



**Harvard** John A. Paulson  
**School of Engineering**  
and Applied Sciences

WHERE  
SCIENCE  
AND  
ENGINEERING  
CONVERGE

# Optimizing and Continually Improving AI From One Deployment to the Next

Asim H. Gazi

June 25, 2025

# We are Developing an Intelligent Mobile Health Intervention for Upper Limb Rehab. Post-Stroke



Bioengineers



Software Developers



Computer Scientists /  
Statisticians



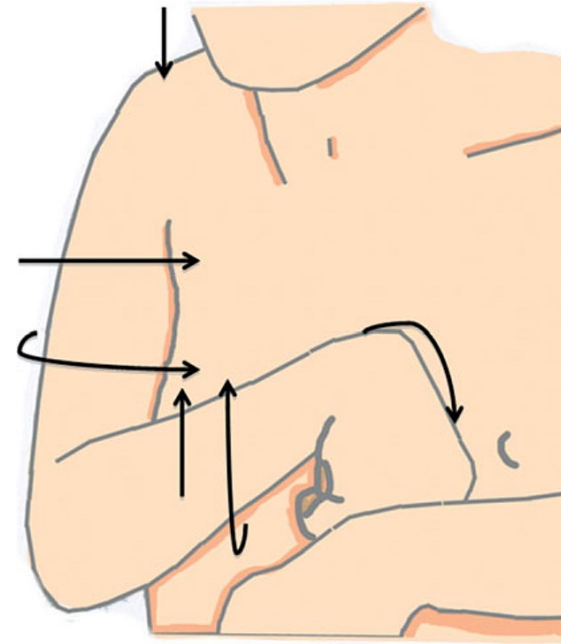
“Friends of  
the Lab”  
Stroke  
Survivors  
(Not Shown)



Occupational  
Therapist



Neurologist

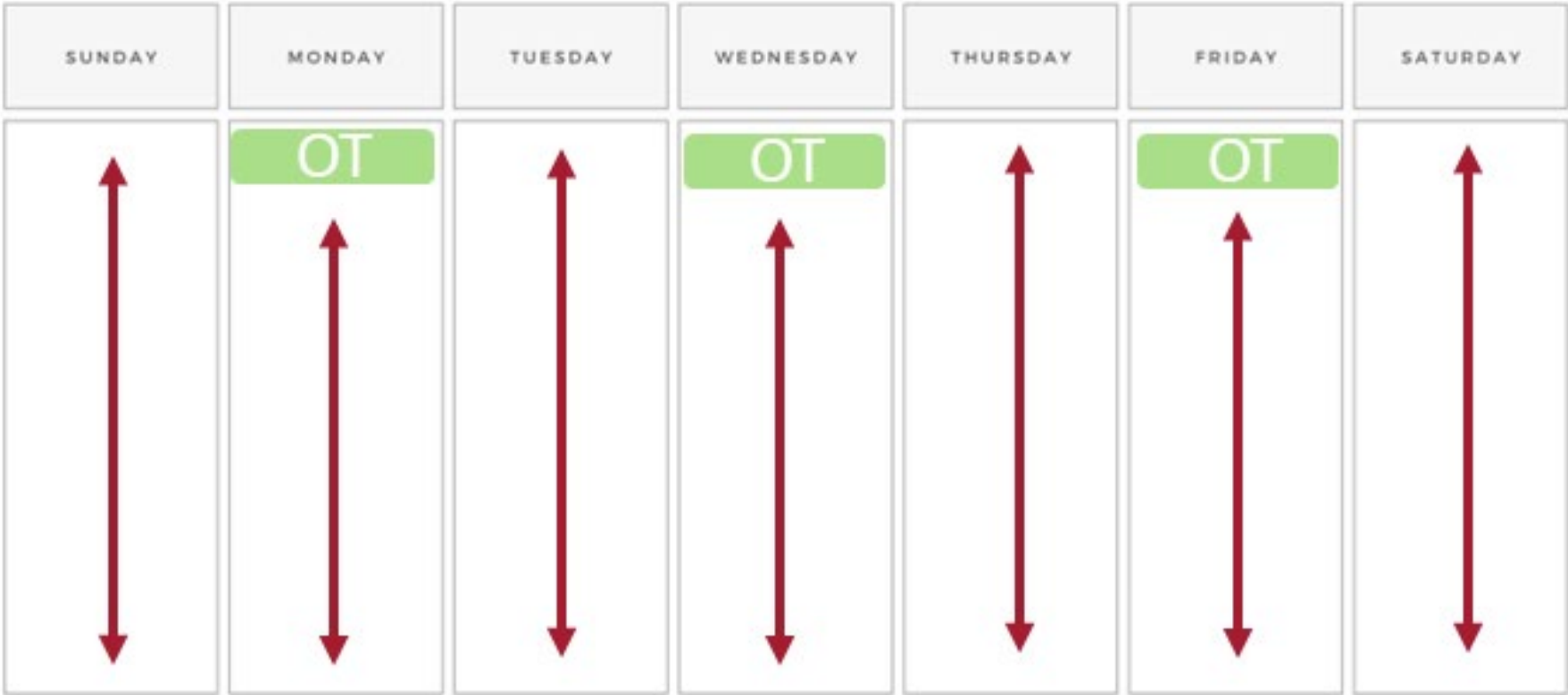


“**Aging** is the most robust non-modifiable **risk factor for incident stroke**, which doubles every 10 years after age 55 years.”

# Our Goal is to Fill Some of the Gap in Support for the 99% of a Survivor's Life Spent on Their Own



## Weekly CALENDAR



During the chronic phase, most of a stroke survivor's time is spent without synchronous support

