Sense Theory

(Part 3)

Sense Derivative

[P-S Standard]

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Abstract.
In an attempt to create a theory for describing such a human phenomenon as a possibility to self-learning, we need to create an instrument for dynamic modeling of **sense-to-sense** (S2S) [3] associations between heterogeneous objects. This instrument would help understand the nature of the cause-to-effect relationship [4] and the creation of new knowledge.

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

1. Introduction

In traditional mathematics, the derivative of a function of a single variable (multiple variables) measures sensitivity to changes of one variable (many variables) towards another one. In Sense Theory, the derivative of a sense function [2] measures sensitivity to property-changes of one No-Sense Set of the object towards sense changes of this object. Also, it clearly shows sense associations between objects of different nature.

Compared with trillions of synaptic connections in the human brain, the sense derivative allows a researcher to analyze trillions of possible sense connections. So a No-Sense Set of n-measurement may include n^n possible sense objects.

2. Problem

Like in traditional differential calculus, in Sense Theory we need to formulate a mechanism of changing S_f (sense constituents) on No-Sense Set $\not{S}_N$. In other words, we need to be able to define sets (subsets) on which the sense limit is:

1. always constant

$$\lim_{S} S_f(\{A_i\}) = \overset{S}{const}, \text{ for any subset } B_j \text{ where } B_j \subseteq A_i$$

2. absent

$$\lim_{S} S_f(\{A_i\}) = \{A_i\} = \emptyset_S$$

3. divergent

$$\lim S_f(\{A_i\}) = \circledcirc_A = \circledcirc_B \text{ where } \lim_{S} A_i \neq \lim_{S} B_i$$

In practice, a set on which the function S_f is defined may as increase as decrease. For these situations, we need to describe a derivative on union (set increasing) and a derivative on disunion (set decreasing). Both derivatives form a new knowledge.

Also, each object has a series of key properties that define it uniquely. For this case, we will describe a derivative on property.

3. Solution

<u>Derivative on 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 derivative* $S_f(\not{S}_K)$ *on union* is

$$S_f(\not{S}_K) \cup S_f(\not{S}_L) = S_f(\not{S}_M)$$

or

$$S_f^{diff}(\not{S}_K) = [S_f(\not{S}_K) \uplus S_f(\not{S}_L)] = S_f(\not{S}_M)$$
,

where K < M, M > L.

The equivalent form is

$$\underset{\uplus}{\mathrm{diff}}\,[S_f(\not{S}_K)]_L = S_f(\not{S}_K \uplus \not{S}_L) = S_f(\not{S}_M)$$

Unlike semantic derivative on disunion, No-Sense Set of $S_f^{(diff)}$ on union can be put as on the left side as on the right side from the operator of semantic union as

$$\not{S}_K \uplus \not{S}_L = \not{S}_L \uplus \not{S}_K$$

<u>**Axiom** (Sense Limit of Derivative)**:**</u>

“The semantic derivative on union has two cases:

1. the sense limit is defined:

$$\lim_{S} \not{S}_M = \circledcirc \quad \text{for } \underset{\uplus}{\mathrm{diff}}\,[S_f(\not{S}_K)]_L$$

2. the sense limit is undefined:

$$\lim_{S} \not{S}_M \neq \circledcirc \quad \text{or} \quad \lim_{S} \not{S}_M = \not{S}_M$$
”

<u>Properties:</u>

1. $$\underset{\uplus}{\mathrm{diff}}\,[S_f(\emptyset_S)]_L = S_f(\emptyset_S \uplus \not{S}_L) = S_f(\not{S}_M)$$
,

where for $S_f(\not{S}_M)$ we have 2 cases:

a. $\lim_{S} \not{S}_M = \not{S}_M$

b. $\lim_{S} \not{S}_M = \circledcirc$

2. $\underset{\cup_{\circ}}{\text{diff}}\ [\underset{\cup_{\ominus}}{\text{diff}}[S_f(A_K)]_L]_L = \circledcirc_A = \overset{S}{\text{const}}$,

where

$$\underset{\cup_{\ominus}}{\text{diff}}\ [S_f(A_K)]_L = \circledcirc_A$$

or

$$\underset{\cup_{\ominus}}{\text{diff}}\ [S_f(A_K)]_L \neq \circledcirc_A$$

3. $\underset{\cup_{\circ}}{\text{diff}}\ [\underset{\cup_{\ominus}}{\text{diff}}[S_f(A_K)]_L]_{L+1} = S_f(A_M)$,

where

$$\underset{\cup_{\ominus}}{\text{diff}}\ [S_f(A_K)]_L = \lim_{S} A_M$$

or

$$\underset{\cup_{\ominus}}{\text{diff}}\ [S_f(A_K)]_L \neq \lim_{S} A_M$$

4. $\underset{\cup_{\circ}}{\text{diff}}\ [S_f(\not{S}_K)]_L \overset{S}{\equiv} \underset{\cup_{\circ}}{\text{diff}}\ [S_f(\not{S}_{K'})]_{L'}$,

