

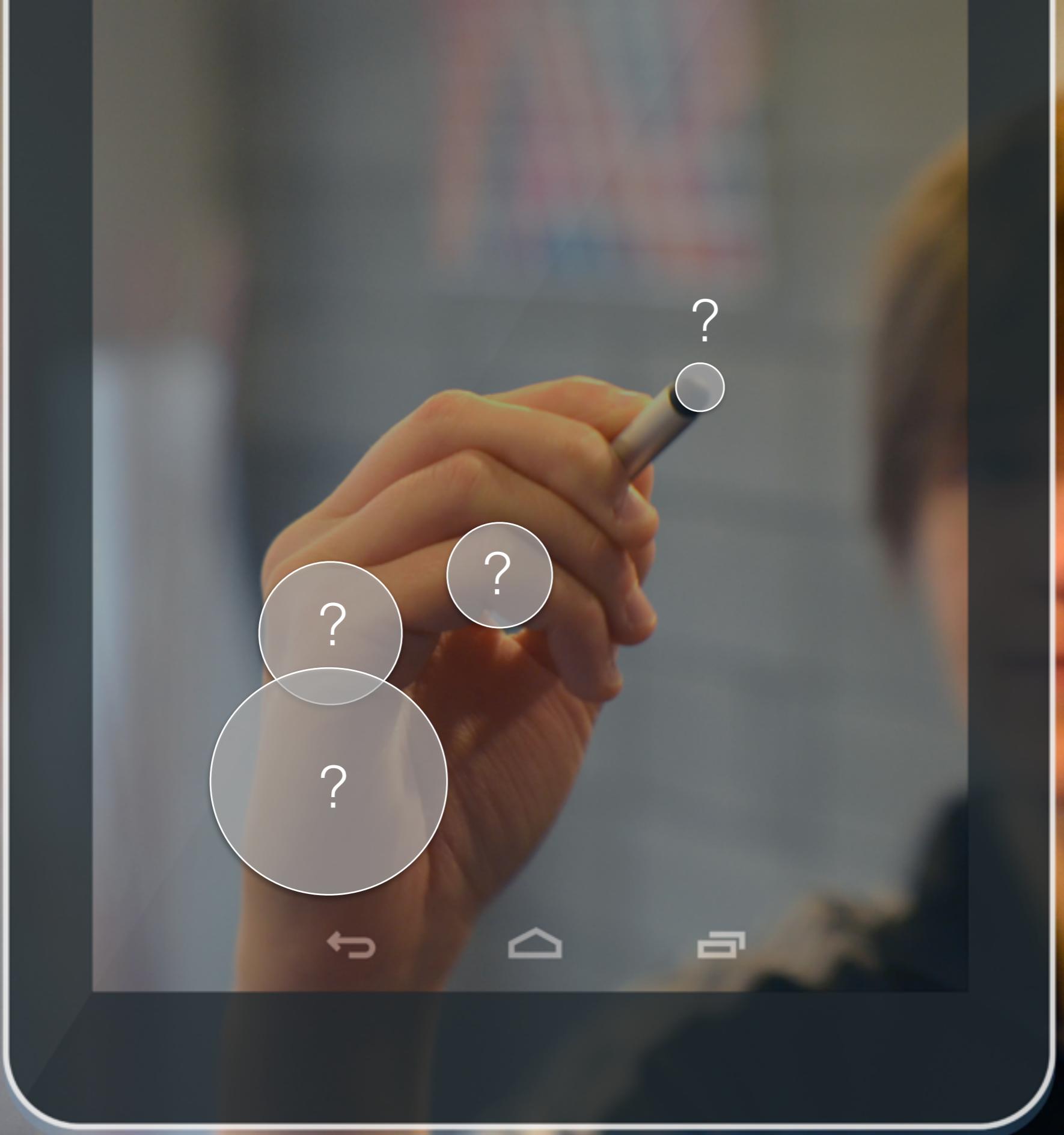
Probabilistic Palm Rejection Using Spatiotemporal Touch Features and Iterative Classification

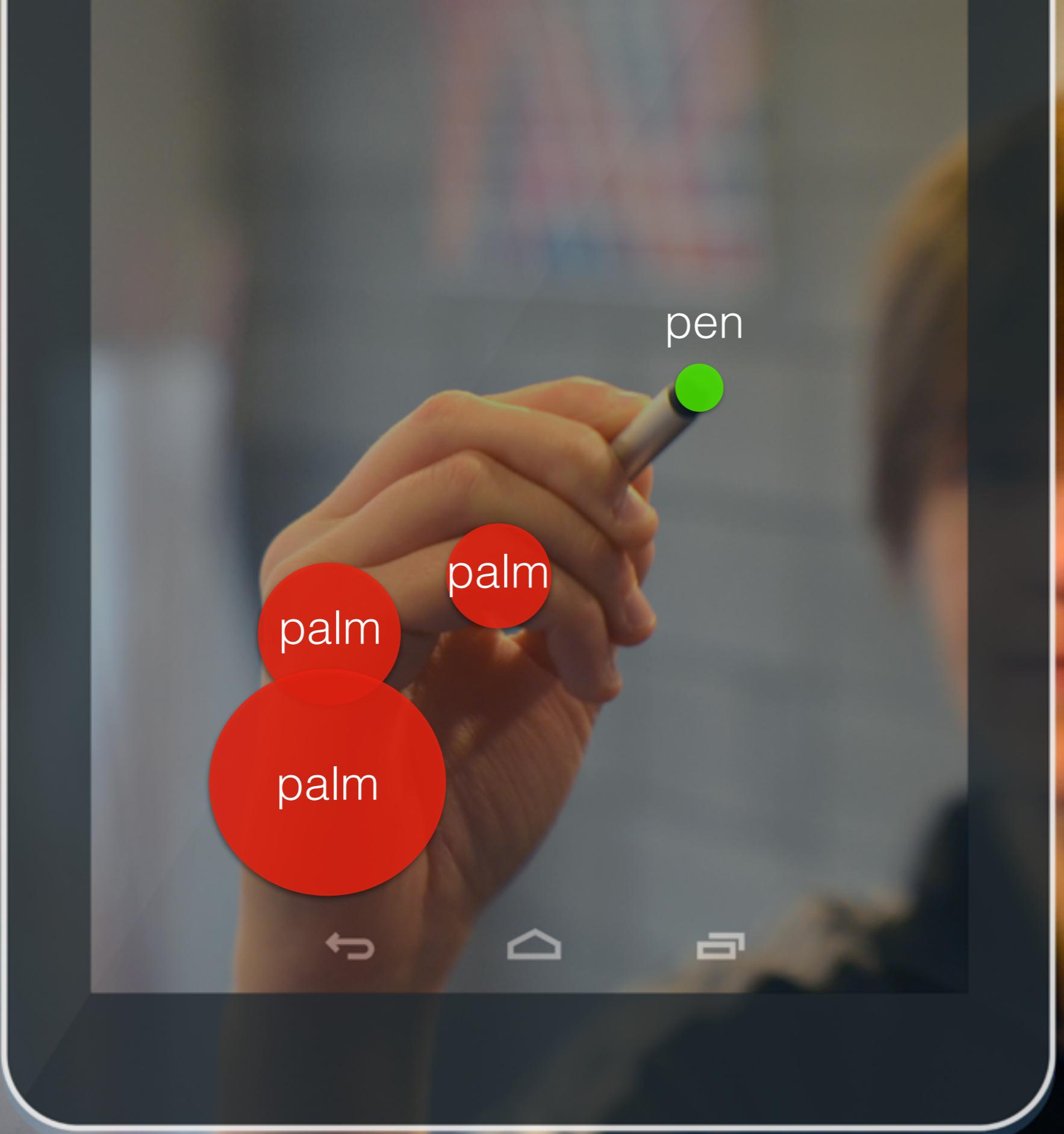
Julia Schwarz, Robert Xiao, Jennifer Mankoff,
Scott E. Hudson, Chris Harrison



