Justice Assessment of AI for Sustainable Development Goals:
an exercise in group modelling with ontologies

Max Willis[0000−0001−9718−4966] and Greta Adamo[0000−0001−8108−2383]

Free University of Bozen-Bolzano, IT

Abstract. The exponential advances in Artificial Intelligence (AI) should provide additional resources for humanity to achieve the Sustainable Development Goals (SDGs). However, the ethical and justice implications of AI use in policy- and decision support regarding the SDGs are insufficiently attended to. Clarification is required on the responsibilities of public institutions and private interests *vis a vis* AI development, on the balance of proprietary knowledge and innovation against common goods, on the many forms of justice and wide range of agents and objects which participate in justice experiences. Scientific and non-scientific stakeholders must equally be able to carry out justice assessments. In this vision paper, we proffer that knowledge engineering can play an essential role in fostering a pluralistic understanding of justice. Its methods of ontological analysis and semantic modelling allow for the interpretation, and conceptual clarification of multiple layers of meanings, to make sense of justice forms and experiences. Seven types of justice are discussed herein, with a draft ontological model of justice assessment. A group modelling worksheet and interactive exercise is presented alongside six AI justice scenarios, taken from the literature, to get acquainted with the concept of justice, and practice *ontology-based justice assessment*.

Keywords: Justice · AI · Ontologies · Sustainable Development Goals · Group modelling

1 Introduction and motivations

Much ado has been made about the potential of AI[1] to accelerate progress on the Sustainable Development Goals (SDGs) [7,10,51]. AI advances are fostering innovations in scientific domains, such as earth-observation, environmental monitoring, geospatial science, and remote sensing [29,44,49]. New fields are emerging, such as geoAI [44], the combination of geography and AI, which requires integration of quantitative spatial and temporal observation data with qualitative

[1] In this writing, AI refers to all types of Artificial Intelligence, including symbolic, sub-symbolic and neuro-symbolic approaches, as well as specific tools and techniques, such as machine learning and neural networks, large language models, ontologies, knowledge representation and reasoning.

place-based, social data [24]. Scientists and policy-makers are increasingly turning to AI for real-world, sometimes real-time decision support, for example in humanitarian relief, disaster response, agriculture projection and urban planning [24,44]. Yet, enthusiasm surrounding the increased efficiency and data-handling capacity of certain AI systems and techniques has obscured the risks associated with unregulated use of emerging AI technologies, such as Large Language Models (LLMs), at scale [3,22] and without comprehensive regulatory frameworks [51]. Decision-making that affects the lives, and livelihoods of individuals and communities, when left solely to a machine, can result in algorithmic injustice [4] and potentially adverse consequences associated with a lack of diversity in training data, bias in labelling and database schemas [25,33], detrimental categorisation with unclear or discriminatory inclusion and exclusion criteria [26,40], and broader implications of unequal access to data, economic and educational barriers to engaging with, and benefiting from AI technologies [7,23].

In recent discourse, the meanings and applications of trustworthiness in AI have proliferated [8,11,12], amplified in the European policy arena through the the release of the "Ethics guidelines for trustworthy AI" [21], and heralded in the European Union's (somewhat partial) adoption of the AI Act [2]. These initiatives to establish a framework for ethical AI reference Floridi and colleagues' earlier outline of five ethical AI principles [12]: Beneficence, Non-maleficence, Autonomy, Justice, and Explicability. Each of these principles is open to multiple interpretations, therefore knowledge engineering approaches are called for, in particular ontologies for semantic clarification. In the field of Requirements Engineering (RE), the locus of ethical considerations in Software Engineering, frameworks for the development of ethical systems have been proposed via Ontology-based Requirements Engineering (ObRE) [18,19]. While these works examine four of the five principles, this vision paper dives into the one remaining, arguably contested, notion of *justice* [47], and extend the ontological analysis to *justice assessment* (see e.g. [27]). After the presentation of popular forms of justice, e.g. distributive, procedural, recognition, and their contextualisation within a justice assessment ontological pattern, we introduce an ontology-based group-modelling exercise that allows multi-party discussions and negotiations on the notions of justice, via AI-SDG scenario analysis.

