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TRAIL RESEARCH CAMP 26’

06/07/2026 – Namur

Project 12

From Rich Laboratory Actimetry to Sparse Real-Life Monitoring

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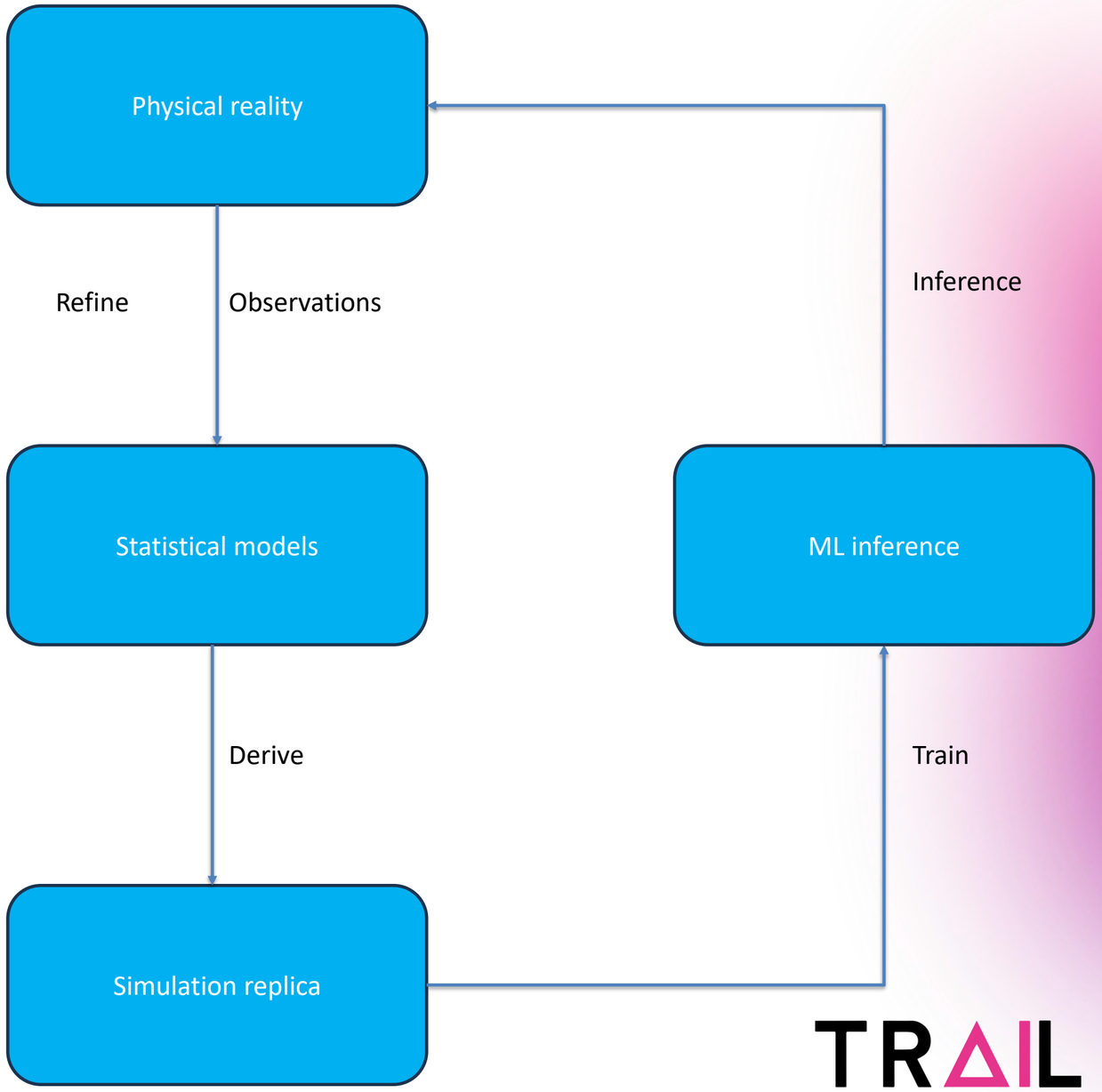
ISCOPE