if

$$\lim_{S} \not{S}_K = \lim_{S} \not{S}_{K'}$$

5. $\underset{\cup_{\circ}}{\text{diff}}\ [S_f(\not{S}_K) \cup_{\circ} S_f(\not{S}_{K'})]_L = \underset{\cup_{\circ}}{\text{diff}}\ [S_f(\not{S}_K)]_{L1} \cup_{\circ} \underset{\cup_{\circ}}{\text{diff}}\ [S_f(\not{S}_{K'})]_{L2}$

where

$$\lim_{S} \not{S}_{K} = \lim_{S} \not{S}_{K'}$$

6. $$\underset{\cup_{\circ}}{\mathrm{diff}}\, [S_F^o]_L = S_f(A_K),\ where\ A_L \subseteq A_K$$

7. $$\underset{\cup_{\circ}}{\mathrm{diff}}\, [S_f(\not{S}_{K}) \cap_{\circ} S_f(\not{S}_{K'})]_L = \underset{\cup_{\circ}}{\mathrm{diff}}\, [S_f(\not{S}_{K})]_{L1} \cap_{\circ} \underset{\cup_{\circ}}{\mathrm{diff}}\, [S_f(\not{S}_{K'})]_{L2}$$

where

$$\underset{\cup_{\circ}}{\mathrm{diff}}\, [S_f(\not{S}_{K})]_{L1} \overset{S}{\equiv} \underset{\cup_{\circ}}{\mathrm{diff}}\, [S_f(\not{S}_{K'})]_{L2}$$

<u>Derivative 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, *semantic derivative* $S_f(\not{S}_{N})$ *on disunion* is

$$S_f(\not{S}_{N}) \cup_{\ominus} S_f(\not{S}_{M}) = S_f(\not{S}_{K})$$

or

$$S_f^{diff}(\not{S}_{N}) = [S_f(\not{S}_{N}) \cup_{\ominus} S_f(\not{S}_{M})] = S_f(\not{S}_{K}),$$

where N > K.

The equivalent form is

$$\underset{\cup_{\ominus}}{\mathrm{diff}}\, [S_f(\not{S}_{N})]_M = S_f(\not{S}_{N}^{(diff)} \cup_{\ominus} \not{S}_{M}) = S_f(\not{S}_{K})$$

It is important to remember that No-Sense Set of $S_f^{(diff)}$ is always put on the left side from the operator of semantic disunion as

$$\not{S}_N \ominus \not{S}_M \neq \not{S}_M \ominus \not{S}_N$$

<u>**Axiom** (Constancy of Sense Limit)**:**</u>

"The semantic derivative on disunion of function S_f defined on set of $\not{S}_N$ has always a limit if and only if the derivative on object of S_f is defined for each element of $\not{S}_N$, then:

$$\lim_{S} \not{S}_K = \circledcirc \quad \text{for } \underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_N)]_M$$

"

<u>Properties:</u>

1. $$\underset{\ominus}{\mathrm{diff}}\ [S_f(\emptyset_S)]_M = S_f(\emptyset_S \ominus \not{S}_M) = S_f(\not{S}_K)$$,

where for $S_f(\not{S}_K)$ we have 2 cases:

a. $\lim_{S} \not{S}_K = \not{S}_K$

b. $\lim_{S} \not{S}_K = \circledcirc$

2. $$\underset{\ominus}{\mathrm{diff}}\ [\underset{\circ}{\mathrm{diff}}[S_f(A_N)]_M]_M = \circledcirc_A = \overset{S}{\mathrm{const}}$$,

where

$$\underset{\circ}{\mathrm{diff}}\ [S_f(A_N)]_M = \circledcirc_A$$

or

$$\underset{\circ}{\mathrm{diff}}\ [S_f(A_N)]_M \neq \circledcirc_A$$

3. $$\underset{\ominus}{\mathrm{diff}}\,[\underset{\circ}{\mathrm{diff}}[S_f(A_N)]_M]_{M+1} = S_f(A_K)$$,

where

$$\lim_{S} A_K = \circledcirc_A$$

4. $$\underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_N)]_M \overset{S}{\equiv} \underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_{N'})]_{M'}$$,

if

$$\lim_{S} \not{S}_N = \lim_{S} \not{S}_{N'}$$

5. $$\underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_N) \uplus_{\ominus} S_f(\not{S}_{N'})]_M = \underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_N)]_{M1} \uplus_{\ominus} \underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_{N'})]_{M2}$$

where

$$\not{S}_N \;|\overset{E}{\Leftrightarrow}|\; \not{S}_{N'}$$

6. $$\underset{\ominus}{\mathrm{diff}}\,[S_F^{\ominus}]_M = S_f(A_N),\ where\ A_M \subseteq A_N$$

7. $$\underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_N) \cap_{\circ} S_f(\not{S}_{N'})]_M = \underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_N)]_{M1} \cap_{\circ} \underset{\ominus}{\mathrm{diff}}\,[S_f(\not{S}_{N'})]_{M2}$$

where

$$\underset{\ominus}{\text{diff}}\,[S_f(\not{S}_N)]_{M1} \leqq \underset{\ominus}{\text{diff}}\,[S_f(\not{S}_{N'})]_{M2}$$

<u>Derivative on property (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 derivative* S_f*(* $\not{S}_N$ *) on* p_i *on disunion* is

$$S_f^{diff}(p_i)(\not{S}_N) = [S_f(\not{S}_N) \ominus S_f(\not{S}_M)]$$

,

where p_i – i-property of $\not{S}_N$,

$p_i \notin \not{S}_M$.

