Unobservable Re-authentication for Smartphones

Lingjun Li, Xinxin Zhao, and Guoliang Xue

Outline

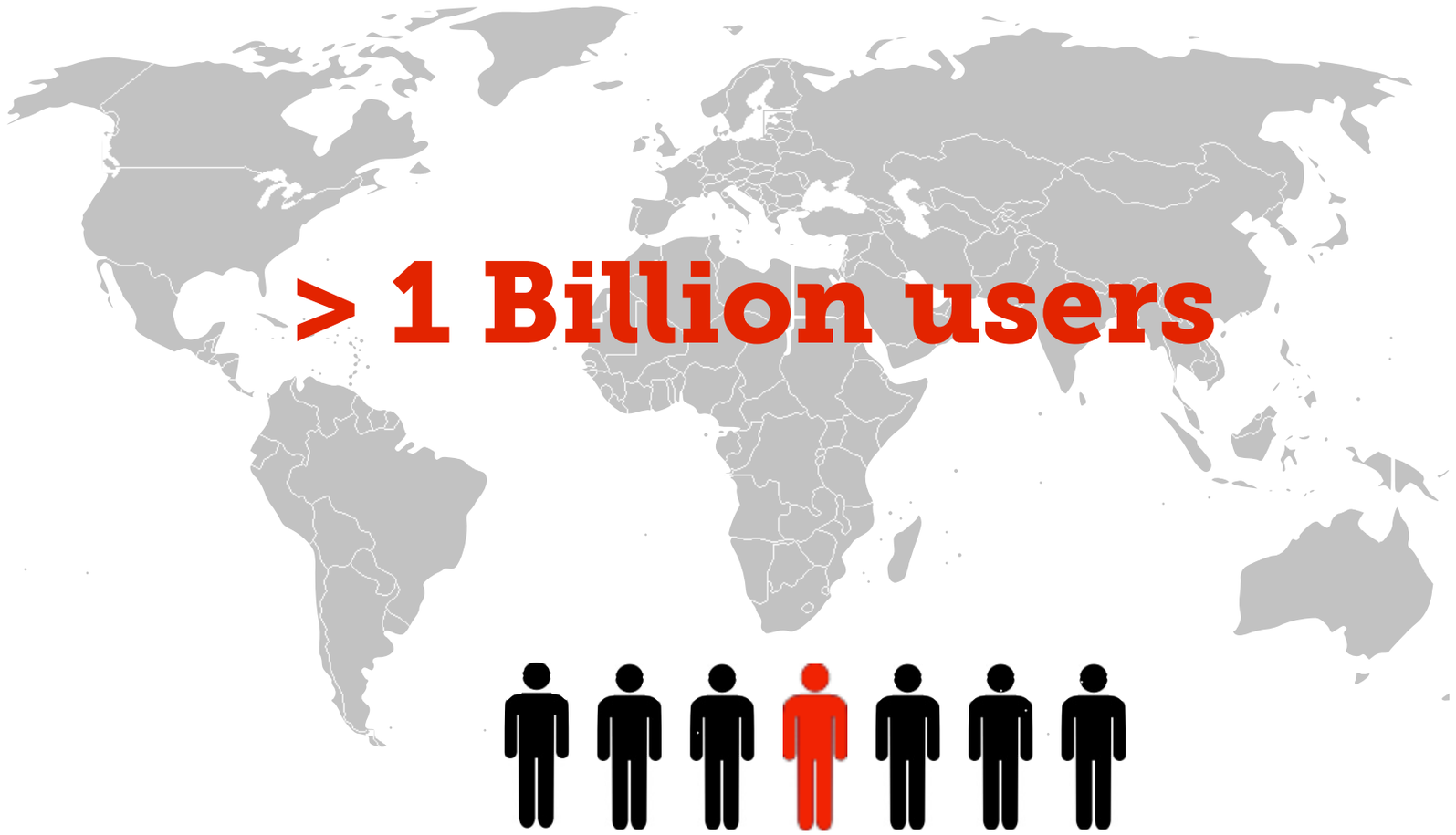
Motivation and Problem

Approach

Characterizing Gestures

Metric Design and Selection

Evaluations and Conclusions



Smartphones are very popular

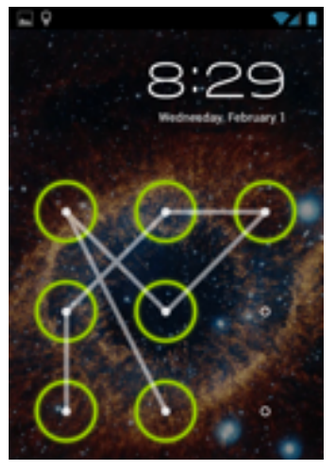
Motivation

- Prone to lifting

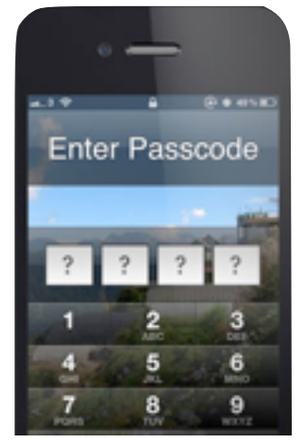
Motivation

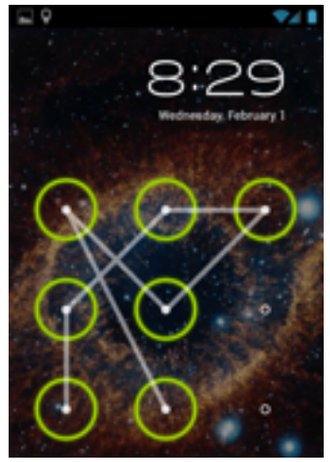
- Prone to lifting
- User authentication

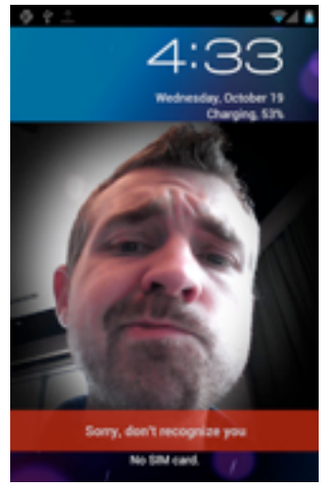
Current Authentication Approaches



Current Authentication Approaches

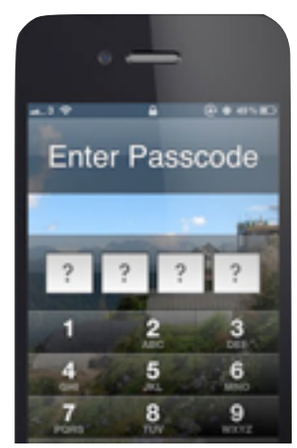


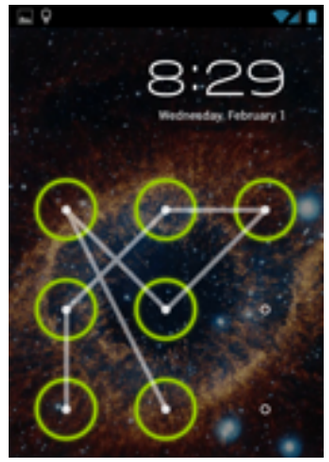


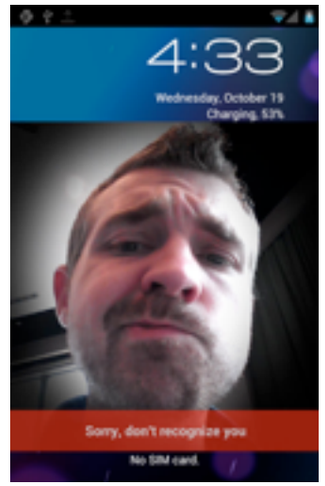


Current Authentication Approaches

- One time

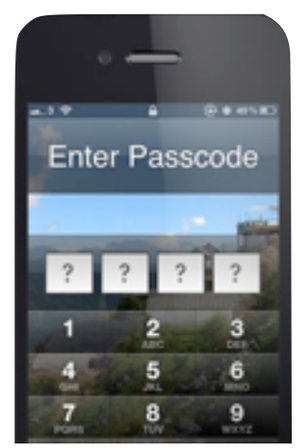


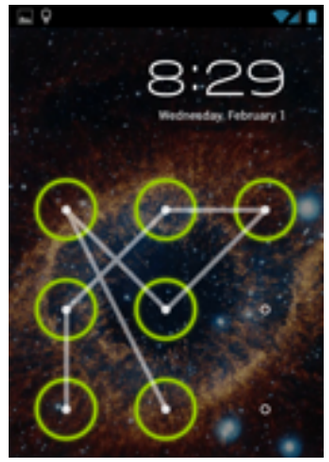


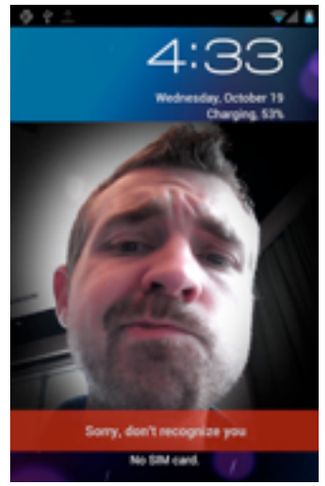


Current Authentication Approaches

- One time
- Interrupt

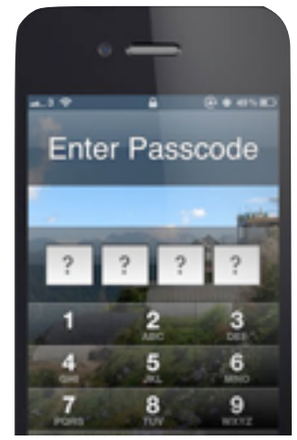


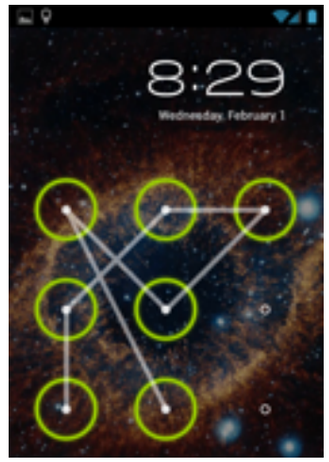


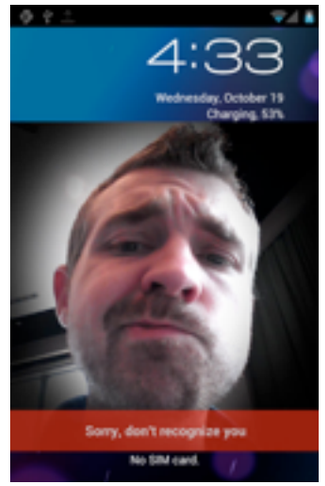


Current Authentication Approaches

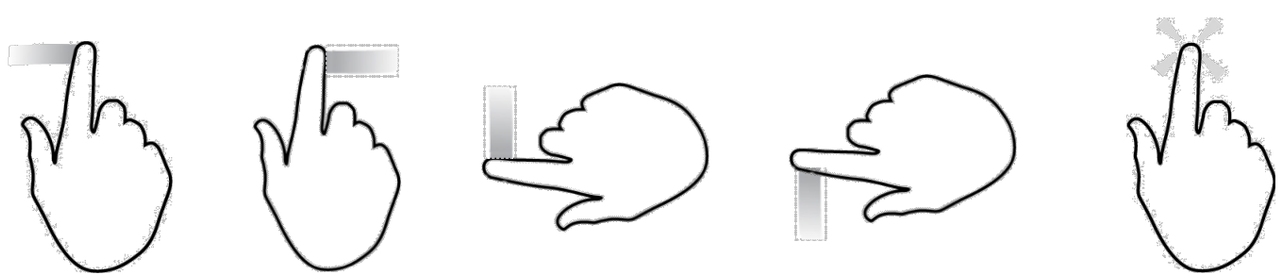
- One time
- Interrupt
- Weak



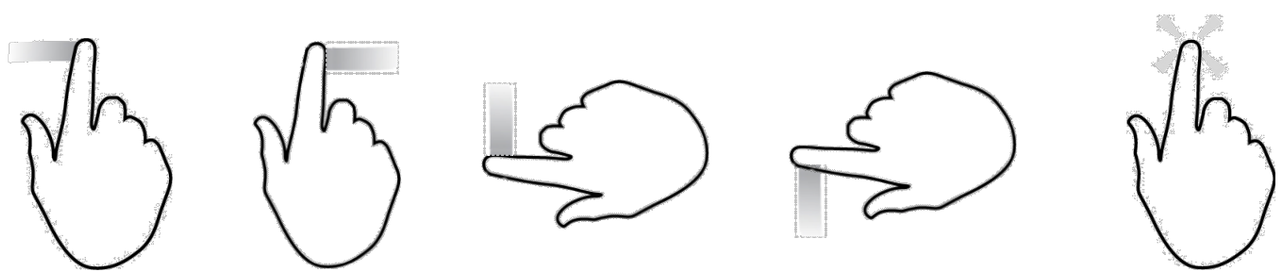




Our approach



Our approach



- Running in the background
- Continuously monitoring

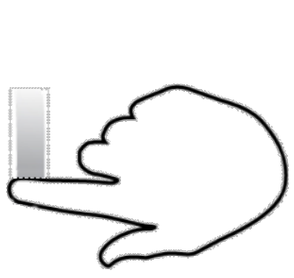
Usage Patterns

- Intermitted Usage
- Spatial Disconnection
- Orientations

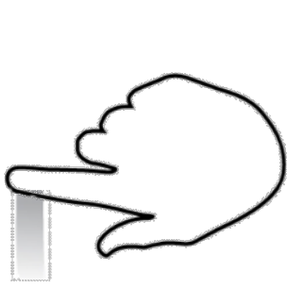
Gestures

sliding right

sliding left

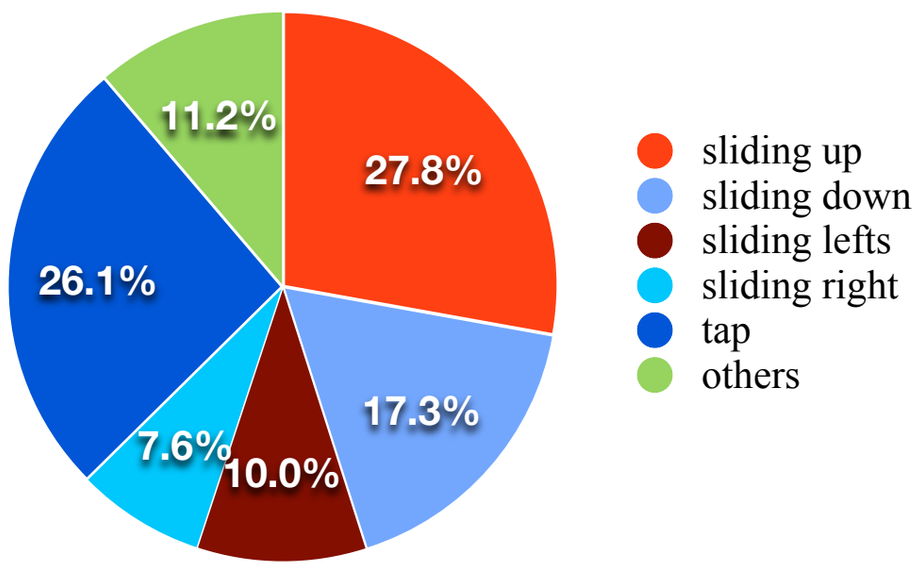


sliding down

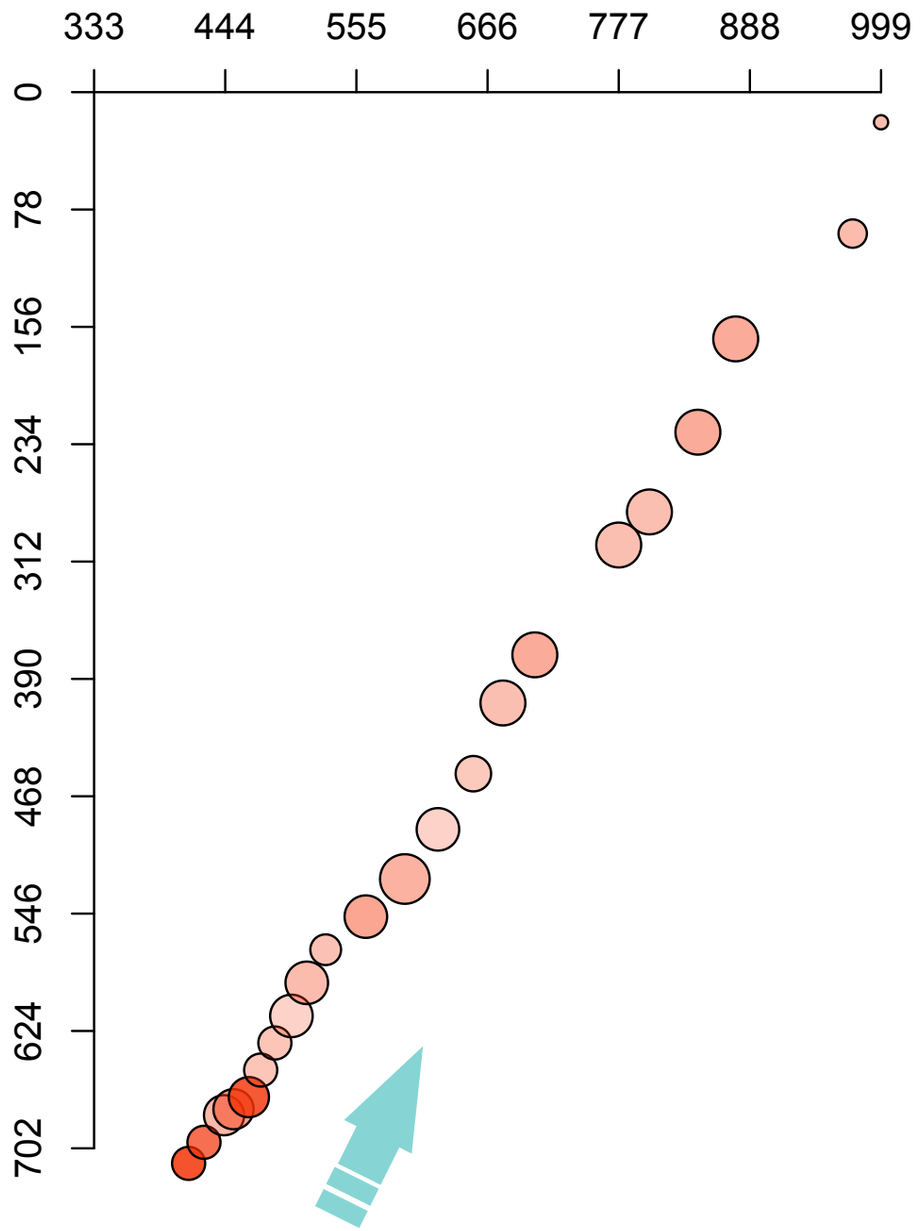


sliding up

tap



Touch Data



sliding up

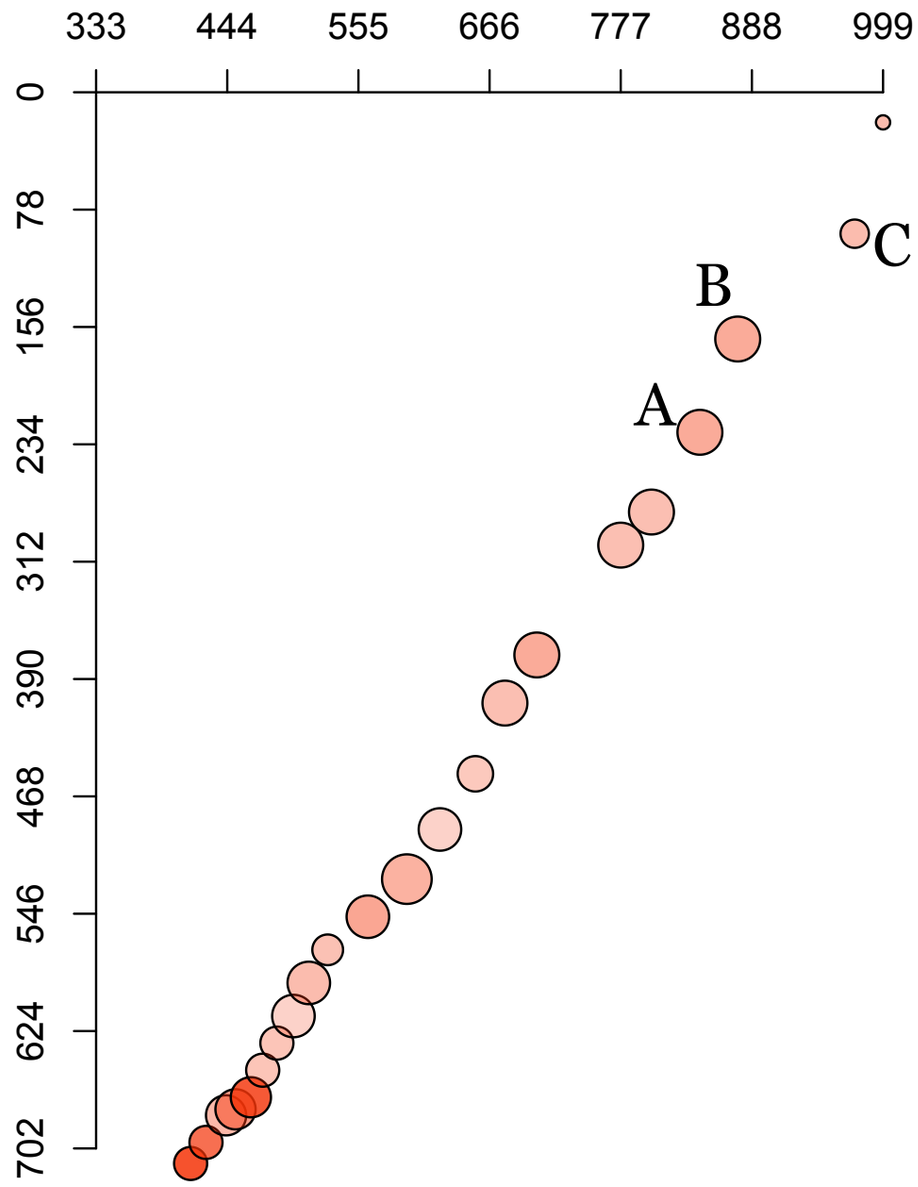
Touch Position

Touch Area

Touch Pressure

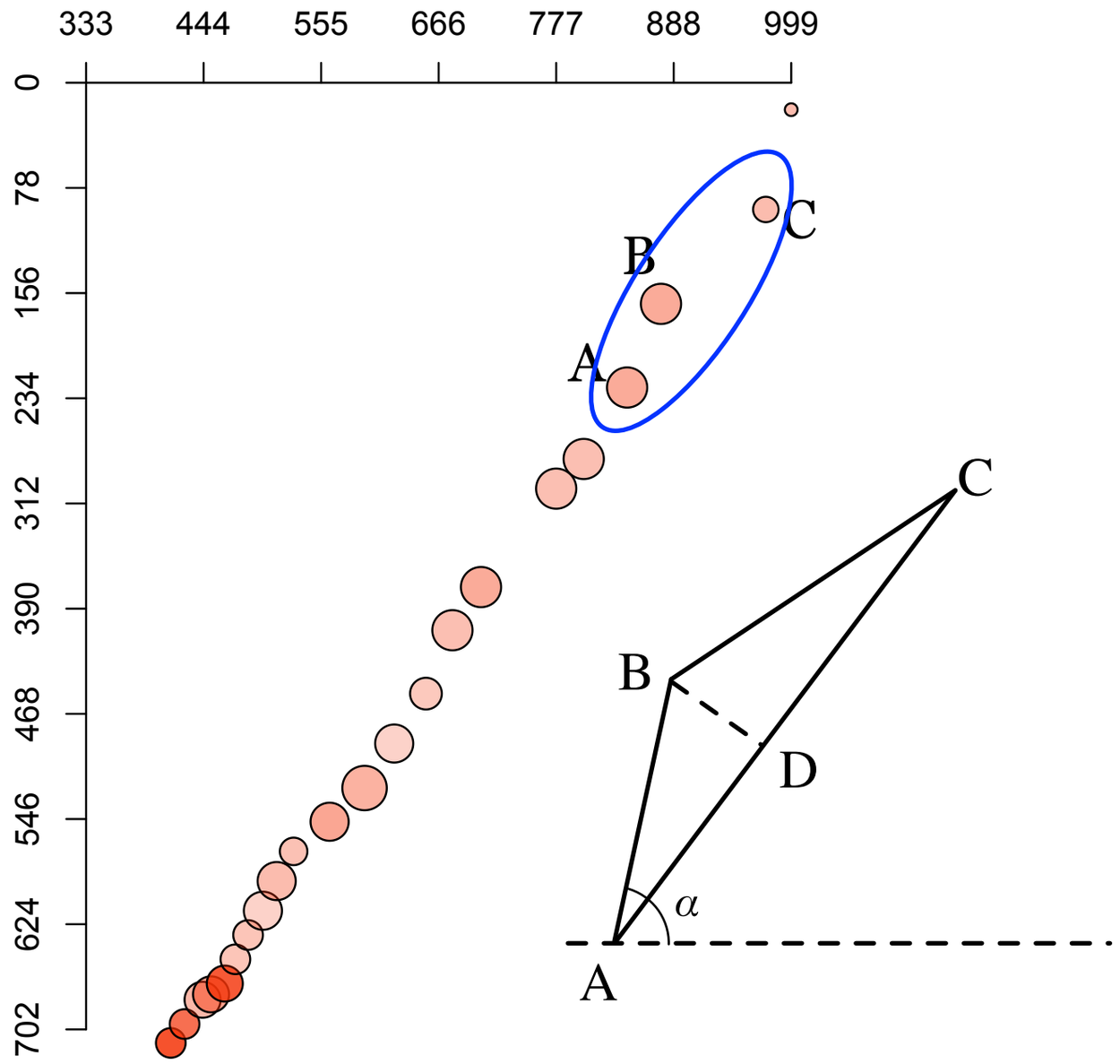
Metrics of Sliding

- First Touch Position
- First Touch Pressure
- First Touch Area
- First Moving Direction
- Moving Distance
- Moving Duration
- Average Moving Direction
- Average Moving Curvature
- Average Curvature Distance