OT: Occupational Therapist

B. M. Young, et al., *Stroke*, 2023  
M. Ghahramanlou-Holloway, *Psychiatry*, 2022

# Our Goal is to Fill Some of the Gap in Support for the 99% of a Survivor's Life Spent on Their Own



## Implementation Intentions

### Weekly CALENDAR



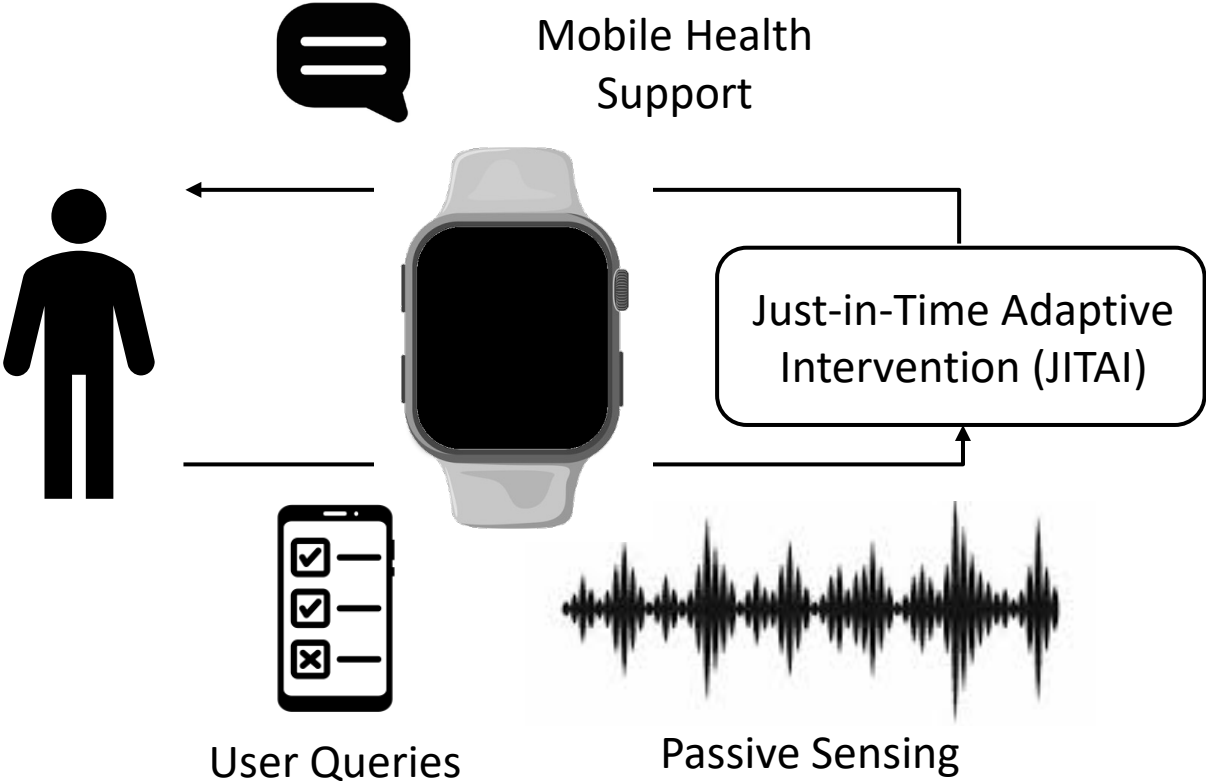
OT: Occupational Therapist

Encouragement



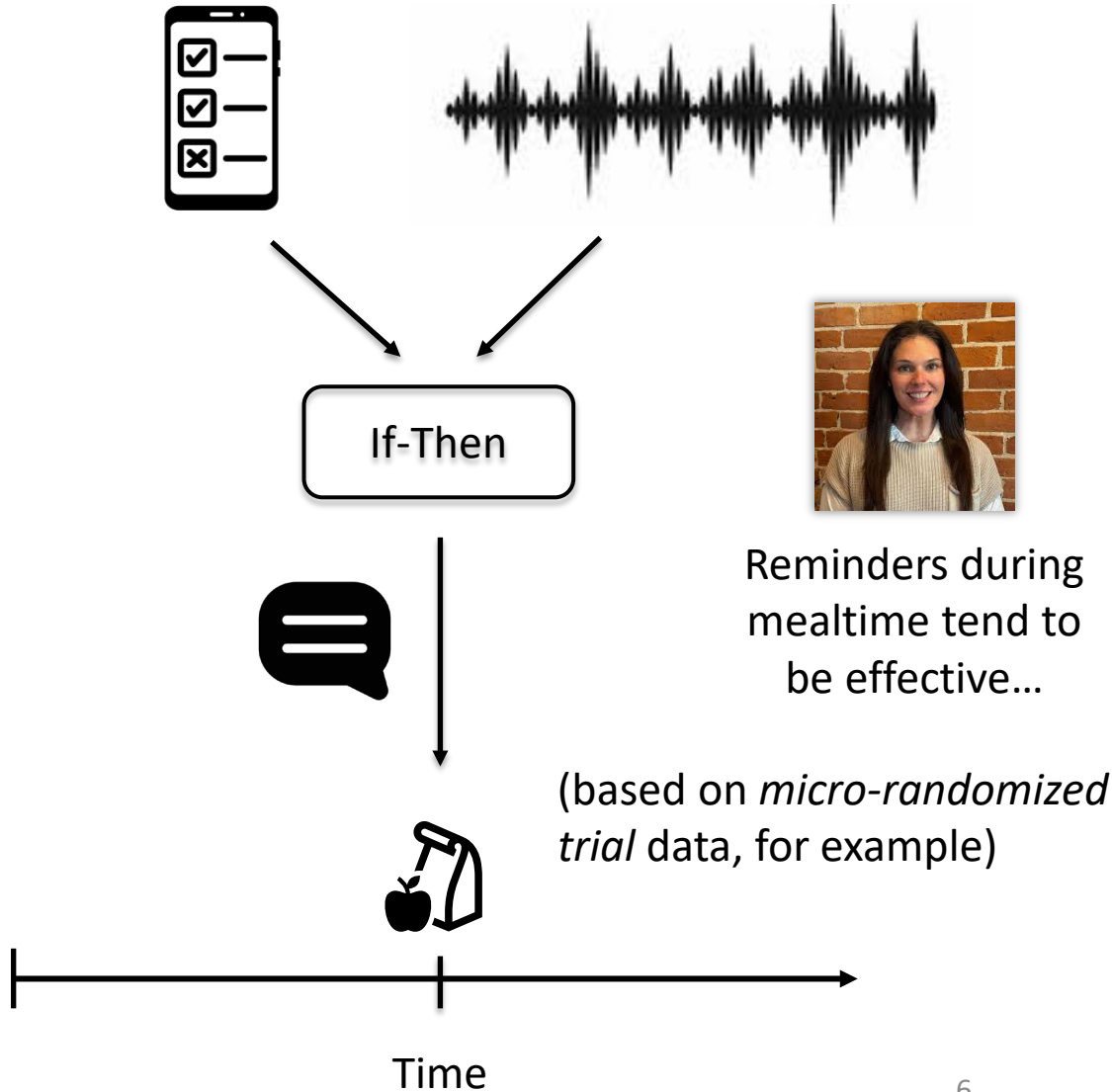
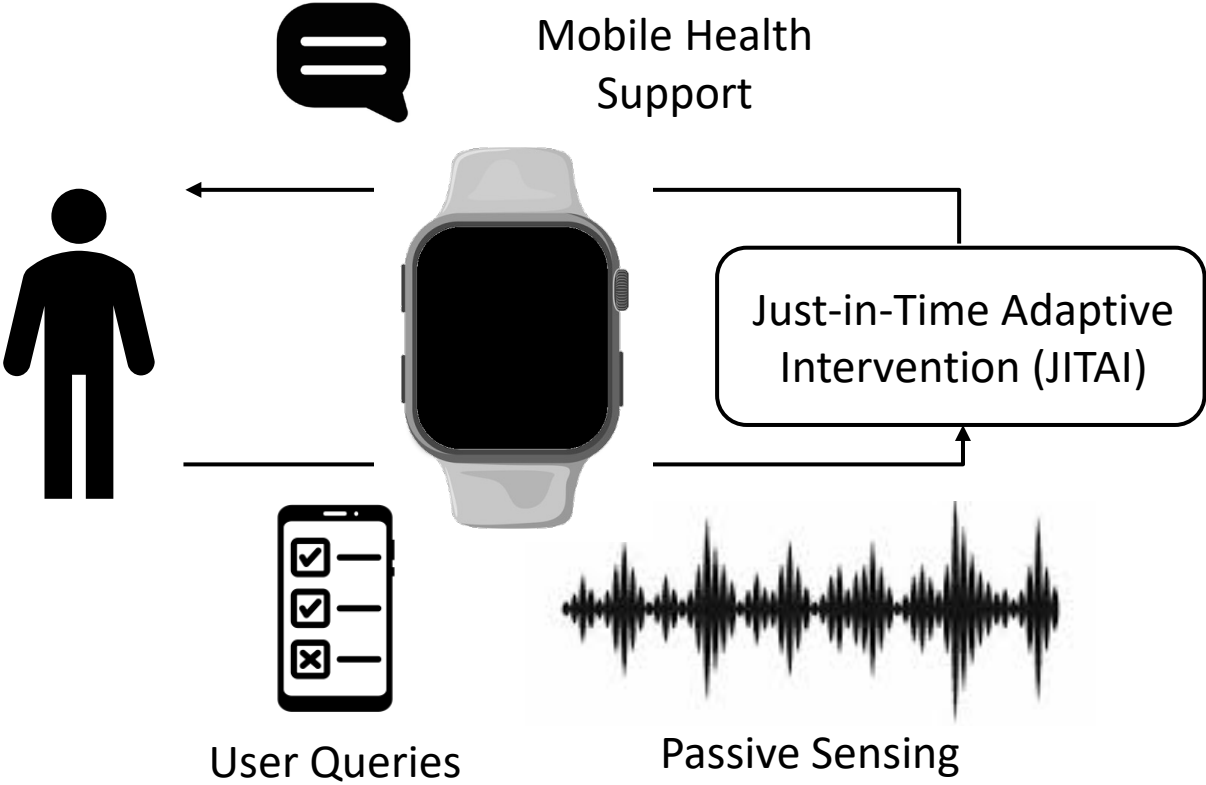
B. M. Young, et al., *Stroke*, 2023  
M. Ghahramanlou-Holloway, *Psychiatry*, 2022

# A Just-in-Time Adaptive Intervention Delivers Support That Adapts to Biobehavioral Context



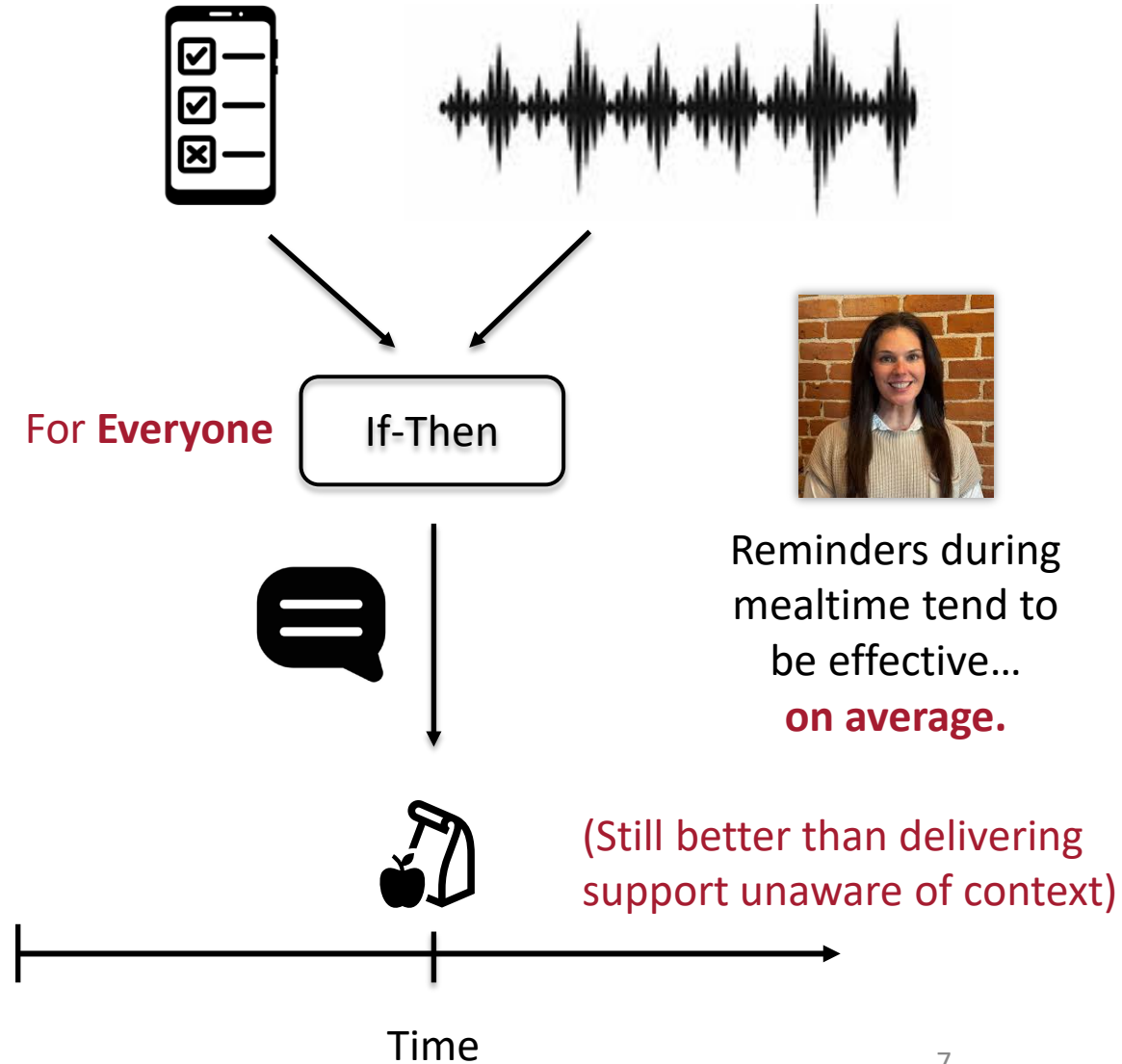
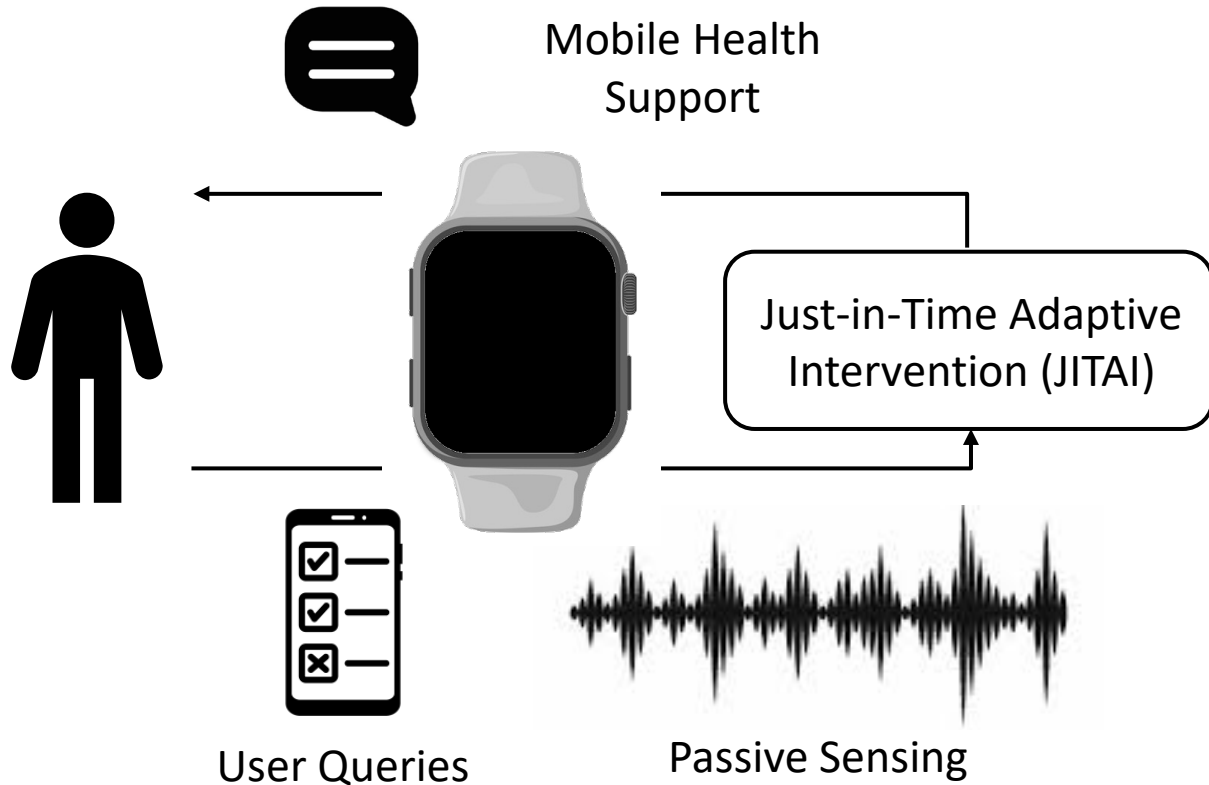
P. Klasnja et al., *Health Psychol*, 2015  
I. Nahum-Shani et al., *Ann Behav Med*, 2017

