What does Carl want me to talk about?

?

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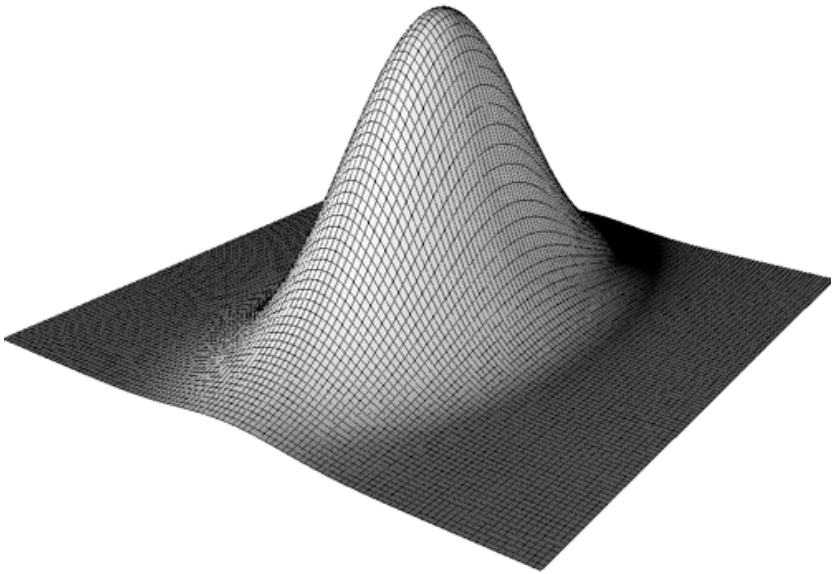
Five conclusions

1. Humans are “fusion” engines (we call it “cue combination”. Very rule-governed)
2. Humans are really good at some tasks (e.g. contour completion, rapid object identification)
3. Humans are really bad at some tasks (e.g. profound capacity limits, Bayes gone bad)
4. Expert behavior is worth studying … and possibly modifying
5. You really want to work with researchers who know about the human angle (and I can help you find them…..*Ellenbogen’s cautionary tale notwithstanding*)

1. Fusion (Cue Combination)

Awesome sensor fusion

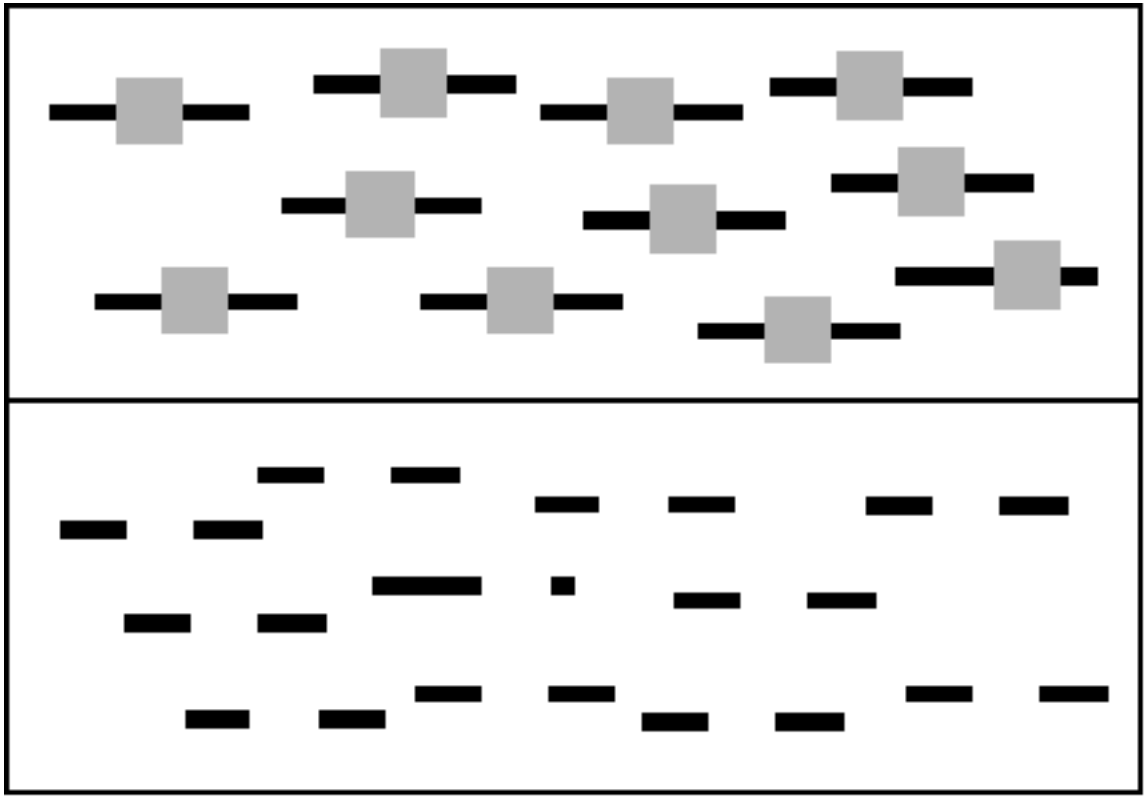
Cue Combination in human vision



Multiple cues to
bump height & shape
Lighting
Texture
Maybe touch
etc

Standard cue combination might be a weighted sum

Cue Combination in human vision



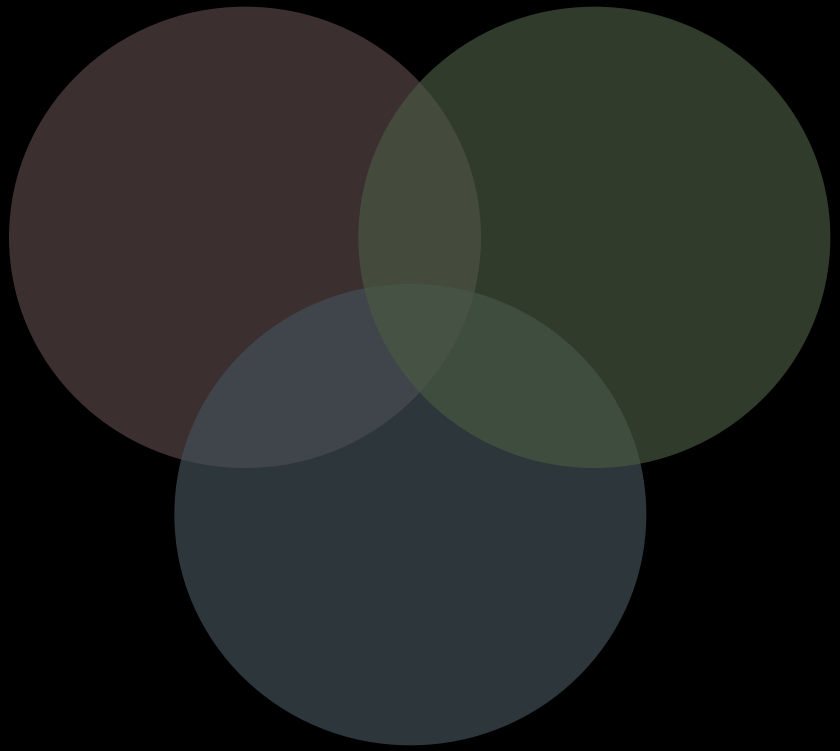
Find the tiny line segment

Sometimes one signal trumps or vetoes the others

Cue Combination in human vision

Sometimes cue combination produces an emergent property like stereoscopic depth

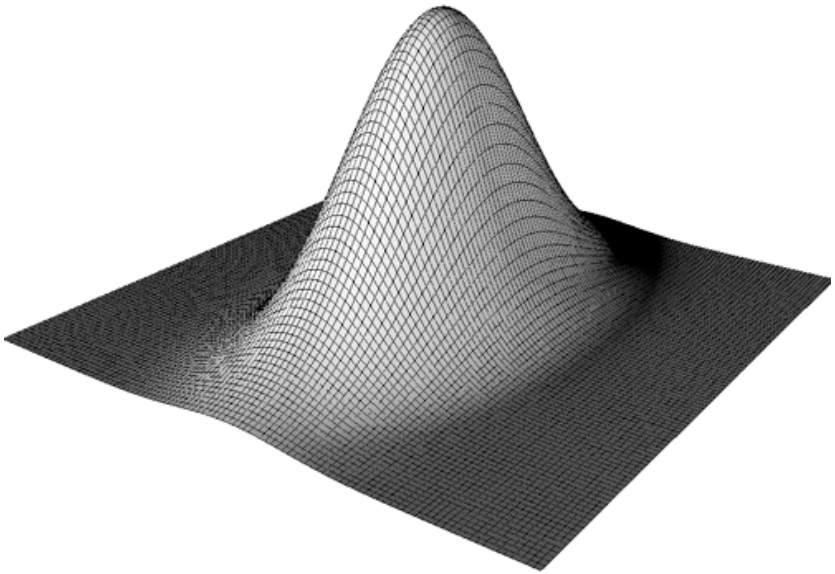
Cue Combination in human vision
The role of the observer



Peter Tse’s Demo

Humans are good

Remember this slide?



shape

Multiple cues to bump height & shape
Lighting
Texture
Maybe touch
etc

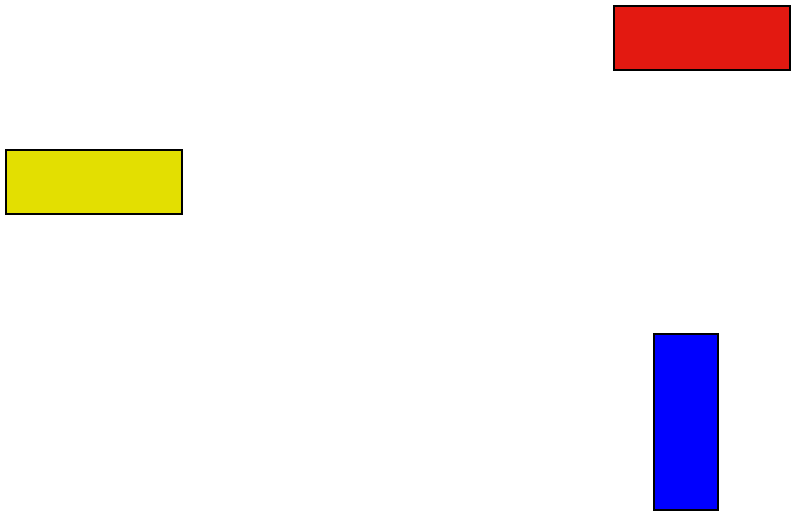
Humans are really good at inferring contours

