Each year, the National Collegiate Athletics Association (NCAA) holds the championship tournament for women's gymnastics to crown the national champion. There are two semi-final meets that consist of four teams, and the top two teams from each semi-final meet square off in the championship finals.

The competition consists of four events:

1. **Vault:** A high-energy, quick event where the gymnast gains momentum by running down a padded runway, jumps onto a springboard, and propels themselves over a slightly inclined vaulting table while performing an aerial combination of flips and twists.
2. **Uneven Bars:** This is a routine in which the gymnast does a variety of flips and rotations on two horizontal bars that are set at different heights. The gymnast mounts onto a bar and the routine consists of transitioning from one bar to the other while swinging and flipping. The routine ends with a dismount off of the bar and onto the floor.
3. **Balance Beam:** Gymnasts mount onto an elevated balance beam, which is a long, firm, padded plank about four inches (10 cm) wide. As the name suggests, this event highlights the gymnast's balance, acrobatic skills, and leaps while they attempt multiple turns, jumps, and flips on the beam before an aerial dismount.
4. **Floor:** The floor routine takes place on a square mat, and the gymnast performs a carefully choreographed routine that shows off dance skills as well as acrobats and tumbling.

Each team is allowed to have up to six people compete on each event, with the top five scores contributing to the combined score of that event for the team. After the entire rotation for each event, the combined scores for the four events are added together for a total score, and the team with the highest overall score is the champion.

Women's college gymnastics uses Perfect 10 scoring, with each routine being judged out of ten points. Gymnasts are evaluated on execution, difficulty, as well as the composition of the routine, and must meet certain requirements for each.

A screenshot of a table

Description automatically generatedA screenshot of a table

Description automatically generatedThe data to the left comes from the dataset **ncaa\_gymnastics.csv**. Each row represents one team that placed either 1st or 4th at the national championship and their respective total scores on each event.

In this activity, we will work to create a bootstrap distribution, and use that to create confidence intervals that allow for comparisons between each ranking.

1. Find the sample average beam score for teams that placed 1st in the national championship as well as those that placed 4th.

Rank = 1:

Rank = 4:

1. Detail how you would use this data to calculate a bootstrap statistic for the average beam score of the teams that placed 1st in the national championship.

You could have a scrap of paper with each beam score of a team that placed 1st in the national championship. To calculate the bootstrap statistic (mean) you need to sample with replacement. So, you would randomly pick a piece of paper with a score, record the score, and then put that piece of paper back. You would do that 17 times in total as there are 17 observations and then you would calculate the mean of the scores you selected.

1. Create one bootstrap sample for the average beam score of teams that placed 1st in the national championship. What is the bootstrap statistic for this sample?

Any random combination of the 17 beam scores for the teams that placed first. An example below.

49.51, 49.42, 49.38, 49.38, 49.62, 49.3, 49.76, 49.49, 49.75, 49.76, 49.61, 49.3, 49.35, 49.38, 49.62, 49.3, 49.75

1. Using StatKey or another statistical software, create a bootstrap distribution for the beam scores of the teams that placed first in the national championship. Describe the shape of the distribution. What is the standard error? Use at least 5000 samples.

A screenshot of a graph

Description automatically generated

The distribution is normal shaped and centered around the sample statistic (49.44). From this distribution on StatKey, we can see that the standard error of the distribution is about 0.052 (could vary slightly based on random sampling)

1. Using the standard error, create a 95% confidence interval for the average beam score of those teams that placed 1st. Interpret it in context.

A screenshot of a computer screen

Description automatically generated

95% CI:

= Statistic +- 2 \* SE

= 49.44 +- 2\* 0.052

=

(49.33, 49.54)

We can say with 95% confidence that the average beam score for teams that placed first in the NCAA Women’s Gymnastics National Championship is between 49.33 and 49.54.

1. Using your answer above and the bootstrap distribution, is it believable that a team that scored 49.1 total points on beam place first in the national championships?

While we cannot say for certain that the team wouldn’t place first, it isn’t likely based on our confidence interval that the team with a score of 49.1 on beam place first at nationals. This is because it falls below the confidence interval and is very far left on the distribution.

1. Using StatKey or another statistical software, create a bootstrap distribution and a 95% confidence interval for the average beam score for teams that placed 4th at the national championship.

A screenshot of a computer screen

Description automatically generated

(49.075, 49.266)

We can say with 95% confidence that the average beam score for teams that placed fourth in the NCAA Women’s Gymnastics National Championship is between 49.075 and 49.266.

1. Can we assume that the average beam scores between the teams that placed 1st and the teams that placed 4th are significantly different? Why or why not.

Yes, you can assume that the beam scores are significantly different because the confidence intervals don’t overlap.