Learning for Humanlike Robots

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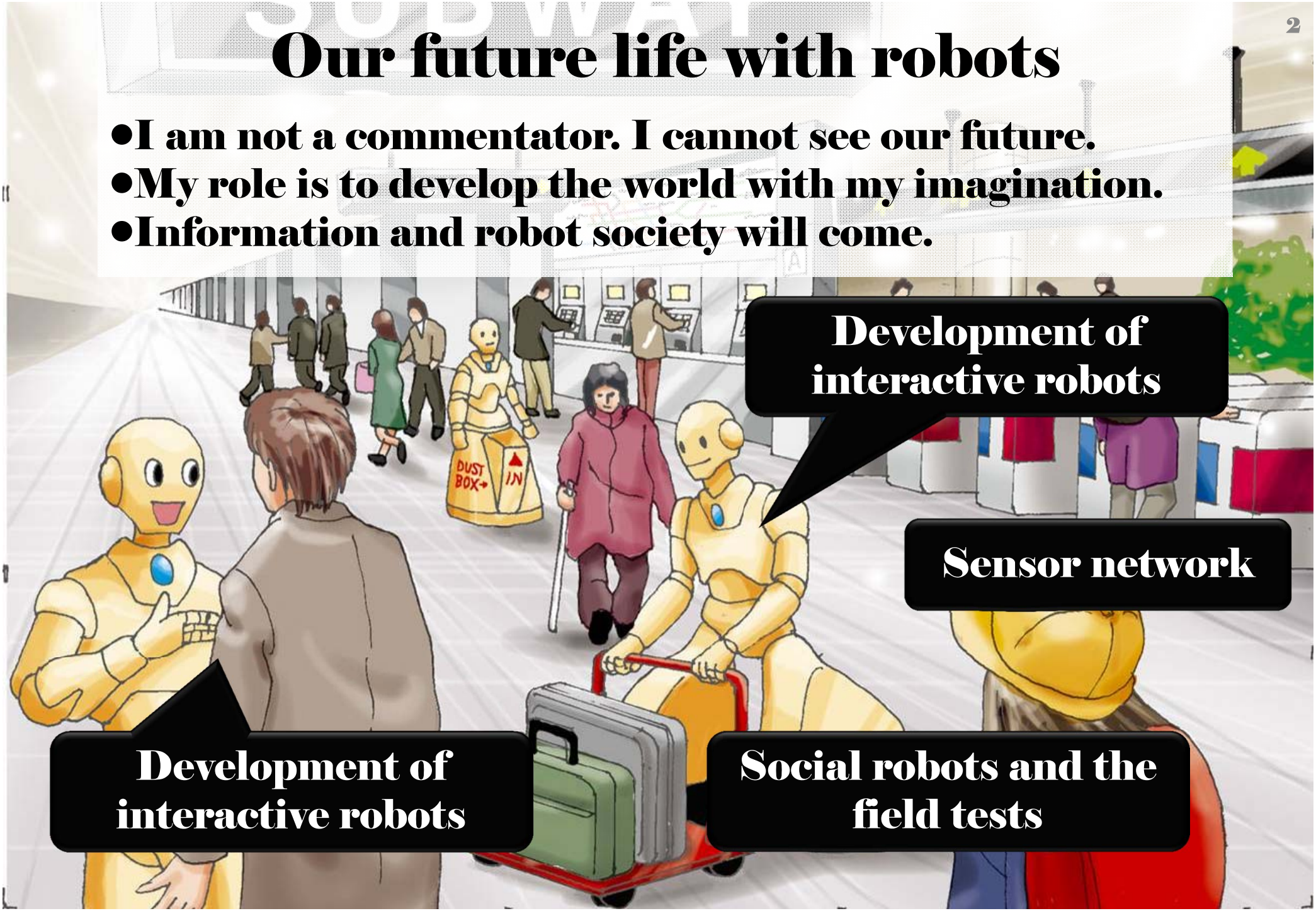
Our future life with robots

- I am not a commentator. I cannot see our future.
- My role is to develop the world with my imagination.
- Information and robot society will come.




A
B
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Sustainable Robotics

Sensor networks

+

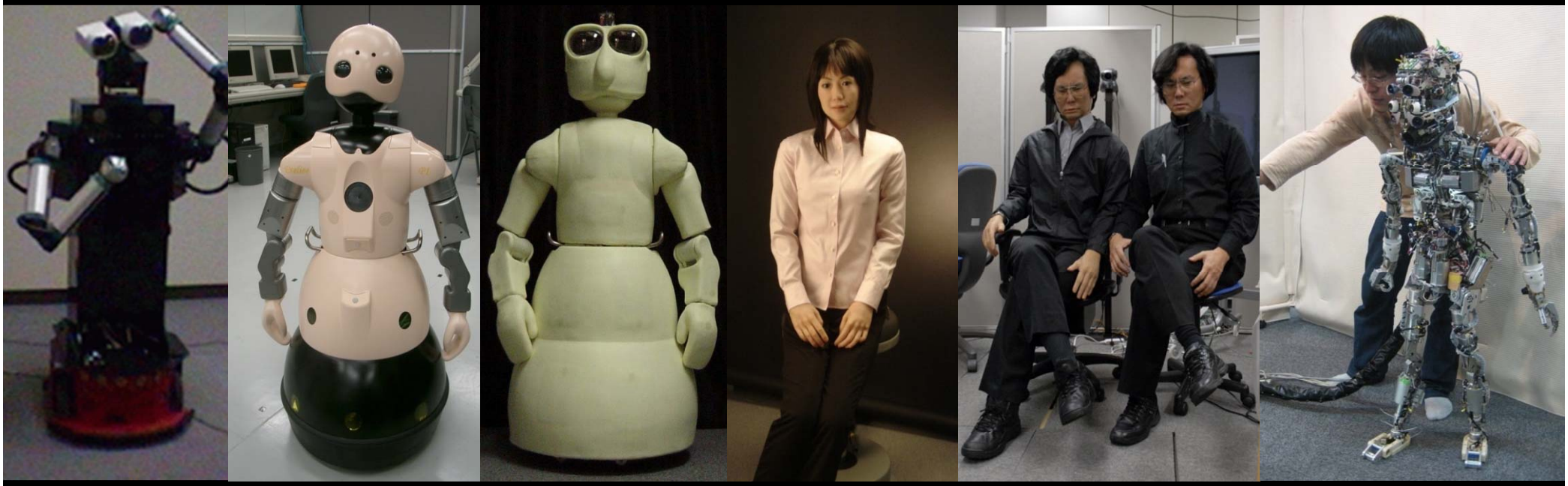
Tele-operation

(Practical systems)

