Predicting Social Anxiety with Application Session Usage Data

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Mental Health in Society

- In the UK, diagnosed individuals increases yearly (1 in 10 in 2005, 1 in 6 in 2007, 1 in 4 in 2016)
- How do individuals with mental health issues feel?
  - Isolated
  - Socially unacceptable
  - A burden on others
- Outside of the UK, mental health disorders considered one of the main contributors to overall disease burden
- Individuals may be misdiagnosed, or may ignore it
- 40-60% chance of premature death

How has society reacted?

- NHS is increasing their investment for mental health care
  - 13 billion pounds estimated to be spent in 2019/20
  - This is equal to about 14% of the entire NHS fund
- Waiting times vary greatly and discourage people
- Many health systems are not adequately prepared
- Large negative social stigma

Social Anxiety

- Overwhelming fear of social situations
- Can be triggered by many circumstances
- What goes on in their mind?
  - Decreased self-confidence
  - Feel like they are incoherent
  - Are not interesting individuals
- All this leads to
  - Lower performance in school/work
  - Strained relationships
  - Lower economic status
- More pressure on health care systems

Researching Mental Health

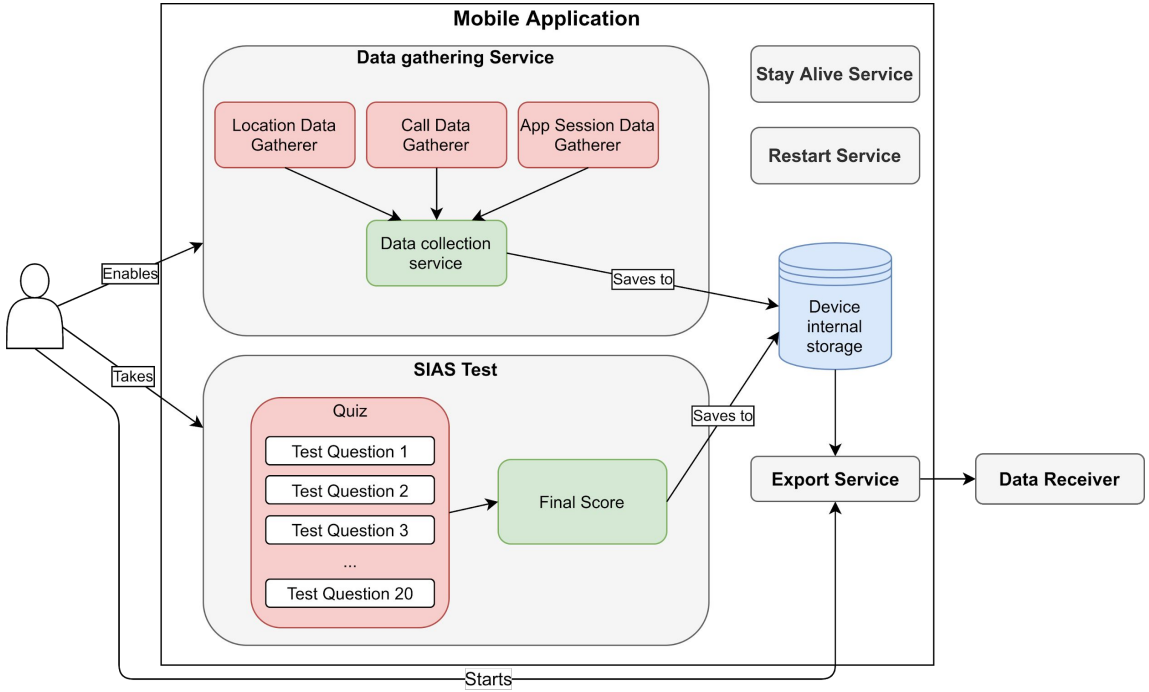
- Wang et al. (2014)
  - Combination of self-report questions and data collection
  - Shows strong connection between student mobility, activity level, sleep, and the mental well-being
- Ben-Zeev et al. (2015)
  - Shows that collected data in the background is enough to analyse user mental health, stress, and depression
- Welke et al. (2016)
  - Shows that it is possible to differentiate between users by their application signature (set of used apps)
- Boukhechba et al. (2017)
  - High accuracy in predicting social anxiety when using location and mobility (call and SMS text) data
- Rauber et al. (2019)
  - Used application usage patterns to accurately differentiate between healthy and cognitively impaired individuals

Project Aim

- Can an individual’s social anxiety be reasonably predicted by observing how they use their mobile phone?
- What can their set of used applications tell us?

