



Robotics Innovation to Amplify People

Max Bajracharya, VP of Robotics

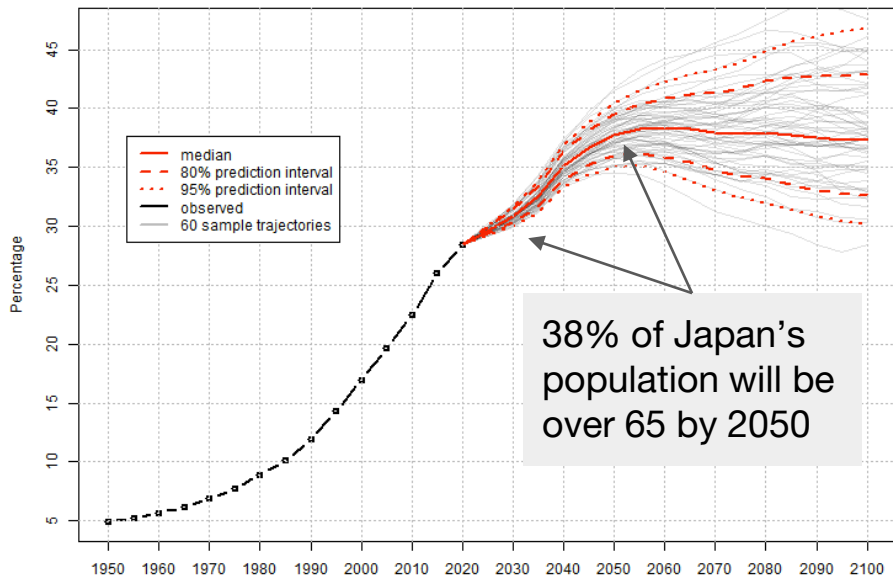
December 2019



Two Trends

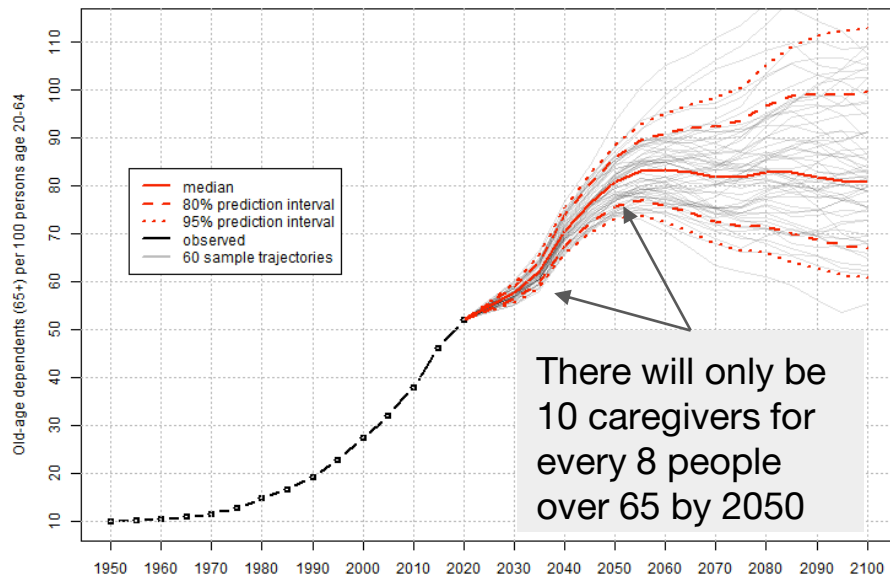
Aging Society is a National Crisis in Japan

Japan: Percentage of population aged 65 years or over



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United Nations, DESA, Population Division. *World Population Prospects 2019*. <http://population.un.org/wpp/>