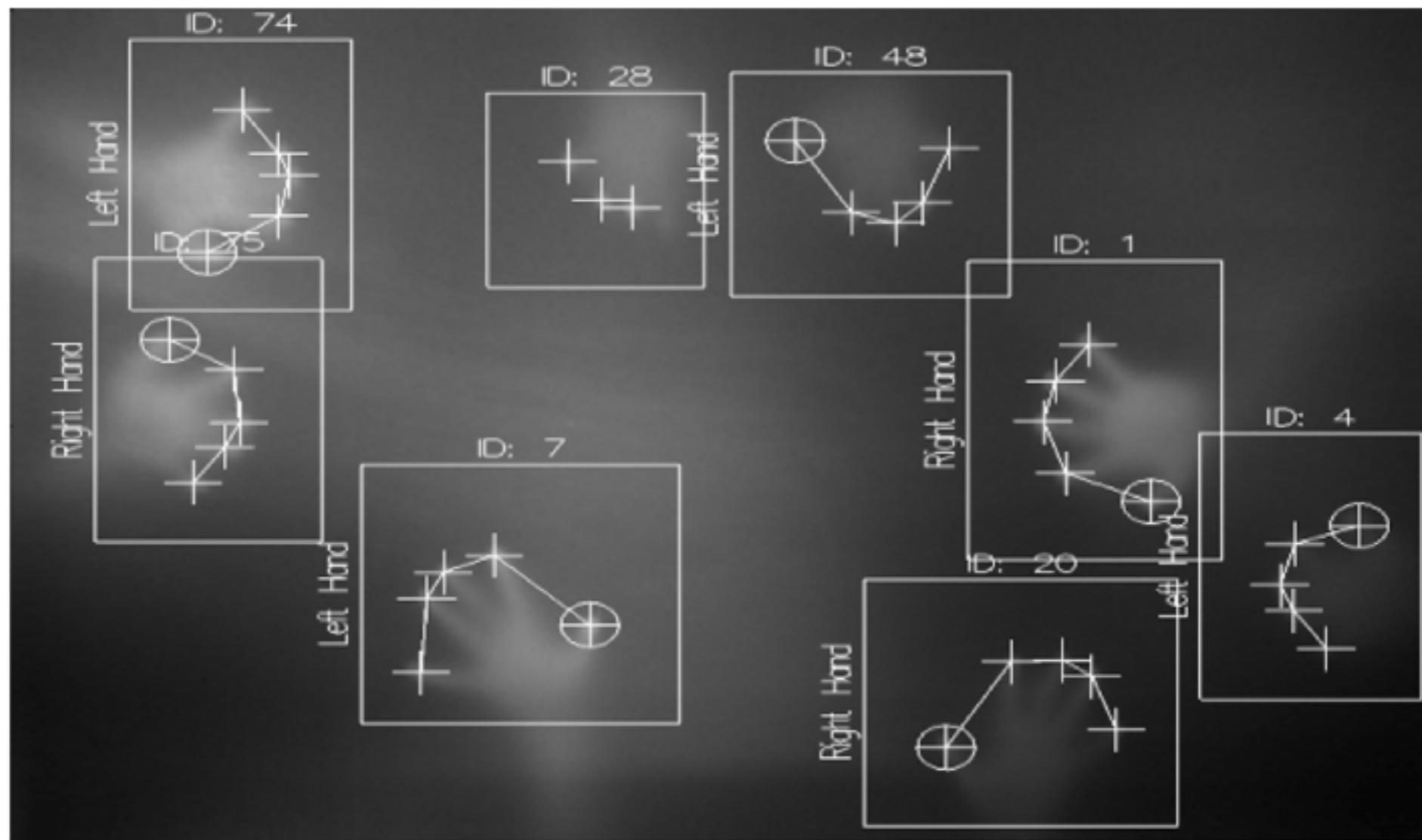








Prior Software-Only Approaches

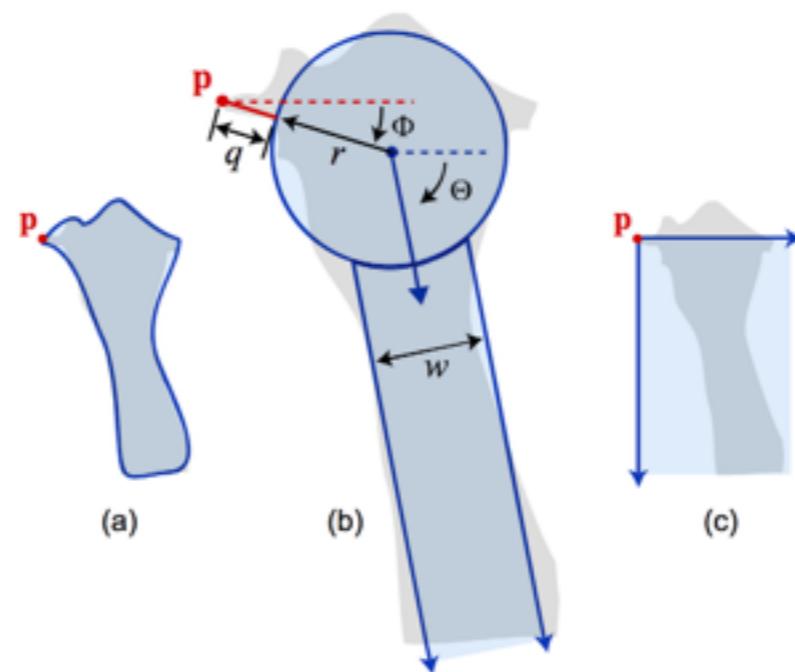


Ewerling et. al, ITS '12



palm rejection region

Notability by Ginger Labs, Inc.



Vogel et al. CHI '09

« Back

Wrist Position



Please tap on the diagram that best reflects your wrist position while writing.



Bamboo Paper

BAMBOO PAPER 2.2

Left-handed writing



Penultimate for iOS



Bamboo Paper for iOS



Our Approach

Collection of decision trees, spatiotemporal features.

Handedness and orientation agnostic.

No calibration required.



