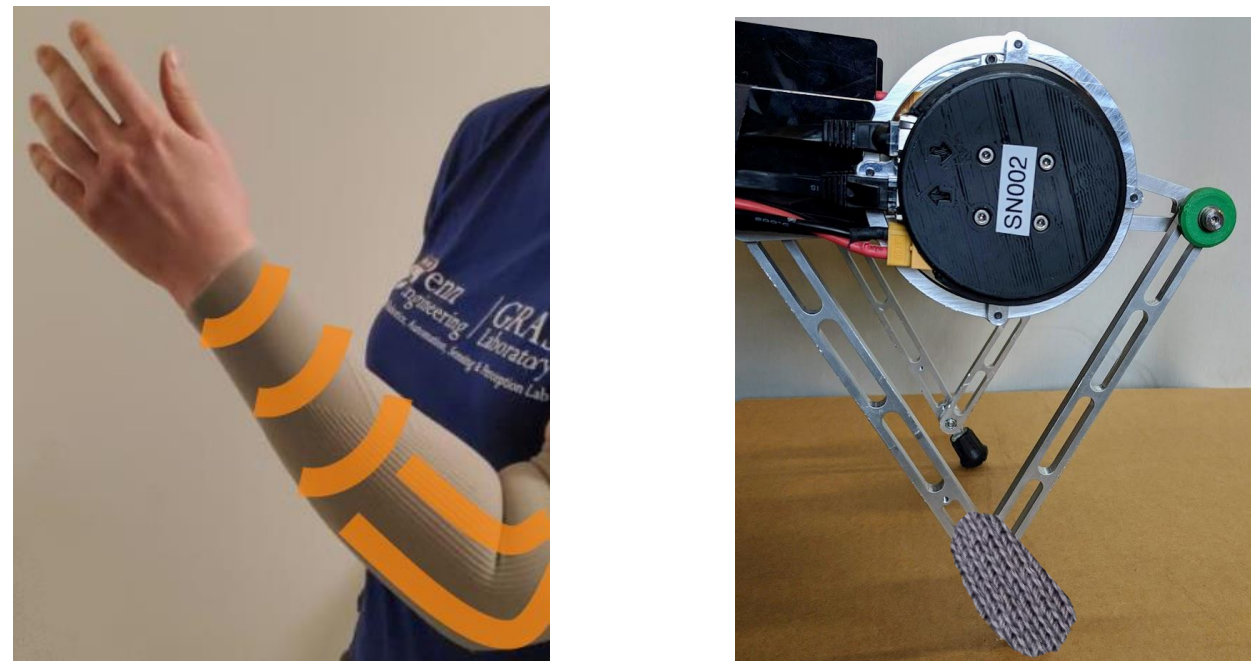


# Knitting for low-cost, fast-manufacturable, programmable, and reconfigurable soft robots

Sonia Roberts, Wesleyan University (starting July 1), Northeastern University (current)

www.soniarobots.com

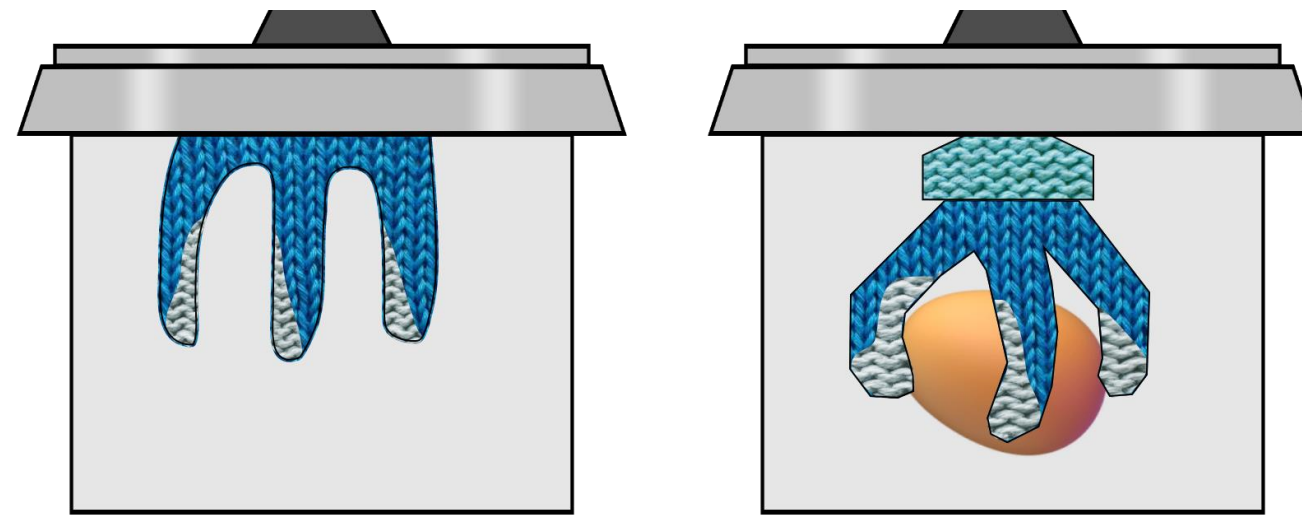
Sensor sleeves for medical applications, rigid robots



