Characterising spatial noise to understand performance limitations in Multiple Object Tracking

Johns Hopkins Krieger School of Arts & Sciences

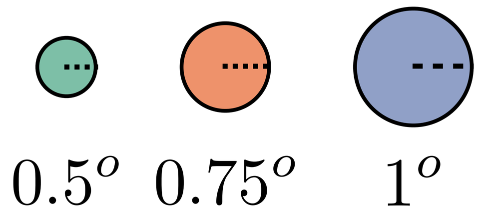
Shanmukha "Adi" Upadhyayula & Jonathan I. Flombaum

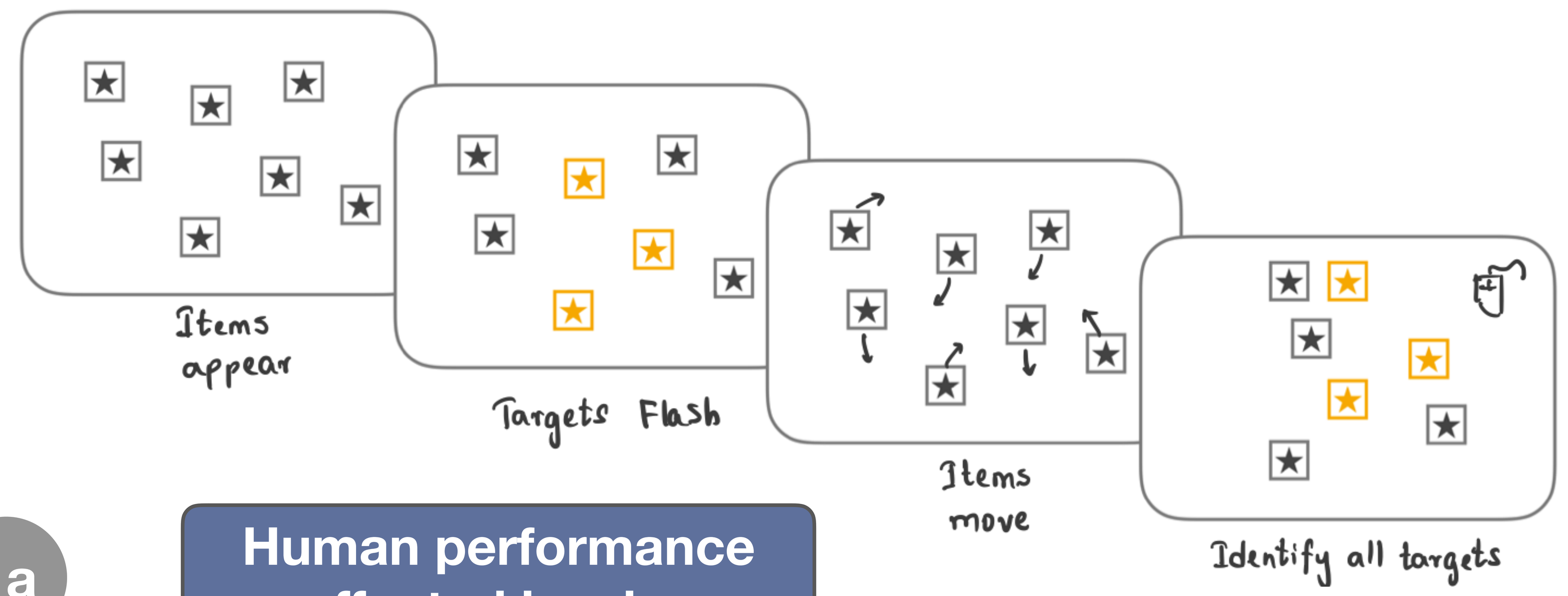
The Vision Sciences Group

Experiment 1: Manipulate Object size in MOT