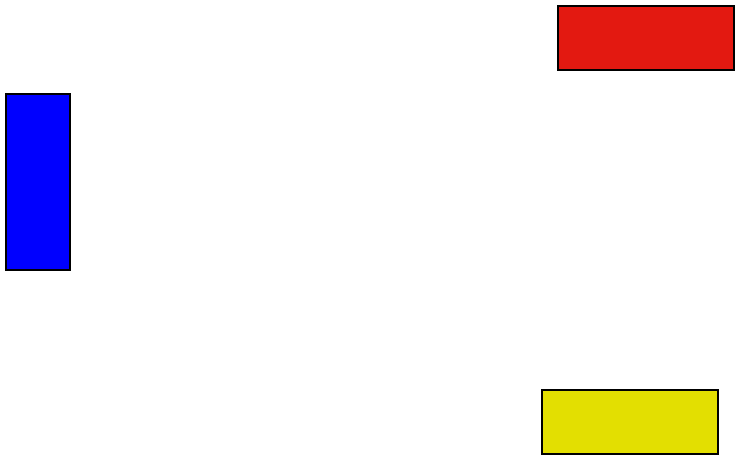
Look for the chimp

Humans can do recognition at high speed

When people fail

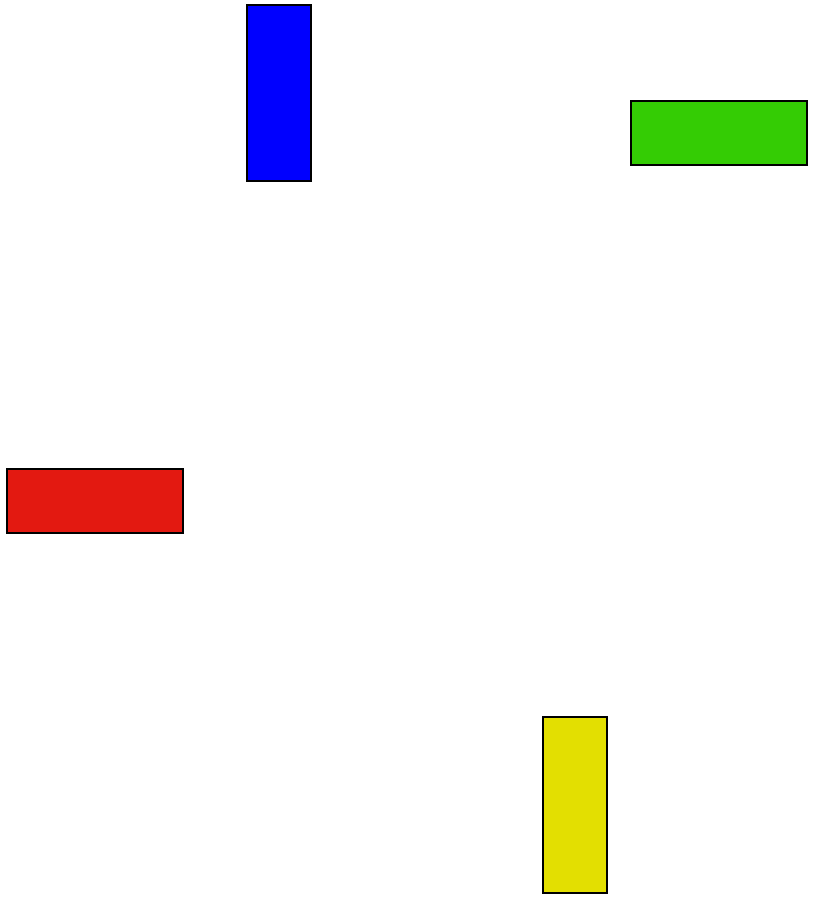
Remember this

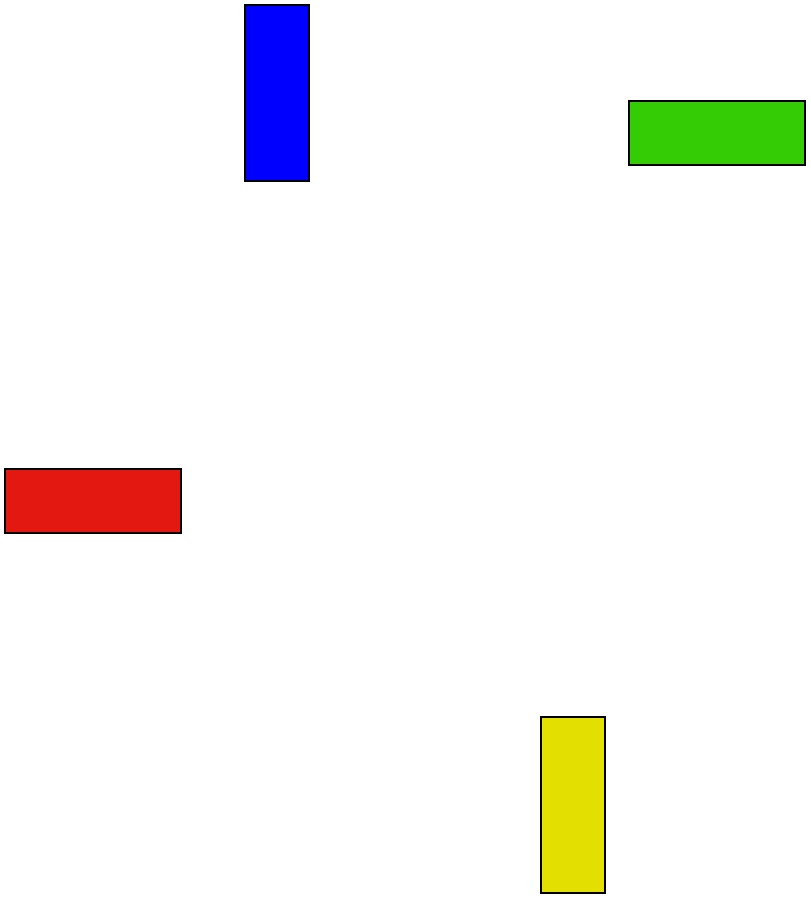




Any change?

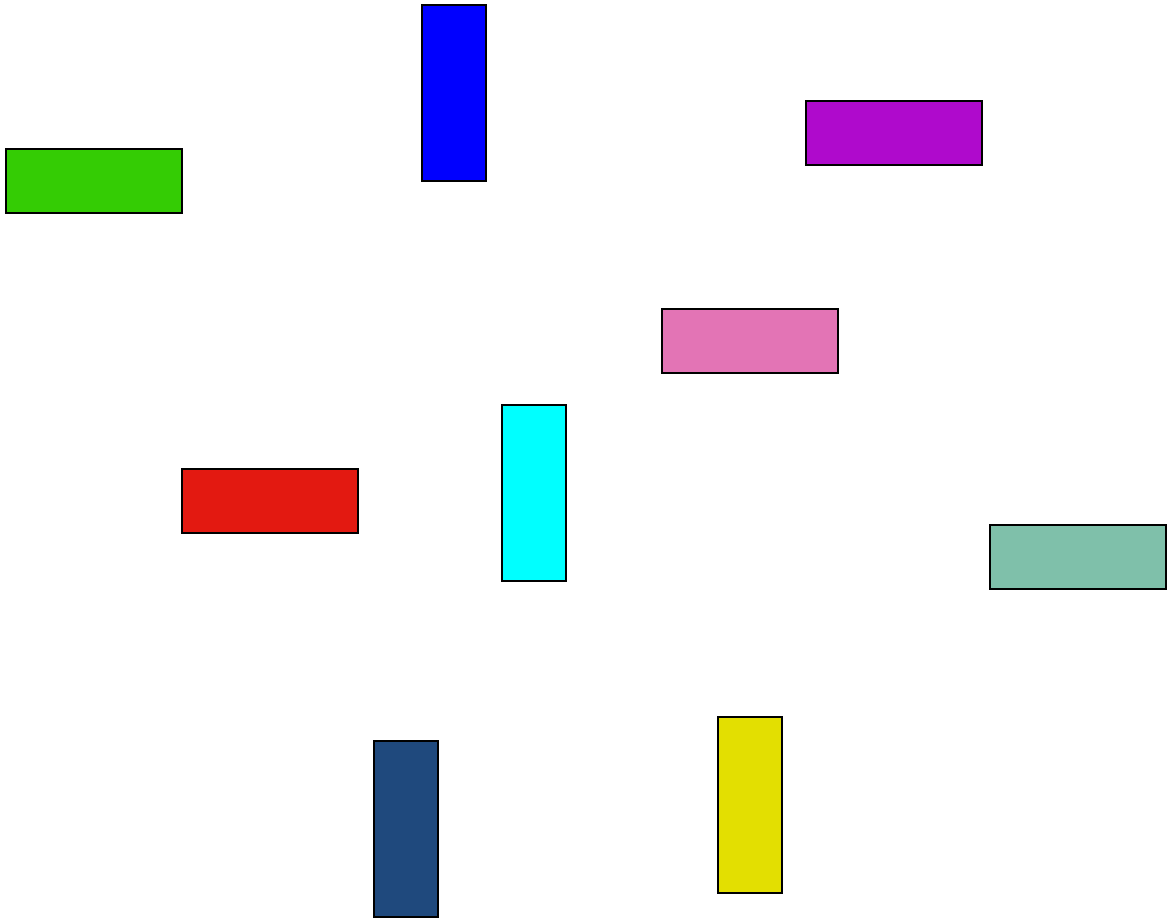
Remember this

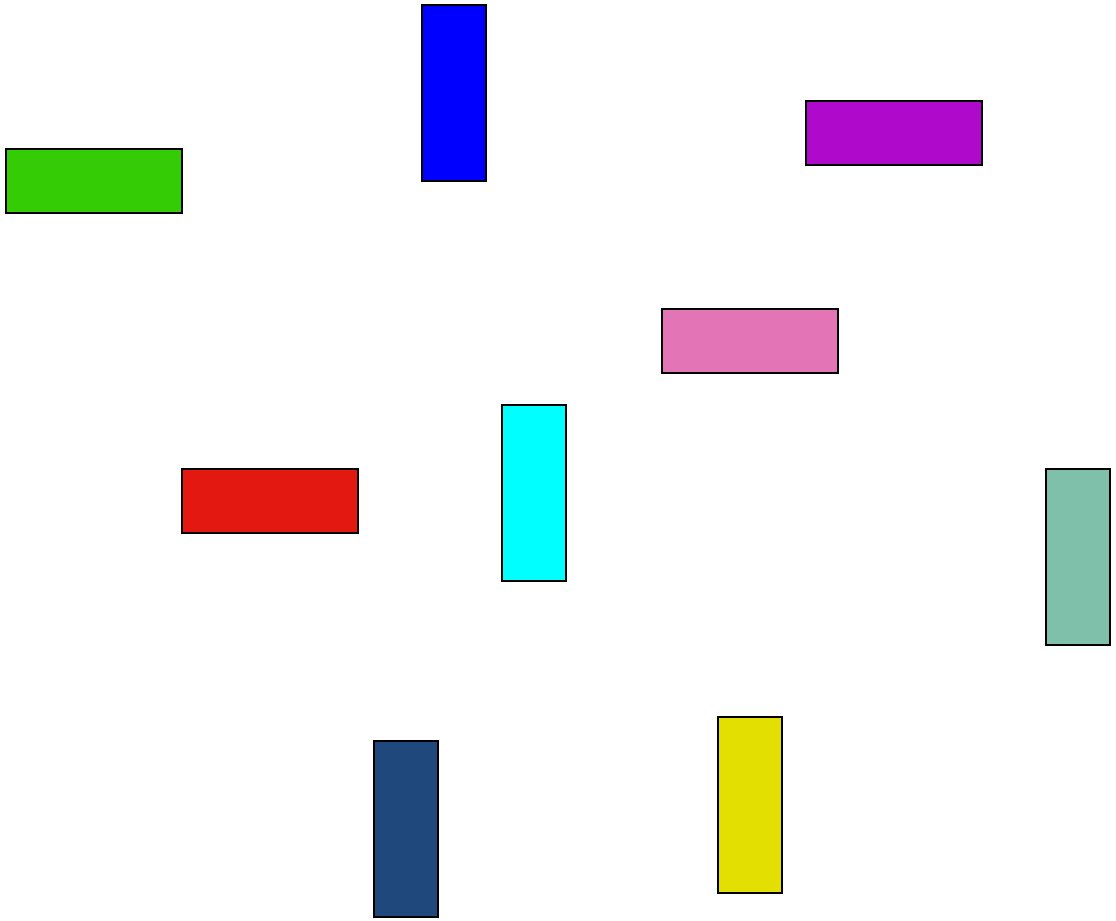




Any change?

Remember this





Any change?

Visual working memory has a capacity limit of ~4

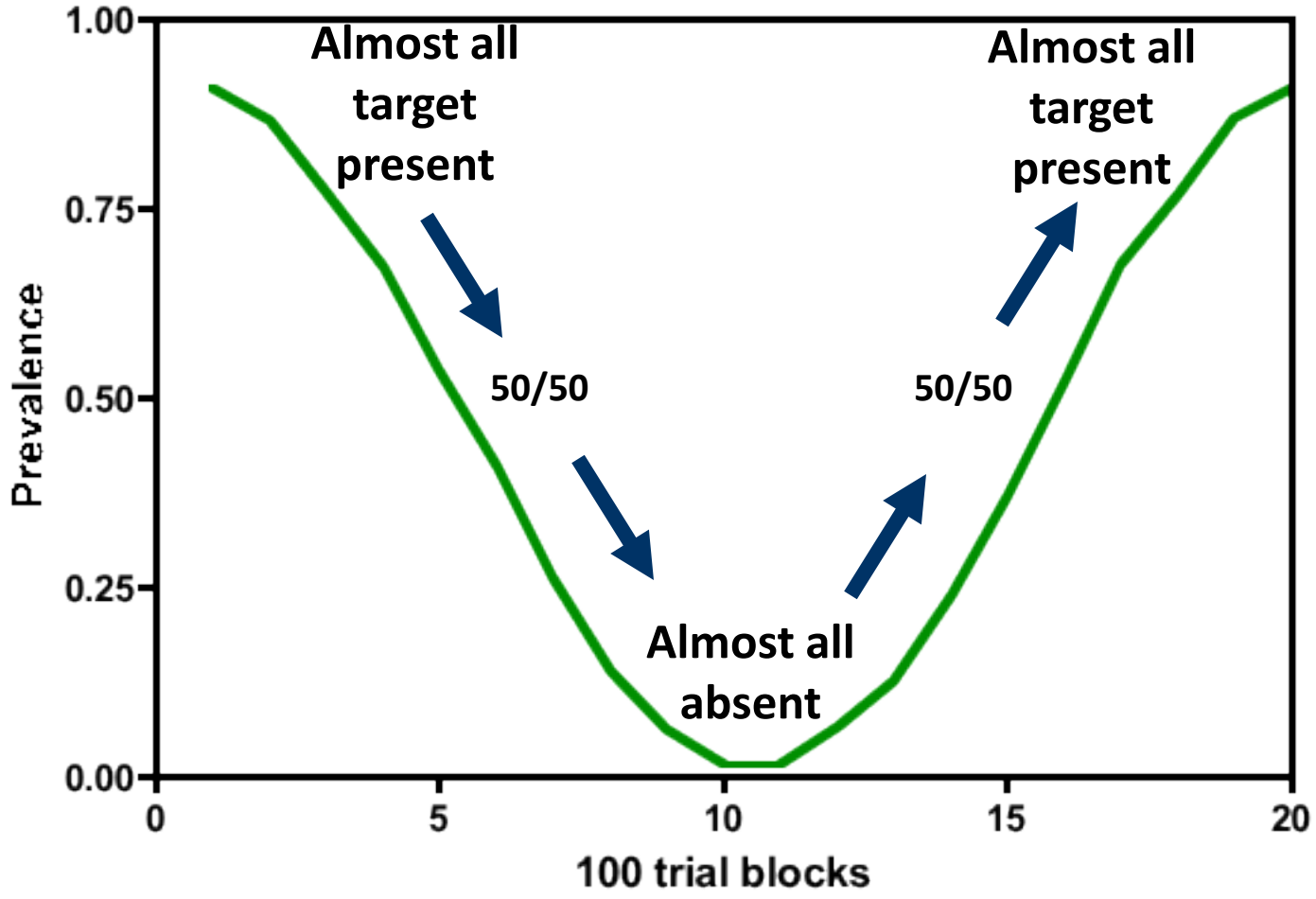
4 what?

Objects?

Features?