# A Just-in-Time Adaptive Intervention Delivers Support That Adapts to Biobehavioral Context

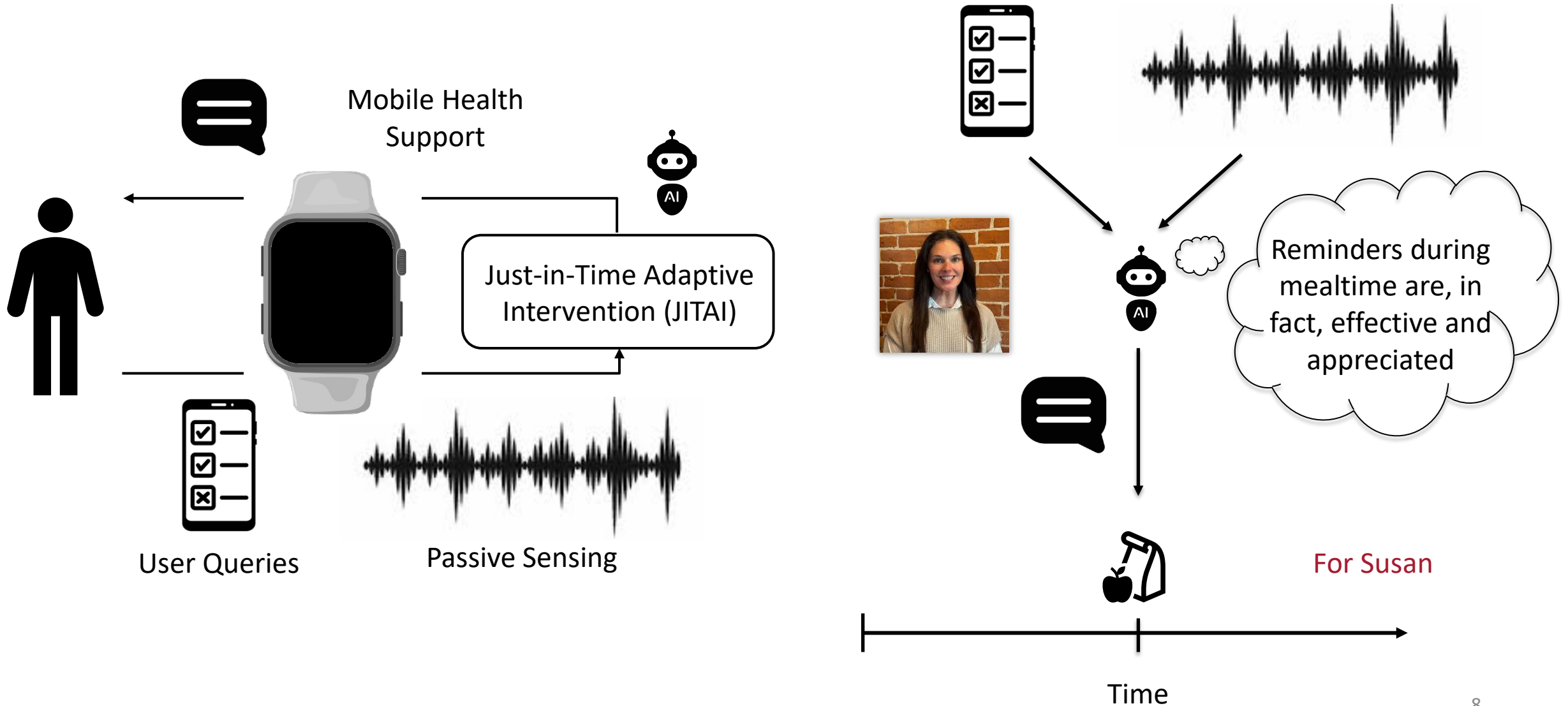


P. Klasnja et al., *Health Psychol*, 2015  
 I. Nahum-Shani et al., *Ann Behav Med*, 2017

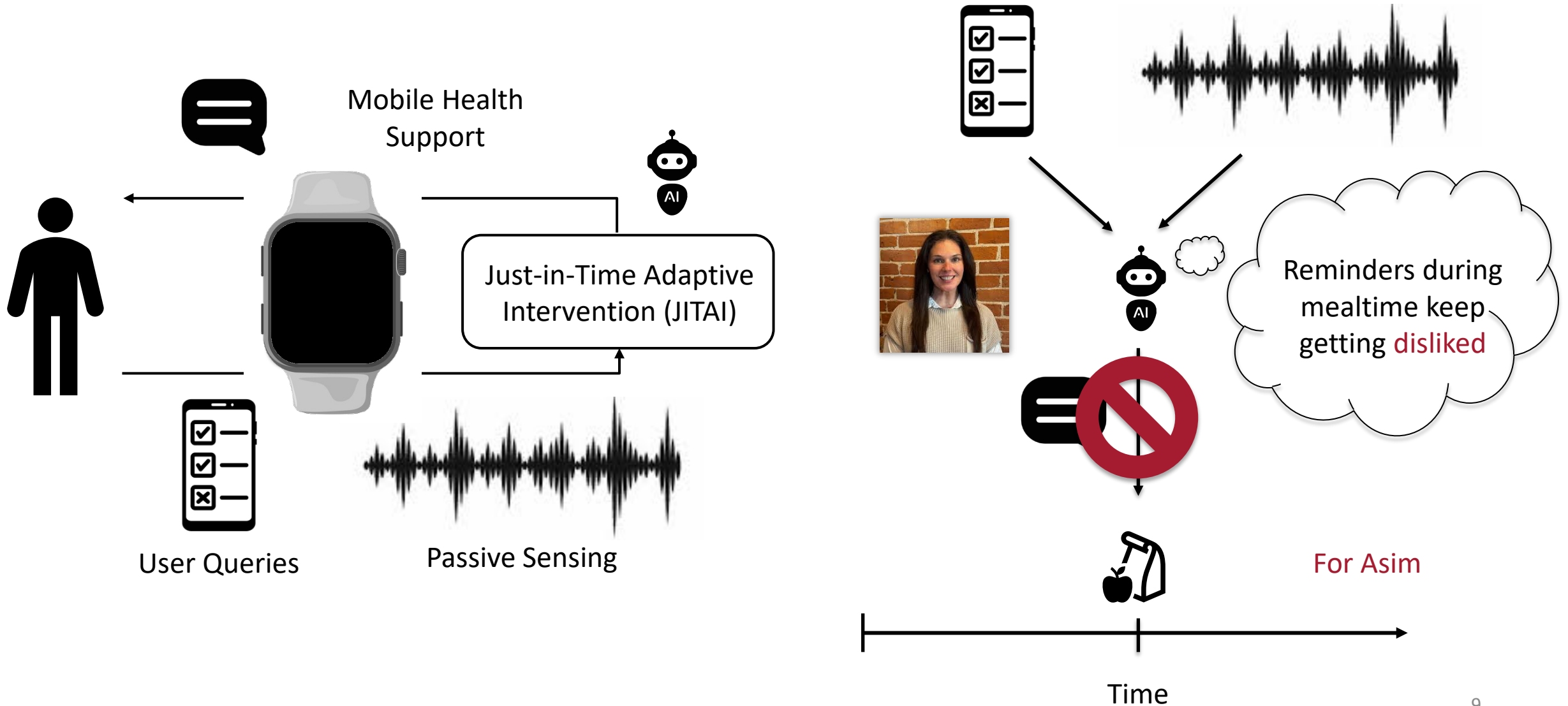
# A Just-in-Time Adaptive Intervention Delivers Support That Adapts to Biobehavioral Context



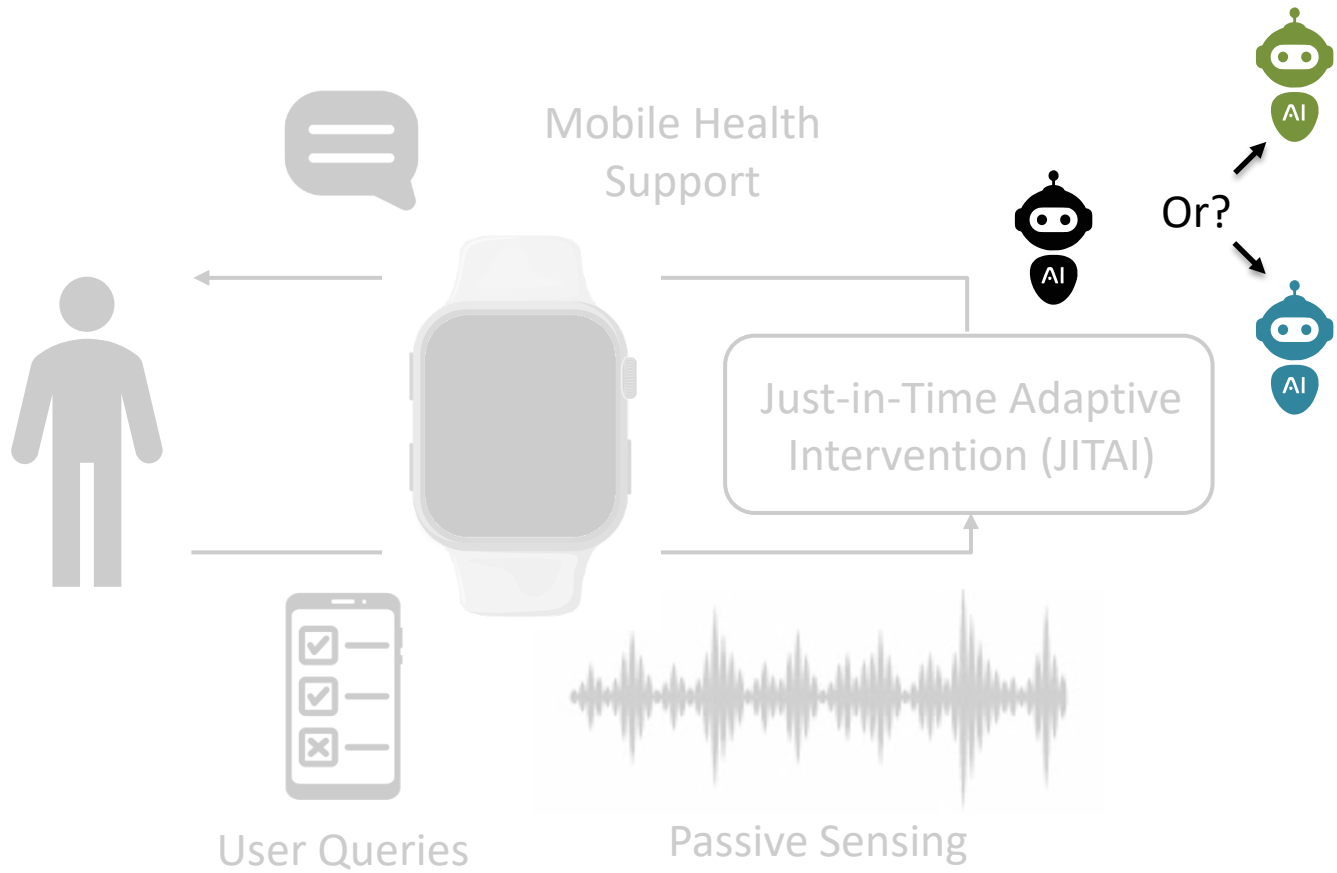
# With AI, We Aim to Personalize the JITAI's Decision Rules to Each Stroke Survivor



