Semantic Templates and Semantic Functions

D. Gueorguiev 5/9/2022

Semantic Functions

Semantic Functions will be denoted with small cap Greek letters capturing the semantics of the specific function such as the *Action function* δ (from Greek δράση for *Action*).
Real valued Semantic function $\varphi\colon \boldsymbol{\Sigma} \to \mathbb{R}$ is function defined on semantic space $\boldsymbol{\Sigma}$ and having a value on the real axis $\mathbb{R}$. Every object in semantic space is represented by its semantic signature.

Semantic Action Functions

What is a Semantic Template?

Every Semantic Template is represented by an incomplete semantic structure which contains missing substructures (i.e. *compound semantic particles*) and/or missing *primitive semantic particles* and/or missing *semantic property particles*. The place of each missing particle is occupied by a relevant *replacement particle* which contains properties generating the necessary binding force and has an appropriate semantic mass which match the position of the particle in the semantic template. The Semantic Templates will be denoted capital fraktur letters ($\mathfrak{T}$, $\mathfrak{P}$, $\mathfrak{I}$, …) subscripted with an index appropriately. The constructs within the Semantic Templates will be denoted with capital Latin letters $M(\mathfrak{T})$, $I(\mathfrak{T})$ where the fraktur letter inside the parentheses indicates the template those constructs are part of. The various semantic spaces such regular semantic space and template space will be denoted with capital Greek letters $\boldsymbol{\Sigma}$, $\mathbf{T}$ subscripted with index appropriately.

Depending on what is being matched we divide all Semantic Templates into two categories – *Logical Semantic Templates* and *Physical Semantic Templates*. With Logical Semantic Templates we are matching **only** traits of the semantic signature within the specified Semantic region. With Physical Semantic Templates we are matching **any physical properties** pertaining to the structures and particles within the specified Semantic region.

Every Semantic Template $\mathfrak{T}$ consists of two constructs – *pattern matching construct* $M(\mathfrak{T})$ and *inference construct* $I(\mathfrak{T})$.

Definition: *Centroid of Semantic Template*: represents the mass center of the template structure using the semantic masses of the replacement particles.

Definition: *Regular Semantic Space (or just Semantic Space)*: Semantic space of dimension L which is populated with the semantic structures created by parsing external constructs or by inference. Denoted with $\boldsymbol{\Sigma}$.

Definition: *Semantic Template Space (or just Template Space)*: Pattern-matching structures exist in a space having the same number of dimensions L as regular semantic space. The template space is parallel to *regular semantic space*. Denoted with $\mathbf{T}$ (tau). Unlike regular semantic space the *template space* is populated with incomplete semantic constructs in which the missing particles (properties, primitive semantic particles, compound semantic particles) are replaced by *template particles*. Each semantic template $\mathfrak{T}$ is associated with a region $\mathfrak{A}(\mathfrak{T})$ (region of *applicability*) of regular semantic space $\mathbf{\Sigma}$ in which the template is valid. To be precise, $\mathfrak{A}(\mathfrak{T}) \subset \mathbf{\Sigma}$ is a region in which its centroid $C(\mathfrak{T})$ is allowed to be positioned without violating the applicability condition of $\mathfrak{T}$. Obviously, this region changes with the elapsed time as the semantic structures of interest (relevant semantic context) move through $\mathbf{\Sigma}$.

Definition: *Template Inference Space* (or just *Inference Space*):
Denoted with $\mathbf{I}$ (*iota* Greek). Has the same number of dimensions L as regular semantic space $\mathbf{\Sigma}$.

Definition: *Intermediate Space Stack*:
A countable set of Semantic Space sheets each of which is parallel to $\mathbf{\Sigma}$ used to facilitate the template matching and inference. In a sense it plays the role of a semantic scratch pad. Each semantic sheet has the same number of dimensions L as regular semantic space $\mathbf{\Sigma}$. Each semantic sheet is denoted with $\mathbf{\Sigma}_{\boldsymbol{\alpha}}$ where $\boldsymbol{\alpha}$ is the sheet index.