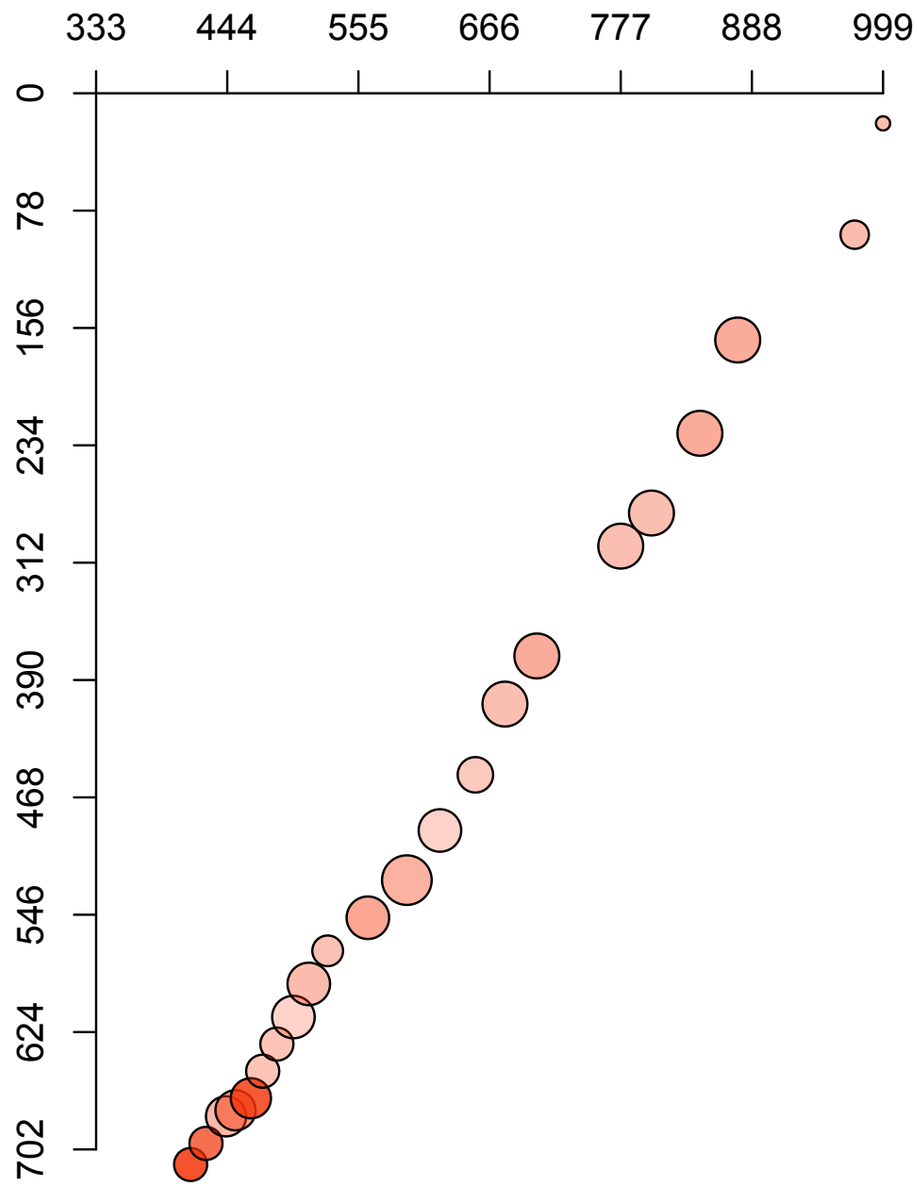
Metrics of Sliding

- First Touch Position
- First Touch Pressure
- First Touch Area
- First Moving Direction
- Moving Distance
- Moving Duration
- Average Moving Direction
- Average Moving Curvature
- Average Curvature Distance



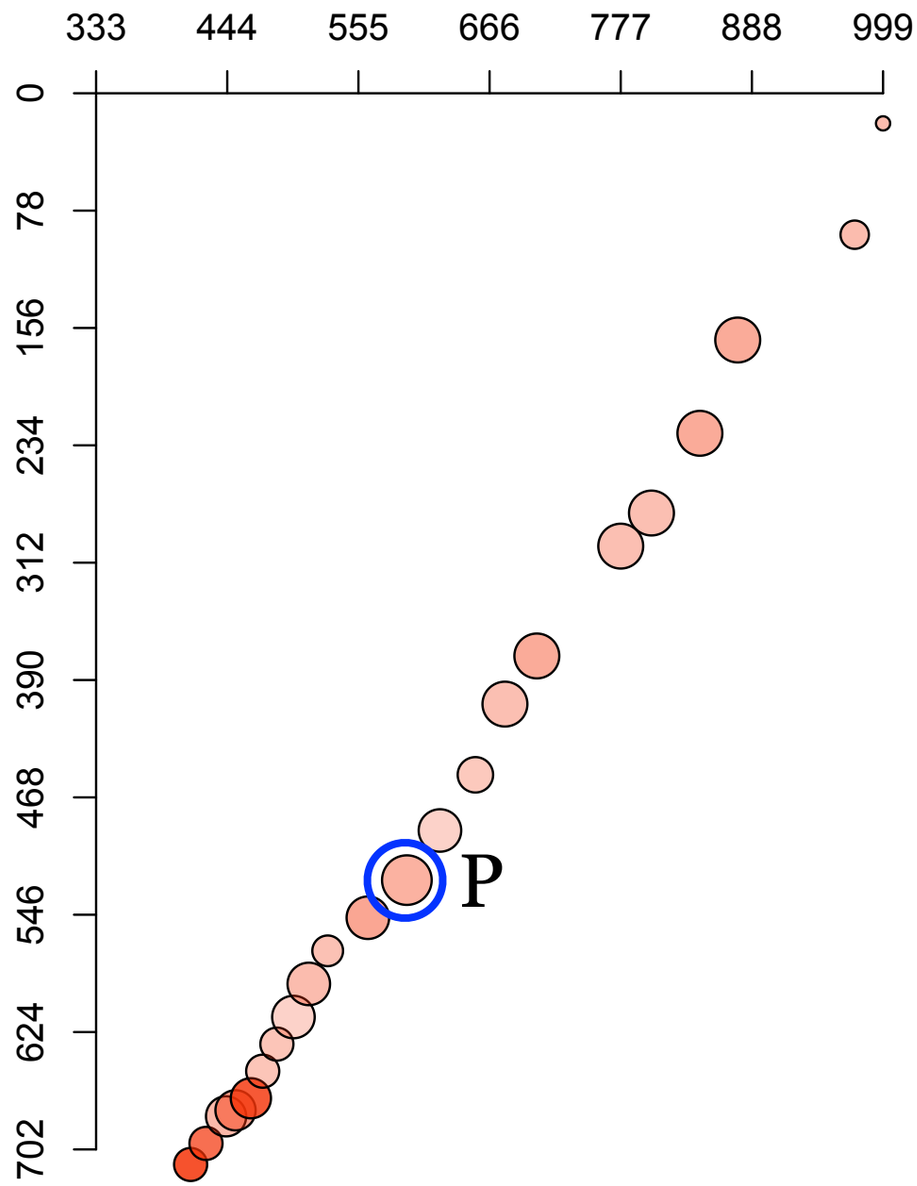
Metrics of Sliding

- Average Pressure
- Average Touch Area
- Max-area Portion
- Min-pressure Portion



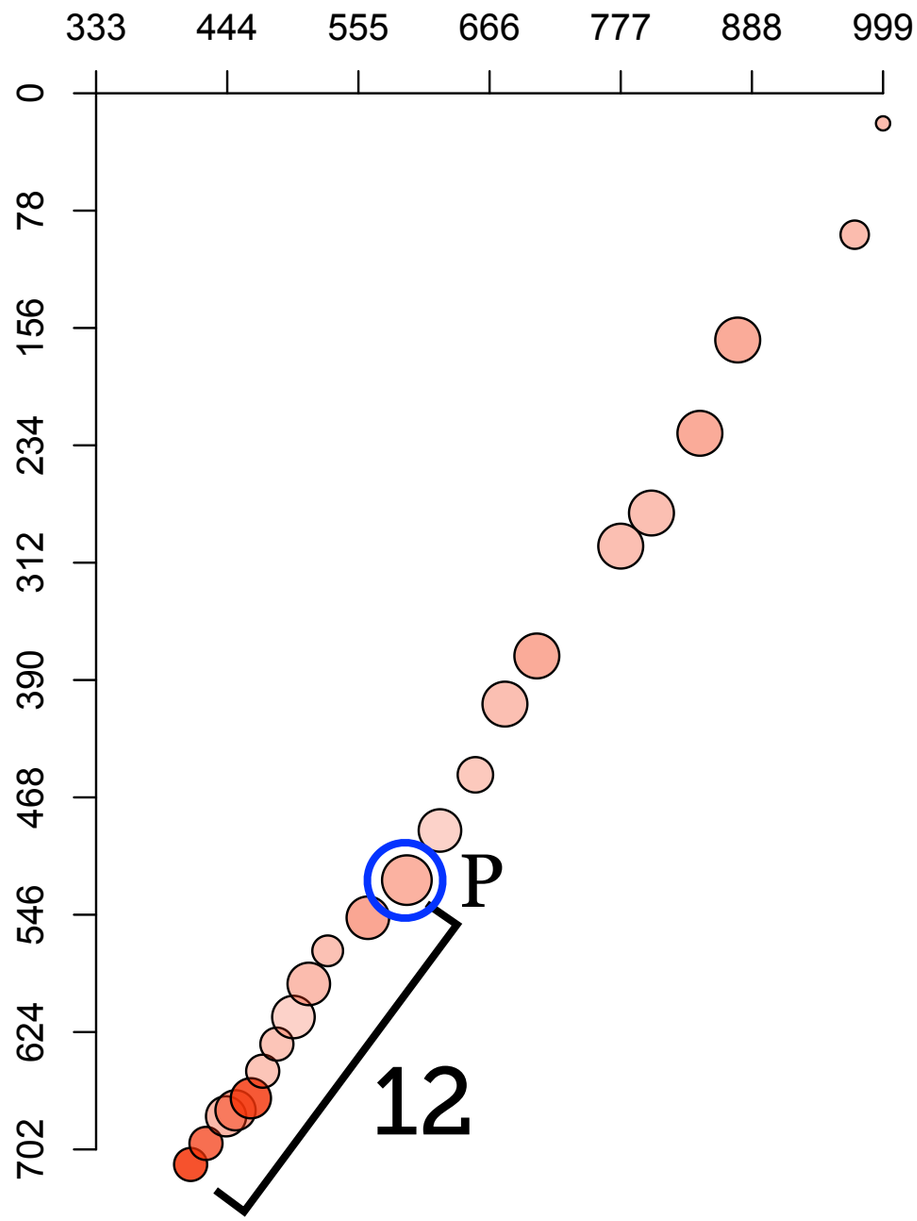
Metrics of Sliding

- Average Pressure
- Average Touch Area
- Max-area Portion
- Min-pressure Portion



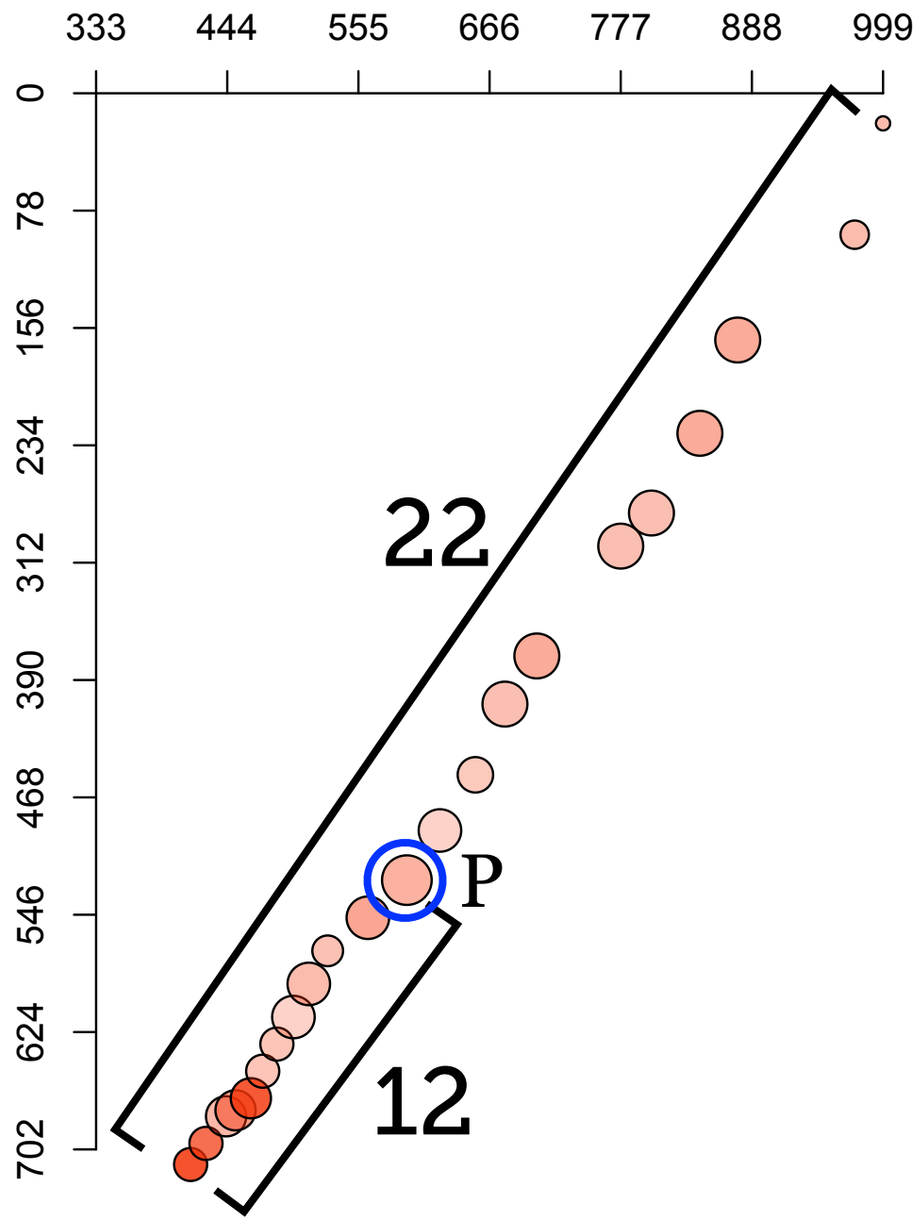
Metrics of Sliding

- Average Pressure
- Average Touch Area
- Max-area Portion
- Min-pressure Portion



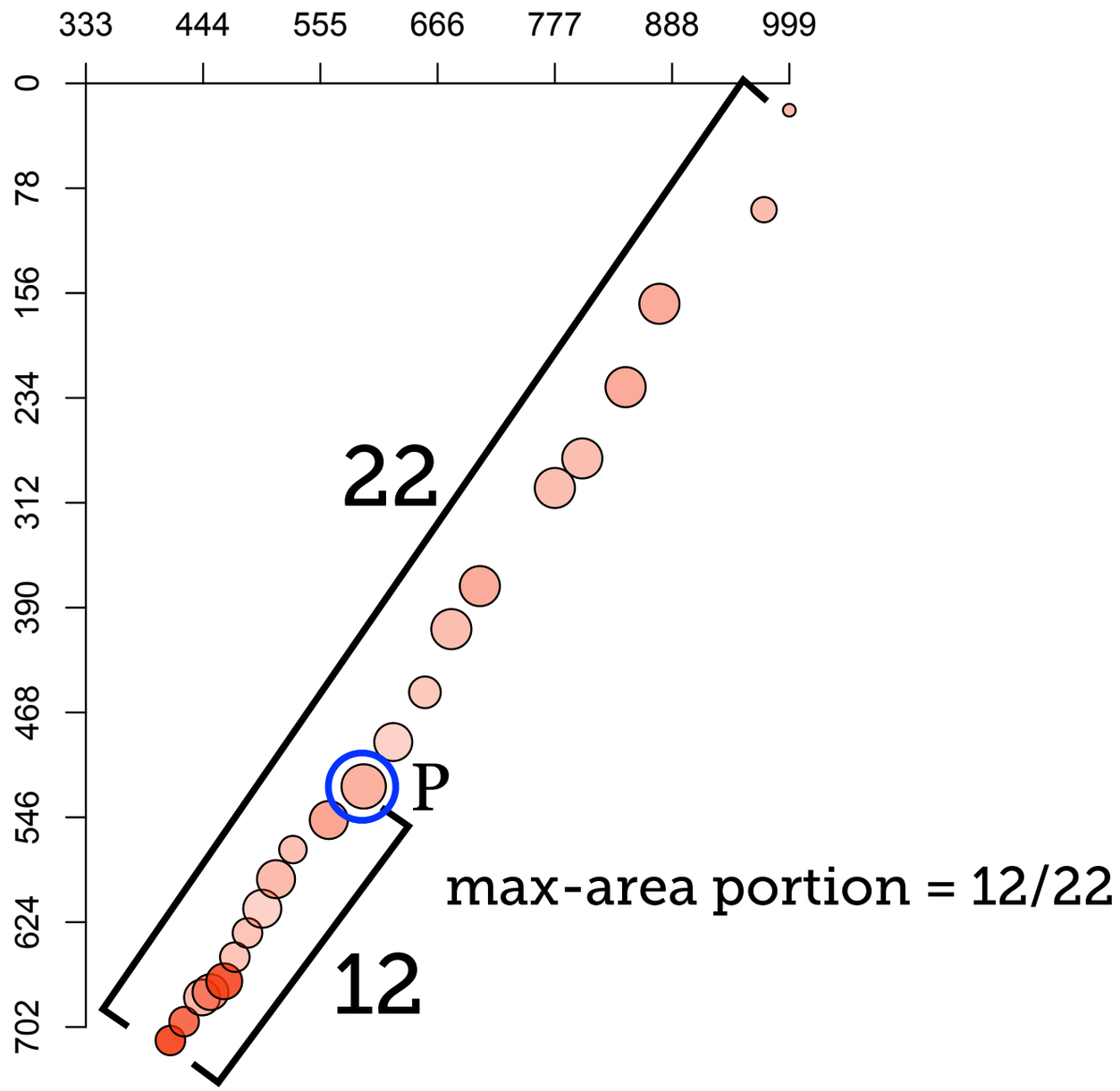
Metrics of Sliding

- Average Pressure
- Average Touch Area
- Max-area Portion
- Min-pressure Portion



Metrics of Sliding

- Average Pressure
- Average Touch Area
- Max-area Portion
- Min-pressure Portion



Metrics of Tap

- Average Touch Area
- Duration
- Average Touch Pressure

Metric Selection

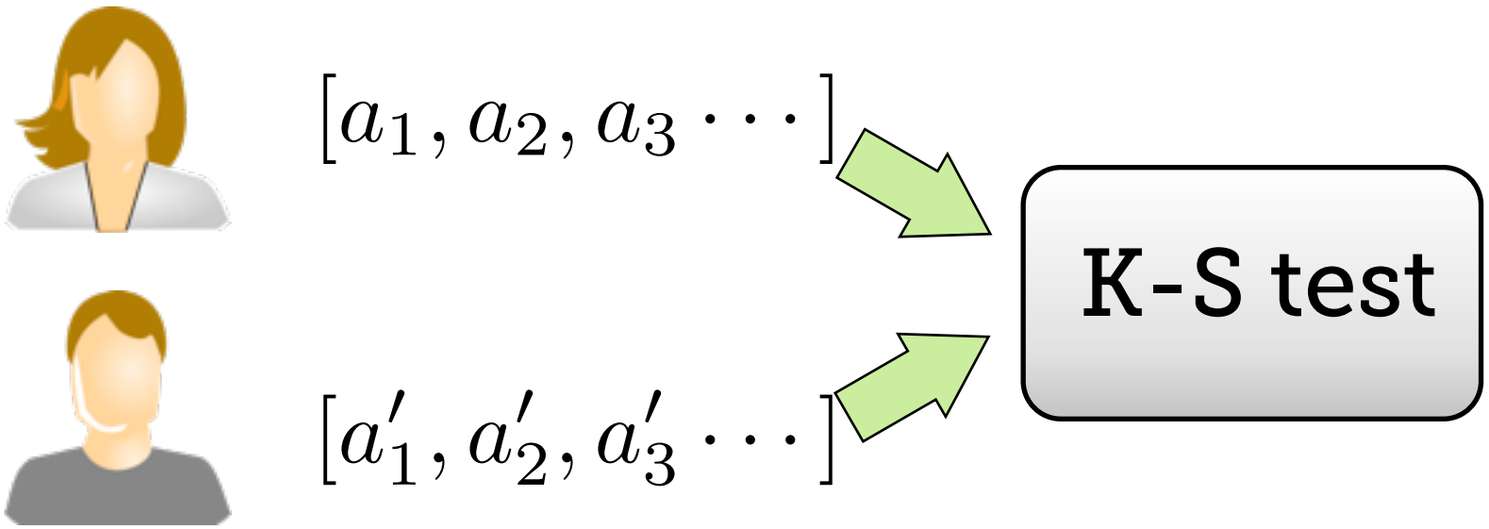
- A good metric can distinguish two users from each other

