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What Are You Doing? Real-Time Activity Recognition using Mobile Phone Sensors

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Introduction & Goals

- Follow-up of work-in-progress paper from last year [1]
- Major Challenge/Goal: detection of people‘s activities regardless of the mobile phone‘s position & orientation
  - 5 modes of locomotion considered: (i) standing, (ii) walking, (iii) running, (iv) walking upstairs, (v) walking downstairs

How can highly accurate real-time activity recognition be realized utilizing a dynamically (i.e. rotation, position and orientation independent) on-body-placed commercial smartphone?

[1] M. Kurz, B. Hiesl, E. Sonnleitner: “Real-Time Activity Recognition Utilizing Dynamically On-Body Placed Smartphones”, The Eleventh International Conference on Adaptive and Self-Adaptive Systems and Applications (ADAPTIVE 2019), pp 84-87, May 2019

Previous Work

- **Data collection**
  - 15 participants, ~4,5hrs data
- **Feature Extraction**
  - Sliding window, Savitzky-Golay-Filter
- **Classification**

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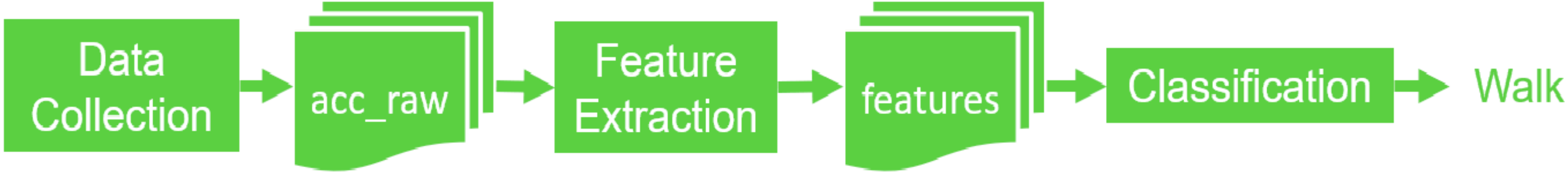
Approach

– **General Methodology [1]**



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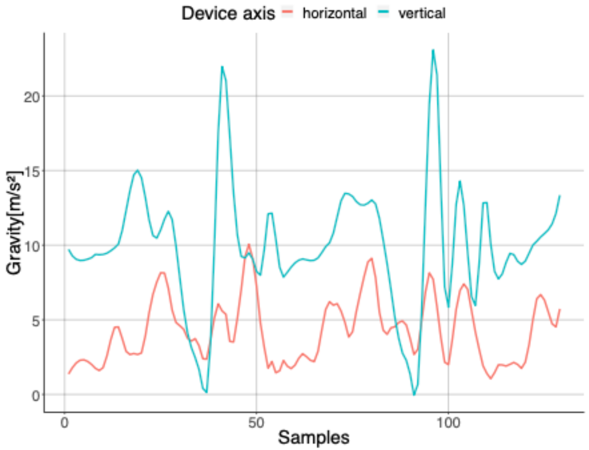
Approach :: Real-Time

- **Sliding Window [2]**



Example of horizontal and vertical movement within one single window

[2] L. Sun, D. Zhang, B. Li, B. Guo, and S. Li, “Activity recognition on an accelerometer embedded mobile phone with varying positions and orientations,” in International conference on ubiquitous intelligence and computing. Springer, 2010, pp. 548–562.

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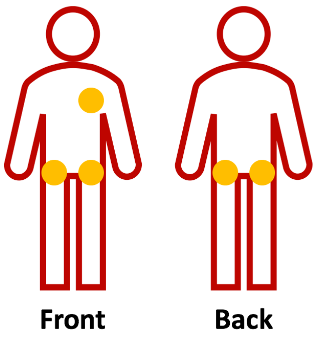
Approach :: Dynamic Placement

i. **Sensor recordings of activities within several body positions**
   > Gathering of position independent data
   > 5 pocket positions considered [1]



ii. **Sensor data transformation (horizontal & vertical)**
   > Becoming orientation independent

iii. **Training of ML models**
   > kNN, Naive Bayes, Decision Tree, Random Forrest

