A study on user-specific threshold configuration for keystroke dynamics in the context of adaptive biometric systems

Paulo Henrique Pisani

Centro de Matemática, Computação e Cognição (CMCC)
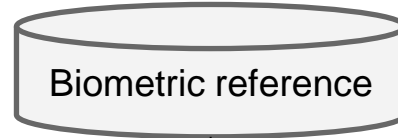Universidade Federal do ABC (UFABC)

Context

- Keystroke dynamics is subject to changes over time [Giot et al. 2011a].

  - The biometric reference may become outdated; Template ageing [Jain et al. 2016].

  - Adaptive biometric systems can automatically update the biometric reference over time [Ryu et al. 2023].
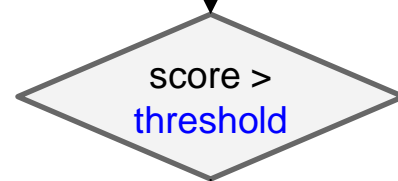
Threshold

Enrolment

Biometric samples ⟹ Biometric reference

Recognition

Query sample ⟹ Compute score

score > threshold

Yes → genuine

No → impostor

Evaluation methodology

- Datasets:
  - CMU [Killourhy and Maxion 2009]: 51 users
  - KeyRecs [Dias et al. 2023]: 99 users

- Adaptation strategies [Kang et al. 2007, Giot et al. 2011a, Giot et al. 2012]:
  - Sliding and growing window.

Evaluation methodology

- Score computation: [Magalhães et al. 2005]
- Threshold:
  - *min-non-outlier* (similar to [Hosseinzadeh and Krishnan 2008]) and *min;*
  - Fixed threshold and Dynamic threshold.