Mock-ups of a sensorized medical sleeve and robot sock

5 years

Mock-up of a knitting machine producing a knitted gripper



Actuated soft wearables, grippers

10 years

Fully actuated soft, reconfigurable robots



Mock-up of a soft fish with actuator stripes

20 years

## Challenges for soft robots

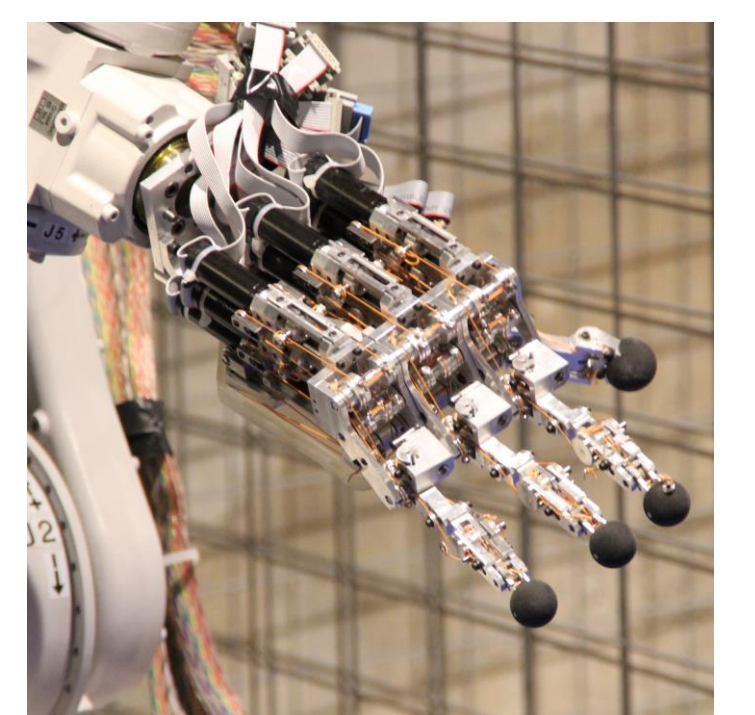
- Specialized equipment with maintenance, troubleshooting costs
- Reconfiguring, recycling, and re-using materials

## Challenges for knitted robots

- Programmable directional sensitivity
- Limited stiffening, actuation capabilities

## Impact on other cyberphysical systems

- Touch sensing for rigid robots
- Proprioceptive pose sensing for soft robots
- Route electronics over other soft robot bodies, e.g. silicone cast, pneumatic, etc.



