Session 4

# Design Pattern for Social and Affective HRI

# Process of designing Intelligent System

In this phrase, the most crucial work is to **design interaction** for your robot in terms of subject, process, behavior, interface, which helps you break down the **ideation** into systematic and tangible **actions**.

# Designing Interaction

Subject

Process

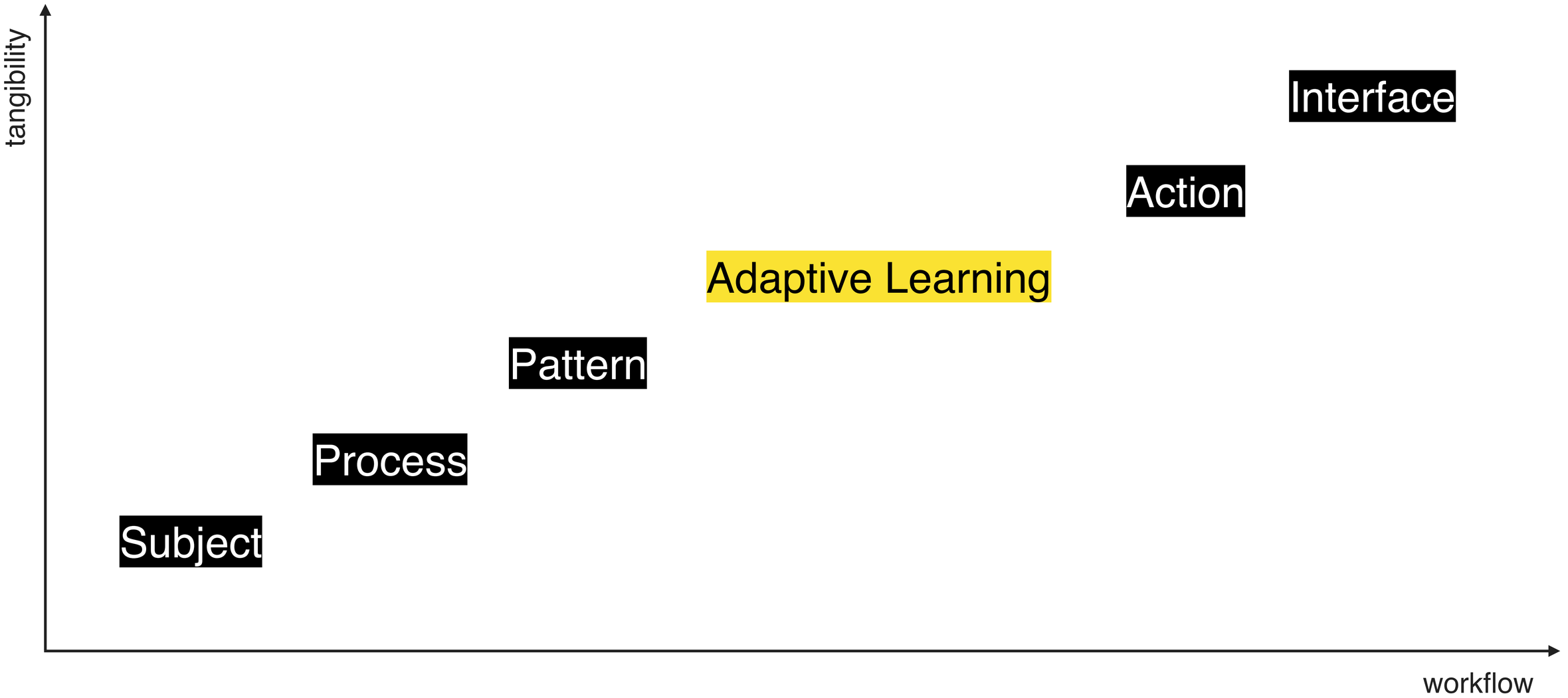
Pattern

Adaptive Learning

Action

Interface

# Designing Interaction



# Jibo

world's first social robot for the home

Jibo experiences the world and reacts with expressive movements and responses. He loves to be around people and engage with people, and the relationships he forms are the single most important thing to him.

# Subject

persons,  physical environment, and social circumstances that are being considered in the scenarios

## User

persona
behavior model
mental model

## Physical Environment

objects
smart devices
animals
map
environmental factors

## Social Circumstances

social relationship
activities
convention
social cues

# Subject

## User

Who will interact with robot?

Can you briefly describe them?

How do they generally behave in the scenario?

What is supposed to be their cognition to your robot?

# Subject

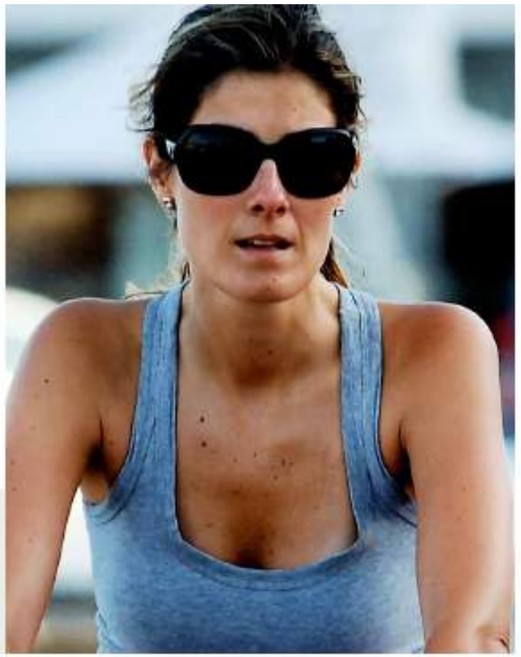
## User

Can you briefly describe them?

**Personas**

distill the relevant characteristics that matters to the interaction with robot

| | |
|---|---|
| Name | Louise Sneddon |
| Age | 36 |
| Profession | Human resources |
| Nationality | Australian (Sydney) |
| Key words | Freedom<br>Healthy lifestyle<br>Natural wildness<br>Custom-made |
| Urban mobility | Walk and bike |



### The sport performer

"One day without running is a wasted day"

*Keeping healthy is my priority. This is why I practise sports whenever I can. The best is to do it in a natural environment instead of closing myself in a gym or in a shanghainese park where is even difficult to breathe.*

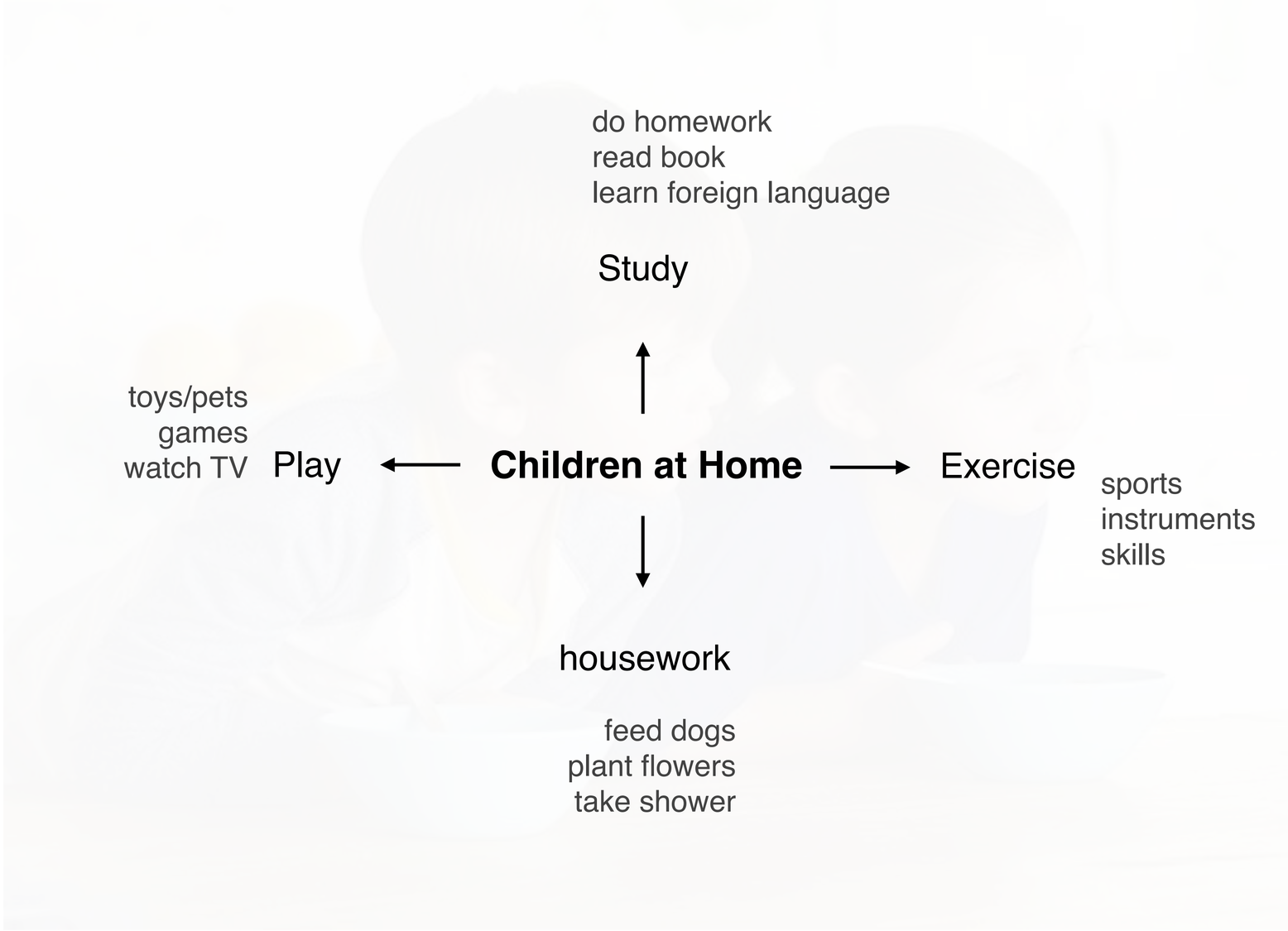
# Subject

## User

How do they generally behave in the scenario?

**Behavior model**

summarize the most typical behavior pattern and the underlying activities and circumstances



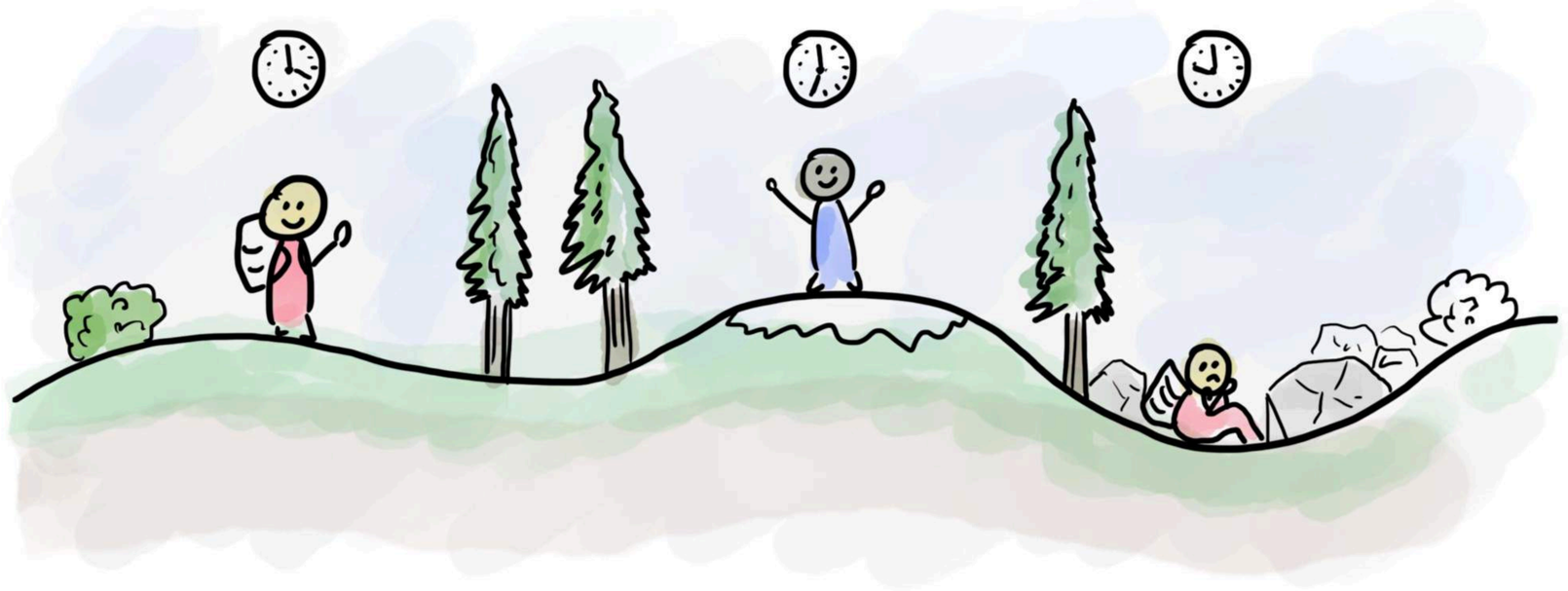
# Subject

## User

How do they generally behave in the scenario?

**Behavior model**

use user journey map to organize the featured activities aligned with a time series



source: The difference between a journey map and a service blueprint

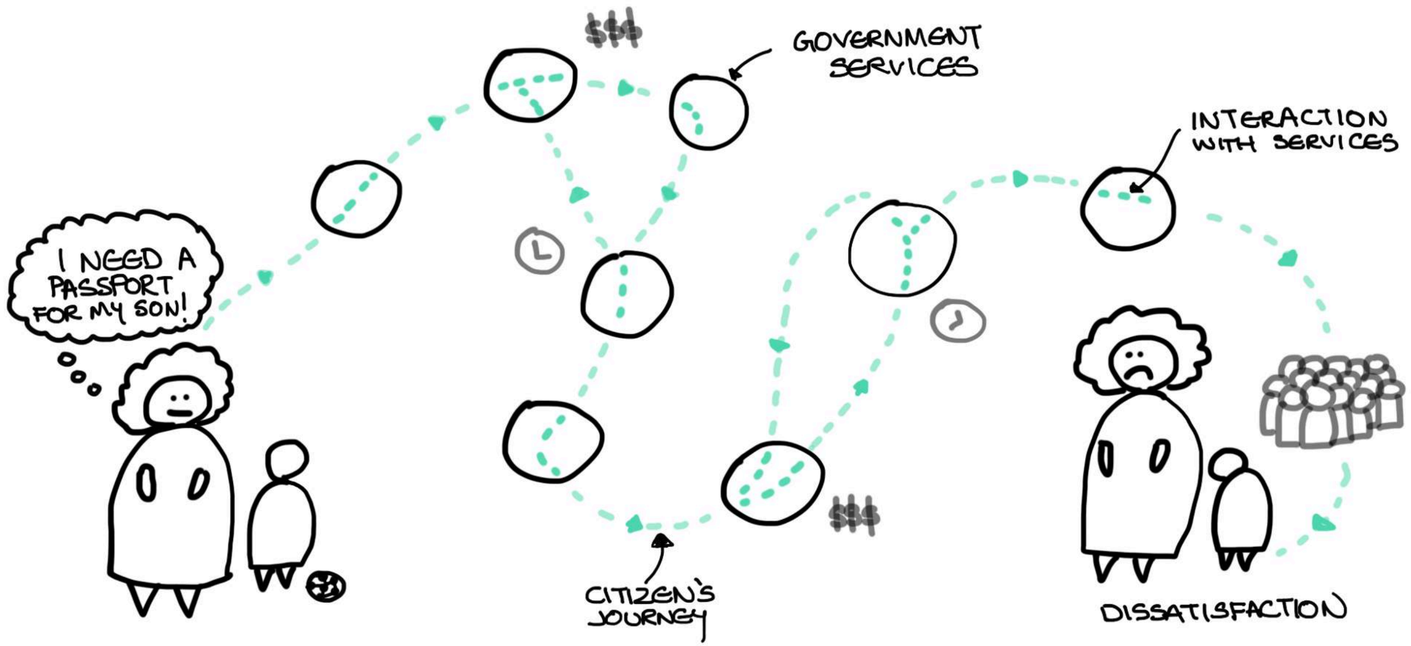
# Subject

## User

How do they generally behave in the scenario?

**Behavior model**

use user journey map to articulate the complex flow and logic concealed in a specific activity




source: What is Civic Service Design? A tale of Citizen Satisfaction in Uganda and beyond

# Subject

## User

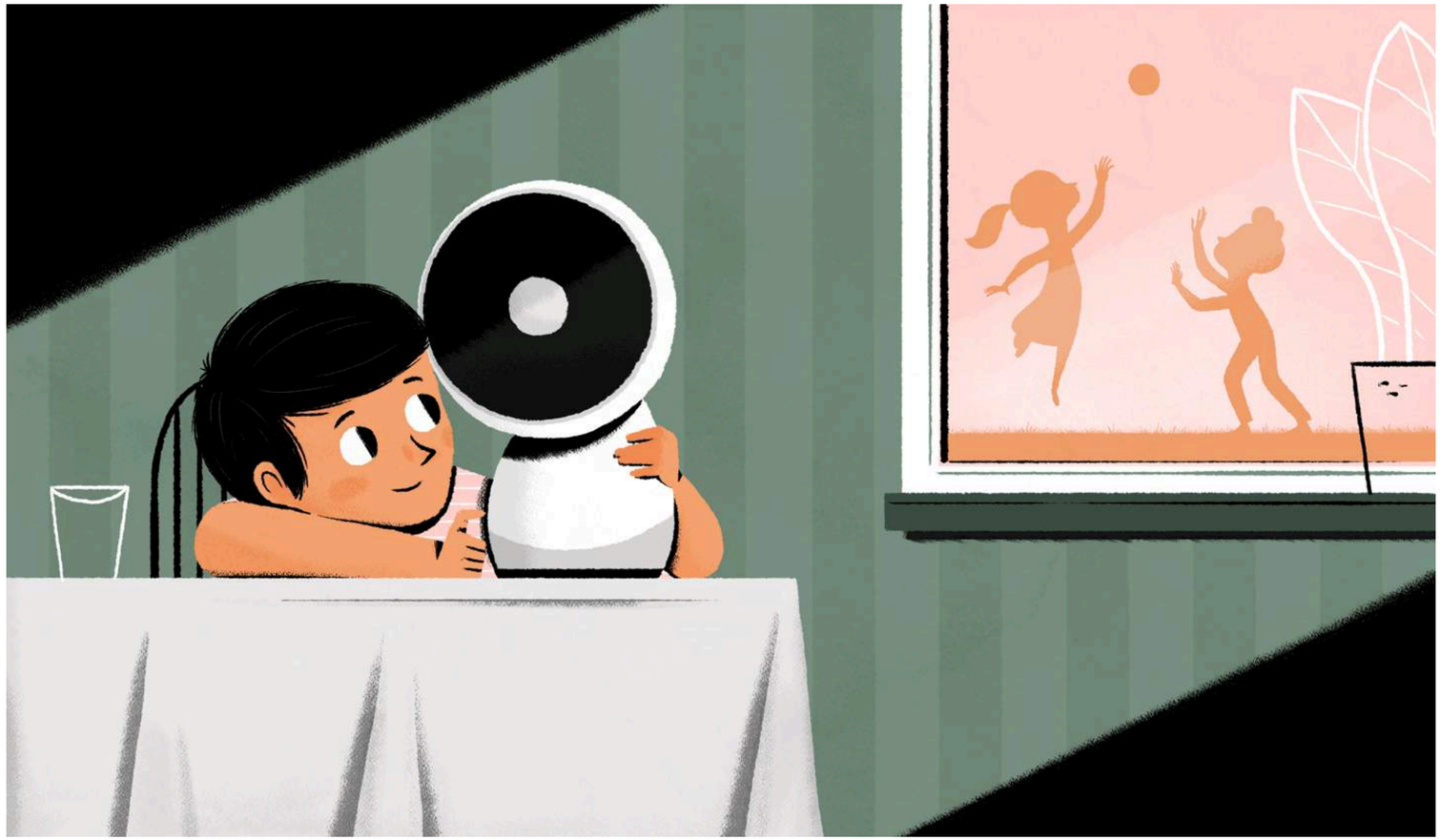
What is supposed to be user's cognition to your robot?

