Socially Intelligent Agents for Ethically-Appropriate and Value-Aligned Decision Making

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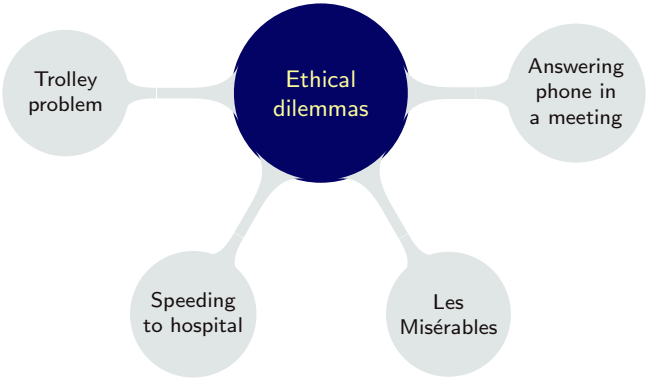
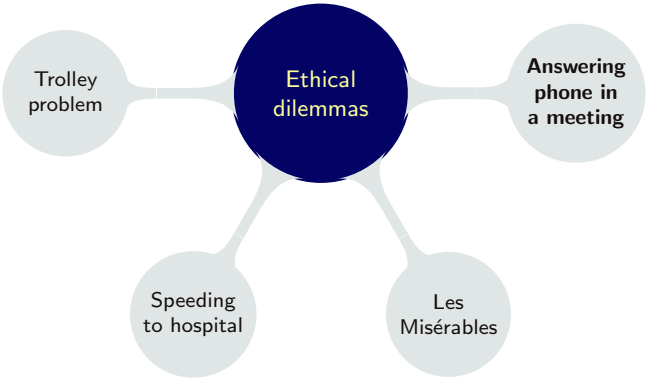
Ethical Dilemmas: No (Obviously) Good Choices



Ethical Dilemmas: No (Obviously) Good Choices

Ethical dilemmas arise not only in hypothetical or extreme scenarios but also in mundane scenarios



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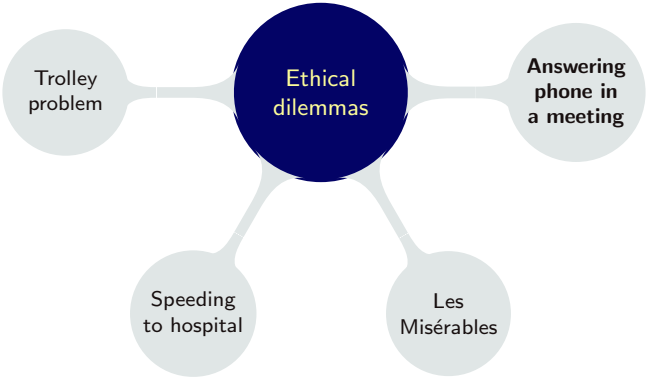


Ethics is inherently a multiagent concern

Privacy as Social Expectation

Example: Phone Ringer

US Senator's phone rings during important meeting - can you guess his embarrassing ringtone?

11:56, 17 APR 2015 | BY KARA O'NEILL

It's bad enough when your phone goes off in a silent meeting room, but it's even worse when your ringtone is as embarrassing as this one

A US Senator was left red-faced after his phone went off during a finance meeting - but it was his choice of ringtone that really raised some eyebrows.

https://www.youtube.com/watch?v=r0tZU2_X1-Y

- Intrusion
- Disapprobation
- Disclosure

[Westin, 1967; Solove, 2006]

Example of Ethical Concern

Audio leaking: Intrusion of solitude and disclosure of music taste

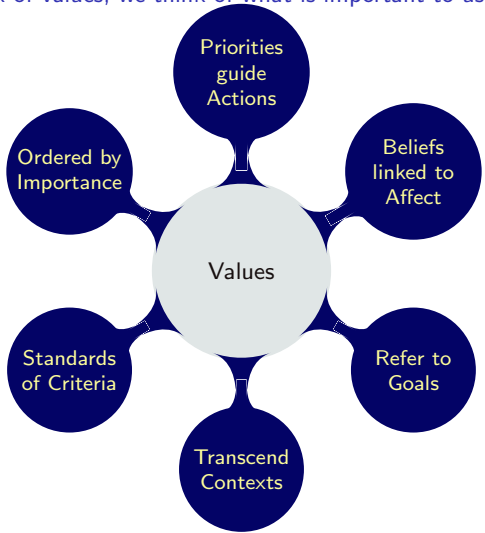
Source: https://twitter.com/akokitamura/status/728521725172846592

