SENSORS

in support of aging-in-place:

The Good, the Bad, and the Opportunities

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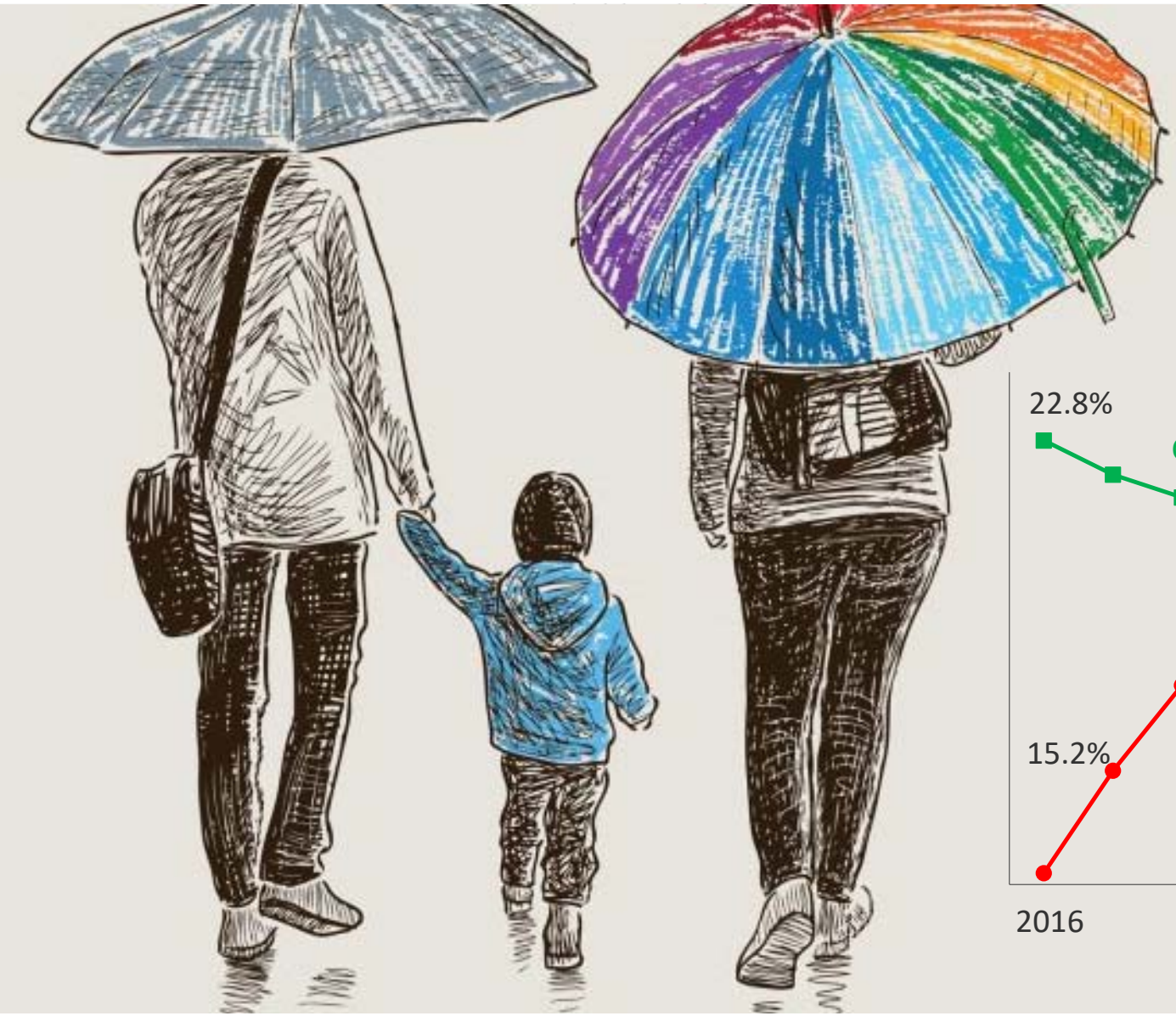
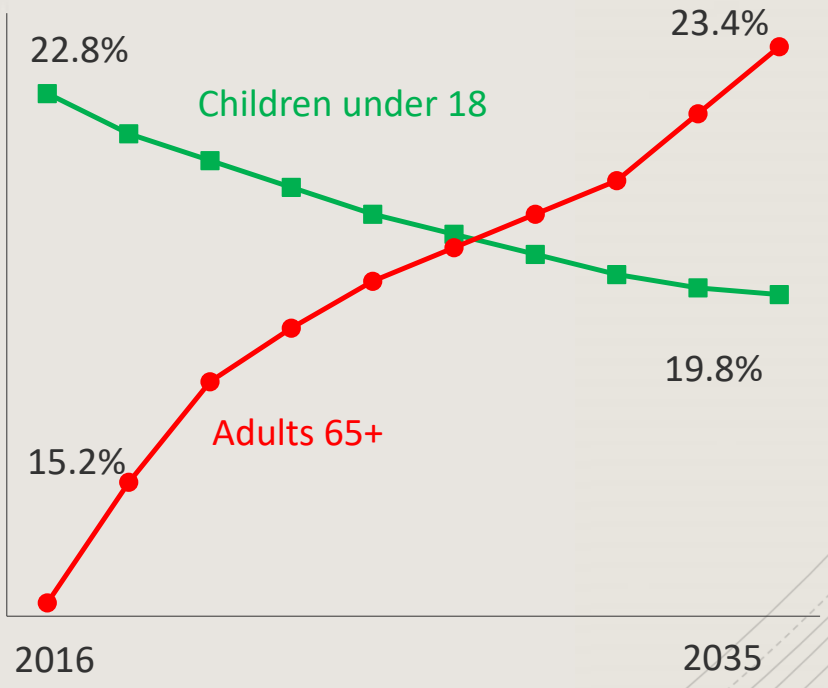
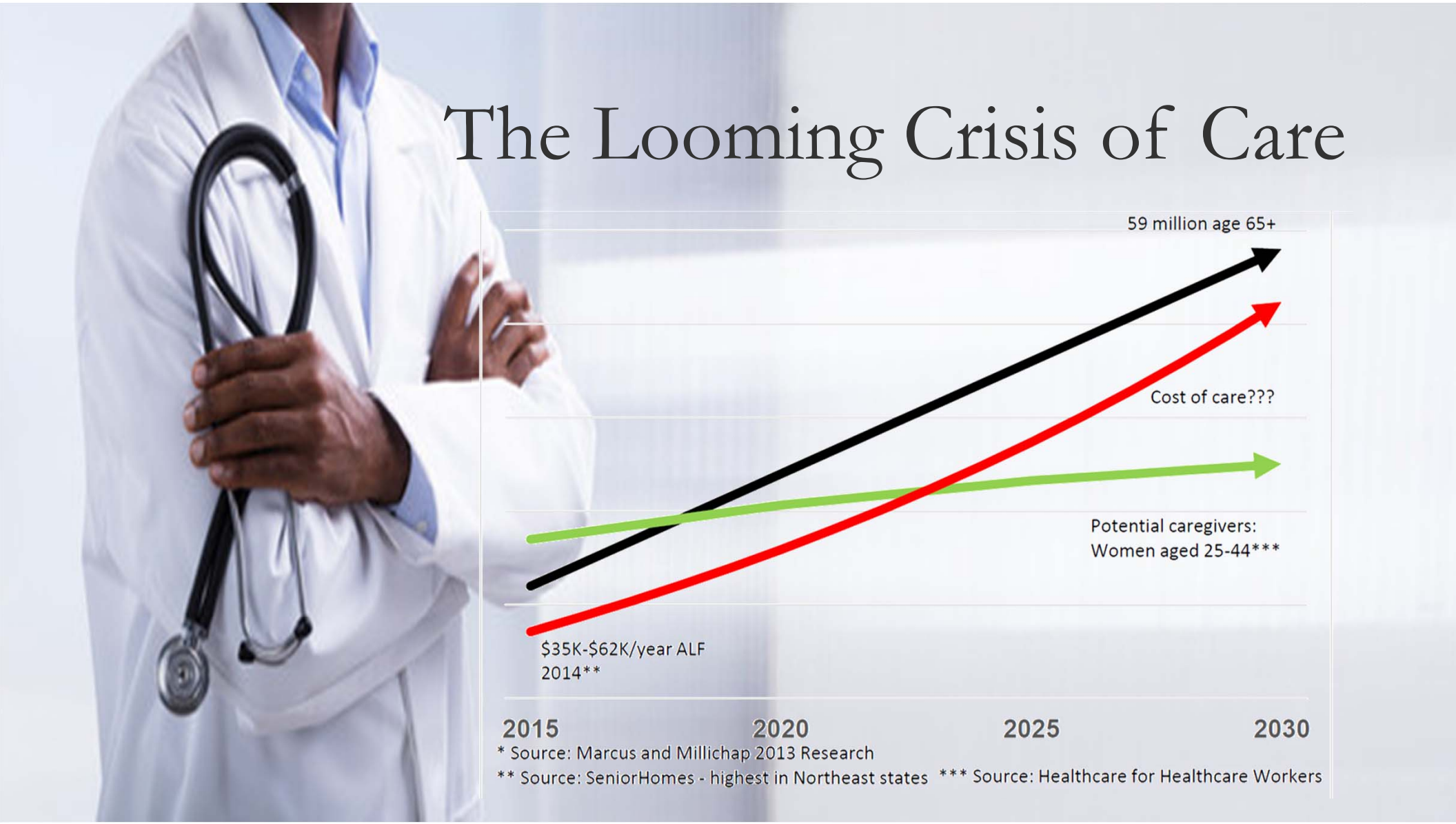



