Exploring Smartphone Keyboard Interactions for Experience Sampling Method driven Probe Generation

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Background

- **Smartphone Keyboard Interaction based Emotion Detection**
  - Mental state tracking [1,2]
  - Guided response generation [3]
  - Adaptive interface design [4,5]

- **At the core of such value-added services**
  - Supervised ML model for emotion inference
    - It requires emotion self-reports (ground truth)

- **Manual Self-report Collection → Experience Sampling Method (ESM)**
  - Time-consuming, fatigue-inducing

Intelligent probing strategies to **probe at opportune moments** for emotion self-report collection are essential.

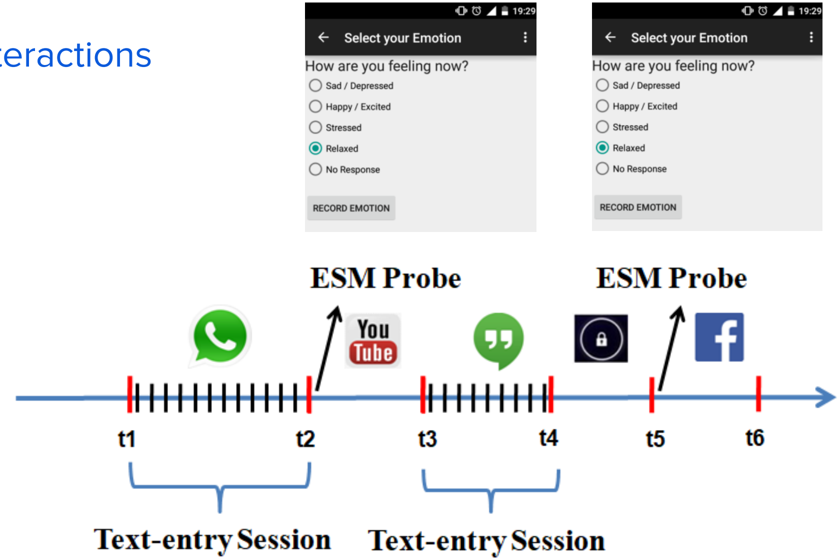
Research Question

- **Typing activities in smartphone contains two facets**
    - *Timing* – relates to time-domain characteristics
    - *Rhythm* – relates to frequency-domain characteristics

Can we leverage these **time and frequency domain characteristics** for intelligent probing?

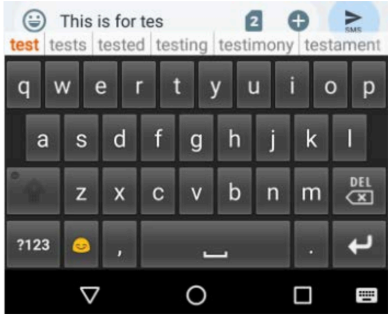
Keyboard Interaction based Probing

- **Identify typing sessions**
  - Track typing sessions from user's smartphone interactions
- **Extract typing characteristics from these sessions**
  - Based on typing patterns, **not actual text**
- **Label the sessions (probing moments)**
  - By collecting self-reports after sessions
- **Develop ML models**
  - Correlating typing characteristics and session labels (opportune / inopportune)

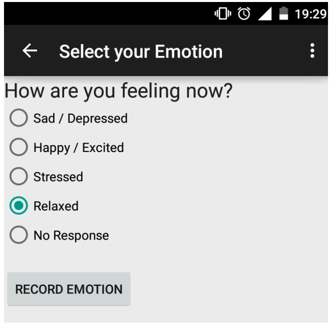


Field Study & Dataset

- **Experiment Apparatus**
  - Android application
    - Tracing keyboard interaction
    - Collect self-reports
      - **Emotion labels → Opportune**
      - **No Response → Inopportune**
- **Study details**
  - 3-week in-the-wild study
  - Number of participants – 22 (18 m, 4 f)
- **Dataset**
  - 3463 sessions (83% opportune, 17% inopportune)



App Keyboard



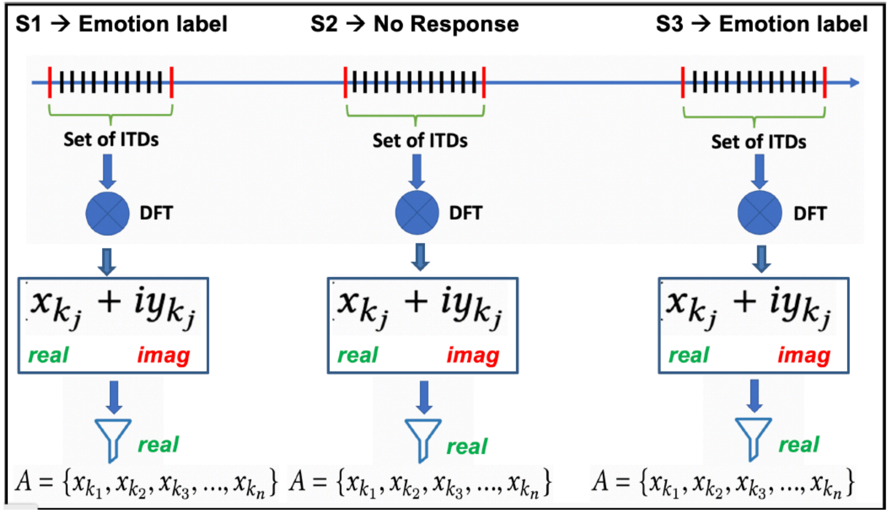
Self-report UI

Methodology

- **Session Representation**
  - A set of ITDs → elapsed time between two consecutive typing events

