

From Architected Materials to Physical Intelligence

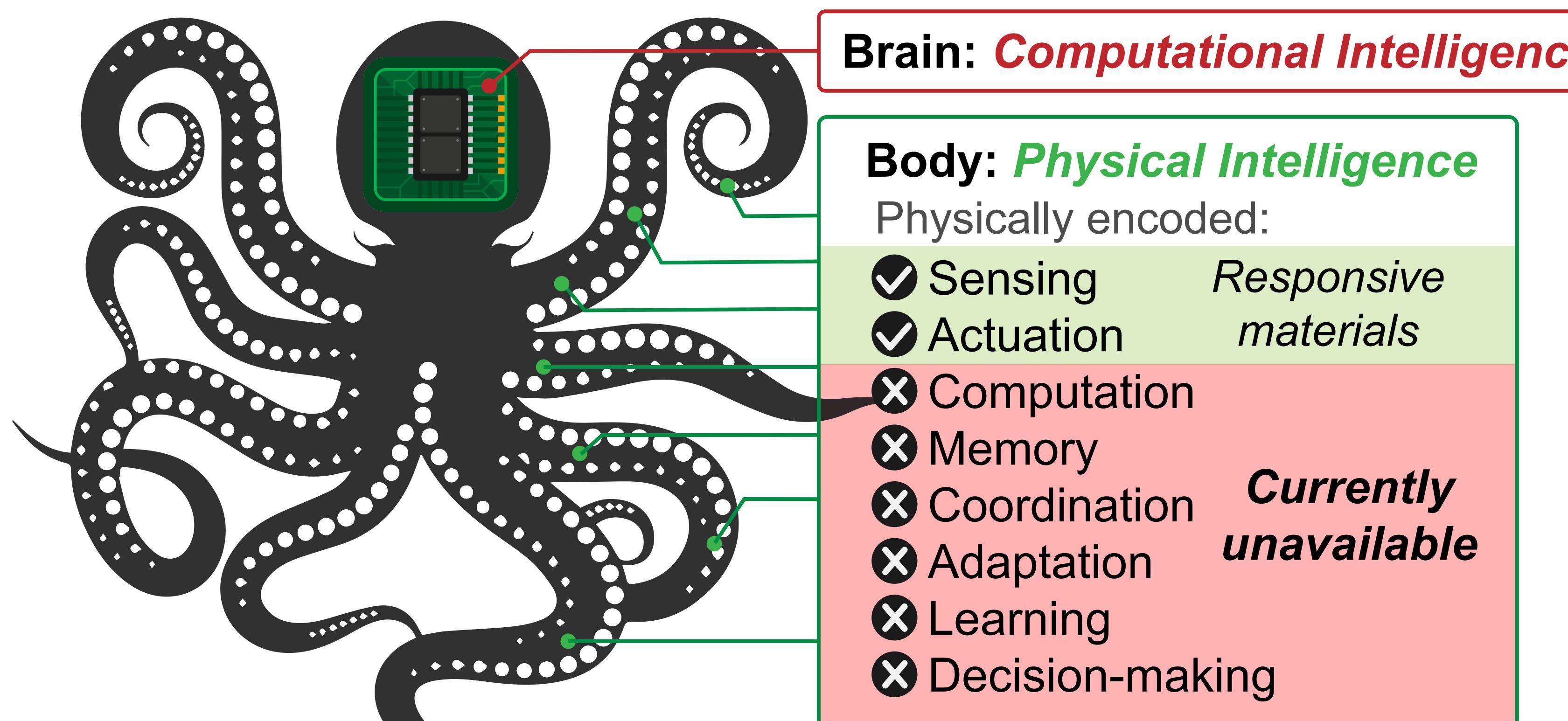
Website
boleideng.com

Bolei Deng

Computer Science & Artificial Intelligence Laboratory (CSAIL), MIT
Department of Mechanical Engineering (MechE), MIT

MIT CSAIL Massachusetts Institute of Technology
MIT MECHE

Next-generation Devices and Robots



MY GOAL: Developing materials, devices, and robots with *Physical Intelligence*.

MY APPROACH: Architected Materials + Design Algorithms + Responsive Materials.

Major Challenge 1: How to inverse design structures for desired nonlinear functionalities?
Solution: Architected Materials + Design Algorithms (Thrust 1)

Major Challenge 2: How to design systems that interact intelligently with environments?
Solution: Architected Materials + Responsive Materials (Thrust 2)

SIGNIFICANCE: Similar to biological systems, a balance between the brain (*Computational Intelligence*) and the body (*Physical Intelligence*) is a **prerequisite** for next-generation devices that can self-respond, self-adapt, self-learn, and self-power in unpredictable environments.

