The Foundations of Semantic Simulation

D. Gueorguiev , 12/29/24

# Notation

denotes *Semantic Space*

denotes a point in *Semantic Space*

(Capital Latin letters) denotes *Semantic Structure*

(Capital Script Latin) denotes sets in general and sets of Semantic Structures

with subscripts denote *Semantic Particles*

# Introductory Notes on Semantic Structures

**Definition**: *Semantic Structure* is a set of semantic particles in Semantic Space which are sufficiently close. More formally, the set of semantic particles are considered -close with respect to some norm in if for each

# Modeling dynamic semantic distance via the dynamical evolution of Semantic Structures

The motion and the mutual positions of structures in semantic space are determined by the equations of evolution of the structures. Because the semantic structures are always in motion the distance between any two structures depends on the evolution of their positions in semantic space. Thus the semantic distance between any two structures and , denoted with , is a dynamic quantity.

There are two mechanisms which will influence the aggregation and dispersal of Semantic Structures:

* *association / dissociation links* which exert forces on small scales and help rearranging the mutual positions of semantic structures which are close enough to each other.
* *semantic energy field* which is subjected to tiny local alterations based on past inferences triggered by semantic structures passing through those semantic locations.

The goal of the simulation is to prove that the semantic distances between structures do not contradict the prescribed meaning of the latter. In other words the result of the simulation without further input should be a resultant steady state which will represent accurately the semantic meanings of the words.

For this purpose let us introduce the following definitions:

**Definition**: *Semantic context*

The semantic structures enclosed in a given region of semantic space. The region does not need to be simply connected. In order a semantic structure to be **in** region of semantic space it needs to be enclosed by in its entirety – that is, there should be no substructure which is outside of .

Let us consider the countable set of semantic structures . Let represents a region of semantic space which contains structures with sufficiently higher *semantic mass* (abbrev. ) than those in . We denote this assumption with . Note, that may be entirely included in , entirely outside of or a part of may be in . Let us consider the semantic structures in and allow those structures to co-evolve with the structures in . In such scenario when the set evolves over time given only the set we say that is given *in* (or *relative to*) the context . We denote the aggregate semantic structure given in the context of with the notation .

**Definition**: *Semantic meaning* of a set of semantic structures in a context

Let us consider a countable set of semantic structures . Each structure is represented by its semantic signature . Let denote an arbitrary semantic structure taken from .

*Semantic meaning* of the set in the context is an ordered set of chains which is created in the following way:

Let us denote with the total order induced by the numerical comparison operator applied to the semantic distance on the set for a given . Then the pair , defines a chain which we will denote using the notation . We denote with the length of . We denote with the semantic structure composed by the structures in in the context . Then for each we can compute and can order the sets by how close each one of them is to . Therefore we can order the chains for each . We will denote with the *aggregate chain* composed of the ordered set of chains .

Two structures and have the same (semantic) meaning in the context if each of them induces the same aggregate chain .

Let and .

# References

[1]

[2]