Project 12

- Observe reality
- Derive statistical models
- Build simulations
- Train inference models
- Refine the model



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Our mission

Actual cohort

18 healthy participants and 18 post-stroke participants. Next goal: 20 participants per group

Portable sensors

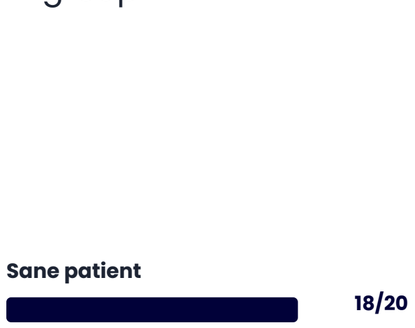
6 accelerometers positioned on the wrists, hips, and ankles.

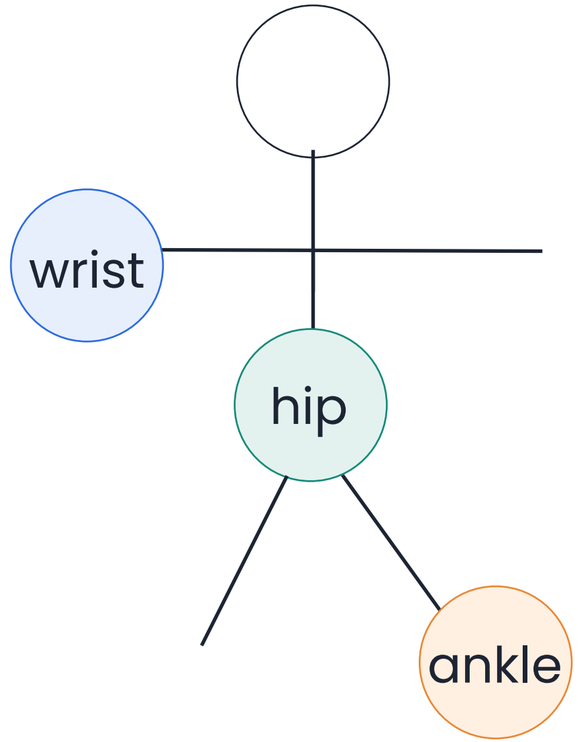
Instrumented souls

Pressure-sensitive insoles with built-in IMUs and accelerometers: on-foot sensors.

Energy consumption

Ergospirometer and heart rate monitor: physiological data synchronized with the protocol.





Nature of the database

- Multi-site inertial signals
- Plantar pressure and foot IMU
- Heart rate and energy expenditure
- Activity labels derived from the protocol

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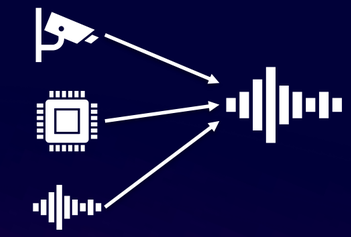
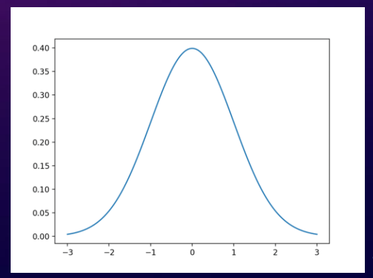
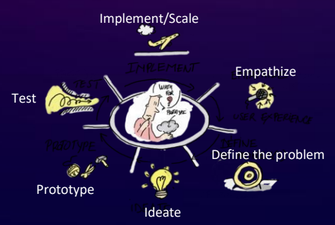
At this stage: Curated and certified data, suitable for training and validating machine learning models.