Autonomous systems

Learning in sustainable robotics

Robotics for understanding humans



Bio-mimetic mechanisms

Learning and Development of the software

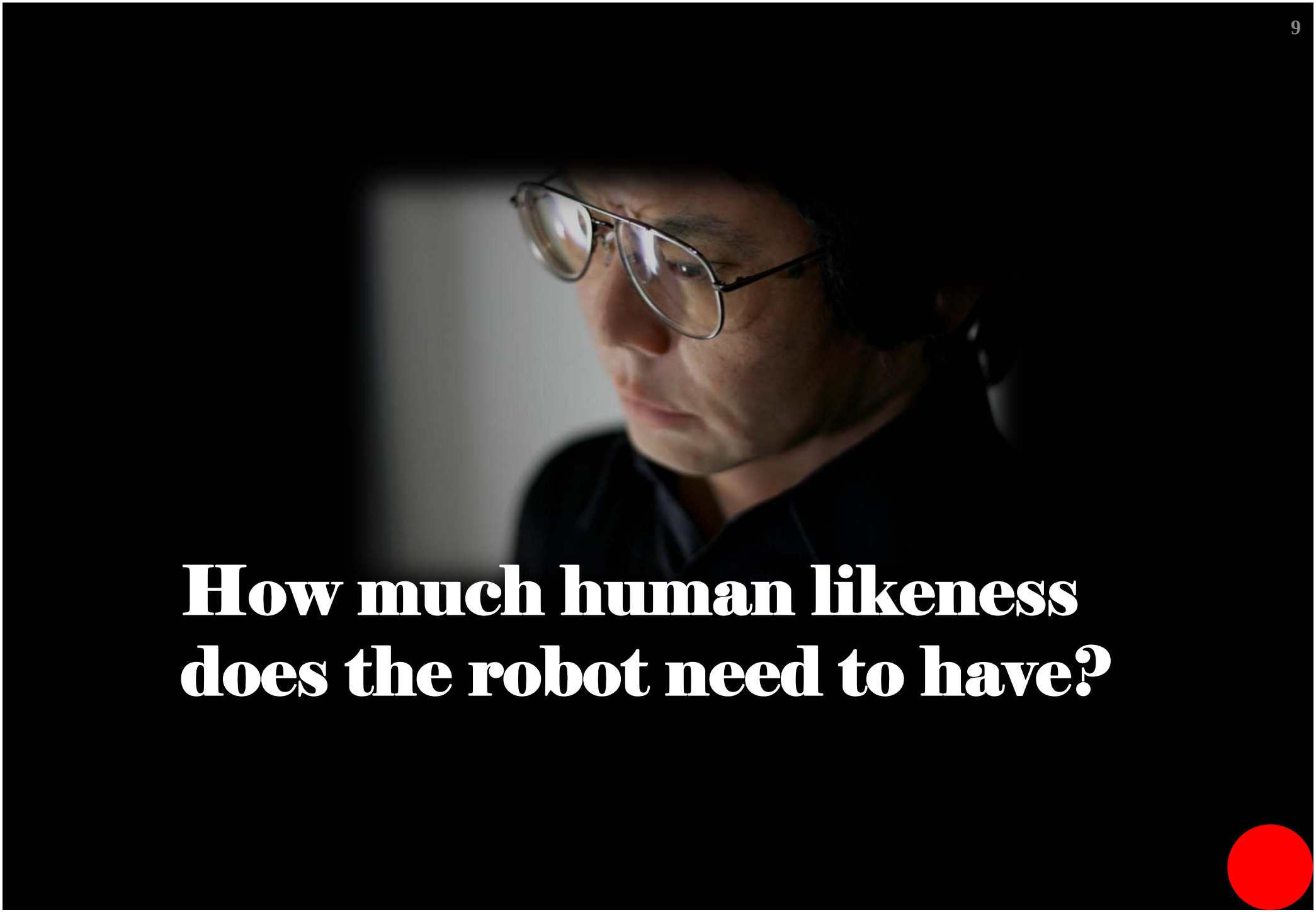
Conversation

Perception

Movement

Appearance

Human



How much human likeness does the robot need to have?

Subconscious and reactive movements

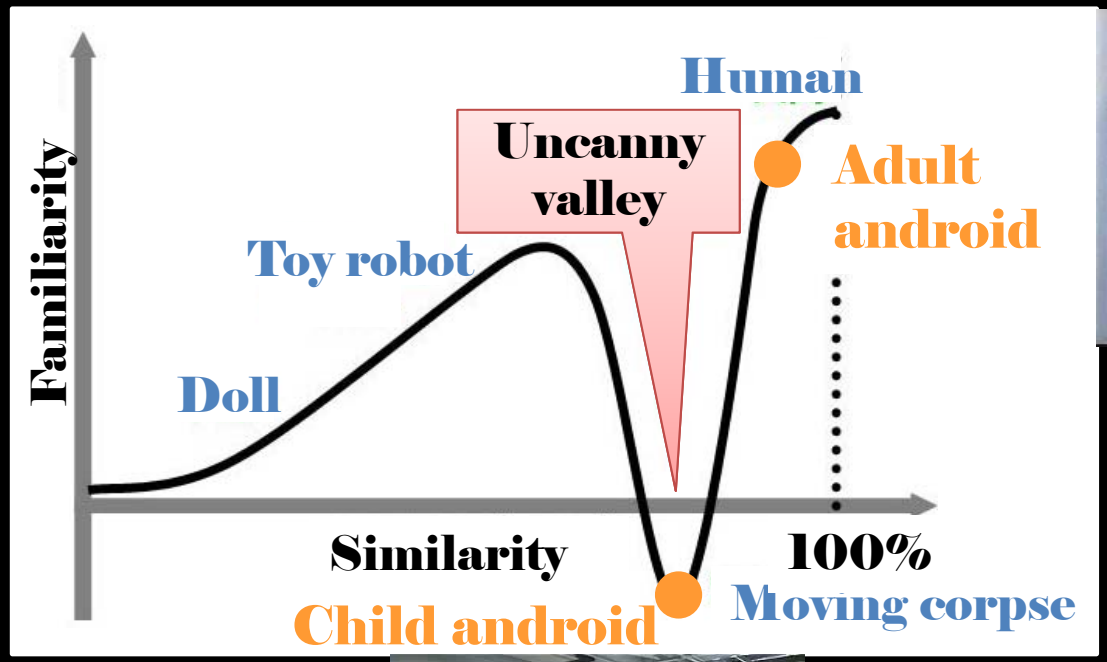
Subconscious movement

Reactive movement

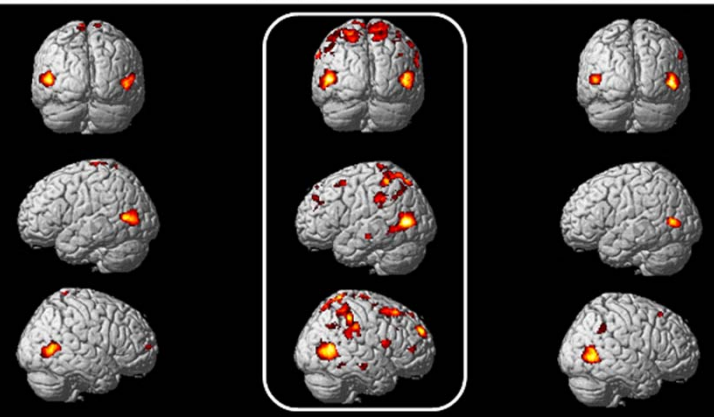
- The subconscious movement gives human likeness to the android. However, professionals find the difference.
- Reactive movements of a human is more complicated since it has mental states.
- Studies on cognitive and brain science improve the android.

