Moonshot Goal 3

Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings, by 2050

- AI robots that humans feel comfortable with, have physical abilities equivalent to or greater than humans, and grow in harmony with human life -

Adaptable AI-enabled Robots to Create a Vibrant Society

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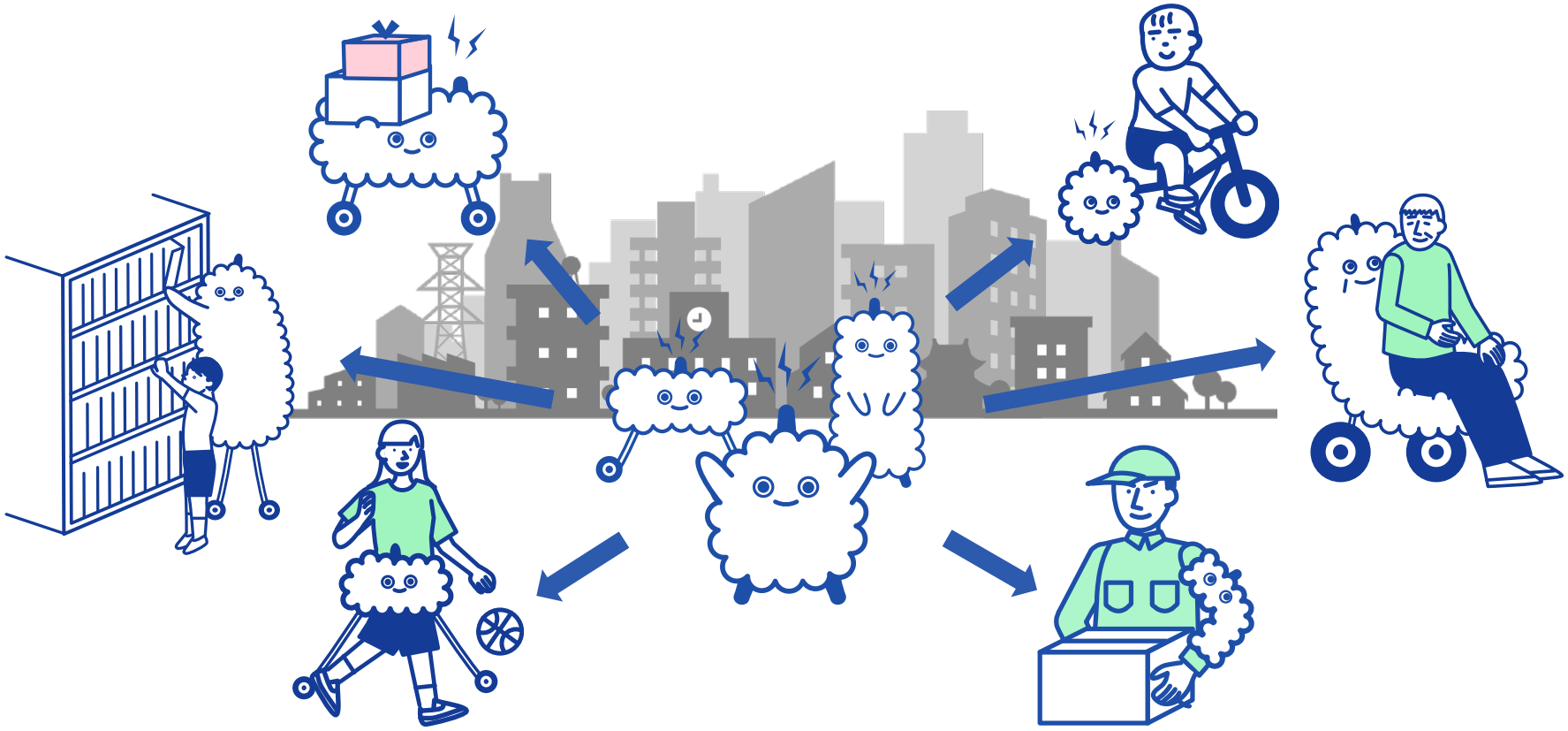
Tohoku University

Vision of the Society of 2050

- Robots will be everywhere in our daily lives, and we will all be using them naturally
  - ✓ Our goal is to develop AI robots that can provide appropriate support and services depending on where they are used and the condition of the user



Adaptable AI Robots

Vision of the Society of 2050

- Adaptable AI robots will be used at many places as part of the infrastructure of society
  - ✓ Commercial facilities, Cultural facilities, Sightseeing spots, Sports facilities, Nursing homes, Hospitals, Childcare facilities, etc.
- Smarter Inclusive Society
  - ✓ A society where everyone lives a healthy life by coexisting with AI robots
  - ✓ A society cultivating the feeling of “I want to do or to be something” and fulfills it using AI robots.

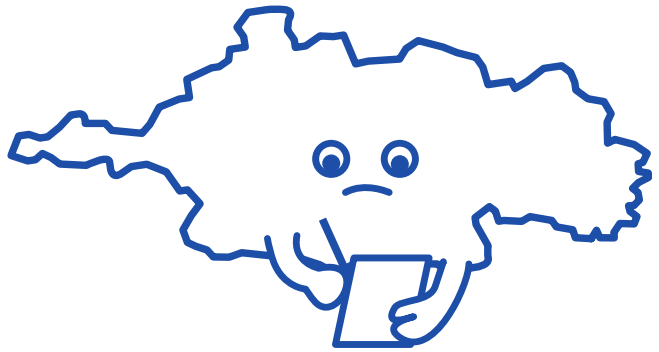
R&D 2

Adaptable AI Robots

To develop robot hardware to provide safe and appropriate assistance to humans

R&D 1

Human-robot Coevolution AI



To design how robots should behave in order to provide appropriate assistance and services to humans.

