SHL Transportation/Locomotion Recognition Challenge 2020

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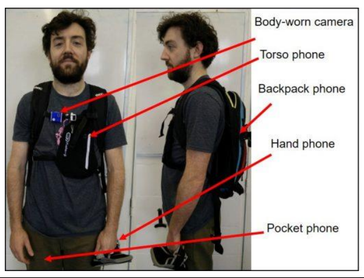
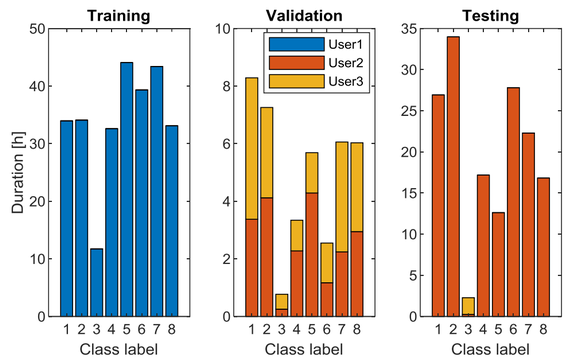
1. SHL recognition challenge

- The third version following successful 2018 [3, 4] and 2019 [5]
- Objective
  - Smartphone-based locomotion/transportation recognition
  - Algorithm designed to be smartphone user independent
    - Trained using data from User1 (Hand, Hips, Torso, Bag smartphones)
    - Evaluated on the data from User2 and User3 (Hips – unknown to participants)
  - Eight classes

    1 - Still; 2 - Walk; 3 - Run; 4 - Bike;

    5 - Car; 6 - Bus; 7 - Train; 8 - Subway
- Dataset
  - Three users from SHL dataset [1, 2]
  - Smartphones at 4 body positions
    - Ha – hand; Hi – Hips; B- Bag; T – Torso
  - 7 sensor modalities, 21 data channels (motion and pressure)
  - Data size
    - 272x4h training data (B/T/Hi/Ha);
    - 40x4h validation data (B/T/Hi/Ha);
    - 160x1h testing data (Hips)
- Evaluation Measure
  - F1 score averaged among all the classes
  - Decision window: 5 seconds

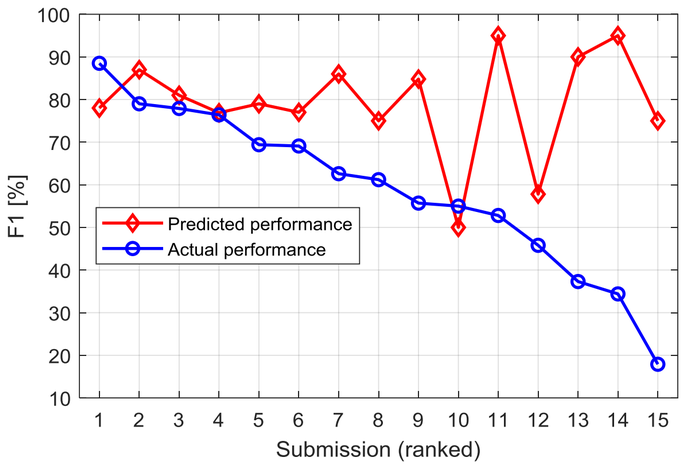




Modality	File	Train (B/T/Hi)	Validation (B/T/Hi/Ha)	Test (Ha)
Accelerator	Acc x.txt Acc y.txt Acc z.txt	✓	✓	✓
Gyroscope	Gyr x.txt Gyr y.txt Gyr z.txt	✓	✓	✓
Magnetometer	Mag x.txt Mag y.txt Mag z.txt	✓	✓	✓
Linear accelerometer	LAcc x.txt LAcc y.txt LAcc z.txt	✓	✓	✓
Gravity	Gra x.txt Gra y.txt Gra z.txt	✓	✓	✓
Orientation	Ori w.txt Ori x.txt Ori y.txt Ori z.txt	✓	✓	✓
Pressure	Pressure.txt	✓	✓	✓
Label	Label.txt	✓	✓	✕

2. Submission results

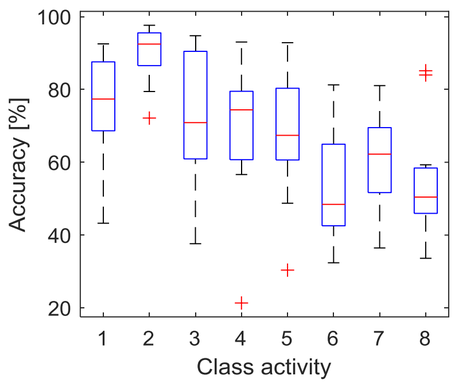
- Strong interests from research community
  - 33 teams expressed interest
  - 15 submissions
- Ranking (F1 for testing data)
  - Highest F1: 88.5%
  - 80%-90%: 1 submission
  - 70%-80%: 3 submissions
  - 60%-70%: 4 submissions
  - < 60%: 7 submission

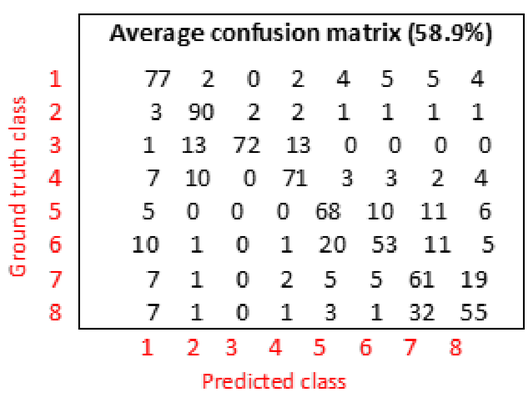


The detailed confusion matrices will be published at the summary paper.