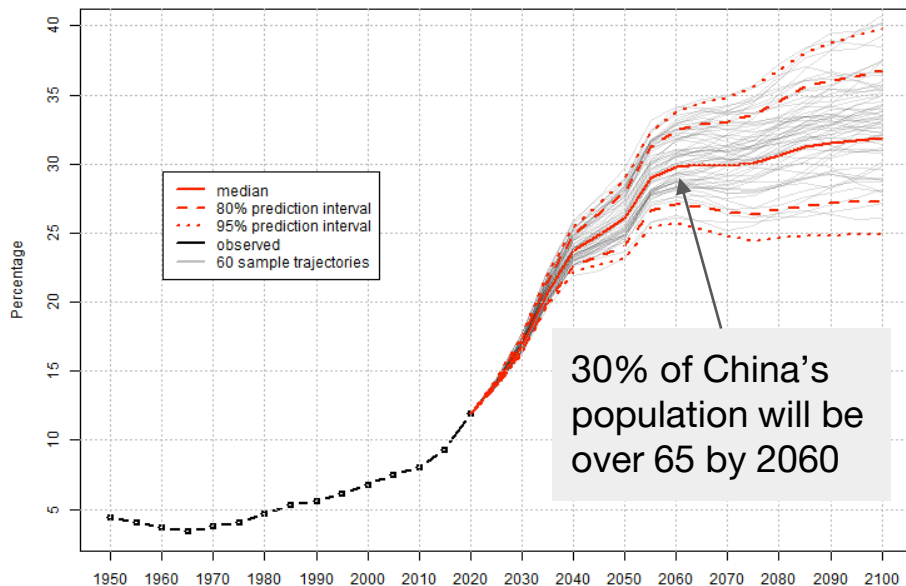
Japan: Old-age Dependency Ratio $\left(\frac{\text{Age 65+}}{\text{Age 20-64}} \right)$



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United Nations, DESA, Population Division. *World Population Prospects 2019*. <http://population.un.org/wpp/>

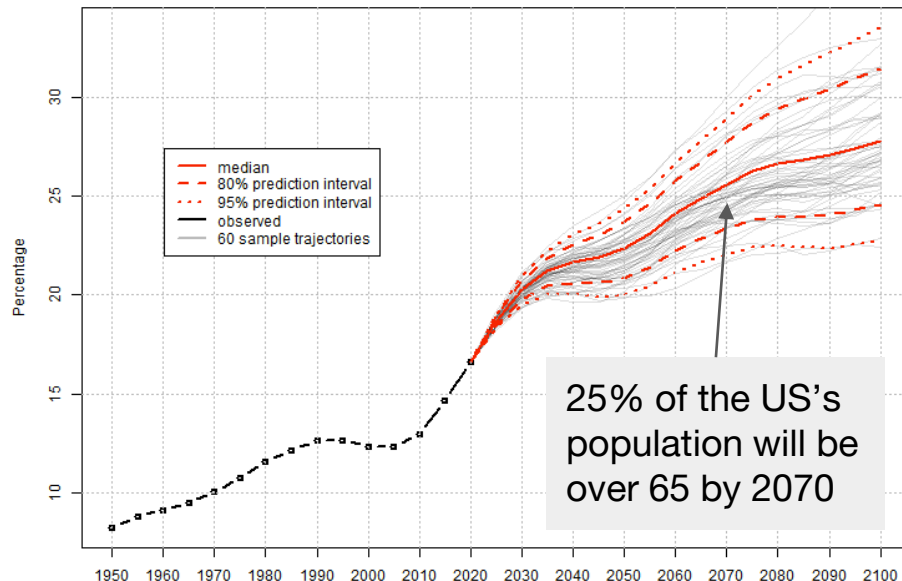
Aging Society Will Have a Worldwide Impact

China: Percentage of population aged 65 years or over



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United Nations, DESA, Population Division. *World Population Prospects 2019*. <http://population.un.org/wpp/>

