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# AI-ASSISTED IN-HOME ELDERLY CARE AMID COVID-19 PANDEMIC

From Early Symptom Detection to  
Chronic Disease Management

**Fei-Fei Li, Ph.D.**

Sequoia Professor, Computer Science Department  
Denning Family Co-Director, Human-Centered AI Institute  
Stanford University

# Team and partners



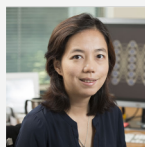
Alan Luo <sup>MS</sup>  
PhD student



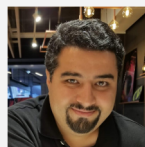
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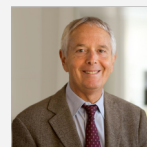
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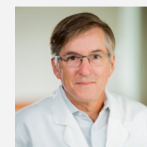
Fei-Fei Li <sup>PhD</sup>  
Professor



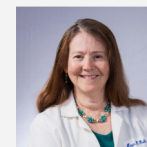
Ehsan Adeli <sup>PhD</sup>  
Postdoc



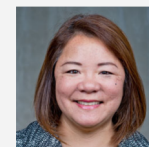
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Haya Rubin <sup>MD, PhD</sup>  
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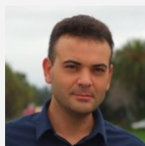
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Chief Executive Officer



Albert Haque <sup>MS</sup>  
PhD student



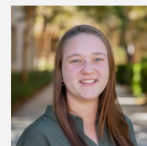
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Undergraduate student



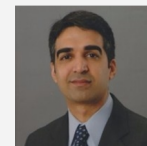
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Postdoc alumni



Serena Yeung <sup>PhD</sup>  
PhD alumni



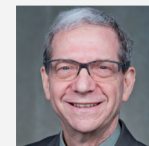
Sara Kelly <sup>BS</sup>  
Research Project Manager



Amit Kaushal <sup>MD, PhD</sup>  
Adjunct Professor



Jia Li <sup>PhD</sup>  
Adjunct Professor



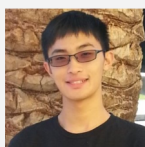
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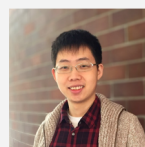
Alisha Rege <sup>MS</sup>  
Graduate alumni



Sanyam Mehra <sup>MS</sup>  
Graduate alumni



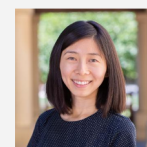
Jun-Ting Hsieh <sup>MS</sup>  
Graduate alumni



Haoye Cai <sup>BS</sup>  
Graduate alumni



Lance Downing <sup>MD</sup>  
Medical Director



Jiayin Xue <sup>MD, MPH</sup>  
Adjunct Professor



Julia Lee <sup>MBA</sup>  
Research Project Manager



Wanda Chin  
Associate Director



“ They spent **eight days** locked at home with a fever of 102°F (39°C).

I tried to call emergency services but no one came to the rescue.

”