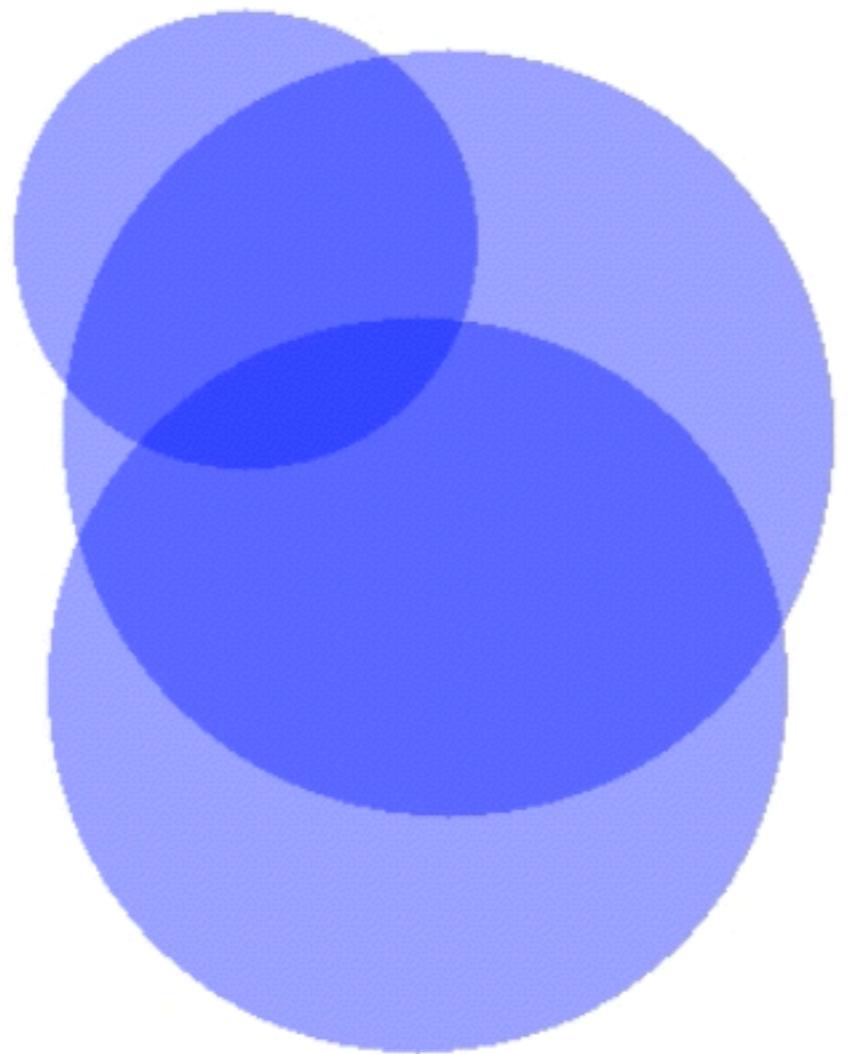
green = stylus
blue = palm

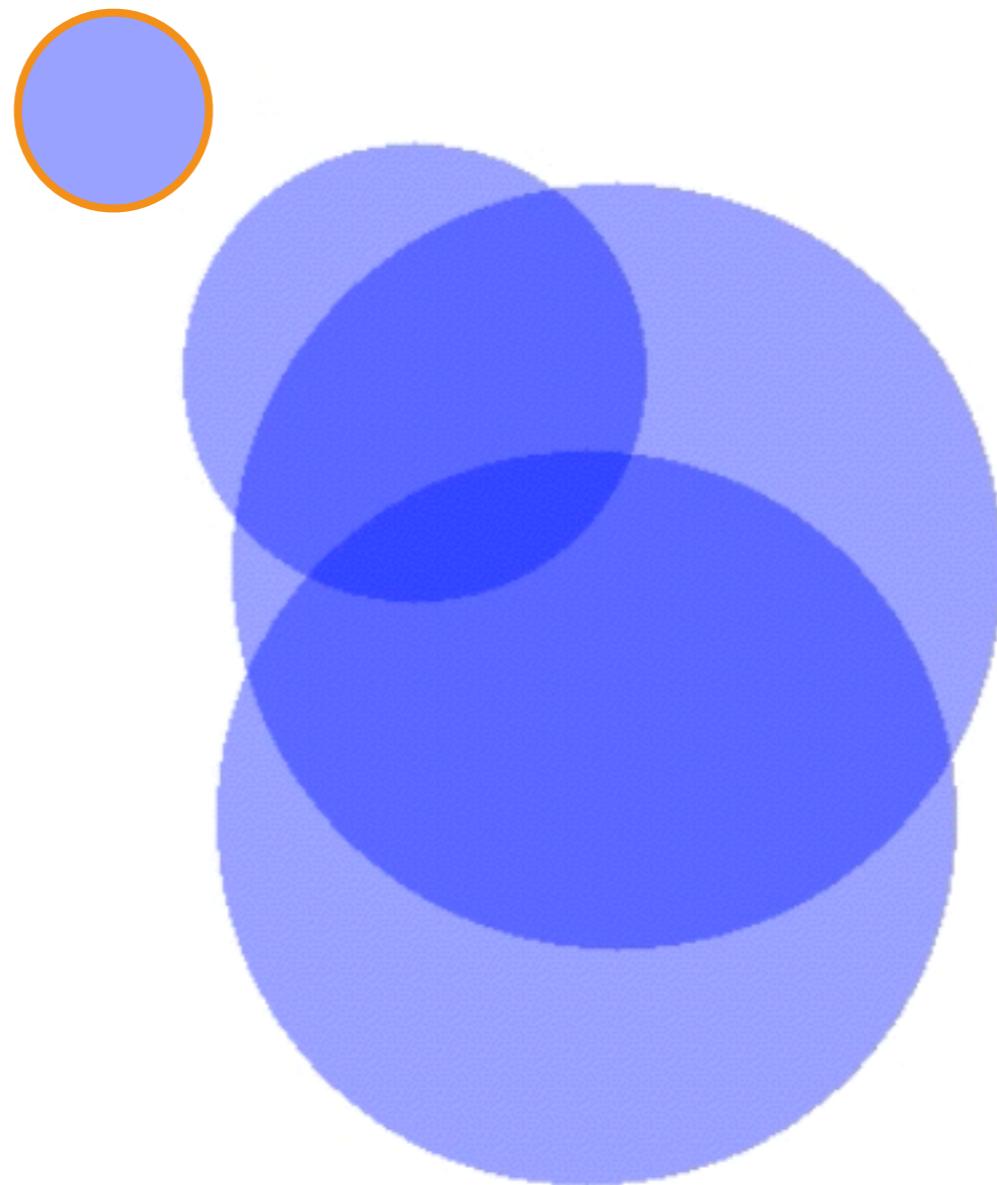
Palms have large radius.

Palms flicker in and out.

Stylus is isolated.

Palms move little, styluses have smooth trajectories.



