Identifying College Students with Depression Using Passive Sensing

Communication Qualifier Talk

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Depression in College Students

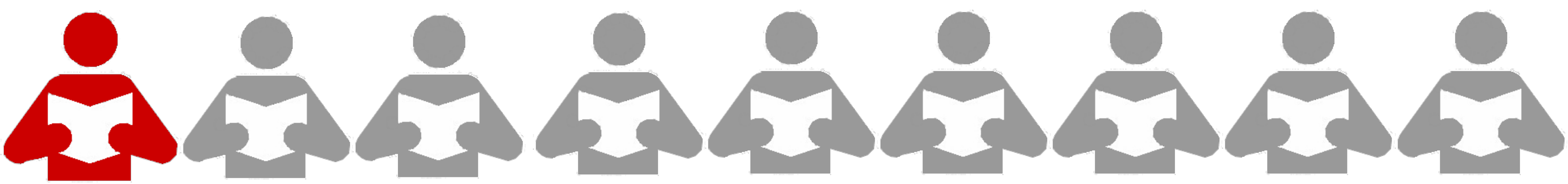
Difficulty functioning due to depression (33%)

Most common disorder among people with suicidal behaviors!

Depression in College Students

Difficulty functioning due to depression (33%)

Considered suicide (11.2%) [2015-16]



Attempted suicide (2.1%) [2015-16]

Current treatments for depression are effective and reduce the risk of suicide…

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…BUT…

Research Problem

- Students face many **barriers to seeking treatment**
  - Most common - “Stress is a normal part of student life”
- Detecting and monitoring depression is **necessary**

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- **Current state**:
  - Periodic psychometric tests → Reduce compliance.

➔Need more efficient tools to detect depression.

Research Goals

1. To detect depression as early as possible.
2. To enable interventions.
3. To further the understanding of depression.

Solution

Our Work:

Capture behavior and symptoms → Detect Depression

- **Detect:**
  1. Post-semester Depression (85.7%)
  2. Change in Depression (84.3%)
  3. Change in Levels of Depression (72.4%)

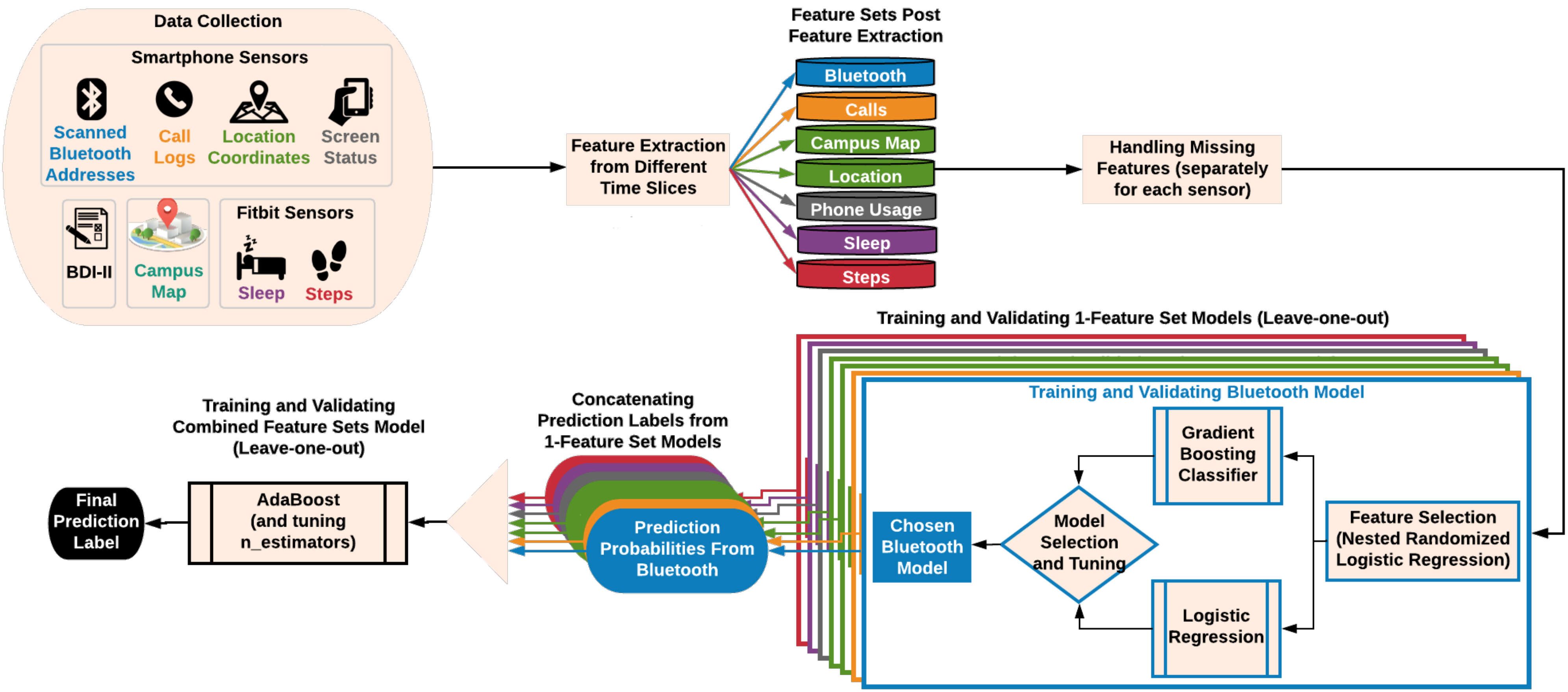
Previous Work

- Relationship between depression and:
  - Location variance, regularity in movement patterns across days, and evenness in time spent across locations.
  - Phone usage and frequency
  - Sleep duration
  - Speech and conversation duration