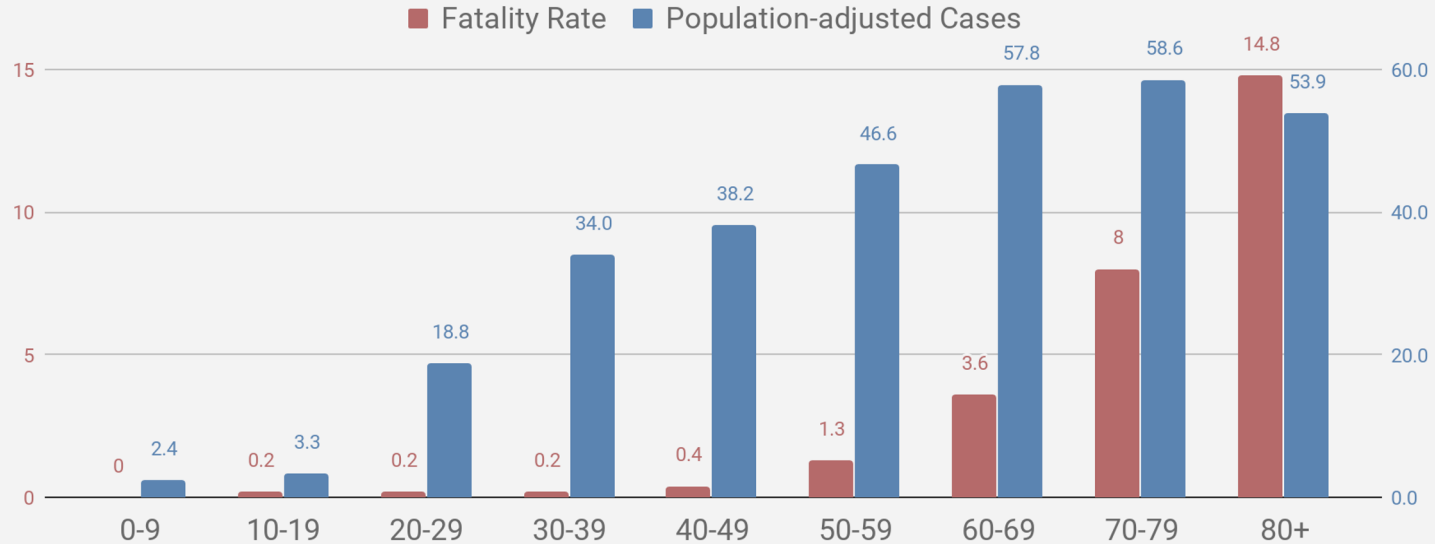
– Luca Carrara, son of victims



Severa Belotti, 82, and Luigi Carrara, 86, from Albino, Bergamo, who died from the COVID-19 just hours apart in northern Italy on March 10.

# Seniors are the most vulnerable to COVID-19

They are more likely to **contract** COVID-19 and **die** from the virus



Population-adjusted cases: Cases with confirmed age per 1 million people in age group

# Various reasons put seniors at a higher risk

**Age**

**65yr**

**Chronic Health Condition**



**Community Living**



**Asymptomatic Caregiver**



**Medical Triage**



**Poor Chronic Care**



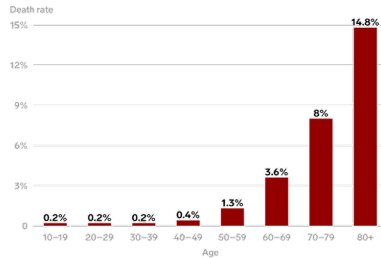


# Various reasons put seniors at a higher risk

## Age

Seniors are at a higher risk of infection and death

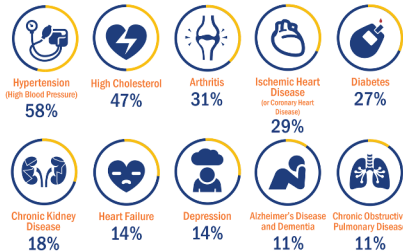
COVID-19 Death Rate by Age



## Chronic Health Condition

75% of seniors have chronic health conditions, which dramatically worsen prognosis

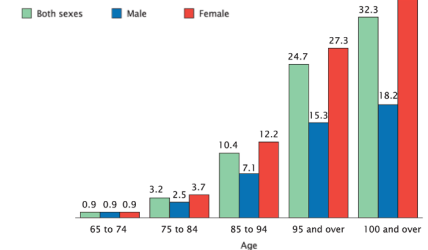
Common Chronic Conditions for Adults 65+



## Community Living

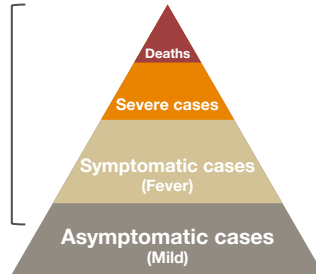
More vulnerable to community outbreaks

Nursing Home Population Aged 65+



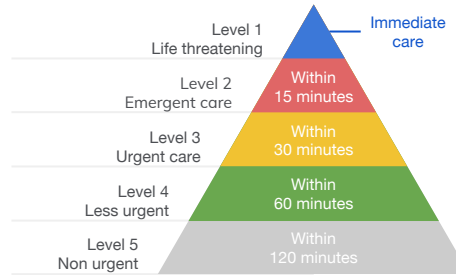
# Various reasons put seniors at a higher risk

Cases detected



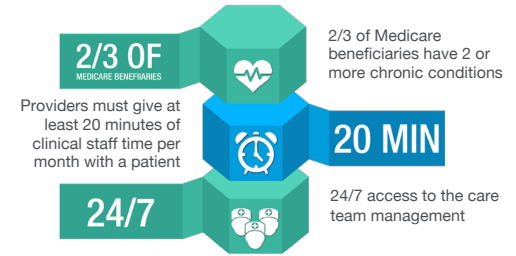
## Asymptomatic Caregiver

Seniors rely on younger caretakers who could be asymptomatic patients



## Medical Triage

Younger patients are prioritized to maximize the chance of therapeutic success



## Poor Chronic Care

Routine chronic care could be delayed or dangerous due to cross-infection in hospitals