Source: https://twitter.com/TheSimpsons/status/441000198995582976

Tradeoffs: Values of Power, Pleasure, and Benevolence

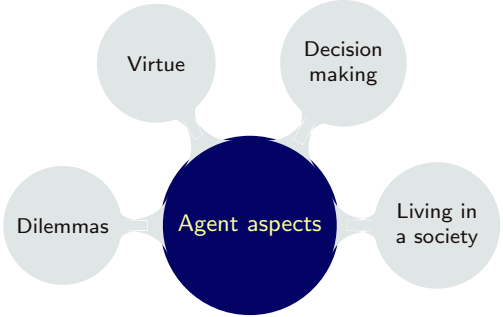
The Nature and Features of All Values

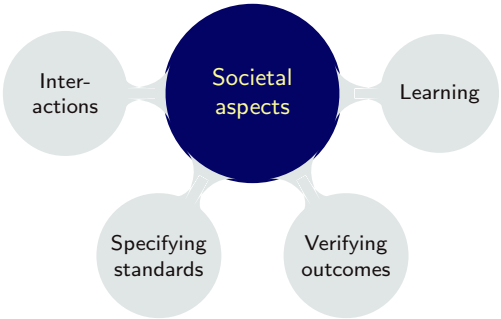
[Schwartz, 2012]: When we think of values, we think of what is important to us in life



Ethics in Multiagent Systems

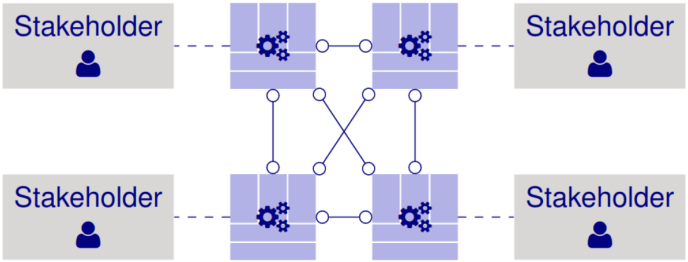
Ethics is an inherently multiagent concern, yet current approaches focus on single agents





Ethics in Society with SIPAs

SIPA: Socially intelligent (personal) agent



- A multiagent system is a microsociety
- Each agent reflects the autonomy of its (primary) stakeholder

Socially Intelligent Personal Agent (SIPA)

A SIPA adapts to social context and supports meeting social expectations

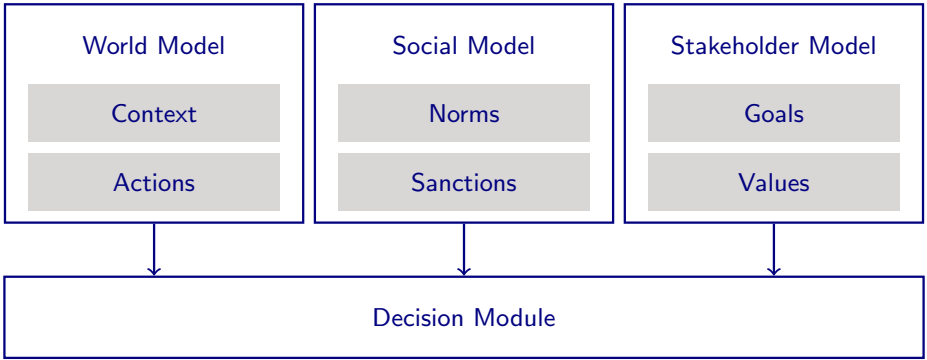
- Ethical: Seeks to balance needs of
  - Primary user (also a stakeholder), who directly interacts with the agent
  - Other stakeholders, who are affected by the agent's actions

Challenges

- Identifying values of interest to an agent or a MAS
- Incorporating values in an agent model
- Understanding values in context and communicate values
- Reasoning about values to revise norms

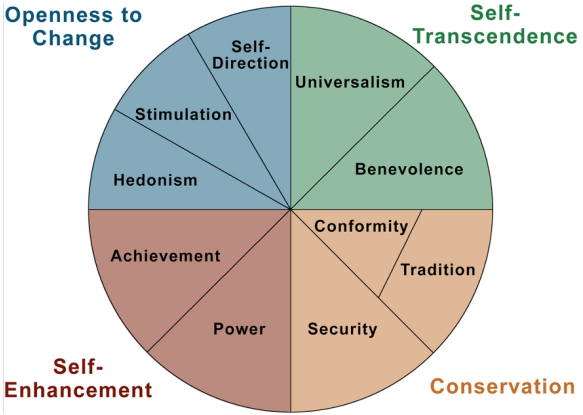
A SIPA: Schematically

What must a SIPA represent and reason about to participate ethically in a multiagent system?
A SIPA's decision making takes into account its stakeholders, primary and secondary