A user-centered pipeline for meaningful anomalies







Sensor sparcification

Multimodal evidence

Scenarios (digital twin)

Dynamic normality

User context

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[Grudin] [Nielsen] [Lundström]

Approach

1

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Approach

1

From Users to Context: Modeling Meaningful Behavior

2

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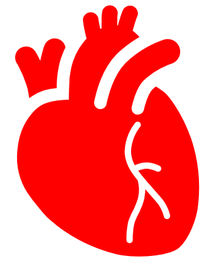

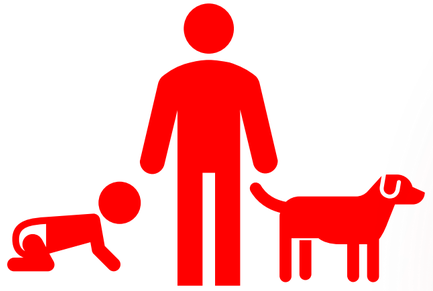

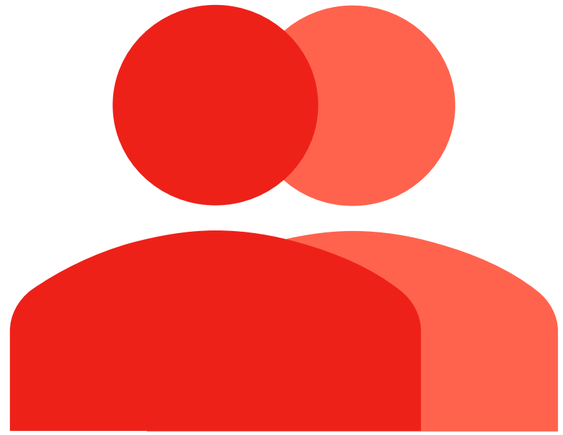

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Approach

