

Social Robotics

PDEEC PhD course on Social Robotics

João Silva Sequeira¹

¹Instituto Superior Técnico
Institute for Systems and Robotics

Spring 2021

Additional food for thought on this simple society –an estimation problem

- Find A such that the outcome of the overall society is close to some reference r (no noise considered)

$$\min \sum_{k=k_0}^n (d_v(Ax(k)) - r)^2$$

where $d_v()$ some norm, and A is assumed constant in the interval considered

- Finding A amounts to each agent having to estimate its own outcomes and those of the other agents (in general perfect information may not assumed)

Potentially interesting questions

- How the average outcome evolves ?
- What's the biggest/lowest outcome ?
- What's the asymptotic behavior of the average outcome ?
- Is there any agent with an outcome without a bounded asymptotic behavior ?
- What's the sensitivity of the outcomes to variations in each agent ?
- Is the linear model adequate ?
- Are the weights (the importance assigned to the outcomes) adequate ?
- Is the connectivity (the relations between agents) right ?

Viability theory basics I

- Equality relations are extended to inclusions

$$\dot{x} \in F(x)$$

where x is a state vector and $F(\cdot)$ is a set-valued map

- Set-valued maps are interesting objects that can accommodate different models

The inclusion relation enables questions on trajectories that must fit wide classes of systems

- Ecological stability (in the sense of [Wiesner et al, 2019]) can be addressed in this framework (to be discussed later on the course)

Viability theory basics II

- Viability Domain (see [Aubin, 1991] for a rigorous statement)
Let f be a function mapping state and a space of motion directions, i.e., defines how system moves
If K is a subset of the state space, it is called a viability domain if $f(x)$ belongs to a set of motion directions that keep the state inside K
- Nagumo theorem (see [Aubin, 1991] for a rigorous statement)
Under assumption of compactness of K and continuity of f , K is locally viable if and only if K is a viability domain
This means that $x \in K$
- This is a powerful result as it states the conditions under which the trajectory of a system lies within a constraint set K
Nagumo theorem can be extended to complex systems, when f is replaced by a set F of motion directions

Viability theory basics III



Jean-Pierre Aubin

“Viability Theory”

Birkhäuser, 1991



K. Wiesner, A. Birdi, T. Eliassi-Rad, H. Farrell, D. Garcia, S. Lewandowsky, P. Palacios, D. Ross, D.

Sornette, K. Thébau

“Stability of democracies: a complex system perspective”

European Journal of Physics, vol 40, 2019

Cultural biases – Robots as tools



Source: (Kanda, Ishiguro, 2013)

Cultural biases – Robots as facilitators of happiness



Source: (FP6 URUS project)



Source: (FP6 URUS project)

- There are elements of happiness here that are not present in the previous slide