# With AI, We Aim to Personalize the JITAI's Decision Rules to Each Stroke Survivor



# AI is Exciting but Adds a New Layer of Complexity to the JITAI Design Process

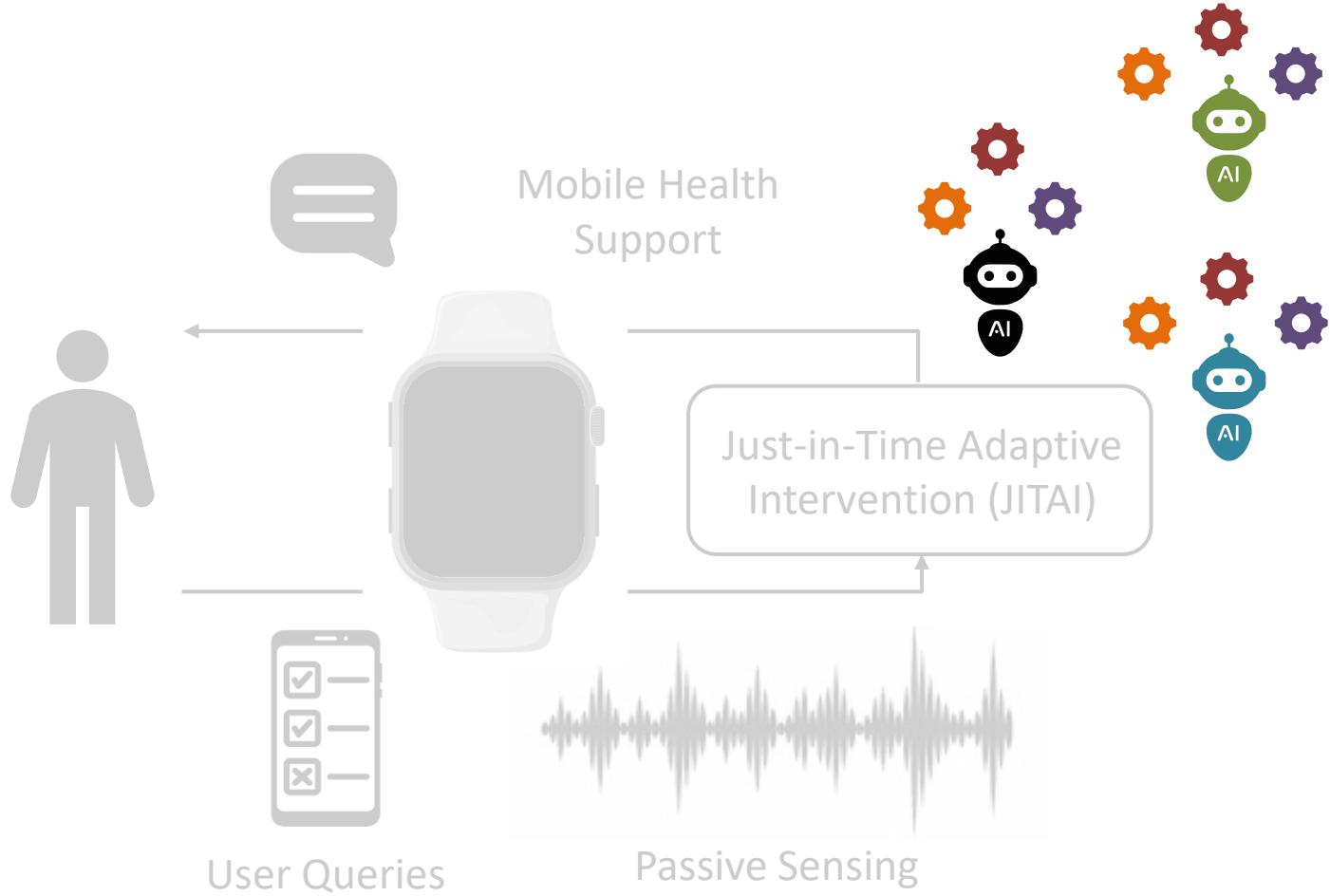


Which AI algorithm to choose?



© marketoonist.com

# AI is Exciting but Adds a New Layer of Complexity to the JITAI Design Process

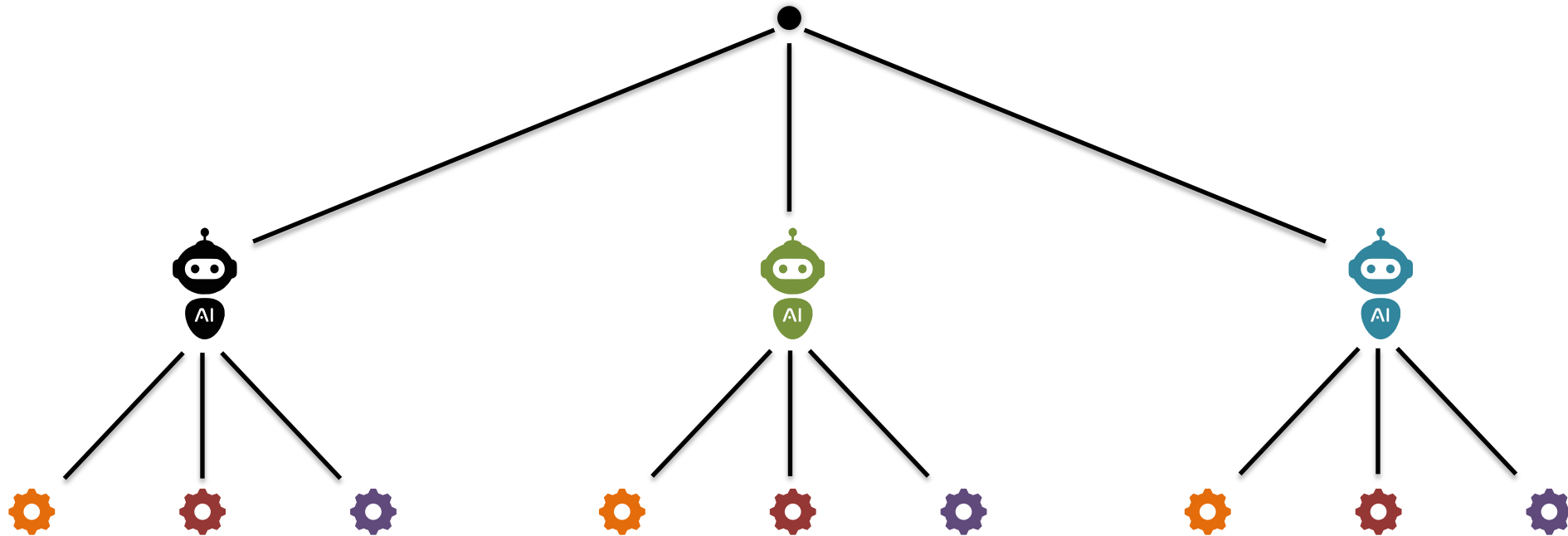


Which AI algorithm to choose?  
What hyperparameters do we use?



© marketoonist.com

# A/B Testing With Real Users is Often Infeasible Due to Resource Constraints or Risks



Even in this simple, illustrative case, we have a 9-arm RCT on our hands...

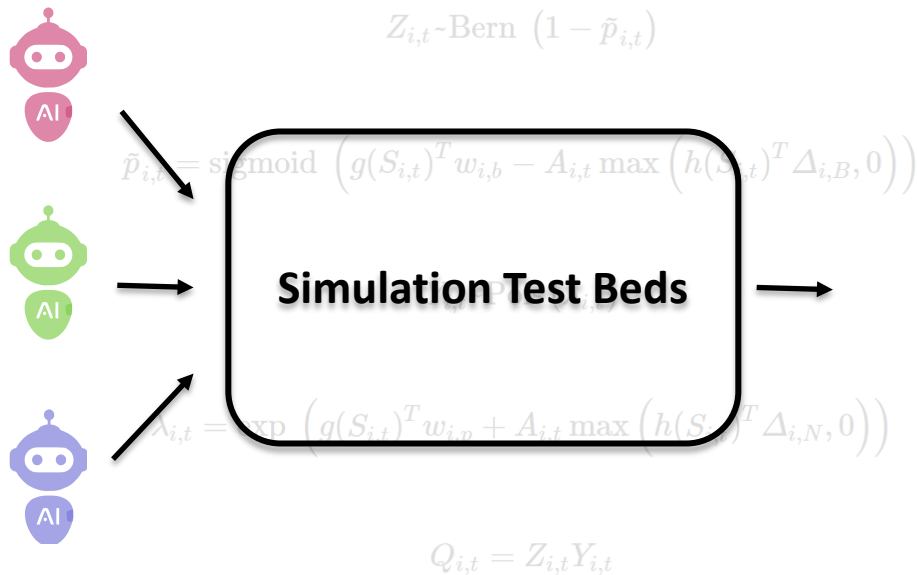


# We Have Used Prior Deployment Data to Build High-Fidelity (As Possible) Simulation Testbeds

$$C_{i,t} := \begin{cases} \xi_1 \mathbb{I} [\bar{B}_{i,t} > b] \mathbb{I} [\bar{A}_{i,t} > a_1] + \xi_2 \mathbb{I} [\bar{A}_{i,t} > a_2] & \text{if } A_{i,t} = 1 \\ 0 & \text{if } A_{i,t} = 0 \end{cases} \quad (3)$$

Hyperparameters

What values to choose and **stick with** for the entire next deployment?