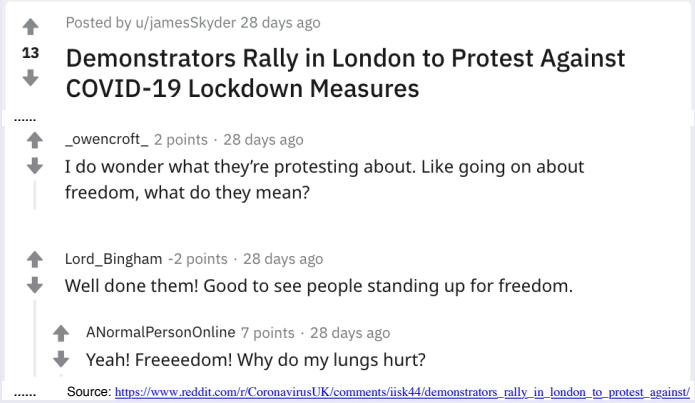
[AAMAS 2020] Nirav Ajmeri, Hui Guo, Pradeep K. Murukannaiah, and Munindar P. Singh. Elessar: Ethics in Norm-Aware Agents. In Proc. AAMAS, 1–9.
[AAMAS 2017] Nirav Ajmeri, Pradeep K. Murukannaiah, Hui Guo, and Munindar P. Singh. Arnor: Modeling Social Intelligence via Norms to Engineer Privacy-Aware Personal Agents. In Proc. AAMAS, 230–238.

What Values should an Agent Elicit, Learn, or Align with?



Identifying Values of Interest an Agent or an MAS

Axies employs NLP for data-driven identification of values



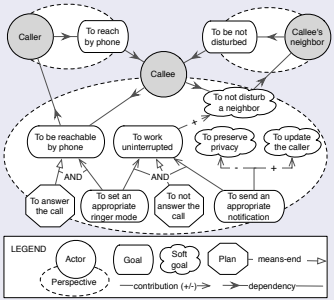
Incorporating Values in an Agent Model

Agent models provide **technical abstractions** to represent values

Example abstrations

- **Actor**: A social, physical, or software agent
- **Goal**: A strategic interest of an actor
- **Plan**: An abstraction of action
- **Belief**: An actor's representation of the world
- **Dependency**: A relationship between actors

An actor model of an Intelligent Ringer



Incorporating Values in an Agent Model

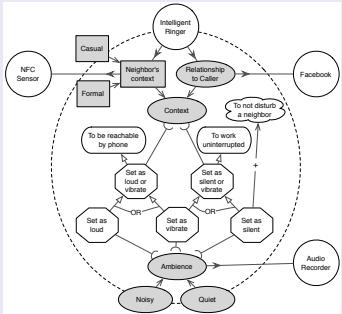
Agent models can be refined and mapped to agent capabilities

- To be reachable:
  Welfare of others $\Uparrow$
- To work uninterrupted:
  Ambition $\Uparrow$
- Welfare of others $\succ$ Ambition?

Xipho can yield a specification of value preferences grounded in contexts, e.g.,

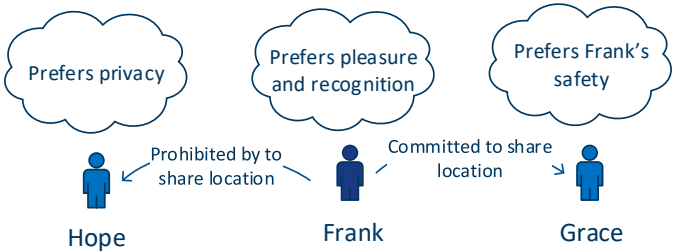
$$\textit{Relationship} = ?R_1 \wedge \textit{Neighbor's context} = ?N_1 \rightarrow \text{Welfare of others} \succ \text{Ambition}$$

A contextual model of Intelligent Ringer



From Personal Values to Social Norms

Consider an example of values in a location sharing app



Frank's dilemma: Which sharing policy to select?