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From Users to Context: Modeling Meaningful Behavior

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Approach

2

From Static Profiles to Dynamic Normality

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From threshold to routine

Static detection	**Dynamic normality**
One threshold	Personal routine
One event	Temporal pattern
Generic rule	Context-aware deviation
Reactive alert	Early warning signal

[Abbate] [Lundström] [Shahid]

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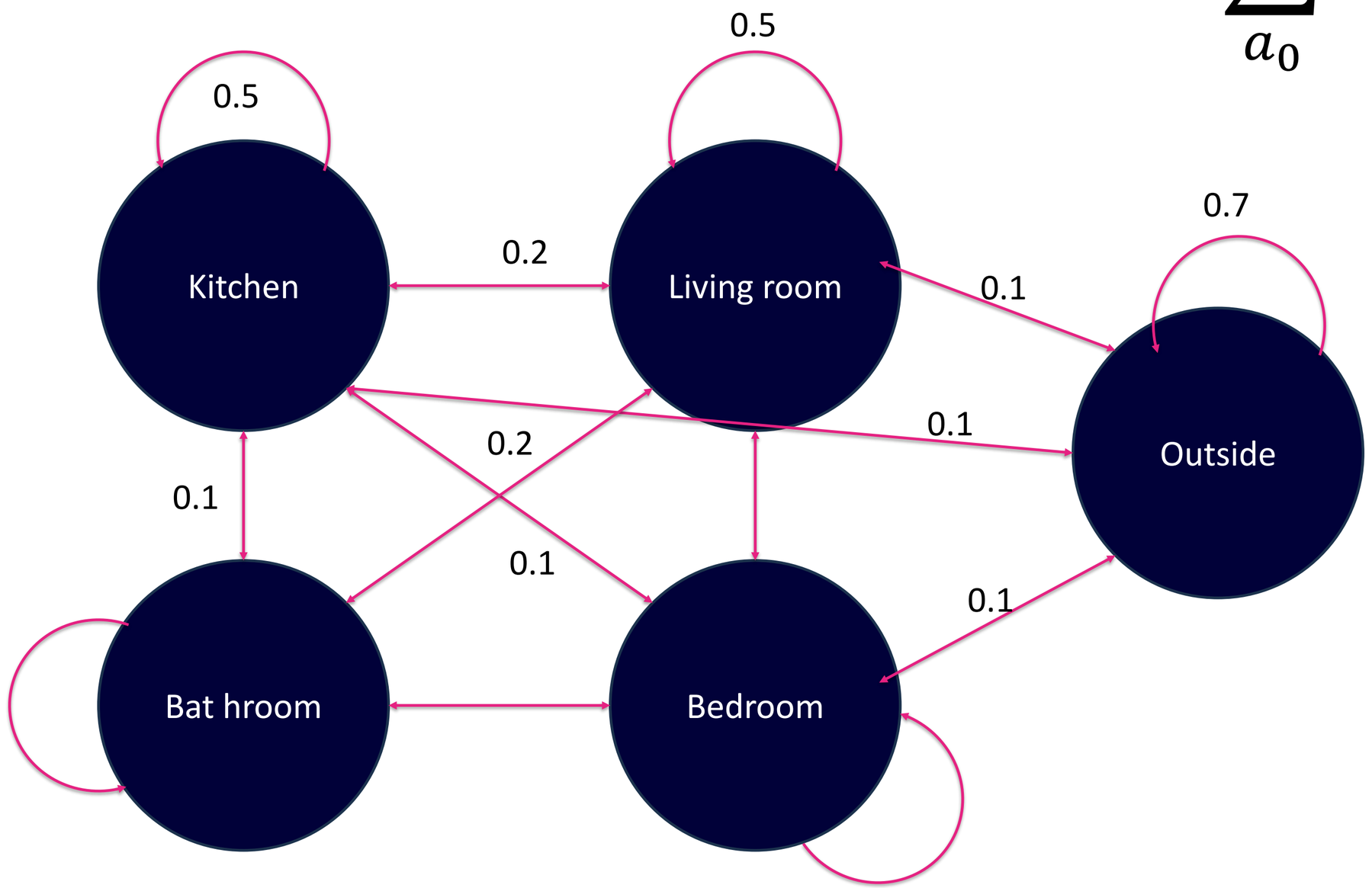
Markov chains