Education & Training

Postdoc, MIT 2021-Present

Advisor: Wojciech Matusik (CSAIL)
Optimization, high performance simulation
Advisor: Xuanhe Zhao (ME)
AI in healthcare, polymer, wearable ultrasound

Ph.D., Harvard University 2016-2021

Advisor: Katia Bertoldi
Thesis: Flexible mechanical metamaterials

B.S., Zhejiang University 2012-2016

Selected Publications

Architected Materials

1. B Deng[†], S Yu[†], et al. *PNAS* (2020).
2. B Deng, L Chen, et al. *Science Advances* (2020).
3. B Deng, V Tournat, et al. *PRL* (2019).
4. B Deng, C Mo, et al. *PRL* (2019).
5. B Deng, JR Raney, et al. *PRL* (2017).
6. B Deng, P Wang, et al. *Nature Comm.* (2018).
7. B Deng, J Li, et al. *JMPS* (2020).
8. B Deng, P Wang, et al. *JMPS* (2020).
9. B Deng[†], M Zanaty[†], et al. *PR Applied* (2022).
10. B Deng, V Tournat, et al. *PRE* (2018).
11. B Deng, JR Raney, et al. *J. Appl. Phys.* (2021).
12. B Deng, Y Zhang, et al. *New J. Phys.* (2019).

Design Algorithms

1. B Deng^{†*}, A Zareei[†], et al. *Advanced Materials* (2022, featured as Cover).
2. B Li, B Deng, et al. *Nature* (under review).

Responsive Materials

1. S Li[†], B Deng[†], et al. *Nature* (2021).
2. S Li[†], MM Lerch[†], JT Waters, B Deng, et al. *Nature* (2022).

Teaching

Teaching Assistant

- Introduction to the Mechanics of Materials Prof. Joost Vlassak, Harvard University
- Two courses in mechanics, Zhejiang University

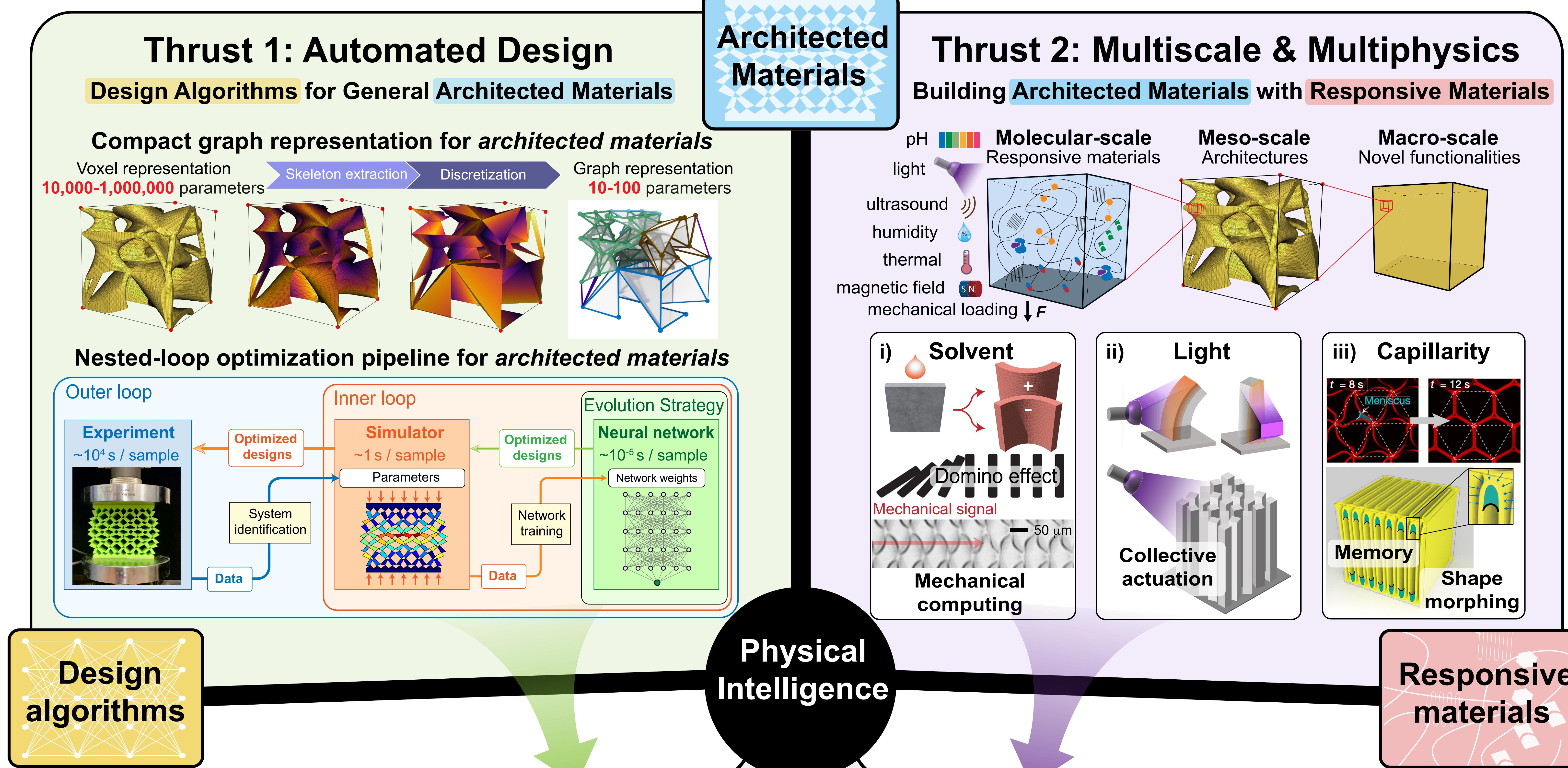
Guest Lecture on Frontier of Wave Mechanics

