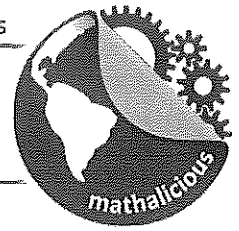


BOOKIE NIGHTS

What's the best way to bet on the Super Bowl?

name _____

date _____



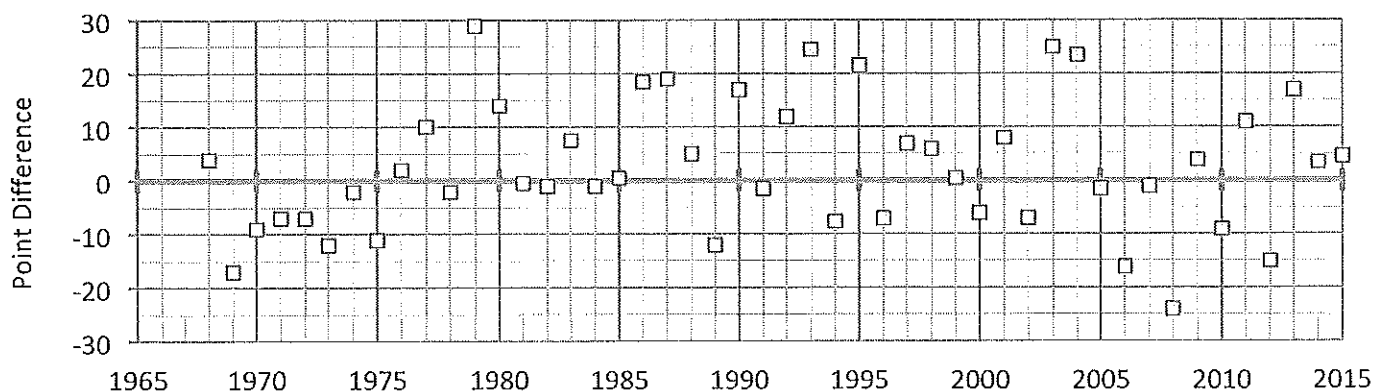
Act One: What's the Point?

- 1 There are many ways to bet on the Super Bowl. One of the most popular is the **over-under**; a bookie predicts how many total points will be scored, and people bet whether the actual total will be more or less than this.

The table below shows the over-under for the past six Super Bowls, as well as the actual scores. For each game, determine which bet would have won: the over or the under.

Year	Over-Under	Score, Favorite	Score, Underdog	Total Points	Winning Bet
2015	47.5	New England 28	Seattle 24		
2014	47.5	Denver 8	Seattle 43		
2013	48	San Francisco 31	Baltimore 34		
2012	53	New England 17	NY Giants 21		
2011	45	Green Bay 31	Pittsburgh 25		
2010	57	Indianapolis 17	New Orleans 31		

- 2 In which year do you think the bookies' prediction was the most accurate? The least accurate? Explain.
- 3 The graph below shows the difference between the total points scored and the over-under for every Super Bowl. Do you think bettors could use this information to decide which bet to make: the over or the under? Explain.

