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# ADM2303: STATISTICS FOR MANAGEMENT

## Mid-term Exam - Summer 2015

**Date: June 20, 2015**

**Duration: 120 minutes**

**Professor :** Davood Astaraky

**Last Name :** _____

**First Name :** _____

**Student Number :** _____

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*Instructions to Students:*

- *Complete your name and signature in the spaces below.*
- *Verify that your exam copy has 7 pages (including this title page). If not, please inform the professor immediately.*
- *One page (8.5 by 11 inches) review sheet, both sides, is permitted.*
- *Answer all questions on this examination copy. Only answers in this exam booklet will be marked. Show all work.*
- *NO COMMUNICATION DEVICES MAY BE WITHIN SIGHT DURING THE EXAM PERIOD.*
- *Graphing calculators, iPads/Pods, notebooks, computers are NOT allowed.*

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| Question | 1 | 2 | 3 | 4 | 5 | 6 | Total |
|---|---|---|---|---|---|---|---|
| Points | | | | | | | |
| Total Value | 10 | 10 | 10 | 10 | 6 | 4 | 50 |

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**Statement to be signed by the student:** I have read the text on academic integrity and I pledge not to have committed or attempted to commit academic fraud in this examination.

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Note: an examination copy or booklet without that signed statement will not be graded and will receive a midterm exam grade of zero.

***Question 1.***

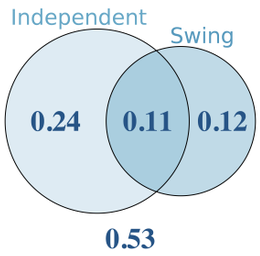
A 2012 Pew Research survey asked 2,373 randomly sampled registered voters their political affliation (Republican, Democrat, or Independent) and whether or not they identify as swing voters. 35% of respondents identified as Independent, 23% identified as swing voters, and 11% identified as both. *(10 points)*

(a) Are being Independent and being a swing voter disjoint, i.e. mutually exclusive? *(1point)*

*No, there are voters who are both independent and swing voters.*

(b) Draw a Venn diagram summarizing the variables and their associated probabilities. *(1 points)*

*The Venn diagram is shown below.*




(c) What percent of voters are Independent but not swing voters? *(2 points)*

*Each Independent voter is either a swing voter or not. Since 35% of voters are Independents and 11% are both Independent and swing voters, the other 24% must not be swing voters.*

(d) What percent of voters are Independent or swing voters? *(2 points)*

*Use the General Addition Rule:*

$$\begin{aligned} P(Independentorswing) &= P(Independent) + P(swing) - P(Independentandswing) \\ &= 0.35 + 0.230.11 = 0.47 \end{aligned}$$

(e) What percent of voters are neither Independent nor swing voters? *(2 points)*

*P(neither Independent nor swing) = 1 - P(Independent or swing) = 1 - 0.47 = 0.53.*

(f) Is the event that someone is a swing voter independent of the event that someone is a political Independent? *(2 points)*

*P(Independent) × P(swing) = 0.35 × 0.23 = 0.08*
*Which does not equal P(Independent and swing) = 0.11, so the events are dependent.*

***Question 2.***

**Part one** - The Behavioral Risk Factor Surveillance System (BRFSS) is an annual telephone survey designed to identify risk factors in the adult population and report emerging health trends. The following table summarizes two variables for the respondents: weight status using body mass index (BMI) and health coverage, which describes whether each respondent had health insurance.

| | | *Weight Status* | | | |
|---|---|---|---|---|---|
| | | Neither overweight nor obese (BMI $<25$) | Overweight ($25 \leq$ BMI $<30$) | Obese (BMI $\geq 30$) | Total |
| *Health Coverage* | Yes | 134,801 | 141,699 | 107,301 | 383,801 |
| | No | 15,098 | 15,327 | 14,412 | 44,837 |
| | Total | 149,899 | 157,026 | 121,713 | 428,638 |

(a) If we draw one individual at random, what is the probability that the respondent is overweight and doesn't have health coverage? *(1 point)*

