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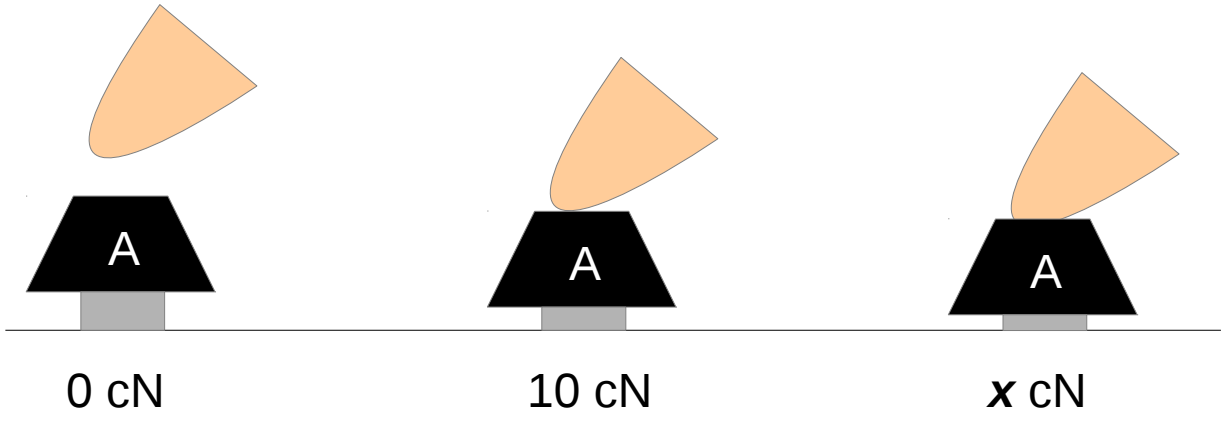
I can be you: Questioning the use of keystroke dynamics as biometrics

Tey Chee Meng, Payas Gupta, Debin Gao

Singapore Management University

Keystroke dynamics: your typing pattern

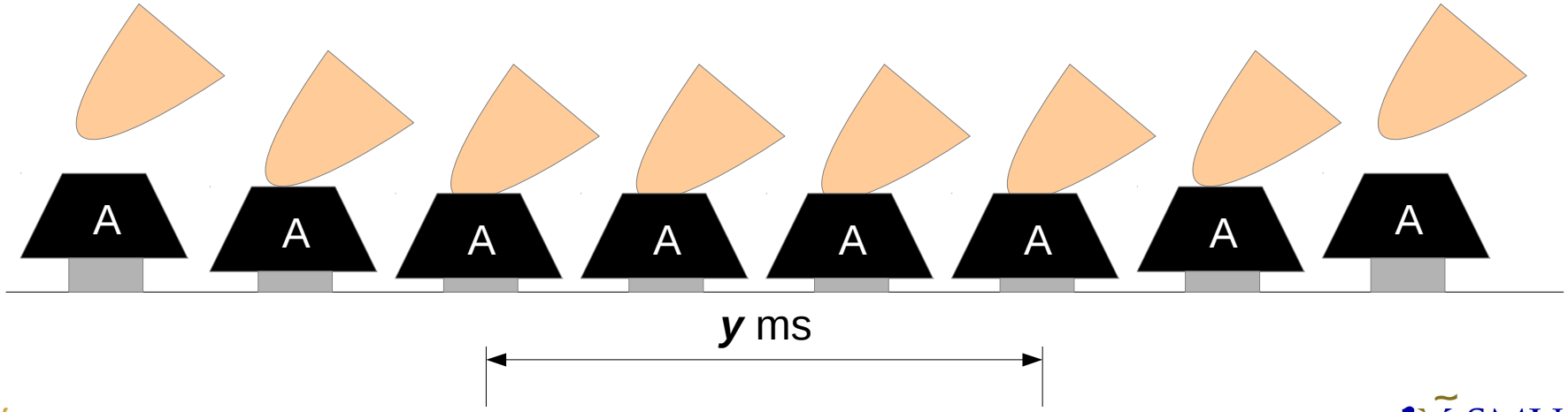
- How hard you press (pressure)



cN: centi-newton

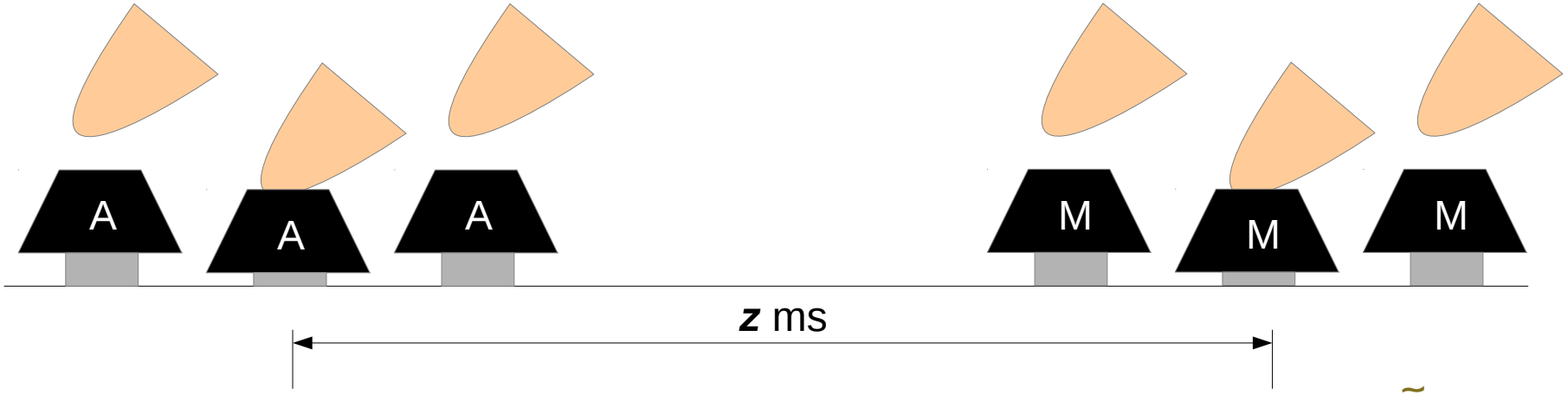
Keystroke dynamics: your typing pattern

- How hard you press (pressure)
- How long you press (hold time)



Keystroke dynamics: your typing pattern

- How hard you press (pressure)
- How long you press (hold time)
- How fast you move (inter-keystroke time)