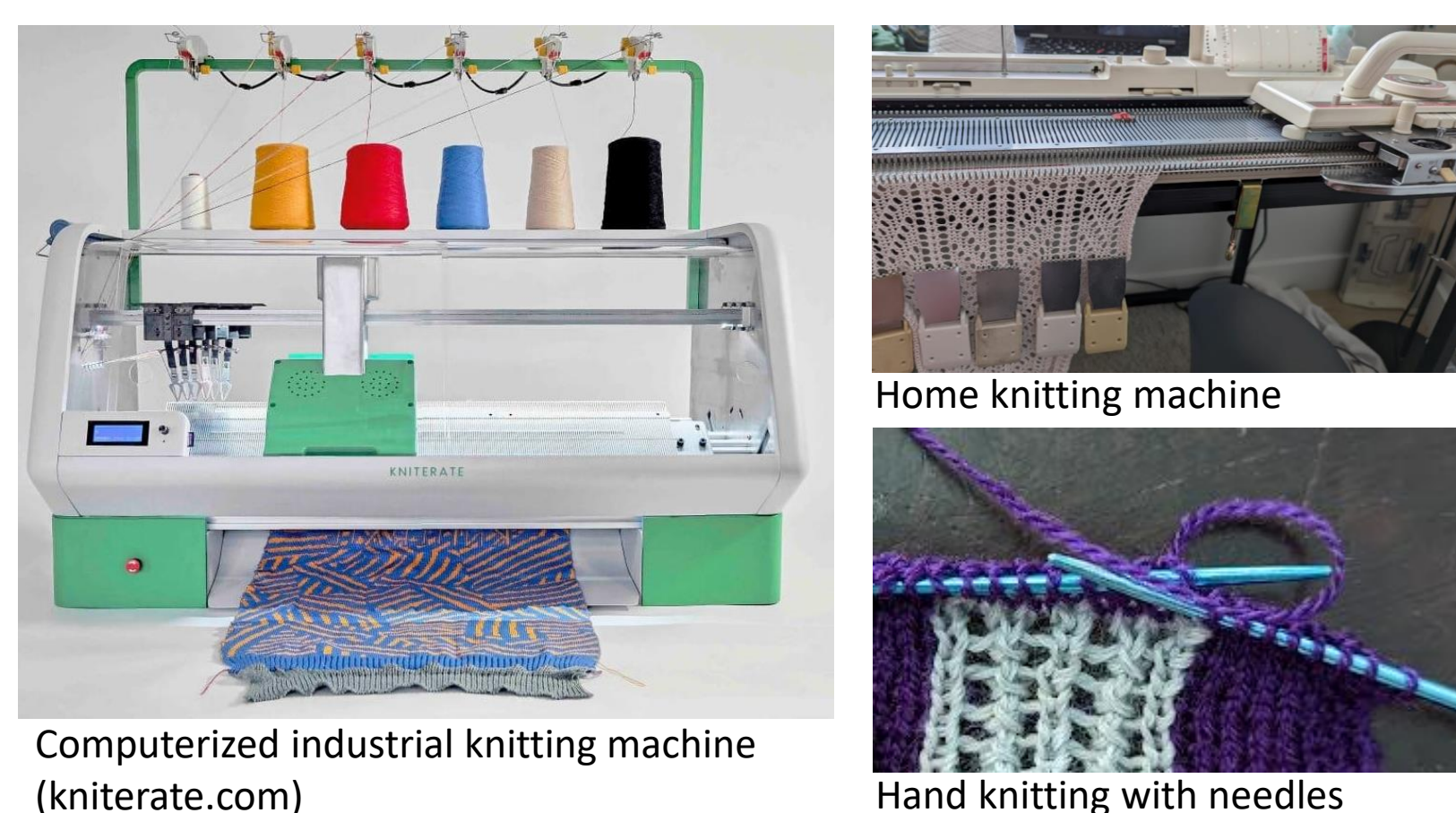
A rigid robot hand which could be sensorized with a knitted glove. Lionel Allorge, Wikimedia Commons