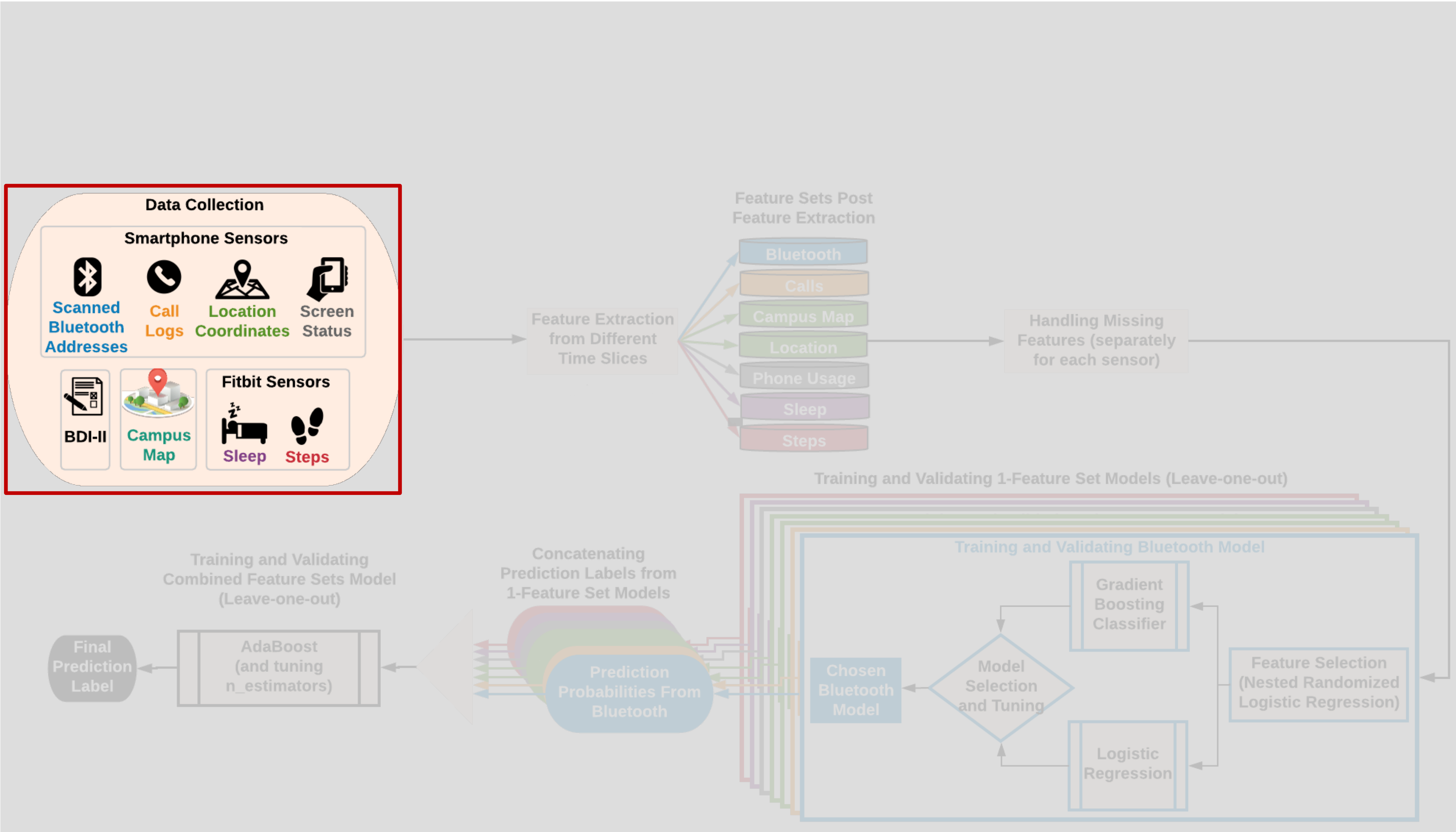
Previous Work

- Used to detect depression using Machine Learning.
- Limitations:
  - Small sample size.
  - Short duration.
  - Limited number and type of sensors.
  - Don’t look at our three outcomes.

Methodology



Methodology



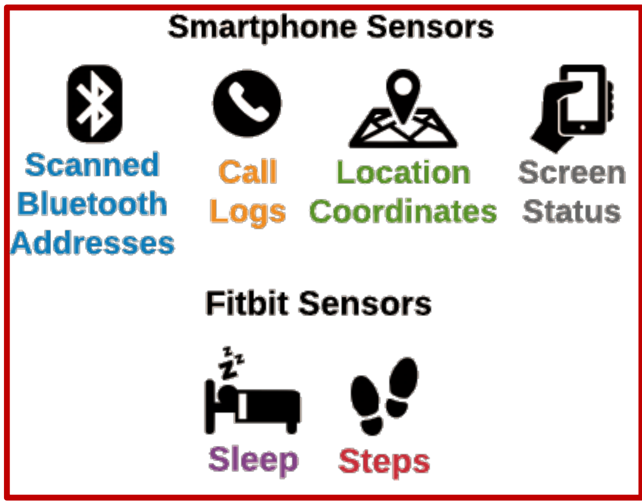
Data Collection

- **Participants**
  - 138 first-year college students.
  - Provided Fitbit Flex 2 and adequately compensated.

- **System for Passive Data Collection**
  - AWARE app for Android/ iOS.
  - Fitbit API.