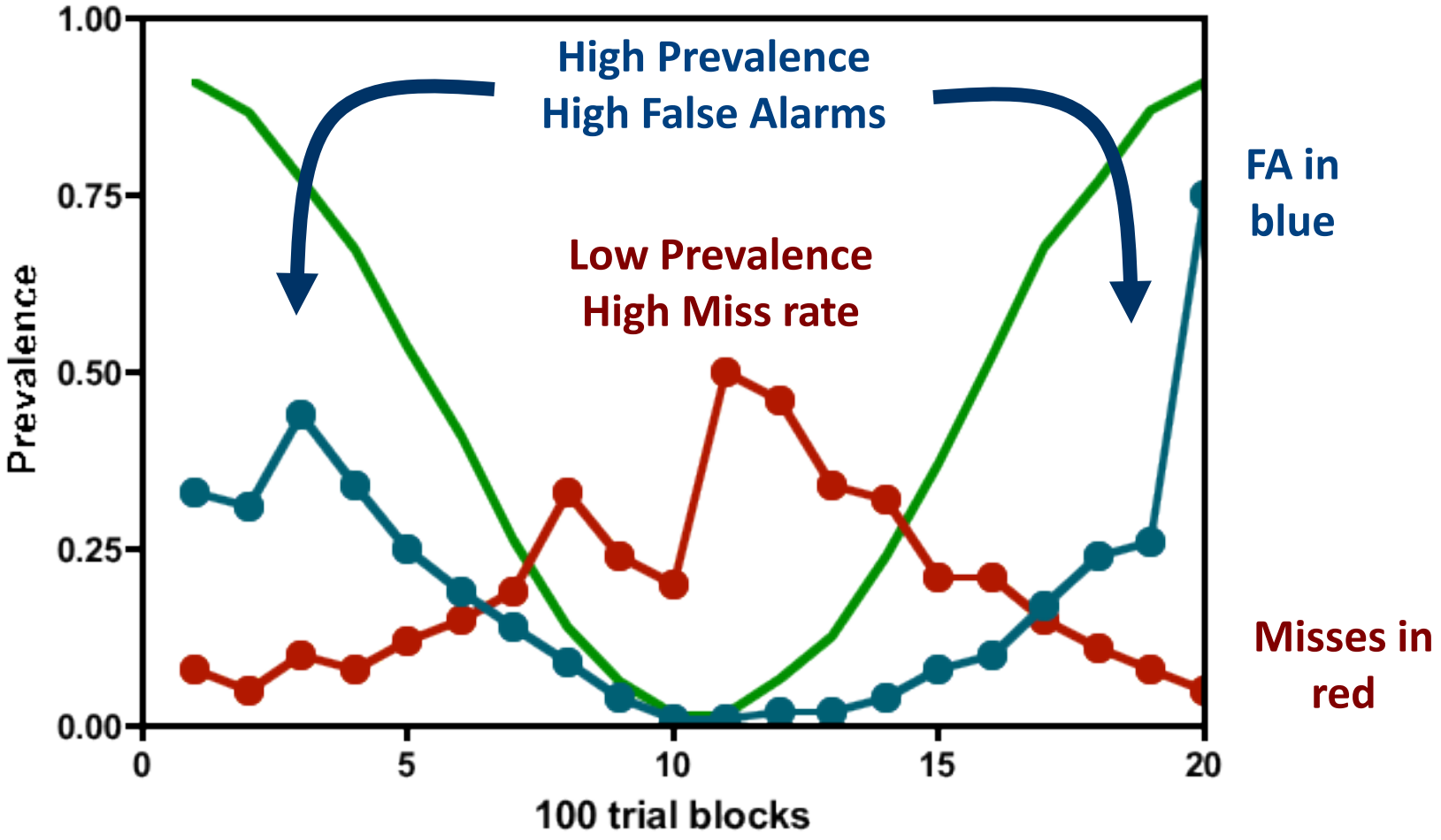
Humans respond to variables in ways that you may not want

Look for the same target at different prevalence



The errors trade off

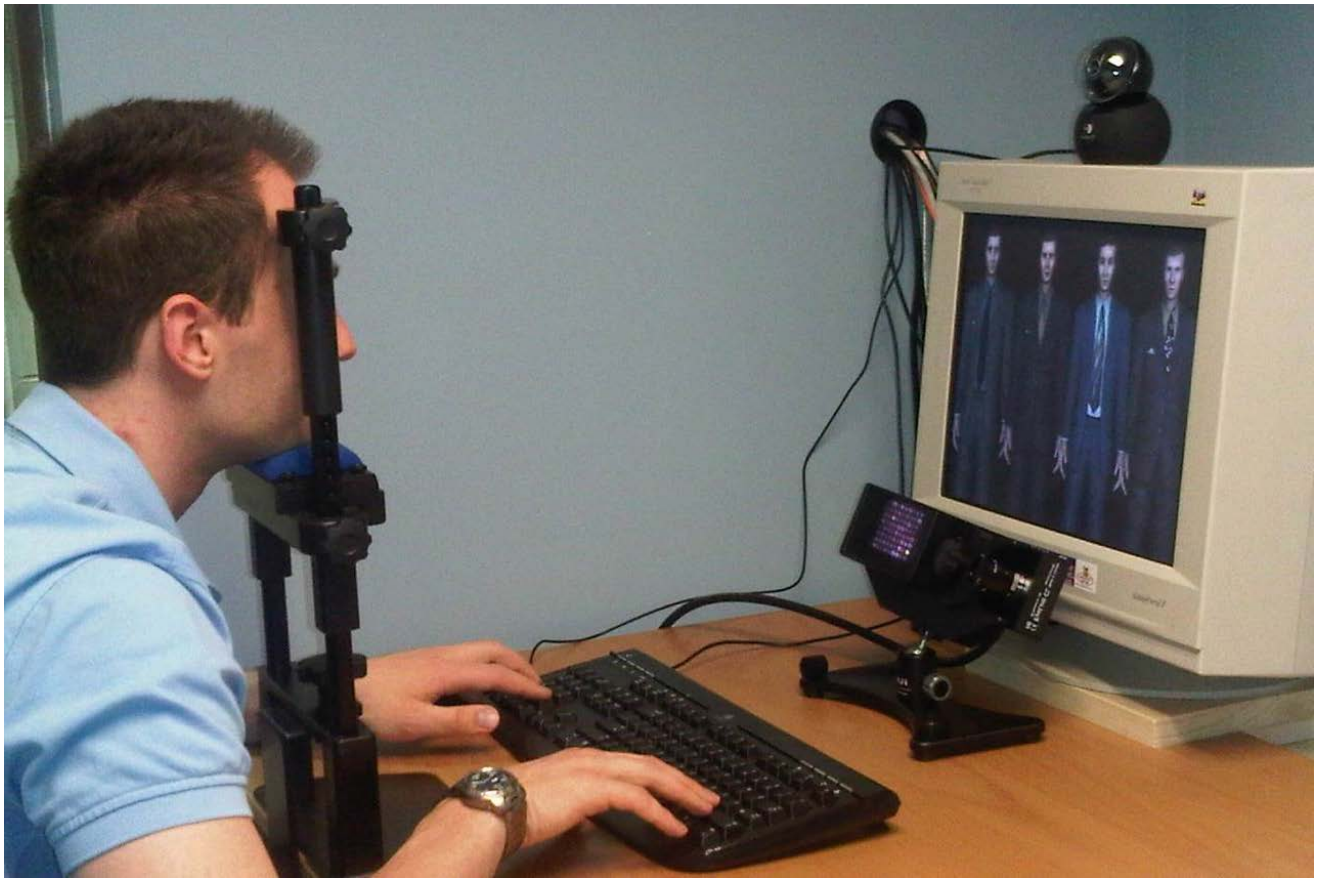
(remember, the stimuli are not changing)



Many other such variables

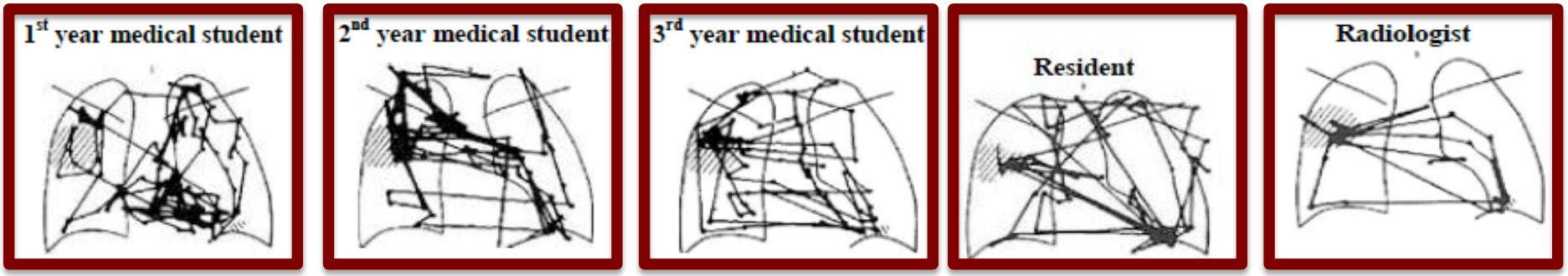
1. Reward structure
2. Fatigue
3. Circadian phase
4. Bias
5. Individual differences
6. etc

