

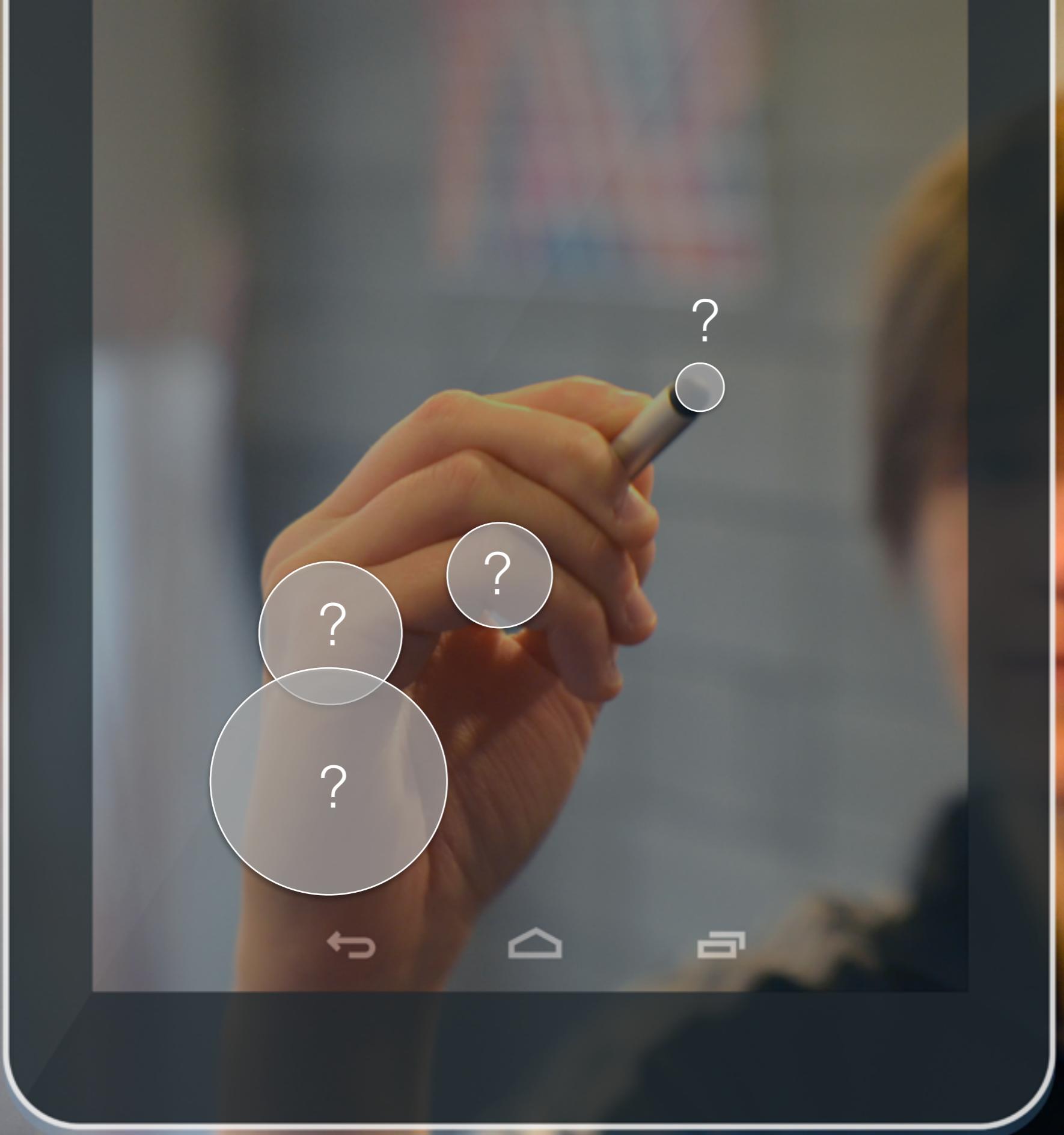
Probabilistic Palm Rejection Using Spatiotemporal Touch Features and Iterative Classification

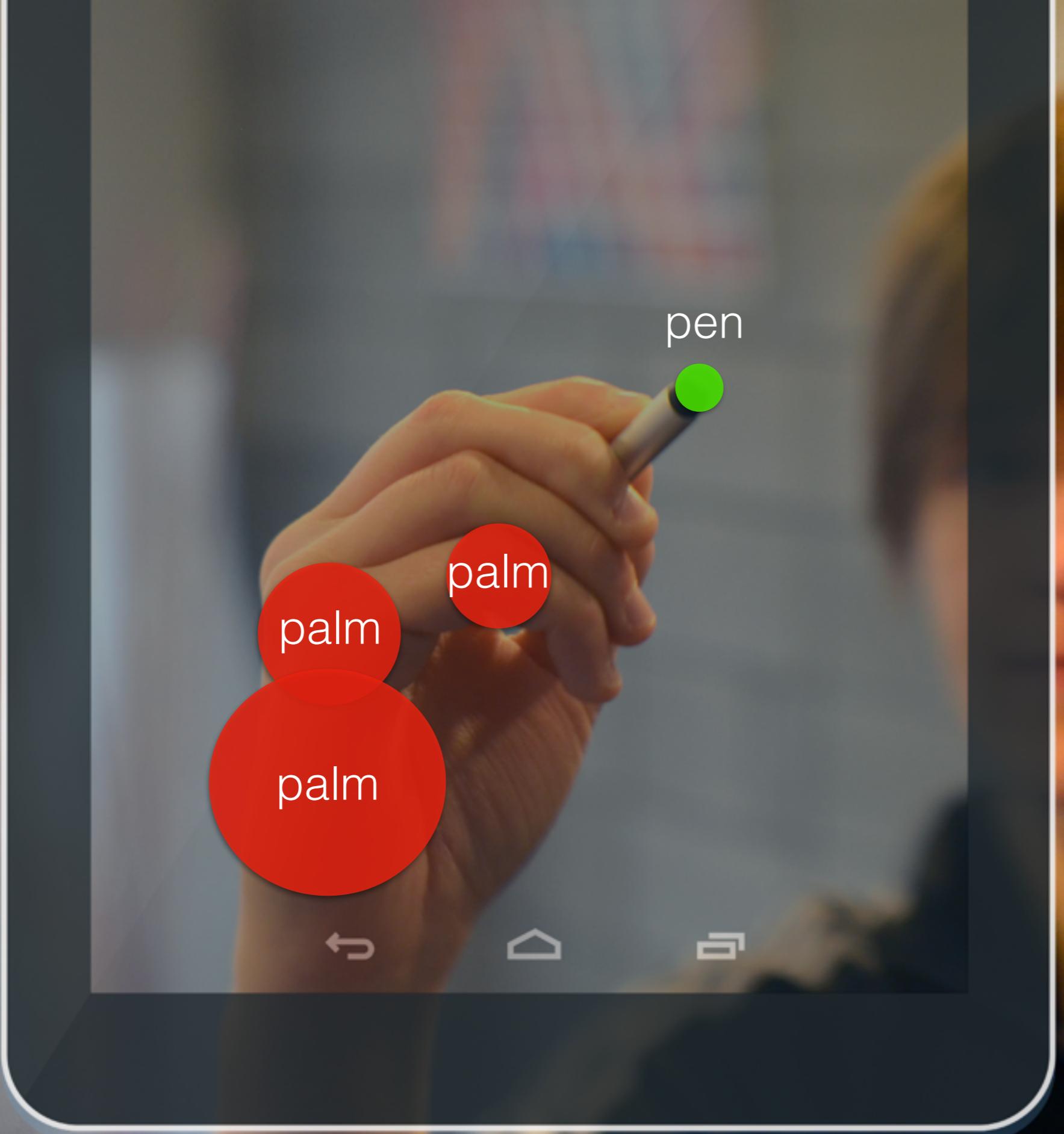
Julia Schwarz, Robert Xiao, Jennifer Mankoff,
Scott E. Hudson, Chris Harrison