Data Collection

Passively collected data



One Semester

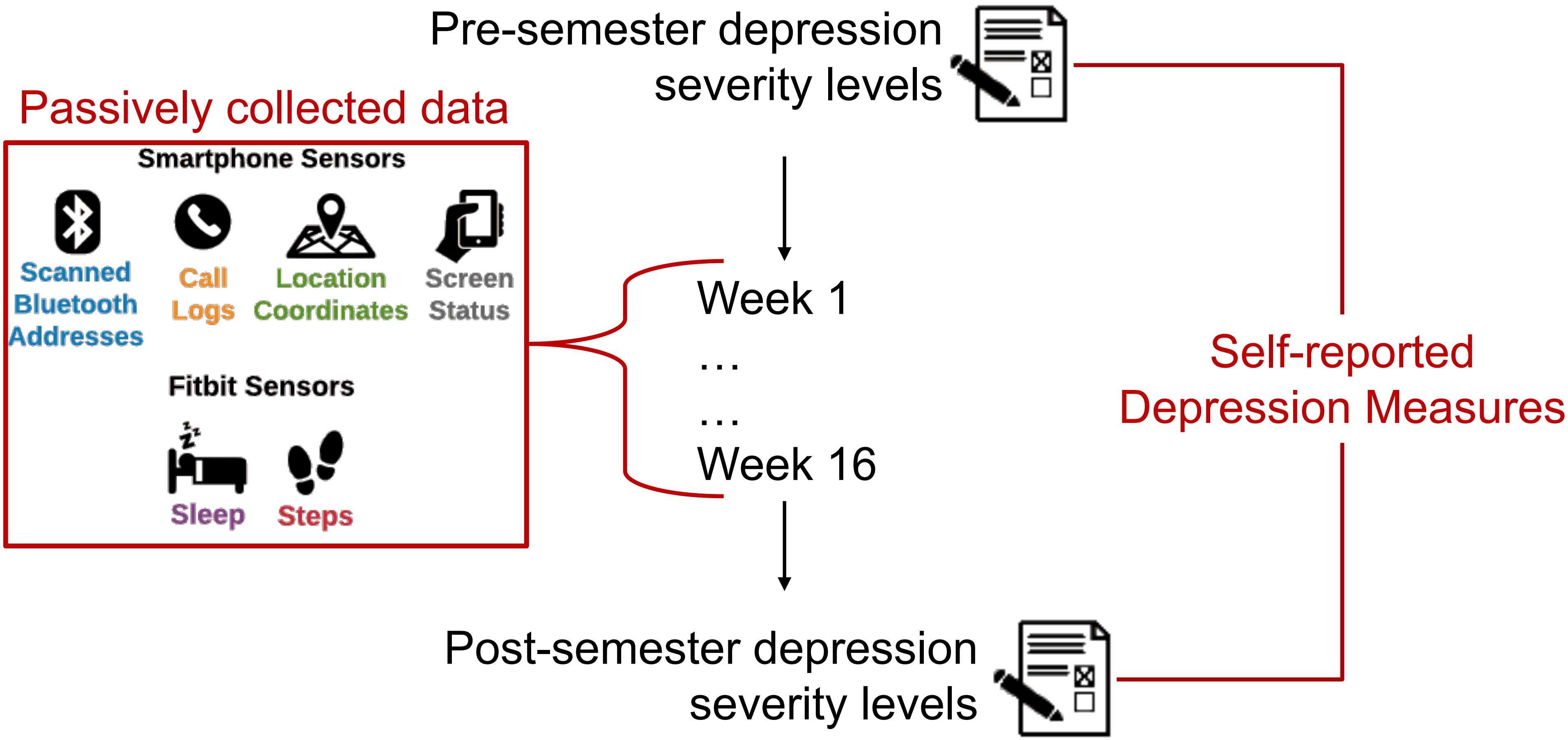
Week 1

…

…

Week 16

Data Collection

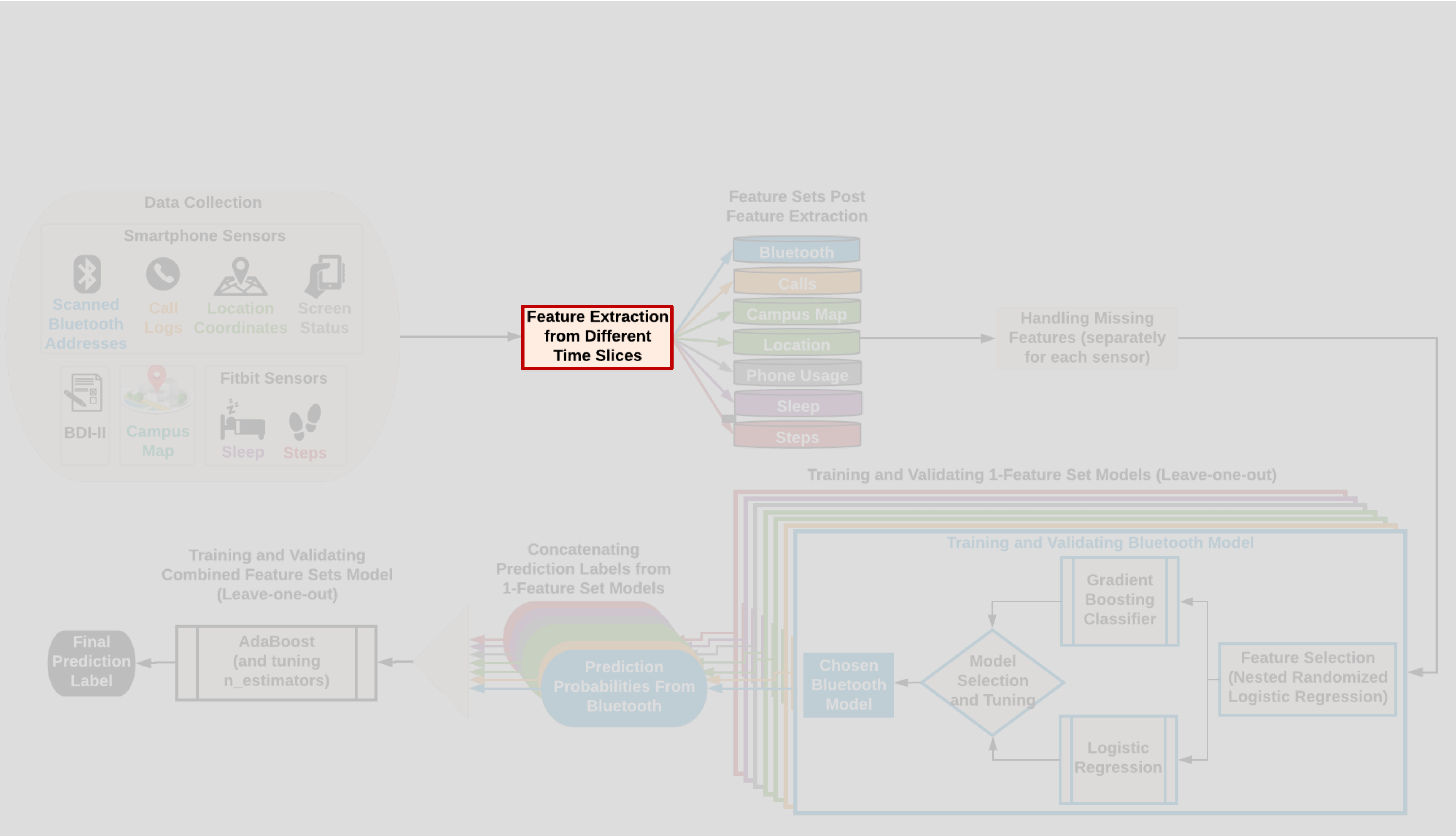


Data Collection

Outcomes (Ground Truth)

- **Post-semester Depression**
  - Binary: *“no depression”* vs. *“mild/ moderate/ severe depression”*
- **Change in Depression**
  - Binary: *“severity level remains the same”* vs. *“severity level worsens”*
- **Change in Levels of Depression**
  - 4-class: By how much does severity level worsen?
    “By 0 (same)” vs. *“by 1”* vs. *“by 2”* vs. *“by 3”*

Methodology



Feature Extraction: Temporal Slicing

- Features are aggregated over different temporal slices instead of the whole semester.
- Why?

Feature Extraction: Temporal Slicing

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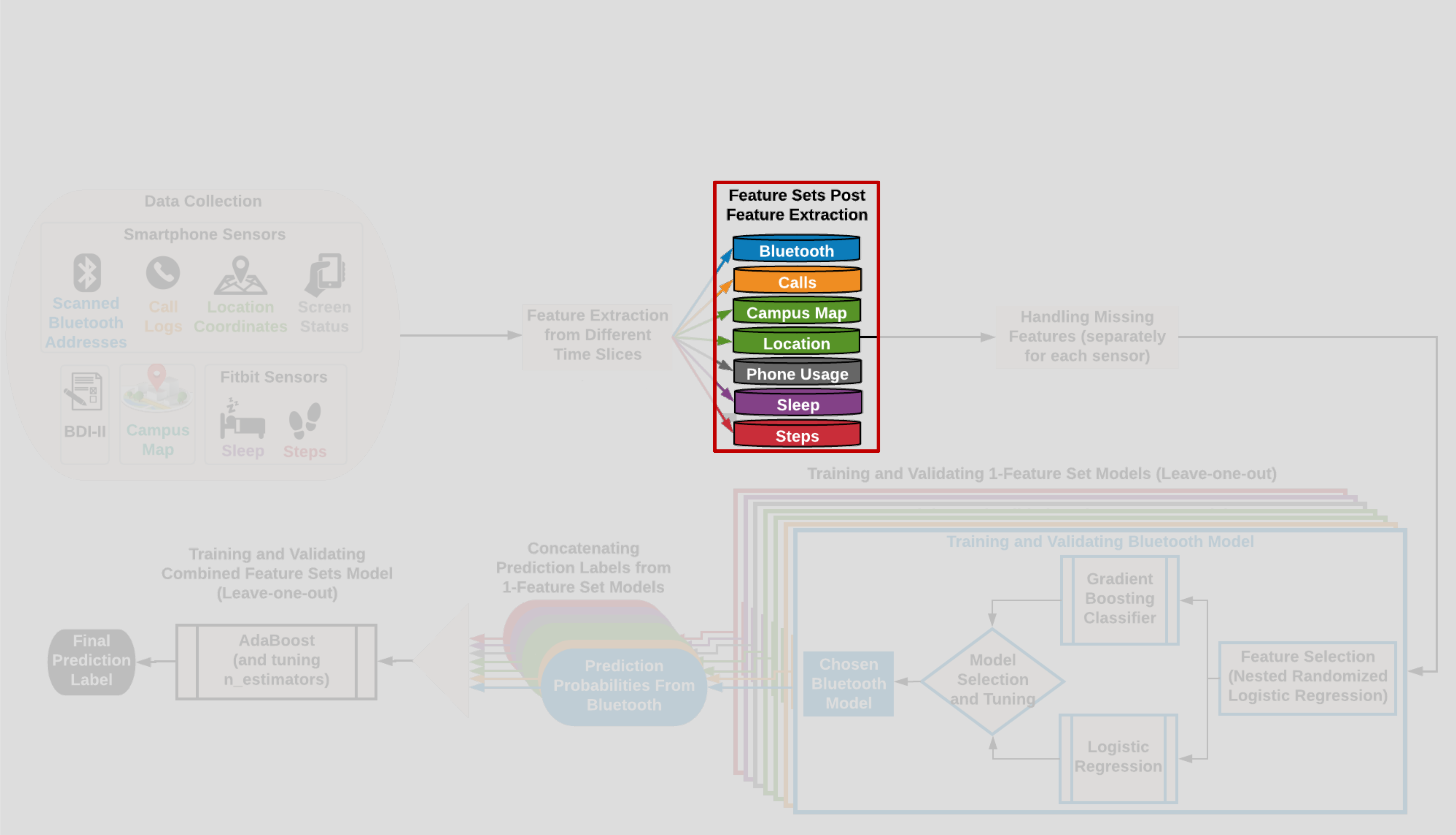
- Why?

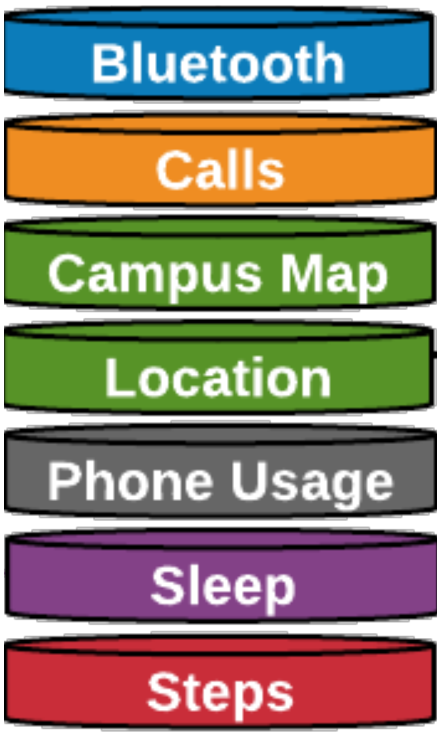
- →There are 45 such temporal slices.