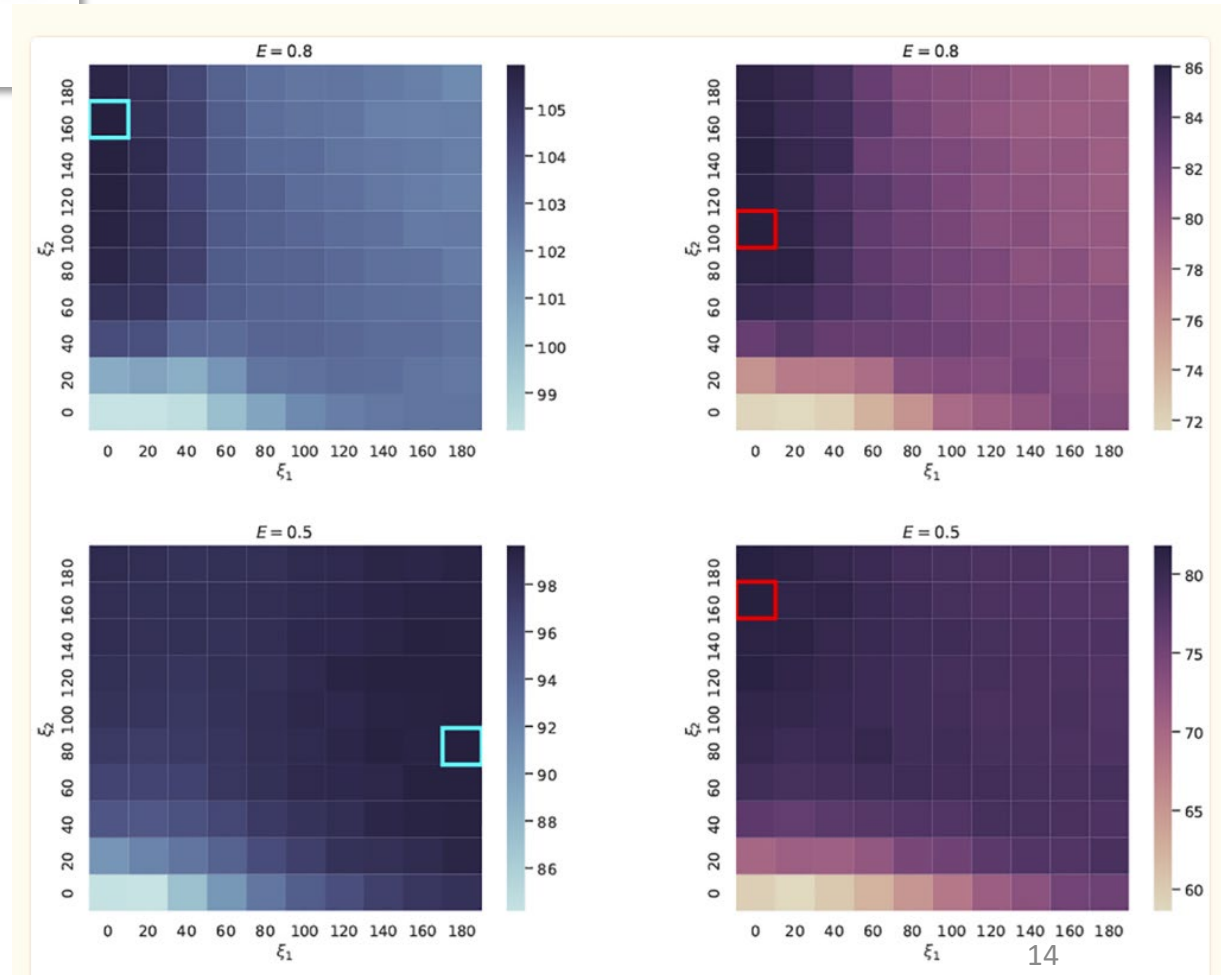
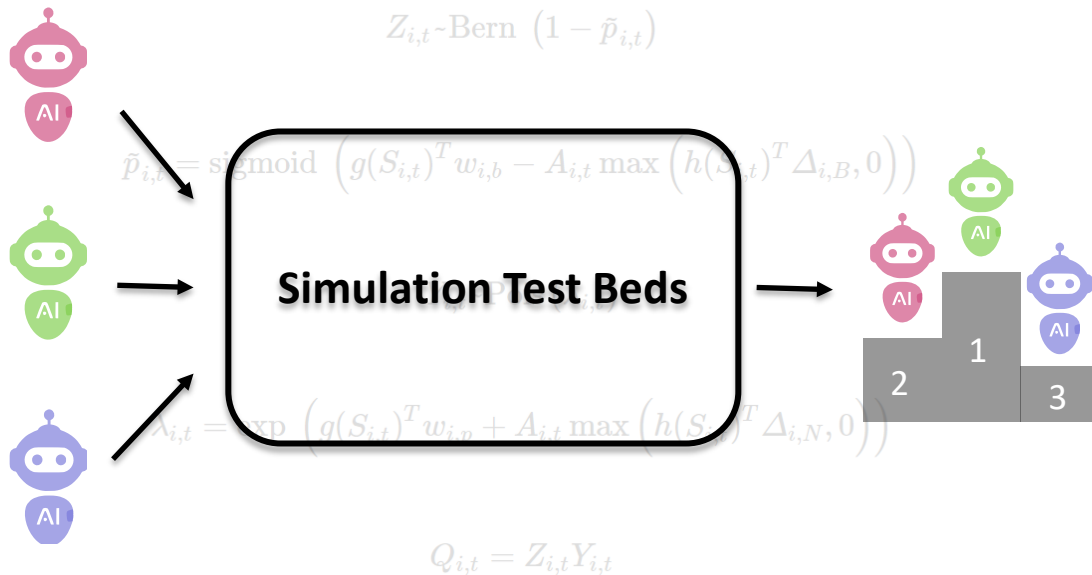


# We Have Used Prior Deployment Data to Build High-Fidelity (As Possible) Simulation Testbeds

$$C_{i,t} := \begin{cases} \xi_1 \mathbb{I} [\bar{B}_{i,t} > b] \mathbb{I} [\bar{A}_{i,t} > a_1] + \xi_2 \mathbb{I} [\bar{A}_{i,t} > a_2] & \text{if } A_{i,t} = 1 \\ 0 & \text{if } A_{i,t} = 0 \end{cases} \quad (3)$$

Hyperparameters

What values to choose and **stick with** for the entire next deployment?



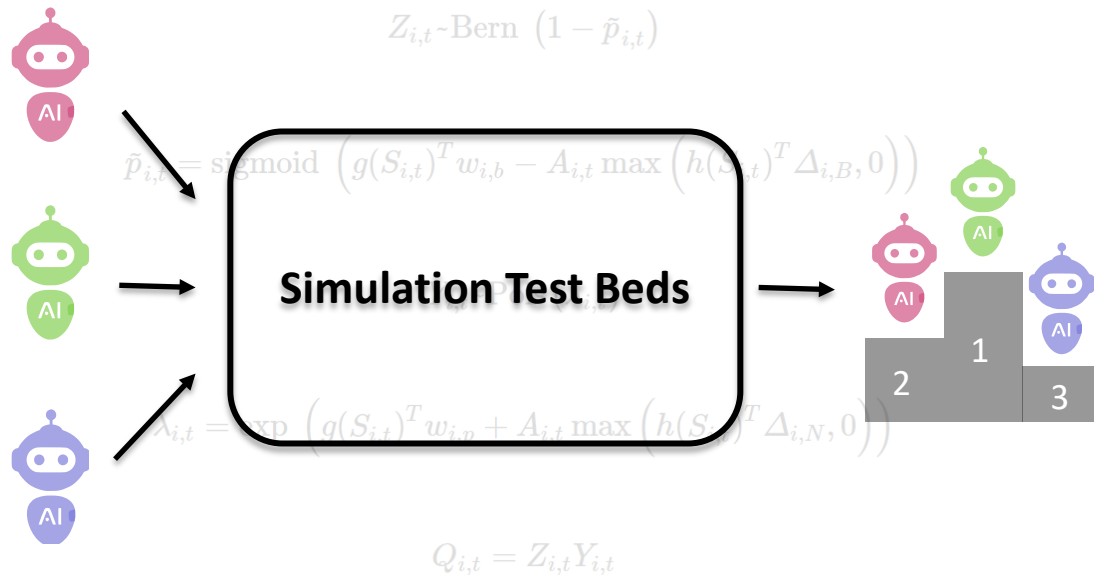


# We Have Used Prior Deployment Data to Build High-Fidelity (As Possible) Simulation Testbeds

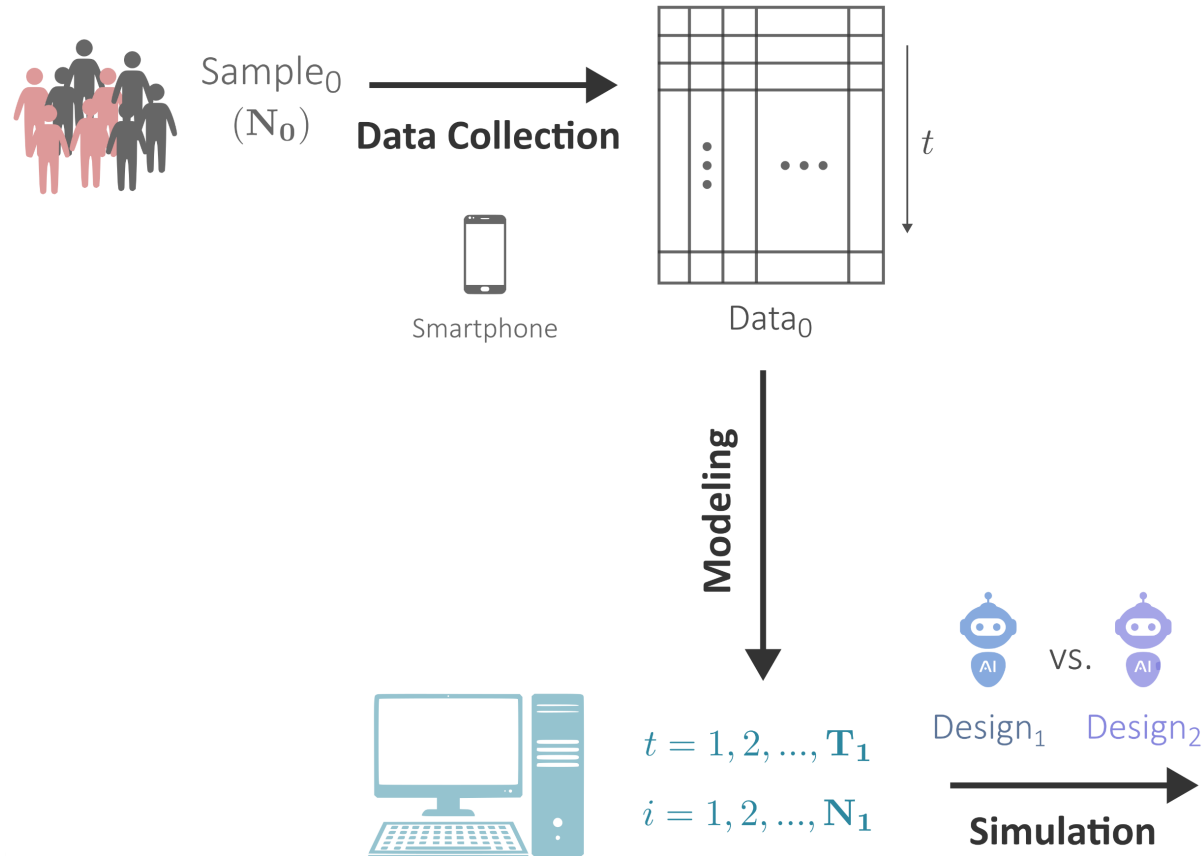
$$C_{i,t} := \begin{cases} \xi_1 \mathbb{I} [\bar{B}_{i,t} > b] \mathbb{I} [\bar{A}_{i,t} > a_1] + \xi_2 \mathbb{I} [\bar{A}_{i,t} > a_2] & \text{if } A_{i,t} = 1 \\ 0 & \text{if } A_{i,t} = 0 \end{cases} \quad (3)$$