2 Forms of justice

Justice has often been considered a *virtue*, either individual or societal (the latter as *à la* John Rawls [39]), or more broadly as a property, ascribed to different entities, also in a relational sense, i.e. how x impacts on the claims/entitlements of y [34,47]. The Stanford Encyclopedia of Philosophy in its *Justice* entry [34] highlights core aspects of justice. For instance, justice concerning individual claims, e.g. freedom, access to resources and services, the involvements of agents and institutions responsible for the enforcement of obligations, the notion of impartiality under the same conditions, and the relevance of agency enabling a course of action, also by omission. While retrieving a comprehensive review

Table 1: Forms of justice definitions.

Justice Form	Definition	Ref.
Distributive	Equitable distribution of costs, benefits and harms among people and communities, acknowledging historic, systemic inequalities and differences e.g. in income, educational opportunities, access to technology, impacts of environmental risks.	[9,31,53,56]
Procedural	Ensuring fair and democratic participation in decision-making processes and practices; meaningfully including relevant and affected stakeholder groups in multi-party discourses that shape decisions, structural and policy changes.	[9,53,56]
Recognition	Explicit acknowledgment of existing identities of inequality and differences in how risk and impact are experienced by advantaged and disadvantaged individuals and communities, and other than humans; Acceptance of pluralist perspectives on the notion of benefit and harm, working to understand assumptions, values, knowledge practices, historical, cultural, and institutional factors that influence experiences of (in)justice.	[37,42]
Epistemic	Critical appraisal of the negative effects of dominance of specific forms of knowledge and expertise (i.e. scientific, juristic) over others (e.g. tacit, local, indigenous); overcoming harms that occur in production and transmission of knowledge and ensuring equitable access to that knowledge; ensuring inclusive participation in co-production of knowledge that recognizes different ways of being and knowing in the world (i.e. cognitive justice).	[30,45,48,50]
Ontic	Attention to the potential harms of inclusion and exclusion in ontological (social) categories, how individuals and social categories are positioned within dominant social structures, how other people perceive and respond to different social categories and kinds, individual and community experiences and relationships to such categorisation	[26,28,40]
Restorative	The healing of identifiable (relational and physical) harm to humans, other species and nature through direct participation of individuals, groups or institutions who take responsibility for harm and those who have suffered harm; ensuring the accountability of those who cause harm to those who have suffered its effects.	[13,15]
Transformative	Challenging and restructuring entrenched paradigms of power, wealth and control that instantiate, contribute to, and/or reinforce social, political, economic and environmental inequities; addressing underlying structures and practices that create and reinforce vulnerabilities as the root causes of injustice.	[16,35]

regarding forms of justice is not trivial, we proceed with a breakdown of justice concepts that, for example, in Floridi's writings have been conflated with fairness, and typically relate to equal distribution of, or access to resources [12]. Drawing from climate change, sustainable development, and disaster risk literature, Table 1 summarises a broader selection of justice forms.

In 2015 the United Nations endorsed the *2030 Agenda for Sustainable Development* [1] and its 17 SDGs,[2] which are actionable plans that encompass key aspects of human and natural ecosystems well-being, e.g. poverty, education, life on land and below water. Throughout the SDG's are found many direct references to *distributive* justice, the equitable sharing and conservation of resources, to *procedural* justice that seeks to greater diversity of stakeholders to participate in knowledge co-production and decision-making processes, and to *recognition* justice, acknowledging diverse identities and experiences of justice,

[2] `https://sdgs.un.org/goals`

risks and impacts. For example, Goal 1 No Poverty, Target 1.4 states, "By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property [...]" This intones *distributive* and *recognition* justices, addressing access to resources and acknowledgment of diverse experiences of (in)justice and vulnerability. In Goal 2 Zero Hunger, Target 2.5 "[...] maintain the genetic diversity [...] and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed" additionally includes *epistemic* justice with reference to traditional knowledge as integral to genetic resources of crops and animals.

