

CoDesigning Participatory Tools for a New Age: A Proposal for Combining Collective and Artificial Intelligences

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ABSTRACT

In the context of a Citizen Lab, this paper describes how a vanguard of activists, designers, scholars and participation practitioners were involved in a participatory prototyping process. As a result, they designed *CoGovern* an online participation tool whose focus is to incorporate citizen preferences in local policy making. *CoGovern* is aimed at supporting informed and transparent participatory processes whilst avoiding that sponsoring authorities *cherry-pick* policy proposals and omit to provide explanations. With this purpose, this paper proposes a decision-making process which incorporates Artificial Intelligence techniques to a collective decision process and whose result is mainly based on standard optimization techniques rather than just vote-counting.

Keywords: *Participatory Democracy, Decision Making, Artificial Intelligence, Collective Intelligence, Participatory Prototyping, CoDesign.*

1. INTRODUCTION

The field of democratic innovations (Fung & Wright, 2001; Smith, 2009) is currently crowded with digital tools aimed at facilitating deliberative and participatory processes. Frequently, these tools emerge within activism environments characterised by a high level of civic engagement and political interest. In particular, most of these environments largely embrace the principles promoted by those social movements in defense of free and open source software such as opensource.org. More recent initiatives also promulgate the coproduction of knowledge between the general public and the scientific community such as Citizen Science (Socientize Consortium, 2013).

This article stems from one of those spaces: MediaLab Prado, a Citizen Lab located in Madrid (Spain). This experimental Lab organized a Workshop for Collective

¹ Authors appear in alphabetic order.

Intelligence on Democracy whose main purpose was to prototype digital tools addressing the challenges posed by citizen participation in the age of social media.

We address some of these challenges by focusing on two main questions: How can digital tools be designed in order to make participatory processes more transparent and accountable? Can artificial intelligence enhance participatory processes in an objective and publicly auditable manner, without deviating from participants' interests?

Firstly, this paper seeks to reflect how a vanguard of activists, designers, scholars and practitioners currently envision what – according to them – will be one of the most common forms of citizen participation in the coming years. Secondly, it proposes the basis for the future development of *CoGovern*, an online citizen participation tool whose focus is to incorporate citizen preferences in local policy-making. Thirdly, our tool proposal aims to ensure informed and transparent participatory processes to avoid that sponsoring authorities *cherry-pick* policy proposals and omit to provide explanations. And finally, for these purposes, this article proposes a decision making process which incorporates artificial intelligence (AI) techniques in order to align citizen preferences, budgetary constraints and priorities, or strategic objectives about what policies and investments should be chosen for implementation.

The result has been the initial design of *CoGovern*, a prototype web application in which citizen participation is grounded in information fusion (Torra, V. & Narukawa, Y., 2007), argumentation theories (Awad, E. et al., 2015), and standard optimization techniques. In other words, the main substantive contribution is to propose a decision-making process in which the outputs – normally participatory policy proposals – are selected using optimization techniques. The central argument is that a proposal selection method based on the best possible combination, according to previously agreed and weighted criteria, instead of the traditional vote-counting system, can enhance participatory decision making.

The article proceeds as follows. The next section presents the sociological and technological research background. In particular, it introduces artificial intelligence techniques that can be applied to decision support in the context of political participatory processes. Next, we present the methodological approach which is based on a collective intelligence (CI) experiment; more specifically, a case study about a Citizen Lab is described. Subsequent section presents the resulting prototype design by focusing on its graphical design, functionalities, and automated decision making. Lastly, some implications of these types of participatory tools and future research paths are discussed.

2. INTRODUCING AI IN PARTICIPATORY DECISION-MAKING PROCESSES

Political sociology often distinguishes three decision-making models in democratic regimes: representative, participatory, and technocratic (Bengtsson & Christensen, 2014). The major difference between them resides in the actors responsible for the decision making. Thus, in the representative model, a group of elected politicians are in

charge of making decisions, whereas that is the responsibility of citizens and experts in the participatory and technocratic models, respectively. Recent public opinion research argues that most citizens prefer decision-making processes that involve both elected politicians and ordinary people; however, people believe that decisions are solely taken by elected politicians (Allen et al. 2015; Font et al. 2015, 2017).

On the contrary, in *Stealth Democracy*, Hibbing and Theiss-Morse (2002) question the existence of a real demand for more participation. They argue that people actually prefer not to participate but decisions to be taken “efficiently, objectively and without commotion and disagreement” (2002:143). Other participation criticisms revolve issues such as the lack of efficiency and the perception that participatory processes are highly time consuming. This article addresses this tension between a desire for more opportunities to participate and a demand of political processes to be more objective and efficient. Overall, our aim is to work towards convergence of diverting positions rather than their confrontation.

Despite this ambivalence results on citizen process preferences, “the participatory turn” has become rooted in political agendas (Bherer et al., 2016). As a result, during the last decades, participatory experiences have widespread around the world putting the stress on different aspects such as: prioritization of the aggregative component (e.g. voting) vs. deliberation; interested groups participation vs. open participation; top-down vs. bottom-up; or consultative vs. “more” binding processes.