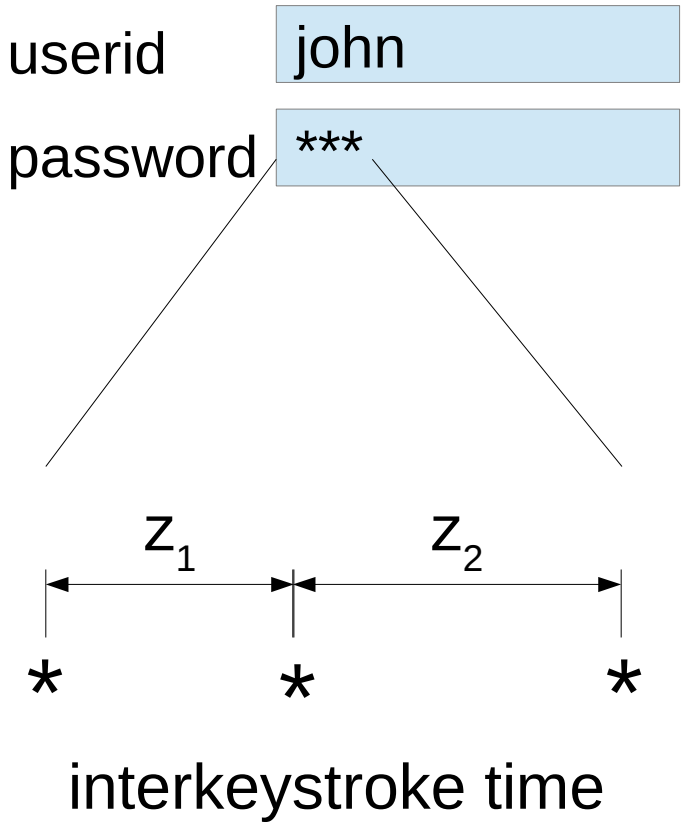


Example

userid john

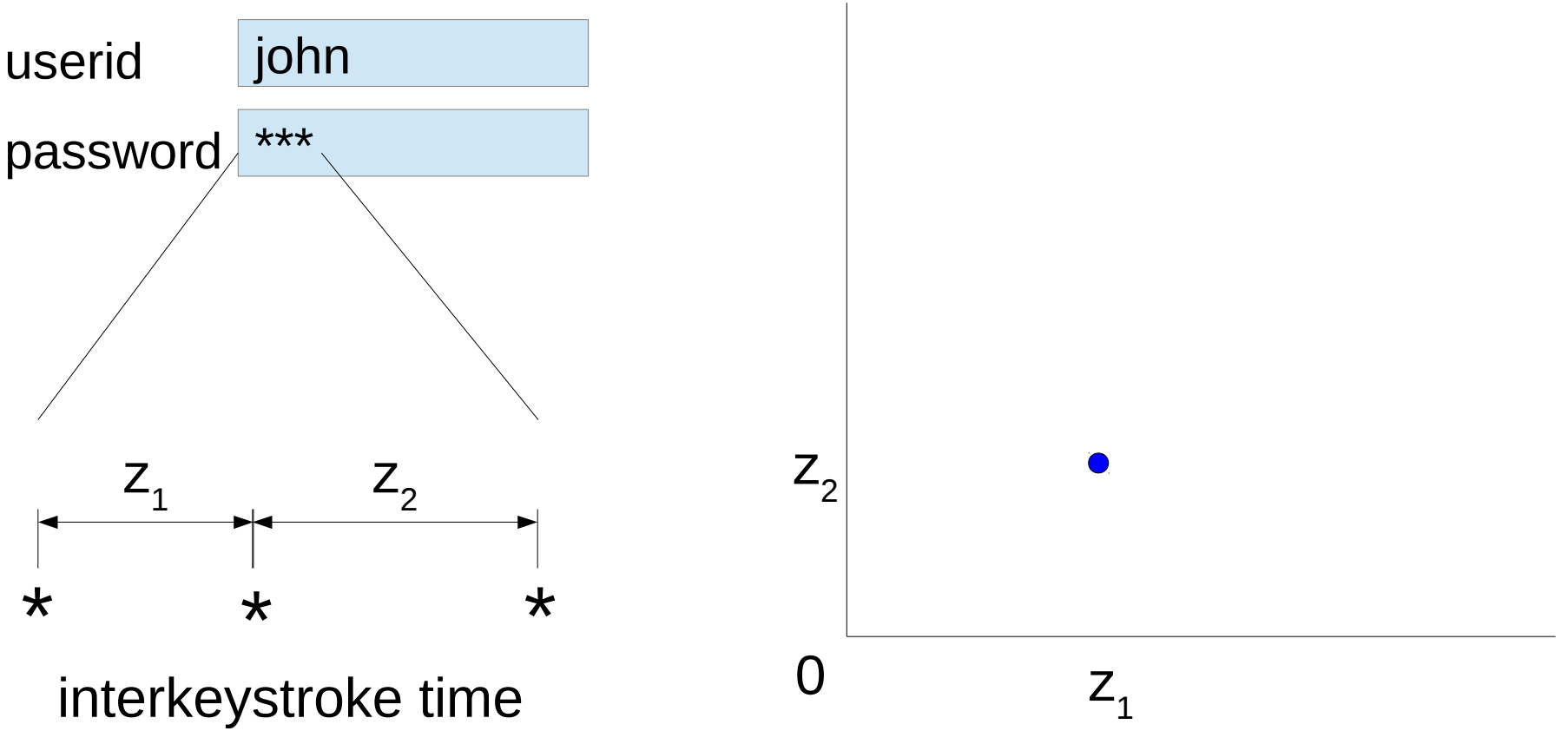
password ***

Example

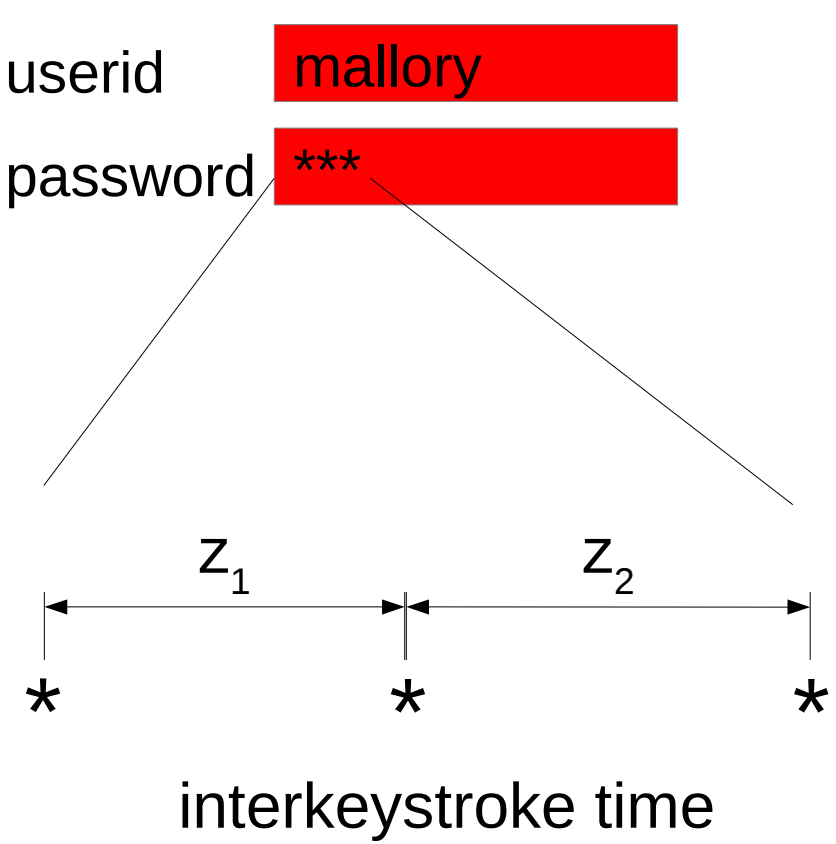


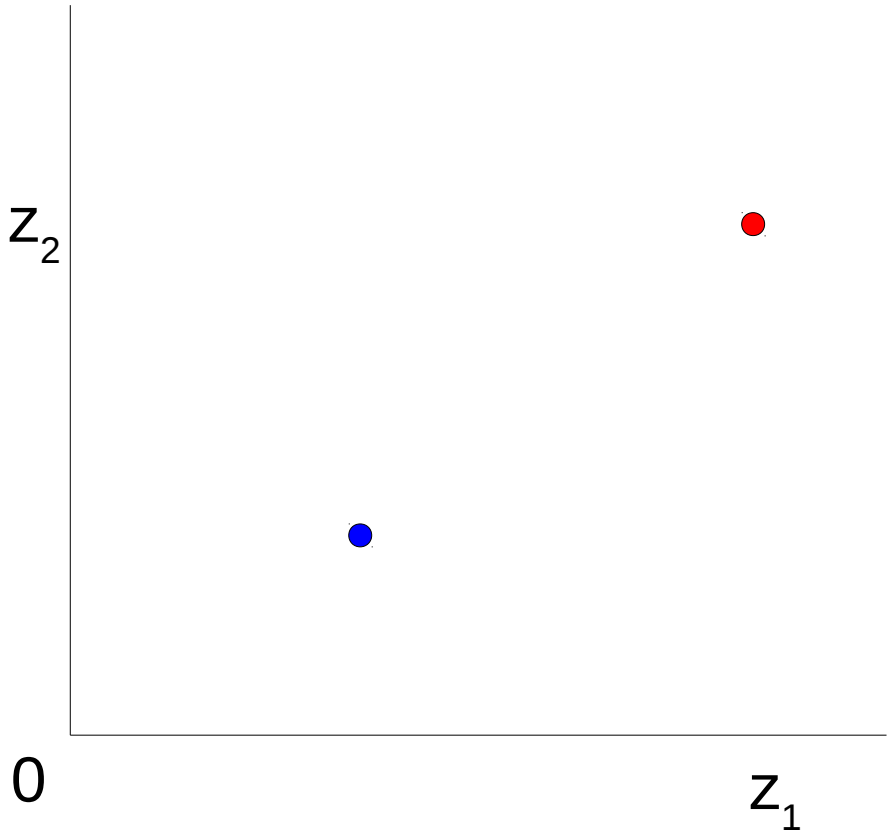
interkeystroke time

Example

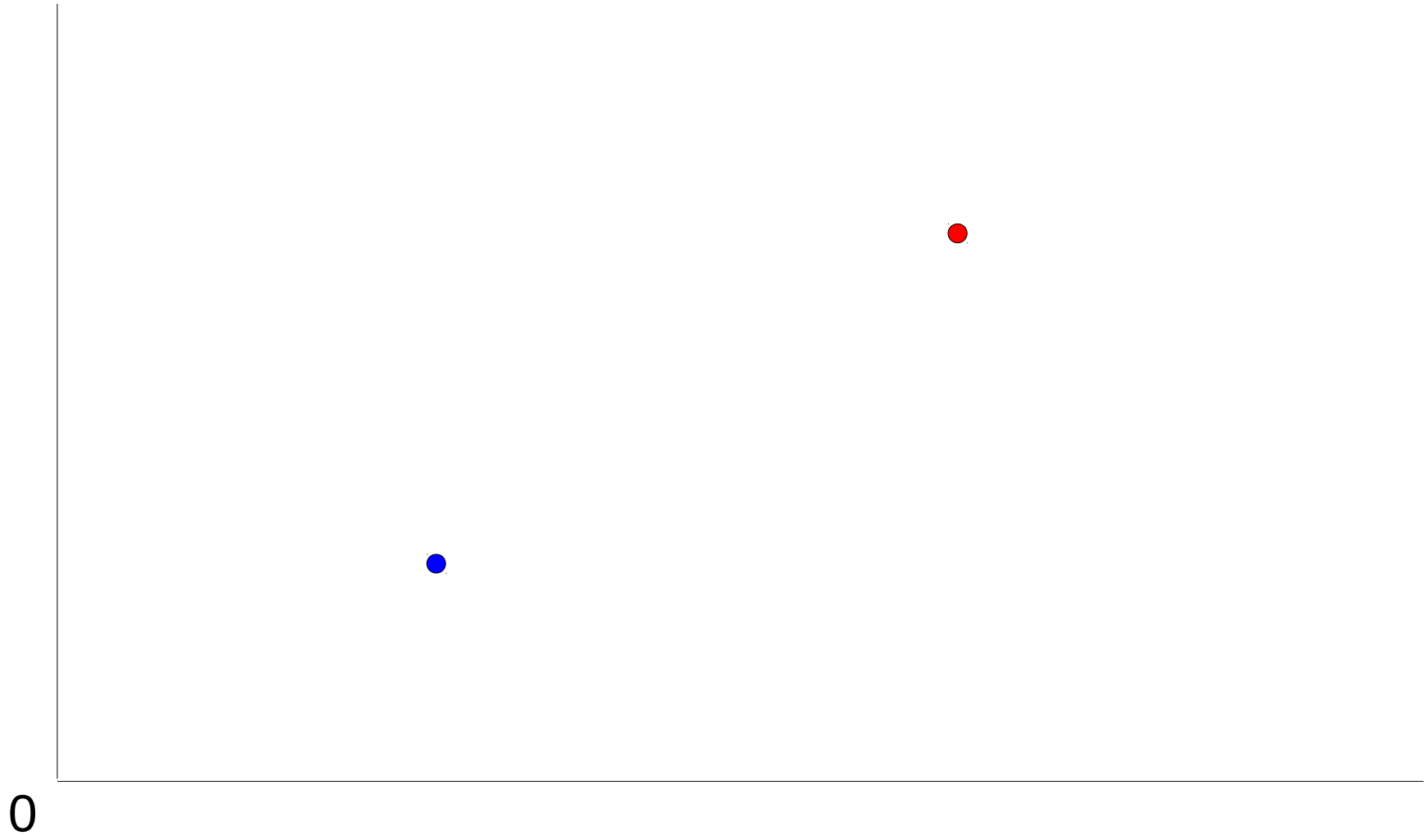


Example





Example



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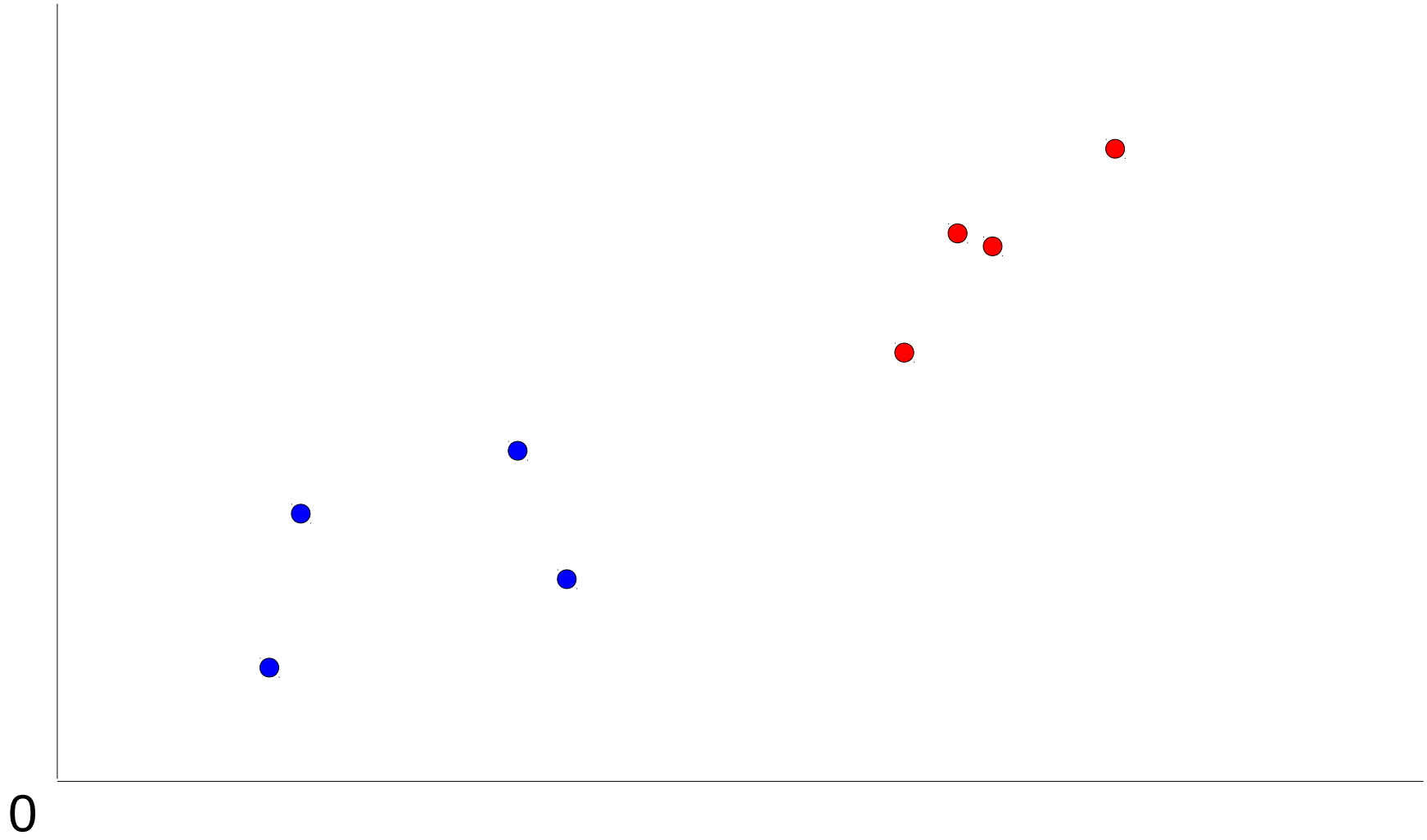

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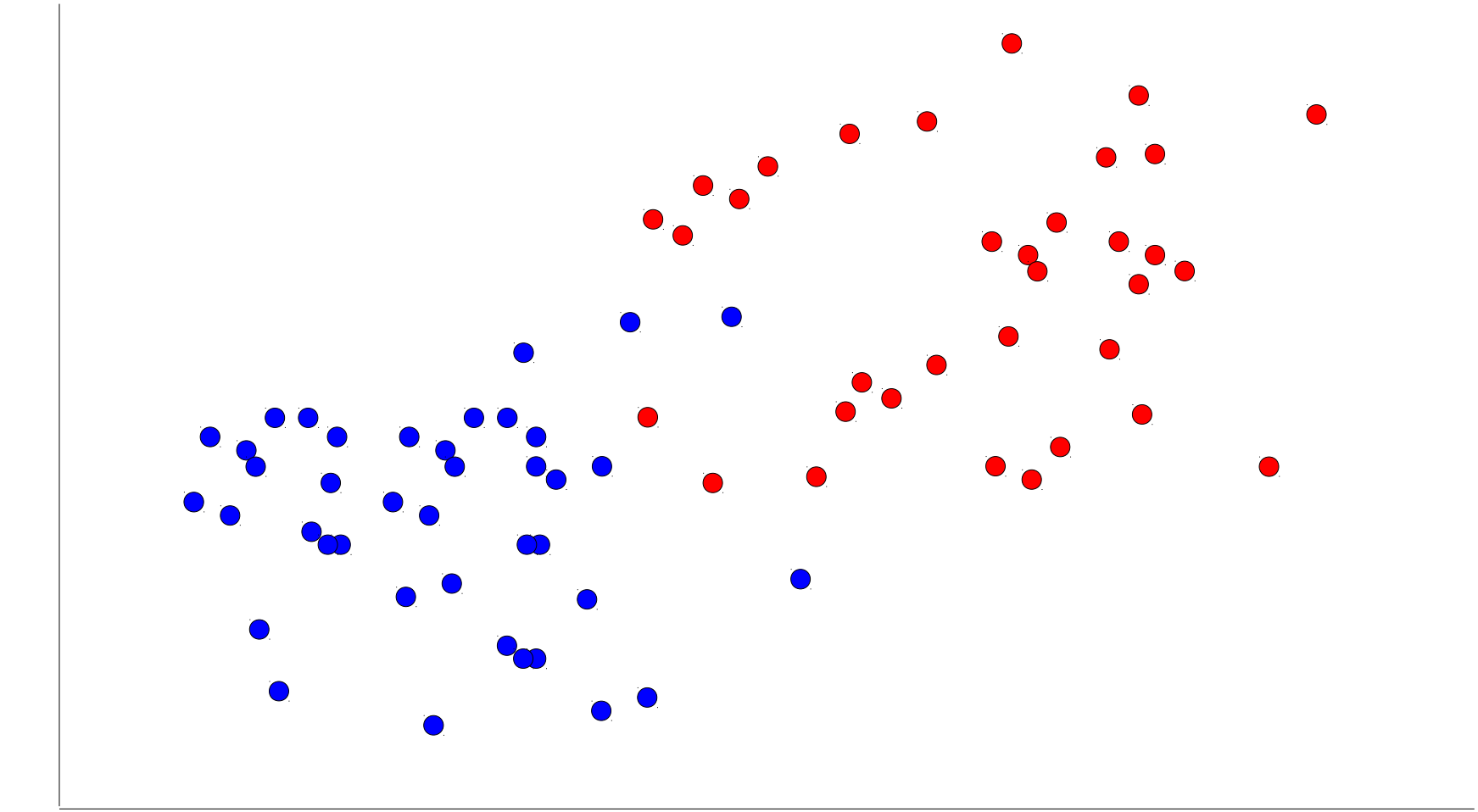

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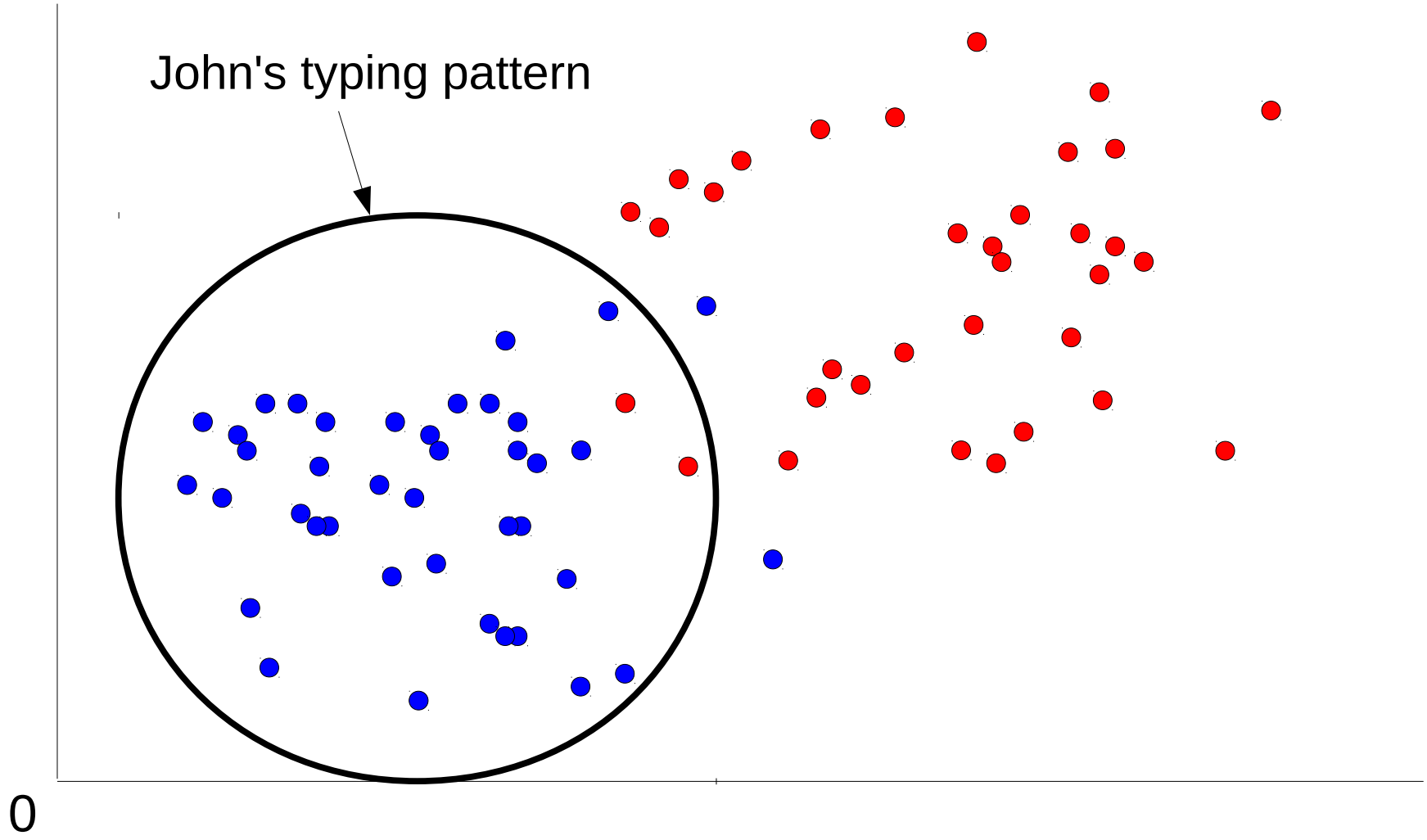

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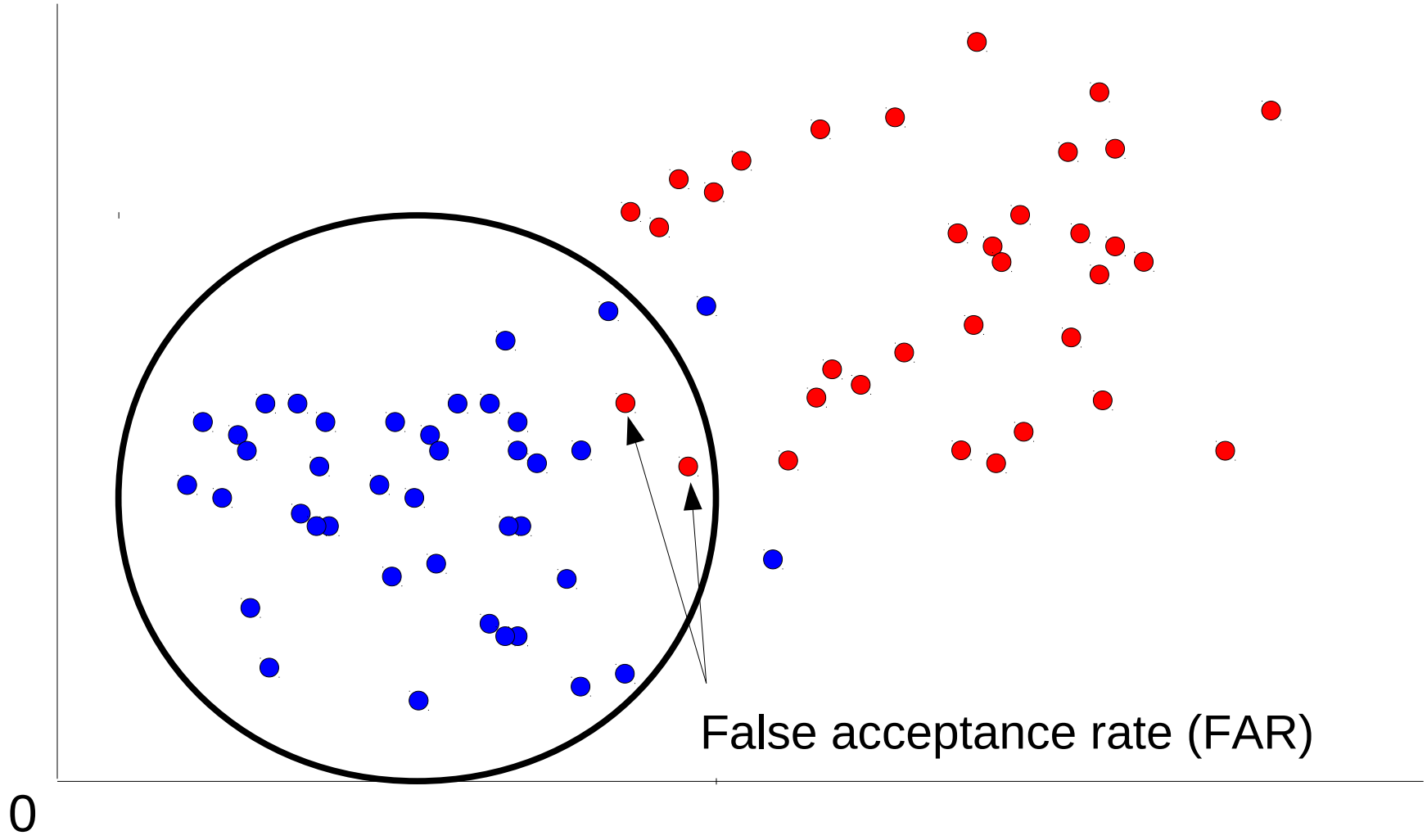

