The Human Social Distance and its Dynamics

Petr Kloucek[1], Armin von Gunten[2]

[1]CAMPsyN, SUPPA, Hôpital de Cery, Route de Cery, CH-1008 Prilly, Lausanne, Switzerland; e-mail: petr.kloucek@iCloud.com

[2]SUPPA, CAMPsyN, Hôpital de Cery, Route de Cery, CH-1008 Prilly, Lausanne, Switzerland; e-mail: Armin.Von-Gunten@chuv.ch

Keywords: Behavioural complexity, physiological and behavioural surrogate, Lagrangian of behavioral, mental and environmental data, self-similar normally distributed precesses, Hurst index, behavioural reactivity, behavioral entropy, mental entropy.

Abstract

A Lagrangian based on behavioral and mental time-series combined with environmental impacts is presented. The underlying Euler-Lagrange equations then provide a measure of social distance and its dynamics. The behavioral time-series are computed using objective sensory surrogate data. The mental time-series are computed using AI based on subjective data. The environmental impacts are modeled by density of population, space topology and temperature. Consequently, we solve the Least Action optimization problem

$$\min \int_0^t L\left(\{\mathcal{X}^p(t)\}_{i=1}^n, \{\mathcal{Y}^p(t)\}_{j=1}^m, f(\mathcal{A}[m^2]/\mathbb{N}(t), \mathcal{A}[m^2], T(t)[^\circ C]), t\right) \tag{1}$$

where $f(\mathcal{A}(m^2)/\mathbb{N}(t)), A, T)$ is a description of an environment in terms of population density $A/\mathbb{N}(t)$ at time t, the environment area A and temperature T, for $n, m > 1, p > 1$. The flocking dynamics is given by solving Euler-Lagrange equations

$$-\frac{\partial}{\partial t} L(\cdot,\cdot,\cdot) + \frac{\partial}{\partial \mathbb{Z}} L(\cdot,\cdot,\cdot) = 0 \tag{2}$$

where $\mathbb{Z} = \{\mathcal{X}, \mathcal{Y}\}$. Initial condition and a boundary conditions are prescribed.

Corresponding author: Petr Kloucek, petr.kloucek@iCloud.com

The Lagrangian, similar the Second Newton's Law Lagragian, is given by

$$L \overset{\text{def}}{=} \frac{1}{2}\tau(t)\,\|\mathcal{Y}(t)\|^2 - \phi(t), \qquad \text{where} \tag{3}$$

$\tau(\cdot)$ is a geometric mental index given by

$$\tau(\mathcal{X};\gamma) \overset{\text{def}}{=} \frac{\text{meas}\left(\bigcup_{j\geq 1}\Omega_j^+\right)}{\text{meas}(\Omega)} \in [0,1], \qquad j>1. \tag{4}$$

The time-sequence $\mathcal{X}$ is based on subjective data, and γ represents a mental binary perceptron. The subdomains Ω_j^+ are computed using different AI strategies finding a hyperplanes separating mental phase space given by $\gamma = 1$ from the subdomains characterized by $\gamma = -1$.

The coarse-grained behavioral surrogate sensory data, $\mathcal{Y}$, are based on complexity analysis using the Hausdorff-Besicovitch non-integer dimension.

The environmental potential, ϕ, is given by

$$\phi(t) \overset{\text{def}}{=} \int_0^t \frac{|\mathcal{A}|^2}{\mathbb{N}(t)}\frac{1}{T(t)}\,dt. \tag{5}$$

The social dynamics is given by a weak solution, when differentiable, of

$$\mathbb{Z}_t(t) + H(D\,\mathbb{Z}(t)) = 0, \tag{6}$$

where H is the the Hamiltonian corresponding to the Lagrangian by $H = L^*$.

The social distance at time t is defined by

$$\|\mathbb{Z}(t)^p - Z(t)^q\|, \qquad p \neq q > 1 \qquad \text{p, q resent different subjects,} \tag{7}$$

with $\mathbb{Z}$ solving (6).

Examples based on synthetic data of normally distributed self-similar time-series representing both mental and behavioral states are provided.