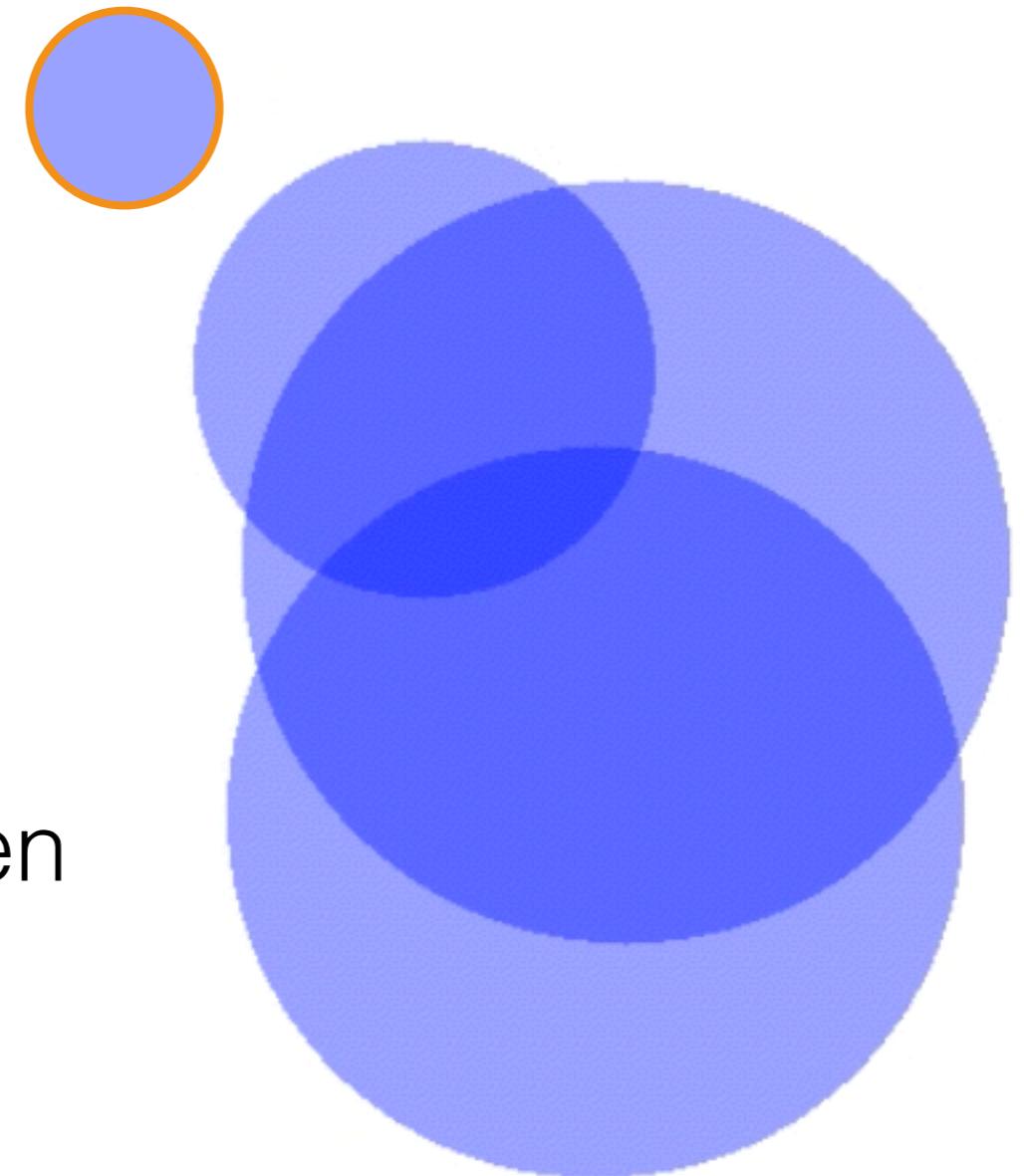


$t = 0$

Instantaneous Features

Touch radius

Distance to other touches on screen



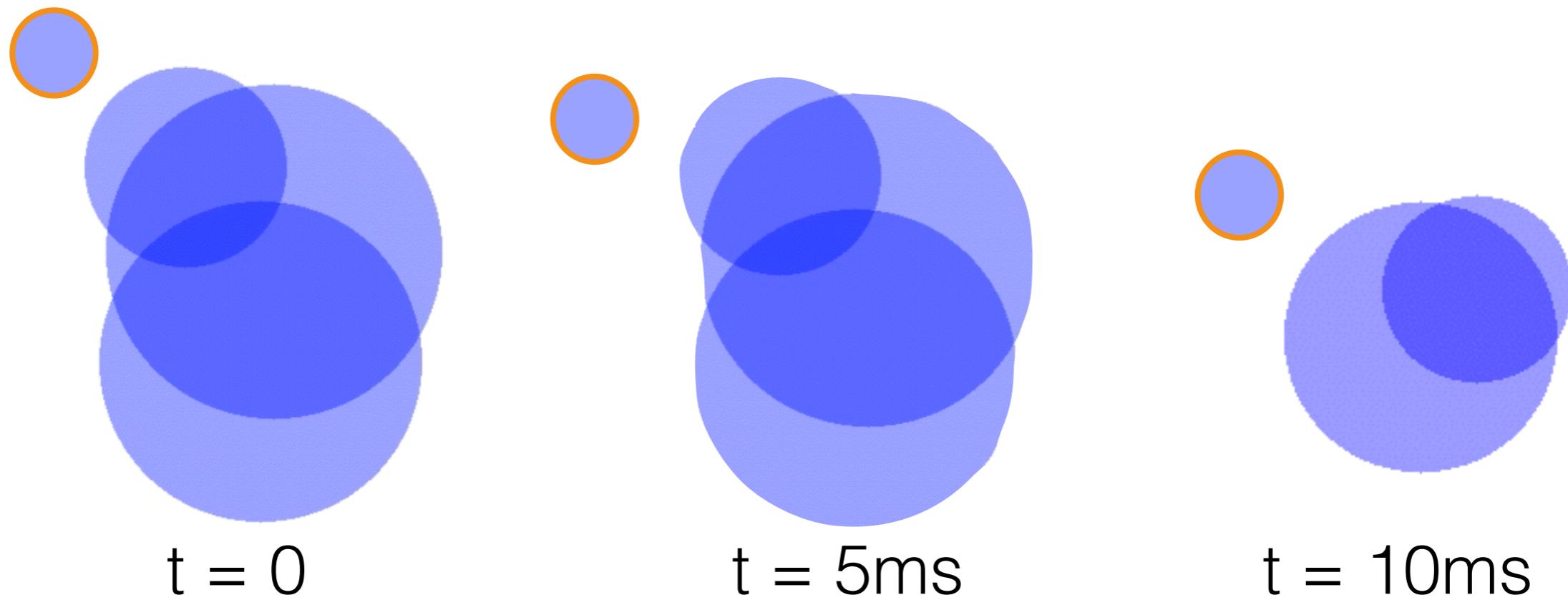
$t = 0$

Touch Sequence Features

[μ, σ, \min, \max] touch radius over sequence

[μ, σ, \min, \max] distance to other touches in sequence

[μ, σ, \min, \max] velocity, acceleration

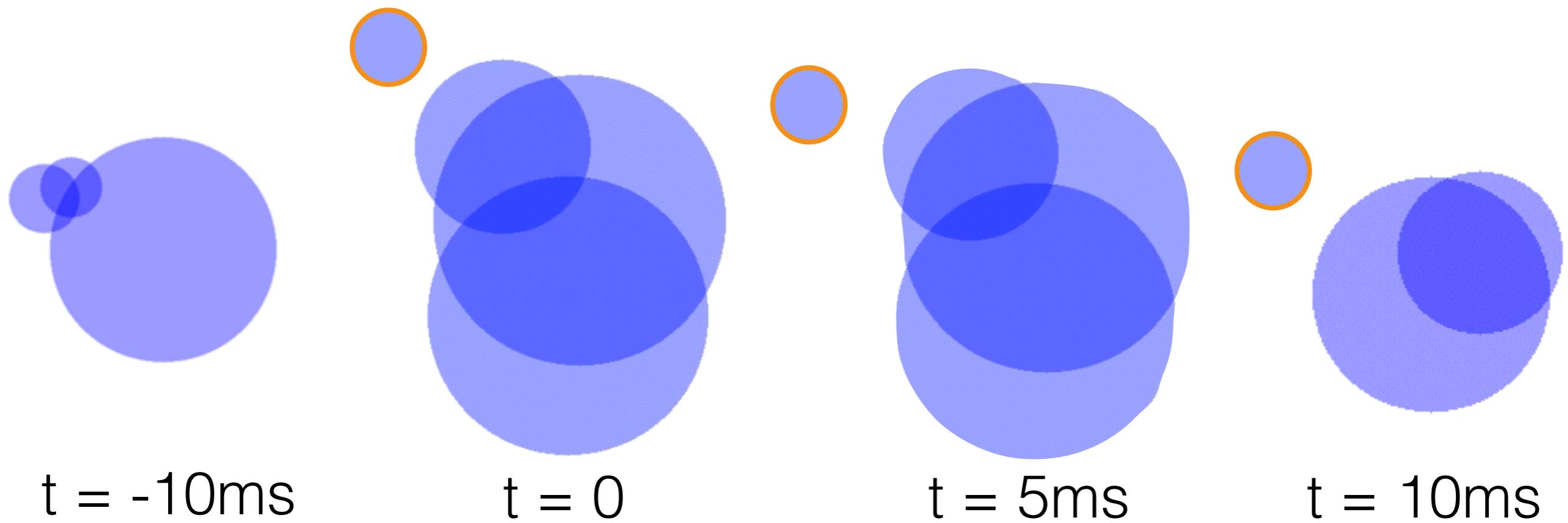