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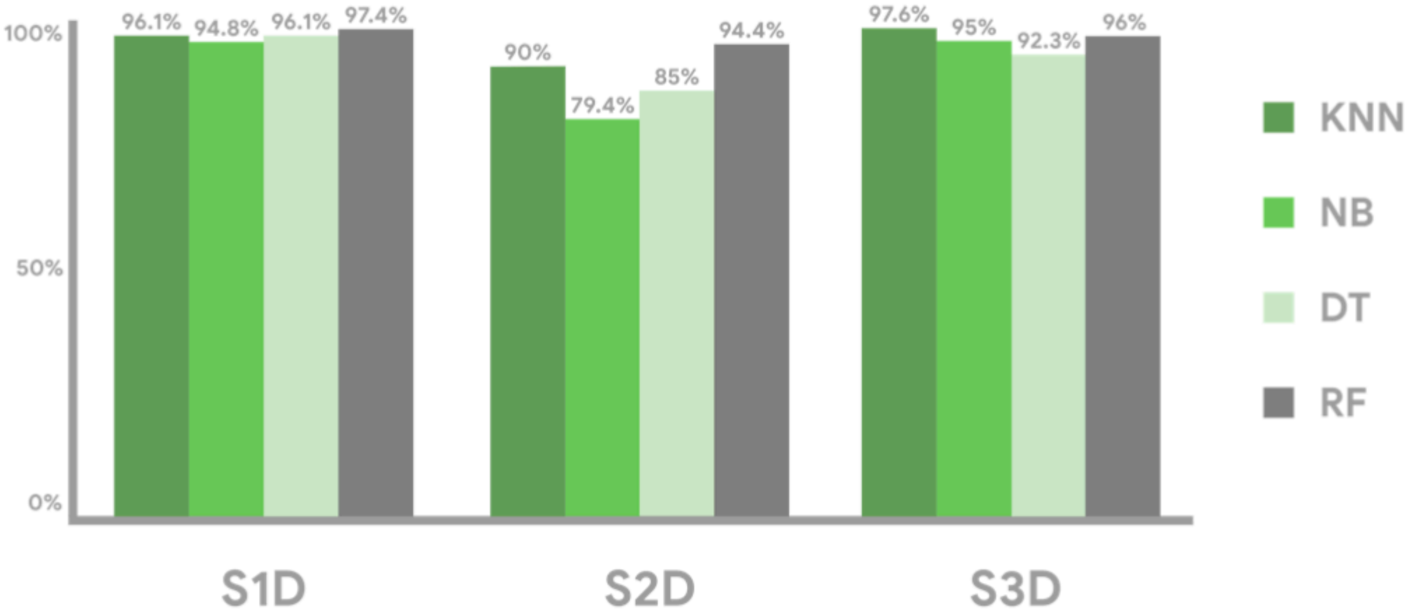
Results :: Overview

- **Three different testing scenarios were applied**
  - > Environment changes (e.g. different stairs, different floor surfaces, etc.) → S1
  - > Varying performing speed → S2
  - > Changing positions → S3

- Each testing scenario is evaluated using sensor data:
  - > **Gallery dependent** (subject within the training set) → D
  - > **Gallery independent** (subject not inside the training set) → I