Hyperparameters

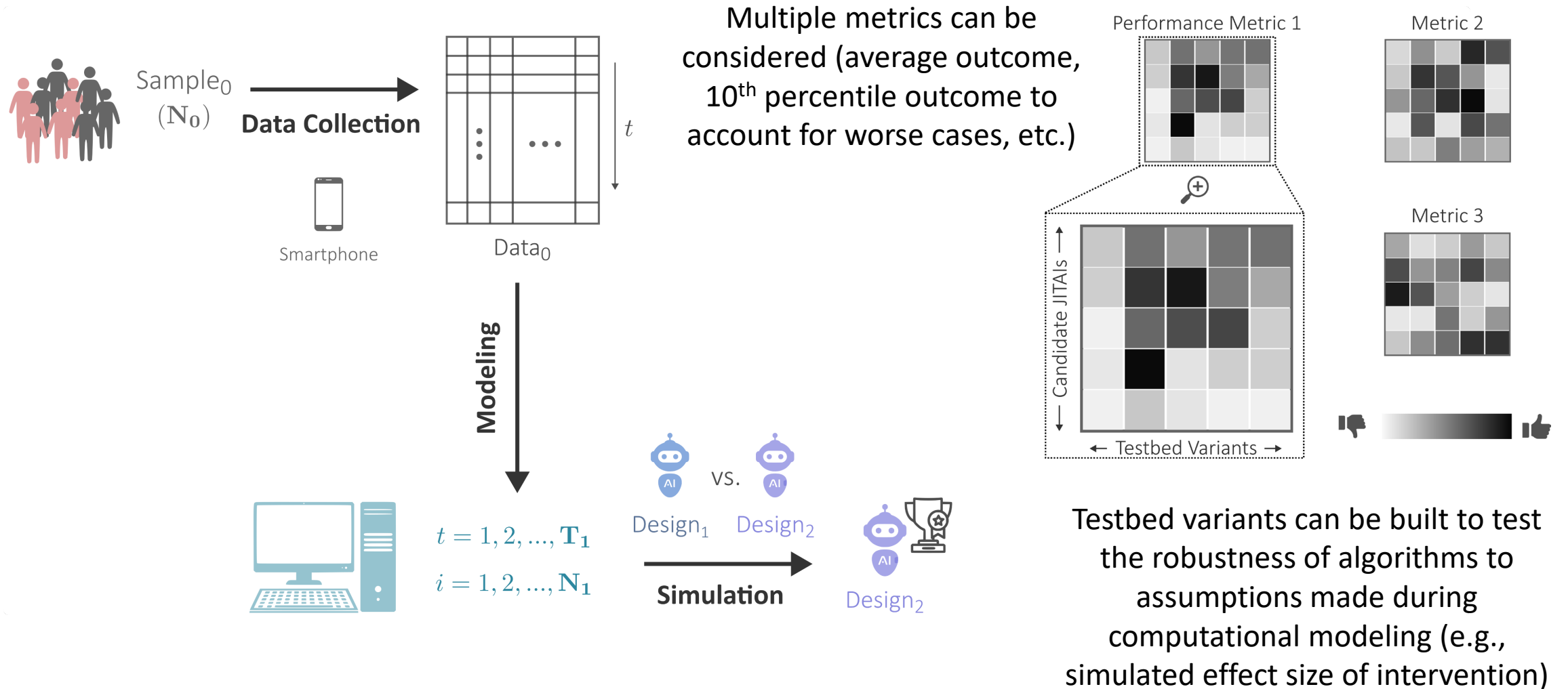
What values to choose and **stick with** for the entire next deployment?



# Simulation-Informed Decision Making is Key to Making Thoughtful Design Decisions for JITAIs

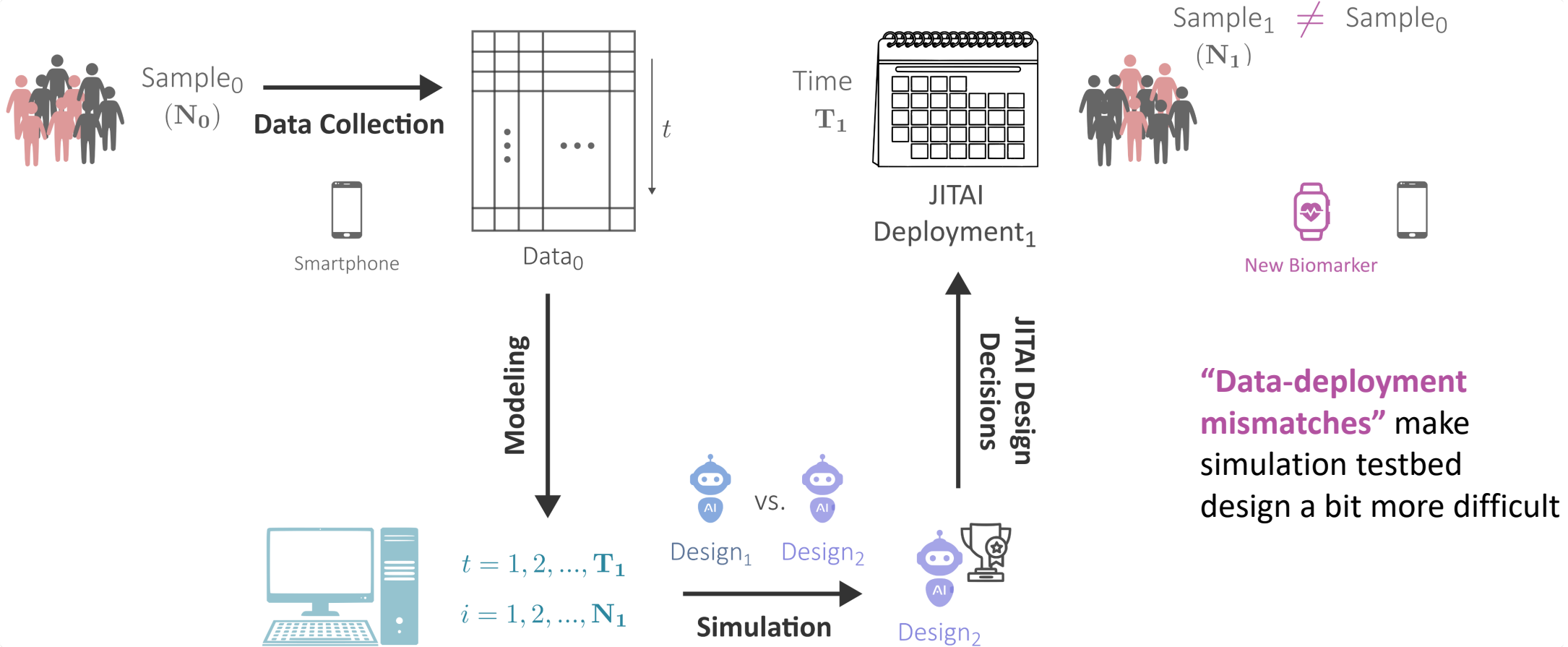


# Simulation-Informed Decision Making is Key to Making Thoughtful Design Decisions for JITAIs



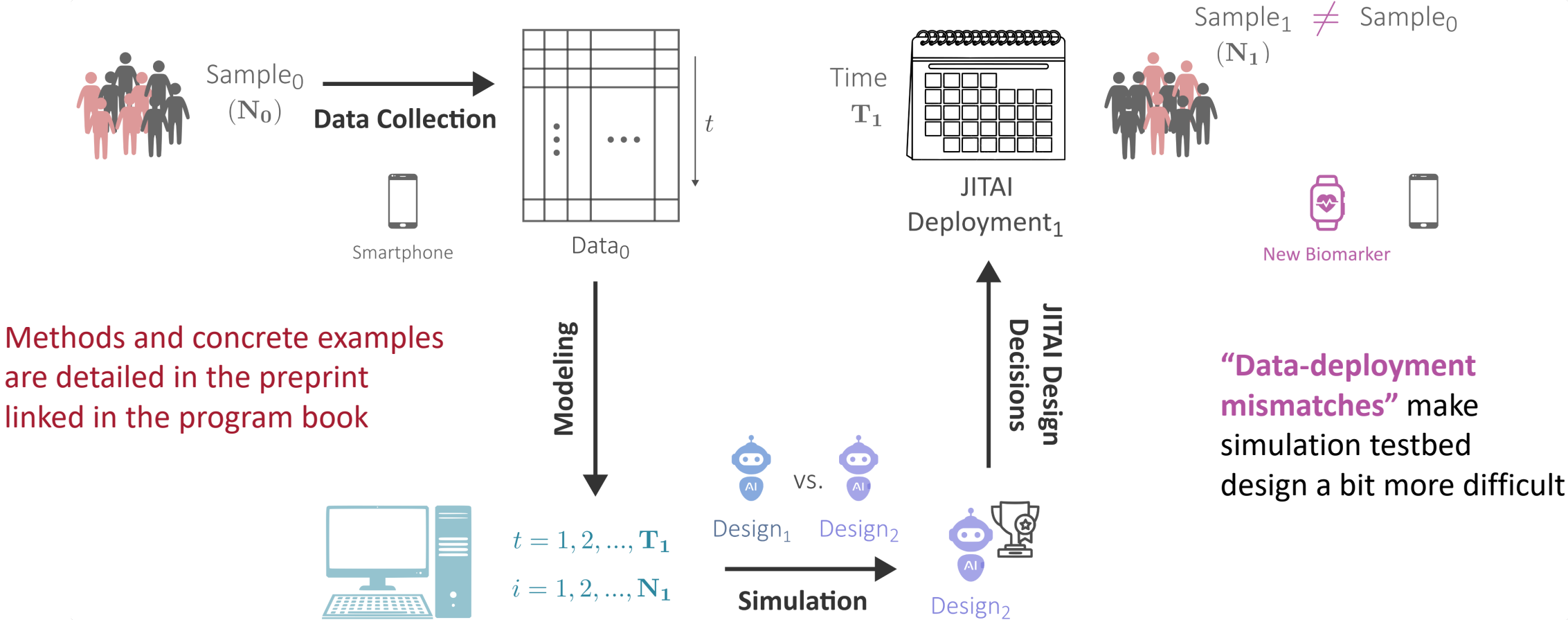


# Data-Deployment Mismatches Make Simulation Testbed Design a Bit More Difficult

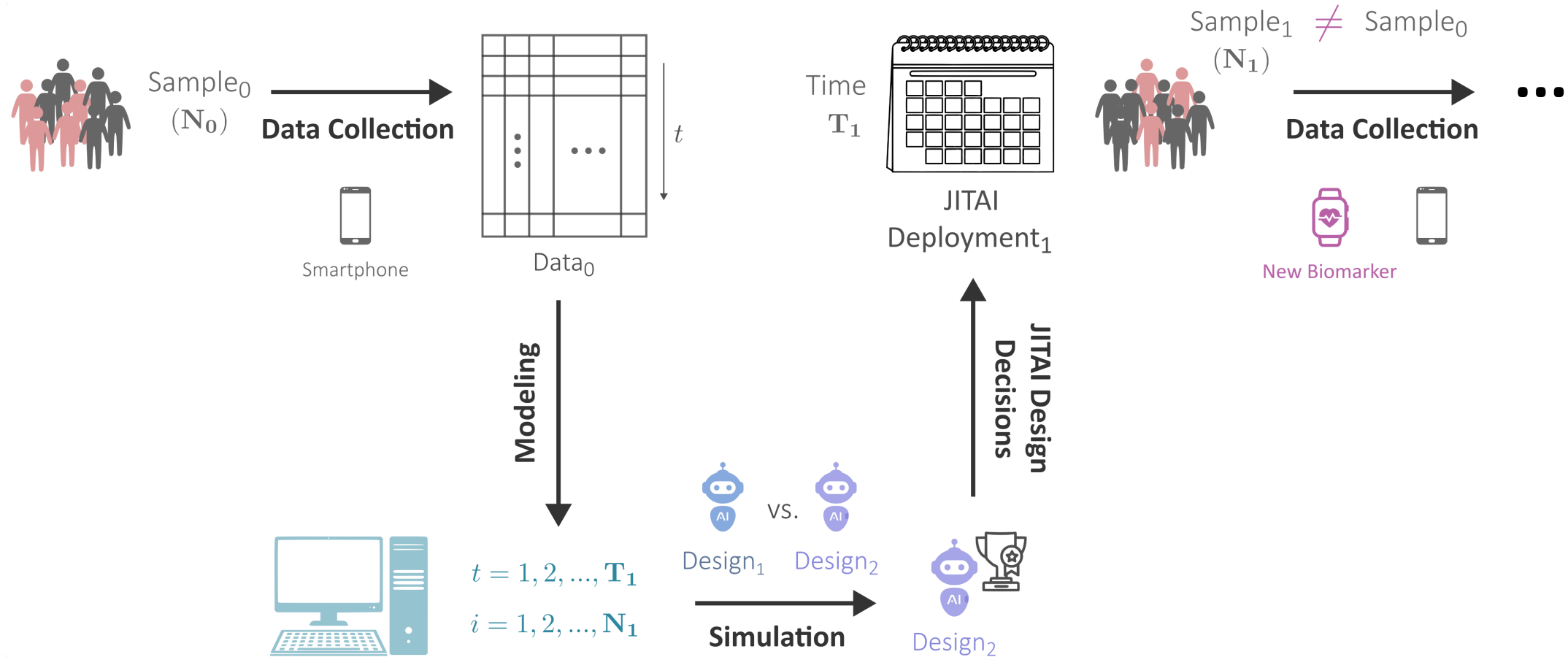




# Data-Deployment Mismatches Make Simulation Testbed Design a Bit More Difficult



# But AI Optimization and JITAI Design Does Not Stop There – **the Cycle Continues**



# The HeartSteps JITA! is a Great Example of the Need for Continual Improvement



► [Ann Behav Med.](#) 2018 Sep 5;53(6):573–582. doi: [10.1093/abm/kay067](#)

► [Proc ACM Interact Mob Wearable Ubiquitous Technol.](#) Author manuscript; available in PMC: 2021 Sep 14.

