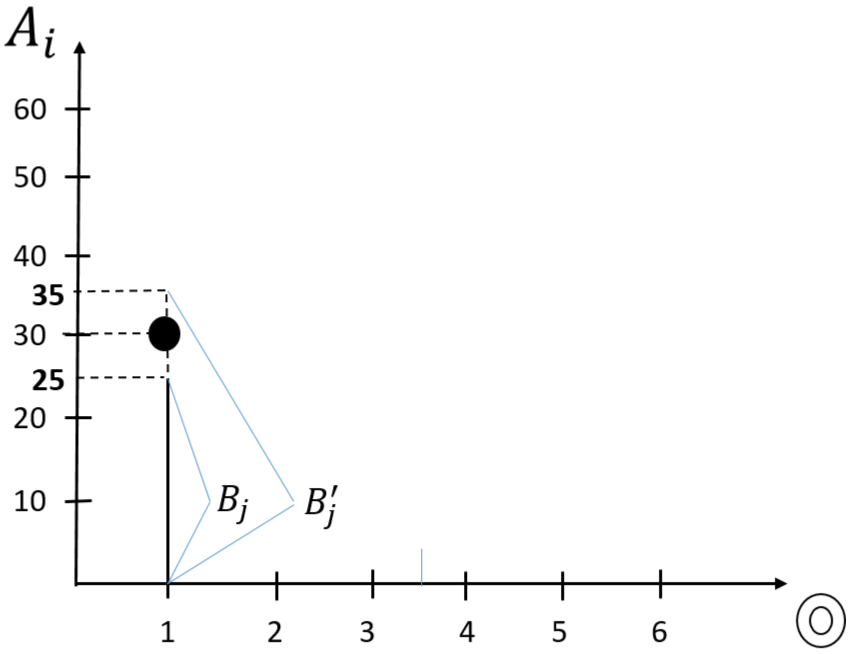
2. $$\oint [S_f(A_i)] = undefined,\ where\ \lim_S A_i = B_i = \emptyset_S$$, for any B_j or B'_j **(II)**

3. $$\oint [S_f(A_i)] = \{◎\}_{i=1,2,3,\dots}\ where\ ◎_1 \neq ◎_2 \neq \dots \neq ◎_n$$, for any B_j or B'_j **(III)**

In practice, it is crucial to define conditions on which (I), (II) and (III) met. It will extremely help understand a new knowledge formation.

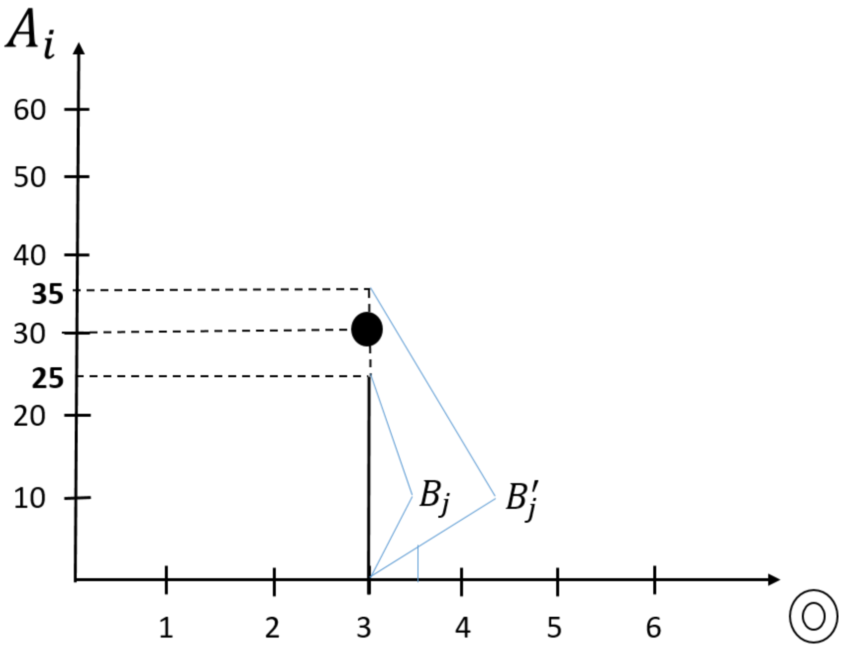
3. Solution

For (I) we have the following ($i = 30, B_j = A_{25}, B'_j = A_{35}$),



$\{◎\}_1$

In practice, we can also have the following case,



$\{◎\}_3$

The graph above shows that there is a set of $\{◎\}_n$ for which the sense integral $\oint$ of S_f will always be constant and equal to the set.

