Biases in human estimation are well-described by clustering algorithms from computer vision

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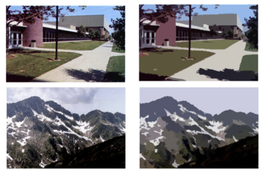
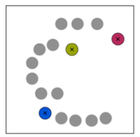
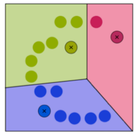
COMPUTER VISION



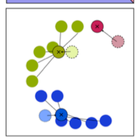
In computer vision, image segmentation is the process of partitioning an image into multiple segments (e.g., groups of pixels). The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. The K-means is one of the popular algorithms that is used to iteratively partition an image into K clusters. The basic algorithm is:



1) k initial "means"
(in this case k = 3) are randomly generated within the data domain (shown in color)



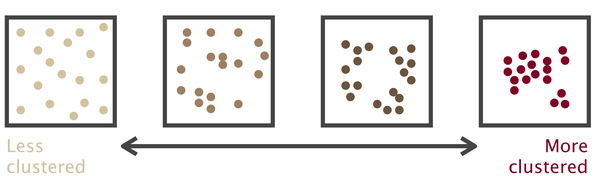
2) k clusters are created by associating every observation with the nearest mean



3) The centroid of each of the k clusters becomes the new mean

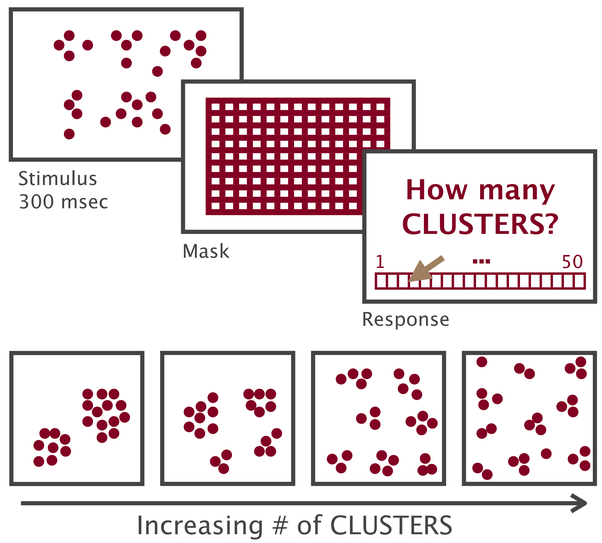
4) Steps 2 and 3 are repeated until convergence has been reached (e.g., no pixels change clusters).

Here we apply this algorithm to identify the unit of Gestalt clusters in dot displays. Specifically, we implemented a model that utilizes K-means clustering algorithm. The model estimates the number of clusters for our stimulus images containing multiple dots with a single free parameter for center-to-center distance among items (i.e., clustering threshold).

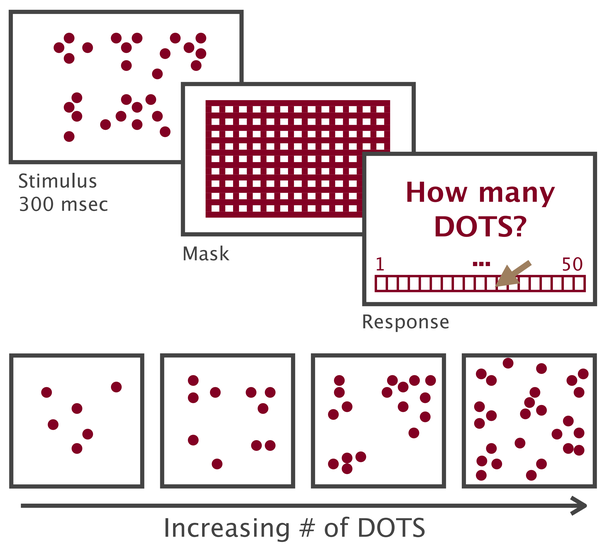


HUMAN VISION

Exp 1: Cluster Experiment

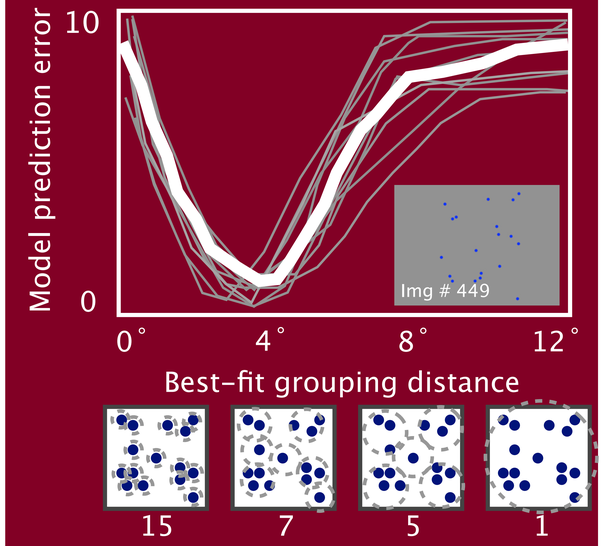


Exp 2: Dot Experiment



A CONNECTION

Fitting the k-means clustering model with a free parameter for the grouping distance to determine the most likely human grouping threshold

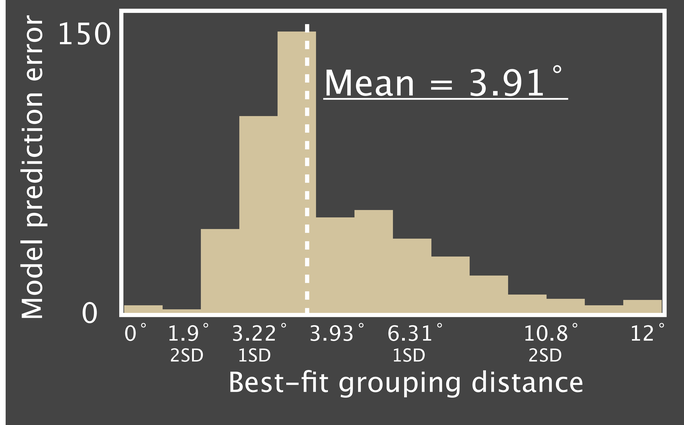


Using the k-means clustering model to estimate clustering in random displays to describe the human visual number extraction algotirhm

# of clusters	16	6	10	5
# of dots	16	9	20	20
Clusteredness	1	1.5	2	4

RESULT

The most likely human grouping distance is 4°



RESULT

More clustering in an image leads humans to more underestimate the the number of items