Methodology



Feature Extraction: Feature Sets

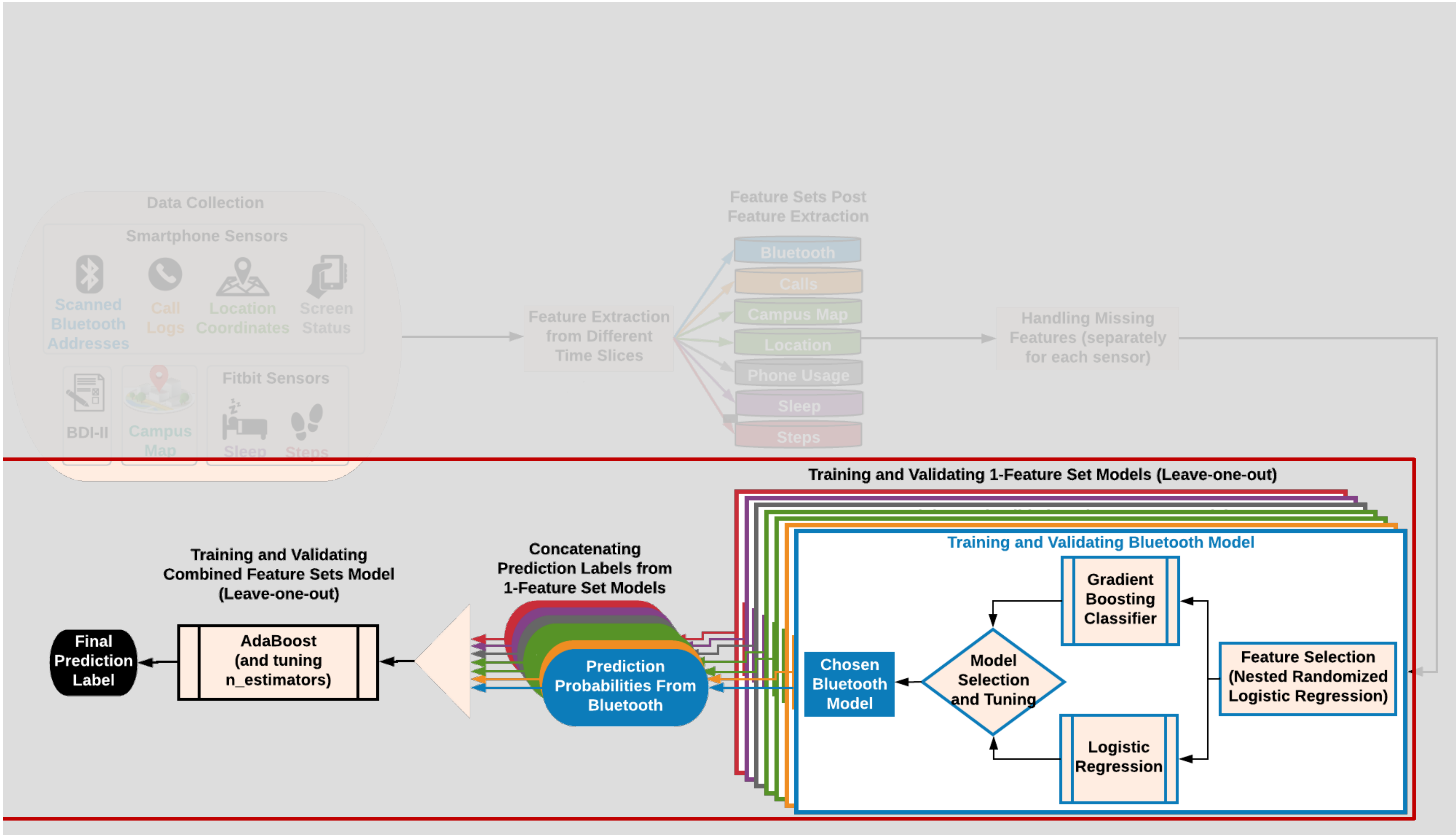
- 7 feature sets



- Each contains behavioral features calculated over 45 temporal slices.

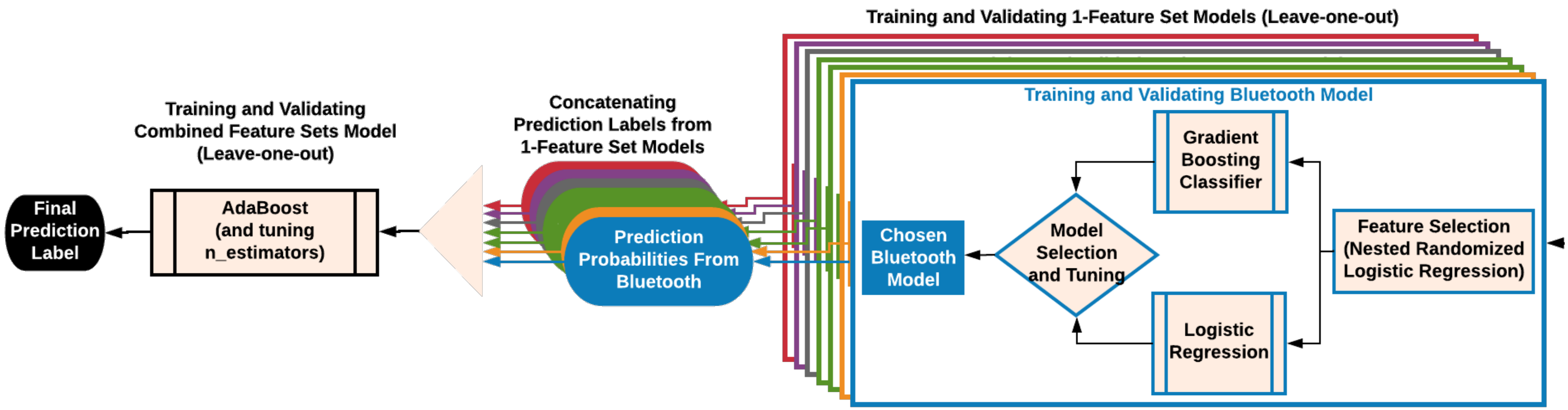
- Understandable
  - E.g. Location → “circadian movement” (regularity in a person’s movement patterns).

Methodology



Modeling

> **50K features** and only **79 people** from **all** feature sets!
→Feature selection very challenging!