However, over the past years, a new generation of participatory institutions is announced, mostly characterized by the use of the new information and communication technologies (ICTs). It is still early to assess whether the spread use of the ICTs entails a entirely new generation of participatory institutions. Nevertheless, what is certain is that, at least, they introduce new demarcation lines when designing participatory processes. For instance, according to Dahlberg’s classification (2011), we can find four main categories of e-democracy tools: *counter-publics*, *autonomous Marxists*, *liberal consumer* and *deliberative*. Whilst the first would seek shaping groups of activists to perform contestatory actions, the second would be oriented towards the networking and self-organization outside the capitalist system (see also Chadwick, 2009:21). On the other hand, those under the category of *liberal consumer* would be oriented towards making requests and receiving support for them. Some scholars (London, 1995; Bohman, 1998) critically name these spaces as a “Marketplace of ideas” competing between them and introducing game elements (*gamification*) (Secchi & Spada, 2017). In contrast, those under the category of *Deliberative* would include argumentation systems to transform particular interests or concerns into common and consensual ones through the rational model of deliberation (Dahlberg, 2011). *CoGovern*, our participatory tool proposal, lies within this last category.

One of the most important changes that these new tools have introduced is the fact of increasing the number and diversity of participants. Although dilemmas on some key issues, such as anonymity and the digital divide, remain unsolved, large participation allows to build streamlined participatory processes as well as to scaling-

up. However, this comes at a cost, since it also increases the complexity of the decision-making process. Taking into account this and other challenges facing participatory democracy, this article develops a theoretical decision-making process which incorporates AI techniques. In particular, it proposes a selection method of citizens proposals which determines the best possible combination (of proposals) rather than conducting the traditional vote-counting ranking. But, can AI expected always to enhance participatory processes? We must be prudent about the most suitable application scope of AI when considering democratic processes, since there are many AI techniques, and we cannot foresee all the consequences of introducing general AI in our everyday political life. On the contrary, this article focuses on a specific aspect that can certainly benefit from the incorporation of a particular AI technique: the objective proposals' selection in participatory processes based on optimization techniques.

Nowadays, it is most often the case that authorities sponsor participatory processes to gather citizens preferences about what policies are needed and, once the consultation is finished, they might: (i) just *cherry-pick* a subset of proposals without giving any reasoned explanation; or (ii) prioritize the proposals in decreasing order of citizen support (normally gathered through voting), and choose the first ones in the ranking² so as to implement them as long as the budget lasts. Nevertheless, technology can enrich the whole participatory process. In particular, there are some areas of AI related to information aggregation, argumentation, and optimisation that can be applied. On the one hand, information aggregation (Torra & Narukawa, 2007) and argumentation (Awad et al., 2015) can be applied to opinion gathering. On the other hand, optimisation techniques (Hwang & Masud, 2012) are particularly suited for choosing the best subset of citizen proposals once their characteristics are quantified and selection criteria are clearly stated.

Regarding opinion gathering, voting is the hegemonic mechanism in democratic societies. It is simple and scales-up well. Thus, citizens are familiar with it and it allows the participation of a large number of citizens. Nevertheless, most times decisions are taken in a biased or even uninformed way. Ideally, arguments in favor and against a proposal should be thoughtfully pondered before voting for it. Forums in online participatory processes try to leverage these shortages, but they are unstructured and they just work well for small groups. Argumentation theory (Awad et al., 2015) is a research area concerned with reaching agreements through logical reasoning that consider supporting or/and attacking arguments. Most research work on argumentation is kept at a theoretical level; however, Deliberatorium, an on-line tool for collaborative deliberation (Klein, 2012) constitutes a remarkable exception. Moreover, aggregation operators, such as Weighted Ordered Weighted Aggregation operators (WOWA) (Torra & Narukawa, 2007), constitute mathematical methods that combine information in a richer and more general manner than standard methods such as the average or the mean computation.

² Rare exceptions, such as the one in Paris described in the discussion section, do also consider additional constraints that impose ad-hoc priorities.

As for choosing the best subset of proposals, optimisation methods have been long applied to economic contexts so to maximise the benefit in the selection. Combinatorial auctions (Cramton et al., 2006) for trading bundles of products in markets constitute a representative example. Most commonly, benefit is associated to monetary aspects, but in fact it can be computed with respect to several criteria, as long as they are quantified. The optimisation problems that consider different criteria simultaneously constitute the so-called multi-objective optimisation problems, and linear programming (Hwang & Masud, 2012) is a computational technique designed to solve them (i.e., to maximise the compound benefit). These methods compute the best solution (or, in other words, optimizes an objective function) that satisfies some additional restrictions.

In the subsequent sections of the article, we develop a method through which citizens can rate participatory proposals and also provide arguments in favour or against other citizens' arguments. Furthermore, proposals are selected by means of standard optimisation methods (Hwang & Masud, 2012). Specifically, proposals are chosen for implementation based on a set of criteria: citizen support, budget constraints, and, as we will detail later on, proposal alignment with pre-agreed priorities or strategic objectives.³ In this manner, decisions are publicly known to be the best ones according to the previously established criteria. To the best of our knowledge, participatory processes do not use any of these methods to select proposals. Our central argument is that these methods enhance transparency and effectiveness in citizen participation because it makes transparent the functioning rules before starting the participatory process. Thus, *CoGovern* prevents arbitrary actions by the authorities such as *cherry-picking* and, on the other hand, selects the best possible combination of proposals, taking into account citizen support, budget constraints, and a proposal's convergence with priorities or strategic objectives.

3. COLLECTIVE INTELLIGENCE AS A METHODOLOGICAL APPROACH: THE CASE OF A CITIZEN LAB

This section presents the methodological approach adopted in this article. For this purpose, it begins by explaining the starting point of this project. Second, it introduces the role played by a Collective Intelligence experiment (an international workshop) in its development.