Invited by Prof. Pai Wang, University of Utah

Mentorship. Mentored 15 students at Harvard and MIT, including 8 undergraduate students.

Teaching Interest. I am prepared to teach most of the existing courses in **Solid Mechanics**, **Dynamics**, **Fluid Mechanics**, and **Numerical Methods**.

I am also ready to develop a new graduate-level course called **AI in Mechanics**, where I will demonstrate how state-of-the-art AI algorithms can be used to solve contemporary problems in mechanics.



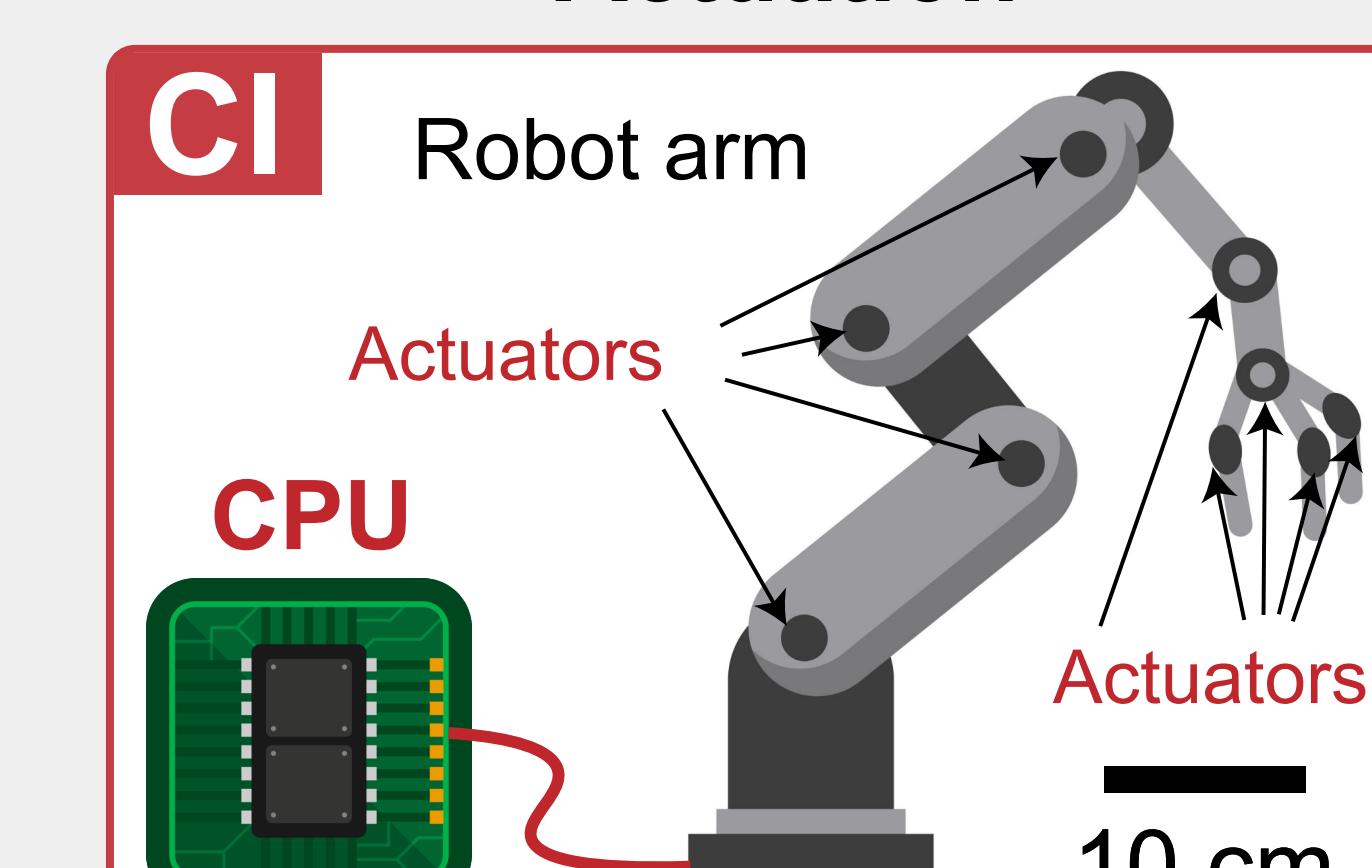
CI Computational Intelligence

PI Physical Intelligence

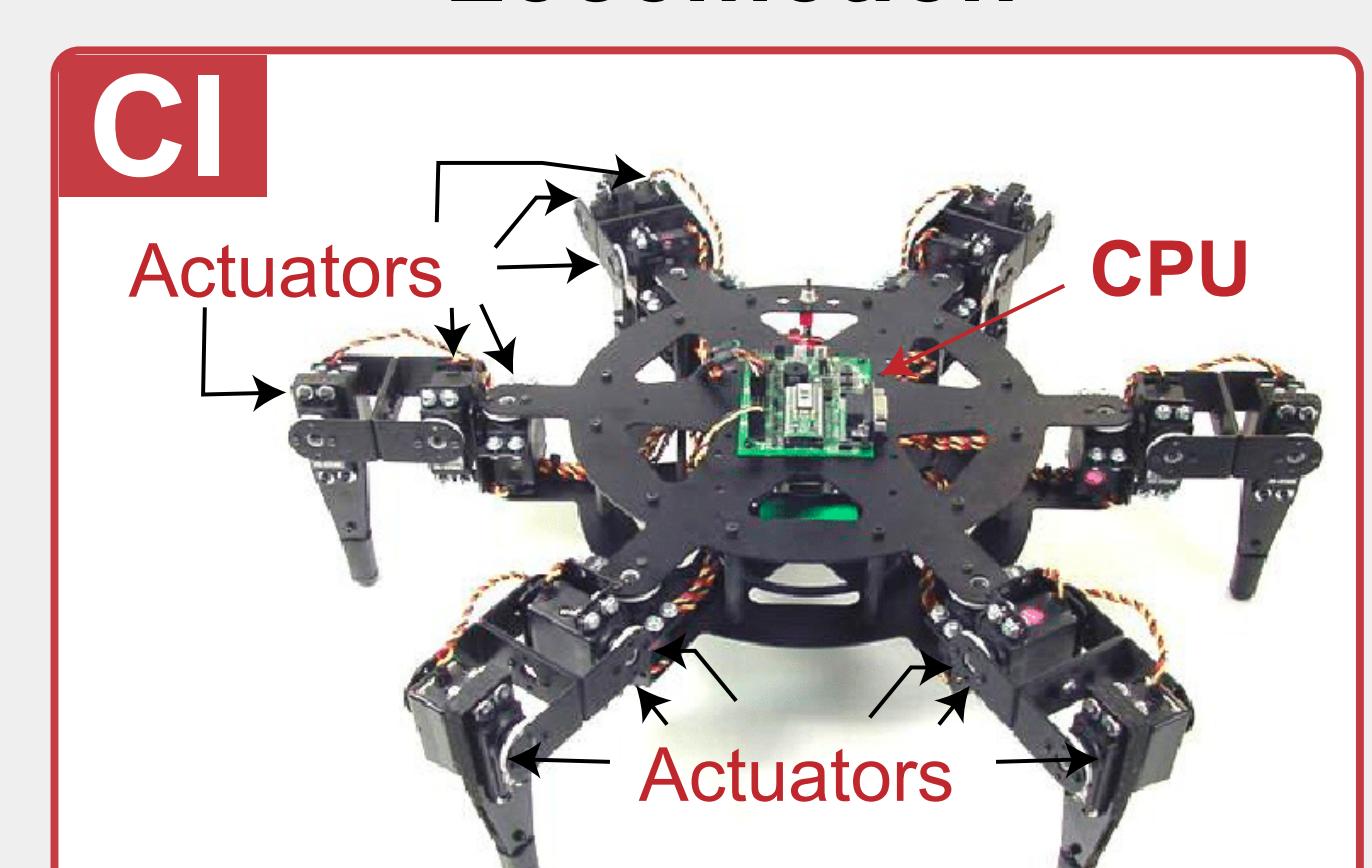
Thrust 3: Systems with Physical Intelligence

PI can largely **simplify**, **strengthen**, and **miniturize** current CI-based devices.