22.8%
Children under 18
23.4%
19.8%
Adults 65+
15.2%
2016
2035

The Looming Crisis of Care

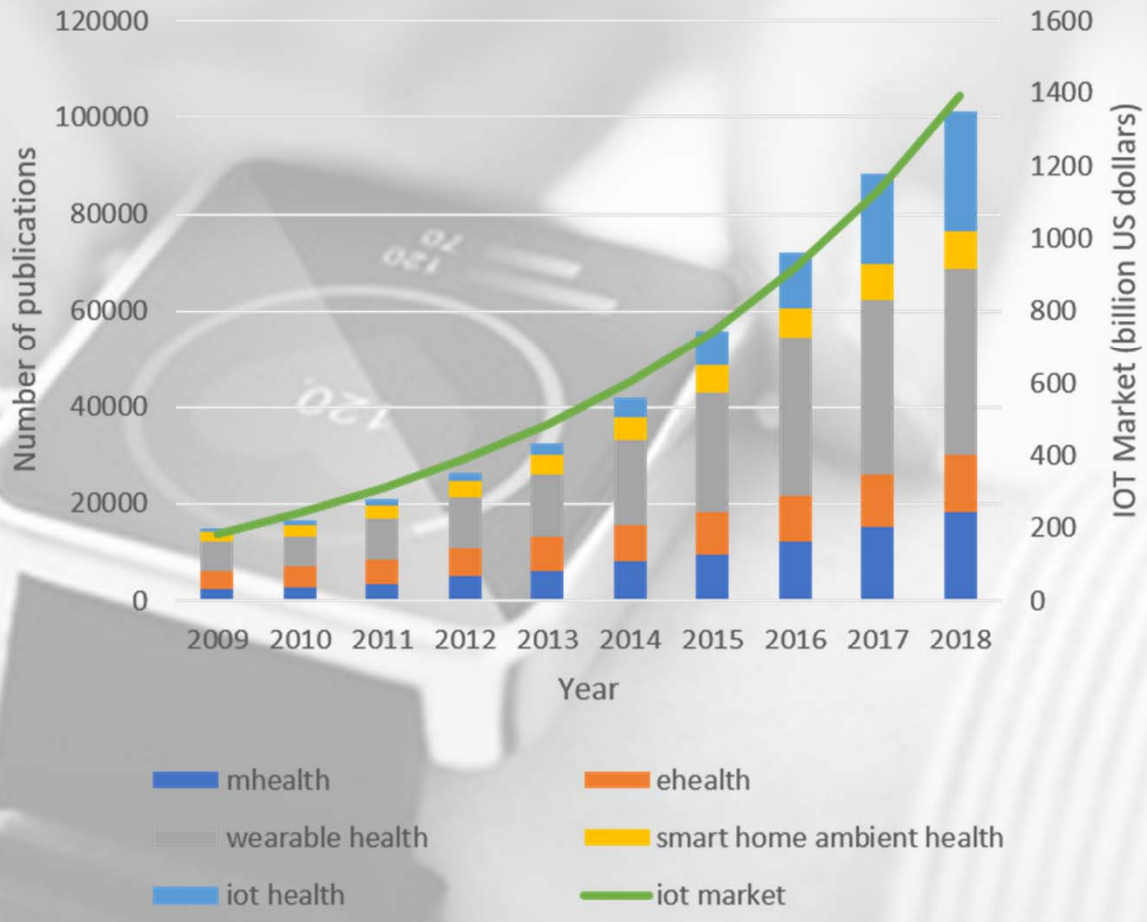


* Source: Marcus and Millichap 2013 Research

** Source: SeniorHomes - highest in Northeast states

*** Source: Healthcare for Healthcare Workers

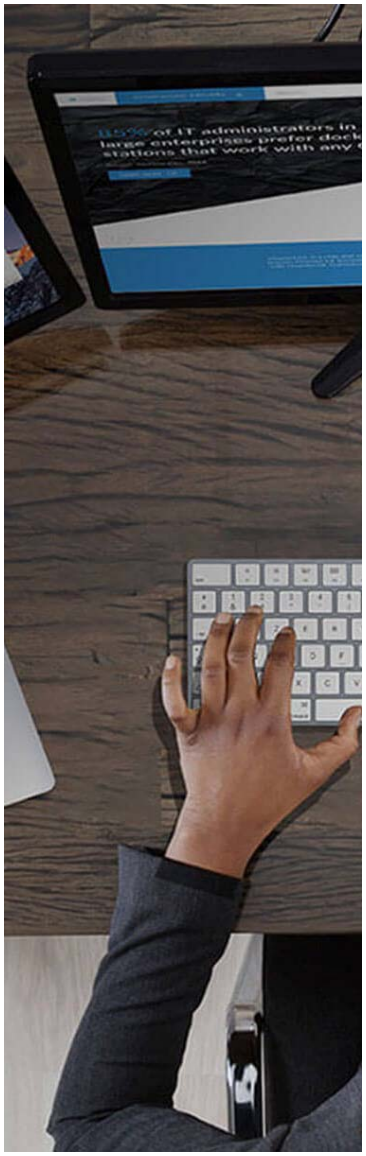
Sensor-Driven Healthcare



AGELAB

Sensors
Behavior markers
Assessment
Intervention

Sensors



Sensors

Ambient
Attached to environment, passive

Wearable
Attached to person, requires compliance

External
Double duty from outside sources

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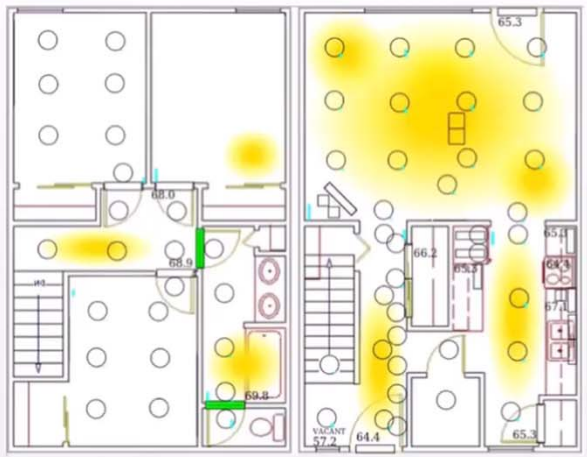