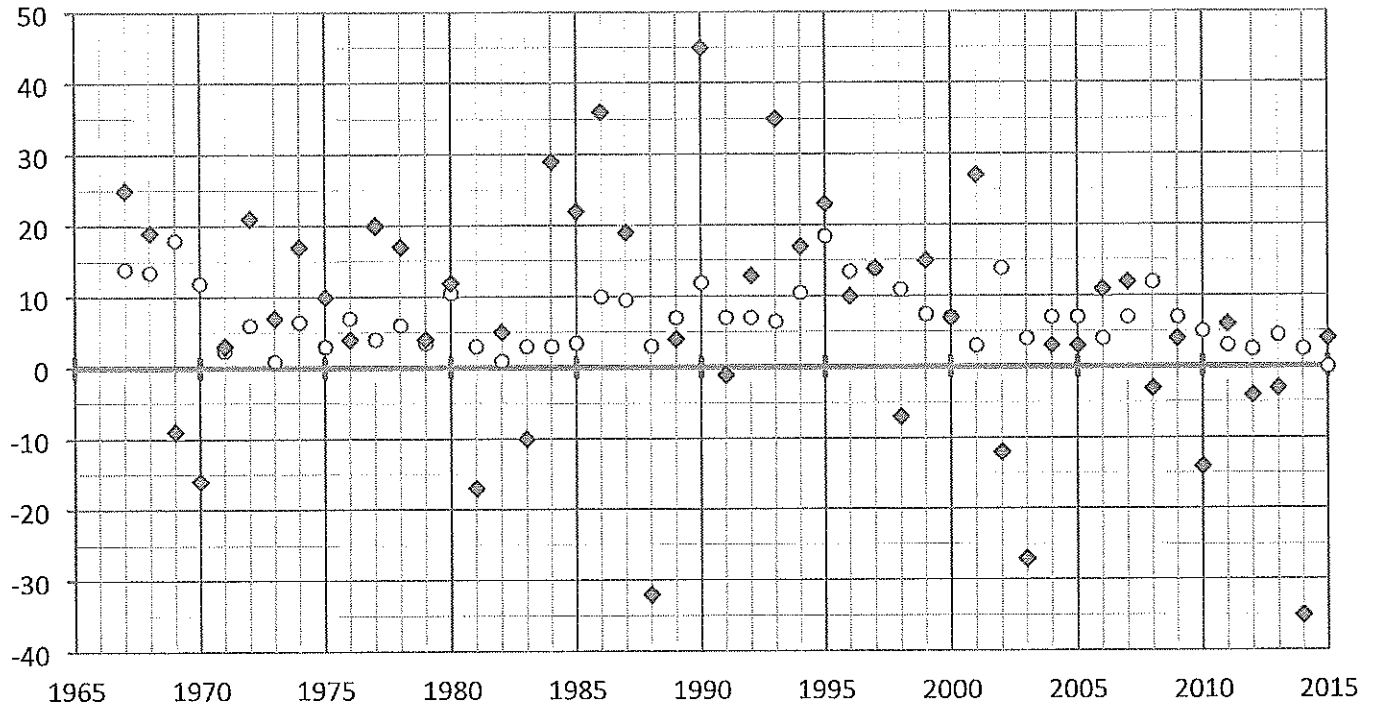




Act Two: Spread Formation

- 4 The over-under isn't the only Super Bowl bet. Bettors can also bet whether a team will "cover the spread." In most games, one team is the favorite. The spread is the number of points this team is expected to win by.

Below, the circles (○) refer to the Super Bowl spread, while the diamonds (◆) refer to the favorite team's actual margin of victory. For example, in 2011 bookies expected the Green Bay Packers to beat the Pittsburgh Steelers by 3 points. In the actual game, the Packers won by 6 points and covered the spread.

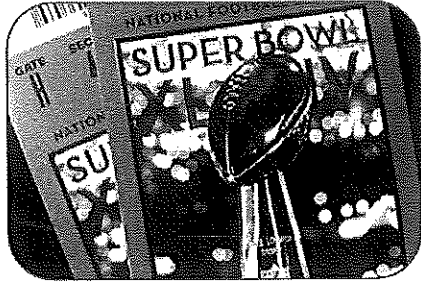


<p>a. Before kickoff, which game seemed like it was going to be the most competitive? The least?</p>	<p>b. In reality, which Super Bowl do you think turned out to be the most exciting to watch and why?</p>
<p>c. Which Super Bowl would you say resulted in the biggest upset? Explain.</p>	<p>d. Historically, which do you think has been a better bet – covering the spread or not – and why?</p>

BOOKIE NIGHTS

What's the best way to bet on the Super Bowl?

lesson guide



The Super Bowl is one of the year's biggest events in sports. It's also one of the biggest events in gambling. Every January, fans around the world bet millions (billions) on the game. What are bettors betting on, and how have they historically been the most successful?

In this lesson, students add and subtract positive and negative numbers to explore two popular types of bet: the over-under and the spread. Students analyze the results from every Super Bowl to determine which bets have been the most effective and consider the best ways to win big on the big game.

Primary Objectives

- Find absolute differences between the actual total of both teams' scores from Super Bowl games and bookies' predictions of the total, and use them to rank the quality of bookies' past predictions
- Interpret positive and negative numbers on a graph and understand what they represent in the context of Super Bowl betting
- Estimate the probability of winning certain types of bets based on an analysis of past betting results
- For the difference between the expected winner's and expected loser's scores, interpret what a positive or negative sign or a large or small magnitude imply about the predicted or actual outcome of a game

Content Standards (CCSS)		Mathematical Practices (CCMP)	Materials
Grade 6	NS.5, NS.7	MP.1, MP.2, MP.7	<ul style="list-style-type: none"> • Student handout • LCD projector • Computer speakers

Before Beginning...