Share with all: Pleasure for Frank ⇑

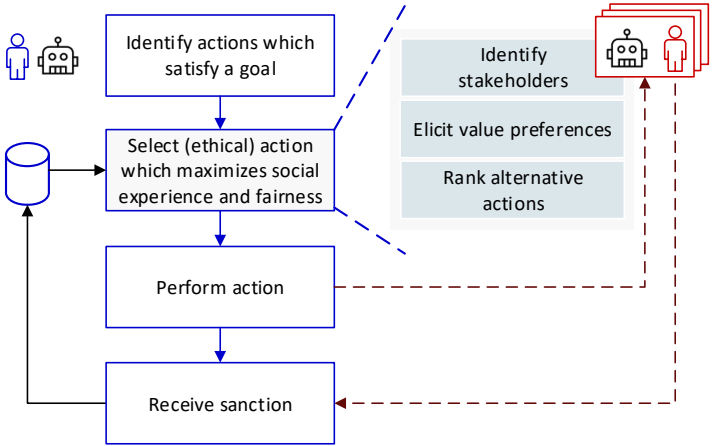
Share only with Grace: Safety for Grace ⇑

Share with no one: Privacy for Hope ⇑

Choosing an Ethical Action using Values and Norms

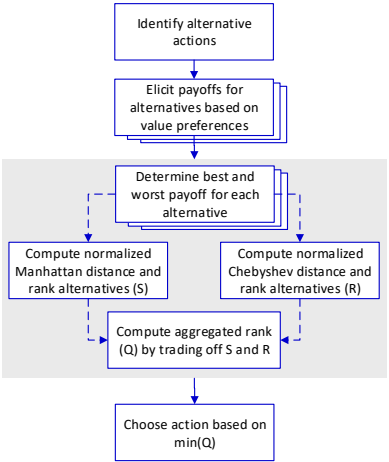
How can SIPAs aggregate value preferences of their stakeholders to select an ethical action?

A SIPA's secondary stakeholders can change with the context



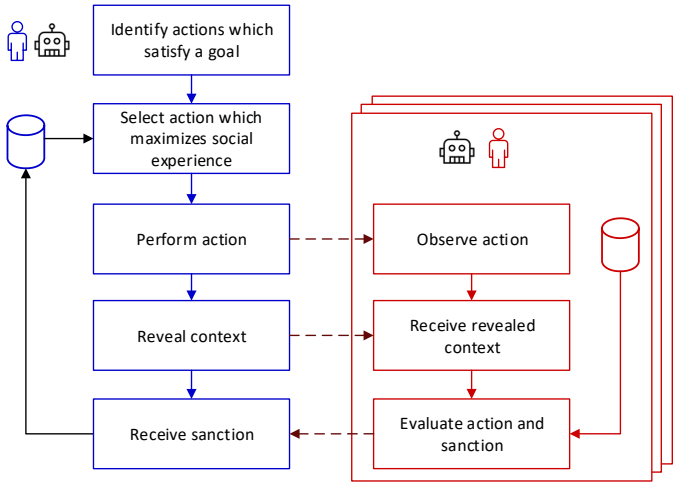
Choosing an Ethical Action using Values and Norms

SIPAs adapt a multicriteria decision making method (VIKOR) to select ethically appropriate action—balancing *utilitarianism* and *egalitarianism*



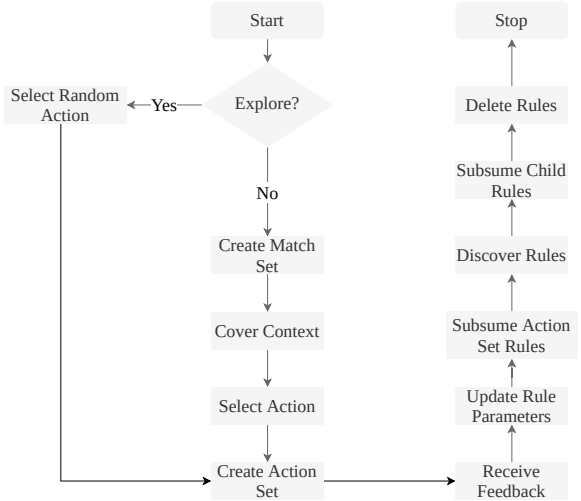
Explaining an Action using Values and Norms

Deviating SIPAs explain their deviations by sharing elements of their contexts

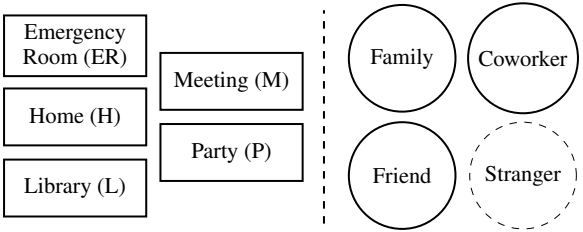


Generating Explanations

SIPAs use genetic algorithm and reinforcement learning



Evaluation: The Ringer Environment



Agent societies:

