Modelling policy shift advocacy

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Abstract. In this paper, we propose to enrich standard agent-based social simulation for policy-making with affordances inspired by *second-order emergent social phenomena*. Namely, we explore the inclusion of agents who have means to perceive, aggregate and respond to emergent collective outcomes, for example by promoting some reaction in other agents. These enhancements are intended for a subclass of socio-cognitive technical systems that we call *value-driven policy-making systems*. We motivate and illustrate our proposal with a model of policy shift advocacy in urban water management.

Keywords: agent-based social simulation · socio-cognitive technical systems · policy-making · values · second-order emergent phenomena · socio-hydrology

1 Introduction

Agent-based social simulation (ABSS) has been shown to be an appropriate tool for policy-making [6]. Nonetheless, it has been suggested that in order to increase the usability for policy-making, standard ABSS may be enriched with some specific socio-cognitive *affordances* [12].

In this spirit, we proposed to afford some type of ethical reasoning and means to foster and assess moral behaviour [14]. The rationale being that, on the one hand, policy-makers draw on their political views and principles to design a policy intended to bring about a better state of the world, and deploy policy instruments that are consistent with such aim; and, on the other hand, those agents who are subject to such policy act according to their own values, interests and motivations [17,3].

With this understanding in mind, we characterised a type of agent-based simulators of public policies as a subclass of socio-cognitive technical systems [10],

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that we called *value-driven policy-making systems*. They involve *values* as a first class notion, and propose their operationalisation through *policy-schemas*, which consist of sets of *policy means* and *policy ends* [14].

In this paper, we extend that work with an affordance that we find specially relevant in some policy domains; namely, means to perceive emergent collective outcomes and react by gathering social support for a response to that outcome. This affordance is inspired by the notion *second-order emergent social phenomena* [12,4]. To illustrate our proposal, we model the management of urban water and, more specifically, the interplay between influential stakeholders (e.g. political factions) and their target groups (households) in the process of advocating policy changes.

For these purposes, we start with a brief overview of our previous work and the type of second-order emergent social phenomena simulation we propose (Sec. 2). In Sec. 3 we propose the core components that extend our original conceptual framework for simulation of second order emergent phenomena. In Sec. 4 we outline a model for policy change advocacy in urban water management that shows how to instantiate the enhanced framework and discuss some simulation results. We close with remarks on further work (Sec. 5).

2 Background

1. Values. We assume a cognitive notion of value to model value-based reasoning for individuals, and value-based assessment of a state of the world [9,13,8,16,18]. Thus, we assume that values have the following properties [16]:
(P1): Values are beliefs;
(P2): Values refer to desirable goals;
(P3): Values serve as standards or criteria;
(P4): Values are ordered by importance;
(P5): The relative importance of multiple values guides action;
(P6): Values transcend specific situations.

In order to make these ideas operational (in a simulator), we assume a *consequentalist* view of values —values are known by their consequences and observable. In order to formulate assessments (and decisions) that involve several values we assume **commensurability**.

2. Socio-cognitive technical systems (SCTS) are situated, on-line, hybrid, open regulated multi-agent systems [10]. They are composed by two first class entities: a *social space* and participating *agents*, who have socio-cognitive (opaque) decision models that guide their actions. One may characterise subclasses of SCTS by postulating a meta-model that supports some specific affordances. Two remarks on this:

(i) The key idea is that an *instantiation* of a metamodel produces a formal or abstract *model* of a SCTS that belongs to that subclass [10] (see [2] for examples of metamodels).
(ii) An *affordance* is a property of the SCTS (of individual agents, of groups of agents or of social space) that supports effective interactions of agents

within an SCTS. All SCTS require three affordances: (a) *Awareness*, which provides participating entities access to those elements of the shared state of the world that should enable them to decide what to do; (b) *Coordination*, so that the actions of individuals are conducive to the collective endeavour that brings them to participate in the SCTS; and (c) *Validity*: the simulated world is a correct implementation of a model of the world, that is, the model is a faithful representation of the relevant part of the world and the simulated behaviour corresponds with the actual behaviour.

