Gamification and Simulation for Innovation

Petra Ahrweiler[1][0009-0008-8773-3181], Nigel Gilbert[2][0000-0002-5937-2410],

Martha Bicket[2][0000-0001-9904-4182], Albert Sabater Coll[3][0000-0003-3532-6572],

Blanca Luque Capellas[1][0000-0002-9237-5285], David Wurster[1][0009-0005-2312-6532],

Jesús M. Siqueiros[1,4][0000-0001-8008-6198], and Elisabeth Späth[1][0009-0001-5872-5050]

[1] TISSS Lab, Johannes Gutenberg University, Jakob-Welder-Weg 20, 55128 Mainz, Germany
[2] CRESS, University of Surrey, Guildford G2 7XH, United Kingdom
[3] Observatory for Ethics in Artificial Intelligence, University of Girona, 17004 Girona, Spain
[4] IIMAS, Universidad Nacional Autónoma de México, Yucatán, México
petra.ahrweiler@uni-mainz.de

Abstract. This paper introduces and illustrates a process for stakeholder-driven innovation in a highly contested domain: using artificial intelligence (AI) algorithms for social service delivery in national welfare systems. AI technologies are increasingly being applied because they are assumed to lead to efficiency gains. However, the use of AI is being challenged for its fairness. Existing biases and discrimination in service delivery appear to be perpetuated and cemented as a result of basing the AI on machine learning of past data. Fairness, however, is a dynamic cultural concept: its meaning in terms of values and beliefs, its implications for technology design, and the desired techno-futures need to be societally negotiated with all stakeholders, especially vulnerable groups suffering from current practices. The challenge is to provide contextualized, value-sensitive and participatory AI that is responsive to societal needs and change. The 'AI for Assessment' (AI FORA[1]) project combines empirical research on AI-based social service delivery with gamification at community-based multi-stakeholder workshops and a series of case-specific agent-based models for assessing the status quo of AI-based distribution fairness in different countries, for simulating desired policy scenarios, and for generating an approach to 'Better AI'. The paper is structured as follows: after introducing the participatory approach of AI FORA with its motivation and overall elements, the paper focuses on gamification and simulation as central components of the modelling strategy. Case-specific game design and ABMs are described and illustrated using the example of the AI FORA Spanish case study.

Keywords: Stakeholder-Driven Innovation, Artificial Intelligence For Assessment, Gamification.

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1 Participatory approach

1.1 Motivation

Public administrations are increasingly using Artificial Intelligence (AI) algorithms to decide on the provision of public social services such as unemployment benefits, pension entitlements, kindergarten places and social assistance to their citizens, hoping to achieve greater efficiency and objectivity [1] [2]. Data profiles of citizens are analysed and assessed, and profiles automatically checked and scored to determine whether their owners are eligible to receive support from the state. However, AI-based social assessment systems, because they are based on machine learning from historical data, are accused of perpetuating bias and discrimination, often to the detriment of the most vulnerable groups in society.

Everybody is a stakeholder

Worldwide, national welfare systems are challenged by scarce public resources, increasing citizen demands for state support, and growing population sizes. Public social services address people's vital needs from cradle to grave, trying to alleviate poverty and inequalities and ensure fair living conditions. Most people use them at some point in their lives [3]. How to ensure a fair distribution of taxpayers' money is therefore a recurrent policy issue that depends on a society's ideas of social justice and fairness.

The question of social assessment, i.e., who gets what from the state, concerns everybody, whether a policymaker hoping for efficiency and objectivity in allocation, a recipient hoping for support and wellbeing, a service provider, a taxpayer, or a member of a vulnerable group. Whether the introduction of AI into social assessment makes things better or worse is of interest to everyone and makes everyone a potential stakeholder in determining the design of social assessment innovations. The participatory approach described below involves multiple societal groups co-designing technology for AI-based social assessment.