Definition: *Virtual Semantic Space*. Denoted with $\mathbf{E}$ (from εικονικός Greek *pretend*, *mock*)
Has one more dimension $L+1$ than regular semantic space $\mathbf{\Sigma}$. Introduced to facilitate semantic computations.
All defined so far semantic spaces <u>except</u> regular semantic space $\mathbf{\Sigma}$ will be considered part of the virtual semantic space. Thus $\mathbf{\Sigma}_{\boldsymbol{\alpha}} \subset \mathbf{E}$, $\mathbf{I} \subset \mathbf{E}$, $\mathbf{T} \subset \mathbf{E}$.

Definition: *Semantic Template*: It is a semantic relation which maps a semantic structure from semantic space $\mathbf{\Sigma}$ to new *non-empty* semantic structure from $\mathbf{\Sigma}$ if the pattern matching region $\mathfrak{P}(\mathfrak{T})$ has been matched to some semantic structure S from $\mathbf{\Sigma}$ or it is the empty semantic structure [] if no match is found.

Definition: *Centroid and Radius of Semantic Template*: *Centroid* is the current point C in Semantic Space where the pattern matching construct $M(\mathfrak{T})$ is centered thereby assuming *Radius (or Range)* R. The centroid of the pattern-matching construct is mapped to a point in regular semantic space indicating the possible location of the root node of the semantic structure S which will be pattern-matched by $M(\mathfrak{T})$. Let us denote with $O(\mathfrak{T}, C, R)$ the semantic output of the pattern matching region centered in C with radius R. The structures of $O(\mathfrak{T}, C, R)$ will be created in one of the semantic sheets $\mathbf{\Sigma}_{\boldsymbol{\alpha}}$.

Definition: *Matching of Semantic Template*: the centroid of the pattern matching construct $M(\mathfrak{T})$ moves within the region of applicability $\mathfrak{A}(\mathfrak{T})$ in Semantic Template Space $\mathbf{T}$. When the semantic latch μ associated with $\mathfrak{T}$ is triggered the centroid of $\mathfrak{T}$ is affixed to the point which has triggered the latch. The radius of the pattern matching region starts expanding until *optimal match* is selected. For definition of optimal match refer to Pattern Matching Structure of Semantic Template.

Pattern Matching Structure of Semantic Template

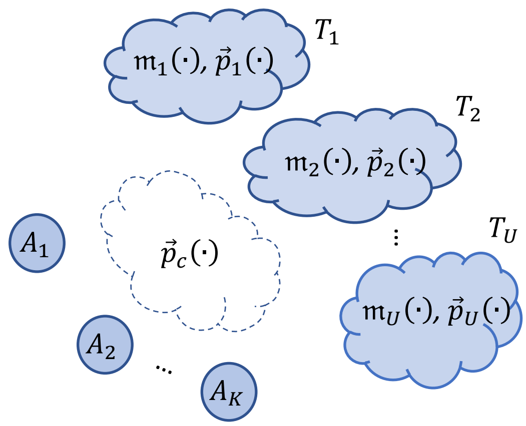
The pattern matching construct $\mathfrak{P}(\mathfrak{T})$ of any template $\mathfrak{T}$ is represented by a semantic tree T in which every node is one of the three:

a) semantic structure S
b) primitive semantic particle V
c) template particle X

Template Particles

A template particle can be viewed as ~~a statistical distribution~~ stochastic generalization of regular semantic particles.
We will consider template property particles and template semantic particles

Definition: *Template property particle*: we have a set of given aspects $A_1, \dots, A_K$ and at least one *cloud* of unknown aspects which are characterized by their mass constraints and their location constraints. Let us denote the cloud of unknown aspects with T.



Definition: Optimal Match of The Pattern Matching Region

Inference Structure of Semantic Template

Example of Semantic Template: Calculation of attractive force between semantic structures

Let us consider a newly formed semantic structure S_1. The closest semantic structure will be denoted with S_0. On aggregation level l the nearby semantic structure S_0 can be represented as a graph of n_l substructures.