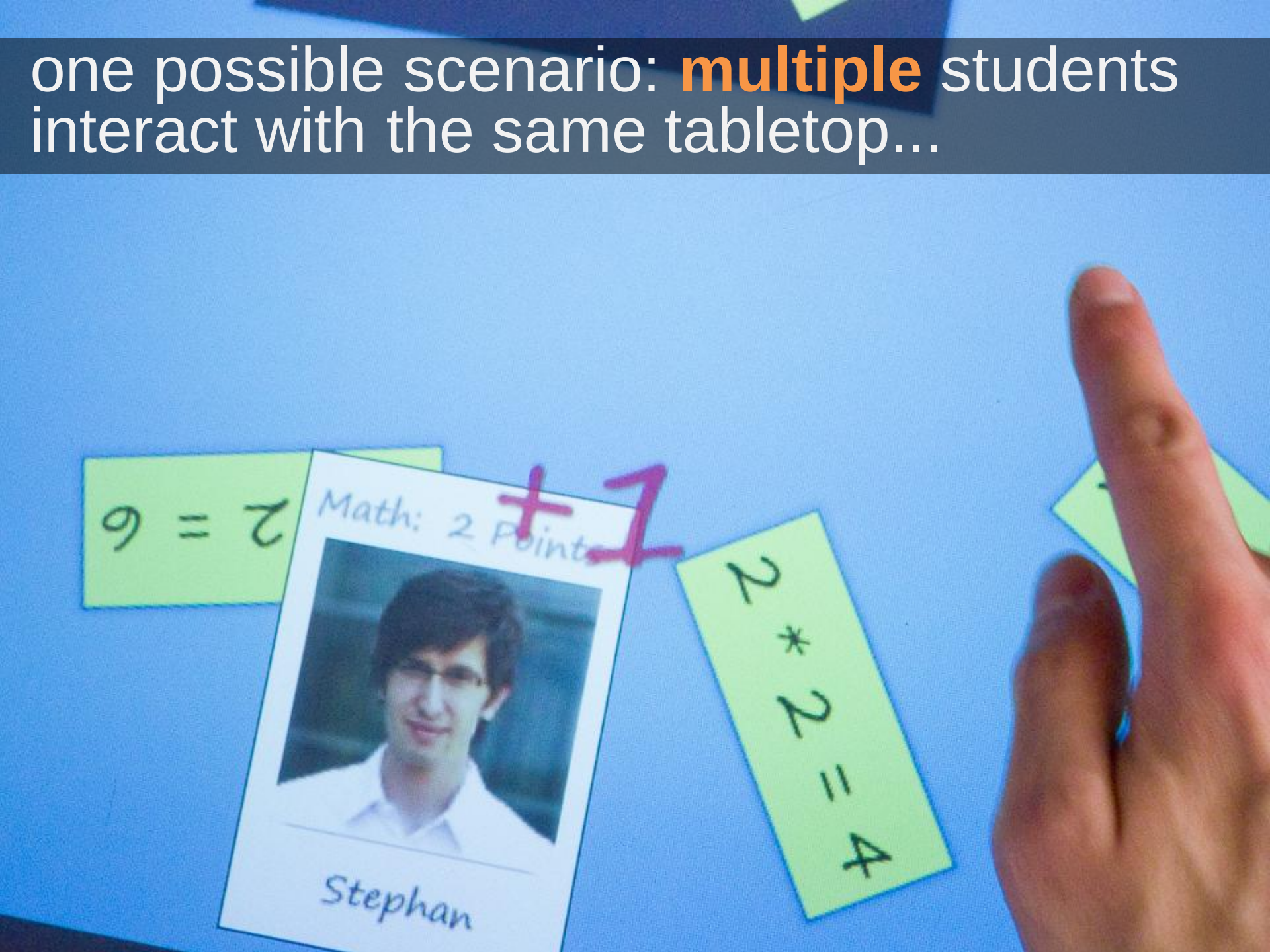
# Bootstrapper

## recognizing tabletop users by their shoes

**Stephan R. Richter | Christian Holz | Patrick Baudisch**

# one possible scenario: **multiple** students interact with the same tabletop...




allow teacher to monitor progress
per-student to support them best


approach: identify user **by their shoes**

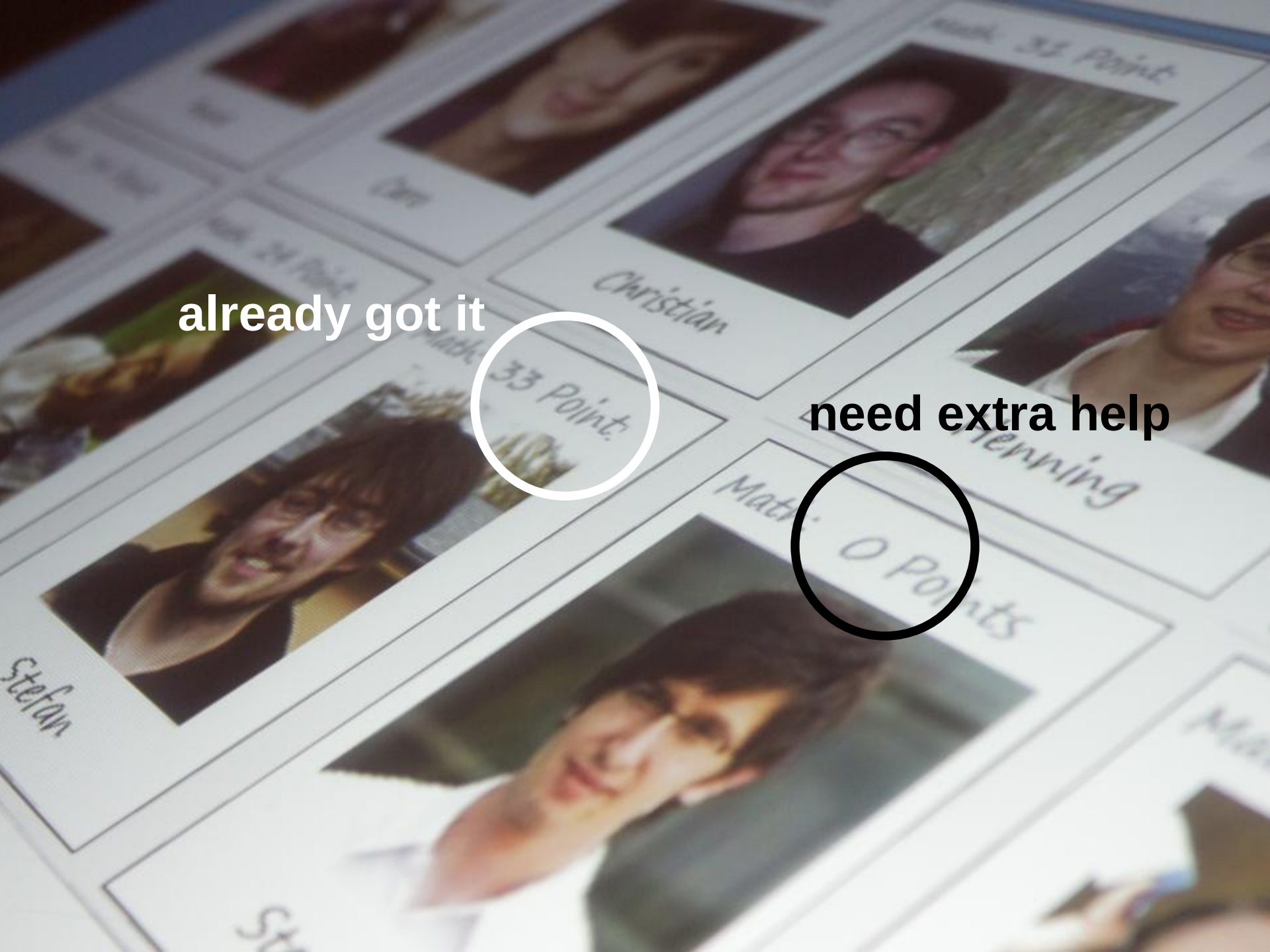
# walkthrough


Bootstrapper recognizes me by my shoes

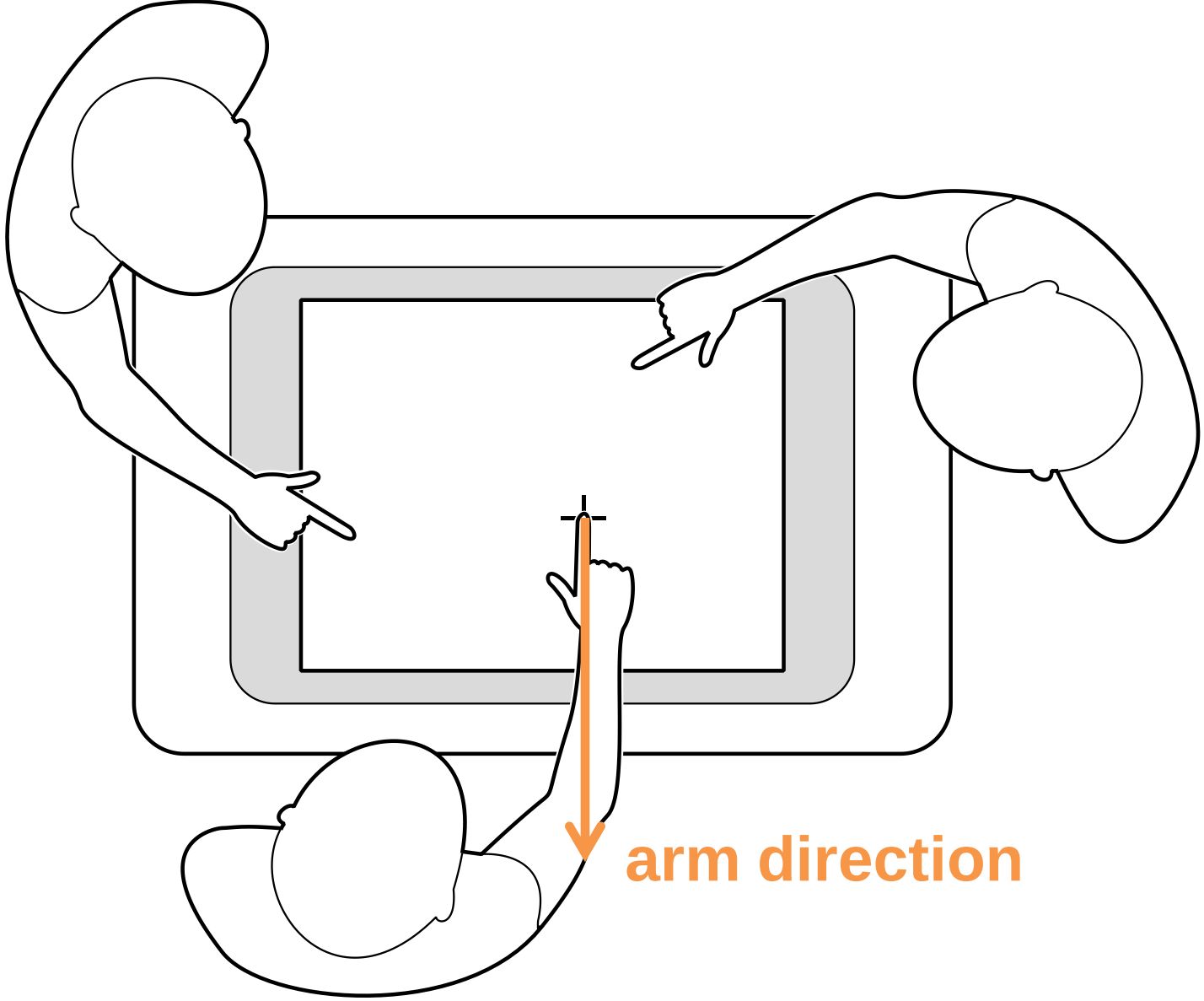

…displays my badge…
Math: 0 Points

# …and now adds my achievements to it


later, my teacher checks our progress…


already got it
need extra help
33 Point
Christian
Stefan

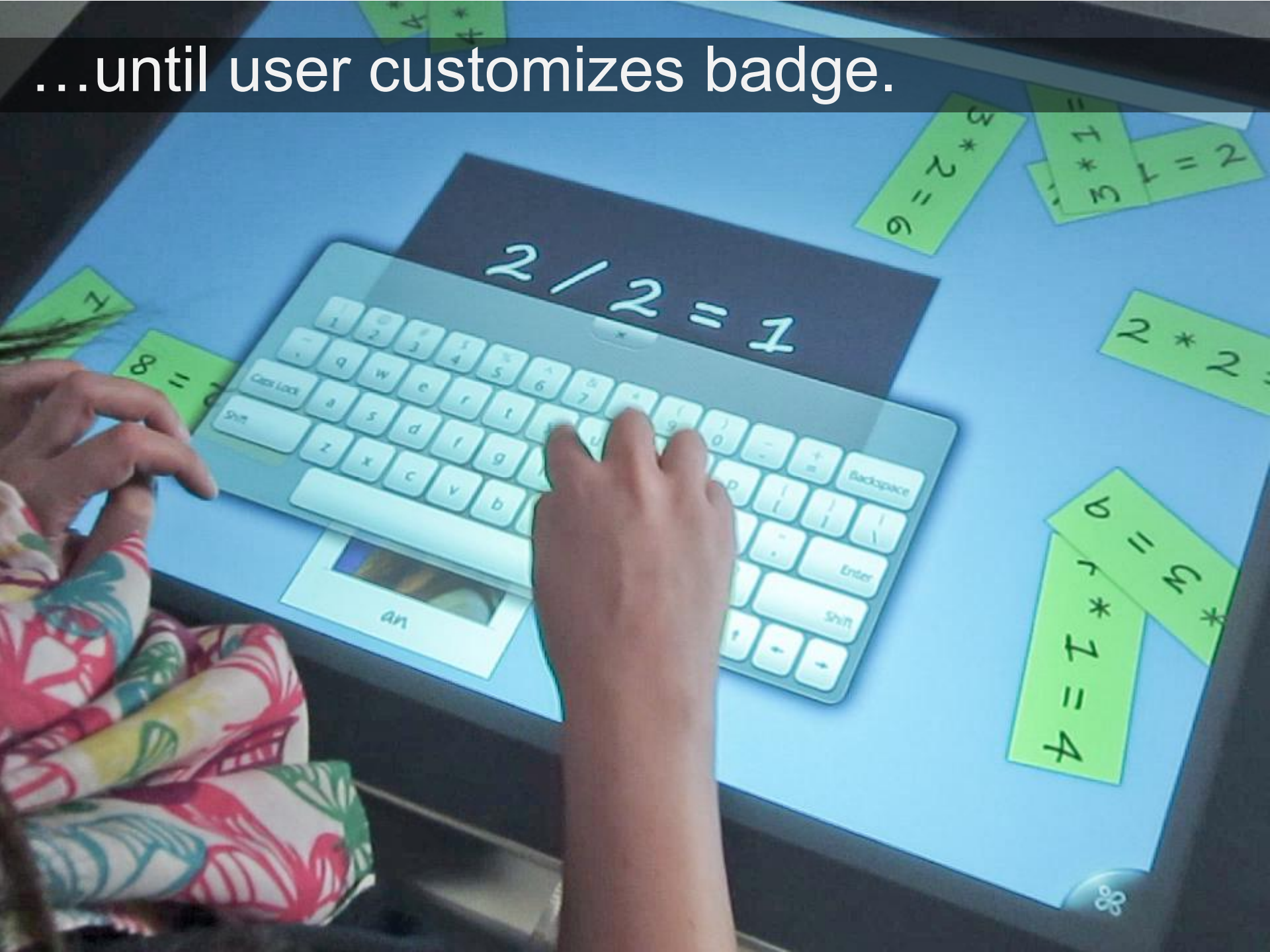

for multiple simultaneous users…




