Towards Estimating Missing Emotion Self-reports Leveraging User Similarity: A Multi-task Learning Approach

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Motivation and Background

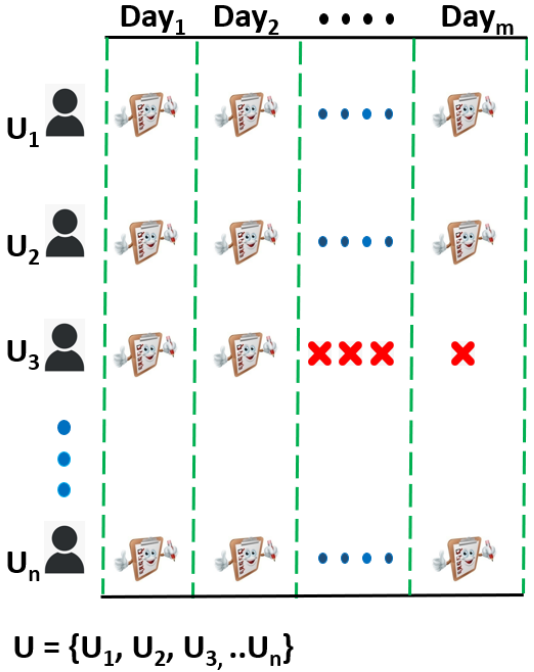
Let’s assume a scenario,

- An HCI researcher plans for a long-term user study
  - for emotion self-report collection

Motivation and Background

During the study,

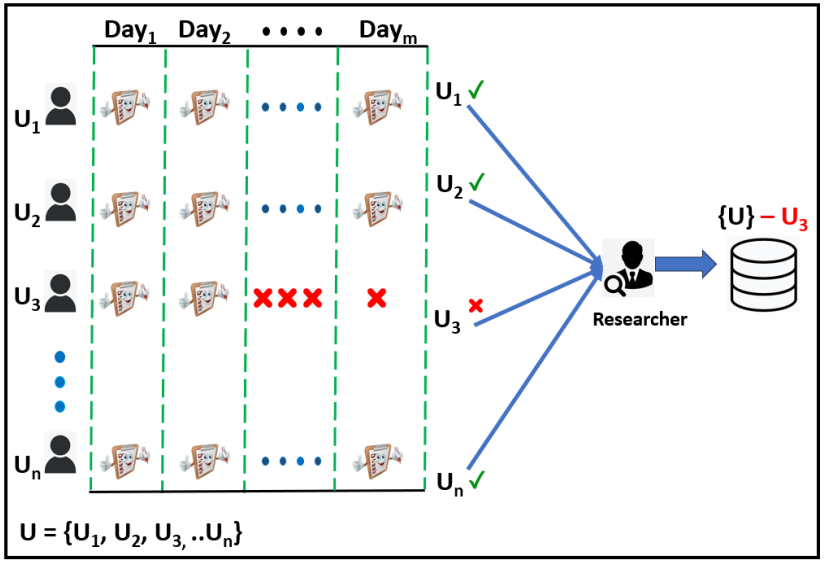
- some participants drop out in between



Motivation and Background

During the study,

- some participants drop out in between
- therefore, the researcher needs to discard data from these participants