In a previous work [14], we proposed to model *value-driven policy-making systems* (*VDPMS*) as a sub-class of *SCTS* where values play a fundamental role in the regulation of the social space and in the decision-making of agents. We postulated a core meta-model whose main constructs are (Fig. 1):

(i) A **domain ontology** (like in any other SCTS) that establishes primitive entities that define the state of the world, actions and events that change that state. In simple terms, we assumed that policy-making occurs in a particular domain, that contains the relevant part of the world, within a social, environmental, economic context.
(ii) A **social model** containing at least two *agent roles*: (a) *policy-makers*, who aim at improving the state of the social space and institute means and ends in order to govern the activity of other agents; and (b) *policy-targets*, who are those that are affected by the policy, and whose behavioural change is going to drive the system towards that desirable state.
(iii) A (cyclic) **performative structure** involving a policy-design subprocess and other interrelated sub-processes like, negotiation, enactment, monitoring, assessment and revision.
(iv) The *policy-schema* data structure, composed of *means* —that aim to produce that behavioural change on policy-targets— and *ends* —that define those desirable world-states.
(v) A **policy schema** formed by a set of policy means (norms, incentives, actions, messages) and ends (goals that the policy means are meant to achieve).
(vi) A **value model**, consisting of a finite set of *values* ($\mathcal{V}$) and a *value profile* for each agent. A value profile includes a subset of $\mathcal{V}$ and a *value aggregation model* that the agent uses to assess the state of the world and make decisions. Values are projected onto the *policy-schema*, and *value aggregation models* are based on factual indicators.

3. Second order emergence social phenomena (*EP2*) refers to the idea that agents may recognise an emerging macro-phenomenon and, as a consequence, they intentionally react to it (support, change or contest) [4,15,12]. Castelfranchi [4] approached *EP2* as the *cognitive emergence* of the macro-phenomena in the agent's mind (i.e. recognition of the phenomena), and afterwards a process of *cognitive immergence* that changes its behaviour (i.e. consequential adaptation of the behaviour). He discusses examples where the awareness of the phenomenon can promote or discourage it, as, for instance, urban segregation: an agent, who wants to stay close to agents with similar cultural

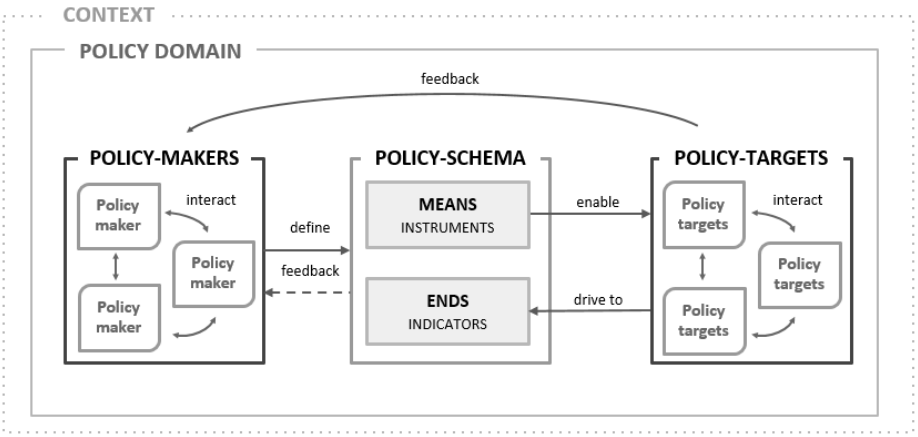


Fig. 1: Distinctive features of policy-making as a *value-driven socio-cognitive system* [14]

background, realises that the territory is becoming shared with agents with different cultural background, and as a consequence, its goal is to actively oppose new-coming residents in that territory.

In [12] it was discussed how to refine the class of SCTS in order to capture *EP2* features. In particular, *generic* affordances to support the simulation of *EP2* (in general), and affordances that are *specific* for a cognitive model of reputation.

3 An enhanced conceptual framework for modelling policy shift advocacy

We want to enhance the core metamodel for value-driven policy-making systems (*VDPMS*), that we described in the previous section, with affordances for modelling some emergent second order social phenomena (*EP2*). More specifically, we want to model the processes through which some stakeholders seek support for initiatives that may affect the social space and specifically a current policy schema.

For instance in a *context* of a neighbourhood gentrification, an *influential* association of tenants may perceive a degradation of *conviviality* caused by an increase in the number of bars and the influx of tourism. The association *identifies* an "increase of police force" as a solution, and asks *households* to endorse it because it would increase *security*. If enough neighbours endorse the demand, the tenants association moves the proposal to the city government.