Cultural values and social context are key

Who is considered as eligible, needy and deserving to be a beneficiary will always imply decisions that privilege certain groups while discriminating against others. Criteria vary widely around the world. There is no approach to social assessment that would be perceived as fair everywhere.

Fairness concepts vary across national welfare systems depending on culture, religious tradition, and belief system [4] [5] [6]. In India, for example, decisions of the Public Distribution System (PDS) are related to caste membership; and in the Chinese social credit system, people receive benefits according to their individual 'social credit' score that rewards state-desired behaviour. Even within Europe, there is wide variation in the cultural connotations of fairness: while in some cultures age discrimination in the labour market is highly objectionable, in other cultures it is more accepted on the grounds that it makes room for younger generations and can be compensated through

pension benefits. All of this is in constant flux and impacts on the margin of discretion [4] [7] [8] [9] [10] that public administrations have while following legal and policy frameworks on social assessment. Can a machine map this cultural diversity of ideas of social justice? And perhaps even dynamically address social reform processes that seek to reduce discrimination and bias in individual societies? The participatory approach described below provides input for contextualized AI that is responsive to societal value dynamics and allows for case-specific answers and solutions.

Involving vulnerable groups in innovation

In each national welfare system, there are winners and losers and sometimes the most vulnerable groups that should benefit most from state interventions fall through the social net [11]. 'Losers' are often not sufficiently represented in democratic procedures and political participation activities. However, vulnerable groups, in particular those who have fallen through the social net or are not benefiting from it, can provide valuable information about the injustices, failures, and flaws of existing social assessment systems [12] [13]. To improve such systems, vulnerable groups need to be empowered to bring their experience to bear on the co-design of technology [12] [14] [13]. Eliminating injustice, bias, and discrimination in AI-enabled social service delivery requires the voices of non-recipients and critics, not just those of recipients, decision-makers, service providers, or technology producers. The participatory approach described below allows inputs from all these groups.

1.2 Method

How can contextualized, value-sensitive, responsive and dynamic AI systems be co-designed starting from existing systems that are perceived as problematic? It needs a participatory reconstruction and review of existing systems followed by a participatory anticipation, projection and realisation of the desired systems. The 'AI for Assessment' (AI FORA) project is following this sequence for a range of case study welfare systems, chosen to maximise their heterogeneity.

Selecting welfare systems for case studies

To achieve the required heterogeneity of national welfare systems from a broad variety of cultural contexts, we used the seventh wave of the World Values Survey 2021, the so-called Inglehart-Welzel map [15], supported by a factor analysis from the Hofstede dimensions [16], to select countries from cultural clusters that were as heterogeneous as possible. This led to the following set of welfare systems: Estonia, Spain, USA, India, Germany, China, Ukraine, Iran, and Nigeria (in addition, Mexico was planned but could not be realised).

From existing to desired systems

The participatory modelling strategy was designed to support the transition from existing to desired systems. The strategy has the following elements for each case study:

1. A workshop is held to map out the overall existing case study system as a flow chart.
2. An Agent-Based Model (ABM) that models the current social assessment system, including the initial ruleset (ruleset version 1) and exemplar agent attributes, is written.
3. The initial ruleset is checked and refined by running the ABM to become ruleset version 2.
4. Rules for a game to be played with stakeholders are written.
5. At a gamification workshop with the stakeholders, ruleset version 2 is gradually adapted by the stakeholders to become a better ruleset (version 3).
6. The 'better ruleset' is extracted using the records from the game play.
7. The ABM is modified to incorporate the better ruleset.
8. As a demonstration of how the ruleset could be used within an AI based assessment system, a neural network trained using data generated from the ABM ruleset version 3 is created which could be used to assess applicants.

Figure 1 depicts the modelling process, elements of which are now introduced in more detail.