<u>**Theorem** (Existence of Integral Set)**:**</u>

“For any sense function S_f defined on arbitrary set of A_i, there is at least a single set of $\{◎\}_{j=1,2,...n}$ (n>1):

$$\oint[S_f(A_i)] = \{◎\}_j$$

, where j > 1”

For j = 3,

$$\oint[S_f(A_i)] = ◎_1$$

,

$$\oint[S_f(A_i)] = ◎_2$$

,

$$\oint[S_f(A_i)] = ◎_3$$

,

where $◎_1 \neq ◎_2 \neq ◎_3$.

Thus, we may rewrite (I) as follows

$$\oint[S_f(A_i)] = \underset{\{◎\}_3}{\overset{S}{\text{const}}}$$

, **(A)**

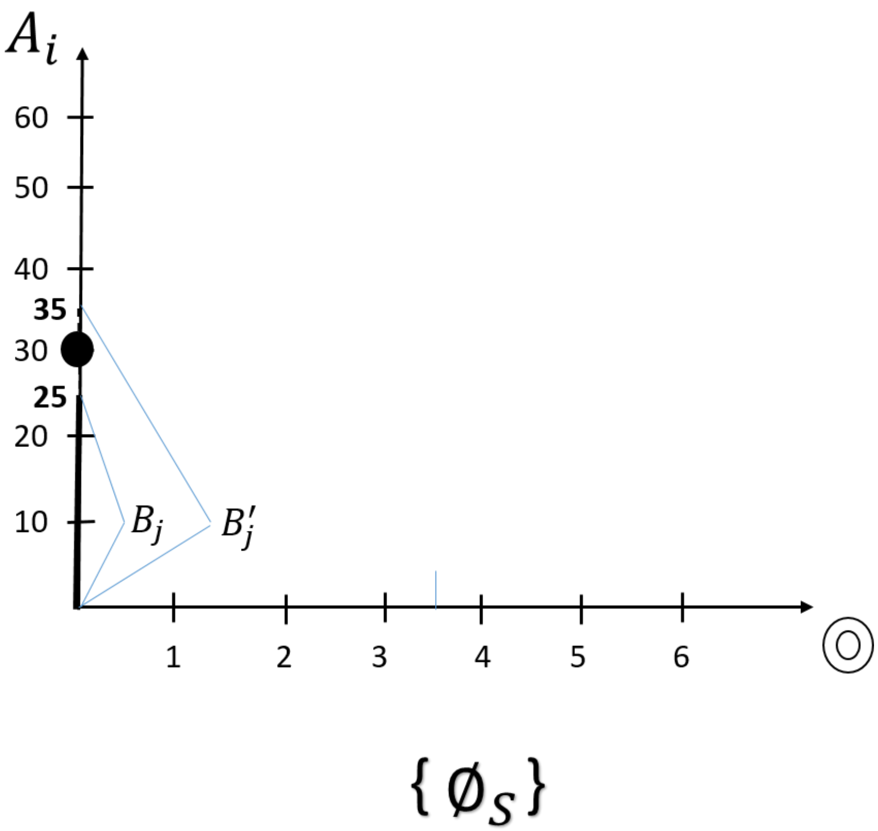
for any B_j and B_j' where $S_f(A_i)$ is $S_f - partial\ function$

The integral in (A) is *a sense integral defined on set of objects* $\{◎\}_3$ *or definite sense integral*.

Proof.

The proof of the theorem deduces from Definition 5 [1], Theorem (Surjection of Function) [1] and Definition 8 [1].