# How to take care of seniors while keeping them safe?



Early Symptom Detection  
of COVID-19



Monitor Patients with  
Mild Symptoms



Manage Chronic Conditions





# Endowing in-home care with AI-Powered Smart Sensor Technology

**Versatile**



Mobility



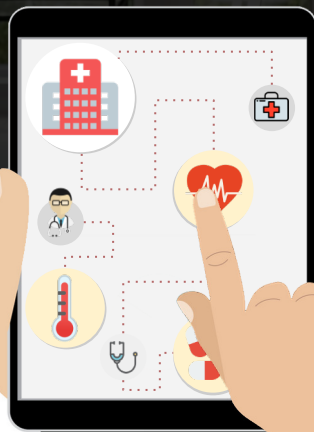
Infection



Sleep



Diet



**Scalable**



Low-cost

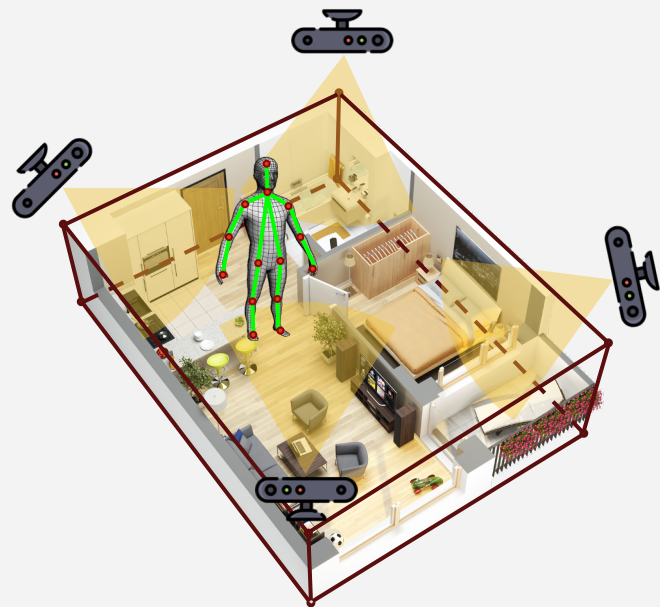


Burden-free




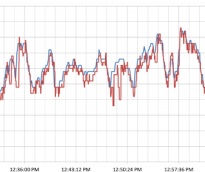


## A system overview

# Multimodal & privacy-preserving data collection



### Our research

Sensor	RGB (smartphones & cameras)	Depth	Thermal	Wearable (Fitbit/Apple Watch)
Function	Perceives the world in visible light	Measures distance	Measures temperature	Measures vital signs and motion
Use case	Object recognition, person detection, complex behavior understanding	Pose estimation, gait analysis	Fever detection, respiratory rate monitoring	Heart rate, sleep, and step tracking
Example data				