R&D 3

Social implementation of AI robots

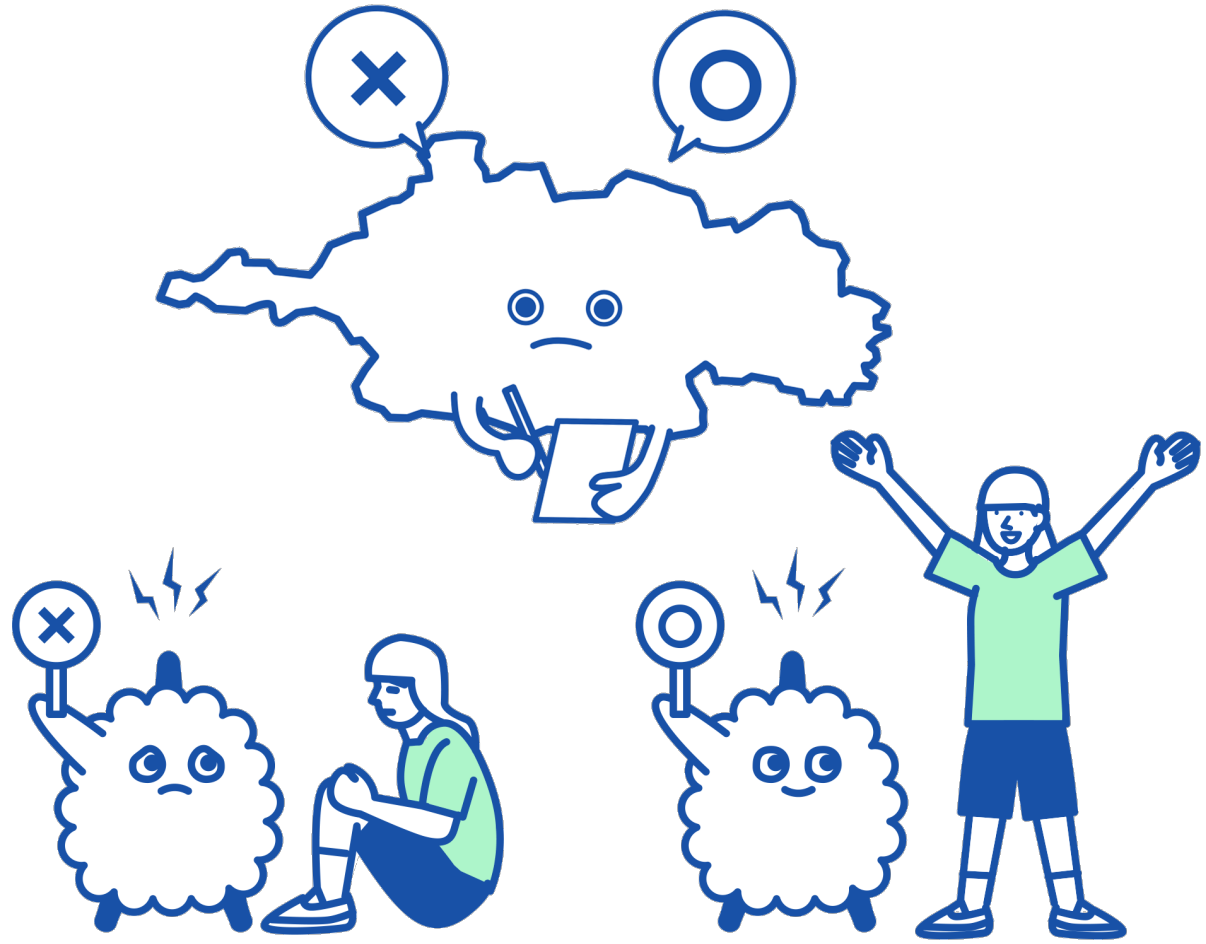
Social implementation where AI and robot hardware mutually evolve and AI robots can be used in everyday life

R&D 1

Human-robot Coevolution AI

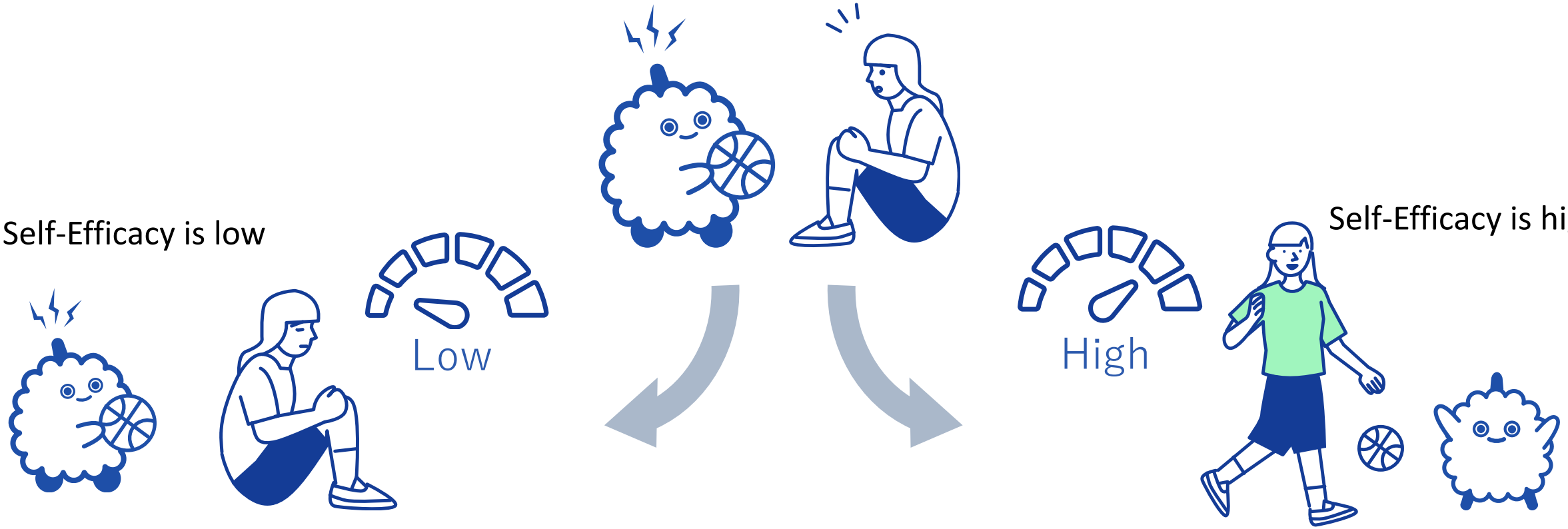
To design how robots should behave in order to provide appropriate assistance and services to humans.

Our goal is to develop an AI robots that encourages people to act on their own without providing excessive assistance.



Self-Efficacy

Expectation of how well you can perform actions necessary to produce a certain result and the recognition of possibility of your own actions.

