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:

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

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

Here each of the quantities $\boldsymbol{p}$ denotes the property signature vector of the corresponding property P of the V particle. The vector $\boldsymbol{a}_{r,s}$ 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 $mbind(MA)$:

$$mbind(MA) = [\mathbf{B}_1 \, \mathbf{B}_2 \, \mathbf{B}_3 \;\; \dots \;\; \mathbf{B}_q]$$

$$\mathbf{B}_1 = [\boldsymbol{p}_0 \;\; \boldsymbol{a}_{0,1} \;\; \boldsymbol{p}_1] \, , \mathbf{B}_2 = [\boldsymbol{p}_0 \;\; \boldsymbol{a}_{0,2} \;\; \boldsymbol{p}_2] \, , \mathbf{B}_3 = [\boldsymbol{p}_0 \;\; \boldsymbol{a}_{0,3} \;\; \boldsymbol{p}_3] \, , \dots , \; \mathbf{B}_n = [\boldsymbol{p}_p \;\; \boldsymbol{a}_{p,q} \;\; \boldsymbol{p}_q]$$

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

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

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

Let a primitive particle V has the following semantic signature:

$ssig(V) = \;\; [\mathbf{B}^1 \mathbf{B}^2 \dots \mathbf{B}^m]$

Let us denote by $f_{i,j}$ the semantic distance between the binding element $\mathbf{B}_i$ of MA and the semantic element $\mathbf{B}^j$ of V

$f_{i,j} = \|\mathbf{B}_i \ominus \mathbf{B}^j\| \, , \mathbf{B}_i = [\boldsymbol{p}_p \;\; \boldsymbol{a}_{p,q} \;\; \boldsymbol{p}_q], \mathbf{B}^j = [\boldsymbol{p}^r \;\; \boldsymbol{a}^{r,s} \;\; \boldsymbol{p}^s]$

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

$\|\mathbf{B}_i \ominus \mathbf{B}^j\| = |\boldsymbol{p}_p||\boldsymbol{p}_p - \boldsymbol{p}^r| + |\boldsymbol{a}_{p,q}||\boldsymbol{a}_{p,q} - \boldsymbol{a}^{r,s}| + |\boldsymbol{p}_q||\boldsymbol{p}_q - \boldsymbol{p}^s|$

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

$\mathbf{B}_i \circledast \mathbf{B}^j = \boldsymbol{p}_p \cdot \boldsymbol{p}^r + \boldsymbol{a}_{p,q} \cdot \boldsymbol{a}^{r,s} + \boldsymbol{p}_q \cdot \boldsymbol{p}^s$

TODO: finish this

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:

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

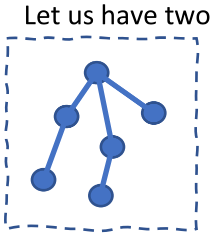
Here $I_i, i = 1,2, \dots, k$ are identity matrices which represent the regions of interest in the semantic signature matrix of V to the match seeking particle MA.

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

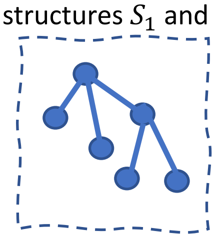
$$sreg(MA, V) = sfil(MA, V) \times ssig(V)$$

Between two semantic structures

Let us have two semantic structures S_1 and S_2.



S_1



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