3. Understanding expert behavior

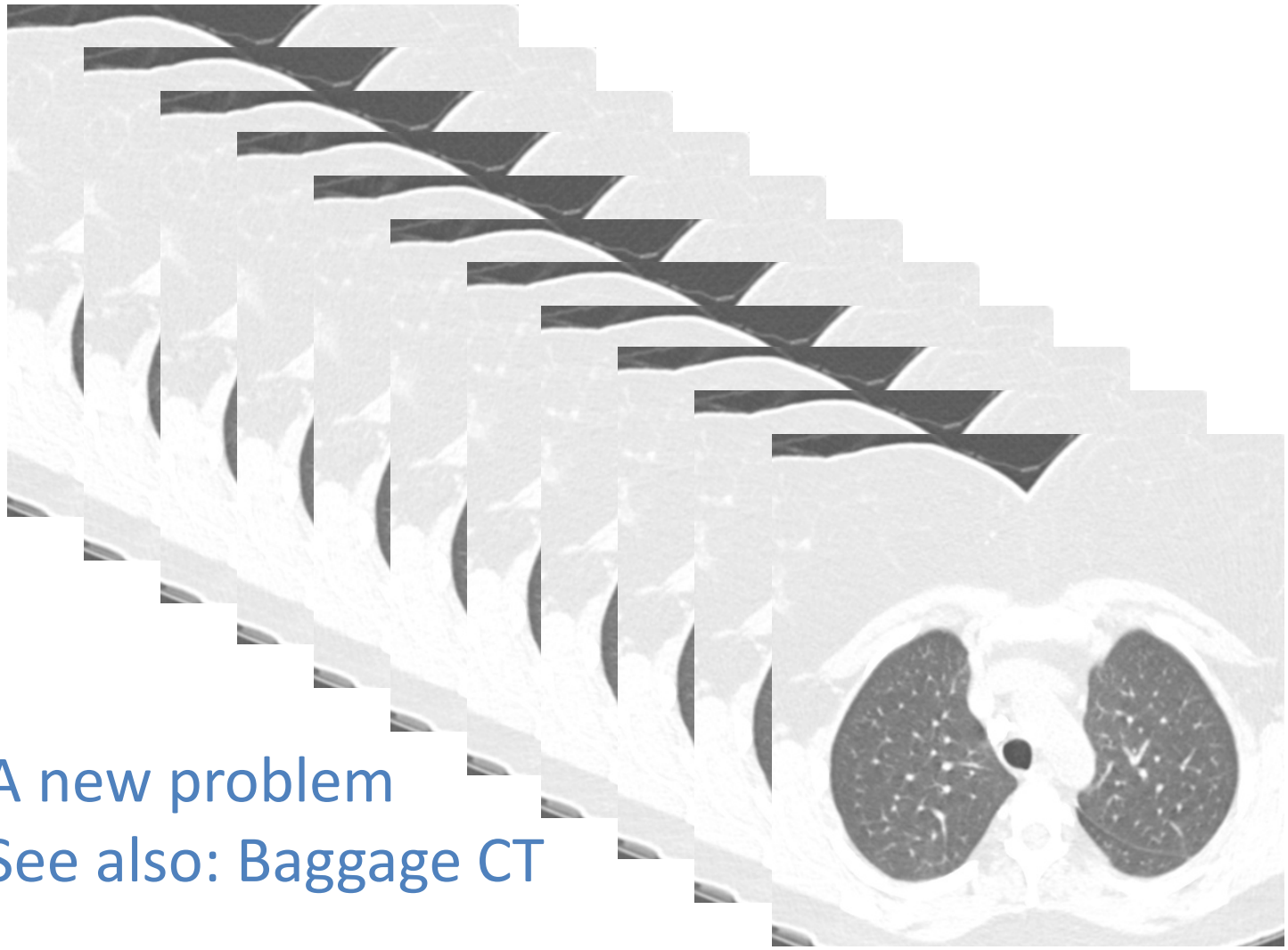


Eye tracking is a good example

The classic eye tracking result on the development of expertise



Eye movements in 3d volumes of images



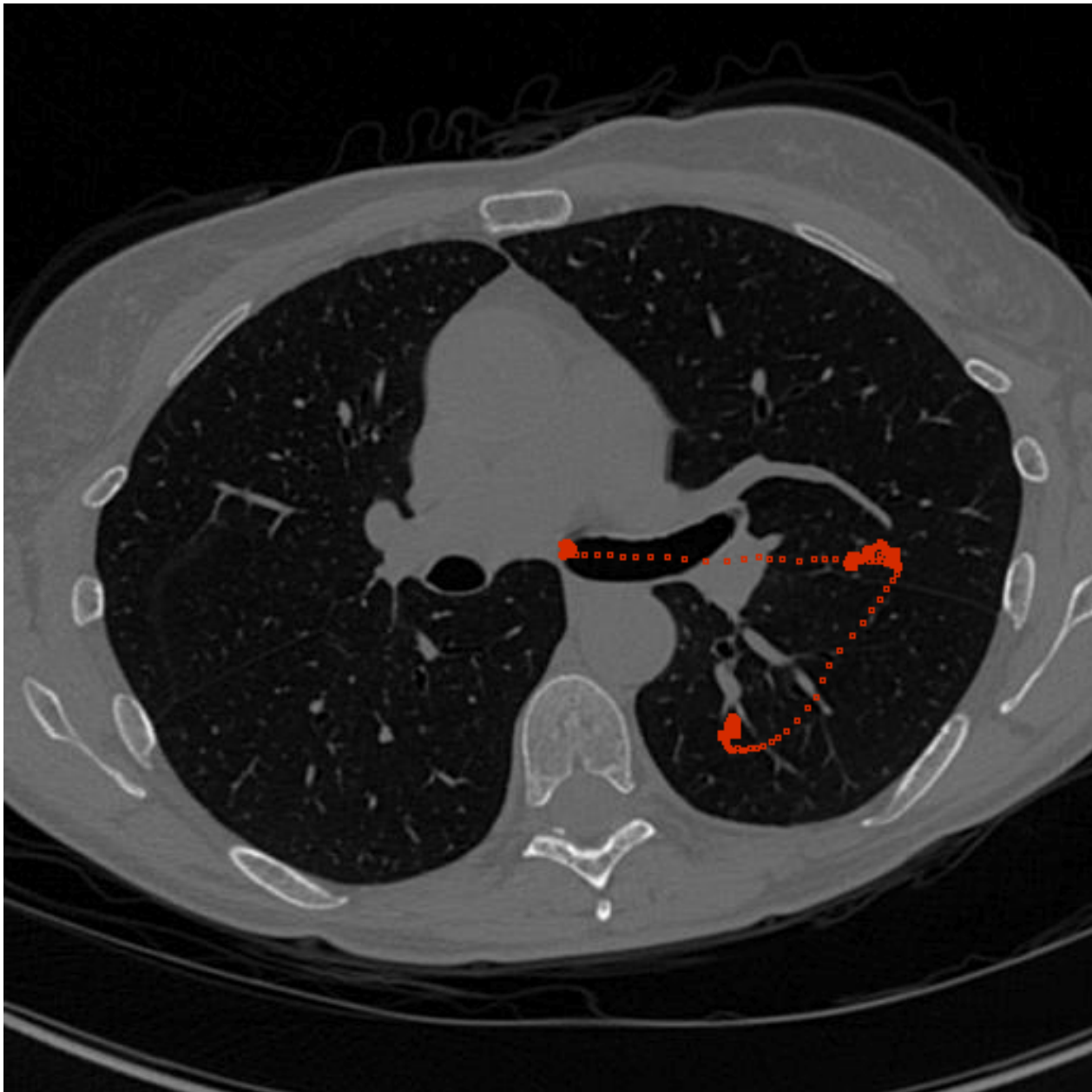
A new problem

See also: Baggage CT

What the behavior looks like

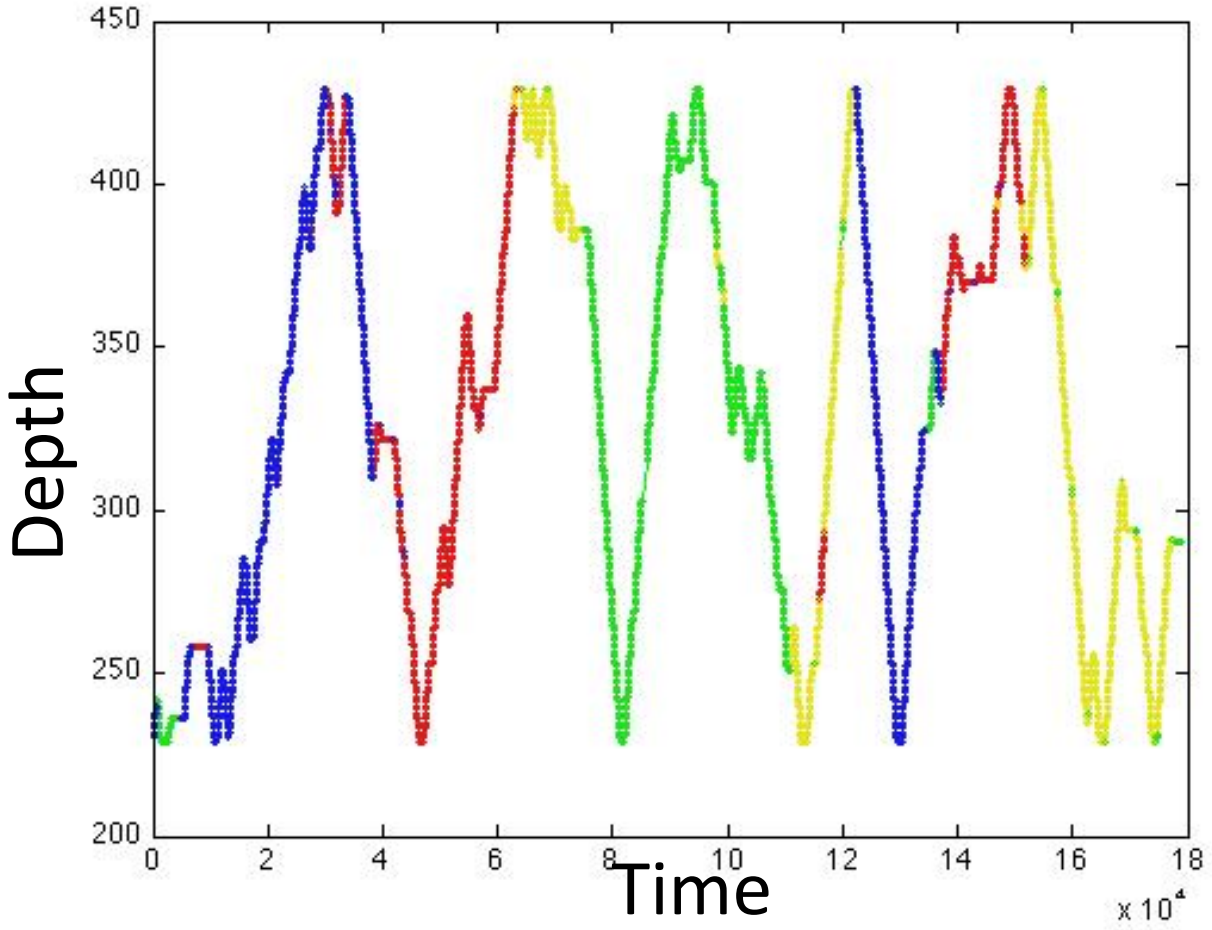
Red traces show eye movements in X & Y

We are also tracking the slice as a measure of Z position.

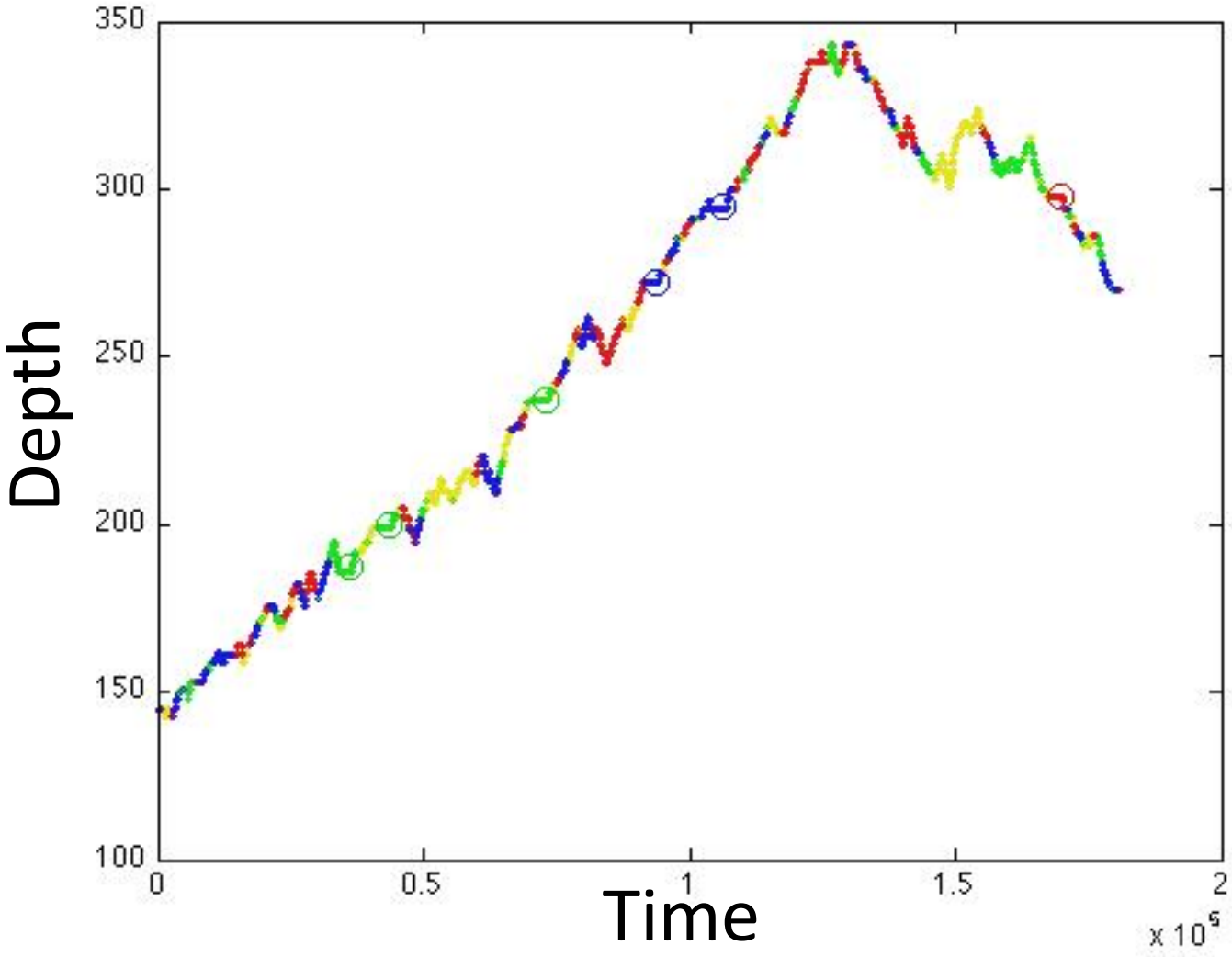


Let’s color code the quadrants

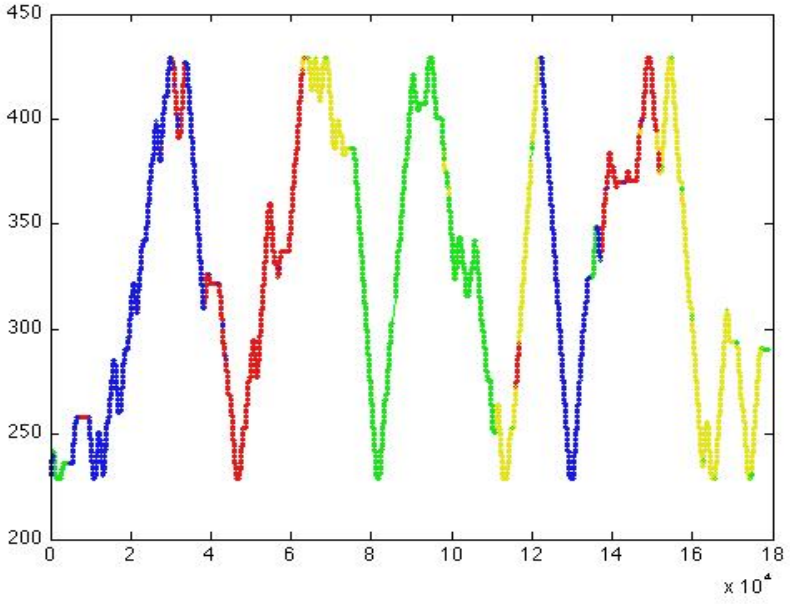
Here is Z with quadrants in XY color-coded for one expert radiologist