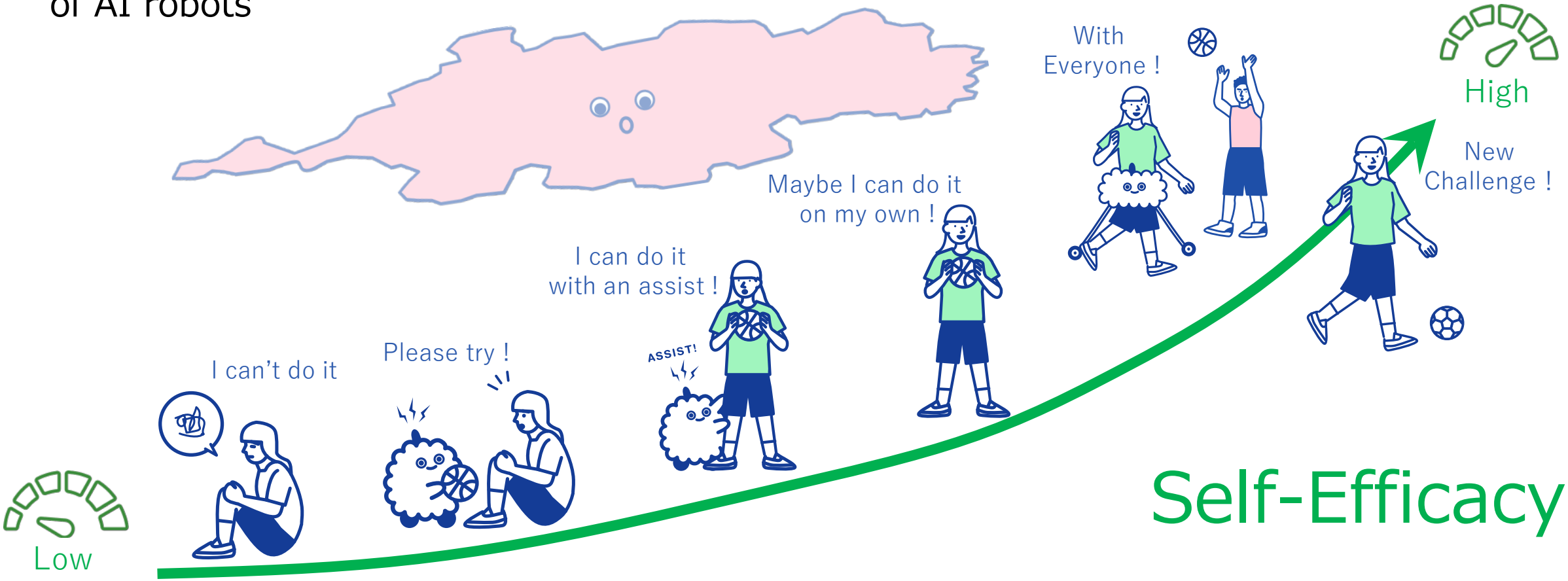


Hesitant to try new things, thinking that I can't do it or that I might course trouble for others

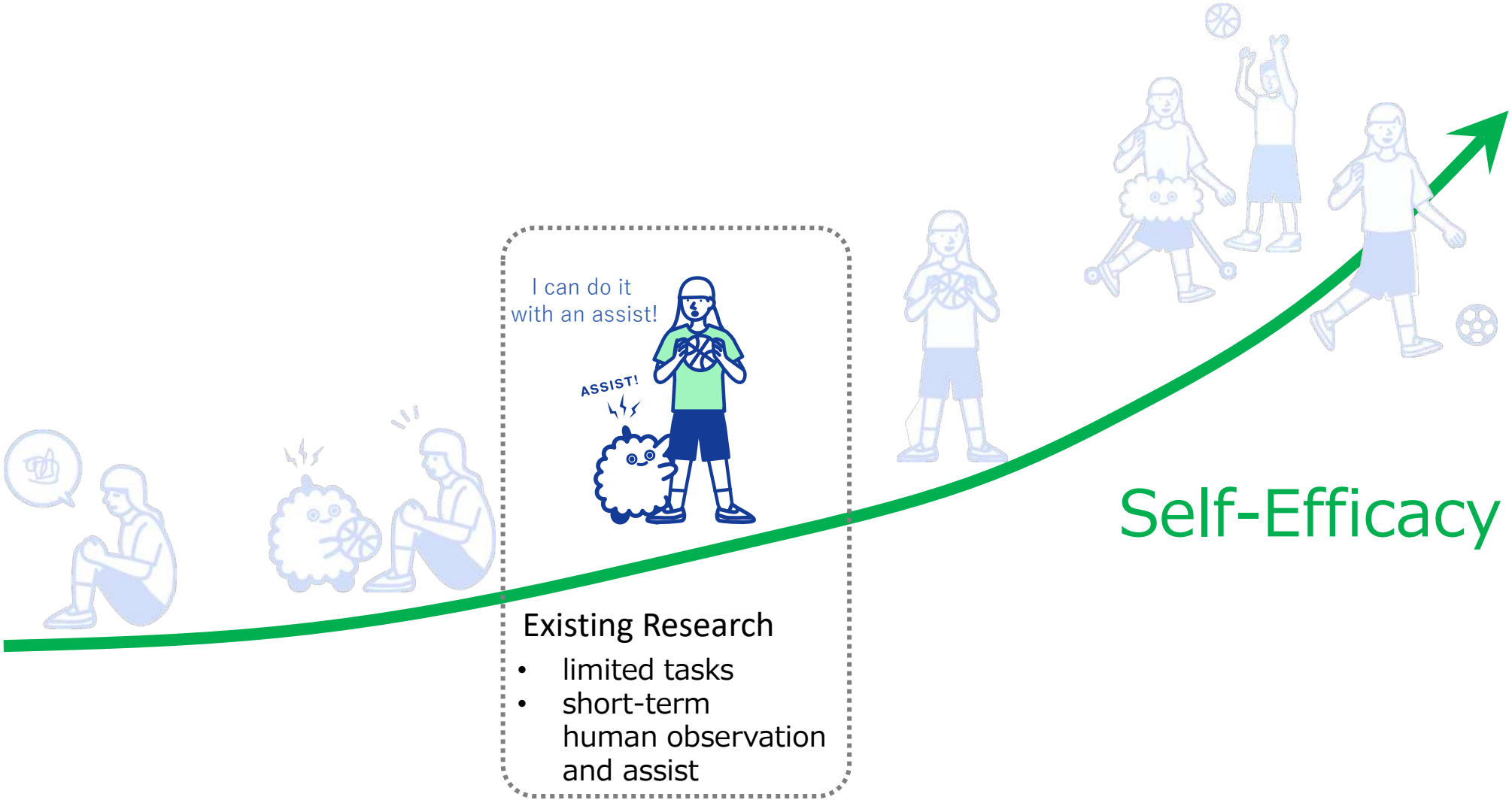
Try new things, thinking that I can do them by myself.

