Adaptive Algorithms in Accelerometer Biometrics

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1. Introduction

2. Immune Positive Selection and Proposal

3. Experimental Results and Conclusion

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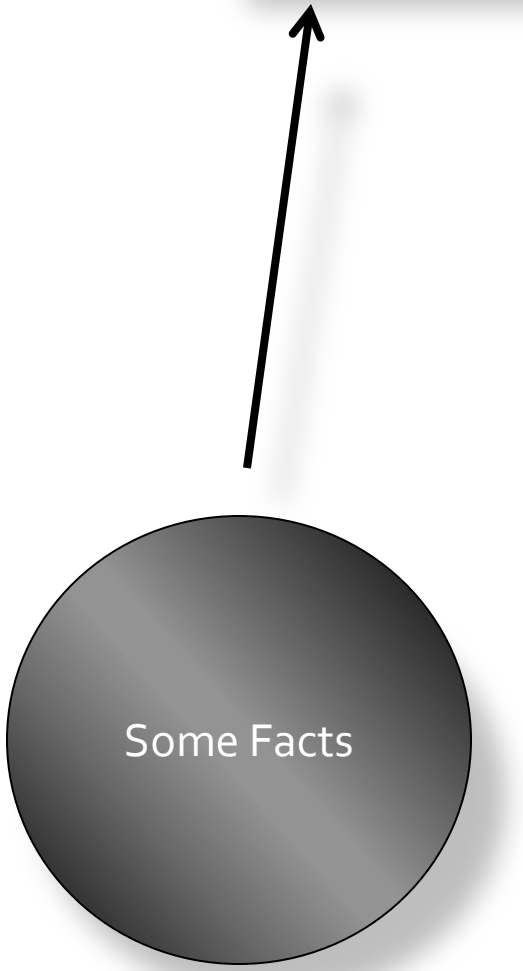
2. Immune Positive Selection and Proposal

3. Experimental Results and Conclusion

Several services, **both personal and corporate**, are currently available in the **Internet**.



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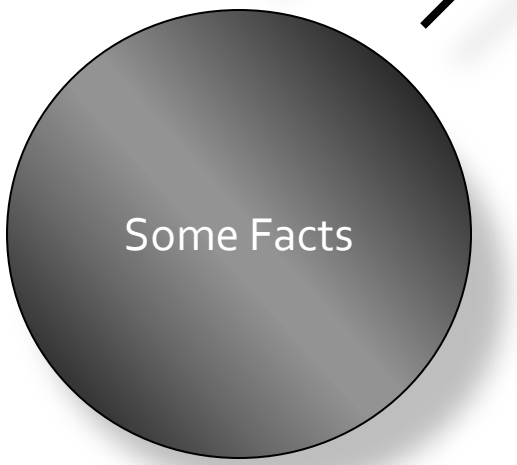
Many of these services **can be accessed from mobile devices**, such as tablets and smartphones.



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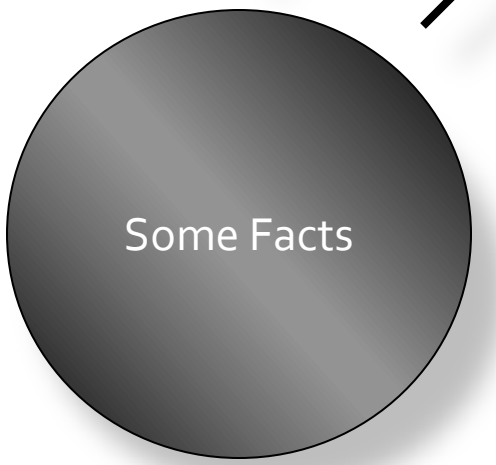

A recent study [1] showed that worldwide smartphone sales reached the sum of **225 million units just in the second quarter of 2013**

Update: more than 300 million in the second quarter of 2014!
(http://www.idc.com/getdoc.jsp?containerId=prUS25037214)

Several services, **both personal and corporate**, are currently available in the **Internet**.

However, does commonly used authentication mechanisms provide enough security to them?

Moreover, does people use these authentication mechanisms?

accessed
tablets and

Some Facts

A recent study [1] showed that worldwide smartphone sales reached the sum of **225 million units just in the second quarter of 2013**

Several services, **both personal and corporate**, are currently available in the **Internet**.

Many of these services **can be accessed**

A study on security of mobile devices [2] showed a worrying number: only 13% of the participants used PIN or visual code.

Some Facts

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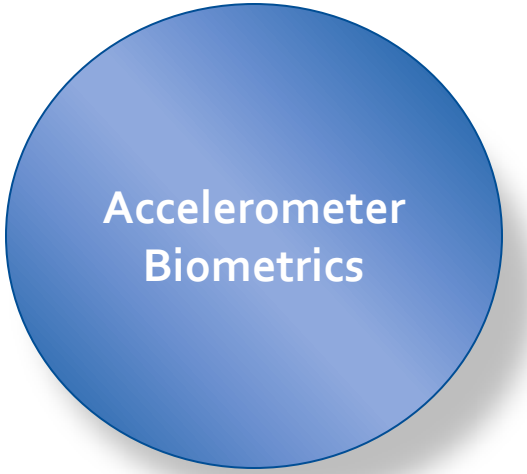
Many of these services **can be accessed**

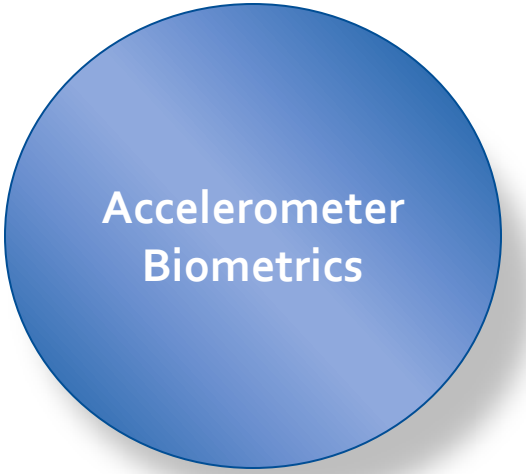
A study on security of mobile devices [2] showed a worrying number: only 13% of the participants used PIN or visual code.

The main reason given was that, without authentication, it is faster to use the device.

Some Facts

second quarter of 2013


Accelerometer
Biometrics



This technology can be used **without interrupting user activities**.

Accelerometer Biometrics [3][4].

As it is behavioural technology, it may be subject to changes over time (concept drift).

Question: does user behaviour changes over time on accelerometer biometrics using smartphone data? If so, how does it affect user recognition performance?