we **trace** arm reflection to the user

new user…

# shows up as placeholder badge…


…until user customizes badge.
2 / 2 = 1


same with new shoes…

# …placeholder badge…

# …until user selects himself from db.

# vs. related work

# RFID badge...


Olwal & Wilson 2008


…ID wristband…

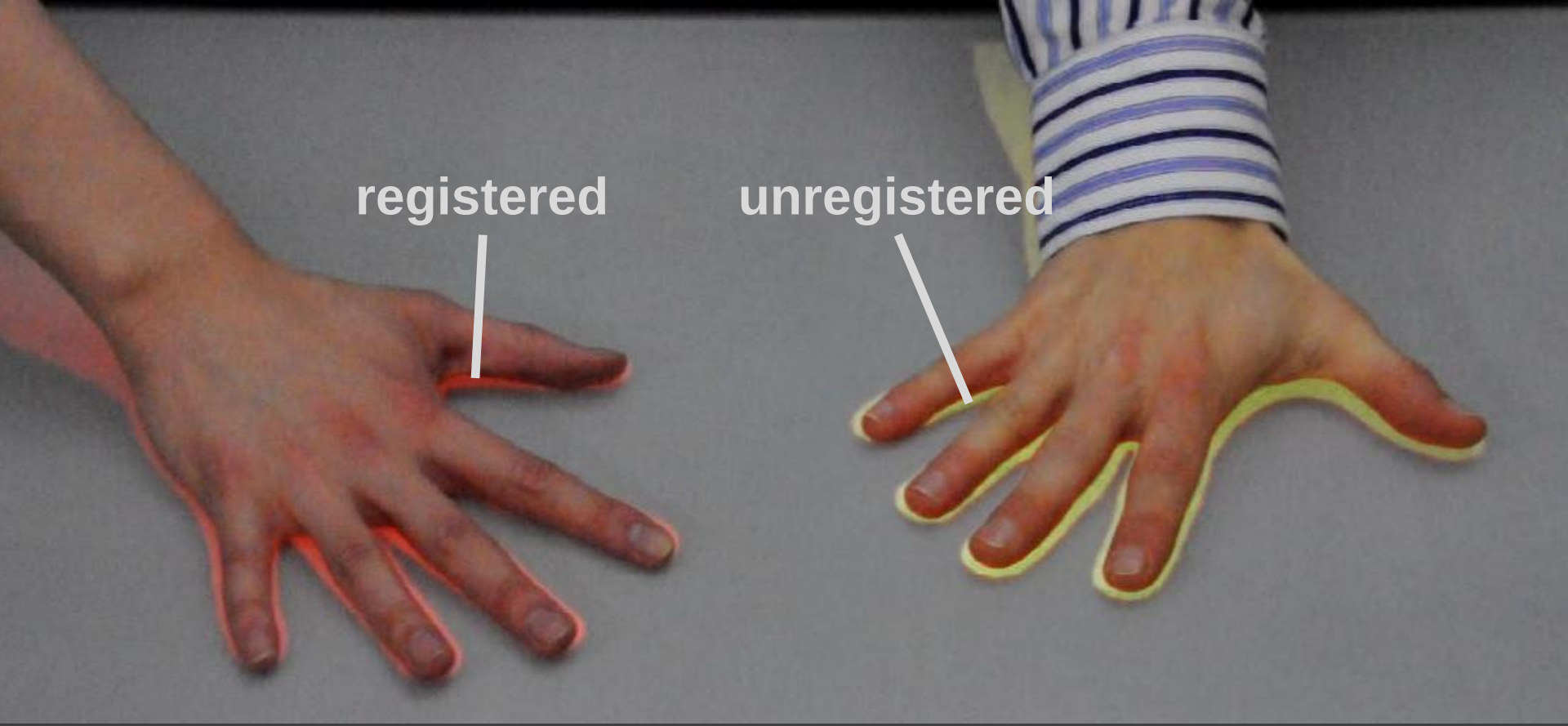
Meyer Schmidt 2010

…or IR Ring.

Roth et al. 2010


based on the chair they sit in…
DiamondTouch Dietz & Leigh 2001


biometrics, such as fingerprints…
Sugiura & Koseki 1998




…or shape of hands.

HandsDown, Schmidt et al. 2010


bootstrapper is different:
1. requires no keycard or ring
2. allows users to move around freely
3. keeps hands free to interact


…might even work in a kindergarden.

