PBS2: Psychological Enquiry and Methods

Statistics Examination Handout

1. Symbols

	population parameter	sample statistic
mean	μ, μ_X	$\bar{X}, \bar{X}_i$
standard deviation X	σ, σ_X	s, s_X
variance X	σ^2, σ_X^2	s^2, s_X^2

2. Central tendency and dispersion

2.1 Mean

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{N}$$

$\bar{X}$ represents the sample mean

$\bar{X}_i$ represents the value for the *i*th observation

$\sum_{i=1}^{n} X_i$ represents the sum of all your observation values

N represents the total number of cases

2.2 Variance and standard deviation

$$\text{Variance } \left(s^2\right) = \frac{\sum\left(X_i - \bar{X}\right)^2}{N-1} = \frac{\sum\left(X_i - \bar{X}\right)\left(X_i - \bar{X}\right)}{N-1}$$

2.3 Covariance

$$\text{cov}\left(X, Y\right) = \frac{\sum\left(X_i - \bar{X}\right)\left(Y_i - \bar{Y}\right)}{N-1}$$

2.4 Standard error of the mean (standard deviation of the sampling distribution of the mean)

$$\sigma_{\bar{X}} = \frac{\sigma_X}{\sqrt{n}} \qquad s_{\bar{X}} = \frac{s_X}{\sqrt{n}}$$

2.5 Interquartile range (IQR)

IQR = Q3 – Q1 Q1 = ¼ (n + 1)th value Q3 = ¾ (n +1)th value

3. Normal distribution

3.1 Standardized score (number of standard deviations above the mean)

$$z = \frac{X - \mu}{\sigma}$$

3.2 Binomial standardized score

$$z_{binomial} = \frac{X - Np}{\sqrt{Npq}}$$

Mean = Np Variance = Npq Standard deviation = √Npq

4. Discrete random variables

4.1 Expected value: $E[X] = \Sigma\, xP(x)$

4.2 Variance: $Var[X] = \Sigma x^2 P(x) - E[X]^2$

5. Simple and conditional probability

5.1 Mutually exclusive events: P(A or B) = P(A) + P(B)

5.2 Non-mutually exclusive events: P(A or B) = P(A) + P(B) – P(A and B)

5.3 Independent events: P(A and B) = P(A) x P(B)

5.4 Conditional probability

$$P(A \mid B) = \frac{P(A \wedge B)}{P(B)}$$

5.5 Reverse conditional probability

$$P(B \mid A) = \frac{P(A \wedge B)}{P(A)}$$

5.6 Bayes' rule

$$P(A \mid B) = \frac{P(B \mid A) \times P(A)}{P(B)}$$

6. Correlation and regression

6.1 Pearson's product moment correlation coefficient (r)

$$r = \frac{\mathrm{cov}_{XY}}{s_X s_Y}$$

6.2 Regression line model

$$Y_i = A + B\mathrm{X}_i + e_i$$

Where A is the y-intercept, B is the slope, and e_i is the residual error term.

6.3 The y-intercept: $A = \bar{y} - B\bar{x}$

6.4 The slope: $B = r\frac{S_Y}{S_X}$

7. Hypothesis testing

Null hypothesis	H_o	Alternative hypothesis	H_1
Probability (given H_o)	p	Significance level	α
Chance of a type I error	α	Chance of a type II error	β

Power = 1 - β

7.1 Hypothesis testing using the sample mean

$$z = \frac{\overline{X} - \mu}{\sigma_{\overline{X}}} = \frac{\overline{X} - \mu}{\sigma_X / \sqrt{n}}$$

7.2 Critical values

5% 2-tailed critical value for z: ± 1.96
1% 2-tailed critical value for z: ± 2.58

7. Matrix Laboratory (MATLAB)

7.1 Defining/changing variables

`x = 3` *% define variable x to be 3*

`x = [1 2 3]` *% set x to the 1 x 3 row-vector (1,2,3)*

`x = [1; 2; 3]` *% set x to be the 3 x 1 column vector (1,2,3)*

`x(2) = 7` *% change x from (1,2,3) to (1,7,3)*

`s = 'a string'` *% make the variable s equal the string 'a string'*

`c = {'one','two','three'}` *% define a cell array (c) containing three strings*

7.2 Constructing simple matrices

`rand(12,1)` *% a 12 x 1 matrix of numbers in uniform distribution of [0, 1)*

`randn(12,1)` *% a 12 x 1 matrix of numbers from a normal distribution with mean 0 and variance 1*

`randi(10,12,1)` *% a 12 x 1 matrix of random integers between 1 and 10*

`randperm(12,10)` *% 10 unique random numbers between 1 and 12*

`zeros(12,1)` *% a 12 x 1 matrix filled with zeros*

7.3 Portions of matrices and vectors

`x(2:12)` *% the 2nd to the 12 elements of x*

`x(2:end)` *% the 2nd to the last element of x*

`x(1:2:end)` *% every 2nd element of x from the first to the last*

`x(:)` *% all the elements of x*

`x(5,:)` *% the fifth row of x*

`x(:,2)` *% the 2nd column of x*

`x(x < 5)` *% all values of x less than 5*

`find(x<5)` *% the index of elements in x that are less than 5*

7.4 Simple loops and flow control

```
if x == 1 % if variable x is equal to 1
  FunctionA % then run Function A
elseif x == 2 % or if x is equal to 2
  FunctionB % then run Function B
else      % otherwise
  FunctionC % run Function C
end

for i = 1 : 4 % loop 4 times
  FunctionA(i) % over Function A using i as the input
end

k = 0; % set the variable k to zero
while (k < 5) % loop until k is equal to 5
  FunctionA % run Function A
  k = k + 1; % increase the value of k by 1
end

if strcmp(s,'a string') == 1 % is s contains the string 'a string'
    FunctionA % run Function A
end

arrayfun(@(x) FunctionA(x),TheArray) % run the function FunctionA using each element of
the array named TheArray as an input

cellfun(@(x) FunctionA(x),TheCells) % run the function FunctionA using each element of
the array named TheArray as an input
```

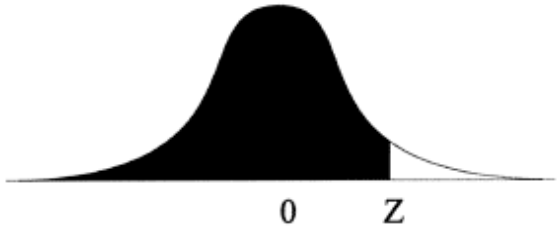
7.5 Declaring a function

```
function [out] = functionName(in) % declare a function called functionName with one
 output and one input
```

7.6 Simple plotting

```
plot(x) % plot y on the y axis with 1, 2, 3,... as the x axis

plot(x,y) % plot y vs x (x and y must be the same length)

axis equal % force x and y axes to be scaled equally

title('A title') % change the plot title to A title

xlabel('x units') % change the x axis label to x units

ylabel('y units') % change the y axis label to y units
```

8. Areas (probabilities) under a normal distribution



The **left column** gives the **first decimal place** and the top row gives the second decimal place. So the area (probability) corresponding to Z1 = 0.23, for example, is in the row labelled 0.2 and the column headed .03, value = 0.5910).

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.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

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