

## On the signature matrix of semantic property

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### Notation

$L$  : the number of semantic dimensions

$K$  : the number of semantic dimensions in a property represented as  $K$ -polytope

$N$  : number of semantic aspects in a property

$\mathcal{P}$  : set of points forming the  $K$ -polytope of a semantic property

$A_i$  : denotes the  $i$ -th semantic aspect of a semantic property

$P_i$  : denotes semantic property

$V_i$  : denotes primitive semantic particle

$\vec{r}_c$  : in the context of a property: the center of mass of the property

In the context of an ensemble of properties: the center of mass of the ensemble

$\vec{p}_i$  : In the context of a property: semantic position of the aspect  $A_i$

In the context of an ensemble of properties: the center of mass of the property

$l_i$  : the type of the aspect  $A_i$

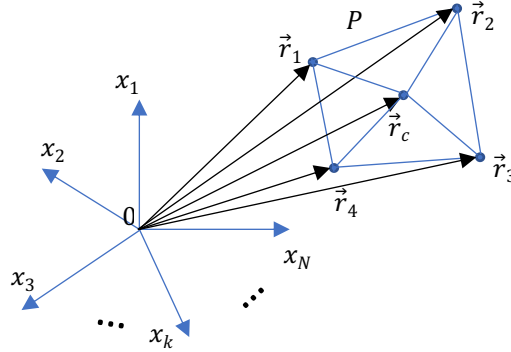
$\theta_j$  : angle between the current aspect and semantic axis  $x_j$

$\Theta$  : a vector with all angular coordinates of the current aspect to the semantic axes

$$\vec{r}_c = \frac{\sum_{i=1}^{|\mathcal{P}|} m_i \vec{r}_i}{\sum_{i=1}^{|\mathcal{P}|} m_i} \quad (1)$$

If  $m_l = m = \text{const}$

$$\vec{r}_c = \frac{\sum_{i=1}^{|\mathcal{P}|} \vec{r}_i}{|\mathcal{P}|} \quad (2)$$



$$\vec{p}_i = \vec{r}_i - \vec{r}_c \quad (3)$$

$$\vec{p}_i = \left(1 - \frac{m_i}{\sum_{l=1}^{|\mathcal{P}|} m_l}\right) \vec{r}_i - \sum_{j=1, j \neq i}^{|\mathcal{P}|} \frac{m_j}{\sum_{l=1}^{|\mathcal{P}|} m_l} \vec{r}_j \quad (4)$$

With  $\hat{m}_i = \frac{m_i}{\sum_{l=1}^{|\mathcal{P}|} m_l}$  we write:

$$\vec{p}_i = (1 - \hat{m}_i) \vec{r}_i - \sum_{j=1, j \neq i}^{|\mathcal{P}|} \hat{m}_j \vec{r}_j \quad (5)$$

In a matrix form:

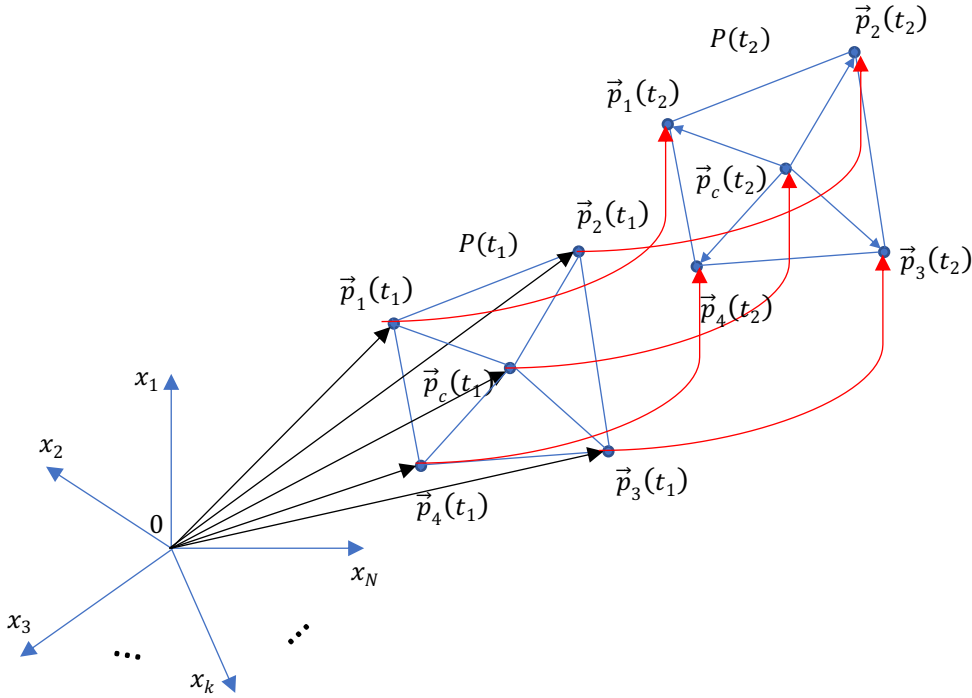
$$P = \begin{bmatrix} 1 - \hat{m}_1 & -\hat{m}_2 & \cdots & -\hat{m}_N \\ -\hat{m}_1 & 1 - \hat{m}_2 & \cdots & -\hat{m}_N \\ \vdots & \vdots & \ddots & \vdots \\ -\hat{m}_1 & -\hat{m}_2 & \cdots & 1 - \hat{m}_N \end{bmatrix} \begin{Bmatrix} \vec{r}_1 \\ \vec{r}_2 \\ \vdots \\ \vec{r}_N \end{Bmatrix} \quad (6)$$

or succinctly

$$P = MX \quad (7)$$

$$\text{where } M = \begin{bmatrix} 1 - \hat{m}_1 & -\hat{m}_2 & \cdots & -\hat{m}_N \\ -\hat{m}_1 & 1 - \hat{m}_2 & \cdots & -\hat{m}_N \\ \vdots & \vdots & \ddots & \vdots \\ -\hat{m}_1 & -\hat{m}_2 & \cdots & 1 - \hat{m}_N \end{bmatrix} \quad X = \begin{bmatrix} x_{1,1} & x_{1,2} & \cdots & x_{1,L} \\ x_{2,1} & x_{2,2} & \cdots & x_{2,L} \\ \vdots & \vdots & \ddots & \vdots \\ x_{N,1} & x_{N,2} & \cdots & x_{N,L} \end{bmatrix} \quad (8)$$

While  $P$  is traversing the semantic space each aspect  $A_i$  retains its properties – this means that each  $\vec{p}_i$  is invariant when  $P$  traverses semantic space. That is -  $l_i$  and  $\theta_i$  remain constant.



The last statement, obviously, implies that there does not exist inverse matrix  $M^{-1}$  as the set of  $N \times N$  matrices  $X$  which map to a given matrix  $P$  is a continuum.