Students should be prepared to calculate with positive and negative numbers and to think about the sign and the magnitude of real numbers in a meaningful context. They will need to be able to read and interpret a graph that includes negative coordinate values. Students should have a very basic understanding of probability in order to compare the likelihood of two different events, although no formal notation is required. Knowledge of absolute values is helpful in making some connections and could lead to richer discussions, but it is not strictly necessary.

Preview & Guiding Questions

Students begin the Preview activity by watching a recap of the 2015 Super Bowl XLIX between the New England Patriots and the Seattle Seahawks. Students may recall the game's dramatic ending. Trailing by four points and with less than a minute to go, the Seahawks had the ball on the 1-yard line. Instead of running the ball, the Seahawks opted for a pass...which was intercepted. Patriots fans were elated while Seahawks fans were devastated. As a class, have students discuss whether they watch the Super Bowl and whether they can remember the results from any previous games. Additionally, consider asking whether they know anyone who bets on the game and, if so, what type of bet they make. Even if they're not sure, students may have. For instance, maybe people bet on which team will win the coin toss, which will score first, or even which company's commercial will be aired first. The goal is for students to realize that there are lots of things people might bet on...and probably do!

(Note: Students familiar with Roman numerals will know that I = 1, V = 5, X = 10, and L = 50. When a smaller number comes after a larger one, you add: VI = 6. When the smaller number comes before the larger number, on the other hand, you subtract: IV = 4. We can think of Super Bowl XLIX as including two parts: XL = 40, and IX = 9, so Super Bowl XLIX = Super Bowl 49. So what will be the next five Super Bowls? Super Bowl L, LI, LII, LIII, and LIV.)

- *Do you typically watch the Super Bowl? Can you remember any close games? Any blowouts?*
- *Does anyone you know bet on the Super Bowl? If so, what do they bet on?*
- *What are some possible Super Bowl bets that people might make?*
- *What number was Super Bowl XLIX? What will be the next Super Bowl? The next five Super Bowls?*

Act One

In Act One, students consider one common type of bet, the over-under. In this type of bet, bookies predict the combined total scores of two teams, and people bet whether they think the actual total will be *over* or *under* this amount. Students examine the results from recent Super Bowls and determine which bet was the winner in each year: the over or the under. At the end of Act One, students interpret a graph showing the over-under results from every Super Bowl ever played and conclude whether, in general, it has been better to bet over or under the bookies' predicted total.

Act Two

In Act Two, students consider spread betting. In over-under betting, in Act One, it didn't matter which team won each game or how close the score was; however, for spread betting, those things are exactly what bettors gamble on. For example, if bookies decide the favorite team is likely to beat the underdog by 7 points, bettors who vote to "cover the spread" win if the favorite wins by a margin of victory more than 7 points. On the other hand, if the favorite wins by less than 7 points *or* the underdog wins, then people who betted against covering the spread win their bets.

Students interpret graphical information about the bookies' spread and the actual margin of victory for previous Super Bowl games. They consider which games were expected to be close and which actually were, whether the bookies correctly predicted the winner, and how we represent a margin of "victory" when the expected winner loses. To conclude Act Two, students analyze whether betting to cover the spread has been more or less advantageous than betting to *not* cover the spread.

Act One: What's the Point?

- 1 There are many ways to bet on the Super Bowl. One of the most popular is the **over-under**; a bookie predicts how many total points will be scored, and people bet whether the actual total will be more or less than this.

The table below shows the over-under for the past six Super Bowls, as well as the actual scores. For each game, determine which bet would have won: the over or the under.

Year	Over-Under	Score, Favorite		Score, Underdog		Total Points	Winning Bet
2015	47.5	New England	28	Seattle	24	52	<i>Over</i>
2014	47.5	Denver	8	Seattle	43	51	<i>Over</i>
2013	48	San Francisco	31	Baltimore	34	65	<i>Over</i>
2012	53	New England	17	NY Giants	21	38	<i>Under</i>
2011	45	Green Bay	31	Pittsburgh	25	56	<i>Over</i>
2010	57	Indianapolis	17	New Orleans	31	48	<i>Under</i>

Explanation & Guiding Questions

Some of your students probably care a lot about the results for the Super Bowl, but thinking of games in terms of betting with a bookie will be less familiar to them (we hope). It may be tricky for students to read and understand how over-under bets work and recognize that some things they may typically care about (like who won and by how much) don't affect them. Going through an example as a whole class might help. For instance, in 2013, over bettors won their bets, because the total scores added up to 65, which is *over* 48. That year, over bettors also would have won if San Francisco had been the 34-31 winner or if Baltimore had beaten San Francisco 35-21 or with *any* other game score for which the total score of the teams exceeded 48.