3.1 Starting point for the project

The *CoGovern* project stems from a previous research named *Information fusion for norm consensus in virtual communities* (Serramia, 2016) developed at the University of Barcelona (UB) and the Artificial Intelligence Research Institute (IIIA-CSIC). This

³ As explained in the discussion, GoGovern has been designed to be applied mainly in two well-known types of participatory processes: participatory budgeting and strategic planning. Most often, we refer to priorities in the former and to strategic objectives in the latter, which may be more accurate.

project was oriented to facilitate that members from a virtual community were able to decide their own community rules. Briefly, it aims to enable large-scale debates for collective decision making. The main idea is that users can express their support to a presented norm proposal by exposing arguments in favour and against it, as well as scoring (in a 1-5 points scale) each one of the arguments made by other users. By doing so, an argumentative structure (the so-called norm argument map) is naturally created. Aggregation methods are then used to, first, assess the collective support for each argument and, second, compute the collective support for the whole proposed norm. Two pilot tests were performed in order to evaluate the functionality of the norm argument map. Tests encompassed, respectively, 11 (Rodriguez-Aguilar et al., 2016) and 17 (Garcia-Heveling, 2017) people debating on norms within a prototyped football social network. Most users were male university students who reported having participated in virtual communities before. The average age was 25.5 years old. During the tests users debated normally about a few norms (they created and rated up to 76 arguments per norm); afterwards, a satisfaction survey asked them if resulting aggregated ratings were reasonable. In a scale from 1 to 5, the answers' mean was 3.36 respectively, which can be considered as a positive preliminary result if we take into account the usability deficiencies of our prototype.

Considering these modest tests as a starting point, the research team from UB and IIIA decided to look into the field of participatory processes to broaden the application of their research. Thus, in contrast with other projects in alpha or production stages⁴, *CoGovern* is in an incipient stage whose goal is to clearly define both the project and the scope of its applications. This stage would correspond to a conceptualization phase encompassing the Envision and Speculate phases defined by Mario Špundak (2014).

3.2 Collective Intelligence at Medialab Prado

The project aforementioned (Serramia, 2016) was presented to the call for “Collective Intelligence for Democracy” by Medialab Prado. This call consisted on a two weeks international workshop aimed at exploring new ideas to design innovative participation tools. Medialab Prado is a Citizen Lab (Mazé, 2014; Hillgren et al., 2011; Seravalli, 2011) where individuals from different backgrounds – scientists, policy makers, lay citizens, programmers or designers – work together to solve complex social problems through participatory prototyping (Brodersen et al., 2008) and co-design. The interaction of these elements is what is known as collective intelligence. Following Chadwick,

the core idea is that a distributed network of creators and contributors, the majority of them amateurs, can, using simple online tools, produce information goods that may outperform those produced by so-called authoritative, concentrated sources (2009:21).

⁴ Alpha projects: projects in demo phase that require a last revision to better define its functionalities. Projects in state of production: projects that are in the final phase of its development.

This international workshop applied work dynamics that come from the “hackathon” logic. According to Gerard Briscoe (2014), hackathon settings involve people working intensively during a limited period of time. The main goal is to generate ideas rather than develop fully operational tools. Documentation becomes crucial for these events, since it allows to have a registry of all the process which is fundamental to continue the work in the future. Another important factor of this methodology is the relationship established between the participants. *CoGovern* involved two main actors: project coordinators (who applied to the call by Medialab Prado) and external collaborators (who chose the project according to their preferences). The involvement degree between these two roles was balanced in order to guarantee an open participation (Manzini & Coad, 2015; Manzini & Rizzo; Lee, 2008). Finally, *CoGovern* team was composed by a wide range of profiles including architects, political scientists, designers and social workers of different ages and nationalities (Latin America and Spain).⁵ This diversity caused the participation to respond to different interests and expectations.

Once the coordinator exposed the initial project, the collaborators concluded that there were already other tools addressing deliberative processes through aggregation methods, and only a few included some specific artificial intelligence techniques (see Table 1 in discussion section). Thus, an initial conceptual mapping was developed in order to find out some gaps in the existing participatory and deliberative tools. After comparing a number of digital tools, the team decided to focus on three dimensions: i) how citizens can participate and express their preferences; ii) to what extent the decisions taken are binding; and iii) the existence of monitoring mechanisms to follow-up the decisions approved. Afterwards, the work team was divided into groups to work these dimensions focusing specially on the design of the different interface’s sections: i) *participation*: how to create proposals and how to structure and aggregate argumentation; ii) *decisions (outputs)*: show how the final list of proposals that have been selected according to pre-established priorities, citizen support and budget; and iii) *follow-up (outcomes)*: tracking the fate of the proposals (implementation, modification or cancellation). Finally, the resulting preliminary prototype conceptualization and design was presented (and discussed with other groups and participants) at the closing event of the workshop.

4. CO-GOVERN: A PARTICIPATORY TOOL PROPOSAL

Figure 1 details the overall participatory process in *CoGovern*, which can be described in terms of the following stages:

1. *To release the functioning rules*: Initially, the authority releases the necessary information to fully understand the process so to be aware of the “rules of game”: informing about the prioritization criteria: i) citizen support; ii) budgetary aspects; and

⁵ CoGovern project members, in alphabetical order: Nella Charms, Jennifer Clavijo, Ana Doria, José Luís Fernández-Martínez, Maite Lopez-Sanchez, Lizeth Ramírez, Juan A. Rodríguez-Aguilar, Jairo Salazar, Dionisio Sánchez, Marcelo Sánchez, Sayuri Susuki, and Berenice Zambrano.

iii) alignment with a set of priorities or strategic goals. An information sharing event can help to disseminate and clarify the participatory process as well as to learn how the online tool works.

