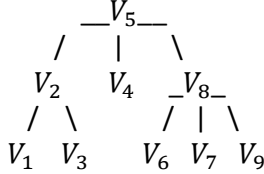


The Signature of Semantic Structures

Let us have the compound particle V_{comp} represented by its elementary particle sequence and semantic tree $stree(V_{comp})$:

$$V_{comp} = [V_1 A_1 V_2 A_2 \dots V_9 A_9]$$

$$stree(V_{comp}) =$$



The property tree for each V -particle $V_k, k = 1..9$ are given with the algebraic notation discussed in [Semantic Tree Operations](#).

$ptree(V_k) = \sum_{k \in \mathfrak{T}(V_k), i \in \mathbb{P}(V_k)} (\mathbf{k}, P_i)$. Here \mathbf{k} denotes the path $(k_{l_1}, k_{l_2}, \dots, k_{l_h})$ constructed by branching consecutively along the k_{l_1} -th branch from the top level, then the k_{l_2} -th branch from the lower level and finally k_{l_h} -th branch from the h -th level. The set $\mathfrak{T}(V_k)$ denotes the set of all paths from the root to a leaf in the property tree of V_k . The set $\mathbb{P}(V_k)$ denotes the indices of the vertices in the property tree of V_k .



Expressing the property tree of V_1 with the algebraic notation discussed earlier:

$$ptree(V_1) = \sum_{k_j \in \mathfrak{T}(V_1), i \in \mathbb{P}(V_k)} (k_j, P_j)$$

Similarly, $ptree(V_2)$ is given with

$$ptree(V_2) = (1, P_0) + (k_1, P_1) + (k_2, P_2) + (k_3, P_3) + (k_4, P_4) + (k_5, P_5) + (k_3 k_1, P_6) + (k_3 k_2, P_7) + (k_5 k_1, P_8) + (k_5 k_2, P_9) + (k_3 k_1 k_1, P_{10})$$

Here P_0 is $text(V_2)$.

Now if we expand the property trees for each V -particle in the semantic tree for the composite particle V_{comp} we will have a larger augmented property tree. This augmented property tree represents the semantic structure of V_{comp} and can be recorded in a matrix form which is the semantic signature of V_{comp} . The semantic signature matrix of V_{comp} will have the following structure:

$$ssig(V_{comp}) = \begin{pmatrix} P_0 \\ A_{0,1} \\ P_1 \\ P_0 \\ A_{0,2} \\ P_2 \\ P_0 \\ A_{0,3} \\ P_3 \\ \vdots \\ P_p \\ A_{p,q} \\ P_q \end{pmatrix}. \text{ Here } A_{0,1} \text{ denotes the arc between property } P_0 \text{ and property } P_1. A_{p,q} \text{ denotes}$$

the arc between property P_p and P_q . Let us denote the number of rows of $ssig(V_{comp})$ by N and number of columns by M .

The semantic signature matrix $ssig(V_{comp})$ can be decomposed as a sum of two intrinsic structural matrices – property signature matrix $psig(V_{comp})$ and connectivity signature matrix $csig(V_{comp})$:

$$ssig(V_{comp}) = psig(V_{comp}) + csig(V_{comp})$$

$$psig(V_{comp}) = \begin{pmatrix} P_0 \\ 0 \\ P_1 \\ P_0 \\ 0 \\ P_2 \\ P_0 \\ 0 \\ P_3 \\ \vdots \\ P_p \\ 0 \\ P_q \end{pmatrix}, \quad csig(V_{comp}) = \begin{pmatrix} 0 \\ A_{0,1} \\ 0 \\ 0 \\ A_{0,2} \\ 0 \\ 0 \\ A_{0,3} \\ 0 \\ \vdots \\ 0 \\ A_{p,q} \\ 0 \end{pmatrix}$$

Here are some interesting properties of $ssig(V_{comp})$:

The number of rows N in $ssig(V_{comp})$ is $3 \times$ the number of arcs in the augmented property tree of V_{comp} .

The rank of