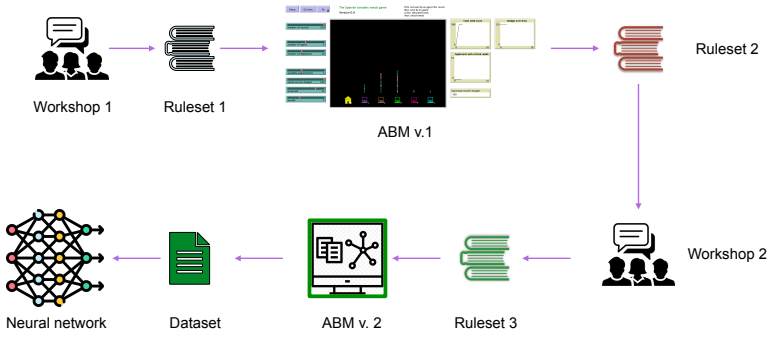

Fig. 1. Illustration of the modelling strategy

Review of existing systems

A detailed system map about how social assessment routines for distributing social services are conceptualised, organised and institutionalized in each case study country was created. This included a policy analysis and a technical analysis for each context. Mapping the existing actor network required research, both quantitative and qualitative, complemented by Participatory Systems Mapping [17] to reconstruct the existing system from the perspective of stakeholders. This work provided information on the

actors involved, the societal norms and values that stakeholders used as reference for social assessment routines, the organisational practices and routines in place, and the system's performance.

One challenge was to include vulnerable groups in the co-design process. To encourage and empower 'losers' and critics of current distribution practices to make their voices heard, the 'Safe Spaces' concept was used [20] to provide opportunities for actors to communicate without being preconfigured, discriminated against or intimidated by the environment. Several of the safe spaces were in monasteries, which provided a neutral and unthreatening context.

The system mapping revealed gaps and barriers apparent from the perspective of stakeholders. It also showed their views about more desirable solutions in both the technical and the social realms. These findings were then validated in multi-stakeholder workshops, described in the next sub-section.

Gamification as a method

Interactive and participatory formats at multi-stakeholder workshops brought forth the culturally shaped and heterogeneous value perspectives of the local social groups. As a central component, participants played 'serious games' for co-designing better AI systems [18] [19] [21]. Gamification, i.e., applying game elements in non-game contexts [22], is a low-threshold entry point for non-scientists to contribute to research. The games were designed to explore how people from different backgrounds would create systems that were better from their cultural perspective. Each gamification workshop included about 25 participants and was preceded by surveys of participants, training including role-playing, group work and guided consideration, and focus groups for discussion and deliberation. Games create a controlled setting with observability, measurability and comparability. They complement data collection on the desired scenarios for better AI systems from a stakeholder perspective [14] [23] and help to identify questions for scenario simulations. Stakeholders suggested, discussed, co-developed and tested interventions in all parts of the system, including the social assessment criteria ('changing the algorithm'). The gamification approach empowered stakeholders to deal with the problem of distributing scarce resources in the discussion and negotiation context of their specific socio-cultural setting. Data about their 'gamified solution' was used as input for the ABM of the desired system.

Anticipating, projecting and realising desired systems

Once the 'better' ruleset had been determined though the iterative process of building ABMs and running gamification workshops, it was used to generate a neural network as a demonstration of how such a ruleset could be deployed for social assessment. The neural network (a form of artificial intelligence tool) was trained to mimic the inputs and outputs of the ABM. Once trained, it could be tested using the attributes of real applicants and its verdicts considered in a further and final workshop with stakeholders.

Using the example of our most-advanced Spanish case study, the next section of the paper will look at the participatory modelling strategy in more detail focusing on the interplay between gamification at stakeholder workshops and agent-based simulation.