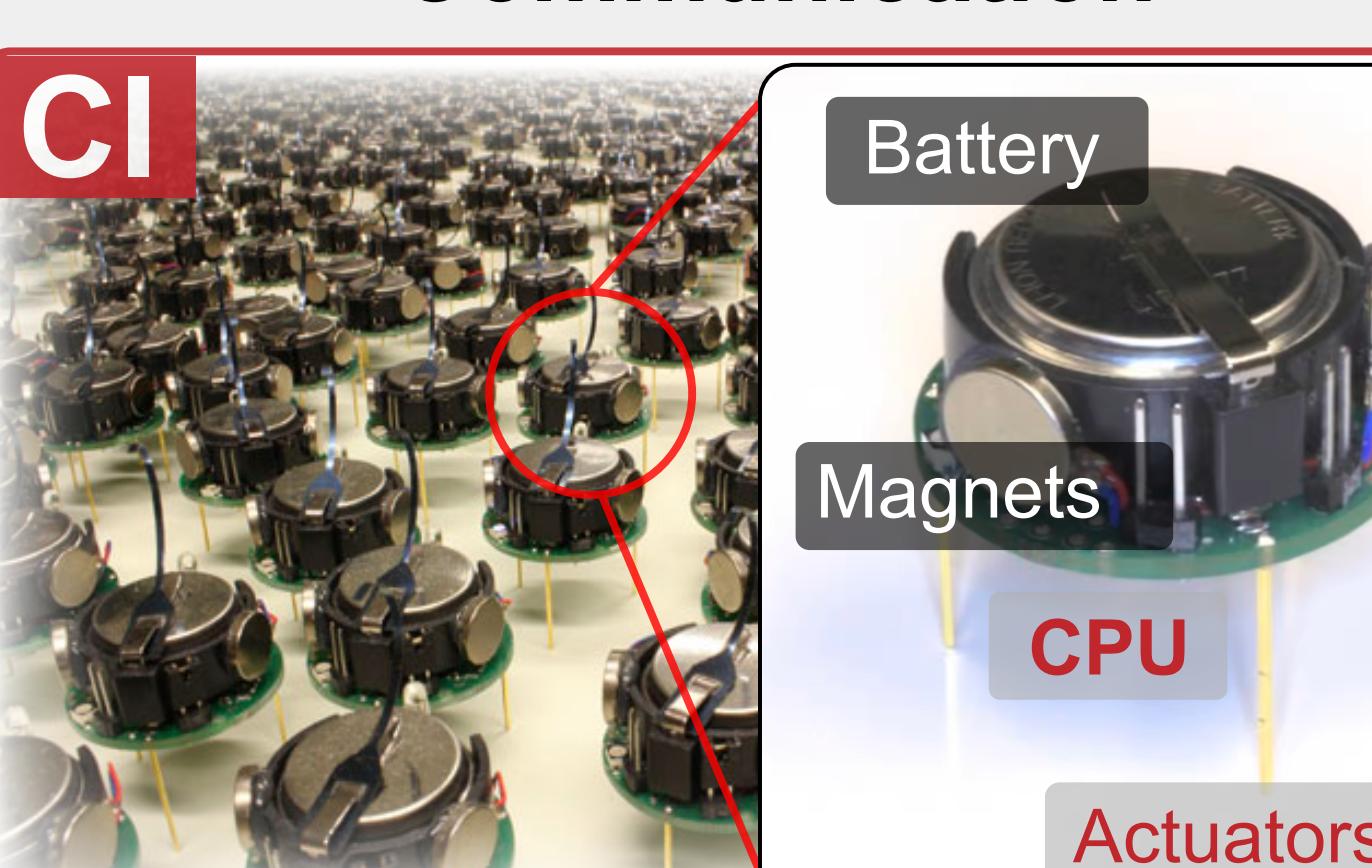
Actuation



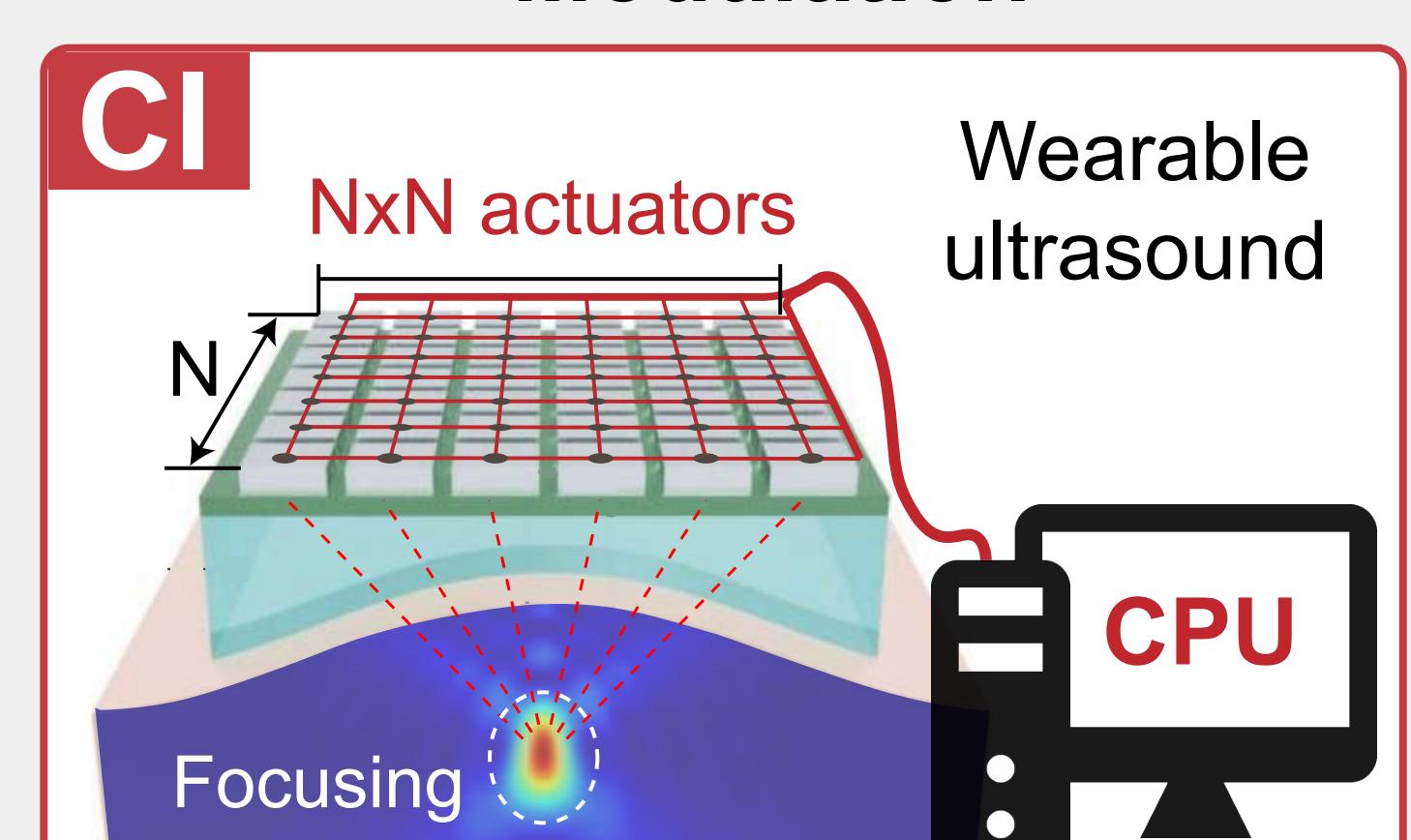
Locomotion



Communication

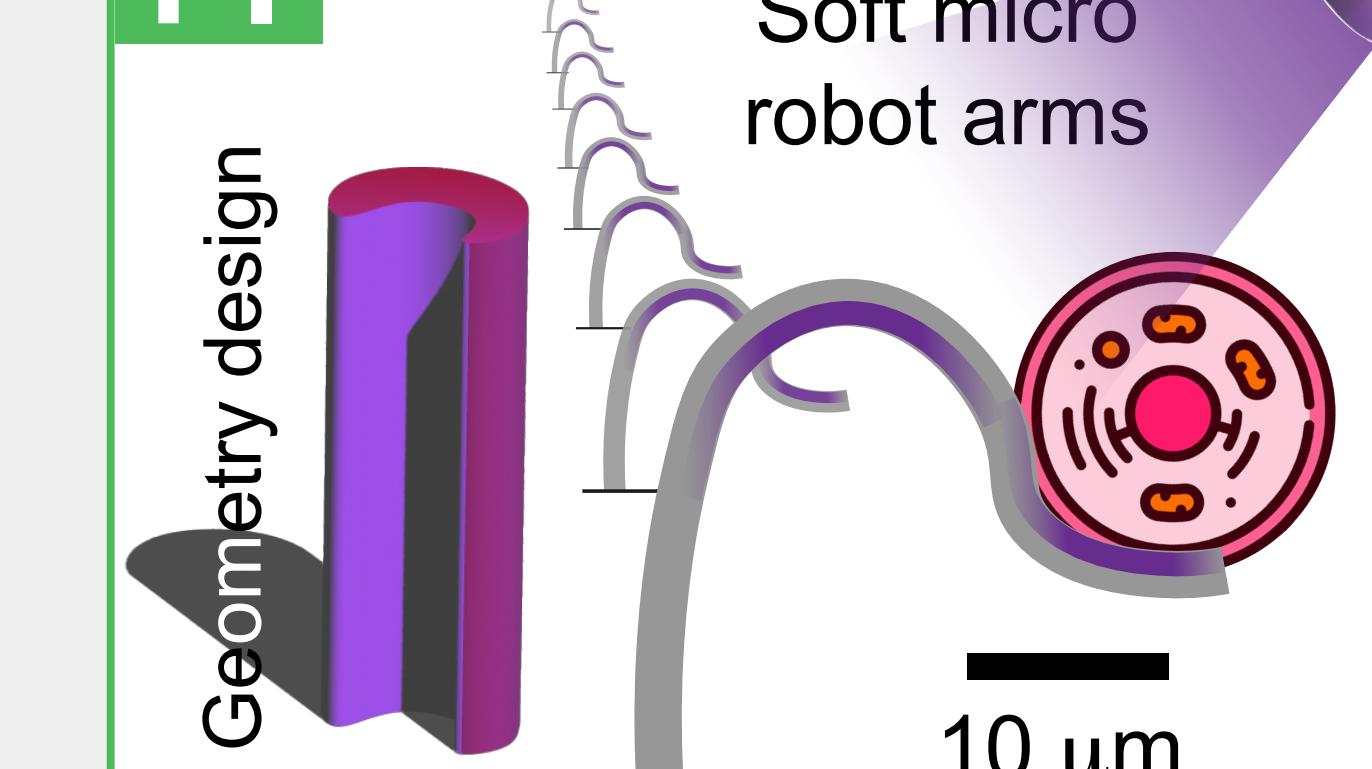