1

Data Collection

2

Data Annotation

3

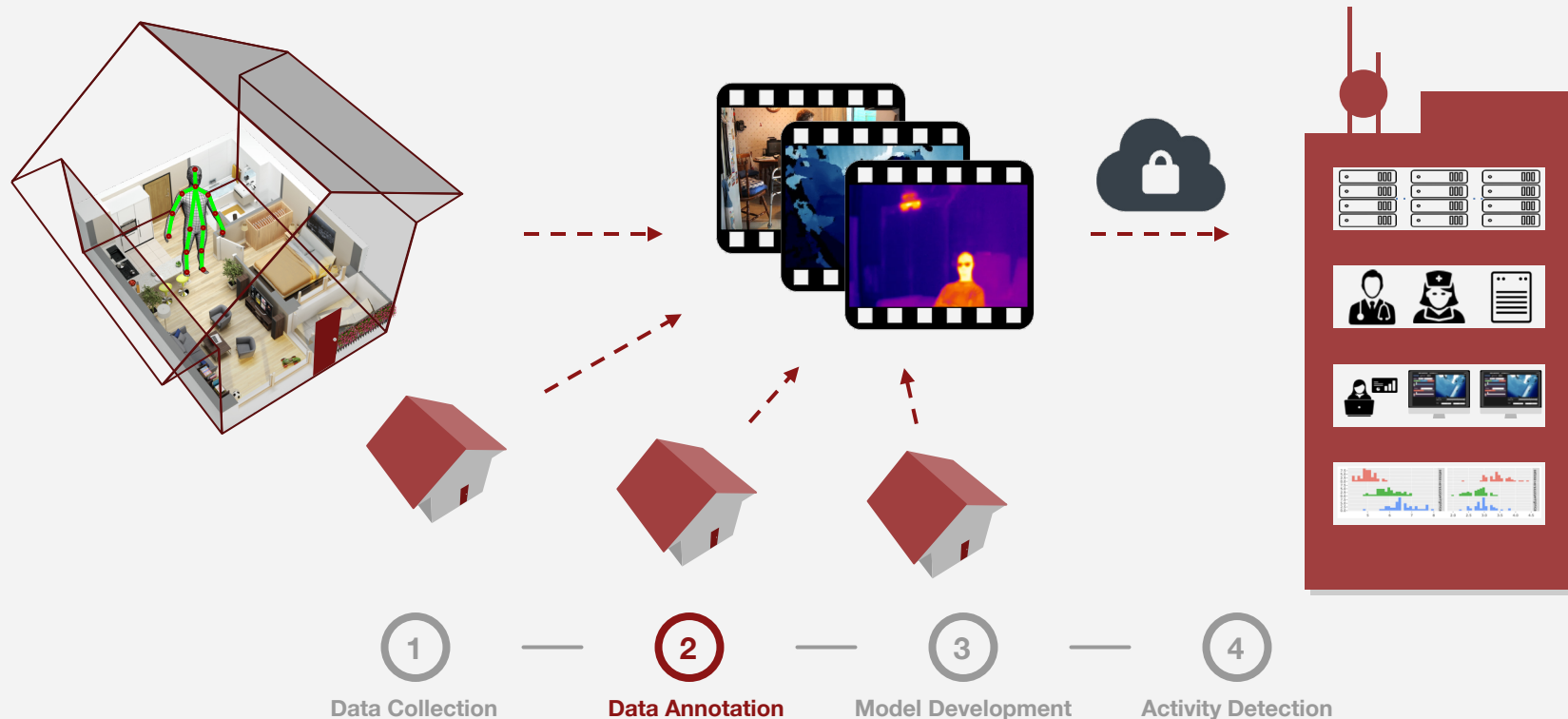
Model Development

4

Activity Detection