Self-Efficacy

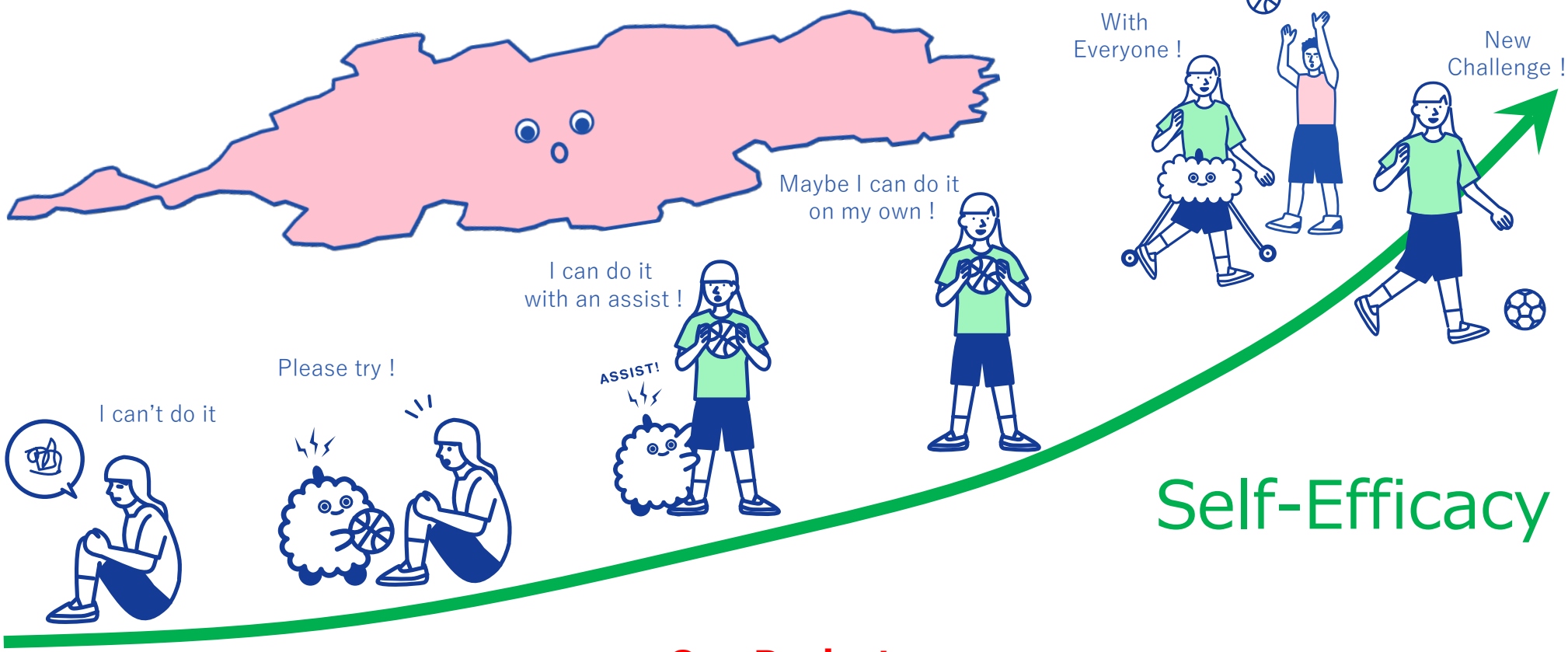
- To find out a mechanism of change in self-efficacy, feelings like “I may be able to do it” or “I will try it.”
- To set appropriate goals for each task for improving self-efficacy and to design behaviors of AI robots



Improving Self-Efficacy through Long-term Human Observation



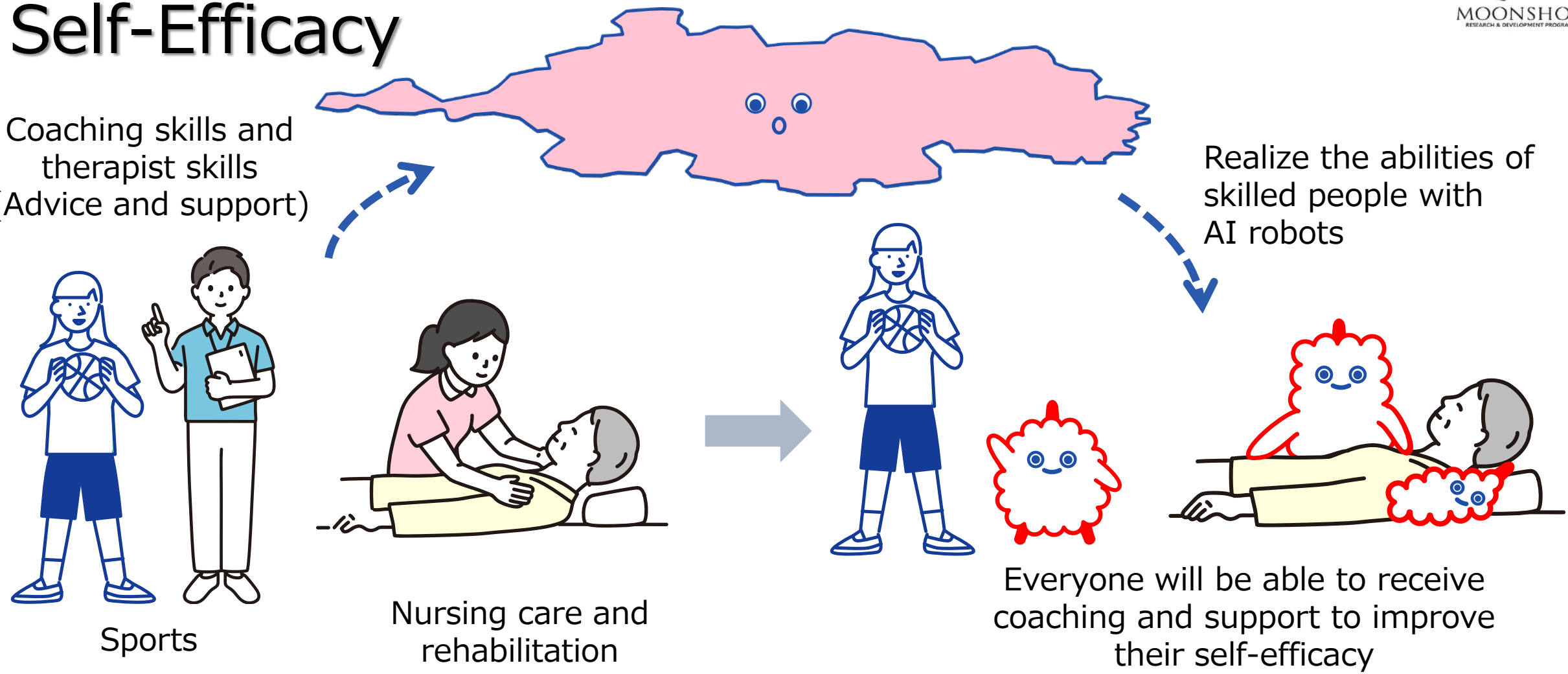
Improving Self-Efficacy through Long-term Human Observation



