Homework 3, Please submit your completed homework by a single pdf file

1. you must have completed the online videos and quizzes in the online course "Visual attention and V1 Saliency Hypothesis" Please send me a record, such as a screen shot at the online course, showing your progress status by the homework due date to indicate either that you have already completed all the lessons, or which lessons you have completed.

2. Write a 2-5 page summary of the materials about "Visual attention and V1 Saliency Hypothesis".

3. Practice exercises for consolidation of the learning on the V1 mechanisms for visual saliency.

   Consider a visual search task to look for a bar that is odd, in color, orientation, or both, please refer to figure 1. Let there be three kinds of V1 cells, C, O, and CO, for V1 neurons tuned to color only, to orientation only, or to both color and orientation conjunctively. Let C_X, O_X, CO_X denote the maximum responses from the respective types of neurons to a visual input denoted by the subscript X. When $X = C$, the visual input is a color singleton, and C_C, O_C, CO_C, are the maximum responses of the respective neurons to a color singleton. When $X = O$, then the maximum responses to the orientation singleton are C_O, O_O, CO_O. When $X = CO$, then the maximum responses are to the double-feature CO singleton. When $X = B$, then the maximum responses are to a background bar.

   - (A): Which of the following statements are correct
     (1) $O_C < O_B$, (2) $O_C = O_B$, (3), $O_C > O_B$.
   - (B): Which of the following statements are correct
     (1) $C_C < C_B$, (2) $C_C = C_B$, (3), $C_C > C_B$.
   - (C): Which of the following statements are correct
     (1) $CO_C < CO_B$, (2) $CO_C = CO_B$, (3), $CO_C > CO_B$.
   - (D) Acccording to the V1 Saliency Hypothesis (V1SH), the saliency of the location at a bar in such visula search images is given by the maximal V1 firing rate that it induces, thus the saliency of the C singleton bar (call it $SMAP_C$) can be represented by (tick all that apply)
     (1) max (C_C, O_C), (2) max (C_C, O_C, CO_C), (3) max (C_C, CO_C), (4) max (O_C, CO_C),
   - (E) Please use '>', '=', or '<' signs to fill in the following relations:
     O_O__O_B, C_O__C_B, CO_O__CO_B.
   - (F) The saliency of the O singleton bar (call it $SMAP_O$) can be represented by (tick all that apply)
     (1) max(C_O, O_O), (2) max(C_O, O_O, CO_O), (3) max(C_O, CO_O), (4) max(O_O, CO_O),
   - (G) Consider how V1 neurons respond to the visual inputs in Figure 1C. Please use '>', '=', or '<' signs to fill in the following relations:
     O_C__O_{CO} __ O_O,