Touch Sequence Features

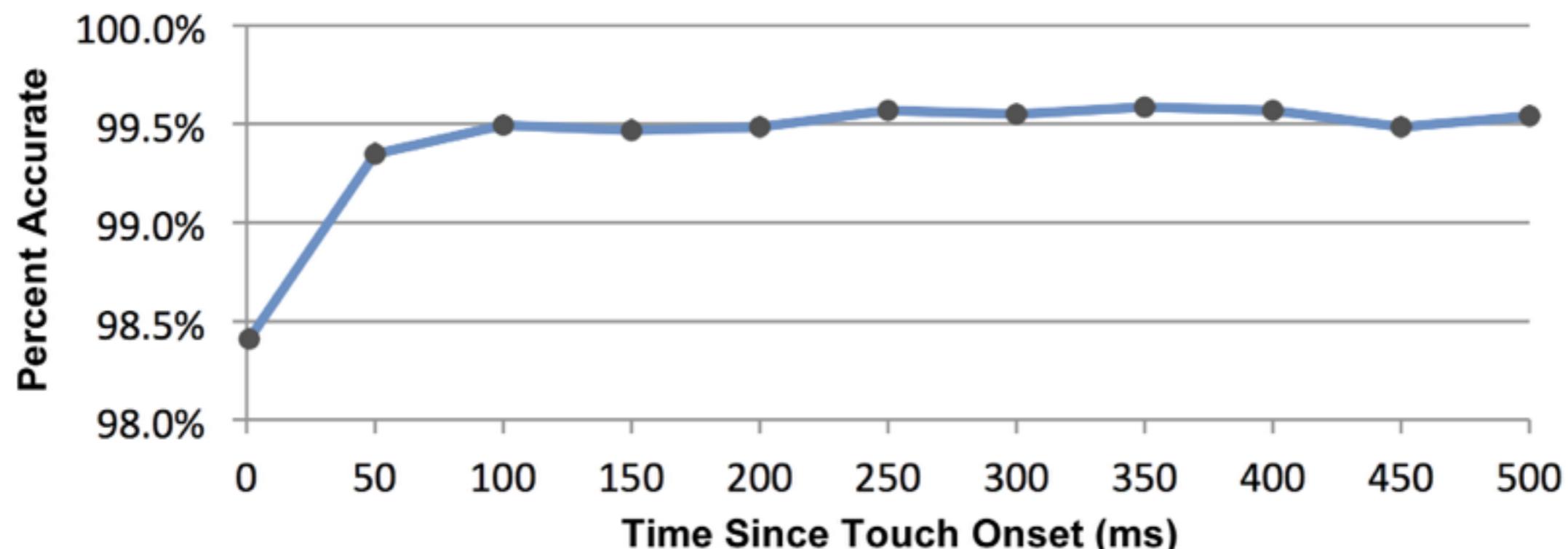
[μ, σ, \min, \max] touch radius over sequence

[μ, σ, \min, \max] distance to other touches in sequence

[μ, σ, \min, \max] velocity, acceleration



train: 11,000 instances from 3 people
test: 11,000 instances from 2 different people
train and test data gathered in different locations and on different days