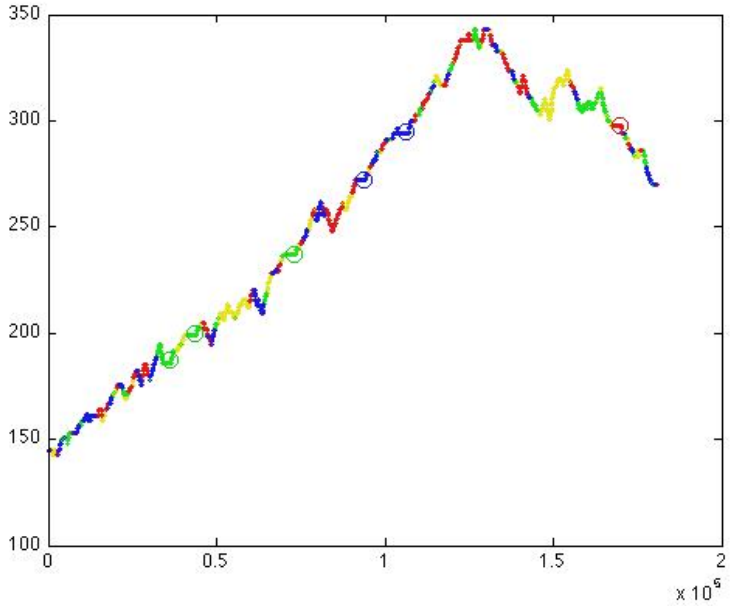


But here is another expert

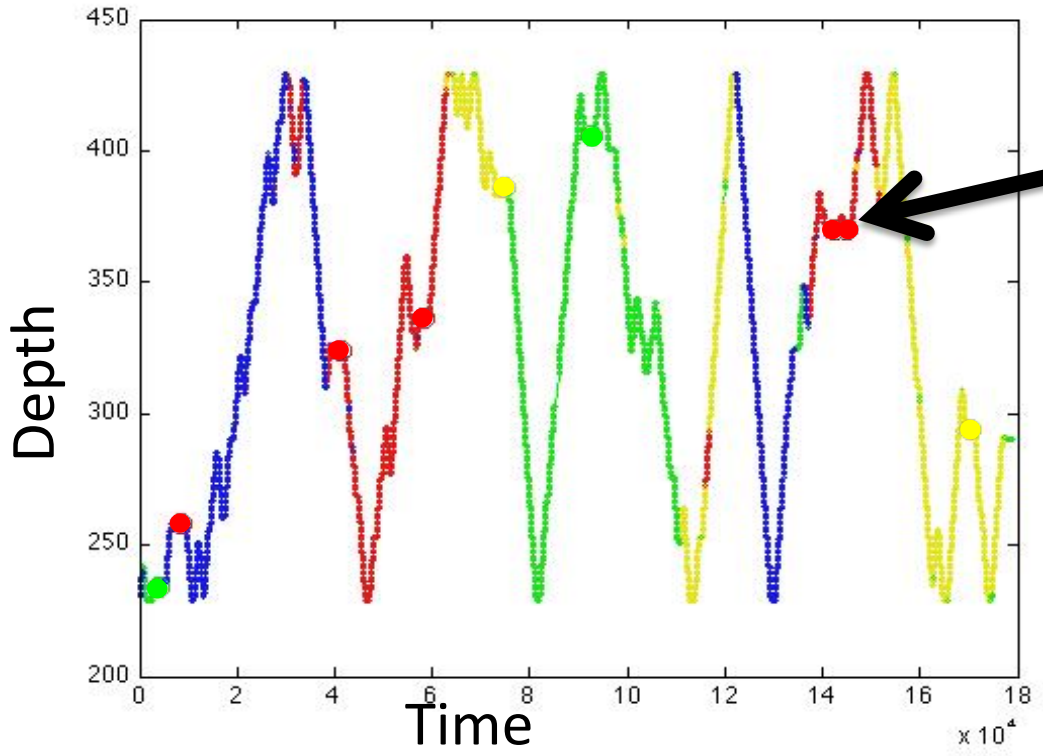


Drillers & Scanners

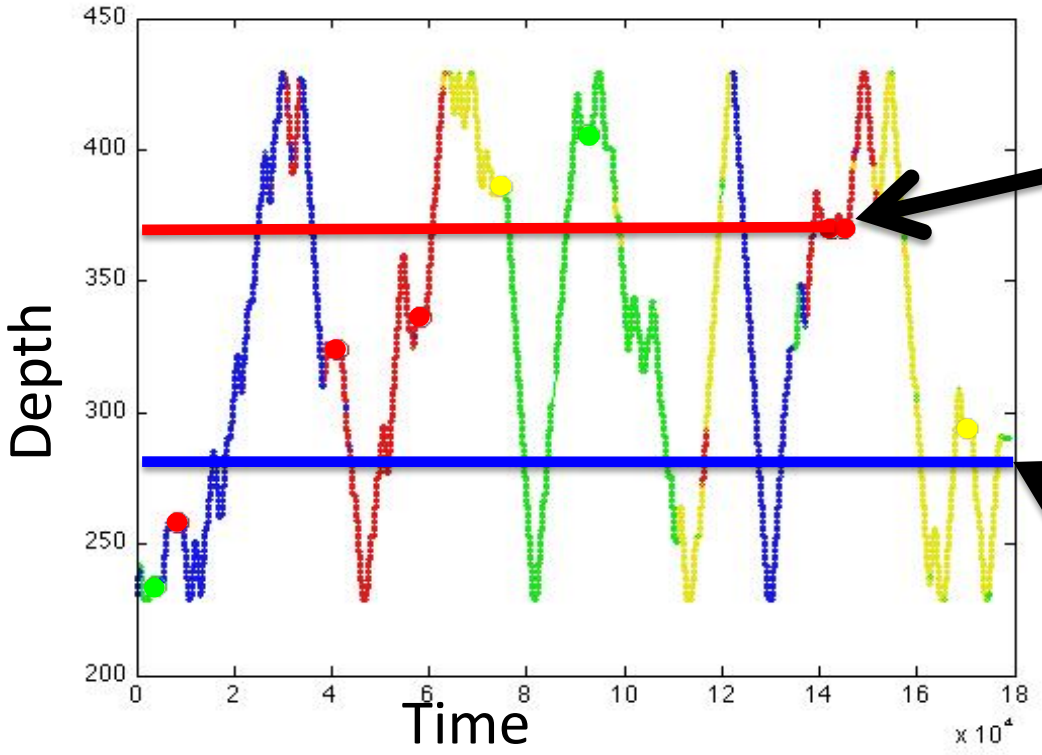




Does it matter?



Mark when a target is found

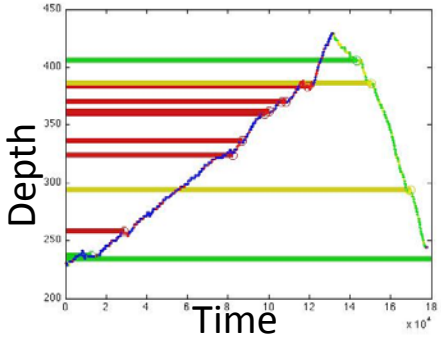


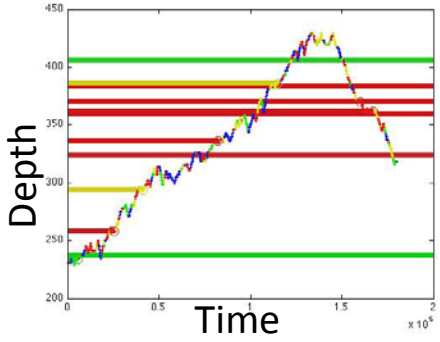
Use a line to show how long a target survives undetected

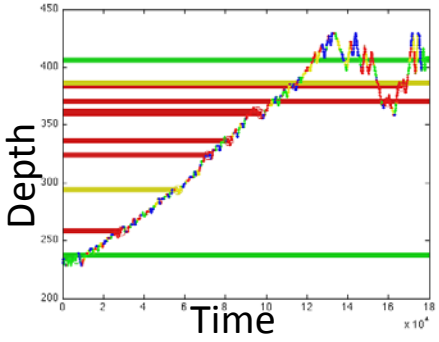
A line that makes it all the way across shows a target that was never found

6 experts

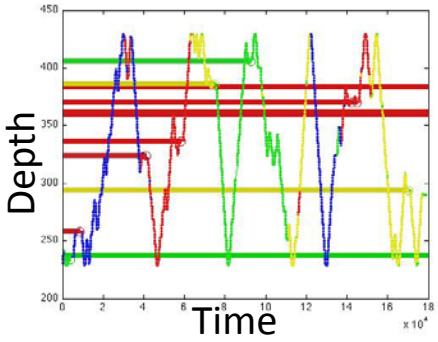
‘Scanners’

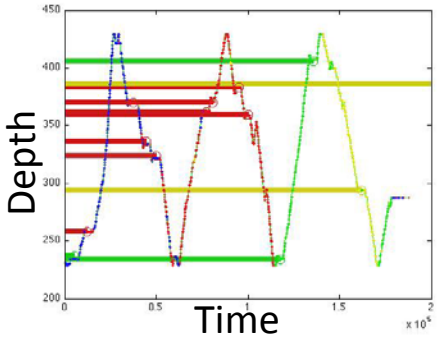


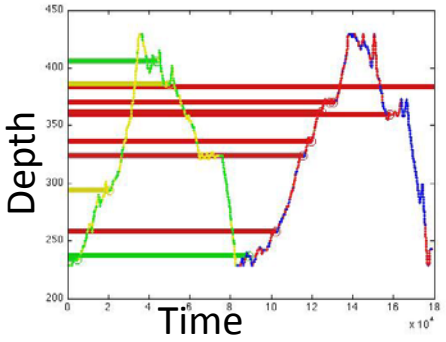




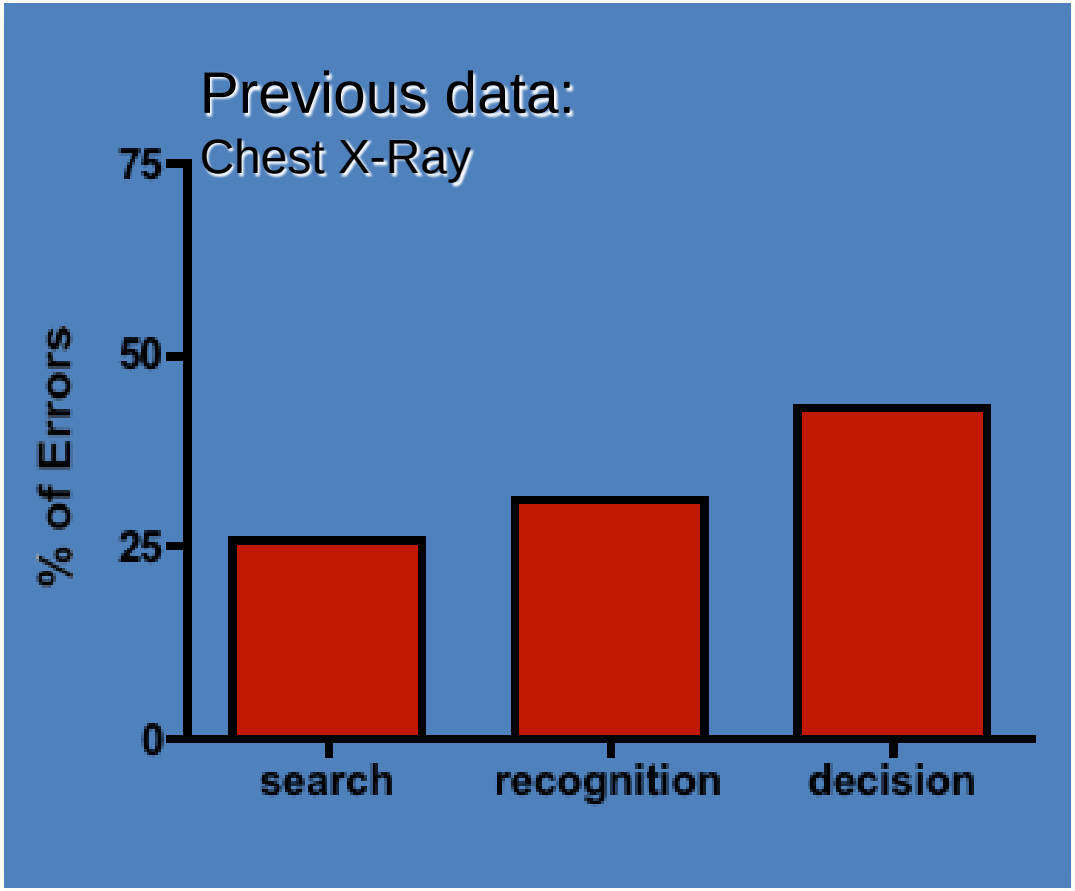
‘Drillers’