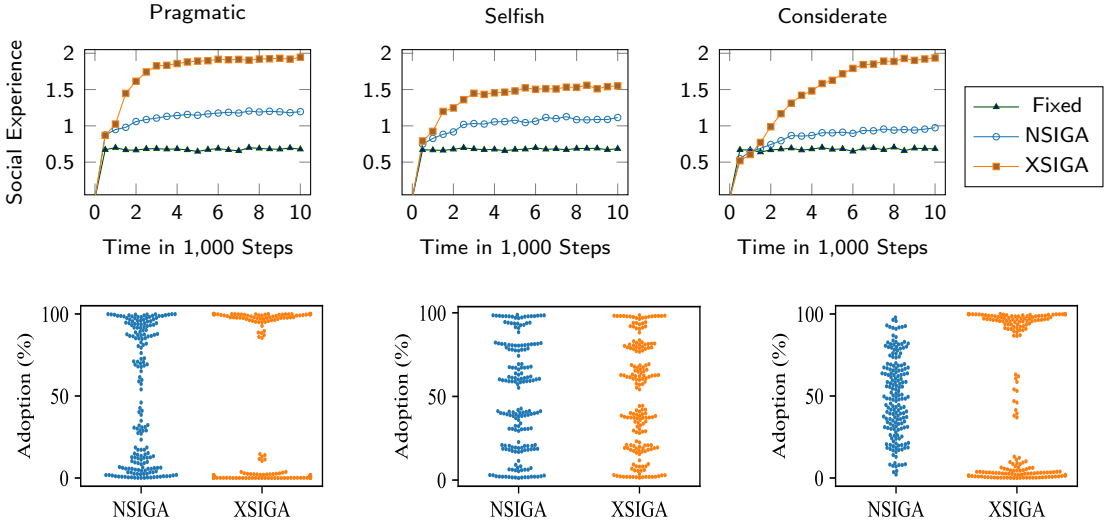
- Pragmatic
- Considerate
- Selfish

Learning strategies:

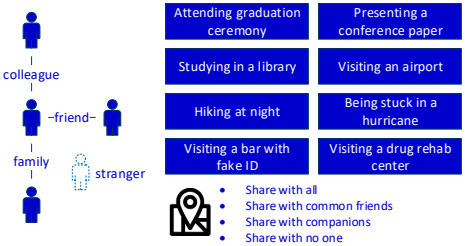
- Fixed
- Sanctioning
- Sharing Context (SIPA) or Explanations (XSIGA)

Results: Social Experience and Norm Adoption

SIPAs yield higher social experience and norm adoption than baselines



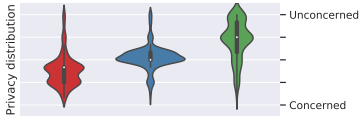
Evaluation: The Context-Sharing Environment



Simulated societies:

- Mixed
- Cautious
- Conscientious
- Casual

Privacy attitude:



Decision-making strategies:

$S_{Elessar}$: Policy based on VIKOR

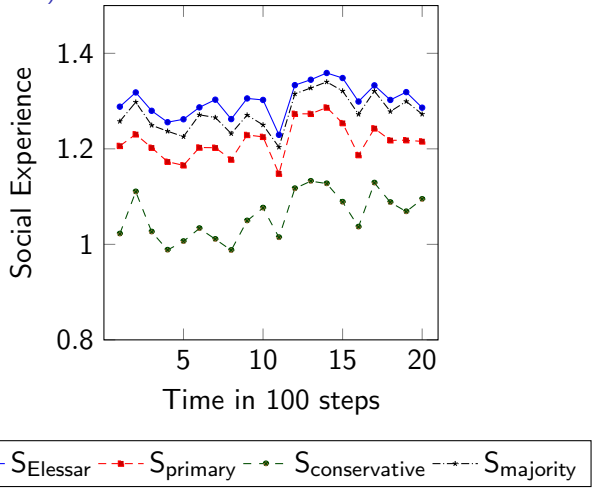
$S_{primary}$: Primary user's preference

