OVERVIEW

This activity builds on students' ability to recognize trends in time series graphs, and has them compare the time series graphs of two different groups. Specifically, students will compare the trends of gold-medal times for men and for women in the same event.

Because of the added complexity of comparing two time series graphs, this activity may not work well with younger students (grades 4 and 5), especially if they haven't first done the activity Men's 100-Meter Dash at the Olympics.

For students in prealgebra or algebra, you can challenge them to find "lines of fit" for the time series graphs (although the data are probably not fit best with lines). You may even introduce the concept of systems of equations by sketching the two lines and locating the point of intersection.

Because women did not compete in every year of the Olympic Games, students' graphs will include *excluded cases.* When a case does not have a value for a plotted attribute, the case's icon is stacked above an asterisk to the right of the plot. If students have not experienced excluded cases before, you'll need to explain them during this activity.

Activity Time: One class period

Objectives

- Compare related sets of data.
- Represent data with graphs.
- Use time series graphs to make conjectures about possible relationships between two attributes.
- Justify predictions based on data.

Common Core Standards Addressed

Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

Grade 7, Statistics and Probability Standard 3

Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.

Grade 7, Statistics and Probability Standard 4

Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

Grade 8, Statistics and Probability Standard 1

Prerequisites

- Students should have had some experience with graphs that use two axes to compare two attributes, such as *line graphs* or *scatter plots*. Students also need to be able to add and subtract *decimal numbers* or, at least, to estimate the difference between decimal numbers.

- It is best if students have first done Men's 100-Meter Dash at the Olympics. Doing that activity as a prerequisite gives students experience with the Olympics data, making time series graphs, and looking for patterns in bivariate data.

- During this activity, students will probably want to use *color keys* to help distinguish between men's and women's results, so you'll need to be prepared to help them locate the **Key** button.

Materials

- Men and Women at the Olympics worksheet (one copy per student)

- **Olympics Men Women.tp**

Lesson Plan

Think About It (5 minutes)

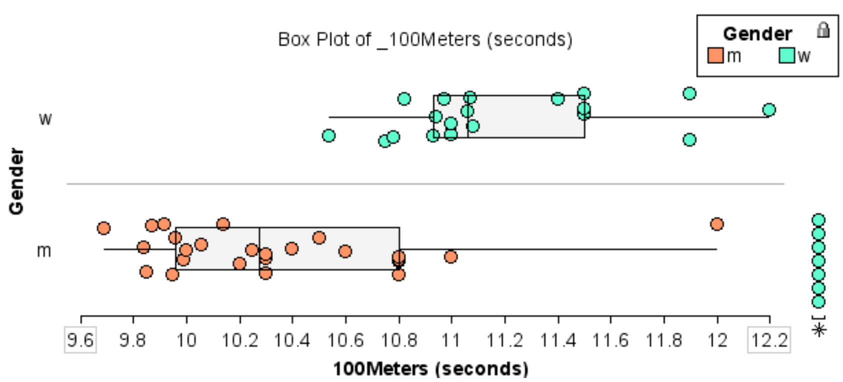
Hand out the Men and Women at the Olympics worksheet. Read through the introduction as a class.

Encourage students to work in pairs or small groups to write answers for the Think About It questions, or have students write individual answers and then discuss them in groups. Involving students in group discussions will foster communication, help make apparent common expectations about the data and questions, and illuminate alternative ideas.

Plot and Investigate (30 minutes)

Have students move to computers and open the document **Olympics Men Women.tp** to explore Olympics data.

Some students might use dot plots or box plots to explore the data. These plots don't show differences over time, so this isn't the ideal way to explore these questions. However, these graphs do give a sense of the overall difference in performance, and can therefore be a good place to start.



See the sample plots provided in the answers for other possible plots that students might create and explore.

Wrap-Up (10 minutes)

Have a couple of students share their answers to Step 8. Make sure they explain the plot they used, and how that helped them draw their conclusion.

Extensions (optional)

1. For students in prealgebra or algebra, challenge them to find linear equations that fit the men's and women's data for the 200-meter dash. (Remind them, however, that a line may not be the best way to summarize the trend, particularly if they believe the gold-medal times have begun to level off, or will eventually.) Graph both lines and use the graph to approximate the point of intersection. Discuss what's important about this point (it's when the men's and women's times will be equal according to their model). If students have learned formal methods of solving systems of equations (for example, substitution or elimination), have them solve the system algebraically and compare the solution to the graphical solution.

2. Discuss whether environmental factors (altitude, temperature, humidity, etc.) might affect the gold-medal times and distances, and which events might be most affected. Students can make a list of conjectures and then turn to TinkerPlots to test some of them. The document **Olympics Men Women.tp** already has data about altitude; students will need to do their own research and add an attribute for any other factor they might suspect.

3. Look at what happened to the gold-medal times and distances during periods when the Olympics were not held (during World Wars I and II). Students will find that most events suffered a setback or showed no improvement in the Olympics immediately following these gaps. Discuss factors that may have contributed to these setbacks, including lack of training during war years, lack of funding for training after the wars, or loss of athletes during combat.

