57 Questions, 5 pages name (required) _____ _

You must turn in this hard copy (with your name on it) and your scantron to receive credit for this exam.

One answer and only one answer per question. Leaving a question blank or filling in 2+ answers will be incorrect no matter what.

Where relevant, the goal is underlined. *Italicized phrases are true.* Do not assume more than is given in a question.

A = True, B = False unless indicated otherwise. If any part of an answer is incorrect, treat all of it as incorrect. If different parts of an option are inconsistent with each other, consider it incorrect.

Data Quality: Errors and fixes

(RPA = rounding, precision, accuracy; H&T = human & technical; standards = knowns)

1-6. (2.5pts each) Which type of error is indicated in each of the following paragraphs? (One answer per question)

1. You want to weigh a piece of solid gold jewelry to estimate its value based on its gold content. Your scale weighs it at 2 grams; not 1 or 3 grams (which are the nearest alternative weights that your scale could provide). Your friend's scale weighs it at 1.7 grams. Both scales correctly give the weight of a 10 gram 'standard' weight as 10 grams (10.0 on your friend's scale). Since gold is selling at $50/gram, the value based on the weight provided by your scale is $100, but the value based on your friend's scale is only $85. You decide to claim the value of your piece as $100 worth of gold. What type of error may plausibly underlie your use of the weight from your scale instead of your friend's?

(A) Bias (B) H&T (C) RPA (D) Sampling (E) None

2. You are going to put wooden slats in a 50-foot long fence and you want to know how many slats to purchase. The slats will be put in edge-to-edge with no space between them. You measure the width of slats as 8" to the nearest ½ inch. You do the calculation (50 feet is 600 inches, divide by 8" per slat = 75) and decide you need 75 slats. All slats are made to the same size specification, so there is no concern that some slats will be wider than others, so you purchase exactly 75 slats for the fence. But when you put the slats on the fence, you discover you are 2 slats short – you actually needed 77 slats. What type of error may plausibly account for your mistake in purchasing slightly fewer slats than you needed?

(A) Bias (B) H&T (C) RPA (D) Sampling (E) None

3. You want to measure the temperature (degrees centigrade) of a water bath. Your mercury thermometer has lost some mercury and reads 37.1 degrees instead of 40.1. What type of error applies to this incorrect reading?

(A) Bias (B) H&T (C) RPA (D) Sampling (E) None

4. A company sells a kit to help couples conceive a boy instead of a girl – to actually influence the outcome of boy versus girl. They gather data on the efficacy of the kit by having couples voluntarily send post card responses once their child is born – to say whether their child was in fact a boy. The company sells 50,000 kits but gets only 3,573 post cards. The responses indicate that a boy was born 75% of the time, and the 75% is statistically different from 50%. If the kits do not actually work (that is, if only 50% of all kit's users had a boy), what kind of error are these data most likely to have experienced?

(A) Bias (B) H&T (C) RPA (D) Sampling (E) None

5. *Black Bull* and Oolong tea are drinks that each have caffeine. The company selling *Black Bull* wants to compare the caffeine content between its drink and Oolong tea. It measures the caffeine content in 35 cups of both drinks (all are 8-ounce cups). It finds that *Black Bull* has 100 milligrams of caffeine per cup, whereas Oolong has 35 milligrms per cup. The difference is consistent and statistically significant. To what type of error do we attribute the observed difference in caffeine content between *Black Bull* and Oolong tea?

(A) Bias (B) H&T (C) RPA (D) Sampling (E) None

6. A clinical trial designed to measure the effect of a new drug is careful to ensure that neither its subjects nor its observers know whether a subject is assigned to the control or treatment group (the control group gets a placebo). Unknown to them, the first subjects to enroll were assigned to the treatment group until that group filled, then the last subjects to enroll were all assigned to the control group. The study results indicated that the drug had a statistically significant effect when compared to the control group, even though in reality there is no effect of the drug. What type of error plausibly accounts for the finding of an effect of the drug when there really is none?

