

## The Concept of Semantic Space, Affinity Space and Execution Space

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### The Concept of Semantic Space

Every V-particle is adorned with a semantic signature which can be represented by a DAG where each node contents can be represented as an integer number and each arc is assigned a weight which is a positive real number. Equivalently, the semantic signature can be represented as a matrix (refer to the document [Thought Synthesis](#) for details). Every semantic structure is represented by its semantic signature. The weights of the arcs in its semantic signature represent confidence values which are not normalized. The Semantic space is a metric space where the metric (norm) is the semantic distance denoted by  $sdist$ . The semantic distance is defined recursively as:

Let us denote the semantic distance between two particles  $V_{a_1}$  and  $V_{b_1}$  with  $sdist(V_{a_1}, V_{b_1})$ .

Let us evaluate the semantic distance between  $V_{a_1}$  and  $V_{b_1}$ .

$$\frac{V_{a_2}}{w}$$

Here  $V_{a_1}$  is connected to  $V_{a_2}$  with an arc having a weight  $w$ . Let us assume that the  $sdist(V_{a_1}, V_{b_1}) < \varepsilon$  where  $\varepsilon$  is a small positive number. Let us denote the new compound V particle with  $V_{new} = [V_{a_1} \xrightarrow{w} V_{a_2}]$ . We want the following asymptotic behavior to hold true when we make the weight arbitrary small:

$$sdist(V_{new}, V_{a_2}) < \varepsilon \text{ when } w \rightarrow 0$$

We want also  $sdist(V_{new}, V_{a_2}) < \varepsilon$  when  $sdist(V_{a_2}, V_{\emptyset})$  is small enough. Here  $V_{\emptyset}$  represents the null semantic particle which has no meaning i.e. it is arbitrarily close in terms of semantic distance to any other semantic structure or particle. The last asymptotic relation is equivalent to disregarding V-particles which do not enrich the semantic structure of the resulting compound particle.

Example:

$text(V_{new}) = \text{"Yes, he is Dimitar, yup"}$   
 $text(V_{a_1}) = \text{"Yes, he is Dimitar"}, text(V_{a_2}) = \text{"yup"}$

Possible ways to define semantic distance and equivalence between the semantic DAG  $G$  and signature matrix  $S$

We want to create the signature matrix  $S$  from the semantic DAG  $G$  in such way that we preserve the asymptotic closeness properties of the semantic space defined earlier. Let us define the signature matrix of V particle in such a way that each row corresponds to a property from the property graph  $G(V)$  of V particle traversed *in order*. For details on the Property Graph of semantic particle consult *Properties and Dependent Properties* paragraph in the document [Inference and Execution](#).

Using the definition of signature of semantic structure we will define  $\varepsilon$ -closeness of two semantic structures. The semantic structures  $S_1$  and  $S_2$  are  $\varepsilon$ -close if there exist a difference matrix  $D = ssig(S_1) -$

## Notes on Semantic Distance

Semantic distance between two structures is a measure of how well those two structures align. One criterion measuring the structural alignment is the connectedness of each structure to the enclosing context. If the two structures are to be close semantically with respect to the enclosing context the connections between each structure and the enclosing context should be similar. The other obvious criterion is the similarity of the semantic signatures. If the two structures are to have short semantic distance the semantic signatures should be similar. Here we should elaborate on an important detail of the last criterion - the semantic signatures of which structures should be compared? The signatures of the **augmented** structures are those which matter and those which should be compared. The augmented structure of a given semantic structure  $S$  relative to some context  $C$  is obtained by replacing all inbound similarity links, denoted by  $SA^-(S)$  with the structures they refer to within the context  $C$ . For more details on the similarity links see the paragraph *The notion of effective mass of a semantic structure* in the document [Connecting Semantically Related Structures](#).

Let us study the following problem-

We have an enclosing semantic structure (context)  $C_1$  and we have associated with  $C_1$  two separate semantic structures  $S_1$  and  $S_2$ . Let the semantic structure  $S_1$  is represented by the DAG  $G_1$  composed of  $p$   $V$ -particles and  $q$   $A$ -particles. The set of the  $V$ -particles in  $G_1$  will be denoted by  $\mathfrak{S}_V = \{V_{k_1}, V_{k_2}, \dots, V_{k_p}\}$ .

//TODO: finish this