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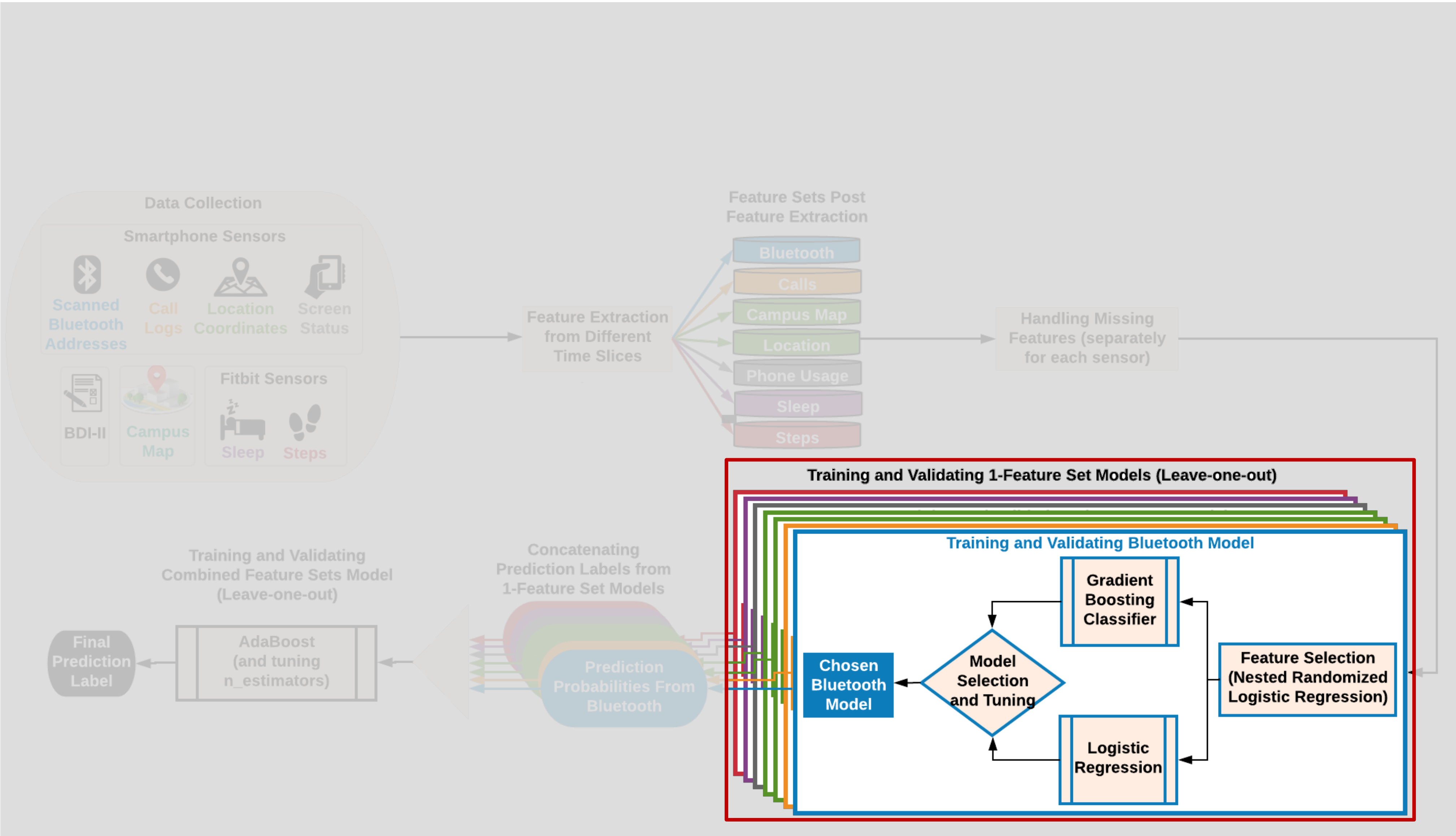
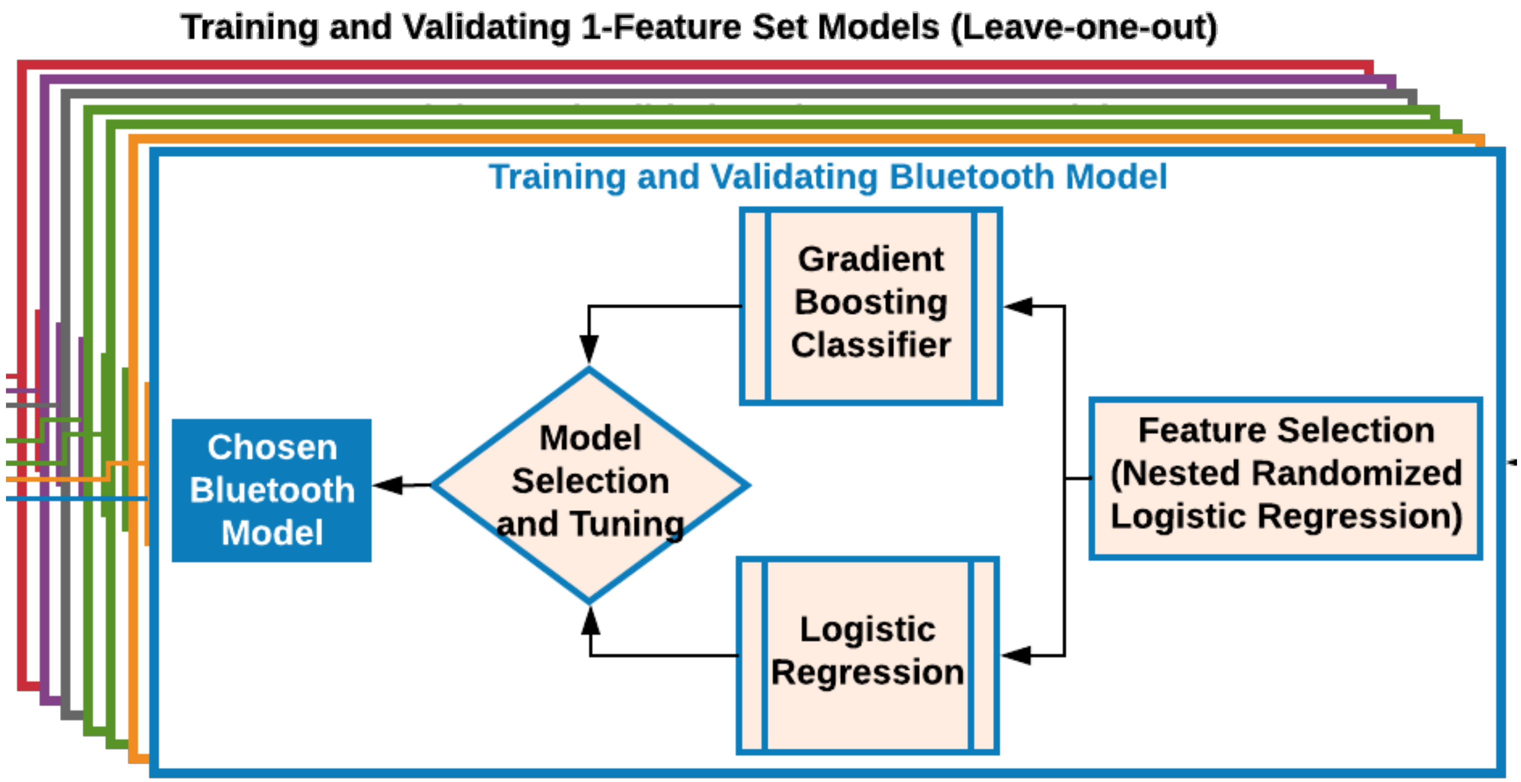
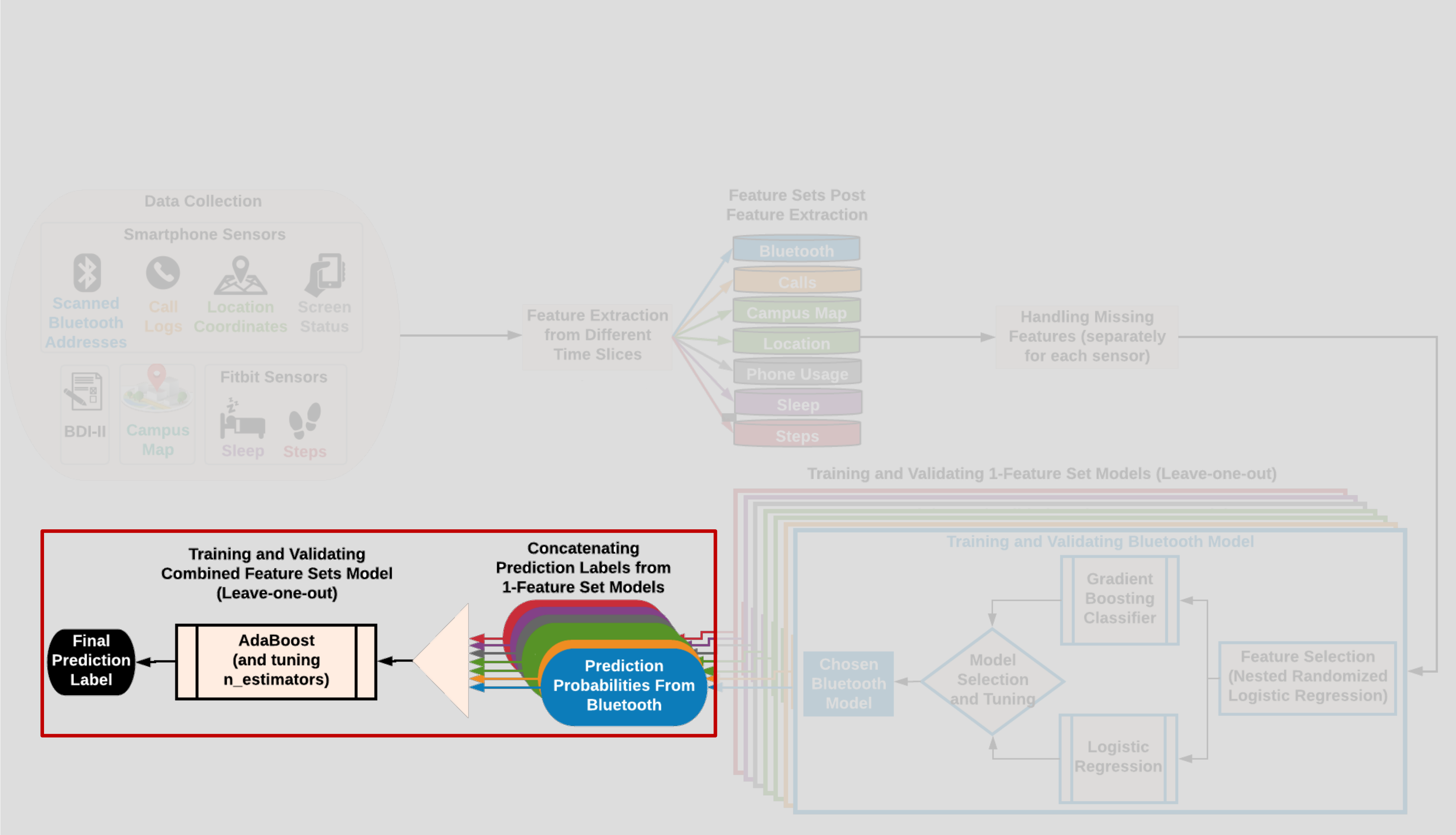