Results: *min-non-outlier*

| Adaptation strategy	CMU			KeyRecs		
	BAcc	*FMR*	*FNMR*	*BAcc*	*FMR*	*FNMR*
No adaptation	0.774 (0.120)	0.238 (0.213)	0.214 (0.213)	0.671 (0.124)	0.613 (0.248)	0.045 (0.090)
Growing (fixed threshold)	0.824 (0.116)	0.312 (0.244)	0.040 (0.056)	0.626 (0.122)	0.733 (0.234)	**0.016** (0.064)
Sliding (fixed threshold)	0.881 (0.088)	0.140 (0.184)	0.097 (0.113)	0.709 (0.130)	0.547 (0.263)	0.036 (0.074)
Growing (dynamic threshold)	0.817 (0.114)	0.336 (0.232)	**0.029** (0.038)	0.634 (0.118)	0.715 (0.226)	0.018 (0.065)
Sliding (dynamic threshold)	**0.889** (0.066)	**0.110** (0.152)	0.112 (0.063)	**0.762** (0.122)	**0.415** (0.246)	0.060 (0.088)
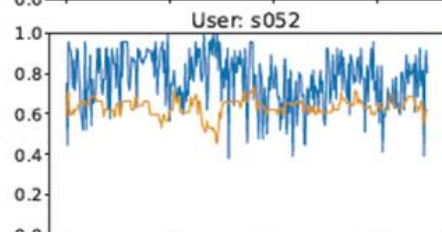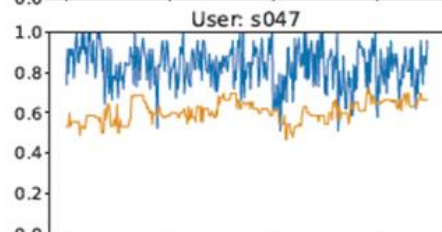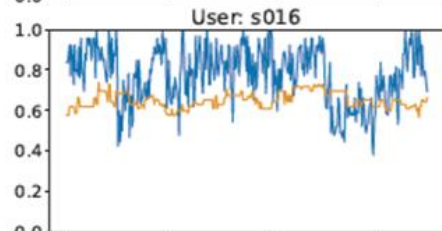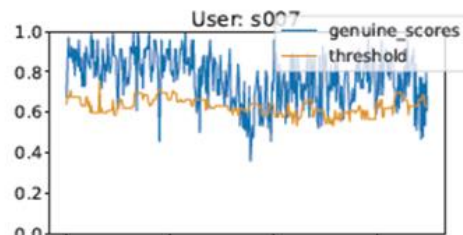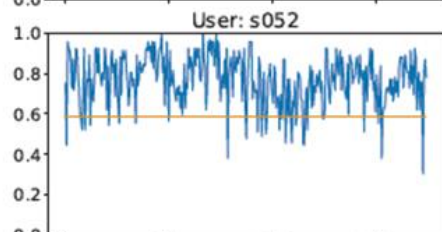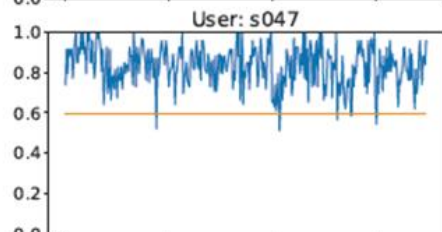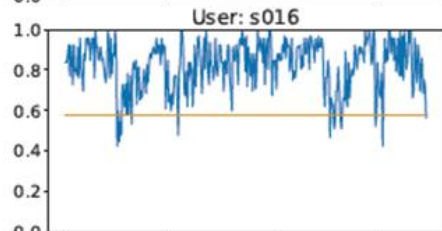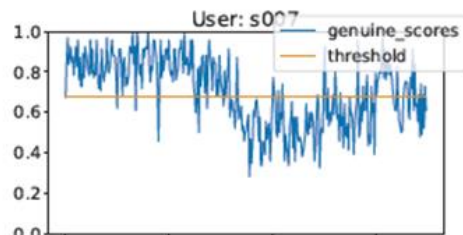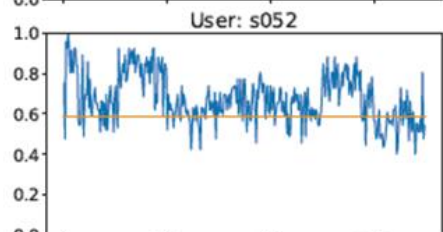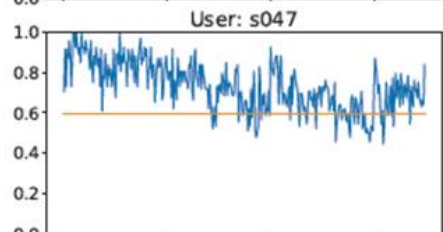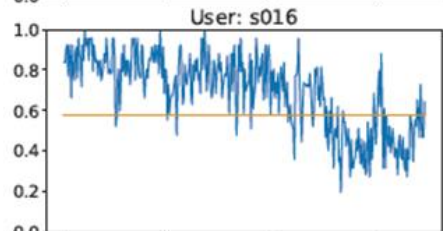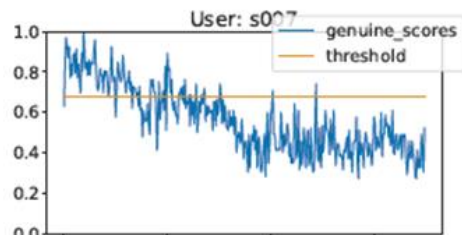
(a) No adaptation - CMU.   **(b) Sliding (fixed) - CMU.**   **(c) Sliding (dynamic) - CMU.**
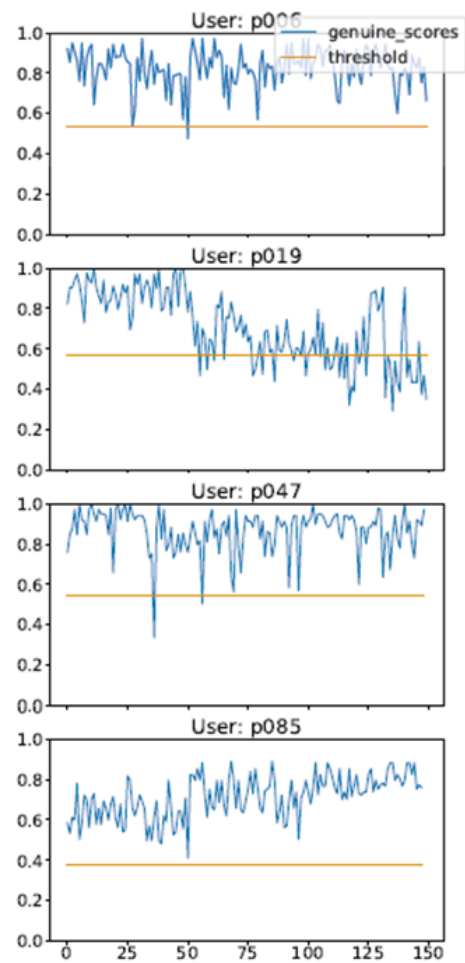
(d) No adaptation - KeyRecs. **(e) Sliding (fixed) - KeyRecs.** **(f) Sliding (dynamic) - KeyRecs.**