For (II) we have the following ($i = 30, B_j = A_{25}, B_j' = A_{35}$),



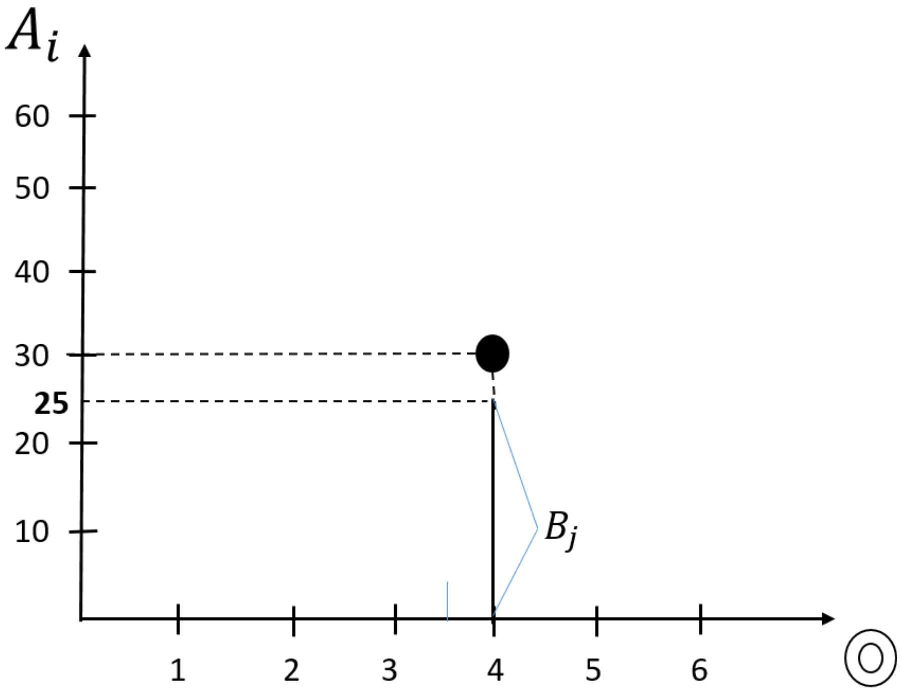
And, expressing through sense integral,

$$S_F = \mathop{S\!\!\!\int}\left[\, S_f(A_i)\right] = B_j = B'_j = \emptyset_S$$

(B)

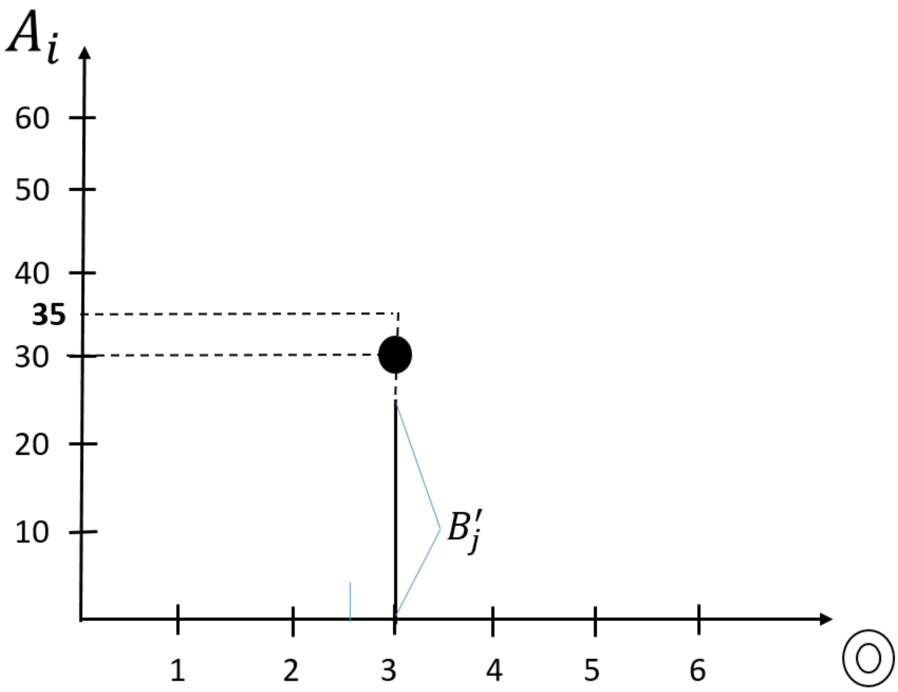
The integral in (B) is *a sense integral undefined on set of* B_j *(*B'_j*) or indefinite sense integral.*

For (III) we have the following ($i = 30, B_j = A_{25}$),



$\{◎\}_4$

For $B'_j = A_{35}$,



$\{◎\}_3$

where $◎_1 \neq ◎_2 \neq ◎_3 \neq ◎_4$.