# why bootstrapper works


1. shoes have more salient features than hands


2. feet align with the ground:
solve as a simpler 2D problem


Limitations: can be fooled
same shoes, same profile
photo by flicker.com/charlesfred

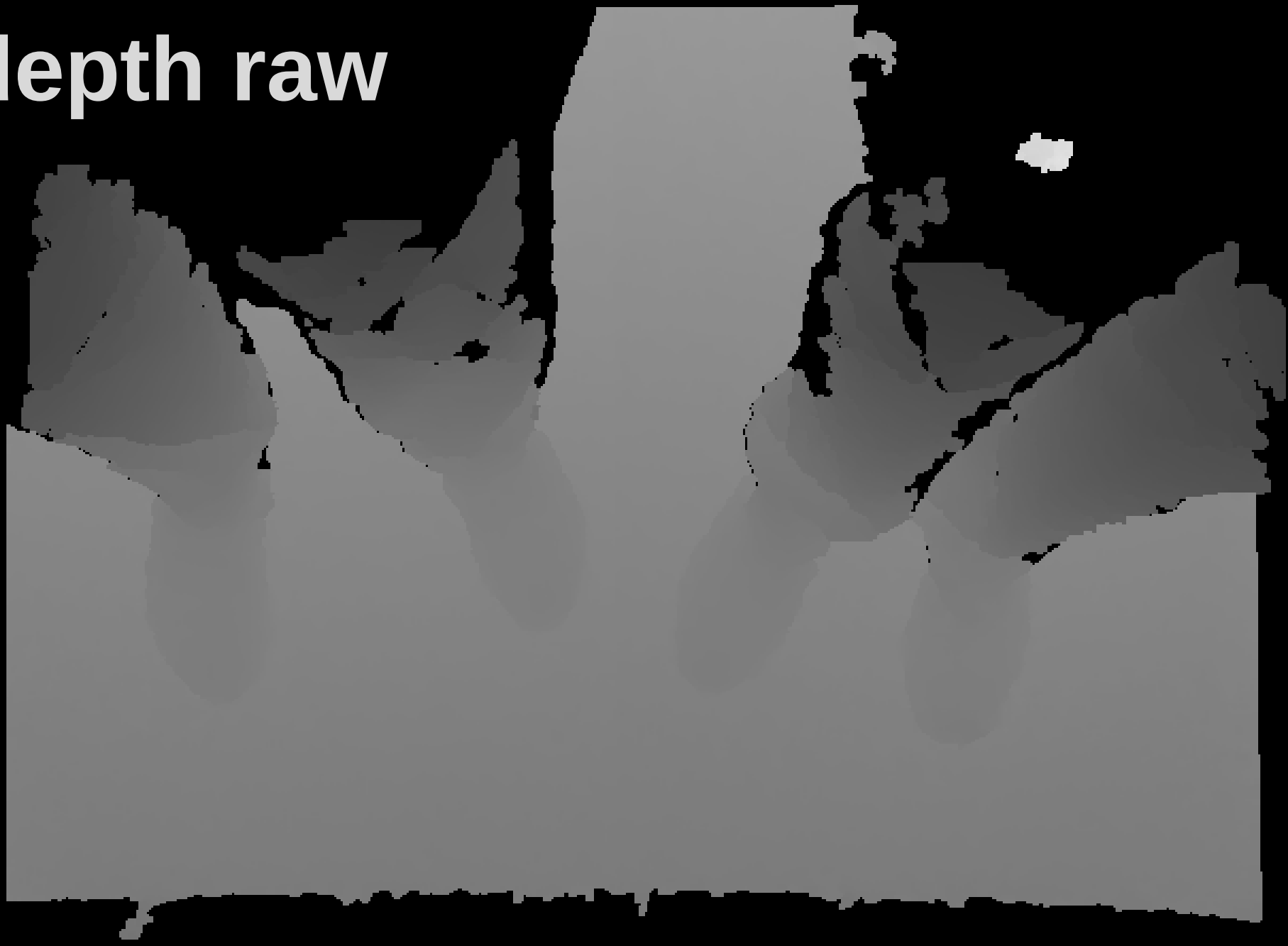

thus we would not use for authentication


…but for logging

