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PhoneMD: Learning to Diagnose Parkinson's Disease from Smartphone Data

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1 Introduction

Parkinson's disease (PD) is a **neurodegenerative disease** that can affect a person's **movement**, **speech**, **dexterity**, and **cognition**. Physicians typically diagnose PD based on a **subjective clinical assessment of symptoms**. However, ...

- **Misdiagnoses** are common [1]
- Symptom severity may **fluctuate** over time [1]
- Symptoms may **not** be **pronounced during assessment**

2 Smartphone Tasks

To address these issues, we present a machine-learning approach to diagnosing PD from **long-term data collected from smartphone-based tests**. We utilise data collected during the **mPower study** [2].

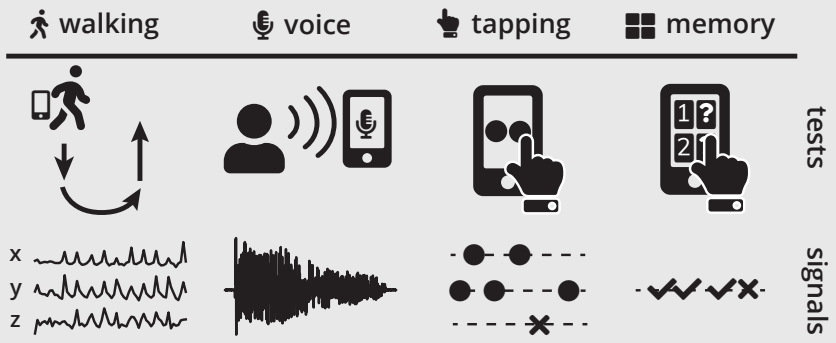
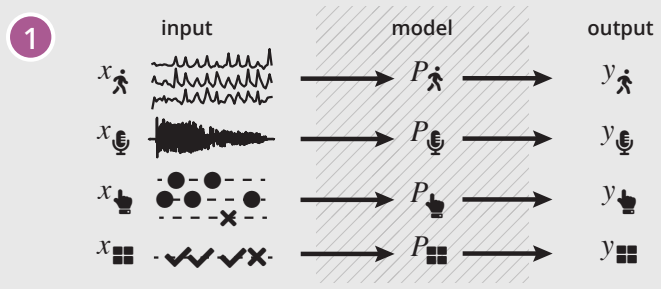


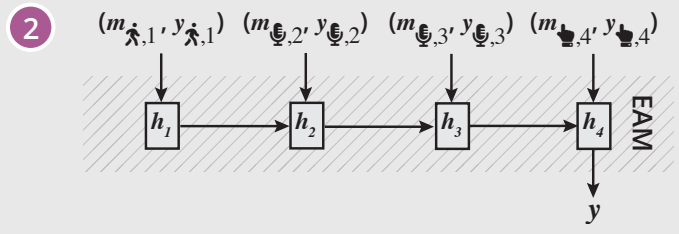
Figure 1. Smartphones can be used to perform tests that are designed to trigger symptoms of Parkinson's disease (top). During these tests, smartphone sensors record highresolution signals (bottom) that we can use to diagnose Parkinson's disease.

3 Hierarchical Model

Per-test Models: Specialised for each test type.



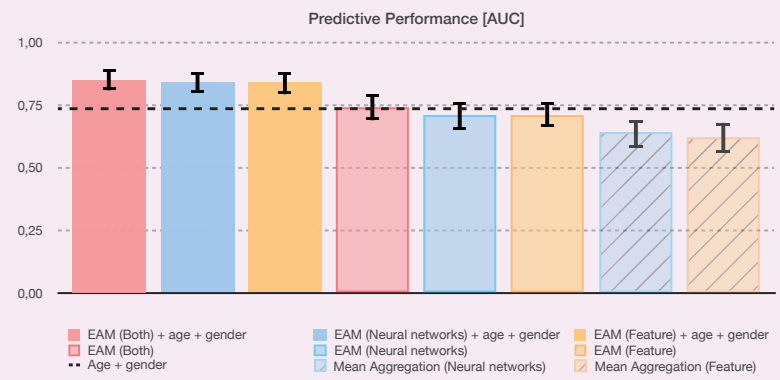
Evidence Aggregation Model (EAM): Aggregate test data over time.



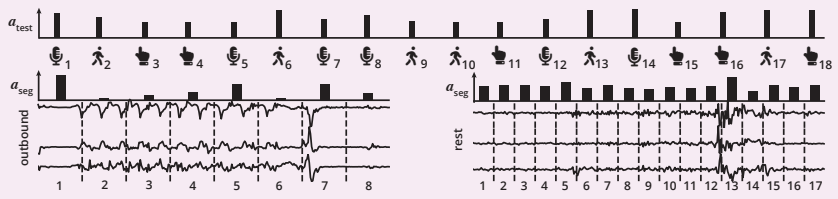
4 Results

We evaluated the proposed hiearchical machine-learning model with several baselines and under various configurations on a held-out test set of 347 patients (20%) of which 56.2% had PD. We found that ...

- The **EAM models significantly outperformed** the demographic baseline (Age + gender), and Mean and Max Aggregation.
- Expert features achieved similar performances as learned features.
- Expert features and learned features were to some degree complementary, as EAMs that used both performed slightly better.



Hierarchical Attention: We additionally determined the importance of individual tests and segments within those tests towards the final diagnostic decision using hierarchical neural attention.



5 Conclusion

We present an approach to diagnosing PD that ...

- **works** based on multiple smartphone-based tests that **cover** a **wide range of symptoms**
- informs the clinician about the **importance of tests and segments within those tests** using neural attention
- achieves **strong performance** in a **large, representative cohort** with an **AUC of 0.85 (95% CI: 0.81, 0.89)**

In addition, we highlight the potential of **smartphones** as accessible **tools** for gathering **clinically relevant data in the wild.**

6 References

1. Pahwa, R., and Lyons, K. E. 2010. Early diagnosis of Parkinson's disease: recommendations from diagnostic clinical guidelines. AmJ Manag Care 16(4):94–99.
2. Bot, B. M.; Suver, C.; Neto, E. C.; Kellen, M.; Klein, A.; Bare, C.; Doerr, M.; Pratap, A.; Wilbanks, J.; Dorsey, E. R.; et al. 2016. The mPower study, Parkinson disease mobile data collected using ResearchKit. Scientific data 3:160011. Web: https://parkinsonmpower.org
3. Schwab, P., and Karlen, W. 2019. PhoneMD: Learning to Diagnose Parkinson's Disease with Smartphone Data. AAAI Conference on Artificial Intelligence.

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FNSNF Swiss National Science Foundation

75 NRP Big Data National Research Programme