Research Question

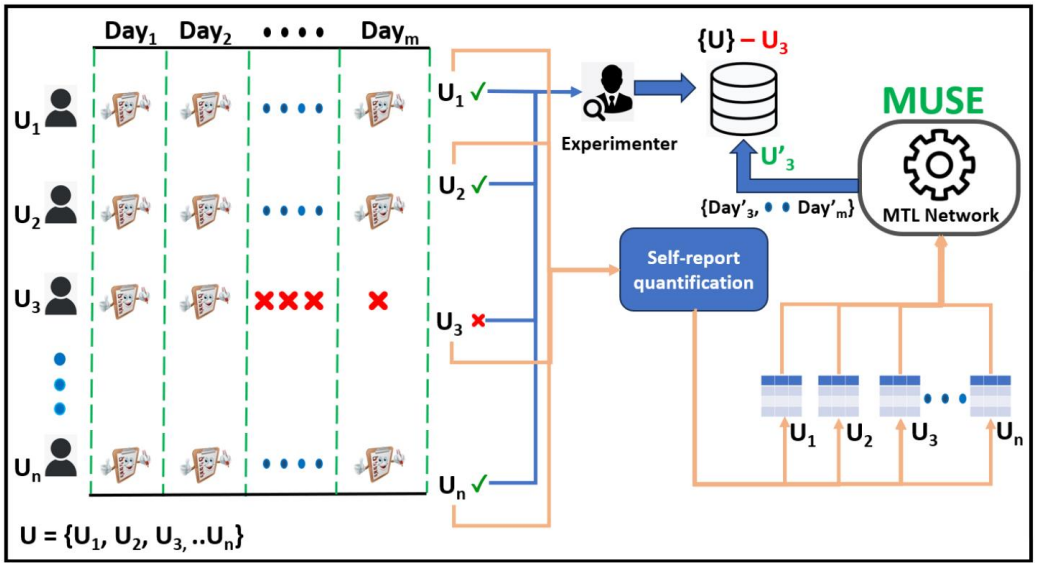
Can we develop efficient approaches to counter the data loss?

- without rerunning user study
  - incurs cost (time, effort)
- without using any additional sensor details
  - incurs energy, raises privacy concerns

MUSE: MTL for Emotion Self-report Estimation

MUSE: Multi-task Learning Framework for **U**ser **S**imilarity based **E**motion Self-report Estimation

- estimate missing emotion self-reports of drop-out participants



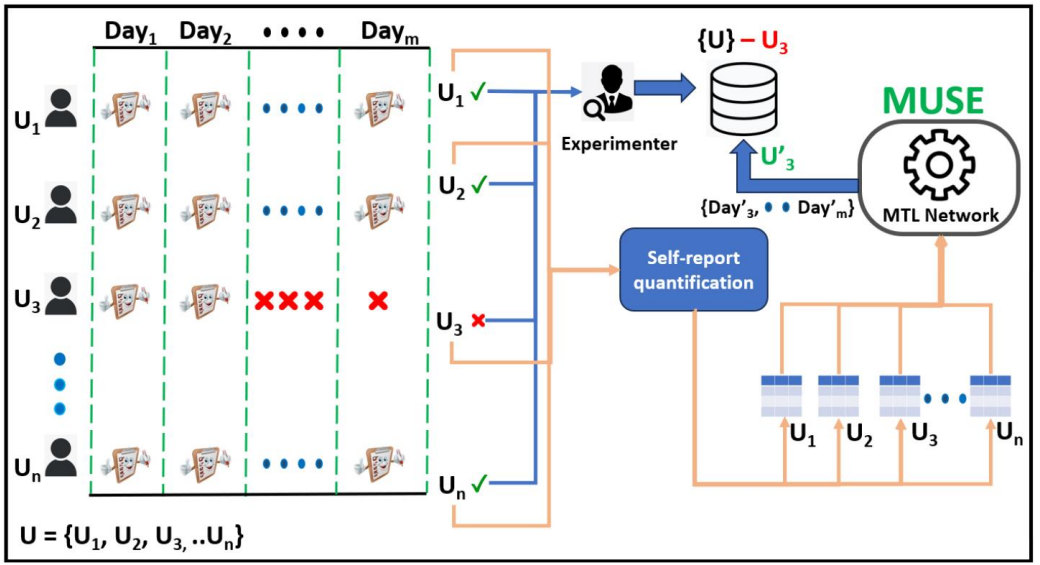
MUSE: MTL framework for emotion self-report estimation

MUSE: MTL for Emotion Self-report Estimation

Why MTL?