References

AlQahtani, A. A. S., El-Awadi, Z., and Min, M. (2021). A survey on user authentication factors. In 2021 IEEE 12th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), pages 0323–0328.
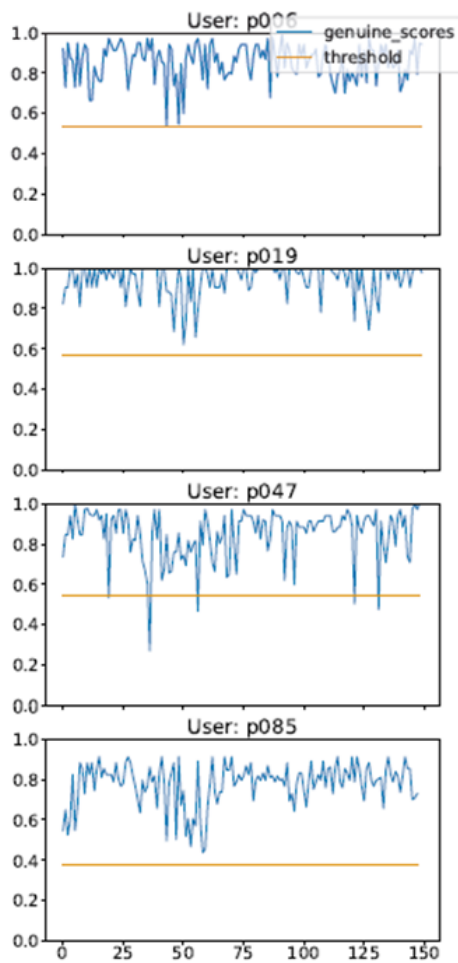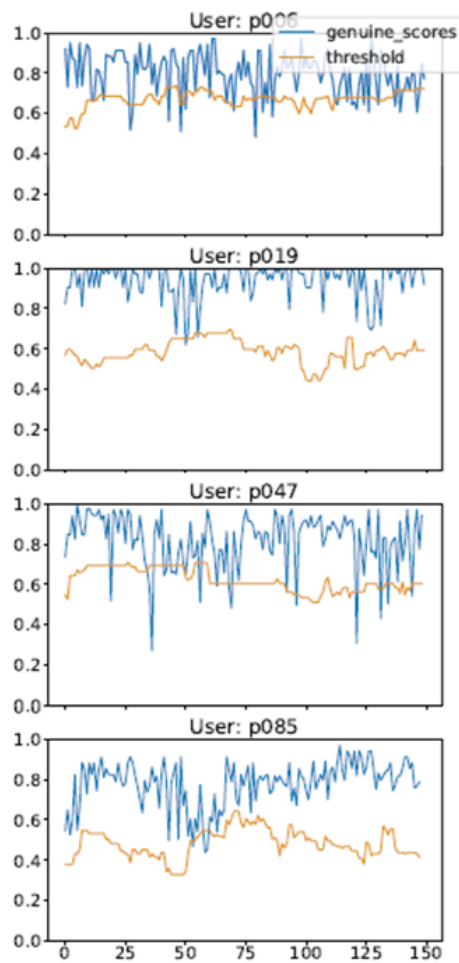
Dias, T., ao Vitorino, J., Maia, E., Sousa, O., and Praça, I. (2023). KeyRecs: A keystroke dynamics and typing pattern recognition dataset. Data in Brief, 50:109509.