$\frac{15,327}{428,638} = .036$

(b) If we draw one individual at random, what is the probability that the respondent is overweight or doesn't have health coverage? *(2 points)*

$P(A \cup B) = P(A) + P(B) - (A \cap B) = \frac{157,026}{428,638} + \frac{44,837}{428,638} - 0.036 = 0.435$

**Part two** - In the contingency table below counts have been replaced by relative frequencies (probability estimates).

| | | *Weight Status* | | | |
|---|---|---|---|---|---|
| | | Neither overweight nor obese (BMI $<25$) | Overweight ($25 \leq$ BMI $<30$) | Obese (BMI $\geq 30$) | Total |
| *Health Coverage* | Yes | 0.3145 | 0.3306 | 0.2503 | 0.8954 |
| | No | 0.0352 | 0.0358 | 0.0336 | 0.1046 |
| | Total | 0.3497 | 0.3664 | 0.2839 | 1.0000 |

(a) What is the probability that a randomly chosen individual is obese? *(1 point)*

0.2839

(b) What is the probability that a randomly chosen individual is obese given that he has health coverage? *(2 points)*

$0.2503/0.8954 = 0.2795$

(c) What is the probability that a randomly chosen individual is obese given that he doesnt have health coverage? *(2 points)*

$0.0336/0.1046 = 0.3212$

(d) Do being overweight and having health coverage appear to be independent? *(2 points)*

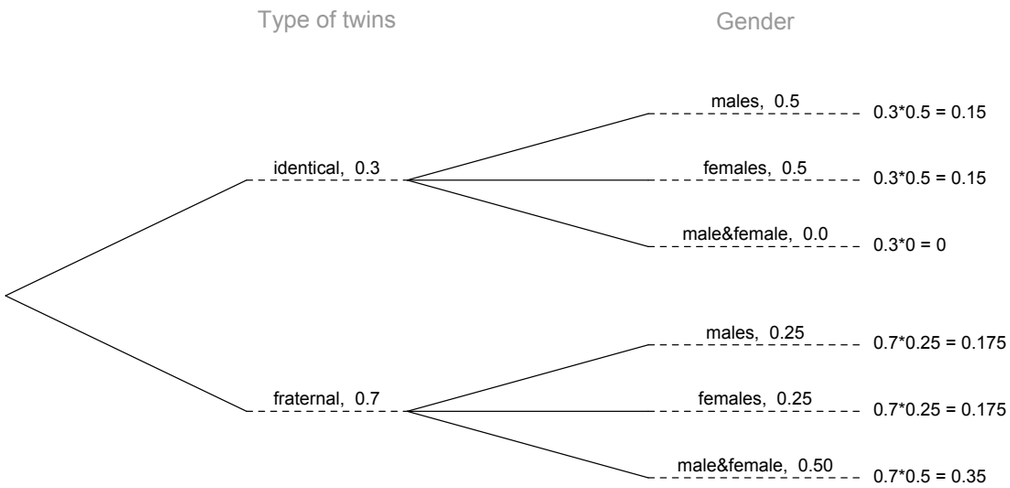
$0.3306/0.8954 = 0.3692$

*Almost, because $0.3692 \approx 0.3664$. Unsurprising though being overweight and having health coverage do not appear to be exactly independent. It does however seem that independence is a reasonable approximation.*

***Question 3.***

About 30% of human twins are identical and the rest are fraternal. Identical twins are necessarily the same sex – half are males and the other half are females. One-quarter of fraternal twins are both male, one-quarter both female, and one-half are mixes: one male, one female. Given this information :

(a) Draw a tree diagram to represent all the information in the paragraph above. *(4 points)*