2. *To create proposals:* Upon login, city residents and government can create proposals that are classified by administrative areas in case of a process in which different sectorial actions are aimed to be carried out. Users can also obtain information on the other proposals.

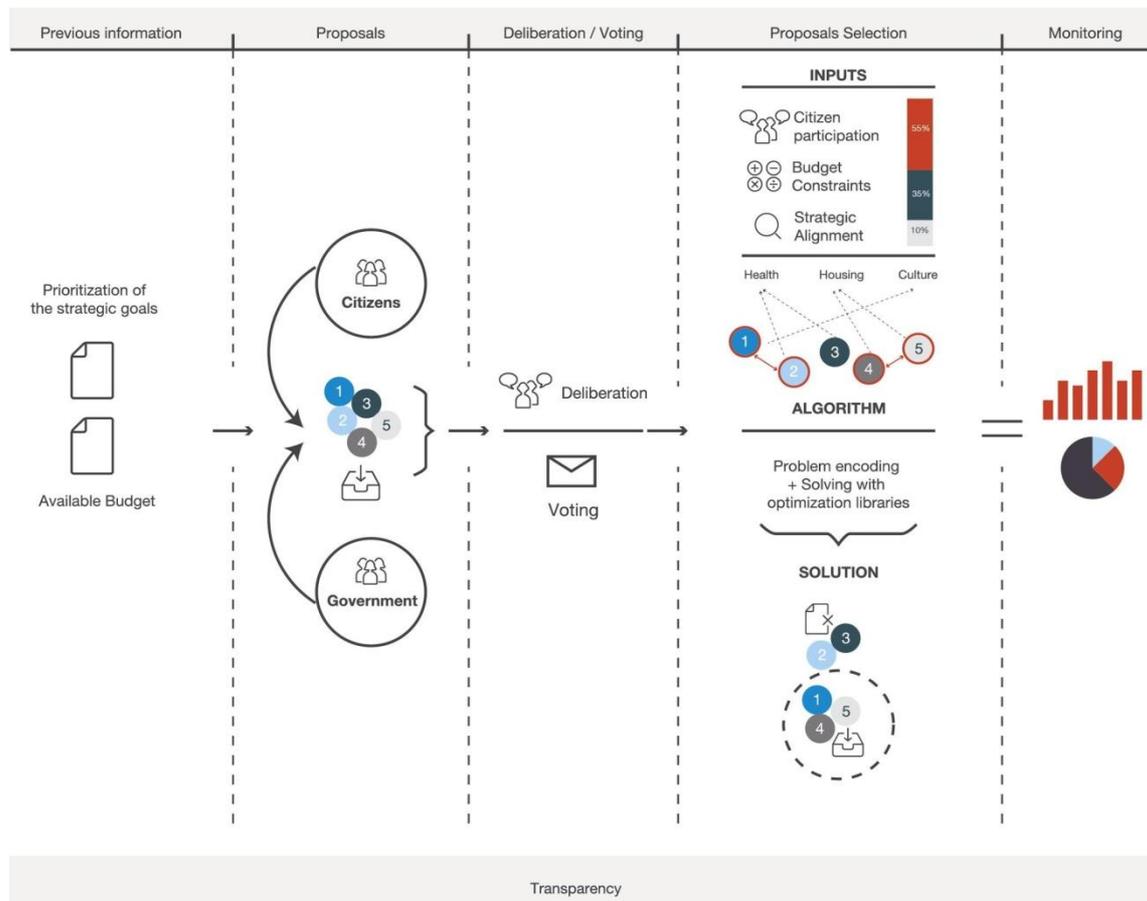


Figure 1: CoGovern proposal selection process.

3. *To deliberate and vote:* A key feature of CoGovern is that it supports citizens to vote for and/or deliberate about proposals at their own convenience. The deliberative interface (Figure 2) shows the distribution of votes (it also offers the possibility of voting), as well as pro and cons arguments. Citizens can both provide new arguments and express their agreement, neutrality, or disagreement in relation to their peers' arguments. Argument information is aggregated⁶ and added to the general voting by modifying the level of citizen support of each proposal.

4. *To filter and fully specify proposals:* After reviewing the contributions made by citizens, authorities' technical staff filter out illegal proposals and introduce both the cost and their strategic alignment (since most probably proposals will vary in their support to stated priorities or strategic goals) for the remaining proposals. Moreover,

⁶ By means of WOVA operators (see Serramia et al. 2016 and Torra & Narukawa, 2007).

technicians are also required to specify those incompatibility relationships that hold between proposals. Such incompatibilities correspond to objective –and documentable– impediments for proposals to be simultaneously selected. Thus, for example, two proposals of alternative urban interventions designed for the same location are infeasible. This specification relates to the recommendations of the Participatory Budget Partners in UK,⁷ that state that this indispensable technical input “might include reference to existing or planned spending proposals, to avoid duplication in allocating resources.”



Figure 2: CoGovern participation interface for argumentation.