We propose to extend the core metamodel with the following elements:

(i) **EP2 perception**. That is, the generic affordances defined in [12] that enable an agent to perceive, assess and react to an emergent phenomenon.

(ii) **New actions**:

   (a) **formulate initiative**: broadcast an initiative to a group of policy-subjects
   (b) **process an initiative**: decide to endorse or not the demand, taking the appeal into consideration.
   (c) **support a demand**: express the endorsement of a demand
   (d) **move demand**: present a demand to a policy-maker
   (e) **enact demand**: modify the current policy-schema to accommodate the demand;
(iii) **New data structures**:
   (a) **Initiative** consists of a *demand* and an *appeal*
   (b) **Demand** is a change to the current policy-schema (actions, norms, incentives, campaigns)
   (c) **Appeal** a set of factual indicators and indexes, and an evaluation model.
(iv) **New roles**
   (a) **Policy-influencer**, who has EP2 perception and is capable to formulate initiatives and move and enact demands.
   (b) **Policy-target**, who is capable of evaluating an initiative and support a demand.

The key ideas are:

a. *Policy-influencers* are political stakeholders in the domain —with their own values and goals— and perceive and evaluate the world-state at the macro-level.
b. *Policy-targets* are not necessarily able to perceive emergent phenomena, but are capable of evaluating the state of the world at the macro-level since they have ethical and political interests.
c. *Policy-targets* may have no access to aggregated data but they may receive it, from *policy-influencers* and other sources, and then evaluate and react to it. *Influencer*'s opinion and information is more acceptable if it shares the values and the interests of the *policy-target* (i.e. the *policy-subject* is biased to consider the *policy-influencer* to be more trustworthy).

The rationale is that most citizens do not have enough resources (e.g. time, attention, motivation, economic, technical, etc.) to process and reason about data and information that concern macro-scales in multiple domains [1]. Nonetheless, citizens still participate in the political world. Usually, they retrieve information from trusted influential stakeholders that are capable of observing emergent macro-phenomena (e.g. gentrification, demographic change, water use trends, etc.). These *policy-influencers* are usually collectives (e.g. mass media companies, NGOs, think tanks, political parties, interest groups, social movements, etc.) that, if are displeased with the state of the world, may advocate for policy shifts, in order to imbue their values into public policies.

Agents use their *value aggregation models* to evaluate the state of the world and define their political satisfaction. Agents assess the current state of the world by comparing it with desired states. With this in mind, dissatisfaction

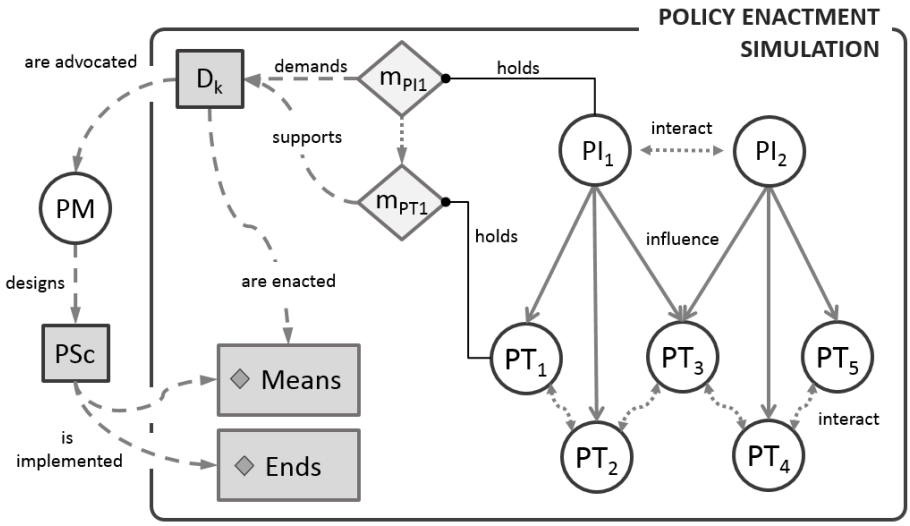


Fig. 2: Diagram of policy-influencers raising political demands for producing policy shifts as a consequence of the policy enactment

with the current political situation may motivate political participation [11]. *Policy influencers* use their own value aggregation model to generate the appeals that are sent to *policy-target* agents, who then may support to produce policy shifts. It is convenient to remark that *policy-targets* may perceive the world-state indirectly through *policy-influencers*.