# algorithms #1: identifying users

# rgb raw

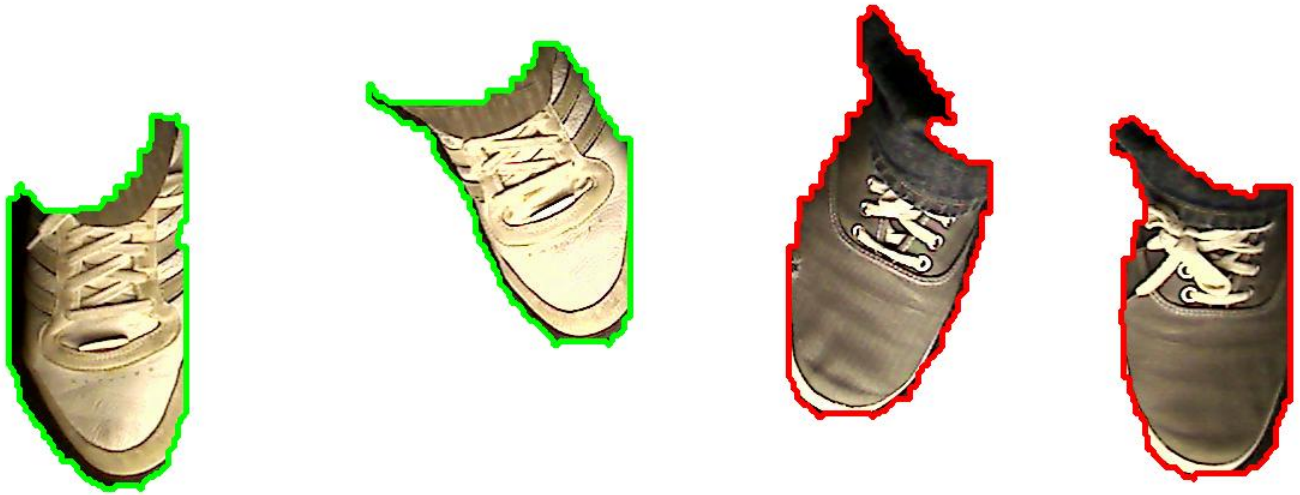
# depth raw



subtract background

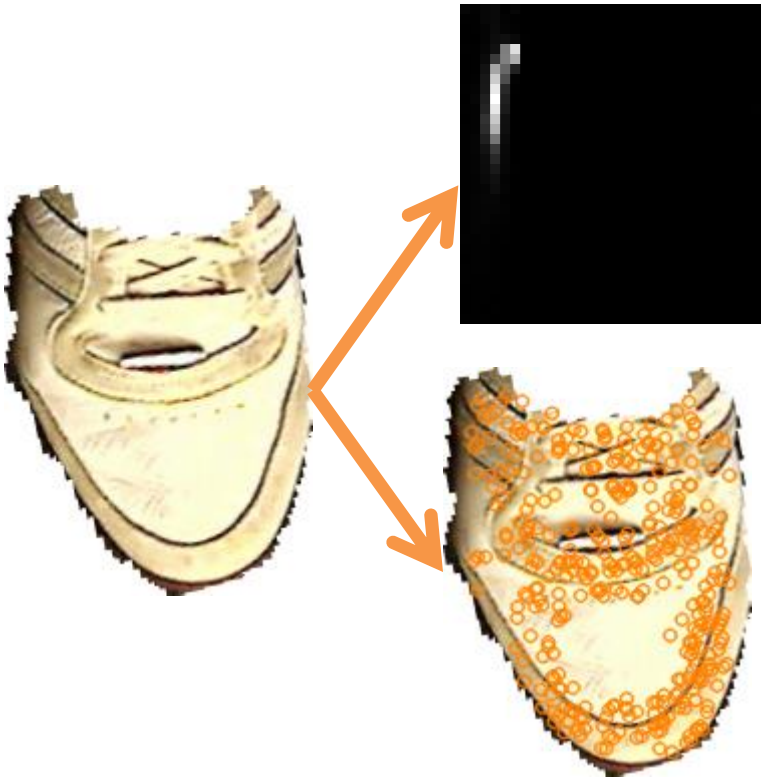
# mask

# extracted shoes



# feature extraction

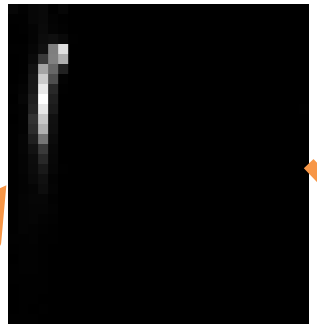
hsv histogram



surf features

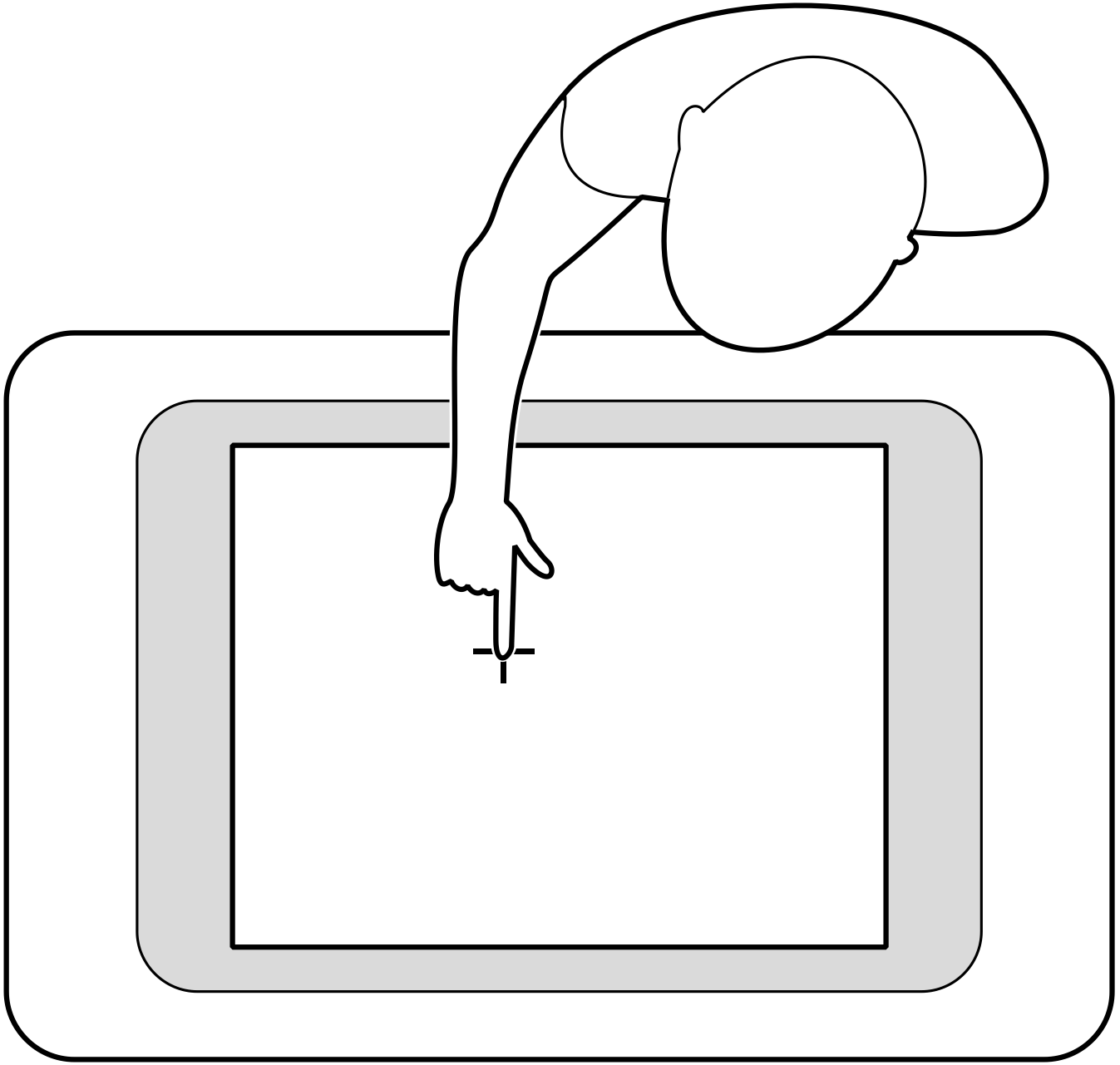
# matching

hsv histogram



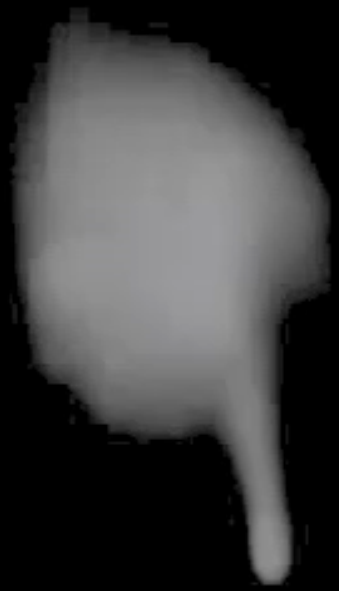
surf features