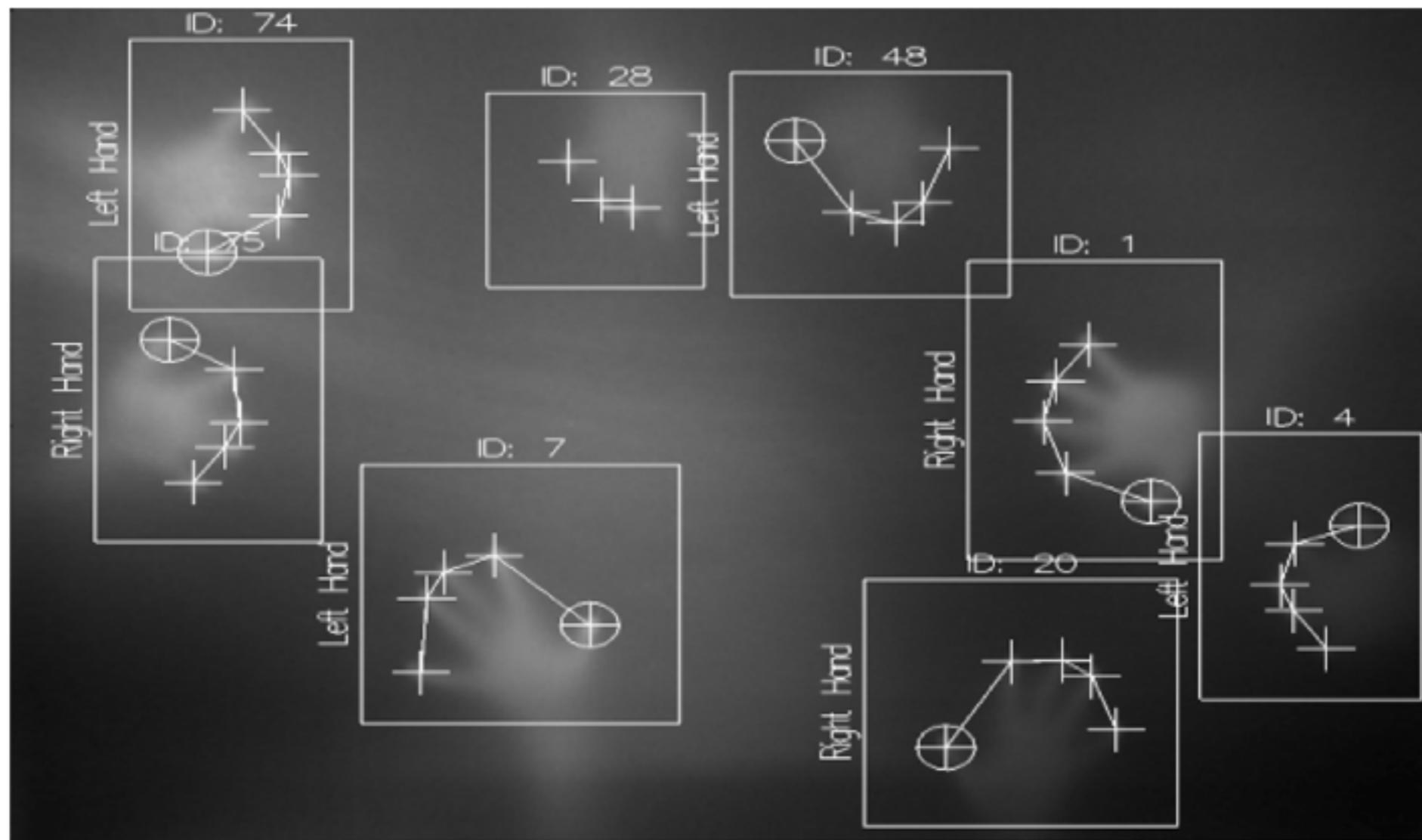








Prior Software-Only Approaches

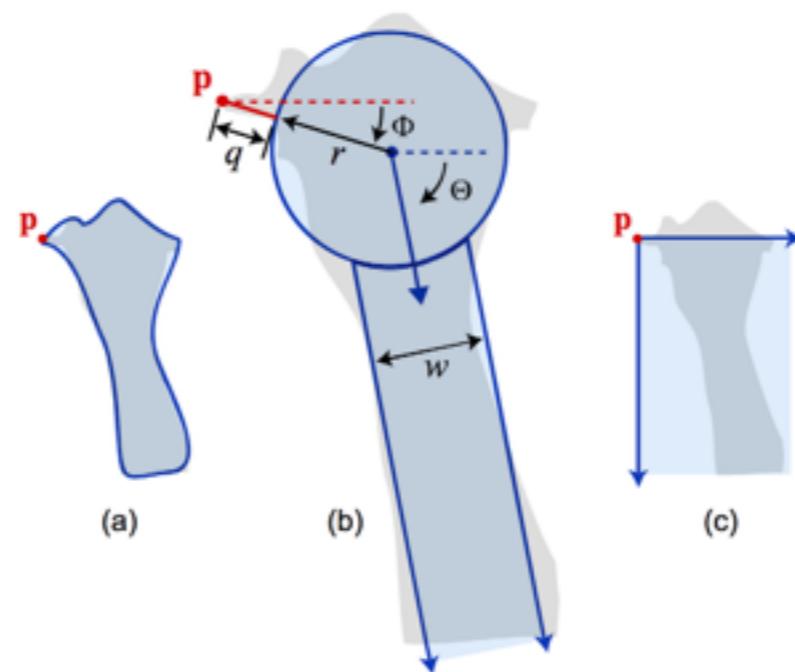


Ewerling et. al, ITS '12



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.



Penultimate for iOS



Bamboo Paper for iOS



Our Approach

Collection of decision trees, spatiotemporal features.

Handedness and orientation agnostic.

No calibration required.