5. *To select proposals*: Once the data is gathered –citizen support (after computing voting and argumentative support), costs and strategic alignment– the proposals are selected according to an algorithm publicly known beforehand. Next subsection details how this selection process is automated.

6. *To visualize the results*: Users can inspect each proposal. Figure 3 depicts its state (selected or not) and its alignment with the considered criteria (citizen support; budgetary constraints, and alignment with pre-established priorities or strategic objectives) by means of colored bars.

7. *To follow up selected proposals*: Selected proposals are ordered according to its implementation degree. Users can also monitor their implementation schedule,

⁷ <https://pbnetwork.org.uk/wp-content/uploads/2016/10/PB-Mainstreaming.pdf> (page 9).

deviations from the initial budgeting, and companies in charge. Once the project is completed, a report with all the information (Figure 4) will become available.

Co-gobierna  Participa  Decisiones  Seguimiento  Dionisanchez 

Áreas Rendición de cuentas
Transparencia

Educación	Raoul Lemercier 3 febrero, 2016 Plan de Urbanismo para el nuevo barrio El Cañaveral	Seleccionada
	Obra nueva de edificios municipales destinados a equipamientos deportivos	Resumen de la actuación
	Economía y Hacienda, cultura y deportes	Otras áreas de gobierno
	(1) Cohesionar y reequilibrar la ciudad (3) Promover el desarrollo integral de los niños, niñas, adolescentes y jóvenes de la ciudad (4) Favorecer una ciudad activa y saludable	Objetivos
	2.500.000€	Monto de la inversión
	Presupuesto de inversión 0%  80% 100% Concordancia con los objetivos del gobierno 0%  65% 100% Apoyo ciudadano 0%  90% 100%	Área de Urbanismo Mayte@areaurbanismo.gov +347 653 298 909

Figure 3: CoGovern accountability interface.

Áreas Urbanismo

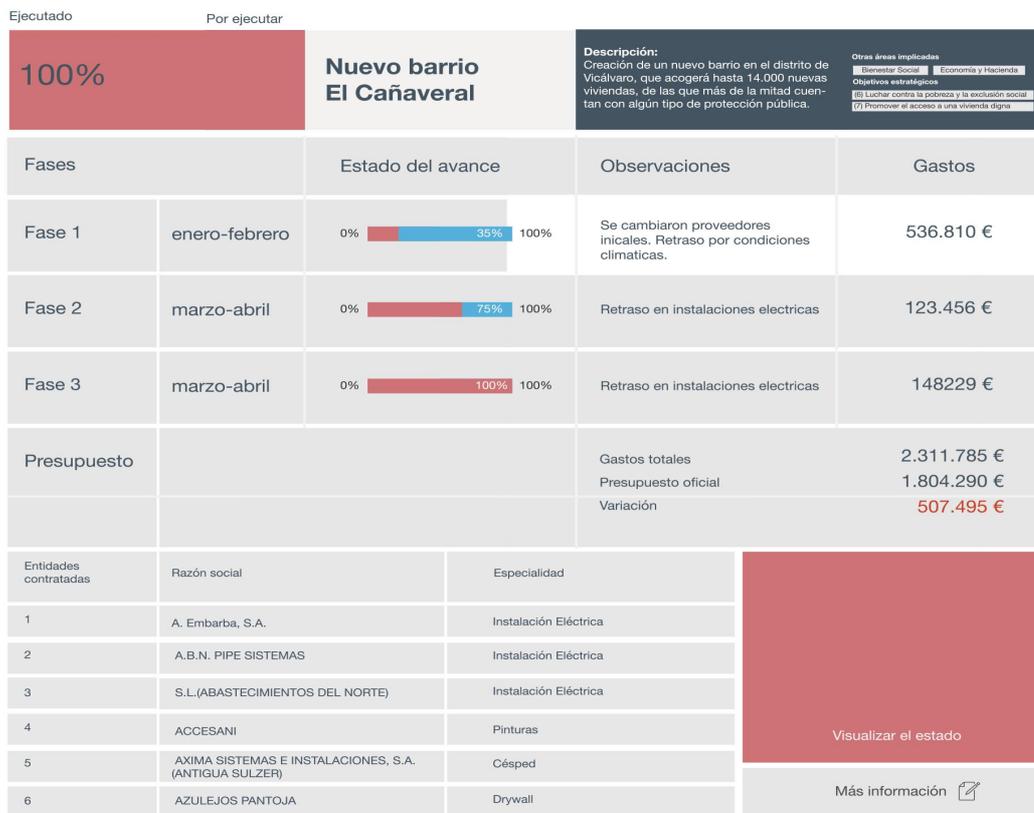


Figure 4: CoGovern monitoring interface.

4.1 How Does Artificial Intelligence Operates in CoGovern?

Leaving aside the number of proposals to deal with, choosing the best combination of proposals constitutes a complex task, since selected proposals must satisfy incompatibility constraints and balance different criteria. Thus, for instance, it could be the case that the proposal with highest citizen support turns out to be so expensive that it alone depletes the overall available budget so that there is no budget left for implementing other interesting proposals. Alternatively, it could also be the case that the chosen proposals are not aligned with the administrative strategic objectives. For example, if promoting social cohesion is very important for the authorities, then a proposal dividing two neighborhoods should not be prioritised. This is so because co-governance is about seeking agreements between citizens and authorities, deciding upon those sets of proposals that are good enough for all the actors involved in the process. Overall, it is fundamental for transparency and accountability that the selection process is properly publicized, that it is objective, and that it encompasses rules for balancing different criteria that are clear from the very beginning, before the deliberation process starts.