$[a_1, a_2, a_3 \cdots]$

$[a'_1, a'_2, a'_3 \cdots]$

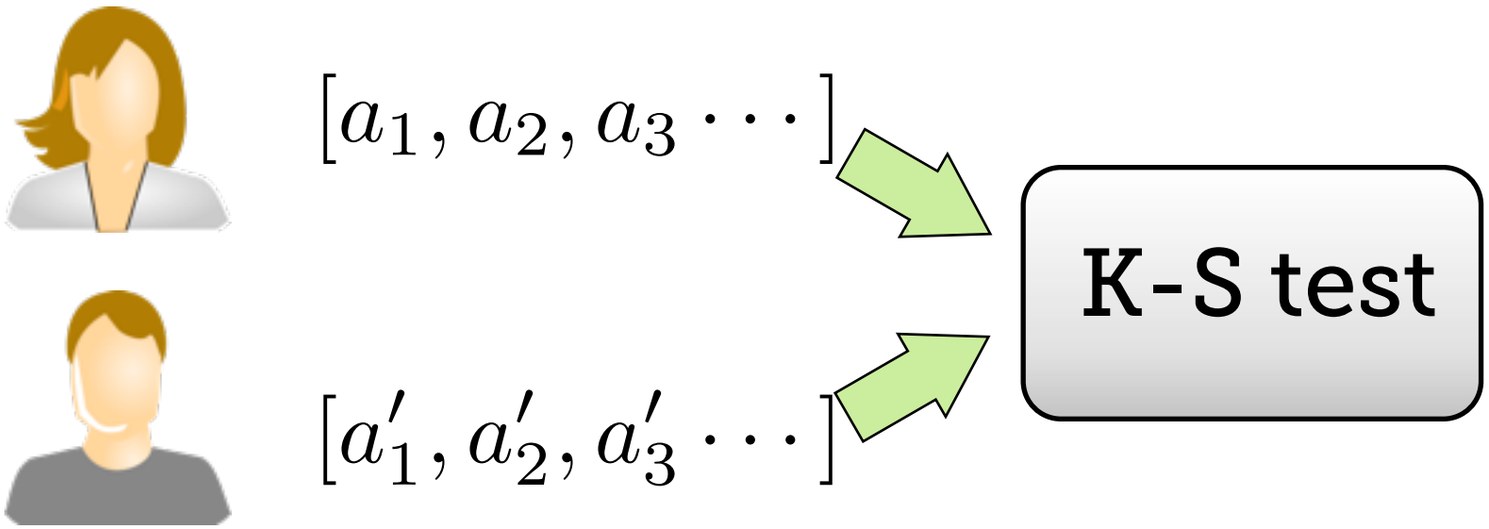
Metric Selection

- A good metric can distinguish two users from each other



Metric Selection

- A good metric can distinguish two users from each other

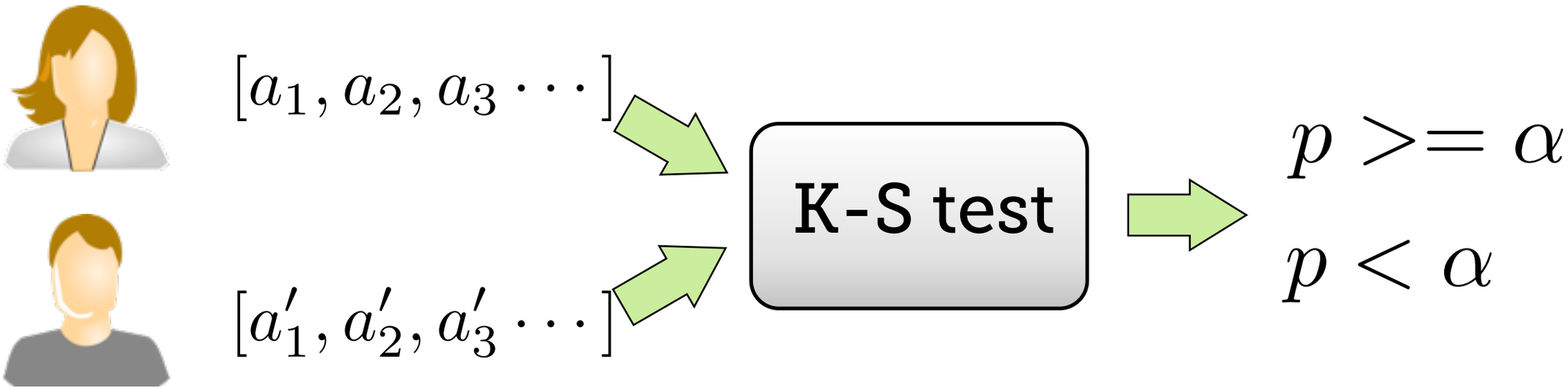


H_0: from the same distribution

H_1: from different distributions

Metric Selection

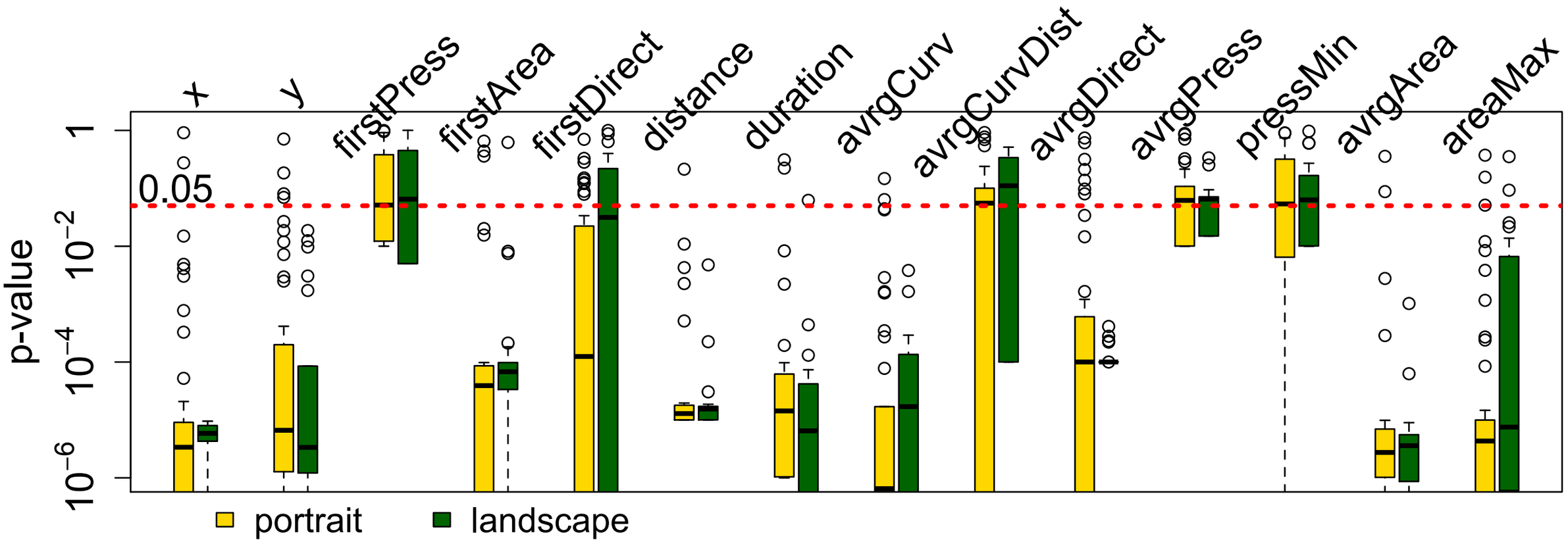
- A good metric can distinguish two users from each other