## A system overview

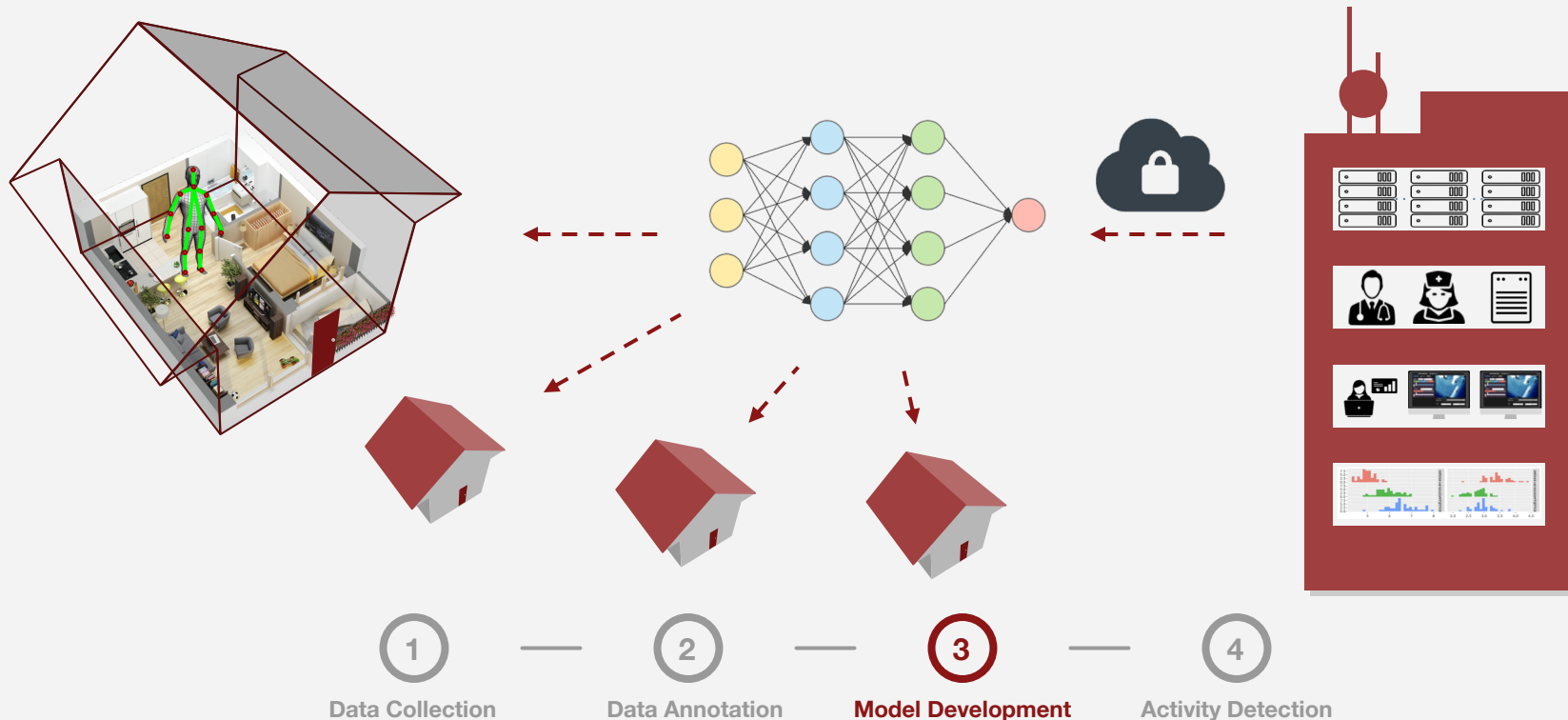
# Data encryption, transfer, and annotation