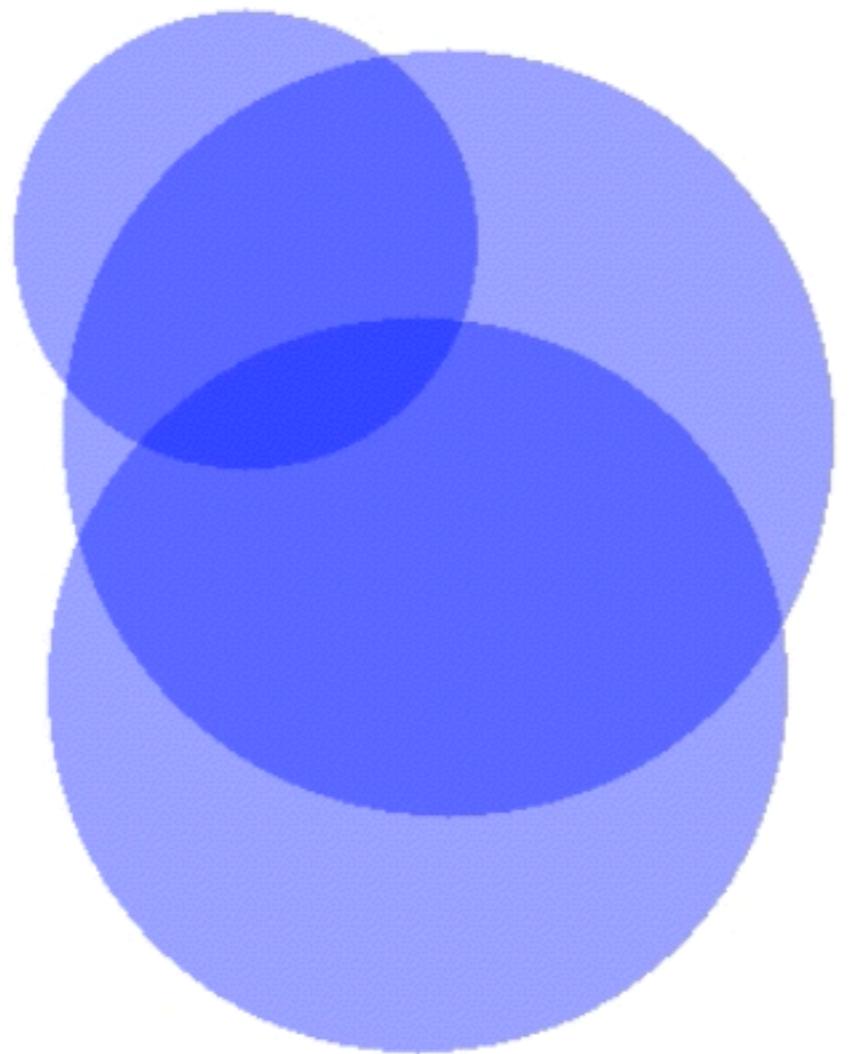
green = stylus
blue = palm

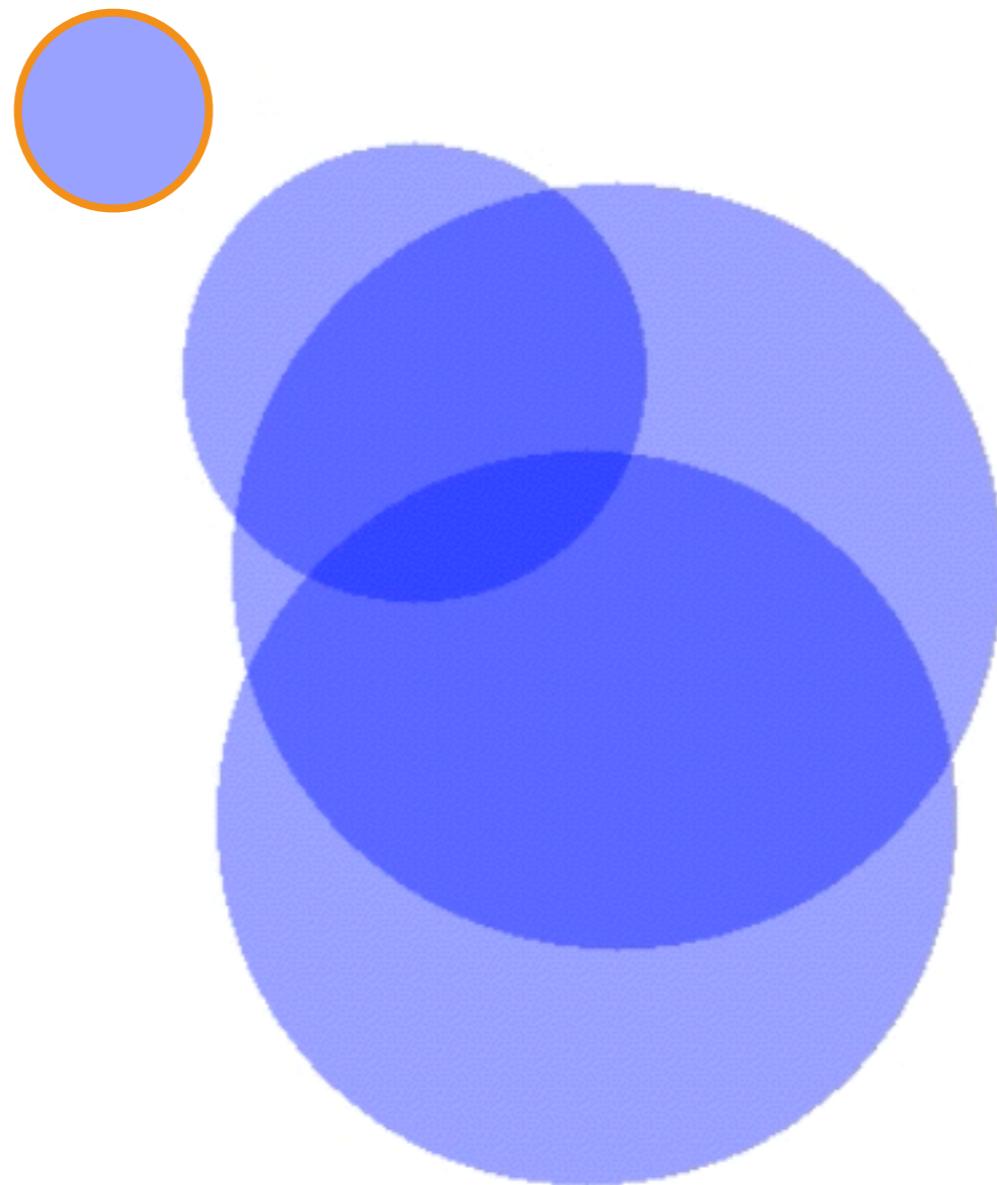
Palms have large radius.

Palms flicker in and out.

Stylus is isolated.

Palms move little, styluses have smooth trajectories.