Making explicit the selection process requires some details to be released. Firstly, the overall available budget is needed not only to know how much can be spent

but also to characterize proposals accurately. Secondly, since several criteria are taken into account (citizen support, budgetary constraints, and alignment with priorities or strategic objectives), we need to know if all of them are considered to be equally important or if there are some preferences over some of them. If this is the case (e.g., citizen support is considered to be more important than cost) then the actual weights have to be clearly stated. Similarly, it is also necessary that priorities or strategic objectives are prioritized among them, so that they are presented in an orderly manner. Finally, in addition to the specific characteristics of each proposal, such as citizen support or implementation cost, it is also necessary that proposal incompatibilities are clearly displayed so that whenever a proposal is chosen, all participants understand that those other proposals that are incompatible with it cannot be possibly chosen.

Once this information becomes clear, it is possible to compute the best subset of proposals to implement. This selection process can be automatized by applying optimization techniques. More specifically, we propose to specify an optimization problem that seeks to maximize, i) the number of proposals; ii) the citizen support; iii) the support to administrative strategic objectives; whilst minimizing cost. Optimization problems can be encoded as linear programs that can be automatically solved by means of state-of-the-art solvers (i.e., optimization code libraries). In particular, considering a set of proposals P , we encode the problem by defining a set of binary decision variables $\{x_1, \dots, x_{|P|}\}$ where each $x_i \in \{0,1\}$ encodes the decision of whether proposal p_i will be selected (thus taking value 1) by the system or not (i.e., $x_i = 0$). Therefore, solving the problem amounts to solving the following linear program:

$$\max \sum_{i=1}^{|A|} x_i$$

$\max \sum_{i=1}^{|A|} s(p_i) \cdot x_p$, being $s(p_i)$ a function that provides the support obtained by each proposal p_i .

$$\min \sum_{i=1}^{|A|} c(p_i) \cdot x_p \text{ being } c(p_i) \text{ a function reporting the cost of each proposal } p_i.$$

$\max \sum_{i=1}^{|A|} v_p(p_i) \cdot x_i$ being $v_p(p_i)$ a function that considers some values associated to the ordered strategic objectives so that, if we assume there are $|O|$ strategic objectives, then we have $v_1 > \dots > v_{|O|}$, where each v_i corresponds to the i -th strategic objective. Then, using an intermediate function f that specifies, for each proposal p_i , the strategic objectives it is aligned with, we compute $v_p(p_i) = \sum_{j \in \mathcal{A}(p_i)} v_j$

We can cast this problem specification as a single objective optimization problem that can be solved by the following linear program (refer to Lopez-Sanchez et al., 2017 for a more comprehensive and detailed explanation):

$$\max \left[\frac{w_r}{|A|} \cdot \sum_{i=1}^{|A|} x_i + \frac{w_s}{S_{max}} \cdot \sum_{i=1}^{|A|} s(p_i) \cdot x_i + \frac{w_v}{V_{max}} \cdot \sum_{i=1}^{|A|} v_p(p_i) \cdot x_i + w_c \cdot \left(y - \frac{1}{b} \cdot \sum_{i=1}^{|A|} c(p_i) \cdot x_i \right) \right] \quad (1)$$

Subject to a number of constraints encoding maximum budget, incompatibility relationships or the importance awarded to criteria.

Figure 5 illustrates the resolution of this problem with an example: Imagine decision makers have the following priorities: (i) Promote health; (ii) Provide access to affordable housing; and (iii) Promote culture. We consider they are ordered in decreasing order of importance (that is, health is the most important priority, and it gets a value $v_1=3$ whereas culture is the least preferred one with value $v_3=1$). Additionally, we consider five different proposals promoting some of these values and described in Table 1. Notice that, as depicted in Figure 5, p_1 and p_2 are exclusive (i.e., they cannot be simultaneously chosen). This is so because they would be built in the same plot of land. Similarly, p_4 and p_5 are exclusive because urban architects constitute a scarce resource that can only work on a single urban plan at a time.

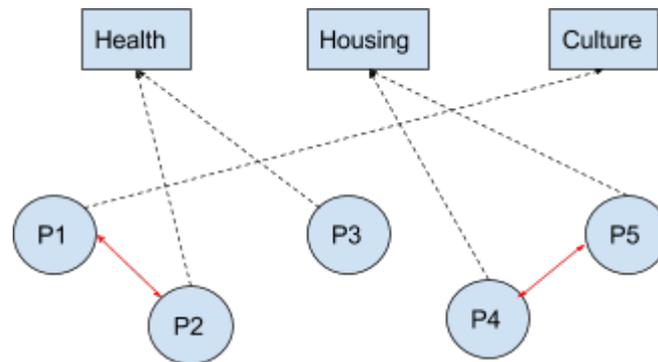


Figure 5: Example of proposals (circles) and priorities (rectangles). Dashed (black) lines relate proposals to the priorities they promote. Solid (red) lines relate incompatible proposals.

Last column in Table 1 shows how the standard way of choosing proposals would order them by just considering citizen support.

proposal p_i	description	citizen support $s(p_i)$	cost $c(p_i)$	strategic objective $f(p_i)$	standard ranking
p_1	Build a library.	0.6	1	culture $f(p_1) = 3$	4
p_2	Build a new medical assistance center	0.7	2	health $f(p_2) = 1$	3
p_3	Improve ambulance services	0.4	1	health $f(p_3) = 1$	5
p_4	Rehabilitation of a deteriorated neighbourhood	0.8	2	housing $f(p_4) = 2$	2
p_5	Promotion of a new neighbourhood	0.9	4	housing $f(p_5) = 2$	1

Table 1. Proposals example. Source: own elaboration.