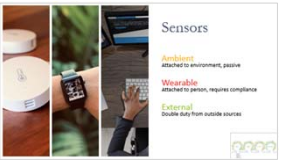

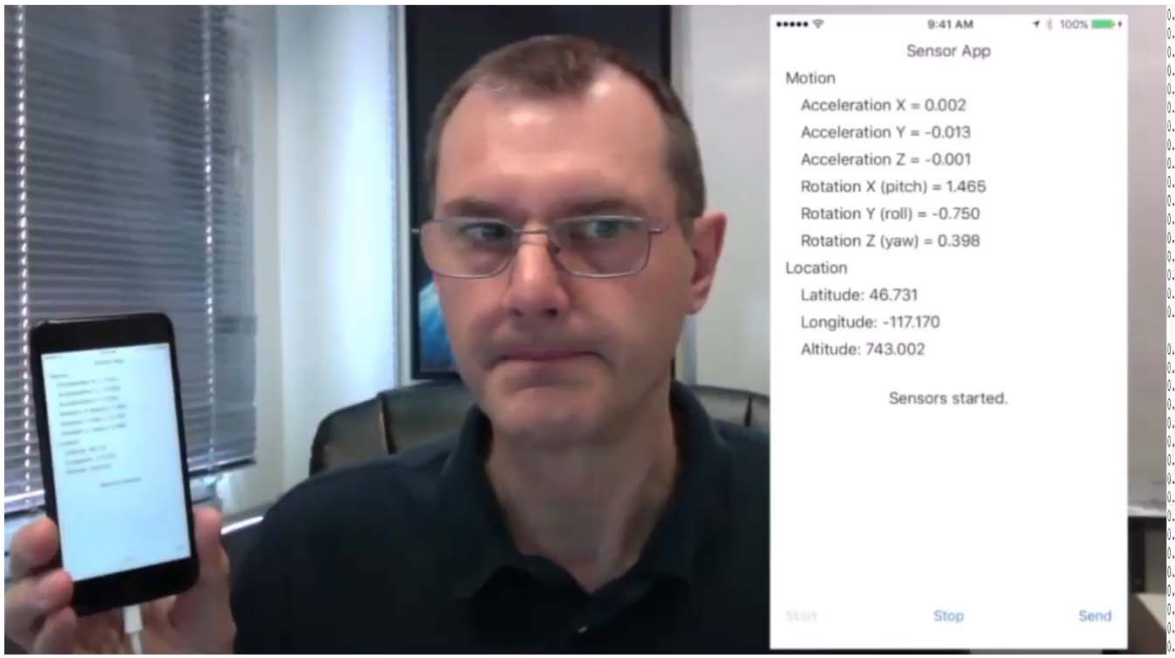

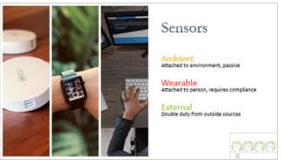

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