It is obvious that as $S_f(B_j)$ as $S_f(B'_j)$ is $S_f - partial\ function$.

Thus,

$$\oint [\, S_f(B_j)] = \{\circledcirc\}_4 \quad , \quad \textbf{(C)}$$

and

$$\oint [\, S_f(B_j')] = \{\circledcirc\}_3 \quad \textbf{(D)}$$

The integral in (C) and in (D) as well is *a sense integral diverging on set of* B_j *and set of* B_j'*, respectfully.*

<u>**Theorem** (Convergent Integral)**:**</u>

"To be convergent, necessary and sufficient, an integrand of the sense integral must be $S_f - complete$"

Proof.

The proof of the theorem deduces from Definition 4 [1], Axiom (Semantic Derivative on disunion) [2], Axiom (Absence of Derivative) [2], Axiom of Constancy [2] and, the rules of semantic normalization [2].

<u>Sense Integral on disunion</u>

Let's S_f to be defined on the set of $\not{S}_N$ or $\not{S}_{O(N)}$. Then for any $S_f(\not{S}_M)$ defined on $\not{S}_M$ ($\not{S}_{O(M)}$), where M < N and M ⊆ N, *semantic integral* S_f*(*$\not{S}_N$ *) on disunion* is

$$\overset{\ominus}{\oint} [S_f(\not{S}_N)] = S_F^{\ominus}$$

or

$$\overset{\ominus}{\oint} [S_f(\not{S}_N)] = \underset{\circledcirc}{\text{diff}}\, [S_f(\not{S}_N)]_M = S_f(\not{S}_{N+M})$$

where $\underset{\ominus}{\text{diff}}\, [S_F^{\ominus}]_M = S_f(\not{S}_N)$.

<u>Properties:</u>

1. $\underset{\cup_{\ominus}}{\text{diff}}\ [\oint^{\ominus} [S_f(\not{S}_{N})]]_M = S_f(\not{S}_{N})$

2. $\oint^{\ominus} [S_f(\not{S}_{N}) \cup_{\ominus} S_f(\not{S}_{M})] = \oint^{\ominus} [S_f(\not{S}_{N})] \cup_{\ominus} \oint^{\ominus} [S_f(\not{S}_{M})]$

3. $\oint^{\ominus} [S_f(\emptyset_S)] = \underset{\cup_{\circ}}{\text{diff}}\ [S_f(\emptyset_S)]_M = S_f(\not{S}_{K})$

$$S_f(\not{S}_{K}) = \begin{cases} defined, \text{ if } \lim\limits_{S} \not{S}_{K} = \circledcirc \\ undefined, \text{ if } \lim\limits_{S} \not{S}_{K} \neq \circledcirc \end{cases}$$

where , according to Axiom (Sense Limit of Derivative) [2]

4. $\oint^{\ominus} [\oint^{\circ} [S_f(\not{S}_{K})]] = S_f(\not{S}_{K})$

5. $\oint^{\ominus} [\oint^{\ominus} [S_f(\not{S}_{N})]] = S_f(\not{S}_{N}) \cup_{\circ} S_f(\not{S}_{2M})$

6. $\oint^{\ominus} [S_f(\not{S}_{N})] \overset{S}{\leqq} \oint^{\ominus} [S_f(\not{S}_{N'})]$,

if $S^{\theta}_{F(N)} \overset{S}{\leqq} S^{\theta}_{F(N')}$, however there is a situation when

$S_f(\not{S}_{N}) \overset{S}{\neq} S_f(\not{S}_{N'})$

7. $$\oint^{\ominus}[S_f(\$_N) \cap S_f(\$_{N'})] = \oint^{\ominus}[S_f(\$_N)]_{M1} \cap \oint^{\ominus}[S_f(\$_{N'})]_{M2}$$,

if $\$_N \subseteqq S^{\ominus}_{F(M1)}$, $\$_{N'} \subseteqq S^{\ominus}_{F(M2)}$

Sense Integral on union

Let's S_f to be defined on the set of $\$_K$ or $\$_{O(K)}$. Then for any S_f($\$_L$) defined on $\$_L$ ($\$_{O(L)}$), *semantic integral* S_f($\$_K$ *) on union* is

$$\oint^{\bigcirc}[S_f(\$_K)] = S_F^{\bigcirc}$$

or

$$\oint^{\bigcirc}[S_f(\$_K)] = \underset{\ominus}{\text{diff}}\,[S_f(\$_K)]_L = S_f(\$_{K-L})$$