2 An example: the Spanish case

The participatory modelling strategy is now illustrated by describing how it has been applied to the Spanish case study. The main goal of this case study is to examine the perceptions, attitudes and acceptance of AI-based social assessment technologies by policy makers and administrative agencies locally in Catalonia, a frontrunner Spanish region in the adoption of digital technologies for the public sector. A mixed-methods methodology which involves gamification workshops, focus groups, and discourse analysis with in-depth interviews with a variety of stakeholders and media sources from state, regional and local news, was employed. Given the overrepresentation of vulnerable groups who use social services in the cities of Barcelona, Girona, Mataró and Olot, special emphasis was given to the impact of AI systems on such groups, particularly migrant populations.

Since poverty, social exclusion and vulnerability require information and access to various data sources to make a proper assessment of an individual's social status, a digital assessment tool supports social service clerks in the diagnosis and detection of complex cases and guides the intervention and follow up on each individual case. The tool is called the 'Self-Sufficiency Matrix Catalunya (SSM-Cat)' by municipalities in Catalonia. It originated from The Netherlands [26] and the USA [27] and was adapted and validated by the Department of Work, Social Affairs and Families of the Generalitat de Catalunya, in collaboration with Municipal Associations and the College of Social Work and the College of Educators and Social Educators. It is now in use in all municipalities with the aim of unifying an assessment system that, until recently, only existed in some localities.

While previous methods of assessment for social provision of complex needs were subjective, depending on the opinions of social service clerks, the SSM-Cat reduces discretion by measuring an individual's degree of self-sufficiency along 13 dimensions. In doing so, the tool reduces the social worker's task to obtaining a relatively simple view of complex social needs.

The introduction of the SSM-Cat at the local level had two main objectives. First, it aimed to increase transparency in the decision-making process. Second, it was designed to provide a more consistent and comparable tool for monitoring the allocation of social services across municipalities whilst striving to enhance fairness in social service provision.

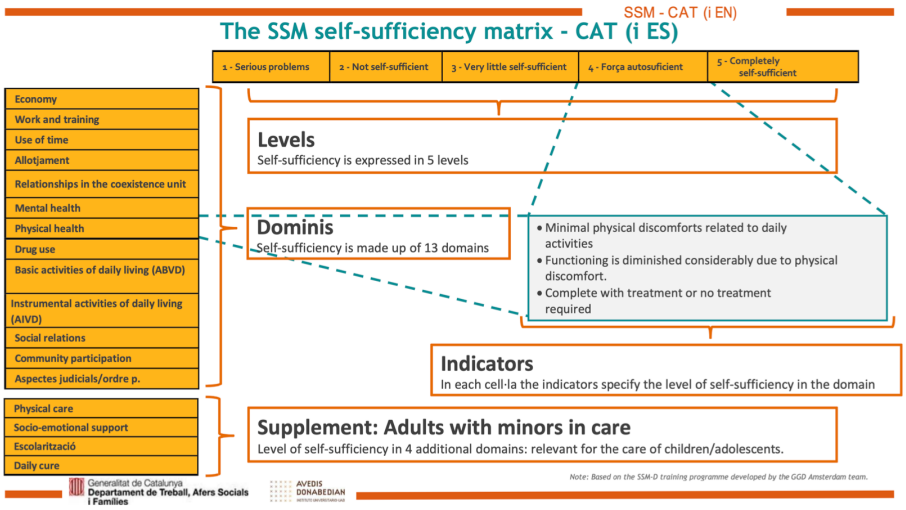

Fig. 2. The Self-Sufficiency Matrix (SSM)

2.1 The Spanish ABM

An agent-based model was developed to represent the existing system of social assessment used by local authorities in the region of Catalunya known as the SSM-Cat. While the SSM-Cat evaluates 13 dimensions of an individual's well-being and classifies each dimension into levels of fulfilment, for the sake of simplicity the ABM reduced this to 6 dimensions: household income, accommodation, work and training, mental health and physical health, and an overall need score. The level of self-sufficiency on each dimension is scored on a five-point Likert scale, where 5 indicates that they are entirely self-sufficient, and 1 that they have acute problems or needs.

In this section, the main features of the ABM are described using the framework proposed in [28].