Our Project

We want to develop an AI robot that can improve self-efficacy from long-term observation of the user and encourage him/her to take on new challenges.

Learning from Skilled People for Improving Self-Efficacy



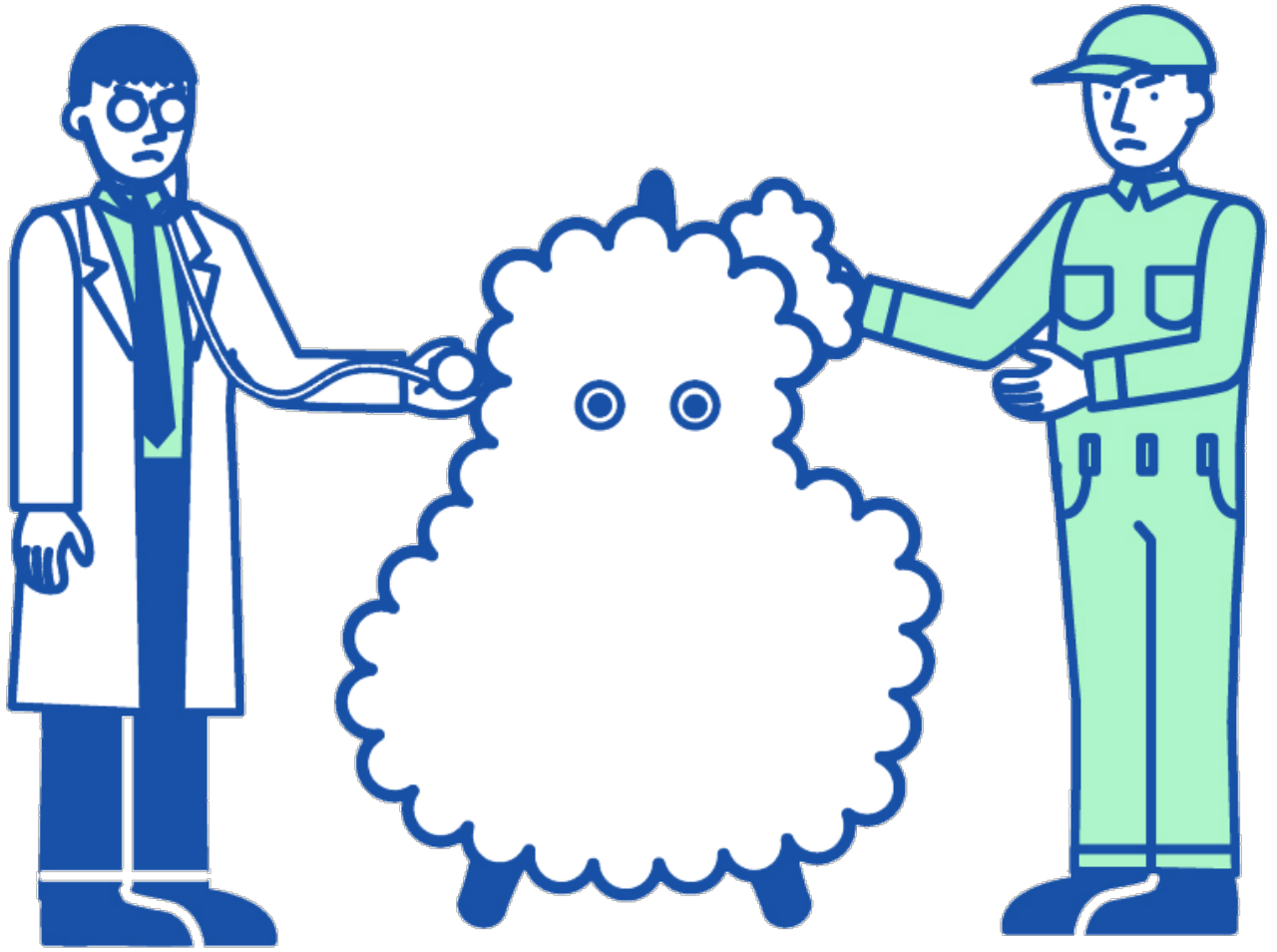
If AI robots installed can continuously watch over a person, it will be possible to find the most appropriate support and services for that person, which even skilled people are not aware of

R&D 2

Adaptable AI Robots

Development of robot hardware to provide safe and appropriate assistance to humans

Adaptable AI robots can change its shape and form according to the user's condition, environment, and the purpose of the task, and provide appropriate assistance to encourage the user to take independent action.

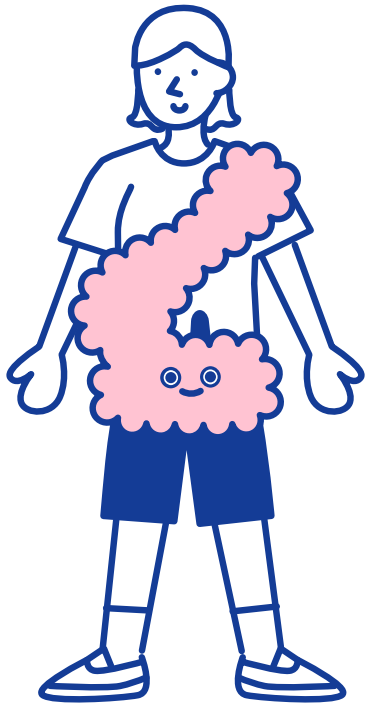


Robotic Nimbus※

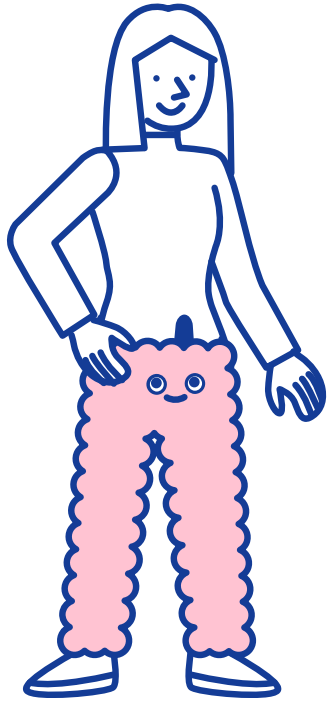
※Nimbus “A splendid atmosphere or aura that surrounds a person or thing”
American Heritage Dictionally

MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM

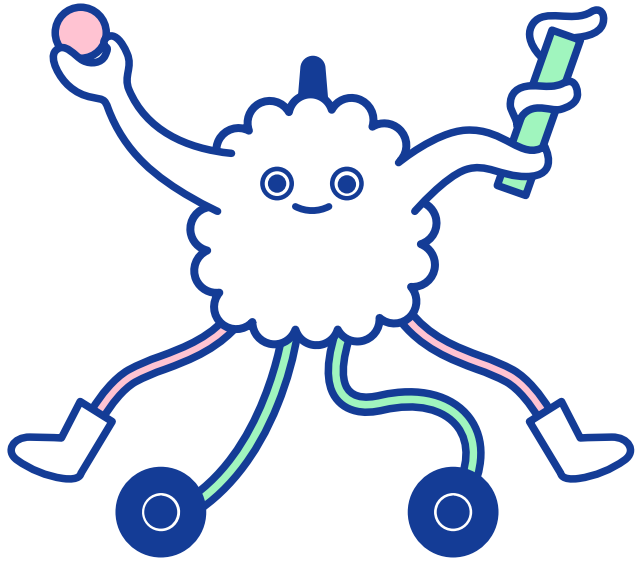
To assist the user's proactive actions naturally, while transforming into various shapes like a cloud and gently enveloping the user



Nimbus Holder
Holder for people and objects gently and firmly



Nimbus Wear
light and comfortable assistive and sensing wear



Nimbus Limbs
Limbs that deform and expand according to their purpose

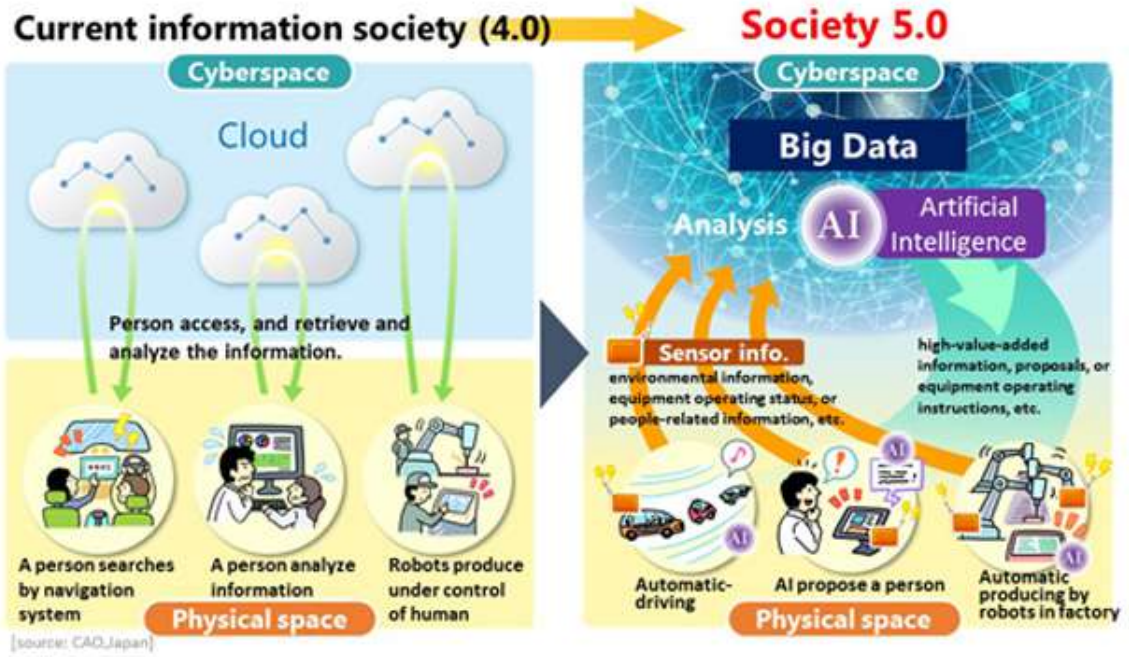
Robotic Nimbus

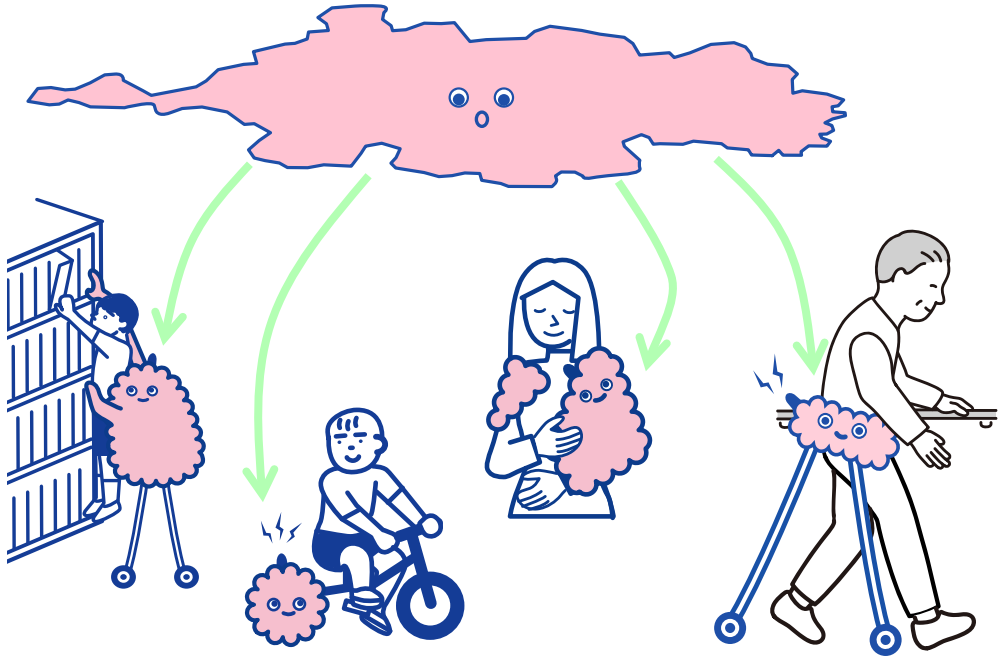
- Nimbus Holder
  - ✓ To support stable movements by restraining the movement of upper and lower limbs, and to support walking and standing of people with lower limb disabilities.
- Nimbus Wear
  - ✓ Not only to realize power assist and motion guidance, but also to relieve human tension and anxiety by controlling the wearer's comfort based on human sensing.
- Nimbus Limbs
  - ✓ To extend human motor and work capabilities using the third and fourth arms and legs.