The equivalent form is

$$\underset{\ominus}{\text{diff}}\,(p_i)[S_f(\not{S}_N)]_M = S_f(\not{S}_N \ominus \not{S}_M)$$

.

<u>Properties:</u>

Items 1, 2 and 3 is identical to the derivative on disunion if the following requirements are met:

$$p_i \notin A_M, A_{M+1}, \not{S}_M$$

4. $p_i \in \not{S}_N, \not{S}_{N'}$, $p_i \notin \not{S}_M, \not{S}_{M'}$.

5,7. $p_i \in \not{S}_N, \not{S}_{N'}$, $p_i \notin \not{S}_M, \not{S}_{M1}, \not{S}_{M2}$.

6. $p_i \notin A_M$.

Derivative on property (union).

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 derivative* $S_f($ $\not S_N$ $)$ *on* p_i *on union* is

$$S_f^{diff}(p_i)(\not S_K) = [S_f(\not S_K) \uplus S_f(\not S_L)]$$

,

where p_i – i-property of $\not S_K$,

$\not S_L$ - $\underset{S}{\mathrm{PN}}(\not S_L\ (p_i))$, where $\underset{S}{\mathrm{PN}}()$ – **sense punctured neighborhood**.

The equivalent form is

$$\underset{\uplus}{\mathrm{diff}}\,(p_i)[S_f(\not S_K)]_L = S_f(\not S_K \uplus \not S_L)$$

Properties:

1, 2, 3: $\not S_L$: $\underset{S}{\mathrm{PN}}(\not S_L\ (p_i))$, A_L: $\underset{S}{\mathrm{PN}}(A_L(p_i))$, A_{L+1}: $\underset{S}{\mathrm{PN}}(A_{L+1}(p_i))$

4. $p_i \in \not S_K, \not S_{K'}$, $\not S_L$: $\underset{S}{\mathrm{PN}}(\not S_L\ (p_i))$, $\not S_{L'}$: $\underset{S}{\mathrm{PN}}(\not S_{L'}\ (p_i))$.

5,7. $p_i \in \not S_K, \not S_{K'}$, $\not S_L$: $\underset{S}{\mathrm{PN}}(\not S_L\ (p_i))$, $\not S_{L1}$: $\underset{S}{\mathrm{PN}}(\not S_{L1}\ (p_i))$, $\not S_{L2}$: $\underset{S}{\mathrm{PN}}(\not S_{L2}\ (p_i))$.

6. A_L: $\underset{S}{\mathrm{PN}}(A_L(p_i))$.

Derivative on object (disunion).

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 derivative* $S_f($ $\not S_N$ $)$ *on object* O_N *on disunion* is

$$S_f^{diff}(O_N)(\not S_N) = [S_f(\not S_N) \ominus S_f(\not S_M)]_{\circledcirc = \mathrm{const}}$$,

where $O_N = \lim\limits_{S} \not S_N$.

The equivalent form is

$$\underset{\ominus}{\mathrm{diff}}(O_N)[S_f(\not S_N)]_M = S_f(\not S_N \ominus \not S_M) = \circledcirc = \mathrm{const}$$.

<u>Properties:</u>

1. $\underset{\ominus}{\mathrm{diff}}(O_N)\ [S_f(\emptyset_S)]_M$ - undefined as $\lim\limits_{S} \emptyset_S \neq O_N$.

2. $\underset{\ominus}{\mathrm{diff}}(O_N)[\underset{\circ}{\mathrm{diff}}(O_N)[S_f(A_N)]_M]_M = \circledcirc_A = \overset{S}{\mathrm{const}}$,

   where

   $$\underset{\circ}{\mathrm{diff}}(O_N)\ [S_f(A_N)]_M = \overset{S}{\mathrm{const}}$$

3. $\underset{\ominus}{\mathrm{diff}}(O_N)[\underset{\circ}{\mathrm{diff}}(O_N)[S_f(A_N)]_M]_{M+1} = S_f(A_K)$,

   where

   $$\lim\limits_{S} A_K = \circledcirc_A$$

4, 5, 6, 7. Evident, based on derivative on disunion.

<u>Derivative on object (union).</u>

1-7 properties is being derived by the rules for the derivative on object (disunion).

4. Conclusion

In this article, we presented the instrument for dynamic modeling of sense-to-sense (S2S) [3] associations between heterogeneous objects. It will help better understand the nature of the sense constituent of the object.

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

To be continued.

References

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