

Note on Match-seeking and Match-repelling particles

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Between two primitive particles

Let us consider two V -particles which are not composite – they are given with their semantic signatures respectively:

$$ssig(V') = [p'_0 \ a'_{0,1} \ p'_1 \ p'_0 \ a'_{0,2} \ p'_2 \ p'_0 \ a'_{0,3} \ p'_3 \ \dots \ p'_i \ a'_{i,n} \ p'_n]$$

$$ssig(V'') = [p''_0 \ a''_{0,1} \ p''_1 \ p''_0 \ a''_{0,2} \ p''_2 \ p''_0 \ a''_{0,3} \ p''_3 \ \dots \ p''_j \ a''_{j,m} \ p''_m]$$

Here each of the quantities p denotes the property signature vector of the corresponding property P of the V particle. The vector $a_{r,s}$ denotes the signature of the property association particle $A_{r,s}$ which binds to a pair of properties P_r and P_s in the property graph \mathcal{P} of the V particle.

Match-seeking particle MA binds to a subgraph \mathcal{S} of the property graph \mathcal{P} of the V particle.

There is a closeness condition which needs to be obeyed in order the particle MA to bind to the particle V .

Binding matrix of a match-seeking particle

The match-seeking particle MA exposes a binding matrix $mbind(MA)$:

$$mbind(MA) = [B^1 \ B^2 \ B^3 \ \dots \ B^q]$$

$$B^1 = [p^0 \ a^{0,1} \ p^1], B^2 = [p^0 \ a^{0,2} \ p^2], B^3 = [p^0 \ a^{0,3} \ p^3], \dots, B^q = [p^p \ a^{p,q} \ p^q]$$

Obviously, each of the blocks B^i is $N \times 3$ matrix where N is the dimension of semantic space. From now on we will denote the block matrices B^i as *binding elements* of the match-seeking particle M .

Note that in each of those blocks having the general form $B^i = [p^p \ a^{p,q} \ p^q]$ it is possible to have $a^{p,q} = p^q = \mathbf{0}$ where $\mathbf{0}$ represents the null vector in semantic space. However, p^p is never close to the null vector i.e. $|p^p| > 0$.

Binding of match-seeking particle against V -particle formulated as optimization problem

Let a primitive particle V has the following semantic signature:

$$ssig(V) = [B_1 B_2 \dots B_m]$$

Let us denote by f_j^i the semantic distance between the binding element B^i of MA and the semantic element B_j of V

$$f_j^i = \|B^i \ominus B_j\|, B^i = [p^p \ a^{p,q} \ p^q], B_j = [p_r \ a_{r,s} \ p_s]$$

Here the operation $\|\ominus\|$ denotes the following metric:

$$\|B^i \ominus B_j\| = |p^p| |p^p - p_r| + |a^{p,q}| |a^{p,q} - a_{r,s}| + |p^q| |p^q - p_s|$$

We also use the operation \odot to denote columnar dot product defined as:

$$B^i \odot B_j = p^p \cdot p_r + a^{p,q} \cdot a_{r,s} + p^q \cdot p_s$$

TODO: finish this

Recursive definition of the semantic distance?

$$f_j^i(B) = \|B^i \ominus B_j\|, f_q^p(a) = \|a^p \ominus a_q\|, f_s^r(w) = \|w^r \ominus w_s\|$$

Here $w \subset a \subset B$.

$$f_j^i(B) = |\mathbf{p}^p| |\mathbf{p}^p - \mathbf{p}_r| + |\mathbf{a}^{p,q}| f_{r,s}^{p,q}(a) + f_{r,s}^{p,q}(w) |\mathbf{p}^q| |\mathbf{p}^q - \mathbf{p}_s|$$

In abbreviated form:

$$f(B) = |\mathbf{p}^1| |\mathbf{p}^1 - \mathbf{p}_1| + |\mathbf{a}^{1,2}| f(a) + f(w) |\mathbf{p}^2| |\mathbf{p}^2 - \mathbf{p}_2|$$

Closeness condition for a bind between match seeking particle and primitive semantic particle
Let us denote by $sfil(MA, V)$ the following diagonal matrix which will be named *Filter matrix* of the match seeking particle:

$$sfil(MA, V) = \begin{bmatrix} I_1 & & & & \\ & 0 & & & \\ & & I_2 & & \\ & & & 0 & \\ & & & & \ddots \\ & & & & & I_k \end{bmatrix}$$

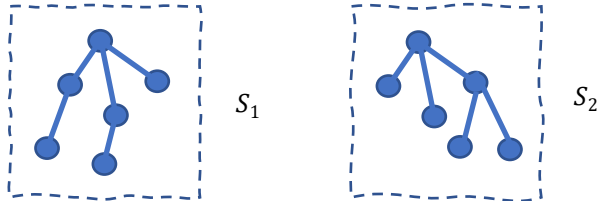
Here $I_i, i = 1, 2, \dots, k$ are identity matrices which represent the regions of interest in the semantic signature matrix of V to the match seeking particle MA .

The regions of interest $sreg(MA, V)$ in the semantic signature of V are obtained by multiplying $sfil(MA, V)$ with $ssig(V)$:

$$sreg(MA, V) = sfil(MA, V) \times ssig(V)$$

Between two semantic structures

Let us have two semantic structures S_1 and S_2 .



Let the semantic signature of S_1 is given with:

$$ssig(S_1) = [\mathbf{V}_1 \mathbf{A}_{1,2} \mathbf{V}_2 \mathbf{A}_{1,3} \mathbf{V}_3 \dots \mathbf{A}_{r,p} \mathbf{V}_p]$$

and the semantic signature of S_2 is given with:

Between a primitive V particle and a semantic structure S