Agents

The central entities of the ABM are social service clerks working in a municipality. Clerks work at desks. They seek to allocate limited social service resources to deserving applicants, many of whom have multiple, complex needs in their profiles. Applicants hoping to be seen and allocated budget by the clerks are represented as agents positioned and progressing in front of clerks' desks. The clerks' aim is to identify and allocate social service resources to applicants to maximise the wellbeing of applicants. For this, clerks try to minimise the sum of the applicants' needs scores on six attributes with a score between 1 and 5 score on each (1 = self-sufficient; 5 = needy), resulting in a need score between 6 and 30.

The applicants have attributes that either vary during the simulation or are fixed at initialisation.

Varying

- Overall need score
- Household income
- Accommodation[2]
- Work and training[2]
- Mental health[2]
- Physical health[2]

Fixed:

- Number of dependents

Environment

Applicants can be at home (at the end of each round), or they can be queueing in front of a clerk's desk.

Some global attributes describe the environment in which the clerks and applicants interact:

- Number of applicants
- Number of clerks
- Number of the round, starting with zero
- Social services budget measured in money units, which is refreshed at the end of each round
- Available appointments (the number of applicants that clerks can see each round)
- Threshold (the threshold above which applicants are considered critically-in-need). If any applicant's need score is above this threshold, the next round's budget is reduced.

The clerks can observe the budget, the number of applicants queueing at their desk and the threshold.

Actions and interactions

Clerks review and score applicants based on an algorithm that depends on the ruleset and the applicants' attributes. The initial algorithm is described below, but new rules can be implemented to match a desired system e.g., by applying a new rule to the order in which applicants are seen by agents in each round, changing the scoring algorithm, or changing how the budget is allocated to successful applicants at the end of each round.

For the attributes, *household income* and *number of dependents*, applicants are ranked against each other and given between 1 and 5 need points based on their position

[2] * These attributes correspond directly to those in the SSM-CAT self-sufficiency matrix (2020_07_08_sistemes informació SSM-CAT en-GB.pdf)

relative to other applicants that round. For all other attributes, the points assigned to applicants by clerks are shown in Table 1.

Table 1. Need points for scoring

Need points	5	4	3	2	1
Applicant´s score	Serious problems	Not self-sufficient	Minimally self-sufficient	Sufficiently self-sufficient	Completely self-sufficient

Receiving support alleviates an applicant's worst needs-category (decreasing it by 1). If an applicant did not receive any support in that round, and if they had any categories where they had a score greater than or equal to 4 (not self-sufficient) then those and one other attribute, chosen at random, gets worse (their scores are decreased by 1).

An applicant may then experience a random change in fortune before the next round. There is a 10% chance that one of their attributes will worsen by 1 and a 10% chance that one of them will improve by 1.

When critically needy applicants' requirements are not met in a round, this impacts the upcoming round's available budget because these applicants will draw on social services elsewhere in the system. However, the applicants' need scores are not improved.

Temporality

If an applicant's score is good enough (<= 2), applicants stay at home for a round rather than visiting a clerk. Applicants in need of an appointment are evenly distributed to clerks at the beginning of each round.

At the end of the round the social service budget is distributed to successful applicants in order of severity: the highest scoring applicant is paid, then second highest applicant and so on until the budget for that round is used up.

At the end of each round, applicants' needs are updated depending on their existing needs and whether they received support.

The run ends if there is no budget left at the beginning of a round to allocate to applicants.

NetLogo implementation and interface

The model is implemented in NetLogo and available at https://github.com/micrology/AIFORA/tree/main/Games/Spain. Figure 3 depicts the interface after ten rounds.