Goal 5 Gender Equality, Target 5.5 "Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life" directly calls for *procedural* justice, and Goal 17 Partnerships for the Goals, Target 17.6 "Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms [...]" expresses *epistemic* and *restorative* justice with reference to knowledge sharing and pluralistic negotiation with historically marginalized participants. Less prevalent are explicit calls for *ontic* justice, however one can be found in Goal 16 Peace, Justice and Strong Institutions, Target 16.9 "[...] provide legal identity for all, including birth registration" More explicit language regarding *restorative* and *transformative* justice has emerged in subsequent intergovernmental agreements (e.g. [32]).

3 A preliminary ontological analysis of justice assessment

An initial ontology analysis for *justice assessment* has been developed following the Ontology-based Requirements Engineering (ObRE) [18,19] approach, where ethicality requirements, including justice, are modelled using the Non-Functional Requirements Ontology (NFRO) [20] and the Common Ontology of Value and Risk (COVER) [41]. We extend ObRE, by tailoring justice-specific ontological and conceptual analyses, reusing notions from [47], and the work of Johannesson et al. on justice [27] (abbreviated as JZHK following the authors' names). Note that JZHK, NFRO and COVER are all based on the Unified Foundational Ontology, UFO [17]. The ontology pattern in Fig. 1 is not meant to be definitive, complete or mandatory, rather a starting-point to engage in multi-party discussions on the nature of justice and its assessment.

In line with COVER and similar to JZHK, JUSTICE ASSESSMENT is modelled in a relational structure as a value ascription, in which the JUSTICE ASSESSOR (an agent x) passes judgement on a JUSTICE EXPERIENCE, in which participates a JUDICANDUM OBJECT, JUDICANDUM AGENT and JUSTICE RECIPIENT. The JUDICANDUM is what is being judged, and comprises a wide variety of entities with different ontological properties, such as individual and social ACTORS (e.g. software developers, regulatory bodies), OBJECTS (e.g. AI systems, algorithms,

datasets), EVENTS (e.g. deliberations, analyses), and norms (e.g. statutes, regulations) [27]. In the context of this paper, the JUDICANDUM OBJECT is an AI artefact with DISPOSITIONS, including CAPABILITIES and VULNERABILITIES. The use of the AI results in a VALUE EVENT, that can be a negative LOSS EVENT and or a positive GAIN EVENT, while the JUDICANDUM AGENT is whoever is responsible for the design and development of the AI, the regulation of its use, and/or its actual deployment. As an example, a geoAI tool for risk assessment can be taken as a judicandum object, which has the capability (i.e. disposition) to predict drought hazards that is enabled by a machine learning algorithm. The JUSTICE RECIPIENT [27], an agent or an object *valued* by the agent, participates in a JUSTICE EXPERIENCE of justice or injustice, depending on whether their INTENTIONS are positively or negatively affected by the VALUE EVENT. In our geoAI example, indigenous people might be find themselves experiencing injustice, as justice recipients, if the land area in which they reside is excluded from drought hazard prediction due to a lack of available data.

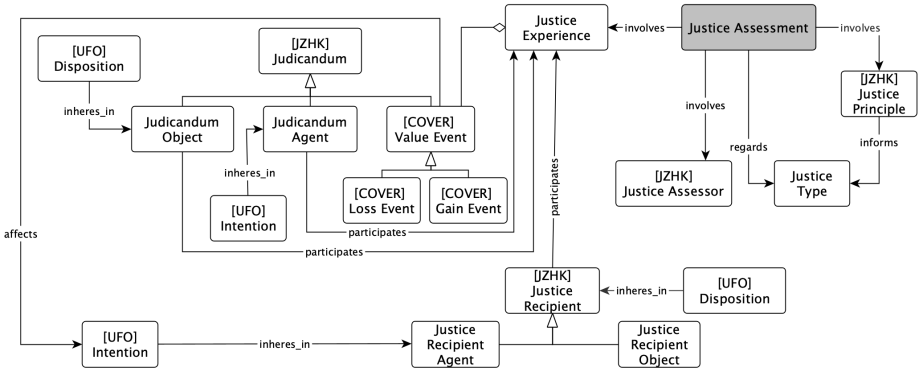


Fig. 1: Justice assessment pattern.