Learning for humanlike behaviors

Overcoming the uncanny valley



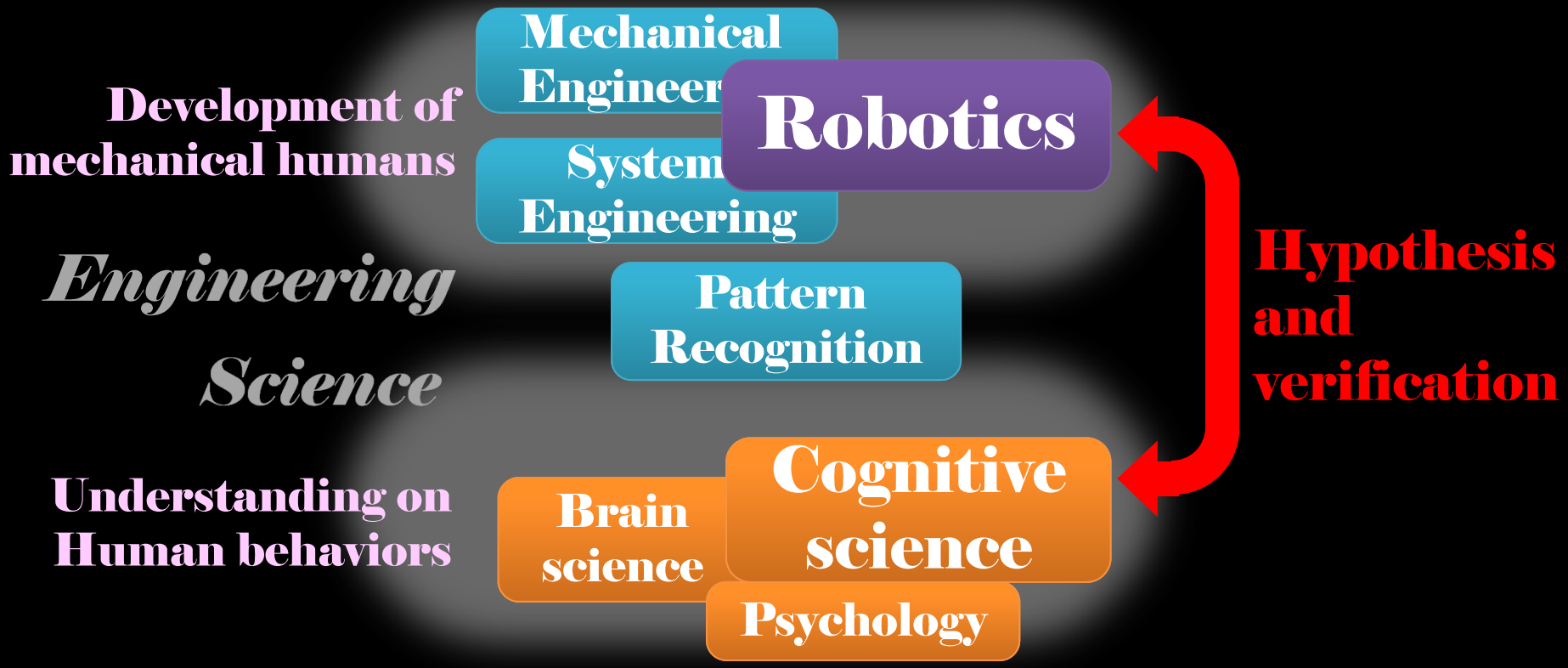
Neuroscience study on uncanny valley



- The female android is not uncanny anymore.
- Cognitive science and neuroscience with androids
- Android Science: Integration of human studies and robotics

Android Science

Robotics and Cognitive Science



Scientific issue

Human likeness (appearance , movement, perception)

Engineering issue

Simple and interactive communication tasks

Can we develop androids that talk like humans?

Geminoid

Teleoperated android of an existing person

Internet

Operator

Virtual tactile sensation

Internet

Operator

We do not know ourselves as much as we know others.

