

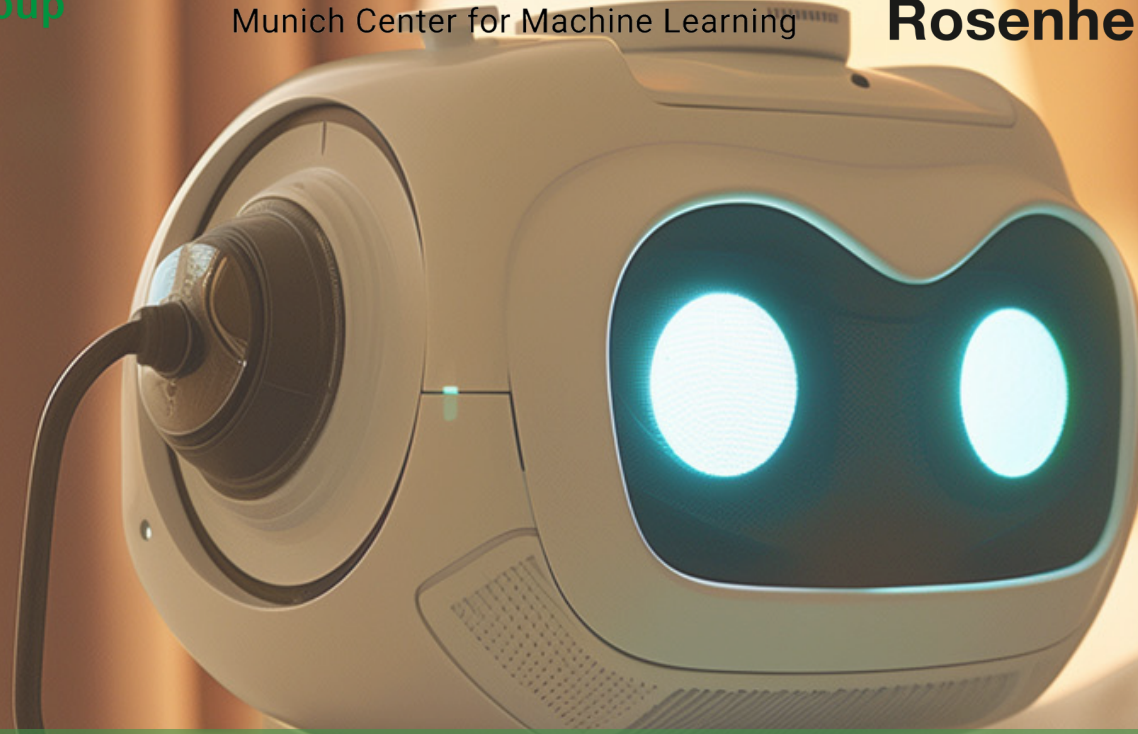


Media  
Informatics  
Group



Munich Center for Machine Learning

Technische  
Hochschule  
**Rosenheim**



# Privacy Communication Patterns for Domestic Robots

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# Research Questions

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RQ1

How do privacy concerns change with increasing levels of **locomotion** and **interaction** capabilities?

RQ2

Which **patterns** should domestic robots employ to communicate their privacy-relevant functionalities to users?

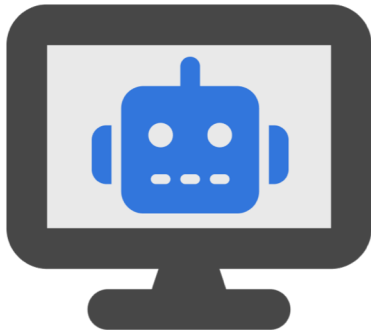
RQ3

Which communication patterns perform best regarding **trust**, **privacy**, **understandability**, **notification qualities**, and **general user preference**?