- Allows to learn multiple (*similar*) tasks at the same time (even with limited data from individual task)

- Every user → a task



MUSE: MTL framework for emotion self-report estimation

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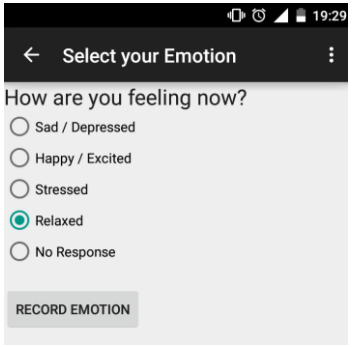
MUSE: Multi-task Learning Framework for **U**ser **S**imilarity based **E**motion Self-report Estimation

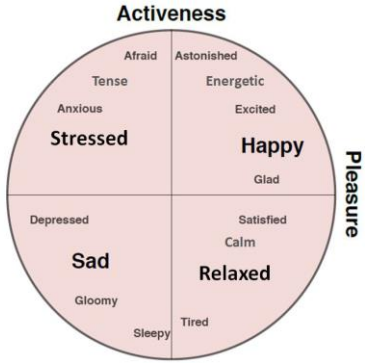
- estimate missing emotion self-reports of drop-out participants
  - quantify emotion self-report behvaior
  - Self-report estimation modeling

User Study I: Homogeneous Population

- 24 participants (20M, 4F) → university students
- Reported four emotions using the UI as shown
  - Happy, sad, stressed, relaxed
  - 6-week study
  - Total self-reports: 5677



Self-report UI



Circumplex model

User Study I: Homogeneous Population

- Self-report quantification
  - Emotion transition
  - Emotion persistence
  - Emotion recurrence length

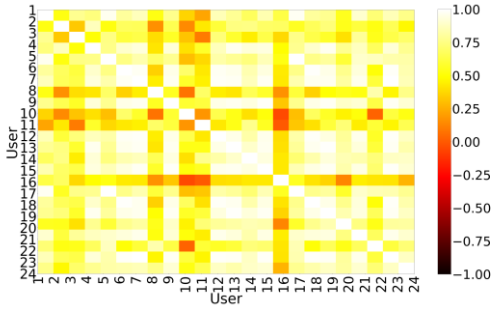
$$p_{xy} = \frac{n_{xy}}{n_x}$$

$$P = \begin{pmatrix} p_{hh} & p_{hs} & p_{ht} & p_{hr} \\ p_{sh} & p_{ss} & p_{st} & p_{sr} \\ p_{th} & p_{ts} & p_{tt} & p_{tr} \\ p_{rh} & p_{rs} & p_{rt} & p_{rr} \end{pmatrix}$$

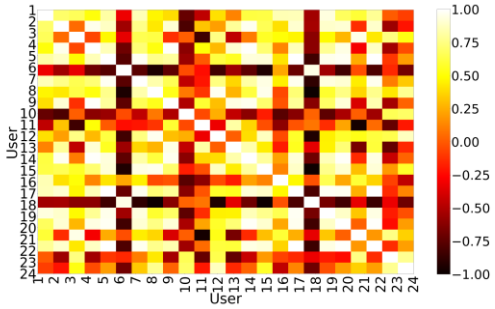
Sequence number	1	2	3	4	5	6	7	8
Self-report	H	H	S	R	H	H	H	T
Elapsed time (in Hr.)	2	3	2	3	6	4	2	3