Presumably, *policy-influencers*' *trustworthiness* and *relevance* arise from the citizen identifying with and sharing their values (at least, those that are publicised). Eventually, the citizen trusts the stakeholder, who shares the citizen's values and has its own political agenda, provides him with *useful* information and a *sound* framing (see [7]). This view is compatible with politics driven by group identities, which are not about adherence to a group ideology, but rather emotional attachments that transcend specific situations [1].

In crude terms, we implement *social support* and *policy shifts* as follows (Fig. 2):

1. The *policy-influencer* agent PI_1 has a political evaluation model m_{PI1}, determined by a value aggregation model, that computes its political satisfaction.
2. The *policy-target* agent PT_1 "delegates" its model of political satisfaction to the *policy-influencer* PI_1. It receives m_{PI1} and adapts its own model m_{PT1} to take into account micro-level and macro-level features.
3. The *policy-target* agent PT_3 looks upon two *policy-influencers*, so it receives models m_{PI1} and m_{PI2}. It can take both for its own model m_{PT3} (e.g. by combining them, discarding one, etc.).

4. If a *policy-influencer* is not politically satisfied (that is, the *desired world-state* and the *current world-state* are different enough), it may raise *political demands* D_k.
5. *Policy-targets* may support these, depending on their own satisfaction and values —if they are displeased, they will be open to interventions that change the world-state.
6. The *policy-maker* agent PM designs a *policy-schema* PSc (i.e. *means* and *ends*) according to its values and, presumably, taking into consideration the *political demands* raised in the social space.
7. It is possible that particular demands raised by *policy-influencers* may intervene directly on the social space bypassing *policy-makers* (e.g. persuading messages to encourage *policy-targets* to adopt social norms). This can be interpreted as new, enacted *means*.
8. Eventually, an updated *policy-schema* is enacted in the social space.

4 A model of policy shift advocacy

Picture a neighbourhood of a city: each household houses a family with a certain income level, water needs, and conservation practices. There is a water utility company that supplies water, a public service that is supported by a fee. Citizens assess the service they get and may at some point want to have better conditions. Their satisfaction depends on what they believe is important (i.e. values), and they may identify some ways of intervening politically in order to increase their level of satisfaction. However, this is based not only on those variables that affect them directly, but also on some features that affect the neighbourhood as a whole. Likewise, there are other stakeholders that assess the world-state with respect to their own values and may promote adjustments in the way water is being governed. As a consequence, there may be an interaction between stakeholders and citizens to stimulate political action, which implies multiple socio-cultural aspects around water governance (e.g. values, biases, trust, power, etc.). In this sense, households are often informed by public stakeholders, who may try to get support to their political demands by persuading households —yet their success would depend on the affinity with the values of the household.

Model. We model a crude urban environment to simulate the enactment of simplistic policies in a space formed by *policy-targets* and *policy-influencers* that hold different value profiles. The point of the exercise is to exemplify the affordances to explore social support of public policies and potential policy shifts, and to illustrate the interplay between *policy-targets* (i.e. households) and *policy-influencers* (i.e. public influencers). This specification of the meta-model featuring policy shifts is summarised in Table 1.

The model represents an urban region and it is focused on the water supply public service and how its policies affect the world-state. On the one hand, citizens make use of the water supply for their basic needs, but they want the service to be managed according to their understanding of justice and welfare

Table 1: Specification of the meta-model in a simple computational model

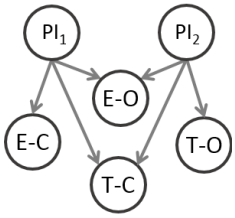
Network	Demand	Set by	Supported by	Type
	Suppress social aid	PI1	E-C, E-O	Advocacy
	Establish social aid	PI2	T-C, T-O	Advocacy
	Change management	PI1, PI2	E-O, T-O	Advocacy
	Control water use	PI1, PI2	E-C, T-C	Enacted

Table 2: Actions of households depending on the environment of intervention

Local	Political
Use water	
Adopt water conservation practices	Retrieve information
Perceive/Evaluate service	Support demands
Global assessment	

as well. On the other hand, influential stakeholders may raise political demands if they consider that the world-state is not aligned with their public values.