- **This study investigates the user recognition performance over time using accelerometer data, considering a data stream context;**

- **Some mofications to a previous adaptive algorithm are also presented and evaluated.**

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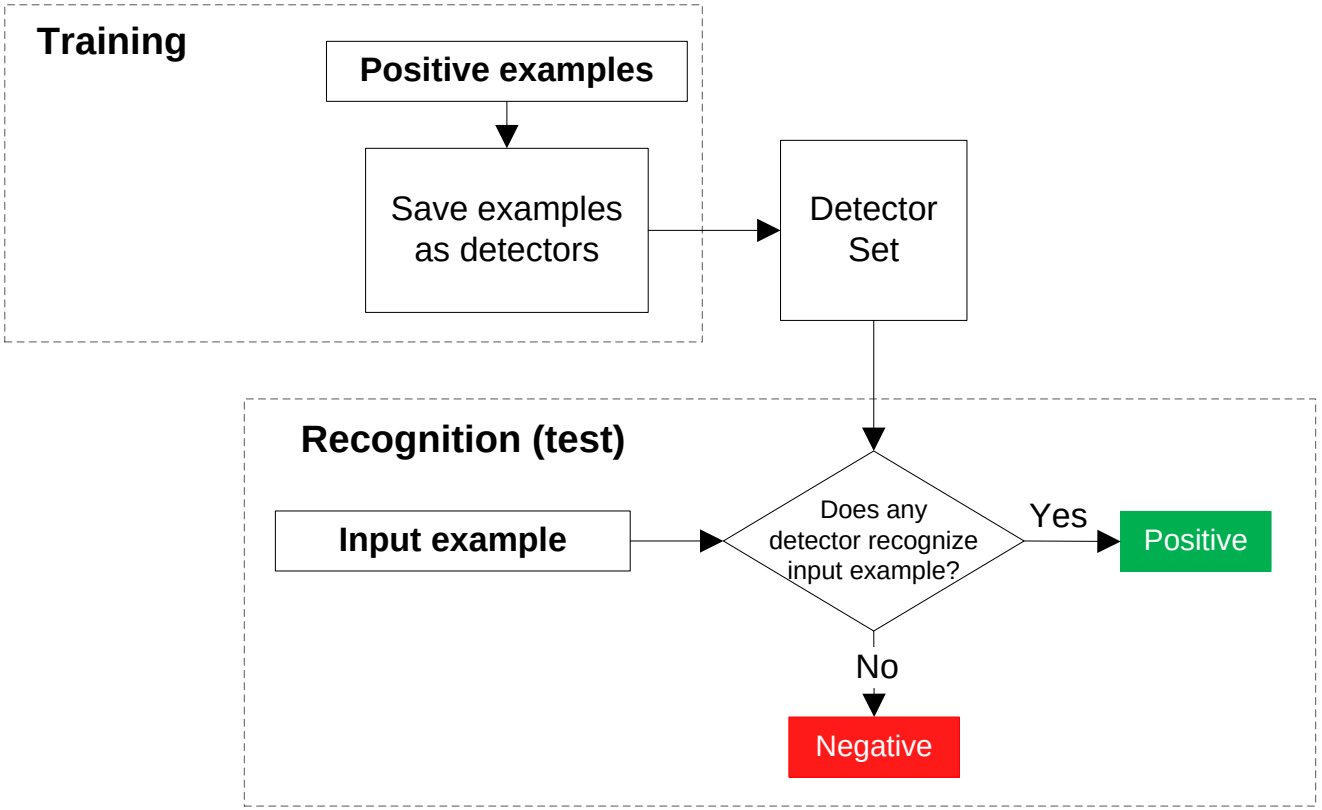
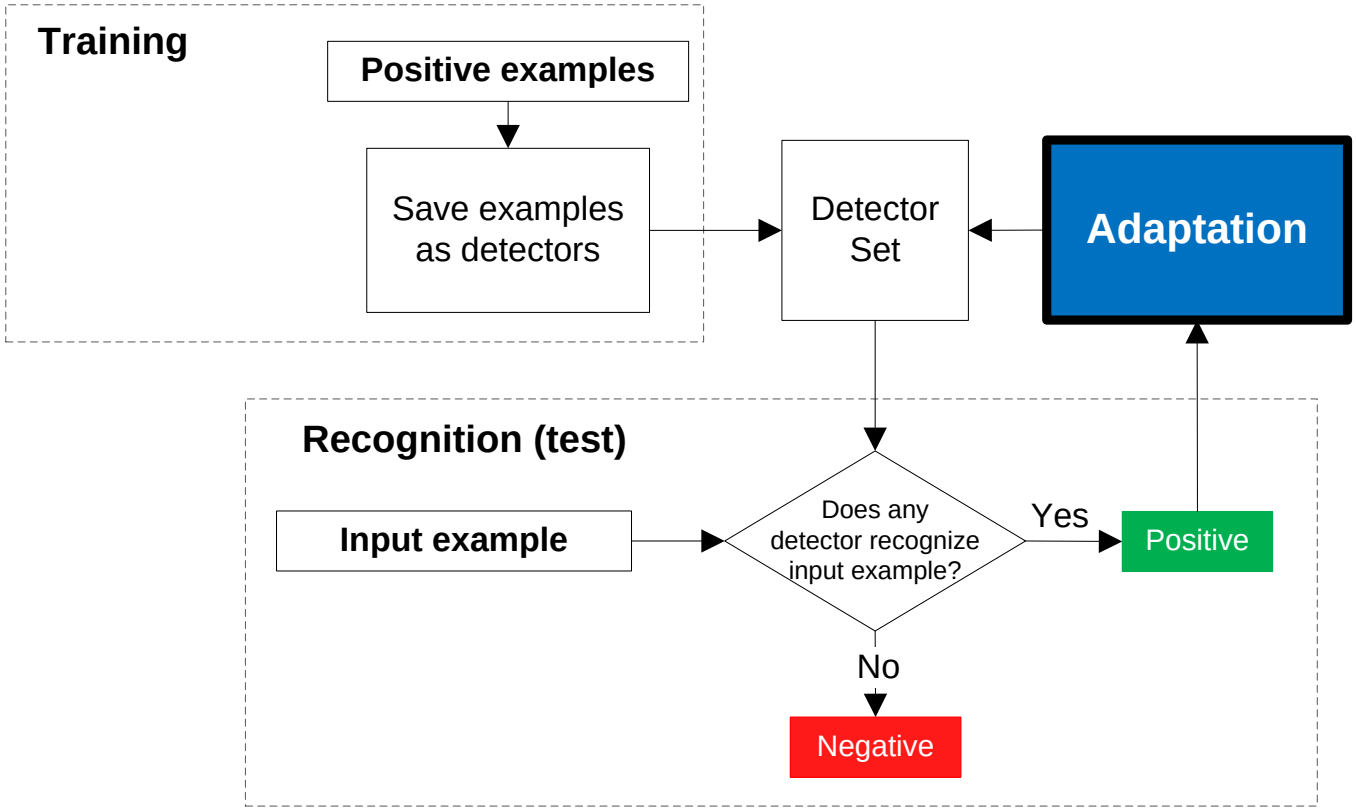
Self-Detector: Original



Immune positive selection [Stibor and Timmis, 2005] (figure adapted from [Pisani, 2012]).