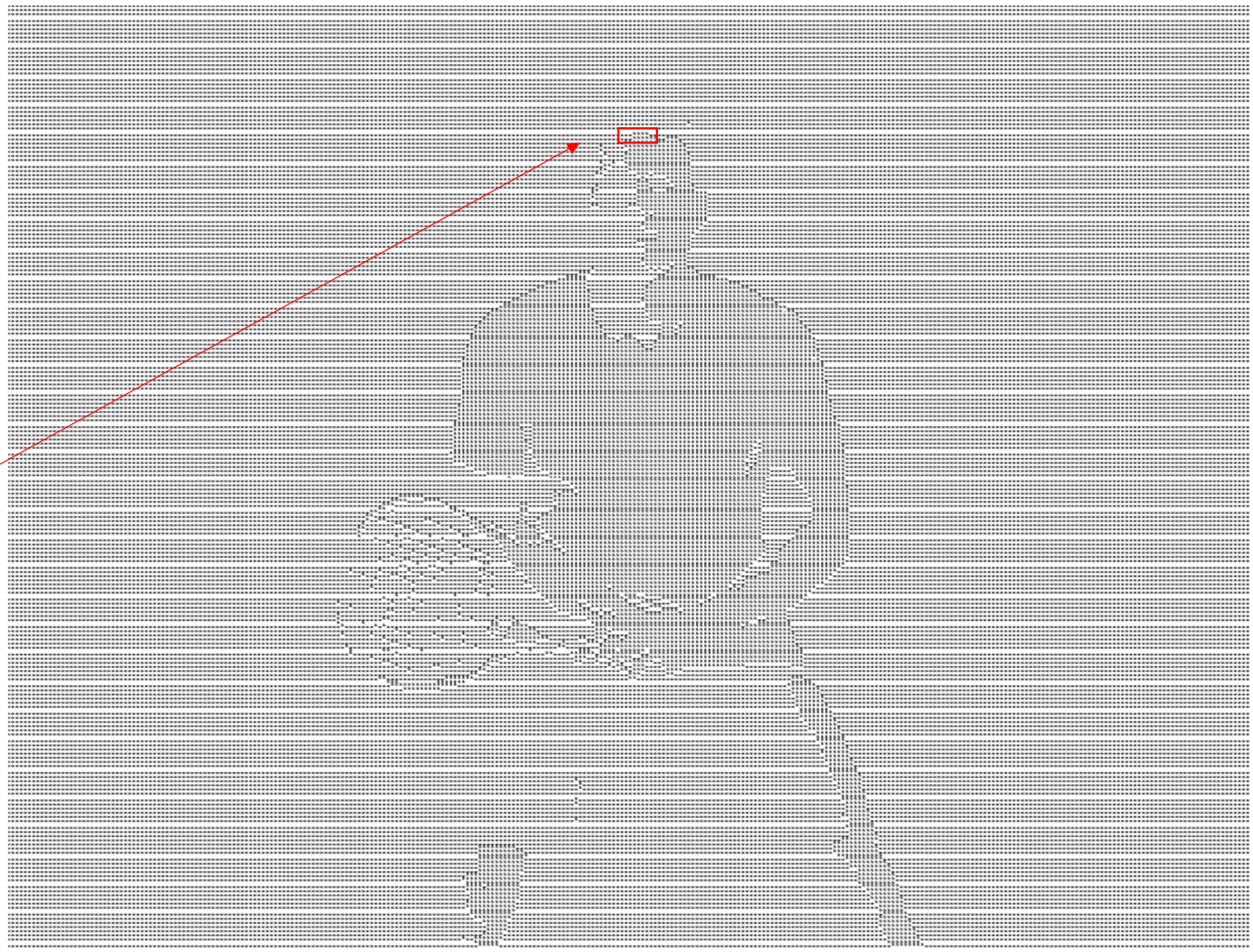

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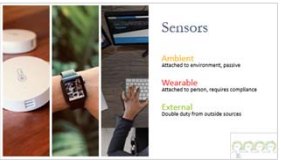
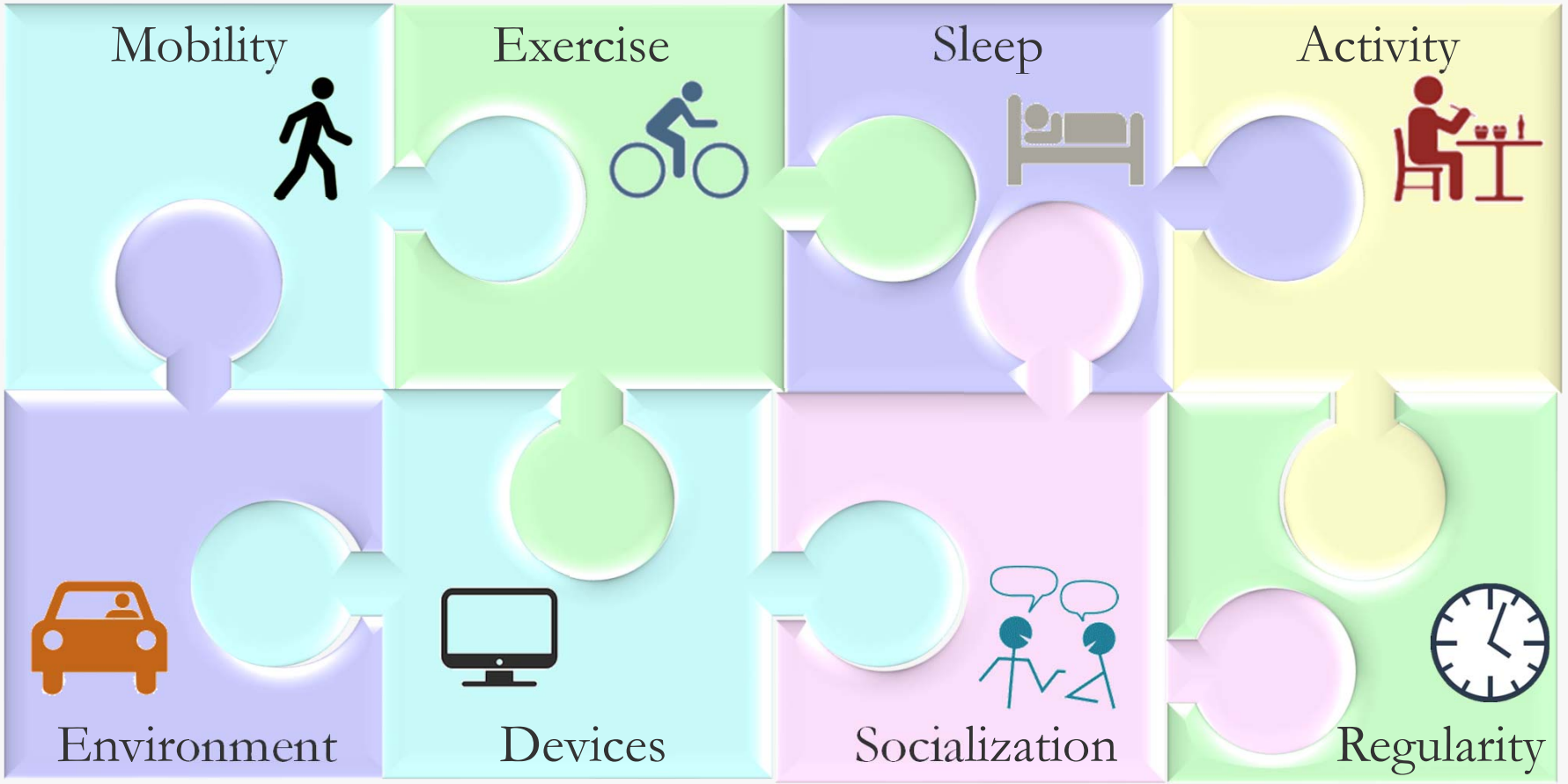