**Mental model**

Outline what concepts are needed for user to understand how to interact with your robot when user are exposed to your robot

1) metaphor and analogies
2) task–domain objects, their attributes, and operations

**How does this boy understand to interact with Jibo?**



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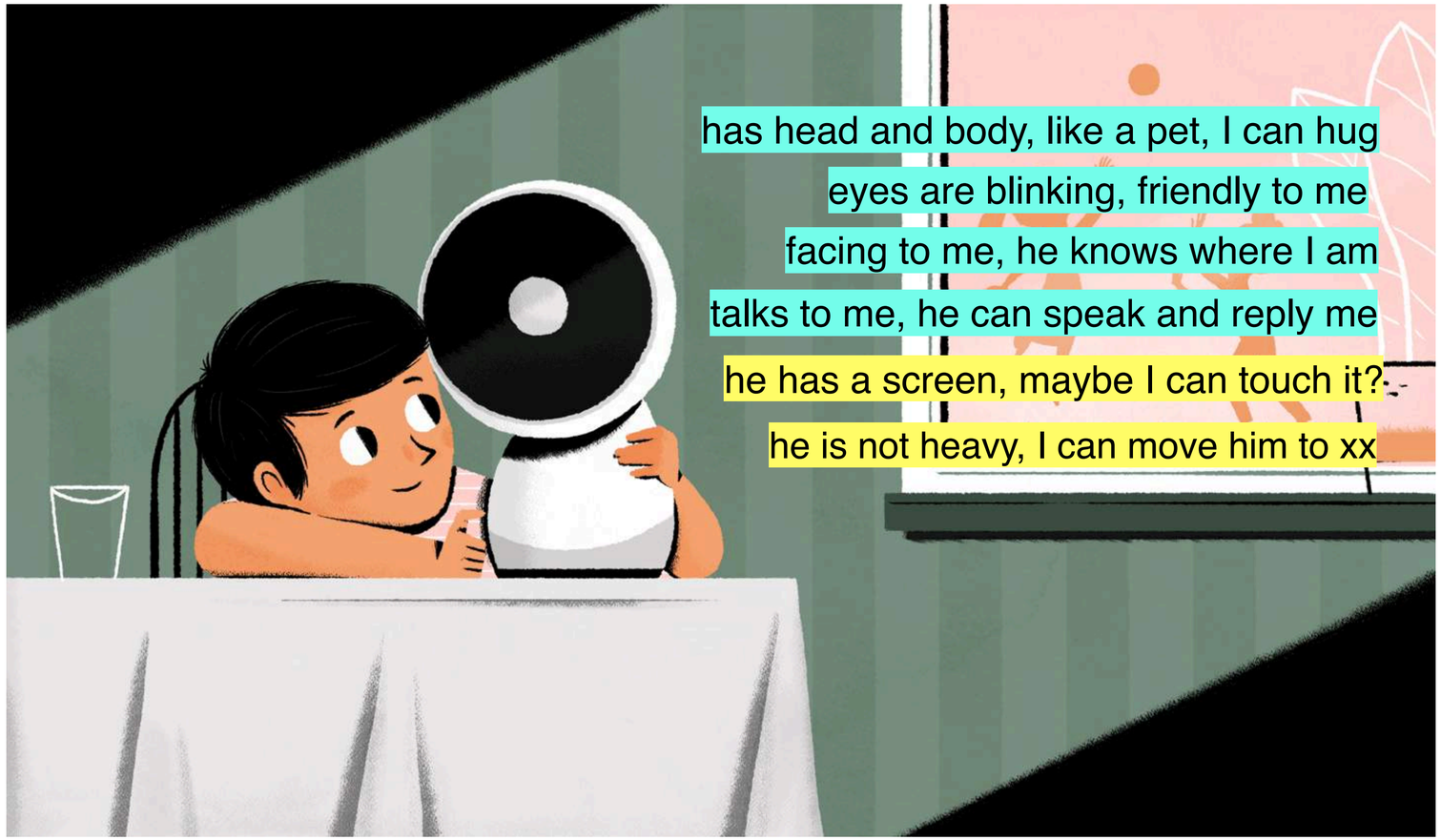
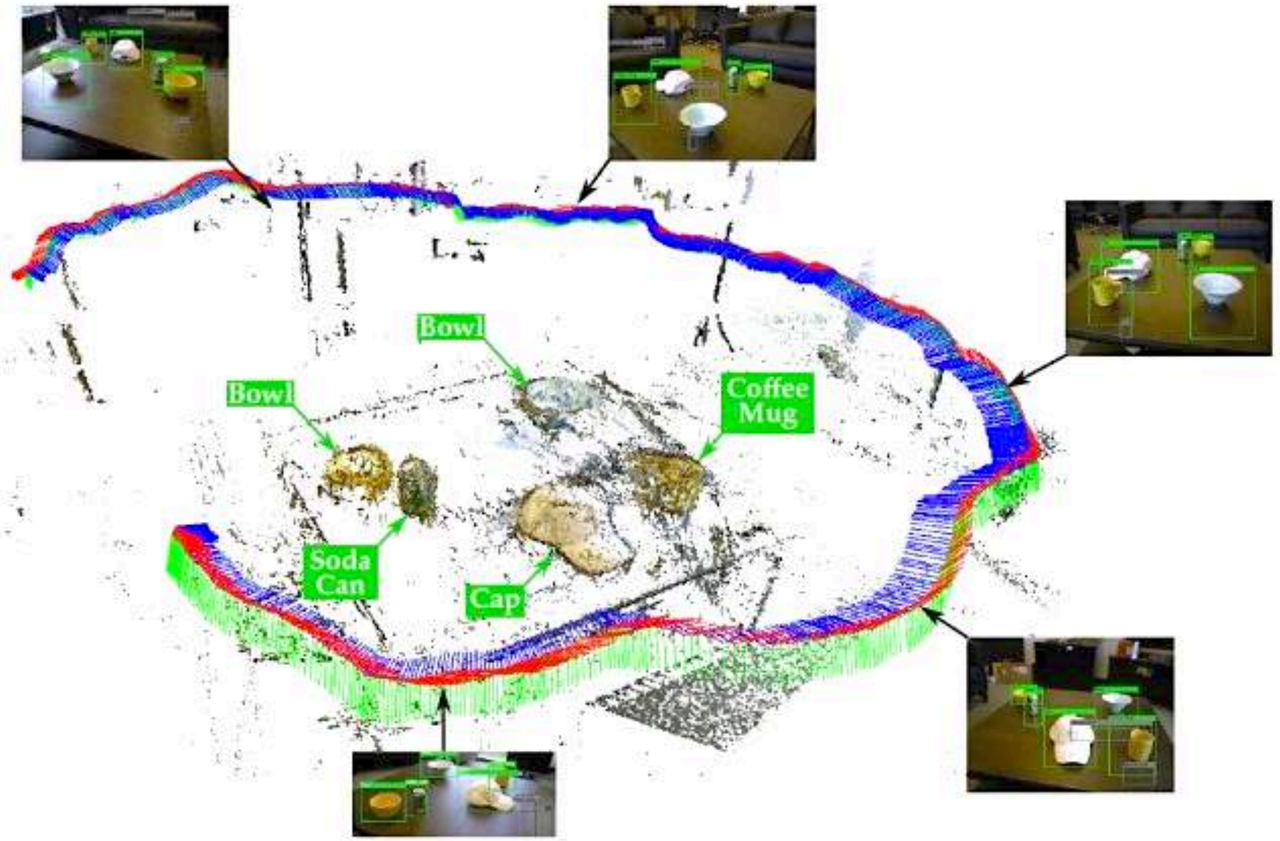


# Subject

## Physical environment

How robot see and understand object?

objects
smart devices
animals
map
environmental factors




1) pre-built in ROS
2) captured and understood by robot
3) represented through robot interface
4) learned by robot

# Subject

## Physical environment

objects
smart devices
animals
map
environmental factors

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How robot connect and control smart devices?

# Subject

## Physical environment

objects
smart devices
animals
map
environmental factors

1) pre-built in ROS
2) captured and understood by robot
3) represented through robot interface
4) learned by robot

How robot connect and control smart devices?

Jibo can manipulate with lighting according to user’s circumstance

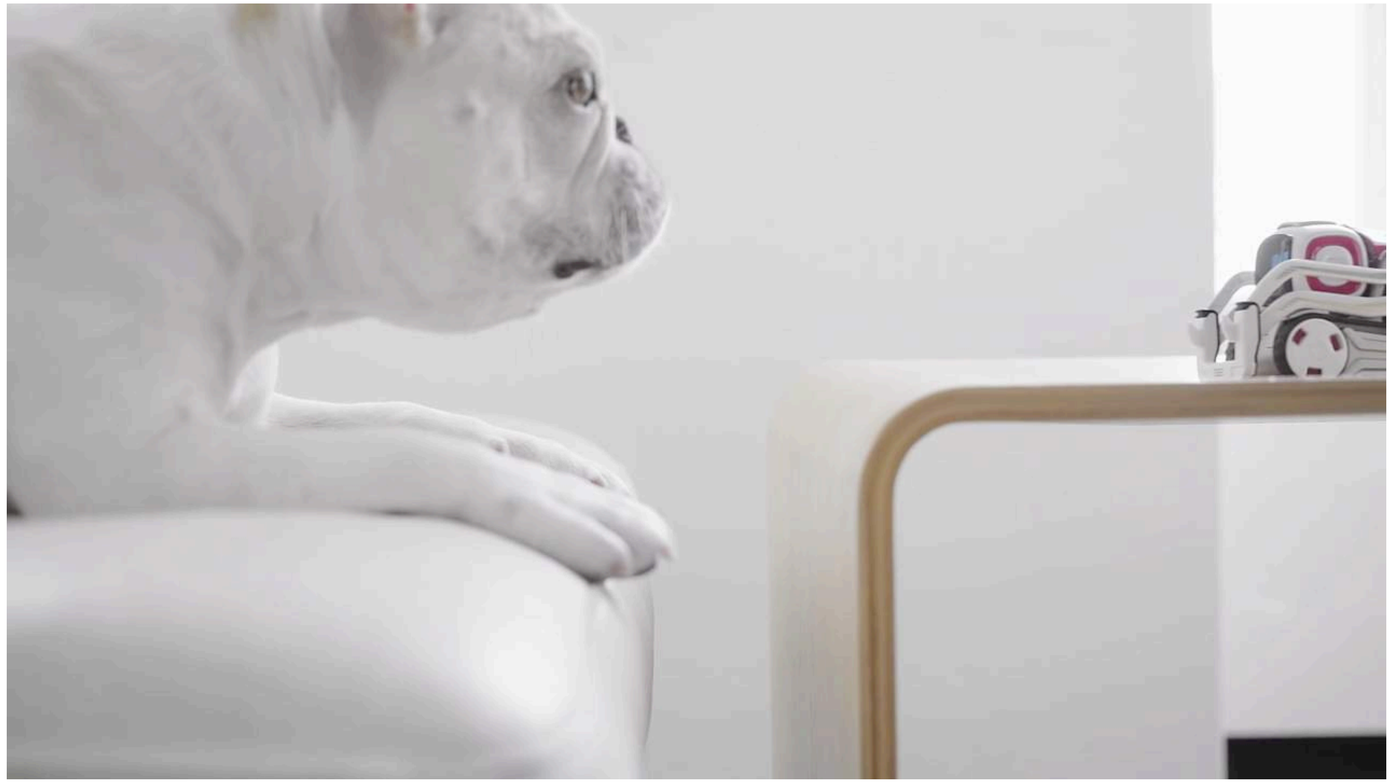
# Subject

## Physical environment

How robot see and interact with pet?

objects
smart devices
animals
map
environmental factors

1) pre-built in ROS
2) captured and understood by robot
3) represented through robot interface
4) learned by robot



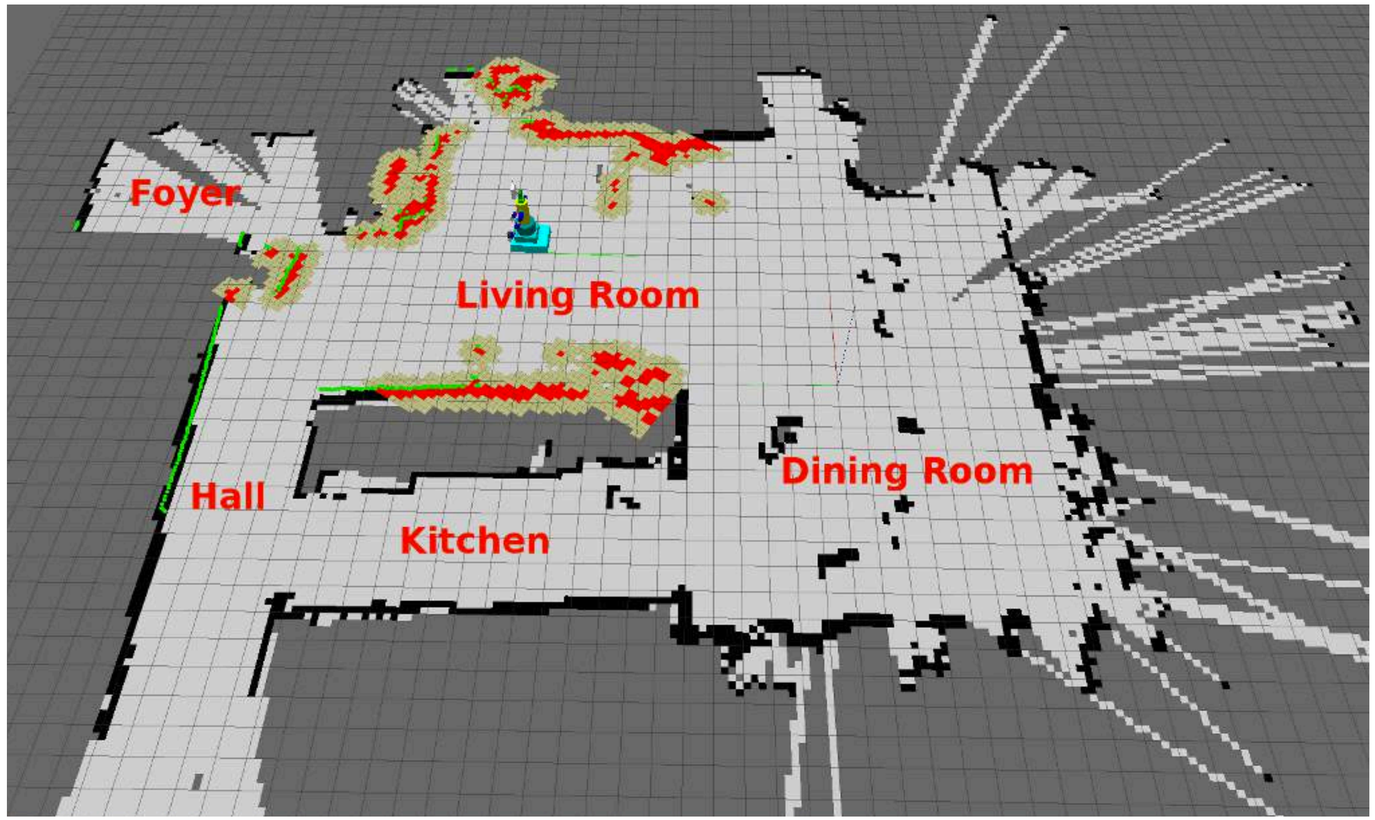
# Subject

## Physical environment

How robot understand spacial information and generate map?

objects
smart devices
animals
map
environmental factors

1) pre-built in ROS
2) captured and understood by robot
3) represented through robot interface
4) learned by robot



# Subject

## Physical environment

How robot percept and response to eviornmental factors?

objects
smart devices
animals
map
environmental factors

1) pre-built in ROS
2) captured and understood by robot
3) represented through robot interface
4) learned by robot

# Subject

## Social Circumstances

social relationship
activities
convention
social cues

How design support robot as a social partner?

Design issues

long term interaction

survival in social world

Interacting with people

learning in the human environment

A robot is part of the physical environment - it shares our world with us. Robots not only have to carry out their tasks, they also have to survive in the human environment. The ability for robots to adapt and learn in their environment is fundamental given that designers cannot predict all the circumstances and challenges a robot will encounter in the scenarios. Human society is a particular challenging environment given its richness, its dynamic nature, its uncertainty, and its unpredictability. Hence, it is a must for designers to foreseen the social circumstances as soon as possible to consider the impacts and dilemmas into the interaction design process.

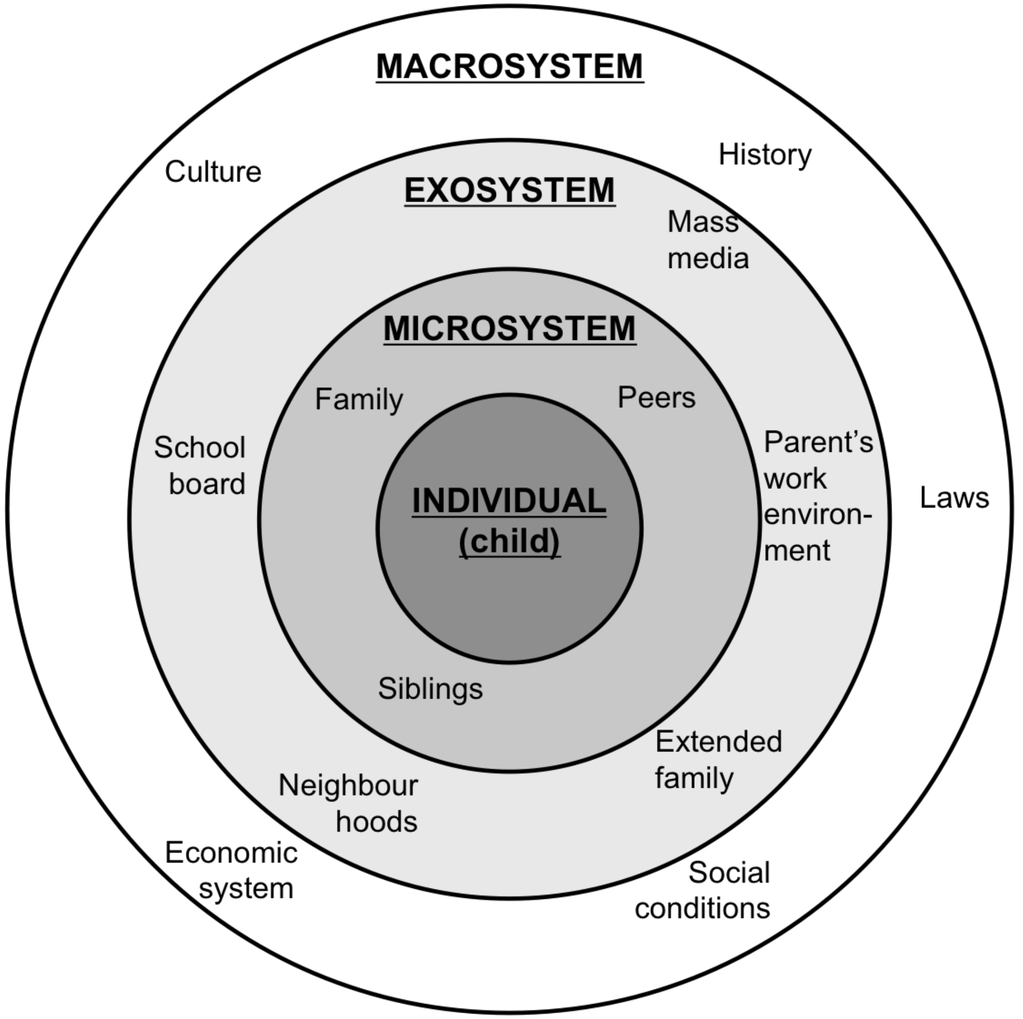
source:
Social Interactions in HRI: The Robot View - Personal Robots Group
http://robotic.media.mit.edu/wp-content/uploads/sites/14/2015/01/Breazeal-IEEESMC-04-trv.pdf

# Subject

## Social Circumstances

social relationship

The **Social Ecological Model** (SEM) is a theory-based framework for understanding the multifaceted and interactive effects of personal and environmental factors that determine behaviors, and for identifying behavioral and organizational leverage points.