Considering a maximum budget of 5 million ($b=5$), the result would be to choose p_5 which has the highest support ($s(p_5)=0.9$) and requires most budget ($c(p_5)=4$). Unfortunately, next proposal in order (p_4 , with 0.8 of support) cannot be included because it is incompatible with p_5 . Subsequent proposal (p_2) cannot be included either because it costs 2 million and its addition to p_5 would exceed the maximum budget $b=5$. An alternative may be to add next proposal in the ordered list that would fit the

available budget (i.e., p_1 , which costs 1M). Thus, if we choose p_5 and p_1 we do not exceed the total budget.

Alternatively, we propose to consider the optimisation mechanism previously introduced that does not only consider citizen support, but it also combines both the cost and the priorities within a single evaluation function. In this case, any state-of-the-art solver such as CPLEX (CPLEX 2009), Gurobi (Gurobi) or GLPK (Makhorin, 2000) that is provided with the linear program encoded in equation 1 would produce as a solution the combination composed by proposals p_2 , p_3 , and p_4 , since it corresponds to the best possible proposal combination.

5. DISCUSSION

This article introduces a proposal for a digital tool for citizen participation. But, in which contexts and spaces can it be applied? Transferability and institutionalization have been central in the tool's design. The former is the capacity of a tool of democratic innovation to "operate in different political contexts, understood in relation to scale, political system or type of issue" (Smith, 2009:13), whereas institutionalizing means "moving from sporadic, episodic experiments toward embedded and routinized and easily replicable structures within government that last beyond the initial enthusiasm" (Russon-Gilman, 2016:119). Taking into account these two principles three main decisions were made during the participatory prototyping process in order to shape the participatory device proposed in this article.

Firstly, the online tool proposed was conceived for two widespread types of participatory processes: participatory budgeting and strategic planning. Through participatory budgeting, authorities allocate a portion of the municipal budget for citizens to decide how to invest it. As for strategic planning, it projects the main lines of action in mid and long terms and seeks to fulfill governance objectives. Both participatory processes can be done on-line. Nevertheless, we should be prudent about the rapid spread of ICTs in participatory democracy. For example, some engaged citizens can perceive a loss of civic rewards as consequence of the digitalization of the participation. In this sense, Russon-Gilman alerts about "how ITCs could alter the character of deliberation and substantive participation within Participatory Budgeting (2016:129-130;138)". Obviously, a face-to-face deliberation cannot be equated to a process based on online argumentation. However, in our opinion, both have pro and cons. On one hand, argumentation allows a greater systematization, although the threat of the digital divide is still an issue. On the other hand, face-to-face deliberation has its own biases since some citizens are not able or willing to attend assemblies due to a lack of time, their different participatory styles, or simply, their fear to speak in public. The solution of the dilemma between online and offline participation seems to be an hybridization. For example, although proposals in participatory budgeting processes are uploaded and voted through on-line applications, currently, some authorities (such as in Getafe, Spain) also offer technical support for those in need at designated physical locations (e.g., civic centres).

Secondly, the approach proposed in *CoGovern* highlights the importance of the convergence between citizens and authorities' perspectives. This recommendation is also shared by the Participatory Budgeting Partners in UK, among others. Nevertheless, it is worth noticing that alignment can lead to an excessive framing and, consequently, some groups may consider this type of participation too constrained. Therefore, before starting the participatory process it becomes key to explain that this alignment pretends to guarantee a high level of political compromise, which is essential for a successful implementation of the results of participatory processes. Moreover, it should be noted that priorities or strategic objectives, and their respective weights, may well be previously agreed between authorities and the community. In fact, this is in line with the principle of transferability which implies a certain degree of flexibility within and adaptation to specific contexts. For example, since 2016 the participatory budgeting of the city of Paris prioritizes projects made on deprived or sensitive areas, reserving 30% of the allocated project. *CoGovern* is much more open and simply makes explicit all the priorities or strategic objectives that will be considered in the selection process.

Thirdly, previous research -focused on democratic innovations- had already put the proposal selection problem on the table (Smith, 2009: 93; Font et al., 2017). These studies found out preliminary evidence about the existence of cherry-picking practices by authorities in the context of local participatory processes in Spain. This article has shown how this specific aspect within institutional participatory processes can benefit from certain AI techniques. However, it must be brought into discussion some considerations about the expansion of the use of algorithms for social purposes. Mattelart & Multigner (2007) – when referring to Gottfried Wilhelm Leibniz – alerted us to the use of algorithms for speculative purposes and their relation to modern capitalism. More recently, critical voices have related its use with the idea of cybercontrol. It is therefore imperative to seek new ways to make use of, visualize, and build the “algorithmic environment” (Álvaro, 2014). Can algorithms contribute to the social progress through its integration in social projects? Through codesign (Fuller, 2003), *CoGovern* has shown an attempt to bring the “algorithmic environment” closer to the society so as to be able to participate in its formulation. Enabling the dialogue between citizens, rulers and experts is an unavoidable task. It is a need, therefore, to create more spaces, such as citizens labs, in which citizens are confronted with the complexity of the institutions and technical issues, and institutions and experts adopt a sincere intent to (co)govern together with the people.