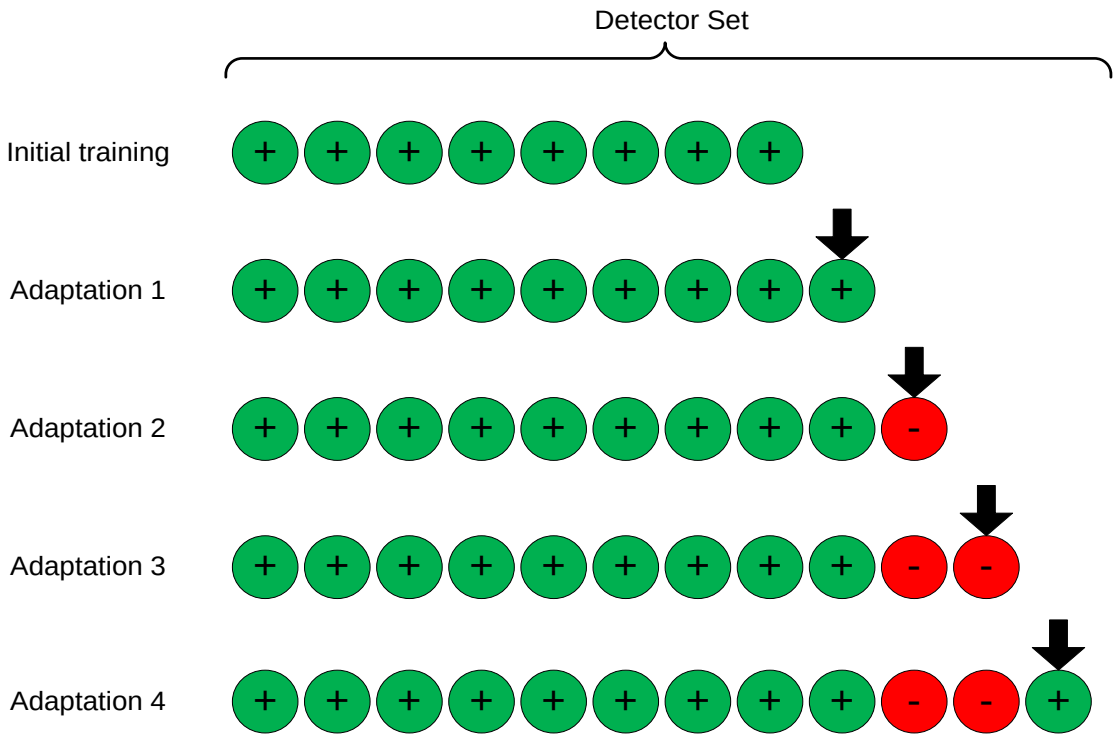
Self-Detector: Adaptive Model



Adaptive immune positive selection.

Self-Detector: Growing*

*uses ideas from [Kang et al. 2007] and [Giot et al. 2012b].



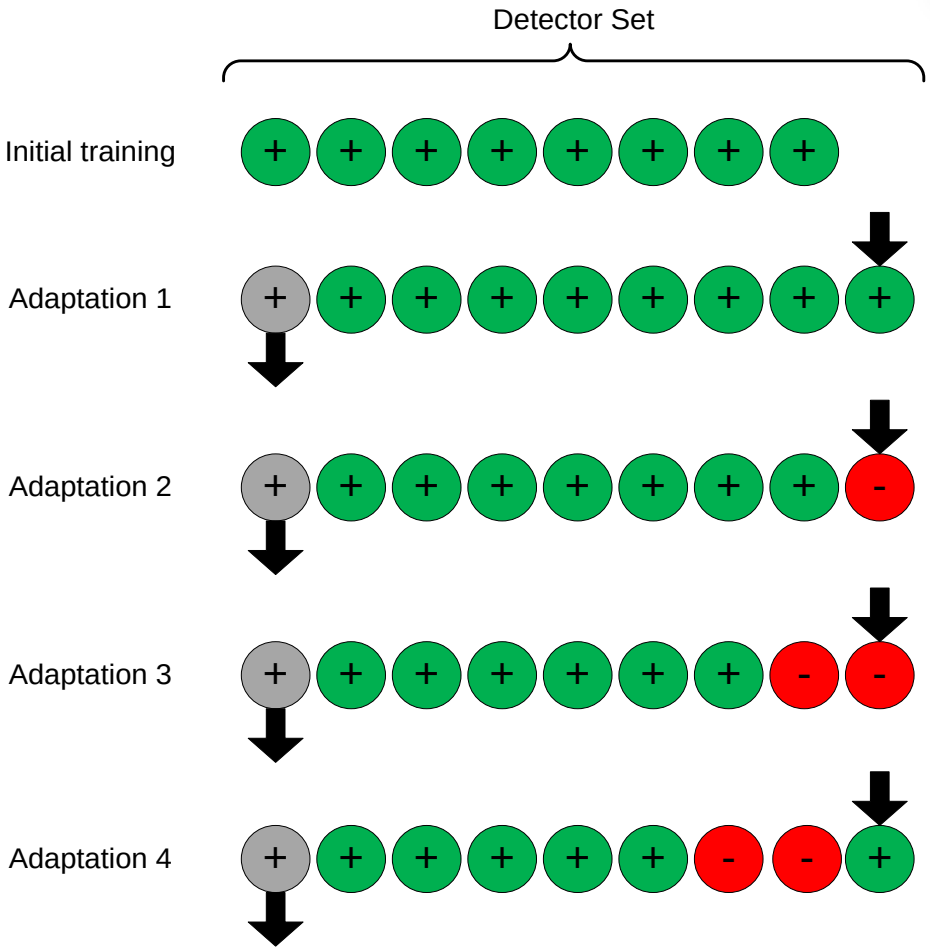
Stores new patterns (new detectors), but **also keeps old patterns** (detectors from the initial training).

+ Detector generated from a **positive example correctly classified** as positive.

- Detector generated from a **negative example incorrently classified** as positive.

Self-Detector: Sliding*

*uses ideas from [Kang et al. 2007] and [Giot et al. 2012b].

