

The Deal

Write Your Answers in Complete Sentences on a Separate Sheet of Paper

1. As of Sunday, November 21, 2010, the college football teams of Southern Mississippi and Hawaii were both averaging 36.45 points per game with standard deviations of 13.5 and 15.8 points, respectively. Which team has been more consistent in scoring for the season? Assuming the data is normally distributed, use the empirical rule to write an interval of scores for Hawaii that represents 95% of their single game point totals. When the Warriors of Hawaii played Boise State, they only scored 7 points against the Broncos; based on the previous calculation, would that be considered unlikely?
2. On August 26th, 1997, the bodies of two homicide victims were found in Spokane, Washington. This was part of a string of disturbing discoveries of bodies in the late 1990's, which led to the creation of a serial killer task force. Eventually, the cases were resolved with the arrest of Robert Lee Yates who is currently on death row. At that time, Spokane averaged only five homicides per year. What was the probability of finding two or more bodies on the same day? What would have been the probability of finding two or more bodies in the same week?
3. Give three examples of pairs of events which are mutually exclusive. Give three examples of pairs of events which are independent. Is it possible for a pair of events to be both mutually exclusive and independent? Give an example or explain why no such example exists. Is it possible for a pair of events to be neither mutually exclusive nor independent? Give an example or explain why no such example exists.
4. How many possible flushes are there in five card poker? How many royal flushes are there? What's the probability of getting a flush? a royal flush?
5. Consider the following frequency table showing the times in minutes between eruptions of Old Faithful (the famous geyser) at Yellowstone National Park.

Time	Frequency
40-49	8
50-59	44
60-69	23
70-79	6
80-89	107
90-99	11
100-109	1

What's the average time between eruptions? What's the median time between eruptions? What's the standard deviation of the time between eruptions?

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6. In *The Ancient Races of Thebaid*, the authors collected data on the maximum breadths (in centimeters) of Egyptian male skulls. Some of the data from two different time periods is summarized below.

4,000 BC:	131	119	138	125	129	126	131	132	126	128	128	131
150 AD:	136	130	126	126	139	141	137	138	133	131	134	129

One can argue that changes in head sizes over time suggest interbreeding with people from other regions. Find the five number summaries for both data sets above and compare box plots on the same scale. How did the basic shape of the data change from 4,000 BC to 150 AD, and what could that insinuate? What happened to the IQR, and what might that mean? Give an alternative explanation (other than interbreeding) for the change in head size.

7. Roulette is a casino game in which a wheel is spun in one direction and a ball is spun in the opposite direction in a track around the circumference of the wheel. The ball eventually falls on to the wheel and into one of 38 colored and numbered pockets on the wheel. There are numbers 1 through 36 (colored red and black) and two green pockets numbered 0 and 00. A bet on "even" means a bet on the numbers 2, 4, 6, ..., 36. If we win betting on even, then we double our money. What's the probability that we win if we place a bet on even? Now suppose we place 100 bets on even of one dollar apiece, one after the other. What's our expected payoff? What's the probability of not losing money in this scenario? What's the probability of losing money? What's the chances that we lose every time? win every time?
8. Using data from the New York State Health Department, if we randomly selected 20,000 people from the general population, then we would expect the following contingency table summarizing the results of an HIV screening test.

	Positive	Negative
HIV infected	57	3
Not infected	997	18,943

Suppose we pick one of these 20,000. What's the probability that they are infected with HIV? What's the probability that they are HIV infected given that their test was negative (false negative)? What's the probability that they tested positive and were HIV infected? What's the probability that they tested positive or were HIV infected? Begin infected or not and testing positive or negative should be highly dependent on each other (since otherwise the test would be useless); what's the p -value of a χ^2 -independence test on this table? Does that p -value make sense? If the rows and columns were independent, how many false positives should we have seen?

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9. In World War II, the German Luftwaffe (Nazi Air Force) developed the V1 “buzz bomb”. This was an early example of what would become a cruise missile; it was designed for the terror bombing of London. To analyze hits by V1 bombs, South London was divided into 576 regions. Each had an area of 0.25 kilometers squared. A total of 535 bombs hit South London during a particular bombing campaign. What’s the probability that a given region was hit exactly twice? What’s the probability that a region is not hit at all? What’s the probability that a region is hit at least once?
10. Suppose five regional managers gather for a meeting. If each manager shakes hands with every other manager, how many total handshakes are there? What’s the general solution for n managers? Let’s say they all sit down at a big round table. How many different ways can the five managers be seated (assuming that if everyone moves to the right, we count this as the same arrangement)? What’s the general solution for n managers?
11. Solve the following jumble puzzles, i.e. unscramble the letters to make words.

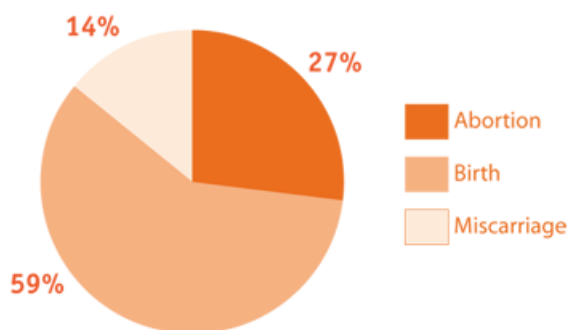
O M O Z	
C O H A M	
Y A T N O B	
T I N T I G F	

If we just re-scrambled at random, what’s the chances we get everything correct?