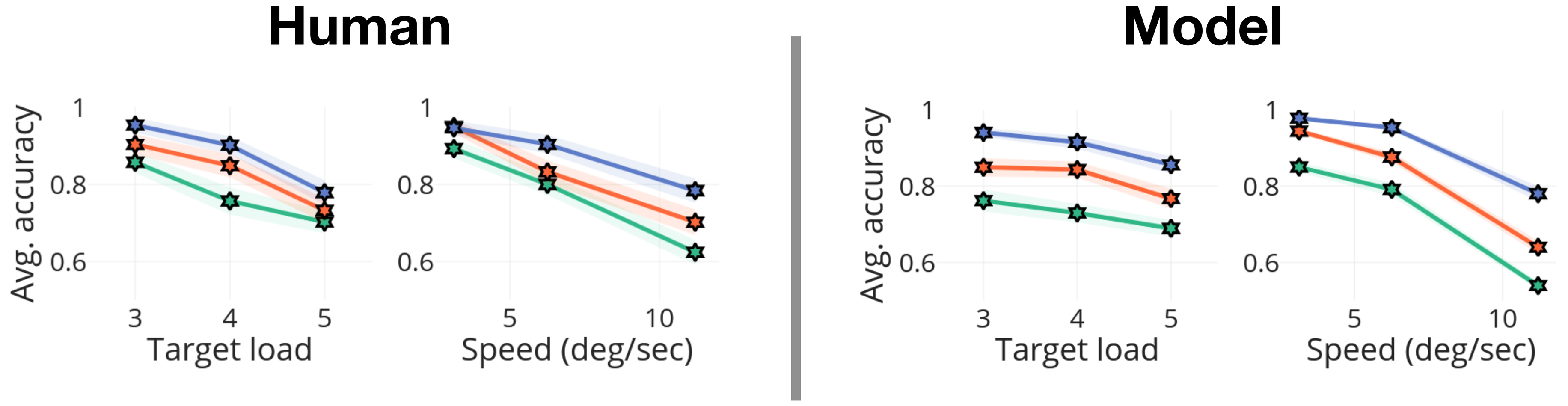
Logic

Manipulate object size because it should interact with eccentricity, and it's not usually manipulated.

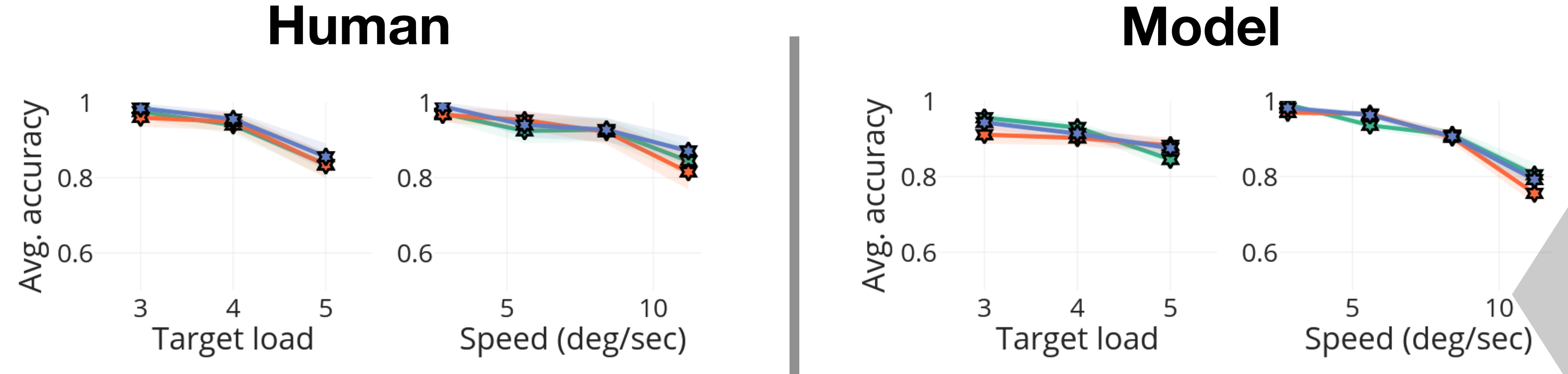




1a — Human performance affected by size



1b — But not when we control for center to center distances. (by making trajectories for the largest objects, and then using those for all sizes)