# Method

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Study I (RQ1): Online Survey  
on Privacy Concern (N=90)



Study II (RQ2): Focus Groups on  
Communication Patterns (N=22)



Study III (RQ3): Communication  
Patterns Evaluation (N=1720)



# Study I: Method

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- Online survey on Prolific (N=90)
- 3 Interaction levels: Passive, limited, full
- 4 locomotion levels: Stationary, linear, planar, world
- Every participant rated all 12 combinations



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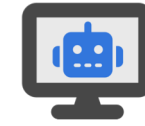
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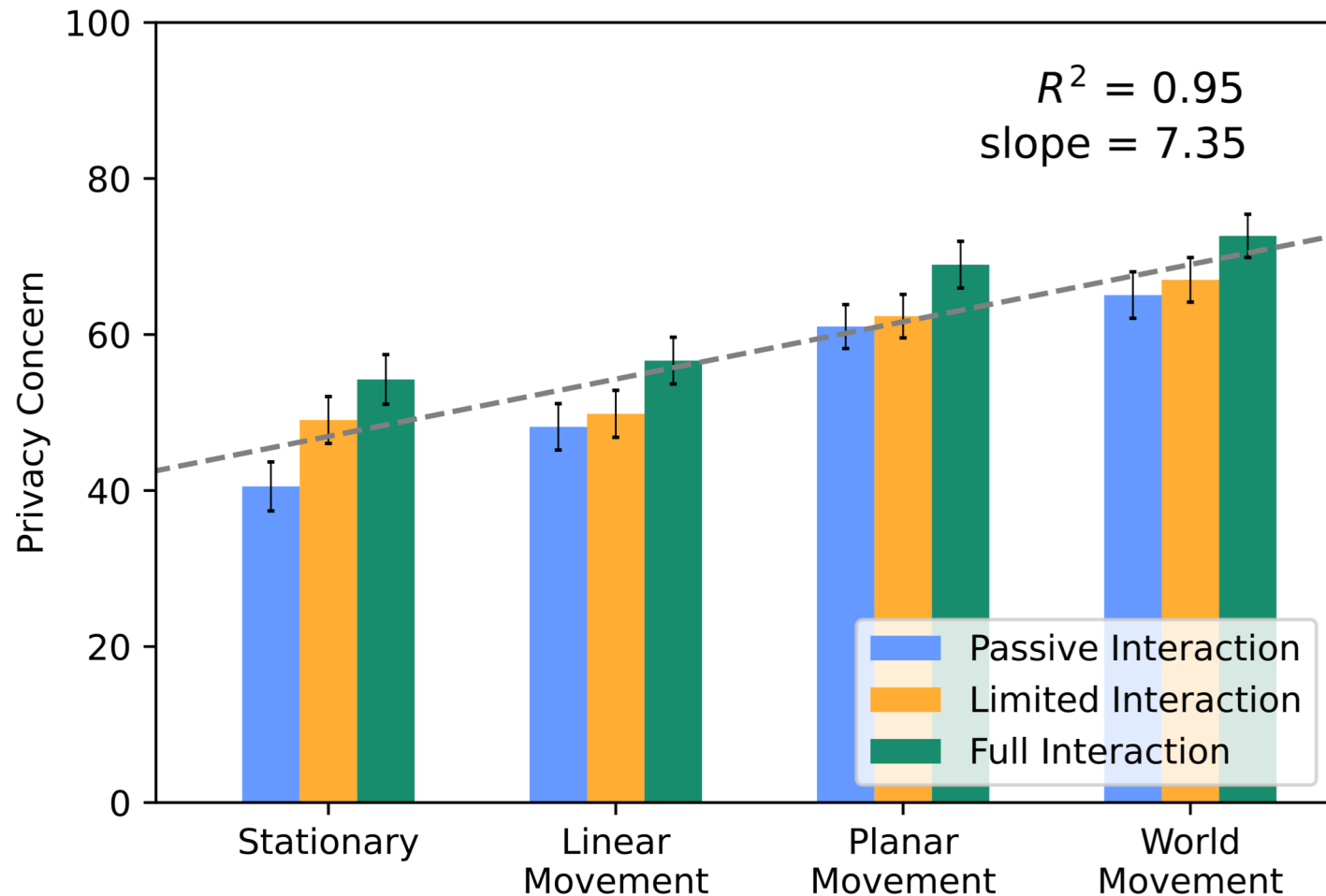
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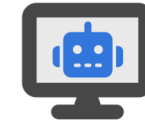
<https://robotsguide.com/robots/atlas2016>



