A Decision Model for Psychophysics

Reading: Macmillan & Creelman, Chaps. 1 & 2

Three Things to Learn

- Procedure
  - What are the stimuli?
  - How do you present them?
  - What are the responses?
  - How do you organize the data?
- Model
  - What are the assumptions?
  - What is the model based on these assumptions?
- Data Processing
  - How do you process the data?
  - What are the results (e.g., threshold)?

Introduction to Signal Detection Theory (SDT)

- Tanner & Swets, 1954
- Key Properties of SDT
  - Noise in perception
  - Probabilistic / stochastic approach
  - Decision process (*a priori* info, bias)
  - Experimental procedure
  - Popular in literature

Why Do We Care About SDT?

- It provides a means to separate decision processes (e.g., bias) from perception.
- We will develop a decision model for psychophysics

The Procedure for One-Interval (1-I) Experiments

- Name:
  - One-Interval, Two-Alternatives (1I 2A)
  - Also known as the "yes-no" experiment (see Macmillan&Creelman's book)
- There are two stimuli S_i (i=1, 2); e.g.,
  - S_1="softer tone", S_2="louder tone"
  - S_1="softer spring", S_2="harder spring"
  - S_1="new face", S_2="old face" (M&C)
  - S_1="noise", S_2="signal embedded in noise"

(*cont.*)

- On each trial, S_i is presented with an *a priori* probability of $P(S_i)$, where $P(S_1)+P(S_2)=1$
- There are two admissible responses R_j (j=1, 2); e.g.,
  - R_1="softer tone", R_2="louder tone"
  - R_1="1", R_2="2"
  - R_1="no", R_2="yes" (hence "yes-no" exp.)
- For simplicity, we assume that R_1 is the correct response to S_1, and R_2 is the correct response to S_2
- Trial-by-trial correct-answer feedback is optional

Data from a 1-I Experiment

	R_1	R_2
S_1	n_{11} *Correct Rejections*	n_{12} *False alarms*
S_2	n_{21} *Misses*	n_{22} *Hits*

- $f(R_1|S_1)=n_{11}/(n_{11}+n_{12})$: frequency of responding R_1 given S_1. We use frequency to estimate probability.
- $P(R_1|S_1)$: probability of responding R_1 given S_1
- $p(R_1|S_1)$: probability density function
- There are only two *independent* measures: *F* and *H*.

Three Examples

(1)

	R_1	R_2
S_1	48	2
S_2	1	49

(2)

	R_1	R_2
S_1	5	45
S_2	1	49

(3)

	R_1	R_2
S_1	2	48
S_2	49	1

In-Class Lab: 1-I Experiment

- Go to “Online Experiments”
- Go down to “Part II. Decision Model for Psychophysics”
- Go to “One-interval Experiment”
- Select “1. Curvature detection”

Discussion of In-Class Demo

- Summarize the procedure
  - What are the stimuli?
  - How do you present them?
  - What are the responses?
  - How do you organize the data?
- Sample output

	R1	R2
S1	37	13
S2	14	36

H = 0.72
F = 0.26
d' = 1.22
c = 0.03

(Please write down your own results in a notebook)