The JUSTICE ASSESSMENT involves a JUSTICE ASSESSOR and JUSTICE PRINCIPLES [27,47] such as capability, entitlement, equality, or proportionality, to ground and justify the assessment, and regards various forms of justice (Table 1), or JUSTICE TYPES. Consider the development of the aforementioned geoAI system for risk assessment: it causes a LOSS EVENT and *distributive injustice* by not including the areas occupied by indigenous people in its drought hazard prediction. The justice assessment can then proceed with a JUSTICE PROPOSAL, for example that by implementing participatory processes and *procedural justice*, the AI could include relevant local data (a GAIN EVENT), and by expanding system capabilities with minority language libraries, a form of *recognition justice*, those historically marginalized communities could benefit from the AI predictions (another GAIN EVENT).

4 Justice assessment exercise

The following activity introduces justice assessment for scientific and non-scientific stakeholders through semantic modelling. It can be performed individually, but better in a group of three or more participants. A workbook can be downloaded at `maxwillis.net/docs/modelling/justice_assessment2026.pdf`, which includes instructions, blank models (see Fig. 2), entity definitions, *Modeller Roles* cards, and an informed consent form, necessary to share your model(s) as research outcomes. One copy of the workbook should be printed (A3 black and white) for each group. Also included are six SDG-based scenarios, taken from the literature, in which AI can be seen as potentially, and actually, inflicting injustice (see Table 2). The Scenarios are (i) Data Centers, Energy and Water, (ii) GeoAI and educational inequalities, (iii) AI Hiring Disability Discrimination, (iv) Data availability and the Digital Divide, (v) AI Bias and Medical Triage, and (vi) AI and Worker Exploitation.

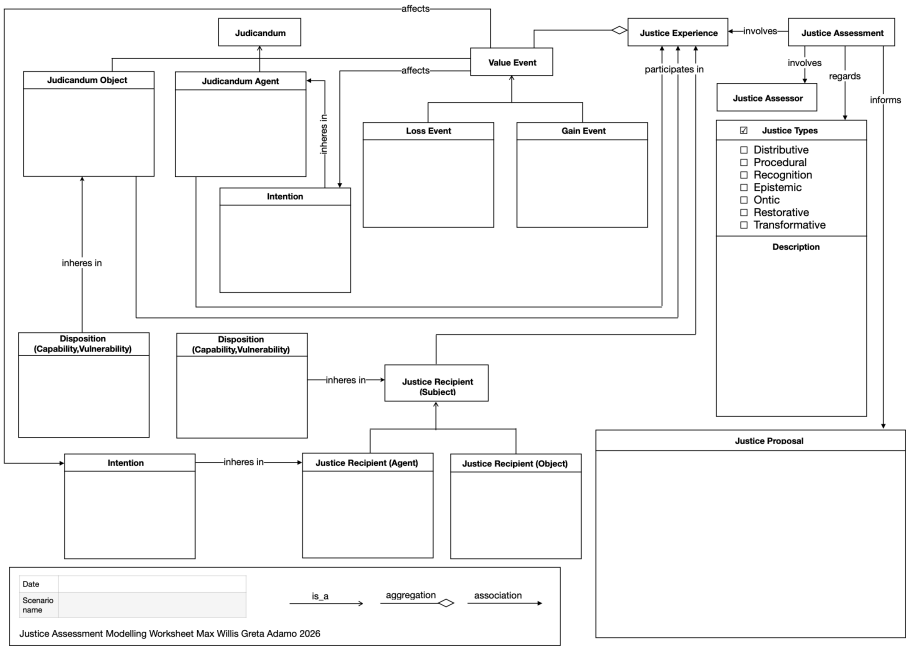


Fig. 2: Justice assessment modelling worksheet.