(b) What is the probability that twins would be both girls ? *(2 points)*

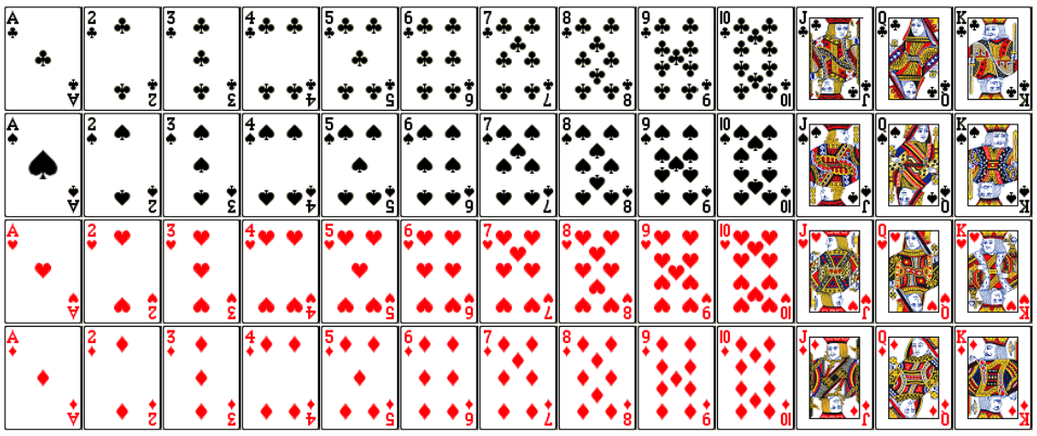
$$P(females) = 0.15 + 0.175$$

(c) You have just become a parent of twins and are told they are both girls. What is the posterior probability that they are identical? *(4 points)*

$$\begin{aligned} P(identical \mid females) &= \frac{P(identical \text{ and } females)}{P(females)} \\ &= \frac{0.15}{0.15 + 0.175} \\ &= 0.46 \end{aligned}$$

***Question 4.***

Consider the following standard deck of cards and answer the questions. (each part is independent of the other)



(a) You draw a card at random from the deck, what is the probability that the card is a queen, given that it is a face card ? *(Jack, King and Queen are face cards ) (2 points)*

$$P(Queen|Face) = \frac{P(Queen\ and\ Face)}{P(Face)} = \frac{4/52}{12/52} = \frac{1}{3}$$

(b) You draw two cards from the deck **without replacement** one at a time, what is the probability that the second card will be an ace if the first card is a king ? *(2 points)*

*P(Ace | King) = 4/51 since there are four aces in the deck but only 51 cards left after the king has been removed.*

(c) You draw three cards from the deck **without replacement** one at a time, what is the probability that the first heart you get is the third card picked ? *(2 points)*

*P(first heart drawn is on the third card) = P(no heart)P(no heart)P(heart) = (39/52) × (38/51) × (13/50)*

(d) You draw thee cards from the deck **without replacement** one at a time, what is the probability of drawing three queens in a row ? *(2 points)*

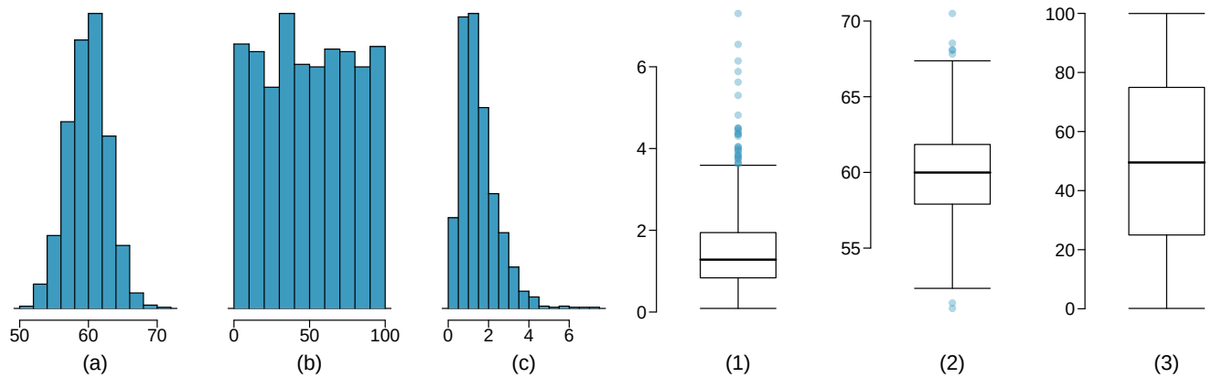
*Using multiplication rule for independent events : P(QQQ) = (4/52) × (3/51) × (2/50)*

