



## LONELINESS DETECTION USING IoT

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### Background

Technological advancements have expanded the role and capabilities of smartphones and wearable devices to monitor users activities and behaviours unobtrusively in real time. User behavioural patterns and contextual information collected through smartphones and wearables can be modelled into passive indicators or identification markers of user's health or wellbeing. Our scoping review showed a similar efficacy in detecting loneliness<sup>1</sup> (Figure 1). Chronic loneliness may lead to health and well-being difficulties, including depression, anxiety, inflammations, diabetes and high blood pressure, and eventually to death<sup>2</sup>. Awareness can prevent chronic loneliness and its subsequent effects.

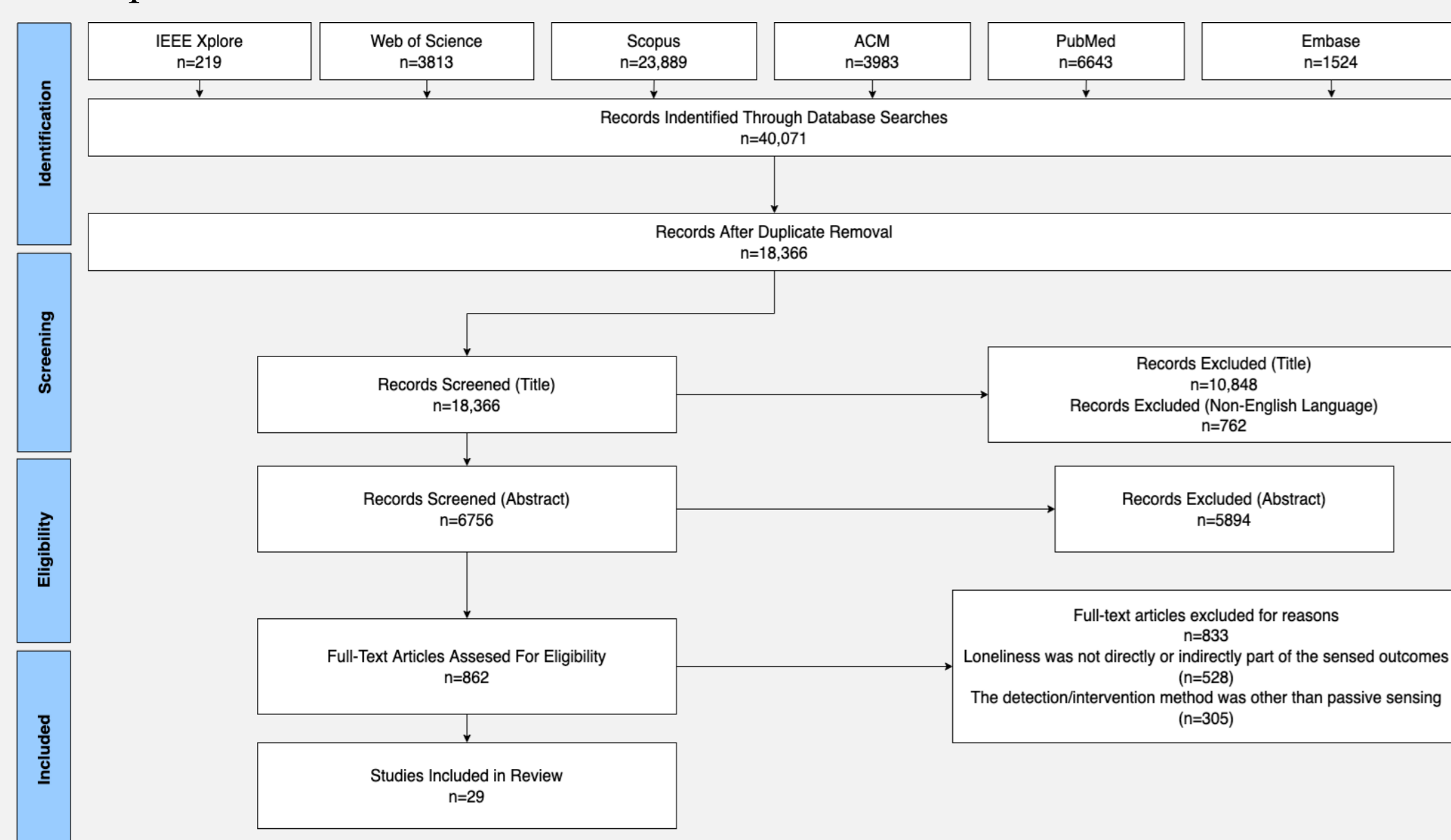


Figure 1. Flow diagram of literature search and selection process

### Aims & Objectives

This study investigated the effectiveness of Federated learning and centralized models to use data from passive sensing to detect loneliness. Current approaches rely on machine learning with centrally held user data, thereby jeopardizing user privacy. To overcome privacy concerns, we explored the use of federated learning on single user data to detect loneliness detected by smartphone sensors. Federated learning protects user privacy by preventing sensitive data from mobile devices sent to a central server. To evaluate the federated method's performance in detecting loneliness, we also presented centralized machine learning methodology to train models on all user data.

### Method

This study analysed data from the StudentLife dataset that includes mobile sensors data from 48 students. We have used activity, conversation, location, calls & SMS logs and Bluetooth sensors data (Figure 2). The dataset also contains scores on the UCLA loneliness scale; a 20-item questionnaire meant to assess subjective feelings of loneliness. This score has been used as ground truth measure for sensors data to detect loneliness levels among students.

