

ROC Curves from MAFC Experiments Using a Sorting Algorithm

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Rationale

Sometimes the area under the ROC curve, a summary of reader performance, is calculated from experiments that collect rating data from observers and sometimes from multiple alternative forced choice (MAFC) experiments. Estimates of AUC between these types of studies may be different because of reader behavior. We would like to compare the form of ROC curves between such studies also. Generally ROC curves can not be generated from MAFC data, so we need to create a method to create ROC curves.

Methods

We developed an algorithm for producing ROC curves from MAFC experiments. The algorithm is efficient in terms of the number of MAFC trials or observations required. This algorithm is similar to common computer sorting algorithms, because constructing an ROC curve is equivalent to sorting the images from least suspicious to most suspicious. The algorithm selects which M images should be presented to the observer for each observer input. As the observer compares and selects images, the algorithm sorts the images by completing a success matrix, and presents the observer with images that are most likely to be informative in sorting. For complete sorting all images need to appear in multiple MAFC trials. To avoid the repeated sequential display of the same image, the algorithm does not use pivots, which is different from typical sorting algorithms. The algorithm can utilize a comparison of an arbitrary M images rather than the typical comparison of two elements. To reduce the number of required MAFC trials required we preferentially select images with few trials and images that have similar estimated ranks. The number of MAFC trials may be additionally reduced with the prior use of a human-like model observer.

Results

Simulations demonstrate that the algorithm is relatively efficient. For an equal number of $N/2$ signal present (SP) and $N/2$ signal absent (SA) images, a most efficient sorting algorithm can sort all images in approximately $0.85 N \cdot \log_2 N$ 2AFC trials. Our algorithm can sort the $N/2$ SP images with respect to the $N/2$ SA images to generate a ROC curve in approximately the same number of trials. At the time of the conference we will present results from studies with real readers.

Conclusions

We developed an efficient sorting algorithm for the construction of ROC curves from MAFC experiments. This will allow us to compare forms of ROC curves from data collected in different kinds of reader study experiments.