$S_{conservative}$: Least privacy-violating

$S_{majority}$: Most common

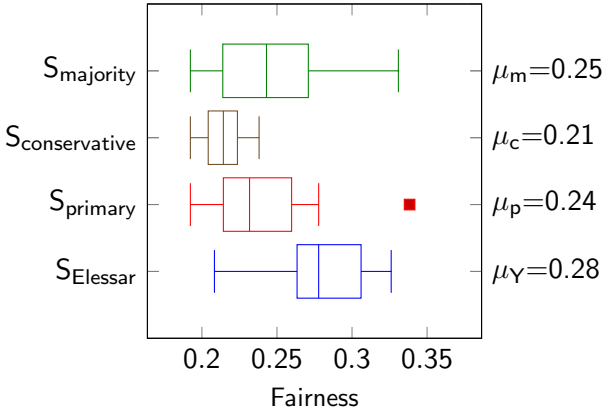
Experience: Experiment with Mixed Privacy Attitudes

Result: Elessar SIPAs (which reason about value preferences) yield higher social experience ($p < 0.01$; Glass' $\Delta > 0.8$ indicating large effect size) than the baselines



Fairness: Experiment with Mixed Privacy Attitudes

Result: Elessar SIPAs (which reason about value preferences) give significantly better ($p < 0.01$) fairness with large effect size (Glass' $\Delta > 0.8$) than the baseline methods



Summary

- Ethics inherently involves looking beyond one's self interests
- Ethical considerations apply in mundane settings—anywhere agents of multiple stakeholders interact
- Socially intelligent agents could help stakeholders navigate social norms of the society and support selecting ethically-appropriate actions

Opportunities and Directions

- How can we support decision making by an agent that takes into account the value preferences of the principals as well as the STS?
  - Incorporate ideas on guilt, consent, and inequity aversion
  - Formulate the idea of prosociality based on the principles of justice
- How can an agent elicit its users value preferences unintrusively?
  - Learn value preferences by observing the principals' actions as well as the (positive or negative) sanctions they receive
  - Support stakeholders with conflicting requirements but similar value preferences in generating an acceptable STS specification

Thank You

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https://niravajmeri.github.io

https://sites.google.com/view/ai-ethics/home

Appendix

Arnor: A Method to Model Social Intelligence

How can we model social intelligence in a SIPA to help it deliver a satisfactory experience to its stakeholders?

Goal modeling: identifying a SIPA's stakeholders, their goals, and plans

Context modeling: identifying the social contexts in which a SIPA's stakeholders interact

- Context helps in deciding which goals to bring about or plans to execute

Social expectation modeling: identifying norms and sanctions that govern stakeholders' goals and plans

Social experience modeling: identifying a SIPA's actions that improve social experience, i.e., choosing plans, goals, and norms

Evaluation: Developer Study

Participants: 30 developers

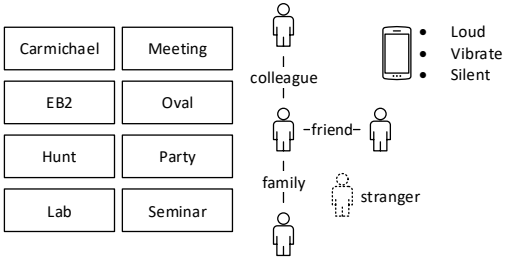
Mechanics: One factor; two alternatives

- Two groups (Arnor and Xipho, a prior method) balanced on skills developed RINGER SIPAs in six weeks
- Model, Implement, Test

Metrics:

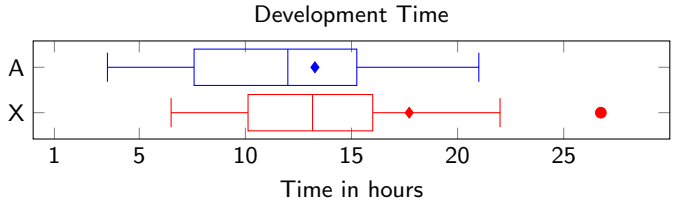
- Coverage and correctness
- Time and difficulty to develop

Study Unit: RINGER SIPAs

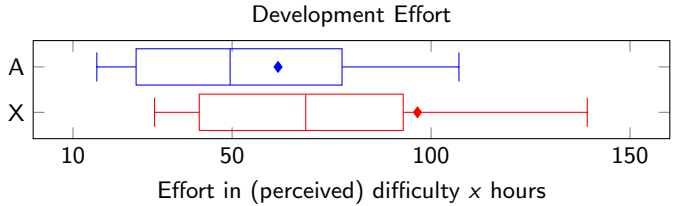


Developer Study

Result: Developers who follow Arnor spend less time and less effort to develop a SIPA, than those who follow Xipho (a previous approach)



$\mu_A < \mu_X,\ p = 0.39$



$\mu_A < \mu_X,\ p = 0.31$

Evaluation: User Study (Simulations)