# algorithms #2:
# associating touches



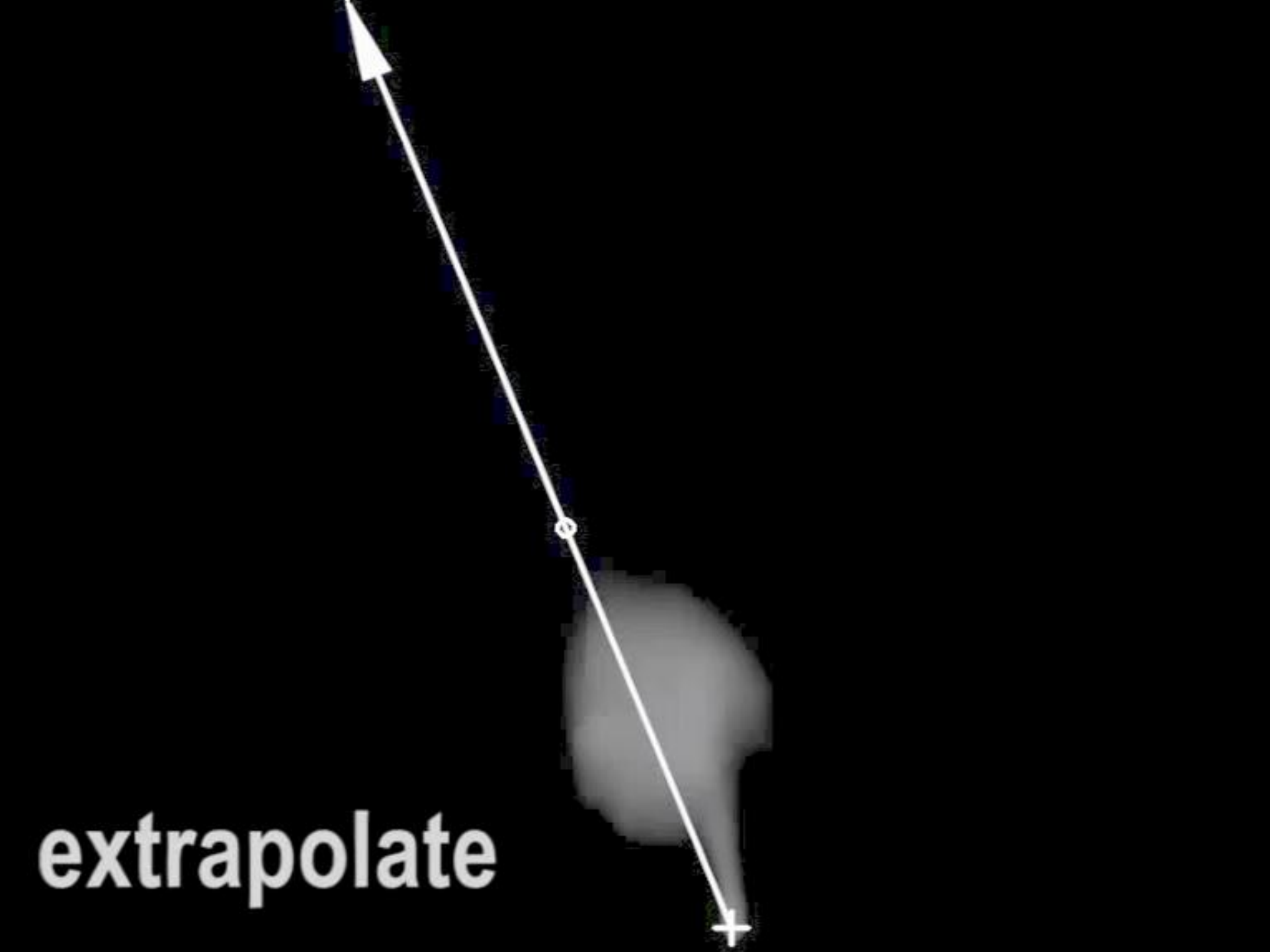

raw di

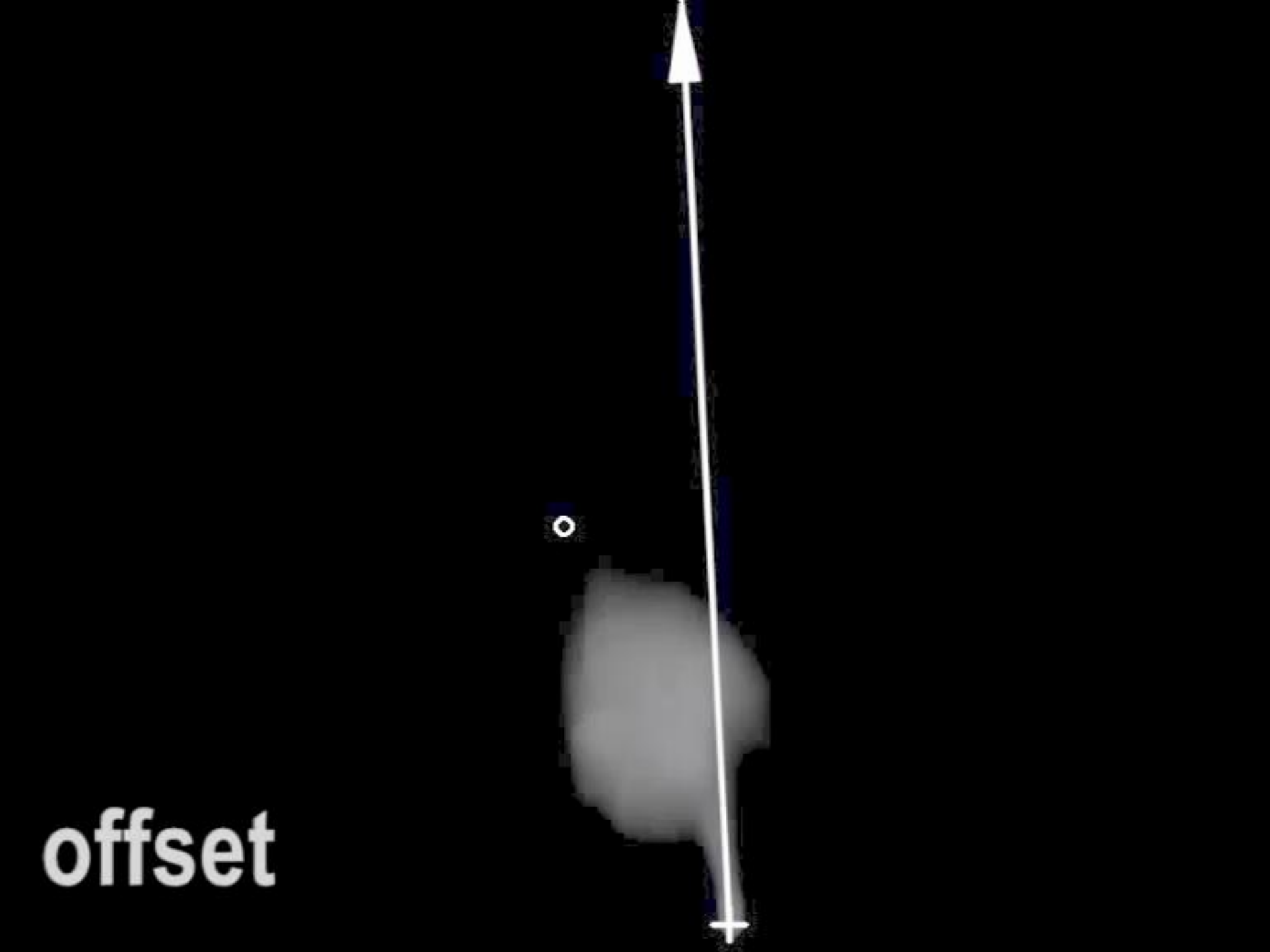
raw di



threshold

farthest
point

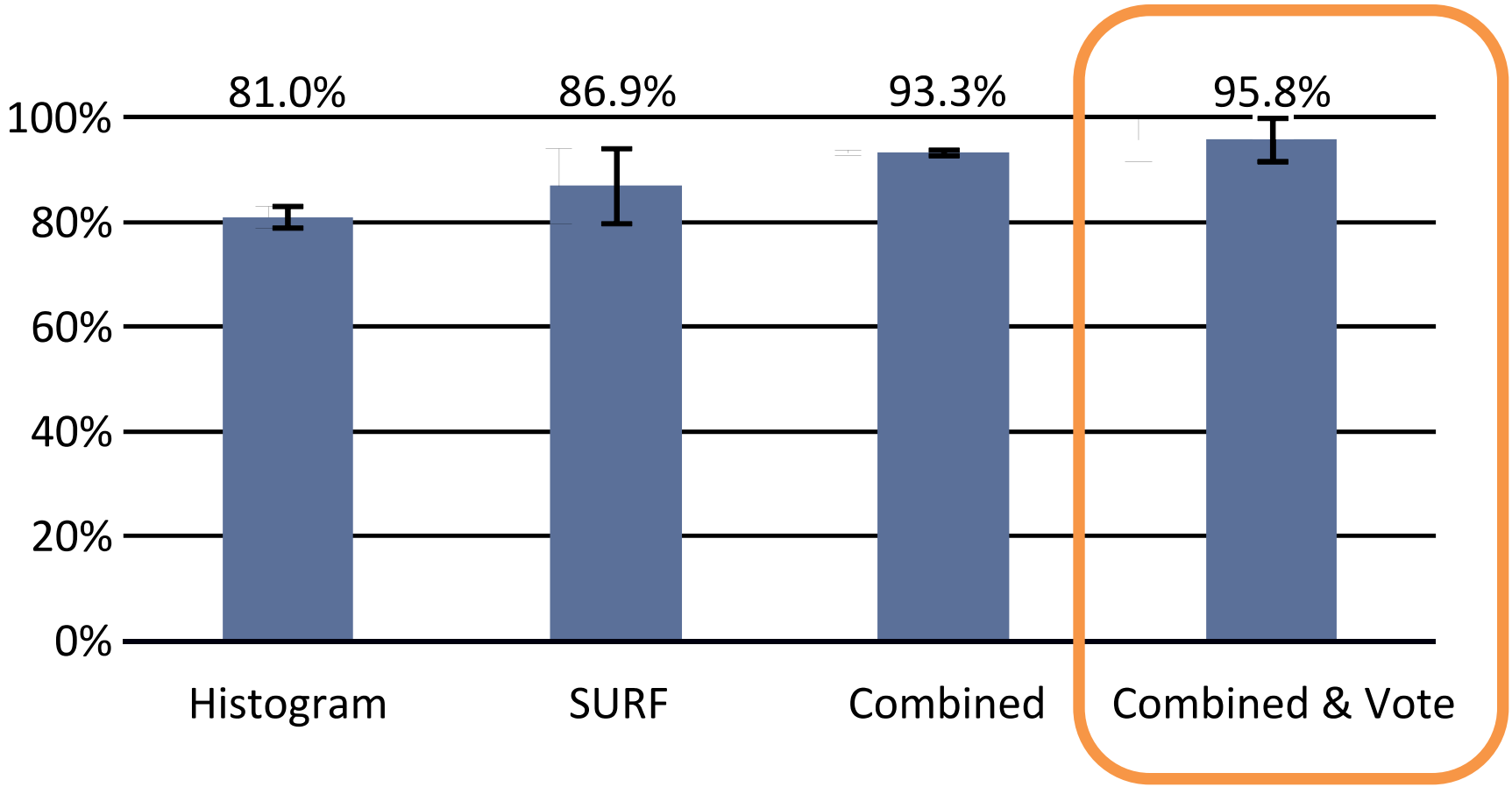

extrapolate


offset

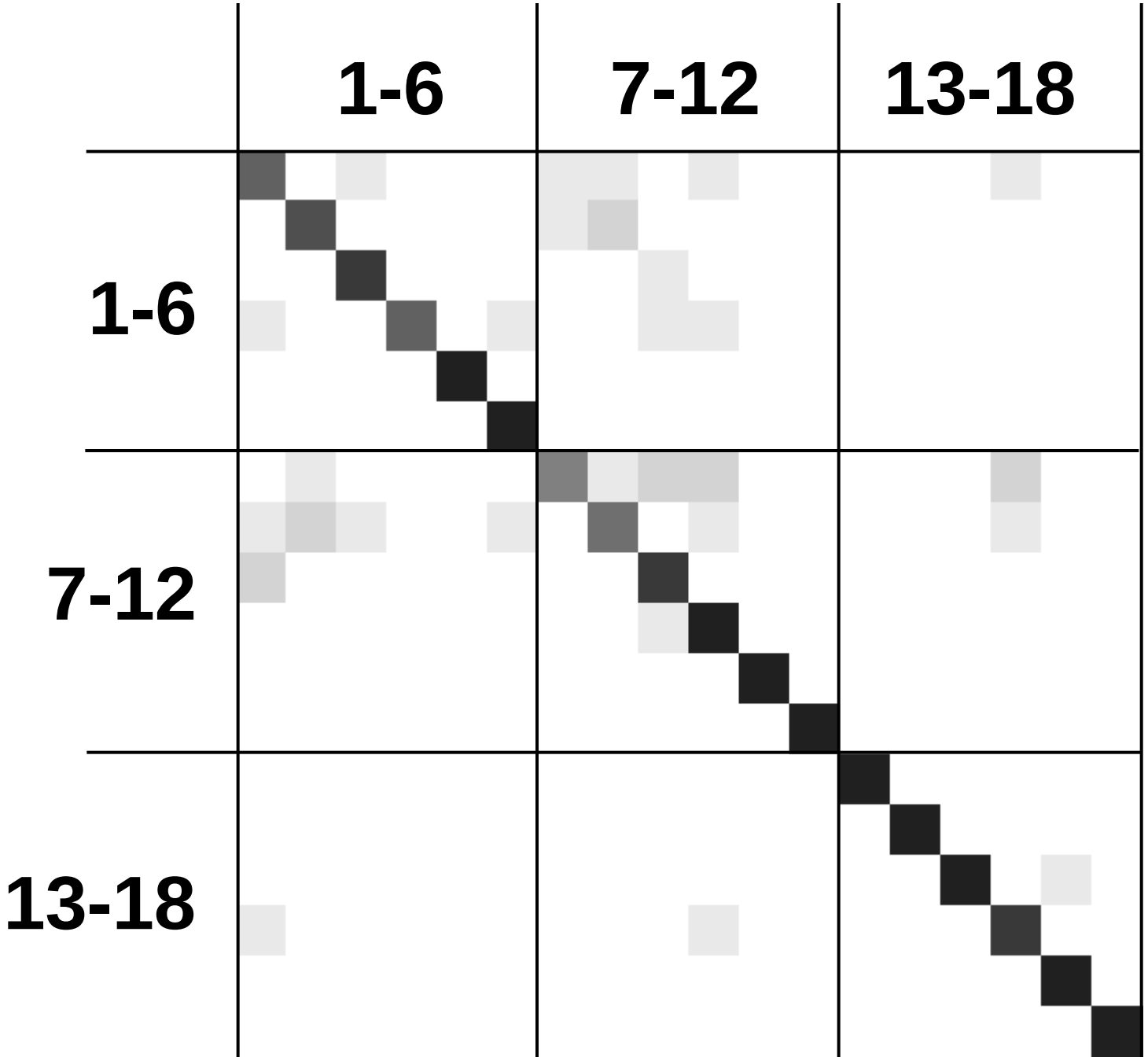
# evaluation #1
# recognizing shoes

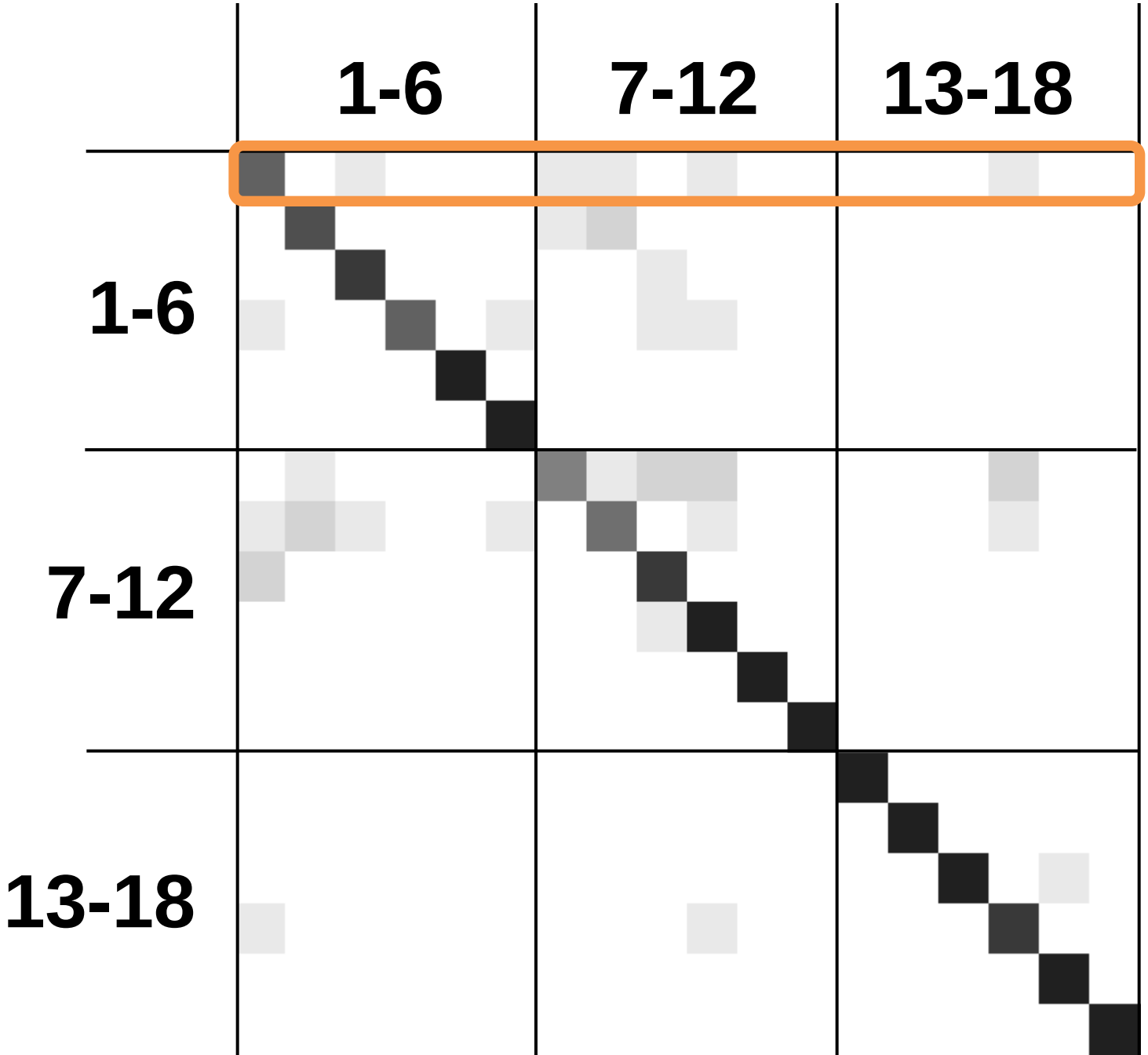

interact with table