$$\forall \text{node}, \sum_{a_0}^{a_n} p(a_i) = 1$$



[Lundström] [Forkan][Galager]

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Approach

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From Static Profiles to Dynamic Normality

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Approach

3

From Real Users to Testable Scenarios: Simulation, Digital Twins, and Validation

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Create a simulation

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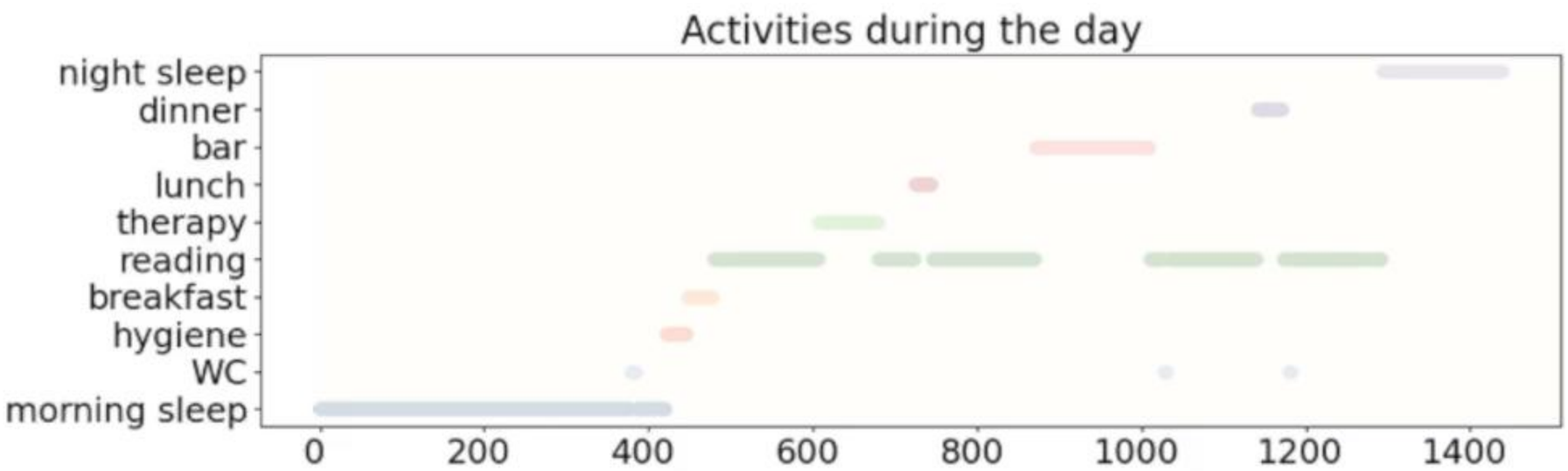
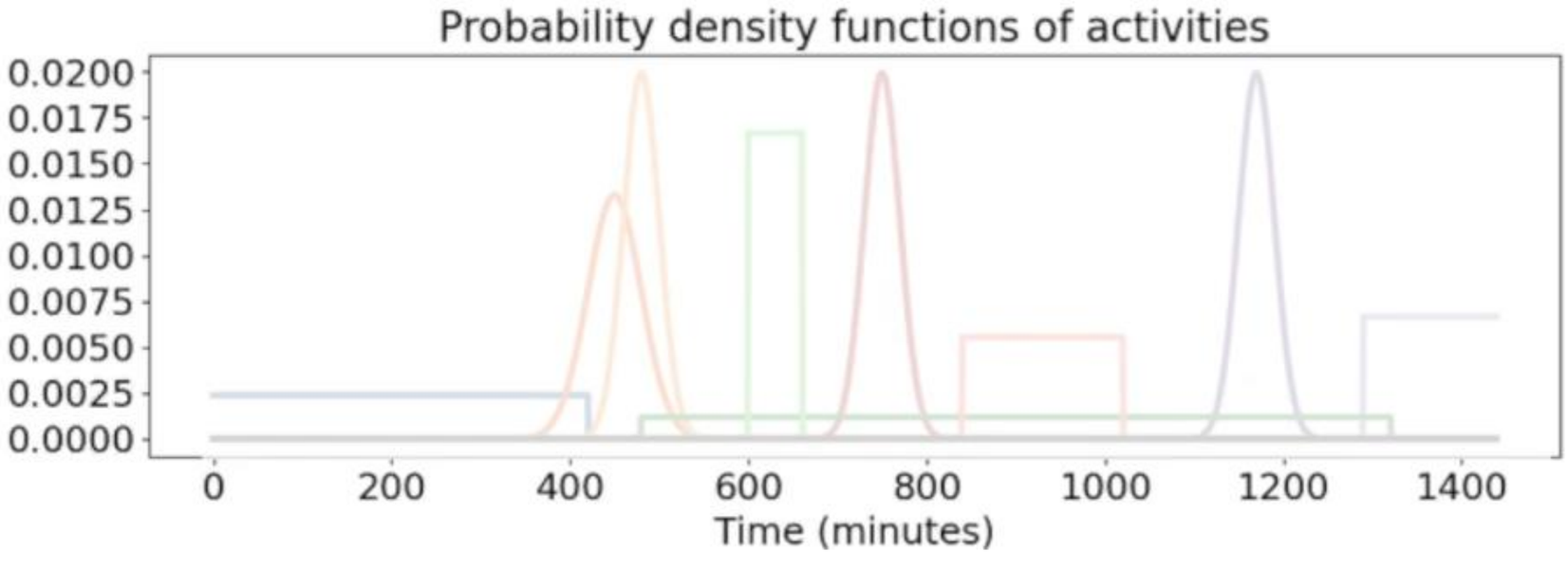
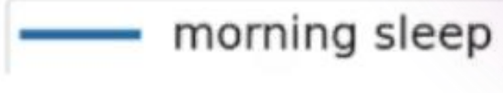
Generate data





Stack



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From Real Users to Testable Scenarios: Simulation, Digital Twins, and Validation

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From Heterogeneous Signals to Shared Evidence

