# On the need of Dynamic Simulation when modeling attractive and repulsive forces in Semantic Structures

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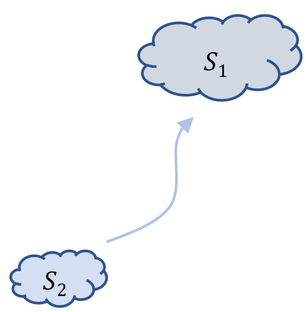
*The machine was all glass retorts and valves and delicately balanced see-saws. Tinted fluids represented different market pressures and financial parameters: interest rates, inflation, trade deficits. The machine sloshed and gurgled, computing ferociously difficult integral equations by the power of applied fluid dynamics. It had enchanted her. She had remade the prototype, adding a few sly refinements of her own. But though the machine had provided some amusement, she had seen only glimpses of emergent behaviour. The machine was too ruthlessly deterministic to throw up any genuine surprises.*
From "*Redemption Ark*", Chapter 7, Alastair Reynolds, 2002

## Dynamic vs Static modeling of the behavior and interactions of Semantic Structures

### What is Static Modeling of the Semantic Structures behavior?

Static modeling implies that we do not model *the time* and we do not have *time coordinate* in our models of the interactions of Semantic Structures. We do not have explicit or implicit *time dependence* in any of our relations and the concept of *passed time* is devoid of meaning.
This brings a simplicity to our models as all adjustments in the positions and the interactions between Semantic Structures are instantaneous. For instance, suppose we have an existing semantic structure $S_1$ which is located on a particular position in Semantic Space. We have just constructed another semantic structure $S_2$ and we would like to evaluate how much it will displace $S_1$ and in which direction.




One can use a static model to calculate what will be the new position of $S_1$ and $S_2$ given their total mass and given the fact that there are
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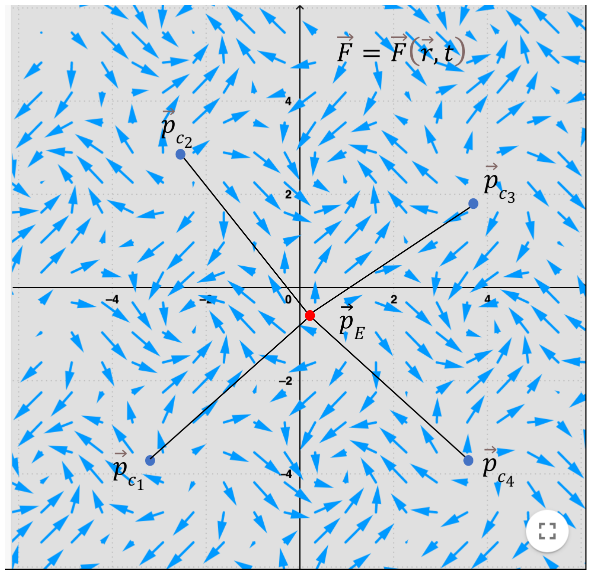
### Introducing Dynamic Model of Semantic Structures behavior

In the Dynamic models for Semantic Structures we define the concept of *time* in semantic space. We also define the vector *velocity* of a semantic particle/structure. We will use both time and velocity to determine the exact time and the amount of interaction between semantic structures which will take place at some future moment.
Let us define a $L$-dimensional vector field $\mathfrak{F}$ in $L$-dimensional semantic space. This field will have an effect of the semantic particles in such a way that it will apply an additional momentum to the particle

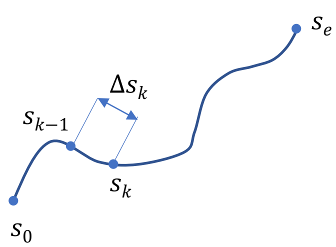
which will be proportional to the travel path of the particle and to the strength and orientation of $\mathfrak{F}$. Let us denote by $\vec{f}$ a vector from the field $\mathfrak{F}$ at position $\vec{r}$ and time $t$:

$$\vec{f} = \vec{f}\,(\vec{r}, t) \qquad (1)$$

For instance, let us consider an ensemble of four properties $P_i, i = 1..4.$ which are not in their bound state positions but in some general positions.




One could think of the vector field $\vec{f}\,(\vec{r}, t)$ as a Force field distributed along the travel path of a semantic particle. The path of any semantic particle in Semantic Space can be expressed in terms of its natural coordinate $s$. On the Figure below it is shown the path of a particle with starting point $s_0$. Let us denote




with $t_0$ the moment of time in which the particle has been at position $s_0$. The particle is in position $s_{k-1}$ at a moment $t_{k\text{-}1}$, it is in position $s_k$ at a moment $t_k$ after traveling $\Delta s_k$ and finally it ends up in position $s_e$. Let us write the recursive relation between two consecutive positions denoted with $k-1$ and $k$ accordingly. Since we are creating a dynamic model which includes a time dependence in each model parameter we are no longer going to use subscripts to denote the positions but rather will use the functional dependence $(\cdot)$ to indicate implicit time dependence for every model parameter. With that note in mind the recursive relation for two consecutive positions given in their natural coordinates $s(k-1)$ and $s(k)$ become:

$$s(k) = s(k-1) + \Delta s(k)$$

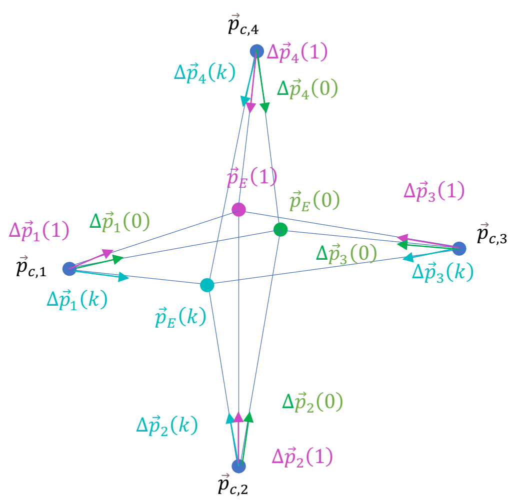
In case of a property $P$ travelling toward its bound state we will have:

$$E_P(k) = E_P(k-1) + \sum_{j=1}^{N(P)} \vec{f}\left(\vec{p}_j(k-1) + \Delta\vec{p}(k), l_j\right)\Delta\vec{p}(k) \qquad (2)$$

Here $N(P)$ represents the number of semantic aspects in $P$. The vector in semantic space $\vec{p}_j(k-1)$ represents the position of the aspect $A_j(P)$ in a previous time moment $t_{k-1}$

If we denote with $\vec{p}_c(k)$ the position of the property $P$ centroid and with $\vec{p}_E(k)$ the position of energy weighted center of the ensemble $V$ at time $t_k$ we have:

$$\Delta\vec{p}(k) = \frac{\vec{p}_E(k) - \vec{p}_c(k)}{|\vec{p}_E(k) - \vec{p}_c(k)|}\Delta s(k) \qquad (3)$$

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