*Published in final edited form as:* [Proc ACM Interact Mob Wearable Ubiquitous Technol.](#) 2020 Mar;4(1):18. doi: [10.1145/3381007](#)

## Efficacy of Contextually Tailored Suggestions for Physical Activity: A Micro-randomized Optimization Trial of HeartSteps

[Predrag Klasnja](#)<sup>1,1,2,✉</sup>, [Shawna Smith](#)<sup>3,4</sup>, [Nicholas J Seewald](#)<sup>5</sup>, [Andy Lee](#)<sup>2</sup>, [Kelly Hall](#)<sup>5</sup>, [Brook Luers](#)<sup>5</sup>, [Eric B Hekler](#)<sup>6</sup>, [Susan A Murphy](#)<sup>7</sup>

V1

## Personalized HeartSteps: A Reinforcement Learning Algorithm for Optimizing Physical Activity

[PENG LIAO](#)<sup>1</sup>, [KRISTJAN GREENEWALD](#)<sup>2</sup>, [PREDRAG KLASNJA](#)<sup>3</sup>, [SUSAN MURPHY](#)<sup>4</sup>

V2

arXiv > cs > arXiv:2410.14659

Search... Help | Adv

Computer Science > Machine Learning

[Submitted on 18 Oct 2024 (v1), last revised 6 May 2025 (this version, v3)]

## Harnessing Causality in Reinforcement Learning With Bagged Decision Times

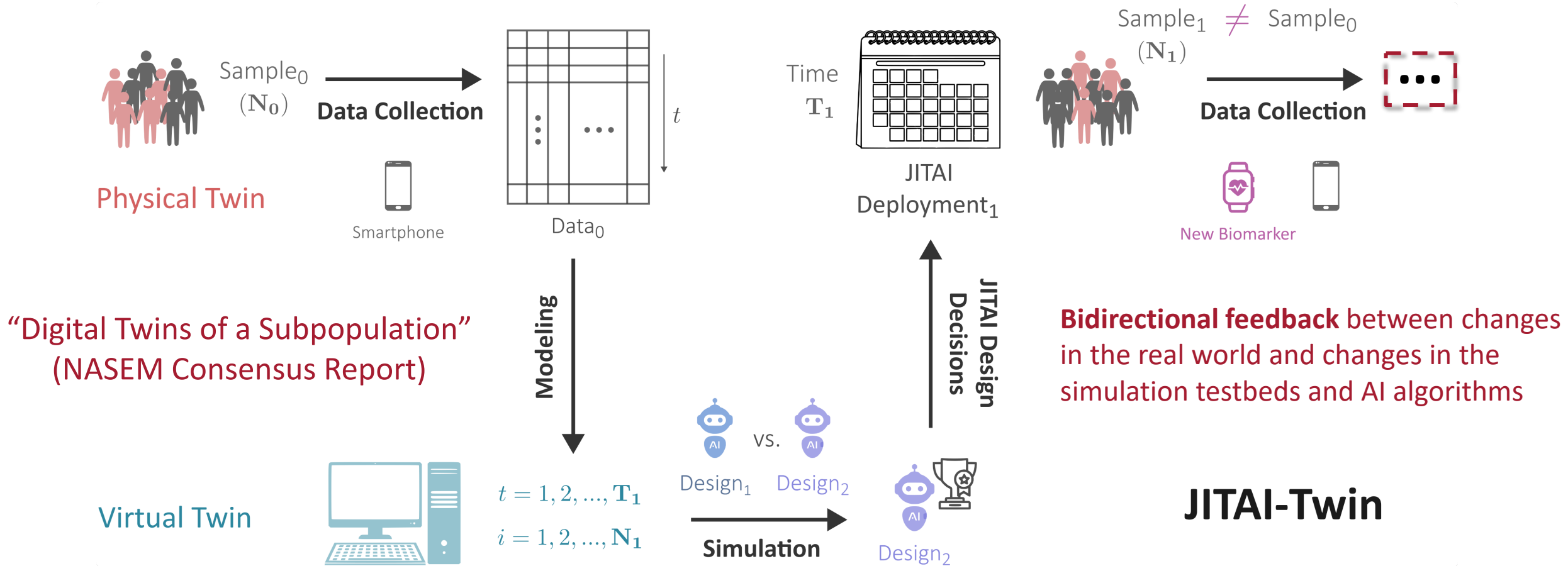
[Daiqi Gao](#), [Hsin-Yu Lai](#), [Predrag Klasnja](#), [Susan A. Murphy](#)

V3

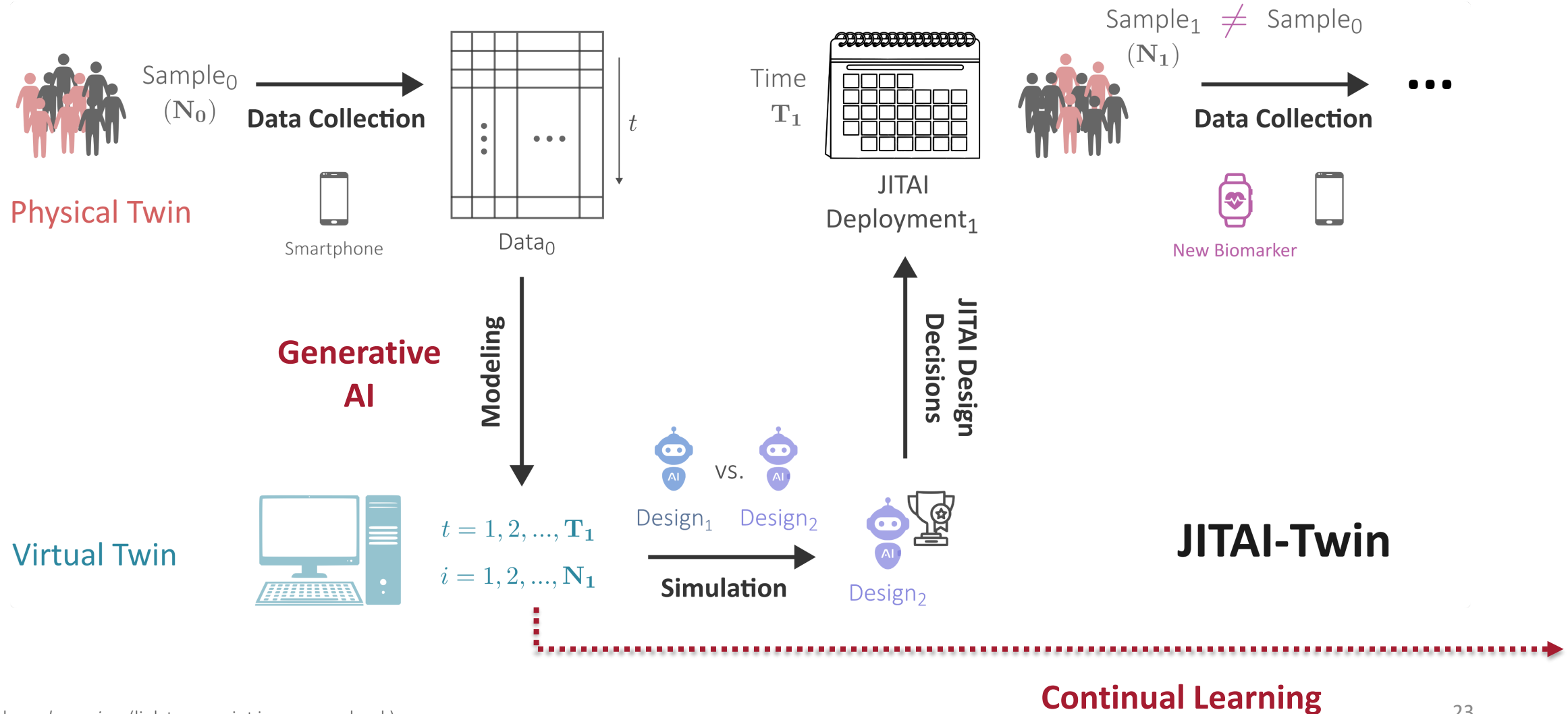


Pedja Klasnja

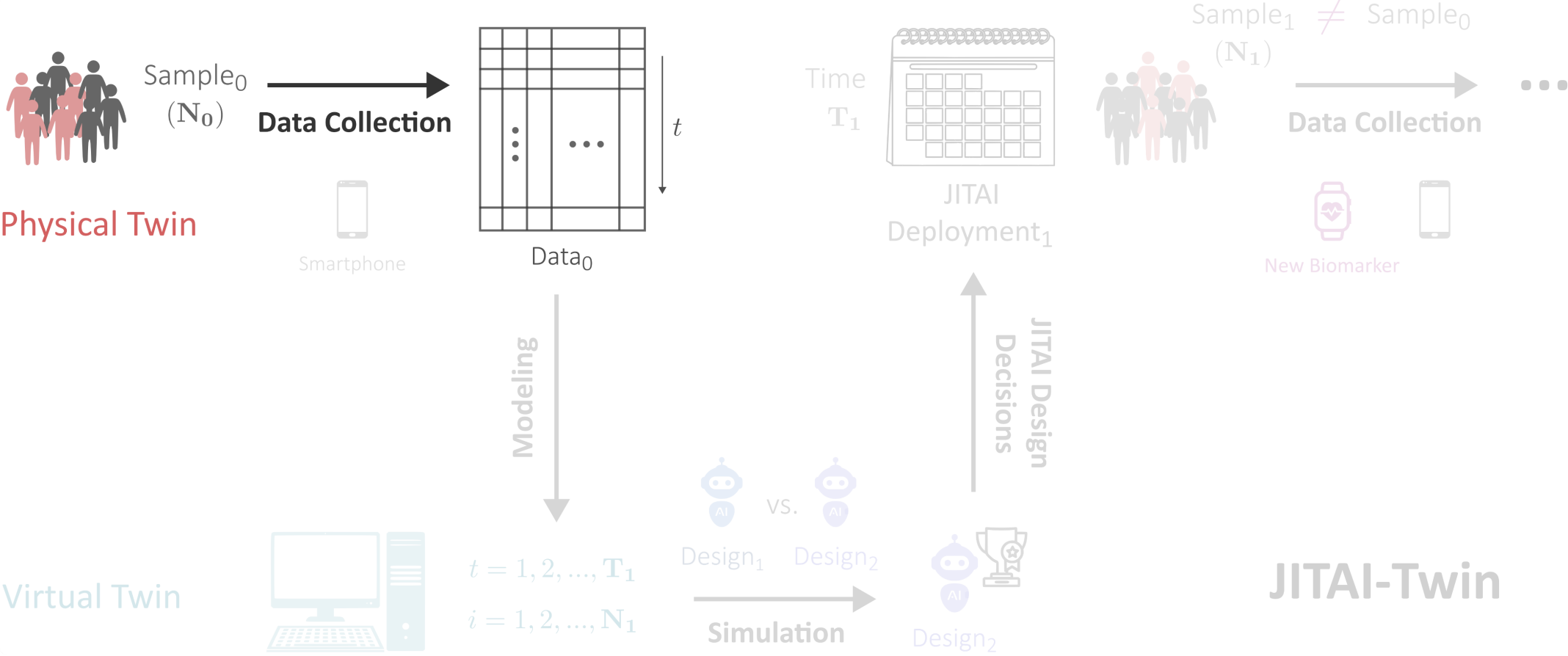
# Deployment and AI Optimization is Not a One-and-Done – It is a Continual Improvement Process