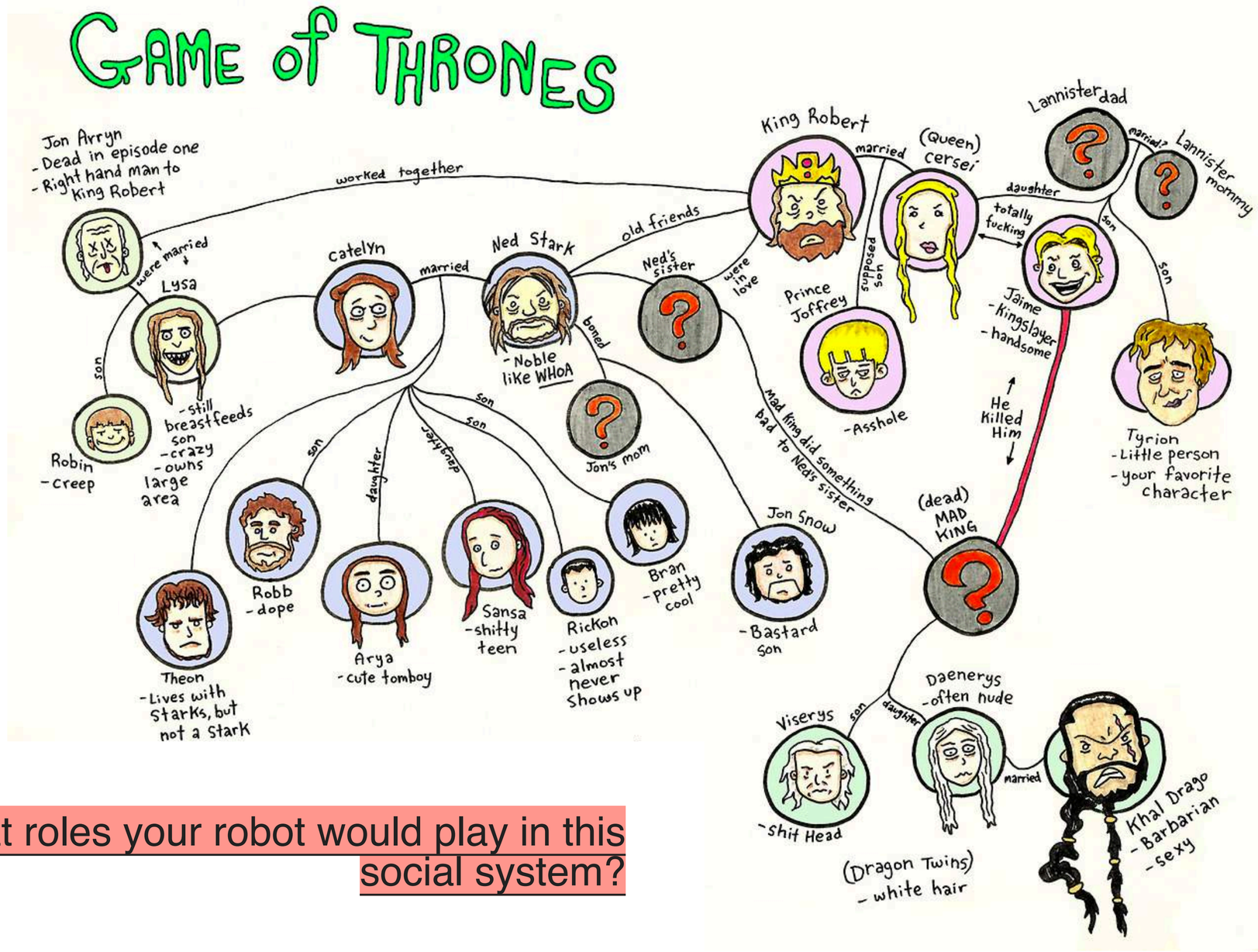

source:
Influence of a lifestyle intervention in preschool children on physiological and psychological parameters (Ballabeina): Study design of a cluster randomized controlled trial

# Subject

## Social Circumstances

social relationship

Outline the social relationship of your users in terms of ecological layer, properties of individuals, relationship between individuals, with all the information organized in a graph.




What roles your robot would play in this social system?

# Subject

## Social Circumstances

How your robot perform as a functional and reliable friend in these social activities?

activities

# Subject

## Social Circumstances

### Convention

Robot should know necessary domain-specific convention in the designed scenarios if this matters to the understanding of people and circumstances, and the representation of interaction with users.

What domain-specific convention should your robot know otherwise learn if not?

Jibo should know the western etiquette or the special convention in this family in order to act acceptable and sensible behavior and functionality.

# Subject

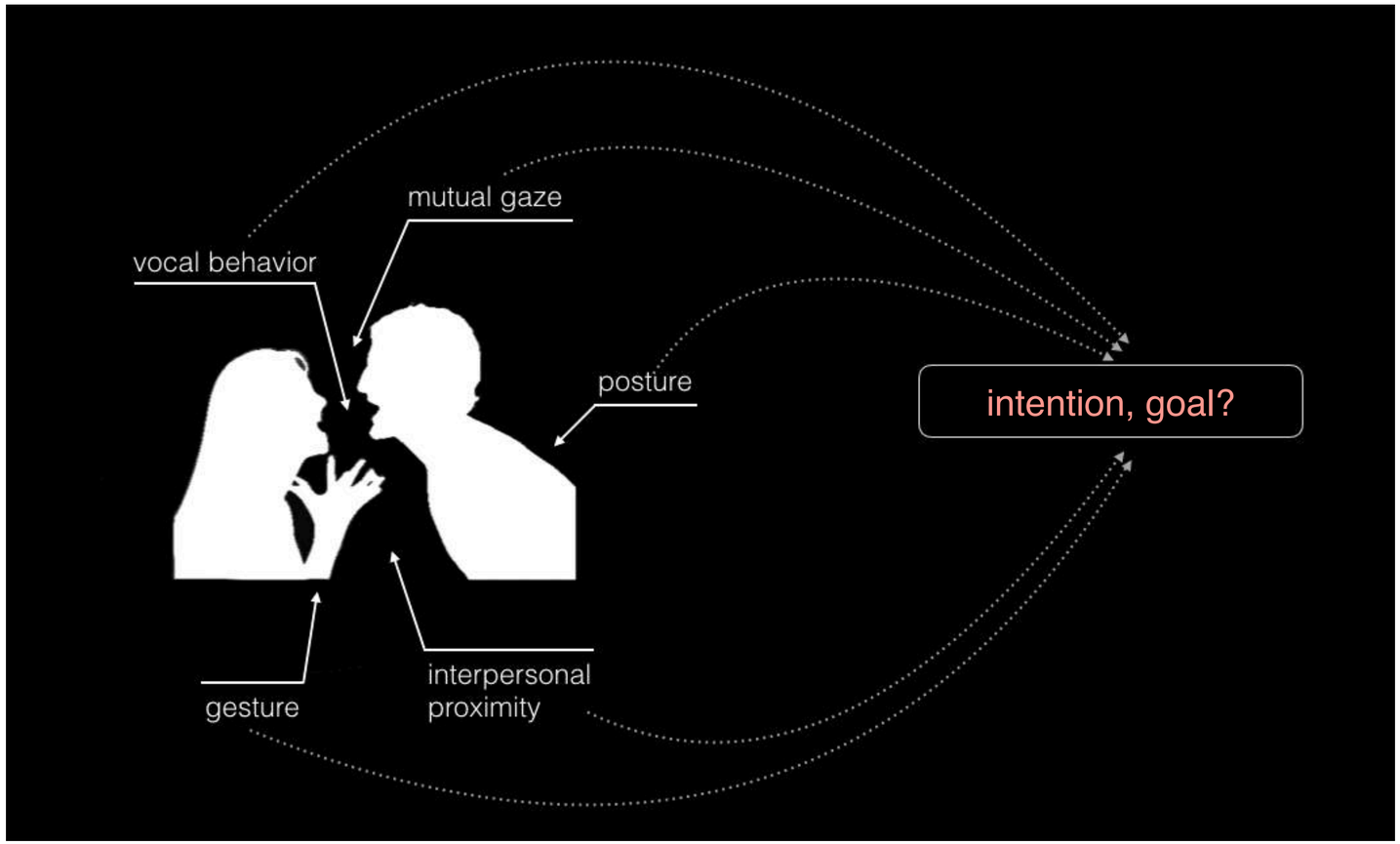
## Social Circumstances

Nonverbal behaviors communicate our underlying intentions, goals, and values

social cues

Social cues serve several purposes in social interactions that help to clarify people's meanings and intentions.

- facial expression
- vocal tone
- body language
- body posture
- gestures
- proximity




source: personal robot group MIT media lab

# Subject

## Social Circumstances

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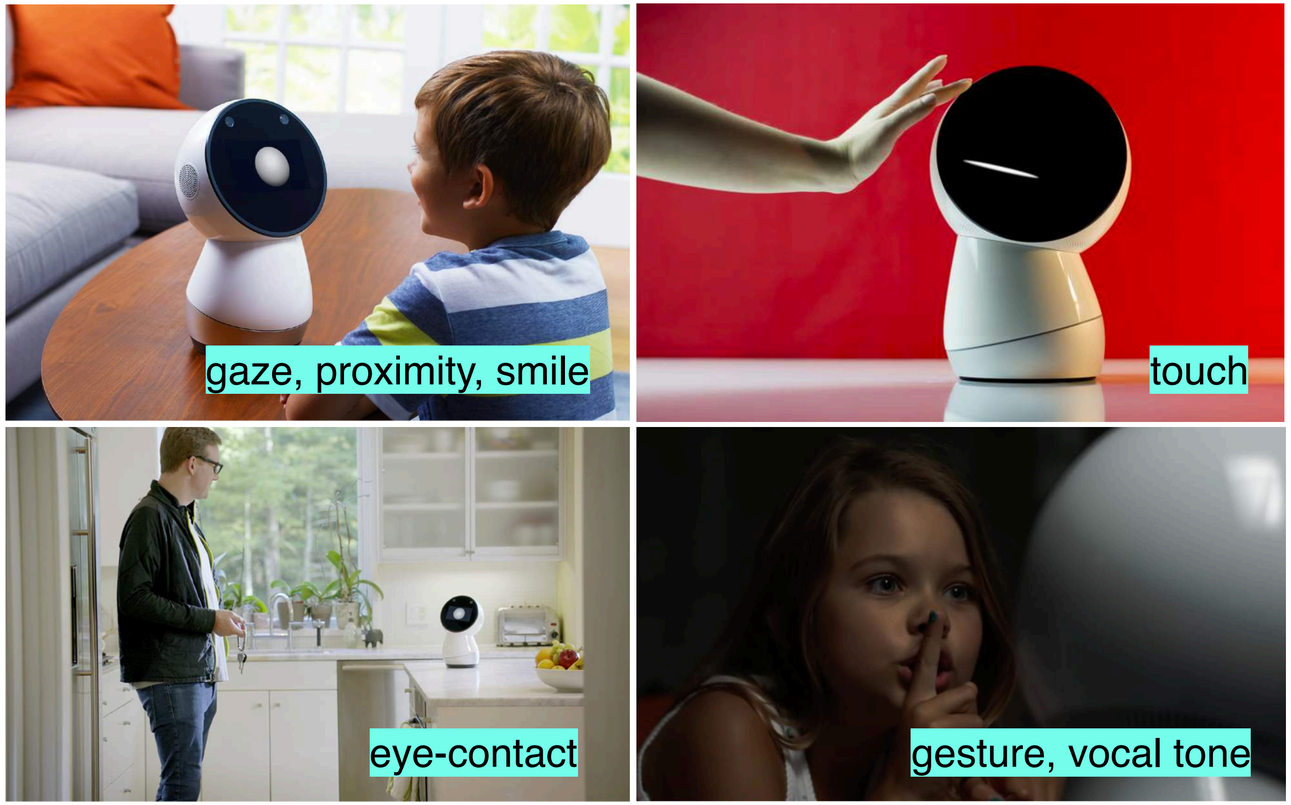
How are users naturally inclined to interact with robot using social cues?

How design support robot’s understanding of social cues and engagement in social interactions?



# Subject

## Social Circumstances

How can robot manage to use social cues to communicate with users?

social cues

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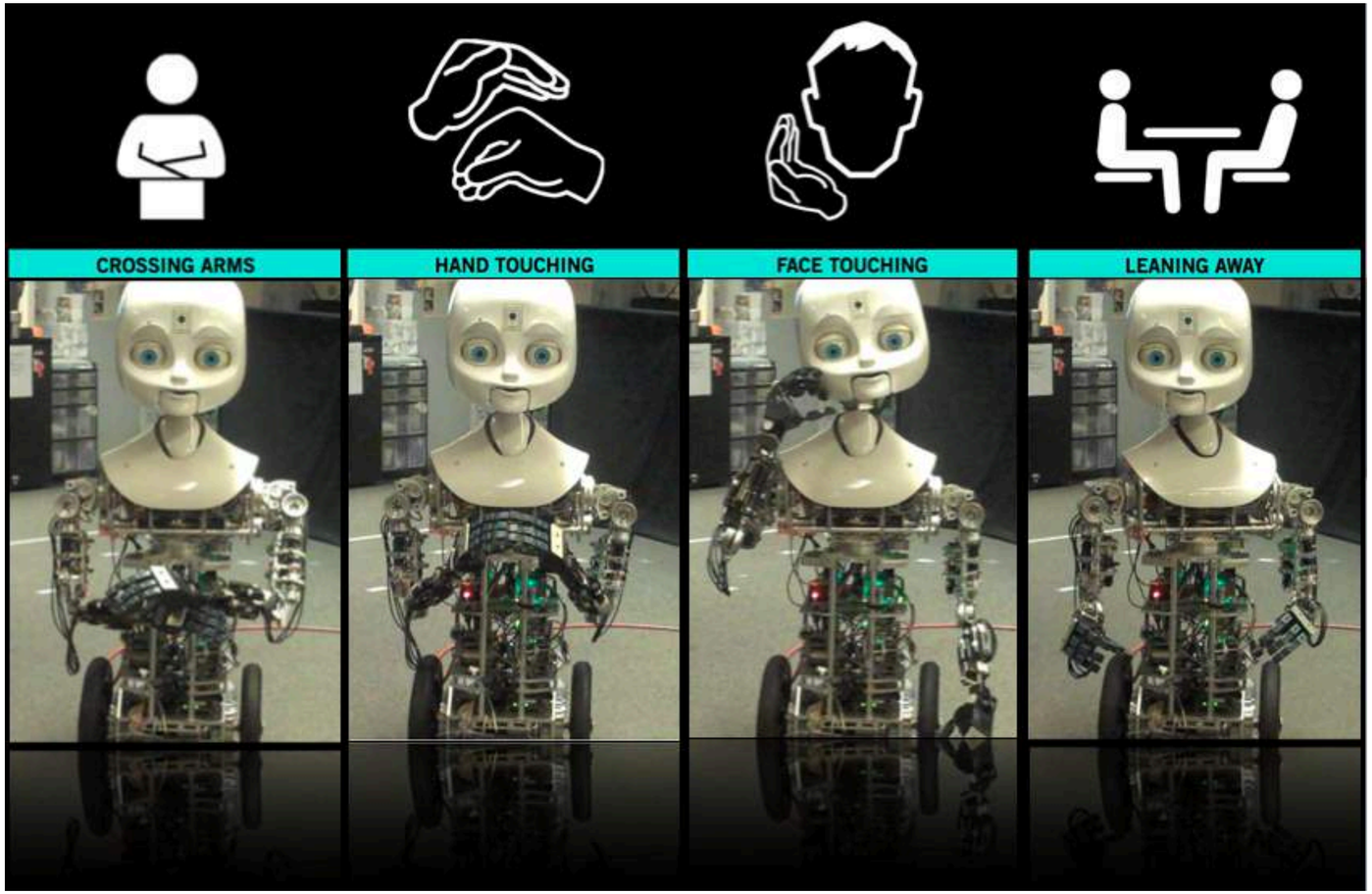


source: personal robot group MIT media lab

# Subject

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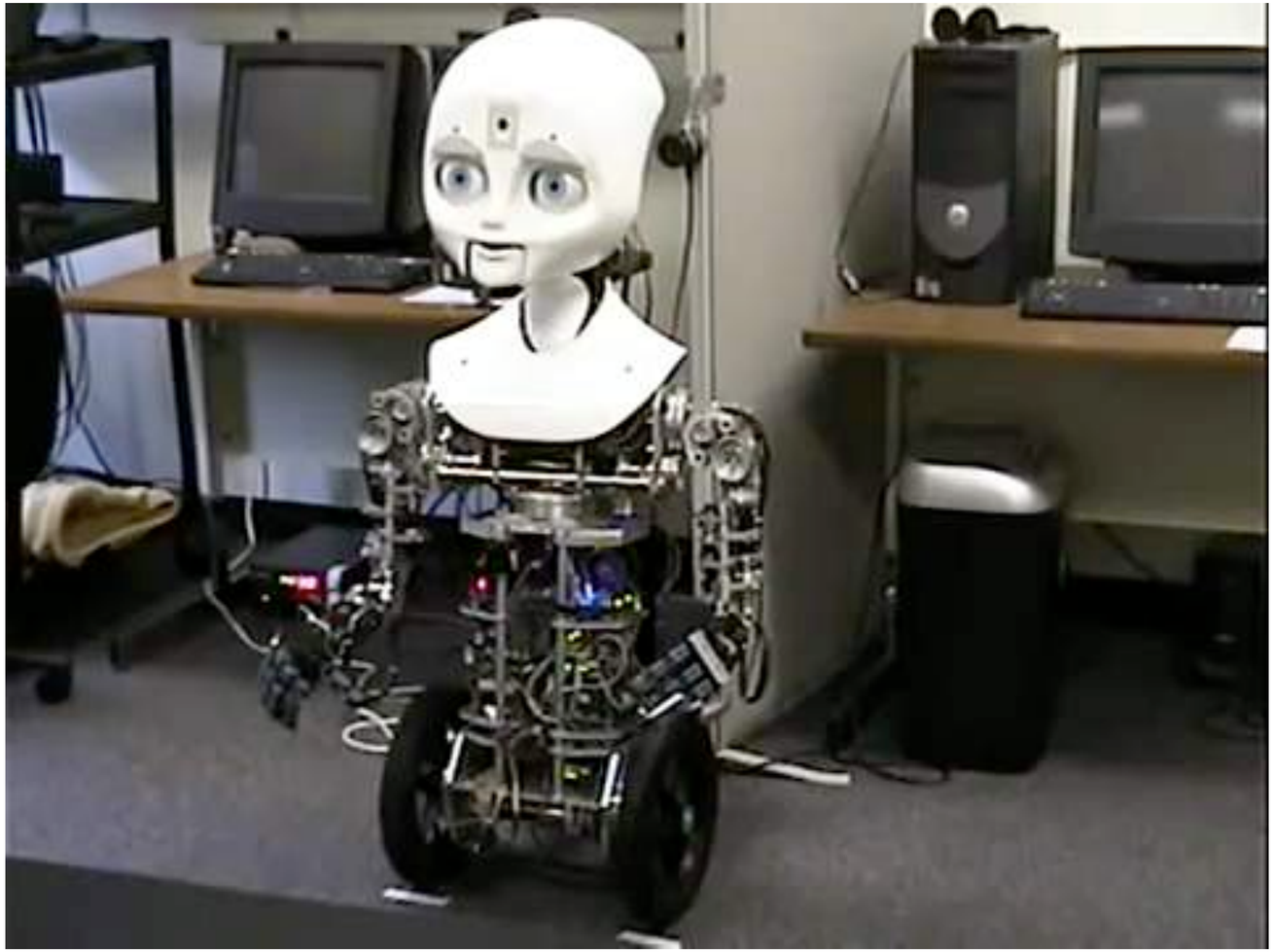