H_0: from the same distribution

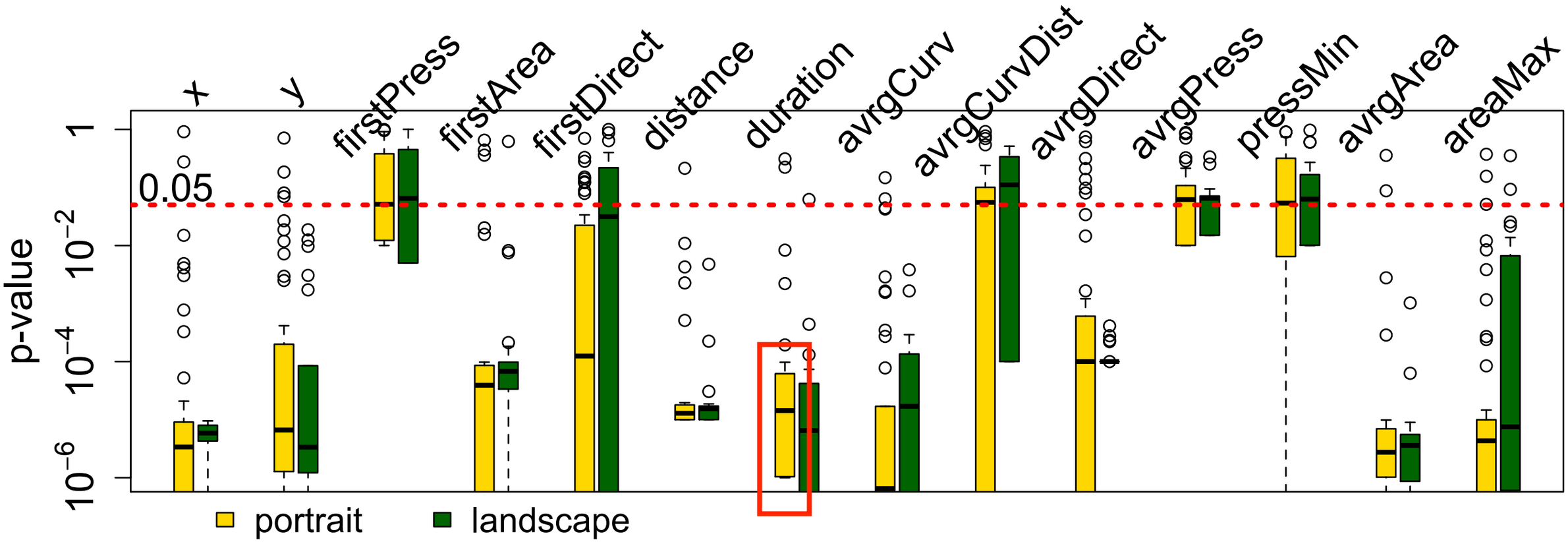
H_1: from different distributions

Metric Selection



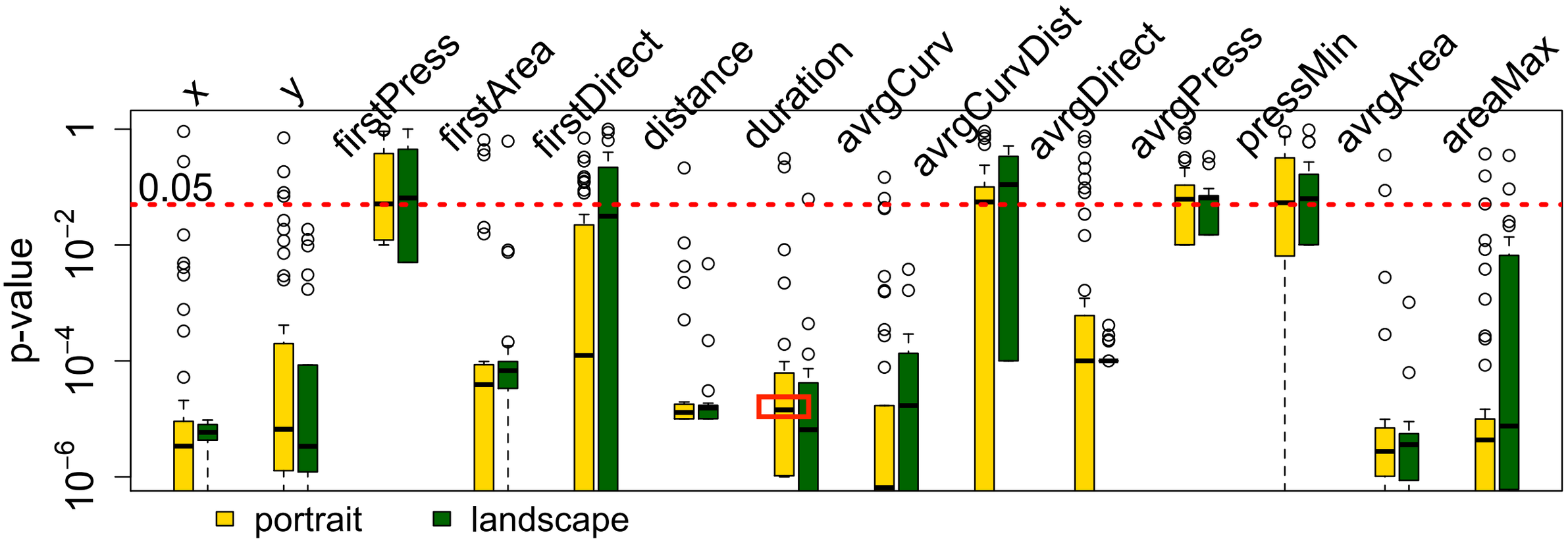
Sliding up

Metric Selection



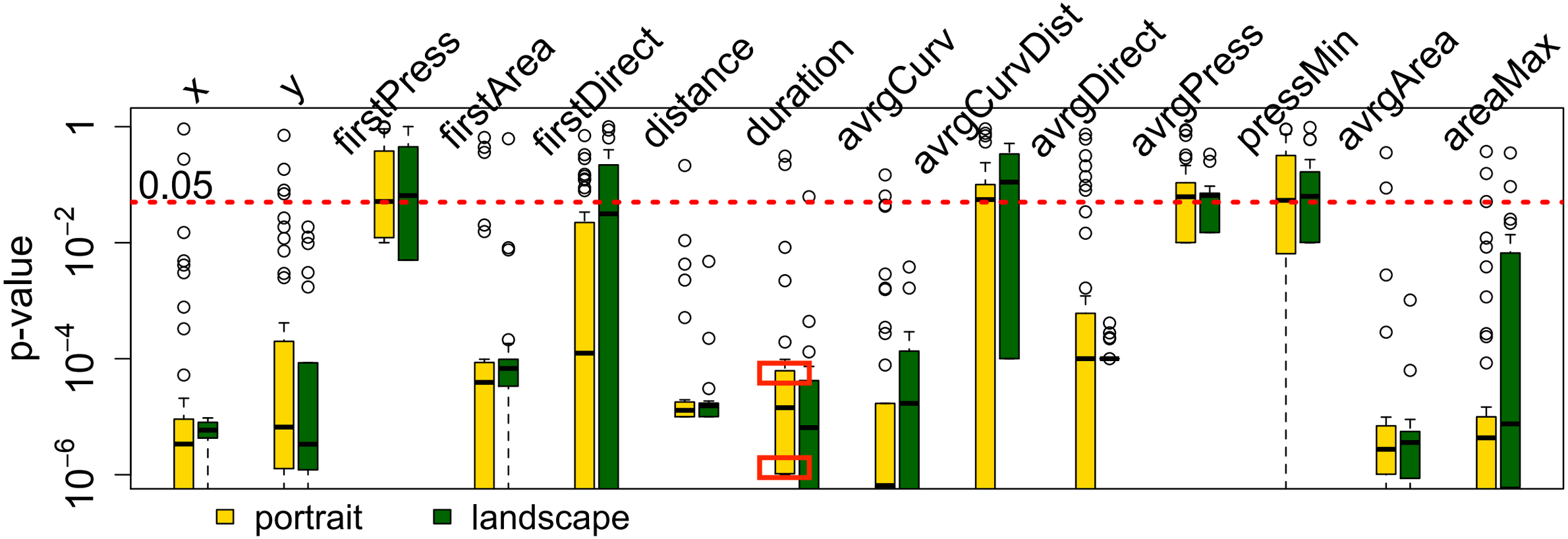
Sliding up

Metric Selection



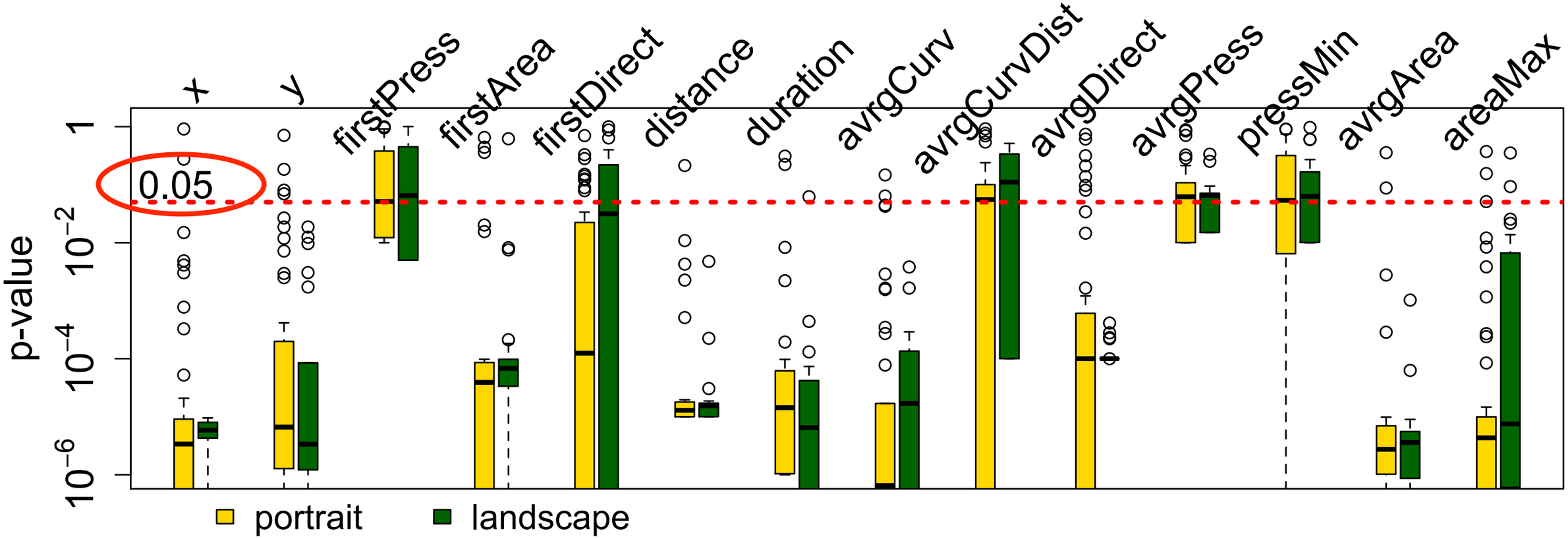
Sliding up

Metric Selection



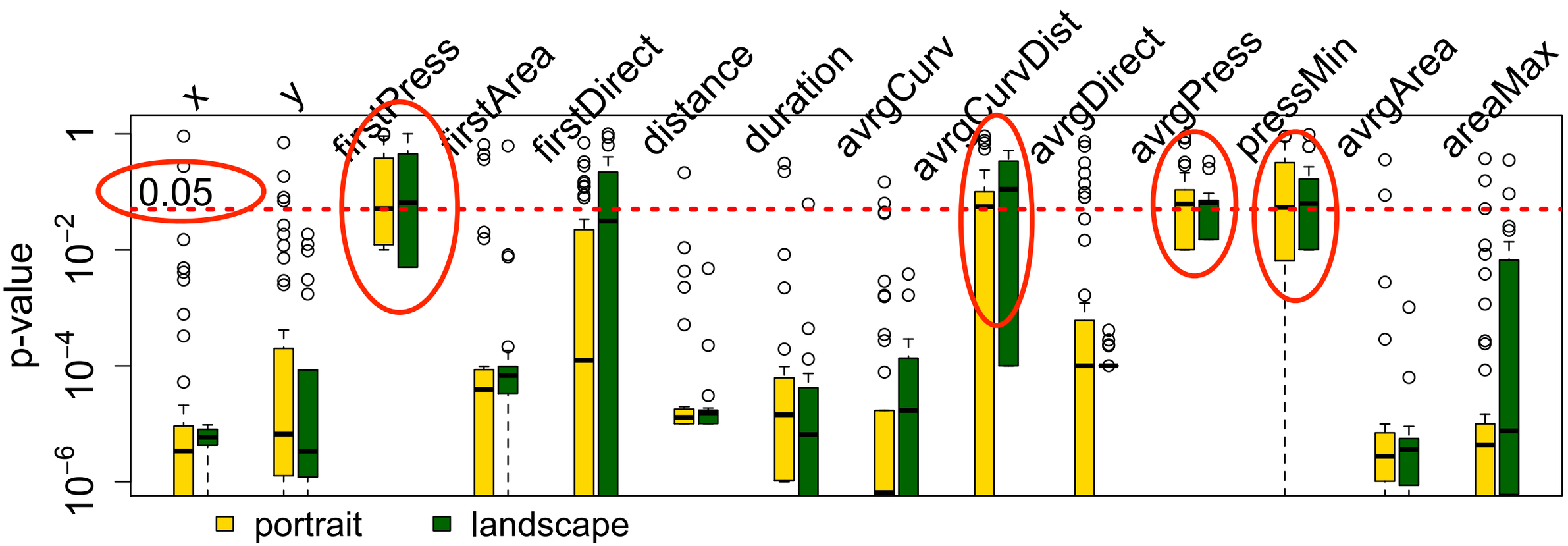
Sliding up

Metric Selection



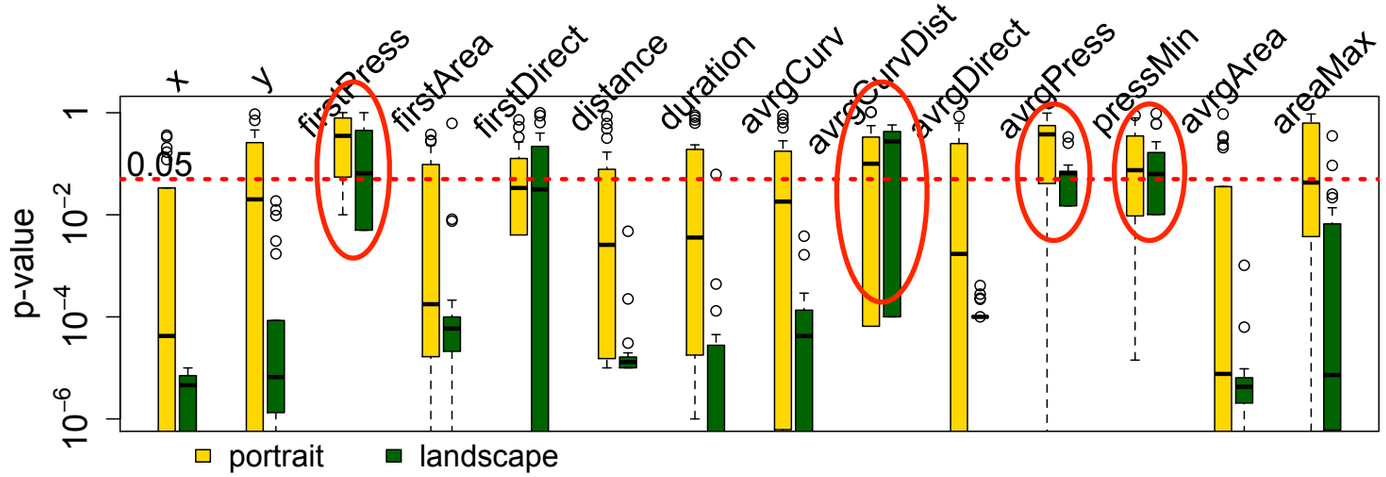
Sliding up

Metric Selection

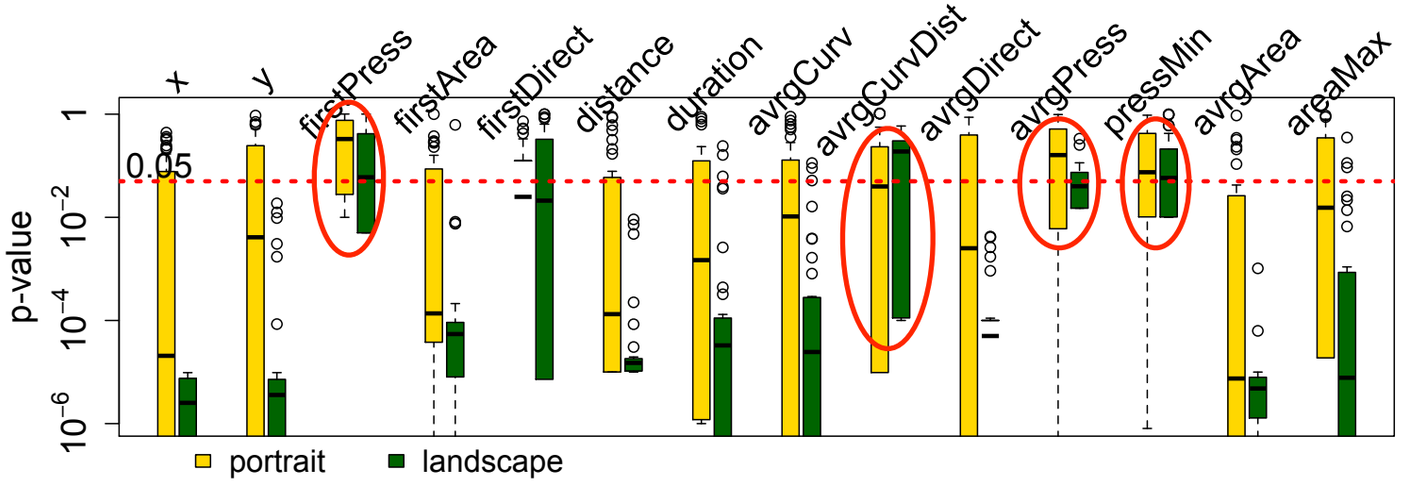


Sliding up

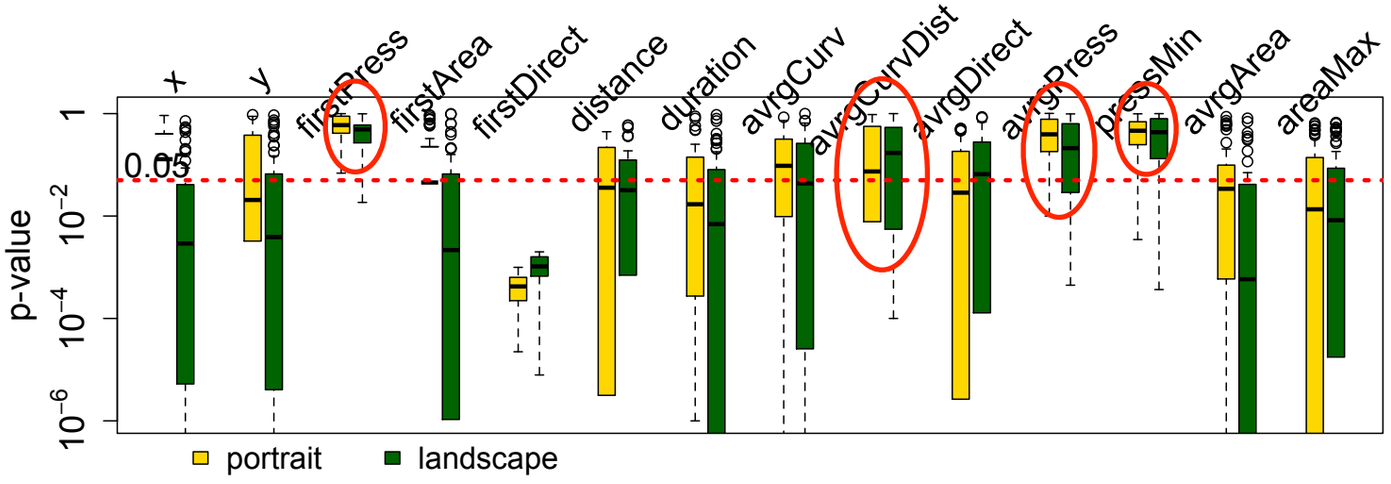
Metric Selection



Sliding down

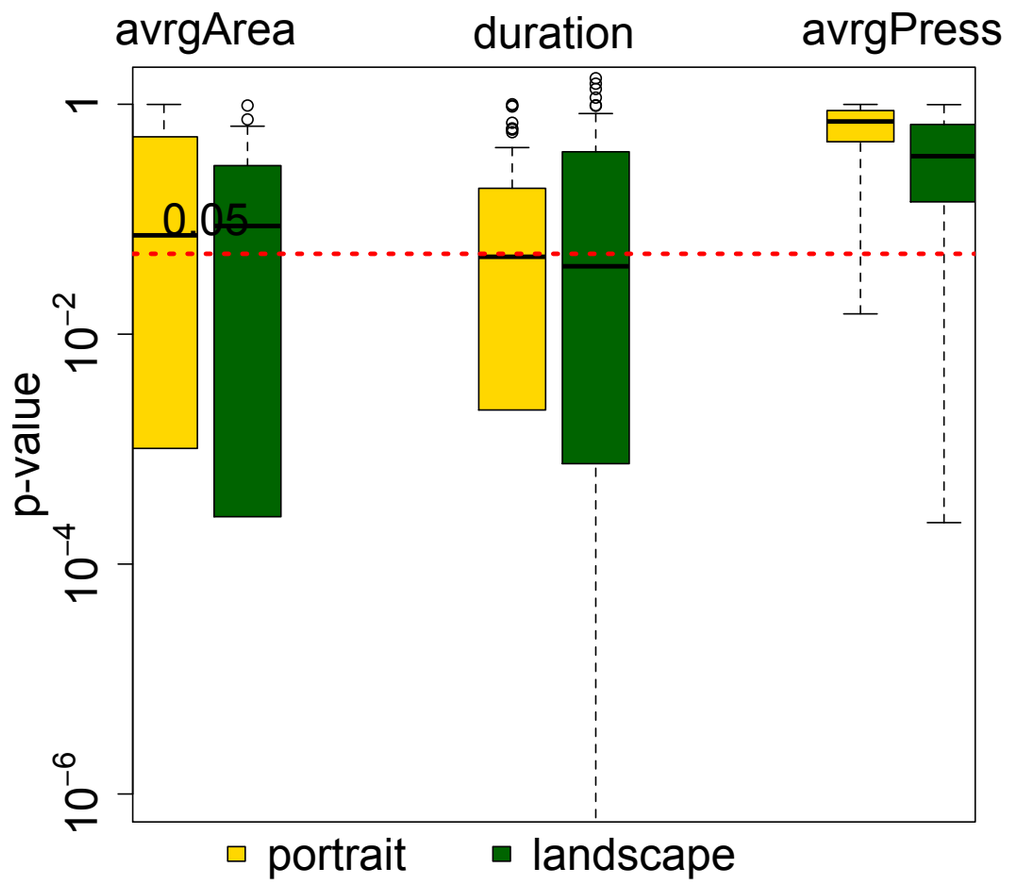


Sliding left



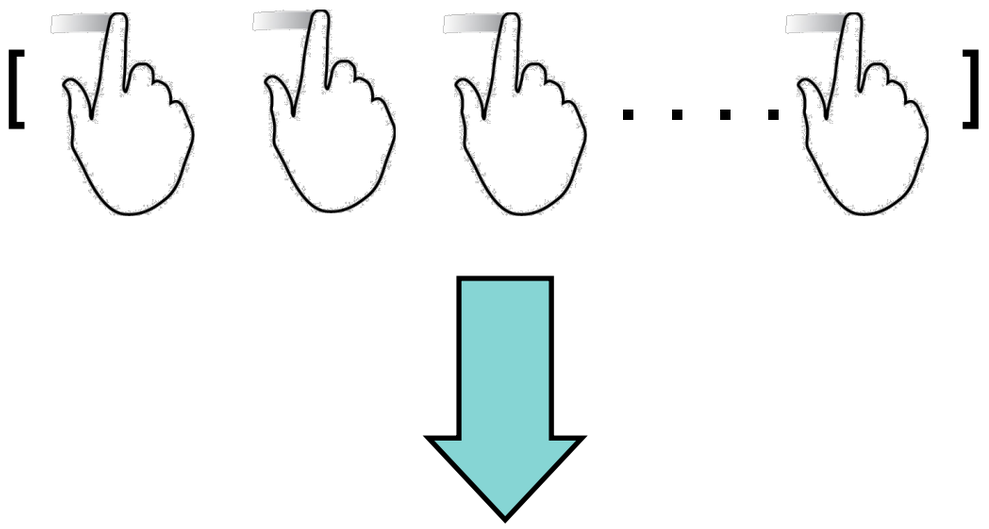
Sliding right

Metric Selection



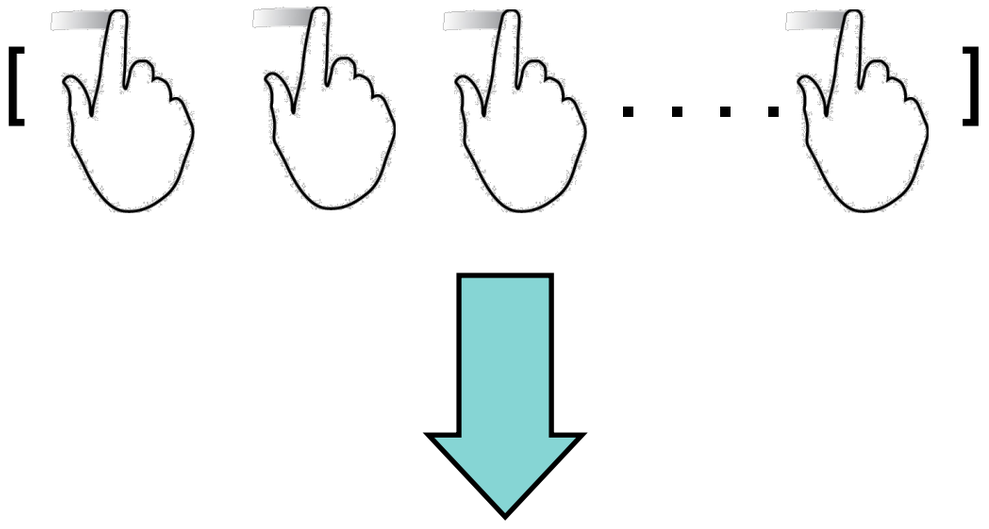
Tap

Feature Vector



feature vector

Feature Vector



feature vector

14 sliding gestures

20 tap gestures

Classification Modules

Portrait	Landscape
sliding up	sliding up
sliding down	sliding down
sliding left	sliding left
sliding right	sliding right
sliding up + tap	sliding up + tap
sliding down + tap	sliding down + tap
sliding left + tap	sliding left + tap
sliding right + tap	sliding right + tap

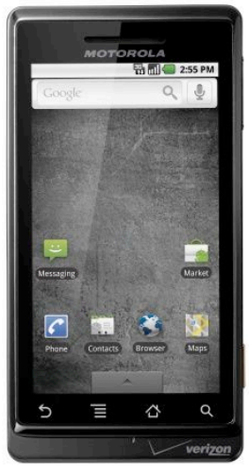
Classification Modules

Portrait	Landscape
sliding up	sliding up
sliding down	sliding down
sliding left	sliding left
sliding right	sliding right
sliding up + tap	sliding up + tap
sliding down + tap	sliding down + tap
sliding left + tap	sliding left + tap
sliding right + tap	sliding right + tap

Classification Modules

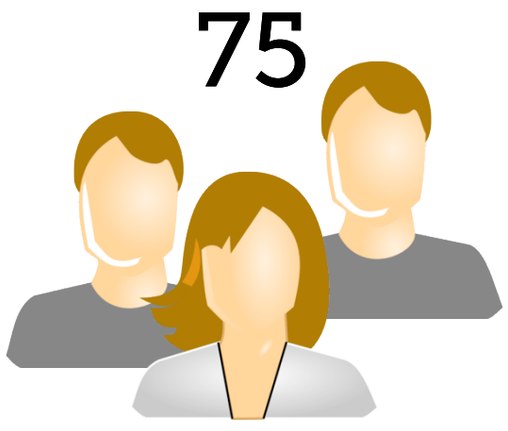
Portrait	Landscape
sliding up	sliding up
sliding down	sliding down
sliding left	sliding left
sliding right	sliding right
sliding up + tap	sliding up + tap
sliding down + tap	sliding down + tap
sliding left + tap	sliding left + tap
sliding right + tap	sliding right + tap