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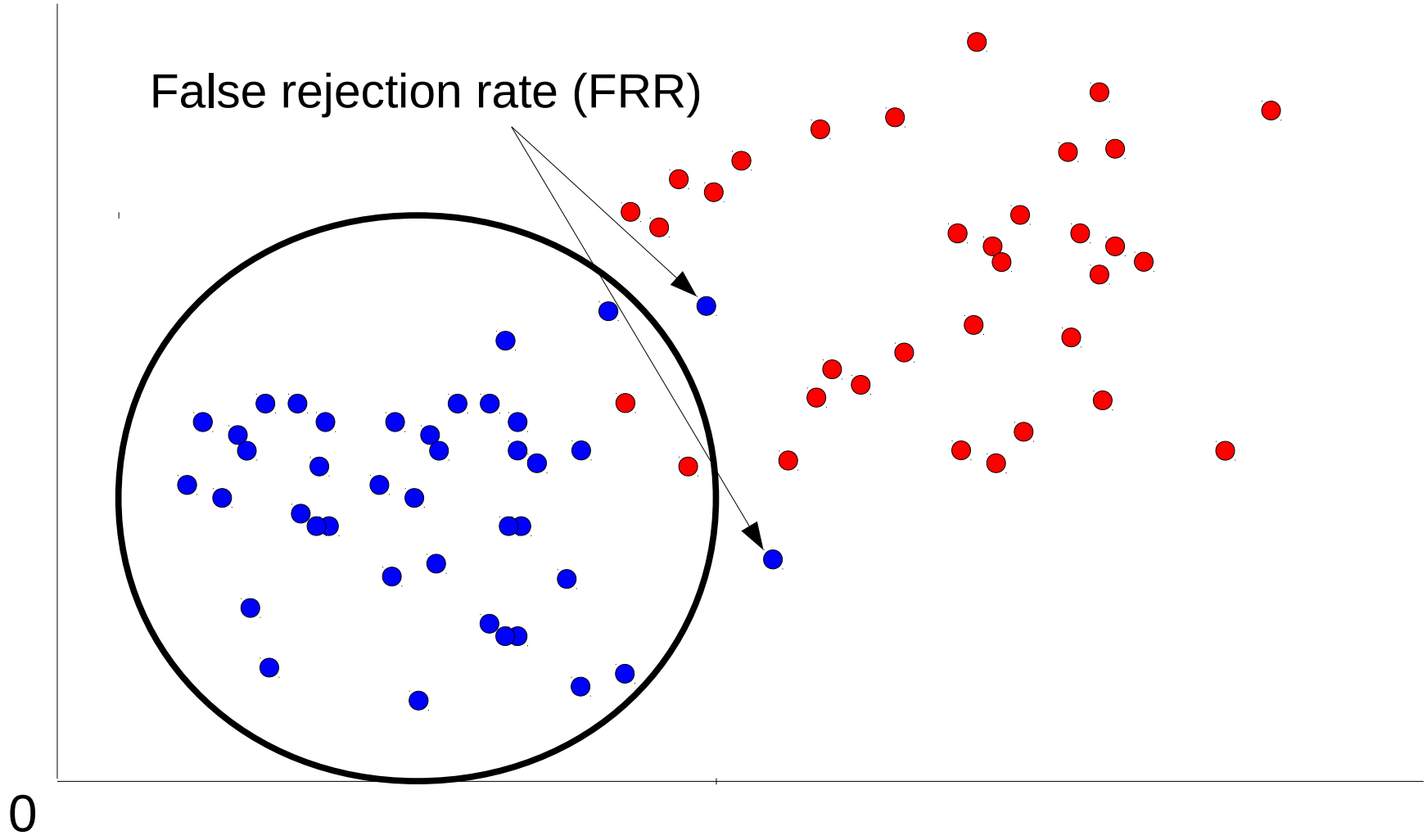
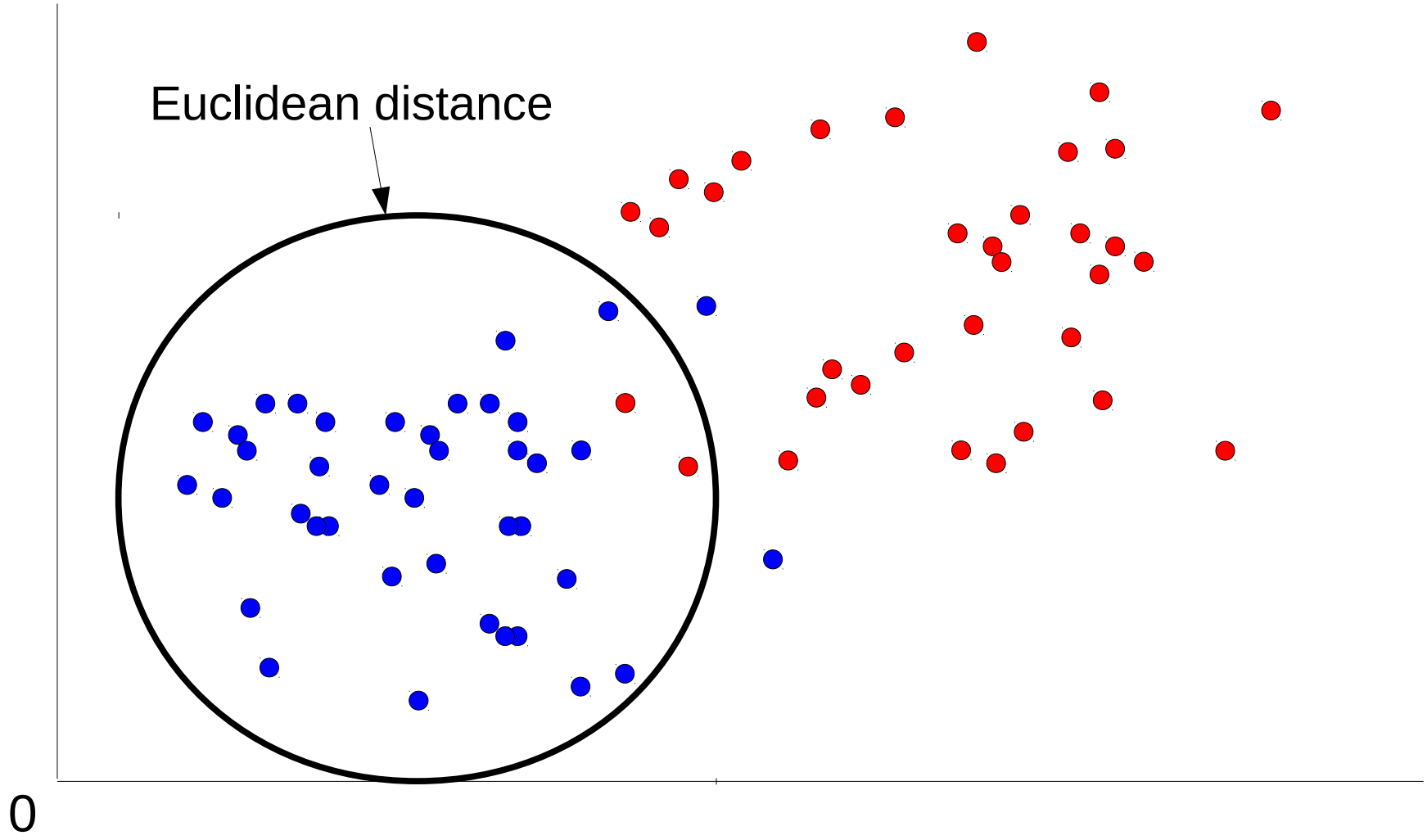


Prior art - classifying algorithms



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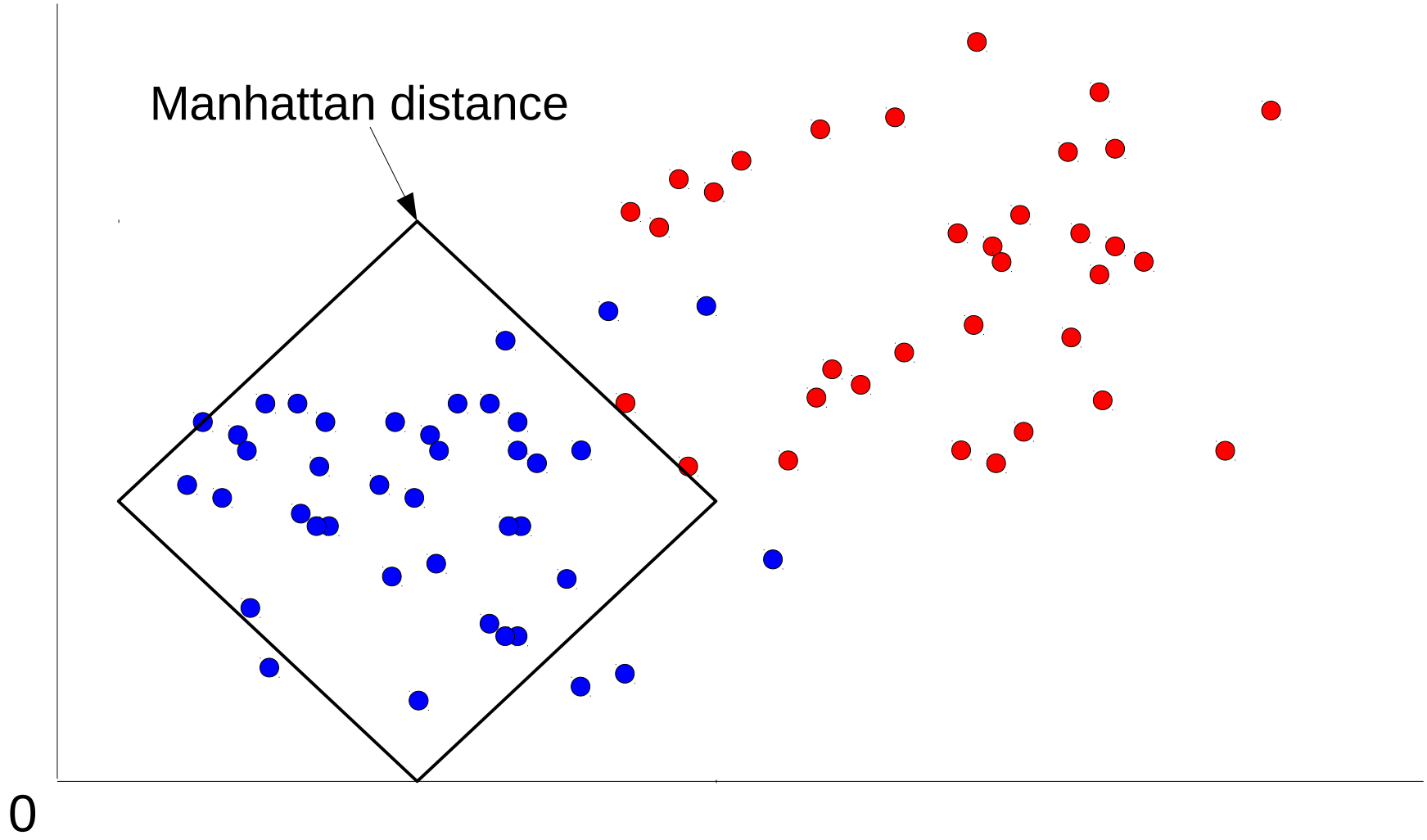

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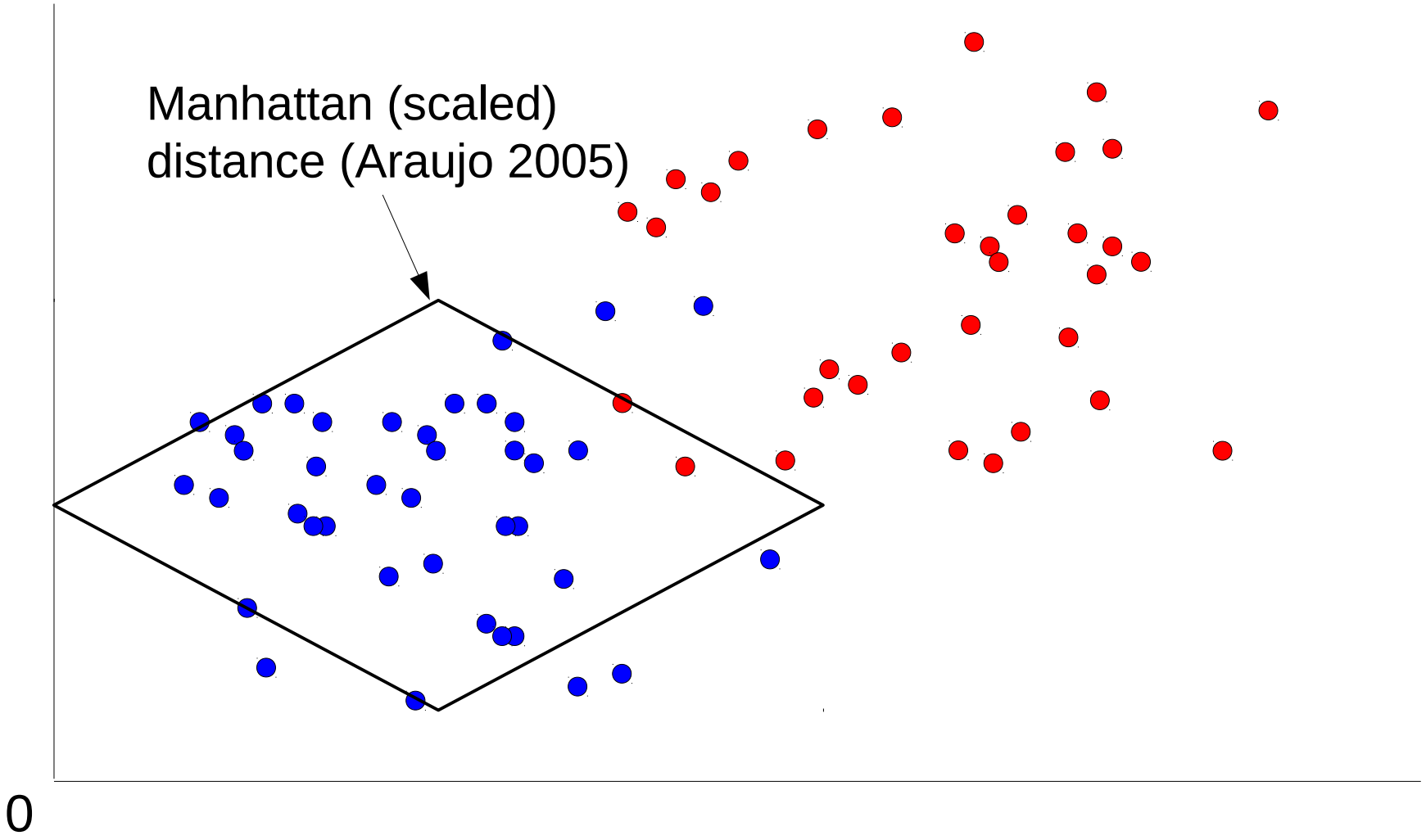
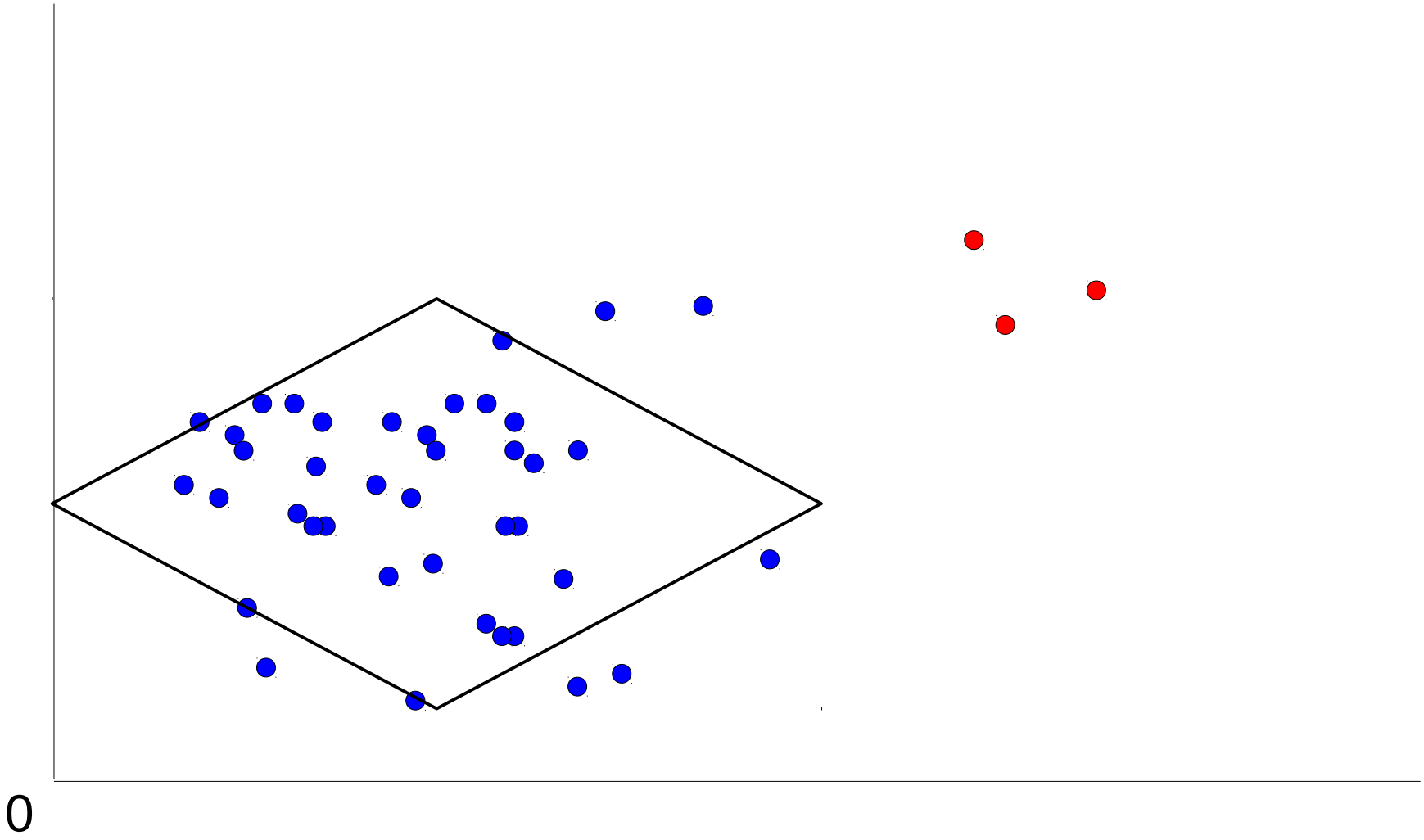
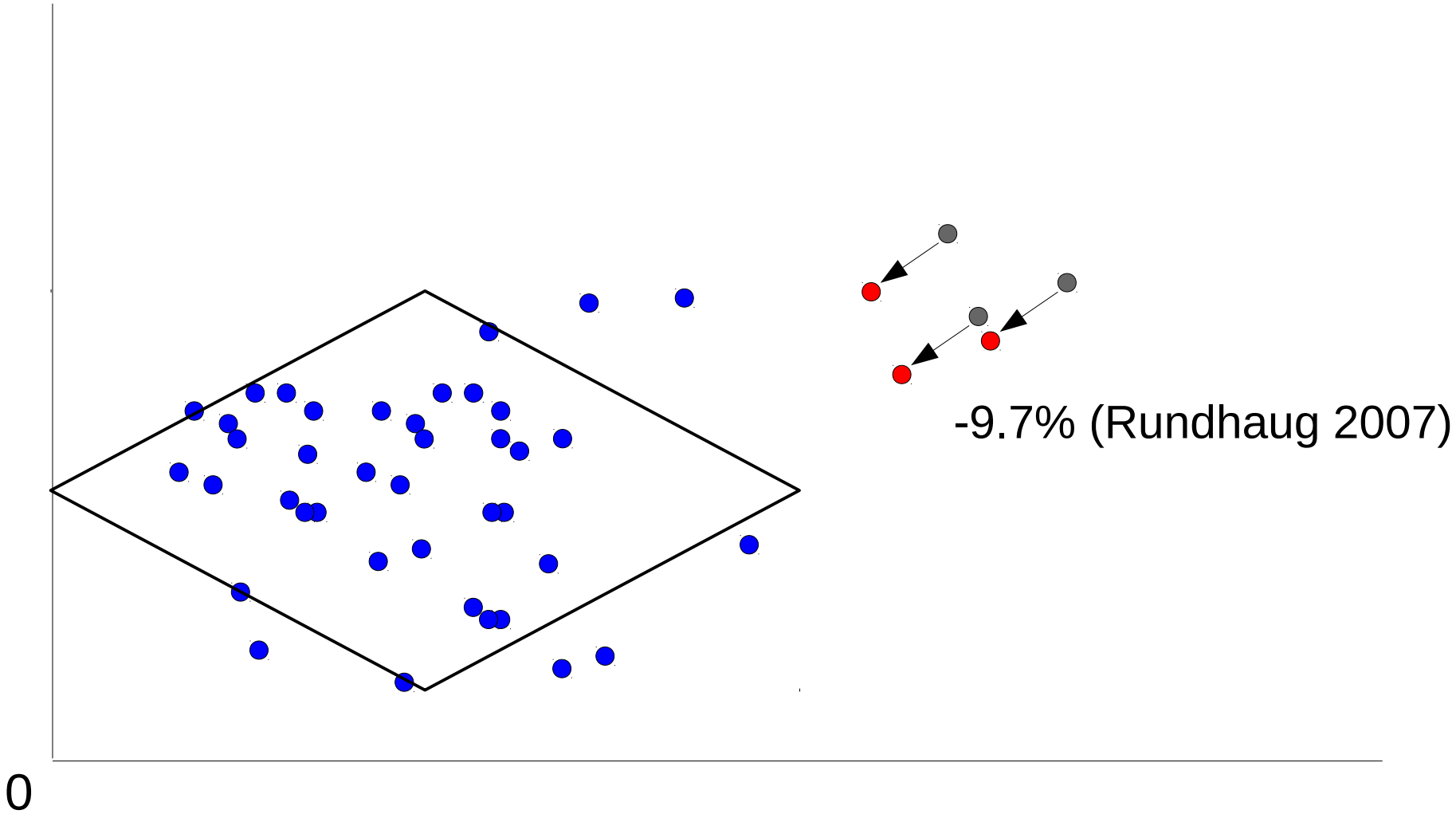