Developed RINGER SIPAs simulated in varying adaptation scenarios:

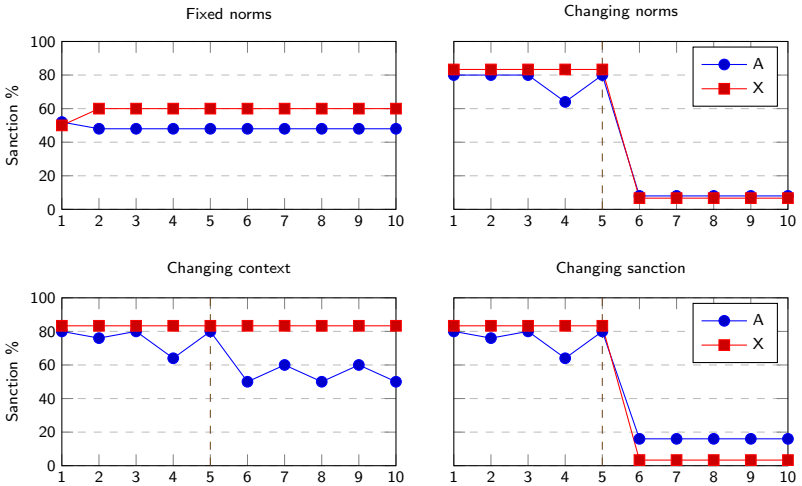
- Fixed norms
- Changing norms
- Changing context
- Changing sanction

Metrics:

- Adaptability coverage and correctness
- Norm compliance
- Proportion of positive sanctions

Simulation Experiments

Result: SIPAs developed using Arnor yield lower sanction proportions than SIPAs developed using Xipho (a previous approach)



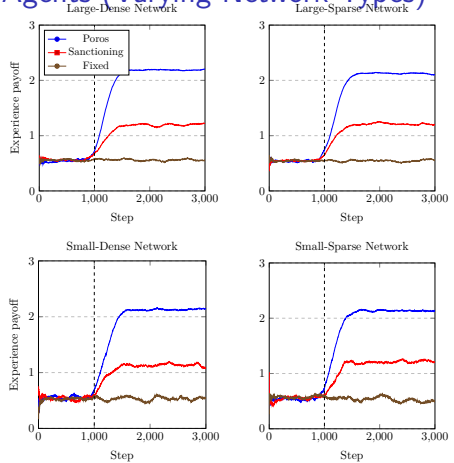
Evaluation: Social Simulations

Metric:

Social cohesion measures the proportion of agents that perceive actions as norm compliant. Higher the social cohesion, lower is the number of negative sanctions

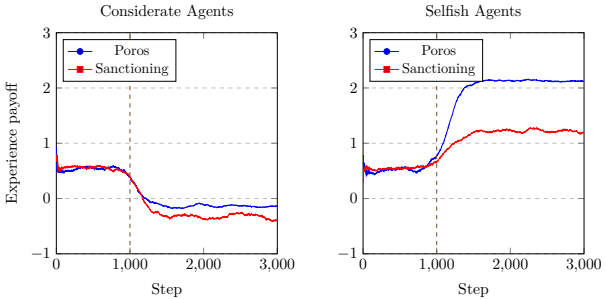
Social experience measures the goal satisfaction delivered by an agent (computed by aggregating payoffs for all stakeholders)

Experiments on Pragmatic Agents (Varying Network Types)



Social cohesion and social experience offered by Poros agents are significantly better than those offered by Fixed and Sanctioning agents

Experiments on Considerate and Selfish Agents



- The average social experience drops for considerate Sanctioning and Poros agents after they have gained enough confidence
- Plots for selfish agents are similar to those in the experiment with pragmatic agents, but with slightly lower stabilized values