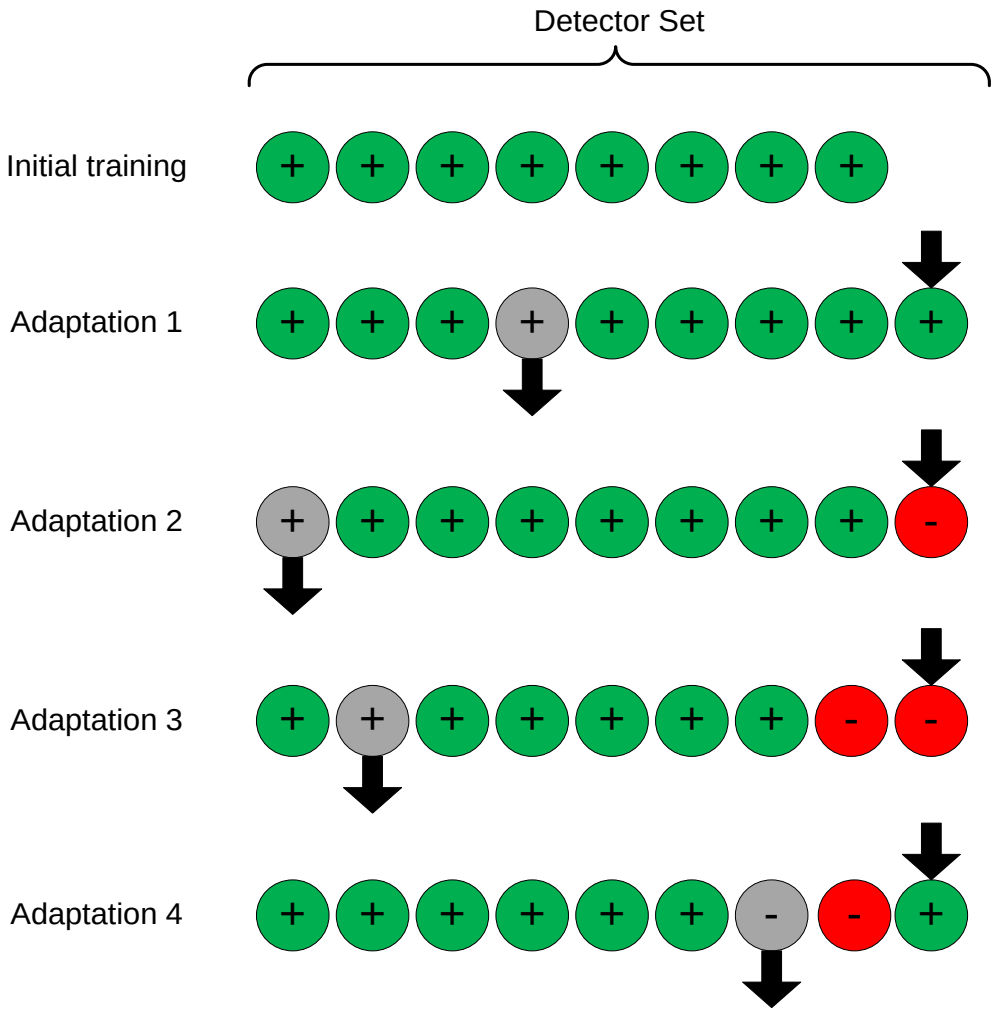


Only keeps newest patterns (new detectors)

+ Detector generated from a **positive example correctly classified** as positive.

- Detector generated from a **negative example incorrently classified** as positive.

Self-Detector: Usage Control*

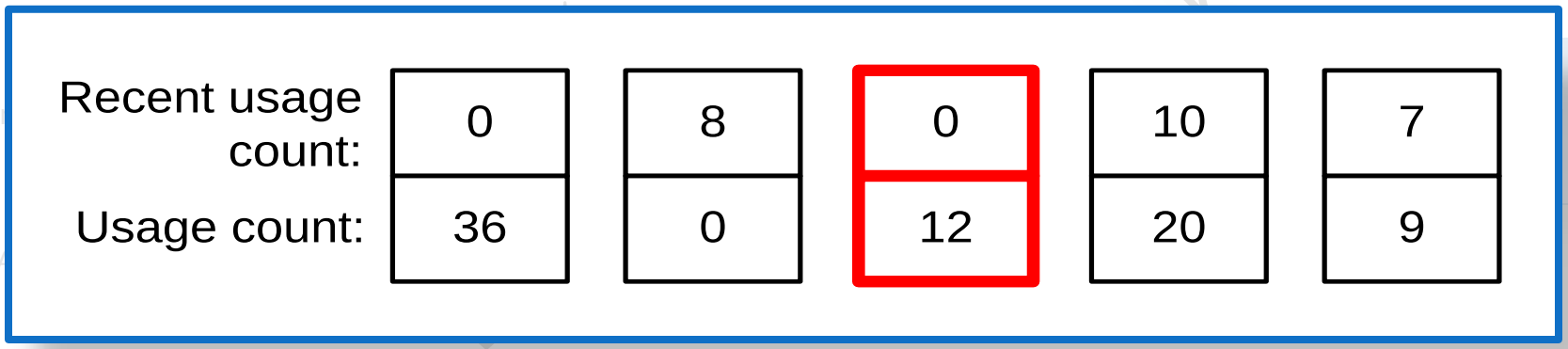


Addition/Removal of detectors is determined by their usage.

+ Detector generated from a **positive example correctly classified** as positive.

- Detector generated from a **negative example incorrently classified** as positive.

Self-Detector: Usage Control*



Usage Control x Usage Control S

Just the first detector which recognizes the example is considered used.

Adaptation **may occur if only one** detector recognizes the example.

Any detector able to recognize the example is considered used.

Adaptation is only performed **if at least two detectors** can recognize the example (higher confidence).