Training and Validating 1 Feature-Set Models

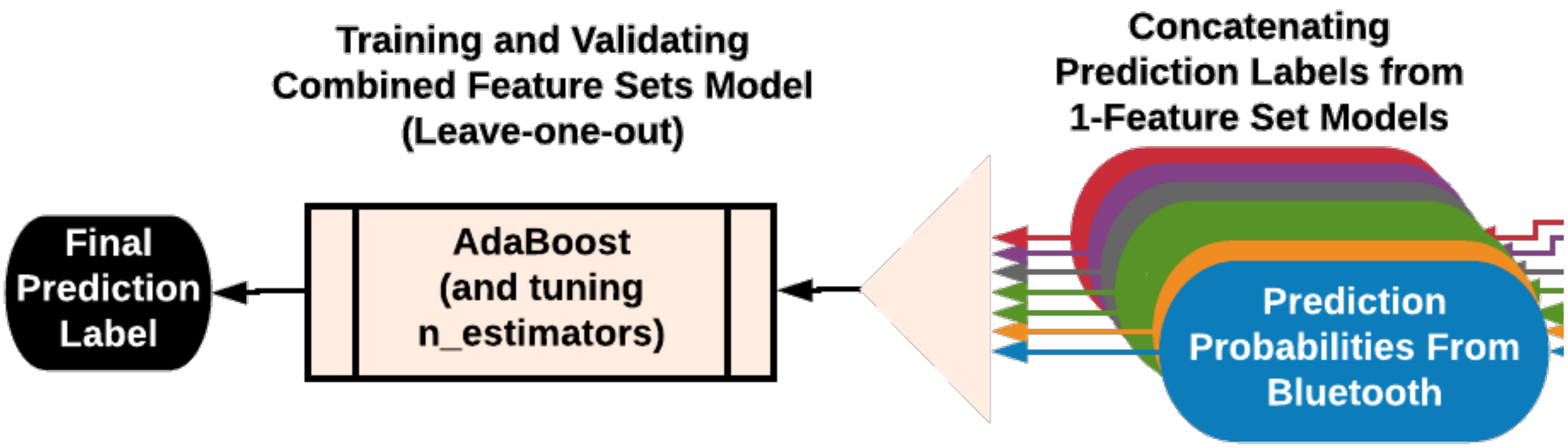


- Leave-one-out cross-validation

Methodology



Training and Validating Combined Feature-Sets Model



- Leave-one-out cross-validation

Descriptive Statistics

- Depression
  - Pre-semester, 14.5% students had depressive symptoms.
  - Post-semester, this increased to 40.6%.

- Change in Depression
  - Depression severity levels remained the same for 63.8% people.
  - Only 3 people got better (and were excluded).
  - Everyone else got worse.

- Change in Levels of Depression
  - 55.3% got worse by 1 severity level.
  - 34.1% got worse by 2 severity levels.
  - 10.6% got worse by 3 severity levels.

Results

Results: Detecting Post-Semester Depression

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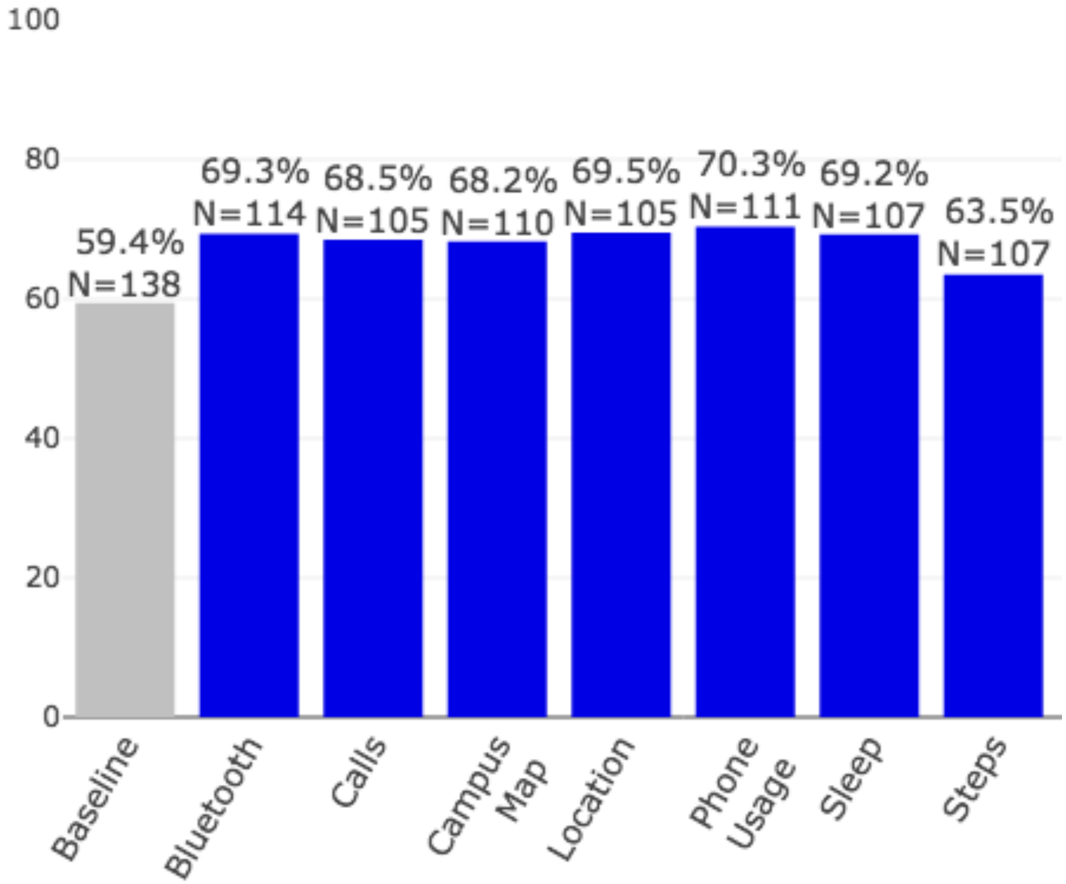
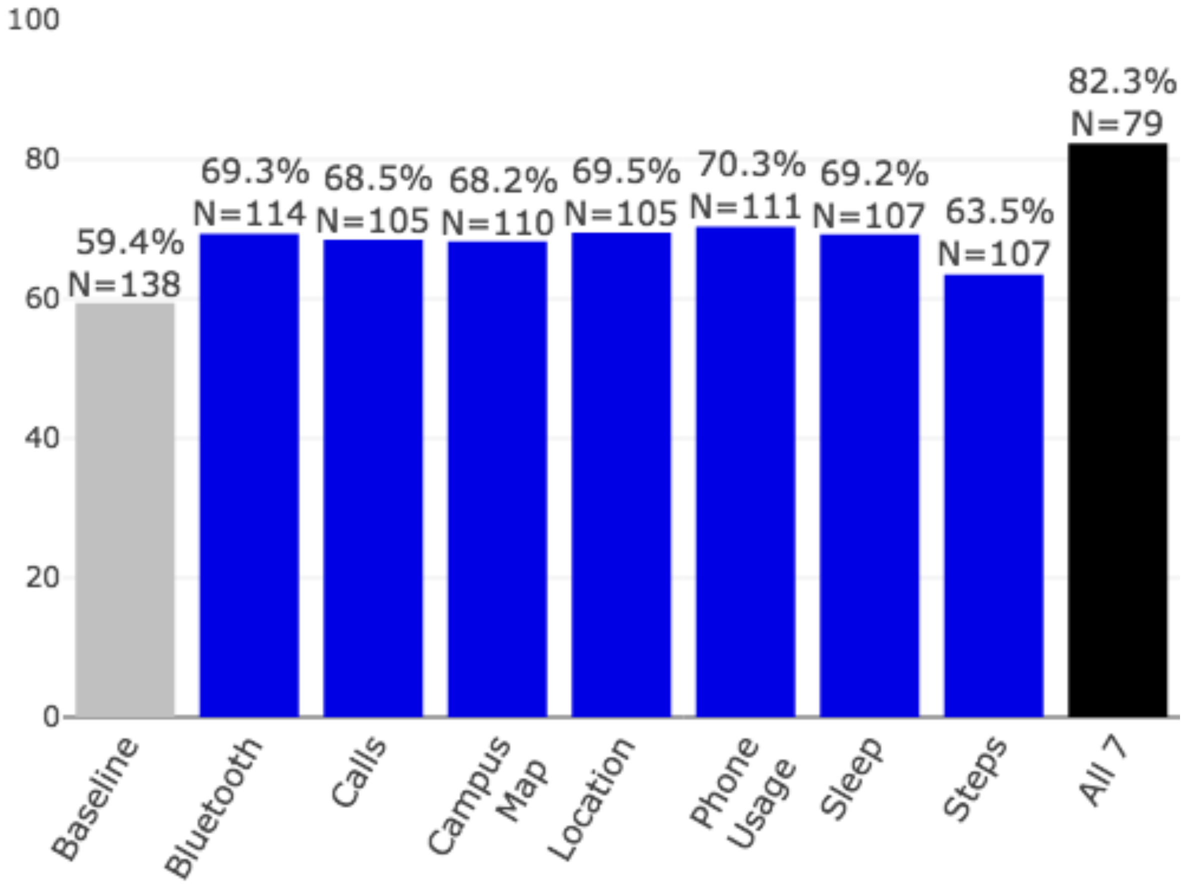
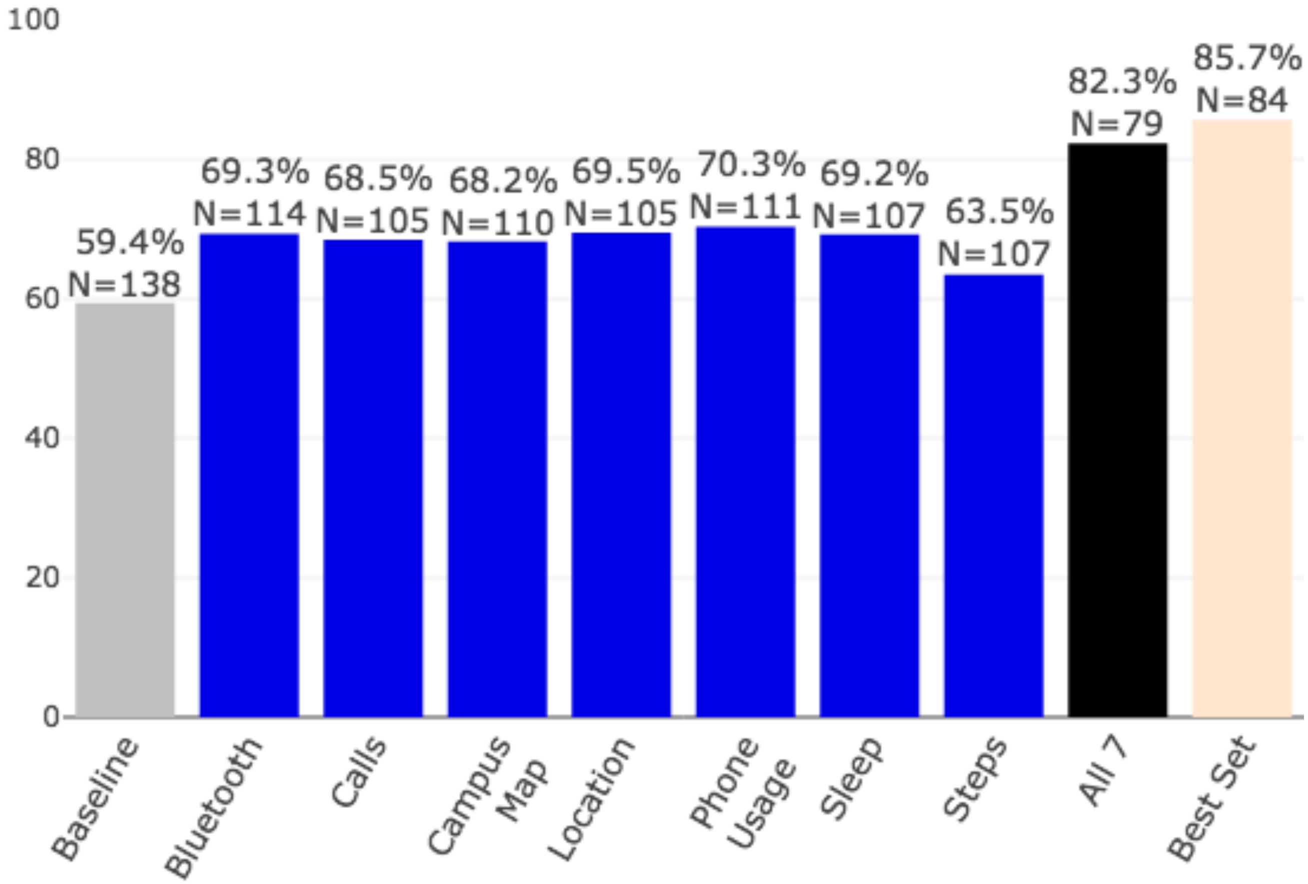