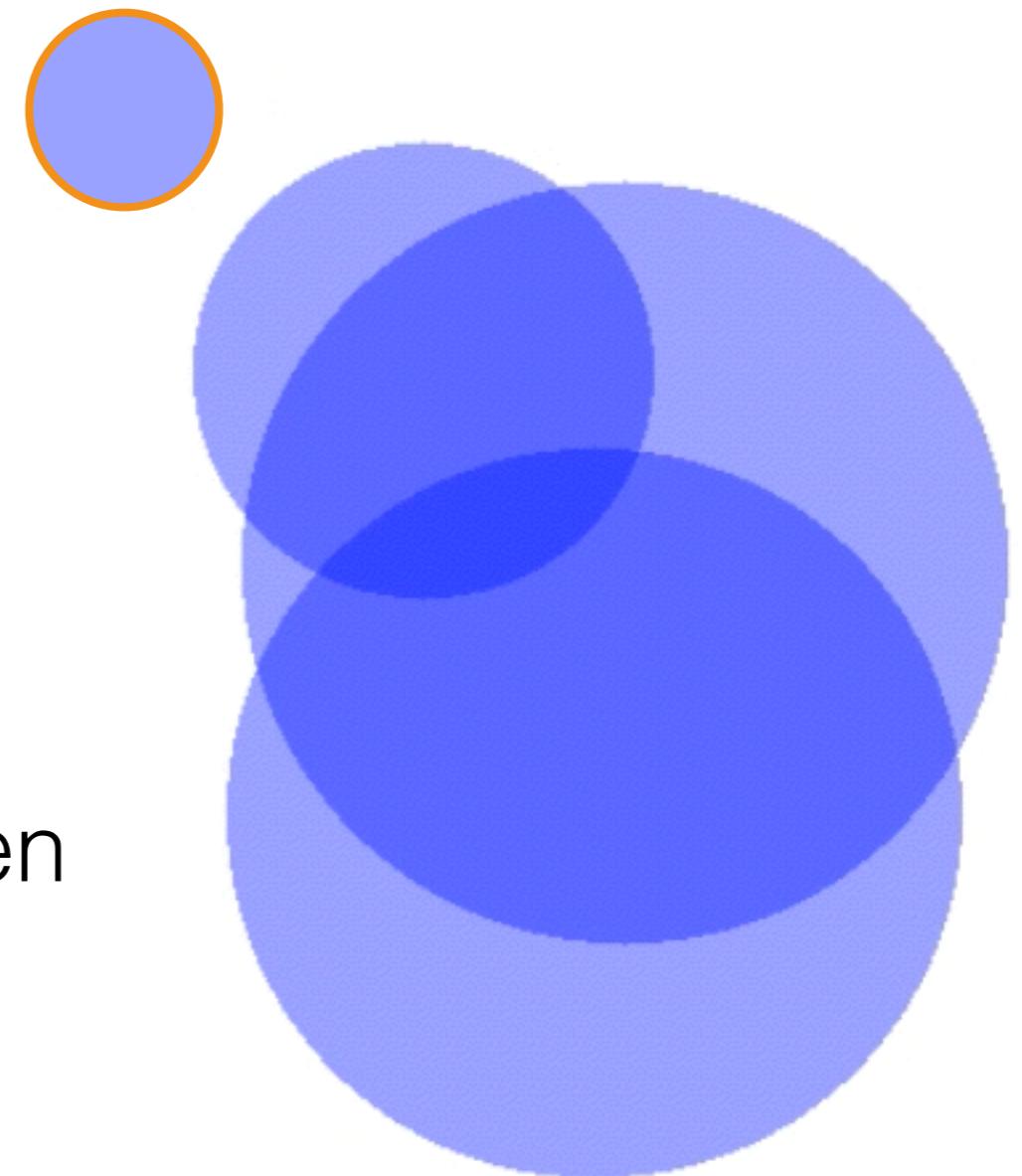


$t = 0$

Instantaneous Features

Touch radius

Distance to other touches on screen



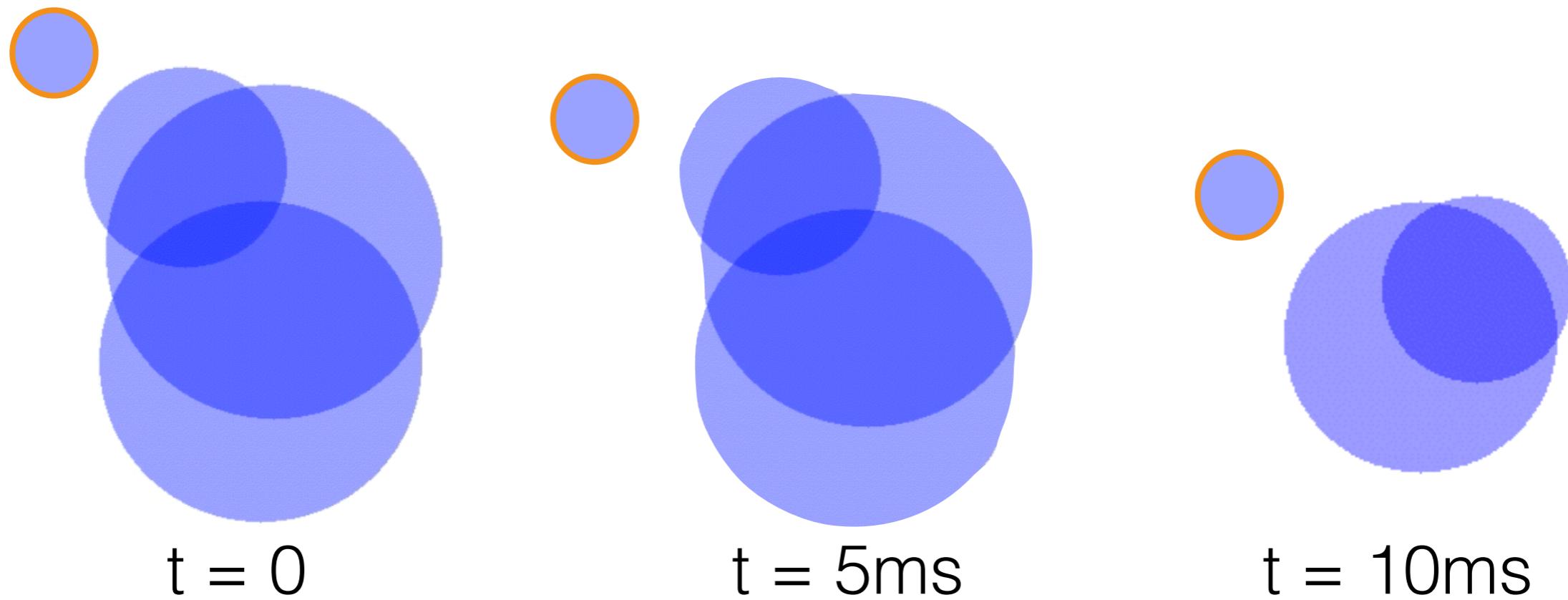
$t = 0$

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

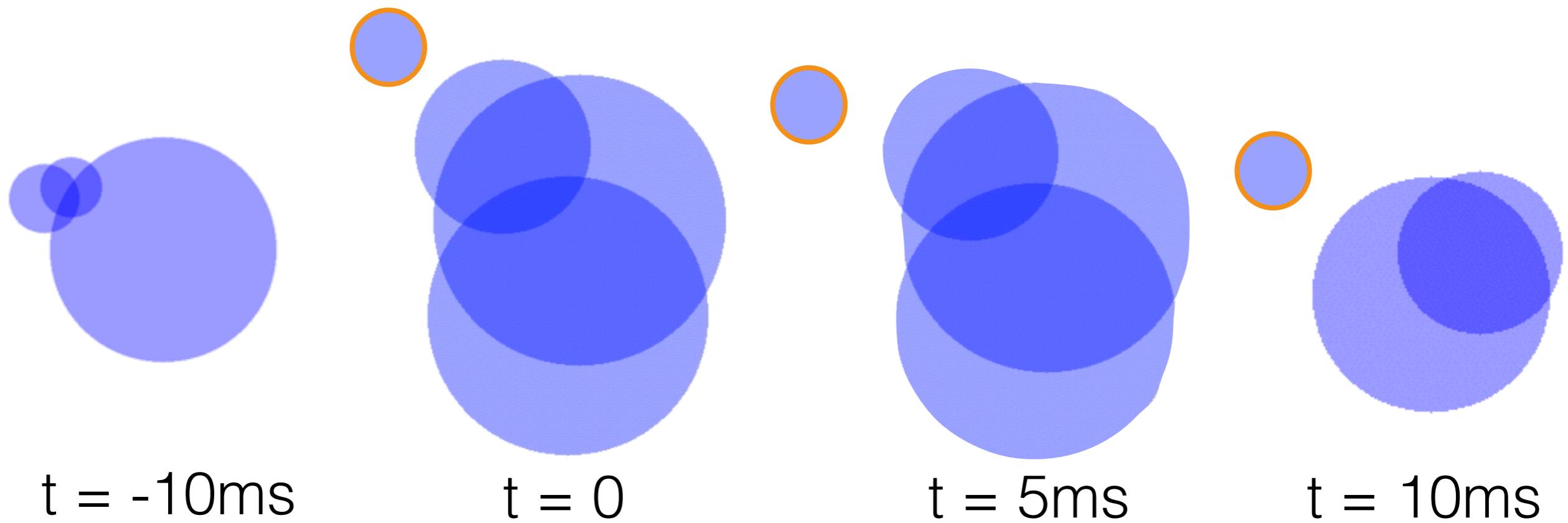


Touch Sequence Features

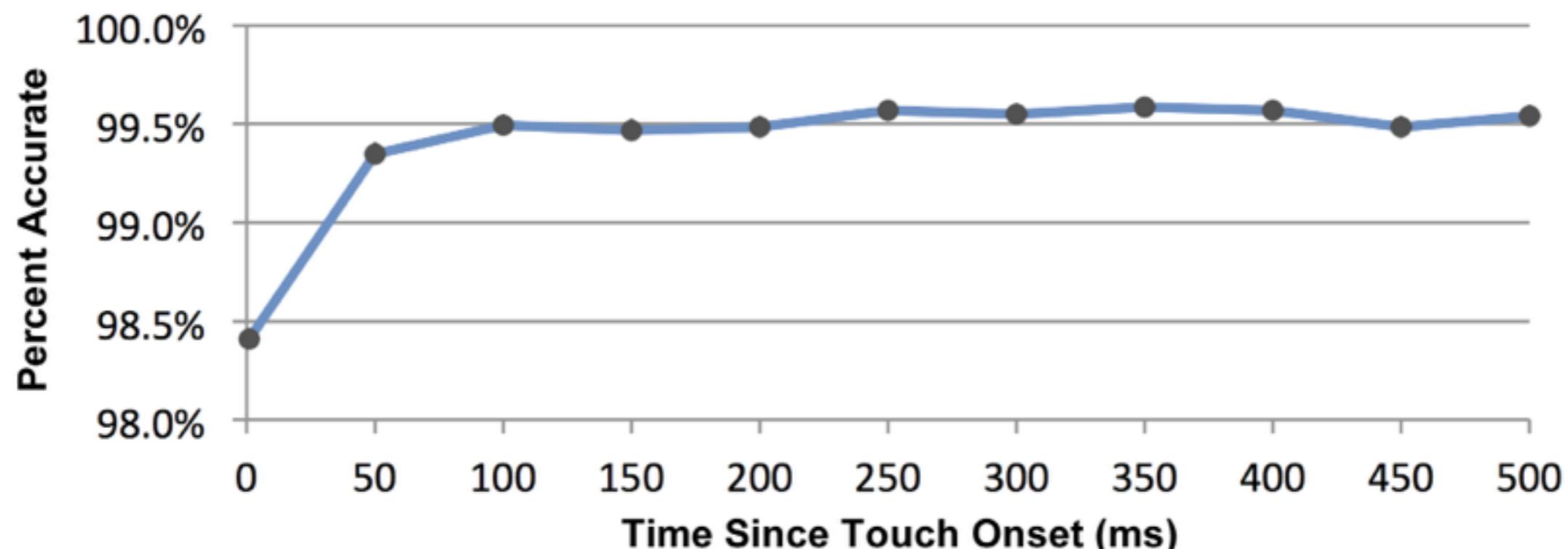
[μ, σ, \min, \max] touch radius over sequence

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

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



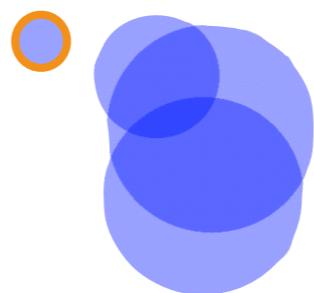
train: 11,000 instances from 3 people
test: 11,000 instances from 2 different people
train and test data gathered in different locations and on different days