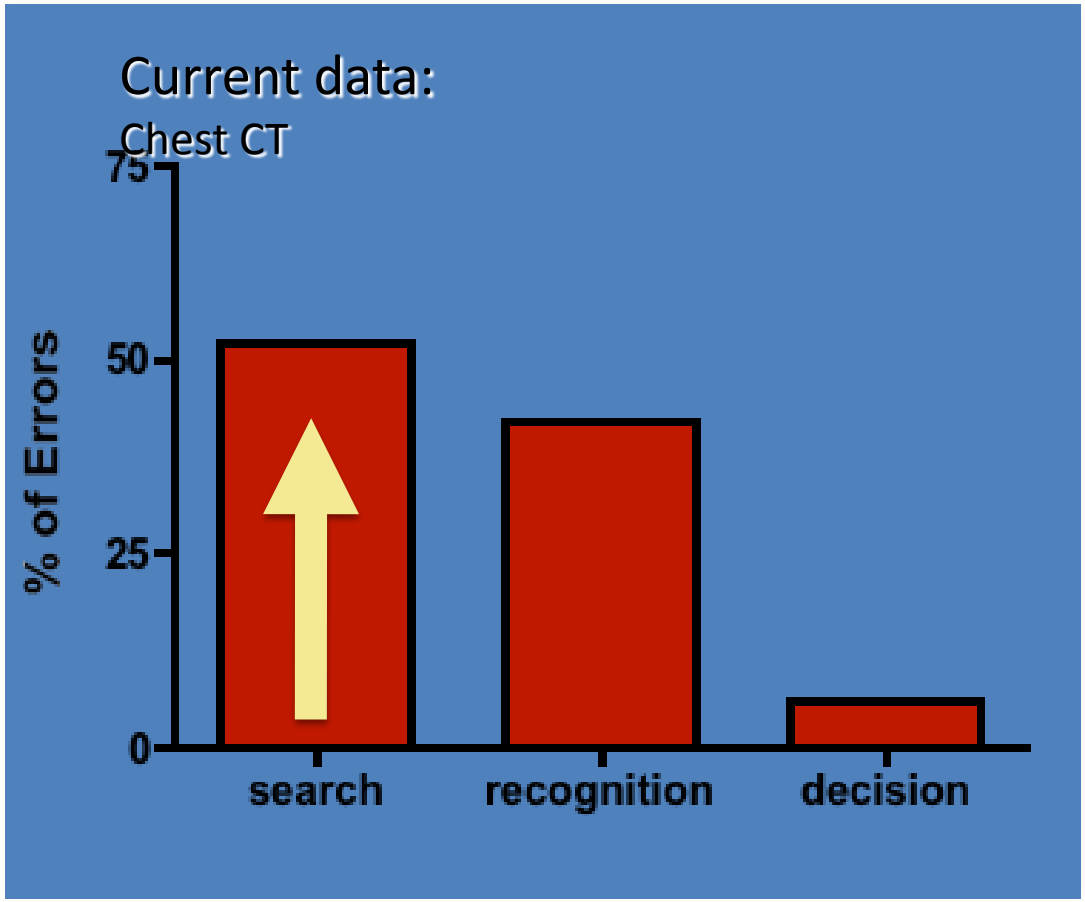


The classic 2D data



Many more search errors

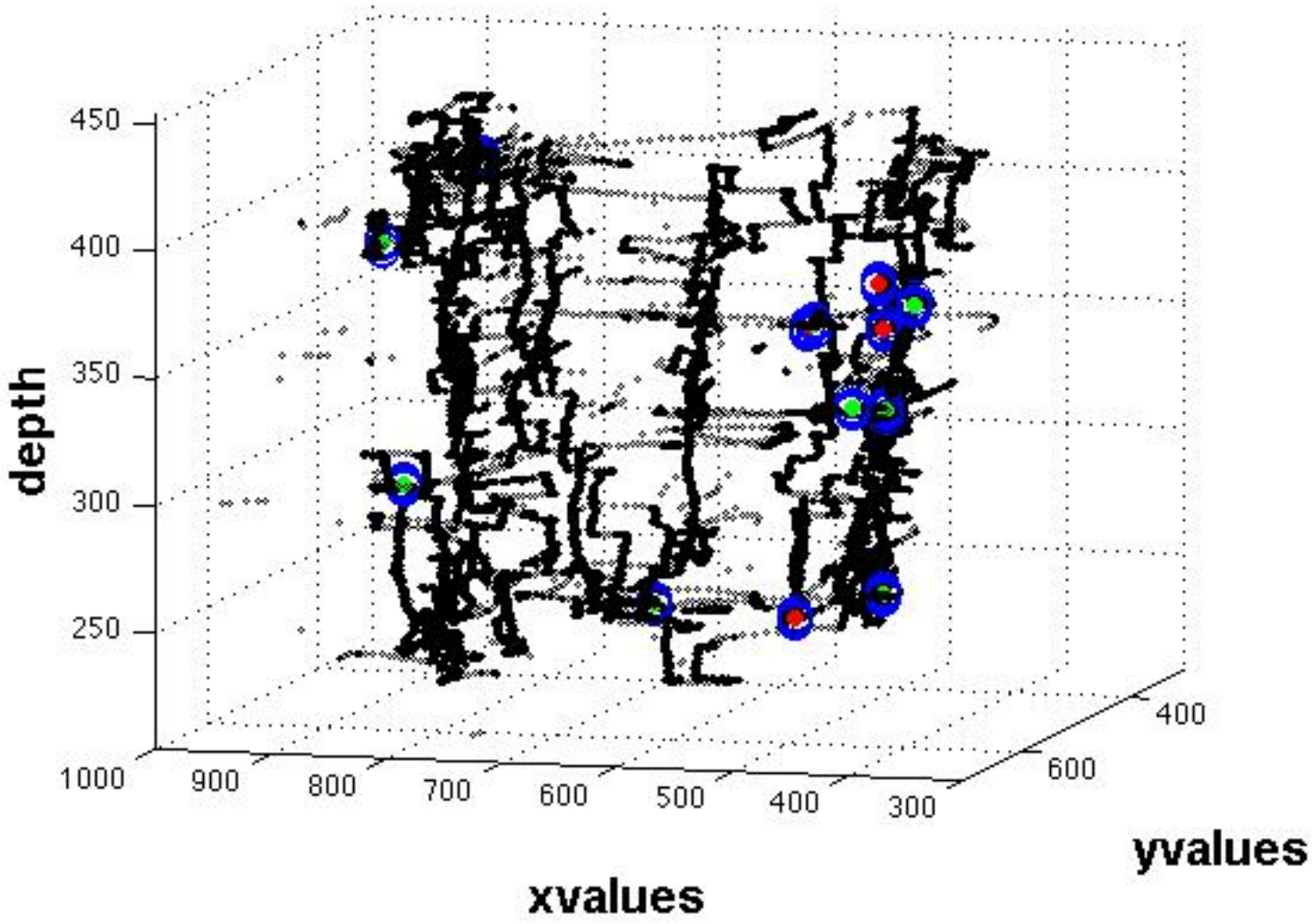
The 3D data



Why do search errors go up?

Many more search errors

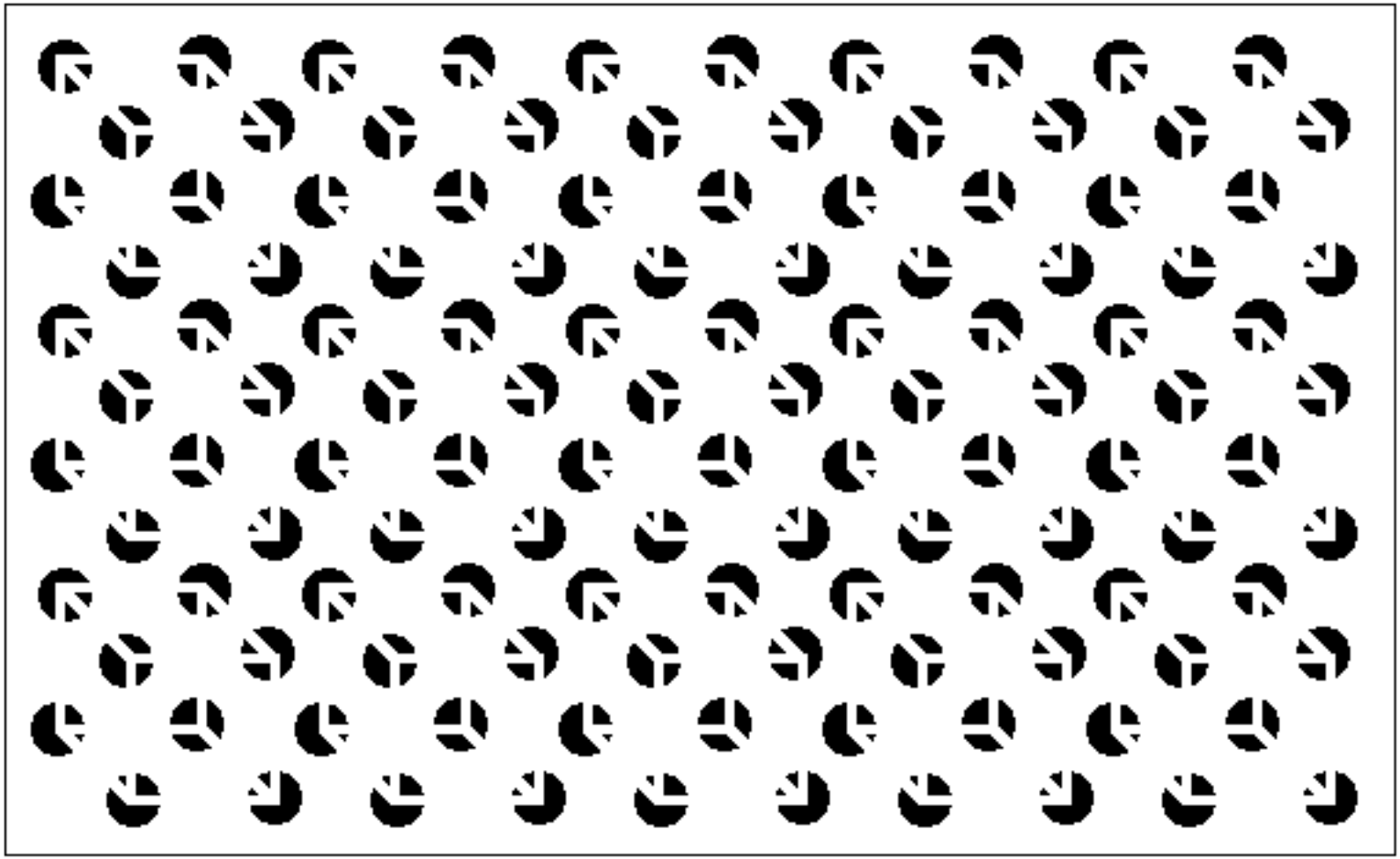
Might be useful to feedback eye movements to the observer.



Part 5: A research strategy

1. Bring in a perception / behavioral science person
2. Ask the right questions
3. Abstract those questions so that they can be studied in NON-experts
4. Transition the key findings into studies with experts.
5. Basic science gets into The Literature
6. Improvements get into design.