User Study I: Homogeneous Population

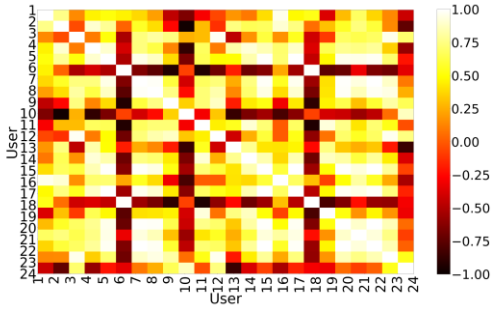
- Self-reporting similarity



Emotion transition similarity



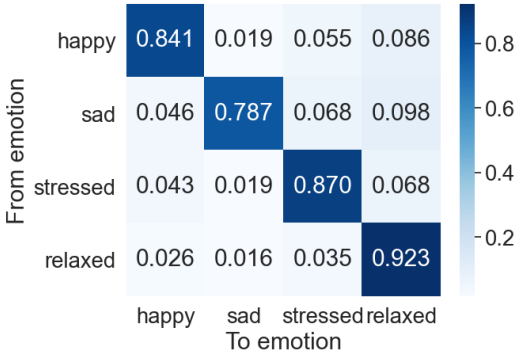
Persistence period similarity



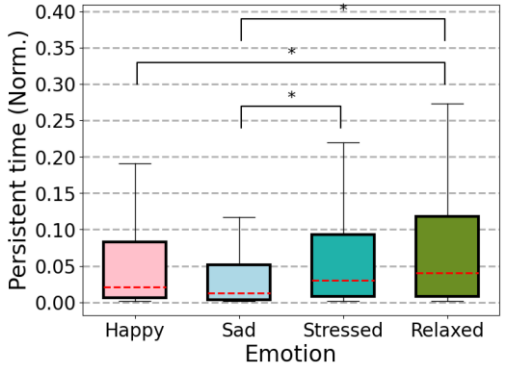
Sequence length similarity

User Study I: Homogeneous Population

- Self-reporting characteristics: Emotion discrimination



Emotion transition probabilities across emotions

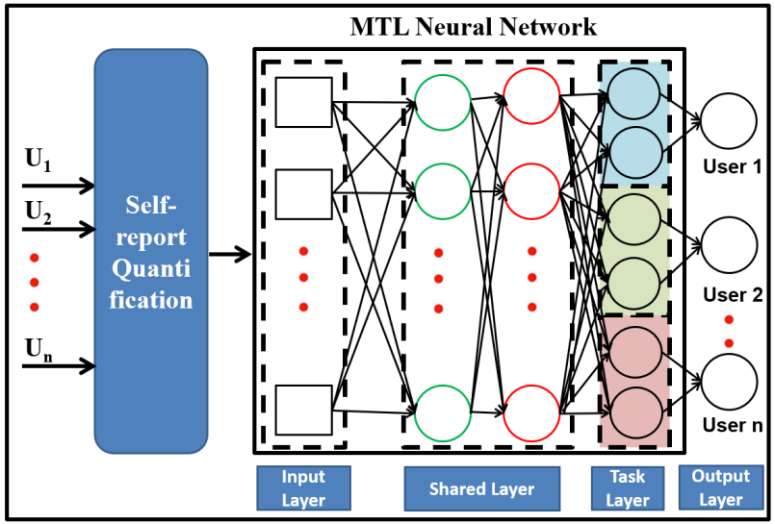


Persistence time comparison

Sequence length comparison

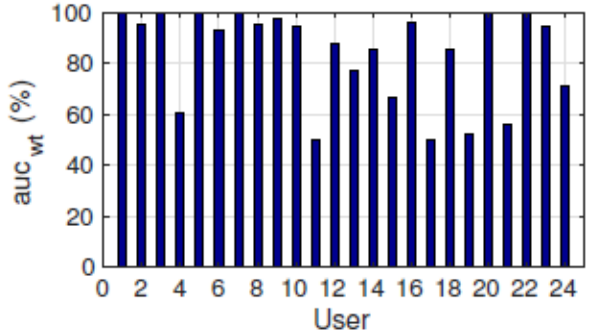
User Study I: Homogeneous Population

- Self-reporting modeling: MTL network
  - Every task → user
    - Shared layer
    - Task-specific layer



User Study I: Homogeneous Population

- Performance evaluation
  - Overall mean AUCROC → 84% (SD: 18%)

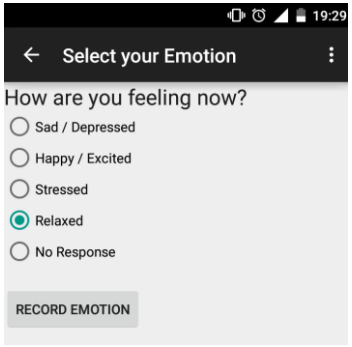


User-wise AUCROC

Emotion-wise AUCROC

User Study II: Heterogeneous Population

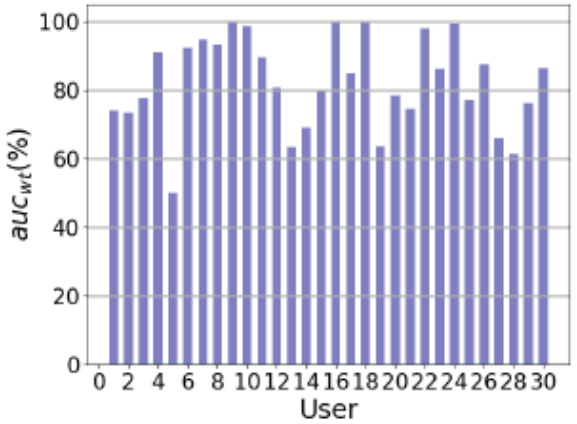
- 30 participants (16M, 14F)
- Diverse profile
  - Geo location, qualification, background
- Reported same four emotions
  - 8-week study
  - Total self-reports: 7314