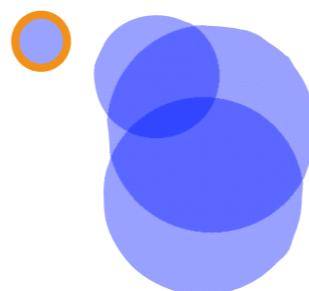


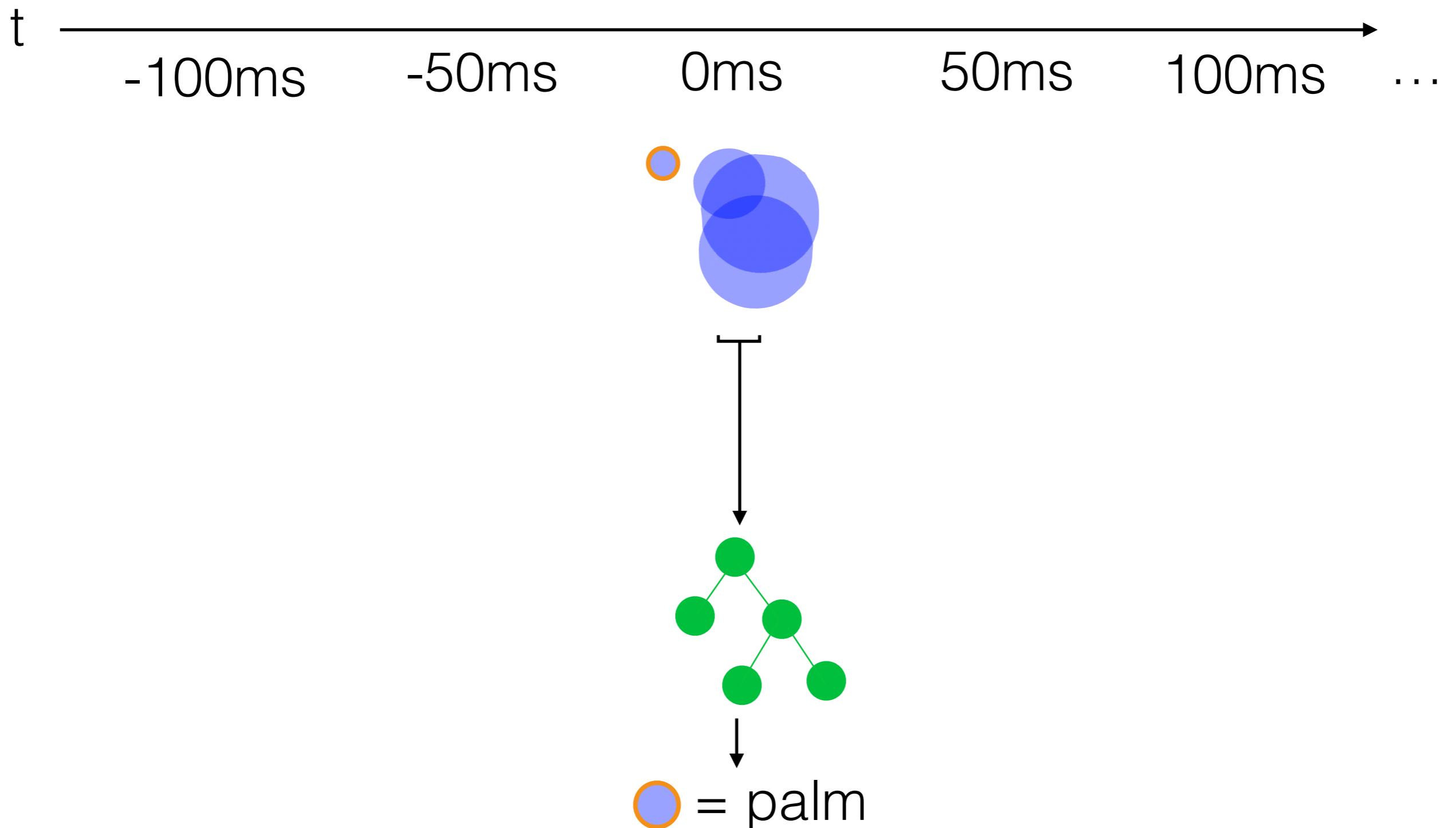
* leftmost point is at t = 1ms

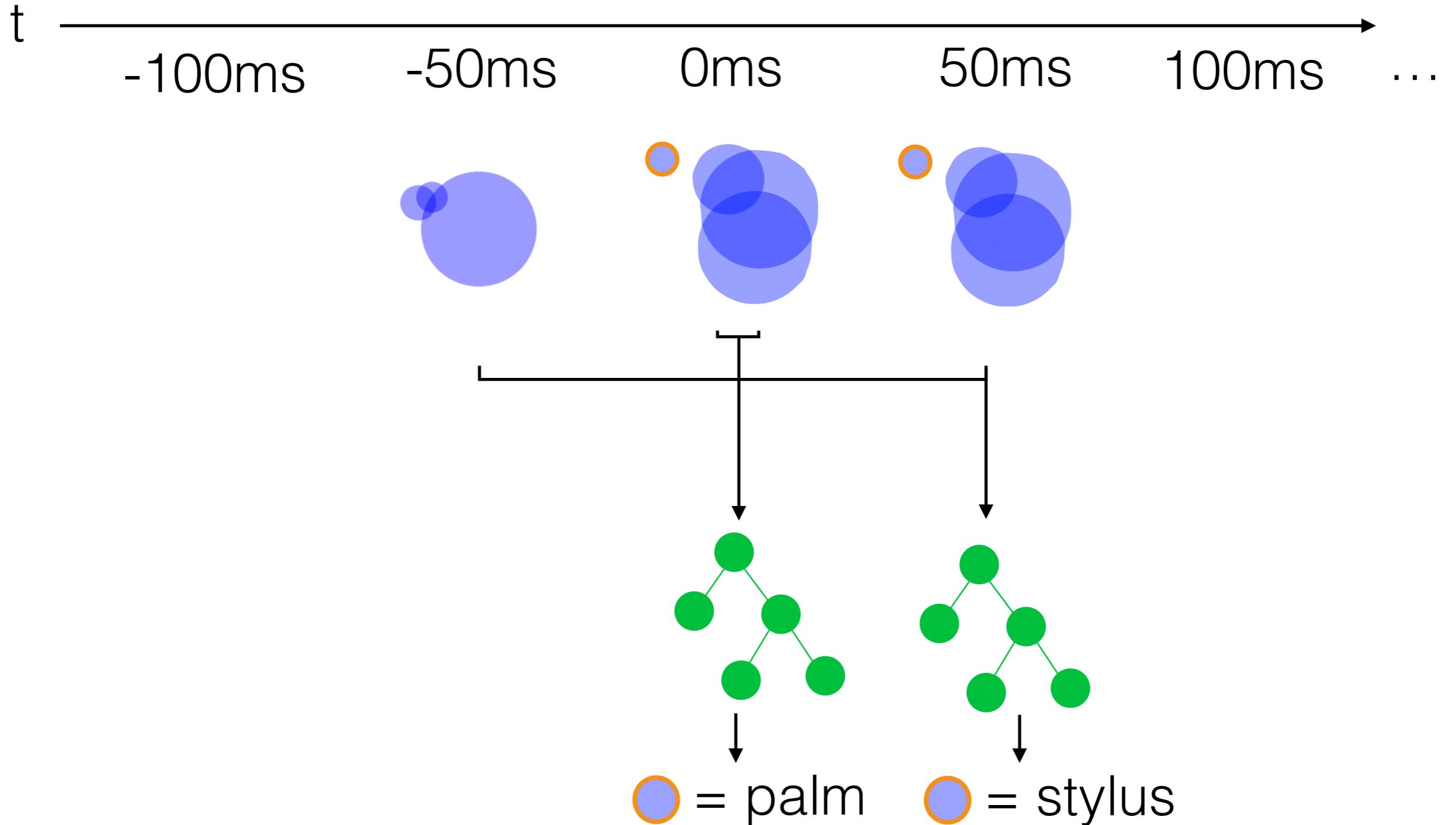
Window size of ~250ms would be ideal.

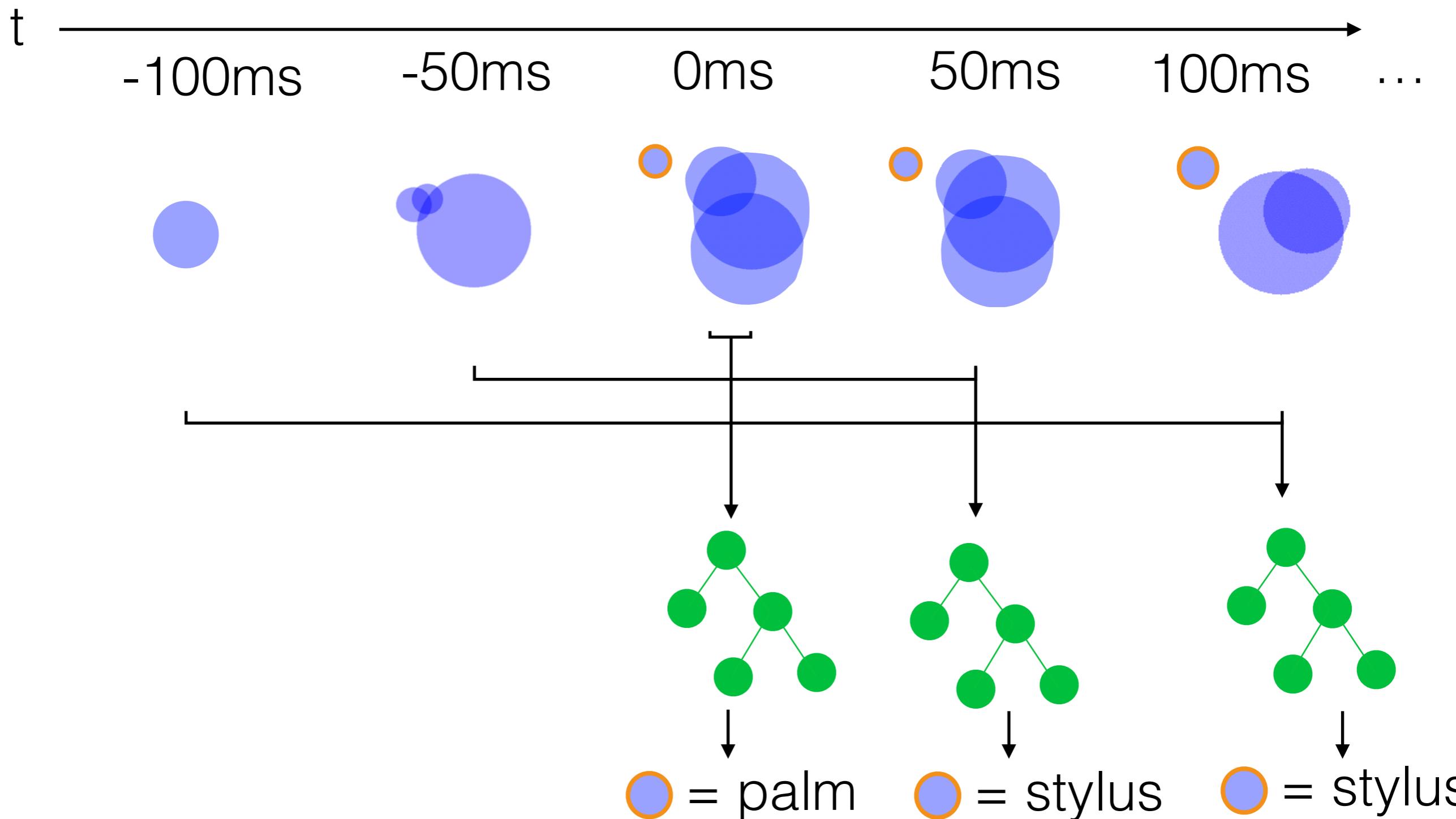
Want to provide immediate feedback to the user.