# Study I: Quantitative Results



*"I am strongly concerned about my privacy due to the presence of the smart assistant."*  
Asked on 100-point visual analogue scale



# Study I: Qualitative Results

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"[I have] full control on what it sees." (P66)

## Concerns Rooted in Interaction

"It can probably open doors and enter areas in times where I don't want it to." (P43)

"It's hard to avoid it popping up unexpectedly, isn't it?" (P56)

## Concerns Rooted in Locomotion

"Due to its limitation to one floor I might feel a bit safer with my privacy, I can move downstairs or upstairs." (P43)

Microphone

"It might be recording conversations." (P27)

Camera

"I don't like to be watched." (P57)

## Additional User Concerns

Internet Connectivity

"I always question if the assistant passes what it perceives to a third party or a remote server." (P46)

A futuristic white robot with glowing blue eyes and a green translucent overlay containing the text "Study II". The robot is positioned in the center of the frame, with its head and upper body visible. The background is a softly lit bedroom with a bed, a lamp, and a window with curtains. The robot has a sleek, rounded design with a prominent eye area that glows with a bright blue light. A green rectangular overlay is placed over the robot's face, and the text "Study II" is written in white, bold, sans-serif font within this overlay. The overall scene is warm and inviting, with a focus on the robot as the central subject.

# Study II



# Study II: Method

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- 3 focus groups (N=22)
- Task: Developing communication patterns for internet connectivity, camera, and microphone



# Study II: Results

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... faces the wall to signal that the camera is off.

... plays distinct audio feedback to signal that it is disconnected from the internet.

## 86 Communication Patterns

... removes the microphone's cable to physically prevent the microphone from recording.

... enters physical confinement to physically prevent all functionality.

# Study II: Results

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... faces the wall to signal that the camera is off.

## Awareness Mechanisms

... plays distinct audio feedback to signal that it is disconnected from the internet.

## 86 Communication Patterns

... removes the microphone's cable to physically prevent the microphone from recording.

## Interventions

... enters physical confinement to physically prevent all functionality.

# Study II: Results

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“We thought about a lock from the outside so the robot [...] itself can’t reopen it.” (P15)

## Trust

“I think that self-destruct is useful. When your robot has so many capabilities, you also need very strong limitations.” (P11)

“If you tell it: Just go away! That doesn’t work if it’s still doing a task.” (P20)

## Usability

“It is fun. Like it’s something that is trying to mimic me, but it’s not me.” (P7)

“If it looks like a human we start having human like expectations.” (P13)

## Humanoid vs. Non-Humanoid

“If a robot is covering its eyes I would be like: What’s wrong with you? Just turn off your camera, dude!” (P5)

A futuristic white robot with glowing blue eyes and a green translucent overlay containing the text "Study III". The robot is positioned in the center of the frame, with its head and upper body visible. The background is a softly lit bedroom with a bed, a lamp, and a window with curtains. The robot has a sleek, rounded design with a prominent eye area and a small antenna-like structure on top. The green overlay is semi-transparent, allowing the robot's features to be seen through it. The text "Study III" is written in a clean, white, sans-serif font, centered within the green area. The overall atmosphere is warm and futuristic, with a focus on the robot as the central subject.