Evaluation Setup



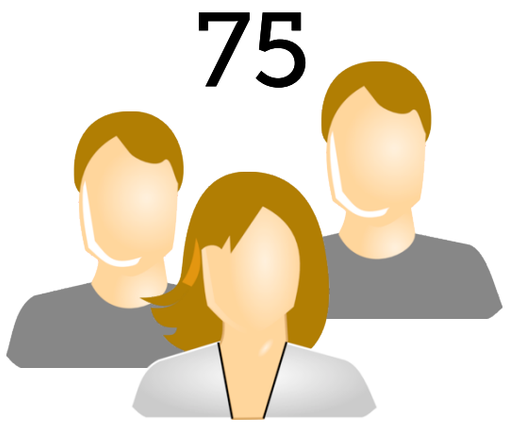
FroYo

Evaluation Setup



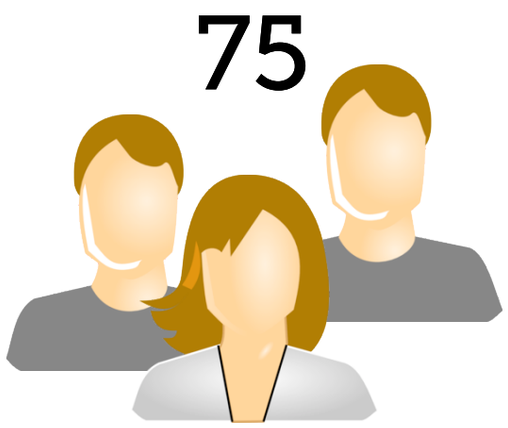
Evaluation Setup

Free style usage

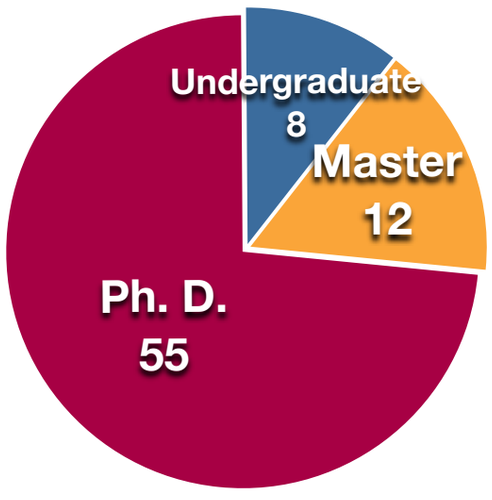


Evaluation Setup

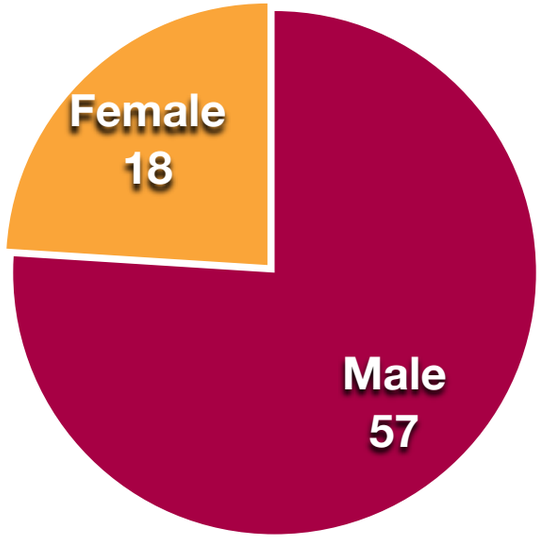
Free style usage



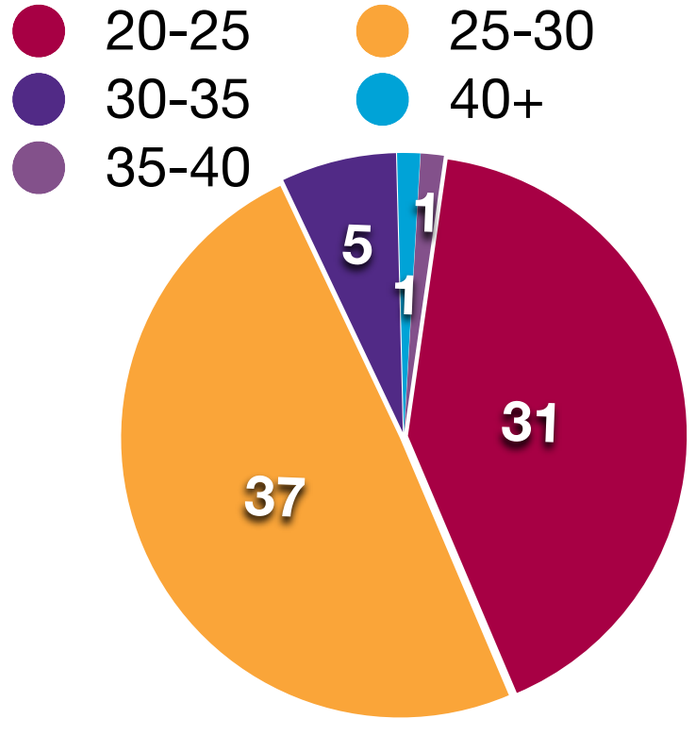
education



gender

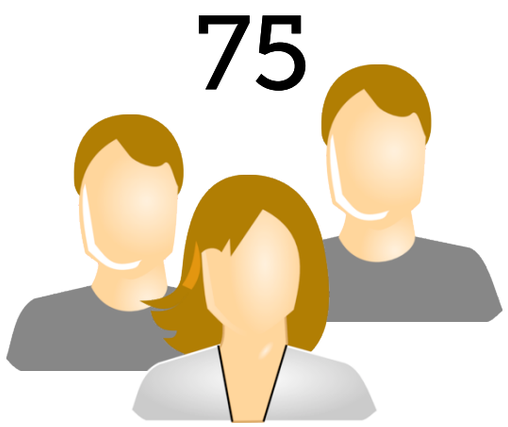


age



Evaluation Setup

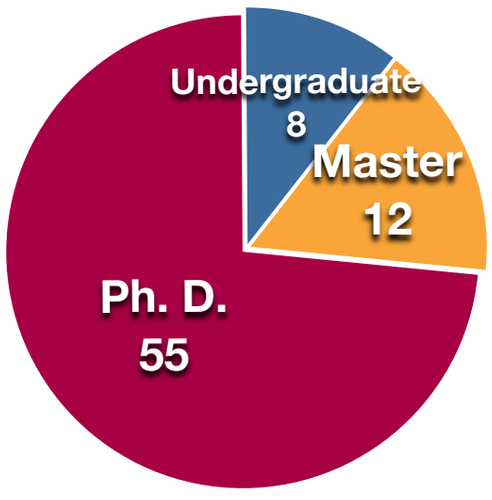
Free style usage



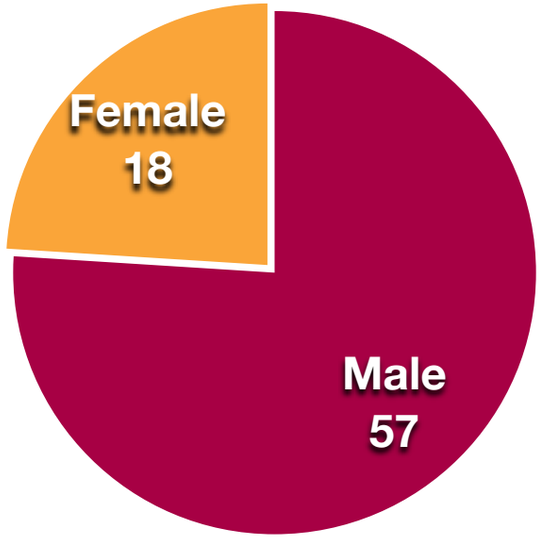
28: enough gestures

47: 15 minutes

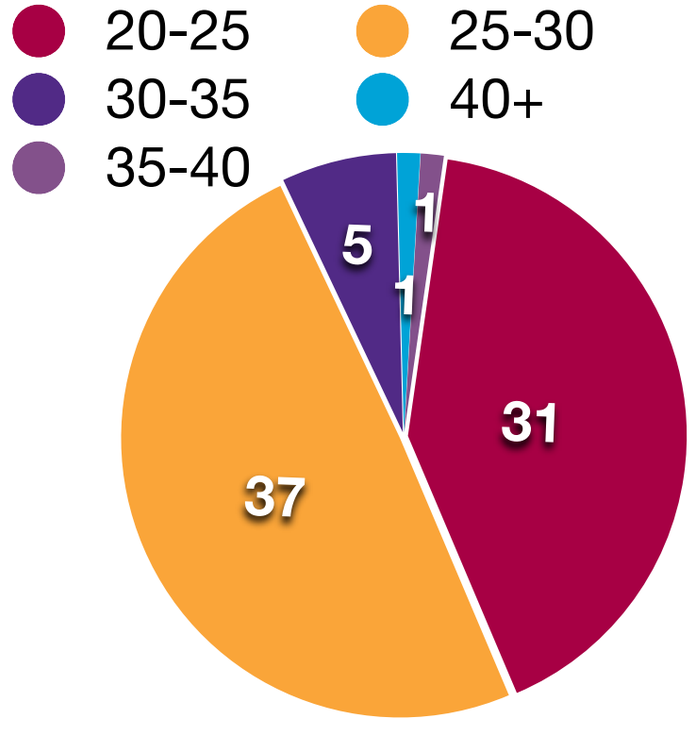
education



gender

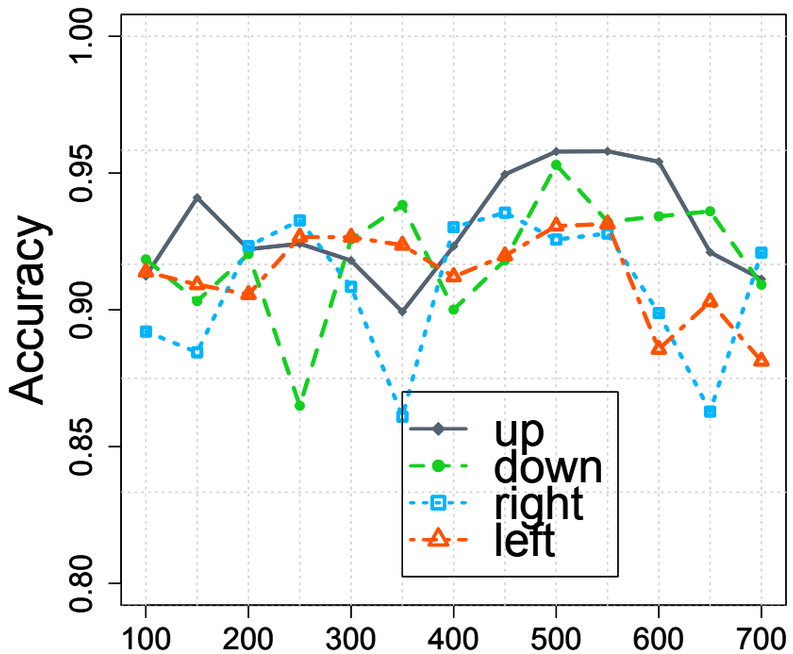


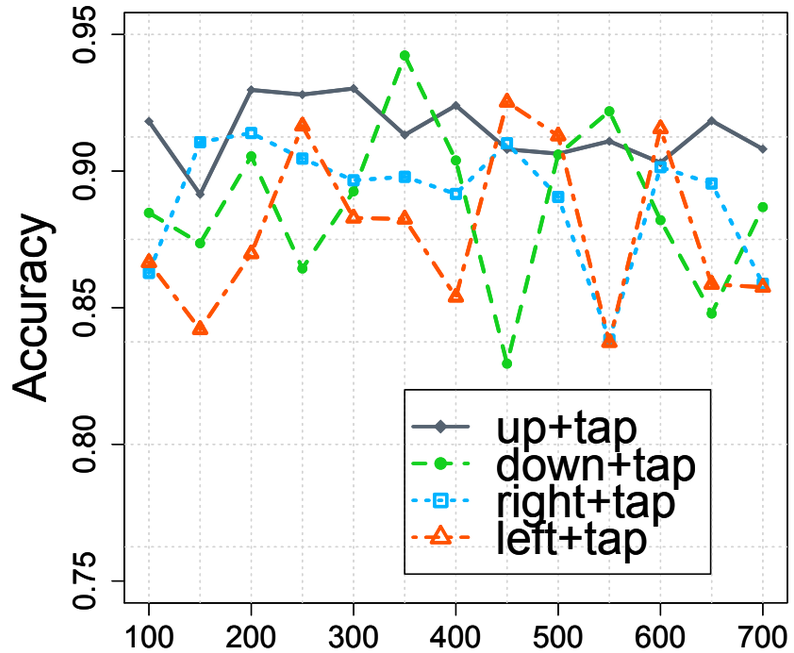
age



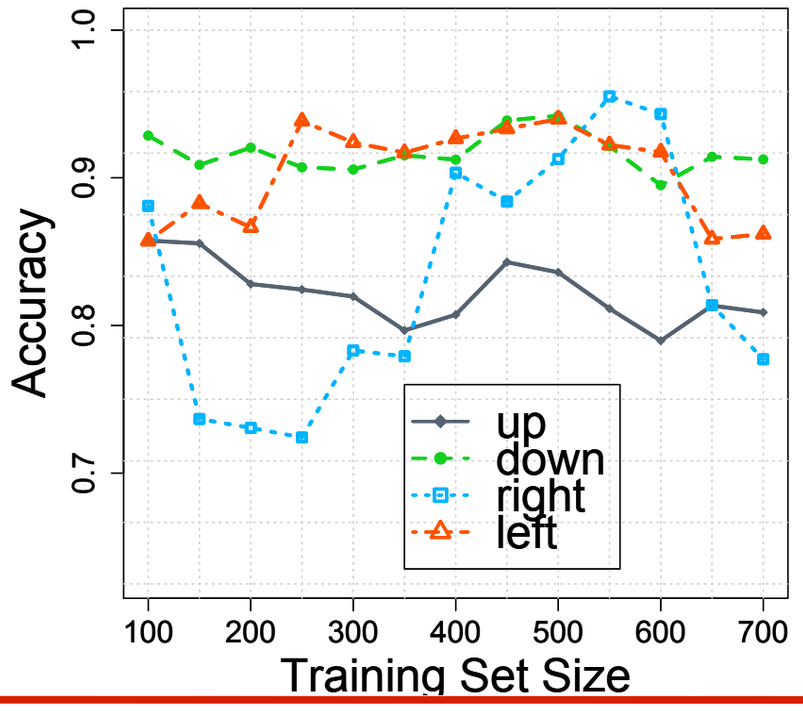
Training Set Size

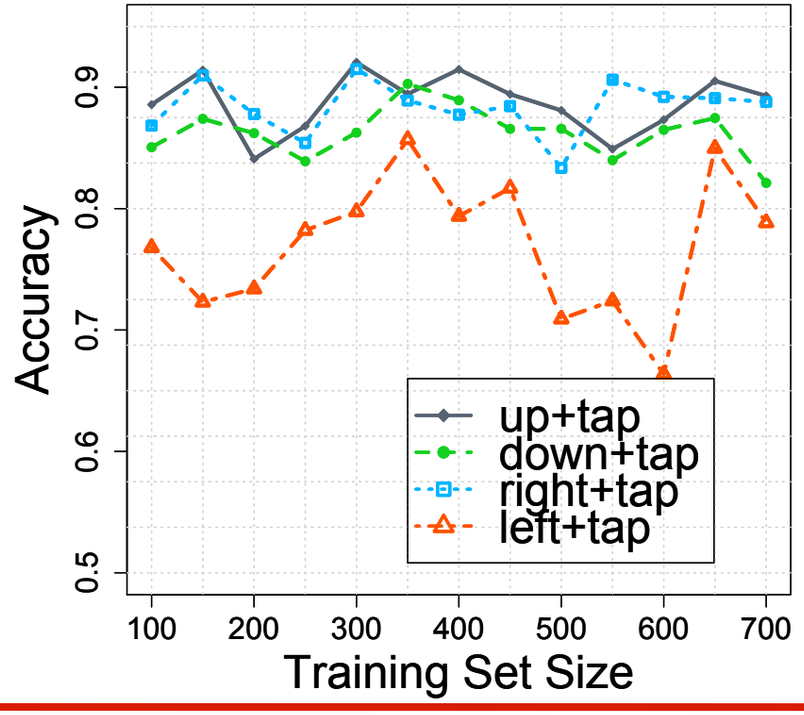
portrait





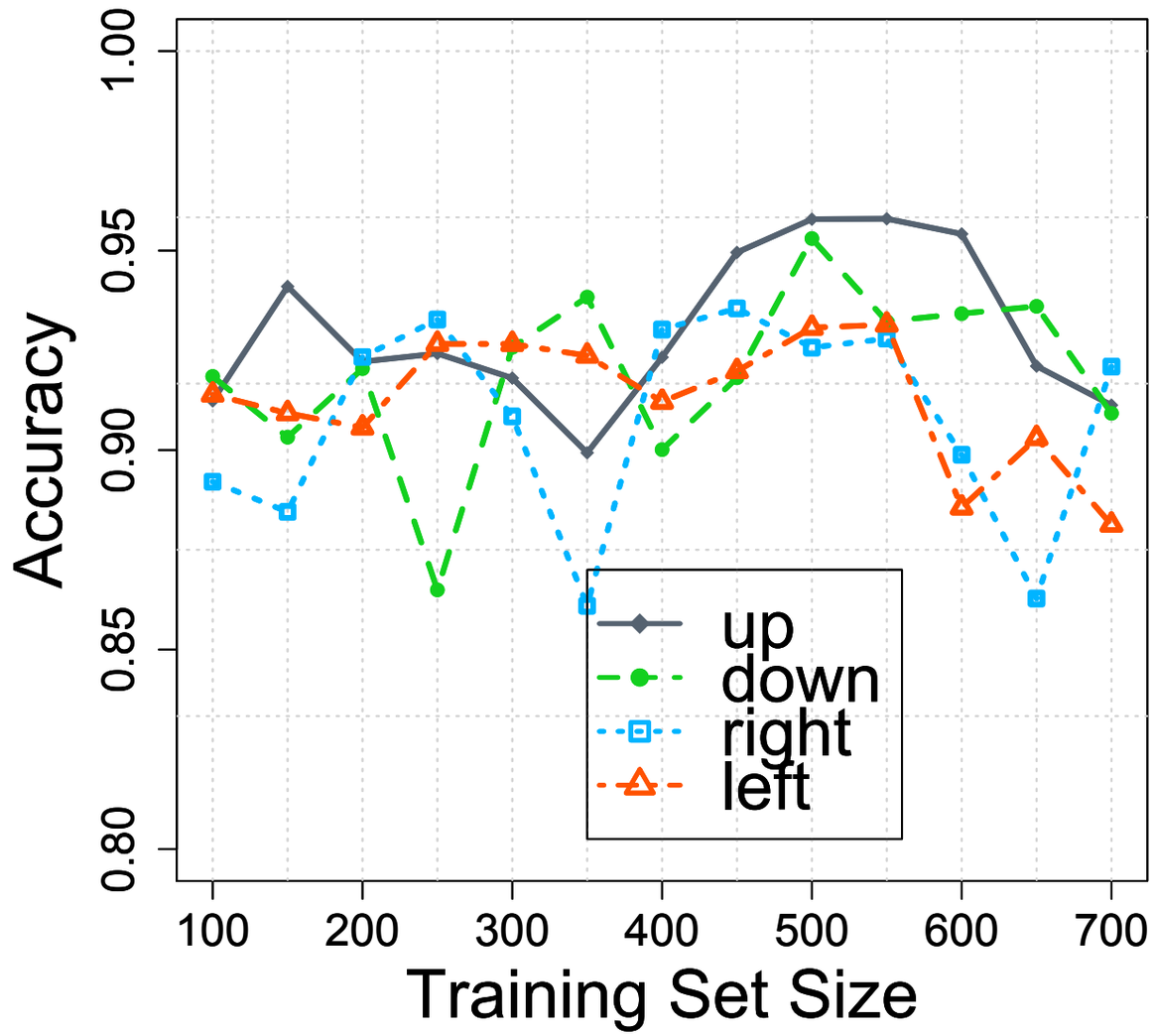
landscape





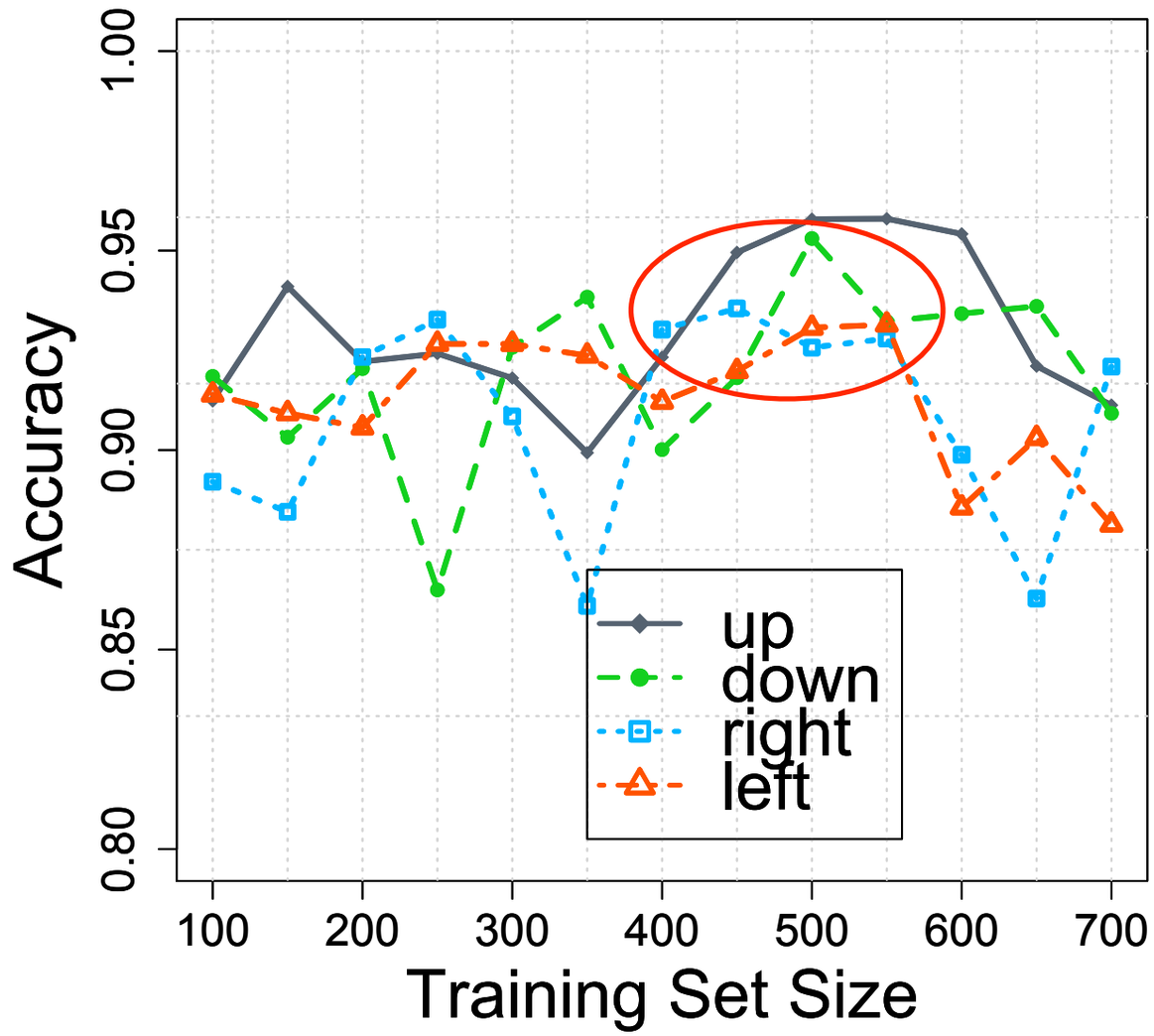
Training Set Size

portrait



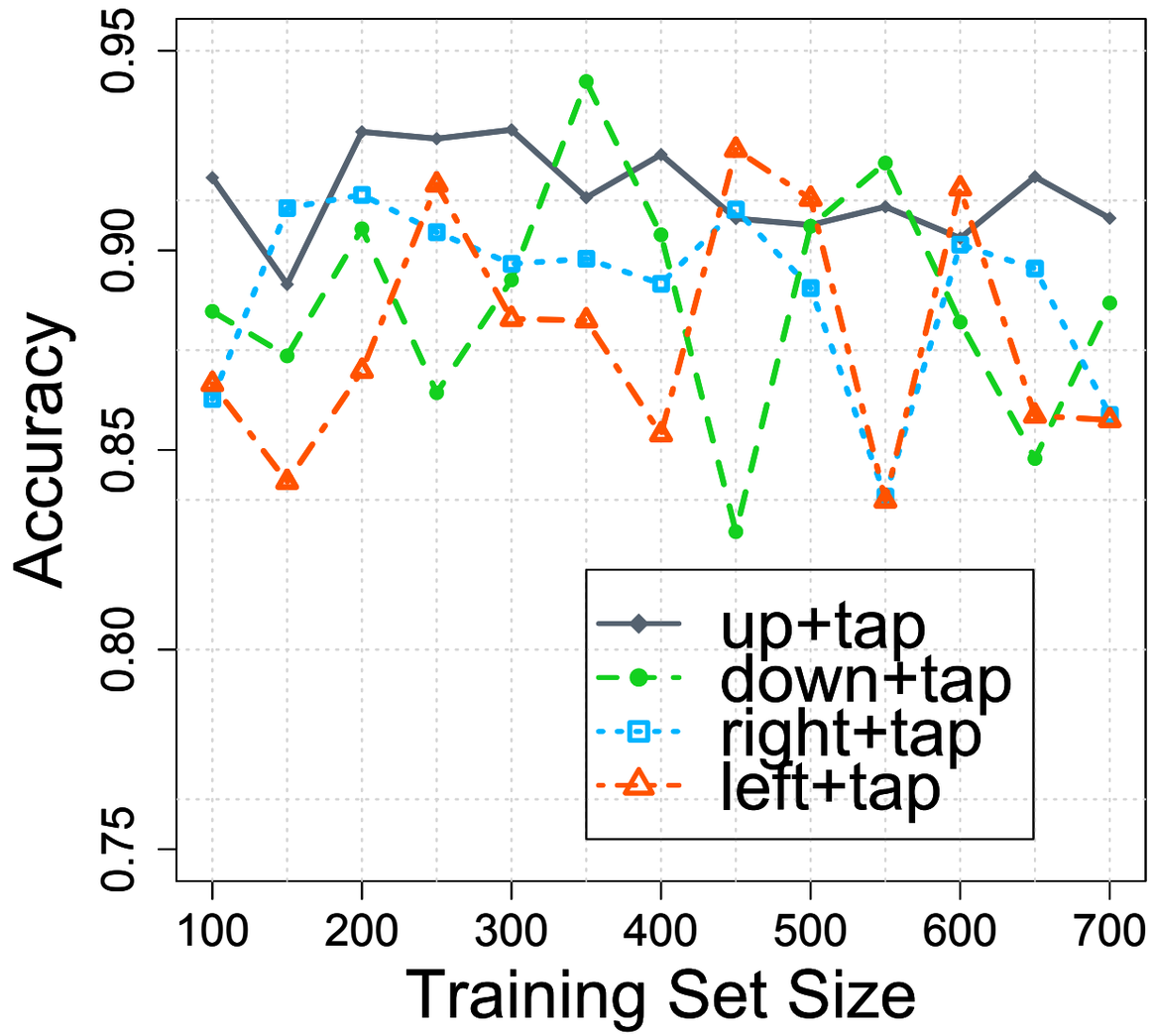
Training Set Size

portrait



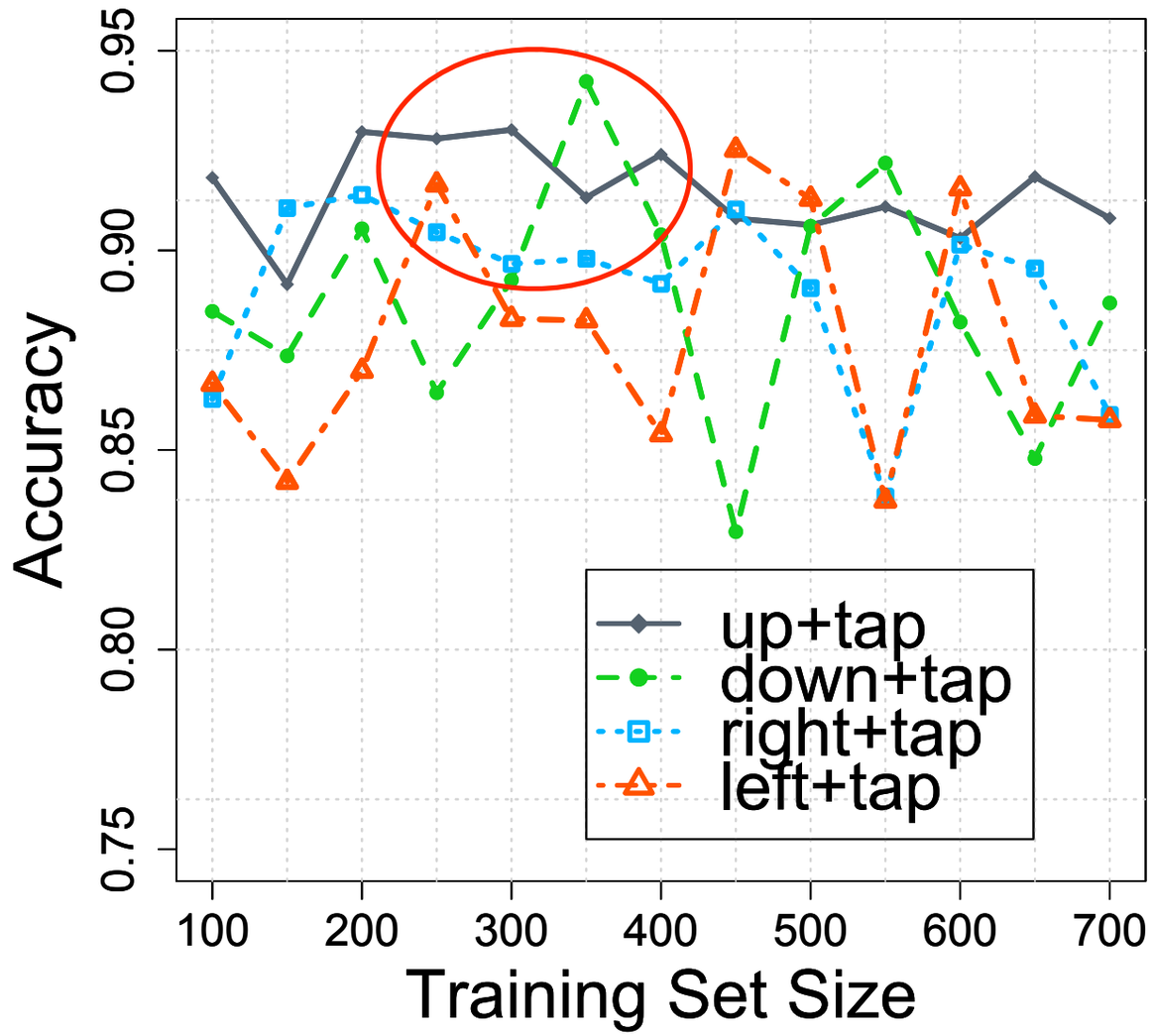
Training Set Size

portrait

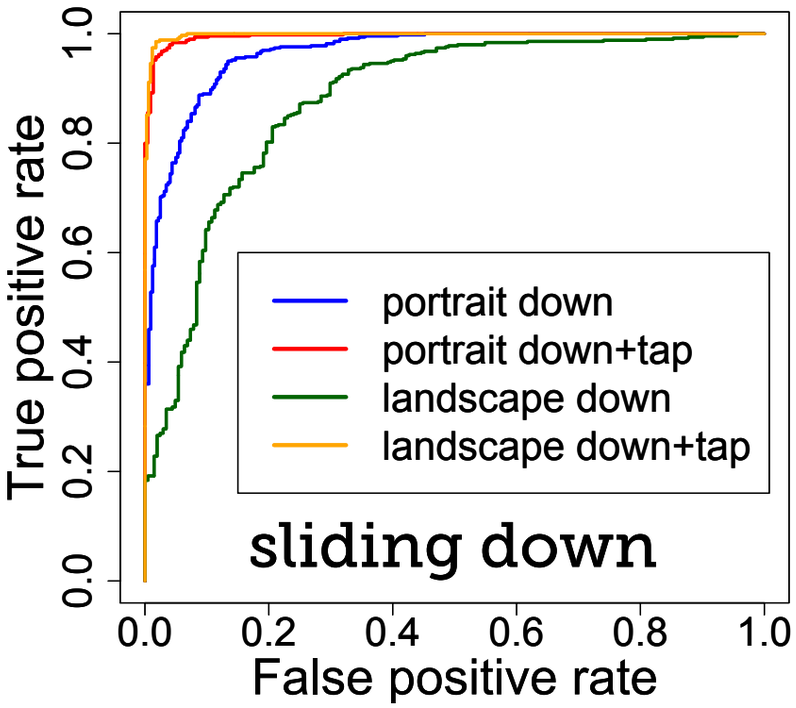


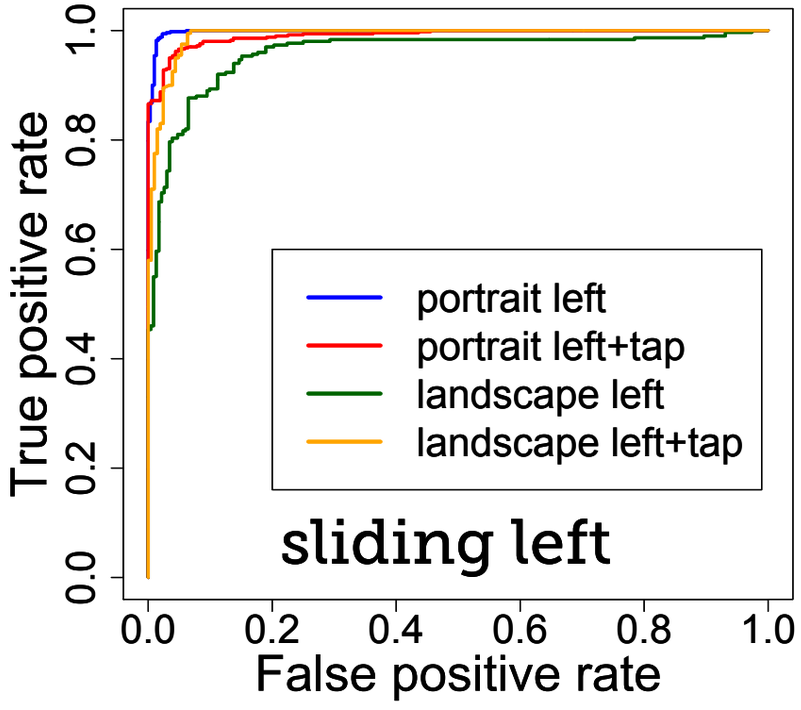
Training Set Size

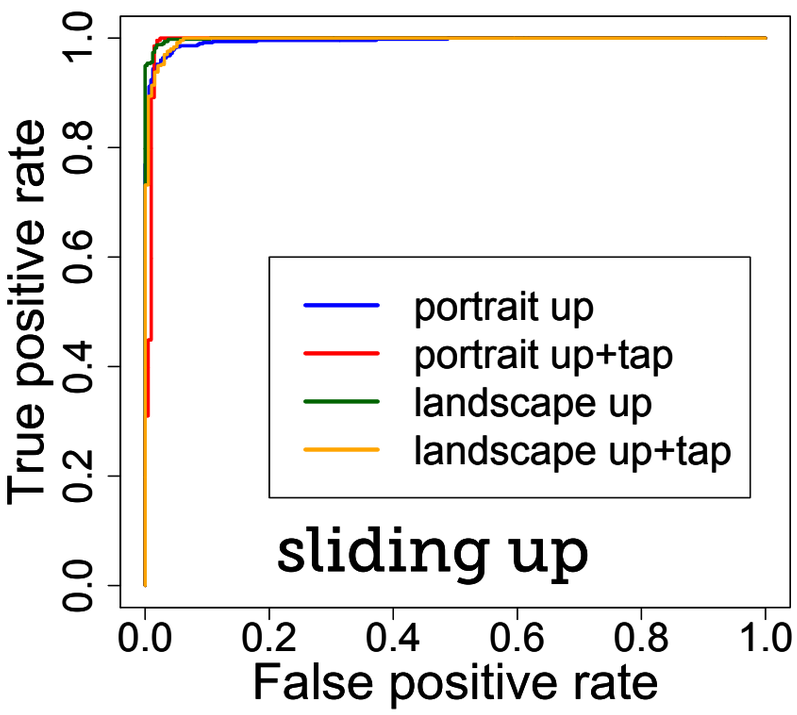
portrait

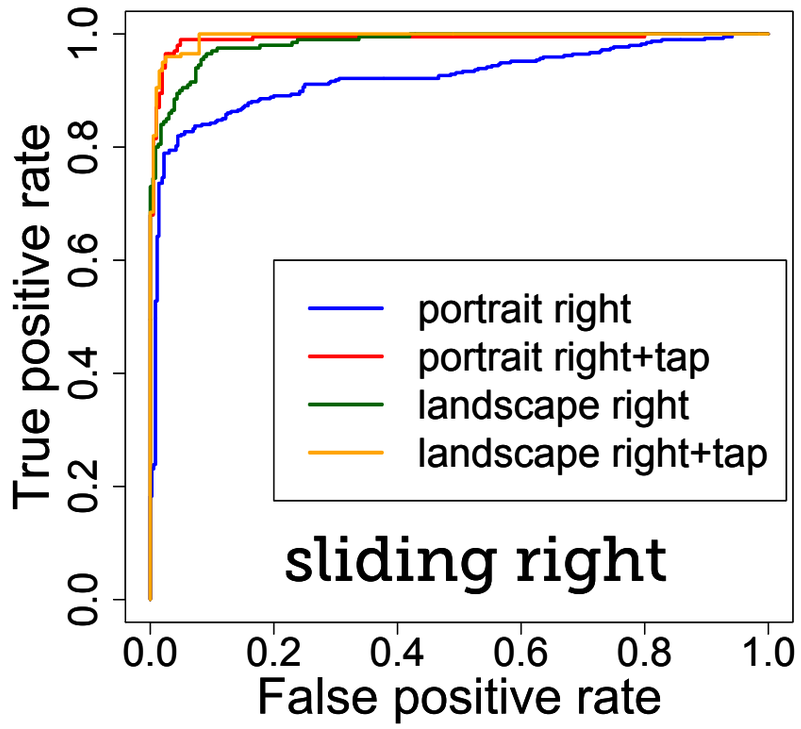


Using Tap

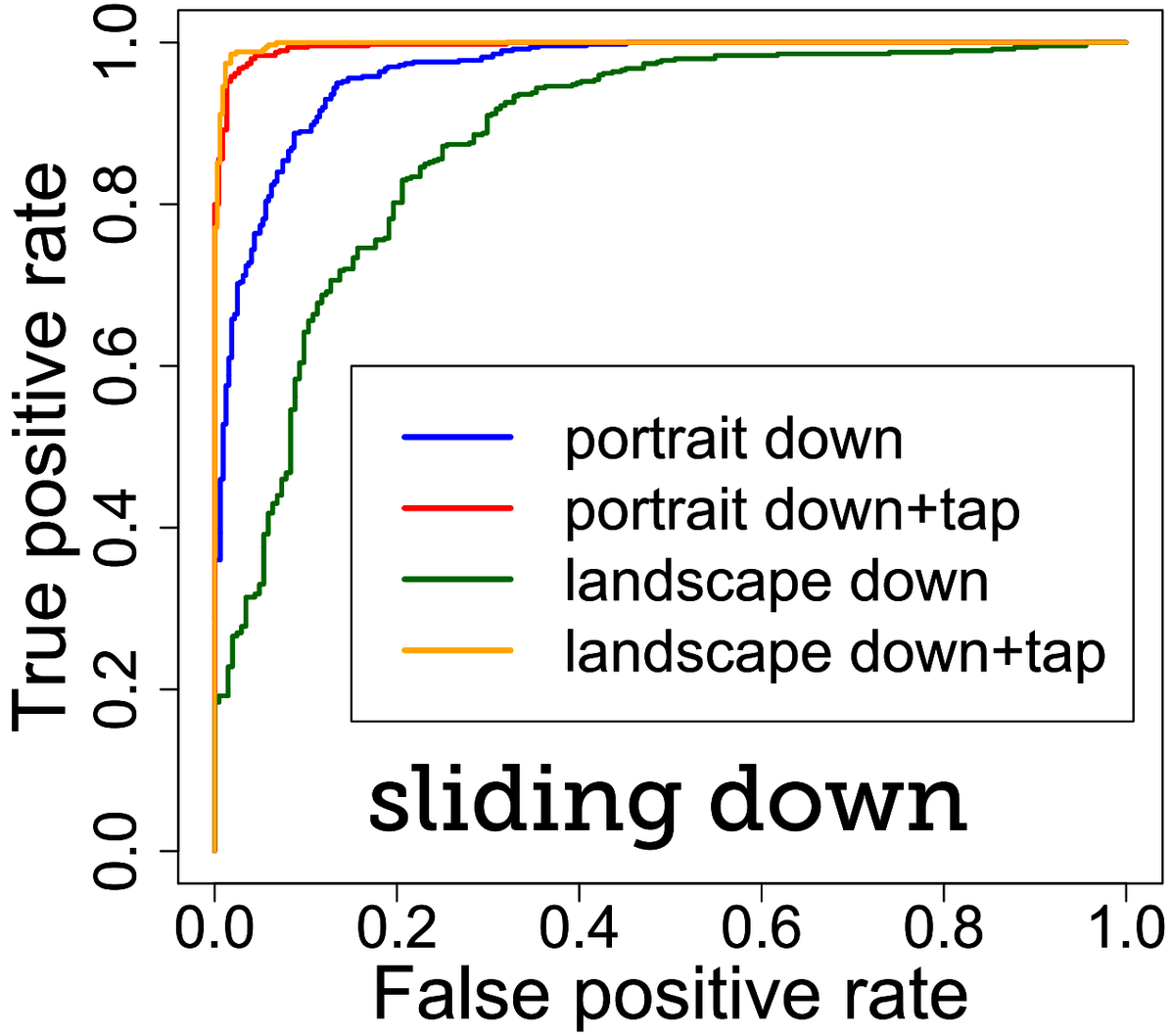

True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait down
portrait down+tap
landscape down
landscape down+tap
sliding down


True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait left
portrait left+tap
landscape left
landscape left+tap
sliding left

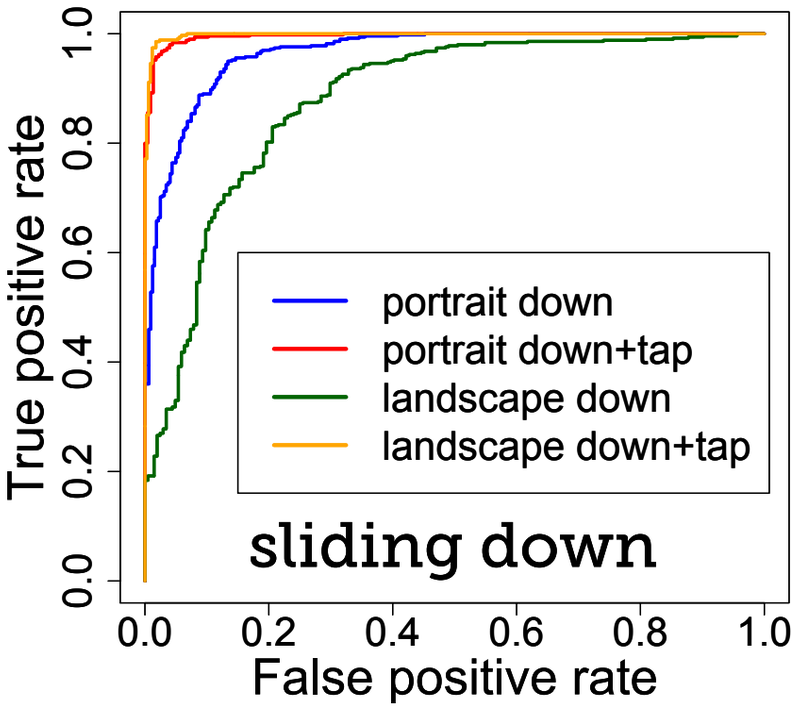

True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait up
portrait up+tap
landscape up
landscape up+tap
sliding up