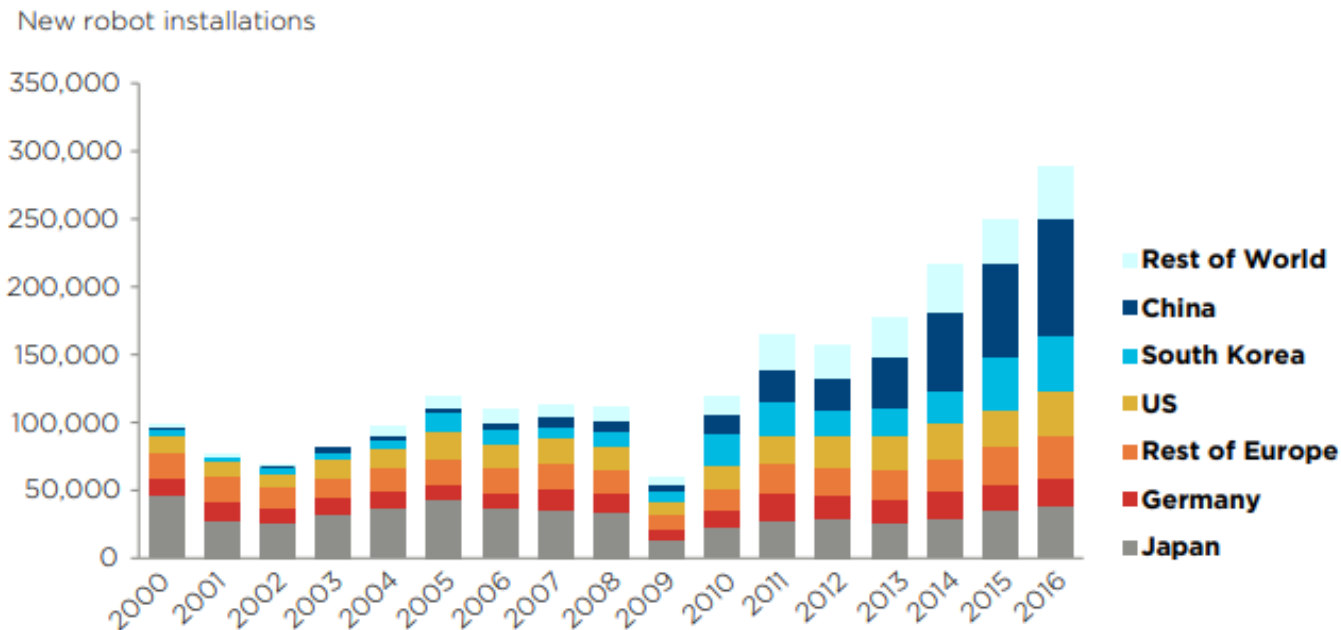
United States of America: Percentage of population aged 65 years or over



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United Nations, DESA, Population Division. *World Population Prospects 2019*. <http://population.un.org/wpp/>