Once students understand the rules of over-under bets, the math in this question is pretty straightforward: for each game, students should add up the two teams' scores to get the total points, then compare that sum to the over-under to determine whether the actual total was *over* or *under* that prediction.

* Note: If the total of the teams' scores is equal to the over-under—a situation called a **push**—all bettors get their money back, but no extra winnings. For the 49 Super Bowls through 2015, there has never been a push for an over-under Super Bowl bet. When bookies set over-unders to non-integers like 47.5, they eliminate the chance of a push.

- *In the 2015 Super Bowl, how many points were scored in total?*
- *Was the total scored in 2015 over or under the number the bookies predicted? How do you know?*
- *If a Seattle Seahawks fan bet over in 2015, would he win or lose his bet? How do you know? Does the fact that the Seahawks lost affect his betting results?*
- *For an over-under of 46, could the total game score match the over-under exactly, instead of being over or under it? What about for an over-under of 46.5?*

Deeper Understanding

- *Is it possible for an over-under to be negative? (Nope. The over-under is a sum of positive numbers, so there's no way for two teams to combine for negative points.)*
- *If a bookie's over-under was far from the actual total score of a Super Bowl game, did she definitely lose money? (It depends how many bettors made similarly bad predictions. For instance, in 2013, if a bookie chose the typical over-under, 48, then she did a terrible job of predicting the actual total score of 65, but she still made money off everyone who bet under. If at least half the money was on under bets, she didn't lose any money overall.)*
- *The over-under in 2012 was 53. Does that tell you whether or not the bookies expected a close game? Why or why not? (We can't really tell what they expected just from the over-under. A total score of 53 could happen from a close game, with a score like 27-26, or from a blowout, with a score like 46-7.)*
- *What's the lowest possible over-under? (The Super Bowl can't end in a tie, which means one team has to score points. The least valuable score in football is a safety, which is worth 2 points. Thus, the lowest possible over-under would be 2.)*
- *What do you think is the lowest actual over-under ever recorded? (Answers will vary.)*

- 2 In which year do you think the bookies' prediction was the most accurate? The least accurate? Explain.

In 2014, the over-under was only 3.5 points from the actual total, so that was the most accurate. In 2013, the over-under was 17 points too low, the farthest from the actual total, so that prediction was the worst.

Explanation & Guiding Questions

Since the over-under is a prediction of total points, students should compare each over-under to the total scored in the actual game. Subtracting the smaller number from the larger one tells us how many points off the bookies' prediction was. In 2015, for example, the bookies' prediction was 4.5 points away from the total points scored in the actual game, because $52 - 47.5 = 4.5$. In 2014, the team scores were quite different, but the bookies' prediction was even closer ($51 - 47.5 = 3.5$).

If students are having trouble getting started, try asking them if they are able to identify a year the bookies really messed up, and ask them what it was about the numbers that made them form that opinion. For some students, identifying that a prediction is "way off" will be easier than describing why that is true mathematically. This is a great opportunity to reinforce a useful role for subtraction: numbers are far apart when the absolute difference between them is large. At the other extreme, if the bookies made a perfect prediction, the over-under and actual total points would be the same, so their difference would be zero.

Absolute values are another useful way to calculate the bookies' error, because then it doesn't matter whether the prediction was too high or too low. For instance, in 2012, the actual total (38) minus the over-under (53) yields quite a low negative number (-15), but the *distance* between the two numbers (the absolute value $|-15|$, that is, 15) is what really matters for evaluating accuracy. This insight is not strictly necessary, but you might choose to draw it out in class discussion.