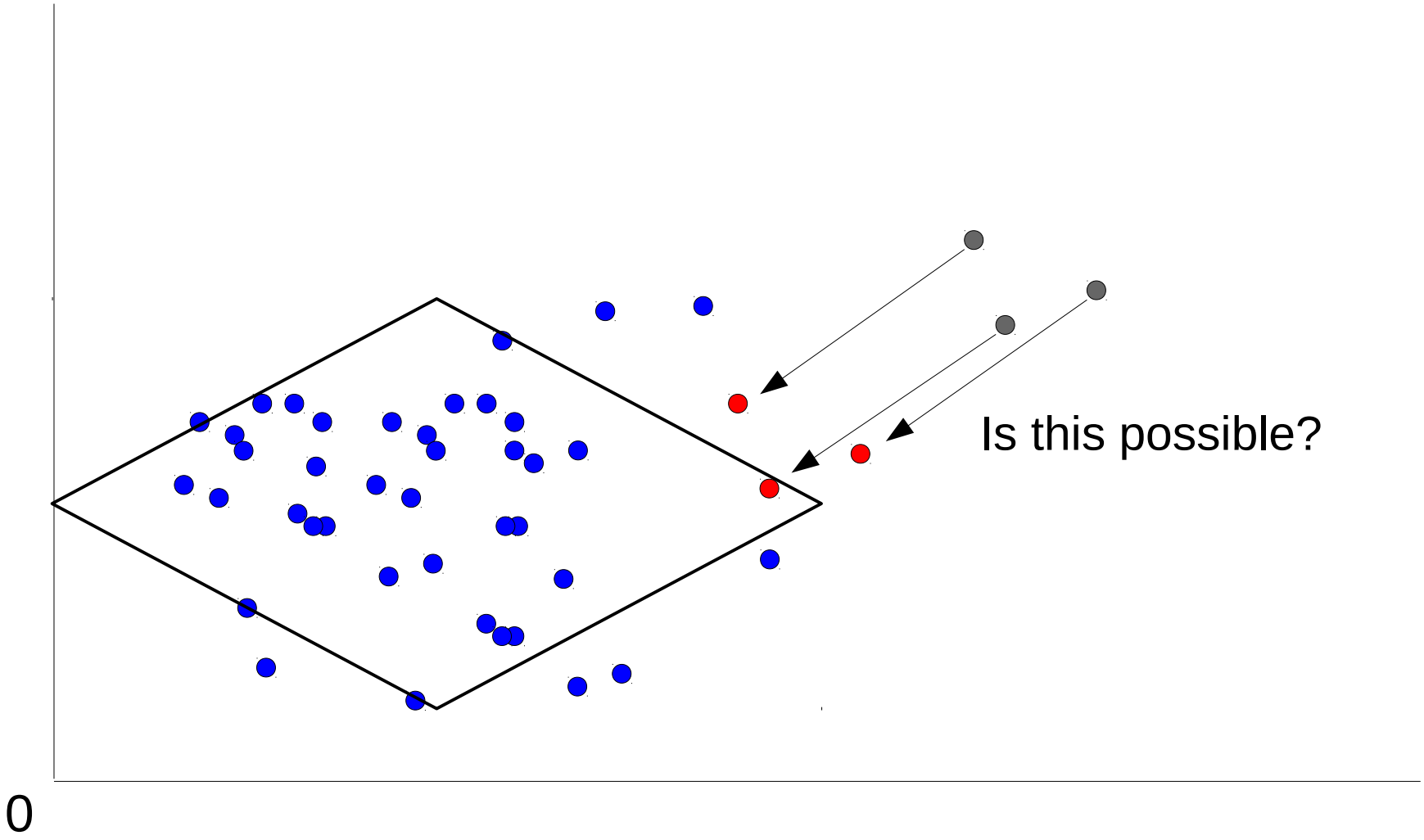
Prior art - imitation



Prior art - imitation



Research question



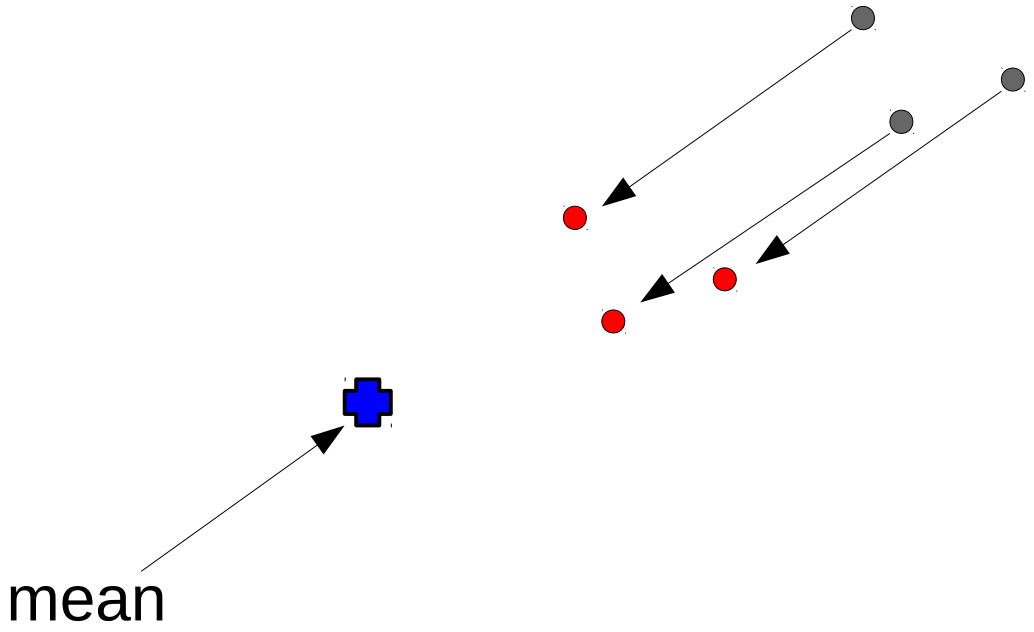
Are there people who can change their typing pattern?

1 person out of 10?
1 person out of 100?
1 person out of 1000?

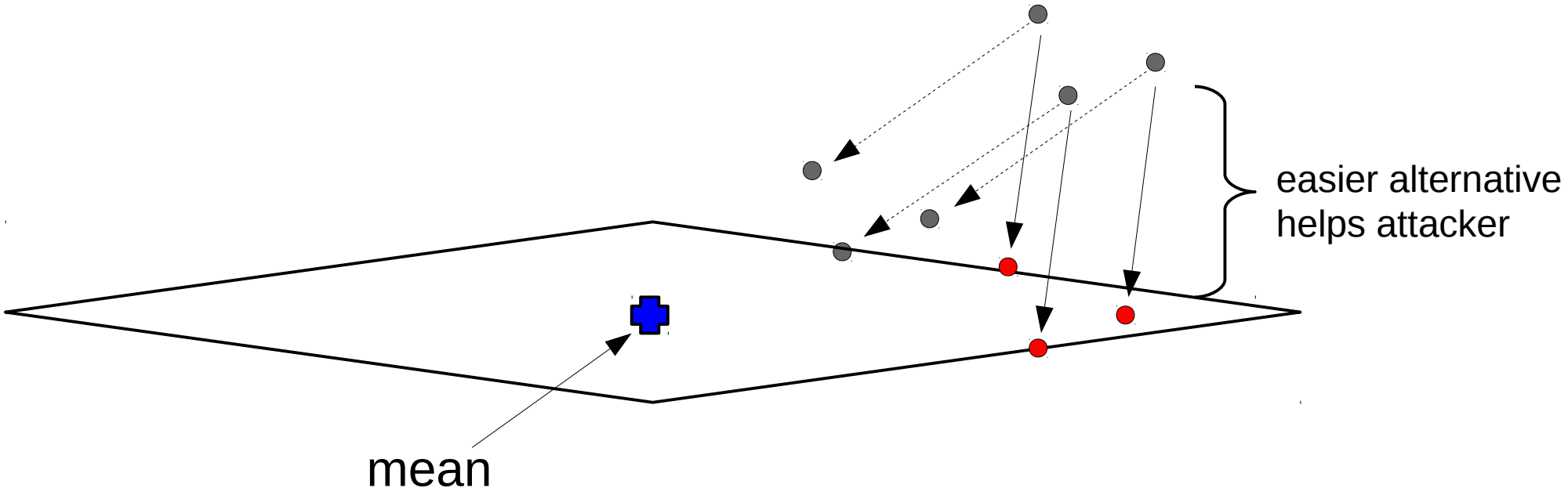
Design considerations

- Choice of detector: Manhattan (scaled) distance classifier (Araujo 2005, Killourhy 2009)
- Motivation: performance bonus
- Basis for comparison: best 20 consecutive
- Choice of password: 1 easy to type (minimize finger movement), 1 hard to type
- Attack scenarios: Euclidean vs Manhattan (scaled) distance

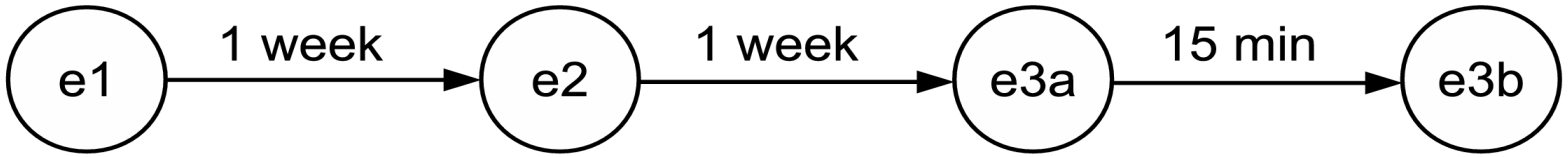
Attack scenario - only mean is known



Attack scenario - full information



Experimental structure

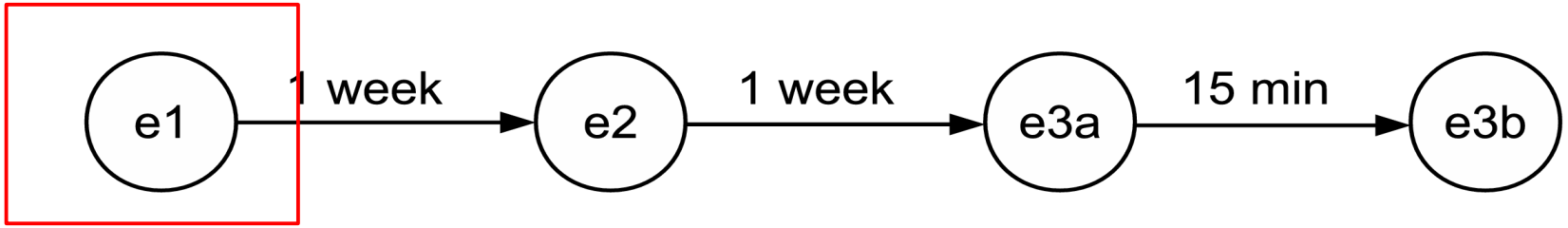


e1	e2	e3a	e3b
Male: 39	Male: 39	Male: 10	Male: 10
Female: 49	Female: 45	Female: 4	Female: 4
Age: 19-33	Age: 19-33	Age: 20-28	Age: 20-28
FB: No	FB: Euclid	FB: Euclid	FB: Scaled
TL: No	TL: 30-45 min	TL: 20 min	TL: up-to 2 hr
$: 8	$: 8	$: 8	$: 8
$+: No	$+: No	$+: No	$+: up-to 16

FB: Type of Feedback	TL: Time limit
$: Base Payment	$+: Performance Bonus
Euclid: Euclidean distance	Scaled: Manhattan (scaled) distance

Experimental structure

Enrolment



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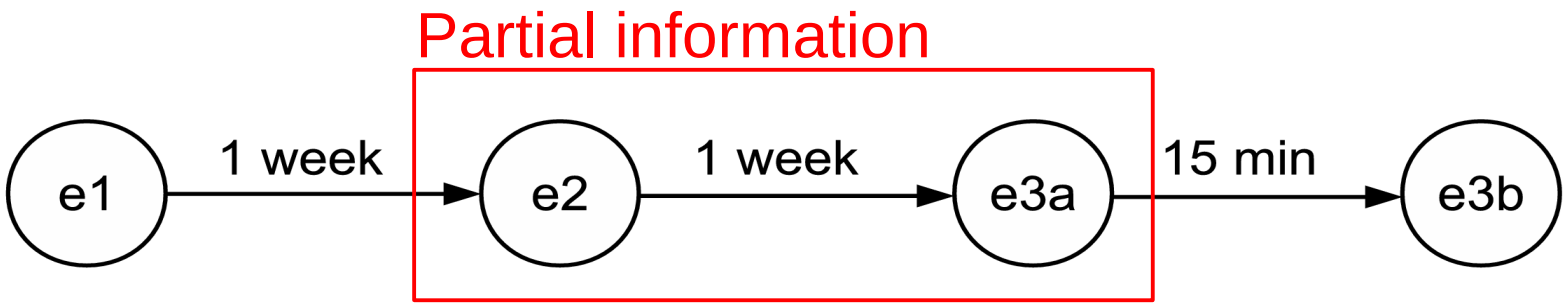

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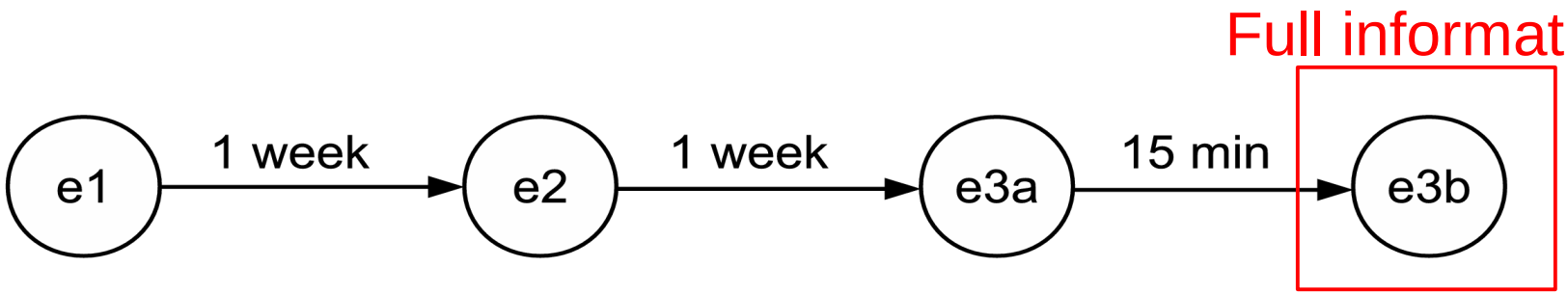

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Perf bonus

Training interface

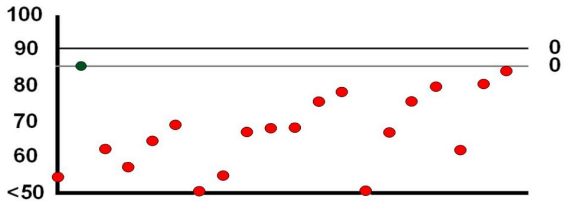
ths.ouR2

Completed: 279.