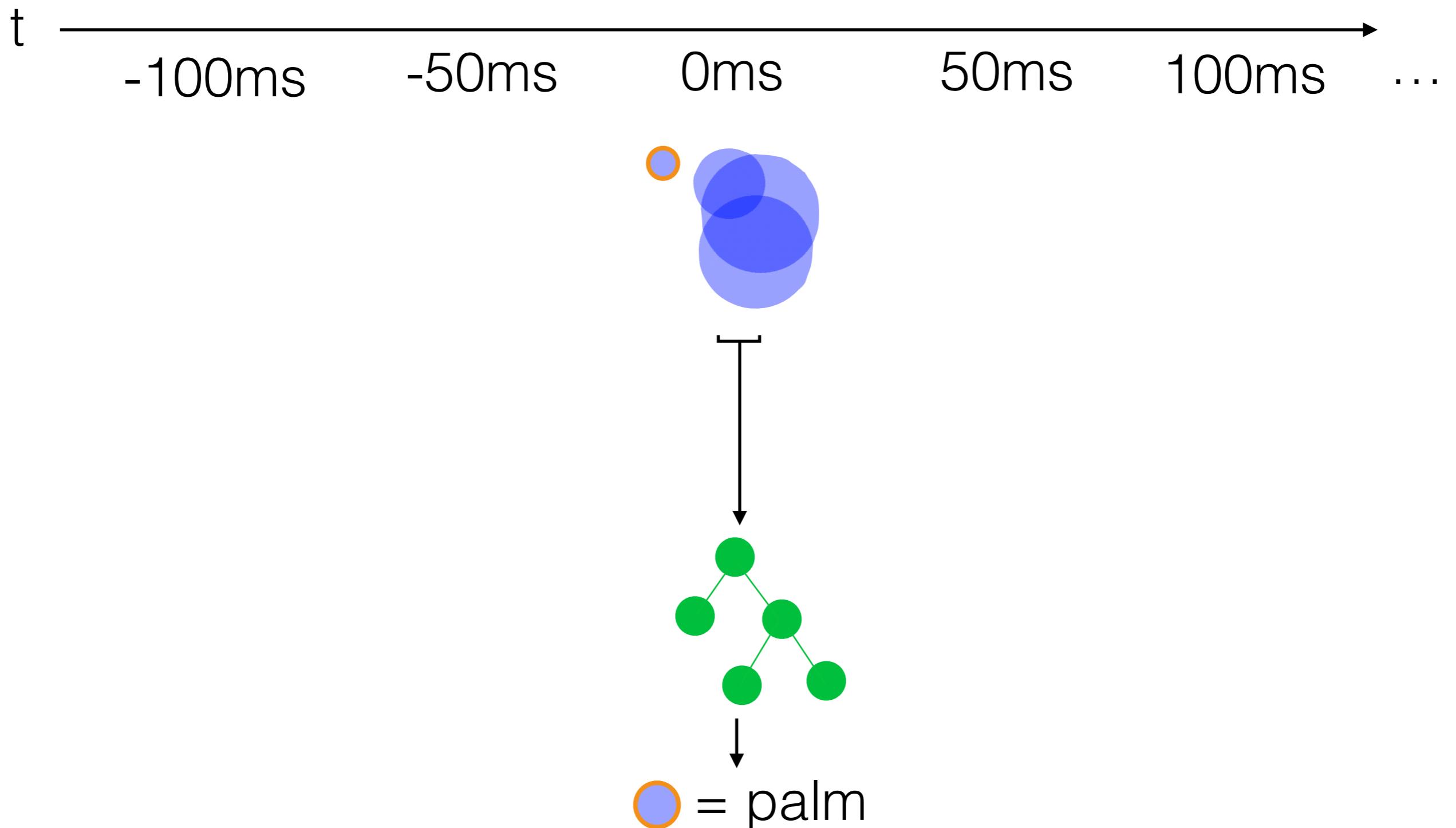


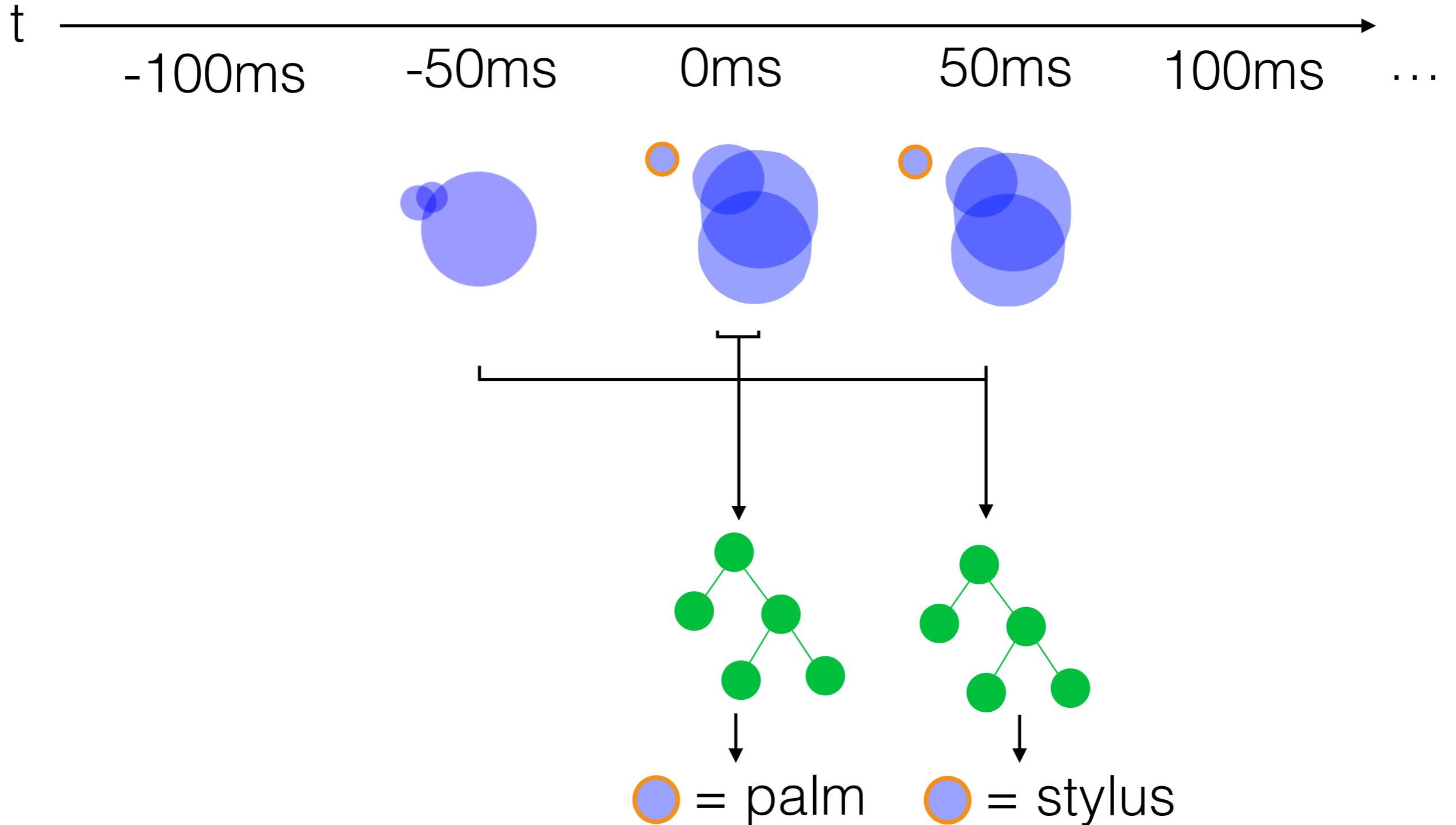
* leftmost point is at t = 1ms

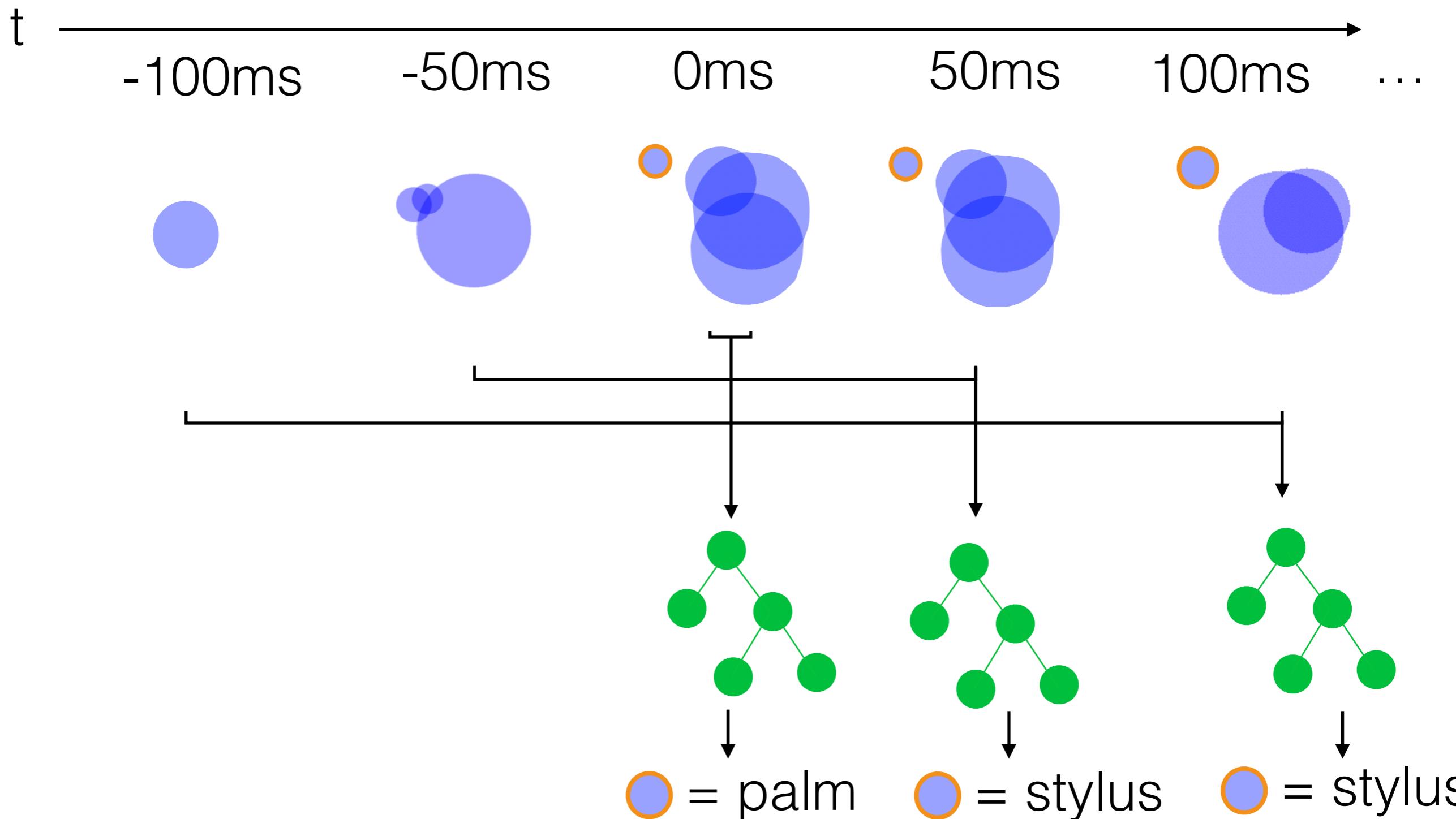
Window size of ~250ms would be ideal.