(A) Bias (B) H&T (C) RPA (D) Sampling (E) None

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7-10. (2 pts each) You will send pairs of tubes to a lab for analysis. For each pair of tubes, you are to decide whether replication for the characteristic indicated is present, absent or unknown to you and also whether it would be known to the lab receiving the samples. (Replication means it is the same across both samples.) You know everything given in the table. The lab only knows what is written on the tube: if a tube has a person's name on it, the lab can assume that the tube contents belong to the name of the person on the label and can infer gender but nothing else. If a tube is labeled with a number, the contents are completely unknown to the lab but known to you to the extent given in the table. However, if two tubes are labeled the same, the lab can assume the contents are the same. A question mark (?) indicates that the state of that particular sample is unknown to you. You may be able to use other information in the table to decide its property. (Gender, marker type and blood type do not change from sample to sample of the same individual, even if the assays are sometimes ambiguous.) Your options for tube contents and tube labels are:

tube	*tube label* -- what you and the lab each see	*Contents are from* – what only you see	*Gender*	Blood type	Marker type
(1)	Chrissie Hynde	Chrissie Hynde	Female	B	negative
(2)	Justin Hayward	Justin Hayward	Male	?	negative
(3)	Margo Timmins	Margo Timmins	Female	A	+
(4)	#2013	Robert Plant	Male	O	?
(5)	#1869	Patsy Cline	Female	A	+
(6)	#1000	James Page	Male	O	+
(7)	Guy Clark	Guy Clark	Male	B	negative
(8)	Nanci Griffith	Nanci Griffith	Female	A	negative
(9)	#2013	Robert Plant	Male	O	?
(10)	#7193	Justin Hayward	Male	A	negative

In the following questions, indicate which pairs of tubes (if any) satisfy the specified criteria.

(A) Absence of replication is known to you, and the lab cannot infer the absence

(B) Absence of replication is known to you and the lab can infer the absence

(C) Presence of replication is known to you, and the lab cannot infer the replication

(D) Presence of replication is known to you, and the lab can infer the replication

(E) Replication is unknown to you and unknown to the lab

7. (A)(B)(C)(D) (E) tubes 9 & 10 analyzed for blood type
8. (A)(B)(C)(D) (E) tubes 4 & 9 analyzed for marker type

9. (A)(B)(C)(D) (E) tubes 1 & 2 analyzed for marker type
10. (A)(B)(C)(D) (E) tubes 5 and 9 analyzed for gender

11 - 20. Which ideal data features are explicitly present in the paragraph?

11-15. (8 pts) George is taking one university class and is trying to find the best way of preparing for exams. He tests 3 different methods, all decided in advance. In advance of exam 1, he merely attends lecture but does nothing else. His first exam score is 43. Between exam 1 and exam 2, he takes notes while attending lecture. His second exam score is 55. Finally, between exam 2 and exam 3, he takes notes while attending lecture and reads the book outside of class. His third exam score is 65.

(**A**) = Present (B**)** = absent or not described

11. (A)(B) Explicit Protocol	**14. (A)(B)** Randomization
12. (A)(B) Replication	**15. (A)(B)** Blind (at least one way)
13. (A)(B) Standards	

16-20. (8 pts) Holly is wanting to find which of 4 varieties of tomato she likes best. She has a greenhouse with 8 large pots for growing the plants. The pots are arranged in two rows of 4, and each variety of plant is grown in one pot of each row; each pot is labeled with the tomato variety so she doesn't forget variety identities. To avoid position effects that might influence tomato quality, she organizes the pots so that the order of plants differs between the rows, and this order is changed weekly. Each pot receives a fixed amount of water daily. When the tomatoes ripen, she tastes them.

. **(A) = Present** (B) = absent or not described

16. (A)(B) Explicit Protocol	**19. (A)(B)** Randomization
17. (A)(B) Replication	**20. (A)(B)** Blind
18. (A)(B) Standards	

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21-23 (5 pts). The following paragraph is a description of a design. In the questions below the paragraph, mark whether the quoted text correctly indicates the data feature is present.

A professor wants to know whether ending a lecture with an unsolved problem increases attendance for the following lecture. On ten odd-numbered class days, she ends lecture with an unsolved question, on 12 even-numbered days she does not; attendance is recorded for each following lecture. Her class is not told the purpose of this study, or even that the study is being conducted.

A = the quote indicates the feature, B = the quote does not

21 (A) (B) Random: "Her class is not told the purpose"
22 (A) (B) Replication: "on ten odd-numbered class days"
23 (A) (B) Blind: "an unsolved problem"

24-27. (7 pts) In an attempt to evaluate bullet lead analysis as a forensic tool, two testing companies (*Alphametrics*, *Betadynamics*) measure the trace arsenic and tin levels in boxes of ammunition from the *CCI* factory in Lewiston, ID. The levels of arsenic and tin are expected to be very small in bullet lead, but detectable with the machines used. *Alphametrics* measures 1000 randomly-chosen bullets from the 1 million bullets manufactured by *CCI* in August, *Betadynamics* measures 8,000 randomly-chosen bullets from the 2 million bullets manufactured by *CCI* in October. The batch of lead used by *CCI* to make the bullets was changed between August and October, so the trace elements may well have differed between those months. What can be said about the data acquired by *Alphametrics* and *Betadynamics*?