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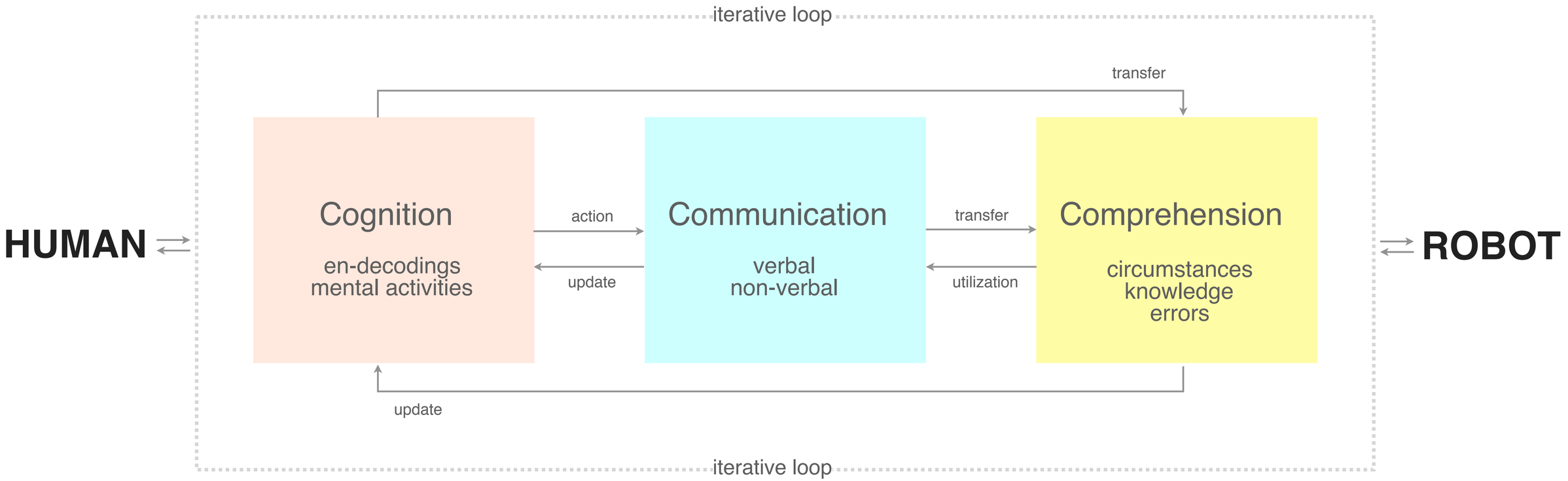
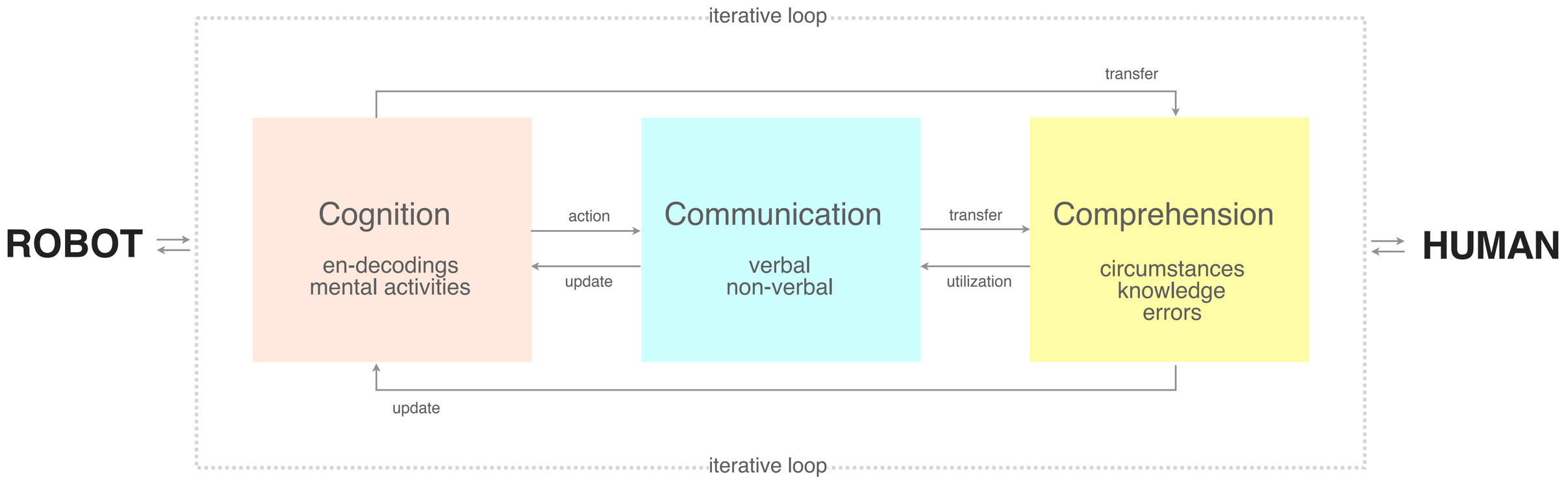
# Process




conceptual model of interaction process

# Process

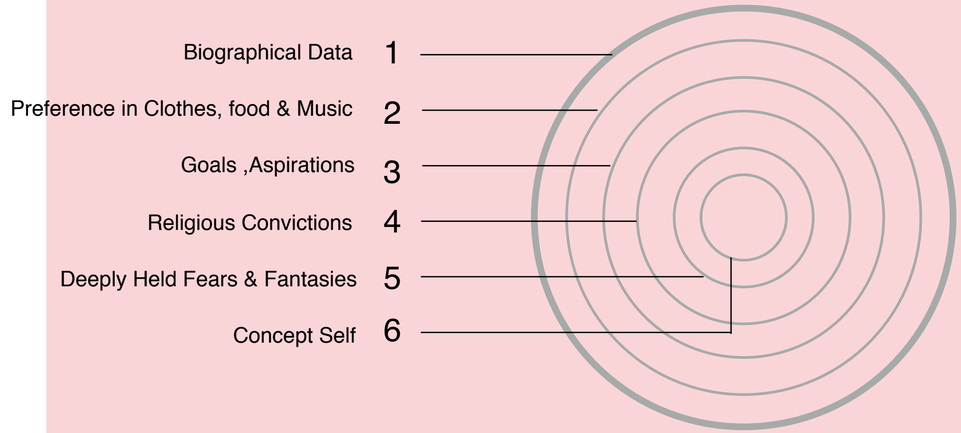



conceptual model of interaction process

# Process

How a person esatablish the cognition upon another person

## Cognition




- **语言信息的披露（有目的的将个人信息按照深度与广度进行披露）**

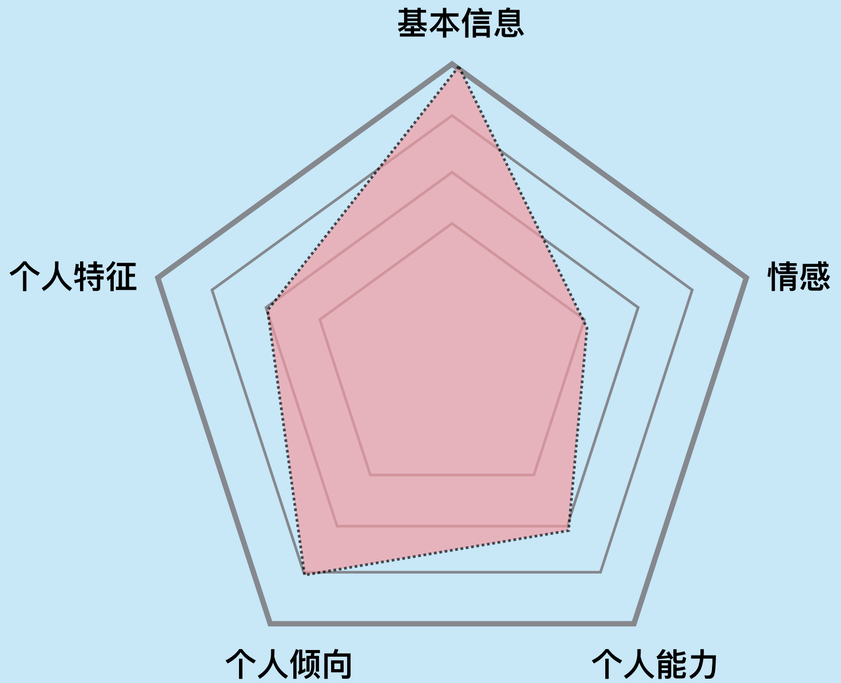
- **非语言信息披露**
  面部表情（笑——正面情绪，哭——负面情绪）
  次语言（语音语调：高亢——兴奋， 语速：快——兴奋
  慢——平和）
  肢体动作（手舞足蹈——开心，激动）

**语言信息**

**语言交流**

**观察分析**

**非语言信息**




- **对搜集到的信息进行分析归类，得到一定程度的认知**

# Process

## Cognition

Step

### STEP2
### 信息的编码

将一种形式的信息转换为另一种形式的信息，以利于信息的贮存和提取、使用。

### STEP3
### 信息的储存

信息以不同形式的记忆储存在大脑中

### STEP4
### 信息的提取

依据一定的线索从记忆中寻找所需要的信息并将它取出来

### STEP1
### 信息的获得

感官的信息：视觉、听觉、嗅觉、味觉、触觉等



### STEP4
### 信息的使用

利用所提取的信息对新信息进行认知加工

# Process

## Cognition

Content

- **Nonsocial Case**
  – Physical Features: Form, Location, Motion
  – Functional Features: Identification, Categorization

- **Social Case**
  – Personal Identity
  – Physical Appearance: Gender, Race, Size
  – Demographic Features: Socioeconomic Status
  – Mental States: Thoughts, Feelings, Desires
  – Behavioral Dispositions: Personality Traits

# Process

## Communication

### Nonverbal communication

Nonverbal communication involves all the things people do in interaction except for what they say

- facial expression
- gaze behavior
- body movement
- touch
- interpersonal Distance
- paralanguage

Providing Information

Regulating Interaction

Defining Relationships

# Process

## Communication

Nonverbal communication

### Facial Expressions

Because facial expressions are so informative, people sometimes try to control them

- Intensifying
- Minimizing
- Neutralizing
- Masking

# Process

## Communication

Nonverbal communication

### Gazing Behavior

The direction and amount of a person’s eye contact is also influential.

# Process

## Communication

Nonverbal communication

### Body Movement

Gestures can replace spoken words, but they vary widely from culture to culture

# Process

## Communication

Nonverbal communication

**Touch**
Touching defines relationships

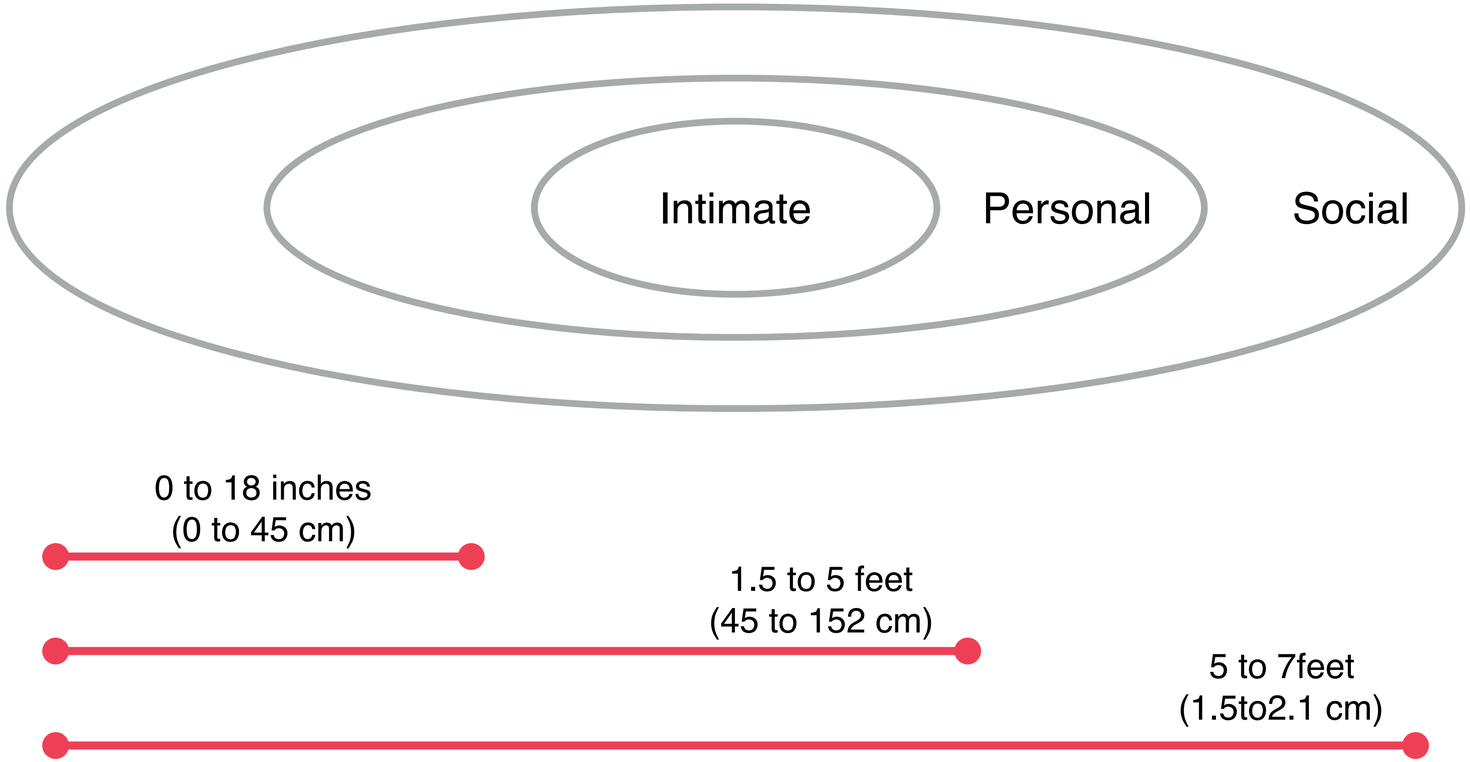
# Process

## Communication

Nonverbal communication

### Interpersonal Distance

- Intimate zone
- Personal zone
- Social zone
- Public zone



# Process

## Communication

Nonverbal communication

### Paralanguage

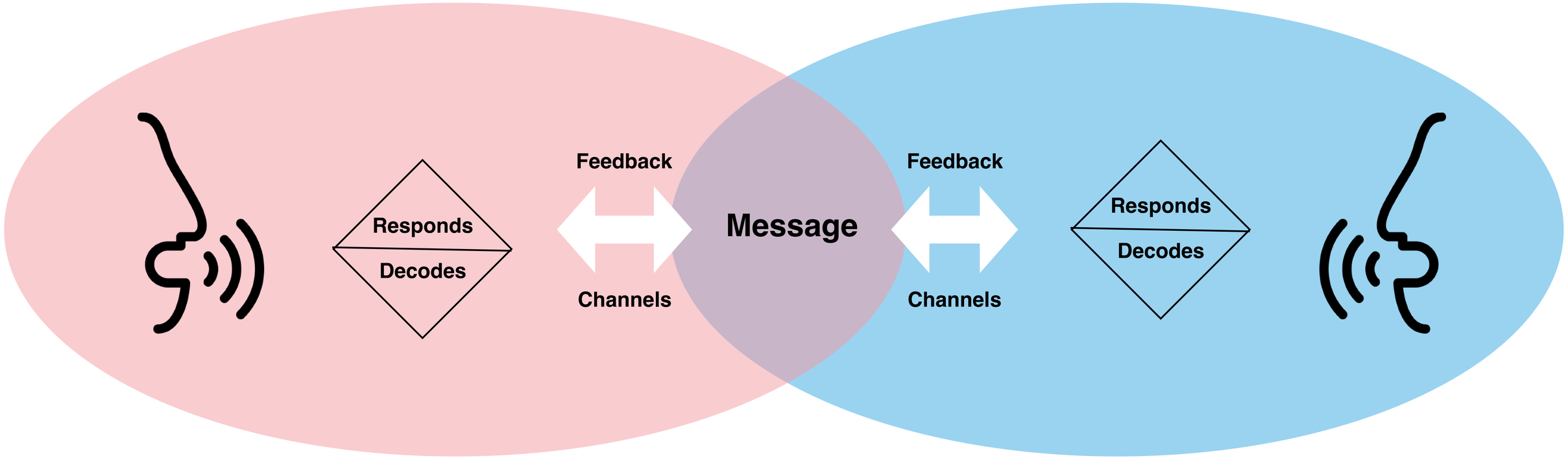
It is not about what you say but how you say it. All the variations in a person’s voice other than the actual words he or she uses.

- rhythm
- pitch
- volume
- rate
- accent

# Process

## Communication

Verbal communication



Verbal communication

同理心

## 自我披露

将个人信息进行编码，在这里表述者个人文化背景，经验等因素影响着信息的编码方式。

## 语言信息

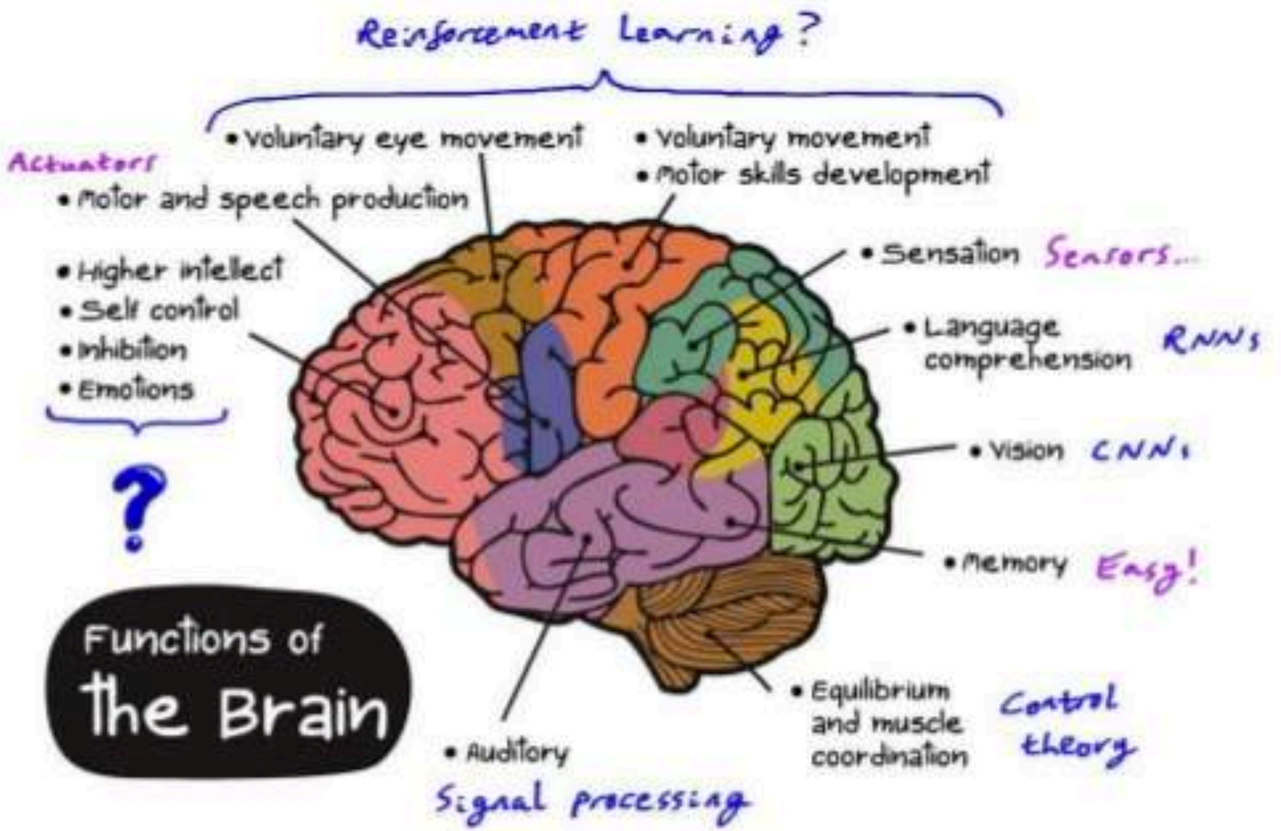
共同使用的语言体系
语法，构词法，词性

## 被接受者转译的信息

经过接收者进行加工与理解的信息，接受者的个人文化背景，经验，理解力的差异也会影响信息能否被准确传输

# Process

## Comprehension



# Pattern

it is a distillation of interactions in a context where this kind of interaction has been found representative

1. Patterns are specified abstractly enough such that many different instantiations of the pattern can be realized in the solution to a problem.