# Study III

# Study III: Method

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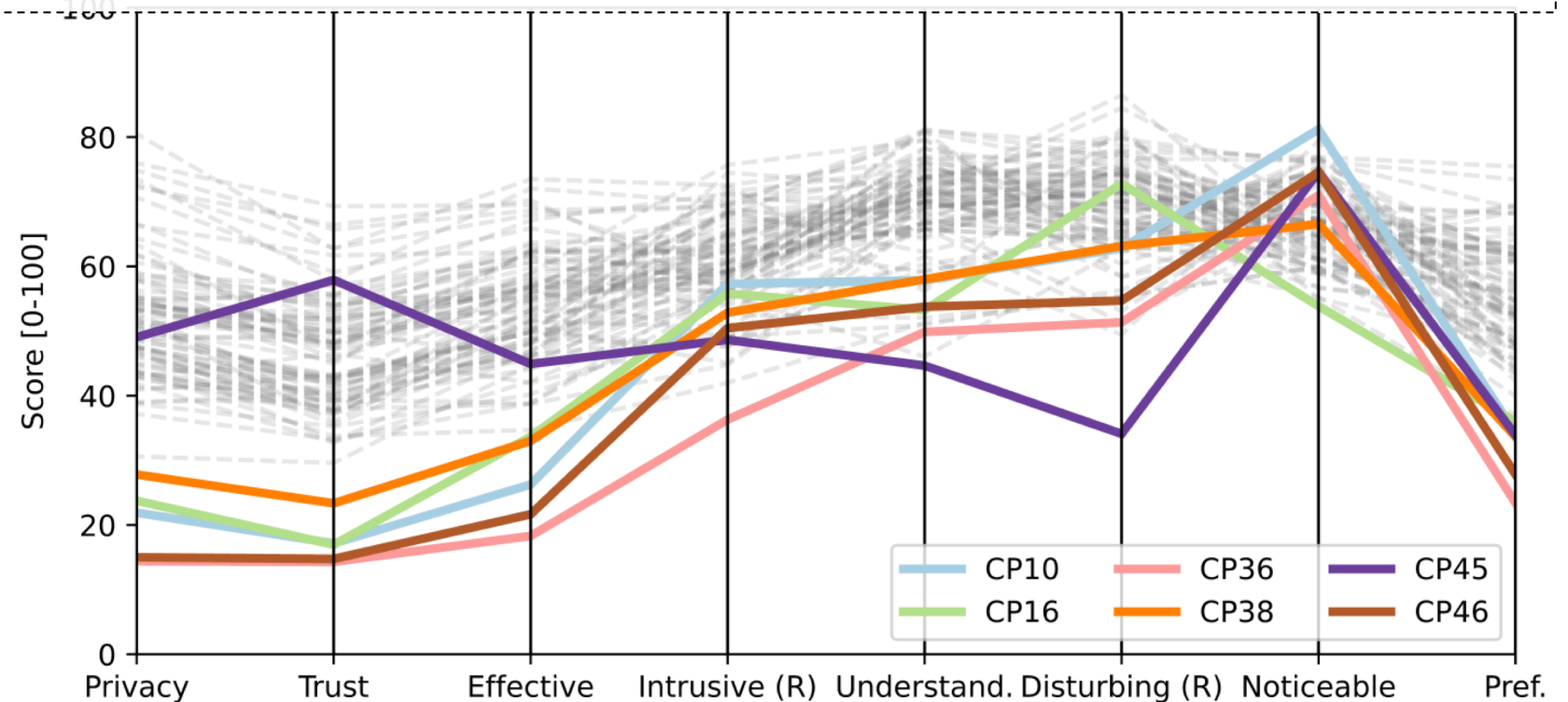
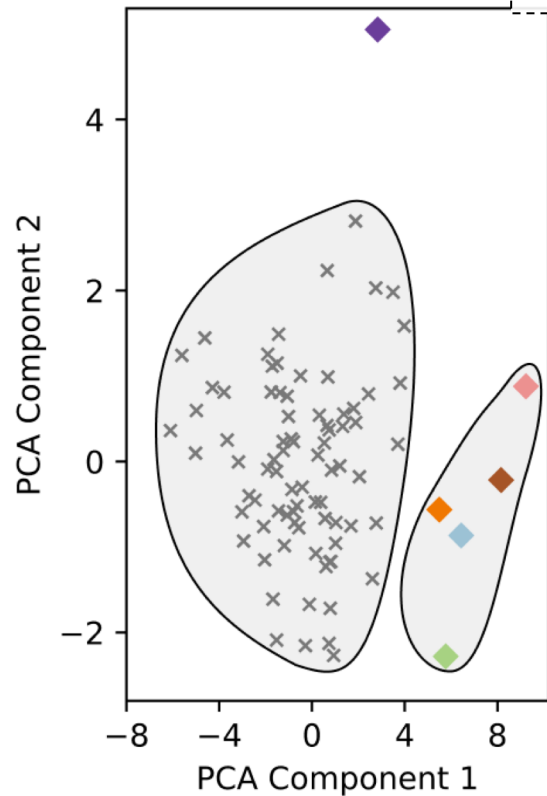