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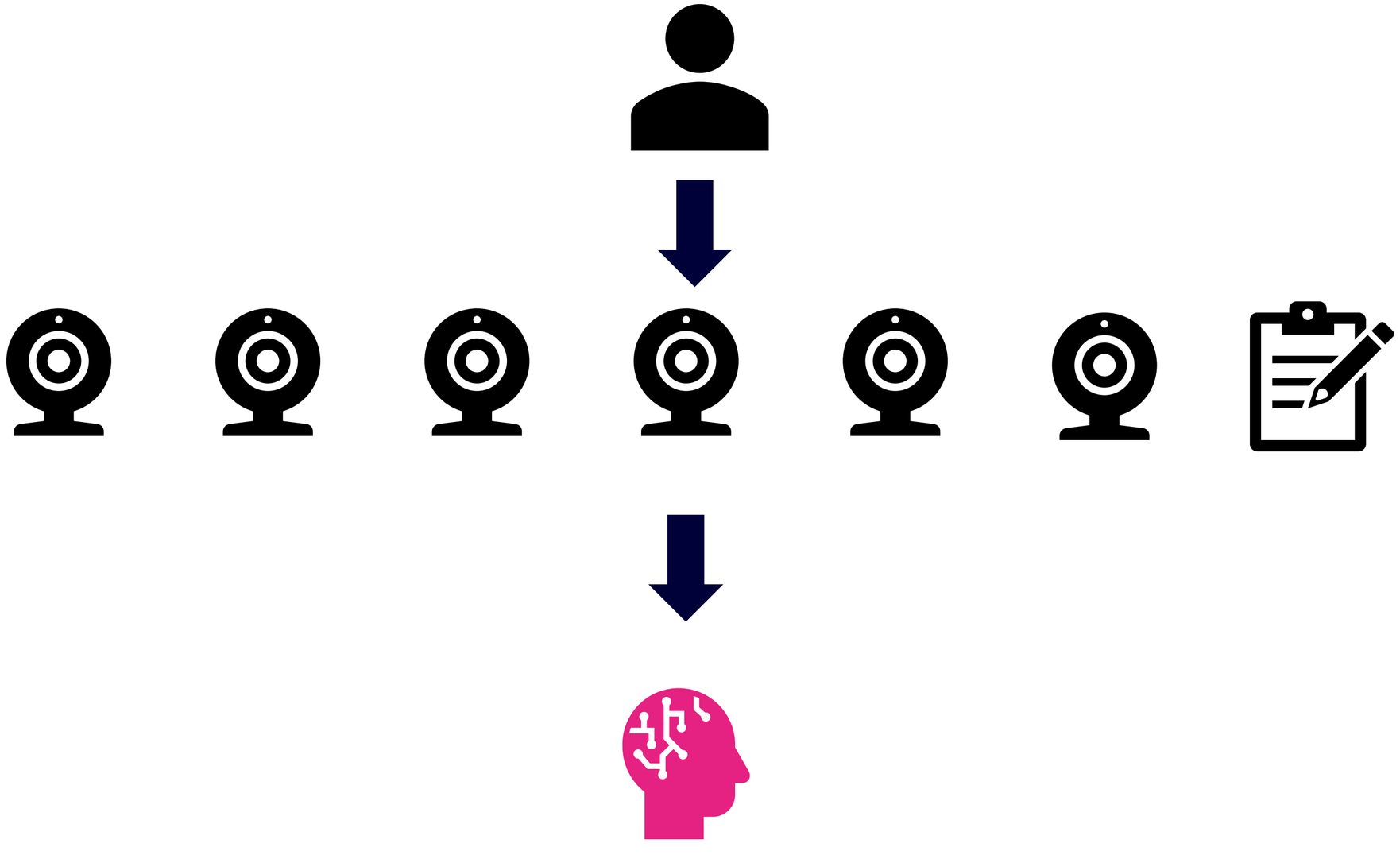
Assessing ground truth



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From Heterogeneous Signals to Shared Evidence

5

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Approach

5

From Sensors in the Lab to an in vivo deployment

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The problem with “more data”

More sensors may improve	**But may also increase**
coverage	intrusiveness
redundancy	noise
detection probability	false alarms
robustness	installation burden
multimodality	interpretability problems

[Abbate] [Lundström] [Shahid]

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RECAP 5 STEPS

Understanding The user

Developing Physicaly sound models

Simulation based on models

Assessing the ground truth

Validate sensor sparcifications

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