Agents. We consider two type of agents in the artificial society: (a) *households* (i.e. *policy-targets*) and (b) *public influencers* (i.e. *policy-influencers*). *Households* are characterised by (i) value profile; (ii) number of members; (iii) income; (iv) water use; (v) conservation practices; (vi) service satisfaction; and (vii) political satisfaction. Elements (ii–iii) are based on real-data (from the Spanish Statistical Office), (iv–vii) evolve as results of the simulation, and (i) is an input of the model. *Public influencers* are characterised by (i) value profile; and (ii) political satisfaction.

Scales and process overview. The model simulates one decade of activity through discrete time steps of one month. Each month households use water and pay the water fees, may adopt conservation practices, assess their satisfaction, and may support political demands (Table 2). Likewise, public influencers evaluate the world-state and may raise political demands (Table 3). Pre-conditions and post-conditions of these actions may depend on the values held by agents (for instance, a household may adopt conservation practices to protect the environment, while another may do so to have more wealth to spend in other goods). Spatially, the model represents an urban district.

Value profiles. Public influencers hold *public values*, that concern the public affairs of the neighbourhood as a whole, for which we use the work on Public Service Values [18]. Households hold *motivational values*, related to needs and

Table 3: Actions of public influencers depending on the environment of intervention

Local	**Political**
-	Perceive/Evaluate world-state Advocate/Enact demands Withdraw demands

goals, for which we use the Schwartz Theory of Basic Values [16], and it is recognised that they also hold *public values*, which are defined by their interaction with the public influencers. In other words, households' values play a role in defining their satisfaction model with regard to the water service at home and to the social outcome of water governance. For the sake of simplicity, values are static during the simulation.

The typologies of households are defined according to the classification of value sets in the Schwartz Theory of Values. There are two pair of opposite dimensions. On the one hand, the pair of *self-enhancement*, which focus on self-esteem and the pursuit of self-interests; and *self-transcendence*, that concern for the welfare and interests of others. On the other hand, the pair of *conservation*, which stress resistance to change, order, self-restriction, and subordination of oneself in favour of socially imposed expectations; and *openness to change*, that emphasises the independent behaviour and readiness for new experiences.

There are four typologies according to the value dimensions that are predominant in the household:

- **E-O:** *self-enhancement* and *openness to change*. *Households E-O* value *power* (i.e. social power, wealth, authority); *achievement* (i.e. ambition, influence, capability); and *self-direction* (i.e. freedom). Besides its own welfare, these households think that the service must ensure the autonomy of households (they consider it is well represented by wealth) and, then, its own (financial) sustainability.
- **E-C:** *self-enhancement* and *conservation*. *Households E-C* value *achievement* (i.e. ambition, influence, capability); *power* (i.e. social power, wealth, authority); and *security* (i.e. social order), *tradition*, and *conformity* (i.e. compliance). Besides its own welfare, these households do not want any shock or policy that can put the institutions and the public service at risk (for example, a social subsidy, that they think that may jeopardise the financial sustainability of the service).
- **T-O:** *self-transcendence* and *openness to change*. *Households T-O* value *benevolence* and *universalism* (i.e. equity, environment, social justice, peace); and *self-direction* (i.e. freedom). Focusing on the social welfare, these households think that the service must protect the access to households while ensuring the preservation of the environment.
- **T-C:** *self-transcendence* and *conservation*. *Households T-C* value *benevolence* and *universalism* (i.e. equity, environment, social justice, peace); and *security* (i.e. social order), *tradition*, and *conformity* (i.e. compliance).

These households believe that the service must provide support to vulnerable households and must not waste resources on respect to others who also need them.

There are two public influencers: *PI1*, whose values are *economic responsibility*, then *citizen autonomy*, and finally *equal treatment*; and *PI2*, whose values are *conservation of the environment*, *social justice*, and *protection of households' access to the service*.