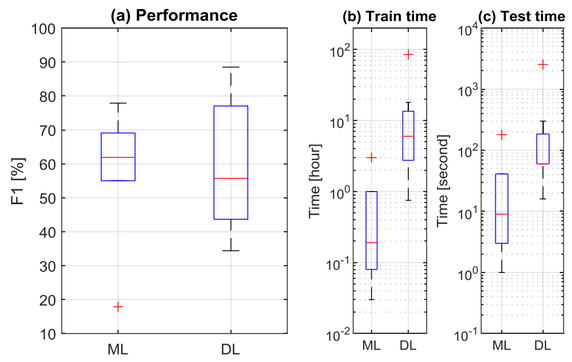
3. Analysis

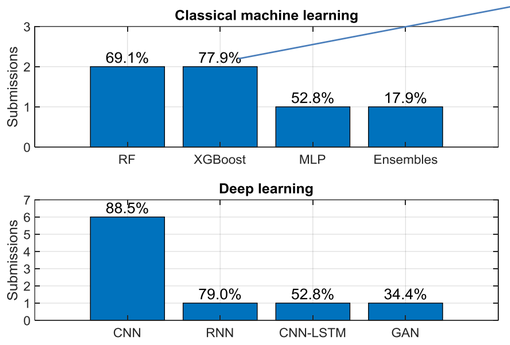
- Average performance from top11 submissions (F1>50%)





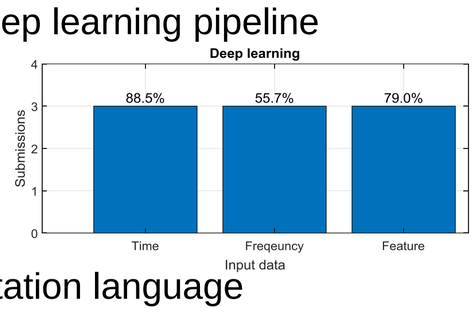
- Machine learning pipelines
  - Classical machine learning (ML): 6 submissions
  - Deep learning (DL): 9 submissions



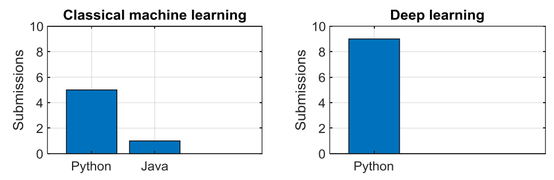


Highest performance in each group

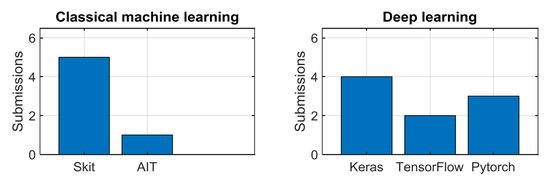
- Input to deep learning pipeline



- Implementation language



- Implementation framework



4. Conclusions

- Highest F1 score: 88.5%
- DL outperforms ML
- Novel techniques to tackle position and user variation
  - Robust representation
  - Position-specific modelling
  - User-specific modelling
- DL outperforms ML
- Future work
  - Comprehensive evaluation with full dataset
  - Multimodal sensor

5. Reference

[1] H. Gjoreski, M. Ciliberto, L. Wang, F. J. O. Morales, S. Mekki, S. Valentin, D. Roggen, "The University of Sussex-Huawei locomotion and transportation dataset for multimodal analytics with mobile devices," *IEEE Access*, 2018.
[2] L. Wang, H. Gjoreski, M. Ciliberto, S. Mekki, S. Valentin, D. Roggen, "Enabling reproducible research in sensor-based transportation mode recognition with the Sussex-Huawei dataset," *IEEE Access*, 2019.
[3] L. Wang, H. Gjoreski, K. Murao, T. Okita, D. Roggen, "Summary of the Sussex-Huawei locomotion-transportation recognition challenge", *Proc. HASCA 2018*.
[4] L. Wang, H. Gjoreski, M. Ciliberto, S. Mekki, S. Valentin, D. Roggen, "Benchmarking the SHL recognition challenge with classical and deep-learning pipelines", *Proc. HASCA 2018*.
[5] L. Wang, H. Gjoreski, M. Ciliberto, P. Lago, K. Murao, T. Okita, D. Roggen, "Summary of the Sussex-Huawei locomotion-transportation recognition challenge 2019", *Proc. HASCA 2019*.

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SHL DATASET
Sussex-Huawei Locomotion-Transportation Dataset
http://www.shl-dataset.org