## First step of solution: Knit sensors with vertical directional sensitivity

Production: Industrial machines, domestic machines, or by hand

Materials: Stretch sensitive fiber, silicone cord

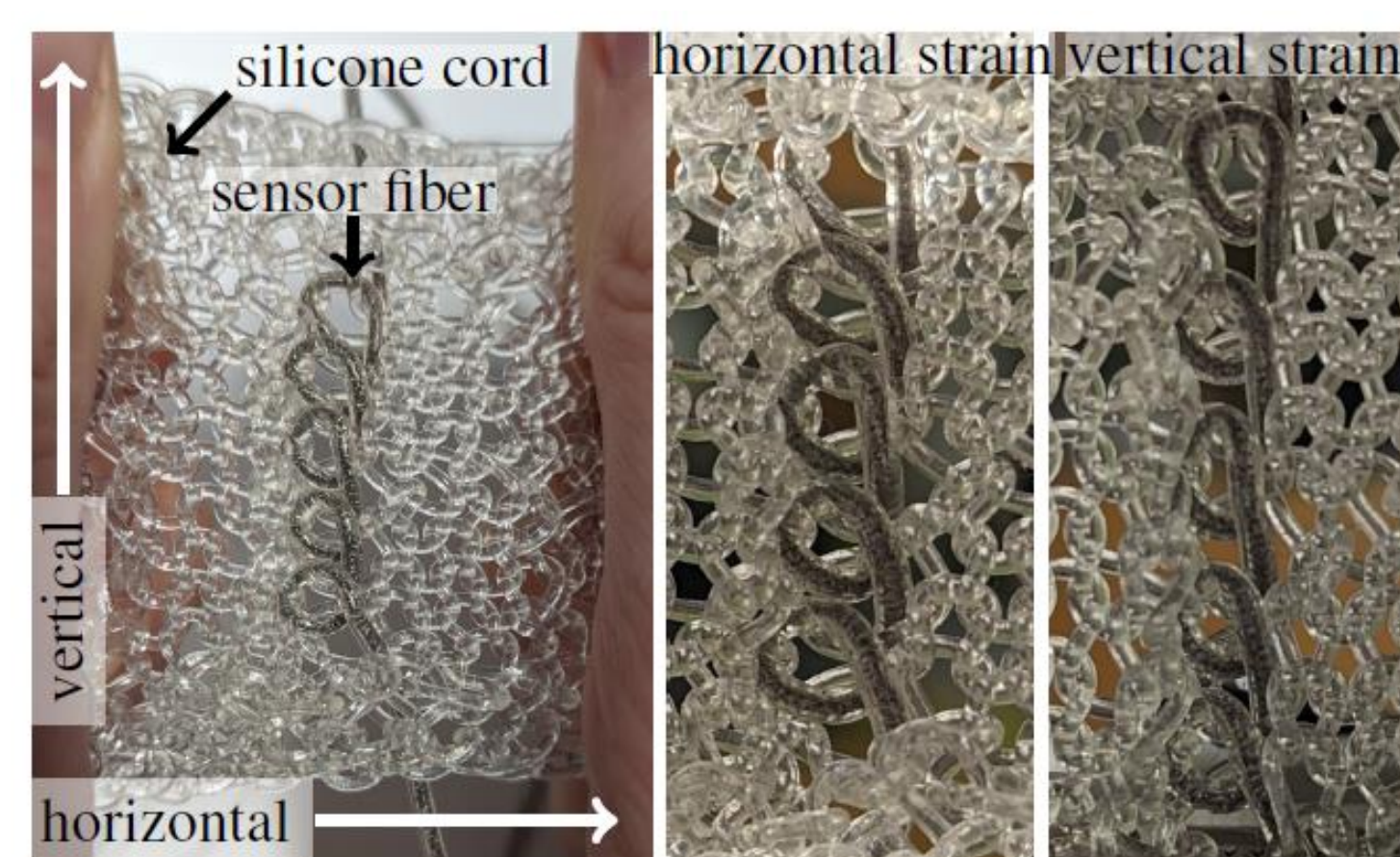
Behavior: Vertically sensitive



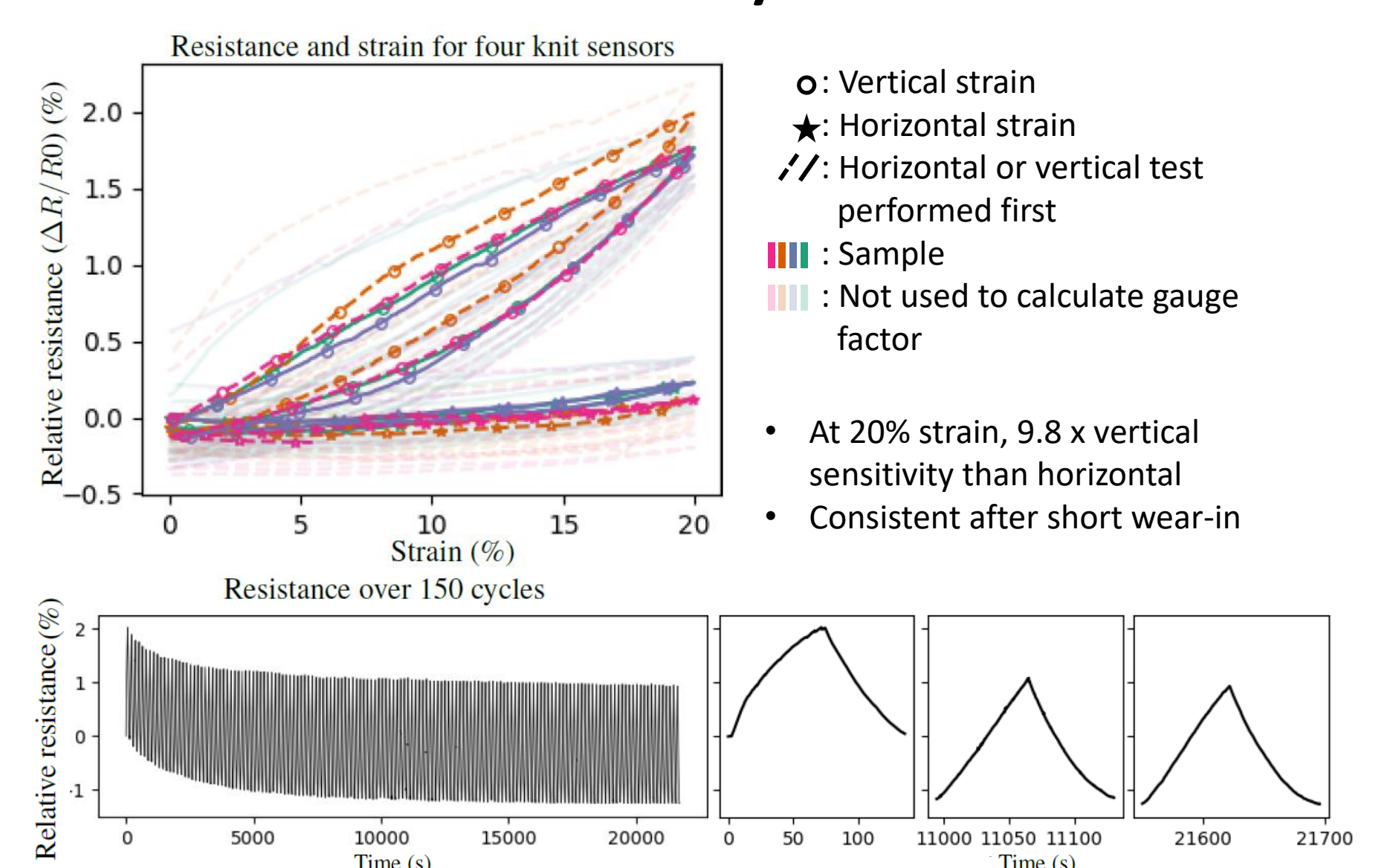
Computerized industrial knitting machine (kniterate.com)

Home knitting machine

Hand knitting with needles



Sensor knit with simple stitches available on industrial and domestic machines



## Societal impacts

- Patients needing compression, e.g. for edema (20% of older adults), incisional hernias (>1 million per year), C-sections (32% of live births)
- Manufacturing and package handling industries manipulating soft, fragile objects
- Low material payload applications, e.g. field research, extraplanetary exploration
- Human interaction, including children & elderly

## Education and outreach

- Wesleyan University: PUI liberal arts college
- **AYAB**: all yarns are beautiful: Open-source computational machine knitting community
- **MAKERSPACECT**: Arduino workshops for public middle and high school STEM teachers
  - Hartford public schools have 90% minority, 63% low-income enrollment
  - Each teacher impacts >3000 students