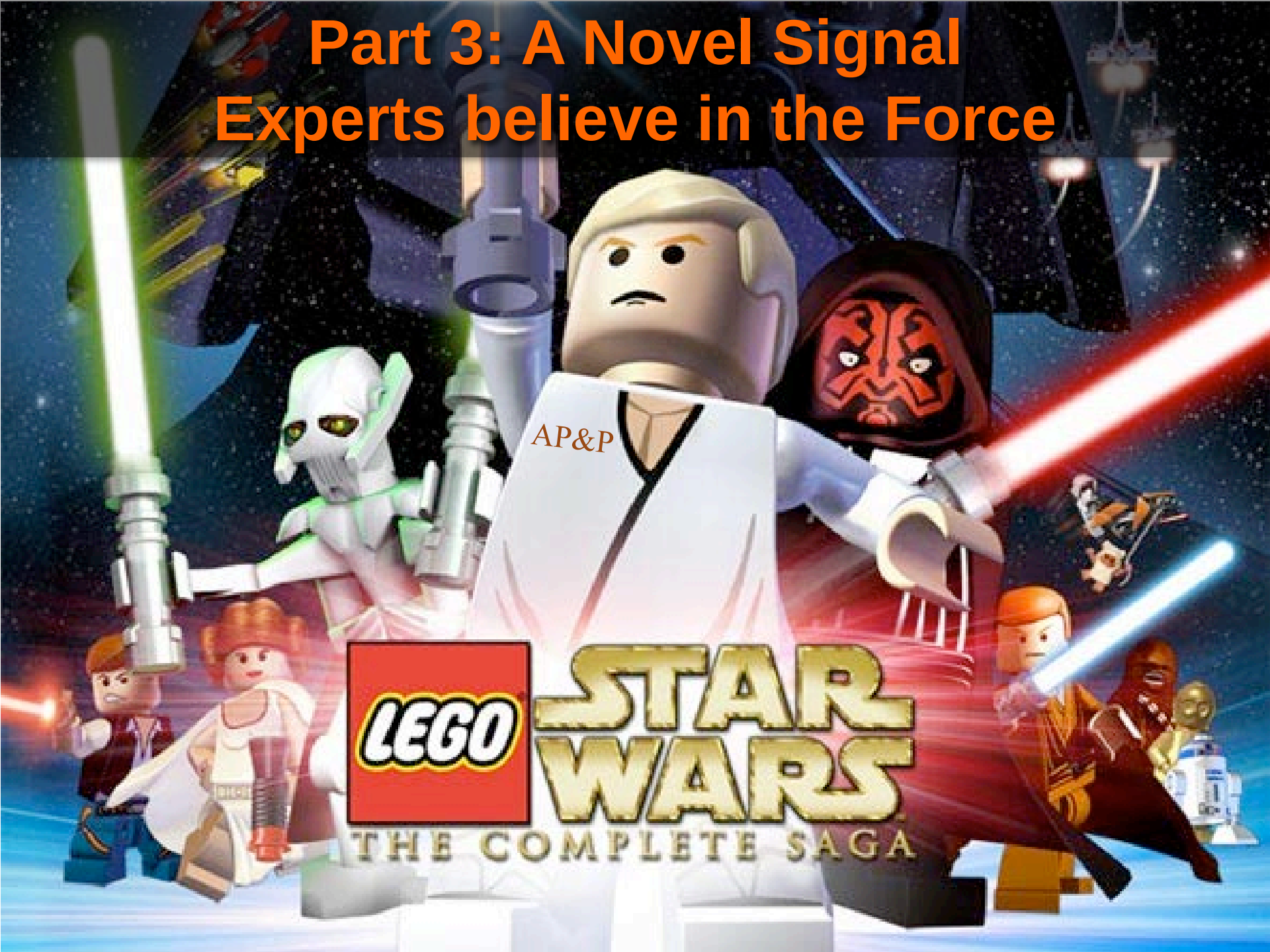
Thanks



If you want to follow-up

wolfe@search.bwh.harvard.edu

Part 3: A Novel Signal
Experts believe in the Force

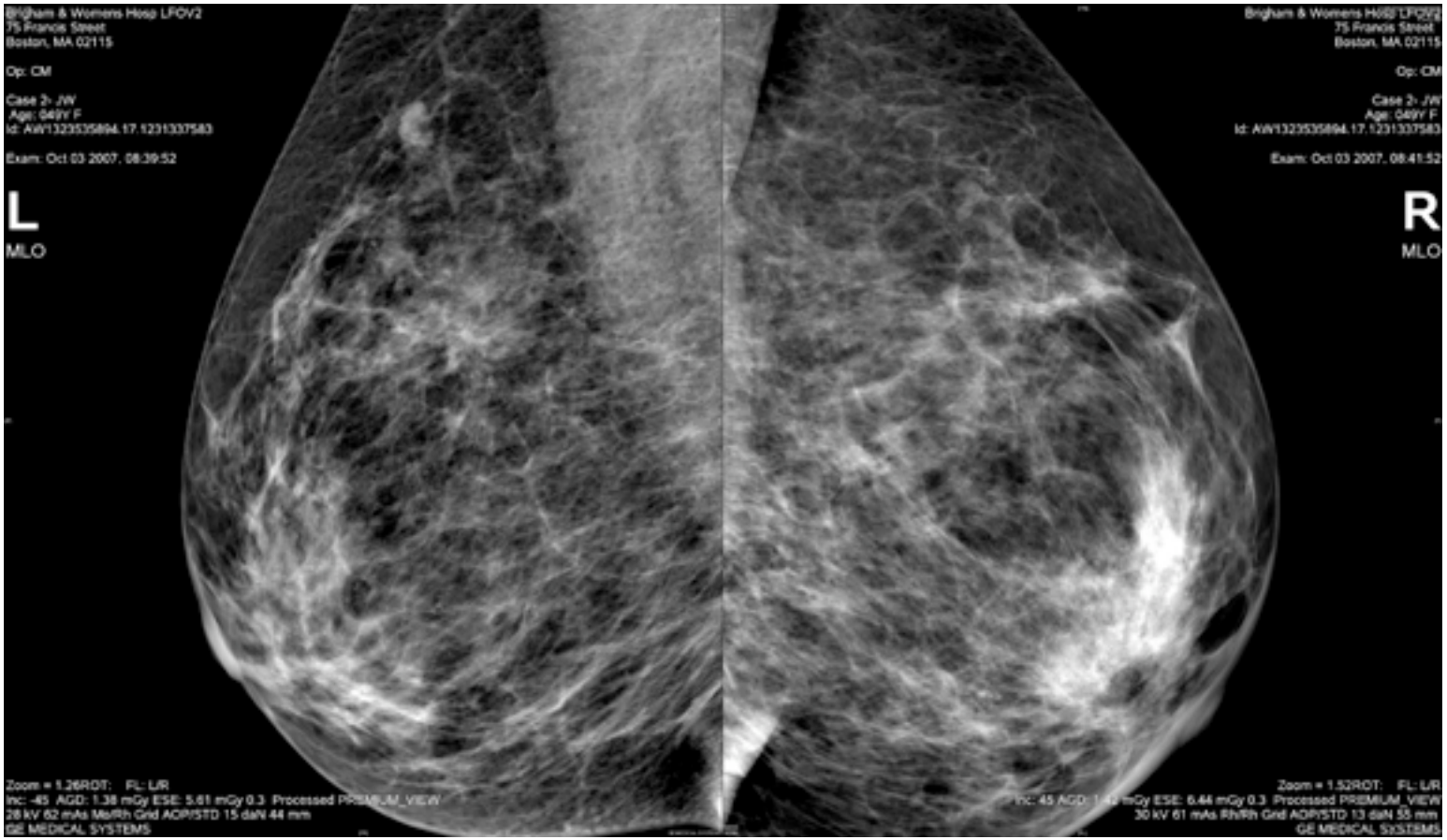


Can radiologist beat chance in a glance? We ran an experiment

Look here

Flash a mammogram for 250 msec

Can radiologist beat chance in a glance? We ran an experiment

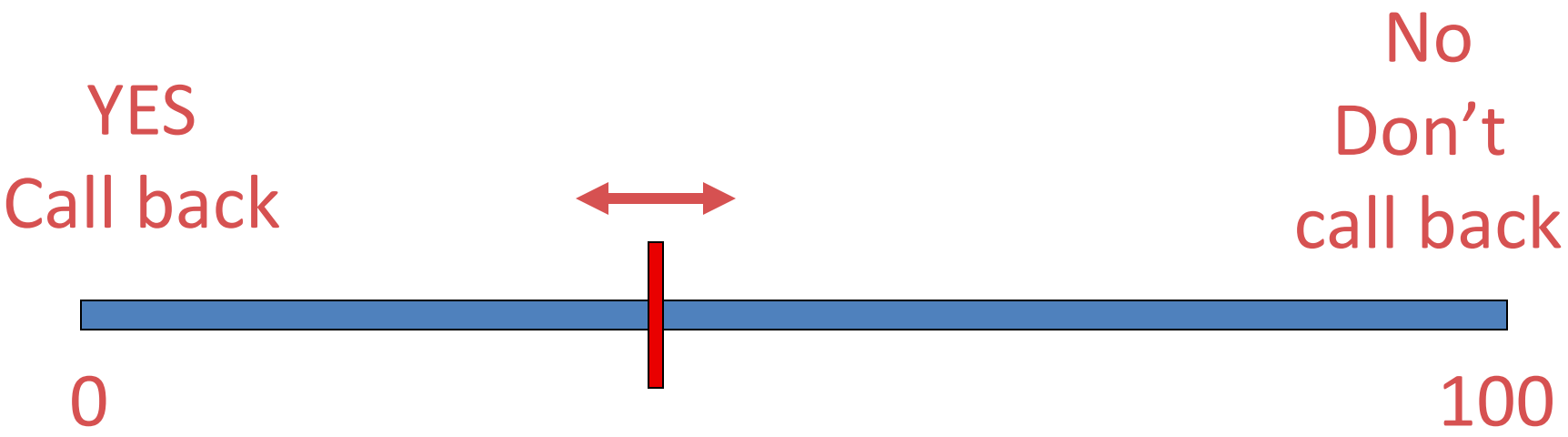


Flash a mammogram for 250 msec

Can radiologist beat chance in a glance? We ran an experiment

Flash a mammogram for 250 msec

Would you call back this patient?