2. Patterns can be and often are combined.

3. Less complex patterns are often hierarchically integrated into more complex patterns.

4. Design patterns are fundamentally patterns of human interaction with the physical and social world.

source:
Design Patterns for Sociality in Human-Robot Interaction

# Pattern Library

it is a distillation of interactions in a context where this kind of interaction has been found representative

## human-generate robot-react

inquiry-answer

command-action

instruction-action

guidance-action

Intimate contact-reaction

## robot-generate human-react

inquiry-answer

remind-feedback

confirmation-feedback

ask for help-action

monologue-feedback

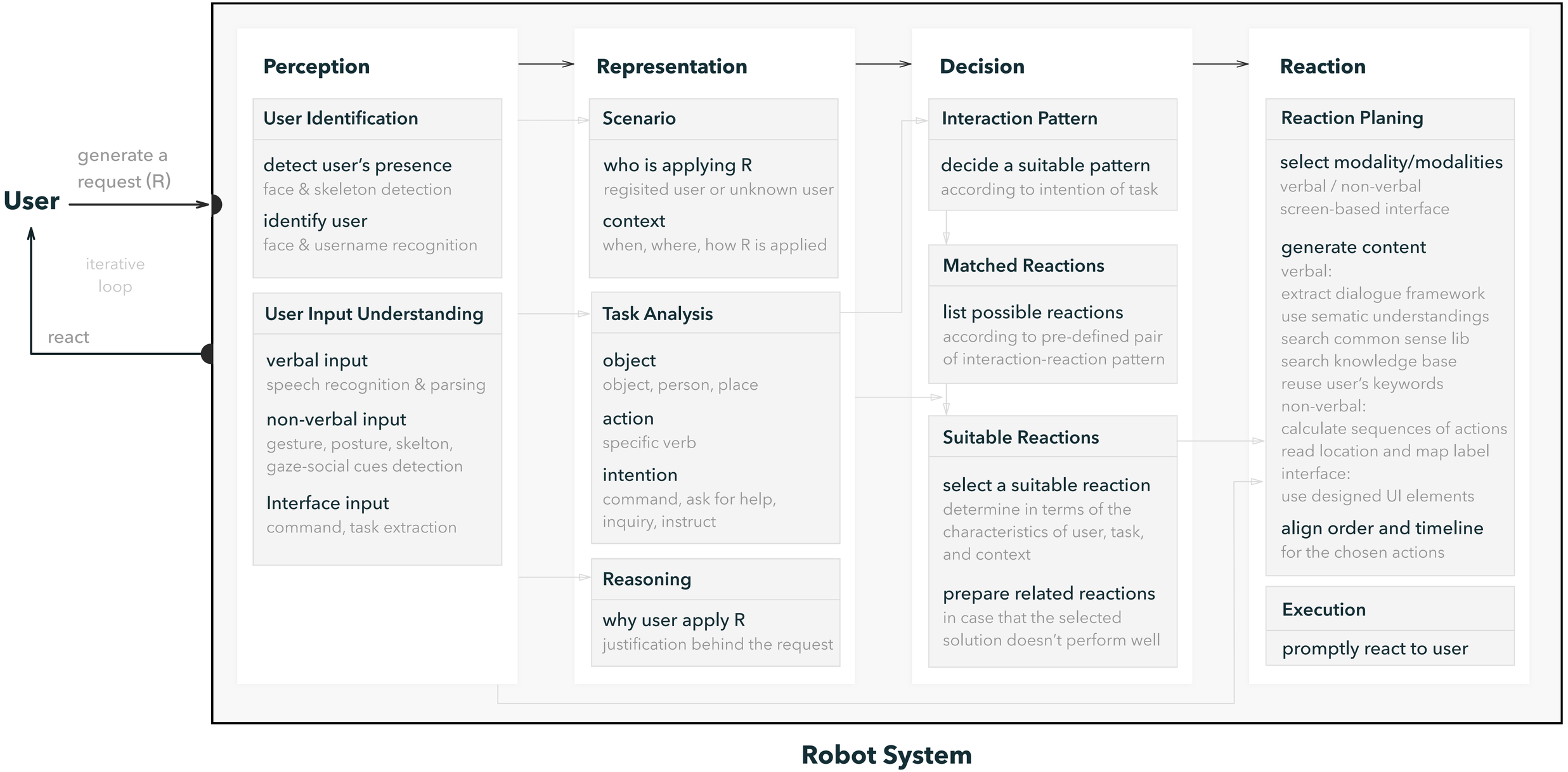
## human-robot joint collaboration

collaborate to work on the same assignment

In Motion together

Turn-Taking inGame Context

# Pattern i: Human-generate Robot-react



# Pattern

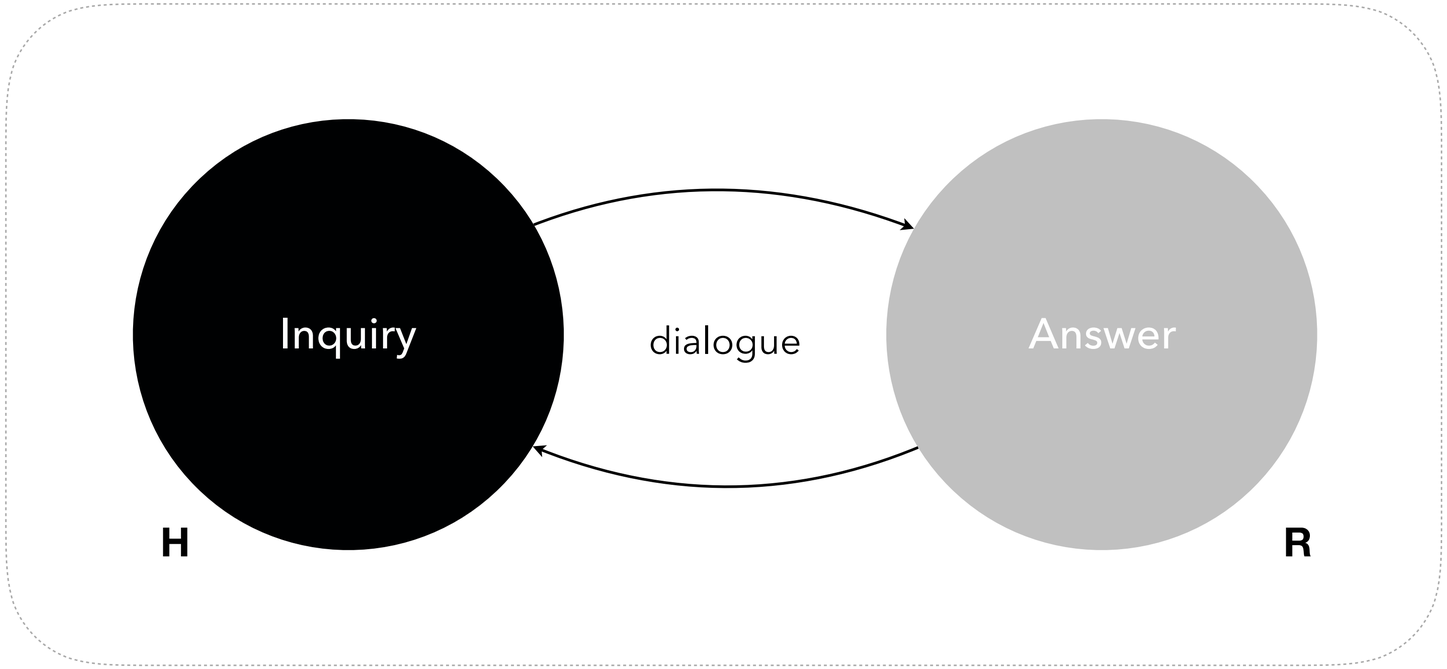
## human-generate robot-react

inquiry-answer

the basic pattern in human-human communication

always in the form of dialogue

the interactions can be iterative



# Pattern

## human-generate robot-react

inquiry-answer

the basic pattern in human-human communication

always in the form of dialogue

the interactions can be iterative

# Pattern

## human-generate robot-react

inquiry-answer

H: Hey buddy! Can you order some take-out for me?

R: Sure thing. Chinese as usual?

H: You know me so well.

# Pattern

## human-generate robot-react

inquiry-answer

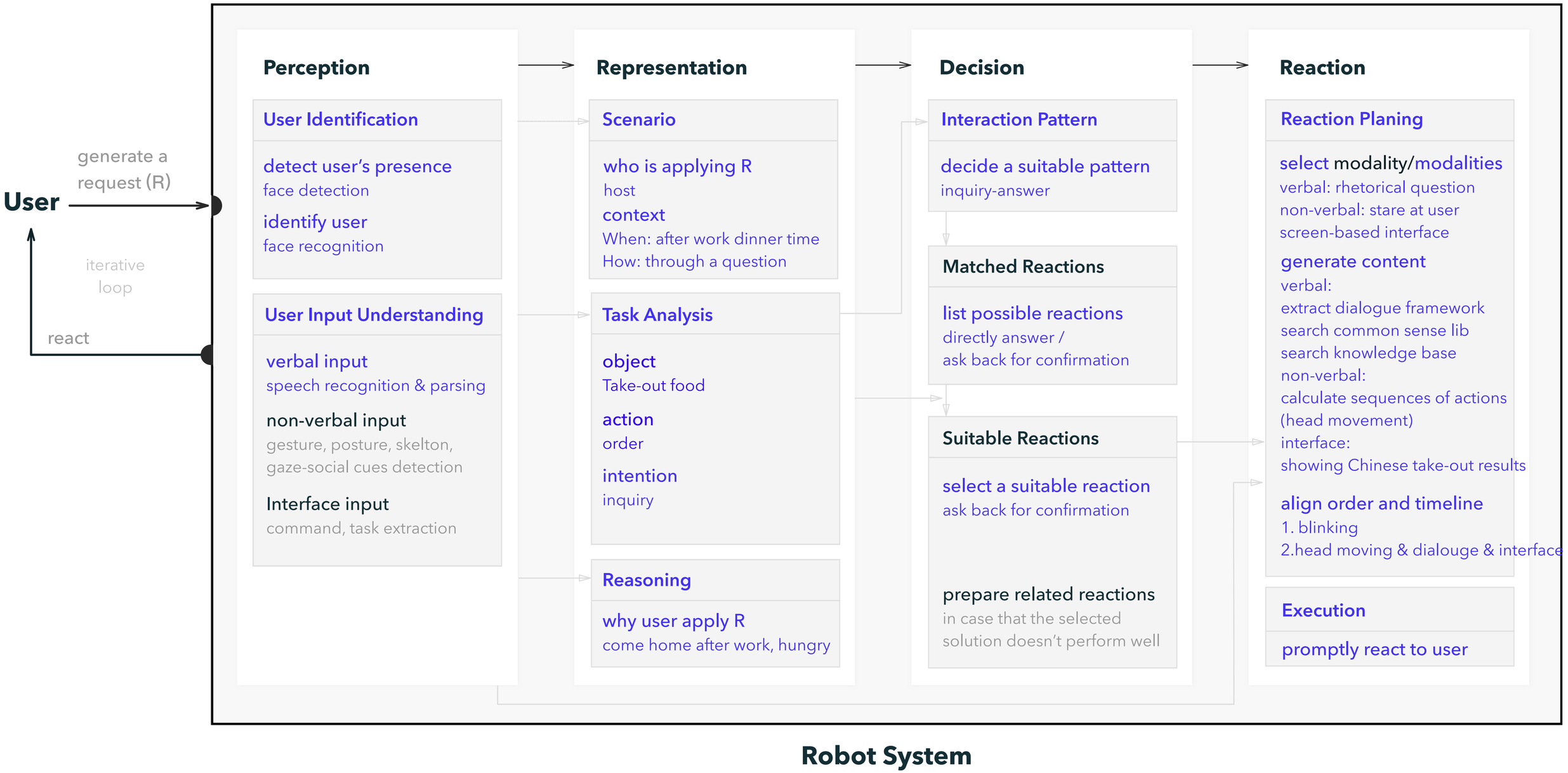
Task Analysis

object
action
intention

H: Hey buddy! Can you order some take-out for me?

R: Sure thing. Chinese as usual?

H: You know me so well.


User
generate a request (R)
iterative loop
react
Perception
User Identification
detect user's presence
face detection
identify user
face recognition
User Input Understanding
verbal input
speech recognition & parsing
non-verbal input
gesture, posture, skelton, gaze-social cues detection
Interface input
command, task extraction
Representation
Scenario
who is applying R
host
context
When: after work dinner time
How: through a question
Task Analysis
object
Take-out food
action
order
intention
inquiry
Reasoning
why user apply R
come home after work, hungry
Decision
Interaction Pattern
decide a suitable pattern
inquiry-answer
Matched Reactions
list possible reactions
directly answer /
ask back for confirmation
Suitable Reactions
select a suitable reaction
ask back for confirmation
prepare related reactions
in case that the selected solution doesn't perform well
Reaction
Reaction Planing
select modality/modalities
verbal: rhetorical question
non-verbal: stare at user
screen-based interface
generate content
verbal:
extract dialogue framework
search common sense lib
search knowledge base
non-verbal:
calculate sequences of actions (head movement)
interface:
showing Chinese take-out results
align order and timeline
1. blinking
2.head moving & dialouge & interface
Execution
promptly react to user
Robot System

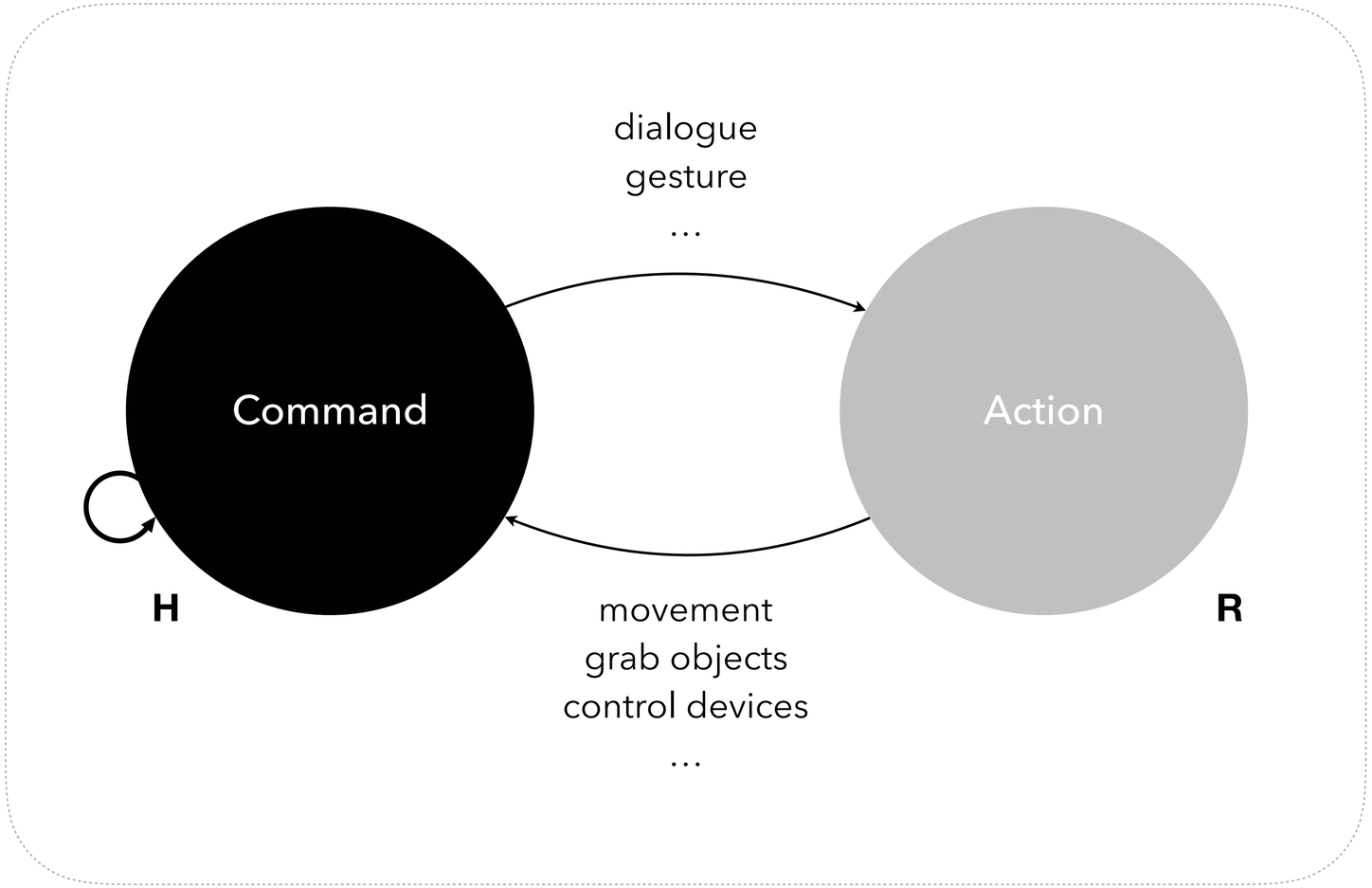
# Pattern

## human-generate robot-react

command-action

the basic pattern in human-human communication

the interactions can be iterative



# Pattern

## human-generate robot-react

command-action

the basic pattern in human-human communication

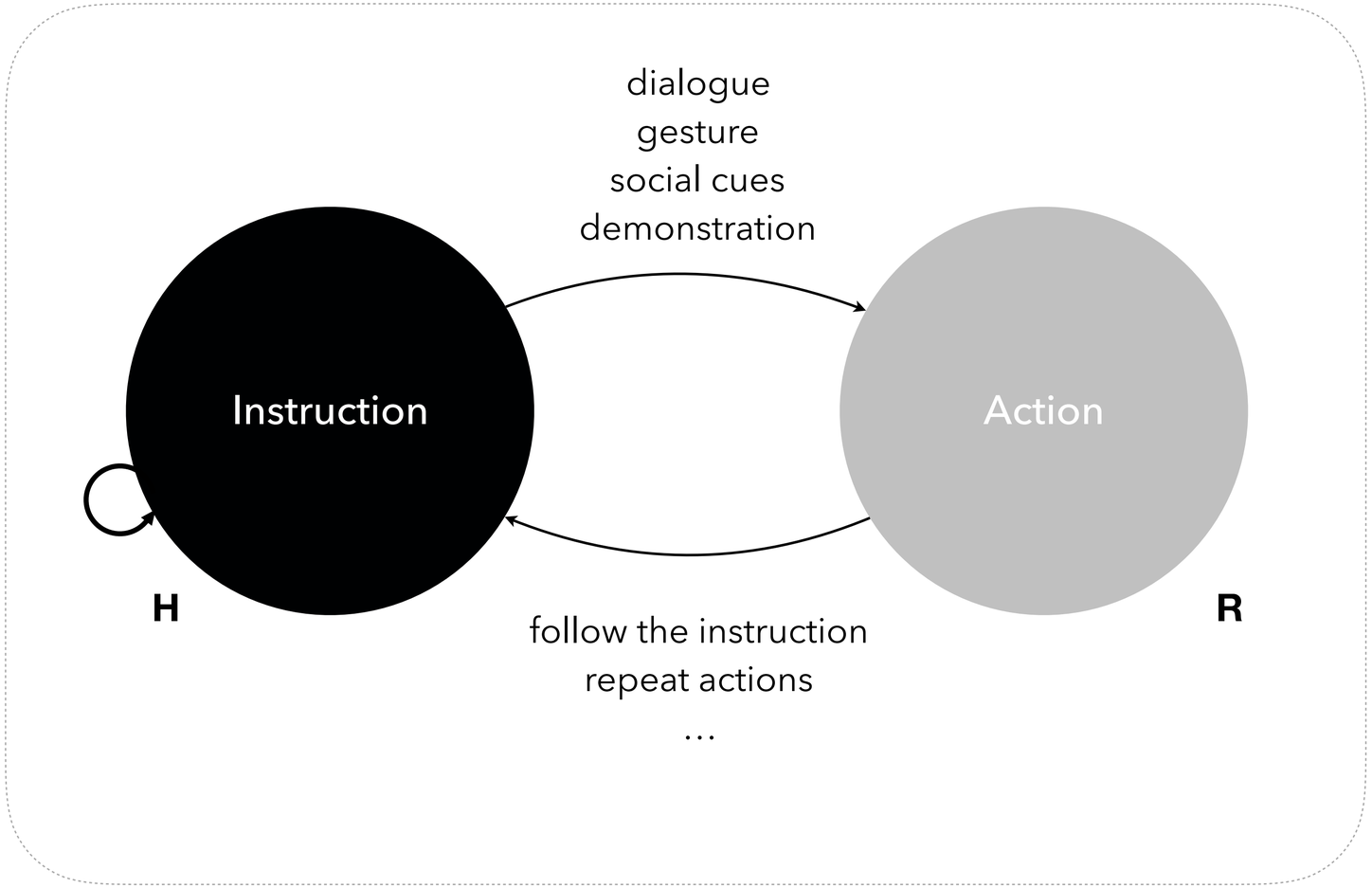
the interactions can be iterative

# Pattern

## human-generate robot-react

Instruction-action

An instruction is offered by one participant to direct the actions of robot. The proper response to this instruction is often an action, although the action might follow the instruction with a delay depending on whether it is an appropriate time to perform that action. Instruction-action pairs are commonly found in teaching scenarios.