task


camera
recording shoes




# recognition rates

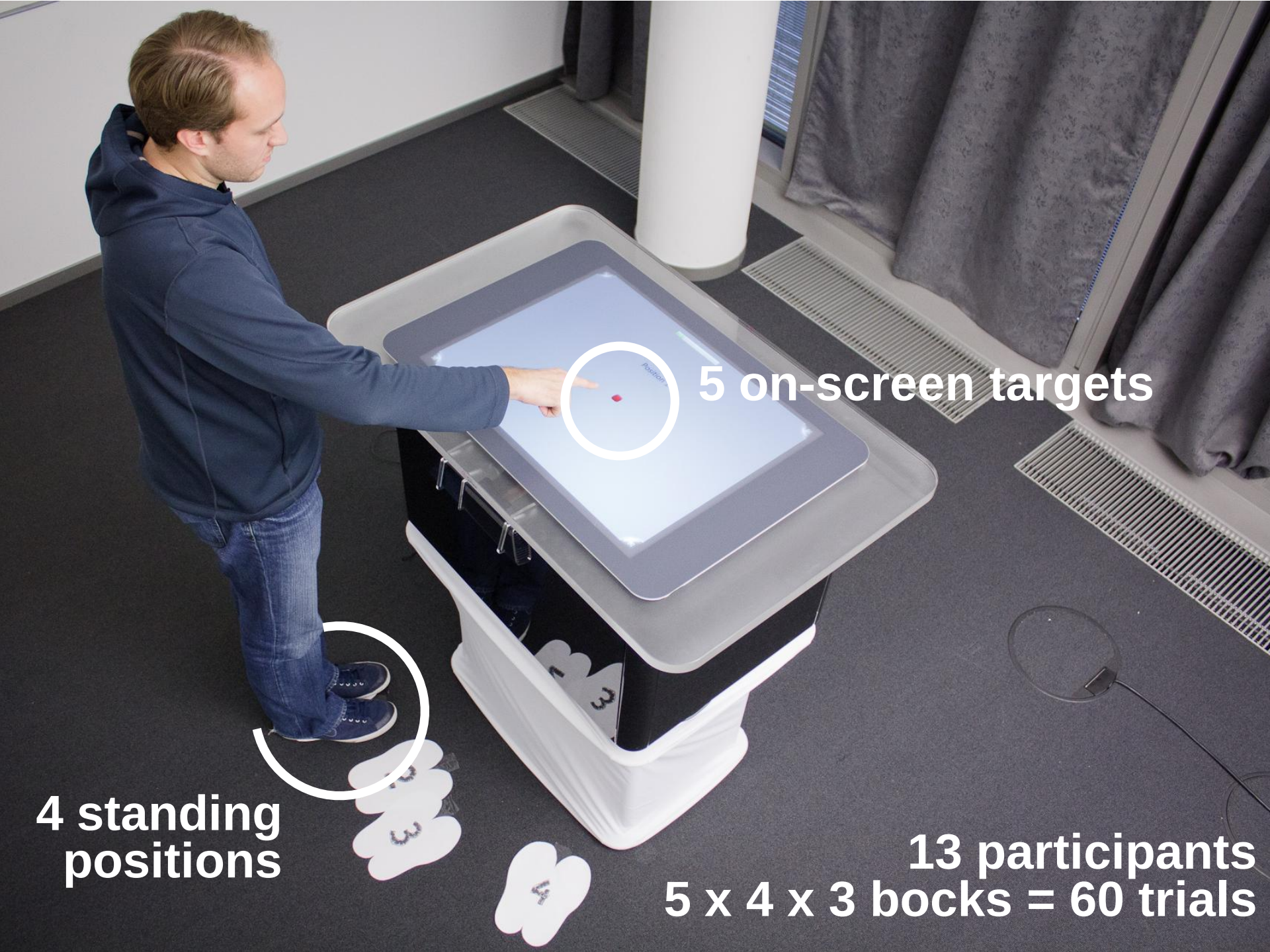

1-6
7-12
13-18
1-6
7-12
13-18

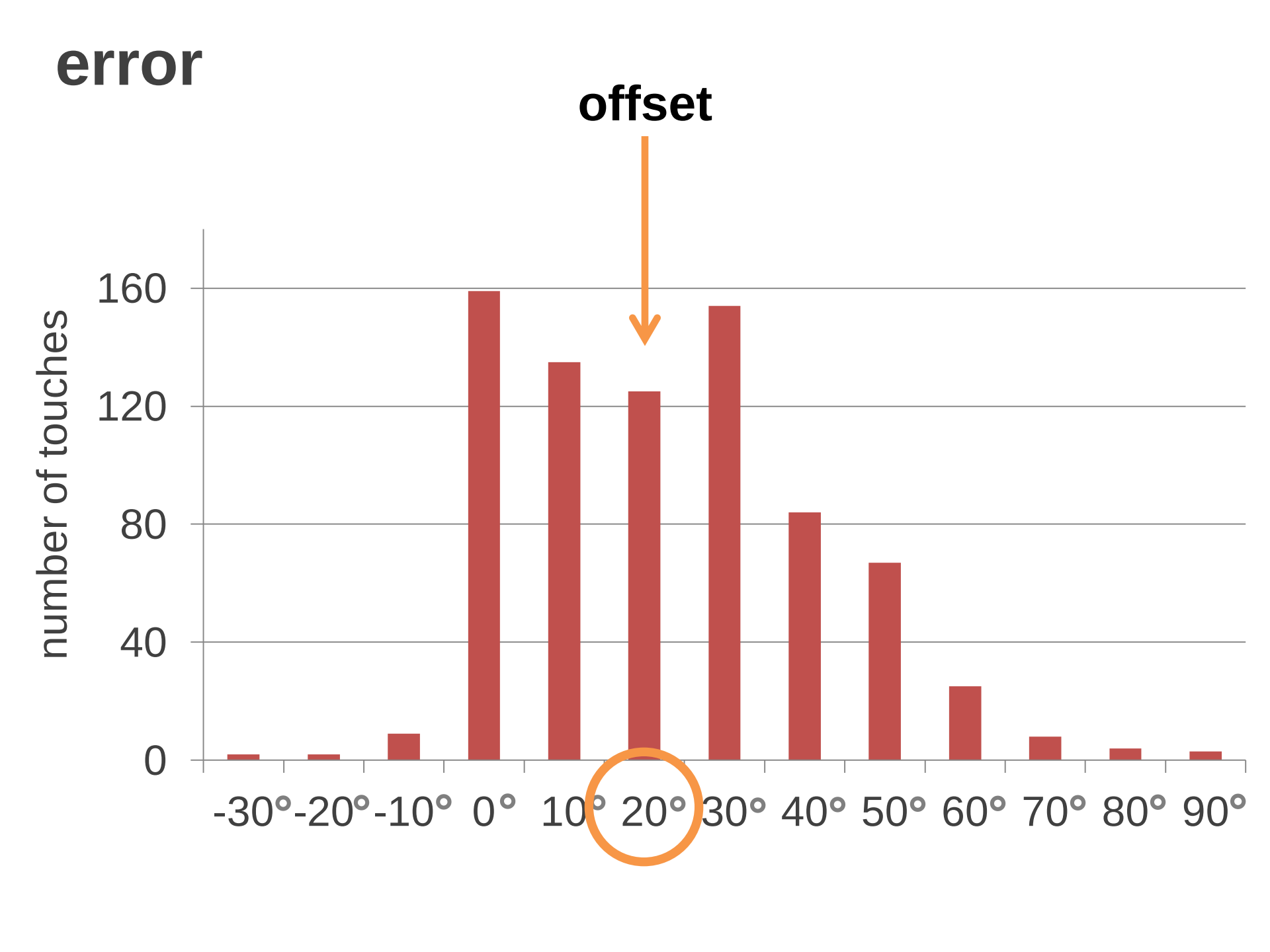

1-6
7-12
13-18
1-6
7-12
13-18

# evaluation #2
# associating touches

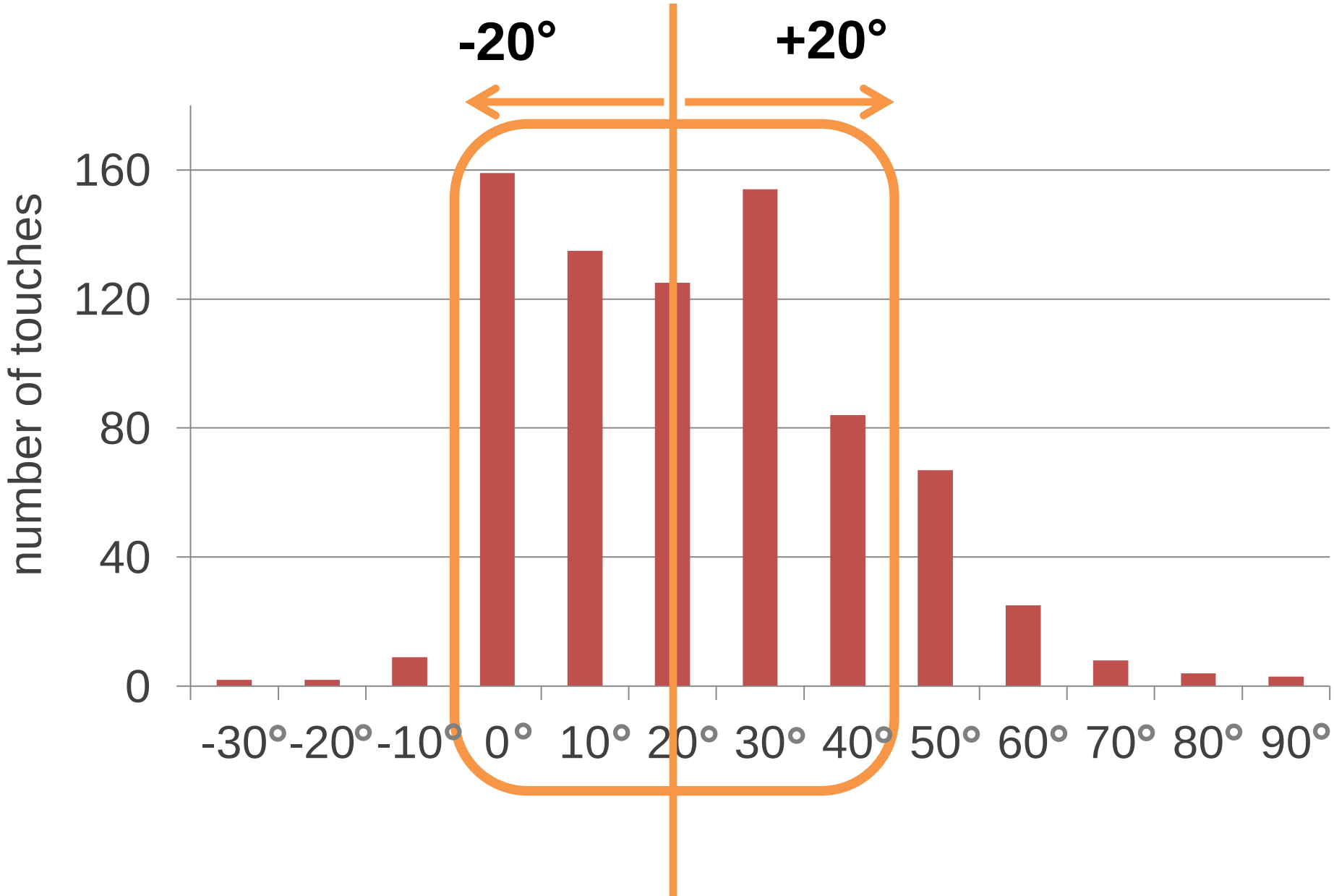

Position 1
2
3
4
task


5 on-screen targets

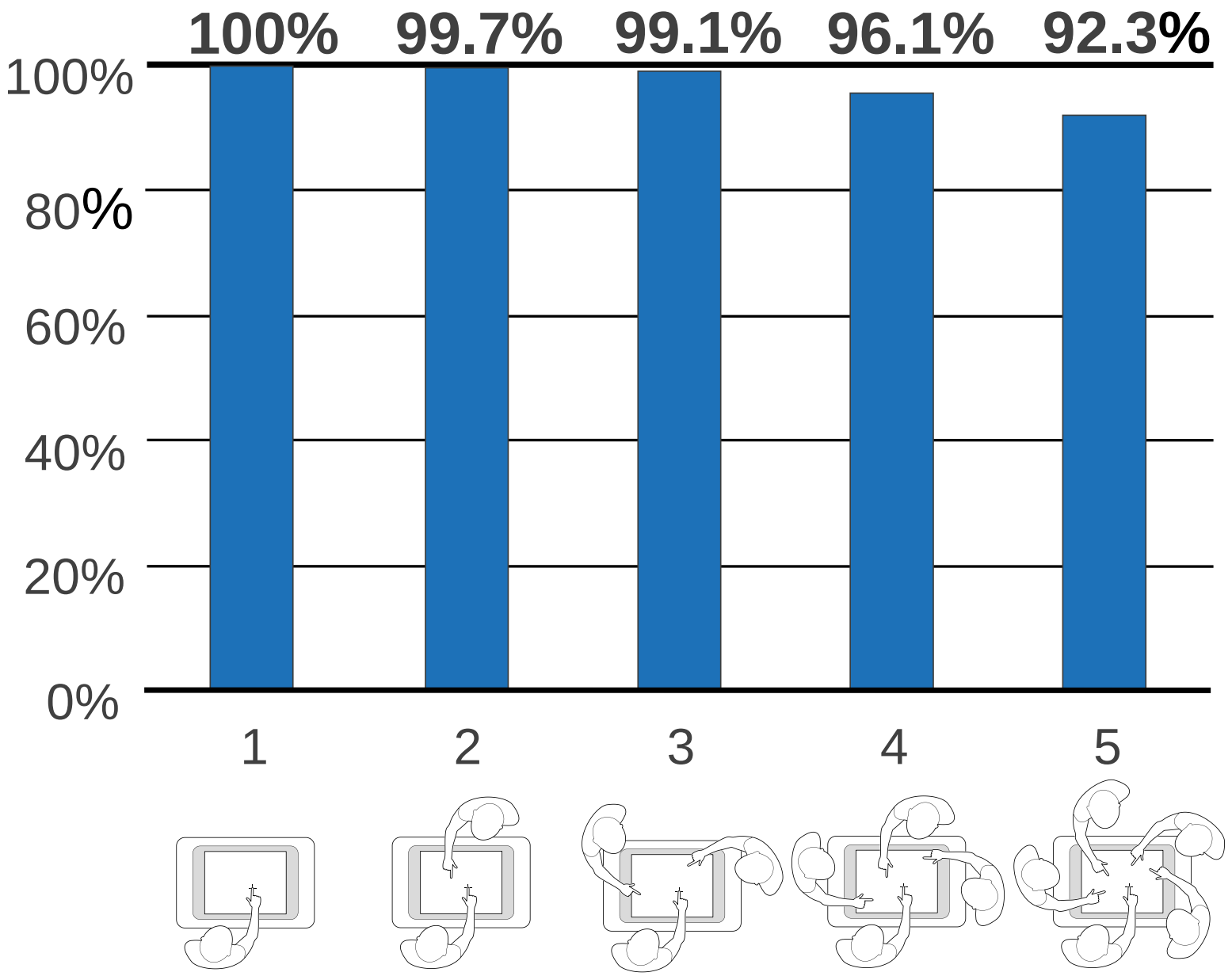