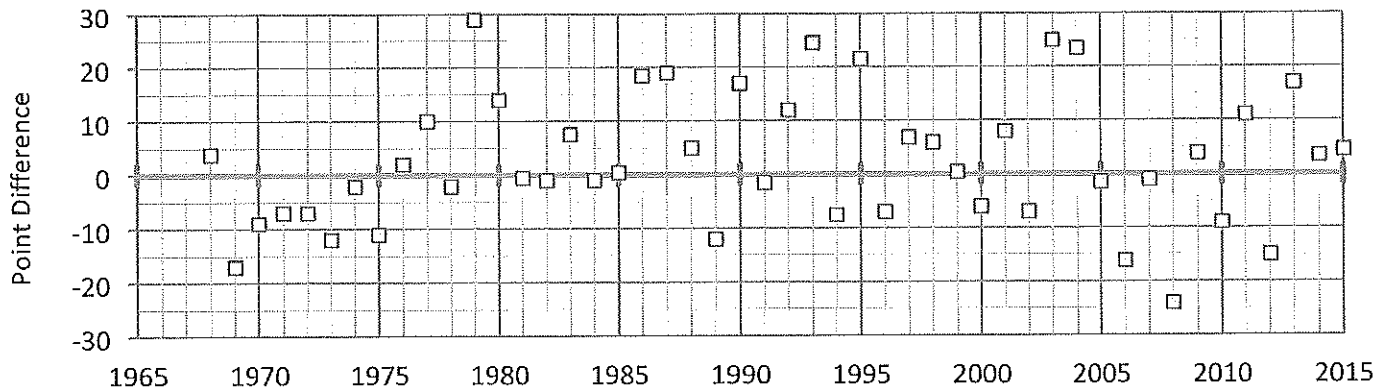
Another possibility for comparing the errors in the over-unders is to find out what *percent* of the actual score the error is. For example, since the 15-point error for 2012's over-under is about 39.4% of the actual 38-point total, you could argue that this prediction was even more inaccurate than 2013's, where the 17-point error was only about 26.1% of the actual 65-point total. (The 2014 over-under, on the other hand, will still be the most accurate by this standard.) However, unless students are already very adept at calculating percent errors, they will probably not take this approach.

- *The over-under was the same, 47.5, in 2014 and 2015, but the actual game scores were different (28-24 versus 43-8). How could you decide which year the bookies more accurately predicted the total game score?*
- *In 2010, when New Orleans beat Indianapolis 31-17, what's the most accurate over-under prediction bookies could possibly have made? How does that compare to the over-under of 57 which they actually chose?*
- *In determining how accurate the bookies' prediction was for a particular year, does it matter whether the over-under was higher or lower than the actual total score?*

Deeper Understanding

- *In 2013, the actual total score was 65, and the bookies' over-under was 48. What would be an even less accurate over-under prediction? What makes you say it's less accurate? (Any number less than 48, or any number greater than 82, would be farther from 65 than 48 is.)*
- *In 1969, the over-under was 40, and teams scored 23 points total. In 2013, the over-under was 48, and teams scored 65 points total. What's different about the two situations, and what's the same? Do you think the 1969 prediction is equally bad compared to 2013's, or not as bad, or even worse? Why? (Students who think the essential thing to consider is the absolute error in points (17 for both years) will argue that the 1969 and 2013 predictions were equally bad. Others may argue that 1969's prediction was worse, because 17 out of 23 gives a much bigger percent error than 17 out of 48.)*

- 3 The graph below shows the difference between the total points scored and the over-under for every Super Bowl. Do you think bettors could use this information to decide which bet to make: the over or the under? Explain.