6. RELATED AND FUTURE WORK

This article proposes *CoGovern* as an online participation tool focused on incorporating citizen preferences to local policy making by means of artificial intelligence techniques. Thus, an unavoidable question has to do with what new elements has *CoGovern* brought into the landscape of participatory and deliberative tools. During the international workshop previously mentioned, invited experts introduced some of the most relevant

participatory tools. Table 2 below summarizes the principal similarities and differences between these tools and *CoGovern*.

Tools	Goals	Types of users	Online argumentation	How do citizens decide?	Monitoring	AI
<i>CoGovern</i>	Incorporate citizens preferences in policy decision-making processes.	City residents	Yes (pro and cons arguments)	Arguments / voting	Yes	Yes (optimal proposal selection)
<i>Loomio</i>	Help small groups make decisions through inclusion	Small groups	Yes (messages)	Arguments / voting	No	No
<i>Baoqu</i>	Solve complex discussions	Large groups	Yes (comments)	Groups of 5 to 25 users in subsequent levels that require qualified majority	No	No
<i>Decide Madrid</i>	Create proposals, deliberate and vote	City residents	Yes (comments)	Popular referendum	Feasibility reports	No
<i>Appgree</i>	Create representativeness of a whole through small groups	Large groups	No (answers to questions)	Representative voting for answers	No	(Demorank)
<i>Quoners</i>	Help groups decide on what they agree (or disagree) with	Large and small groups	Yes (pro and cons arguments)	Vote for multiple answers	No	No
<i>Consider.it</i>	Create a discussion forum: participants opinions grouped in favor or against any topic	Large groups	Yes (pro and cons arguments)	No voting (decision based on opinions)	No	(Doctoral research)
<i>Parlement et Citoyens</i>	Tool that allows citizens and deputies to collaboratively draft legislative proposals	Large groups	Yes (pro and cons arguments)	Arguments / voting	No	No

Table 2. Comparison of different participatory tools. Source: own elaboration.

First, in relation to the main *goals* pursued by these different tools, *CoGovern* and *Decide Madrid* are both oriented to incorporate city residents preferences into policy decision-making processes at local level. The rest of tools, with the exception of the French tool *Parlement et Citoyens* (P&C), do not seek to influence political decisions. P&C allows citizens and deputies to collaboratively draft legislative proposals, therefore, it represents an interesting attempt to scaling-up in terms of political influence beyond local contexts. Second, regarding the *types of users*, three main groups were identified: small groups, large groups, and citizens residents. Small groups refer to, for example, co-workers, family, friends or activists, whilst large groups lack specific shared interests, locations, or strong ties. In contrast, citizens residents refer to the whole set of people officially registered in a particular city. *CoGovern*, therefore, falls clearly into the latter group in which is included *Decide Madrid* as well as other tools developed by local administrations (not included in the table), such as *Decidim Barcelona*, *Participa Getafe* and *Budget Participatif* in Paris. Third, as for *argument functionalities*, although all the tools considered here allow participants to include additional information supporting decisions, most of them are treated as comments. Just *CoGovern*, *quoners*, *consider.it*, and P&C do structure them as arguments in favour and

against. Fourth, regarding *how do citizens decide*, some of them combine the use of online argumentation and voting systems. That is the case of *CoGovern*, *Loomio* and *P&C*. In *consider.it*, by contrast, decisions are not taken through traditional voting, since the aim is to aggregate opinions (not votes). On the other hand, in *Decide-Madrid*, those proposals that have received support from at least 1% of the whole population in Madrid can be voted online or in polling stations during “the referendum week”. *Appgree* and *Quoners* offer different modalities of voting whereas *Baoqu* develops an scalable system for massive deliberation based on agreements in small groups which scales up to higher decisions levels. Fifth, the existence of *monitoring systems* to trace the fate of proposals is especially relevant for our goal of increasing transparency and accountability. As table 1 shows, current tools lack in this respect. Lastly, the most innovative aspect in *CoGovern* is the usage of *AI* in the decision-making process, which seems to be in early development stages for current tools. *Appgree* and *Consider.it* are the tools that include more sophisticated computation or research. Nevertheless, rather than taking decisions, *Appgree* uses an algorithm (DemoRank) to randomly choose a small group of people as representative of the whole, whilst *Consider.it* graphically clusters people based on their opinions.

The future research of the *CoGovern* tool focuses mainly on developing the prototype until reaching an alpha phase, which will allow us to test it with groups of citizens and policymakers to detect which parts can be improved when analyzing the user experience. Specifically, as was done at the beginning of the project (see point 3.1), we should check the degree of satisfaction between citizens and policymakers with both the usability of the tool and the proposals selection method presented in this article. In relation to the latter, we plan to present the outcome of the decision (list of proposals) as a comparison of the traditional model of vote-counting and the optimization proposed by *CoGovern* in order to evaluate the user's reaction.

Beyond implementation of the current proposal, we also plan to include improvements such as the enrichment of the argumentation, so that pro and con arguments can also be counterargued (although simplicity forces us to prevent further counterarguments). Finally, another future objective concerns having the rules of the *game* as transparent as possible, since the proposals selection process constitutes the most sensitive feature of *CoGovern*. In this sense, we consider it fundamental that we be able to communicate in a very intuitive manner about the internal functioning of the tool. To that end, we plan to explore visual metaphors to help explain not only the results of the selection process but also how decisions were taken.

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