Geminoid will be new media that transfer our presence to distant places

Meeting with Geminoid

Learning for adaptive control of Geminoid

Conference with Geminoid

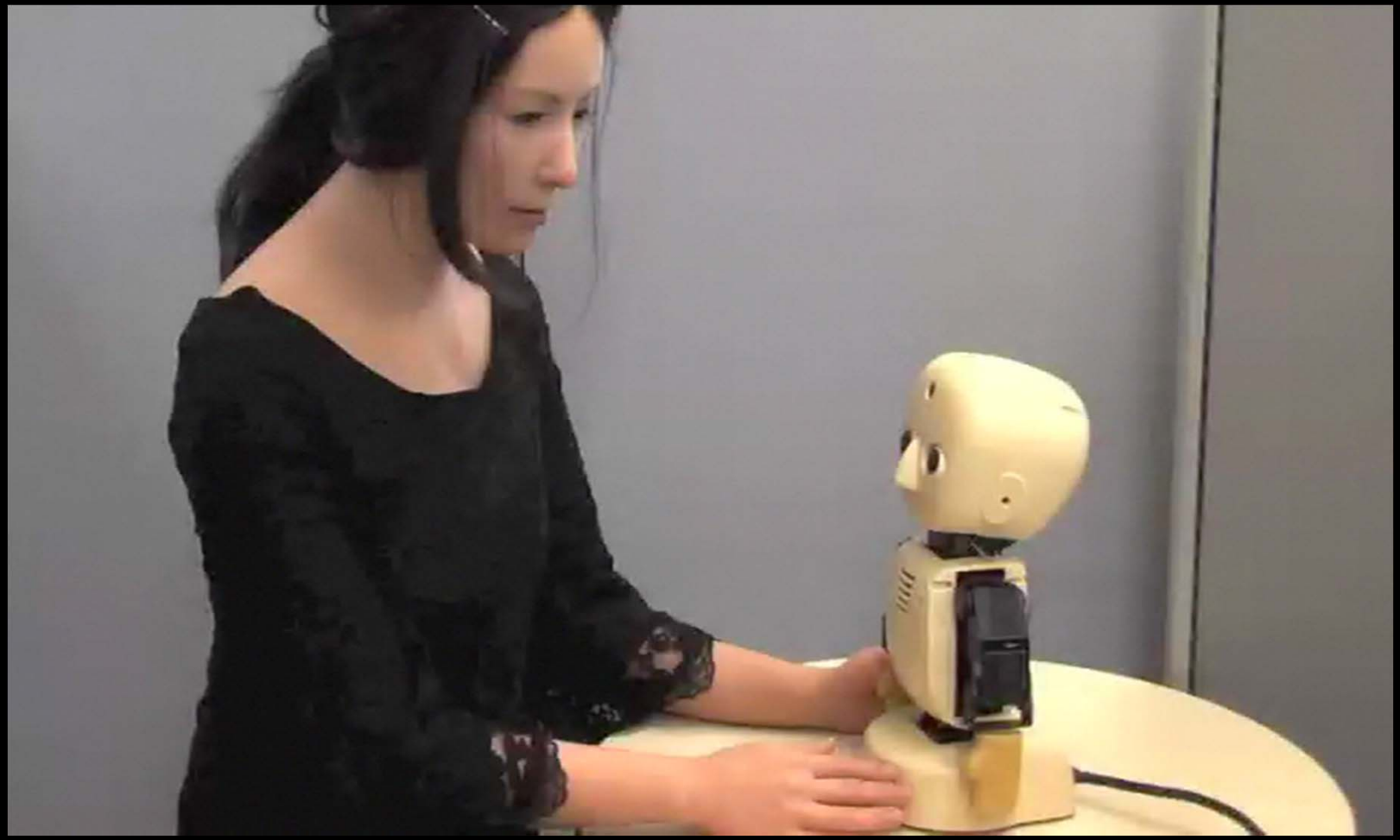
Conversation with blind people

Geminoid in the cafe

Chat and dinner with Geminoid

Intelligence supported by the large data base

Cleverbot on both androids and humanoids



What is the human identity?

Learning for Noisy brain signal

Three Geminoids

Are androids more humanlike than humans?

Sorrowful (crying) android

The perfect android with humanlike appearance, humanlike movements and humanlike talking

It exceeds a human in a particular situation.

Android theater

with Oriza Hirata

- Messages for the dying person
- The poem sounds like the original messages of the android.

Android theater in cathedral

Situated Intelligence

Android in the show window

Twitter: @GeminoidF

Android in the show window in Hong Kong

The perfect android/human is not so humanlike.

What is more humanlike?

Humans do not recognize others by appearance.
One photo does not represent the person.

Humans recognize others based on the imagination.

Humans interact with others by using the imagination.

The minimum design maximizes the imagination.

The minimal design of human

It obviously looks a human

But gender and age are unknown

Telenoid

The imagined face is mentally projected onto the neutral appearance.

Internet

Learning
for autonomous conversation


Telenoid with aged person
October 2010, ATR

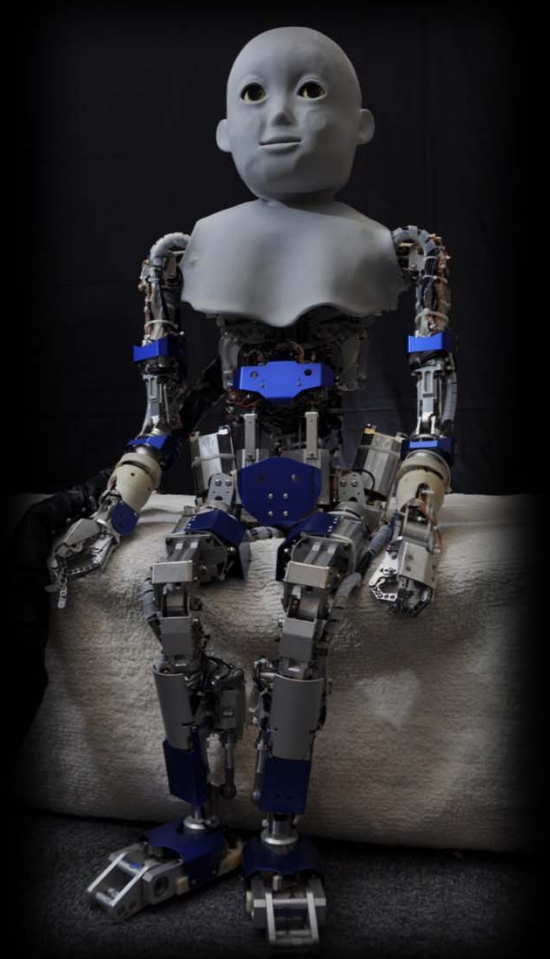

Telenoid with aged pers
October 2010, A


Telenoid with aged person
October 2010, ATR


Telenoid with aged pers
October 2010, A


Telenoid with aged person
October 2010, ATR

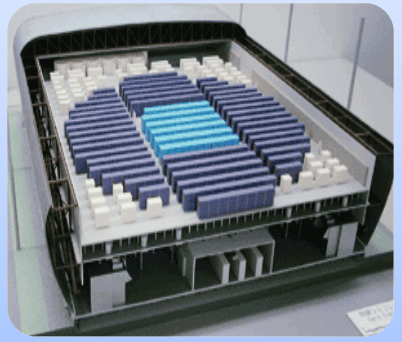
How to develop the complicated robots?



Difference between human and machine

Biological systems robustly control the complicated systems with very small energy by utilizing "Yuragi (biological fluctuation/ noise).