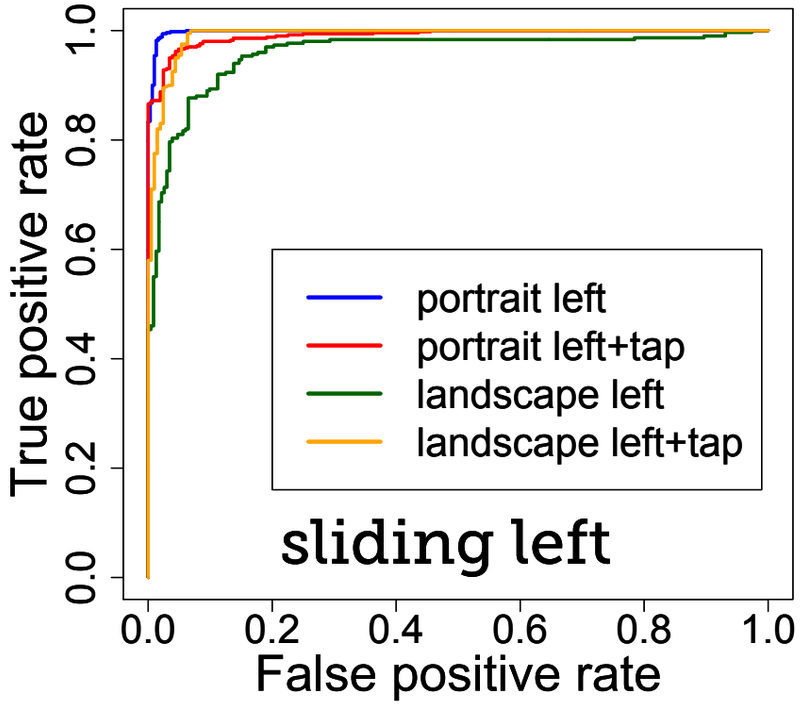

True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait right
portrait right+tap
landscape right
landscape right+tap
sliding right

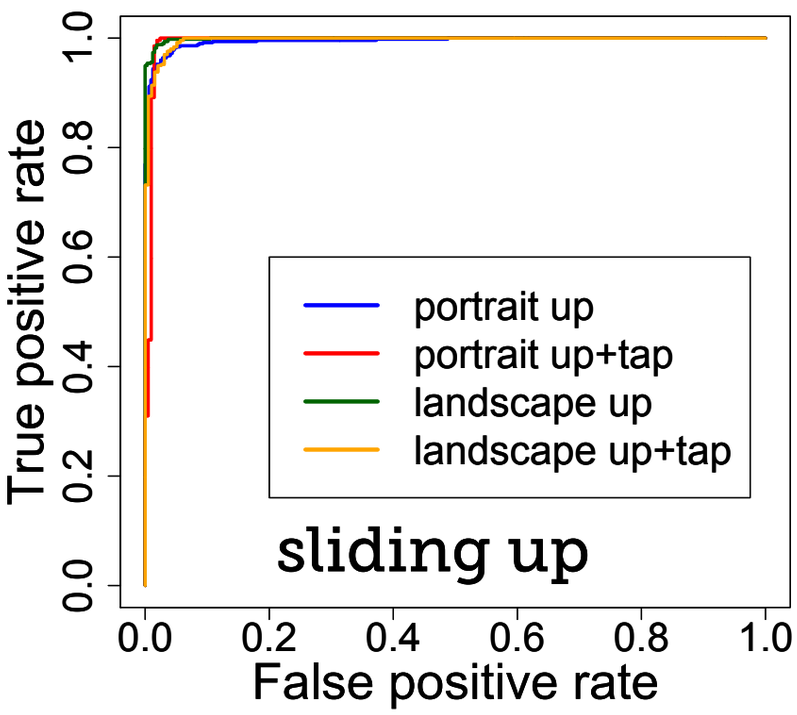
Using Tap

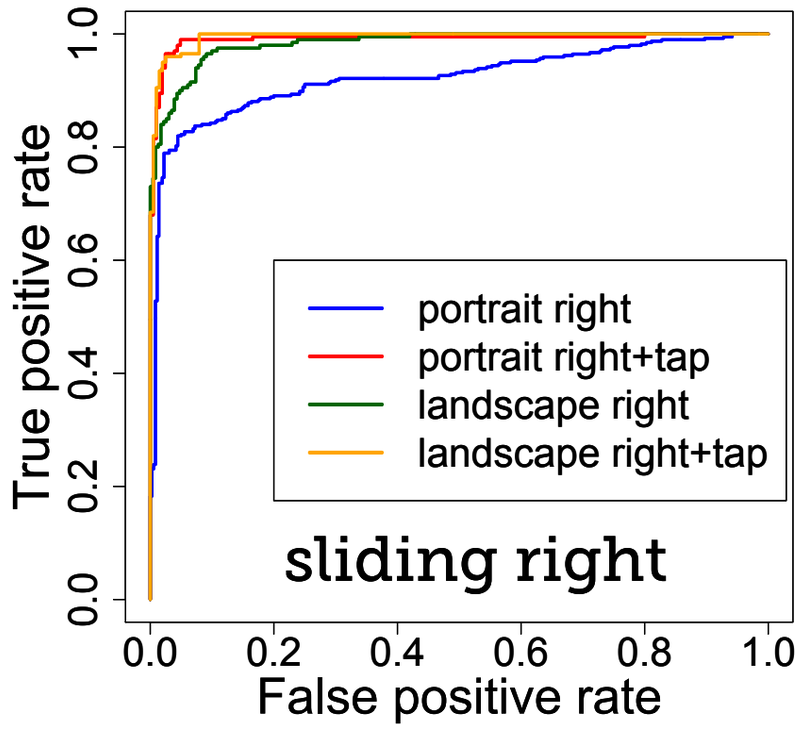

True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait down
portrait down+tap
landscape down
landscape down+tap
sliding down
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate

Using Tap


True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait down
portrait down+tap
landscape down
landscape down+tap
sliding down


True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait left
portrait left+tap
landscape left
landscape left+tap
sliding left


True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait up
portrait up+tap
landscape up
landscape up+tap
sliding up


True positive rate
0.0
0.2
0.4
0.6
0.8
1.0
False positive rate
0.0
0.2
0.4
0.6
0.8
1.0
portrait right
portrait right+tap
landscape right
landscape right+tap
sliding right

Response Time

	sliding up	sliding down	sliding left	sliding right	tap
portrait	8.24	14.25	37.13	22.47	14.12
landscape	12.14	19.23	50.74	34.27	18.73

Response Time

	sliding up	sliding down	sliding left	sliding right	tap
portrait	8.24	14.25	37.13	22.47	14.12
landscape	12.14	19.23	50.74	34.27	18.73

Response Time

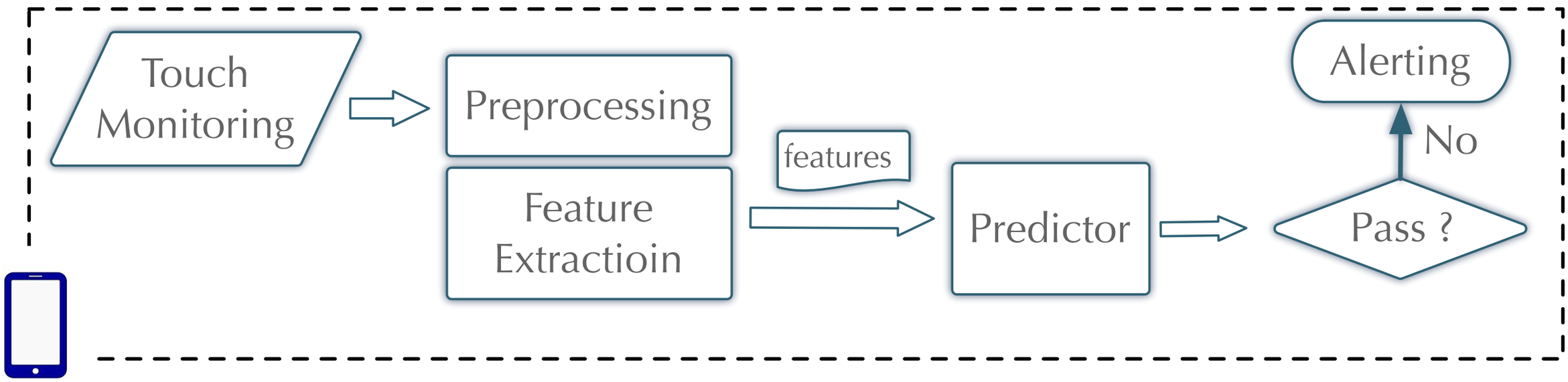
	sliding up	sliding down	sliding left	sliding right	tap
portrait	8.24	14.25	37.13	22.47	14.12
landscape	12.14	19.23	50.74	34.27	18.73

Conclusions

- It is possible to use gesture patterns to re-authenticate users
- Exploring the gesture patterns, we can construct an unobservable and continuous user re-authentication system

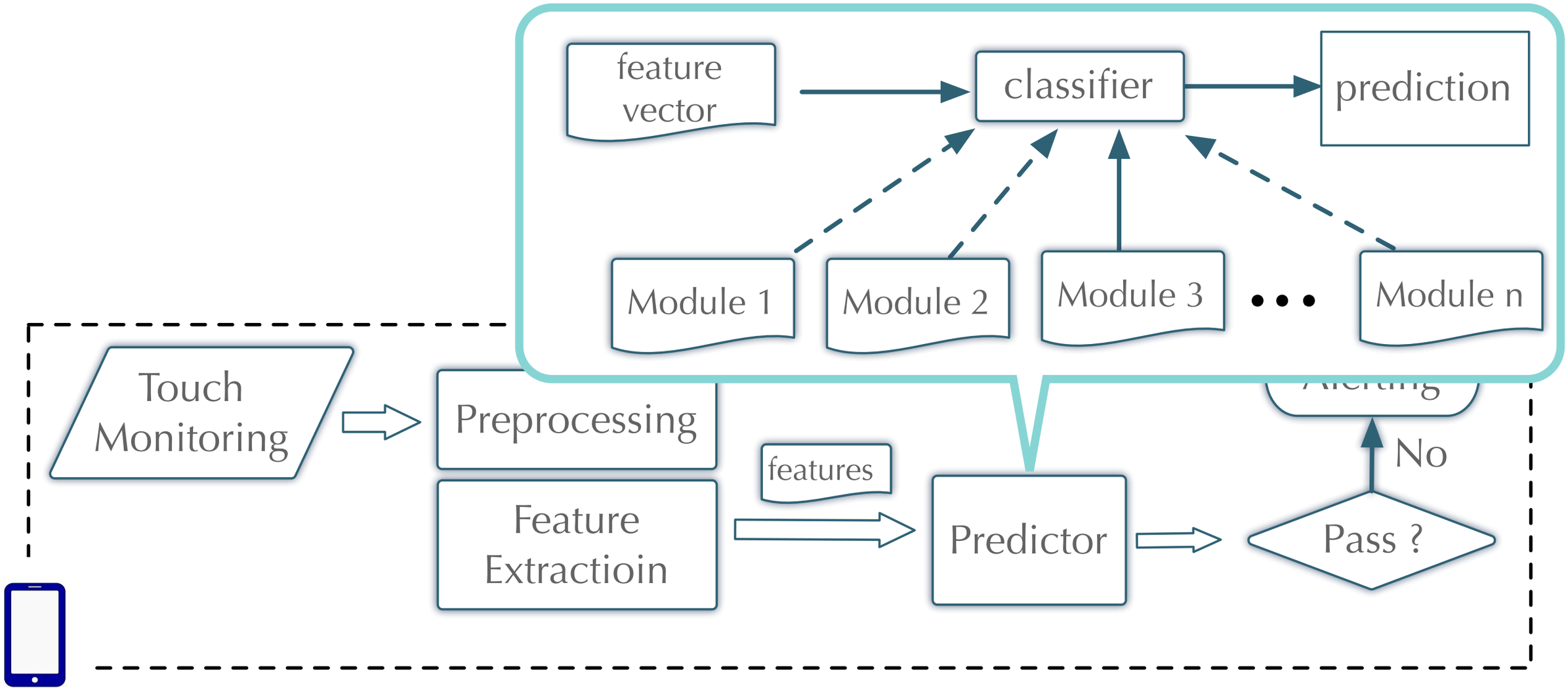
Thank you !