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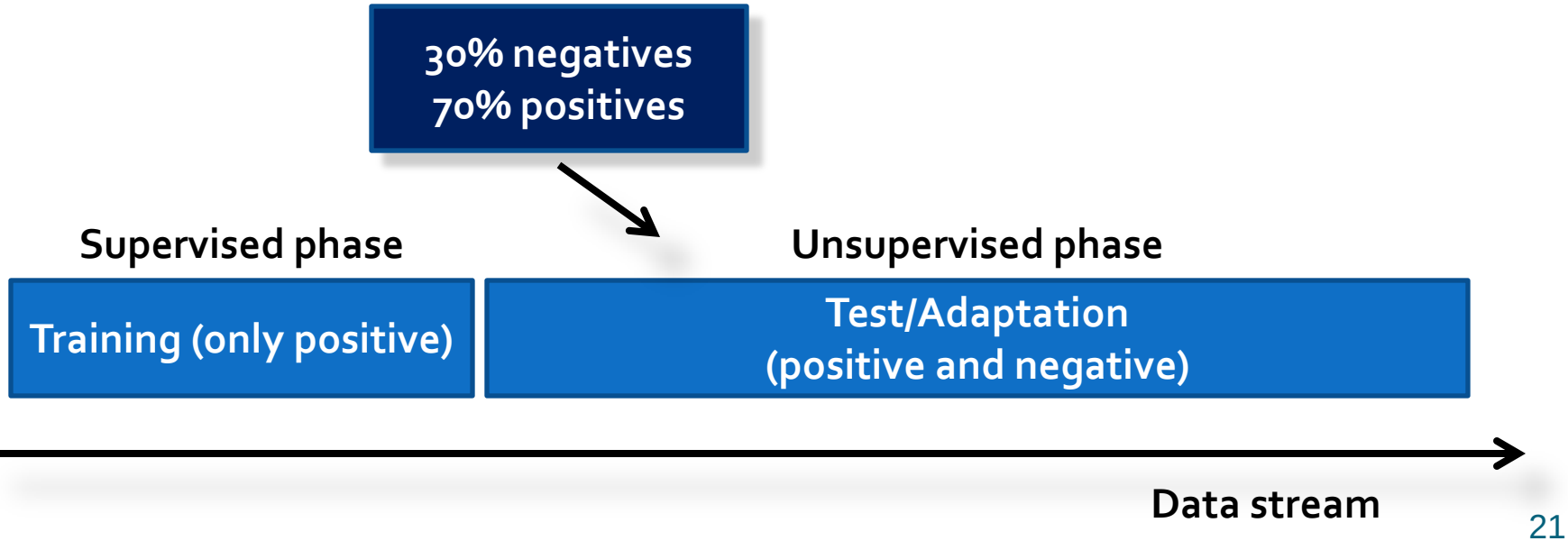
Experimental Setup

- **Datasets** (only users with #examples >= 100, action=walking):
  - Activity Prediction (**Dataset A**): 36 users and a total of 10,591 examples;
  - Actitracker (**Dataset B**): 131 users and a total of 29,190 examples.
- **Evaluation**: as shown in the figure below.



Experimental Setup

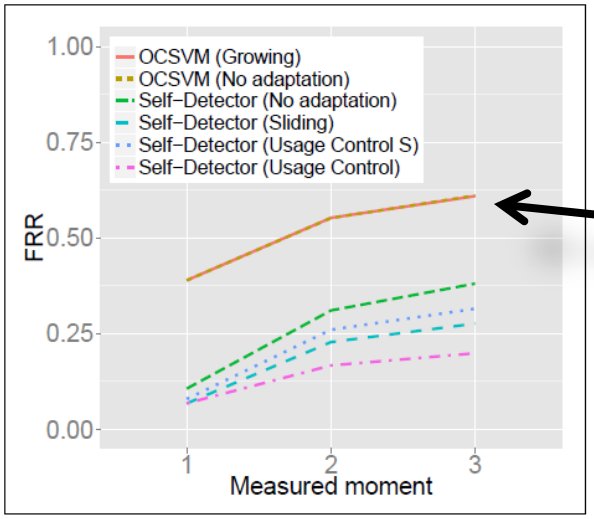
Classification algorithms:

Self-Detector (static)
Self-Detector: *growing* and *sliding* – ideas from [Kang et al., 2007]

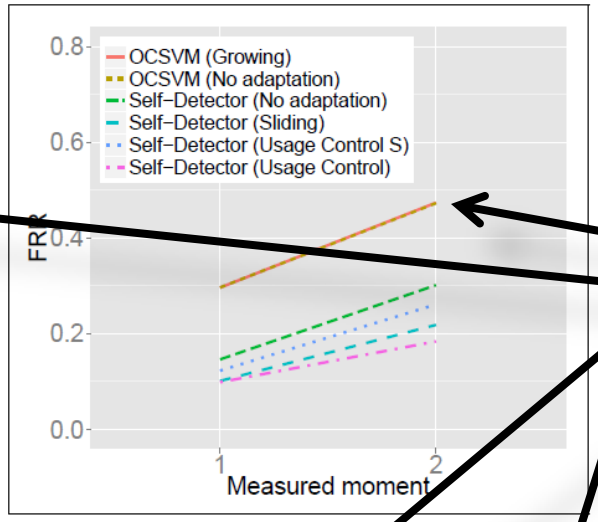
OCSVM [Schölkopf et al., 2001]
OCSVM: *growing* and *sliding* – ideas from [Kang et al., 2007]

Usage Control
Usage Control S (more rigorous adaptive method)

Experimental Results

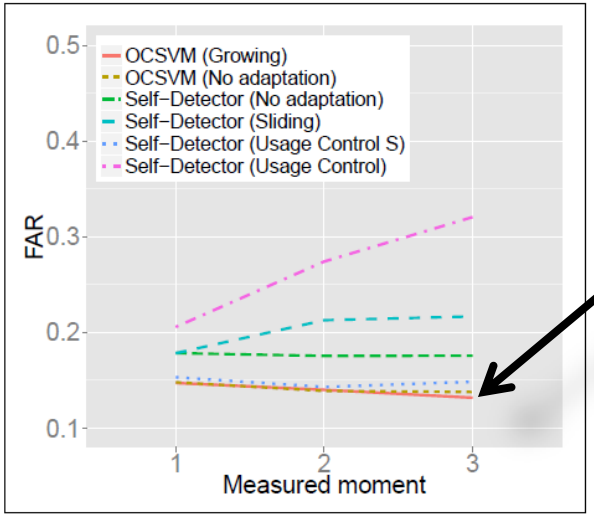


(a) Conjunto de dados A (FRR).

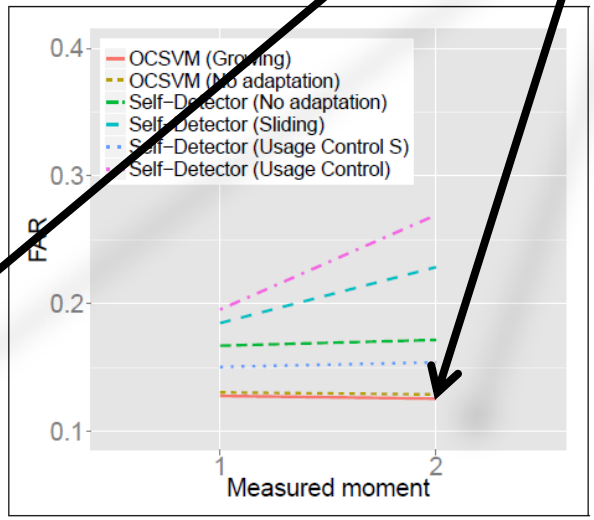


(b) Conjunto de dados B (FRR).