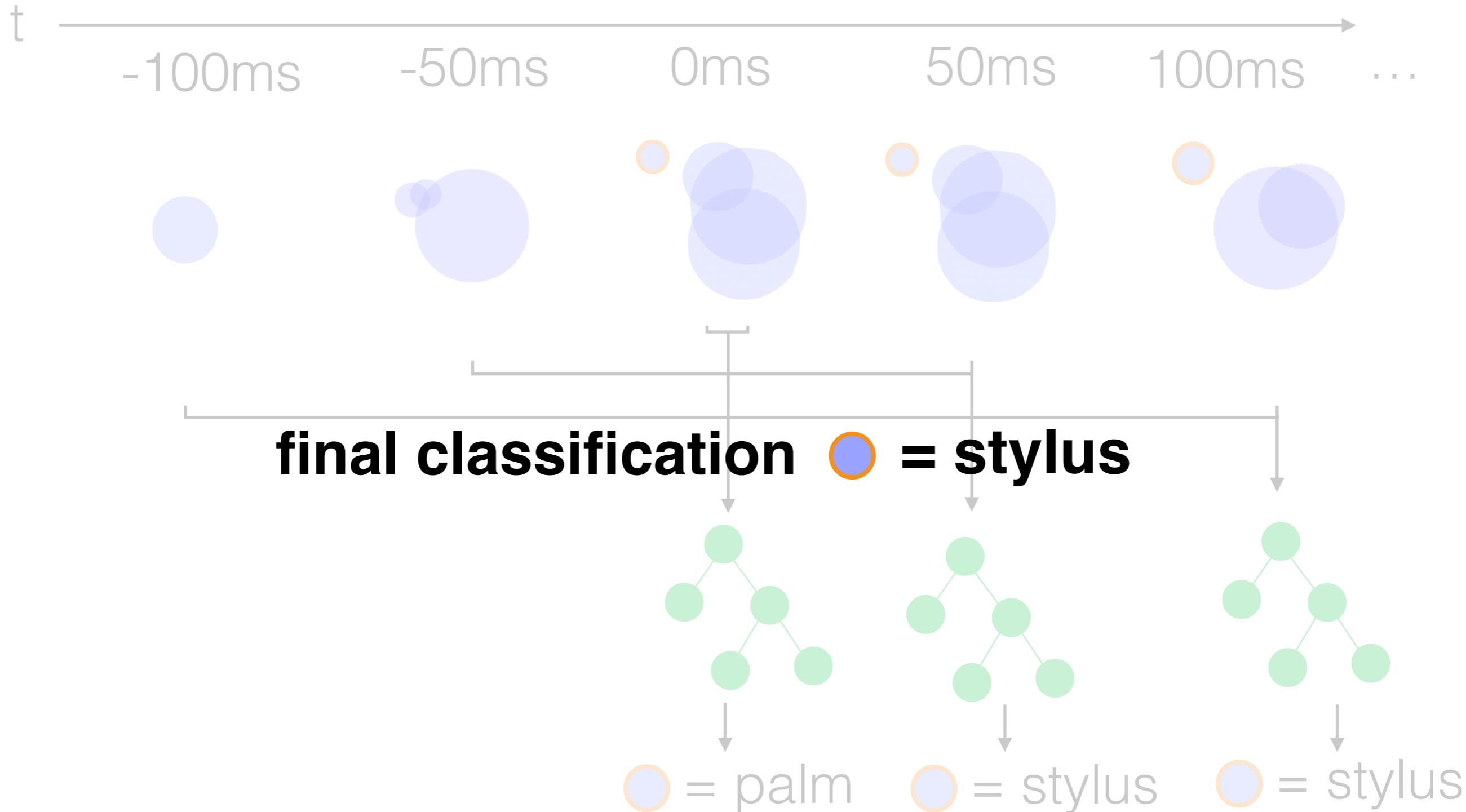
t -100ms -50ms 0ms 50ms 100ms ...











Demo

Evaluation



Penultimate

vs.



Bamboo

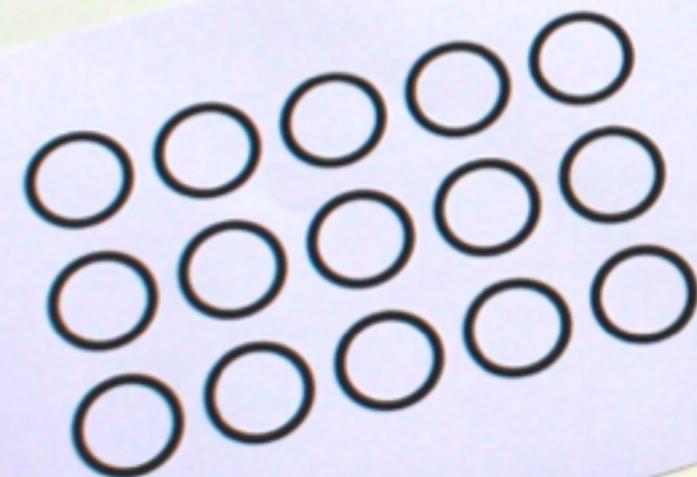
vs.



Our App

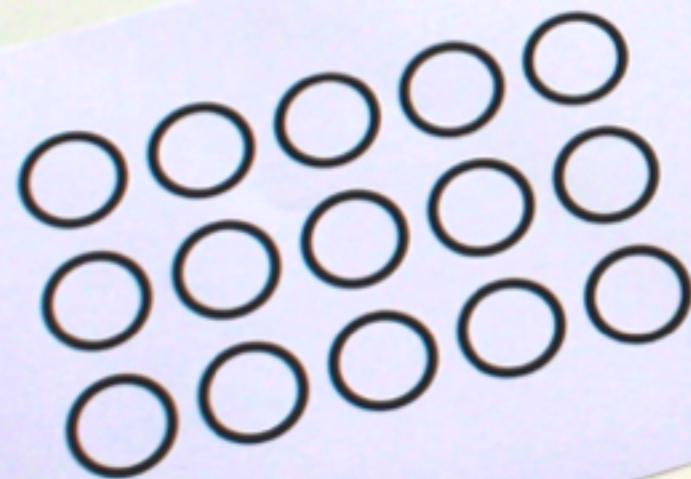
symbols:

SO • - IL

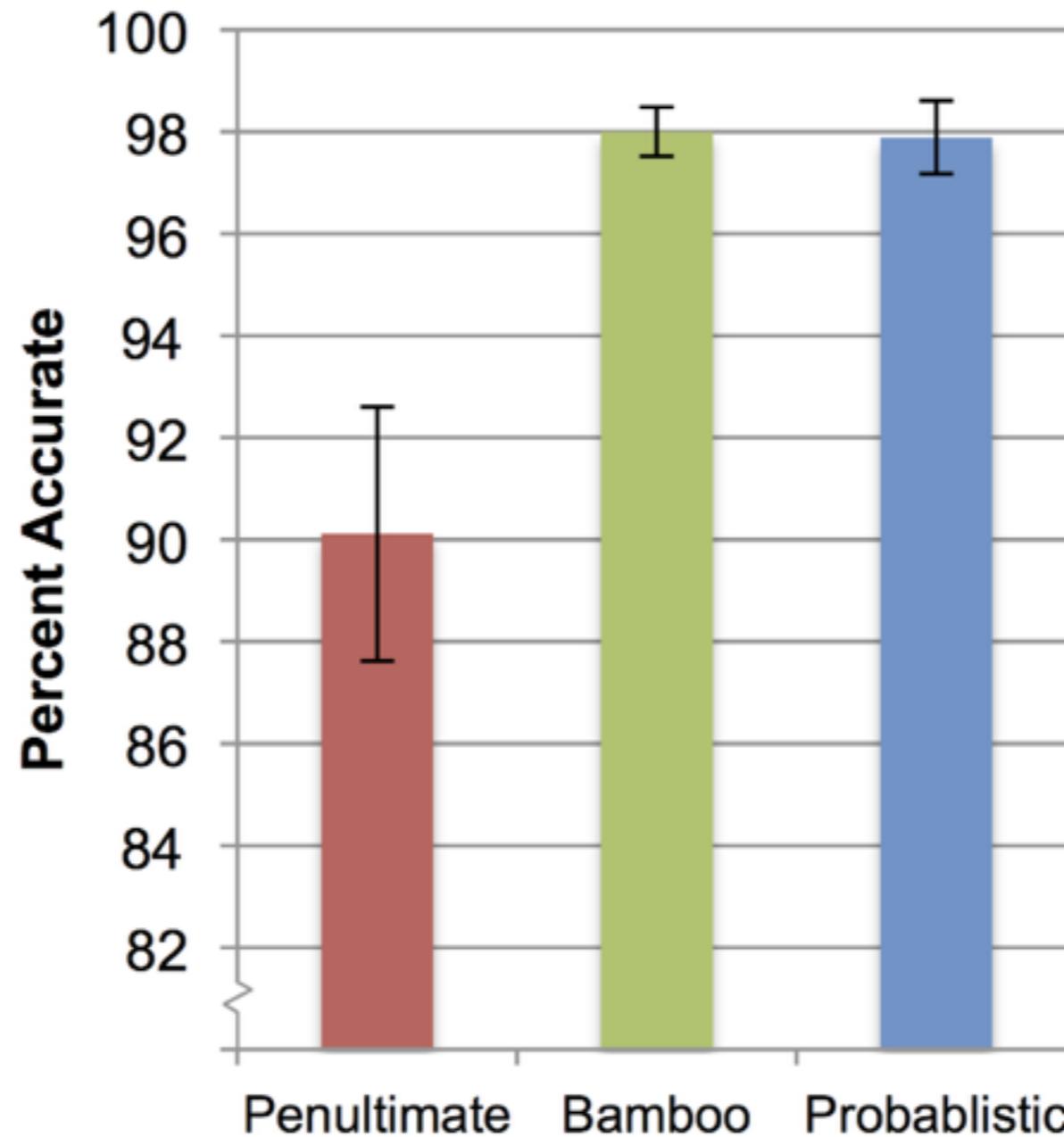


symbols:

SO • - IL



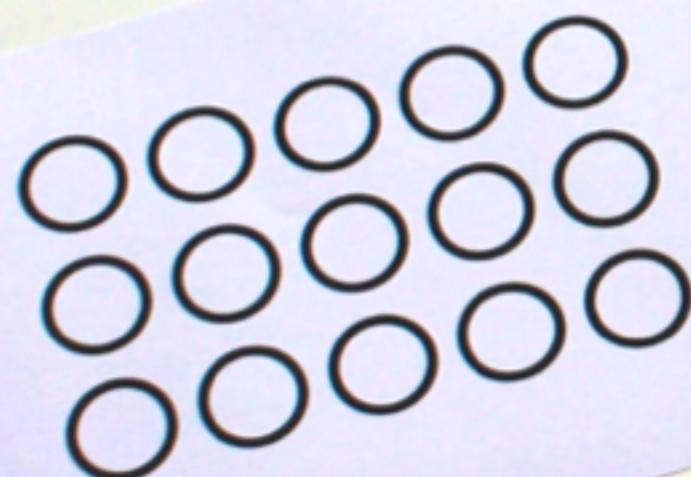
True Positives



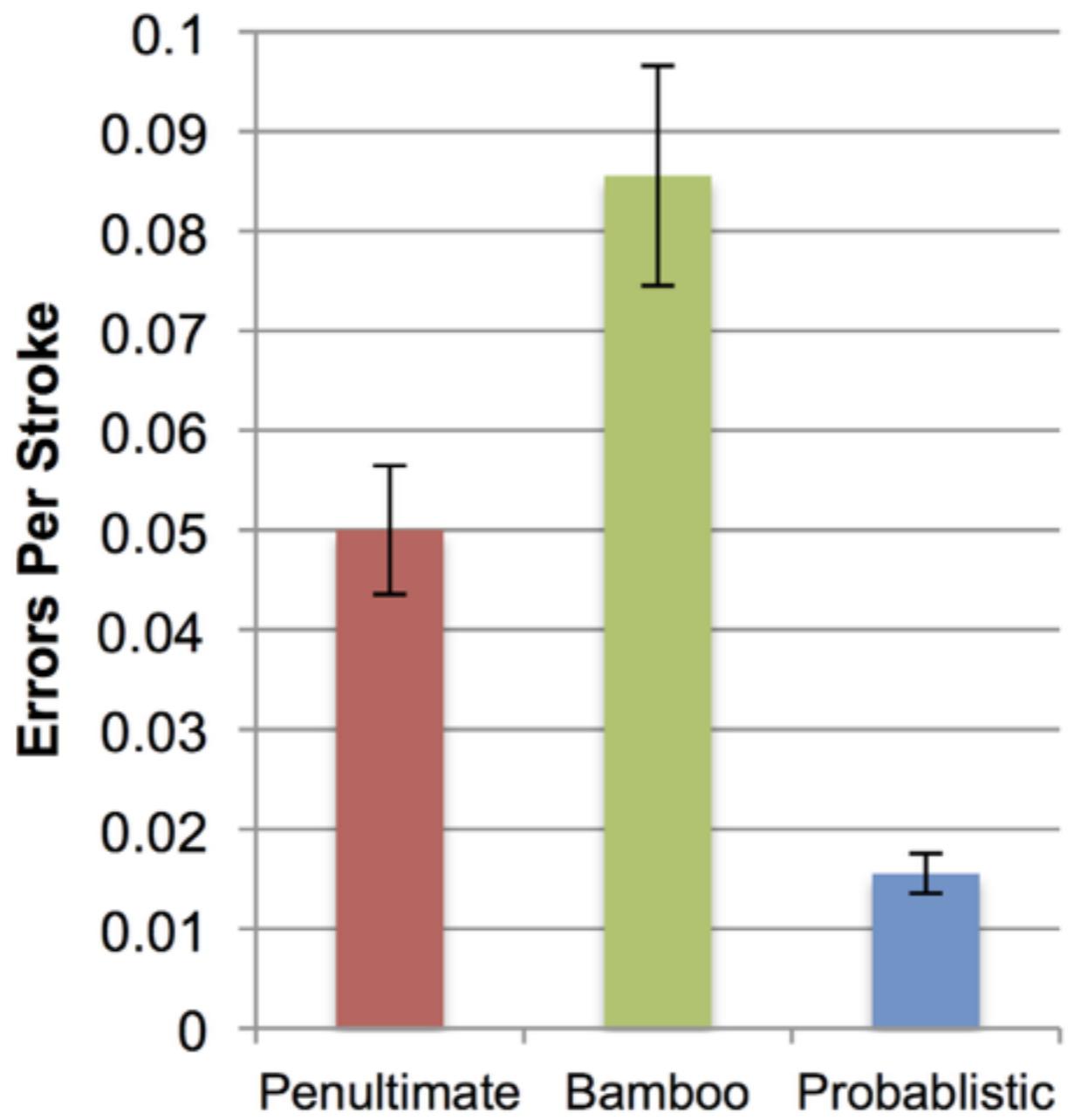
% pen strokes classified as pen strokes
error bars = 95% confidence interval

symbols:

SO • - IL



False Positives



of palm 'splotches' per pen stroke

*error bars = 95% confidence interval

Takeaways

Waiting to see how sensed input evolves before making a decision improves recognition accuracy.

Need a system that can show immediate feedback, but that can refine the interface as more information is presented.

Thank you!

julia@qeexo.com

Special thanks to Jim Baur for photography assistance

Also, thank you to our sponsors:



Why a decision tree?

Limitations

No multitouch gestures (yet)

Algorithm overly reliant on touch radius

Accuracy hit of 1% when not using radius features

Difficult to implement on platforms that do not expose touch radius