5 on-screen targets
4 standing positions
13 participants
5 x 4 x 3 bocks = 60 trials


error
offset
number of touches
160
120
80
40
0
-30°
-20°
-10°
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°

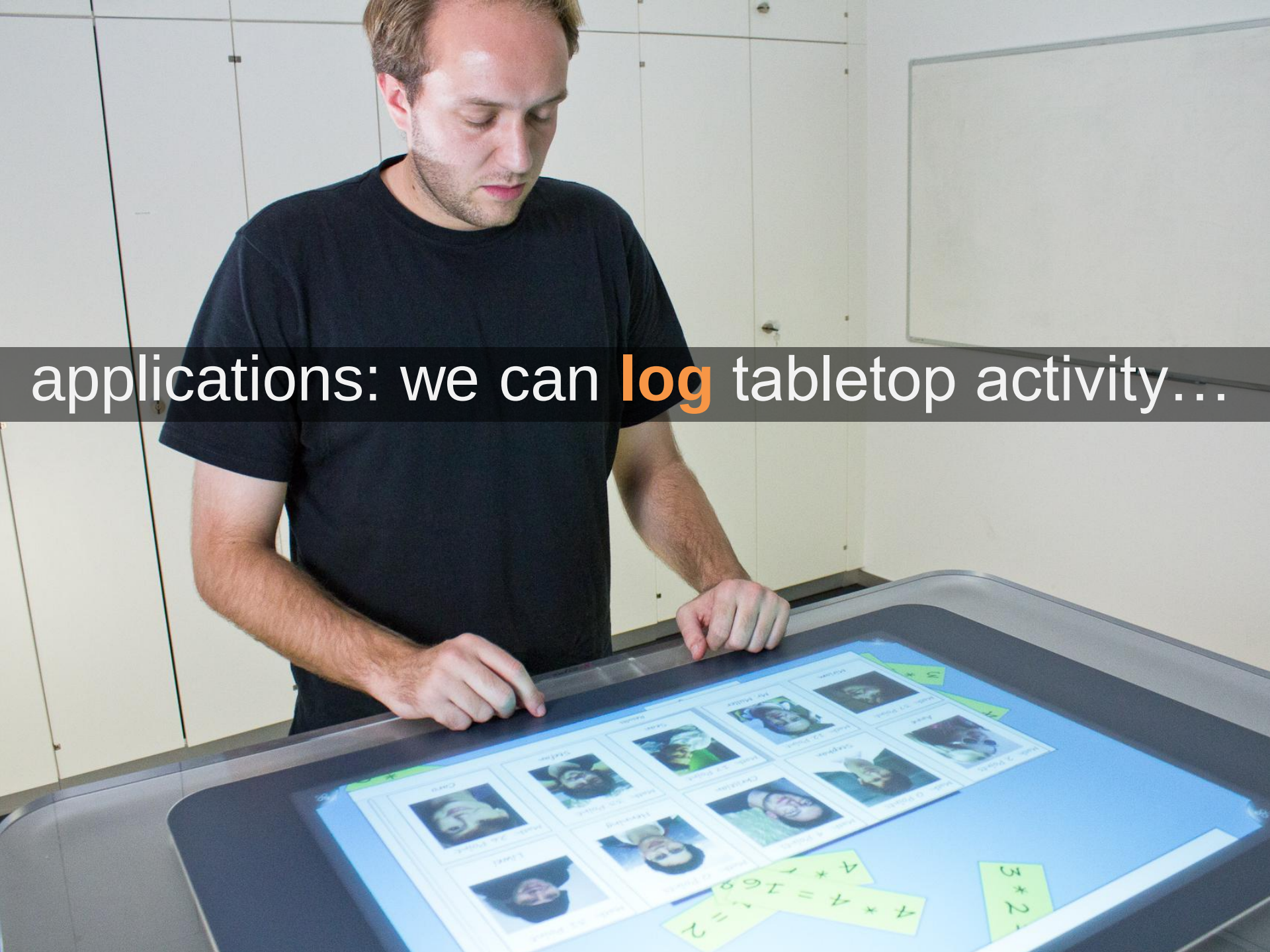
# error


-20°
+20°
number of touches
160
120
80
40
0
-30°
-20°
-10°
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°