# Exciting Opportunities to Improve JITAI-Twin Design via Continual Learning and Generative AI



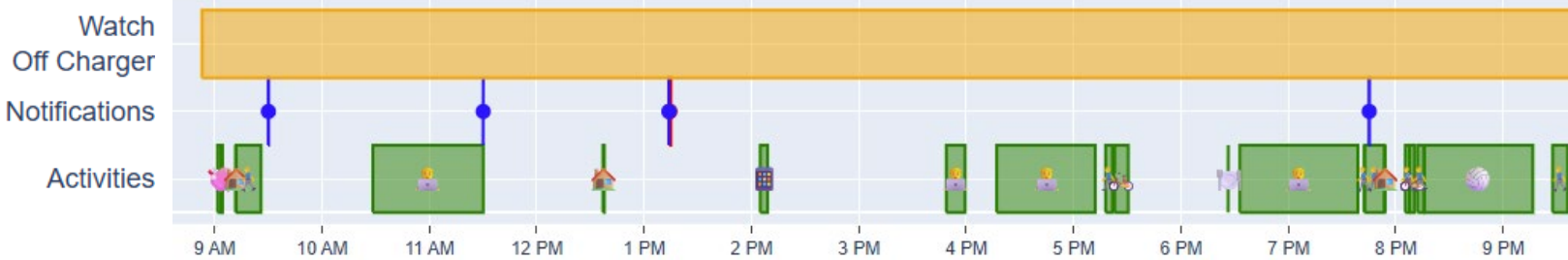
# The Stroke Rehab. Project is in the First Phase of This Continual Improvement Process



# Pilot Data on Activities of Daily Living is Exciting! 100-Hz IMU Data is Collected Throughout



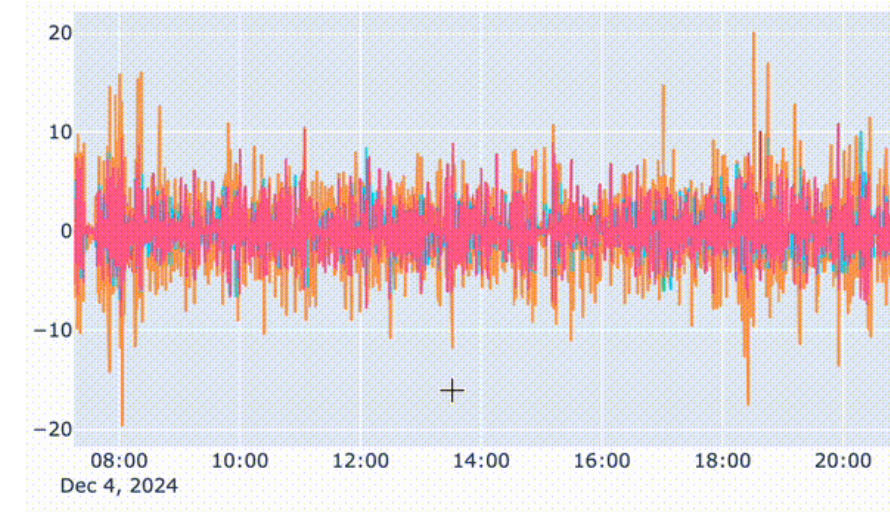
Thursday, April 17, 2025



Friday, April 18, 2025



Saturday, April 19, 2025

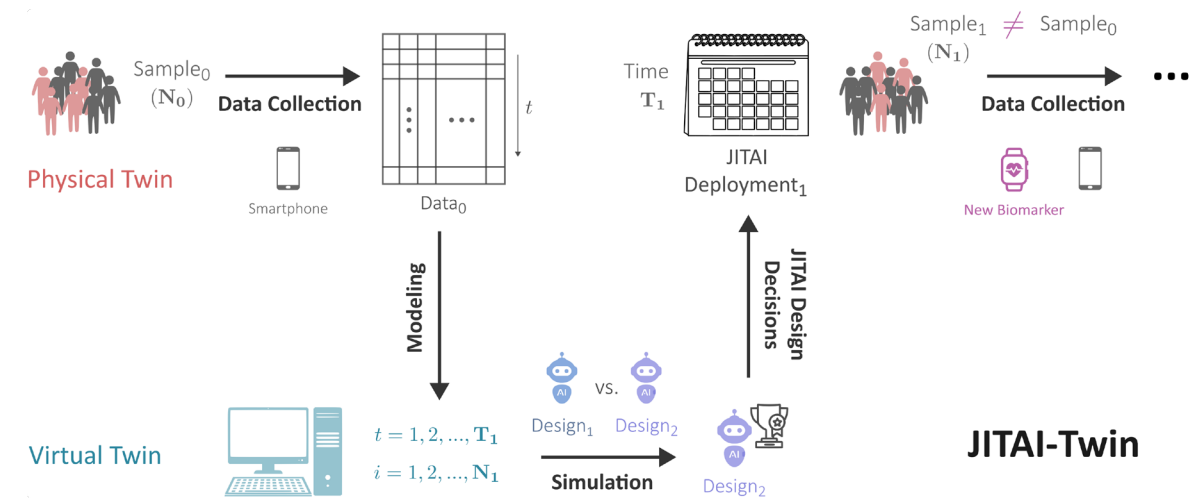
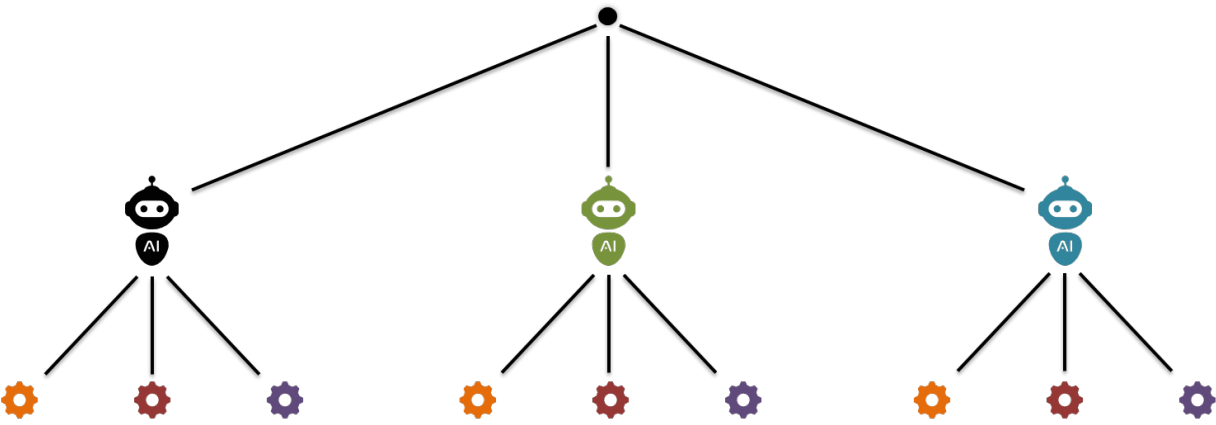
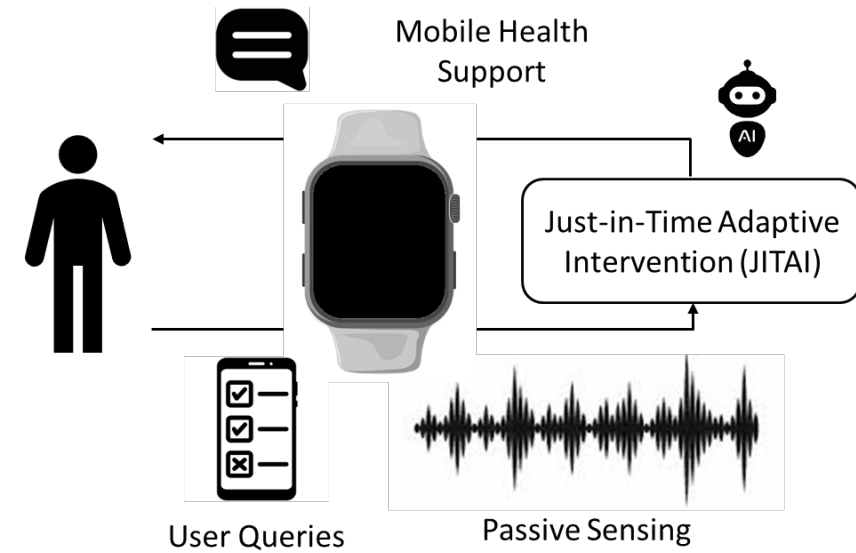




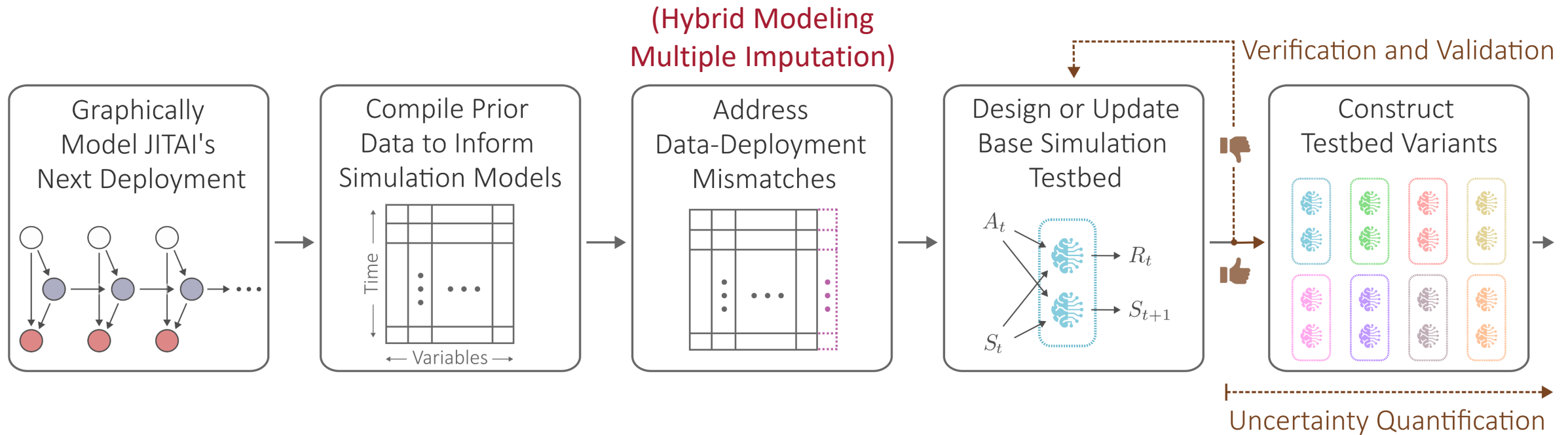
# Questions?

Asim H. Gazi

<https://asimgazi.github.io>



# Simulation-Informed Decision Making is Key to Making Thoughtful Design Decisions for JITAIs



(Concrete examples for each of these steps are provided in the paper)

# Verification, Validation, and Uncertainty Quantification is a Subcycle Within a Larger Cycle