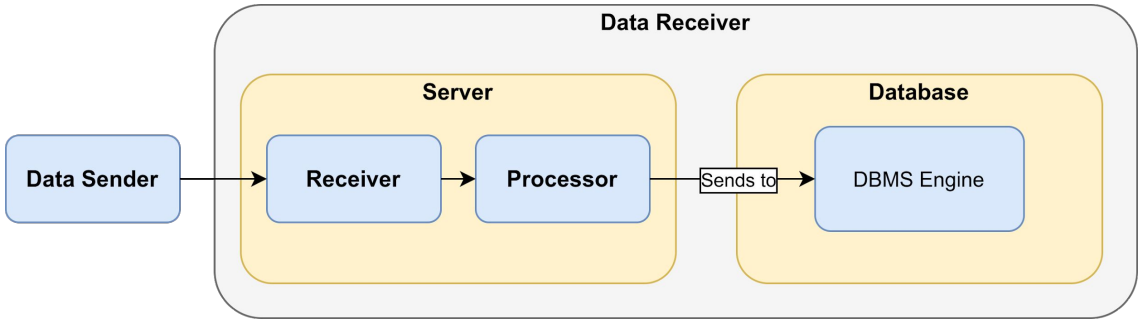
Project Design

- Application to collect data in the background

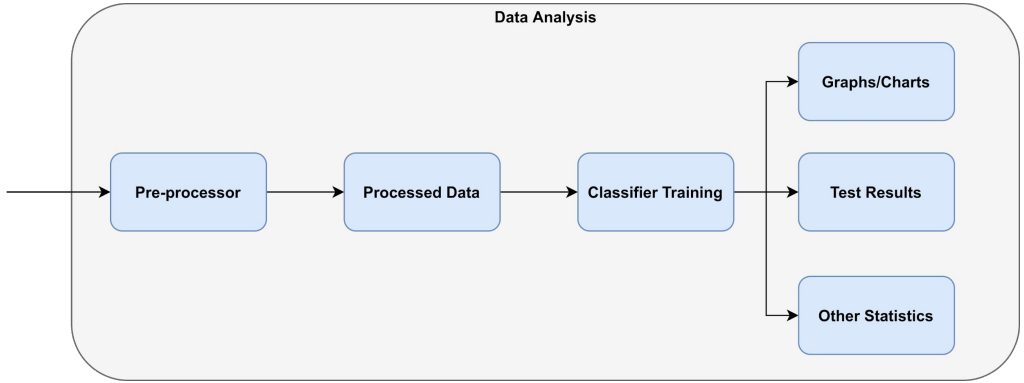


Project Design (cont.)