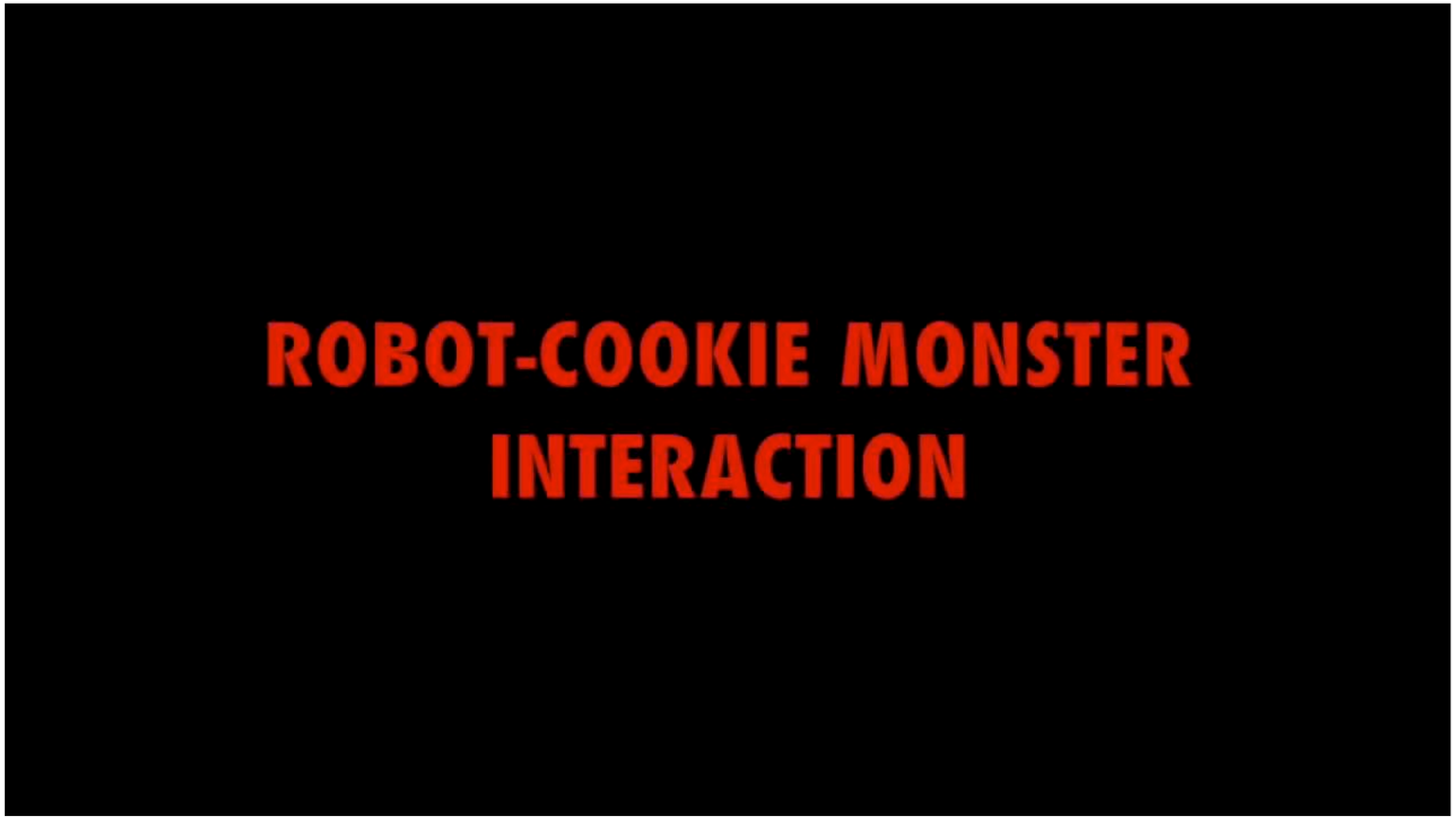


# Pattern

## human-generate robot-react

Instruction-action

An instruction is offered by one participant to direct the actions of robot. The proper response to this instruction is often an action, although the action might follow the instruction with a delay depending on whether it is an appropriate time to perform that action. Instruction-action pairs are commonly found in teaching scenarios.

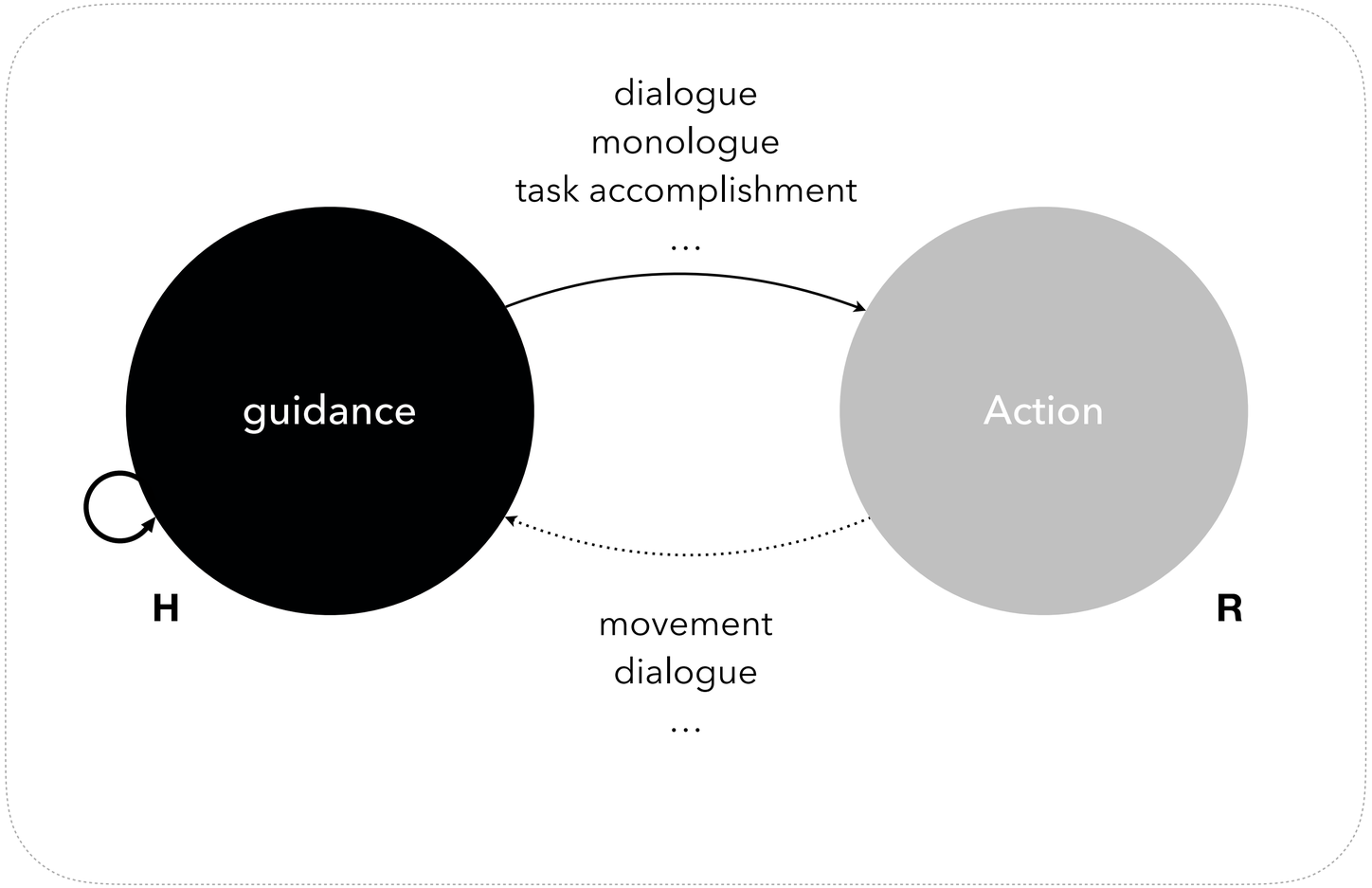


# Pattern

## human-generate robot-react

guidance-action

Compared to instruction-action pair, guidance-action is not intentionally teach robot to learn something, in which user indirectly offer assistance and knowledge to robot.



# Pattern

## human-generate robot-react

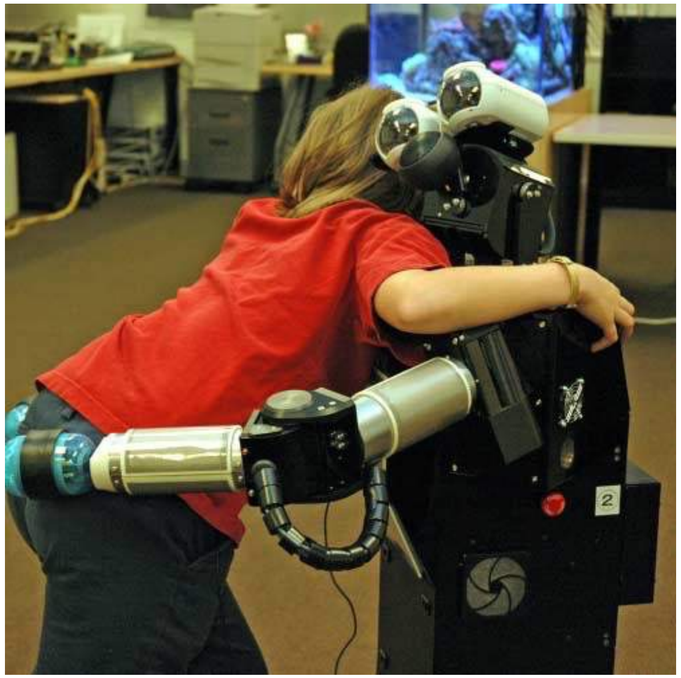
guidance-action

Compared to instruction-action pair, guidance-action is not intentionally teach robot to learn something, in which user indirectly offer assistance and knowledge to robot.

# Pattern

## human-generate robot-react

Intimate contact-reaction



# Pattern

## human-generate
## robot-react

inquiry-answer
command-action
instruction-action
guidance-action

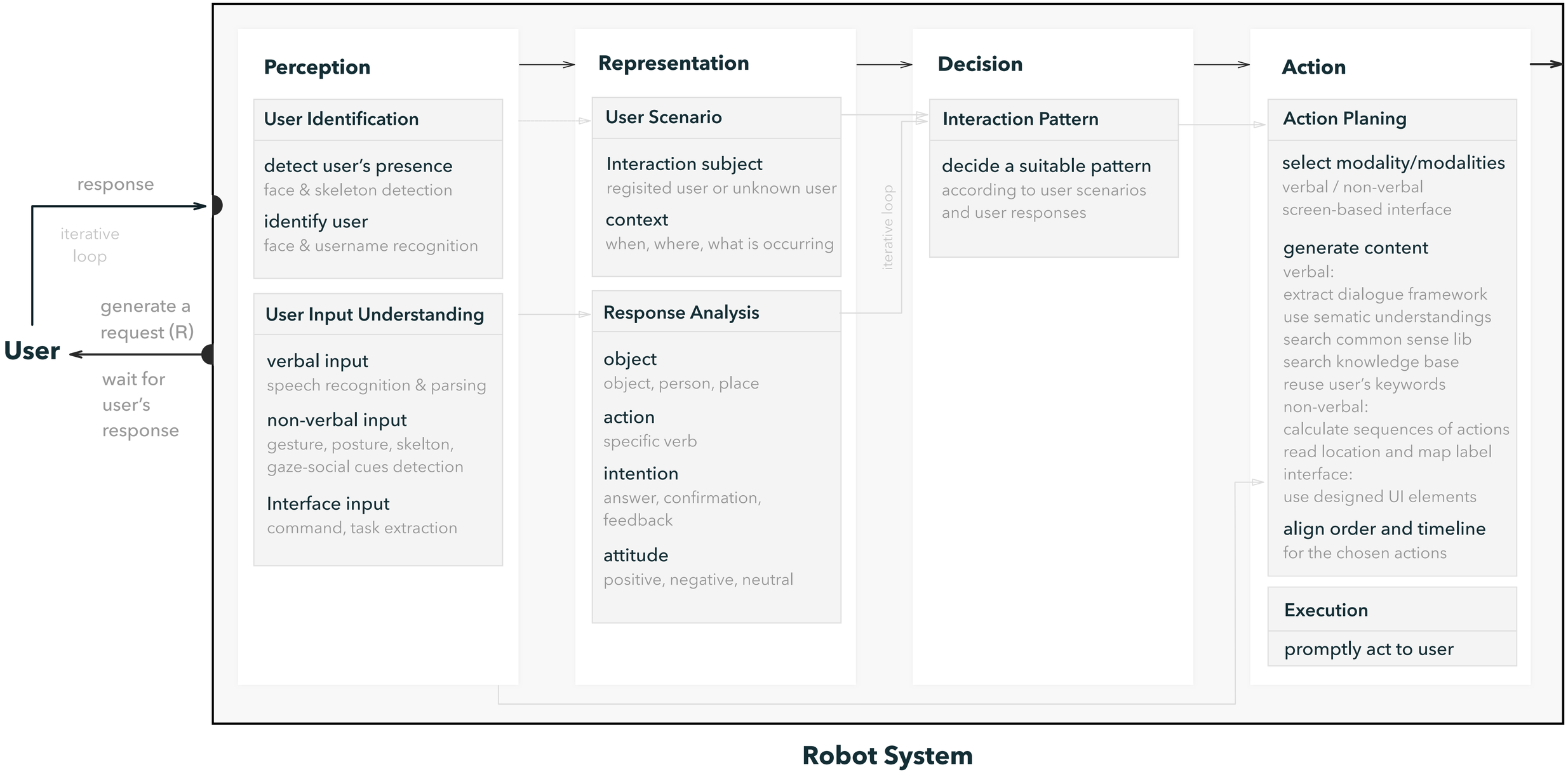
Intimate contact-reaction

# Pattern

## robot-generate
## human-response

inquiry-answer
remind-feedback
confirmation-feedback
ask for help-action
monologue-feedback

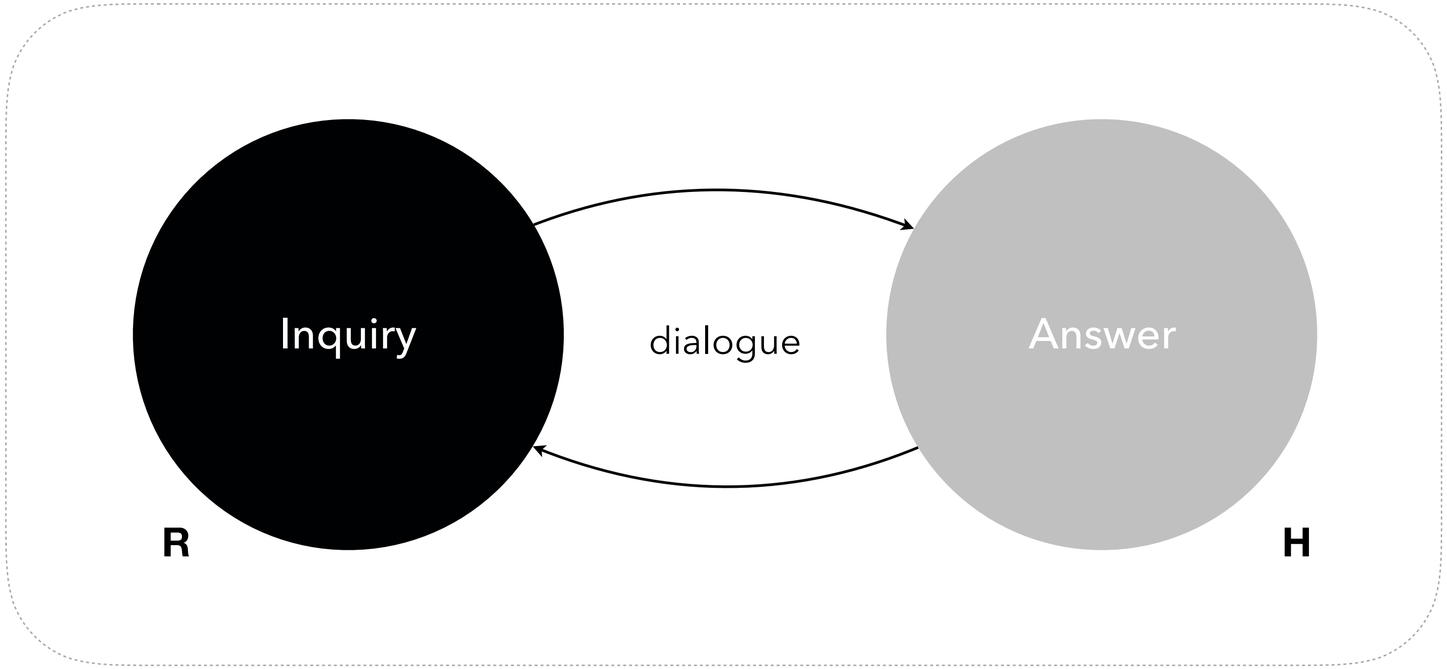
# Pattern ii: Robot-generate Human-response