Hide tables | Hide bottom graph

83.6/100
Current score

67.0/100
Average score

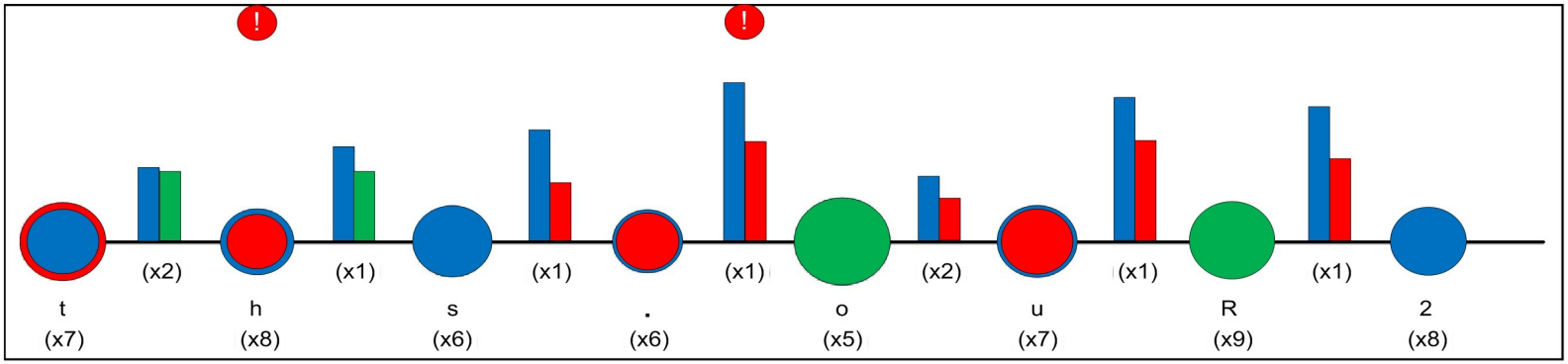


Hold time (time taken to release a key after pressing it):

Character	t (7)	h (8)	s (6)	. (6)	o (5)	u (7)	R (9)	2 (8)
Target timing	97	101	107	96	151	114	113	96
Your timing	128	64	113	79	144	96	112	96
Penalty	218.3	286.9	36.4	103.0	32.3	130.8	6.8	1.3

Interkey time (time between pressing one key and the next):

Character pair	"t h" (2)	"h s" (1)	"s ." (1)	". o" (1)	"o u" (2)	"u R" (1)	"R 2" (1)
Target timing	152	208	257	427	132	372	334
Your timing	144	144	113	223	80	224	176
Penalty	14.4	93.9	128.8	179.6	107.3	112.9	122.3



Training interface

ths.ouR2

Completed: 279.

password

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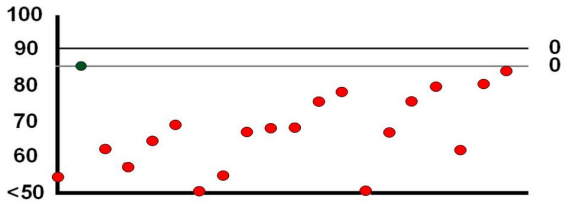

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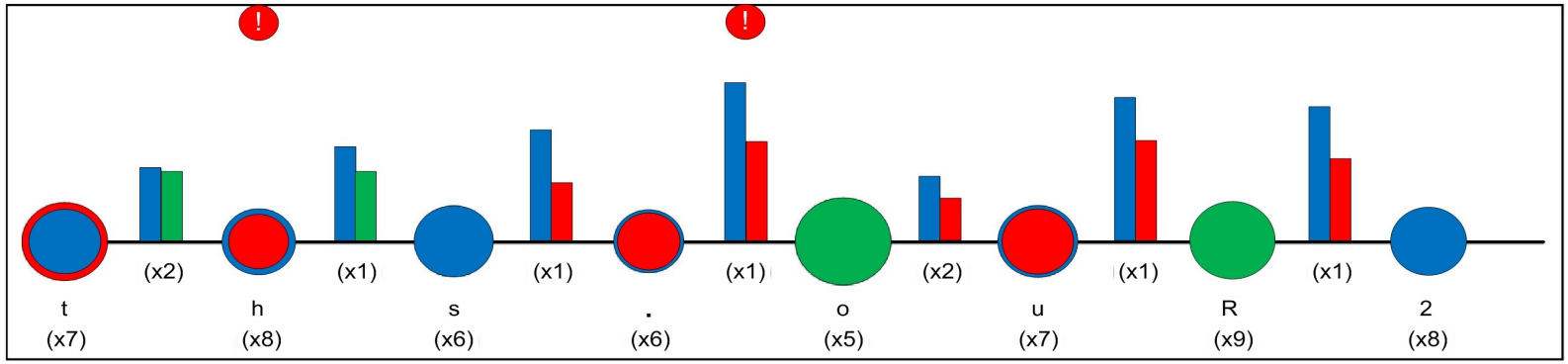

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Training interface

score feedback

ths.ouR2

Completed: 279.

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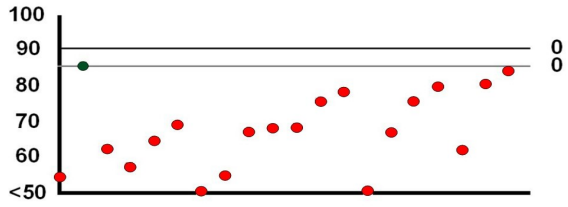

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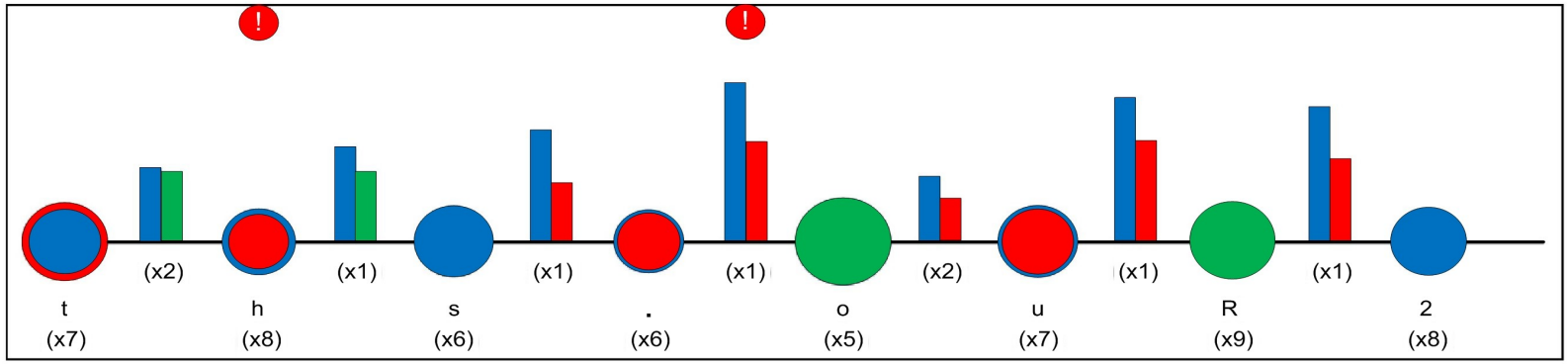

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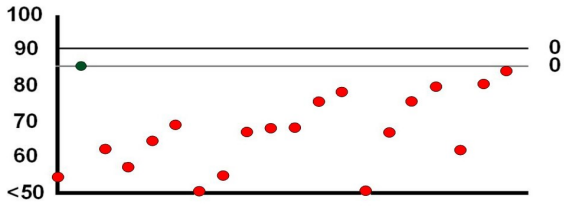

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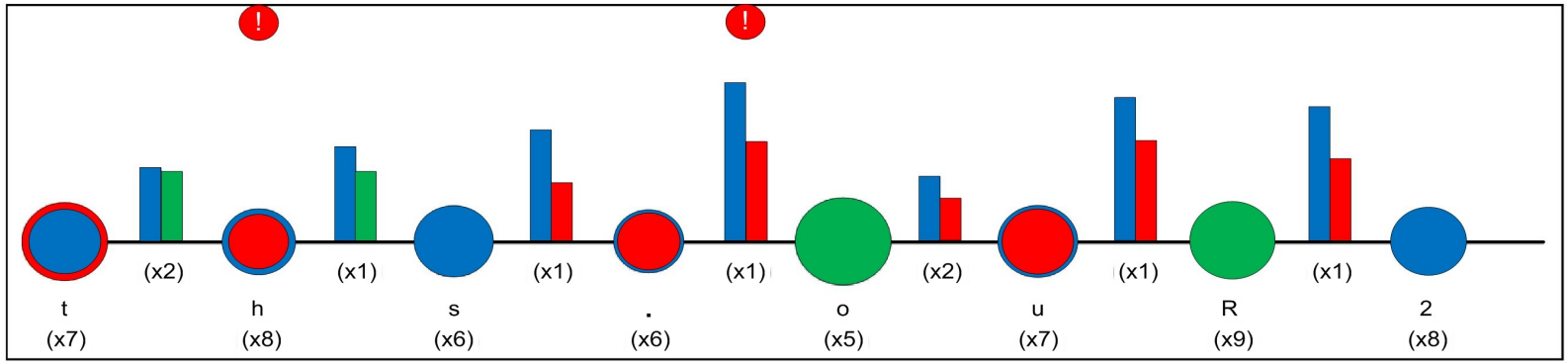
graphical feedback



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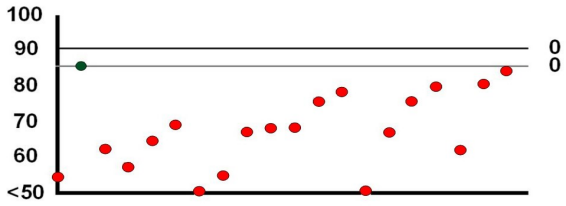

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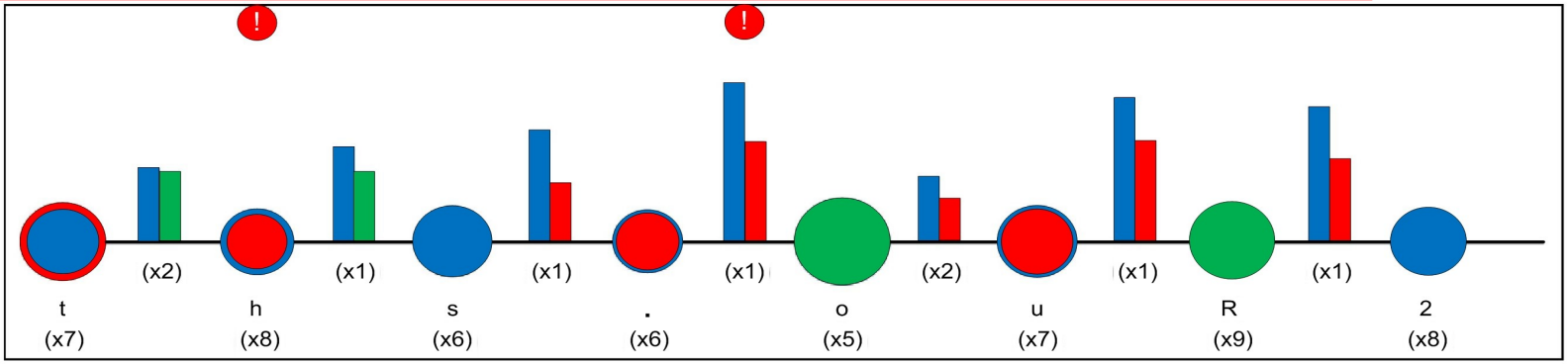
raw timing feedback



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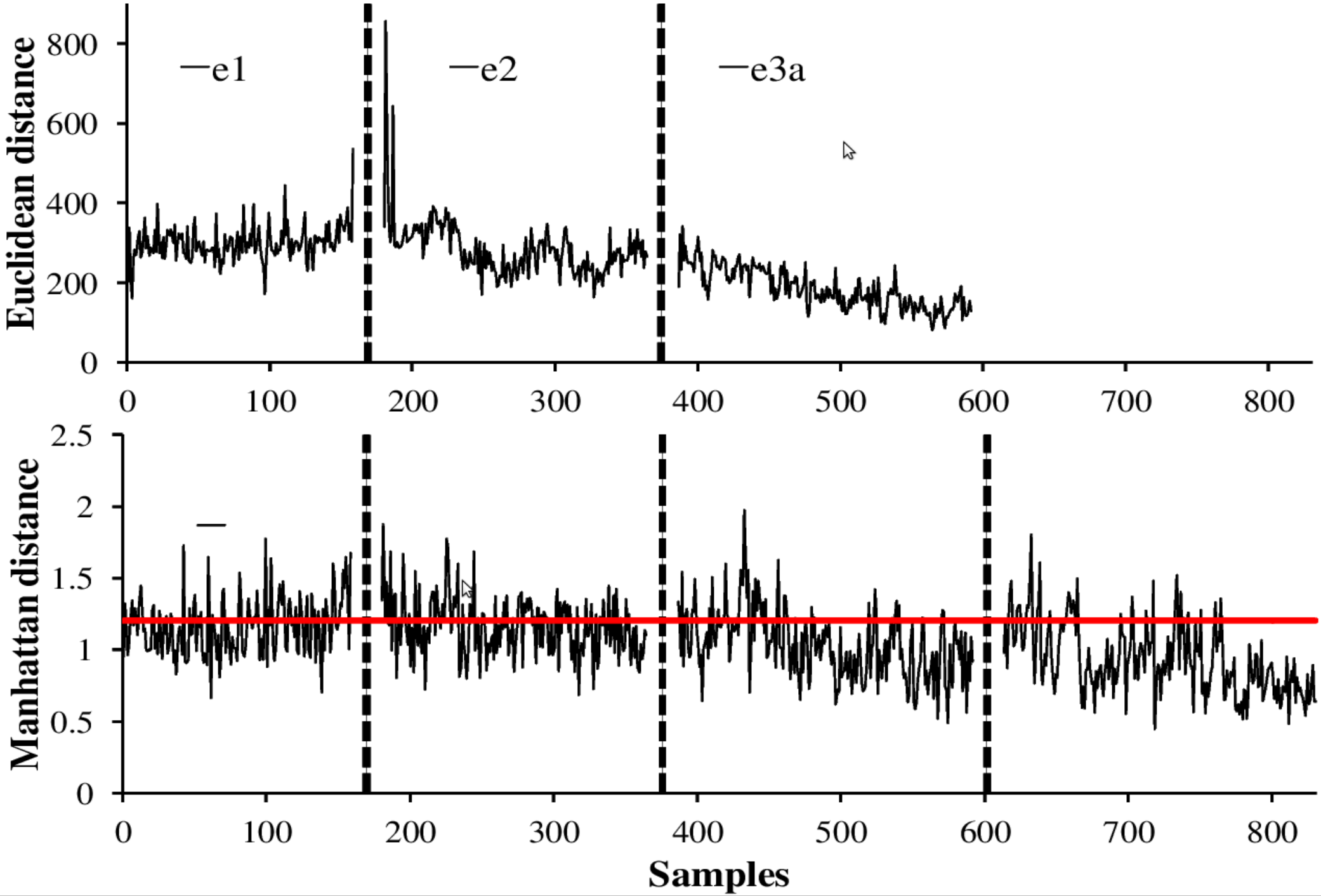
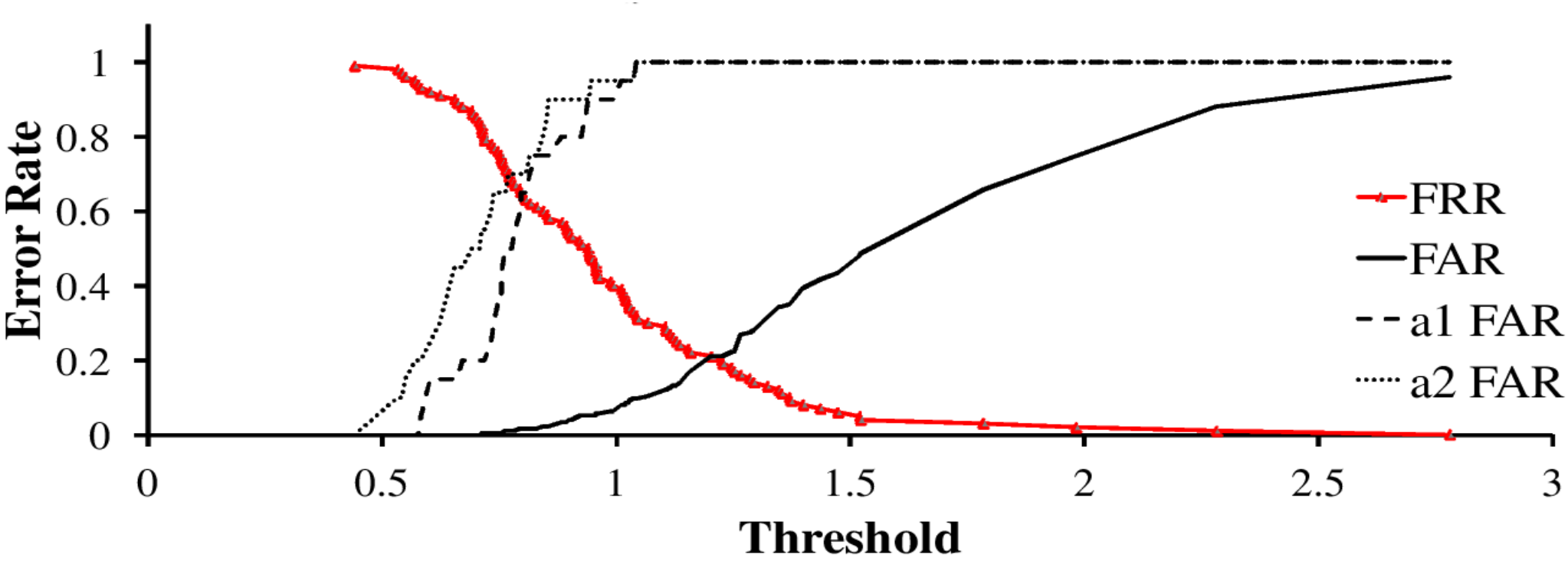
Participants' preference of interface