OCSVM:
Similar performance with and without adaptation – high FRR;



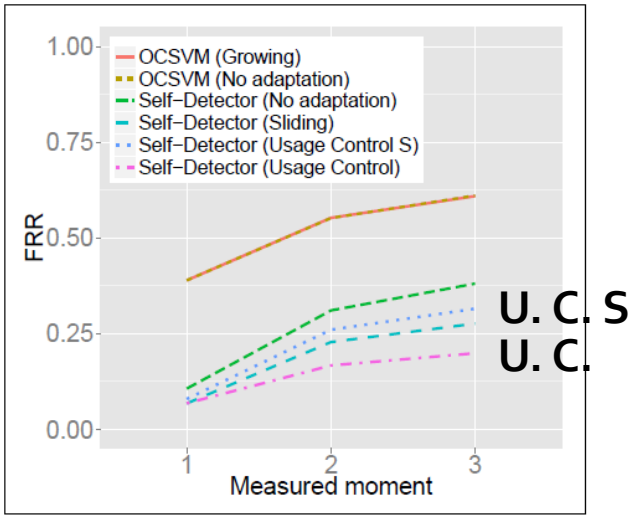
(c) Conjunto de dados A.



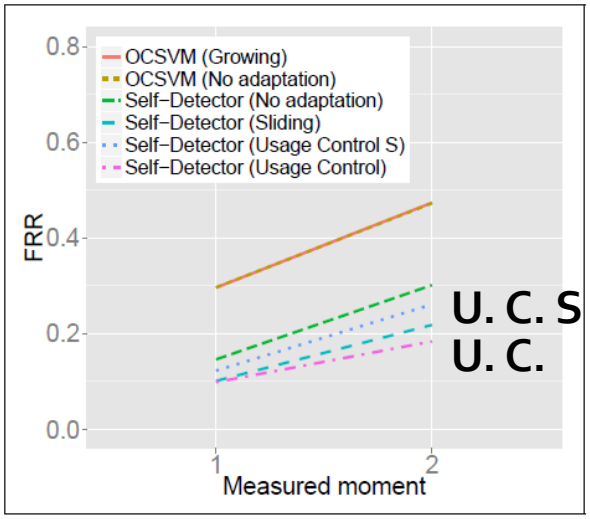
(d) Conjunto de dados B.

FRR and FAR

Experimental Results

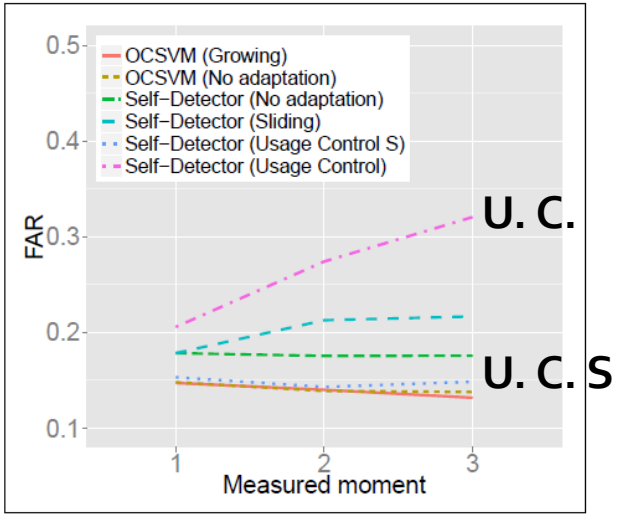


(a) Conjunto de dados A (FRR).

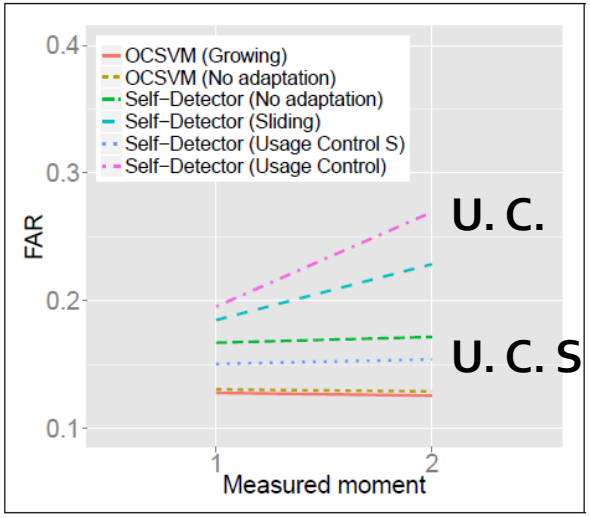


(b) Conjunto de dados B (FRR).

Usage Control:
Low FRR and high FAR;
Usage Control S:
better balance
between FAR and FRR.



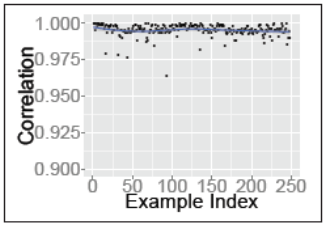
(c) Conjunto de dados A.



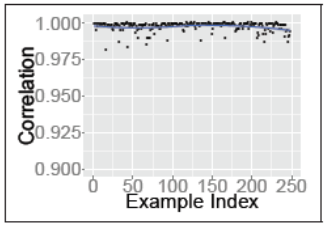
(d) Conjunto de dados B.

FRR and FAR

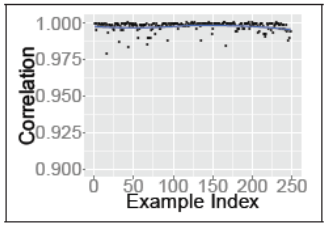
Experimental Results



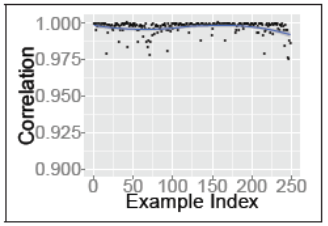
(a) No adaptation (User 1).



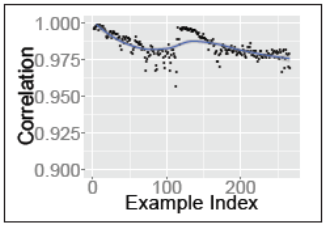
(b) Sliding (User 1).



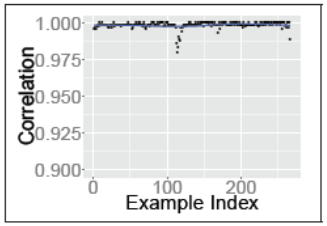
(c) Usage Control (User 1).



