Analyzing keystroke dynamics using transformations and successive averaging

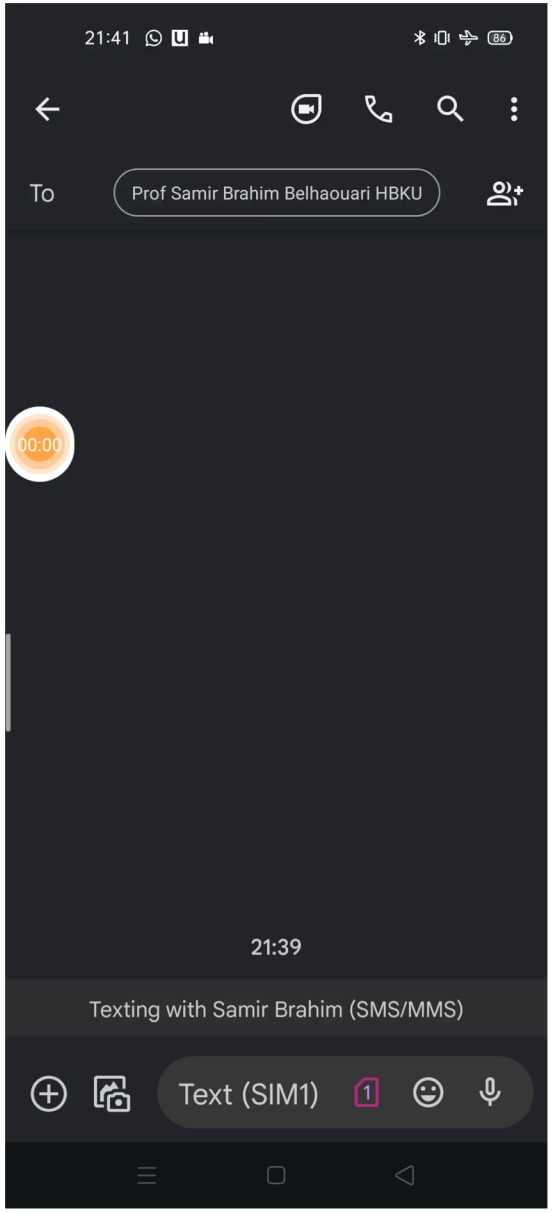
Ashhadul Islam, Samir Brahim Belhauari

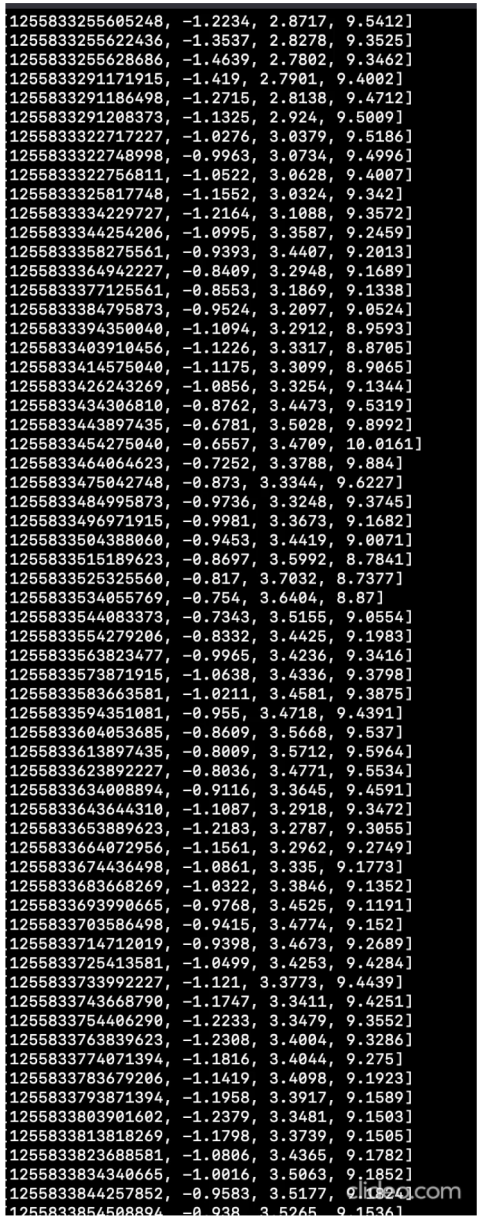
SECURITY IN A DIGITAL AGE

- First line of defense: passwords
- Bio-metric features
  - Face
  - Finger print
  - Iris
  - Additional hardware required
- One-Time Password
  - Expensive