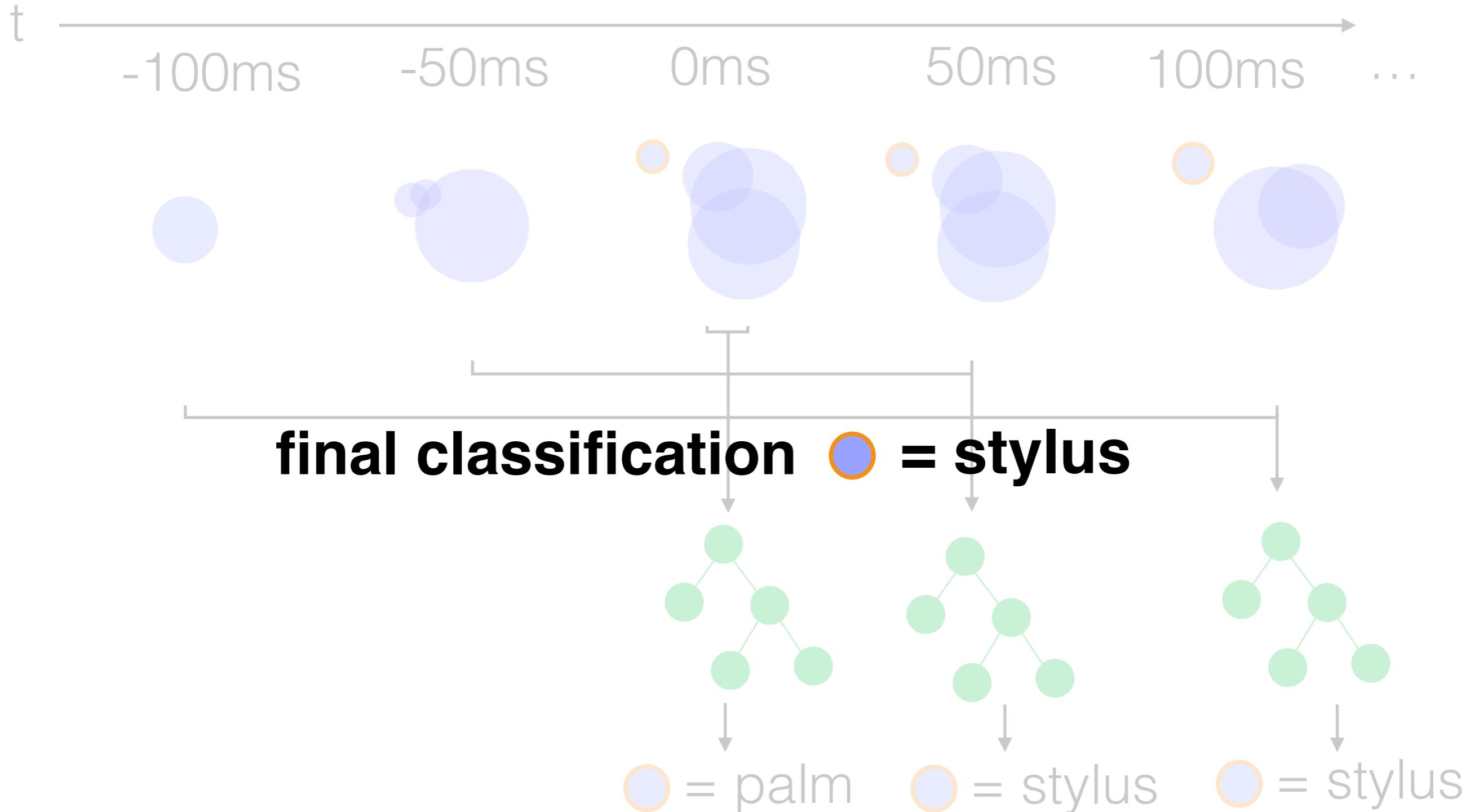
Want to provide immediate feedback to the user.











Demo

Evaluation



Penultimate

vs.



Bamboo

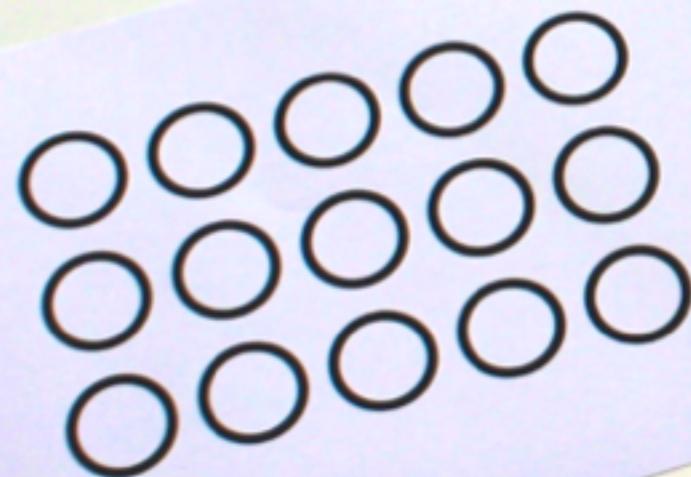
vs.



Our App

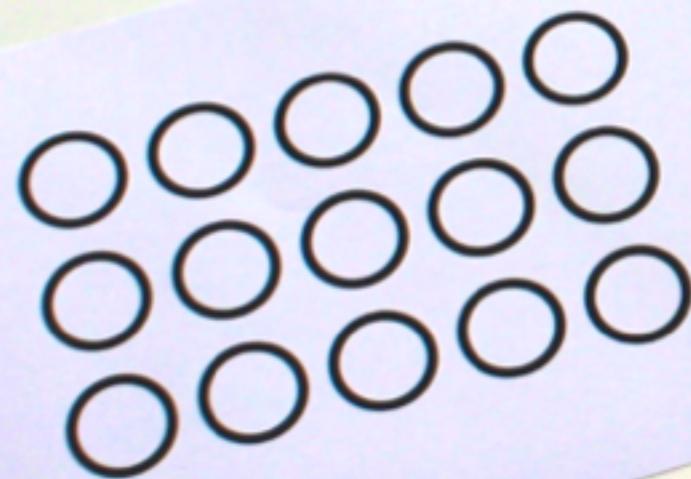
symbols:

SO • - IL

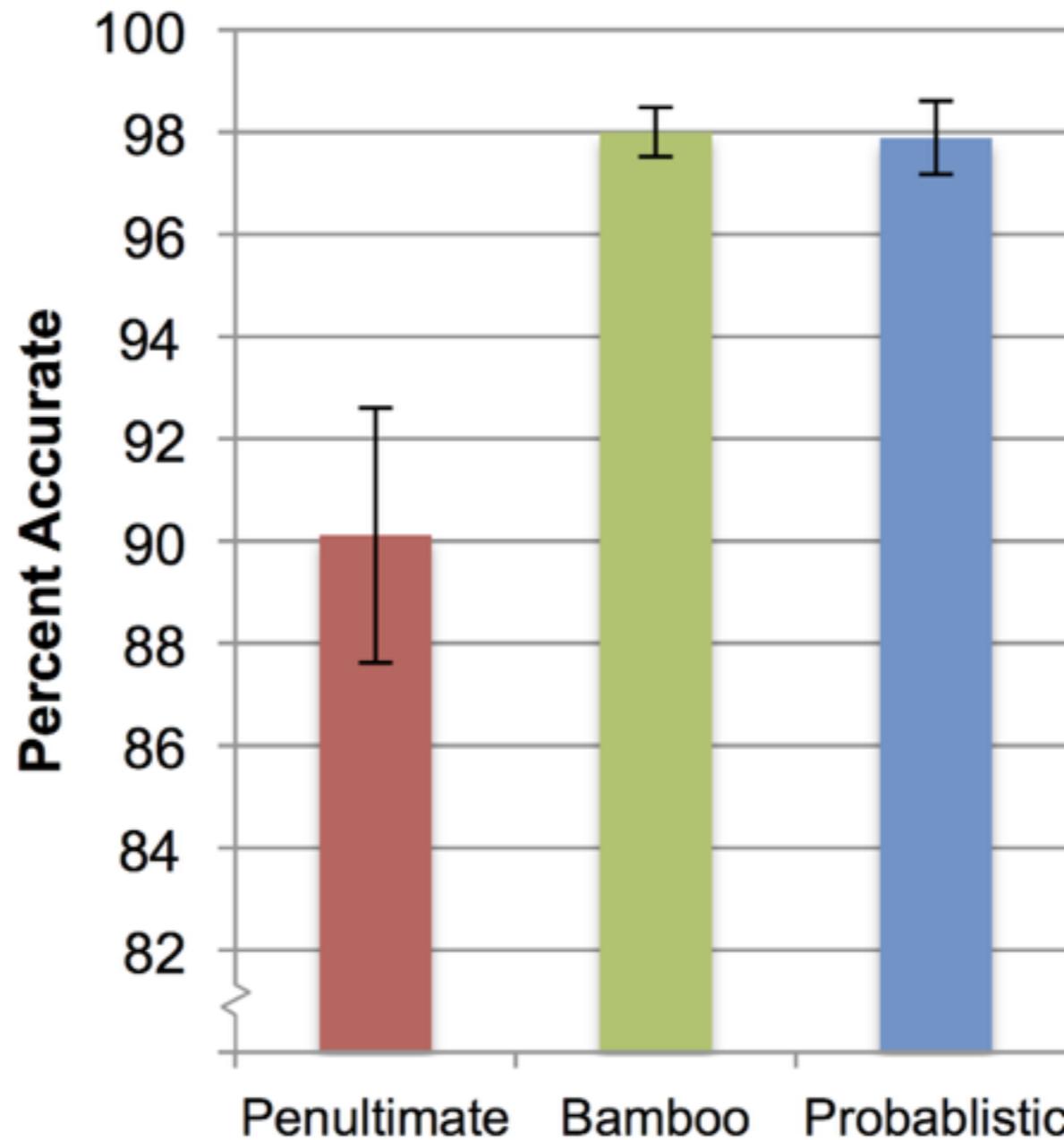


symbols:

SO • - IL



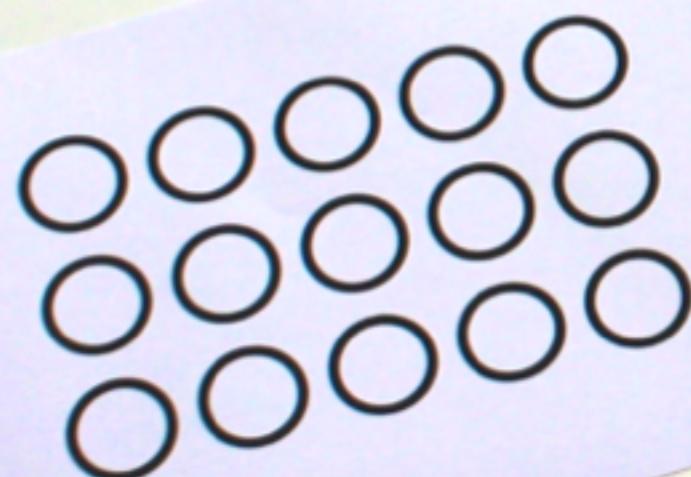
True Positives



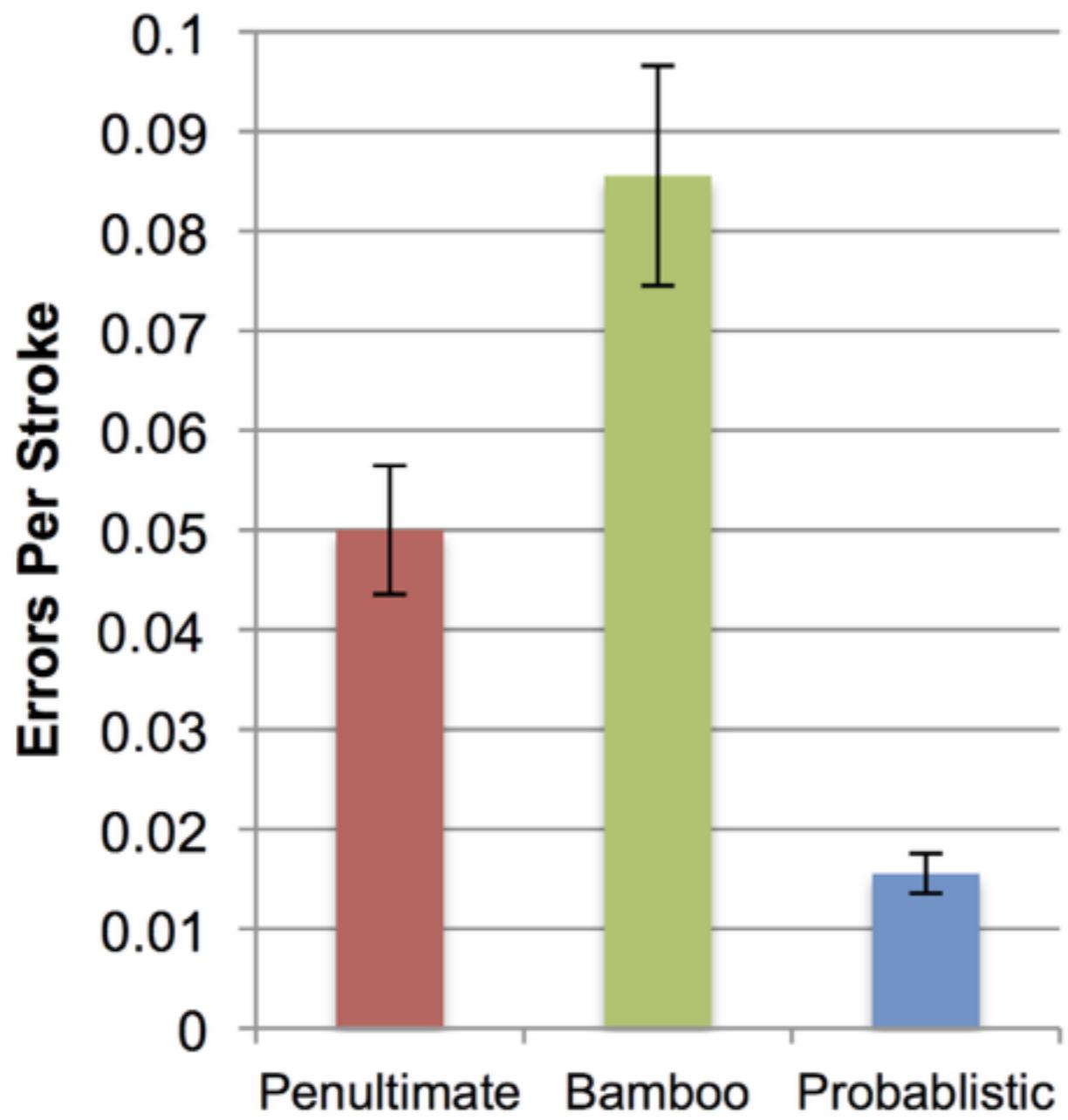
% pen strokes classified as pen strokes
error bars = 95% confidence interval

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