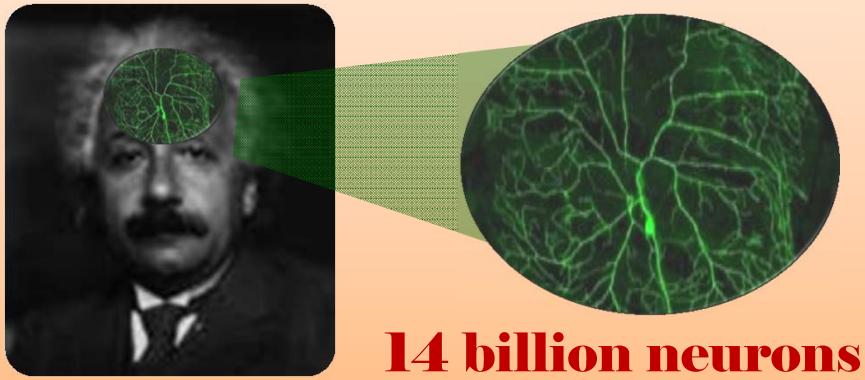
Super computer



10 billion transistors

50,000 watt

Human brain



14 billion neurons

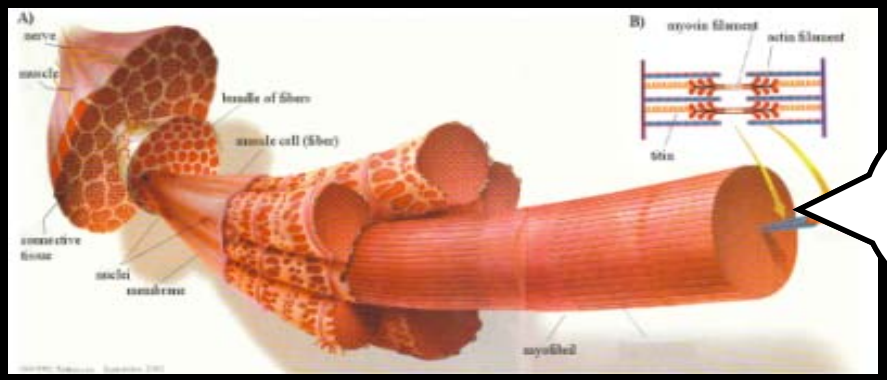
1 watts

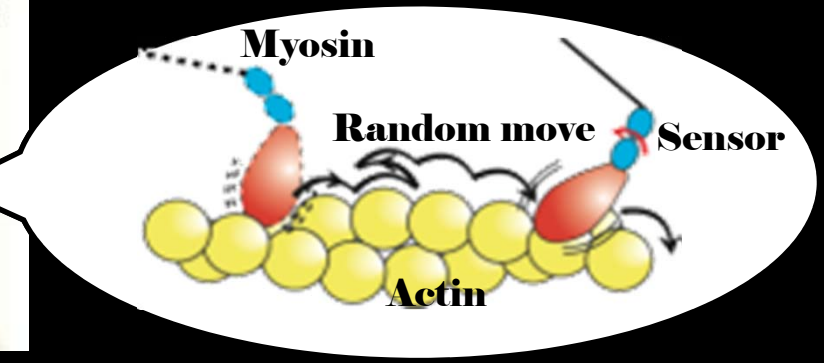
Energy

Biological system utilize Yuragi in all levels from molecule to brain

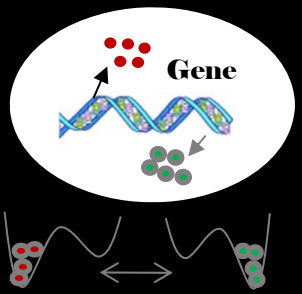
by Prof. Yanagida

Molecular motor





Cell



Molecular level

$$\frac{dx}{dt} = -\frac{1}{\rho}\frac{\partial U(x,t)}{\partial x} B + \sqrt{\frac{2kT}{\rho}}\eta(t)$$

Potential Bias Thermal noise

Yuragi formula

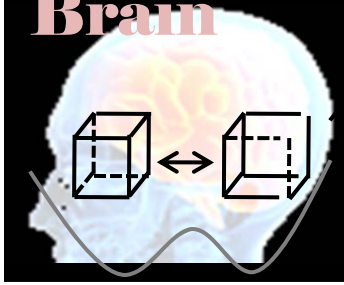
All levels

$$\frac{d}{dt}x = f(x)\cdot activity + \eta$$

Control structure with attractors | Optimization measure | *Yuragi*/ noise

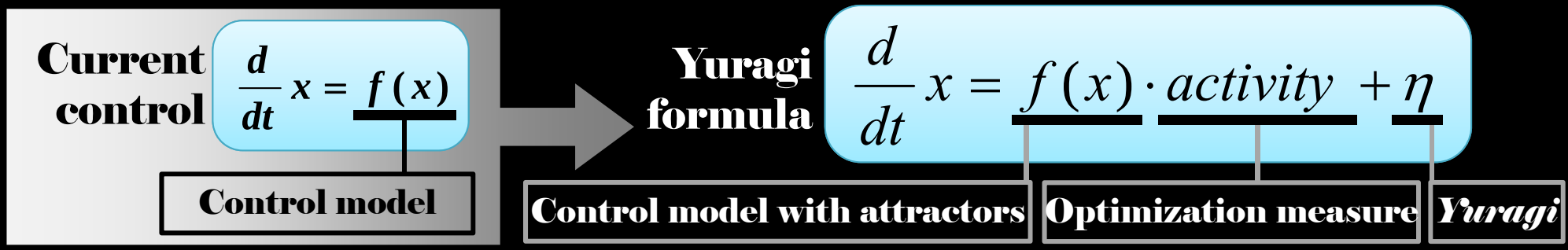
Generalized *Yuragi* formula

Brain



- **Biological systems obtains flexibility and adaptability by utilizing *Yuragi*.**