Use a 100-pt rating scale

We tested 40+ radiologists at the *Society for Breast Imaging*

"We" =

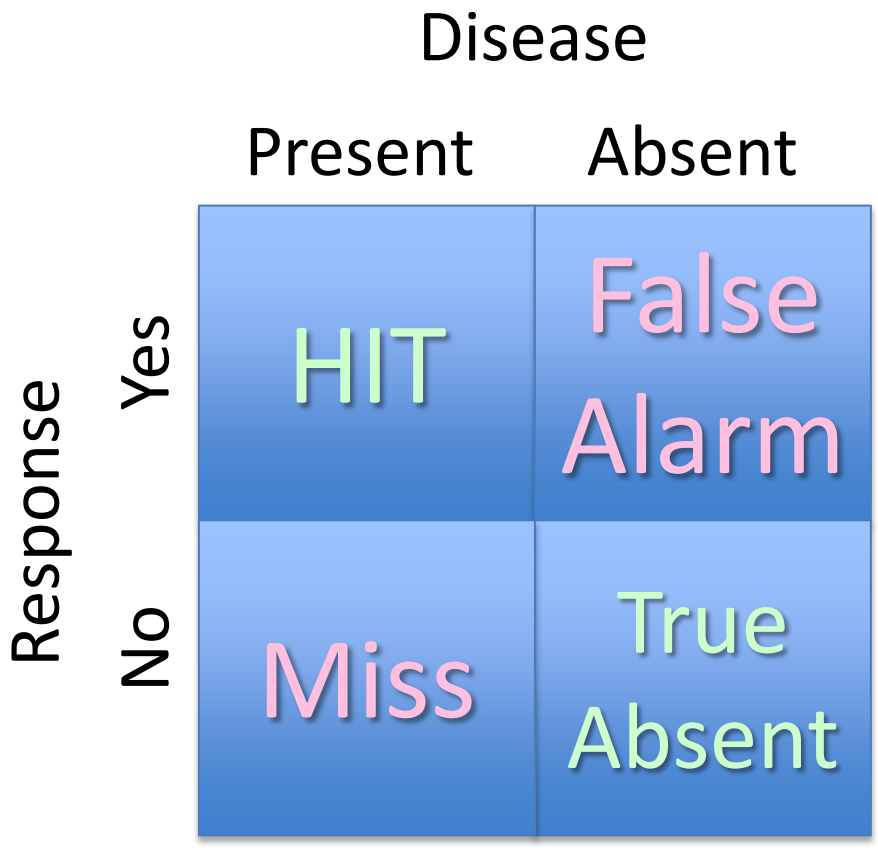
Michelle Greene
MIT

Karla Evans
BWH

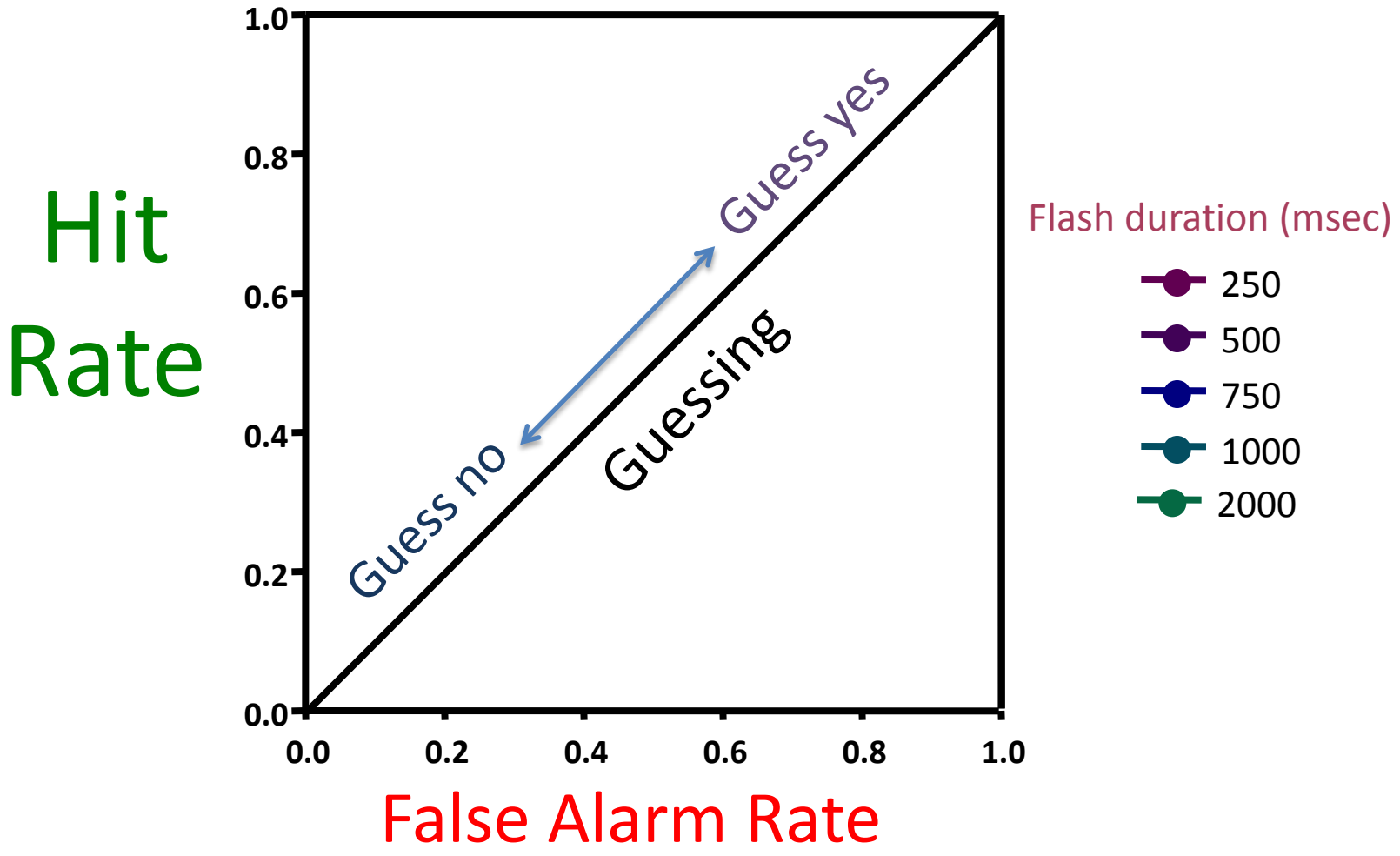
Dianne Georgian-Smith
BWH

Robyn Birdwell
BWH

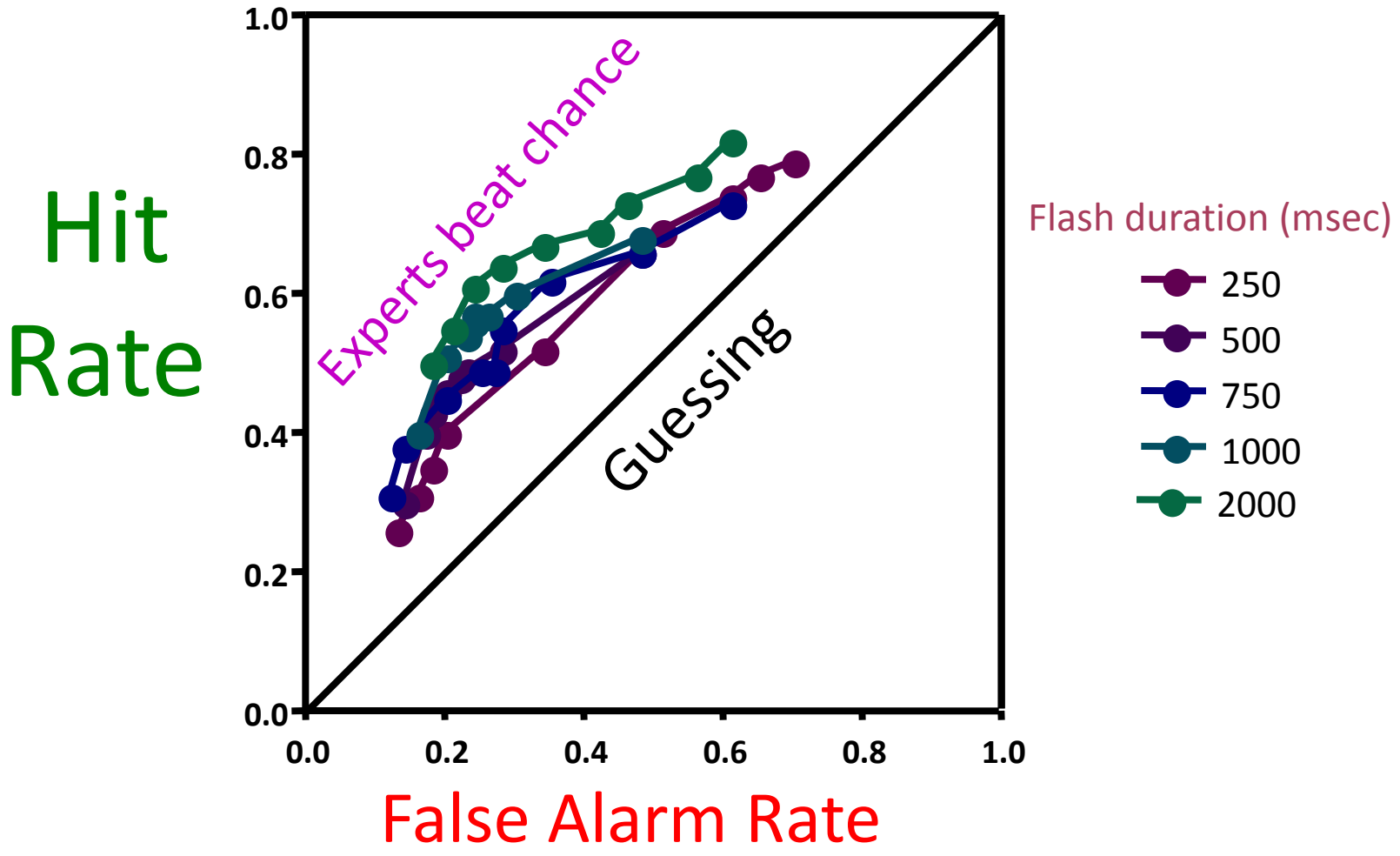
Your answers form a 2 by 2 table



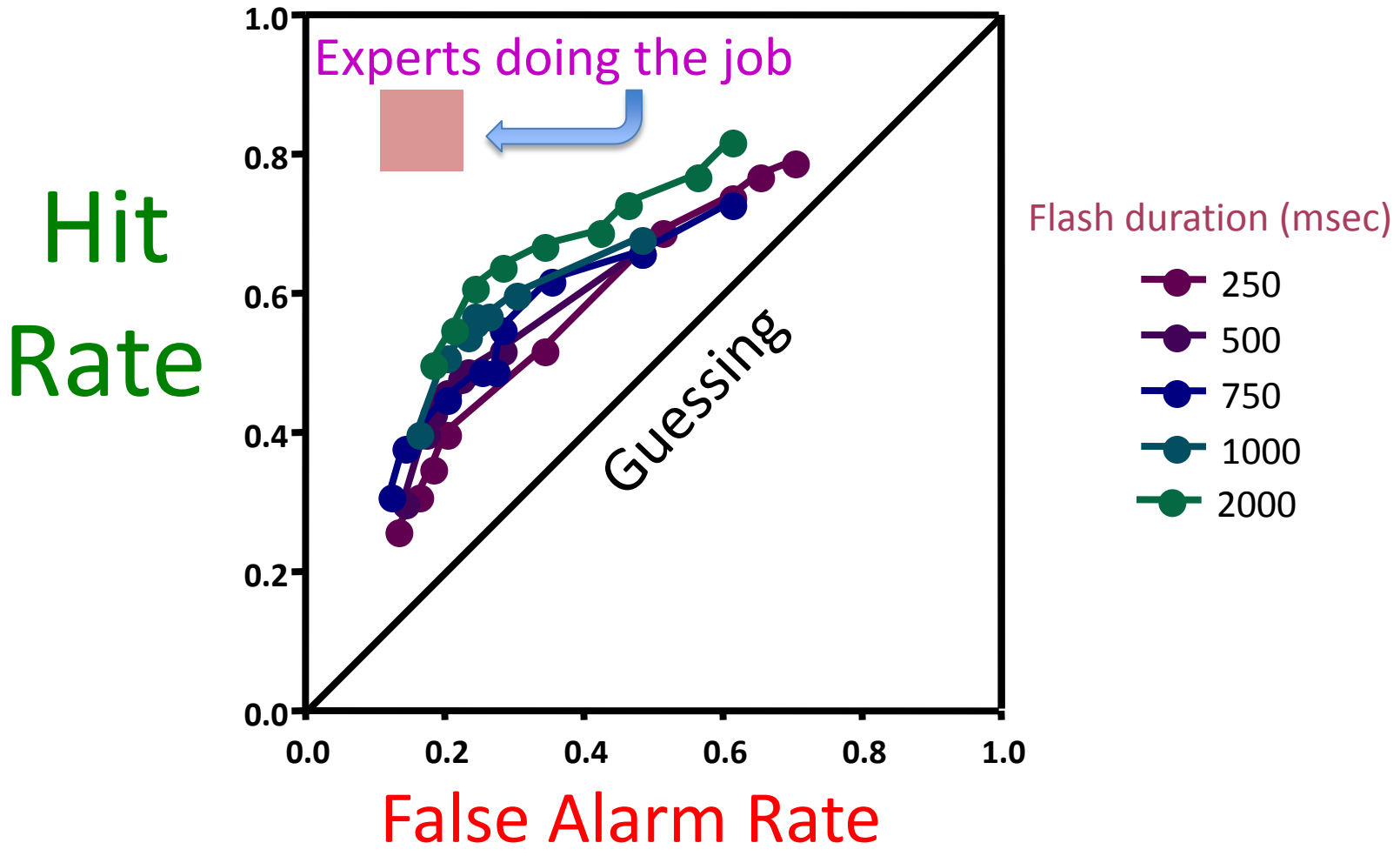
Here is how we are going to plot the data



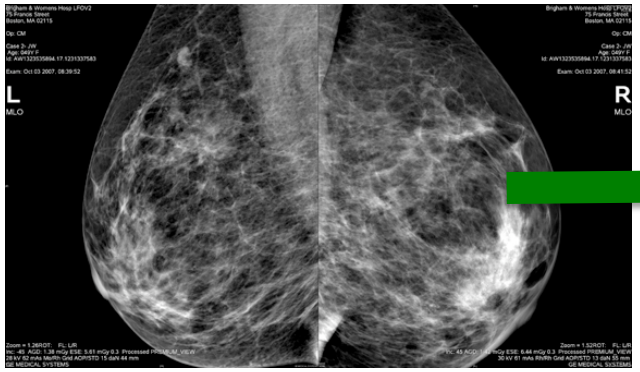
And here are the results

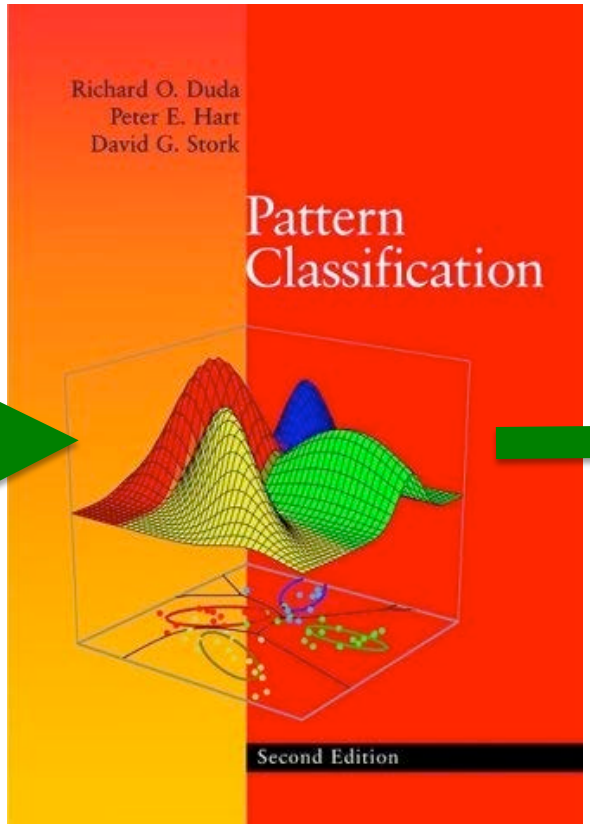


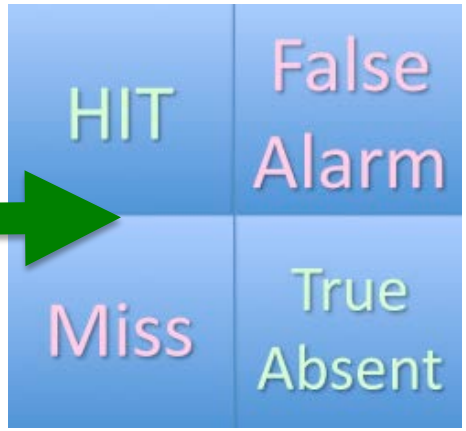
No one is suggesting that your radiologist should make a decision in a quarter second!



How do we exploit this signal?

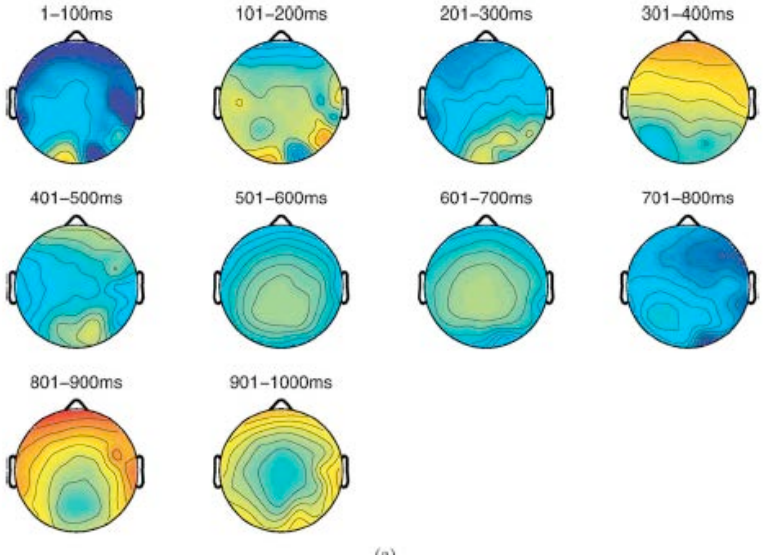






Answer 1: Build a pattern classifier

How do we exploit this signal?



Answer 2: Brain based image triage

See Paul Sajda (Columbia),

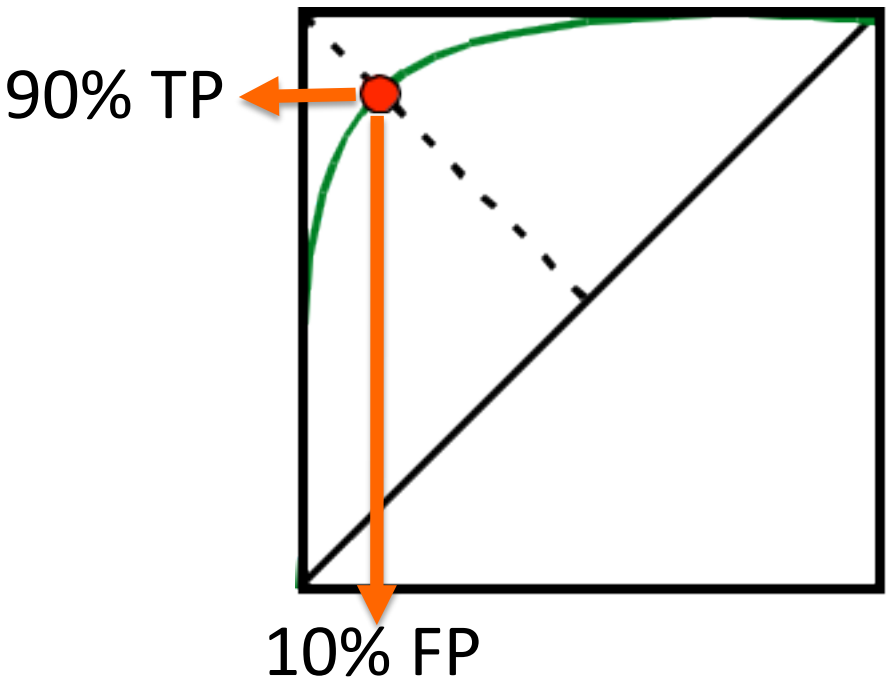
Part 4: Do we have time for a little magic?

http://www.youtube.com/watch?v=2WZVIQNwF0E&feature=related

Why is this interesting?

Part 4: Do we have time for a little magic?

The Problem



When good CAD meets low prevalence, the marks are mostly false positives

AND

Experts don't like advice that is mostly wrong.

Suppose you reverse-engineered this

Sleight of CAD?