- Online survey on Prolific (N=1720)
- 20 ratings per communication patterns
- We asked for perceived
  - Privacy protection
  - Trust
  - Effectiveness
  - Intrusiveness
  - Noticeability
  - Understandability
  - Disturbance
  - Preference



# Study III: Results

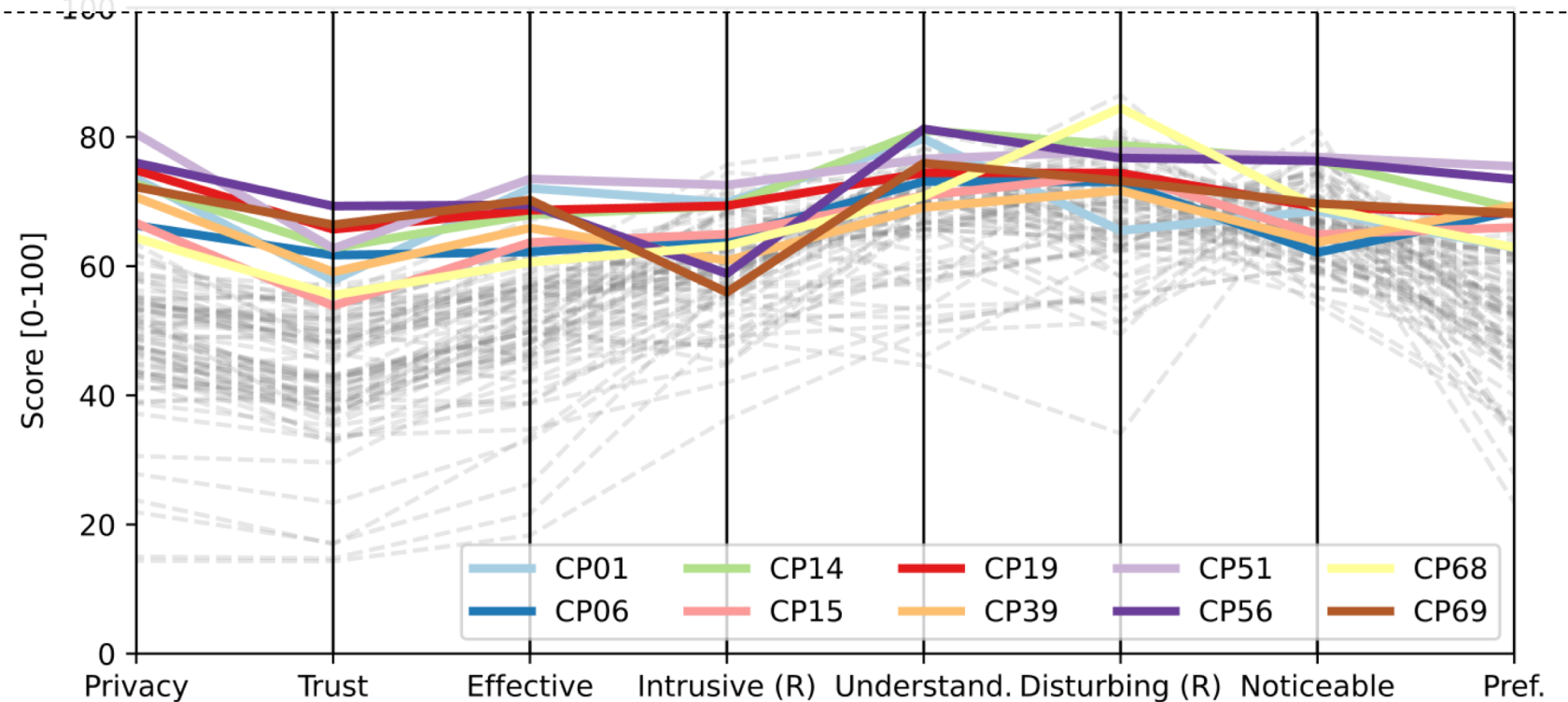
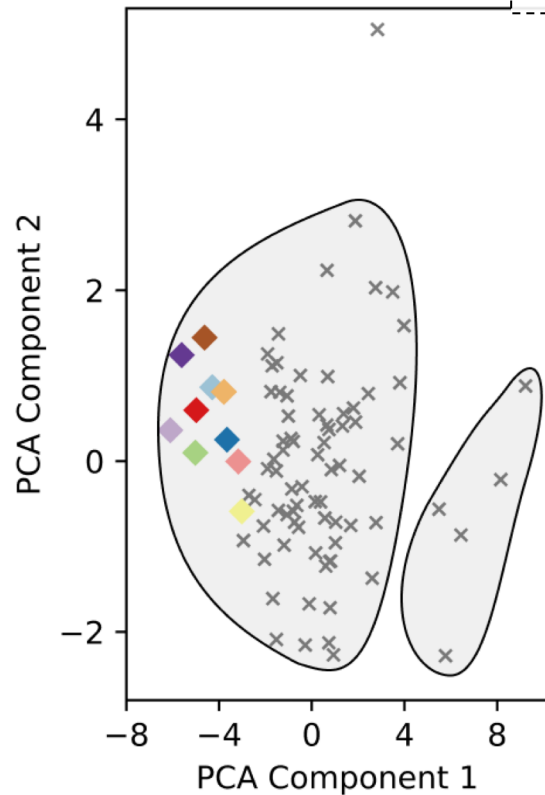
CP10: The robot covers its ears with its hands to prevent audio recording  
CP36: The robot faces the wall to prevent audio recordings  
CP46: The robot parks against a pillow to prevent the microphone from recording  
CP45: The domestic robot kills itself to physically prevent all functionality