KEY-STROKE DYNAMICS BASED AUTHENTICATION

- Behavioral authentication method
- Quantitative data from all user interaction with touchscreens and device sensors
- No need of additional hardware
- Useful for
  - Continuous monitoring of device usage
  - Detecting suspicious activity on a device





Typing 70 characters in 43 seconds in a smartphone generates over 24480 rows of data by touch sensors

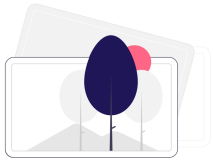
Stragapede, Giuseppe, Ruben Vera-Rodriguez, Ruben Tolosana, and Aythami Morales, 'BehavePassDB: Benchmarking Mobile Behavioral Biometrics', 2022 <http://arxiv.org/abs/2206.02502>

FEATURE EXTRACTION FROM HIGH VOLUME DATA IN SHORT TIME

DATA TRANSFORM AND SUCCESSIVE AVERAGING

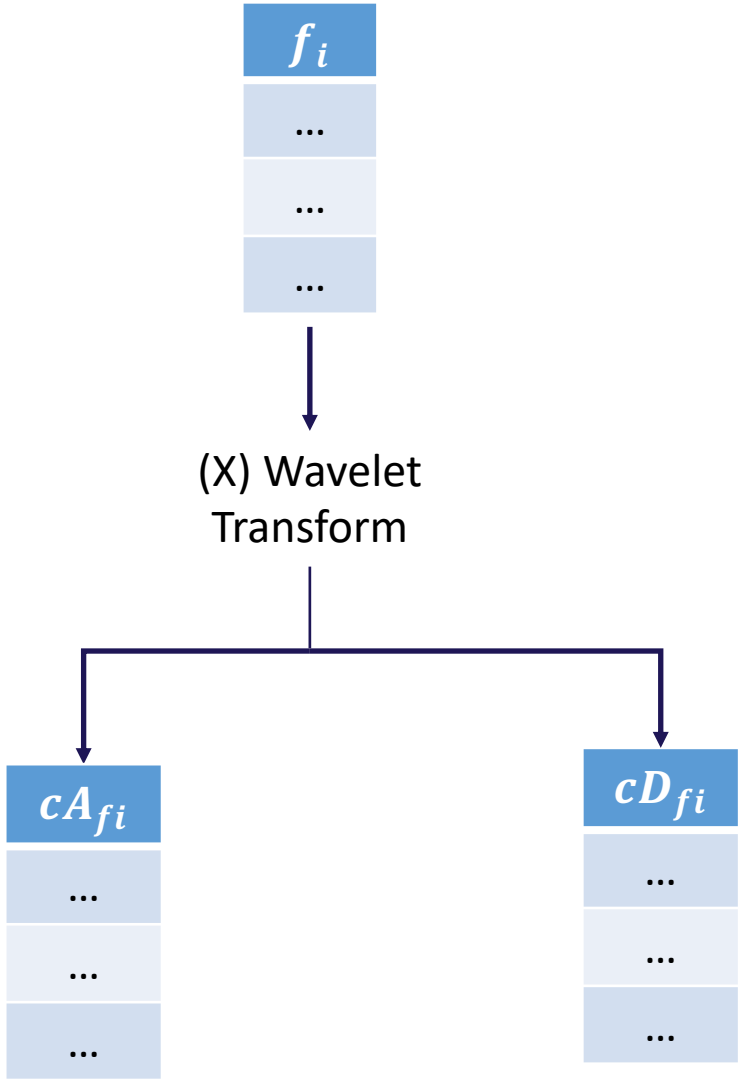
Transform on each feature

Successive averaging of generated coefficients

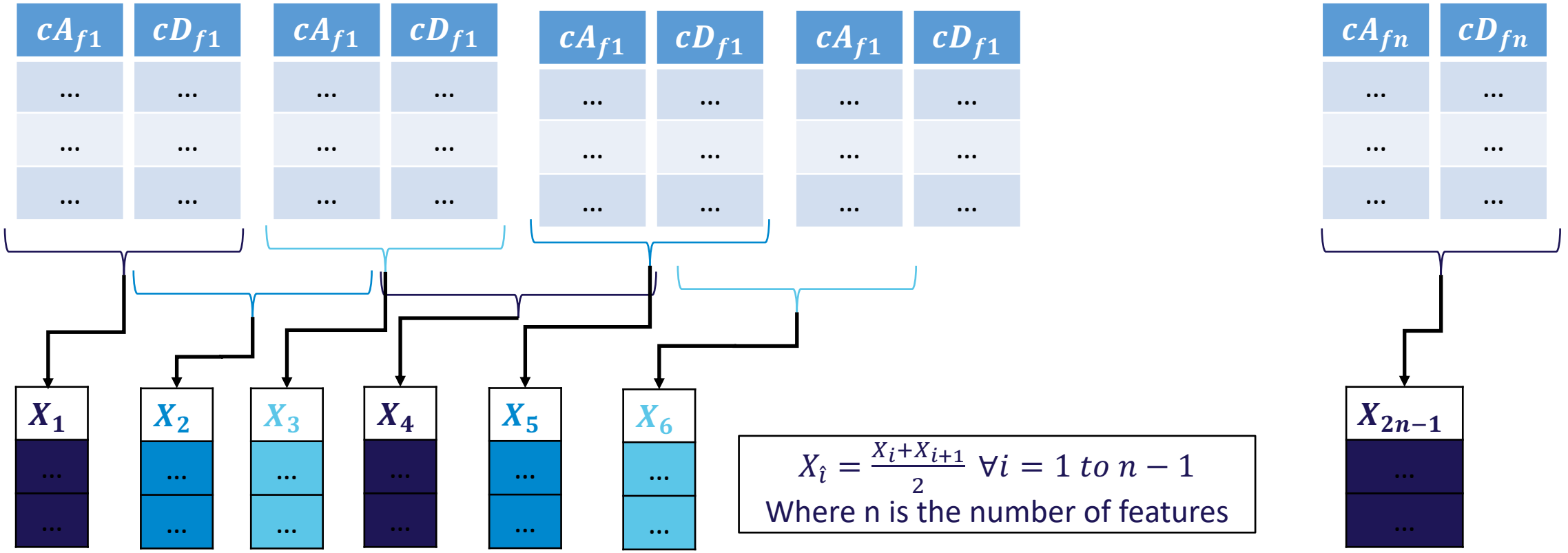


Combine to form RGB images

TRANSFORM ON EACH FEATURE



SUCCESSIVE AVERAGING

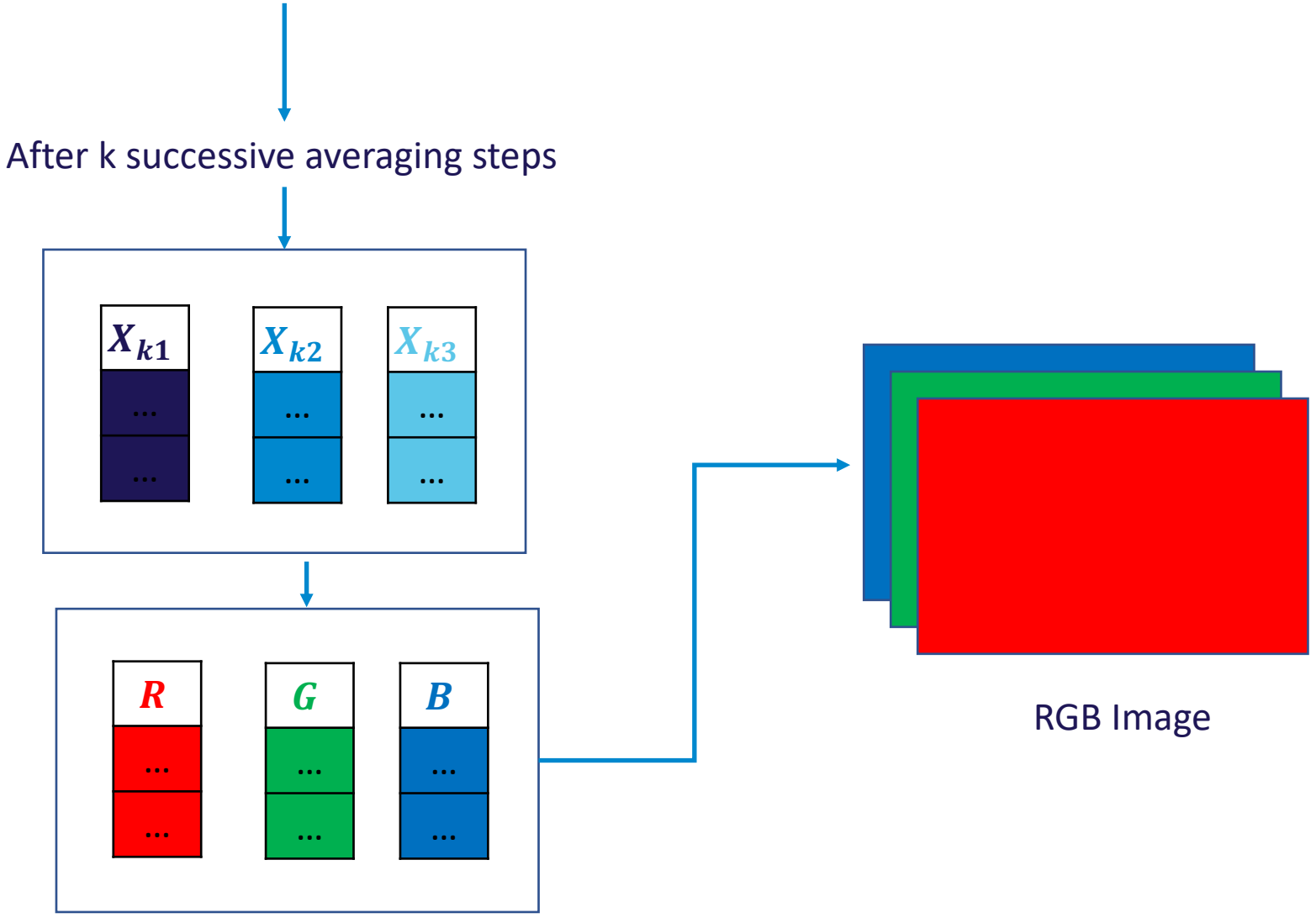


$$X_{\hat{i}} = \frac{X_i + X_{i+1}}{2} \quad \forall i = 1 \; to \; n-1$$

Where n is the number of features

At every step, number of features created is 1 less than number of features in previous step

TRANSFORMATION



EXAMPLES ON KEY-STROKE DATASETS