(e) You draw thee cards from the deck **without replacement** one at a time, what is the probability that you have at least one diamond ? *(2 points)*

$$\begin{aligned} P(at\ least\ one\ of\ the\ cards\ is\ a\ diamond) &= 1 - P(none\ of\ the\ cards\ are\ diamonds) \\ &= 1 - [P(no\ diamond) \times P(\ no\ diamond) \times P(no\ diamond)] \\ &= 1 - (39/52) \times (38/51) \times (37/50) \end{aligned}$$

### *Question 5.*

Consider the following graphs and answer the questions.




(a) Consider only the histograms. Describe the distribution of each of the three histograms in terms of "modality" and "skewness". *(2 points)*

*(a): Uni- modal, symmetric, centered at 60, standard deviation of roughly 3.*
*(b): Symmetric and approximately evenly distributed from 0 to 100.*
*(c): Right skewed, unimodal, centered at about 1.5, with most observations falling between 0 and 3. A very small fraction of observations exceed a value of 5.*

(b) Consider only the boxplots. Which one has higher variability ? Explain what measure of variability you used. *(1 point)*

*Number (3) because of higher IQR.*

(c) Consider only the boxplots. Rank them based on the value of their median. *(1 point)*

$median_2 > median_3 > median_1$

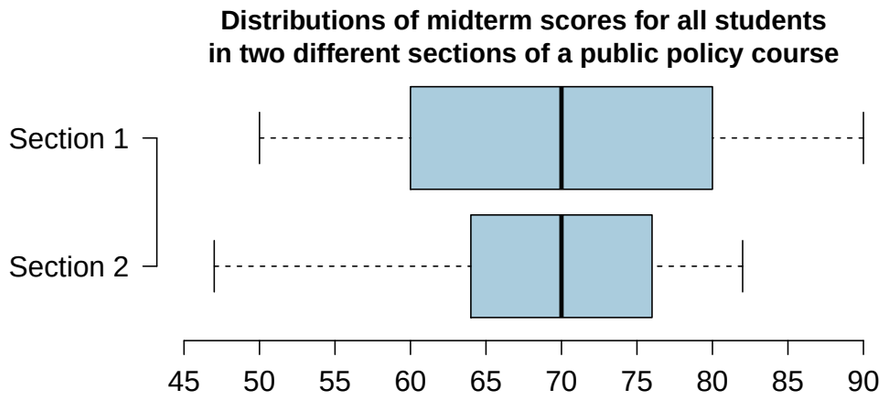
(d) Now consider both the histograms and boxplots. Match the histograms to the box plots. *(2 points)*

*(a) matches 2*
*(b) matches 3*
*(c) matches 1*

***Question 6.***

*Answer questions (1) and (2) based on the information below.*

The two box plots below display distributions of midterm scores for all students in two different sections of a public policy course.




(1) Which section has a greater percentage of students with scores below 55 ? *(1 point)*

(a) Section 1

(b) Section 2

(c) Both sections are about equal

(d) ***It is impossible to tell***

(2) Which section has a greater percentage of students with scores above 70 ? *(1 point)*

(a) Section 1

(b) Section 2

(c) ***Both sections are about equal***

(d) It is impossible to tell

(3) The table below shows some summary statistics of the distributions of resident tuition at public and private medical schools. Determine which of the following statements is true about the spread for medical school resident tuition. *(2 point)*

| | Min | Q1 | Median | Q3 | Max |
|---|---|---|---|---|---|
| Private | \$6,550 | \$30,729 | \$33,850 | \$36,685 | \$41,360 |
| Public | \$0 | \$10,219 | \$16,168 | \$18,800 | \$27,886 |

(a) The ranges of the two distributions are roughly equal indicating that the variability is the same for the two distributions.

(b) ***There is more variation in tuitions for residents at public medical schools than at private medical schools since the interquartile range is higher for public schools.***

(c) There is more variation in tuitions for residents at private medical schools than at public medical schools since there are outliers for private schools.

(d) With these data, we cannot compare the variations of tuitions for residents at private and public medical schools.