# Pattern

## robot-generate human-response

inquiry-answer



# Pattern

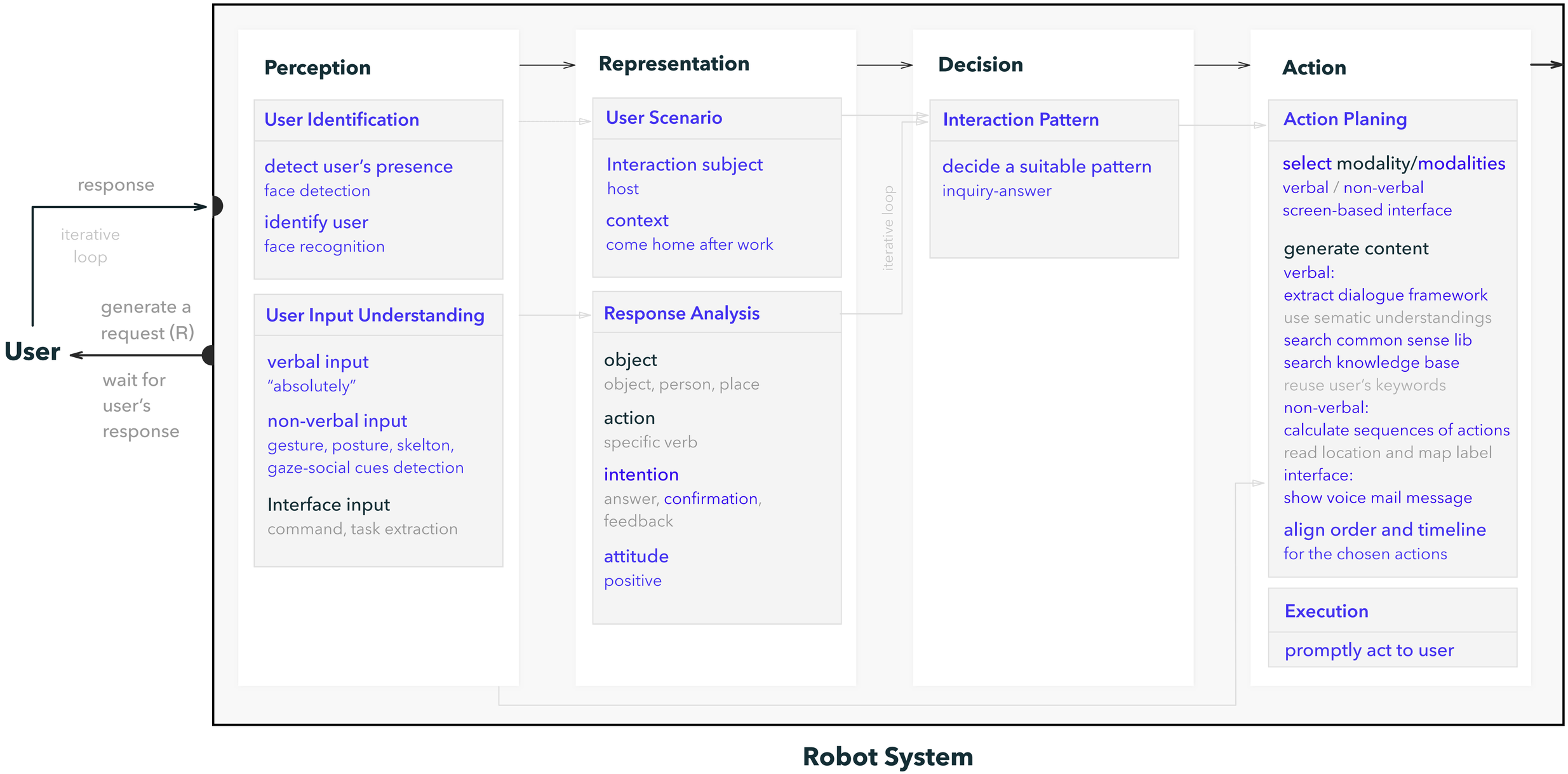
## robot-generate human-response

inquiry-answer

R: You have an voice message from Ashley. **Wanna hear it?**

H: **Absolutely.**

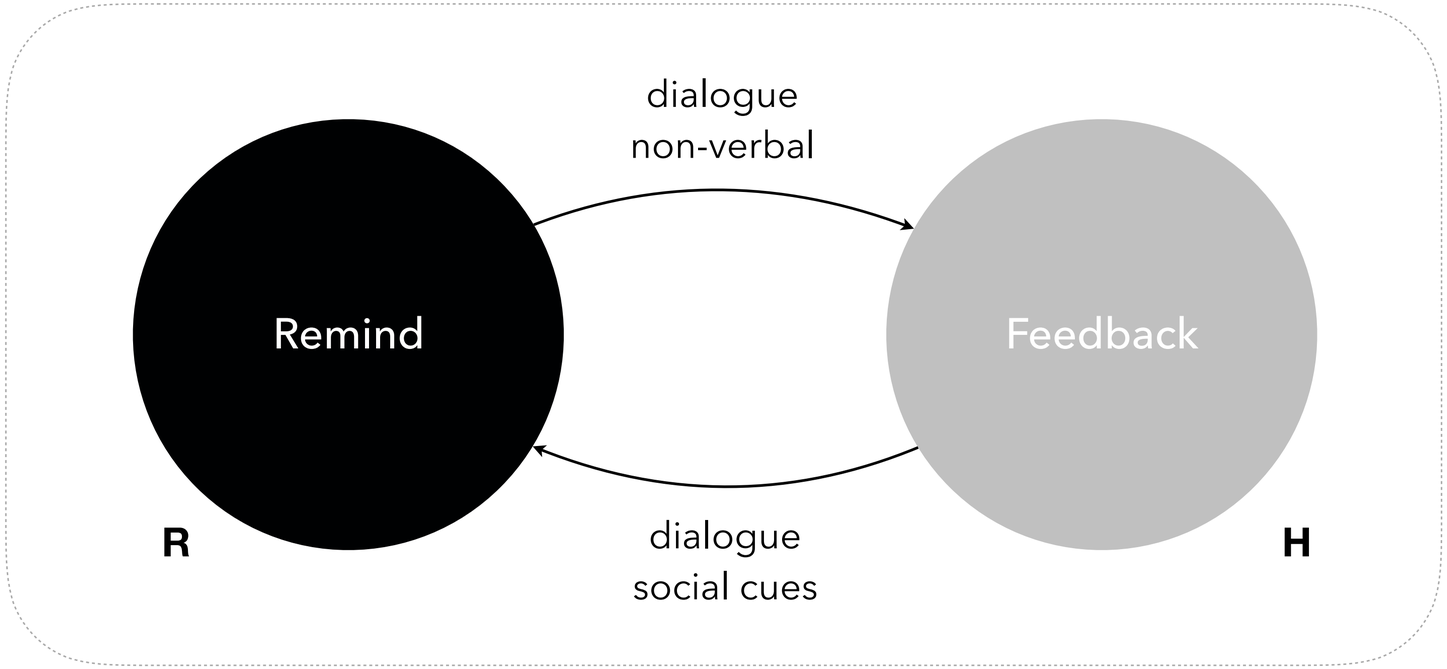
**R is playing the voice message.**


response
iterative loop
generate a request (R)
User
wait for user's response
Perception
User Identification
detect user's presence
face detection
identify user
face recognition
User Input Understanding
verbal input
"absolutely"
non-verbal input
gesture, posture, skelton, gaze-social cues detection
Interface input
command, task extraction
Representation
User Scenario
Interaction subject
host
context
come home after work
Response Analysis
object
object, person, place
action
specific verb
intention
answer, confirmation, feedback
attitude
positive
iterative loop
Decision
Interaction Pattern
decide a suitable pattern
inquiry-answer
Action
Action Planing
select modality/modalities
verbal / non-verbal
screen-based interface
generate content
verbal:
extract dialogue framework
use sematic understandings
search common sense lib
search knowledge base
reuse user's keywords
non-verbal:
calculate sequences of actions
read location and map label
interface:
show voice mail message
align order and timeline
for the chosen actions
Execution
promptly act to user
Robot System

# Pattern

## robot-generate human-response

remind-feedback



# Pattern

## robot-generate human-response

remind-feedback

# Pattern

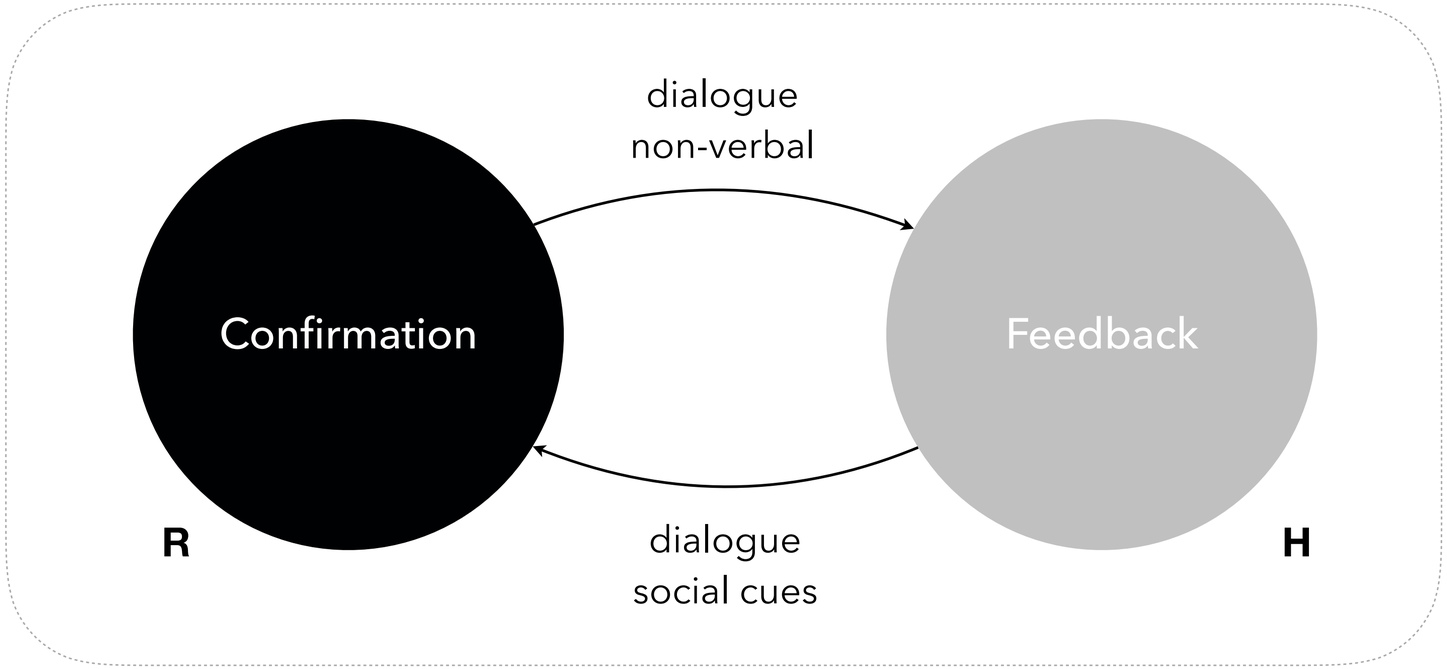
## robot-generate human-response

confirmation-feedback

R: You look so happy. Can I capture this moment for you?

H: Thank you, JIBO.

R is taking photo.



# Pattern

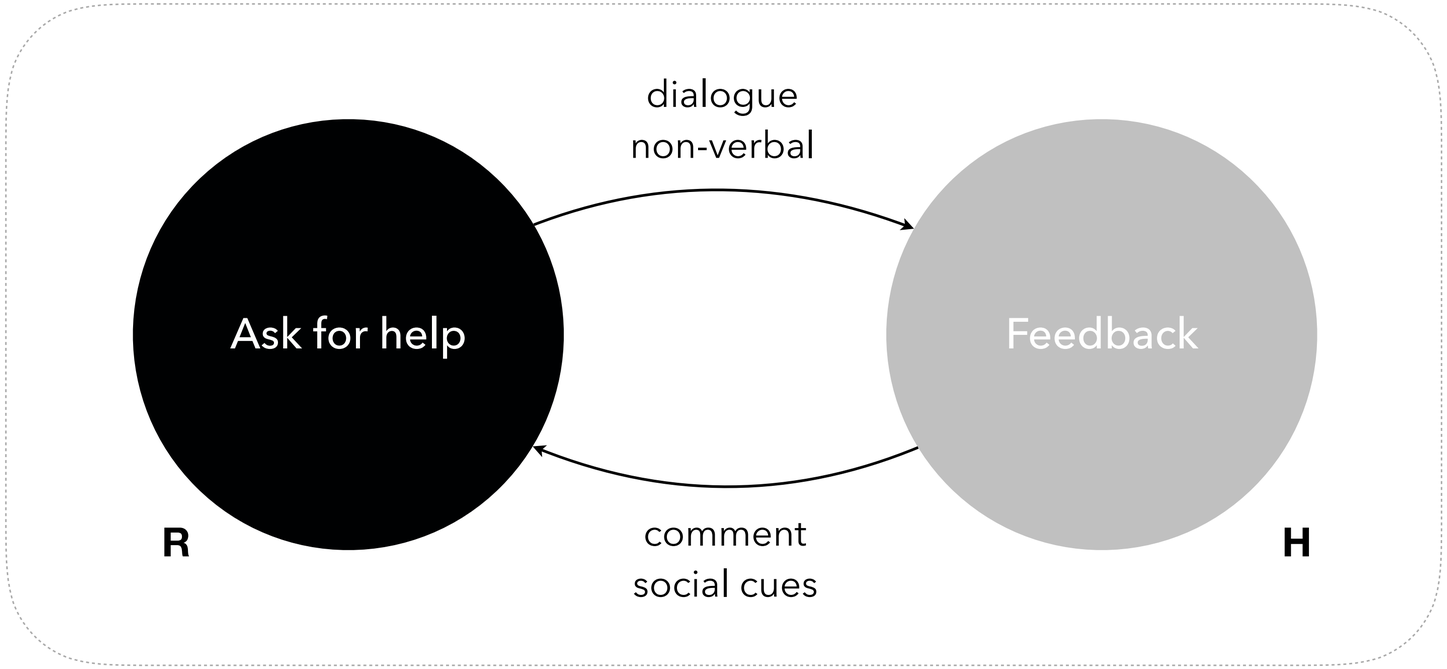
## robot-generate human-response

ask for help-action

R: You know I can't walk, but I want to go to the kitchen to stay with grandma. Can you help move me there?

H: Sure thing!

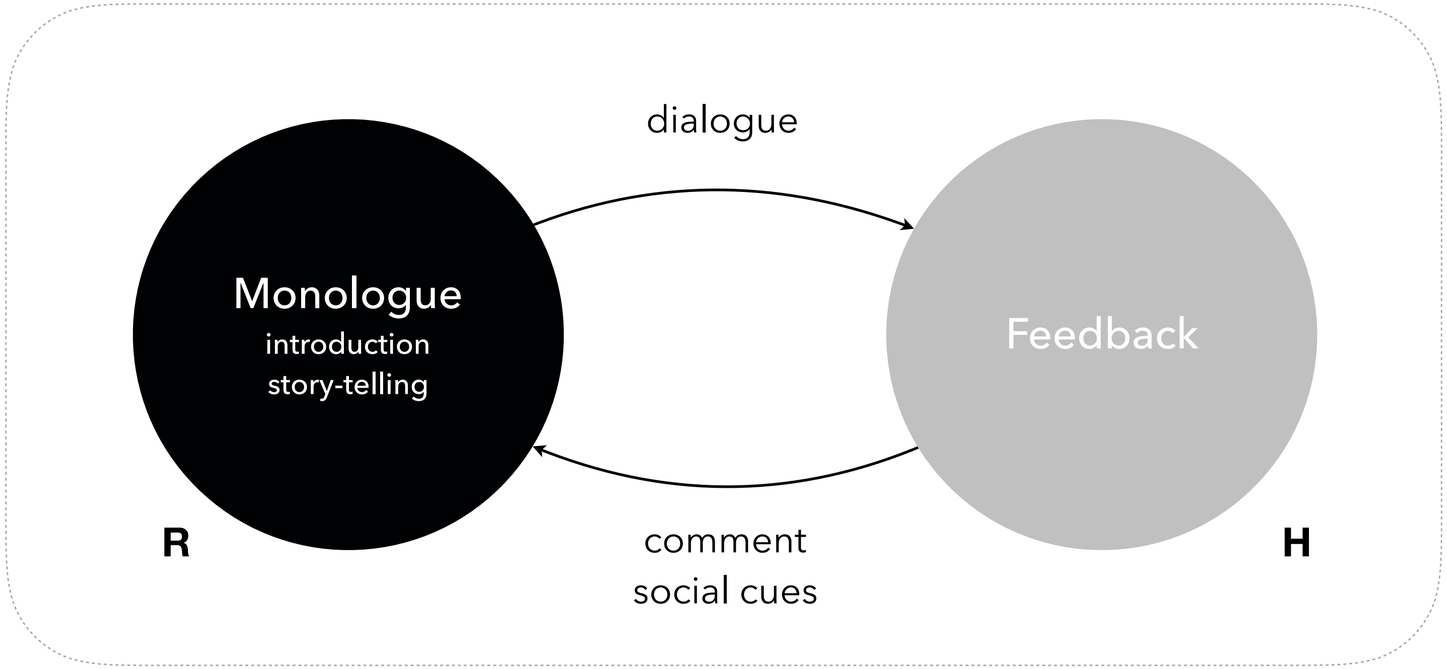
H is moving JIBO to the kitchen.