Public influencers' satisfaction. *PI1* focuses first on the financial sustainability of the water service, that is the extent to what the service costs are covered by the water fees. When the service is financially sustainable, it examines the number of households whose utilities costs in relation to their income are significant. If the service is not sustained by the water fees, it checks whether social aid —which is a subsidised tariff for those households categorised as vulnerable— is active; in case there are many vulnerable households, it may blame that policy for hindering the sustainability of the service. *PI2* audits first the average water use of households, and then also focuses on the number of households whose utilities costs are high. In any case, a policy that establishes social aid for vulnerable households mitigates its discontent.

Notice that this illustrates that it is necessary to translate values into specific terms in the domain in order to work with them in computational models: for instance, *economic responsibility* for *PI1* is reflected by the cost recovery rate.

Households' satisfaction. Households' satisfaction is divided into two components depending on the context: *service satisfaction* (i.e. household context) and *political satisfaction* (i.e. neighbourhood context). On the one hand, households use local variables within the context of using the service at home to decide whether the water service meets their standards or not. So far, as the ABM is basic, they only perceive the impact on their budget, and evaluate the service accordingly. For more sophisticated ABMs, they could include other locally-perceivable variables as access to the service, interruption of supply, water quality, water pressure, company intrusion, etc. On the other hand, households evaluate the world-state according to the values they hold. The political satisfaction components and framing is delegated to the public influencers, as they are capable of perceiving the whole world-state. *Households E-O* and *T-C* look upon both public influencers and make an aggregation, while *households E-C* and *households T-O* take into account only one of them (*PI1* and *PI2*, respectively). Eventually, they make a mean of the two components to elicit their global satisfaction.

Political demands. Both public influencers may try to convince policy-subjects to diminish their water use by releasing information about the water use at the society level and appealing to be within a *normal* range. Notice that it is done due to different motivations depending on the public influencer (i.e. *citizen autonomy* and *conservation of the environment*, respectively). Only *households E-C* and *T-C* can support and follow this advise (because they want to abide by social norms). When the service is not financially sustainable, *PI1* may advocate for suppressing the social aid if it is active, or support to change the

management model in case it is not (e.g. privatisation or terminate the contract for the concession). In contrast, *PI2* may advocate for establishing social aid to protect vulnerable households, or even demand to terminate the contract when the protection of the environment is unacceptable. Households may support these demands depending on their value profile and their level of global satisfaction.

4.1 Simulation example: gentrification

The population starts constituted by 200 households: 25 % *households E-O*, 50 % *households E-C* and 25 % *households T-C*. Each month, households with the lowest income are forced to move out and are replaced by wealthy *households T-O*, causing that the original population is practically replaced in 8 to 10 years. Additionally, a policy that establishes social aid for vulnerable households —those whose water bill exceeds a defined threshold— is enacted at the start of the simulation.

As former residents are replaced by new residents with environmentalist behaviour, the collective water use decreases over time. Consequently, the service becomes financially unsustainable, since it has been designed so that a minimum water amount is used by each person (Fig. 3). Apart from this, new residents are wealthy enough, and therefore they are not categorised as vulnerable households (Fig. 4). This results in a period in which *PI1* is completely displeased (Fig. 5): the service has become financially unsustainable, there are too many households that are not autonomous —in the sense they have to face too high water bills in comparison to their income—, and too many households receive social aid. This leads *PI1* to demand for the suppression of the social aid, proposal that is supported by 10 and 20 % of the population during a period of 2 years (Fig. 6). Nonetheless, its support decreases over time because newcomers' values do not align with the proposal —in Fig. 5 the average household satisfaction reflects *PI1*'s assessment. Anyway, as the population is being replaced, and although the financial situation of the service is only partially acceptable, the new residents are solvent and do not need social aid, which satisfies partially *PI1*. This world-state is acceptable enough to dissuade *PI1* to demand for the suppression of the social aid. *PI2* is satisfied because environmental protection is ensured —households use an acceptable amount of water—, there is a policy of social aid for vulnerable households, and newcomers access to the service is ensured (actually, they are wealthy enough to not be in a precarious situation); this political assessment is communicated to the new population (because they share values), causing the average household satisfaction to increase again (Fig. 5).