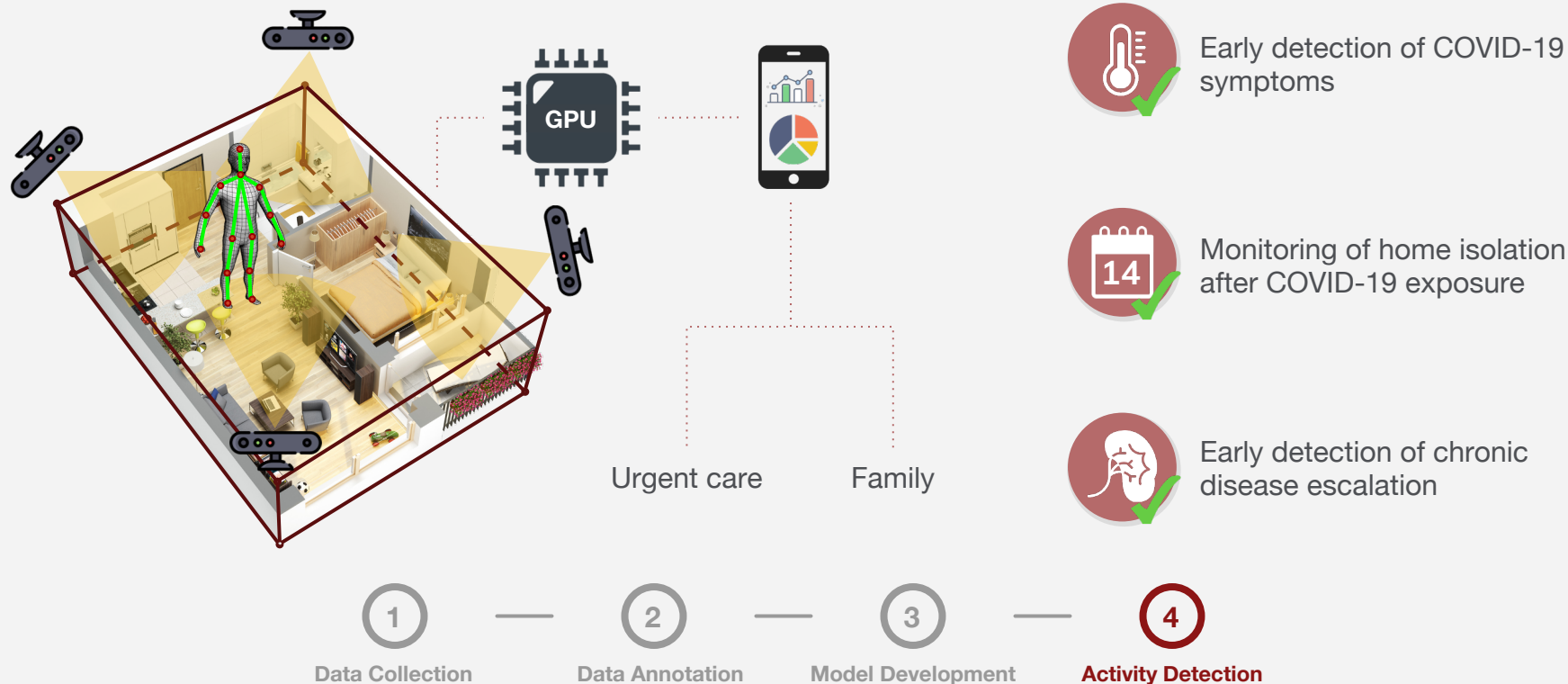
A system overview

# Model development and deployment



A system overview

# Edge computing and data analytics



# Descriptive analytics of clinical status

Can be further interpreted by clinicians and family members



**Infection**

**Mobility**

**Sleep**

**Diet**

Fever

Urinary frequency

Respiratory rate

Falls

Slowed movements

Unstable transfers

Front door loitering

Immobility

Sleeping

Day/night reversal

Eating

Fluid intake

Alcohol consumption

Pill consumption



# Descriptive analytics of clinical status

## Infection



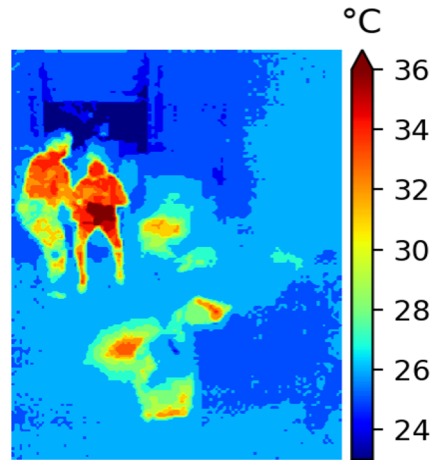
**Infection**

Fever

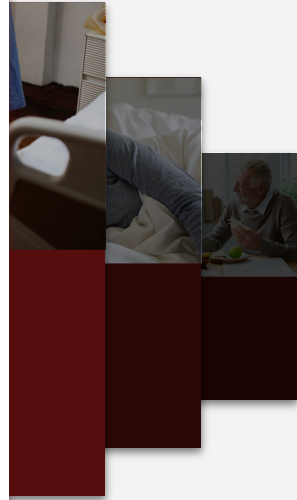
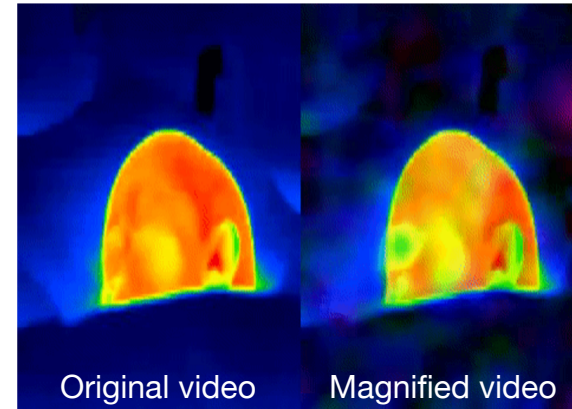
Urinary frequency

Respiratory rate

### Fever detection



### Respiratory rate monitoring

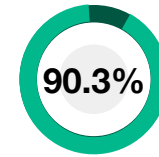
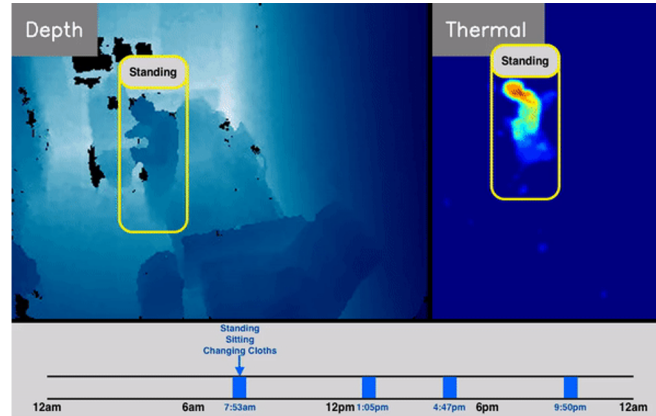