- Remote server and database to receive and store data



- Data analysis



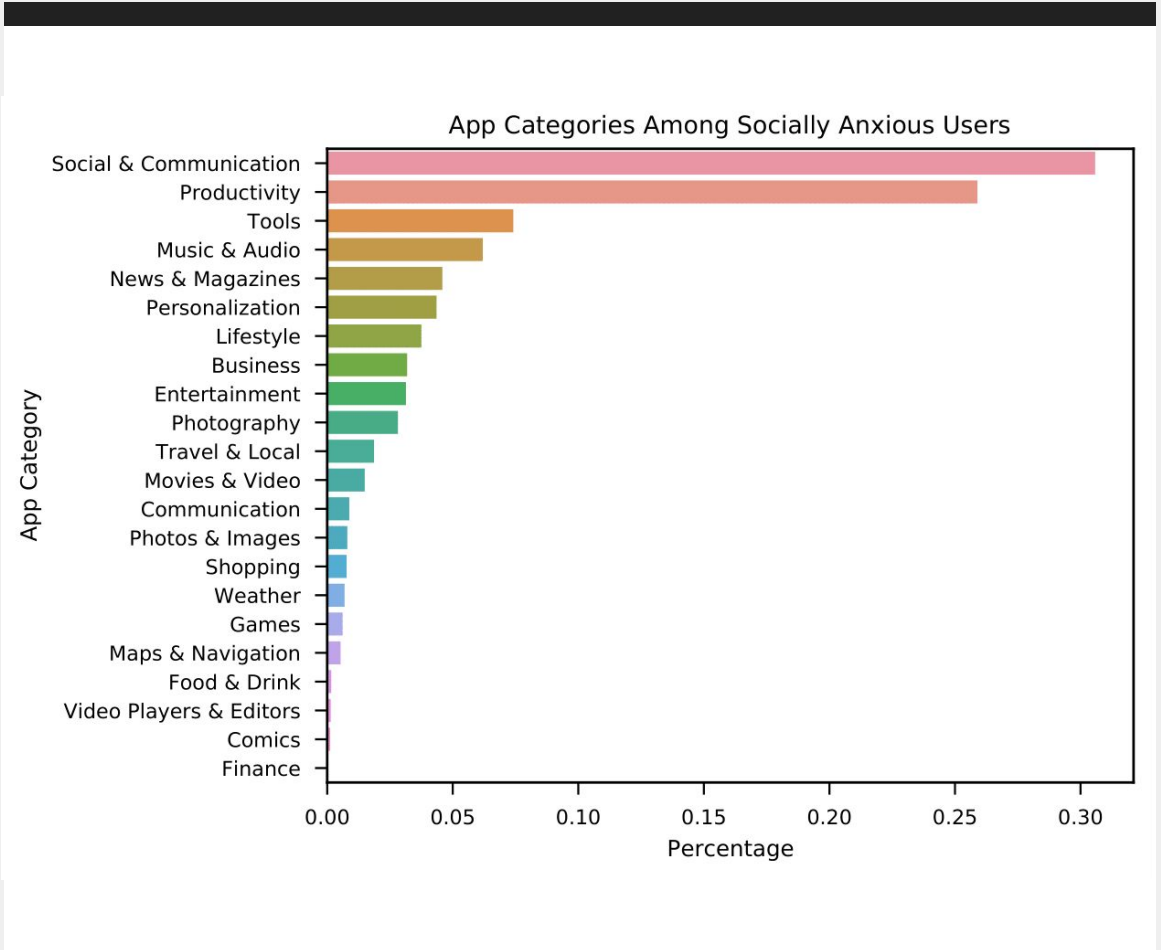
Project Implementation

- Android application
  - SIAS test
  - Location used Fused Location Provider API
  - Session data used Usage Stats Manager API
  - Call duration manually tracked
  - Export service with Okhttp POST requests
- Amazon Web Services for server (EC2) and database (RDS)
- Data analysis
  - Python
  - Pandas and numpy
  - Scikit-learn
    - Decision Tree Classifier
    - Extra Trees Classifier
    - Random Forest Classifier
  - Matplotlib and Seaborn