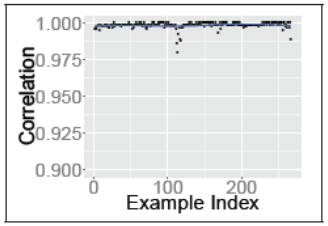
(d) Usage Control S (User 1).



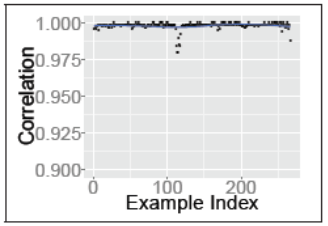
(e) No adaptation (User 2).



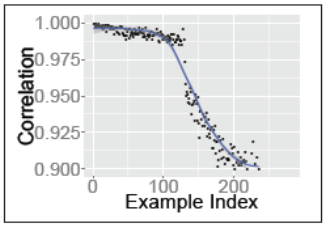
(f) Sliding (User 2).



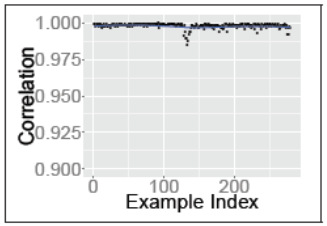
(g) Usage Control (User 2).



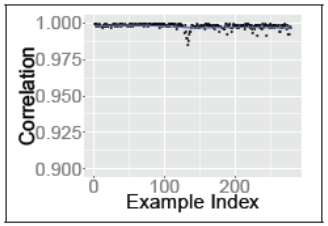
(h) Usage Control S (User 2).



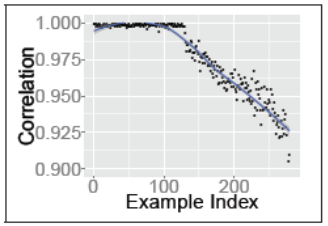
(i) No adaptation (User 3).



(j) Sliding (User 3).



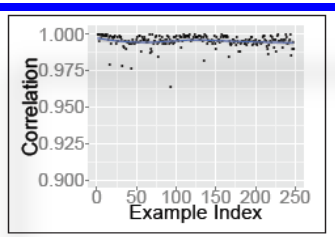
(k) Usage Control (User 3).



(l) Usage Control S (User 3).

Correlation

Experimental Results



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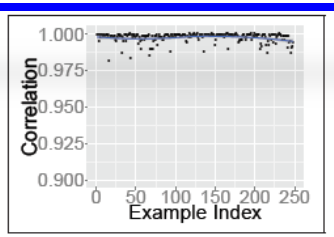
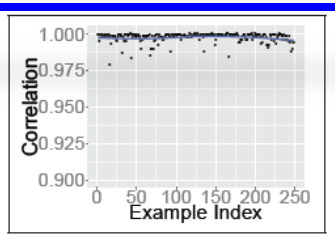
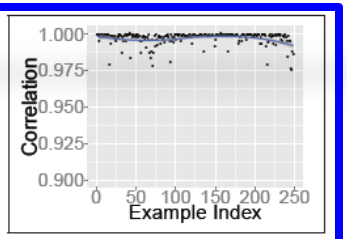


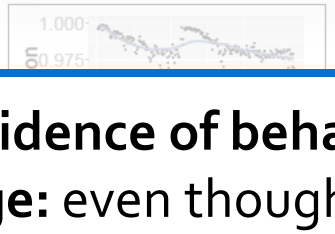
(b) Sliding (User 1).

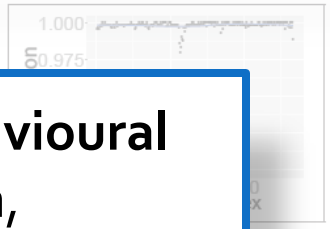


(c) Usage Control (User 1).



(d) Usage Control S (User 1).

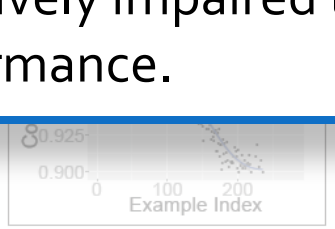


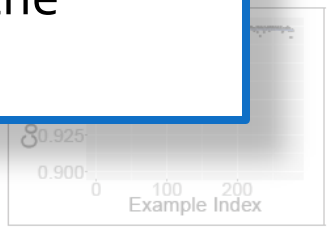


2).

(g) Usage Control (User 2).

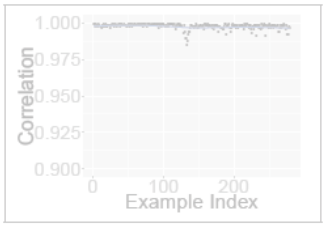
(h) Usage Control S (User 2).



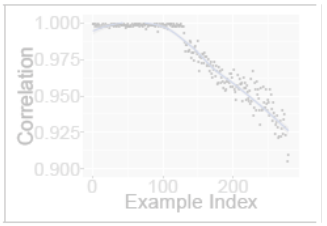


(i) No adaptation (User 3).

(j) Sliding (User 3).



(k) Usage Control (User 3).



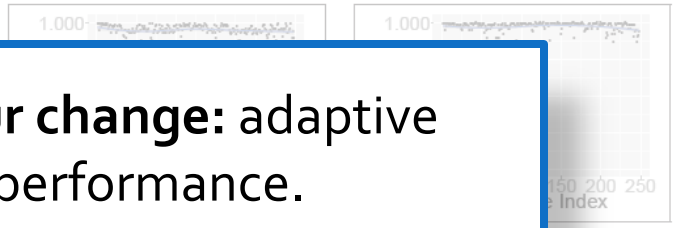
(l) Usage Control S (User 3).

No evidence of behavioural change: even though, adaptive methods did not negatively impaired the performance.

Correlation

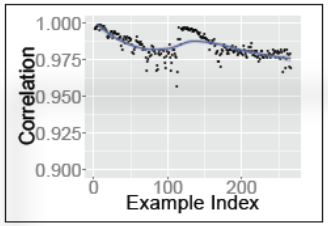
Experimental Results

Suggest behaviour change: adaptive methods improve performance.

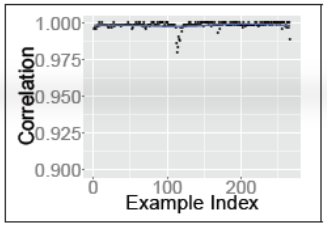


(c) Usage Control (User 1).