# Study III: Results

CP1: The robot detaches its memory card to prevent all functionality  
CP51: The robot puts a physical cover over its camera to prevent camera recordings  
CP39: The robot goes to its docking station to prevent all functionality at once  
CP19: The robot detaches the microphone to prevent audio recordings



# Takeaways

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Familiarity fosters understandability, trust, and general user preference.

One should be careful when employing anthropomorphism to convey privacy states.

The right communication pattern depends on the requirements of a situation.

Paper:



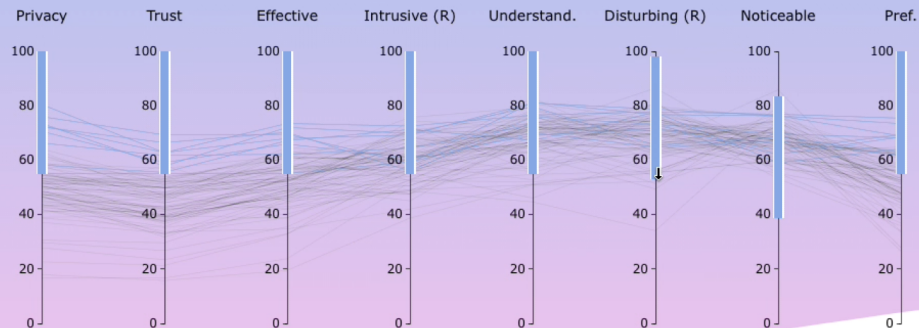
Connect:



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[maximiliane.windl@ifi.lmu.de](mailto:maximiliane.windl@ifi.lmu.de)

# Communication Pattern Finder

You can manipulate the lower and upper limits of the bars and move them along the axis.



9 patterns match your criteria:

ID	Pattern	Functionality
CP1	The domestic robot detaches its memory card to physically prevent the camera, microphone, and internet connection from functioning.	all
CP6	The domestic robot blocks its own movement to physically prevent the camera from recording.	camera
CP14	The domestic robot crosses its arms to signal that it is disconnected from the internet.	connectivity
CP39	The domestic robot goes to its docking station to physically prevent the camera, microphone, and internet connection from functioning.	all
CP41	The domestic robot has a light band attached to signal that it is disconnected from the internet.	connectivity
CP51	The domestic robot puts a physical cover over its camera to physically prevent the camera from recording.	camera
CP56	The domestic robot removes the microphone's cable to physically prevent the microphone from recording.	microphone
CP69	The domestic robot uses a physical switch to physically prevent the camera from recording.	camera
CP70	The domestic robot uses a physical switch to physically prevent the internet connection.	connectivity