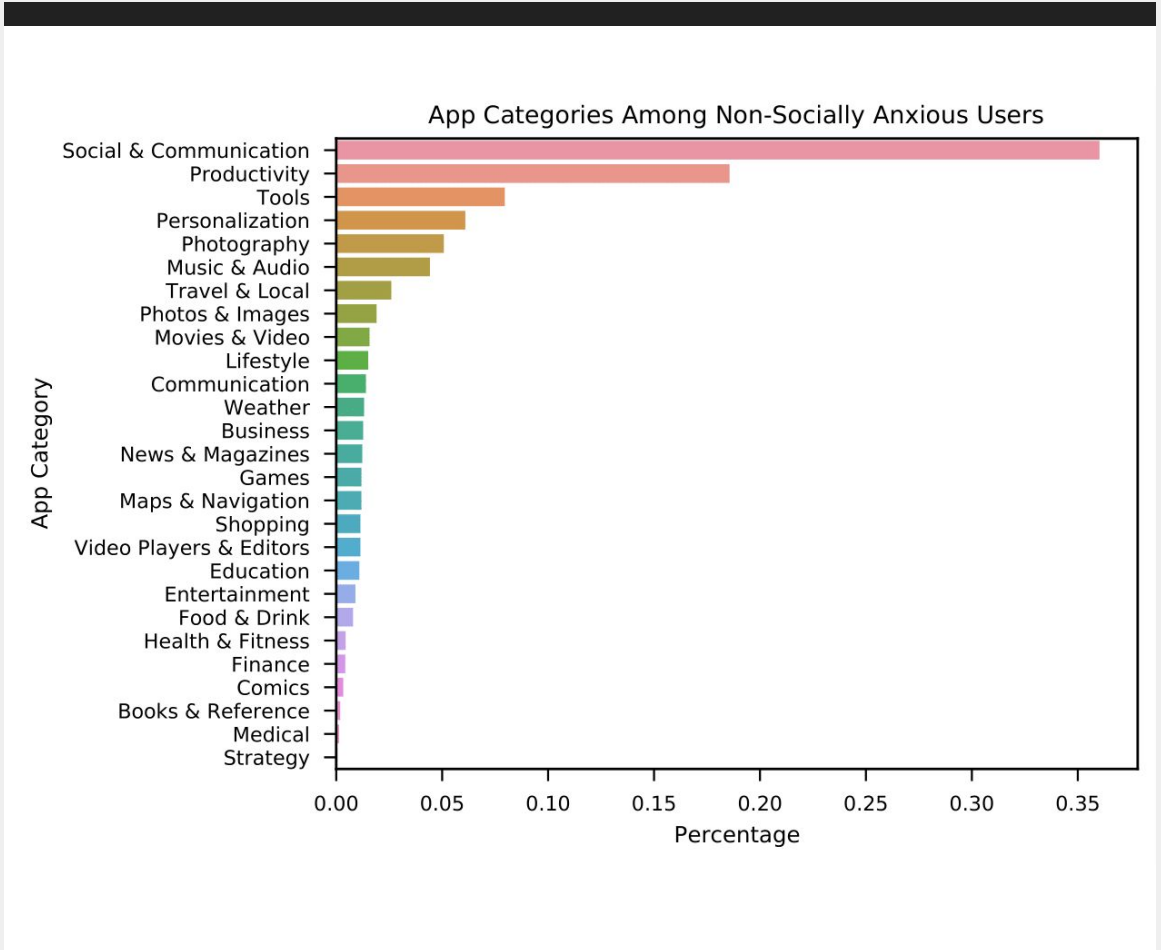
Evaluation

- Decision tree with location data achieved accuracy of 86%
  - This conforms with Boukhechba et al. (2017) and Wood (2019)
  - Cross-validation confirms model accuracy.
  - Most popular location category among socially anxious individuals was *home*
  - More research is needed
  - Care should be taken when processing location data

Evaluation (cont.)