- Movement
- Location
- Physiological readings
- Device usage

Sensors: Behavior Markers



- Movement
- Location
- Physiological readings
- Device usage

- Exercise
- Activities
- Sleep
- Socialization
- Circadian rhythm

Assessment

Assessment

- Mobility
- Mood
- Cognition

- Function

$$h: f(X) \rightarrow y$$

Assessment: Mobility

Target	Subjects	Duration	Findings
Sustained auditory attention	11 healthy, 4 MCI	Scripted	r=0.66
One-leg standing	11 OA, 4 PD, 12 YA	Scripted	Differ among floor types
Fall risk	15 nonfallers, 19 fallers	1 week	Turns slower with more steps for fallers (p=.04)
Stroke recovery	25 subjects with chronic stroke	3-6 months	N/A
Gait assessment	2 adults	15 months	AIC=255.63
Tremor	10 adults with tremor	Scripted	82%

Median: 15

Assessment: Mood

Target	Subjects	Duration	Findings
Social anxiety	54 college students	2 weeks	85% accuracy
Predict emotion	50 young adults	Scripted	p=.006
Detect social interaction	2 homes	1..4 weeks	precision=.64 recall=0.96
Loneliness	16 older adults	1..8 months	r=0.48

Median: 33 (25)

Assessment: Function

Target	Subjects	Duration	Findings
RBANS, TUG	18 older adults	2..8 years	RBANS, 72% accuracy TUG, 76% accuracy
Dementia / Healthy Diagnosis	179 adults	Scripted	AUC=0.94
MCI / Healthy diagnosis	68 older adults	12 weeks	AUC=0.72
Driving behavior	28 older adults	6 months	p<.05
Healthy, MCI, PD/No-MCI, PD/MCI	84 older adults	Scripted	AUC=0.97

Median: 68 (25)

Assessment: Function

Target	Subjects	Duration	Findings
AMPS, KATZ	13 older adults	1 year	AMPS, MAE=0.32 KATZ, MAE=1.19
IADL change	29 older adults	>2 years	Accuracy=0.88

Median: 21 (18)

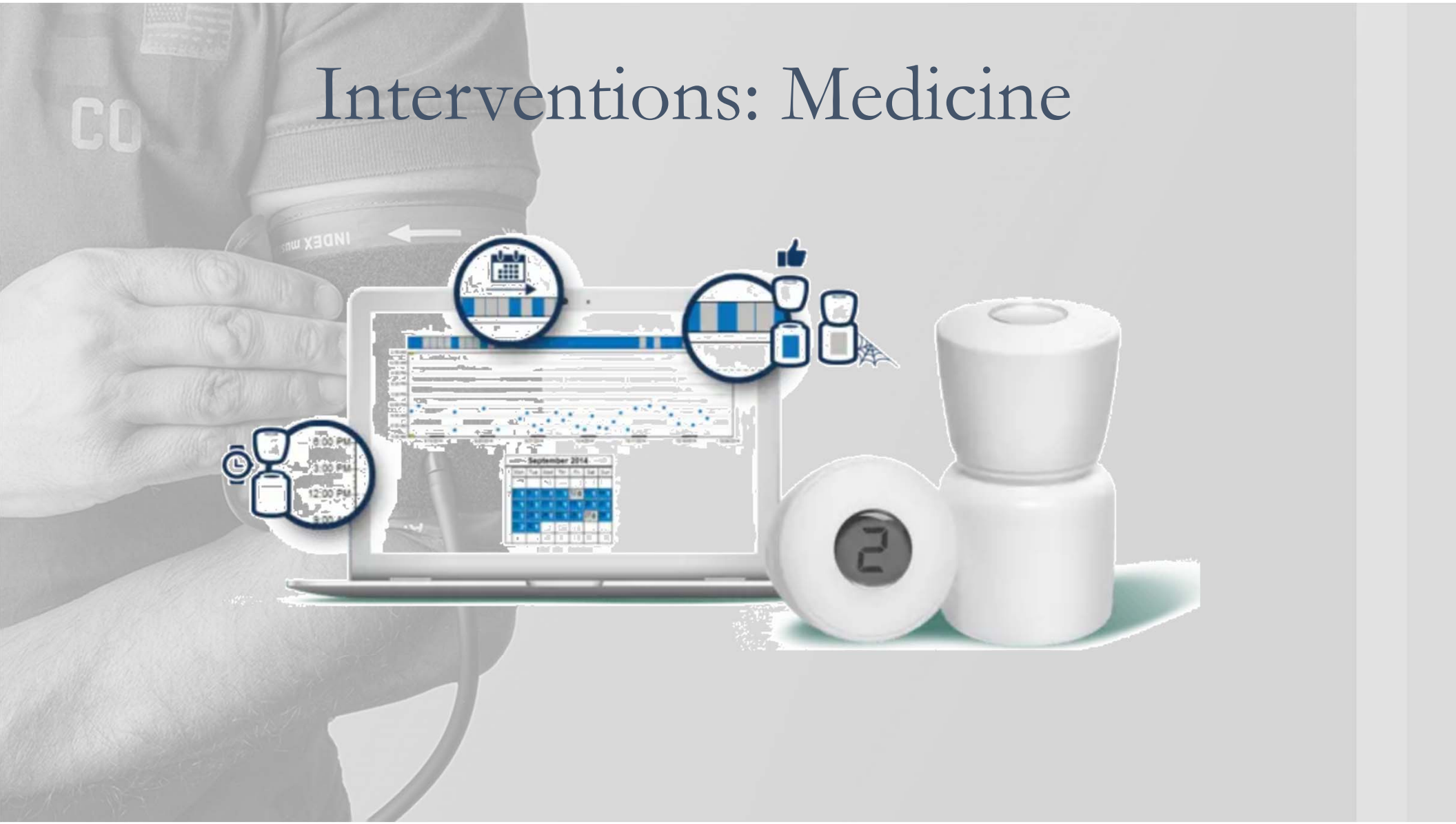
- Movement
- Location
- Physiological readings
- Device usage