Self-report UI

User Study II: Heterogeneous Population

- Performance evaluation
  - Overall mean AUCROC → 82% (SD: 14%)

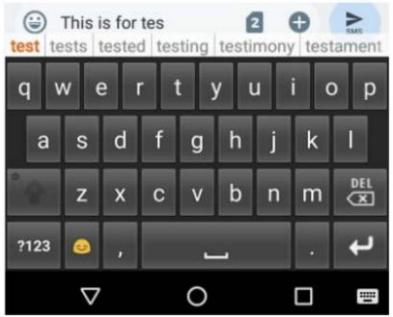


User-wise AUCROC

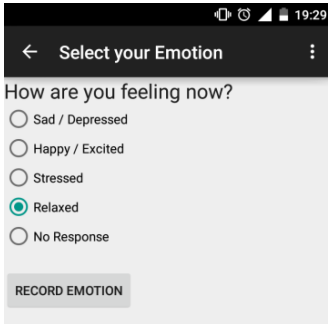
Emotion-wise AUCROC

Utility of MUSE: Downstream Application

- Smartphone keyboard based emotion detection
  - Extract typing features
  - Correlate them with emotion self-reports
    - happy, sad, stressed, relaxed
  - Develop ML model for emotion inference



App keyboard

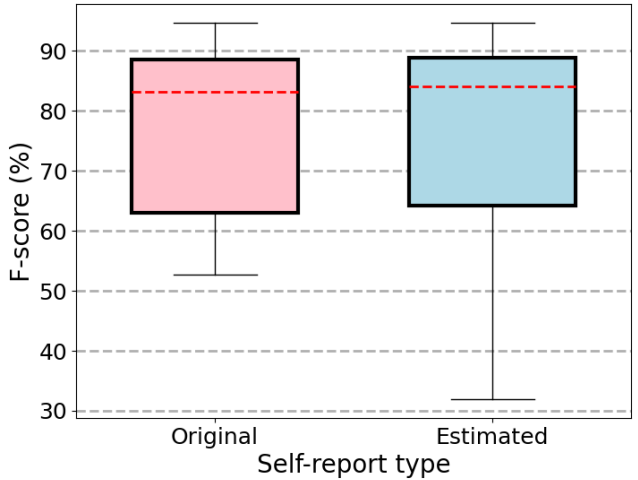


Self-report UI

Utility of MUSE: Downstream Application

- Evaluation
  - Scenario I: Original self-reports are used
  - Scenario II: Estimated self-reports (by MUSE) are used

No significant difference in emotion detection F-score, if estimated self-reports are used to train the model



Conclusion

- Proposed MUSE
  - Multi-task Learning Framework for User Similarity based Emotion Self-report Estimation
    - Self-report quantification
  - Evaluated with two large-scale user studies
  - Efficient in downstream task for smartphone keyboard based emotion detection

More details about the paper,

- https://doi.org/10.1145/3613904.3642833

Thank You!!