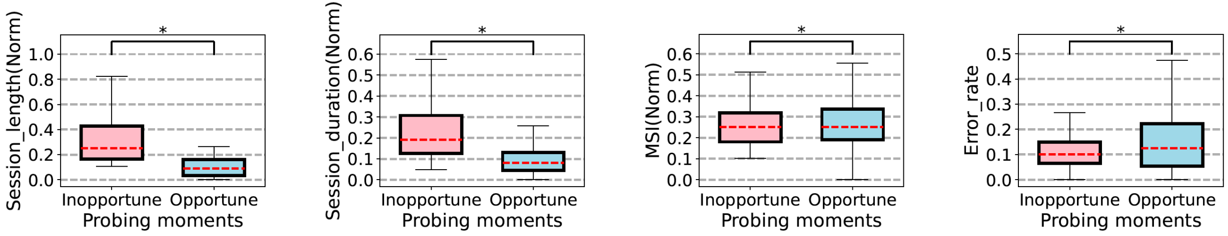
- **Time-domain characteristics**
  - Session length
  - Session duration
  - Session speed
  - Error rate

- **Frequency-domain characteristics (after DFT)**
  - No of peaks
  - Peak_amp1
  - Peak_amp2
  - Peak_amp3



Data Analysis

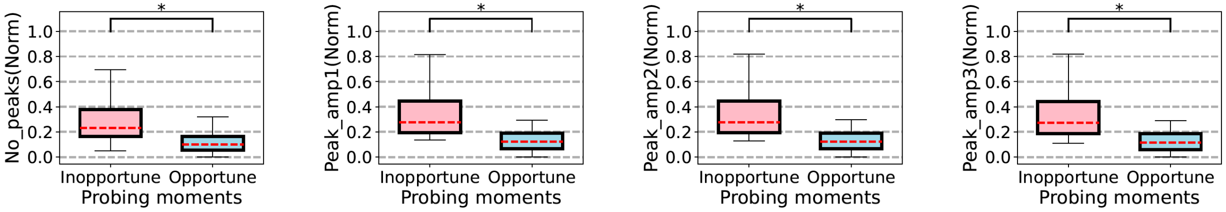
- **Time-domain characteristics**
  - Vary significantly (p<0.001) between two types of probing moments



(a) Session length (b) Session duration (c) Session speed (d) Error rate

- Not normal distribution
- Unpaired Mann-Whitney Test

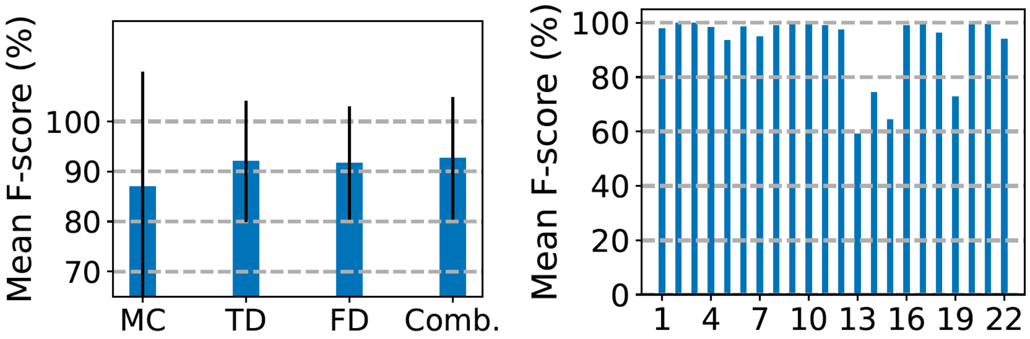
- **Frequency-domain characteristics**
  - Vary significantly (p<0.001) between two types of probing moments



(a) Total no. of peaks (b) First peak amp (c) Second peak amp (d) Third peak amp

Opportune Probing Moment Prediction

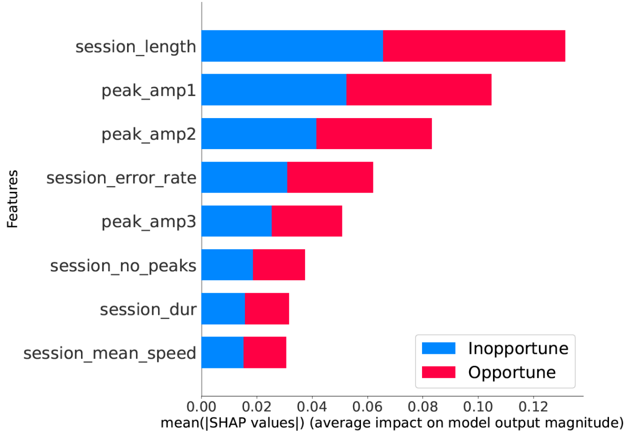
- **Model Performance**
  - MC → Majority class
  - TD → Only time-domain
  - FD → Only freq-domain
  - Comb → TD + FD



(a) Model-wise F-score (b) User-wise F-score

- **Model Performance**
  - Combined model outperforms others
  - Avg F-score: 93% (std. dev 12%)

- **Explainability Analysis**
  - Top time-domain feature: session length
  - Top frequency-domain feature: peak_amp1



Conclusion

- **Smartphone keyboard interaction pattern**
    - Contains both time-domain and frequency-domain signatures
        - vary significantly between opportune and inopportune probing moments

- **Machine learning based model to determine opportune probing moments for self-report collection**
    - Combining both time-domain and frequency-domain signatures
        - Proposed model obtains an average F-score of 93% (std dev 12%)

References

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Thank You!!

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