Modulation

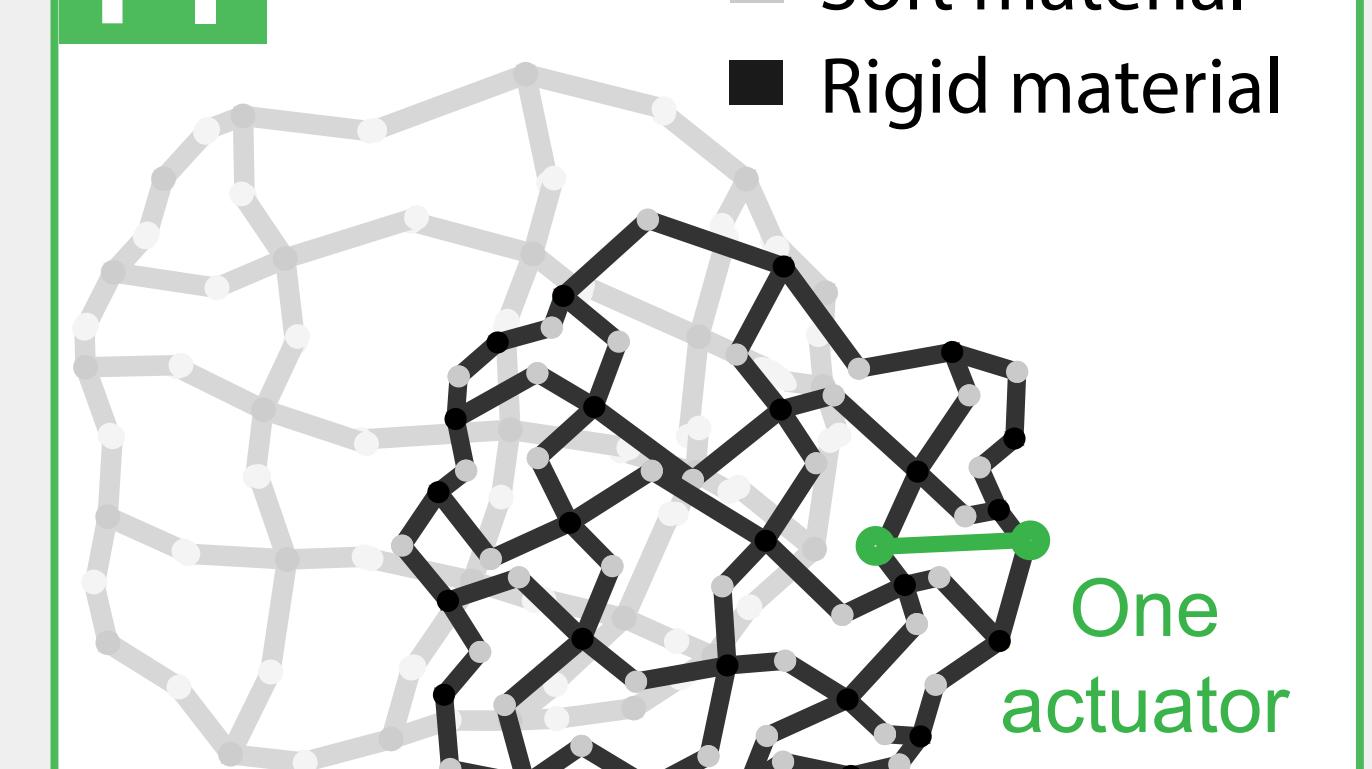


PI

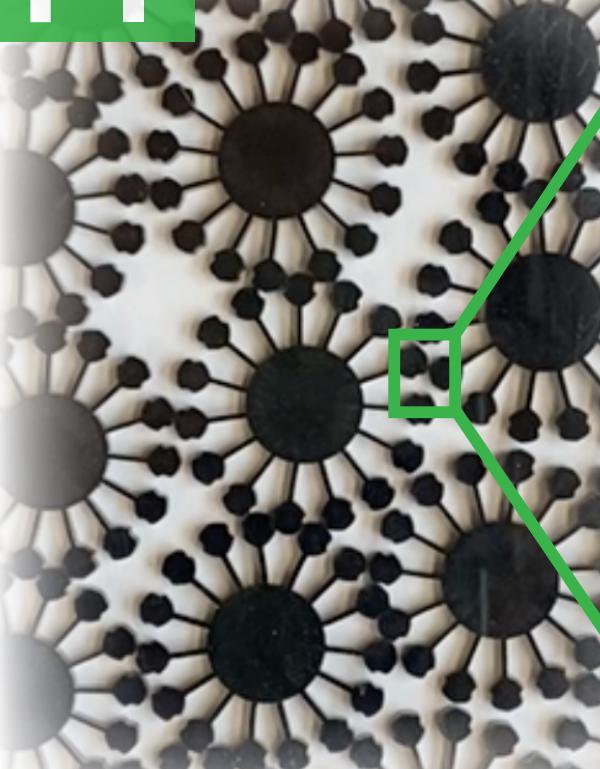
Soft micro robot arms