Technology Is Displacing Traditional Labor

Fig. 2: Robot installations by country, 2000 to 2016*

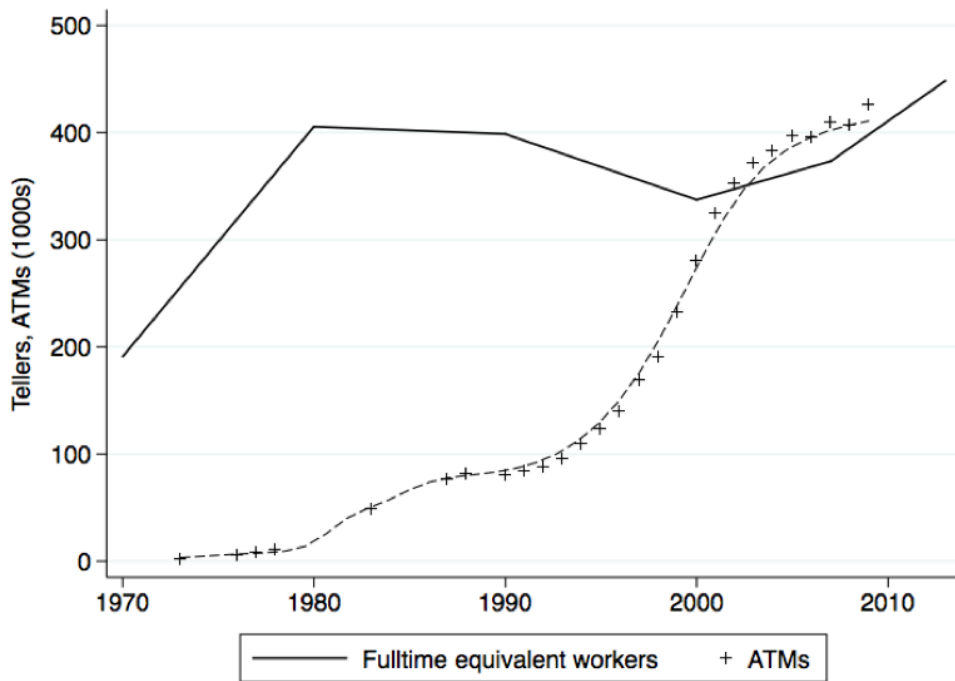


Source: IFR

From: Oxford Economics, How Robots Change the World. 2019

Technology Is Displacing Traditional Labor?

Full time equivalent bank tellers and installed ATM machines in the US



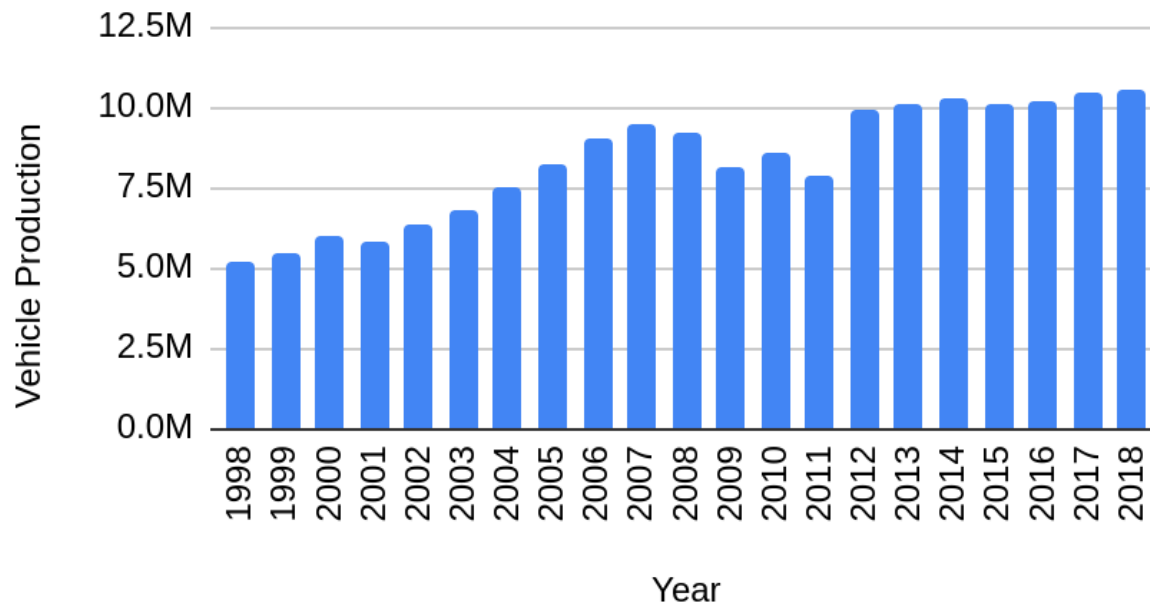
From: James Bessen, How computer automation affects occupations: Technology, jobs, and skills. 2016



Manufacturing At Toyota

Toyota's Investment in Manufacturing

Toyota Motor Corporation Production



From: Toyota Motor Corporation, Annual Reports (1998-2018)

Toyota's Investment in Manufacturing



From: Toyota Motor Corporation, Worldwide Operations

Toyota's Manufacturing Philosophy

Toyota Production System

Just In Time

Jidoka
“Automation with a
Human Touch”

Toyota's Manufacturing Philosophy

“Karakuri” is a mechanism that uses gravity, springs and gears instead of external power sources to manipulate objects.

From: Toyota, econohito season2: The Toyota "Karakuri" meister
leading our continuous improvements



Innovation Strategy

Ultimate Goal: “A Reason for Being”



Leverage Technology for Transformation

Industrial Automation

From Working with Human
Hands ...