Engineering explanation of Yuragi formula



Engineering explanation of Yuragi formula

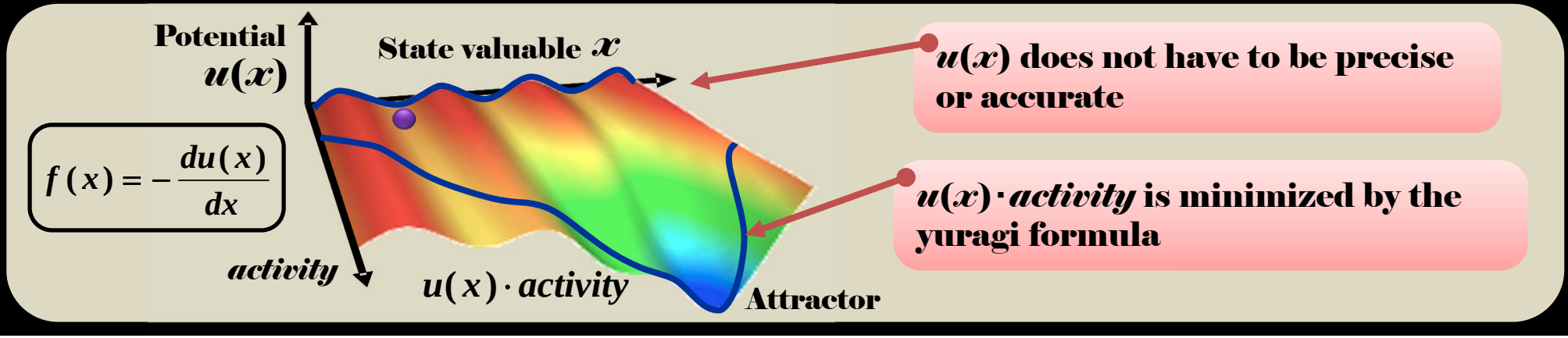
Current control

$$\frac{d}{dt}x = f(x)$$

Control model

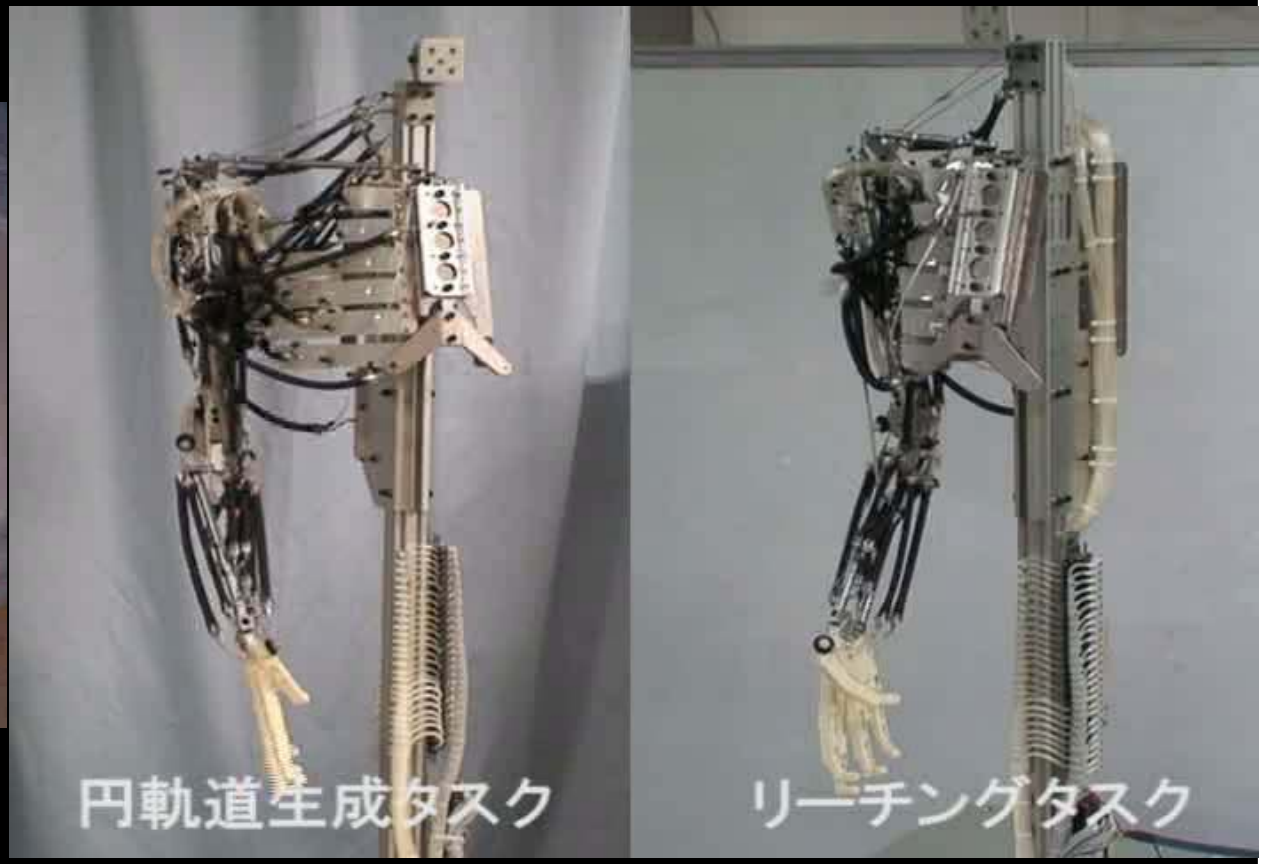
$$\frac{d}{dt}x = f(x)\cdot activity + \eta$$

- When ***activity*** is small, ***Yuragi*** η becomes relatively large, and it searches semi-optimal solution based on Yuragi. Then, ***activity*** becomes large and it stays there.
- It can be applied for complicated cases where proper models do not exist.
- It does not compute all combinations, but it rather searches by Yuragi and drastically reduce the computational cost/energy.



Control of complicated robots based on the biological principle

Bacteria robot with one motor and one sensor

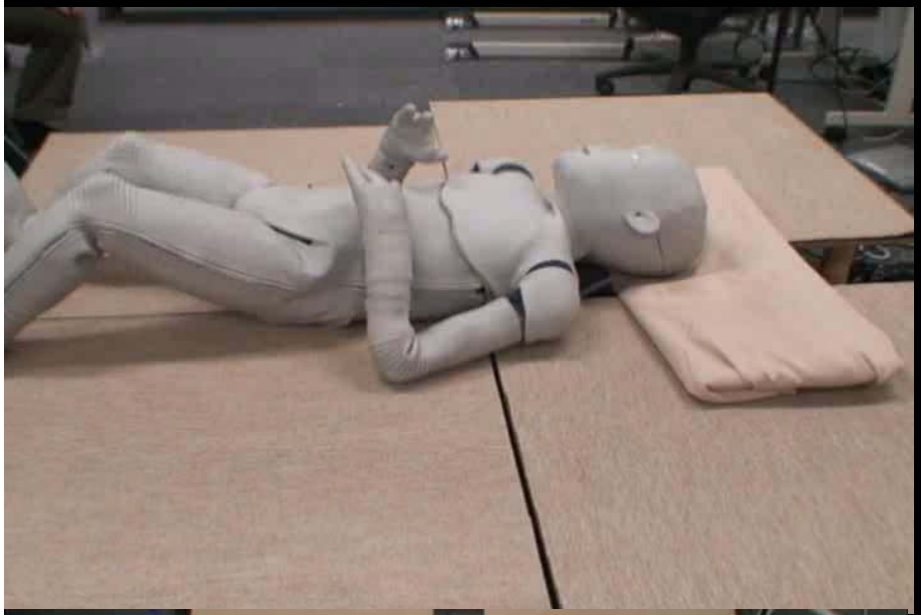


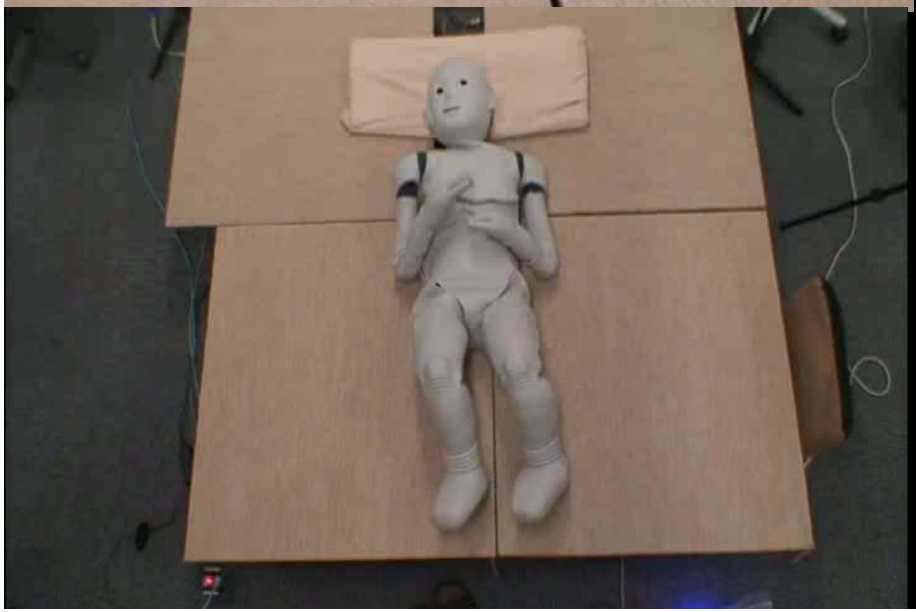
Robotic arm that has humanlike bone structure and muscle arrangement