Results: Detecting Post-Semester Depression



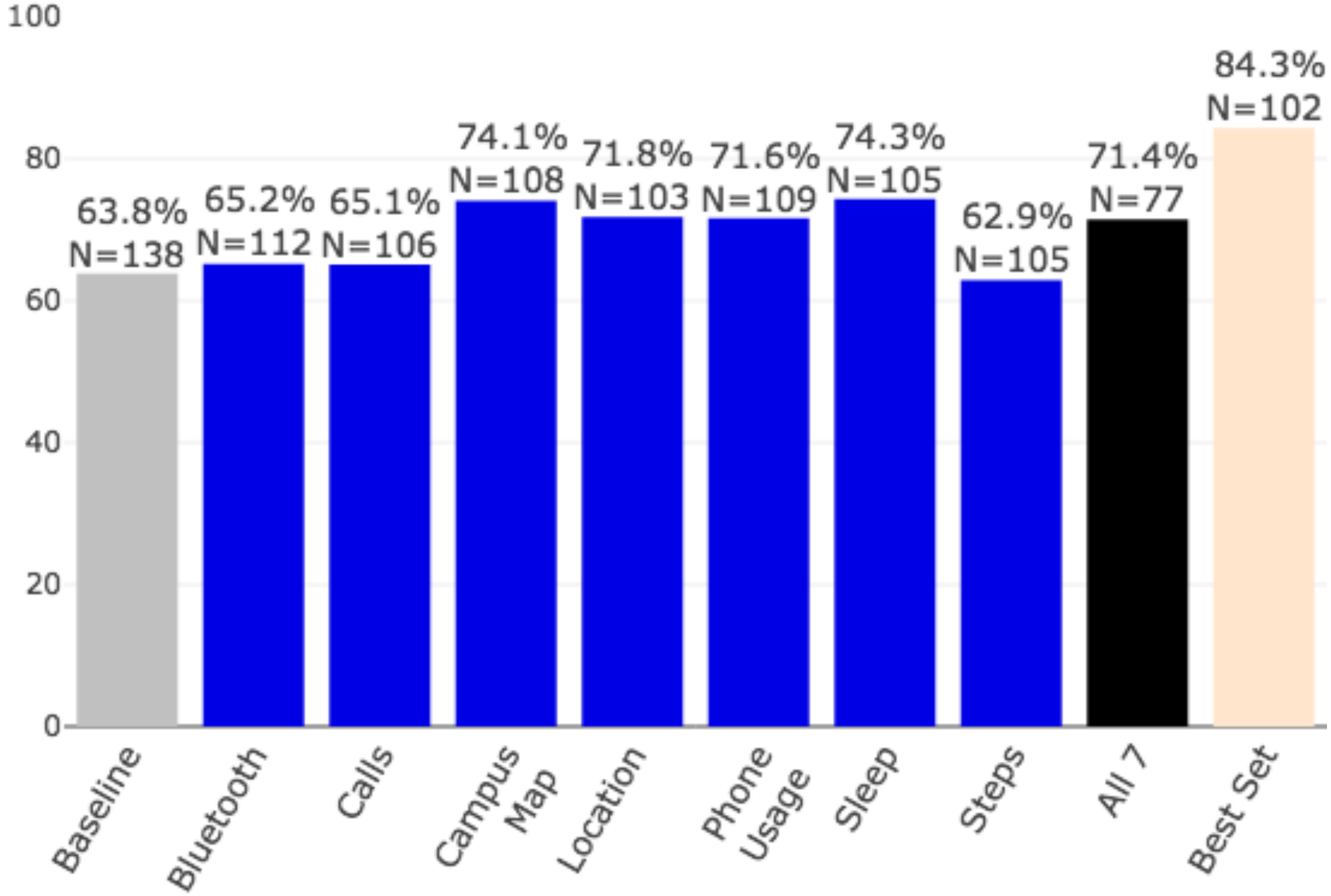
Results: Detecting Post-Semester Depression