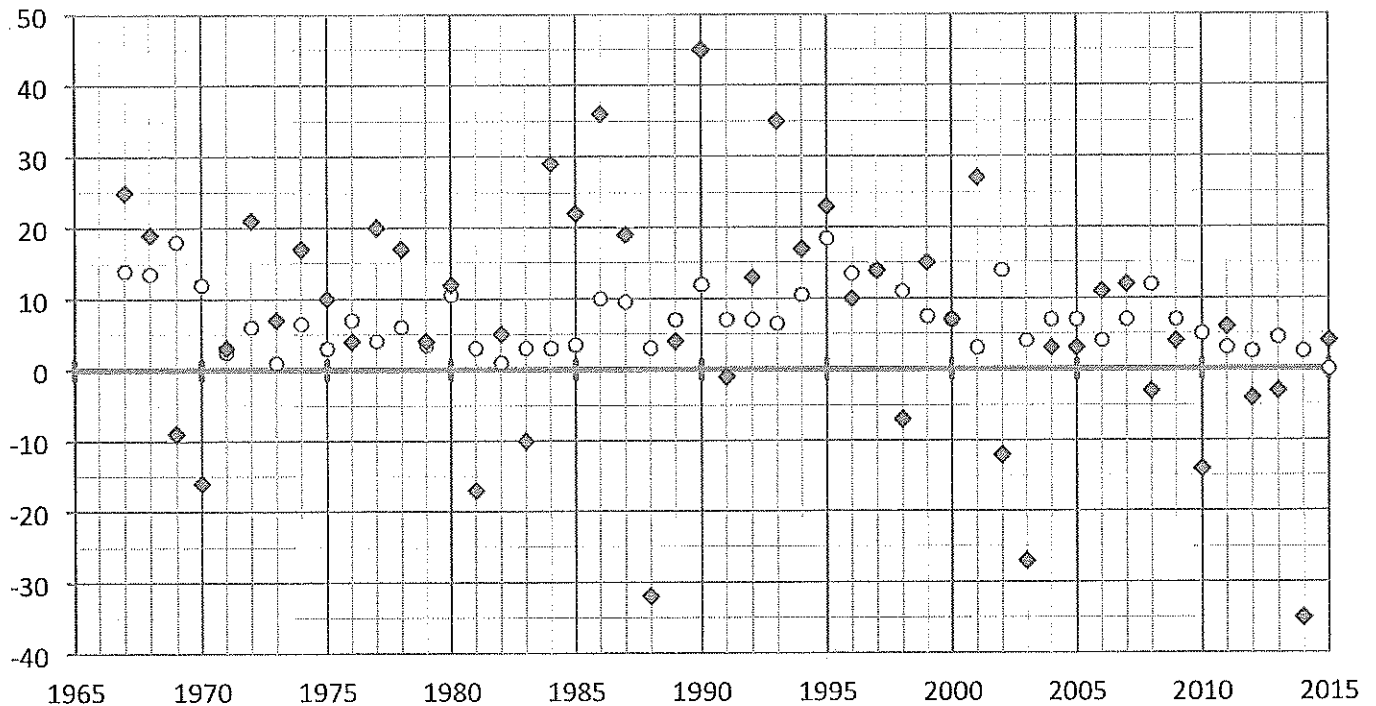


Dots above the 0 line represent when total points were greater than the over-under. When this happened, the over bet won. There are 23 dots above the line, 23 below, and in 1985 and 1999 it's too close to tell, so overs and unders have won equally often so far. Actually, later, with the graph on the computer we found out overs won in 1985 and 1999, so overs won 25/48 of the time – a little more than half.

Act Two: Spread Formation

- 4 The over-under isn't the only Super Bowl bet. Bettors can also bet whether a team will "cover the spread." In most games, one team is the favorite. The spread is the number of points this team is expected to win by.

Below, the circles (○) refer to the Super Bowl spread, while the diamonds (◆) refer to the favorite team's actual margin of victory. For example, in 2011 bookies expected the Green Bay Packers to beat the Pittsburgh Steelers by 3 points. In the actual game, the Packers won by 6 points and covered the spread.



- a. Before kickoff, which game seemed like it was going to be the most competitive? The least?

2015 was crazy close: they predicted a spread of 0, which isn't even a win! In 1995 and 1969, the spread was really high (almost 20), so they expected a blowout then.

- b. In reality, which Super Bowl do you think turned out to be the most exciting to watch and why?

Answers will vary. One possible response: In 1991 the scores were really close and the team predicted to lose actually won, so I think that would be most exciting.

- c. Which Super Bowl would you say resulted in the biggest upset? Explain.

2014 was the biggest upset because the team that was predicted to lose by 2 or 3 points actually won by 35! 1988 was almost as big an upset.

- d. Historically, which do you think has been a better bet – covering the spread or not – and why?

There have been more times when teams covered the spread (27) than when they didn't (20), so covering the spread worked out better more often.

Explanation & Guiding Questions

For this problem, students are provided with a graph showing them a *point difference* calculated by subtracting the over-under from the actual total points. Although we can't tell the over-under or the actual total score from the point difference for any given year, the point difference *does* tell us which was greater and by how much. From that we can deduce which bet, over or under, won that year. For instance, we see on the graph that in 1970, the point difference was about -9 ; this means the actual total of the two teams' scores was about 9 points less than the over-under, and therefore the "unders" won. In contrast, in 1968, the point difference was positive ($+4$), so the actual total was greater than the over-under and the "overs" won.