- Initial phase
  - graphical: 51
  - raw timing: 23
  - graphical + raw: 6
  - score only: 4
- Later phase:
  - score only


Euclidean distance
800
600
400
200
0
—e1
—e2
—e3a
0
100
200
300
400
500
600
700
800
Manhattan distance
2.5
2
1.5
1
0.5
0
—
0
100
200
300
400
500
600
700
800
Samples

Training results



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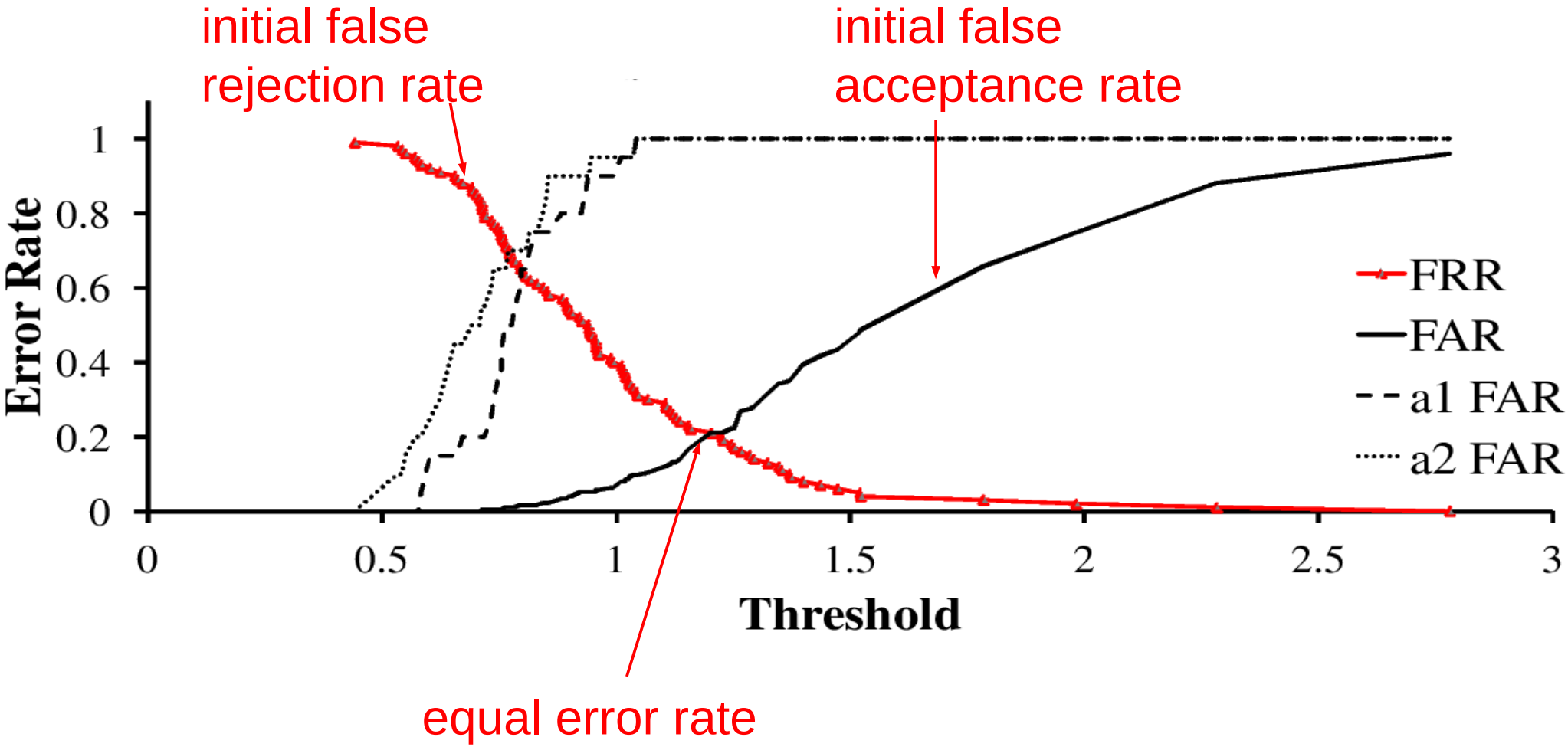

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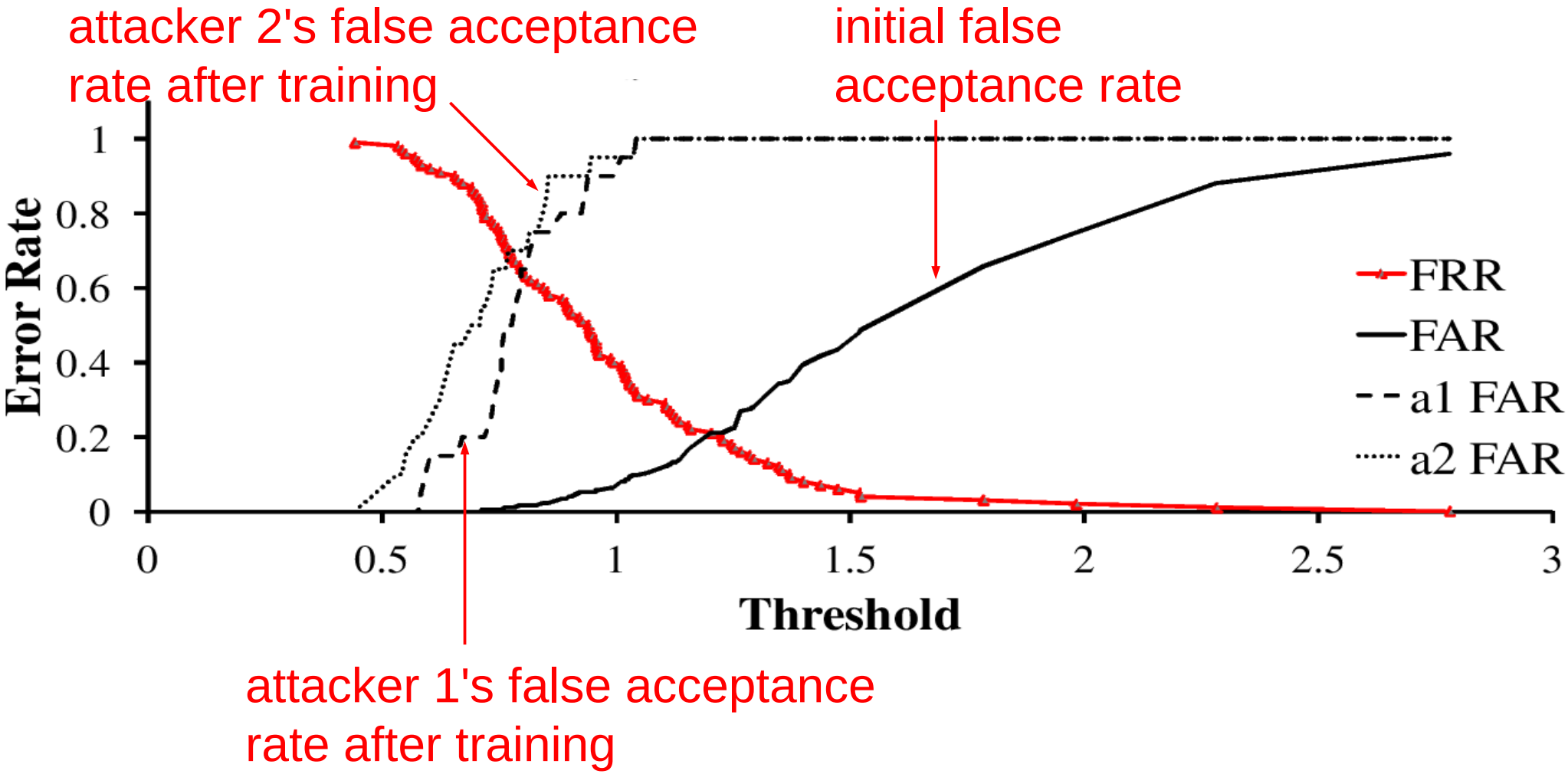
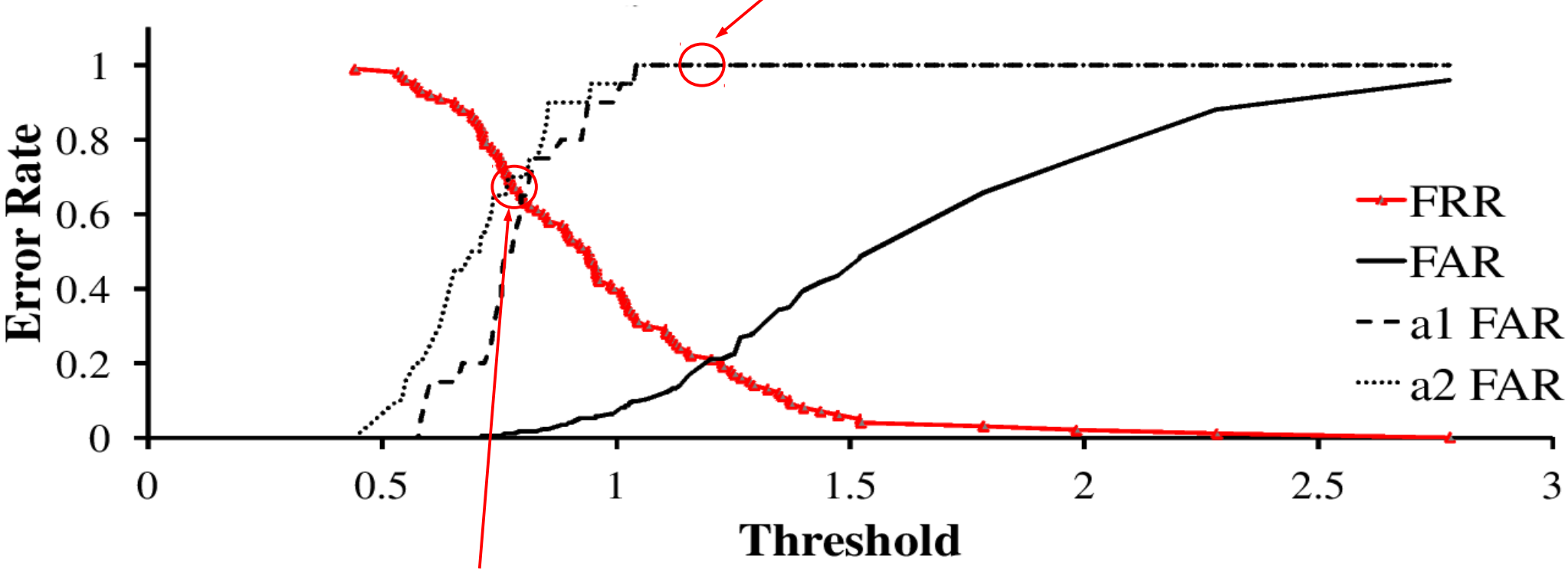