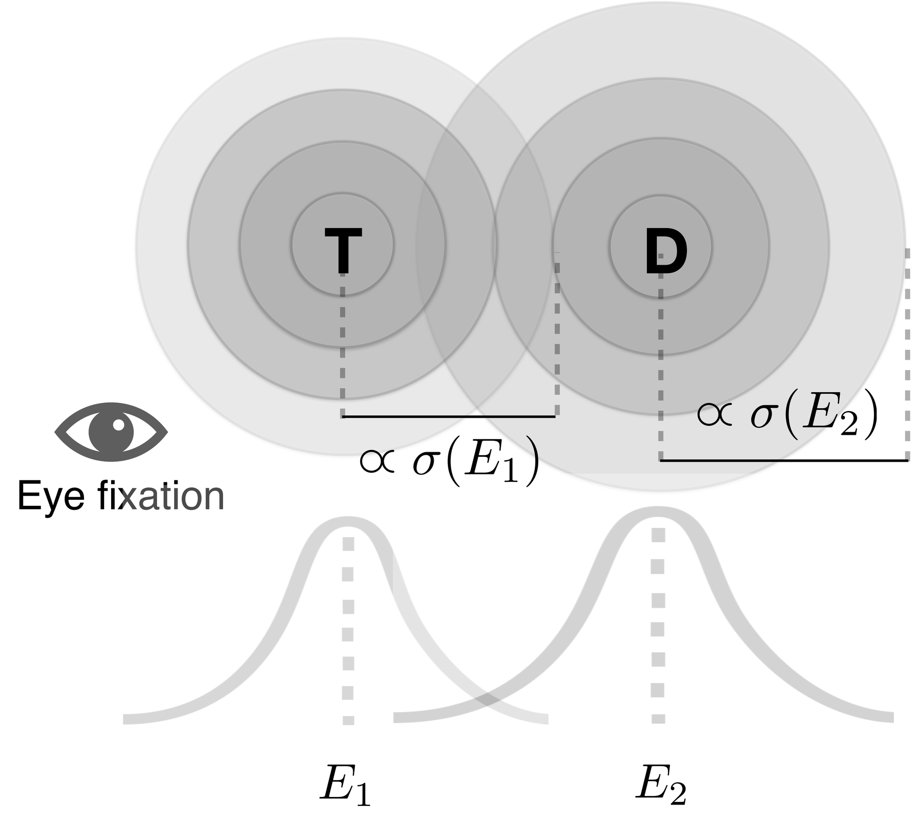
A long term goal

To model Multiple Object Tracking (MOT) in a way that accounts for individual observer eye movements

Why bother with eye movements?

We can't fixate on all the objects we care about at once. So, we want to understand how control of eye movements constrains performance on an individual basis.

The Strategy



We use a model that receives noisy unlabelled samples from the Ts and Ds in the display, and it needs to decide which samples came from the Ts.

The samples are drawn from distributions with ***variance that depends on the observer's current fixation.***

The Problem

So far, we've just been guessing about how the *variance depends on fixation*

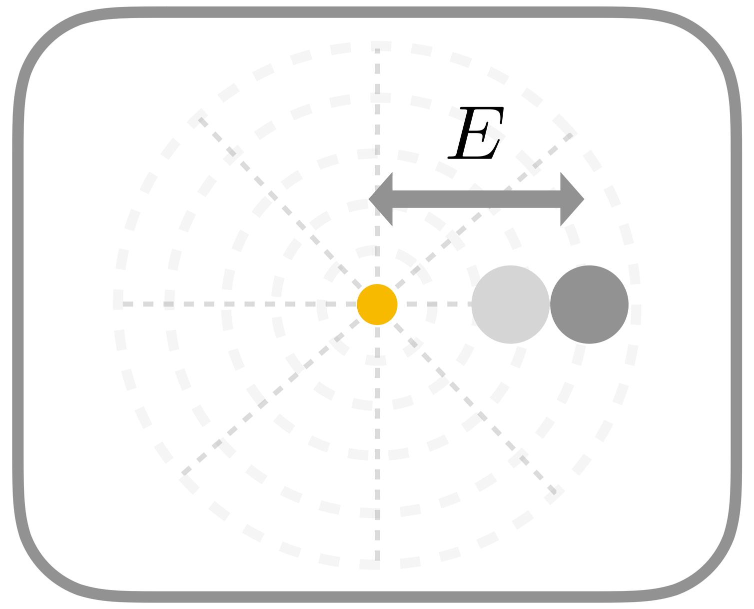
$$\sim \mathcal{N}(E, \sigma = 0.08 * (1 + 0.42 * E))$$