# Descriptive analytics of clinical status

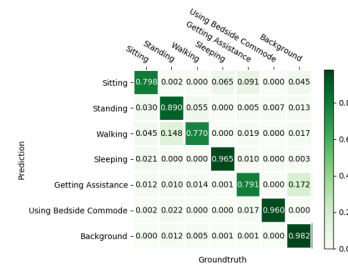
## Mobility

### Mobility

Falls  
Slowed movements  
Unstable transfers  
Front door loitering  
Immobility



Metric: mAP



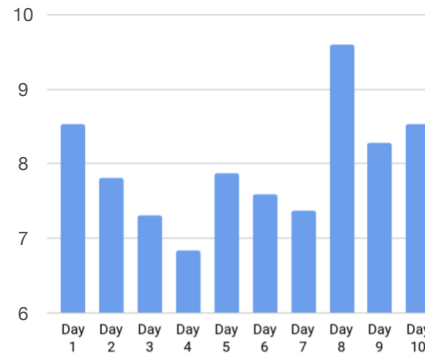
# Descriptive analytics of clinical status

## Sleep

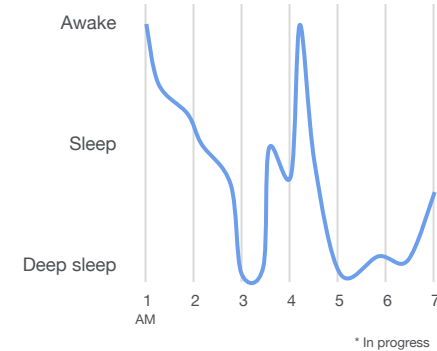
**Sleep**

Sleeping  
Day/night reversal

**Hours of sleep**



**Sleep stages**



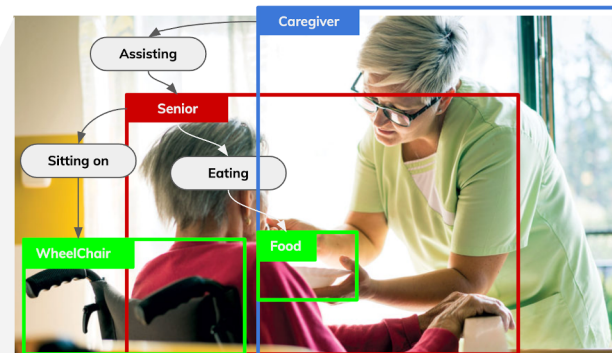
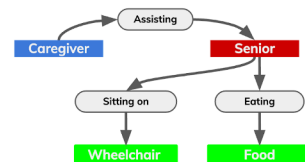
# Descriptive analytics of clinical status

## Diet

### Diet

Eating  
Fluid intake  
Alcohol consumption  
Pill consumption

Activity: eating  
Subjects: caregiver, senior  
Objects: wheelchair, food  
Scene graph:



Spatial-temporal scene graph

\* In progress



# Ethics, privacy, and security

## Step 1

IRB approval  
Minimized population bias  
Proxy consents for cognitively impaired adults