System Architecture



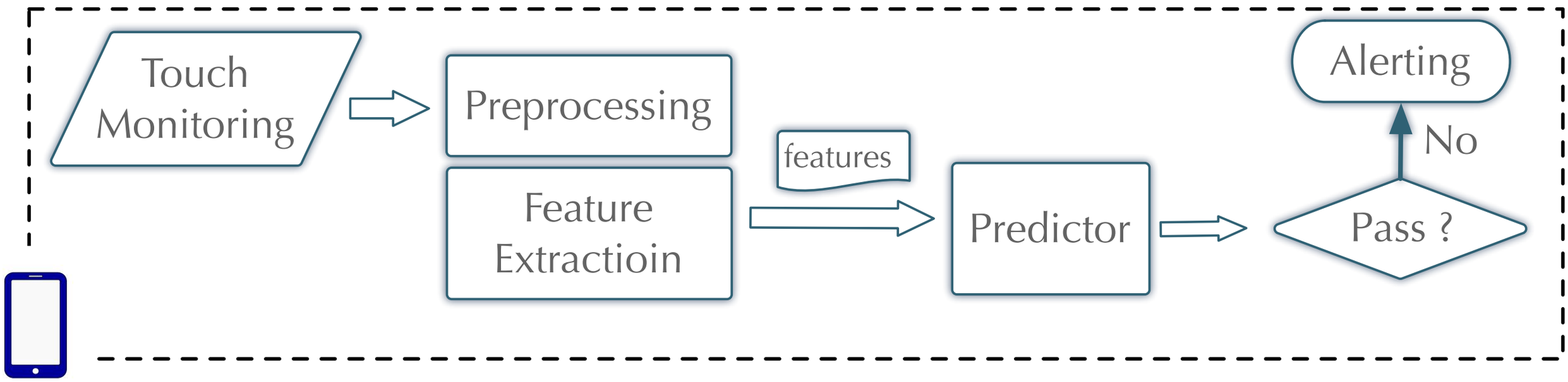
Re-authentication module

System Architecture



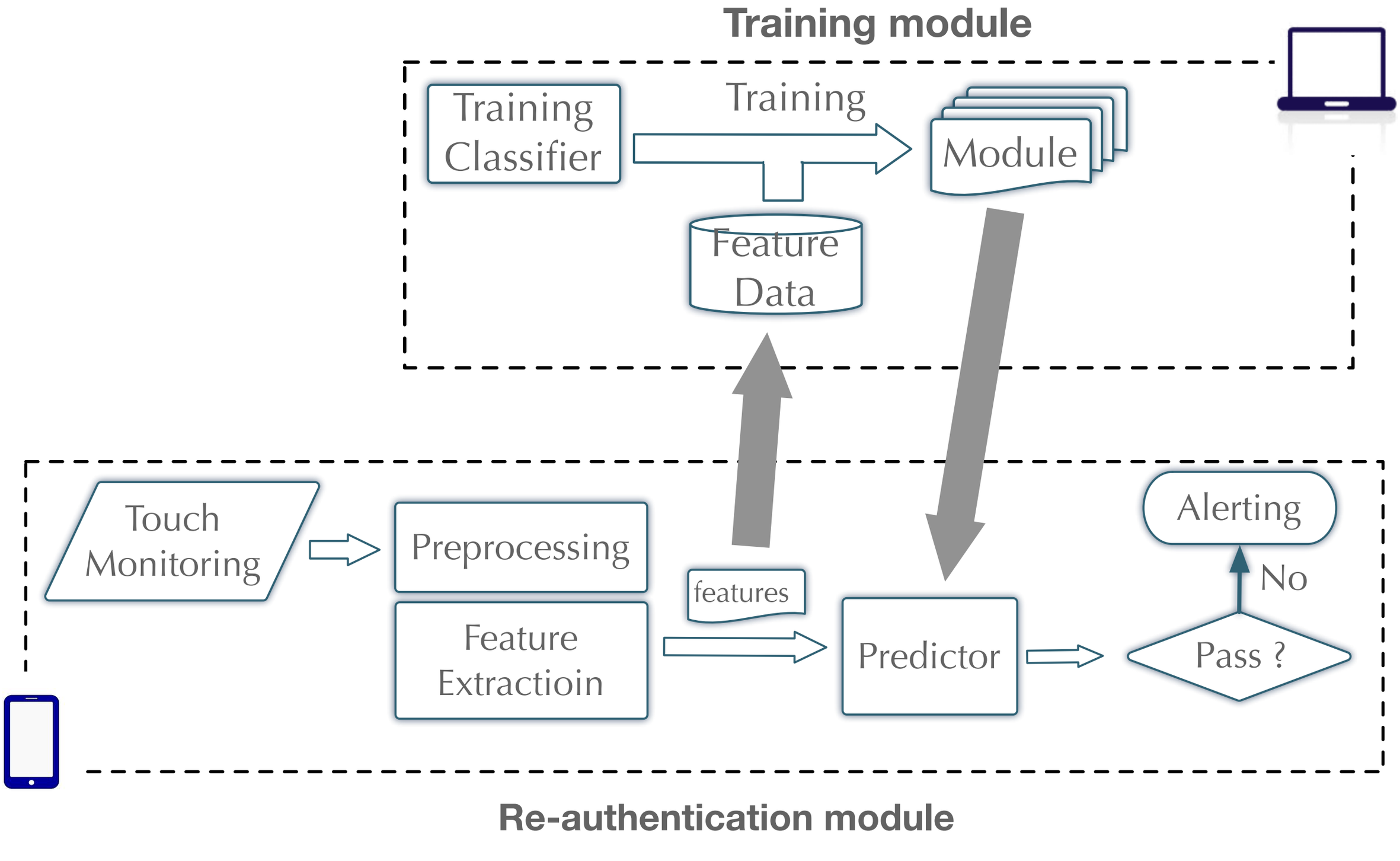
Re-authentication module

System Architecture

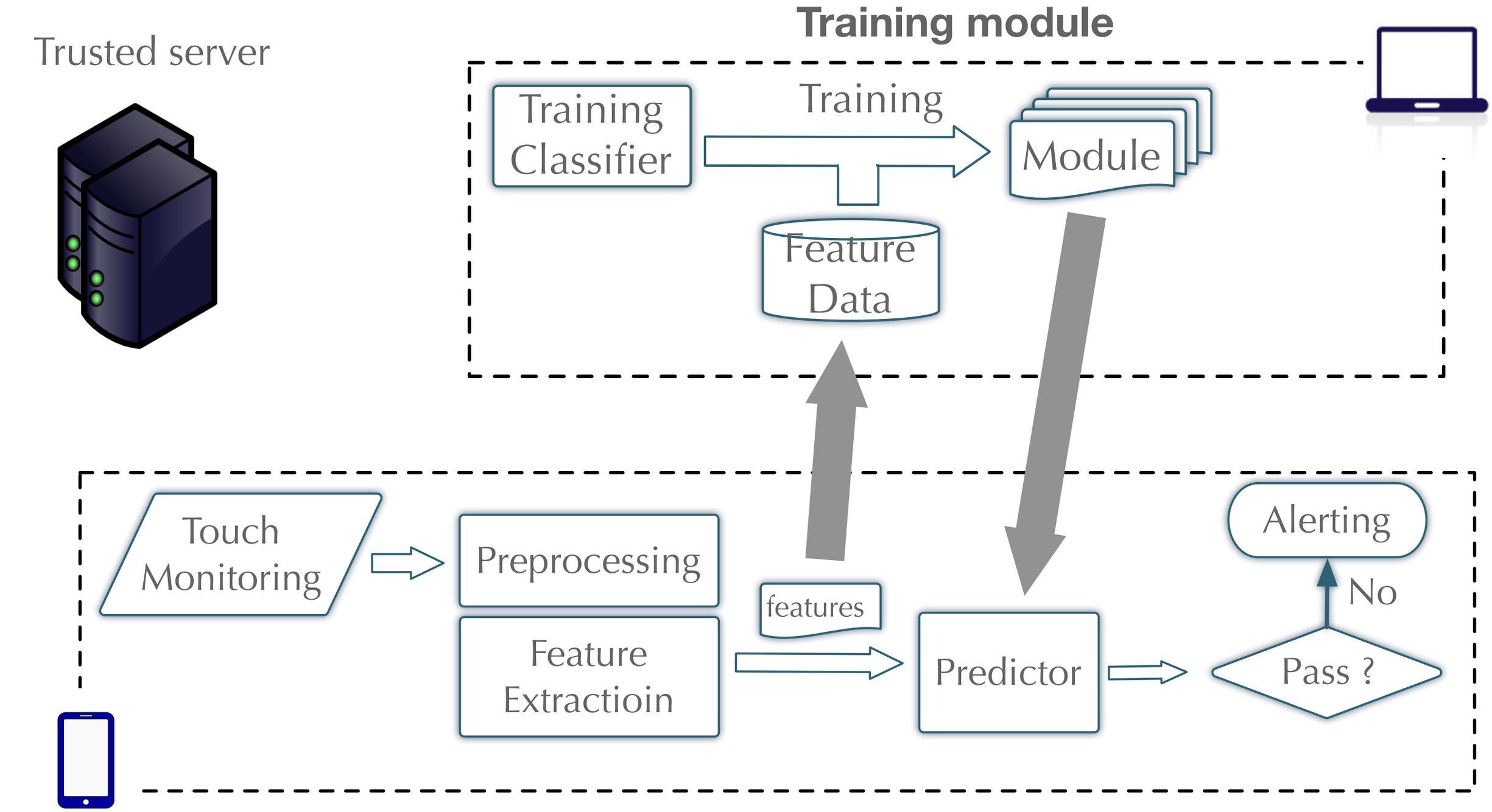


Re-authentication module

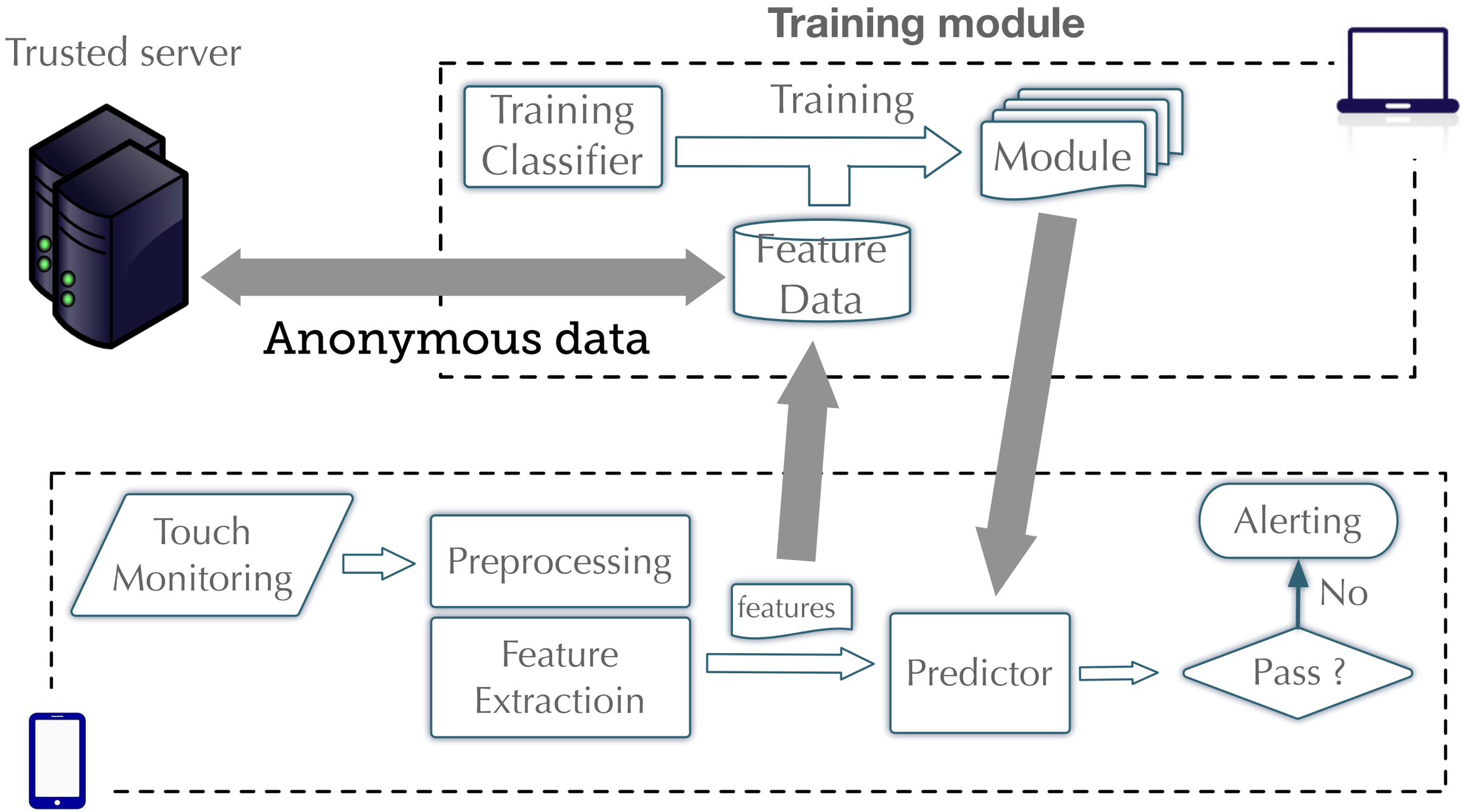
System Architecture



System Architecture



System Architecture



Evaluation Setup

target users

non-target users

training set

testing set

Evaluation Setup

target users

non-target users

training set

testing set

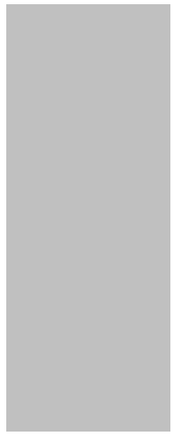
Evaluation Setup

target users

non-target users

training set

testing set



Evaluation Setup

target users

non-target users

training set

testing set

Evaluation Setup

target users

non-target users

training set

testing set

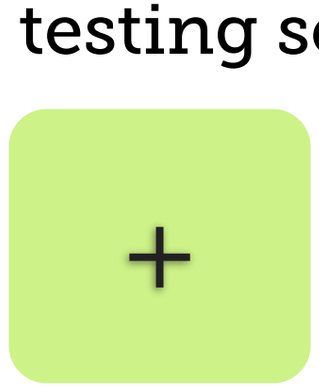
Evaluation Setup

target users

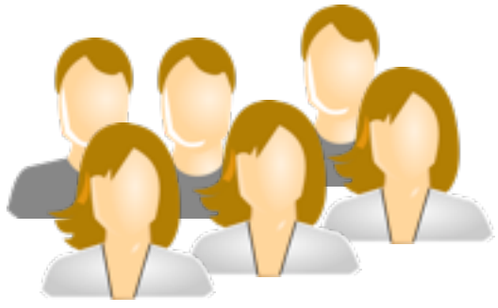
non-target users

training set

testing set



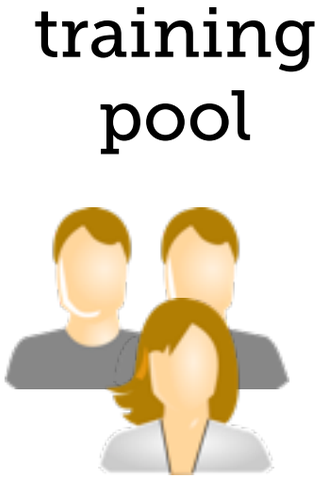
Evaluation Setup

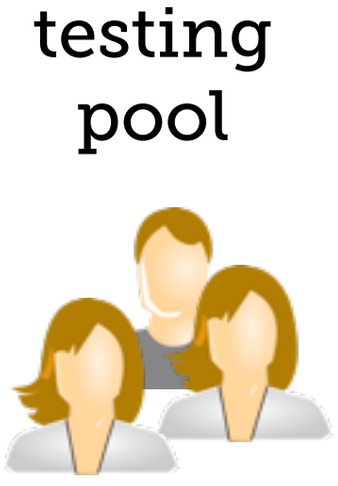


training set

testing set

Evaluation Setup

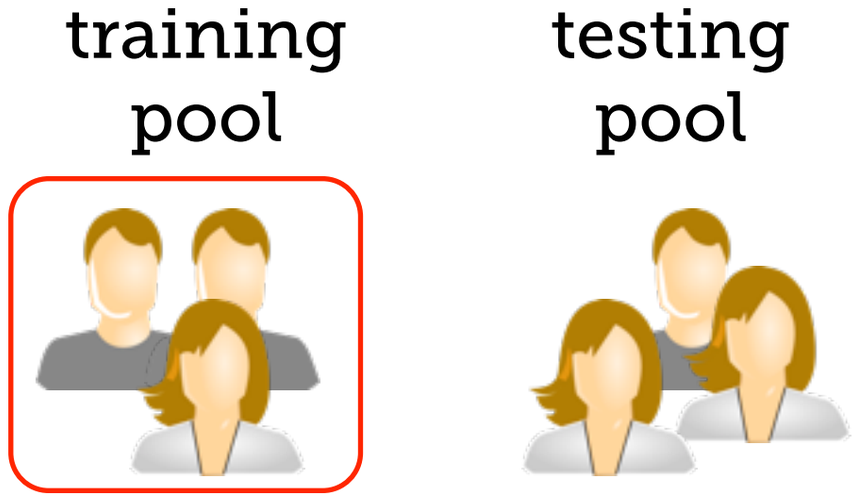




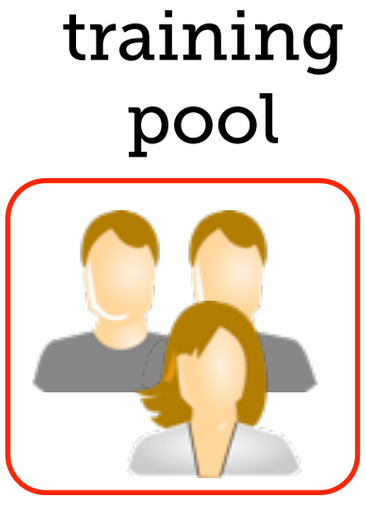
training set

testing set