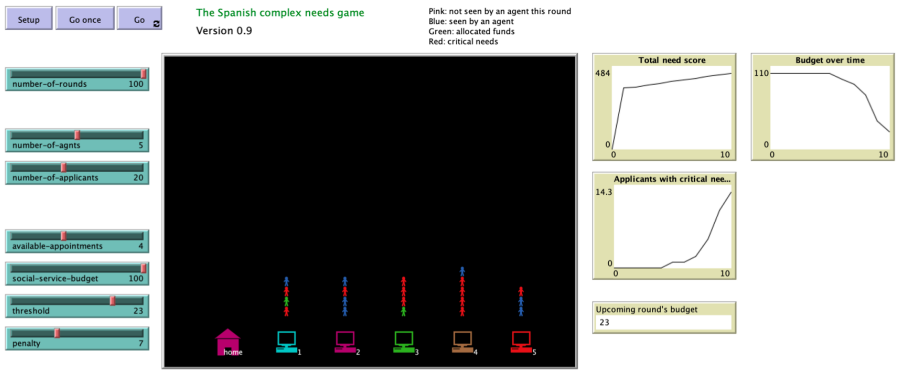

Fig. 3. Spanish case study ABM

A home station and 5 clerk desks can be seen. The number of desks can be changed with a slider. Available appointments per clerk are set to 4. Twenty applicants (this number can be also changed) are distributed between the desks. Blue applicants have been seen by the clerk that round but have not received support; green applicants have received support; and red applicants have critical needs. Pink applicants (there are none in this snapshot) would not have been seen by a clerk that round. The available budget is changeable by a slider, as is the threshold for critical needs and the penalty for having too many applicants with critical needs in the system. As can be seen from the plots on the right, the system is not in good shape: the budget is nearly gone, there is a high total need score, and there are many applicants with critical needs.

2.2 The Spanish game

The role of the ABM described in the previous section is to act as a kind of theorem checking device for the ruleset derived from the one in place in the empirical system under investigation, in this case social assessment in Catalunya. The ABM ensures that the ruleset is coherent and complete, and it acts as an informed starting point for devising a better algorithm. However, the ruleset does not capture informal practice, might be considered as unfair, and might not produce desired system features. Improving the ruleset requires stakeholder involvement.

In Catalunyan municipalities, the assessment of individuals seeking social assistance is not further standardized beyond the SSM-Cat. An individual's assessment depends entirely on the social workers' perceptions and experiences in using, specifying and interpreting the SSM-Cat. The gamification workshop is designed to investigate the assessment behaviour of social workers's involvement in policy practice using the SSM-Cat.

Purpose of the game

The stakeholders attending the workshop held in May 2023 in a 'Safe Space' at Montserrat Abbey consisted of social service workers from Barcelona, Girona and Mataro as well as practitioners in social service provision from local NGOs such as Caritas and the Red Cross, all of whom had a good understanding of the Self-Sufficiency Matrix and experience in using it. Prior research had shown that their ideas for improvements to obtain a more desirable system varied greatly.

The purpose of arranging the game was to investigate the variety of criteria used in decision making for assessment with the SSM-Cat, to examine whether social workers were able to develop an 'interpretation culture' about fairness issues, especially concerning vulnerable populations, and to see whether they would converge in judging applicants' profiles. Although social workers sometimes struggled for consistency in their interpretation of the needy profiles, the game demonstrated that it is generally possible to identify specific guidelines or rules related to an 'interpretation culture' that help them make more accurate and consistent judgments across different applicants or profiles and situations.

The game

The central characters in the game are ten social service clerks working in a municipality. In the game, stakeholders sit in pairs at five service desks, one playing the responsible officer, the other an office helper supporting procedures at the desk, thus allowing his/her colleague to concentrate on an applicant.

The applicants, twenty individuals requesting social service support, are played by researchers present at the workshop. Each applicant has an identity card with a short biographical narrative telling their story and explaining their profile.