Instructions for the activity are as follows:

1. Download and print the exercise workbook (link here).
2. Choose one of the scenarios found in the worksheet (see Table 2).

Table 2: Justice Scenarios.

SDGs	Scenario name	Scenario	Ref.
6,10,12	**Data Centers, Energy and Water**	Rapid expansion of information infrastructures accompanies AI development. Data centers situated in rural areas consume disproportionate amounts of energy, straining local electricity grids, causing periodic outages, and raising prices, which exacerbates pre-existing energy injustice in vulnerable communities. Massive amounts of water are also needed for cooling of data center equipment, which depletes water resources, reduces availability and drives up prices for local consumers. AI and machine learning contribute to achieving energy efficiency, yet energy and water demands potentially offset sustainability gains.	[5,43,54]
4,8,10	**GeoAI and educational inequalities**	AI benefits (and technological advances in general) for work efficiency and productivity are more widely available to people with higher education levels. The integration of Geographical Information Systems, Earth Observation Data, and Machine learning (GeoAI) promises powerful decision-support for example to position and distribute resources in response to natural disasters. Many education systems in the Global South, especially in rural areas, do not have sufficient resources to provide advanced analytical and computational skills necessary for the development and use of GeoA, or the collection of relevant datasets. This reduces people's access to knowledge and AI benefits, in places where effects of natural disasters are disproportionately harsh.	[6,23]
8,10,16	**AI Hiring Disability Discrimination**	A company holds a patent for a system to identify disabled people based on physical markers, speech, mannerisms and tone. The same company markets a decision-support tool to determine which job applicants will, and won't be successful workers, based on a remote video interview. Their AI examines speech patterns, tone of voice, facial movements, and other indicators, which figure in determinations of who should continue with a follow-up interview. The system favours non-disabled people as the norm, and discriminates against job applicants with disabilities affecting vocal and facial expressions, such as deafness, blindness, speech impairments, and/or neurodivergent conditions caused by a stroke.	[14,52]
8,9,10	**Data Availability and the Digital Divide**	A tech startup in Rajastan provides coffee-specific weather forecasts for farmers throughout South India. Their AI - enabled mobile app includes text to speech interaction, in multiple languages, to inform coffee producers in their planting and harvesting schedules. The app also provides real-time market data, which determines farmgate prices for green coffee beans. Labour and financial management of smallholder coffee farms in South India is largely undertaken by women, yet due to their unequal ownership of (and access to) mobile phones, only 26 percent of the app's users are women. Women are thus further marginalized from decision making and lack adequate information to avoid being cheated.	[23,38]
3,5,16	**LLM, Bias and Medical Triage**	Hospitals increasingly implement LLM systems (e.g. GPT-4) to assist in diagnostic reasoning, clinical plan generation, and subjective patient assessment. Patient descriptions, symptoms, medical histories, self-reporting and demographic data is examined to provide preliminary diagnosis and treatment suggestions. However, GPT-4 has been shown to offer differential analysis based on patients' gender and racial profiles, for example grossly overestimating prevalence of HIV in Black males and prostate cancer in White males, suggesting more extensive diagnostic imaging only for White patients, and inferring that White males exaggerate their pain levels, while Black Males are more likely to be abusing pain medication.	[55]
3,8,12	**AI and Worker Exploitation**	Warehouse labourers are subjected to a quality and performance control system optimized in favor of business efficiency. Worker activities are tracked via surveillance while AI calculates a daily optimum productivity "rate" for each worker. If a worker falls behind their expected rate three times in a day, they are automatically fired by the AI, regardless of injury or other extenuating circumstances. The system is driving an increase in psychological stress, and work-related injury, e.g. when workers strive to meet an algorithmically set number of box lifting actions. Workers report prioritising continued work over bathroom breaks in order keep up with the algorithm. The AI dehumanise work in jobs that consistently pay less than a living wage.	[46,52]

