Some Results kept during the Evaluation Process of the Modeling

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In the following table, we present the results of the kNN model. More precisely, as we said in the paper, we split the dataset in 4 smaller datasets, according to the direction of each swipe. Also, we kept only the users that had a lot of swipes (more than 35 for each direction), so that the model would have a lot of data for training and for testing. Then, in order to tune the kNN model and find the appropriate number of nearest neighbors for our model we run the model for 2-5 nearest neighbors and we did that for 50 random users for each direction. So, we conducted 50*4*4 = 800 results. These results are summarized in the following, since for each direction and nearest neighbor, we took the mean value of the 50 users.

nearest neighbors	UP		DOWN		LEFT		RIGHT	
	FRR	*ACC*	*FRR*	*ACC*	*FRR*	*ACC*	*FRR*	*ACC*
2	57.6%	95.6%	47.9%	93.7%	55.8%	92%	53.2%	93.1%
3	27.2%	89.5%	24.5%	86.3%	29.7%	84.3%	28.4%	85.2%
4	20.8%	86.2%	18.5%	81.9%	22.6%	79.4%	20.9%	80.6%
5	18.4%	83.6%	14.4%	79%	14.9%	76%	13.1%	78.1%

Then, we did the same thing in order to tune the SVM model. In this case we took a number of v-γ pairs but we only present and kept the data of 3 pairs. Again, we run 50 users for each direction and pair, thus 50*4*3 = 600 results.

v-γ	UP		DOWN		LEFT		RIGHT	
	FRR	*ACC*	*FRR*	*ACC*	*FRR*	*ACC*	*FRR*	*ACC*
0.005-0.01	1.1%	72.8%	0.9%	70.4%	0.7%	69.3%	0.7%	69.9%
0.005-0.1	8.4%	80.2%	7.8%	79.2%	6.2%	78.1%	6.4%	79.1%
0.005-0.2	22.8%	86.6%	19.7%	84.3%	16.3%	82.5%	17.2%	83.6%

Then we combined those two models together and we found the Accuracy and FRR of the whole confidence-based system. Again, we run 50 different users for each direction. 50*4 = 200 results. Here, we made the assumption that in order to classify a swipe as positive or negative, the certainty of prediction must be greater than 5% or less than -5%. Thus, the final results for the tuned kNN-SVM model are shown in the following table.

v-γ / nearest neighbors	UP		DOWN		LEFT		RIGHT	
	FRR	*ACC*	*FRR*	*ACC*	*FRR*	*ACC*	*FRR*	*ACC*
0.005-0.01 / 3	6.2%	94.3%	8.9%	87.3%	8.1%	88.1%	6.8%	91.8%

Finally, we run the Model.R script for about 100 different users for each direction (100*4 = 400) and the mean number of “attacker” accepted swipes for each direction is shown below.

	UP	*DOWN*	*LEFT*	*RIGHT*
Number of accepted swipes	2.32	2.54	2.51	2.42