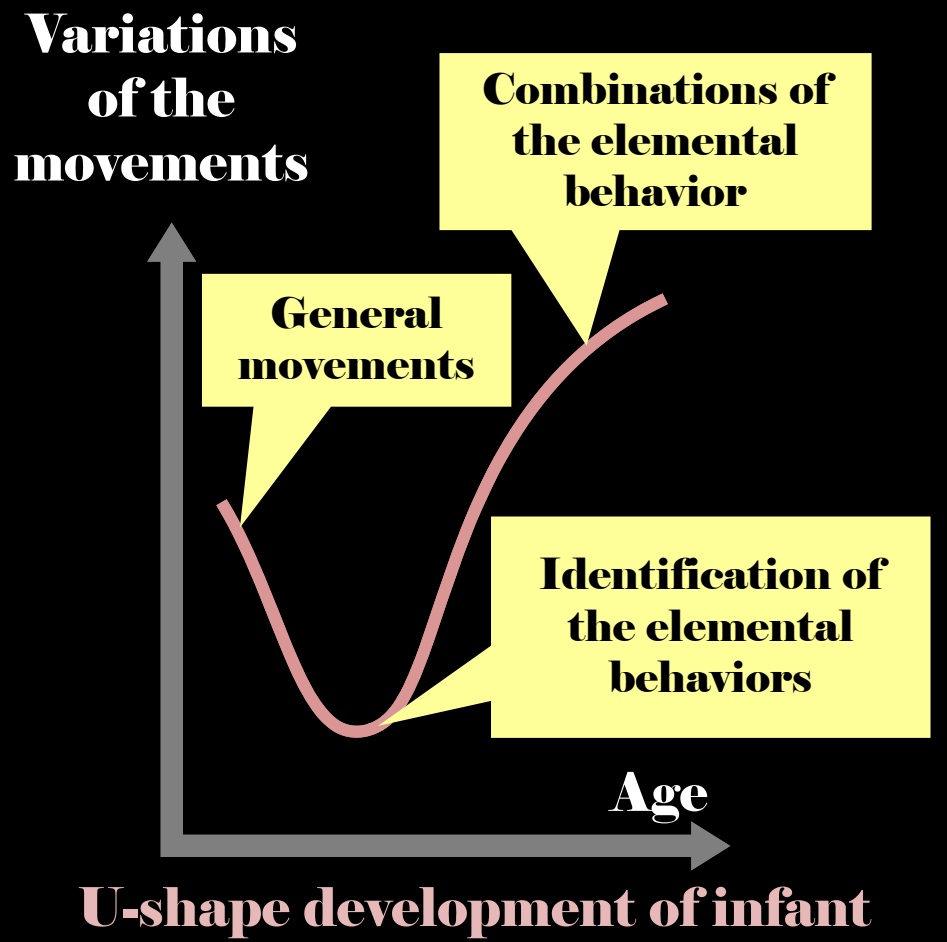
Learning
based on the biological principle

Humanlike developmental mechanism

with Asada (Osaka Univ.)





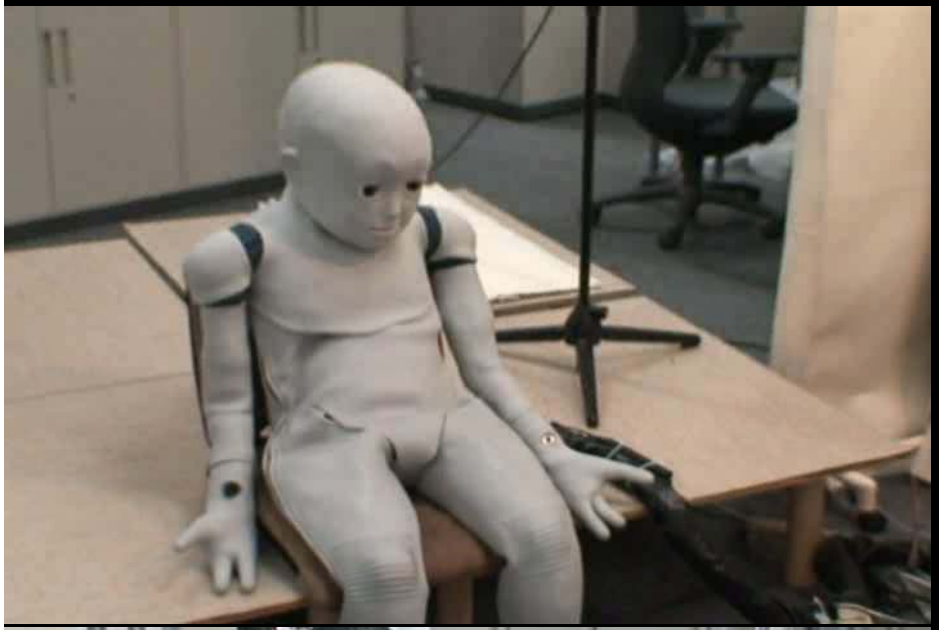


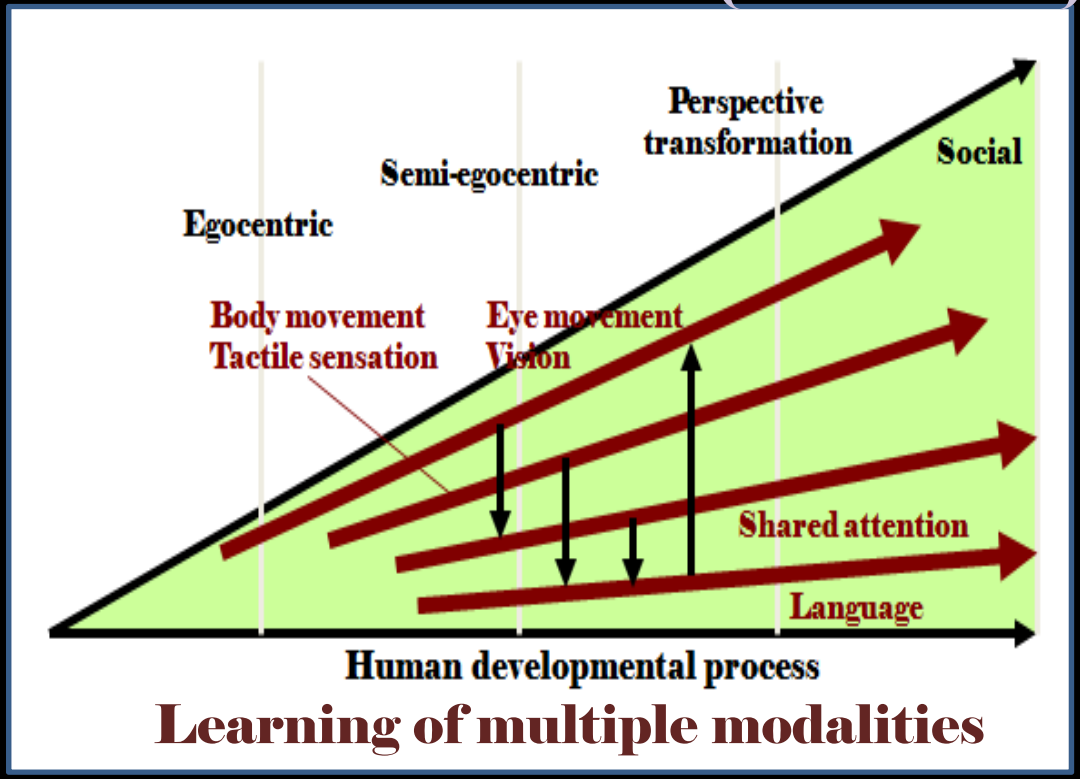
U-shape development of infant

- ***Yuragi*** **simulates the infant developmental process.**

Humanlike developmental mechanism

with Asada (Osaka Univ.)