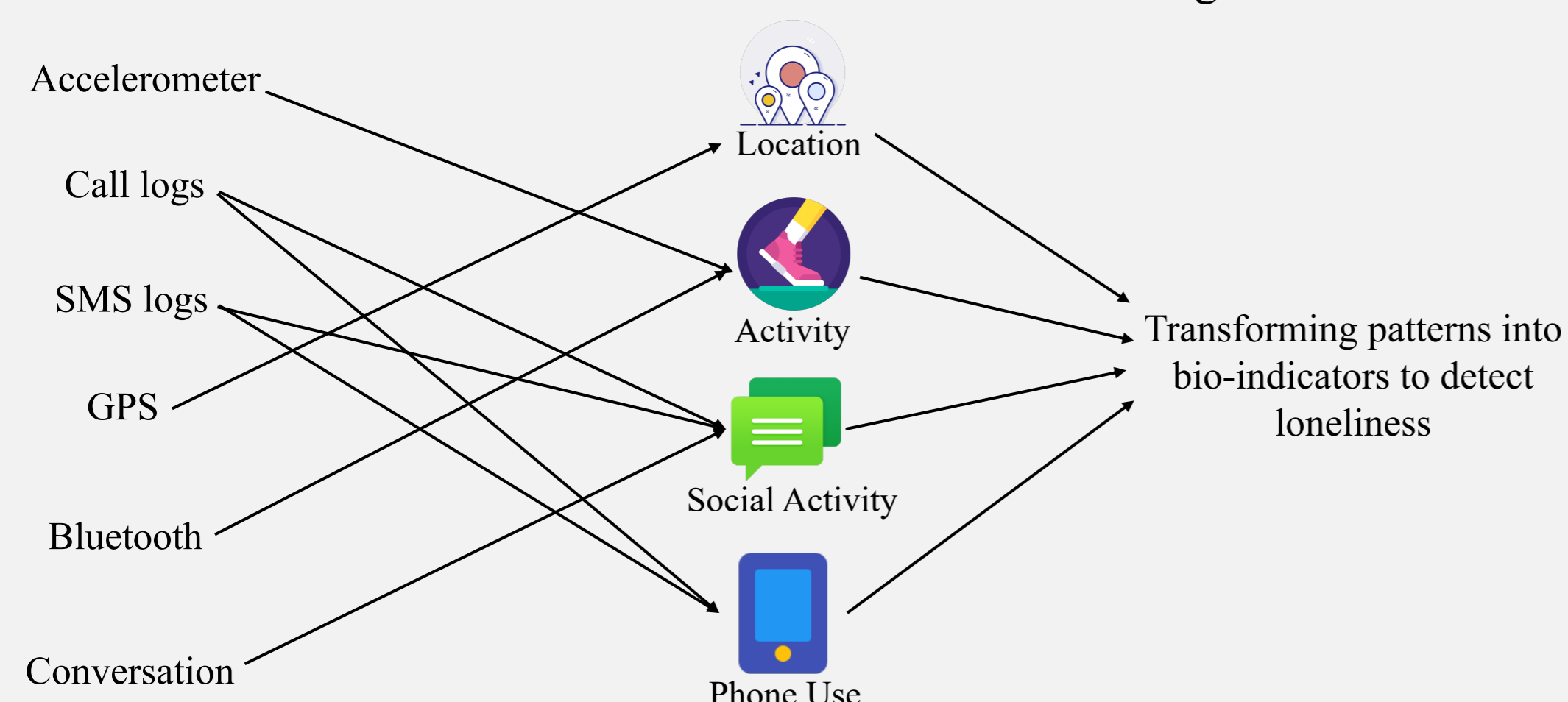


Figure 2. Data collected through smartphones

### Results

The results indicate that while centralised machine learning models perform better than FL models, federated learning has great potential for loneliness detection via passive sensing. Tree-based algorithms showed great performance for both centralised and FL approaches. Centralized and Federated machine learning models showed that XGBoost had the highest accuracy among the models, while logistic regression had the lowest accuracy (Tables 1 & 2).

Table 1. Performance based on centralized models

	Accuracy	Precision	Recall	F1 Score
<b>XGBoost</b>	83%	93%	89%	91.5%
<b>Random Forest</b>	85%	89%	82%	87%
<b>SVM</b>	78.5%	77%	83%	81%
<b>Logistic Regression</b>	73%	68%	79%	75%

Table 2. Performance based on Federated learning

	Accuracy	Precision	Recall	F1 Score
<b>XGBoost</b>	77.5%	81%	84%	81.5%
<b>Random Forest</b>	72%	61.5%	76%	68%
<b>SVM</b>	68%	58%	71%	67%
<b>Logistic Regression</b>	51%	43%	61%	56%

### Conclusions

- Raising awareness at early stages of loneliness may prevent its chronic form and subsequent health and psychological difficulties.
- While centralized models were more accurate in detecting loneliness; Federated learning models showed promising results specially for tree-based
- Our current research aims to expand existing findings to older adults who are at higher risk of loneliness

### UN SDG Challenge and Industry Collaboration

Mental health is at risk, especially after COVID-19