DSL-STRONG PASSWORD DATA

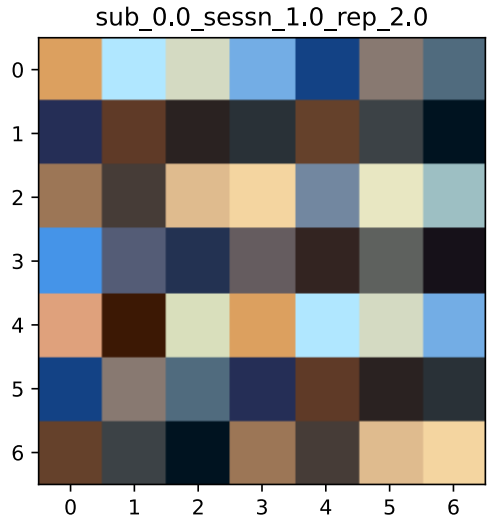
51 subjects (typists), each typing a password (.tie5Roanl) 400 times

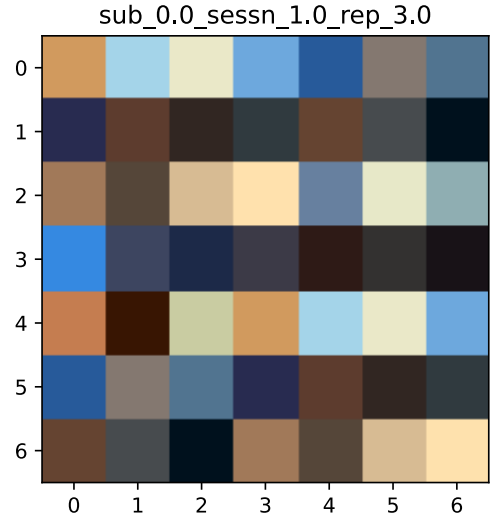
Kevin S. Killourhy and Roy A. Maxion. "Comparing Anomaly Detectors for Keystroke Dynamics," in Proceedings of the 39th Annual International Conference on Dependable Systems and Networks (DSN-2009), pages 125-134, Estoril, Lisbon, Portugal, June 29-July 2, 2009. IEEE Computer Society Press, Los Alamitos, California, 2009

T. Sing, O. Sander, N. Beerenwinkel, T. Lengauer. "ROCR: visualizing classifier performance in R," Bioinformatics 21(20):3940-3941 (2005).