5 Closing remarks

1. In this paper, we characterised a feature that is relevant for policy-making, which is social support of public policies and derived policy shifts. We have proposed to enrich agent-based models for policy-making with new affordances

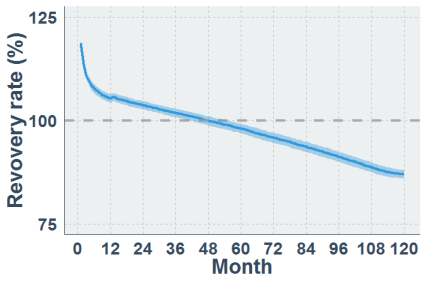


Fig. 3: Water service cost recovery rate (%) under a gentrification scenario.

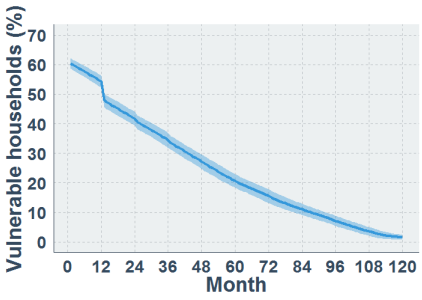


Fig. 4: Households categorised as vulnerable (%) under a gentrification scenario.

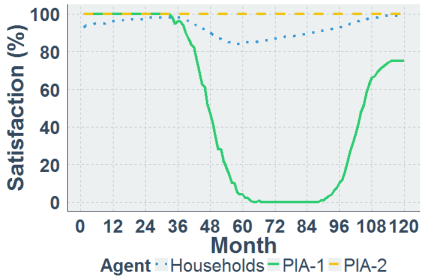


Fig. 5: Satisfaction of agents during the gentrification scenario

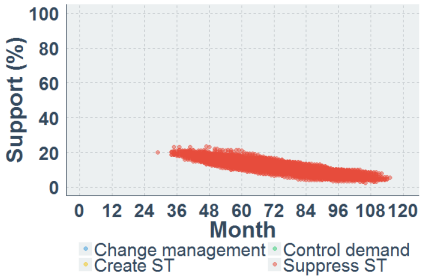


Fig. 6: Demands and support during the gentrification scenario

inspired by *second-order emergent social phenomena* (e.g. perception, aggregation, support, etc.). Further work should enhance the meta-model by considering interactions between policy-influencers in political arenas and more dynamic networks of relationships between *policy-influencers* and *policy-targets*.

2. The simple model we propose may be used to formulate some common issues in policy design, for example:

Irrationality. Satisfaction models are *irrational* when they are *unfeasible*. For instance, an agent wants to satisfy two values at the same time that are directly opposed, being that situation impossible to be reached.

It is true, however, that *unfeasibility* is hard to be demonstrated. Indeed, some agents may invoke unfeasibility as a political argument to rhetorically attack other agents (in which case, it would not be *politically unfeasible*, but rather *politically undesirable* from the argument-maker's point of view).

When a *policy-influencer* holds a satisfaction model that is irrational, this would lead to a perpetual state of dissatisfaction, no matter the policy enacted. If these models are transferred to *policy-targets*, they are likely to be perpetu-

ally displeased too. This would entail unstable social scenarios, as the *policy-influencer* (or another one) could take advantage of the situation to make incoherent political demands (because these do not address variables of the relevant world, either intentionally or unwittingly, and consequently are ineffective to address policy problems).

Policy local/global spheres misalignment. *Policy-targets* might be incapable of perceiving the attainment of policy targets at the macro-scale, either because they do not receive the information by trusted *policy-influencers*, or because they do not have the values to consider these policy outcomes relevant. Nonetheless, *policy-targets* are aware of the local effects of the policy. If the local effects are viewed as negative (e.g. restrictions or taxes), but *policy-targets* are unable to perceive and value the effects at the macro level (e.g. air pollution reduction), this can lead to unstable social situations.

Limited competence of *policy-makers*. *Policy-influencers* may evaluate the world-state using variables that the *policy-makers* in charge may not consider relevant because of their values. Therefore, despite sharing the same world-state, they perceive it differently. Consequently, *policy-makers* will receive the political demands as a reaction of the policy being enacted —thus, the demands have been raised due to political dissatisfaction of *policy-targets* and *policy-influencers*. In this case, the administration of the social space may become socially unstable.

3. Applications of this meta-model need to be complemented with fieldwork to build empirical value aggregation models. Such models should consider empirically elicited values, understandings, indicators and associated political demands.