Properties:

1. $$\underset{\bigcirc}{\text{diff}}\,[\oint^{\bigcirc}[S_f(\$_K)]]_L = S_f(\$_K)$$

2. $$\oint^{\bigcirc}[S_f(\$_K) \cup S_f(\$_{K'})] = \oint^{\bigcirc}[S_f(\$_K)] \cup \oint^{\bigcirc}[S_f(\$_{K'})]$$,

if $\$_L \overset{E}{\Longleftrightarrow} \$_{L1} \cup \$_{L2}$

3. $$\oint^{\bigcirc}[S_f(\emptyset_S)] = \underset{\ominus}{\text{diff}}\,[S_f(\emptyset_S)]_L = S_f(\$_M)$$,

$S_f(\not{S}_M)$ is defined if and only if $\lim\limits_{S} \not{S}_M \neq \not{S}_M$

where

4. $\oint\limits^{\bigcirc}[\oint\limits^{\ominus}[S_f(\not{S}_N)]] = S_f(\not{S}_N)$, if $\not{S}_M \overset{E}{\Leftrightarrow} \not{S}_L$

5. $\oint\limits^{\bigcirc}[\oint\limits^{\bigcirc}[S_f(\not{S}_K)]] = S_f(\not{S}_K) \; \underset{\ominus}{\cup} \; S_f(\not{S}_{2L})$

6. $\oint\limits^{\bigcirc}[S_f(\not{S}_K)] \overset{S}{\leqq} \oint\limits^{\bigcirc}[S_f(\not{S}_{K'})]$, if $S^{\bigcirc}_{F(K)} \overset{S}{\leqq} S^{\bigcirc}_{F(K')}$

however there is a situation when $S_f(\not{S}_K) \overset{S}{\lneqq} S_f(\not{S}_{K'})$

7. $\oint\limits^{\bigcirc}[S_f(\not{S}_K) \overset{\bigcirc}{\cap} S_f(\not{S}_{K'})] = \oint\limits^{\bigcirc}[S_f(\not{S}_K)] \overset{\bigcirc}{\cap} \oint\limits^{\bigcirc}[S_f(\not{S}_{K'})]$,

if $\not{S}_K \overset{S}{\leqq} S^{\bigcirc}_{F(M1)}$, $\not{S}_{K'} \overset{S}{\leqq} S^{\bigcirc}_{F(M2)}$

<u>Sense Integral on property (‘s)</u>

<u>Disunion</u>

Let's S_f to be defined on the set of $\not{S}_N$ or $\not{S}_{O(N)}$. Then for any $S_f(\not{S}_M)$ defined on $\not{S}_M$ ($\not{S}_{O(M)}$), where M<N and M⊆N, *semantic integral* $S_f(\not{S}_N)$ *on* p_i *on disunion* is

$$\oint\limits_{p_i}^{\ominus}[S_f(\not{S}_N)] = S^{\ominus}_{F_{p_i}}$$

or

$$\oint_{p_i}^{\ominus}[S_f(\text{Ꞩ}_{N})] = \underset{\circ}{\text{diff}}\,(p_i)[S_f(\text{Ꞩ}_{N})]_M = S_f(\text{Ꞩ}_{N+M})$$

,

where p_i – i-property of Ꞩ$_N$,

$p_i \notin$ Ꞩ$_M$.

<u>Properties:</u>

Identical to Sense Integral on disunion provided that:

1, 2, 3. $p_i \notin$ Ꞩ$_M$

4. Ꞩ$_L$ = $\underset{S}{\text{PN}}$(Ꞩ$_L(p_i)$)

5. $p_i \notin$ Ꞩ$_{2M}$

6. Ꞩ$_M$= $\underset{S}{\text{PN}}$(Ꞩ$_M(p_i)$) , Ꞩ$_{M'}$ = $\underset{S}{\text{PN}}$(Ꞩ$_{M'}(p_i)$)

7. $p_i \in$ Ꞩ$_N$, Ꞩ$_{N'}$, Ꞩ$_{M1}$= $\underset{S}{\text{PN}}$(Ꞩ$_{M1}(p_i)$) , Ꞩ$_{M2}$= $\underset{S}{\text{PN}}$(Ꞩ$_{M2}(p_i)$)