DSL-STRONG PASSWORD DATA

Same subject performing same activity at different sessions



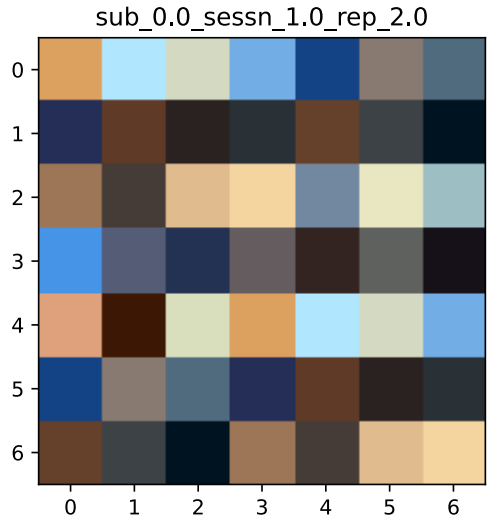


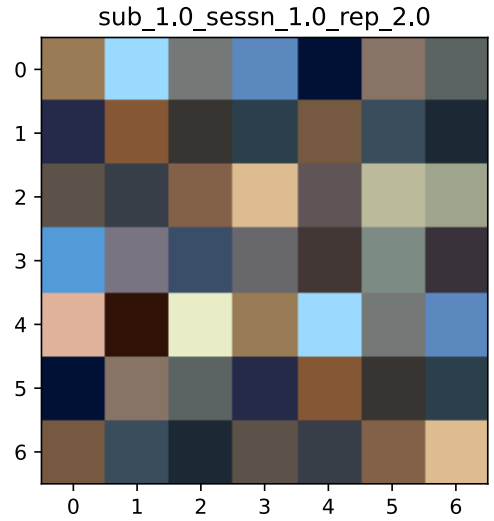
Kevin S. Killourhy and Roy A. Maxion. "Comparing Anomaly Detectors for Keystroke Dynamics," in Proceedings of the 39th Annual International Conference on Dependable Systems and Networks (DSN-2009), pages 125-134, Estoril, Lisbon, Portugal, June 29-July 2, 2009. IEEE Computer Society Press, Los Alamitos, California, 2009

T. Sing, O. Sander, N. Beerenwinkel, T. Lengauer. "ROCR: visualizing classifier performance in R," Bioinformatics 21(20):3940-3941 (2005).

DSL-STRONG PASSWORD DATA

Different subjects performing same activity



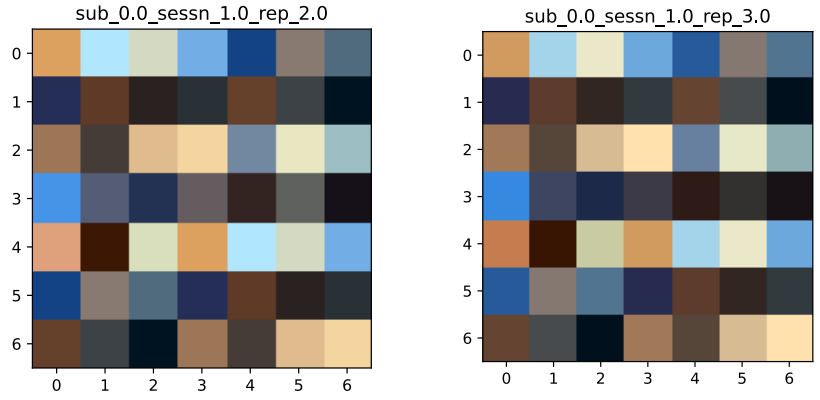


Kevin S. Killourhy and Roy A. Maxion. "Comparing Anomaly Detectors for Keystroke Dynamics," in Proceedings of the 39th Annual International Conference on Dependable Systems and Networks (DSN-2009), pages 125-134, Estoril, Lisbon, Portugal, June 29-July 2, 2009. IEEE Computer Society Press, Los Alamitos, California, 2009

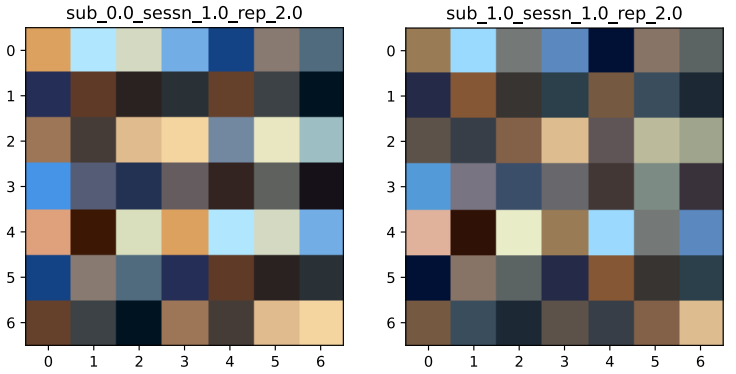
T. Sing, O. Sander, N. Beerenwinkel, T. Lengauer. "ROCR: visualizing classifier performance in R," Bioinformatics 21(20):3940-3941 (2005).

DSL-STRONG PASSWORD DATA

Same subject performing same activity at different sessions



Different subjects performing same activity



Kevin S. Killourhy and Roy A. Maxion. "Comparing Anomaly Detectors for Keystroke Dynamics," in Proceedings of the 39th Annual International Conference on Dependable Systems and Networks (DSN-2009), pages 125-134, Estoril, Lisbon, Portugal, June 29-July 2, 2009. IEEE Computer Society Press, Los Alamitos, California, 2009

T. Sing, O. Sander, N. Beerenwinkel, T. Lengauer. "ROCR: visualizing classifier performance in R," Bioinformatics 21(20):3940-3941 (2005).