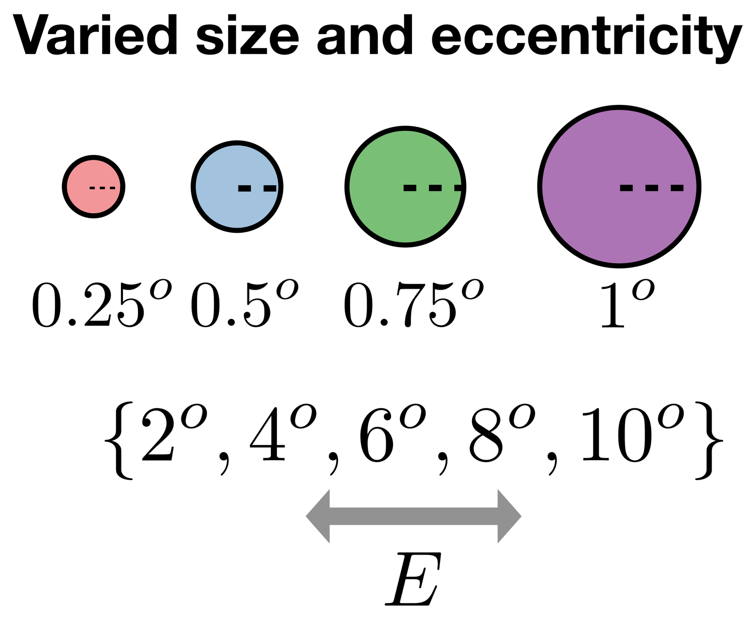
Is the effect of E independent? **So** Can we measure it?

yes ***we think so***

Experiment 2 : Measure the spatial noise equation

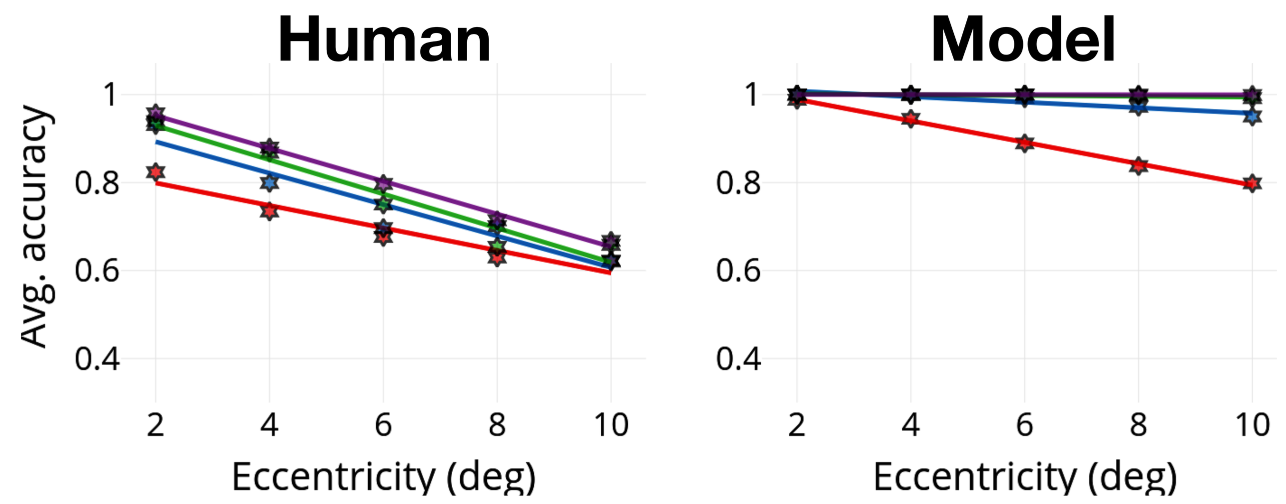
2AFC task : Two discs appear side by side (L/R, U/D).
Say which is the brighter one while fixating in the center





Logic

This simple task should reveal the effects of eccentricity on the position confusability of two items.



Old model way out performs humans in this task

New eccentricity equation fit using signal detection theory for the 2AFC task

$$\sim \mathcal{N}(0, \sigma = 0.04 + 0.23 * E)$$

Ongoing work : Trying to characterise an equation that best explains the human behaviour in both the paradigms!