Which are true? **(A)** = TRUE, (B) = False

24. (A)(B) Randomization in the choice of samples removes any concern of a consistent difference between the *Alphametrics* and *Betadynamics* samples

25. (A)(B) RPA error would not exist in this study because tin and arsenic are uniquely identifiable and cannot be confused with other trace metals.

26. (A)(B) Human and technical error is not a possibility because tin and arsenic levls were measured on machines.

27. (A)(B) Assuming no consistent differences of tin and arsenic levels between August and October, sampling error of the tin and arsenic content will be **smaller** in *Alphametrics* sample (of 1,000) than in *Betadynamics* sample. (of 8,000)

Criminal Justice (RMP is random match probability)

We mentioned 4 features of an 'ideal' forensic method for matching a suspect with a forensic sample: (i) reference database, (ii) discrete characteristics, (iii) independent verification possible, (iv) labs/experts pass blind proficiency tests. Discrete characteristics are all-or-none, not subject to RPA error.

28. (3 pts). Which feature of an ideal method is an assurance that a lab's work can be trusted? (One answer only)

(A) Reference database **(C)** Independent verification **(E)** None

(B) Pass blind proficiency tests **(D)** Discrete characteristics

29-33. (10 pts) Which of the following points correctly identifies a main purpose of the feature, explains the error reduction principle or describes an indicator of the feature's absence? **(A)** = TRUE, **(B)** = false

29. (A)(B) Discrete characters: are needed to have a reference database

30. (A)(B) Discrete characters: an indicator of its absence is the claim that a match is unique

31. (A)(B) Proficiency tests: an indicator of its absence is the lack of a universal protocol

32. (A)(B) Universal protocol: helps enable other labs to independently verify results

33. (A)(B) Reference database: is needed to claim that a match is unique

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34-37. (6 pts) Which of the following would constitute a legitimate reference database for the goal indicated (underlined)? In all cases, we want the database to calculate the RMP of a match between a suspect and a crimescene sample. A legitimate reference database should not have major flaws. In all cases listed below, consider the numbers listed to be sufficient if there are no other problems.

(A) = is a legitimate reference database for the case in question (B) = Has major flaws

34. (A)(B) For a match between the species of grass seeds in a suspect's socks and the scene of a murder in Boise, a highly detailed map of the locations of different grass species in Idaho.

35. (A)(B) For a match between the trace elements in the lipstick found in the kiss mark on a murder victim and the lipstick in the suspect's handbag, the trace element compositions of 10,000 different lipstick tubes sold in the same area where the murder victim and suspect lived.

36. (A)(B) For a shoe-print match obrtained from a crime committed in 2015, prints of 500 different *Nike* brand shoes manufactured in 2015.

37. (A)(B) For a hair match, the characteristics of 1500 hairs from the victim's head

38-41. (7pts) Combining sources of error in forensic matches. In a court case, the forensic lab has declared a match between suspect and sample. The defense emphasizes that there are 3 completely different and unrelated possible reasons that the match may be in 'error' – that the suspect was not the source of the forensic sample. The three individual error probabilities are 0.000001, 0.002, and 0.03 (1 in a million, 2 in a thousand, 3 in a hundred,).

The defense asks you for the overall chance of the match being in error – that the match is false by any combination of the 3 reasons. Which of the following are true? **(A)** = TRUE (B) = false

The overall chance of a 'false' match in this case

38. (A)(B) Is the product of the 3 error probabilities

39. (A)(B) Would change greatly if the 1 in a million error rate was reduced to zero

40. (A)(B) Cannot be less than 0.03

41. (A)(B) Cannot be determined by combining error rates from 3 *completely* different sources

42-46 (8pts). Which of the 4 features of 'ideal forensics' are indicated as being present? For all but 'independent verification', the problem must specifically describe their presence for it to be present. For 'independent verification' the problem must specifically describe it or indicate a means by which independent verification could feasibly be performed by different labs.

The only evidence in a murder trial to connect the defendant to the crime is a match between the nylon rope used to bind the victim and rope found in the defendant's car. The lab providing the evidence based the match on both the total number of nylon fibers in the rope and on trace elements in the rope. The rope in the car and on the victim both had 513 fibers in it. The trace element analysis of both ropes showed similar tiny levels of copper and zinc. The lab analyzed 690 ropes from stores in 20 states in establishing the typical similarity between different ropes. Although the defense attempted to find an expert to challenge this testimony, it discovered that no other lab in the world does this kind of analysis, and the lab uses a proprietary analytical method to declare a match (that it keeps secret) so that no one else can compete with its business. This court case is in fact the first time the lab has applied its method in testing whether two rope samples match.