Learning of multiple modalities

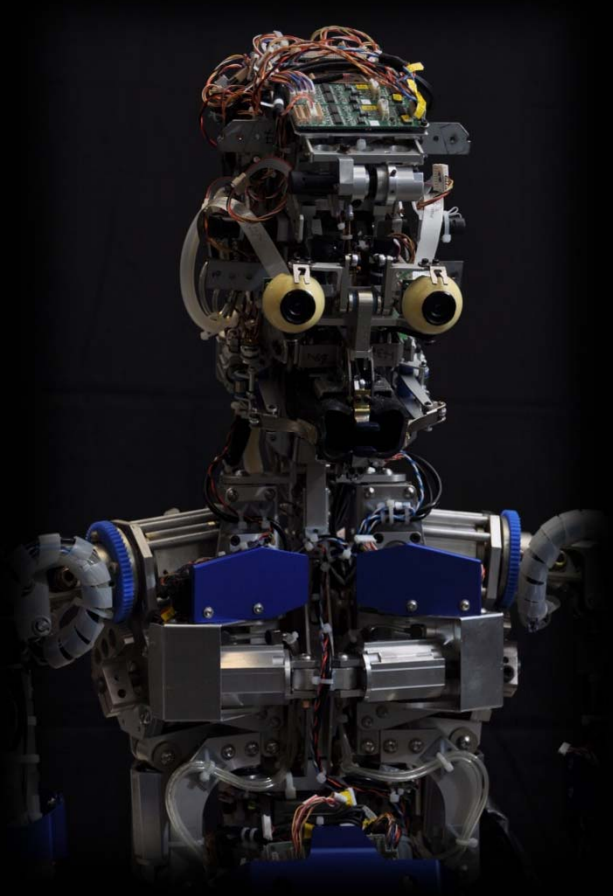
- Yuragi and advanced learning algorisms inspired by cognitive and neuroscience may realize very humanlike developmental mechanisms.

Learning for multiple modalities

Someday, we may build artificial humans.

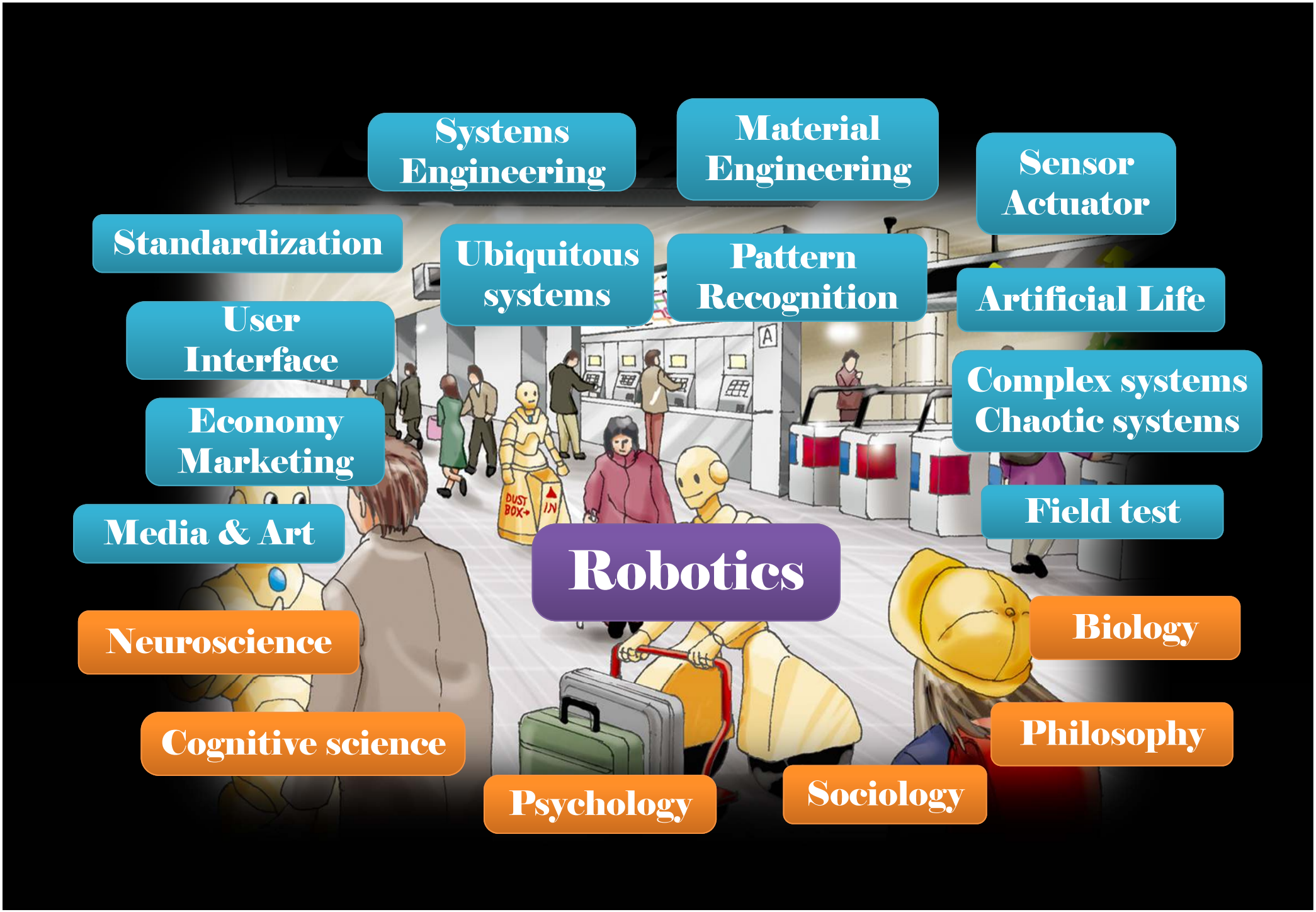
Trans Humanity

Someday, the boundary between human and machine disappears.



What is the remained thing for humans after replacing the bodies with machines?

What is human?
What is heart/mind?


Systems Engineering
Material Engineering
Sensor Actuator
Standardization
Ubiquitous systems
Pattern Recognition
Artificial Life
User Interface
Complex systems
Chaotic systems
Economy
Marketing
Field test
Media & Art
Robotics
Biology
Neuroscience
Cognitive science
Philosophy
Psychology
Sociology