Giot, R., Dorizzi, B., and Rosenberger, C. (2011a). Analysis of template update strategies for keystroke dynamics. In 2011 IEEE Workshop on Computational Intelligence in Biometrics and Identity Management (CIBIM), pages 21–28.

Giot, R., El-Abed, M., Hemery, B., and Rosenberger, C. (2011b). Unconstrained keystroke dynamics authentication with shared secret. Computers & Security, 30(6):427 – 445.

Giot, R., Rosenberger, C., and Dorizzi, B. (2012). Hybrid template update system for unimodal biometric systems. In 2012 IEEE Fifth International Conference on Biometrics: Theory, Applications and Systems (BTAS), pages 1–7. IEEE.

Giot, R., Rosenberger, C., and Dorizzi, B. (2013). A new protocol to evaluate the resistance of template update systems against zero-effort attacks. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops.

Hosseinzadeh, D. and Krishnan, S. (2008). Gaussian mixture modeling of keystroke patterns for biometric applications. IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, 38(6):816–826.

Jain, A. K., Nandakumar, K., and Ross, A. (2016). 50 years of biometric research: Accomplishments, challenges, and opportunities. Pattern Recog. Letters, 79:80 – 105.

Kang, P., Hwang, S.-s., and Cho, S. (2007). Continual retraining of keystroke dynamics based authenticator. In Lee, S.-W. and Li, S. Z., editors, Advances in Biometrics, pages 1203–1211, Berlin, Heidelberg. Springer Berlin Heidelberg.

Killourhy, K. S. and Maxion, R. A. (2009). Comparing anomaly-detection algorithms for keystroke dynamics. Proceedings of the International Conference on Dependable Systems and Networks, pages 125–134.

Magalhães, S. T., Revett, K., and Santos, H. M. D. (2005). Password secured sites - stepping forward with keystroke dynamics. In International Conference on Next Generation Web Services Practices (NWeSP'05), page 293–298.

Mhenni, A., Cherrier, E., Rosenberger, C., and Essoukri Ben Amara, N. (2019). Double serial adaptation mechanism for keystroke dynamics authentication based on a single password. Computers & Security, 83:151–166.

Mhenni, A., Rosenberger, C., Cherrier, E., and Ben Amara, N. E. (2016). Keystroke template update with adapted thresholds. In 2016 2nd International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), pages 483–488.

Precise Biometrics (2014). Understanding biometric performance evaluation.

Roy, S., Pradhan, J., Kumar, A., Adhikary, D. R. D., Roy, U., Sinha, D., and Pal, R. K. (2022). A systematic literature review on latest keystroke dynamics based models. IEEE Access, 10:92192–92236.

Ryu, R., Yeom, S., Herbert, D., and Dermoudy, J. (2023). The design and evaluation of adaptive biometric authentication systems: Current status, challenges and future direction. ICT Express, 9(6):1183–1197.

Sae-Bae, N. and Memon, N. (2022). Distinguishability of keystroke dynamic template. PLOS ONE, 17(1):1–17.