Home: Clerks and applicants start and end their days (a day equates to one round of the game) at home. At the start of each day, applicants receive their identity cards and make themselves familiar with its narrative. In each round, identical profiles are presented at all the desks. Clerks are randomly assigned to desks with office helpers who support filling the self-sufficiency matrix. Applicants are distributed evenly between the desks. At the end of the day, clerks and applicants return home and complete diary entries about their day and their situation.

Desks: The clerks administer the state budget, which decreases after each round of the game according to the services provided. The clerks use the self-sufficiency matrix in their assessment procedure. Clerks evaluate applicants who arrive at their desk and tell their story based on their narrative. Clerks translate the narrative into the categories of the self-sufficiency matrix and provide the applicants with social services, depending on their judgements about the applicant's profile (full social service provision, partial social service provision, or no social service provision). The helpers support the officers to complete the assessment sheets with the score for each applicant. After having seen a clerk, applicants go home. After they have assessed all the waiting applicants at their desk, the clerks go to the Office Meeting Place. Clerks can run out of budget and then have to send applicants home empty-handed.

Office Meeting Place: Clerks interact at the Office Meeting Place, moderated by a local office manager. They bring their assessment notes and can deliberate about the features of the Self-Sufficiency Matrix and their individual assessments of applicants. Clerks propose guidelines for how profiles should be assessed. A vote about whether those guidelines will be implemented is taken at the end of the round before clerks leave for home. If the proposed guidelines are accepted, the Self-Sufficiency Matrix is amended accordingly for the next round and published for all service desks.

A game continues until the state budget is exhausted. It is sufficient if there is at least one desk with budget. When the budget has run out completely, the game is at an end.

3 Outlook

The detailed results of the game for the Spanish case study are currently being analysed. This also applies to the further steps of the modelling strategy, i.e., how the results will be used to create an ABM of the desired system that will generate data for 'better AI'. However, some examples of results from the simulation-gamification component introduced above can illustrate the utility of the modelling strategy introduced in this paper.

The deliberations of the stakeholders revealed that one criterion that all the social workers used in assessment was missing in the SSM-Cat: the applicant's country of origin. The stakeholders discussed whether this criterion should be explicitly added to the SSM-Cat following the current assessment practice, or whether existing practice should be advised to change. The idea will be passed on to local policymakers.

Stakeholders were surprised to discover the degree to which the decisions they made at the start of the game about the fate of applicants varied, although they all presented with the same profile, indicating that the SSM-Cat was interpreted in widely different ways by the social workers. As previously mentioned, deliberating about profiles and assessments, however, led to some convergence of assessments during the game. Stakeholders agreed that it would make sense to develop a common interpretation culture in agencies about the criteria of the SSM-Cat, and that training on profiles and narratives as done in the game could be helpful to establish this. This idea, that will be passed on to those responsible for professional training, suggests that stakeholders engaged in collaborative decision-making processes through discussions, shared insights, and worked together to establish a shared understanding of the rules and criteria for evaluating needy profiles.

It is well documented that AI technology not only may provide biased information, but also can inadvertently reinforce existing cultural, social, and economic inequalities. Thus, if an AI system is trained on data that reflects unqual access to resources or opportunities, it may further entrench these disparities by providing advantages to dominant groups. This problem is especially important when used in the context of social assessment.

In our case study countries, the existing social assessment systems, whether based on AI or merely involving the digitalisation of previously manual systems, were all seen to be biased and discriminate against certain groups, especially vulnerable people.

Since AI is increasing being proposed as a way of making social assessment more efficient, quicker and less costly, it is important to devise ways of making such systems fairer, while recognising that 'fairer' is a culturally specific notion. The challenge that the AI FORA project is aiming to contribute to is how to design social assessment technology that is value-sensitive, contextualized, dynamic and responsive to social change. The work that we have done, using an interacting cycle of agent-based modelling and serious games, points to an approach by which the technology can be specified in a stakeholder-driven way, so that it is more transparent and discursive about bias and discrimination, includes values such as the social justice concept of the society in which it will be used, and is responsive to the needs of vulnerable groups.

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