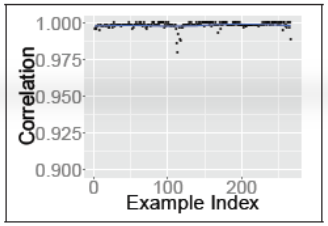
(d) Usage Control S (User 1).



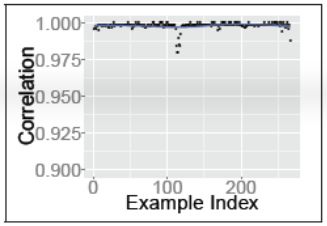
(e) No adaptation (User 2).



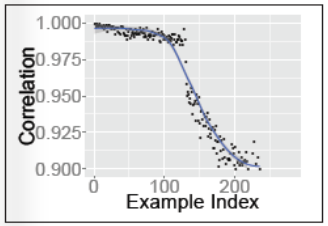
(f) Sliding (User 2).



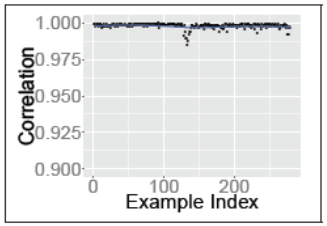
(g) Usage Control (User 2).



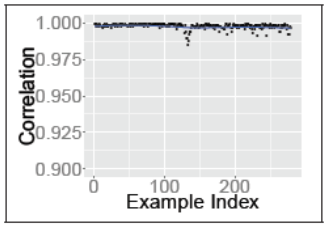
(h) Usage Control S (User 2).



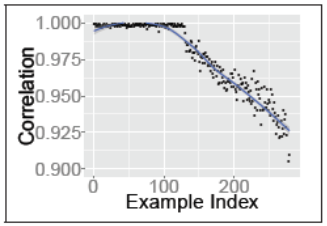
(i) No adaptation (User 3).



(j) Sliding (User 3).



(k) Usage Control (User 3).

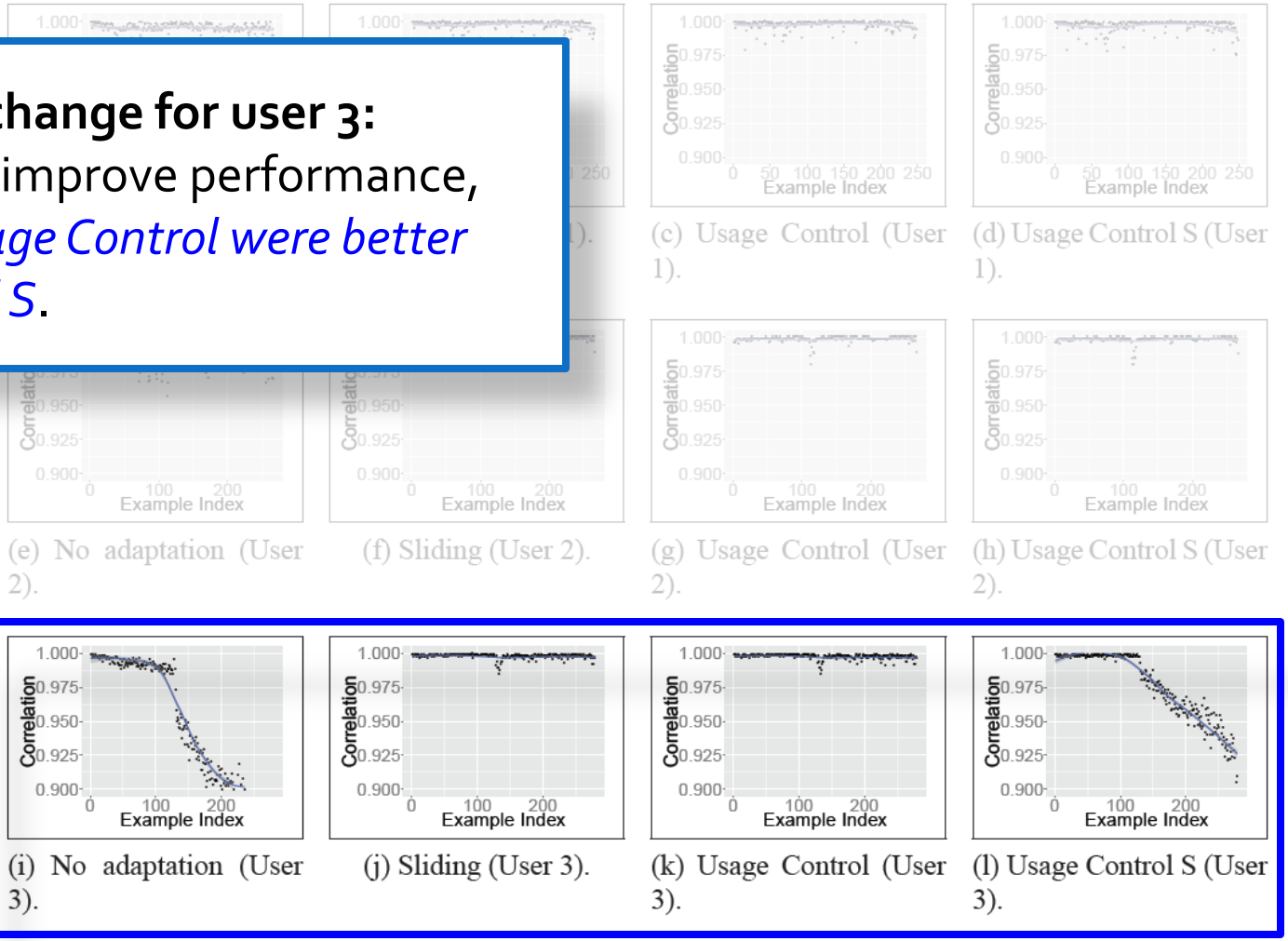


(l) Usage Control S (User 3).

Correlation

Experimental Results

Sharp behaviour change for user 3: adaptive methods improve performance, but *Sliding and Usage Control were better than Usage Control S*.



(c) Usage Control (User 1). (d) Usage Control S (User 1).

(e) No adaptation (User 2). (f) Sliding (User 2). (g) Usage Control (User 2). (h) Usage Control S (User 2).

(i) No adaptation (User 3). (j) Sliding (User 3). (k) Usage Control (User 3). (l) Usage Control S (User 3).

Correlation

1. Introduction

2. Immune Positive Selection and Proposal

3. Experimental Results and Conclusion

Conclusion

- The analysis conducted in this study suggests that *behaviour change* occurs in accelerometer biometrics data, but not for all users.
- Additionally, Usage Control S improved all rates over the non-adaptive *Self-Detector*, indicating that it is suitable for accelerometer biometrics.

Adaptive Algorithms in Accelerometer Biometrics

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