- Exercise
- Activities
- Sleep
- Socialization
- Circadian rhythm

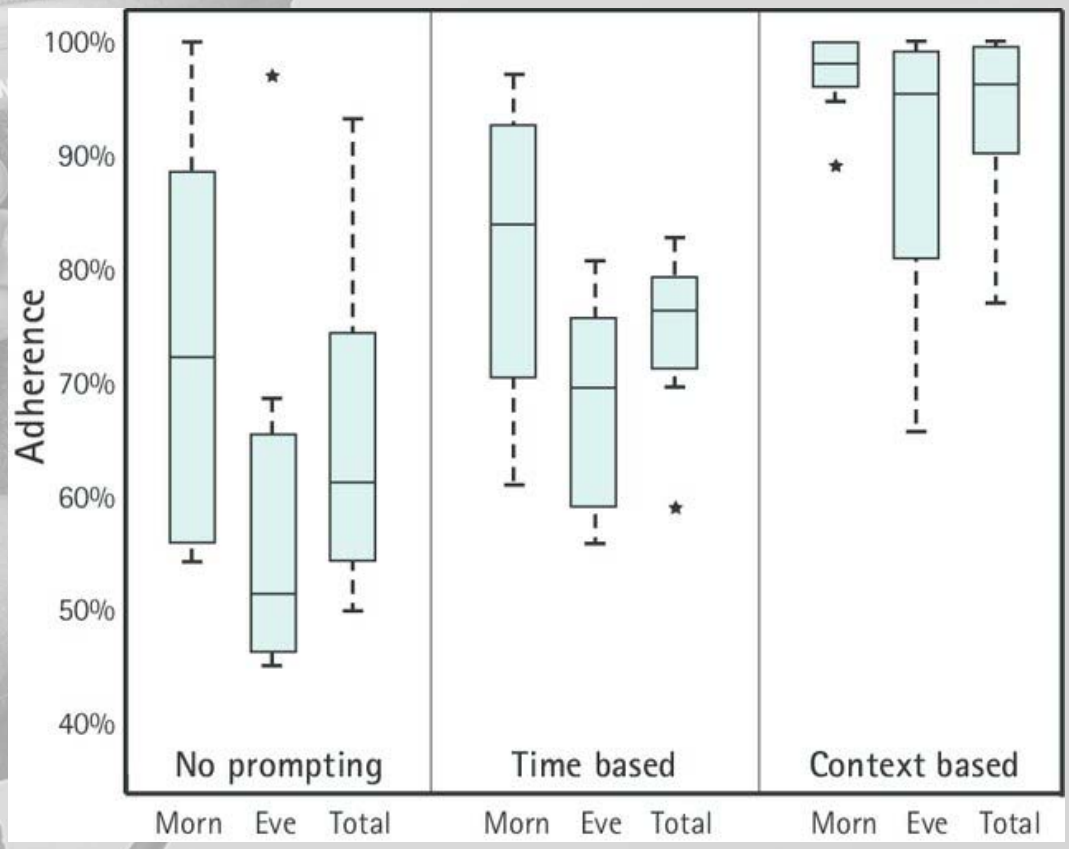
- Mobility
- Mood
- Cognition
- Function