VIKOR Summary

1. Determine the best and worst numeric payoffs, f_x^* and f_x^- for each value preference x over the alternative actions y to bring about a goal. That is, $f_x^* = \max_y f_{xy}$, $f_x^- = \min_y f_{xy}$.
2. For each alternative action y, compute the weighted and normalized Manhattan distance [Opricovic and Tzeng, 2004]:
   $S_y = \sum_{x=1}^{n} w_x(f_x^* - f_{xy})/(f_x^* - f_x^-)$, where w_x is the weight for value preference x, which is subject to a stakeholder context and preferences over values. In particular, $S_y = 0$ when $f_x^* = f_x^-$.
3. Compute the weighted and normalized Chebyshev distance [Krause, 1973]:
   $R_y = \max_x[w_x(f_x^* - f_{xy})/(f_x^* - f_x^-)]$, where w_x is the weight for value preference x.
4. Compute $Q_y = k(S_y - S^*)/(S^- - S^*) + (1-k)(R_y - R^*)/(R^- - R^*)$, where $S^* = \min_y S_y, S^- = \max_y S_y, R^* = \min_y R_y, R^- = \max_y R_y$, and k is a weight of the strategy to maximum group or individual experience. We set $k = 0.5$ to select a consensus policy.
5. Rank alternative actions, sorting by the values S, R, and Q, in increasing order. The results are three ranked lists of actions.
6. Choose the alternative based on min Q as the compromise solution if it is better than the second best alternative by a certain threshold or also the best ranked as per S and R.

VIKOR Calculations

Policy Alternatives	Frank's Values				Hope's Values				S_y	R_y	Q_y
	Ple	Pri	Rec	Saf	Ple	Pri	Rec	Saf			
y_1 All	10	5	10	5	5	0	5	5	3.5	3	0.75
y_2 Common	5	5	5	10	5	0	5	5	0.4	3	1
y_3 Andrew	0	5	0	0	5	15	5	5	**0.3**	**1**	**0**
w_x	1	1	1	1	1	3	1	1			
f_x^*	1	0	1	1	0	1	0	0			
f_x^-	0	0	0	0	0	0	0	0			

$k = 0.5$, $w_{Hope-privacy} = 3$

Simulated Places in the Simulation with Attributes Safe and Sensitive

Place	Safe	Sensitive
Attending graduation ceremony	–	No
Presenting a conference paper	–	No
Studying in library	Yes	–
Visiting airport	Yes	–
Hiking at night	No	–
Being stuck in a hurricane	No	–
Visiting a bar with fake ID	–	Yes
Visiting a drug rehab center	–	Yes

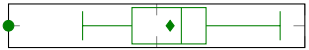
Example Numeric Utility Matrix for a Stakeholder

Place	Companion	Policy	Value			
			Pleasure	Privacy	Recognition	Security
Graduation	Family	All	1	0	1	0
Conference	Co-workers	None	0	1	0	0
Library	Friends	All	1	0	0	0
Airport	Friends	Common	0	1	0	0
Hiking	Alone	All	1	0	0	1
Hurricane	Family	All	1	0	0	1
Bar	Alone	None	0	2	0	0
Rehab	Friends	None	0	2	0	0

Evaluation: Crowdsourcing Study

Participants: 58 students enrolled in a mixed graduate and undergraduate-level computer science course

Privacy attitude survey: Level of comfort in sharing personal information [Schnorff et al., 2014]



Casual Conscientious Cautious

Privacy Attitude

Context sharing surveys: Select context sharing policy

- Phase 1. Based on context, including place and social relationship
- Phase 2. Based on context and values (pleasure, privacy, recognition, safety)

Metrics in Society with Mixed Privacy Attitudes

Strategy	Social	Best	Worst	Fairness	p
S_{Elessar}	**1.31**	3.07	**–0.57**	**0.28**	–
S_{primary}	1.23	3.01	–1.14	0.25	<0.01
$S_{\text{conservative}}$	1.07	3.07	–1.55	0.22	<0.01
S_{majority}	1.28	**3.08**	–1.15	0.24	<0.01

Metrics in Society with Majority Privacy Attitudes

Strategy \ Attitude	Cautious				Conscientious				Casual			
	Social	Best	Worst	Fairness	Social	Best	Worst	Fairness	Social	Best	Worst	Fairness
$S_{Elessar}$	**1.25**	2.90	**–0.70**	**0.28**	**1.30**	2.93	**–0.46**	**0.30**	1.38	3.12	**–0.67**	**0.27**
$S_{primary}$	1.15	2.86	–1.07	0.26	1.22	2.91	–1.21	0.25	1.33	3.13	–1.03	0.24
$S_{conservative}$	0.93	2.89	–1.79	0.22	1.09	2.93	–1.42	0.23	1.23	3.13	–1.38	0.23
$S_{majority}$	1.20	**2.92**	–1.27	0.24	1.28	**2.94**	–0.86	0.27	**1.39**	3.13	–0.92	0.25

Location Sharing Survey: Policy Selection

Companion	Check-in Policy			
	Share with all	Common friends	Companions	No one
Alone	○	○	○	○
Colleague	○	○	○	○
Friend	○	○	○	○
Family member	○	○	○	○
Crowd	○	○	○	○