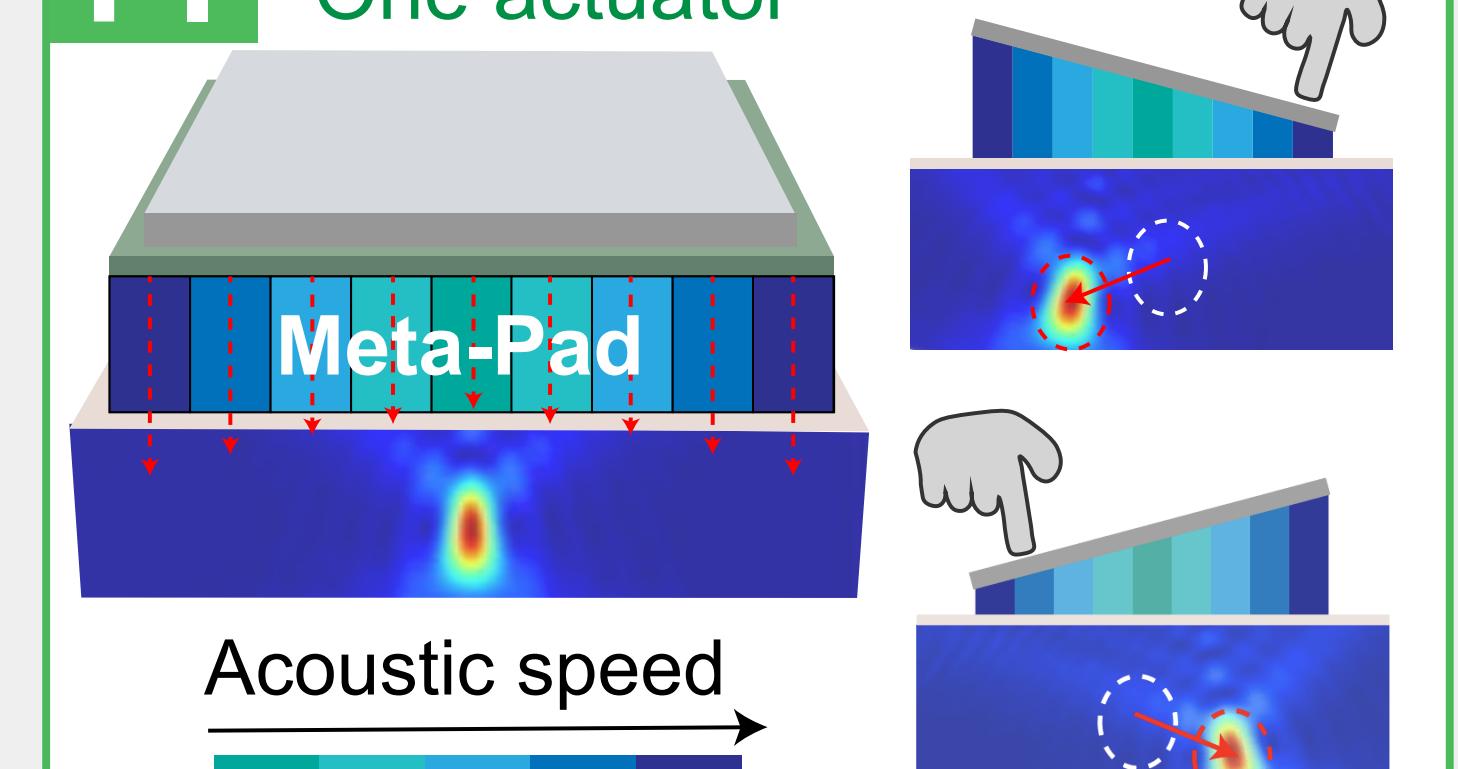
PI



PI



PI



When PI is able to handle **tedious yet specialized tasks**, CI can focus on **more general and abstract problems**. Combining CI and PI, we can make next-generation devices with intelligence, robustness, and efficiency comparable to those of biological organisms.