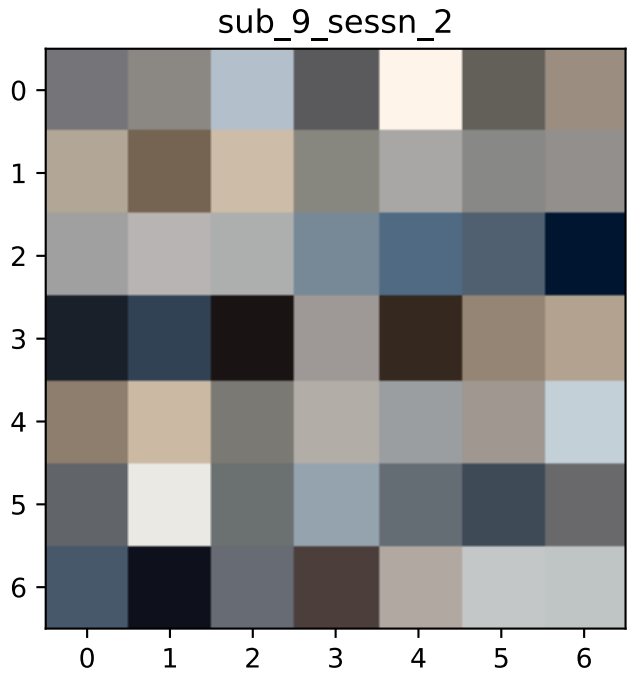
RHU KEYSTROKE DATA

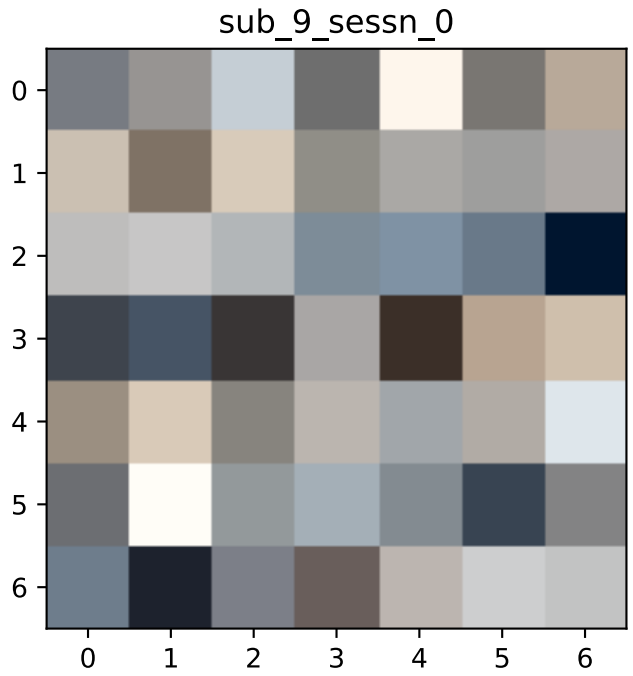
53 participants typing the term “rhu.university” 15 times in 3 sessions

El-Abed, Mohamad, Mostafa Dafer, and Ramzi El Khayat, ‘RHU Keystroke: A Mobile-Based Benchmark for Keystroke Dynamics Systems’, Proceedings - International Carnahan Conference on Security Technology, 2014-Octob.October (2014), 4–7 <https://doi.org/10.1109/CCST.2014.6986984>