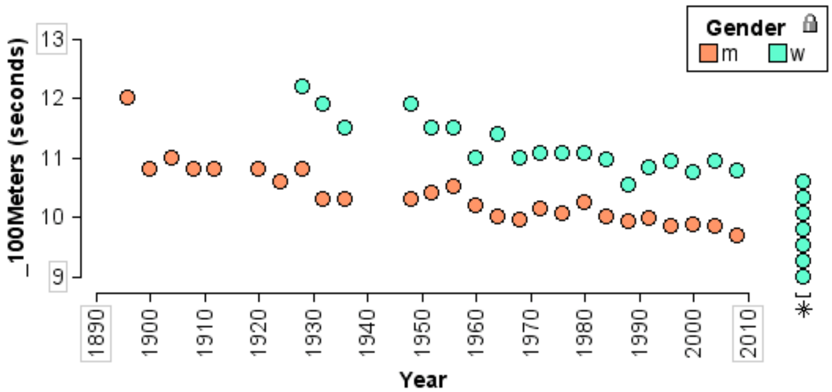
Answers

1. Students will likely guess that the men's gold-medal times are better than the women's gold-medal times. Explanations may include that men are (stereotypically) stronger and can run faster than women, or that men generally have longer legs and can take fewer, longer strides. They may also cite experience from physical education classes, where boys are likely to have run faster than girls.

   Students' answers to "How much better?" will rely on their estimation skills and frames of reference. If students have done track-and-field events in physical education class or after-school sports, they might cite differences anywhere from 1 to 5 seconds based on actual experience. The differences in the Olympic data overall are about 0.8 second. The differences range from 0.62 second to 1.6 seconds.

2. Some students might guess that the difference is getting smaller because interest in female athletics has been growing, attracting more participants and sponsors. Other students might argue that the difference is staying the same because physiological characteristics of men and women (bone structure, musculature, etc.) are not changing that much.

5. The data show that men's times are better than women's times in the 100-meter dash. A useful plot to support this conclusion is a scatter plot of *100Meters* versus *Year* that is colored by *Gender*. Explanations might point out that for each year, the men's case icon is lower on the plot than the women's case icon.



6. Answers will vary depending on the methods used. For specific years, the differences between men's and women's times range from 0.62 second to 1.6 seconds.

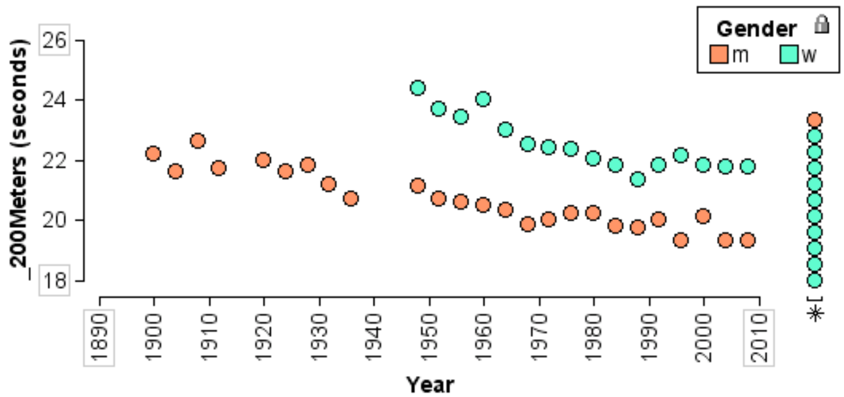
7. Some students might find the difference for only one representative year; for example, the difference in 2008 (the most recent year) was 1.09 second. They could approximate the difference by "eyeballing" the graph; using reference lines; or selecting the case icons, recording the times from the data card, and actually subtracting. If students use this method, encourage them to explain why they think one particular year is representative.

   Other students might find the difference for several years, say 1992 to 2008 (the most recent years), and find the median or mean of these differences. (For 1992 to 2008, the median difference is 1.08 second and the mean difference is 1.002 second.) Again, encourage students to explain why they are choosing these particular years. Some might argue that the difference, while decreasing in earlier Olympics, has begun to level off at around 0.8 second or a little higher. This is a reasonable argument.

   Lastly, some students might find the differences for all of the years. Some students might even go back to the document **Olympics 100 Meter.tp** (from the activity Men's 100-Meter Dash at the Olympics) and define a new attribute that subtracts *M_100Meters* from *W_100Meters*. Stating the range of these differences, 0.62 second to 1.6 seconds, is an appropriate answer.

8. Answers will vary depending on the event chosen and the methods and plots used. Explanations must include how the plot supports the student's conclusions. A few examples follow.

The 200-meter dash data are similar to the 100-meter dash data: men's times have always been better than women's times. This is indicated by the men's case icons always being lower on the plot than the corresponding women's case icons. The differences for specific years range from 1.59 to 3.5 seconds.



For the high jump and long jump, the values are measures of distance, so the time series graphs show an increasing trend. For both, men's distances have always been better than women's distances, shown by the men's case icons being *higher* on the plots. The high jump's differences for specific years range from 0.28 to 0.43 meter; the long jump's differences range from 1.31 to 2.12 meters.