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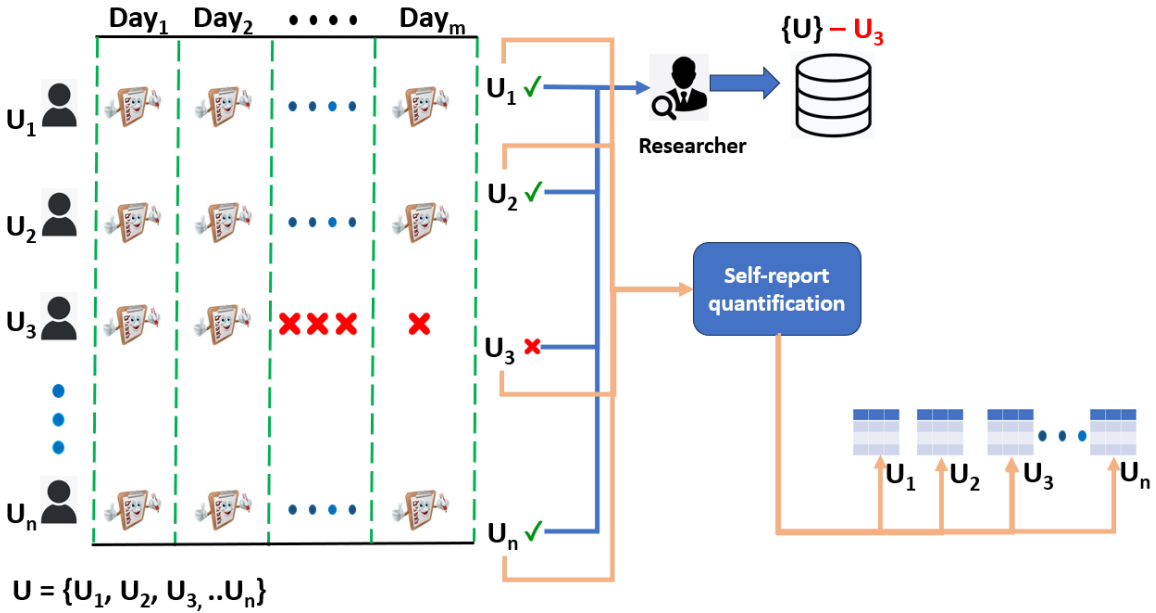
https://surjya-ghosh.github.io/

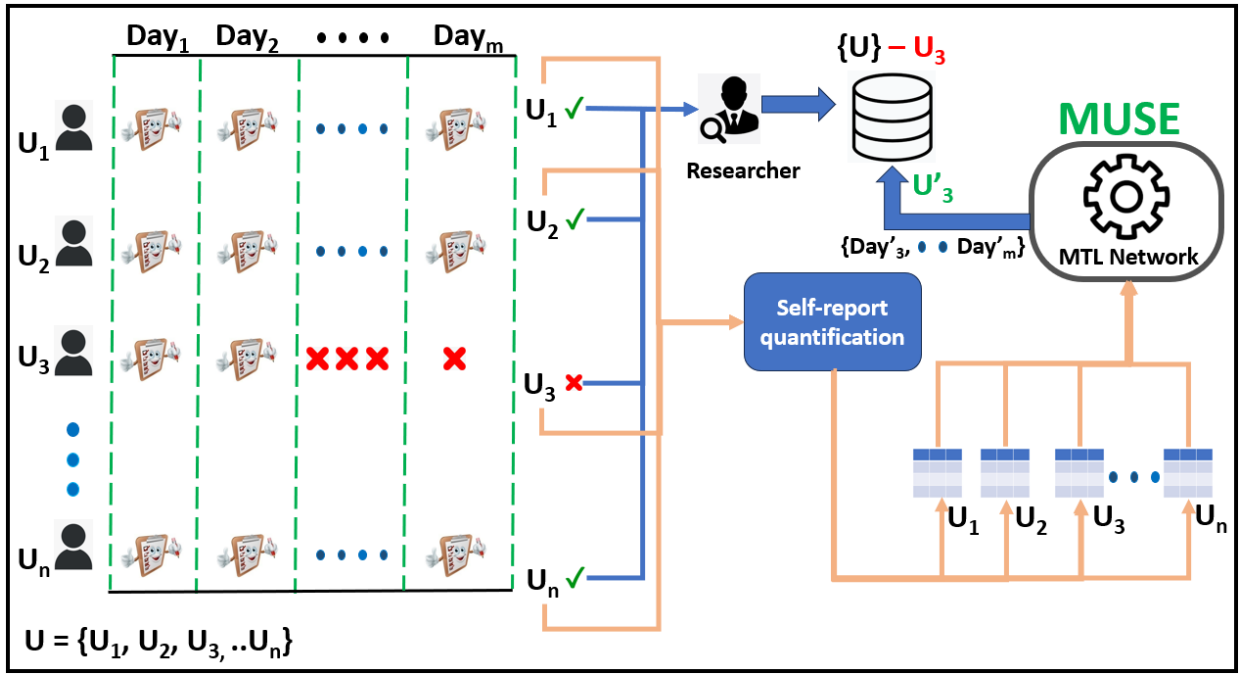
MUSE: Multi-task Learning Framework for User Similarity based Emotion Self-report Estimation