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12. *Dear Abby* is a notable advice column created in 1956 by Pauline Phillips under the pen name Abigail Van Buren. Readers write in and “Abby” answers their question or suggests a resolution to their problem. One reader wrote in and claimed that she gave birth 308 days after a visit from husband, who was in the Navy. Lengths of pregnancies have a mean of 268 days and a standard deviation of 15 days. Compute the z -score of 308 days. What does a z -score tell you in general? Is a length of 308 days unusual in this context? What conclusion might you draw? Are there alternative explanations?
13. The DeLorean DMC-12 was a sports car originally manufactured in Northern Ireland for the American market from 1981 to 1982. The DMC-12 featured gull-wing doors with stainless steel panels. A modified version of the car became iconic for its appearance as a time machine in the movie “Back to the Future” starring Christopher Lloyd and Michael J. Fox. In very cold weather, some of the models had a problem with the throttle. In particular, moisture that enters the throttle cable housing could freeze, causing the throttle to stick; in other words, the driver would have trouble controlling the speed if this happened. It’s estimated that 5,400 DMC-12 models had this problem. In total, around 9,000 DeLorean’s were made. If we randomly start checking DMC-12’s for this problem, what’s the probability that we find our first defective model on the fifth check? It’s believed that there are 6,500 DeLorean’s still on the road. Suppose 1 in every 1,000 of the defective models cause fatal accidents. If the average cost of an out of court settlement for such an accident is \$500,000 and the cost of a recall is 2 million dollars, should a recall be done (assuming the DeLorean Motor Company still existed)?
14. Nearly one third of all teen pregnancies end in abortion. See the pie chart below summarizing the outcomes of teen pregnancies.



What’s the probability that a given teen pregnancy will not result in birth? Given that a pregnancy did not result in birth, what’s the probability that the pregnancy ended in miscarriage? In 2006, the teenage pregnancy rate in the United States was 71.5 pregnancies per 1,000 teenage girls, and there were around 20 million teenage girls. How many teen abortions would we have expected in 2006 given this data?

The Final Deal

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1. The 2005 hurricane season was particularly active in the North Atlantic (a region including the Gulf of Mexico and Florida). Specifically, hurricanes Katrina and Rita ravaged Louisiana, Arkansas, and Texas. The temperature of the sea's surface is strongly correlated with the number and severity of tropical storms; warmer sea water means more storms. Many believe global warming to be the cause of elevated temps and thus more storm activity. The Climate Prediction Center (CPC) estimated that the average number of tropical storms per year should have been 19.5 in 2005. In reality, there were 28 tropical storms in that year. Using the estimate of the CPC, what was the probability of having 27 or less tropical storms in 2005? What was the probability of having 28 or more? OK, so was it unlikely to have a hurricane season like we had in 2005? Why or why not?
2. Below is a contingency table showing a breakdown of Titanic passengers according to their class and whether or not they survived.

Category	Survived	Died
First class	199	130
Second class	119	166
Third class	174	536
Crew	214	685

Suppose that we choose a Titanic passenger at random.

- (a) What's the probability that the passenger survived?
 - (b) What's the probability that the passenger survived given that they were a first class passenger?
 - (c) What's the probability that the passenger survived given that the passenger was a crew member?
 - (d) What's the probability that the passenger survived and was a second class passenger?
 - (e) What's the probability that the passenger survived or was a second class passenger?
 - (f) Run a χ^2 -independence test for the above table (a 4×2 matrix) and interpret the p -value.
 - (g) Recall that the p -value for male/female versus survived/died was 0. With that said, which can you conclude had more to do with surviving the Titanic: gender or class?
3. Suppose the Rolling Stones want to schedule a final US tour and visit all 50 state capitals.
 - (a) How many possible tour routes are there?
 - (b) Let's assume "Mick" Jagger is having health problems and they can only visit ten cities. How many possible tour routes of ten cities are there?
 - (c) How many possible sets of ten cities are there?

4. The Phoenix Suns point guard Steve Nash had an excellent 93.8% free throw percentage in the 2009-2010 season. What's the probability that we would have to wait until Nash's fourth free throw to see his first make? In other words, what's the chance that he misses his first three, but makes his fourth?
5. The five-year survival rate for stage IV breast cancer is 0.15. In a group of 100 women with this stage of breast cancer, what's the probability of exactly 15 surviving five years? What's the probability of less than a quarter (i.e., 24 or less) surviving five years?
6. Pittsburgh has among the worst air qualities of all US cities. The frequency table below shows a summary of the air quality index (AQI) of Allegheny County for all the days in 2005 and 2006.

AQI Range	# of days in 2005	# of days in 2006
Good: 0-50	135	149
Moderate: 50-100	179	170
Sensitive: 100-150	39	42
Unhealthy: 150-200	12	4

Compute the means and standard deviations for 2005 and 2006. What can you conclude about the change in overall air quality during this time span? (Did it get worse or better?) Which year had more consistent AQIs?

7. Former WNBA star Rebecca Lobo is 6 ft 4 in tall, while former NBA star Michael Jordan is a full two inches taller at 6 ft 6 in. For male heights we have $\mu = 69.3$ in and $\sigma = 2.8$ in, but for female heights we have $\mu = 64$ in and $\sigma = 2.7$ in. Compute the z -scores for Lobo and Jordan. Who has the bigger z -score? What does that mean, and, in general, what does a z -score tell you? Heights of men and women are known to be normally distributed. Use the Empirical Rule to construct intervals in which 68% and 95% of the data fall into for men. Do the same for women. Finally, compute the z -score for your own height. Is your height within the 95% interval for your gender?