# Summary

1
**Raw Data**
eg log files

2
**Analytics**
App usage, screen time, consistency

**More Data**
eg. Location

**Prediction**
ML models
4

**Indicators**
(of depression/ stress)
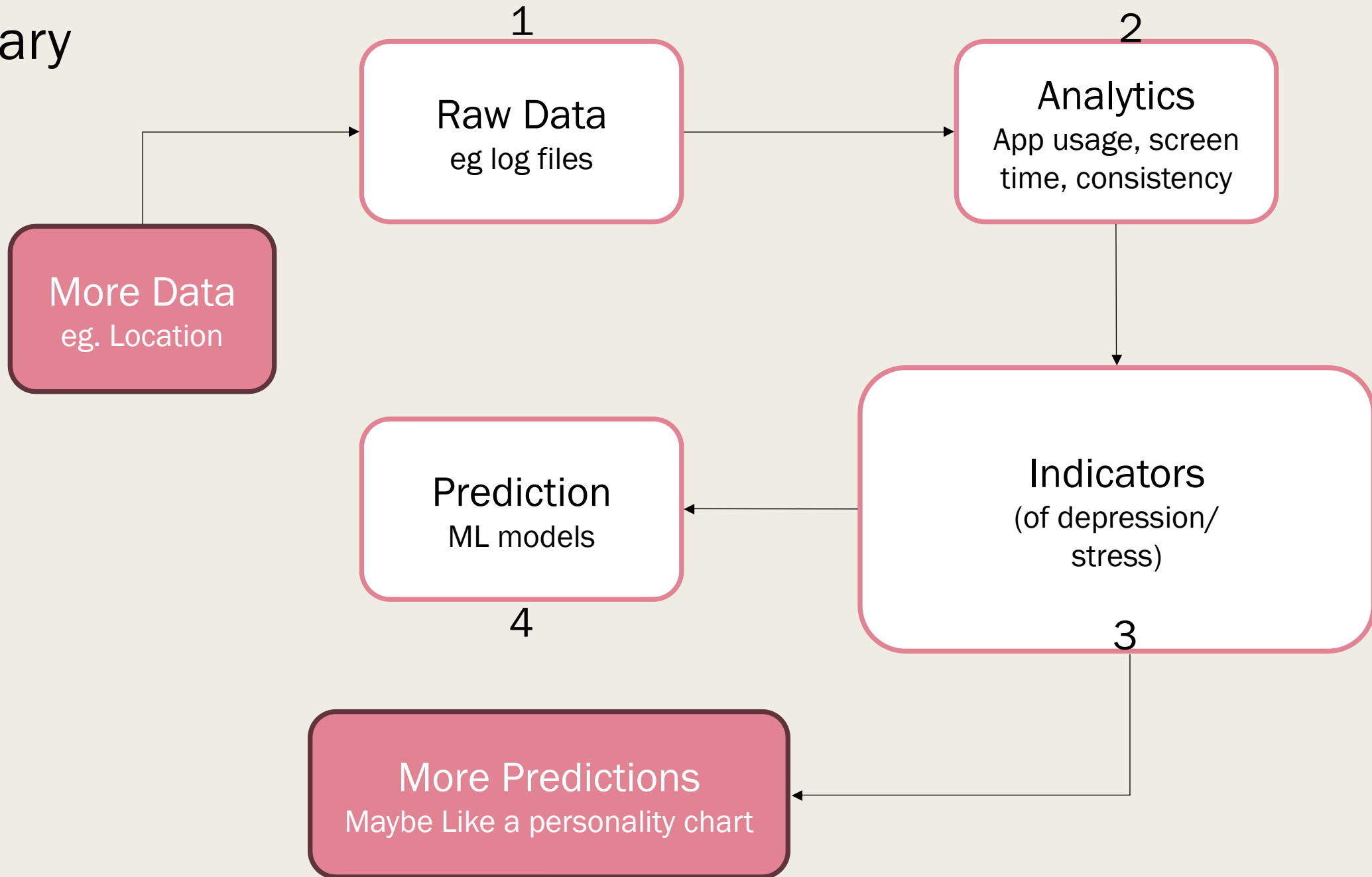3

**More Predictions**
Maybe Like a personality chart

## Next Steps

→ Track the variables and features that were studied in previous works.
→ Research about surveys that can be used to study people and their data better.
→ Collect some data.

# Features study

→ Curated a data of variables studied in 4 research papers.

**Paper 1**: Beames, J. R., Han, J., Shvetcov, A., Zheng, W. Y., Slade, A., Dabash, O., Rosenberg, J, O'Dea, B., Kasturi, S., Hoon, L., Whitton, A. E., Christensen, H., & Newby, J. M. (2024). Use of smartphone sensor data in detecting and predicting depression and anxiety in young people (12–25 years): A scoping review. Heliyon, 10(15), e35472. https://doi.org/10.1016/j.heliyon.2024.e35472

**Paper 2:** Opoku Asare K, Terhorst Y, Vega J, Peltonen E, Lagerspetz E, Ferreira D
Predicting Depression From Smartphone Behavioral Markers Using Machine Learning Methods, Hyperparameter Optimization, and Feature Importance Analysis: Exploratory Study
JMIR Mhealth Uhealth 2021;9(7):e26540
URL: https://mhealth.jmir.org/2021/7/e26540
DOI: 10.2196/26540

# Features study

→ Curated a data of variables studied in 4 research papers.