Prevention and Intervention

Interventions: Medicine



Interventions: Medicine

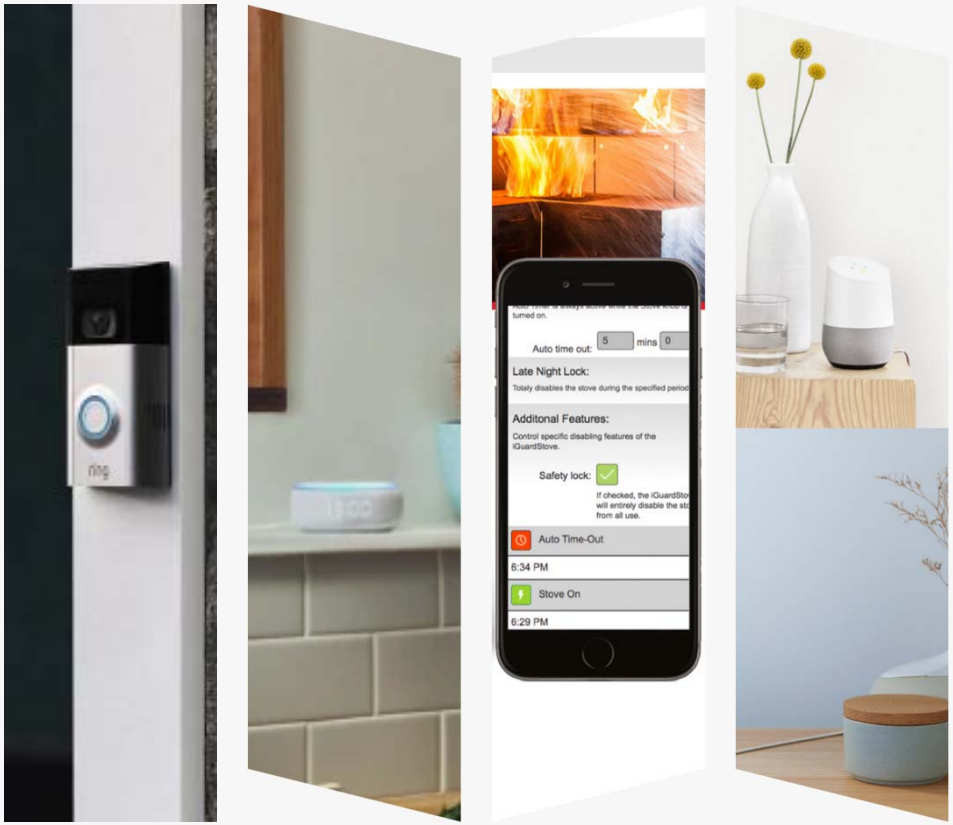


Interventions: Medicine

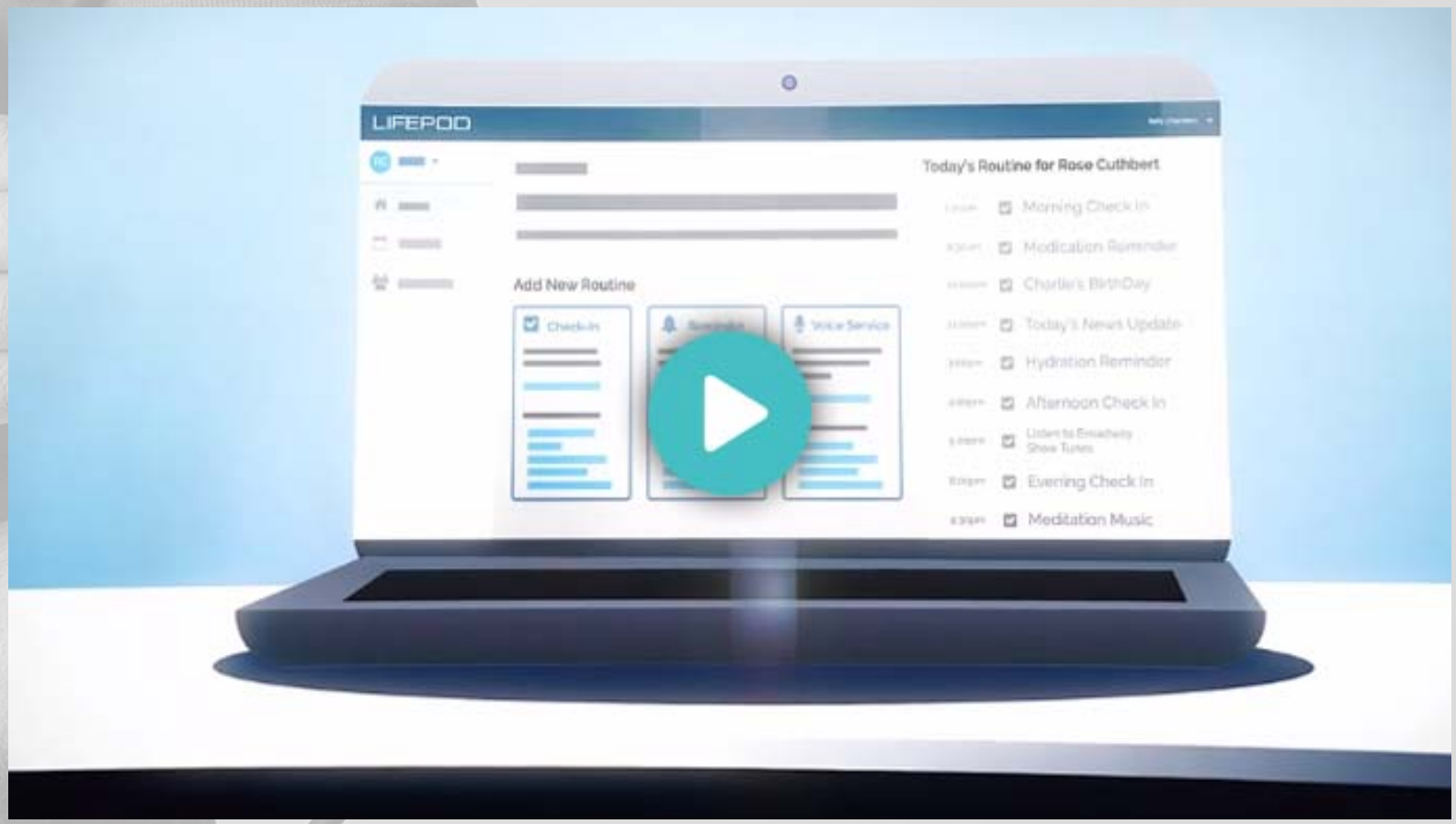
Median: 17

Interventions: Home Automation

Project	Automation
Adaptive Home	Lights, HVAC
MavHome	Lights, devices



HCI


LIFEPOD
Today's Routine for Rose Cuthbert
Add New Routine
Check-In
Voice Service
Morning Check In
Medication Reminder
Charlie's BirthDay
Today's News Update
Hydration Reminder
Afternoon Check In
Evening Check In
Meditation Music