Best Set:

- Bluetooth
- Calls
- Phone Usage
- Steps

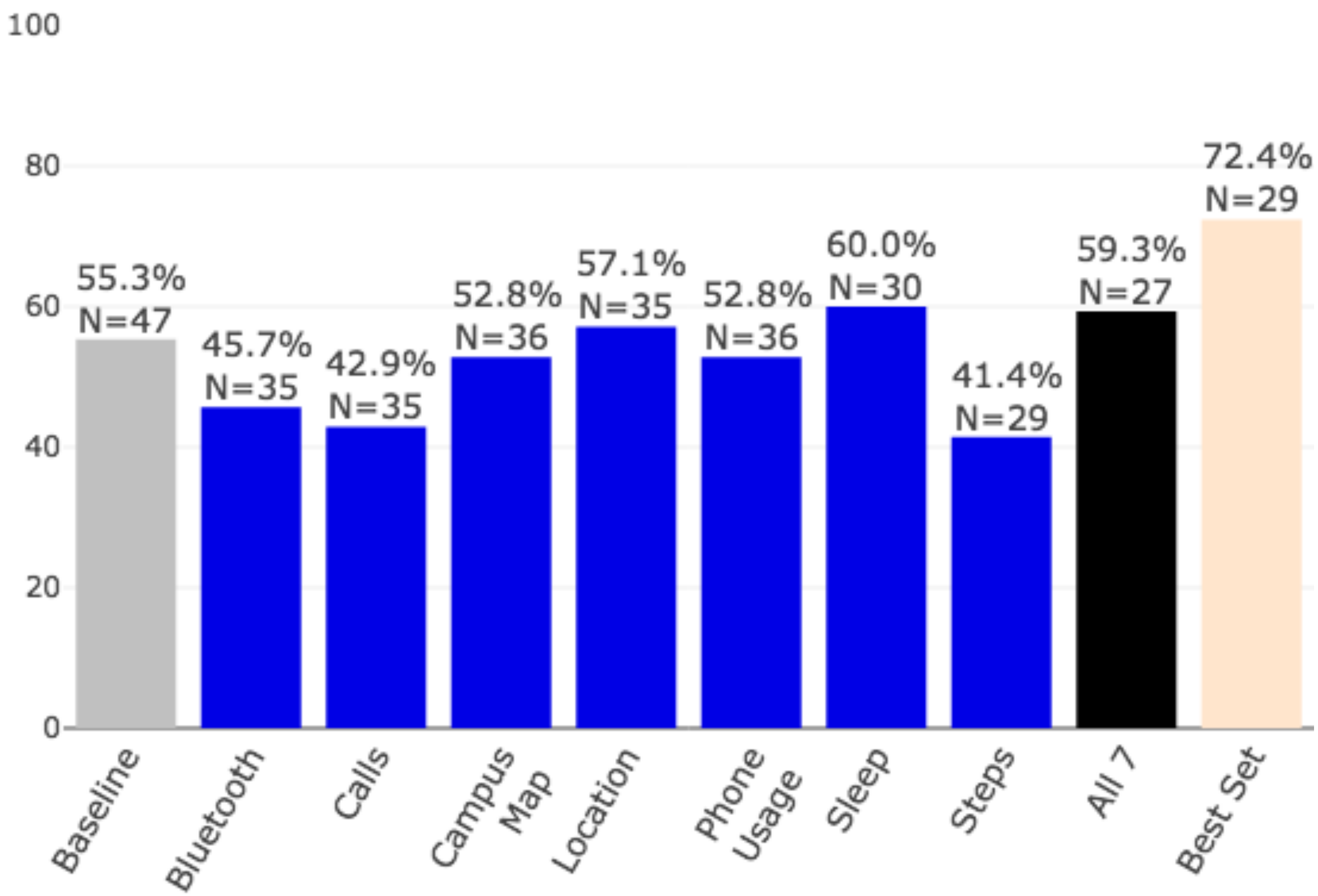
Results: Detecting Change in Depression



Best Set:

- Campus Map
- Phone Usage

Results: Detecting Change in Levels of Depression



Best Set:

- Bluetooth
- Steps

Results: Prediction

- Detection vs Prediction

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- Use data from week 1 to week x.

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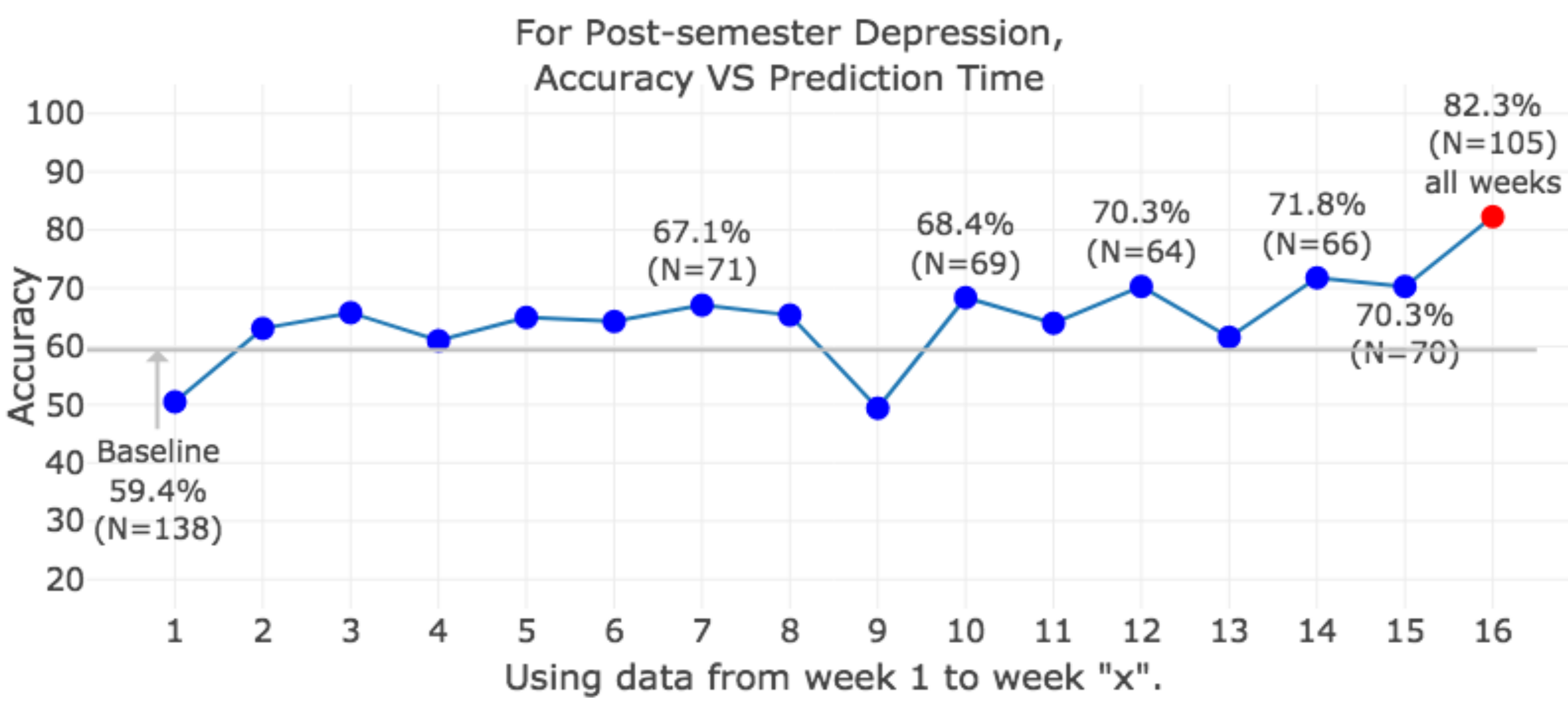

Implications

Implications - Examples

- Early Prediction models

  → Preemptive interventions in future studies

Predicted risk for depression is high!

Implications - Examples

- Understandable model
  → Inform Treatment and self-guided reflection

Implications - Examples

- Our Feature Extraction Library
  - Tens of thousands of behavioral features!
  - Can contribute to:
    - Longitudinal and Inter-University
    - Large initiatives that combine passive sensing with the participants' medical history, biological data, etc.

UCLA Grand Challenges

Depression

(100,000 participants)

THE PRECISION MEDICINE INITIATIVE

(long-term, NIH)

Thank you!

- Questions?

- Contact:
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