**Recruit  
participants**

**Collect &  
store the  
data**

## Step 2

HIPAA compliant platform  
Data and disk encryption

## Step 3

Face & private area blurring

**Annotate  
the data**

## Step 4

Edge computing  
Federated learning

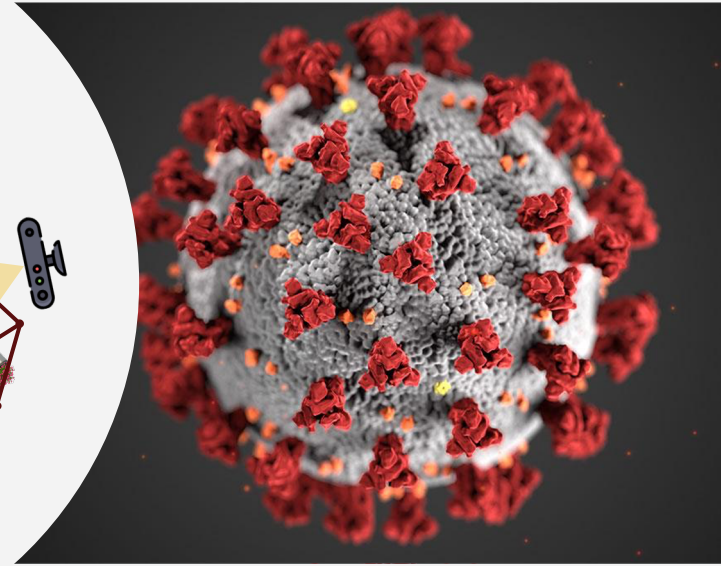
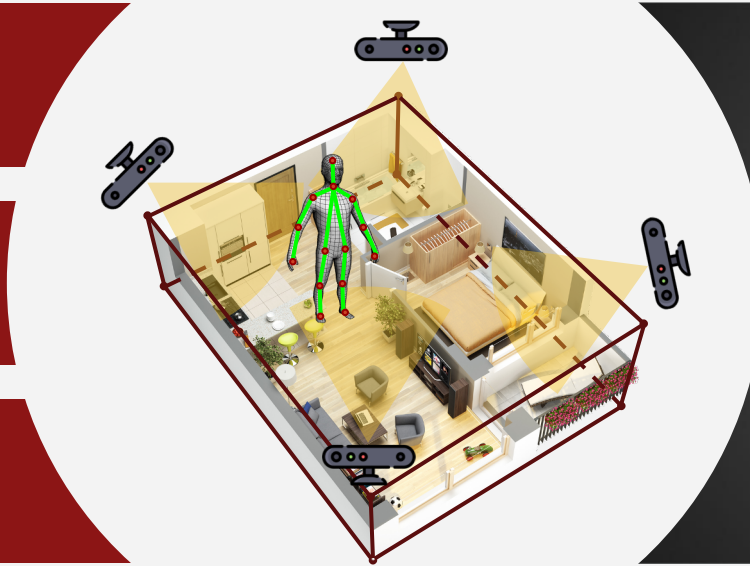
**Develop &  
deploy the  
model**

# AI-powered sensors: Keeping seniors safe and provide assistive care during a pandemic

**In-home Health Monitoring**

**Early Infection & Respiratory Distress Detection**

**Mitigation of Hospital Overload**

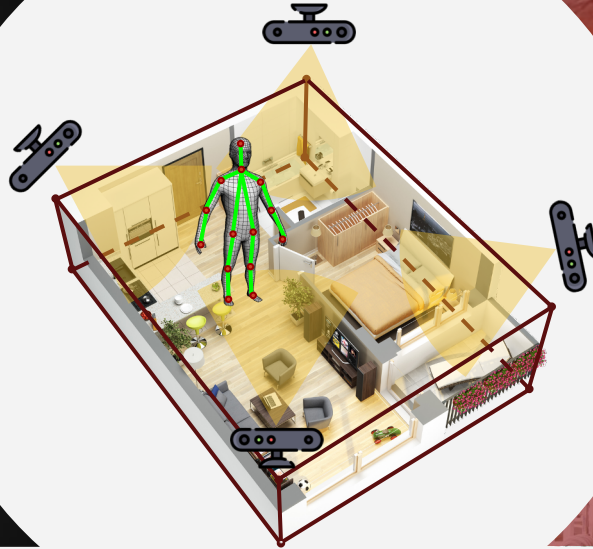


# AI-powered sensors: In-home care opportunities beyond seniors and COVID-19

**In-home Health Monitoring**

**Early Infection & Respiratory Distress Detection**

**Mitigation of Hospital Overload**



**Assistive, Accessible, and Affordable Home Care**

**Chronic Disease Management**

**Rehabilitation**

# Thank you & acknowledgment



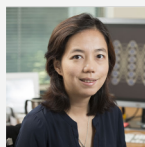
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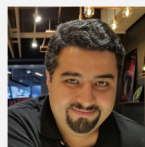
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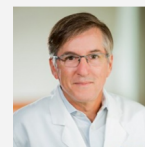
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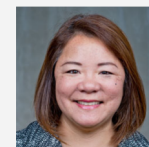
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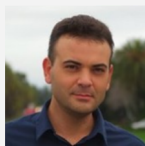
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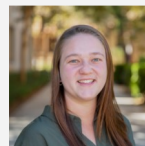
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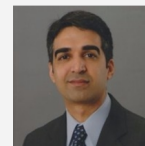
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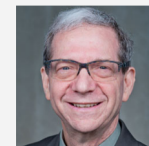
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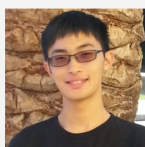
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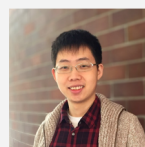
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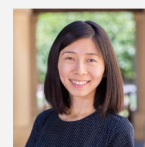
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