3. As modellers you will take the perspective of JUSTICE ASSESSOR.
4. Identify the JUDICANDUM and JUSTICE RECIPIENT in the scenario, then label these entities in blank model.
5. Play the different *Modeller Roles* to fill in details of other relevant elements.
6. Identify and model potential VALUE EVENT (loss and gain) that form the JUSTICE EXPERIENCE.
7. Detail the DISPOSITIONS (CAPABILITIES and VULNERABILITIES) and which INTENTIONS are affected.
8. Add a "checkmark" to each of the JUSTICE TYPES noting why these are relevant.
9. Invent a JUSTICE PROPOSAL to overcome the perceived injustices.
10. Describe what DISPOSITION the JUDICANDUM OBJECT must have to sufficiently achieve each relevant JUSTICE TYPE.
11. If group modelling, vote on whether the proposed dispositional changes are adequate, and the JUSTICE EXPERIENCE can be re-assessed as just.

Cut out and utilise the *Modeller Roles* cards to make scenario modelling more interactive. If you perform the justice assessment solo, mix the cards and play through them randomly, adding to the model systematically as each role card directs. In a group, shuffle and distribute the cards, then take turns (or simultaneously!) to enact each role in the model worksheet. Shuffle and redistribute the cards periodically, so that each modeller has a chance to consider the justice experience from multiple points of view.

Scenario analysis example. In Table 2, consider the last scenario "AI and Worker Exploitation." The AI system is the JUDICANDUM OBJECT, deployed by the company, more specifically the factory managers JUDICANDUM AGENT, which benefits from increased worker productivity, a VALUE EVENT. The maximization of productivity *vis a vis* worker salary is a GAIN EVENT for the factory managers, as it satisfies their INTENTIONS to make the most profit. That same VALUE EVENT manifests as a LOSS EVENT in the workers' JUSTICE EXPERIENCE, for as JUSTICE RECIPIENTS that optimisation impacts negatively on their INTENTIONS, for example to not be injured at work, and to take bathroom breaks without penalty. The AI overlooks, for instance, that some workers, as JUSTICE RECIPIENTS, may have disabilities, recent injuries, or be pregnant their DISPOSITIONS, VULNERABILITIES. These workers cannot constantly perform at the AI-suggested level without negative physical and mental health consequences, a LOSS EVENT.

A union representative might serve as JUSTICE ASSESSOR, and conclude that the system is unjust in terms of *recognition justice*, as it does not attend to the diversity of workers, and *epistemic justice*, as the AI draws all of its knowledge about human capabilities in the factory work from statistical analysis and surveillance of workers activities. A JUSTICE PROPOSAL could suggest, for example, implementing a self-evaluation for workers to report their daily health and well-being status *procedural justice*, which could be factored, by the AI, as a more human-centric information source *epistemic justice* into the expected productivity level. This change represents a potential GAIN EVENT, that can reduce

the physical and mental stress of workers, and create a more just experience in the workplace. By following through the modelling worksheet, and using the modelling role cards, a thorough model or visualisation of the justice scenario can be achieved.

5 Vision recap and conclusion

This paper addresses some of the key themes of the EKAW 2026 conference. Asking what is the role of knowledge engineering in AI, we point out how ontologies and semantic analysis can bridge the gap between knowledge systems and real world issues of ethics and justice. We look forward into potential (and already very real) roadblocks to egalitarian access and just participation in the new AI landscapes that are forming. Through a hands-on ontology-based group modelling activity, we demonstrate how knowledge engineering can bring the human into the loop of any and all AI approaches, overcoming some limitations of algorithmic autocracy with a checks-and-balance that can be performed by scientific and non-scientific stakeholders alike. Ultimately we make the case that justice is not a novel requirement for high-quality knowledge, but an essential one, and by practicing techniques such as group modelling we open the process of knowing, and knowledge co-production [36] to inform near-future revolutions in AI. Most importantly, this vision paper does not speculate on possible roles for knowledge engineers in the emergent future of LLM automation and neuro-symbolic approaches, but offers a concrete example of the discipline in action, enabling Justice Assessment of AI for sustainable development scenarios via participatory group modelling with ontologies.

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