- quantify self-reporting behavior



MUSE: **M**ulti-task Learning Framework for **U**ser **S**imilarity based **E**motion Self-report Estimation

- apply MTL (Multi-task Learning) for self-report estimation



Probable solution,

- rerun user study (to counter data loss)
  - incurs cost (time, effort)

Alternate solution

- Estimate the missing self-reports accurately

MUSE: **M**ulti-task Learning Framework for **U**ser **S**imilarity based **E**motion Self-report Estimation

- estimate missing self-reports of drop-out participants

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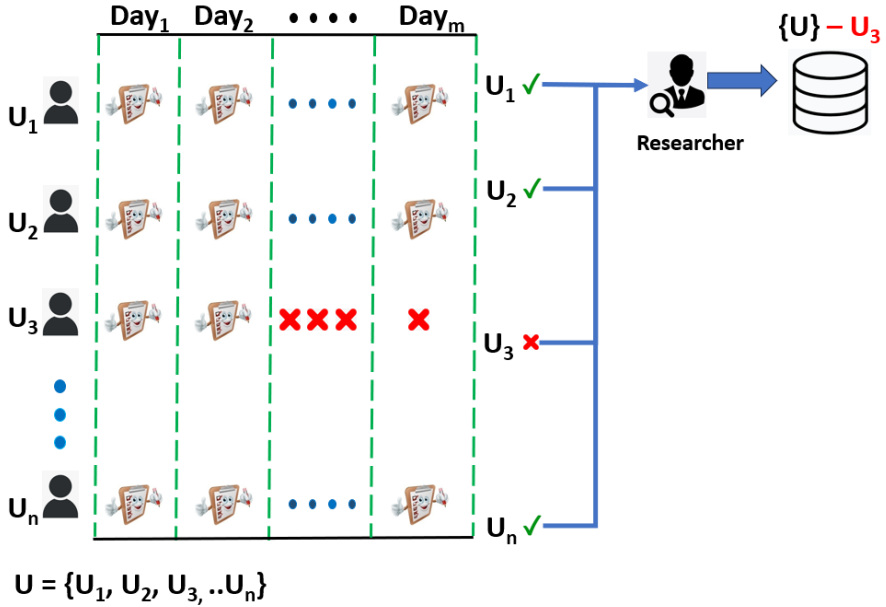
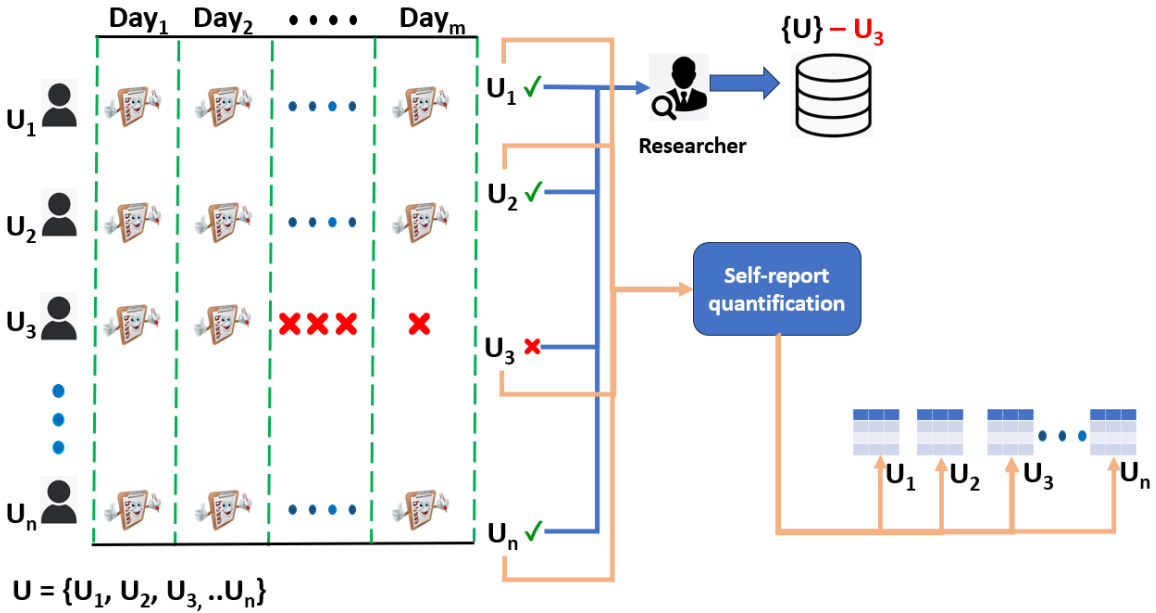