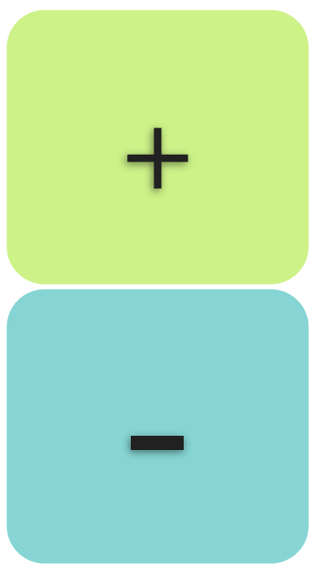
Evaluation Setup



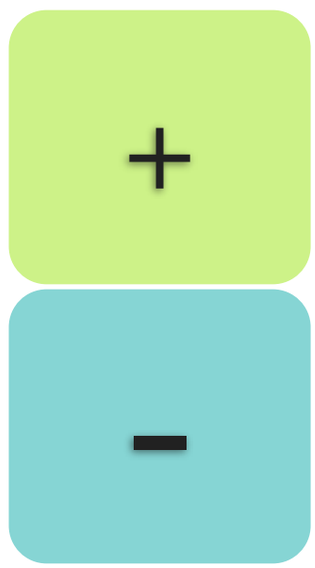
Evaluation Setup



training set

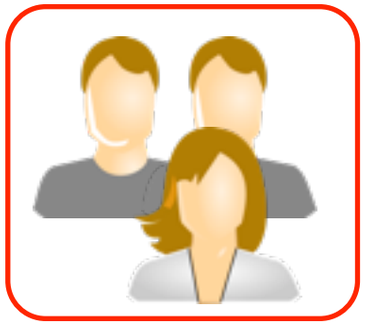


testing set



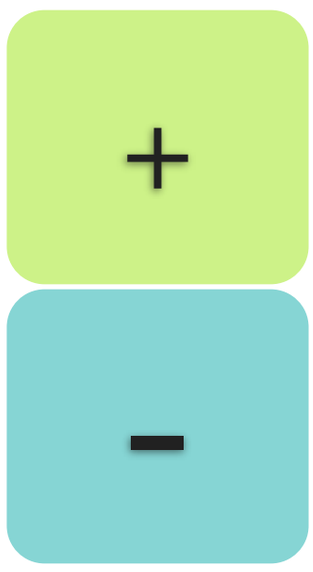
Evaluation Setup

training pool

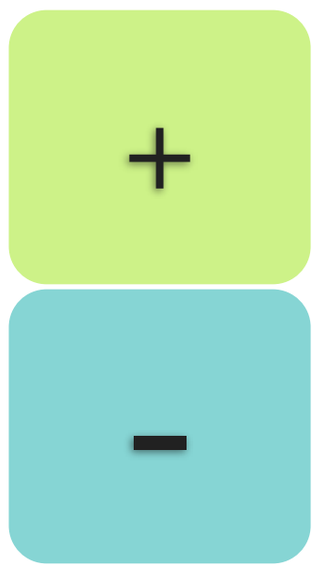


testing pool

training set



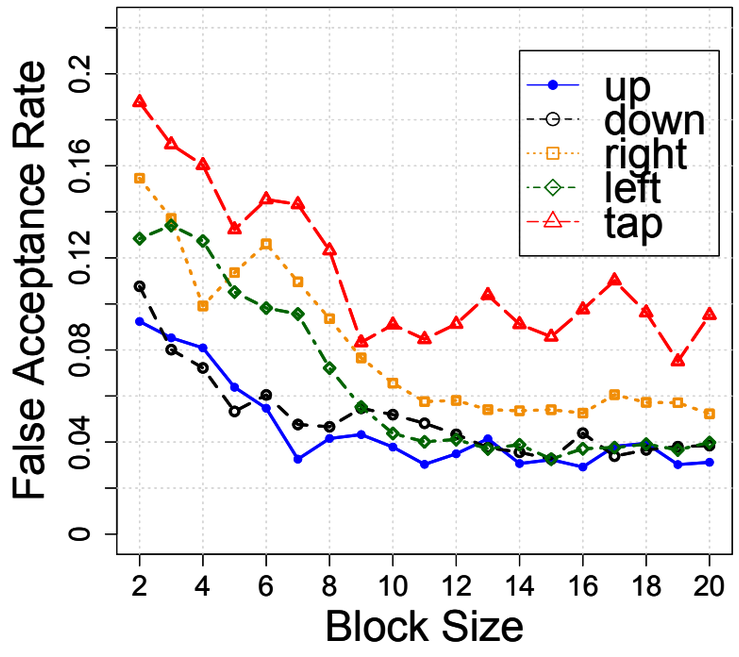
testing set

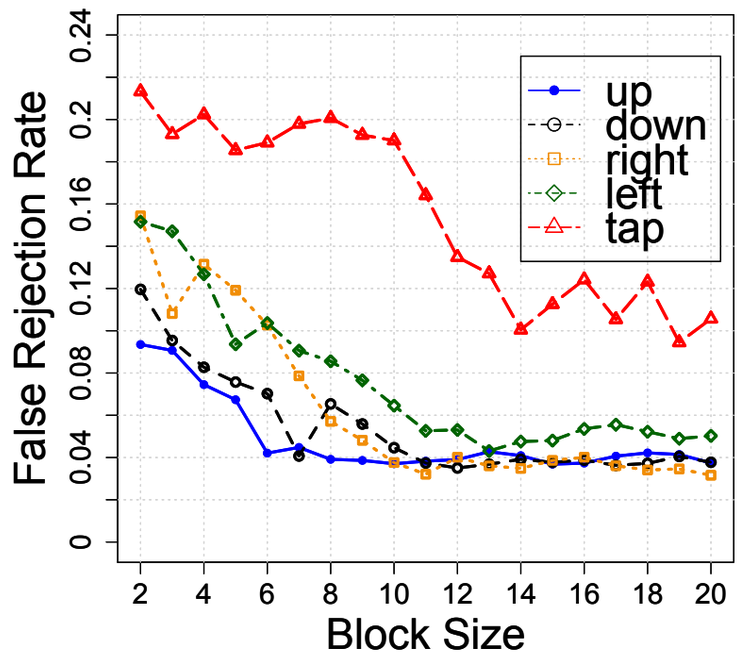


NEW

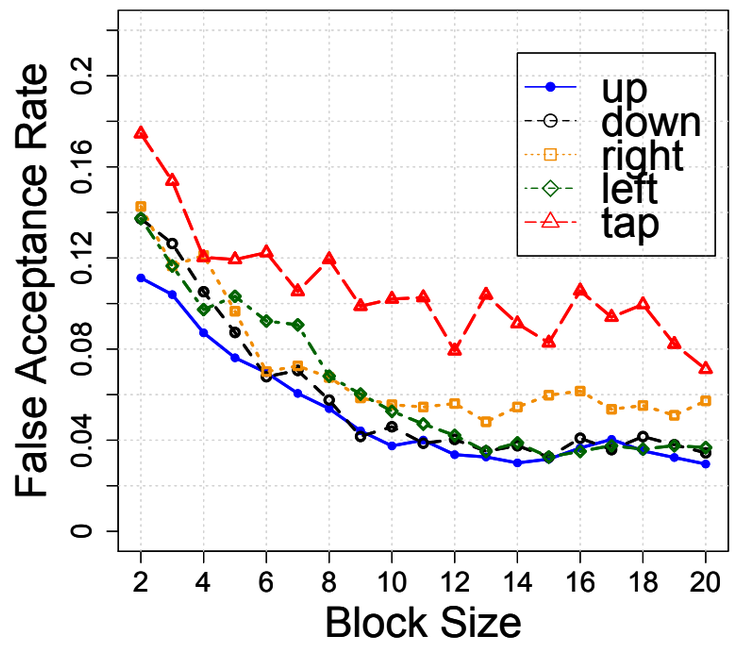
Gesture Block Size

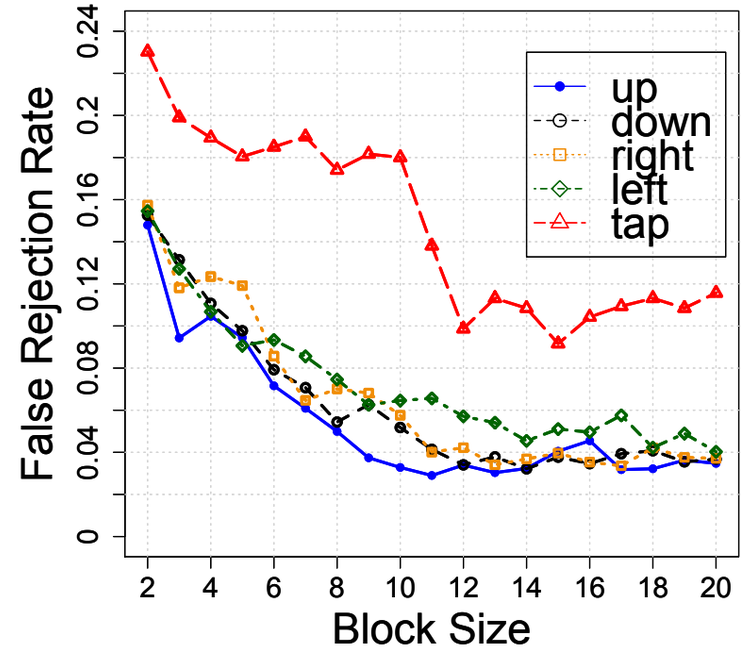
portrait





landscape

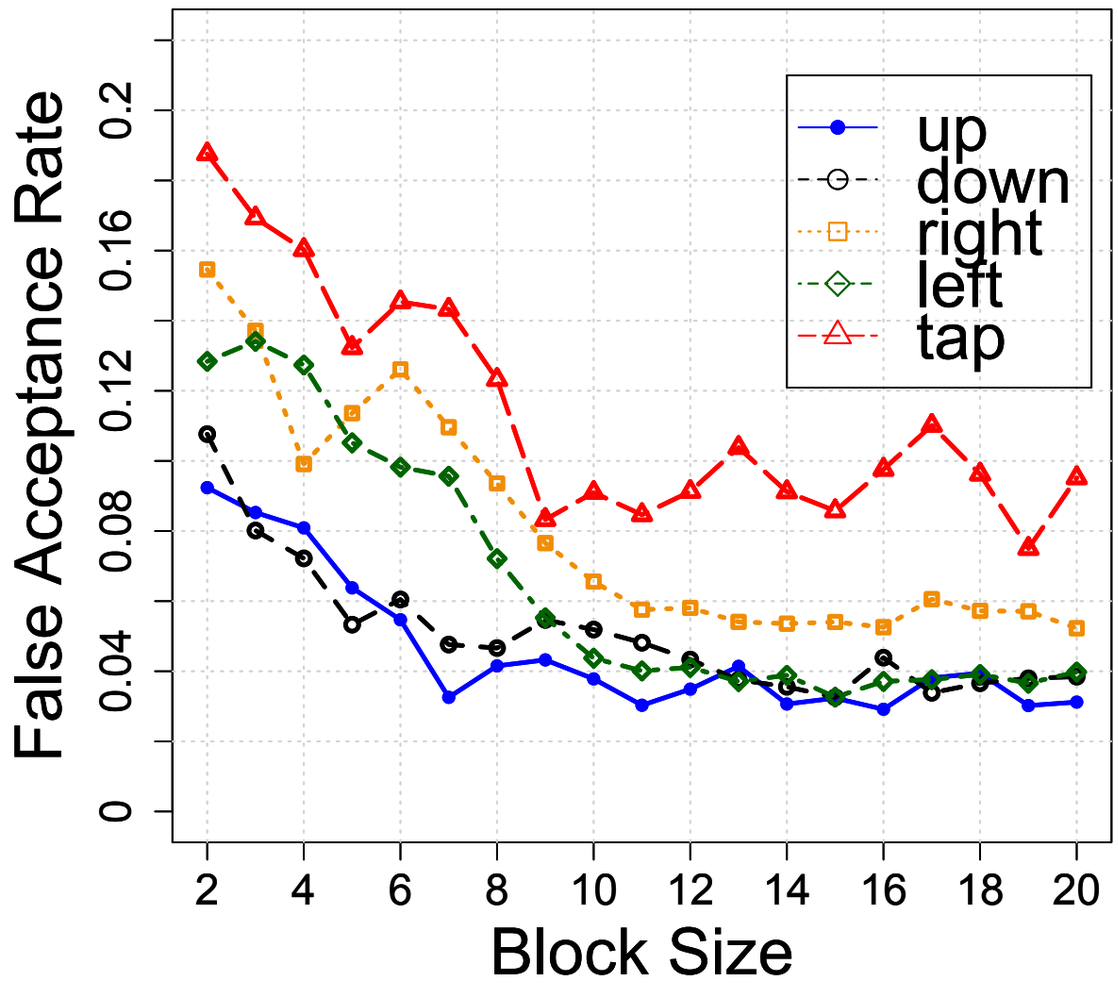




Gesture Block Size

portrait

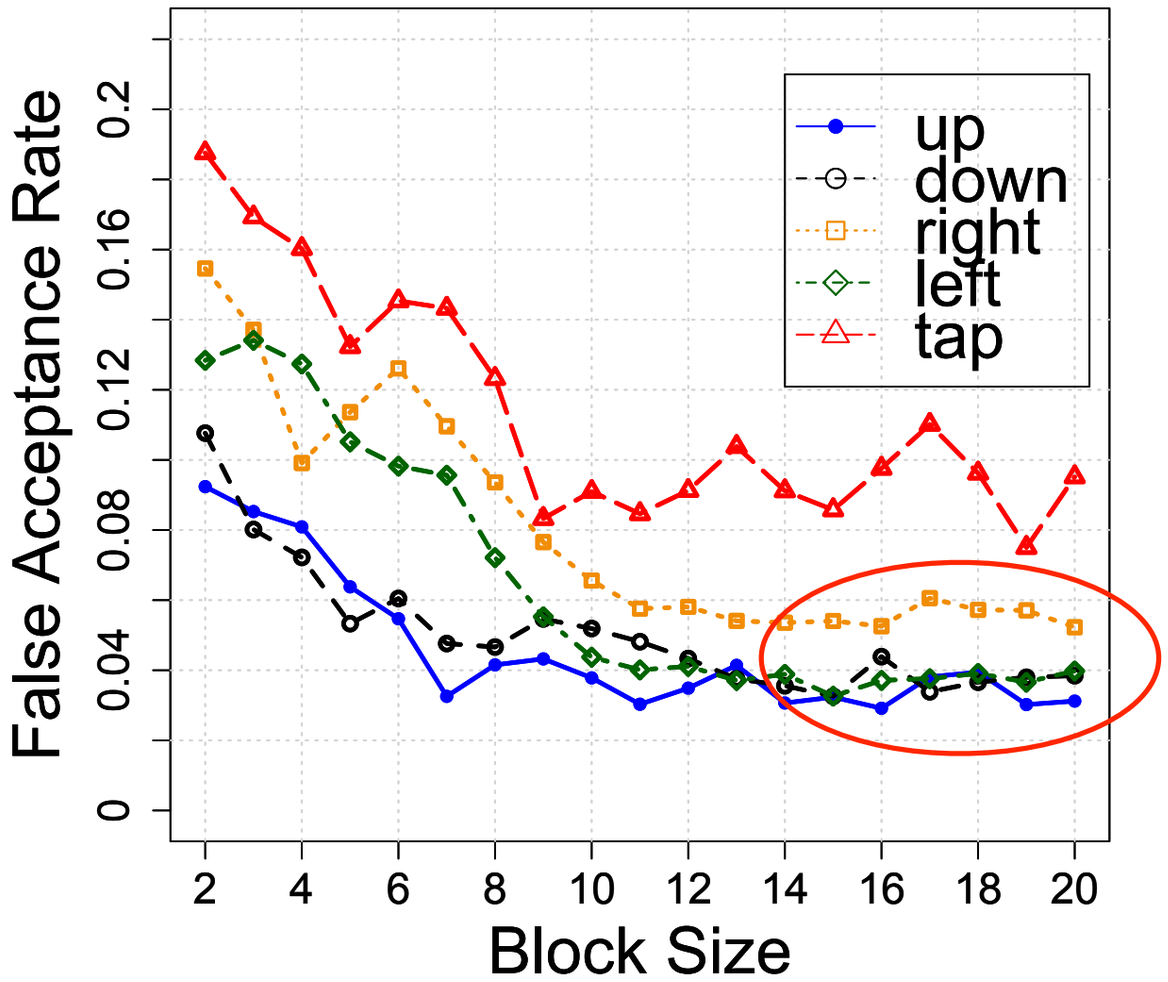
landscape



Gesture Block Size

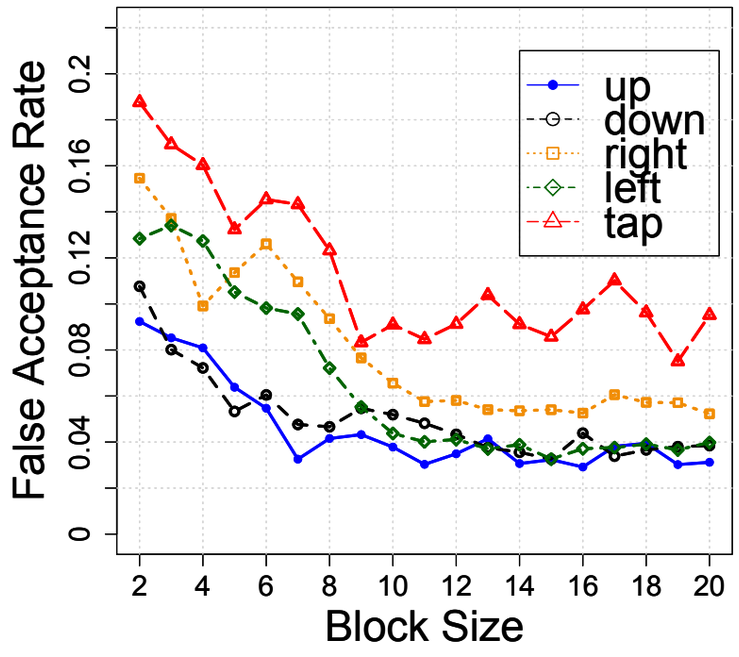
portrait

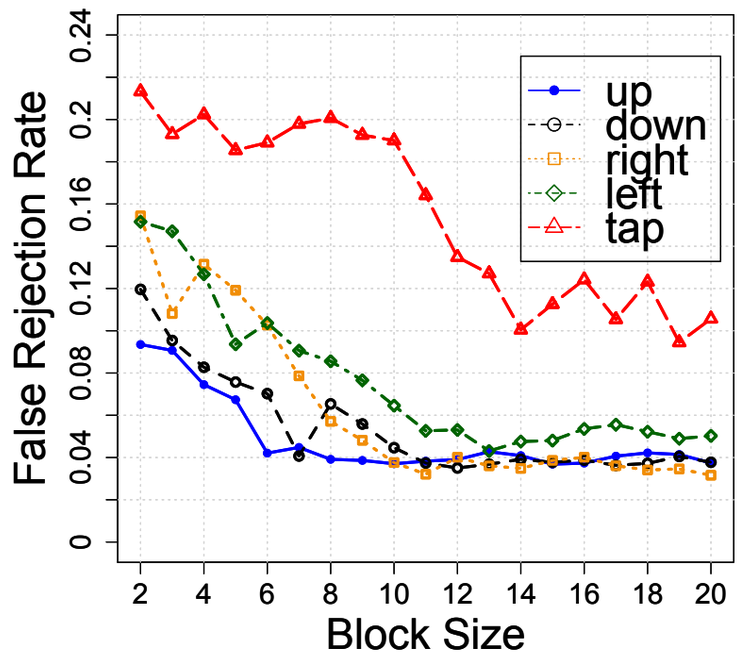
landscape



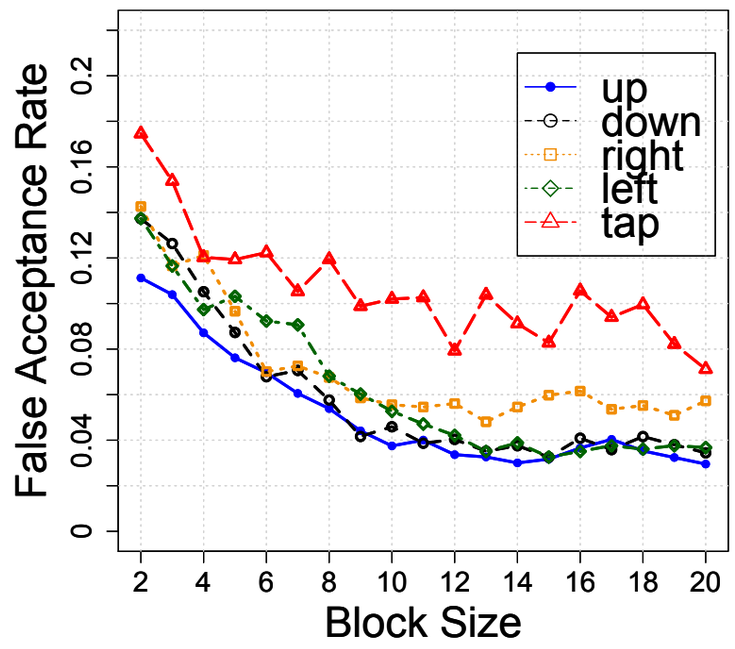
Gesture Block Size

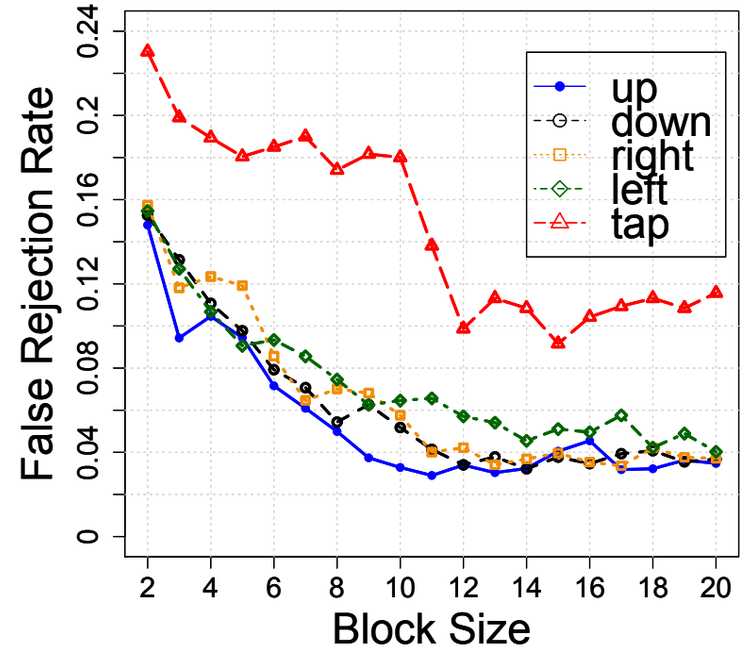
portrait





landscape

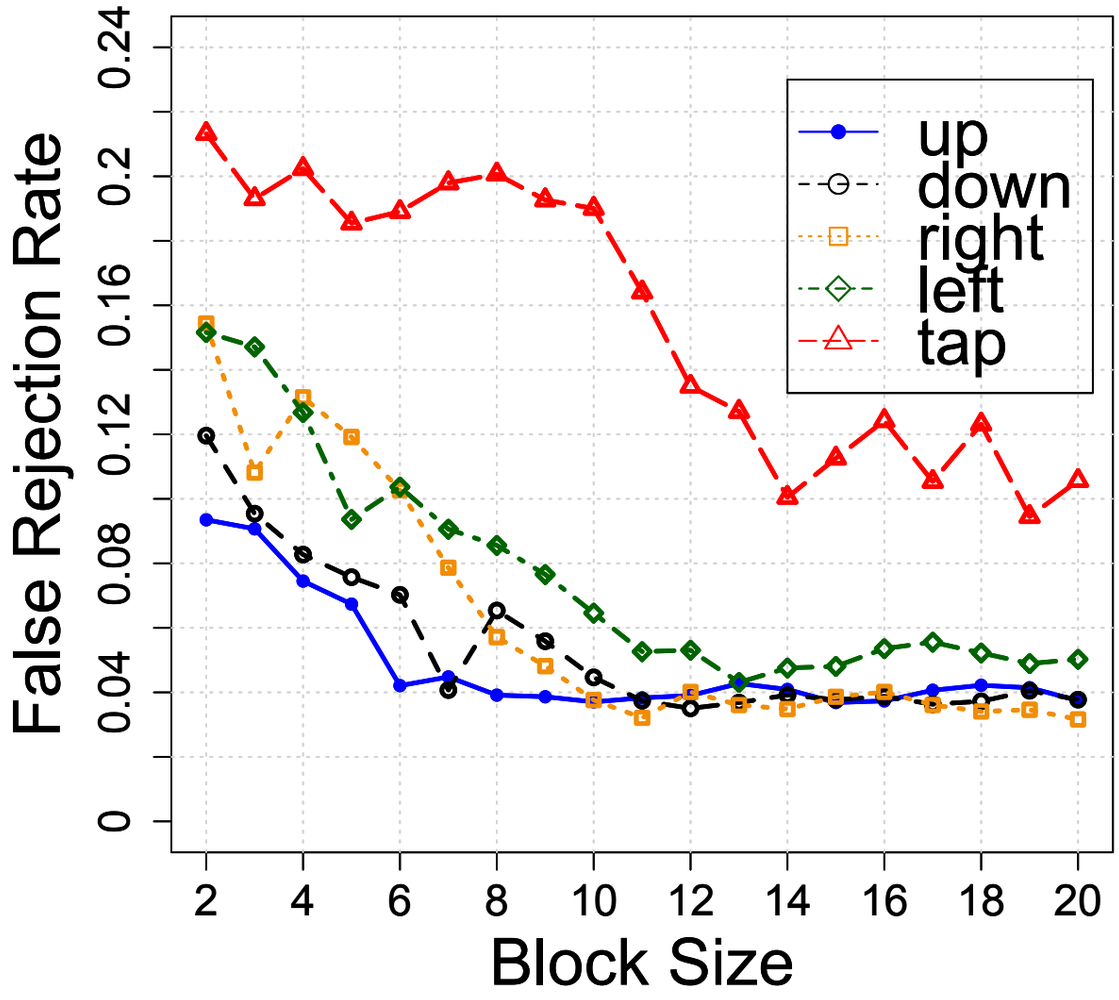




Gesture Block Size

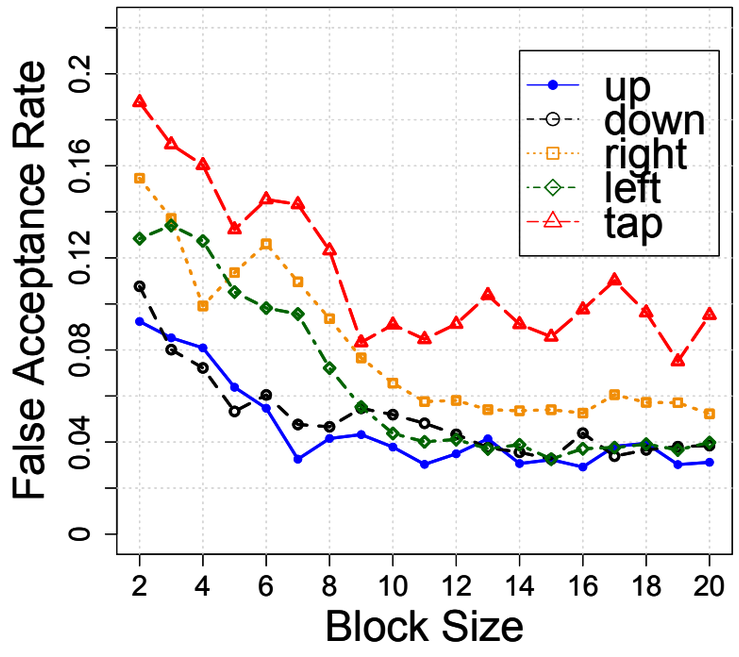
portrait

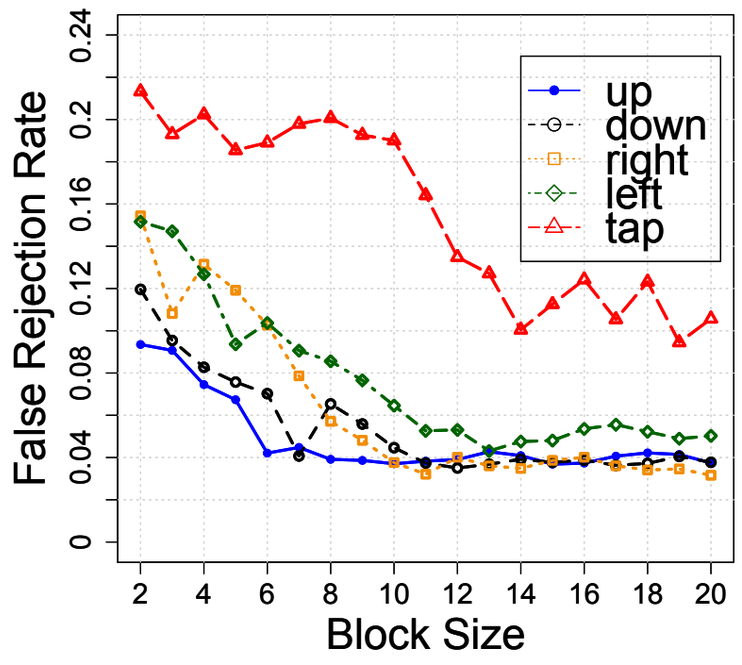
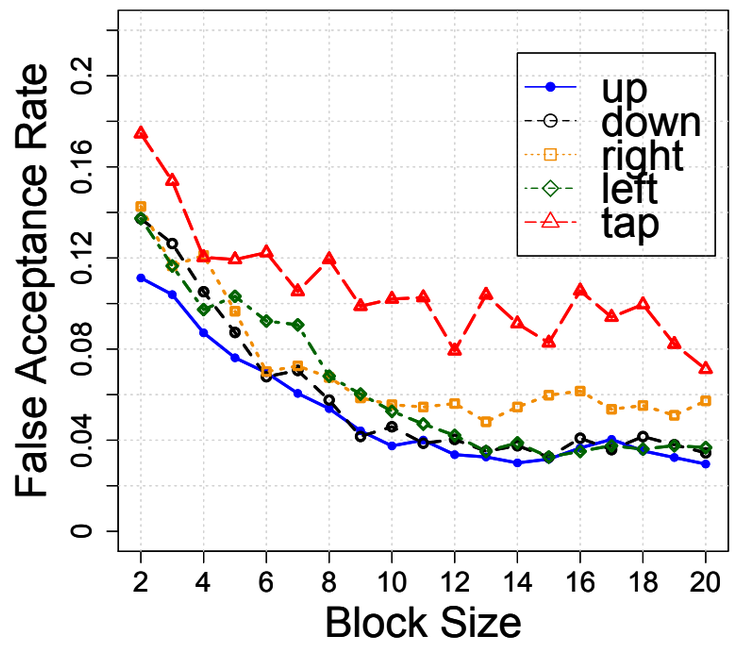
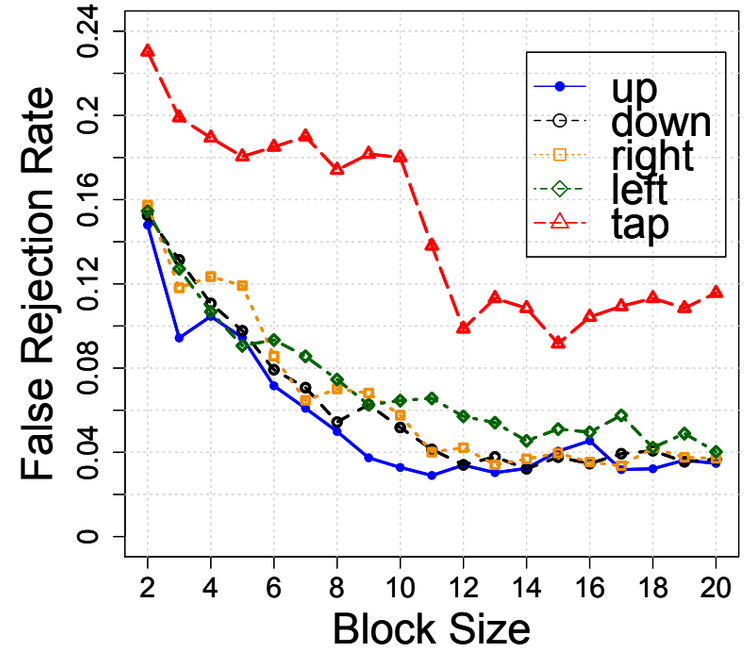
landscape



Gesture Block Size

portrait





landscape