# Pattern

## robot-generate human-response

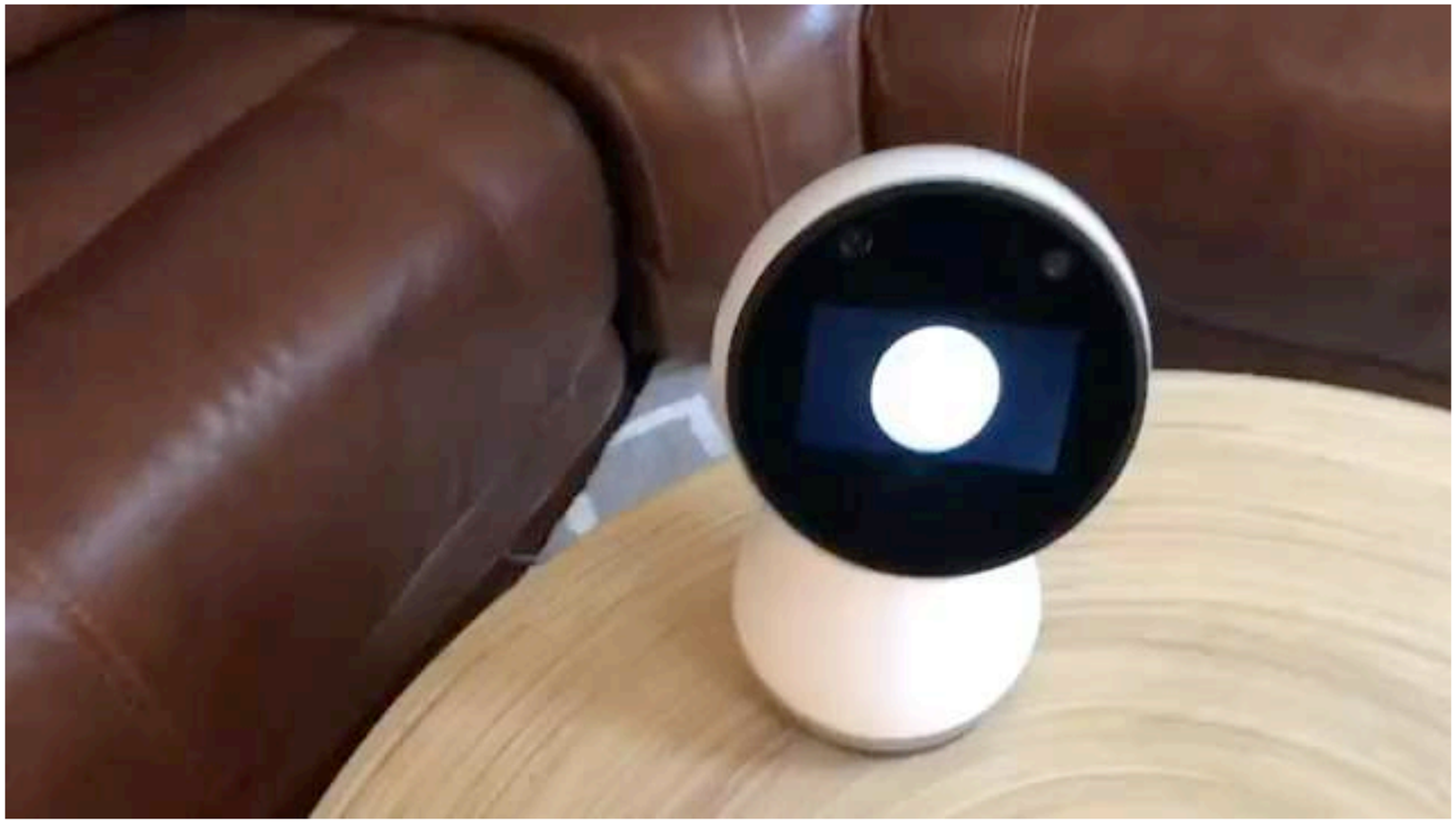
monologue-feedback



# Pattern

## robot-generate human-response

monologue-feedback



# Pattern

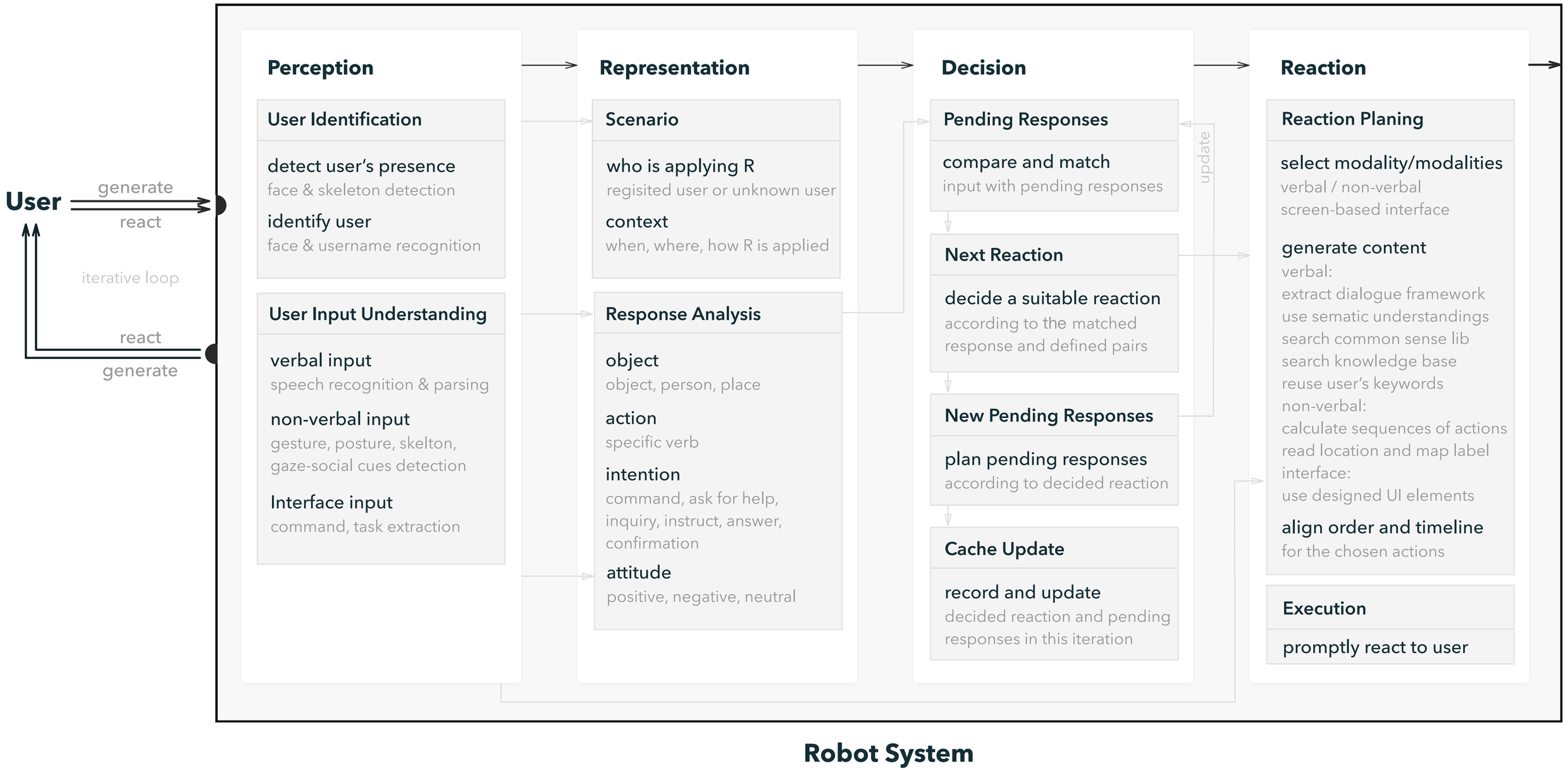
## human-robot joint collaboration

collaborate to work on the same assignment

In Motion together

Turn-Taking in Game Context

# Pattern iii: Robot-generate Human-response



# Pattern

## human-robot joint collaboration

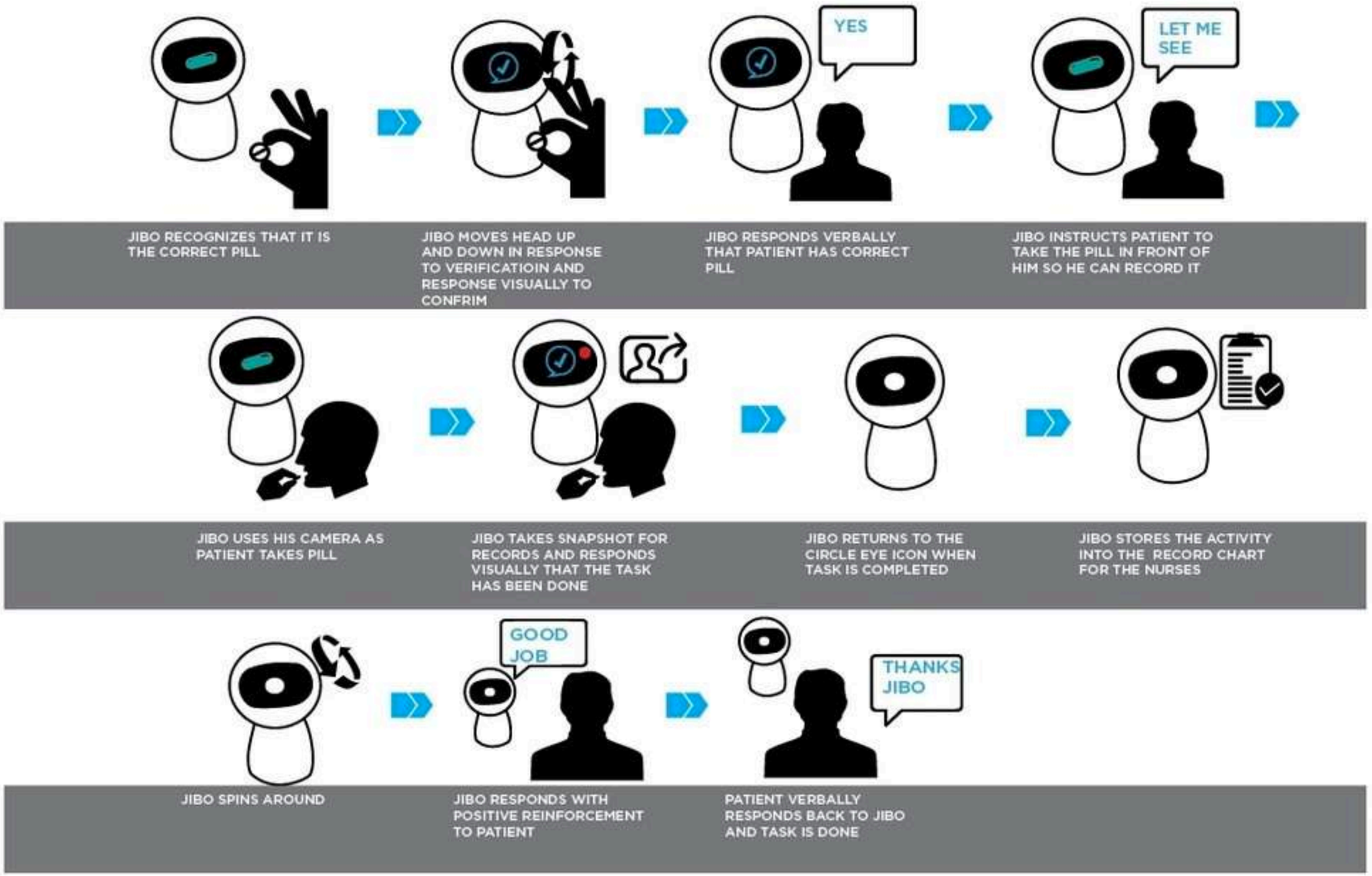
collaborate to work on the same assignment

JIBO assists the patient to take the correct pills

# Pattern

## human-robot joint collaboration

collaborate to work on the same assignment

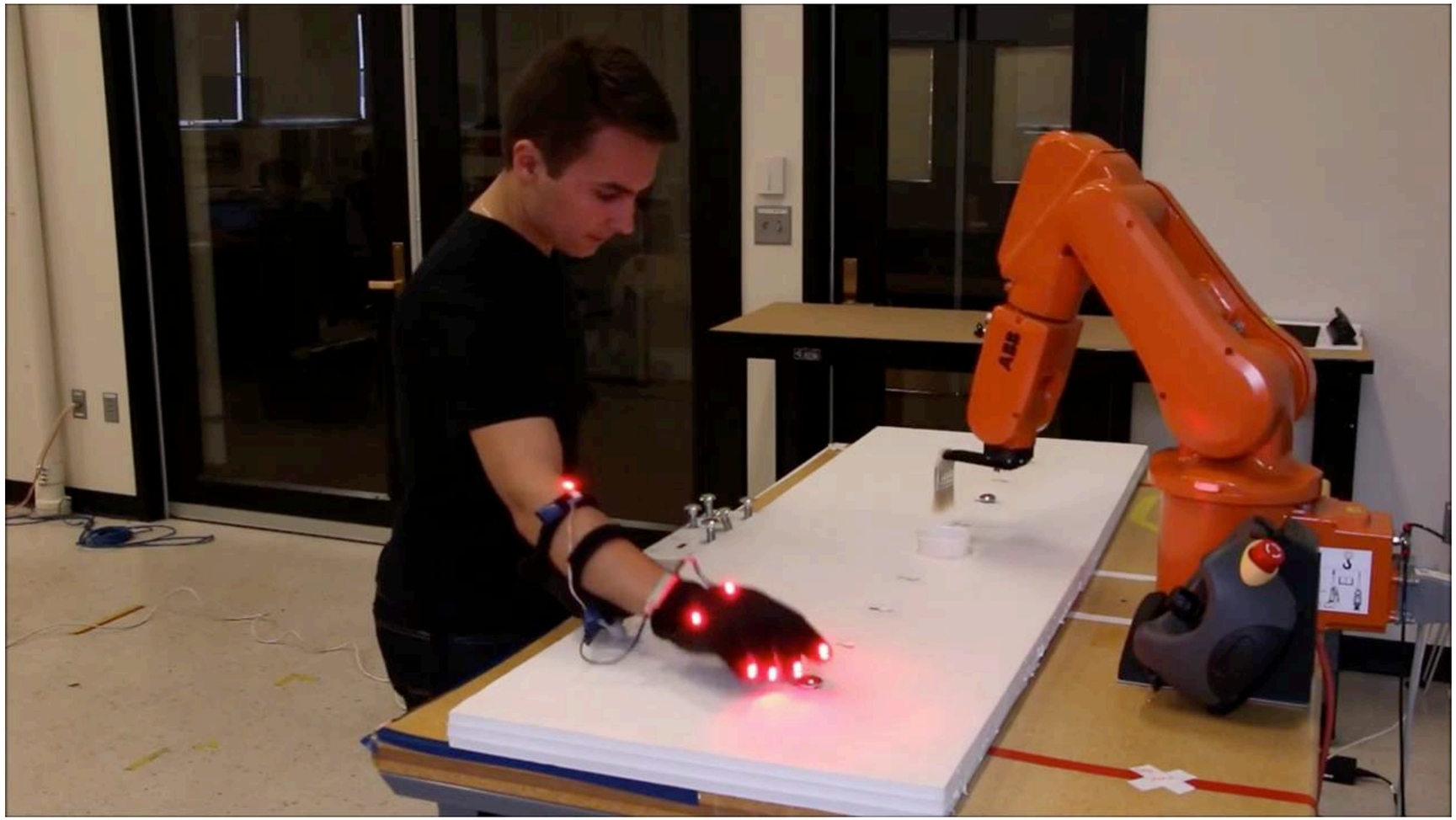



JIBO assists the patient to take the correct pills

# Pattern

## human-robot joint collaboration

collaborate to work on the same assignment



JIBO assists the patient to take the correct pills

# Pattern

## human-robot joint collaboration

In Motion together

**imitation**

accompany

following

In Motion Together with Rethink Robot

# Pattern

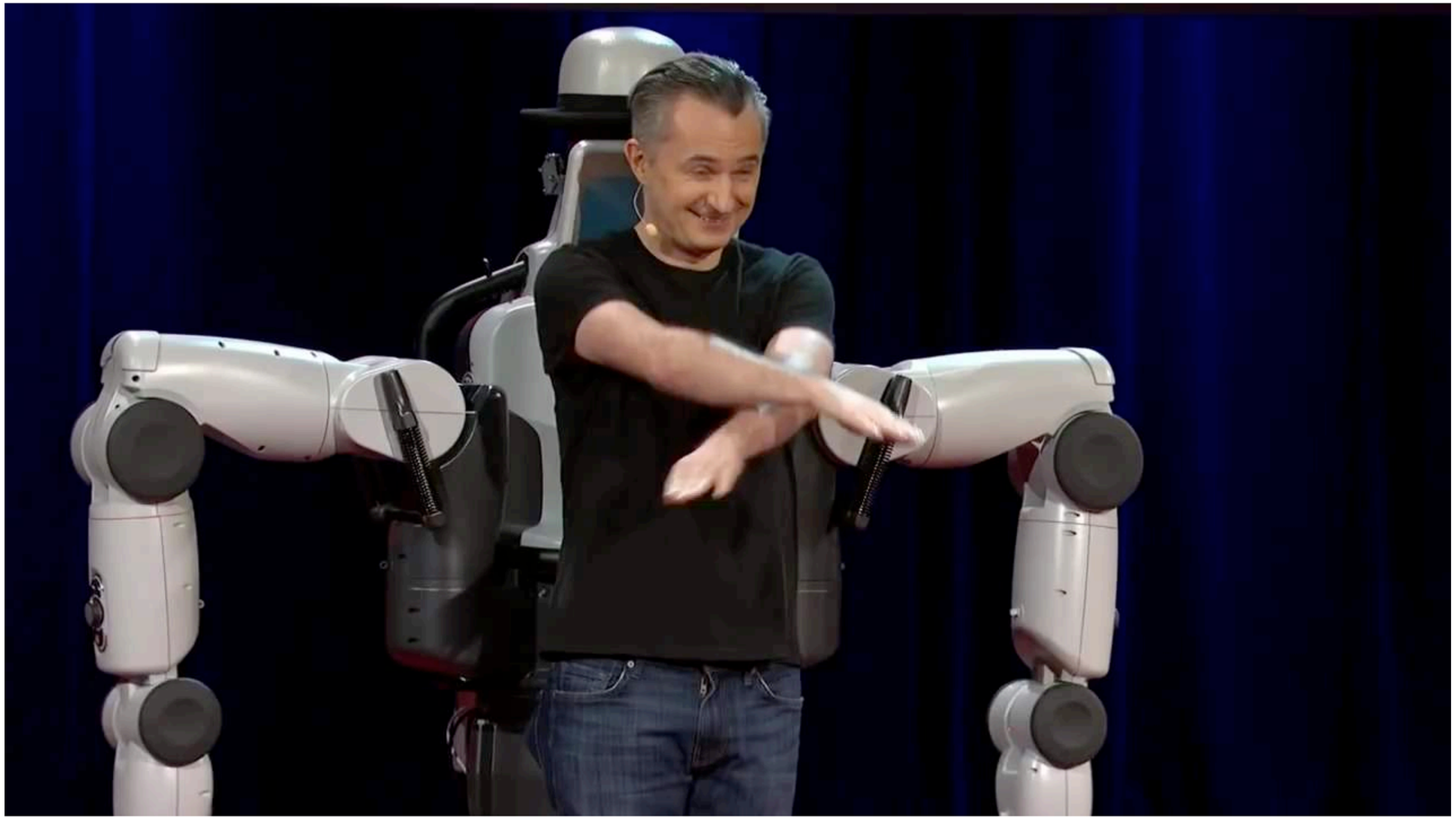
## human-robot joint collaboration

In Motion together

imitation

**accompany**

following



In Motion Together with Rethink Robot

# Pattern

## human-robot joint collaboration

In Motion together

imitation

accompany

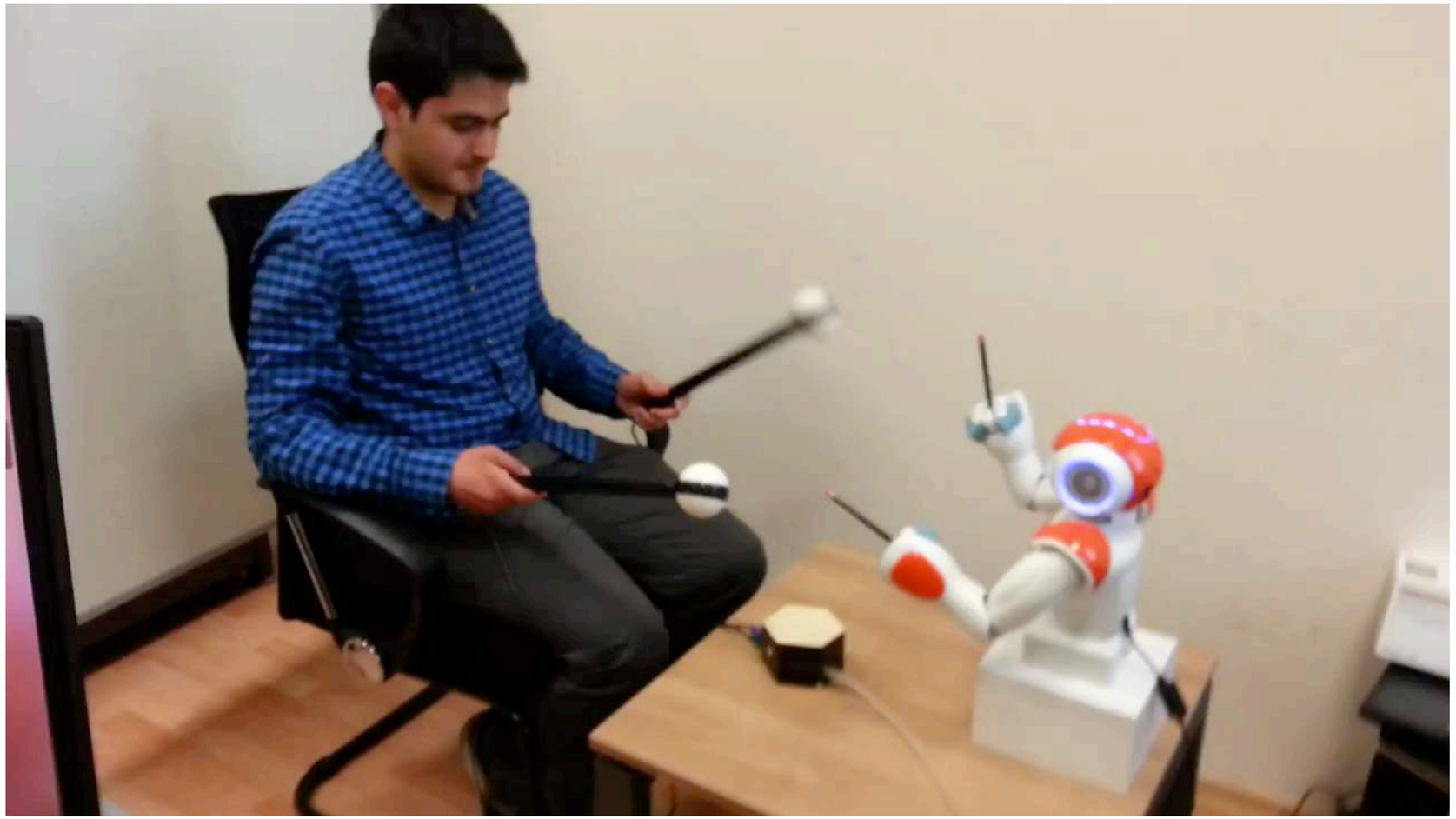
**following**

In Motion Together with Mobile Robot

# Pattern

## human-robot joint collaboration

Turn-Taking in Game Context



Human Robot Interaction using Air Drum Game