MUSE: Multi-task Learning Framework for User Similarity based Emotion Self-report Estimation

- quantify self-reporting behavior



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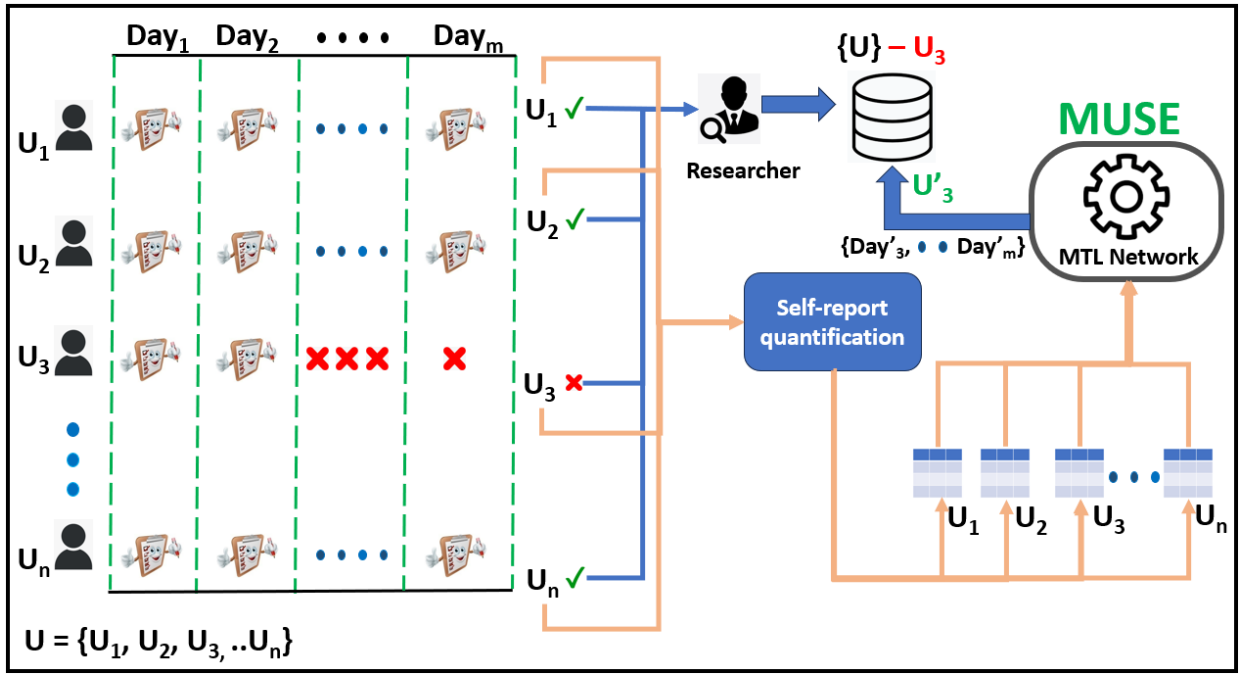

Experimental evaluation

- Estimate four emotions (*happy, sad, stressed, relaxed*)
- Study I (N=24) → AUCROC of 84%
- Study II (N=30) → AUCROC of 82%

More details about the paper,

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