RHU KEYSTROKE DATA

Same subject performing same activity at different sessions

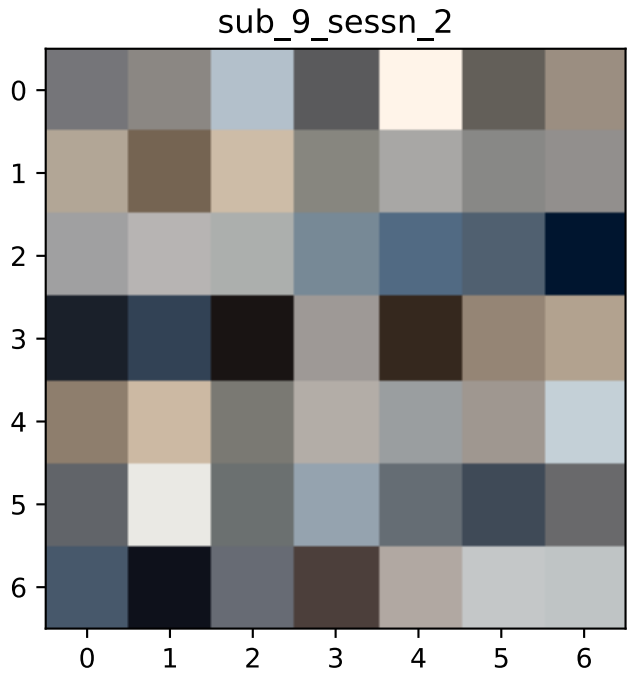


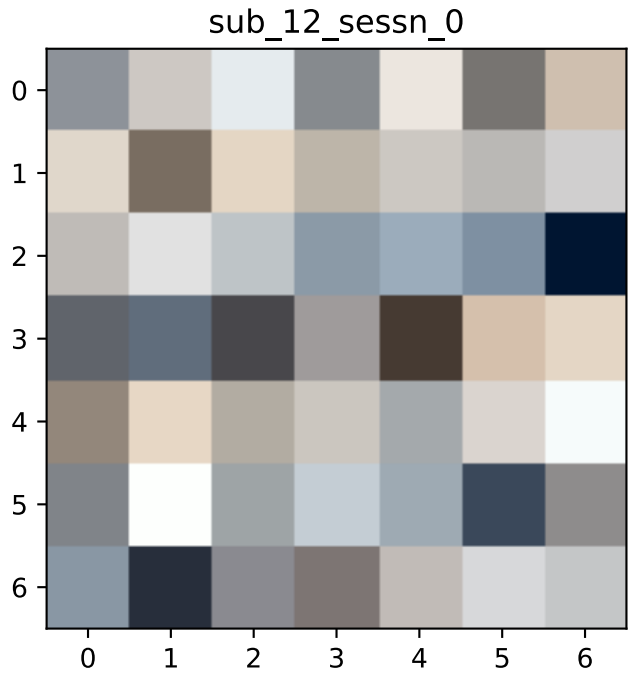


El-Abed, Mohamad, Mostafa Dafer, and Ramzi El Khayat, 'RHU Keystroke: A Mobile-Based Benchmark for Keystroke Dynamics Systems', Proceedings - International Carnahan Conference on Security Technology, 2014-Octob.October (2014), 4–7 <https://doi.org/10.1109/CCST.2014.6986984>

RHU KEYSTROKE DATA

Different subjects performing same activity

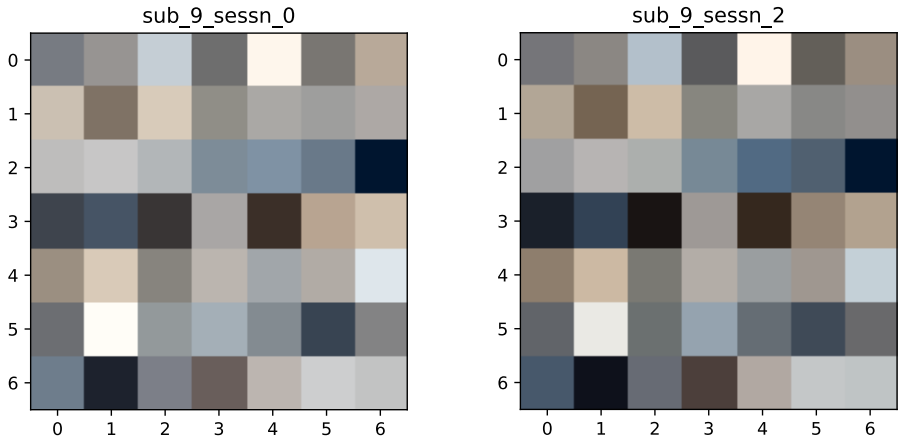




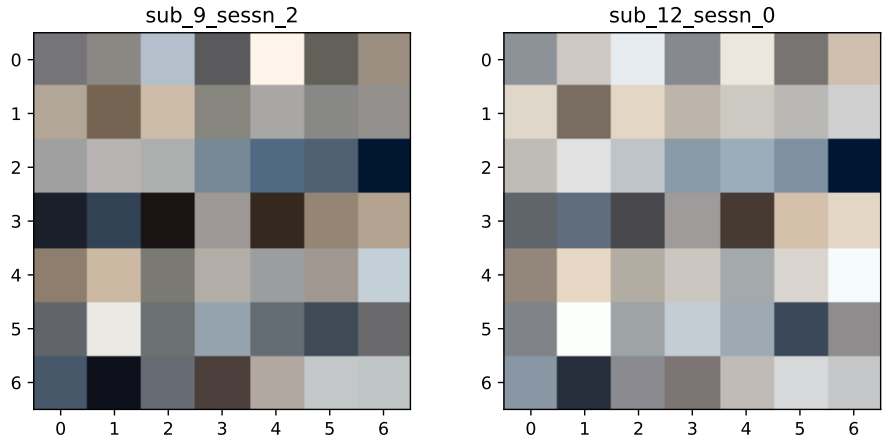
El-Abed, Mohamad, Mostafa Dafer, and Ramzi El Khayat, 'RHU Keystroke: A Mobile-Based Benchmark for Keystroke Dynamics Systems', Proceedings - International Carnahan Conference on Security Technology, 2014-Octob.October (2014), 4–7 <https://doi.org/10.1109/CCST.2014.6986984>