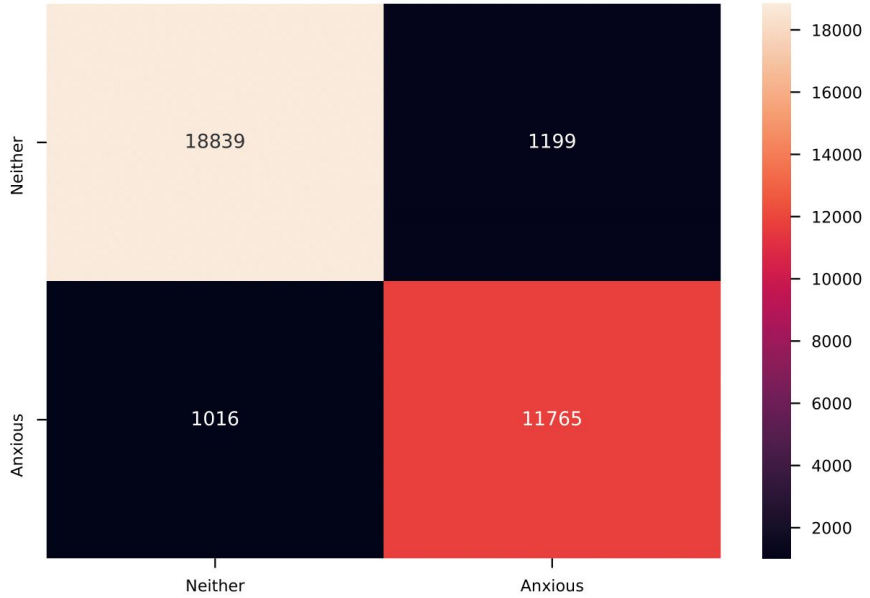


Evaluation (cont.)