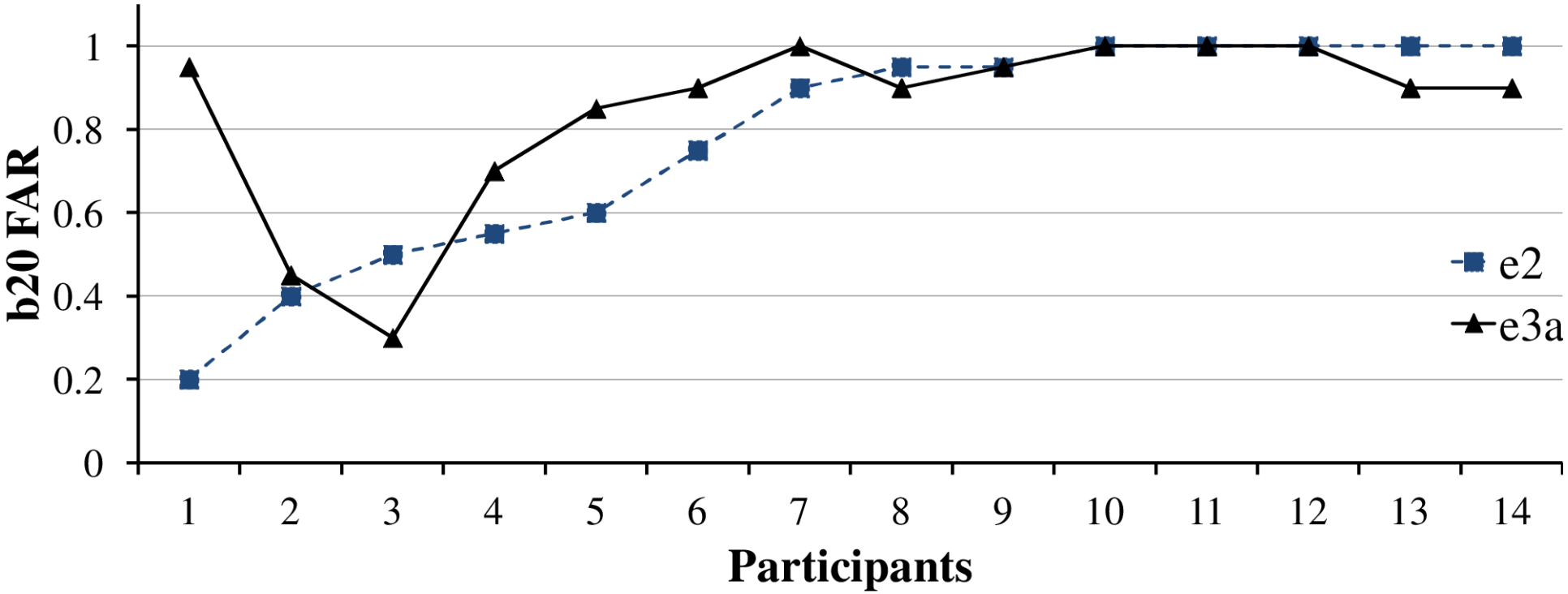
Training results

100% false acceptance if threshold remains unchanged

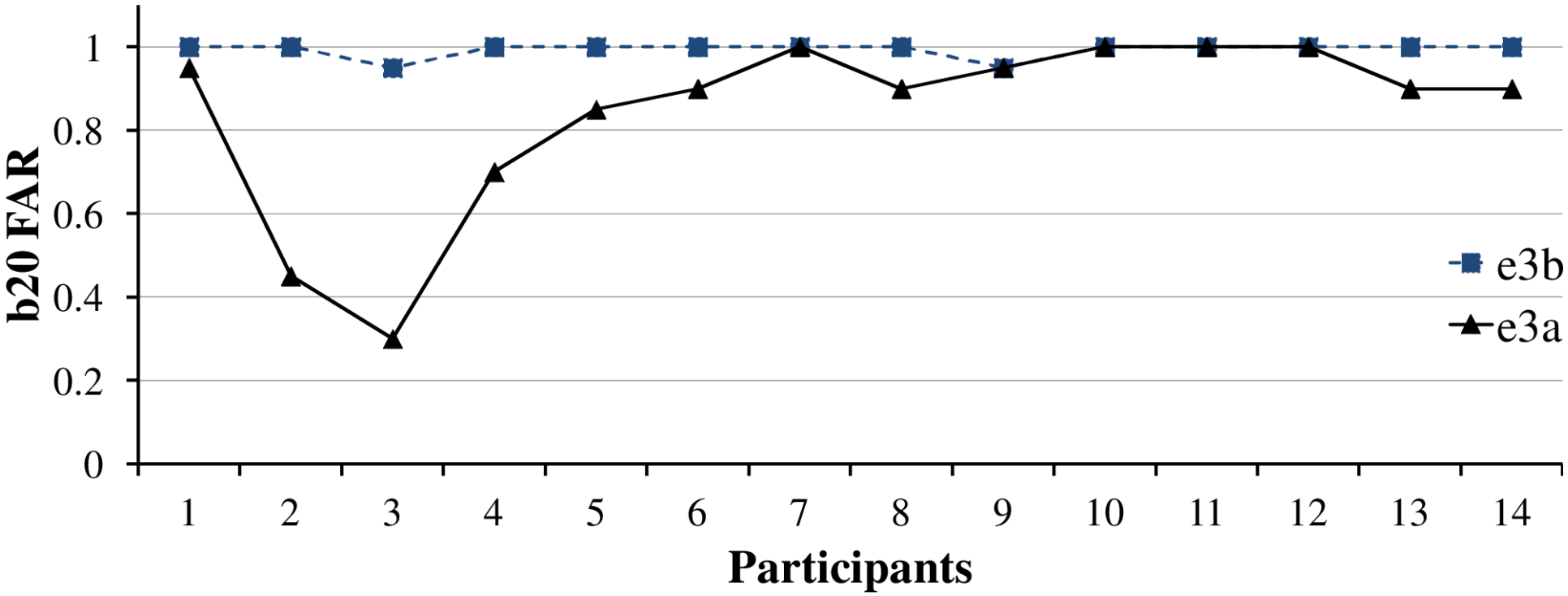


revised equal error rate if threshold updated

Effect of additional session

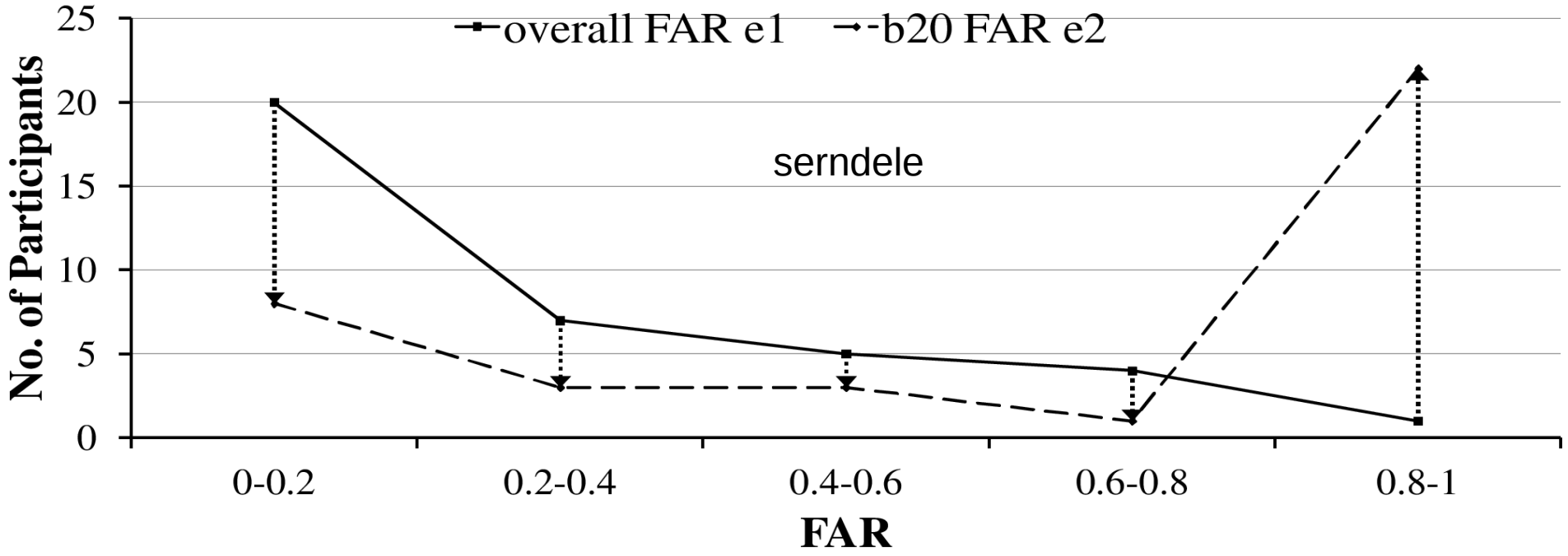


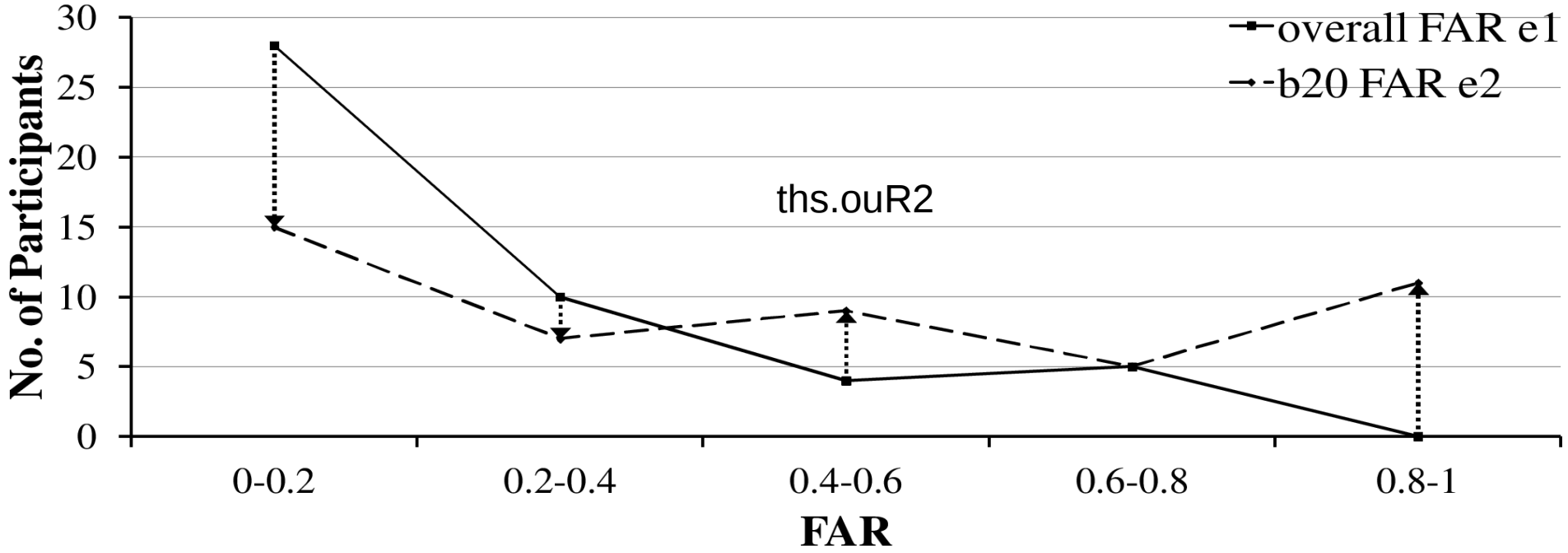
Effect of full information + performance bonus

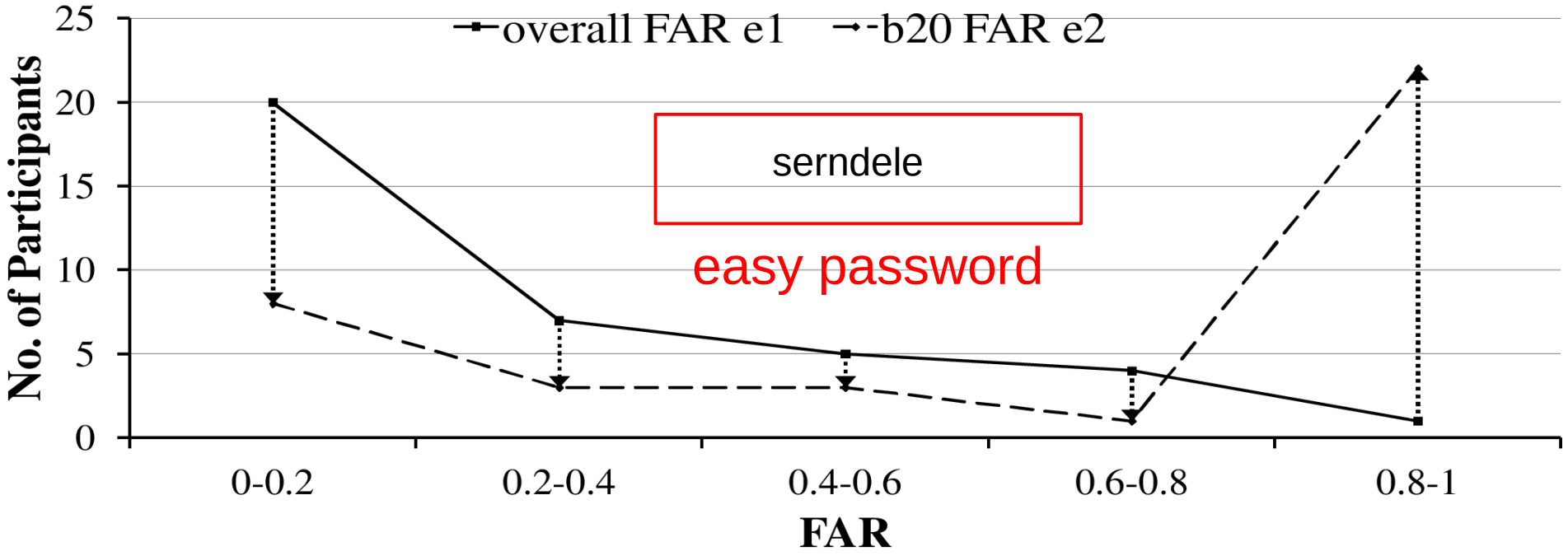


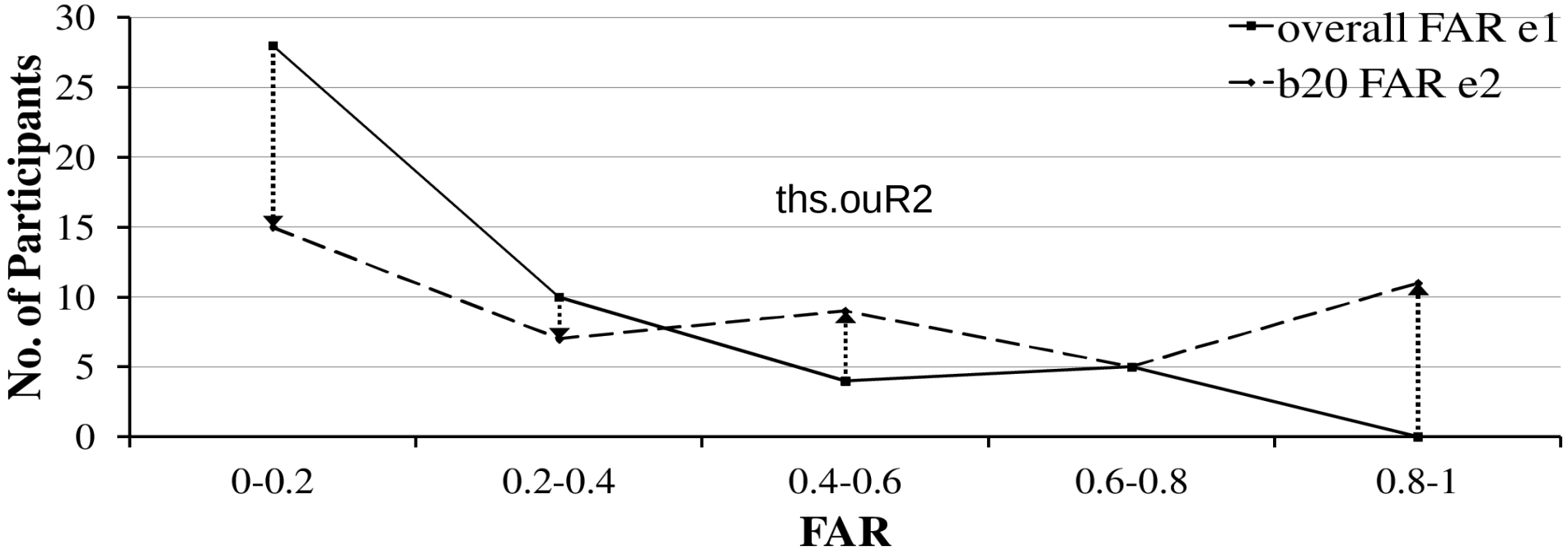
Factors affecting imitation outcome

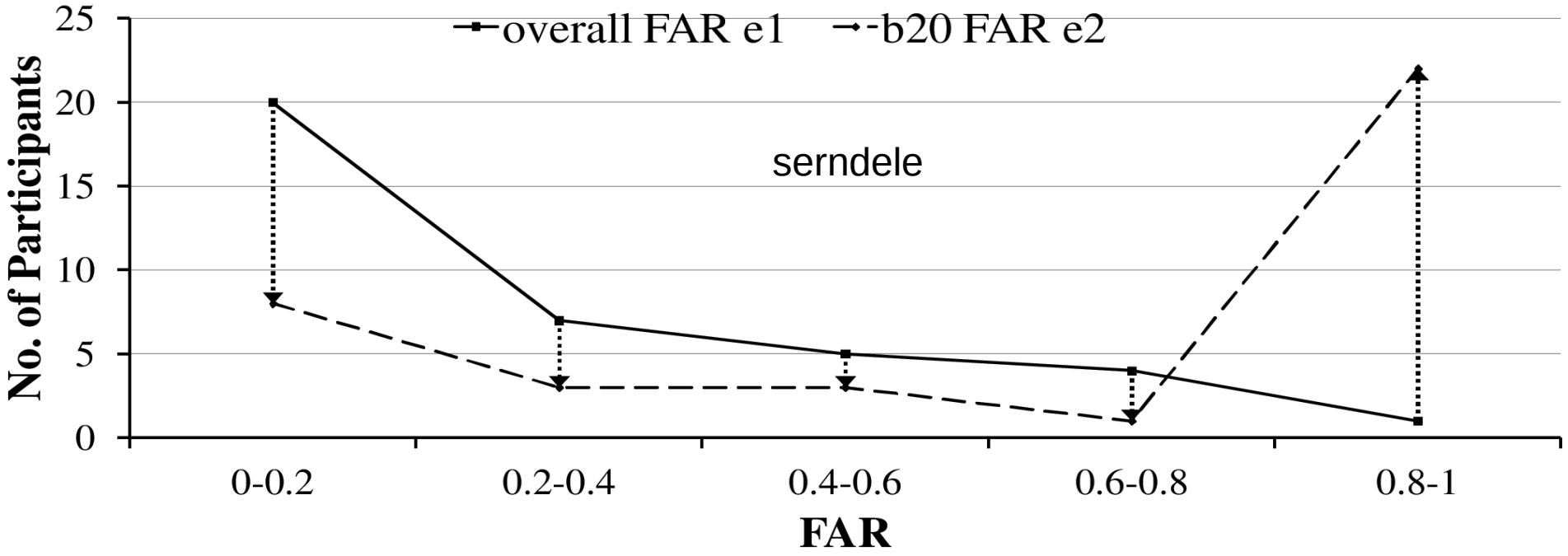
- Password
  - easy to type means easy to imitate
  - implication: keystroke biometrics not as effective in mitigating weak passwords
- Gender
  - male imitate better

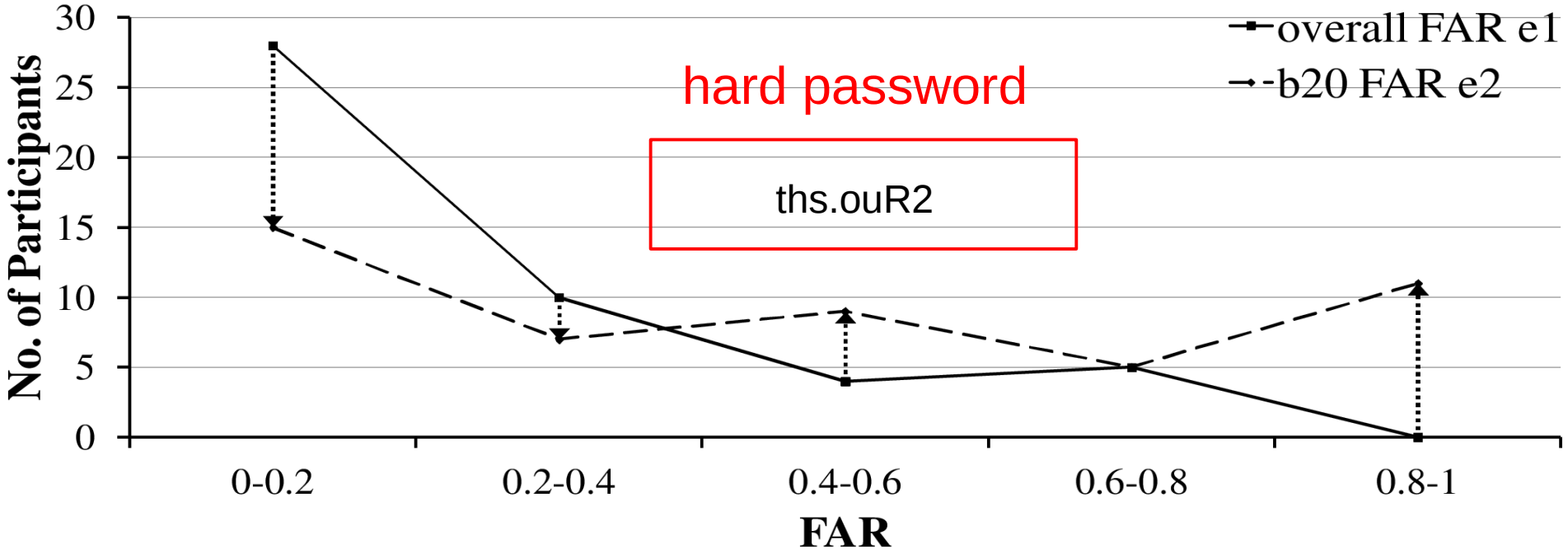

overall FAR e1
b20 FAR e2
serndele
No. of Participants
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR

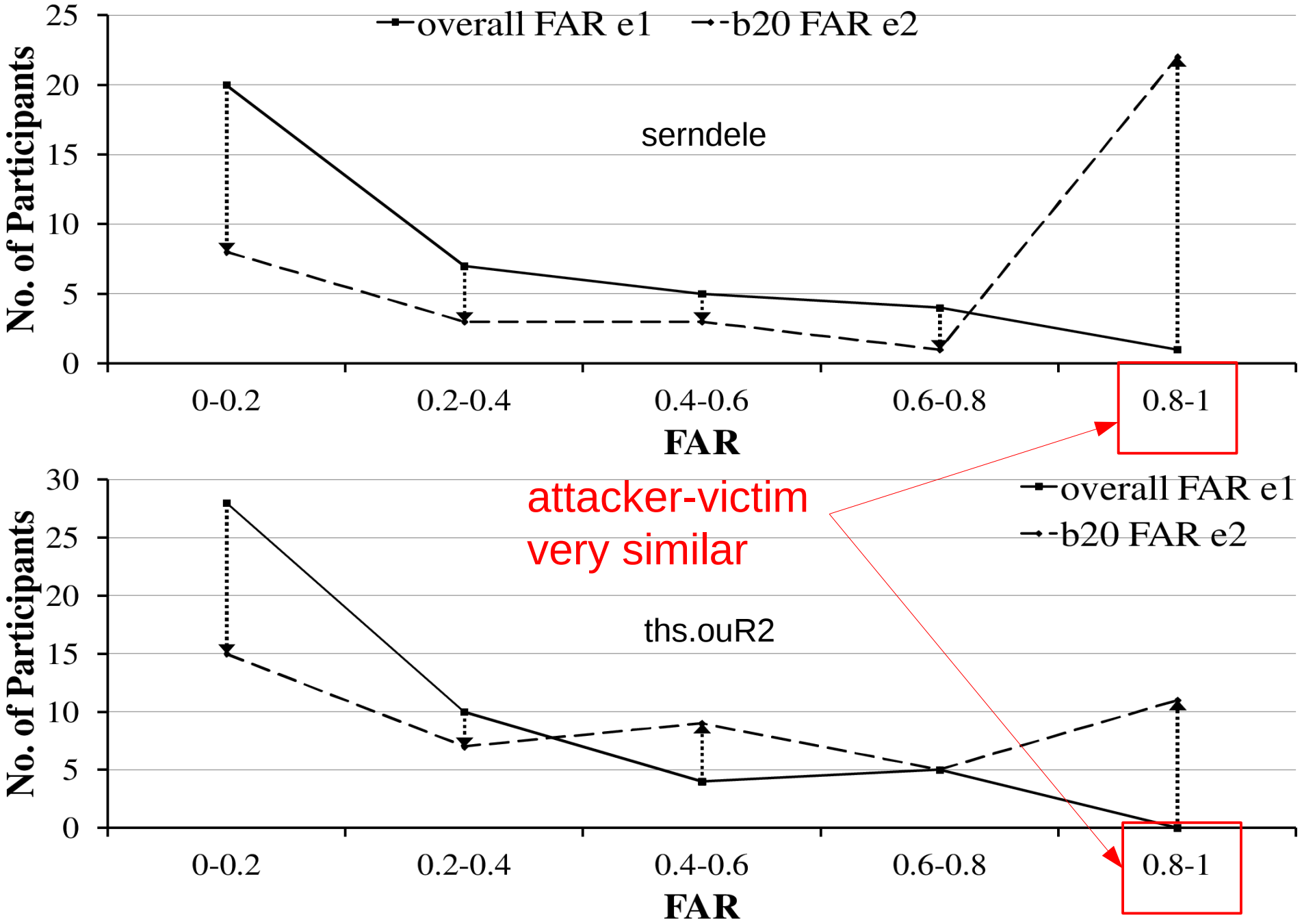

overall FAR e1
b20 FAR e2
ths.ouR2
No. of Participants
30
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR

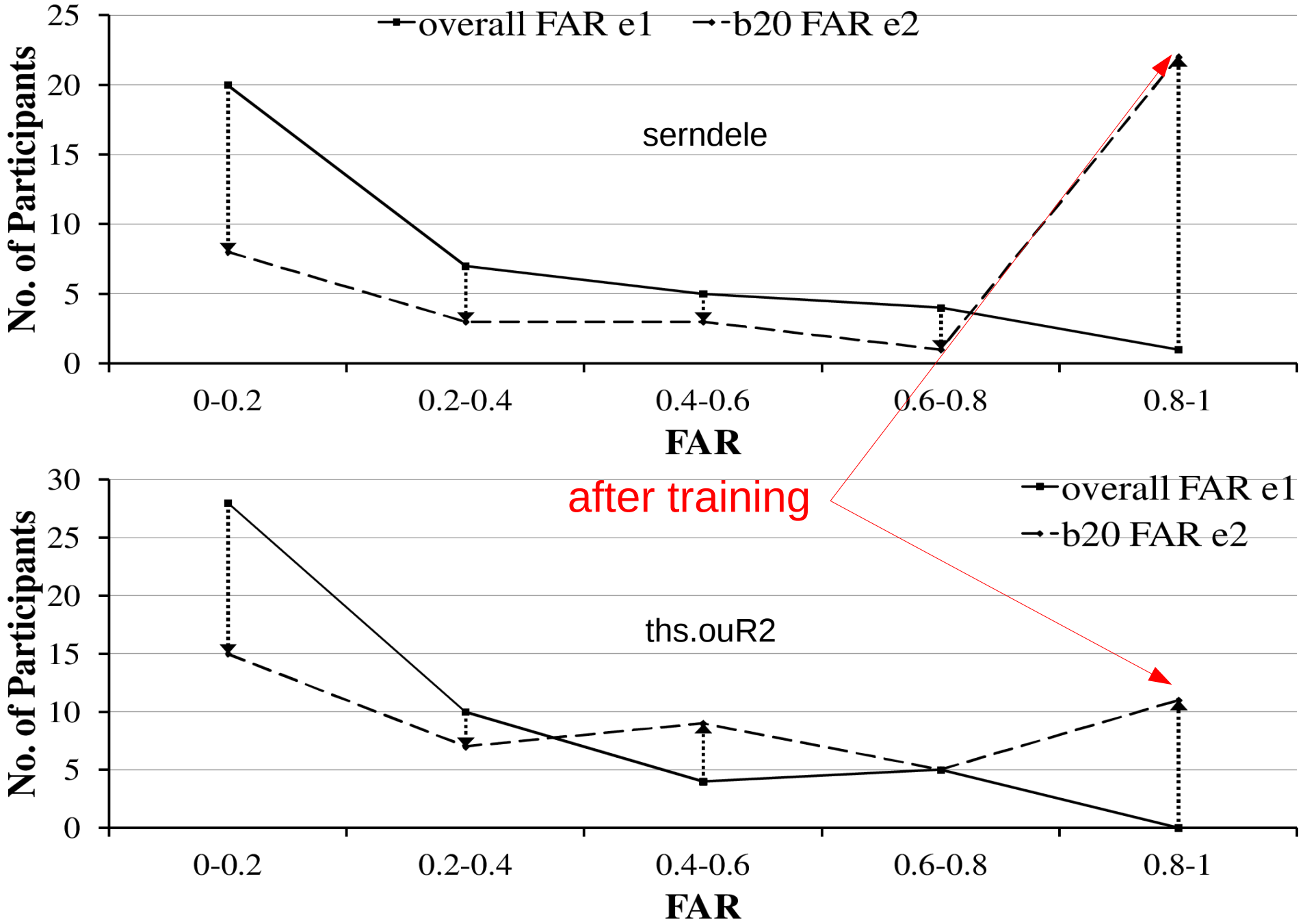

overall FAR e1
b20 FAR e2
No. of Participants
25
20
15
10
5
0
serndele
easy password
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR


overall FAR e1
b20 FAR e2
No. of Participants
30
25
20
15
10
5
0
ths.ouR2
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR

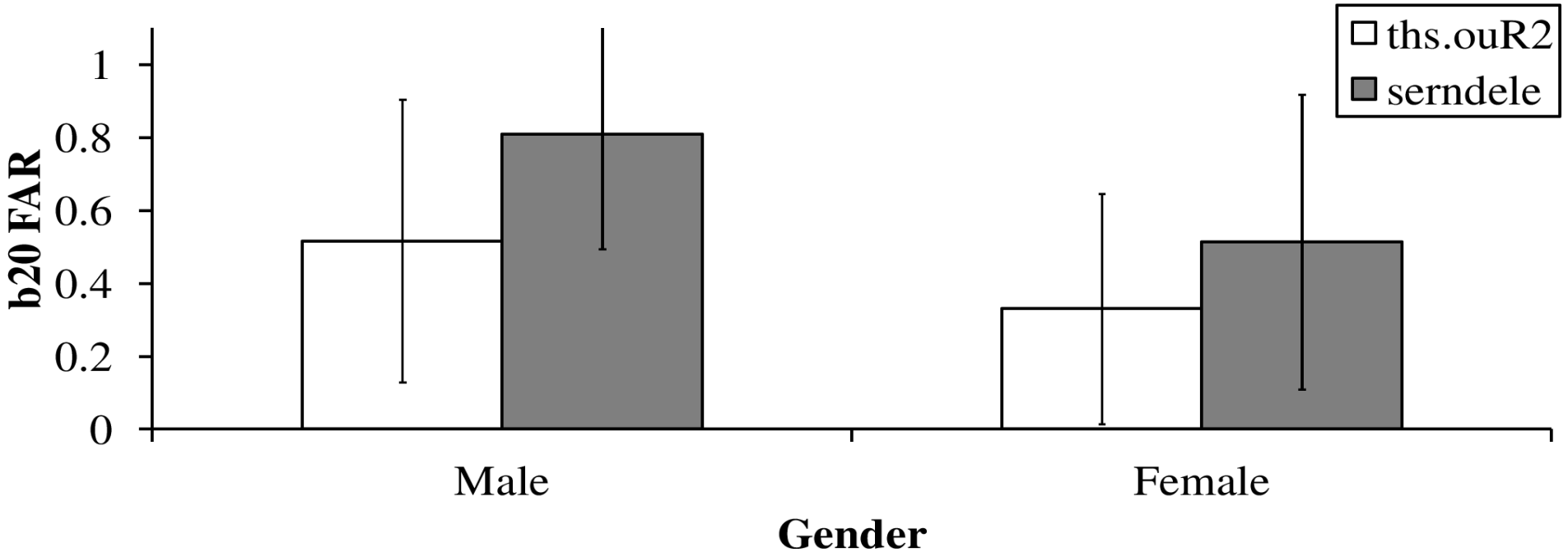

overall FAR e1
b20 FAR e2
serndele
No. of Participants
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR


overall FAR e1
b20 FAR e2
hard password
ths.ouR2
No. of Participants
30
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR

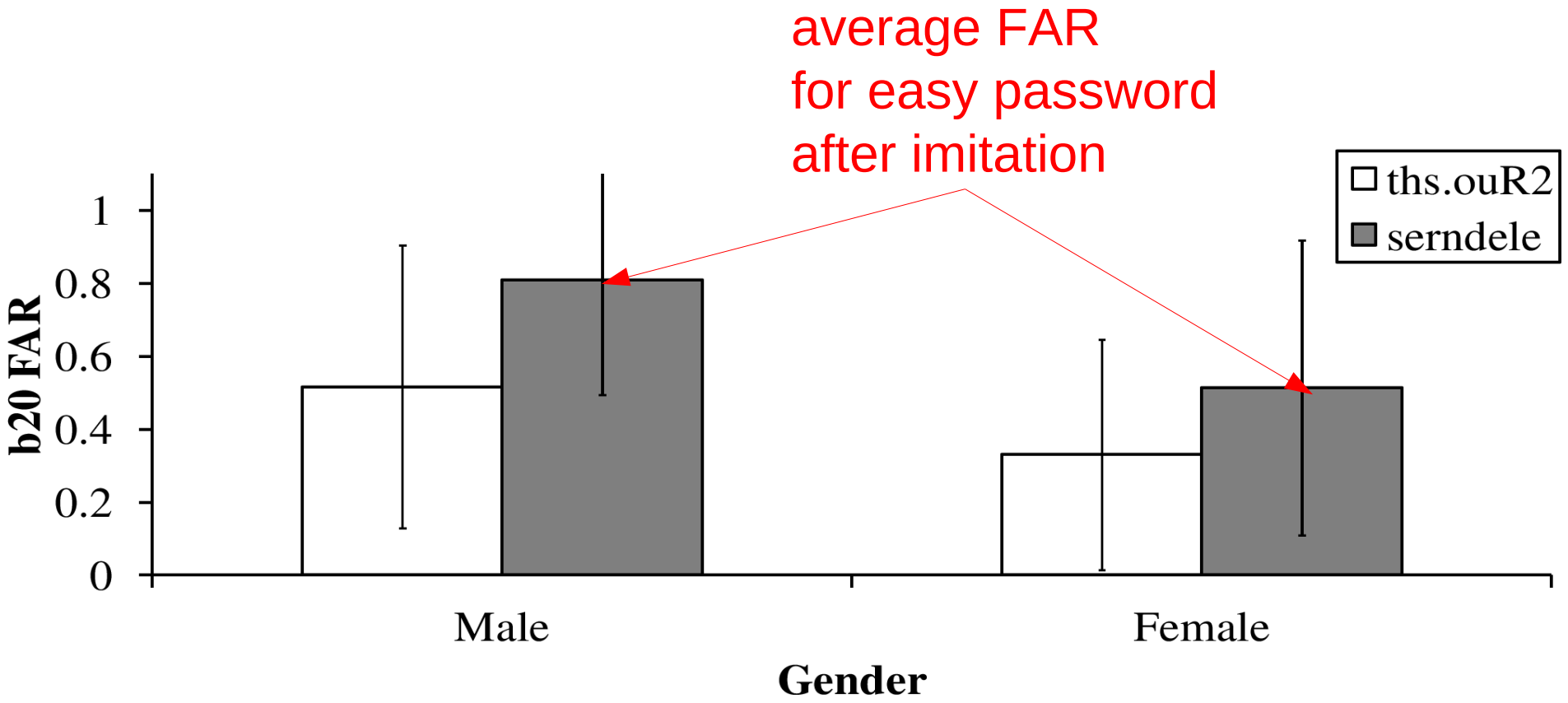

overall FAR e1
b20 FAR e2
serndele
No. of Participants
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR
attacker-victim
very similar
overall FAR e1
b20 FAR e2
ths.ouR2
No. of Participants
30
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR


overall FAR e1
b20 FAR e2
serndele
No. of Participants
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR
after training
overall FAR e1
b20 FAR e2
ths.ouR2
No. of Participants
30
25
20
15
10
5
0
0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1
FAR

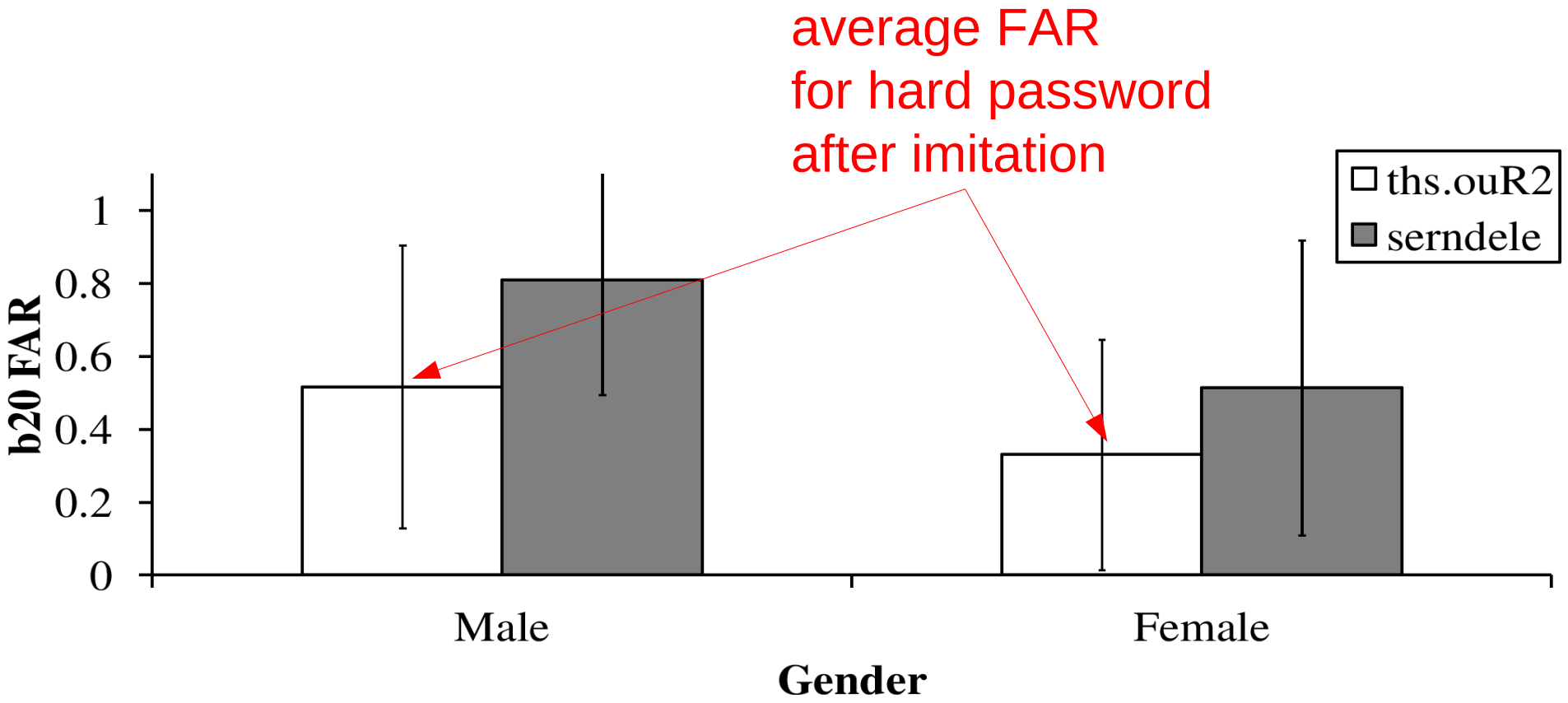
Male vs Female (e2)



Male vs Female (e2)



Male vs Female (e2)



Less important/unimportant factors

- External keyboard
- Natural typing consistency
  - imitation improves consistency
- Typing speed
- Number of tries
- Initial typing similarity

Limitations

- next keydown time - current keyup time
  - excluded from experiment
  - difficult to understand?
- Open question: imitation of freely typed text

Conclusion

- Imitation of password typing pattern possible
- Easy to type => easy to imitate
- Male attackers perform better

Thank you