RHU KEYSTROKE DATA

Same subject performing same activity at different sessions



Different subjects performing same activity



El-Abed, Mohamad, Mostafa Dafer, and Ramzi El Khayat, 'RHU Keystroke: A Mobile-Based Benchmark for Keystroke Dynamics Systems', Proceedings - International Carnahan Conference on Security Technology, 2014-Octob.October (2014), 4–7 <https://doi.org/10.1109/CCST.2014.6986984>

BEHAVE PASS DB

Includes several touch gestures

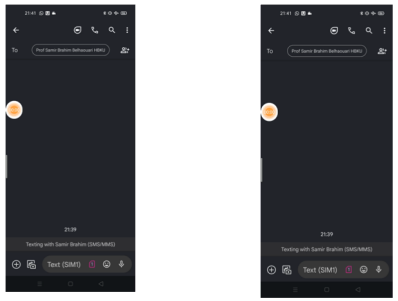
- Free-text keystroke
- Swipe
- tap dynamics

Background sensors

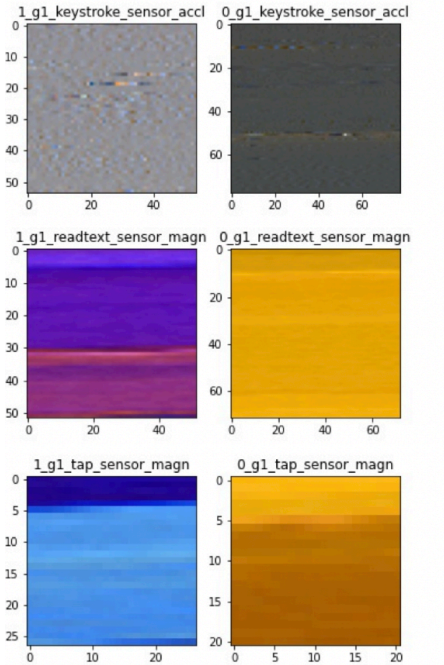
- Accelerometer
- Gyroscope
- Magnetometer
- linear accelerometer
- gravity sensor).

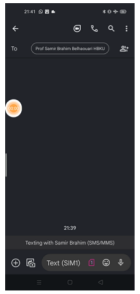
El-Abed, Mohamad, Mostafa Dafer, and Ramzi El Khayat, 'RHU Keystroke: A Mobile-Based Benchmark for Keystroke Dynamics Systems', Proceedings - International Carnahan Conference on Security Technology, 2014-Octob.October (2014), 4–7 <https://doi.org/10.1109/CCST.2014.6986984>

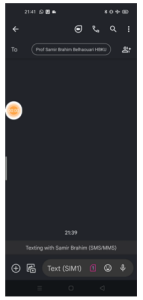
EXAMPLE



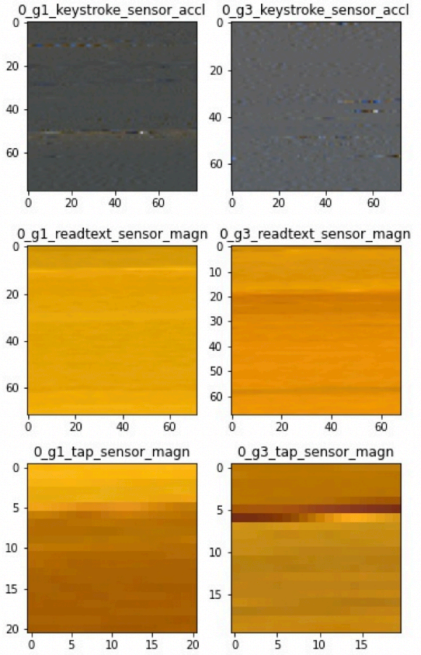
Impersonator vs authentic user.







Authentic User performing same activity



Stragapede, Giuseppe, Ruben Vera-Rodriguez, Ruben Tolosana, and Aythami Morales, 'BehavePassDB: Benchmarking Mobile Behavioral Biometrics', 2022 <http://arxiv.org/abs/2206.02502>