ECE511/PSY511 PSYCHOPHYSICS

A Joint Offering by the School of Electrical and Computer Engineering
And the Department of Psychological Sciences
Purdue University
Fall 2017

HW #3 (Assigned: 09/06/2018; Due: *before lecture* on 09/13/2018)

Topic: A Decision Model for Psychophysics
(Hit and False-alarm Rates, Sensitivity Index d′, Bias c)

(1) Derive the relationships $d' = z(H) - z(F)$ and $c = -0.5[z(H)+z(F)]$. You will need to use the assumption of Gaussian probability density functions with equal variance for $p(x|S_1)$ and $p(x|S_2)$. Also recall that the z-scores (normal deviates) are defined by:

$$H = \int_{-\infty}^{z(H)} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} dx \qquad F = \int_{-\infty}^{z(F)} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} dx$$

[Hint: Try to express z(H) and z(F) in terms of M_1, M_2, k and σ first.]

(2) Suppose d′=1. What is H if F = 0.01, 0.02, 0.10, 0.25 and 0.50? Same for d′=0.5, 1.5 and 2.5. Present your results in a table like the one shown below. Please briefly explain the key steps in your calculations.

[Hint: You can use Table B.1 on p.3 for this and subsequent problems.]

F \ d′	0.5	1.0	1.5	2.5
0.01				
0.02				
0.10				
0.25				
0.50				

(3) For the following data matrices, find d′ and c. Compare and discuss the results.

(a)

	R_1	R_2
S_1	49	1
S_2	2	48

(b)

	R_1	R_2
S_1	4	46
S_2	2	48

(c)

	R_1	R_2
S_1	3	47
S_2	48	2

(4) Suppose $(H_{old}, F_{old}) = (0.75, 0.2)$. If $d'_{new}=2d'_{old}$, find (H_{new}, F_{new}) if

(i) $c_{new}=c_{old}$

(ii) $c'_{new}=c'_{old}$

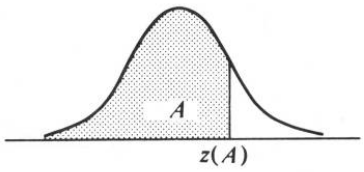
(iii) $\ln(\beta)_{new}=\ln(\beta)_{old}$

[Hint: Refer to Macmillan & Creelman's book for definitions of c′ and ln(β).]

(5) What is the percent-correct score for a 1-I experiment when d′=1.0? You may assume that bias c = 0 in your derivation. If you have made any *additional* assumptions, please state them explicitly and clearly.

TABLE B.1 Cumulative Probabilities of the Standard Normal Distribution.

Entry is area A under the standard normal curve from $-\infty$ to $z(A)$



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

Selected Percentiles

Cumulative probability A:	.90	.95	.975	.98	.99	.995	.999
$z(A)$:	1.282	1.645	1.960	2.054	2.326	2.576	3.090