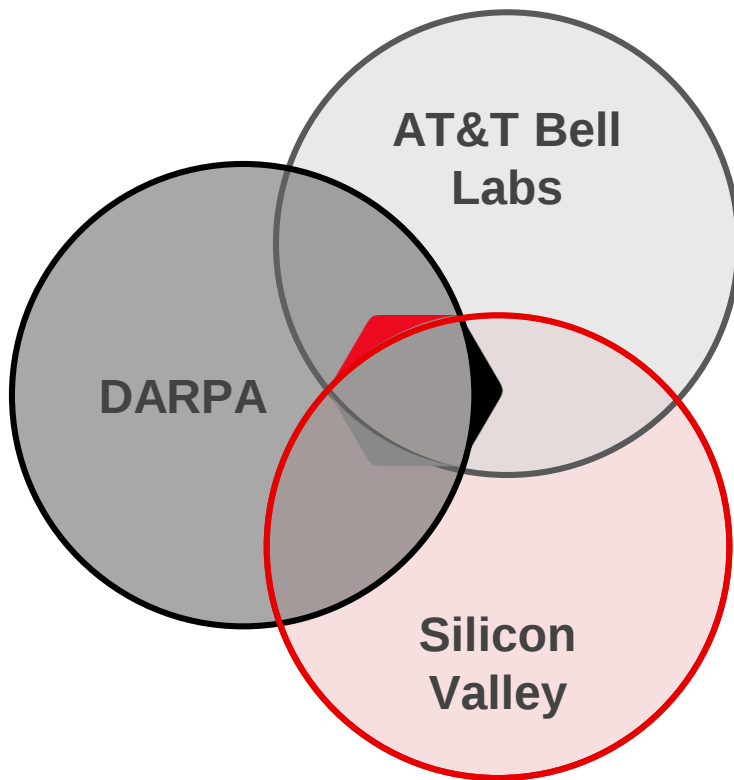
... to Creating and Improving
Machines that Work

Aging Society

From Individual Consumers ...