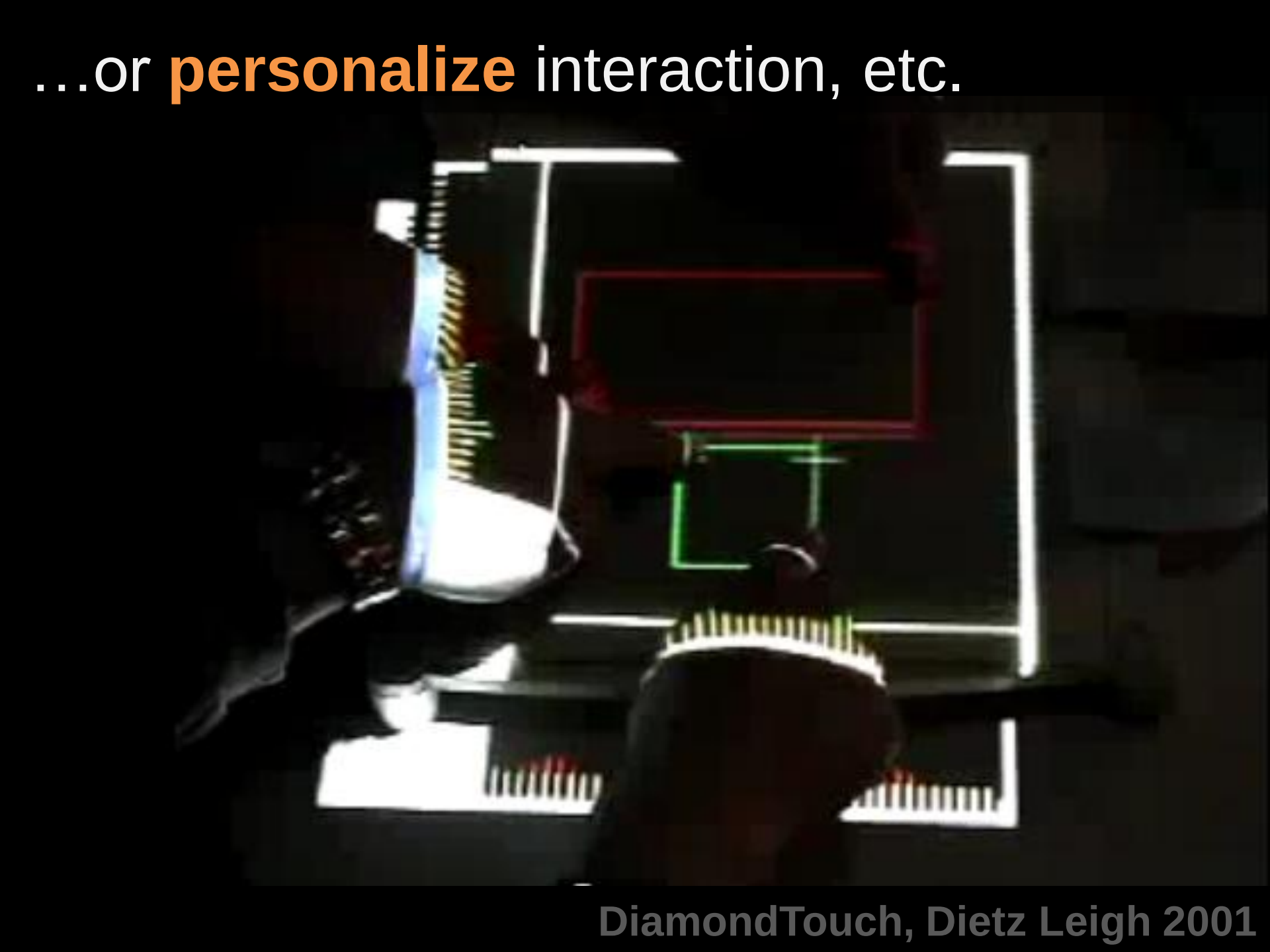
# correct association



# conclusions


applications: we can log tabletop activity…

…or **personalize** interaction, etc.

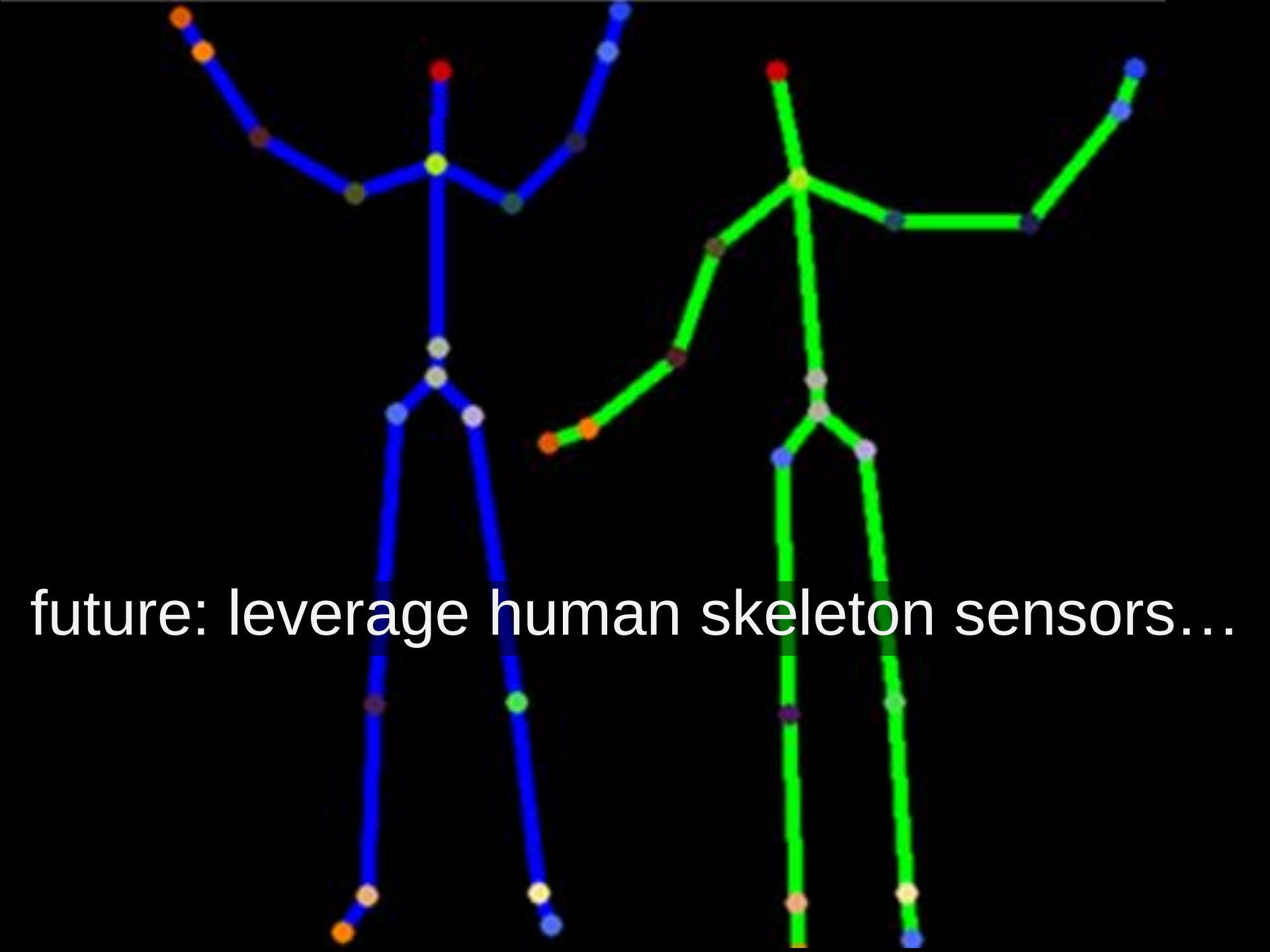


DiamondTouch, Dietz Leigh 2001

on a technical level

traditionally: identify touch → identify **finger**

bootstrapper challenges this

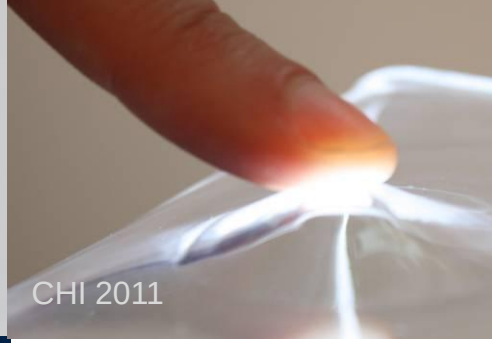

future: leverage human skeleton sensors…

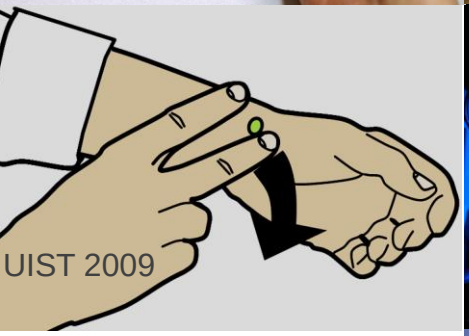
authenticating any part of the body
authenticates the **entire rest of the body**


CHI 2009--nominated


CHI 2010


UIST 2010

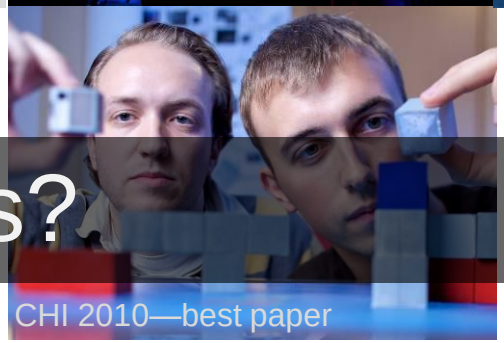

CHI 2011


UIST 2009


CHI 2010

UIST 2010


CHI 2011


CHI 2010—best paper


CHI 2011

# questions?


we have one open
**PhD/postdoc** position

HPI Hasso Plattner Institut