For Question 2, magnitudes of the point difference were what mattered, because they told us the distance between the bookies' predictions and the actual totals. In contrast, here, it doesn't matter how close the bookies' prediction was; we only care about the sign of the point difference. To determine which bet type has been more successful, students can compare the number of times the point difference is positive (when overs won) to the number of times the point difference is negative (when unders won). The easiest way to do this is to compare the number of graph points *over* the zero-difference line to the number of graph points *under* the line.

* Note: For some years like 1985 and 1999, it seems plausible from the student handout graph that some points actually could be *on* the zero-difference line, which would mean the actual total score that year was the same as the bookies' prediction (a *push*). In fact, however, the difference is always non-zero. In all, 25 points on the graph have positive point difference values (over won), and 23 negative (under won), accounting for all 48 over-under betting years. (No over-under betting occurred in the 1967 Super Bowl.)

- *Using the information from the table for Question 1, how can you get the exact point difference in 2012? Where is that on the graph? Why is it below the 0 point difference line?*
- *What is the approximate point difference for 1968?*
- *Was the total of the two teams' scores in the 1968 Super Bowl larger or smaller than the over-under that year? How can you tell?*
- *Which was the winning over-under bet in 1968, over or under?*
- *A "push" on over-under bets could happen if the total points and the over-under were exactly the same. Which years' results were closest to a push?*
- *When you look at a point on the graph, what information do you need to notice in order to tell whether it represents a year the over bets won?*
- *How could you decide whether over or under bets have been more successful for the 48 Super Bowls shown in the graph?*

Deeper Understanding

- *If you knew the over-under and the point difference for a particular year how could you use them to find the actual total score? (Since the point difference is the difference between the actual total score and the over-under, you could add it to the over-under to get the actual total.)*
- *In 2009, the over-under was 46. What do you think the actual total score was? ($46 + 4 = 50$ total points.)*
- *If a bettor in 1975 tried to decide whether over or under bets were more successful, what conclusion do you think he would have drawn? (For the data before 1975's game, under would look like a much safer bet, because at that time the point difference had been negative in six previous years and positive only once.)*
- *Which year's over-under was the least accurate prediction? (The 1979 dot is farthest from 0, so the difference had the biggest magnitude. That year, the actual total was almost 30 points above the over-under.)*

Explanation & Guiding Questions (part a)

There's a lot going on in the graph. Before anything else, it may be helpful to discuss the symbols. Circles represent the spread: the predicted margin. Diamonds represent the actual margin. Since this question (4a) asks which game people expected would be the most competitive, students should focus on the circles and ignore the diamonds.

When bookies choose a low spread, they're predicting that the winning team won't win by very much, so the game is expected to be close; in this case, the circles on the graph representing the spread will be close to zero. The lowest spread on the graph (for 2015) actually is 0, though, which seems to be a prediction that the teams would tie! Bookies didn't really expect that to happen, because post-season games can't end in a tie, but for the first time in a Super Bowl, the teams were so competitive that neither was favored.

High spreads, in contrast, happened when bookies expected one team to really clobber the other. In this case, the circles will be far above zero. Students can see from the graph that the spread was highest in 1995 and 1969, although it may be difficult for them to distinguish 1995's 18.5-point spread from 1969's 18-point spread.

- *In 1977, what point difference would you say is showing for the circle? What about for the diamond? Which one shows what the bookies were expecting to happen?*
- *In 1977, did the expected winner cover the spread?*
- *If bookies expect a game to be very close, how would that affect the spread they choose? What would that look like on the graph?*
- *Do you think bookies expected the 1969 Super Bowl to be close? Why or why not?*

Explanation & Guiding Questions (part b)

Most people would say an exciting game is a close one. Although we can't tell for sure that all of the most exciting Super Bowl games were those with close *final* scores, a close final score certainly means the outcome was competitive and in question until the end. Games like this have margins of victory (diamonds on the graph) that are close to zero, because that margin is the difference between the teams' scores. Less competitive games have margins far from zero, like the blowout in 1990 which had a margin of +45.

The margin of victory closest to zero (-1) was in 1991; this was, in fact, as close as a Super Bowl game score can be, because post-season games can't end in ties (the only way for a game to have a margin of zero). The next closest games, which all had margins of +/- 3 points, were in 1971, 2004, 2005, 2008, and 2013.