Early detection can raise awareness and lead to interventions to deal with loneliness, resulting in better physical and mental health

**GOAL 3 – GOOD HEALTH AND WELL-BEING**

Using ubiquitous devices to detect loneliness while preserving data privacy

Successful use of technology to detect loneliness will open new avenues for other mental health issues

Multiple smartphone vendors, such as Apple and Huawei, are now including various health and well-being built-in apps in their smartphones. They are already collecting a large amount of sensor data from various sensors in order to determine health-related statistics. A possible industry collaboration would be to incorporate a loneliness detection feature into those apps, either using data collected centrally or via federated learning to protect users' data privacy.

### References

- <sup>1</sup>Qirtas, M. M., Zafeiridi, E., Pesch, D., & White, E. B. (2022). Loneliness and Social Isolation Detection Using Passive Sensing Techniques: Scoping Review. JMIR mHealth and uHealth, 10(4), e34638.
- <sup>2</sup>Patterson, A. C. & Veenstra, G. (2010). Loneliness and risk of mortality: A longitudinal investigation in Alameda County, California. Social Science and Medicine, 71, 181-186.
- <sup>3</sup>Qirtas, M. M., Zafeiridi, E., Pesch, D., & White, E. B. (2022). Privacy Preserving Loneliness Detection: A Federated Learning Approach. Submitted in IEEE International Conference on Digital Health 2022.