... to Creators for and
Contributors to Society

Inspirations for Innovation

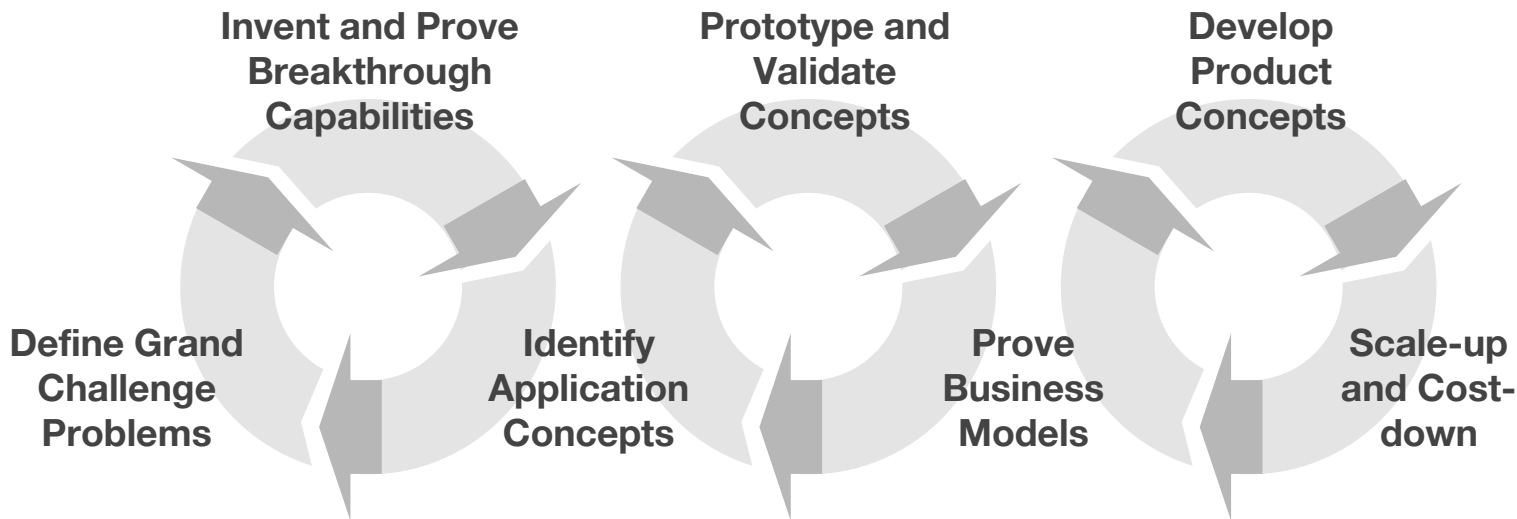


High-risk, failure tolerance
Limited tenure urgency
Collaboration and competition
Focused projects

Large amount of resources
Attracted the best talent
Individual autonomy
Proximity to AT&T

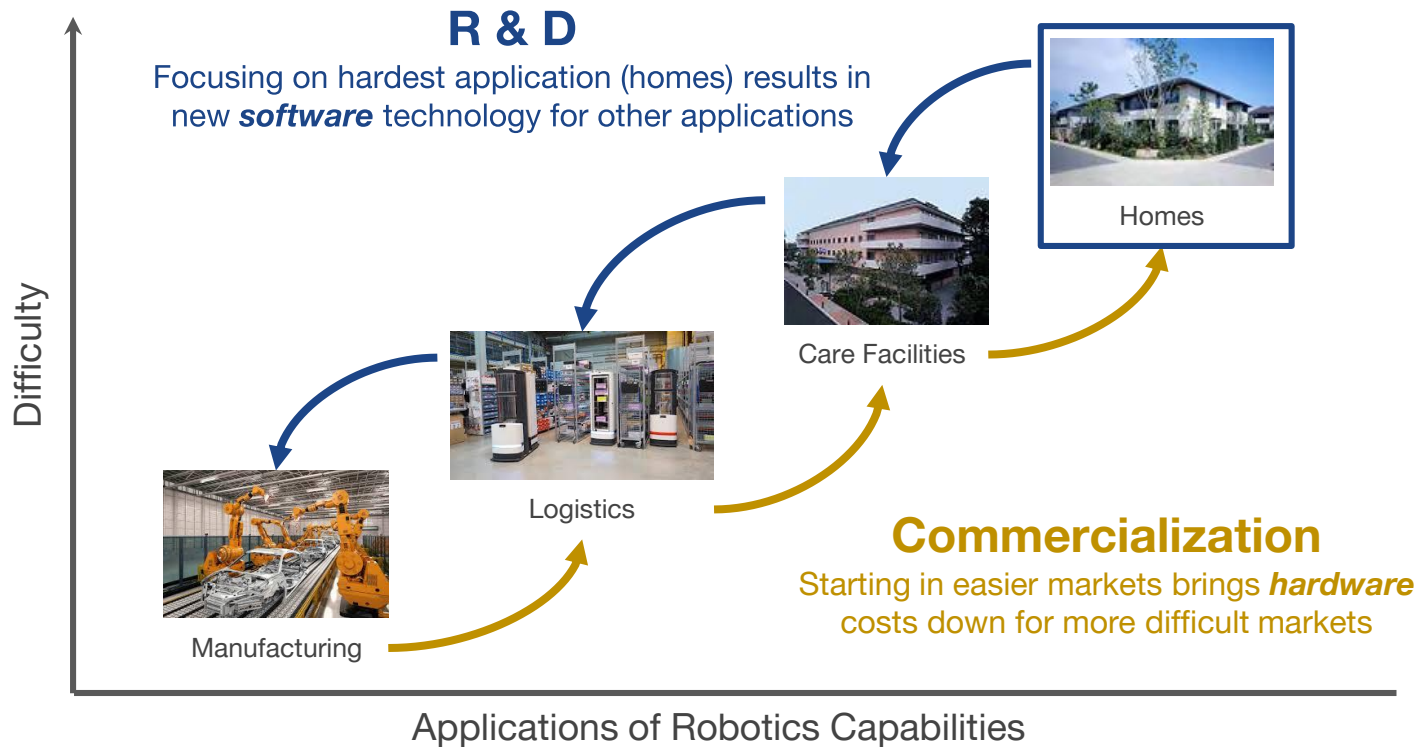
Cooperation spirit
Rotation of talent
Venture capital process
Adjacency to universities