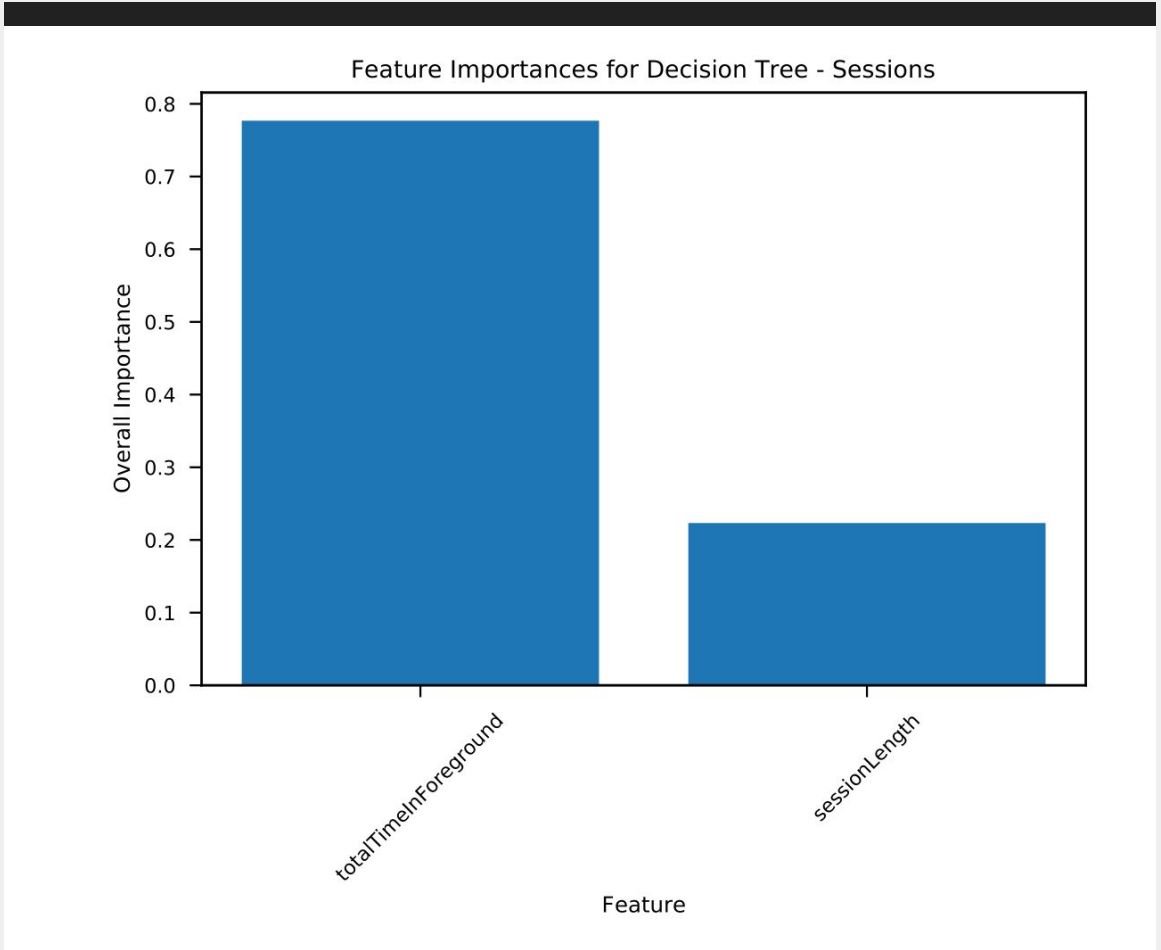


Evaluation (cont.)

- Decision tree with app session usage achieved 93% accuracy
  - Most important indicator is how long application was used
  - Cross-validation shows that the model is sound but suggests that more features need to be added
  - Could the decision tree be overfitting?



Evaluation (cont.)



Evaluation (cont.)

- Extra Trees and Random Forest classifier models were trained
  - Deal with overfitting and class imbalance better
  - Extra trees and random forest accuracy is 86% and 87% respectively
  - Cross-validation shows the models are sound
  - The total time is once again the most important indicator

Conclusion

- Application session usage data can be an indicator of social anxiety
- But...

Future Work

- More data needs to be captured
- More classifier features need to be added
- A different classifier that can account for data related issues should be used
- More participants are needed
    - Different age groups
    - Apple users
- Text embedding method similar to Rauber et al. (2019) is an alternative way of looking at session data
- Can session usage data be used to identify other serious health problems?

References

- Wang, R., Chen, F., Chen, Z., Li, T., Harari, G., Tignor, S., Zhou, X., Ben-Zeev, D. and Campbell, A. T. (2014b), Studentlife: Assessing mental health, academic performance and behavioral trends of college students using smartphones,in ‘Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing’, UbiComp ’14, Association for Computing Machinery, New York, NY, USA, p. 3–14.URL:https://doi.org/10.1145/2632048.2632054
- Ben-Zeev, D., Scherer, E. A., Wang, R., Xie, H. and Campbell, A. T. (2015), ‘Next-generation psychiatric assessment: Using smartphone sensors to monitor behavior and mental health’,Psychiatr Rehabil J38(3), 218–226.
- Welke, P., Andone, I., Blaszkiewicz, K. and Markowetz, A. (2016), Differentiating smartphone users by app usage,in ‘Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing’, UbiComp ’16, Association for Computing Machinery,New York, NY, USA, p. 519–523.URL:https://doi.org/10.1145/2971648.2971707
- Boukhechba, M., Huang, Y., Chow, P., Fua, K., Teachman, B. A. and Barnes, L. E. (2017),Monitoring social anxiety from mobility and communication patterns,in ‘Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers’, UbiComp’17, Association for Computing Machinery, New York, NY, USA, p. 749–753.URL:https://doi.org/10.1145/3123024.3125607
- Rauber, J., Fox, E. B. and Gatys, L. A. (2019), ‘Modeling patterns of smartphone usage and their relationship to cognitive health’.
- Taskforce, M. H. (2016), The five year forward view for mental health, Technical report, Mental Health Taskforce.
- Strategies, M. H. (2008), The 2007/08 national survey of investment in mental health services,Technical report, Department of Health and Social Care.
- WHO (2005), ‘Mental health of children and young people in great britain, 2004’, 20 Avenue Appia, 1211 Geneva 27, Switzerland.
- NIMH (2016), ‘Social anxiety disorder: More than just shyness’,https://www.nimh.nih.gov/health/publications/social-anxiety-disorder-more-than-just-shyness/index.shtml. Last accessed: 2020-03-18.