4. Our proposal applies to hybrid systems where agents may be either human or artificial entities. In the hyper-connected society [5], human agents interact with artificial entities (e.g. virtual assistants, recommendation systems, etc.), and both of them may communicate with different *policy-influencers* (human or artificial). For instance, in the context of a household, a human agent is provided with a service through an appliance (e.g. laundry and washing machine). This device could register data of the user or the environment, and transfer it to a higher artificial entity, who could process aggregated data and then send additional instructions to those basic devices, acting as a *policy-influencer* (e.g. an order to delay a wash program to avoid peak flows). In some way, there is an exchange of information (and resources) between agents of different levels and hierarchies.

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References

1. Achen, C., Bartels, L.: Democracy for realists: Why elections do not produce responsive government. Princeton Studies in Political Behavior, Princeton University Press (2016)
2. Aldewereld, H., Boissier, O., Dignum, V., Noriega, P., Padget, J.: Social Coordination Frameworks for Social Technical Systems. No. 30 in Law, Governance and Technology Series, Springer International Publishing (2016)
3. Botterill, L.C., Fenna, A.: Interrogating Public Policy Theory. Edward Elgar Publishing, Cheltenham, UK (2019)
4. Castelfranchi, C.: Simulating with Cognitive Agents: The Importance of Cognitive Emergence. In: Sichman, J.S., Conte, R., Gilbert, N. (eds.) Multi-Agent Systems and Agent-Based Simulation. pp. 26–44. Springer Berlin Heidelberg (1998)
5. Floridi, L. (ed.): The Onlife Manifesto, pp. 7–13. Springer International Publishing (2015)
6. Gilbert, N., Ahrweiler, P., Barbrook-Johnson, P., Narasimhan, K.P., Wilkinson, H.: Computational modelling of public policy: Reflections on practice. Journal of Artificial Societies and Social Simulation **21**(1), 14 (2018)
7. Lakoff, G.: Why it matters how we frame the environment. Environmental Communication **4**(1), 70–81 (2010)
8. Mercuur, R., Dignum, V., Jonker, C.: The use of values for modeling social agents. In: Quan Bai, Fenghui Ren, M.Z.T.I. (ed.) Proceedings of the 3nd International Workshop on Smart Simulation and Modelling for Complex Systems (2017)
9. Miceli, M., Castelfranchi, C.: A Cognitive Approach to Values. Journal for the Theory of Social Behaviour **19**(2), 169–193 (1989)
10. Noriega, P., Padget, J., Verhagen, H., d'Inverno, M.: Towards a framework for socio-cognitive technical systems. In: Ghose, A., Oren, N., Telang, P., Thangarajah, J. (eds.) Coordination, Organizations, Institutions, and Norms in Agent Systems X. pp. 164–181. Lecture Notes in Computer Science 9372, Springer (2015)
11. Oishi, S., Diener, E., Lucas, R.E.: The optimum level of well-being: Can people be too happy? In: Diener, E. (ed.) The Science of Well-Being, pp. 175–200. Springer Netherlands (2009)
12. Pablo Noriega, Jordi Sabater-Mir, H.V.J.P., d'Inverno, M.: Identifying affordances for modelling second-order emergent phenomena with the WIT framework. In: Sukthankar, G., Rodriguez, J.A. (eds.) AAMAS 2017 Workshops Visionary Papers. Springer International Publishing (2017)
13. Parks, L., Guay, R.P.: Personality, values, and motivation. Personality and Individual Differences **47**(7), 675–684 (2009)
14. Perello-Moragues, A., Noriega, P.: Using Agent-Based Simulation to understand the role of values in policy-making. In: Proceedings of the Social Simulation Conference 2018 (SSC2018) (In Press)
15. Rosaria Conte, Giulia Andrighetto, M.C., Paolucci, M.: Emergent and immergent effects in complex social systems. In: Proceedings of AAAI Symposium, Social and Organizational Aspects of Intelligence. pp. 8–11 (2007)
16. Schwartz, S.H.: Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. In: Zanna, M.P. (ed.) Advances in Experimental Social Psychology, vol. 25, pp. 1–65. Academic Press (1992)
17. Stewart, J.: Public Policy Values. Palgrave Macmillan UK, London, 1st edn. (2009)
18. Witesman, E., Walters, L.: Public Service Values: A new approach to the study of motivation in the public sphere. Public Administration **92**(2), 375–405 (2014)