It's possible that an "exciting" Super Bowl game could mean different things to different people, so you should remain open to other answers as long as they're backed by sound communication and mathematical reasoning.

When reading this graph, students may wonder how a margin of victory can be negative, since a team can't win by a negative number of points. This situation happens because of the conventions used to compare the margin to the expected spread. The spread is a prediction of the number of points the expected winner will win by: the winner's expected score minus the loser's expected score. The margin is the *expected* winner's score minus the expected loser's score. Therefore, a negative margin means the expected loser's score is bigger and the underdog won!

- *What was the margin in 1990? What conclusions can you draw about the 1990 game from the margin?*
- *Do you think the 1990 game would have been exciting to watch? Why or why not?*
- *Could a margin of victory be zero?*
- *In 1983, the bookies predicted that Miami would beat Washington by 3 points, so the spread was 3. In the actual Super Bowl game, Washington beat Miami by 10 points. What do you think the margin was?*
- *What's the 1983 margin shown on the graph?*
- *In some years (like 1983), the graph shows a negative margin of victory. Why would this make any sense when a team can't win by negative points?*

Explanation & Guiding Questions (part c)

Diamonds on the graph show the margin of victory from the actual game scores. In an upset, the underdog wins by outscoring the expected winner, so the margin—expected winner’s score minus expected loser’s score—is *negative*, putting the diamond below the zero line (as it is for 1983). The more negative the margin, the bigger the upset!

By this measure, the biggest upset occurred in the 2014 Super Bowl between the Denver Broncos and the Seattle Seahawks. Bookies predicted Denver would win with a spread of 2.5 points, but Seattle ended up crushing the Broncos 43-8. This game was tied for the third largest margin of victory for a Super Bowl game, and had the largest margin of victory ever for an underdog.

- *What has to happen for a Super Bowl game to be called an upset?*
- *Which game was an upset, 1983 or 1990? How can you tell?*
- *How can you use the graph to quickly determine which games were won by the underdog?*
- *What does the spread have to do with whether a game should be considered a major upset?*

Explanation & Guiding Questions (part d)

When a team “covers the spread,” it means they win and that the margin is greater than the bookies predicted. What this implies, of course, is that only one team can “cover” the spread: the favorite. When this happens, the favorite’s margin of victory will be greater than the spread. For instance, in 1977, the diamond shows a margin of 20, while the circle shows a spread of 4; since $20 > 4$, the favorite covered the spread. The quick way to tell this from the graph is to notice that for 1977, the diamond is higher than the circle.

For several games, the margin and spread are so close that students may have trouble distinguishing them. In 1997 and 2000, in fact, the margin and spread were exactly the same: in these years, bettors experienced a “push,” meaning they all got their money back, but did not win or lose. In both 1971 and 1979, the margin was extremely close to the spread, but covered it by 0.5 points. In total, bettors who bet to cover the spread won 27 times, bettors who bet not to cover the spread won 20 times, and in 1997 and 2000, neither bet won. It’s fair to conclude that betting to cover the spread has been a better, well, bet over the years.

- *In 1977, which was bigger, the margin or the spread?*
- *Who won in 1977, the favorite or the underdog? Did they cover the spread?*
- *How can you tell whether the expected winner covered the spread in a particular year?*
- *Could the margin and spread be the same? What would this look like on the graph? Has it ever happened?*
- *Which type of bet has won more often: betting to cover the spread, or betting not to cover the spread?*

Deeper Understanding

- *What spread do you think bookies use if they think it’s a tossup which team will win (that is, each is equally likely)? (Zero. Bookies did this for the 2015 game.)*
- *For what percentage of Super Bowl games did the bookies pick the wrong winner? (The underdog won 14 times (the games for which the diamonds are under the zero line), or in about 29% of the games.)*
- *Could a game be considered an upset if the expected winner won? (Probably not from a football fan’s point of view. Mathematically, you could argue that if a team was expected to lose by 40 and they actually lost by only 1, they upset expectations!)*
- *Super Bowl commercials are very expensive. If you were an advertiser, which year would you say was the best? (Games expected to be close—those with low spreads—would probably draw a lot of viewers. I’d want the actual score to be close too; if my commercial aired in the fourth quarter of a blowout, people might have already turned off their TVs. The games in 2015 and 1982 probably worked out well for advertisers.)*