Overview

Purpose

To evaluate whether the pragmatist account of value change proposed in van de Poel and Kudina (2022) can successfully reproduce the four phenomena of value change: (1) the inevitability and stability of values, (2) societies differ in openness and resistance to change, (3) moral revolutions, and (4) lock-in.

Entities, state variables, and scales

Globals
- Number of needs in society
- Propensity of society to value dynamism, value adaptation, or innovation
- Openness to changes in society
- Value memory of society
- External shocks affecting society's needs

Needs
- Size
- Type of technologies to be addressed

Humans
- Which needs each human is addressing

Technologies
- Performance level
- List of potential moral problems created when used
- Acceptability

Moral problems
- Size
- State: absent, unperceived, perceived

Values
- Importance
- Moral problem addressed

Process overview and scheduling

1. Agent (huma) chooses a need to fulfill.
2. Agent moves towards technologies and select those required to fulfill the need. If available, the agent chooses technologies that are deemed morally acceptable (black).
3. Agent moves to the need and fulfills it.
4. As a result of the use of the technology, new moral problems can be created or existing moral problems become more severe. If the size of the moral problem exceeds a first threshold, it becomes existent (but still unperceived by society). If the size exceeds a second threshold or if society has values corresponding to this moral problem, the moral problem is perceived.
5. If the technology results in a perceived moral problem, the agent takes action. The agent can choose one of the following actions depending on the preferences of the society:
    a. Value dynamism: the magnitude of the value related to the moral problem increases only temporarily. If the value does not exist, it is created.
    b. Value adaptation: the importance of the value related to the moral problem is increased. If the value does not exist, it is created.
    c. Innovation: a new technology that is in line with values in society (i.e., morally acceptable) is created. The innovation is successful based on a random draw.
6. After having performed one of the action, the agent returns to base.
7. With each tick, the acceptability of technologies is updated. A technology is unacceptable when its negative impacts on certain values are larger than the importance of the corresponding values.

Design concepts

Design concepts

Theoretical and empirical background
- Pragmatist account of value change proposed in van de Poel and Kudina (2022)

Individual decision making
- Agents decide which technology should be used to fulfill the need, and how to react to emerging moral problems (value dynamism, value adaptation, or innovation)

Learning
- Agents learn how to use technologies more efficiently. The more a technology is used, the more efficient its use becomes. A technology used more efficiently will reduce the moral problems it causes, even if some moral problems are unavoidable. This learning effect introduces a lock-in mechanism in the model. Societies might stick to one technology even if a second technology is fundamentally better (i.e., it creates significantly fewer moral concerns).

Individual sensing

	- Agents move towards technologies, needs, values, and the innovation area. Agents adjust their trajectory when technologies and values have moved on the map. *Individual prediction* - None *Interaction* - Agents interact with technologies to evaluate which will be used to address the need. Agents choose morally acceptable technologies (in black in the model) and more efficient (they have been used more frequently by other agents). - Agents interact with needs to address them using the technologies they have gathered. After this interaction, the need is set to 'fulfilled'. - Agents interact with moral concerns to evaluate if they are perceived through societal values or if the severity of the moral problem exceeds a certain threshold). - Agents interact with values to increase their importance due to emerging moral concerns (value dynamism and adaptation). *Collectives* - Multiple technologies that can address the same need may exist (as a result of the creation of new technologies through innovation). Agents choose a morally acceptable technology with the highest performance level if available. *Heterogeneity* - Technologies are heterogeneous in terms of the potential moral problems they may create. - Needs are heterogenous as they require different technologies to be fulfilled. They also have different sizes, which means that addressing this need is likely to cause stronger moral problems. - Values have different levels of importance *Stochasticity* The following elements are stochastic in the model: - At the start of the model: the importance of values, the size of needs, and the potential moral problems created by existing technologies. - The moment a need becomes active, which signals agents that they should take action. - Whether innovation is successful *Observation* The model provides outputs that describe how well society can cope with moral problems: - Number of unperceived moral problems - Number of perceived moral problems - Total severity of moral problems - Number of morally unacceptable technologies in use
Details	**Implementation details** The model was implemented in Netlogo. The analysis was performed with PyNetlogo (Jaxa-Rozen and Kwakkel 2018).
	Initialization - Agents are randomly placed on the model grid - Aents choose a first need to address - Values are attributed an initial level of importance - Needs are attributed an initial size - A number of technologies is created per function - Values evaluate whether existing technologies are morally unacceptable
	Input data - The model was built based on a description of the pragmatist account of value change proposed in van de Poel and Kudina (2022). We have not used empirical data. We attribute values to agents through scales (e.g., between 0 and 10) to evaluate the impact of low and high values on model outcomes (e.g., a low vs. a high propensity for value adaptation).
	Submodels - None