**Paper 3**: De Angel, V., Lewis, S., White, K., Oetzmann, C., Leightley, D., Oprea, E., Lavelle, G., Matcham, F., Pace, A., Mohr, D. C., Dobson, R., & Hotopf, M. (2022). Digital health tools for the passive monitoring of depression: A systematic review of methods. Npj Digital Medicine, 5(1), 1-14.
https://doi.org/10.1038/s41746-021-00548-8

**Paper 4:** Melcher J, Hays R, Torous J
Digital phenotyping for mental health of college students: a clinical review
BMJ Ment Health 2020;23:161-166.
https://mentalhealth.bmj.com/content/23/4/161

**Some Points to remember :**
1. Some of these studies are quite old, and the behavioral patterns of people have shifted in general from then, so directly picking up observations and conclusions might not be appropriate.
2. Largely focused on data of the US and other western countries.

# Features study

→ Curated a data of variables and features studied in 4 research papers.
→ In general, several low level and high level variables were studied.

**Low level features** refer to raw data from mobile phones and wearable devices, and the most common features and their categorization are:

1. Location (GPS, Wi-Fi association)

2. Accelerometer (steps, moving speed)

3. Screen Activity (screen lock/unlock, screen time, regularity)

4. Call/text/social media activity (call logs, SMS logs, Social media apps usage and frequency)

5. Internet Connectivity

6. App Usage (Types of apps, time spent and frequency)

7. Others (microphone, Bluetooth)

# Features study

→ Curated a data of variables and features studied in 4 research papers.
→ In general, several low level and high level variables were studied.

**High level features** refer to behavioral markers which are derived by studying the low-level features :

1. Sleep (duration, regularity, quality)

2. Activity levels (physical activities, steps)

3. Circadian Rhythm (daily routine)

4. Sociability (frequency and duration of calls and messages, social media apps usage)

5. Location/mobility (unique locations visited, distance covered)

6. Phone Usage (screen time, app usage, phone checks per day)

7. Mood status (anxiety severity and frequency, depression symptoms)

8. Combination of features is very commonly used and turns out to be quite effective.

# Mental health assessment surveys

→ PHQ-8 is the most reliable survey for depressive symptoms.

| How often during the past 2 weeks were you bothered by... | Not at all | Several days | More than half the days | Nearly every day |
|---|---|---|---|---|
| 1. Little interest or pleasure in doing things | 0 | 1 | 2 | 3 |
| 2. Feeling down, depressed, or hopeless | 0 | 1 | 2 | 3 |
| 3. Trouble falling or staying asleep, or sleeping too much | 0 | 1 | 2 | 3 |
| 4. Feeling tired or having little energy | 0 | 1 | 2 | 3 |
| 5. Poor appetite or overeating | 0 | 1 | 2 | 3 |
| 6. Feeling bad about yourself, or that you are a failure, or have let yourself or your family down | 0 | 1 | 2 | 3 |
| 7. Trouble concentrating on things, such as reading the newspaper or watching television | 0 | 1 | 2 | 3 |
| 8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual | 0 | 1 | 2 | 3 |

# Mental health assessment surveys

→ GAD-7 is the most reliable survey for anxiety symptoms.

| Over the last two weeks, how often have you been bothered by the following problems? | Not at all | Several days | More than half the days | Nearly every day |
|---|---|---|---|---|
| 1. Feeling nervous, anxious, or on edge | 0 | 1 | 2 | 3 |
| 2. Not being able to stop or control worrying | 0 | 1 | 2 | 3 |
| 3. Worrying too much about different things | 0 | 1 | 2 | 3 |
| 4. Trouble relaxing | 0 | 1 | 2 | 3 |
| 5. Being so restless that it is hard to sit still | 0 | 1 | 2 | 3 |
| 6. Becoming easily annoyed or irritable | 0 | 1 | 2 | 3 |
| 7. Feeling afraid, as if something awful might happen | 0 | 1 | 2 | 3 |

# Predictions & Finding correlations

→ The aim to analyse how can behavioural markers correlate with the scores on the surveys, indicating patterns in behaviour that can indicate depression or anxiety symptoms.

Some results from the studied papers are:

1.**Sleep:** Lower sleep efficiency or quality (including increased sleep fragmentation) is associated with higher depression scores.

2.**Physical Activity:** Lower levels of physical activity are associated with higher depression.

3.**Location:** Increased time spent at home is associated with higher depression scores.

4.**Sociability:** Fewer calls/texts in public places are associated with increased anxiety.

5.**Phone Use:** Averaged number of screen unlocks is negatively associated with depression

6.Combination of features often turn out better indicators of depression and/or anxiety symptoms.

# Steps ahead :

→ Check if these surveys are relevant for our audience. Find more relevant surveys and questionnaires.
→ Collect first hand data.
→ Check out what data can we get, and how can it lead to novel information and research.
→ Instabilities in routines are common in student lives. Find ways that can work for us.