Beyond Society 5.0

- Society 5.0
  - ✓ A concept for the future society proposed by Japan, in which cyberspace and physical space are highly integrated.
  - ✓ Cloud computing in cyberspace is progressing

We aim to realize a cloud that enables safe and secure interaction in physical space, i.e., Robotic Nimbus, as a social infrastructure!.





https://www8.cao.go.jp/cstp/society5_0/

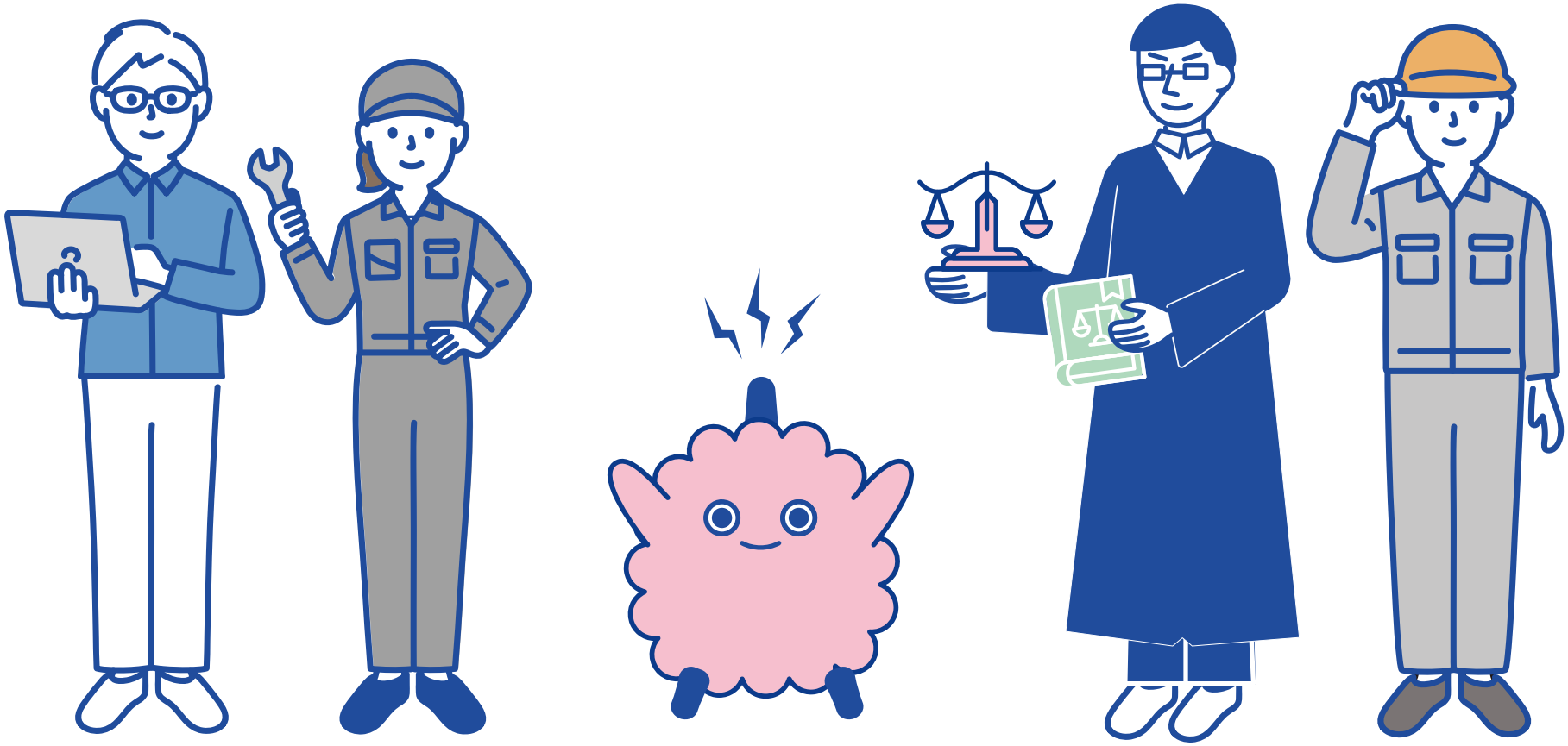
R&D 3

Social implementation of AI robots

How to implement the proposed adaptable AI robots that improve self-efficacy in society