A = present B= absent, incomplete or not used

42. (A) (B) The labs mentioned were able to pass blind proficiency tests

43. (A) (B) Independent verification of a declared match is possible (explicitly present or the means for doing it is described)

44. (A) (B) a reference database that can be screened for a RMP is indicated

45. (A) (B) some of the characteristics used are discrete

46. (A) (B) some of the characteristics used are not discrete

47-50. (8 pts) The class was subjected to a test of eyewitness identification; class was also shown a video of an audience subjected to an eyewitness test. Which are true? **(A)** = TRUE (B) = false

47. (A)(B) More than half of our class correctly identified the perpetrator in the lineup.

48. (A)(B) In the video shown, more than half the audience correctly identified the perpetrator in the lineup.

49. (A)(B) Eyewitness identification satisfies 3 of the 4 criteria of an ideal matching method.

50. (A)(B) The Polleverywhere options for the lineup given in our class allowed for the possibility that you were not sure of the correct identity.

Data Presentation

51-56. (12 pts). Based on the Data Presentation lecture and chapter, which of the following points are true?

(A) = TRUE **(B)** = FALSE in at least one respect

51 (A) (B) Suppose a drug test uses a method that gives the correct answer 99% of the time. A person getting a positive result from that test could actually have a low chance that they were truly positive.

52 (A) (B) A drug test uses a method that gives the correct answer 99% of the time. With this information alone, it is not possible to determine how often a positive result from the test is false (is wrong).

53 (A) (B) Data presented as natural frequencies are harder for most people to understand than data presented as conditional probabilities

54 (A) (B) A drug reducing heart attacks from 4 in 100,000 patients to 1 in 100,000 patients can be advertised legitimately as causing a 75% reduction in heart attacks.

55 (A) (B) Data presented as relative risks are often more impressive than data presented as absolute risks.

56 (A) (B) Graphs can change the information conveyed merely by changing the scale on the axes.

57. (3 pts.) Exam Key Code **B**: **Fill in** bubble **(B)** on question **57** to indicate your exam code; leave the other bubbles blank for this question. Also, fill in the correct bubbles for your name and EID on the scantron form.

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Name

1	A	B	C	D	E	26	A	B	C	D	E	51	A	B	C	D	E
2	A	B	C	D	E	27	A	B	C	D	E	52	A	B	C	D	E
3	A	B	C	D	E	28	A	B	C	D	E	53	A	B	C	D	E
4	A	B	C	D	E	29	A	B	C	D	E	54	A	B	C	D	E
5	A	B	C	D	E	30	A	B	C	D	E	55	A	B	C	D	E
6	A	B	C	D	E	31	A	B	C	D	E	56	A	B	C	D	E
7	A	B	C	D	E	32	A	B	C	D	E	57	A	B	C	D	E
8	A	B	C	D	E	33	A	B	C	D	E	58	A	B	C	D	E
9	A	B	C	D	E	34	A	B	C	D	E	59	A	B	C	D	E
10	A	B	C	D	E	35	A	B	C	D	E	60	A	B	C	D	E
11	A	B	C	D	E	36	A	B	C	D	E	61	A	B	C	D	E
12	A	B	C	D	E	37	A	B	C	D	E	62	A	B	C	D	E
13	A	B	C	D	E	38	A	B	C	D	E	63	A	B	C	D	E
14	A	B	C	D	E	39	A	B	C	D	E	64	A	B	C	D	E
15	A	B	C	D	E	40	A	B	C	D	E	65	A	B	C	D	E
16	A	B	C	D	E	41	A	B	C	D	E	66	A	B	C	D	E
17	A	B	C	D	E	42	A	B	C	D	E	67	A	B	C	D	E
18	A	B	C	D	E	43	A	B	C	D	E	68	A	B	C	D	E
19	A	B	C	D	E	44	A	B	C	D	E	69	A	B	C	D	E
20	A	B	C	D	E	45	A	B	C	D	E	70	A	B	C	D	E
21	A	B	C	D	E	46	A	B	C	D	E	71	A	B	C	D	E
22	A	B	C	D	E	47	A	B	C	D	E	72	A	B	C	D	E
23	A	B	C	D	E	48	A	B	C	D	E	73	A	B	C	D	E
24	A	B	C	D	E	49	A	B	C	D	E	74	A	B	C	D	E
25	A	B	C	D	E	50	A	B	C	D	E	75	A	B	C	D	E

Student ID

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

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