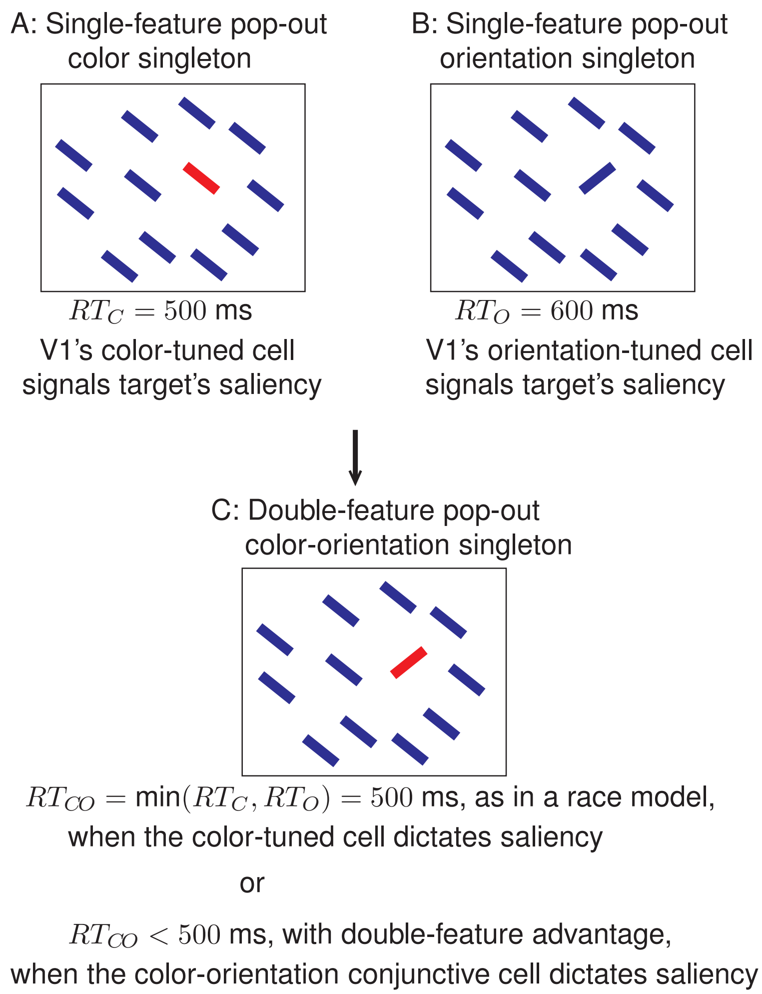

Figure 1: This is from figure 5.40 in the textbook "Understanding vision: theory, models, and data", illustrating the schematic of single- and double-feature pop-out in color and/or orientation. A: The saliency of the color (C) singleton is dictated by the response of the cell tuned to a red color, which is the only cell free from iso-feature suppression for this input stimulus. B: Similarly, the saliency of the orientation (O) singleton is dictated by the response of the cell tuned to its orientation. C: The color-orientation (CO) double-feature singleton highly activates all three cell types: color-tuned, orientation-tuned, and conjunctive color-orientation–tuned cells; the most activated among them should dictate the singleton's saliency. Consider the simplest case when A, B, and C do not differ in the neural responses to the background bars; furthermore, let the color (only)-tuned cell respond identically to the singletons in A and C, and let the orientation (only)-tuned cell respond identically to the singletons in B and C. When the RTs to find the singletons are, for example, $RT_C = 500$ ms for the color singleton and $RT_O = 600$ ms for the orientation singleton, whether RT_{CO} for the color-orientation singleton is less than or equal to $\min(RT_C, RT_O) = 500$ ms depends on whether the conjunctive cell is the most active cell responding to the CO singleton and is more active than its activation in A and B.

C_C ___ C_{CO} ___ C_O,

CO_{CO} ___ CO_O, CO_{CO} ___ CO_C,

- (H) The saliency $SMAP_{CO}$ of the CO double-feature singleton bar can be represented by (tick all that apply)

  (1) $SMAP_{CO} = max(C_C, O_O, CO_{CO})$,

  (2) $SMAP_{CO} = max(SMAP_C, CO_O, CO_{CO})$,

  (3) $SMAP_{CO} = max(SMAP_O, CO_C, CO_{CO})$,

  (4) $SMAP_{CO} = max(SMAP_C, SMAP_O, CO_{CO})$.

- From the above, we can know that $SMAP_{CO} \geqslant max(SMAP_C, SMAP_O)$, and the $\geqslant$ becomes $=$ when there is no CO neurons. In general, in a visual search task, the higher the saliency of a target, the shorter the reaction time RT to find it.

- let RT_C, RT_O, RT_{CO} represent the reaction time for finding a C, O, and CO singleton target, respectively. Which of the following RT relations can we infer?

  (1) $RT_{CO} \leqslant max(RT_C, RT_O)$,

  (2) $RT_{CO} \leqslant min(RT_C, RT_O)$,

  (3) $RT_{CO} \geqslant max(RT_C, RT_O)$,

  (4) $RT_{CO} \geqslant min(RT_C, RT_O)$,

4. Import the data files (the three csv files vp004rb_C.csv, vp004rb_CO.csv, vp004rb_O.csv,) into your program. they are at

   https://www.lizhaoping.org/zhaoping/Dir_ForExerciseDataFiles_forVisionCourses/vp004rb_C.csv
   https://www.lizhaoping.org/zhaoping/Dir_ForExerciseDataFiles_forVisionCourses/vp004rb_O.csv
   https://www.lizhaoping.org/zhaoping/Dir_ForExerciseDataFiles_forVisionCourses/vp004rb_CO.csv

   Plot the probability distribution function and cumulative distribution functions of the RT_C, RT_O, RT_{CO}, respectively.

5. (Race model), Use Monte Carlo simuation to generate a sample of $RT_{CO}^{race} = min(RT_C, RT_O)$ as follows. For each simulated trial, (1) randoly choose one data sample from the RT_C data pool as RT_C^{sim}; (2) randoly choose one data sample from the RT_O data pool as RT_O^{sim}; (3) take the minimum of RT_C^{sim} and RT_O^{sim} as RT_{CO}^{race} in this simulated trial. repeat this for 10000 times to get a simlated collection of samples for RT_{CO}^{race}.

6. Plot and compare the probability distribution and cumulative distribution of your simulated collection of RT_{CO}^{race} and the real data you uploaded for RT_{CO}.

7. Compare to see whether RT_{CO}^{race} is larger or smaller or the same as the data for RT_{CO}. You should try to compare in all kinds of ways you can think of, such as compare the means from each distribution, and so on.