The good…

- Movement
- Location
- Physiological readings
- Device usage

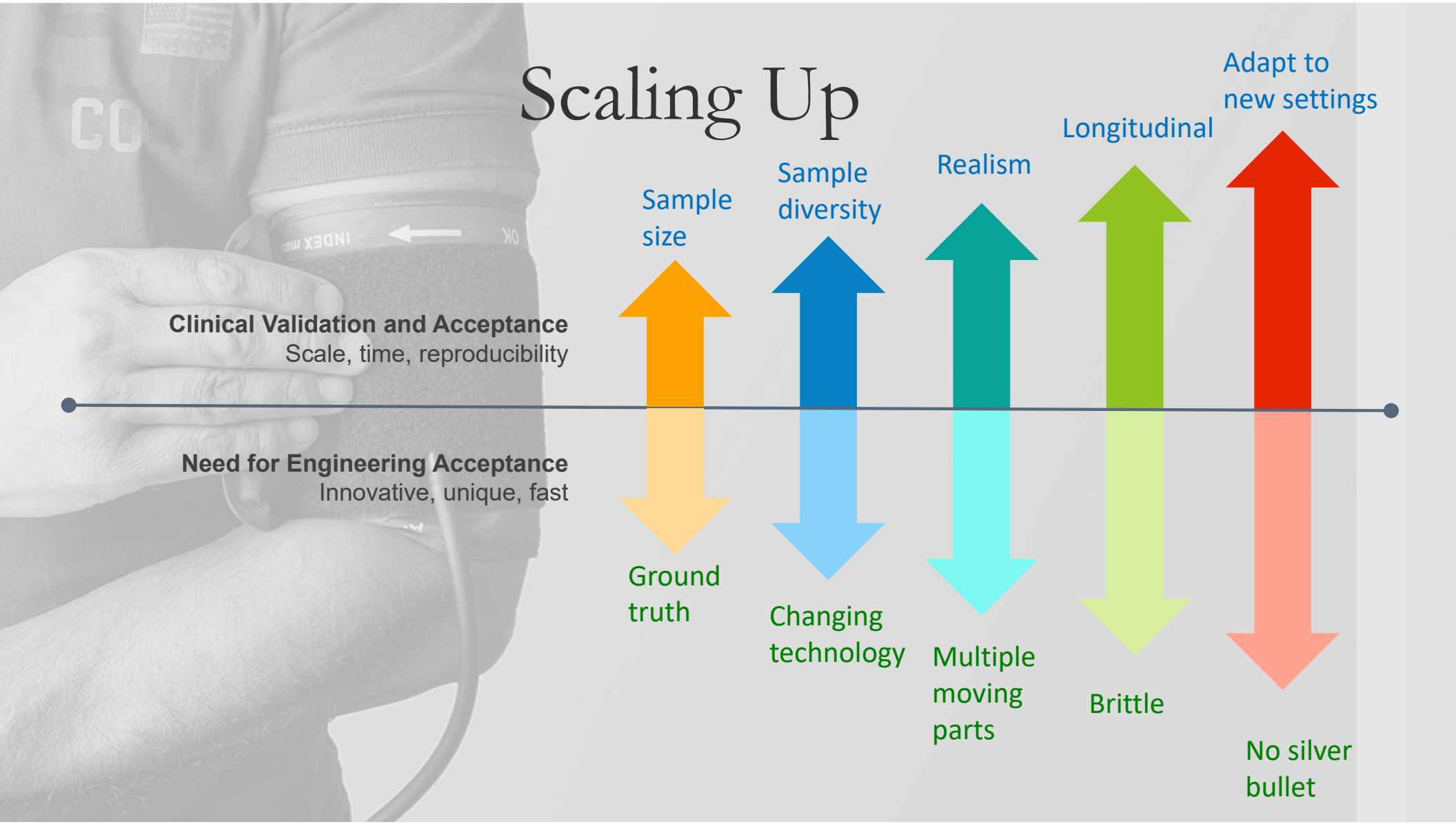
- Exercise
- Activities
- Sleep
- Socialization
- Circadian rhythm

- Mobility
- Mood
- Cognition
- Function

- Adherence
- Prompts
- Automation
- Anomaly detection

~~The bad~~

The opportunities


Scaling Up
Clinical Validation and Acceptance
Scale, time, reproducibility
Need for Engineering Acceptance
Innovative, unique, fast
Sample size
Sample diversity
Realism
Longitudinal
Adapt to new settings
Ground truth
Changing technology
Multiple moving parts
Brittle
No silver bullet

Bias and Fairness

Business

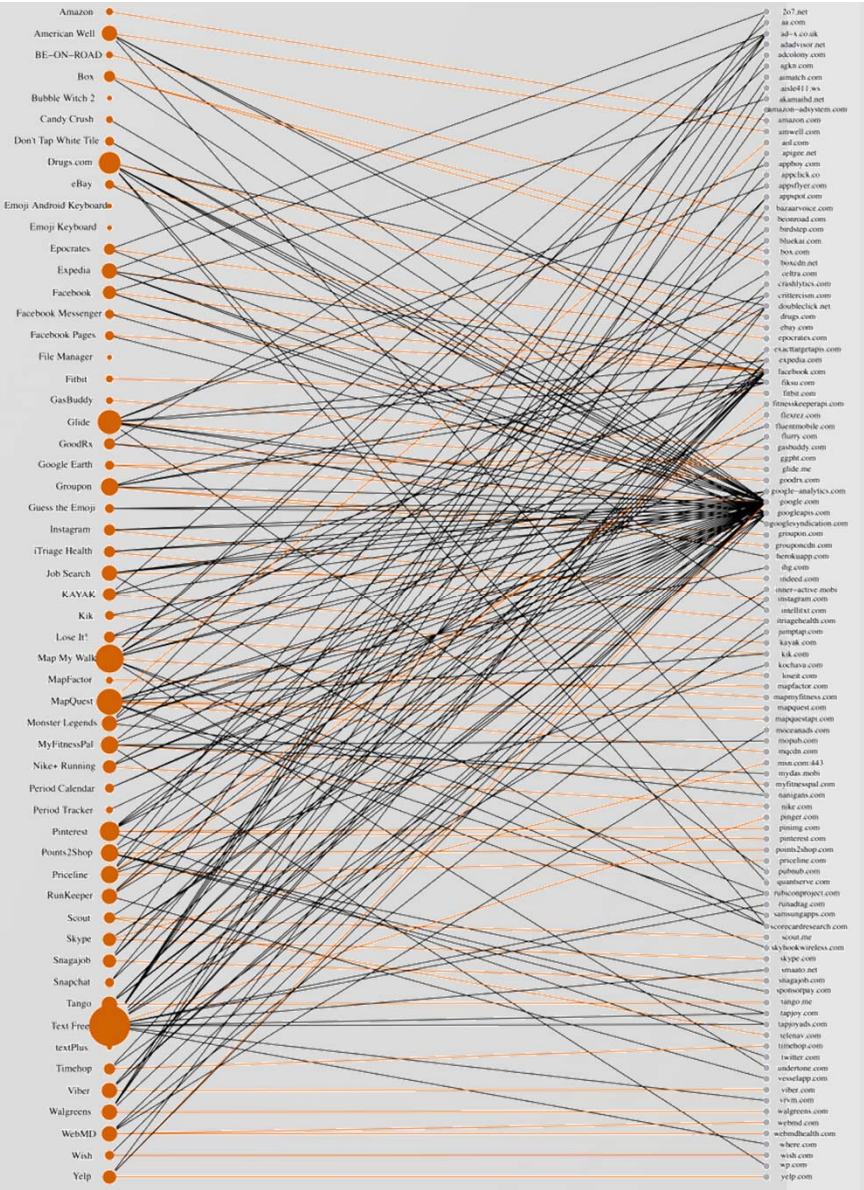
Apple Card algorithm sparks gender bias allegations against Goldman Sachs

COMPUTING

Racial Bias Found in a Major Health Care Risk Algorithm

When a Computer Program Keeps You in Jail

Privacy and Security



Technology Adoption

Conclusions