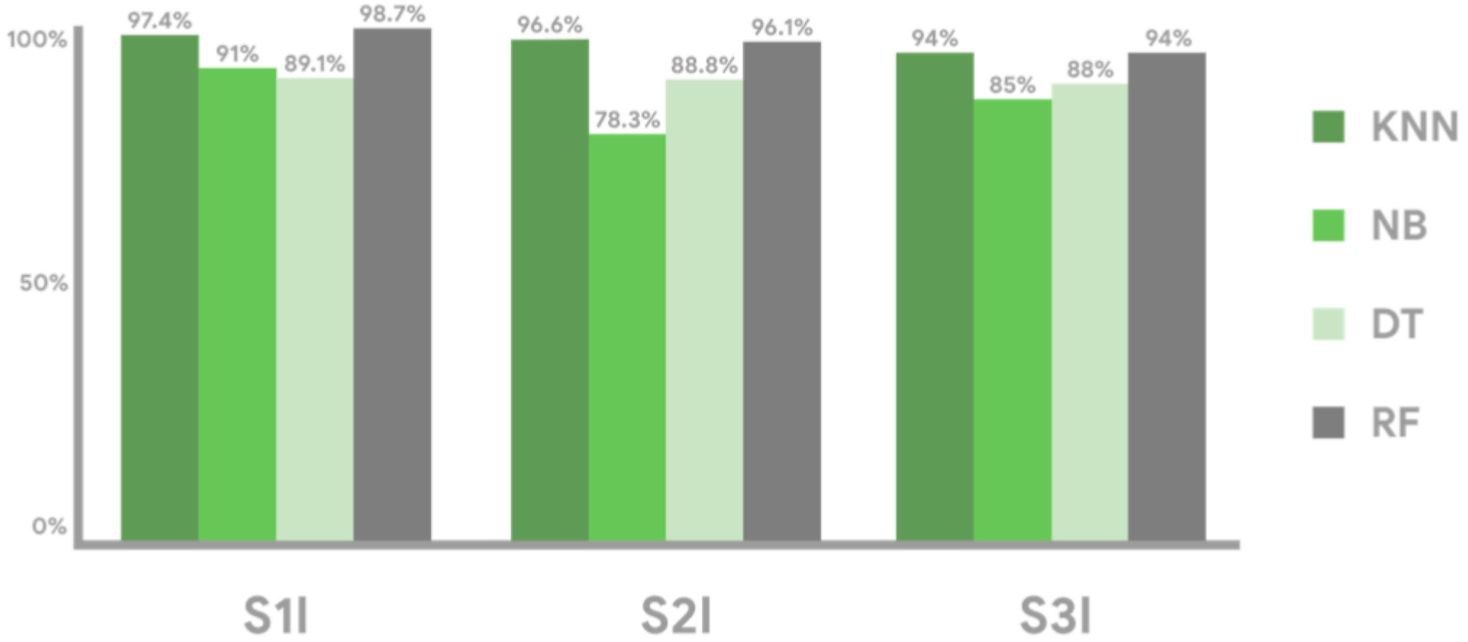
e.g. S1D means environment with gallery dependent subject…