TRI Robotics Innovation Strategy



TOYOTA
RESEARCH INSTITUTE

R&D for Home Robotics Results in Paradigm Shift for Other Applications



A Connected Home with Robotics Capabilities



+





Advances and Implications

Fleet Learning

Memory-Based
Autonomy

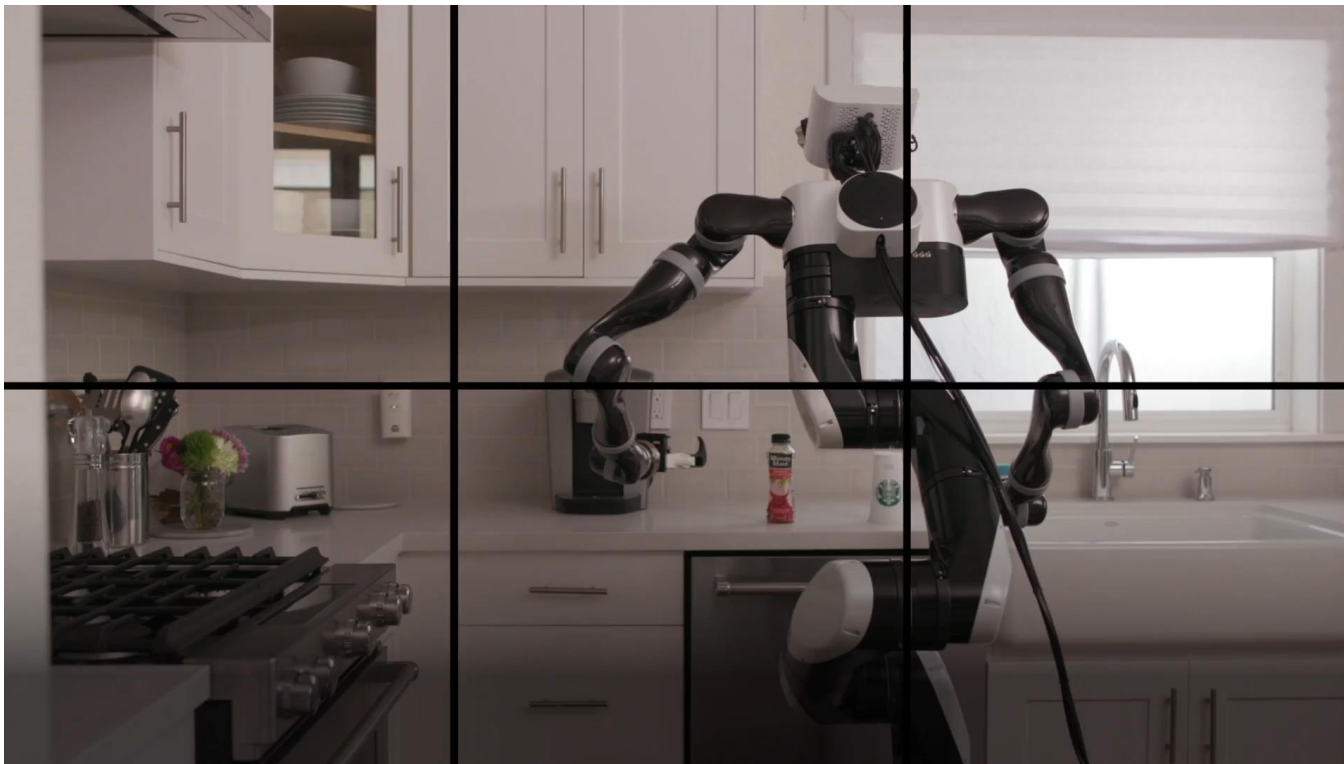
Learning from People

Learning from
Imagination

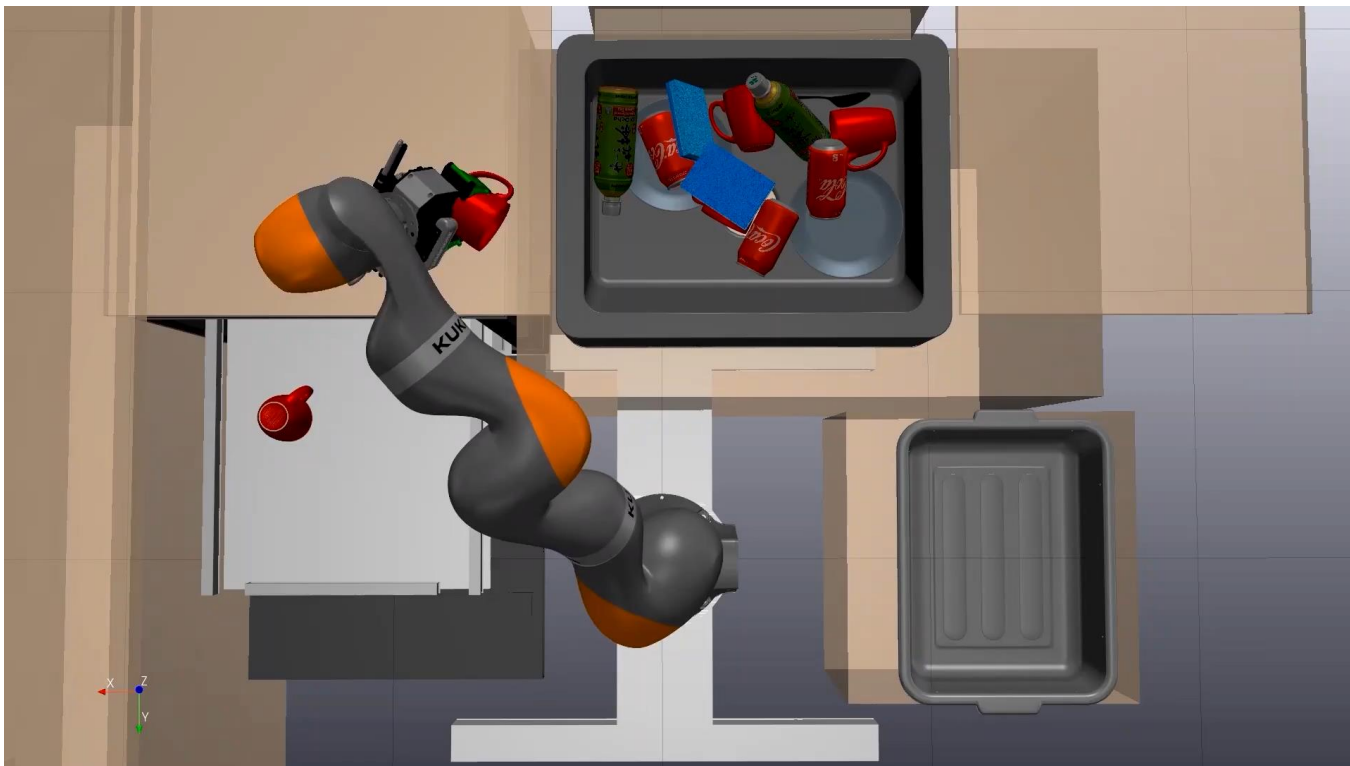
High-Speed Sharing
of Experiences

Gill Pratt, “Is a Cambrian Explosion Coming for Robotics?”
Journal of Economic Perspectives

Telepresent Teaching of Robots



Learning from Simulation



From Capabilities to Concepts



From Capabilities to Concepts



Robotics Innovation to Amplify People

1. Robotics to amplify, not replace
2. Innovate by focusing on hard domains first
3. Tie back to applications to achieve transformations
 - a. Industrial automation
 - b. Aging population



Thank You