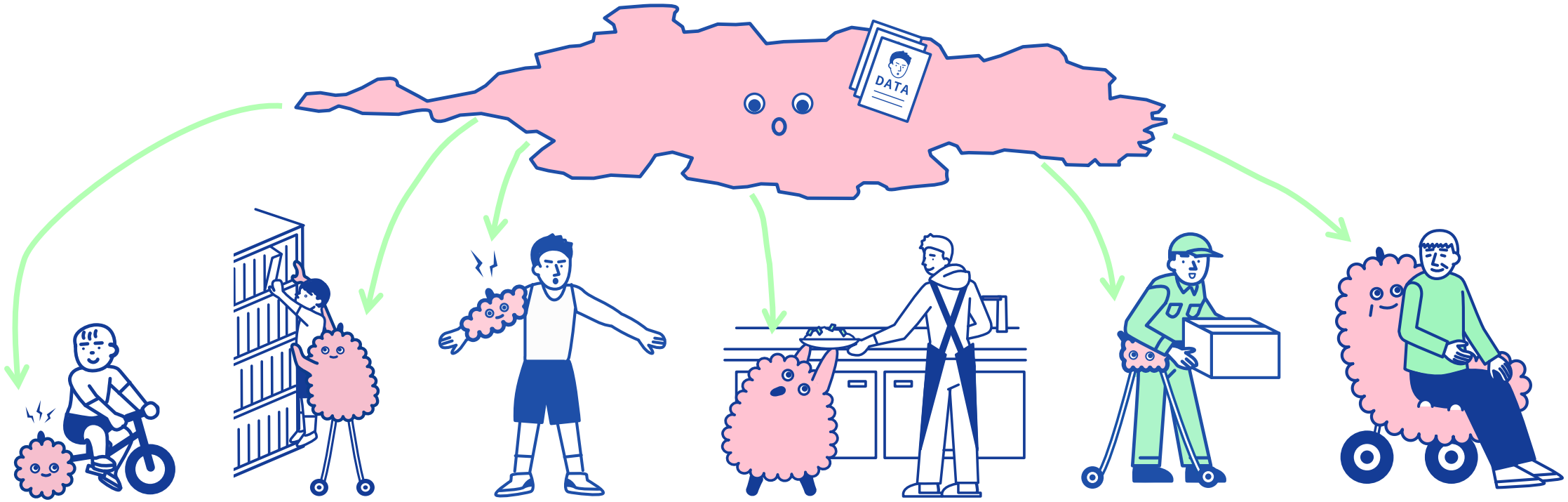
ELSI and Safety

- In order for AI robots to be accepted by humans and society
  - ✓ To obtain a social consensus on how to control the robots from the perspective of ethics and law, as well as personal information protection
  - ✓ To establish safety evaluation standards for adaptable AI robots so that all people can use them



Sharing Experiences

- The fact that AI robots are installed everywhere as part of social infrastructure means that people do not always use the same AI robot
  - ✓ We aim to develop a technology to share the experience of user-AI robot interaction with other AI robots, so that even if the AI robot has a different form or function, the user can recognize it as the "usual" AI robot that knows him/her well.



Level of Self-Efficacy for Each Individual

With the assistance of adaptive AI robots, the user will feel that he/she is capable of proactively participating in society, and will change their own behavior

With the assistance of adaptive AI robots, the user will feel that he/she can achieve a new task, and will try different activities

With the assistance of adaptive AI robots, the user will feel that he/she can achieve a similar task, and will expand the range of activities

With the assistance of adaptive AI robots, the user will feel that he/she can achieve a specific task consisted of several movements, and will take action to realize it

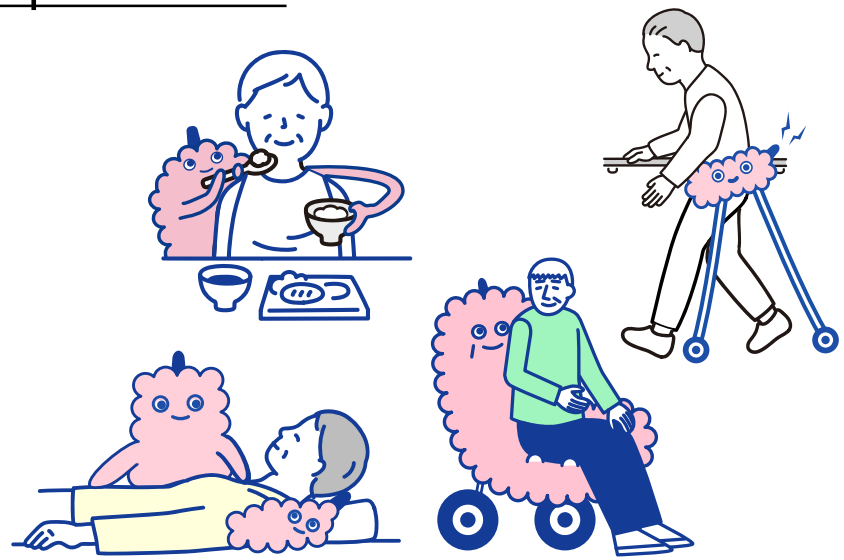
With the assistance of adaptive AI robots, the user will feel that he/she can achieve a single movement, and will exercise to achieve it

Milestones for the Year 2030

To show that the adaptable AI robot can be a driving force for creating a vibrant society in which everyone can participate enthusiastically not only in daily life but also in travel, sports, and other activities.

We aim to achieve this milestone through demonstrations in the field of nursing care, because Japan's current super-aging society has a variety of problems.

- In 2019, there were about 300,000 people who could not enter a special nursing home even if they wanted to.
- It is reported that there will be a shortage of about 800,000 nursing care workers in 2035.
- In 2017, about 90,000 people left the workforce because of family care.



Innovative solutions that can be used in the future as a moonshot

Challenges for Super-aging Society

Realistic solutions that can be adapted to the near future

Project Manager
HIRATA Yasuhisa (Tohoku University)

R&D item 1:
R&D of human-robot coevolution AI

01 Experience Acquisition and Accumulation Ecosystems
KUBOTA Naoyuki
(Tokyo Metropolitan University)

02 Successful Experience Manager
INAMURA Tetsunari
(National Institute of Informatics)

03 Self-Efficacy Estimator
WEN Wen
(The University of Tokyo)

04 Self-Efficacy Promoting Navigator
YAMAMOTO Junichi
(Keio University)

05 Assist Planner
NODA Tomoyuki (ATR)

R&D item 2
R&D of adaptable AI-enabled robots

01 Human/Environment-adaptive transformable robotic mechanism
TADAKUMA Kenjiro (Tohoku University)

02 Smart skin enabling adaptable contact
WATANABE Tetsuyou (Kanazawa University)

03 Assistive control with multi-point contacting by multi-DoF robots
YAMAZAKI Kimitoshi (Shinshu University)

04 Human-Robot Integrated Interface
KIGUCHI Kazuo (Kyushu University)

05 Smart Assist Wear
HARADA Kensuke (Osaka University)

06 Adaptive Limbs
HASEGAWA Yasuhisa (Nagoya University)

07 Cooperation of AI-Robot Enablers
HIRATA Yasuhisa (Tohoku University)

R&D item 3
Social implementation of a collective of coevolution AI robots

01 Construction of coevolutionary empirical experiment platform
KATO Kenji
(National Center for Geriatrics and Gerontrogy)

02 ELSI-based AI Robots Group Design
WENG Yueh-Hsuan (Tohoku University)

03 Establishing Safety Criteria for AI Robots
OKABE Kohei
(National Institute of Occupational Safety and Health, Japan)

04 Systems Integration for AI Robots
KUBOTA Naoyuki
(Tokyo Metropolitan University)

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