<u>Union</u>

Let's S_f to be defined on the set of Ꞩ$_K$ or Ꞩ$_{O(K)}$. Then for any S_f(Ꞩ$_L$) defined on Ꞩ$_L$ (Ꞩ$_{O(L)}$), *semantic integral* S_f*(* Ꞩ$_K$ *) on* p_i *on union* is

$$\oint_{p_i}^{\bigcirc}[S_f(\text{Ꞩ}_{K})] = S_{F\,p_i}^{\bigcirc}$$

or

$$\oint_{p_i}^{\bigcirc}[S_f(\text{Ꞩ}_{K})] = \underset{\ominus}{\text{diff}}\,(p_i)[S_f(\text{Ꞩ}_{K})]_L = S_f(\text{Ꞩ}_{K-L})$$

where p_i – i-property of $\not{S}_K$,
$p_i \notin \not{S}_L$.

<u>Properties:</u>
Identical to Sense Integral on union provided that:

1. $p_i \notin \not{S}_L$
2. $p_i \notin \not{S}_L , \not{S}_{L1} , \not{S}_{L2}$
3. $p_i \notin \not{S}_L$
4. $\not{S}_M = \underset{S}{PN}(\not{S}_M(p_i))$
5. $p_i \notin \not{S}_{2L}$
6. $p_i \notin \not{S}_L , \not{S}_{L'}$
7. $p_i \in \not{S}_K , \not{S}_{K'} , p_i \notin \not{S}_L , \not{S}_{L'}$

Sense Integral on n properties has the same above-mentioned properties and denoted as:

$$\underset{\{p_i\}_n}{\overset{\ominus}{\oint}}[S_f(\not{S}_N)] = S_{F\;\{p_i\}_n}^{\ominus}$$

and

$$\underset{\{p_i\}_n}{\overset{\bigcirc}{\oint}}[S_f(\not{S}_K)] = S_{F\;\{p_i\}_n}^{\bigcirc}$$

<u>Sense Integral on object</u>

<u>Disunion</u>

Let's S_f to be defined on the set of $\not{S}_N$ or $\not{S}_{O(N)}$. Then for any $S_f(\not{S}_M)$ defined on $\not{S}_M$ ($\not{S}_{O(M)}$), where M < N and M ⊆ N, *semantic integral* S_f*(*$\not{S}_N$*) on object* O_N on *disunion* is

$$\oint_{\circledcirc}^{\ominus}[S_f(\not{S}_N)] = S_{F\,\circledcirc}^{\ominus}$$

or

$$\oint_{\circledcirc}^{\ominus}[S_f(\not{S}_N)] = \underset{\circledcirc}{\mathrm{diff}}\,(O_N)[S_f(\not{S}_N)]_M = S_f(\not{S}_{N+M}) = \circledcirc = \overset{S}{\mathrm{const}}$$

The properties of sense integral on an object are identical to the properties of sense integral on disunion and have a place if and only if any sense derivative on O_N is exist.

<u>Union</u>

Let's S_f to be defined on the set of $\not{S}_K$ or $\not{S}_{O(K)}$. Then for any $S_f(\not{S}_L)$ defined on $\not{S}_L$ ($\not{S}_{O(L)}$), *semantic integral* S_f*(*$\not{S}_K$*) on* O_N *on union* is

$$\oint_{\circledcirc}^{\bigcirc}[S_f(\not{S}_K)] = S_{F\,\circledcirc}^{\bigcirc}$$

or

$$\oint_{\circledcirc}^{\bigcirc}[S_f(\not{S}_K)] = \underset{\ominus}{\mathrm{diff}}\,(O_N)[S_f(\not{S}_K)]_L = S_f(\not{S}_{K-L}) = \circledcirc = \overset{S}{\mathrm{const}}$$

The properties of sense integral on an object are identical to the properties of sense integral on union and have a place if and only if any sense derivative on O_N is exist.

8. Conclusion

In this article, we presented the instrument for dynamic formation of a new knowledge, Sense Integral. It allows finding semantic connections between a pair of different objects and between billions of objects of different nature as well. One of the crucial features of Sense Integral is the capability for determining latent knowledge of an object.

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

To be continued.

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