Results :: Offline* Evaluation



** using newly recorded data and performing recognition offline*

Results :: Offline* Evaluation



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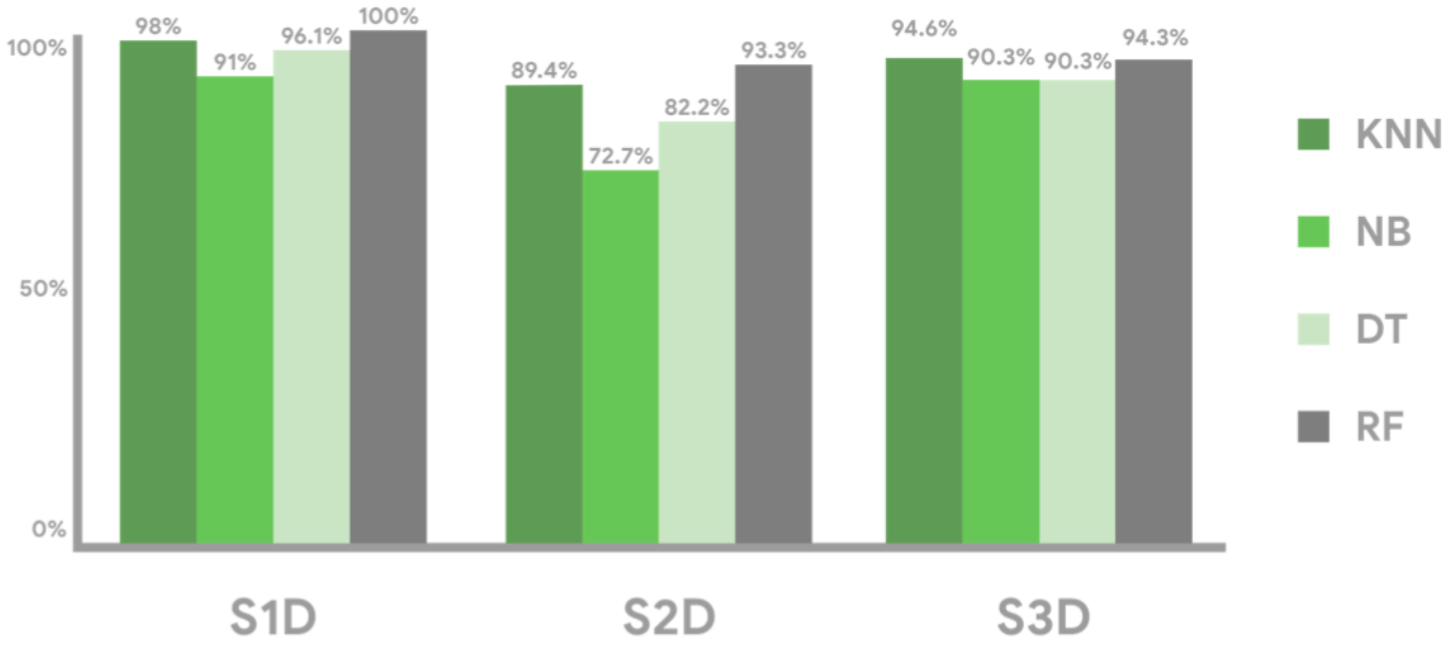
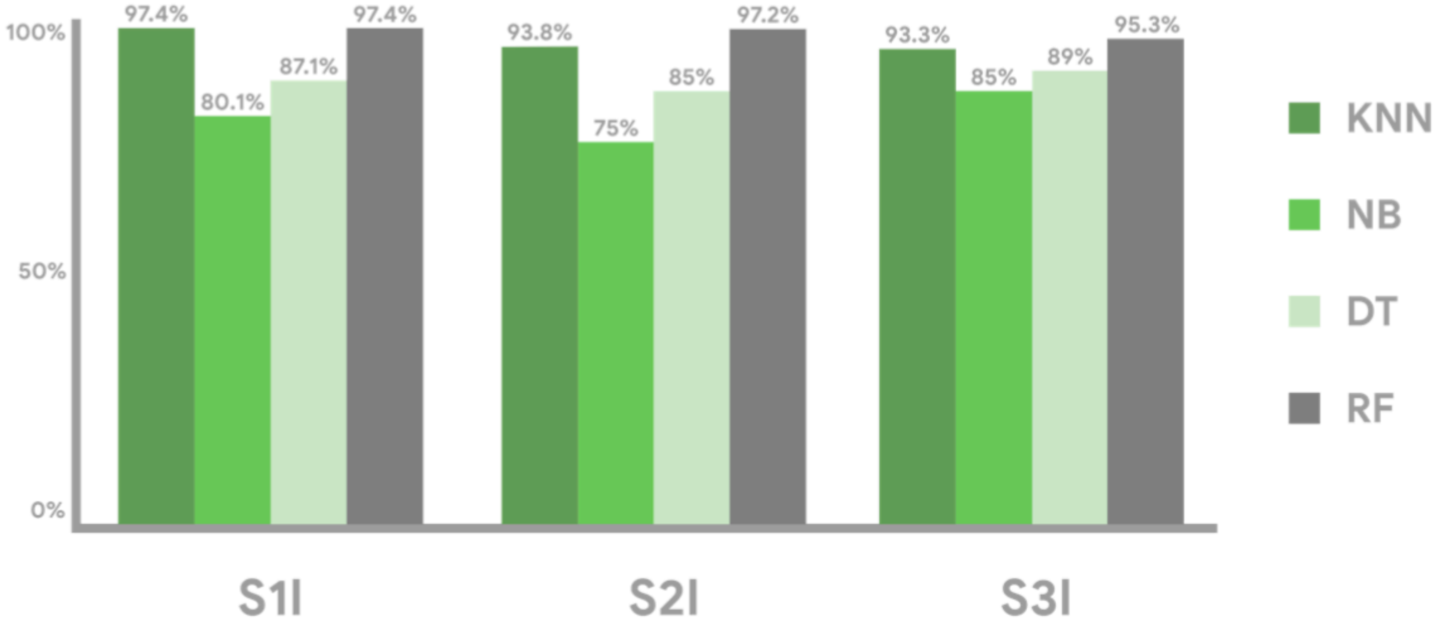
Results :: Online* Evaluation



** using sensor data processed in real-time on the smart-phone*

Results :: Online* Evaluation



* *using sensor data processed in real-time on the smart-phone*

Summary & Conclusion

- Developing a gait recognition system which is **position and orientation independent**
  - Could be beneficial for different commercial use-cases, e.g.
    - Physiotherapy, elderly care, industrial manufacturing, etc.
- Performance up to **96.1% accuracy**
- **Real-Time** processing of sensor data
- Detection of **significant features** from the feature vector (currently 177 features) could be improved
  - E.g. by using a grid search algorithm
  - Would most likely **further improve** the accuracy of the system

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