

# Chapter 14

## Time Series

### 14.1 Study Suggestions

Chapter 14 has a very modest goal, namely, to provide a gentle introduction to the ideas of time series analysis.

It is important to remember that autocorrelation and smoothing simply are descriptive techniques. In addition, since a time series is observational, all of the earlier warnings about how to interpret an observational study apply to time series data.

Finally, I hope the examples in the text make clear how important it is for a researcher to understand the process that is generating the time series.

### 14.2 Solutions to Odd-Numbered Exercises

- (a) The first year and the last three years of Aaron's career stand out as having very low home run totals. The totals for the second and third years also are somewhat low. The rest of the series has little pattern to it, except for three low values in 1964, 1965, and 1968.
- (b) Excluding the first four and the last three years of his career, Aaron performed at a fairly constant level with the exception of a two year dip in 1964 and 1965.
- (c) The smoothed series makes his long period of consistency more apparent, although it hides the low value in 1968.
- (d) The relationship is direct and too strong for  $r = 0.003$ , but too weak for  $r = 0.823$ . By elimination,  $r = 0.405$ .

- (e) With the stated exclusion, the lag one values are essentially uncorrelated.

### 14.3 Exam Questions

- The number of hits for Wade Boggs during the six seasons 1983–1988 are as follows:

|      |      |      |      |
|------|------|------|------|
| Year | 1983 | 1984 | 1985 |
| Hits | 210  | 203  | 240  |

|      |      |      |      |
|------|------|------|------|
| Year | 1986 | 1987 | 1988 |
| Hits | 207  | 200  | 214  |

Construct the time series plot of these data.

- The number of hits for Wade Boggs during the six seasons 1983–1988 was given in the previous question.

Find the series that results from one application of the running median of three smoother.

- True or false? A time series plot is a scatterplot of the response versus the trial number (or time order of the response).
- A time series of 5 observations is

10 18 21 16 25

Apply the running median of three smoother to this series (once) and present the smoothed series.

5. Tom collects one observation per day for four weeks, yielding a time series with 28 observations.

True or false? If each observation is associated (for the purpose of computing an autocorrelation) with the observation that occurred one week later, the lag length is 7.

6. Tom collects one observation per day for four weeks.

True or false? Viewing the resulting 28 numbers as a time series, the lag of the series is one day.

7. An observation in a time series is smaller than the observations on either side of it.

True or false? One application of the running median of three smoother will convert this observation to a larger number.

8. An observation in a time series is larger than the observations on either side of it.

True or false? One application of the running median of three smoother will convert this observation to a larger number.

9. A time series of 50 observations has the following characteristics.

- The odd-numbered observations (numbers 1, 3, ..., 49) are all between 10 and 11.
- The even-numbered observations (numbers 2, 4, ..., 50) are all between 0 and 1.

Which of the following is correct? (Hint: Sketch a picture of the time series.)

- (a) The lag one autocorrelation coefficient is substantially smaller than 0.
- (b) The lag one autocorrelation coefficient is 0 or very close to 0.
- (c) The lag one autocorrelation coefficient is substantially larger than 0.
- (d) There is insufficient information to establish any of the above choices.

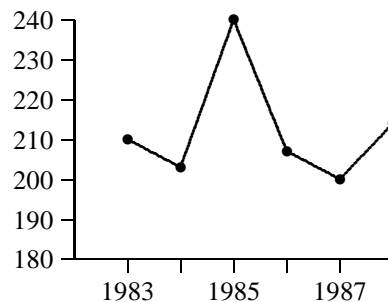
10. Refer to the time series described in the previous question.

Which of the following is correct? (Hint: Sketch a picture of the time series.)

- (a) The lag two autocorrelation coefficient is substantially smaller than 0.
- (b) The lag two autocorrelation coefficient is 0 or very close to 0.
- (c) The lag two autocorrelation coefficient is substantially larger than 0.
- (d) There is insufficient information to establish any of the above choices.

## 14.4 Solutions to Exam Questions

1. The time series plot is below.



2. The smoothed time series is

210, 210, 207, 207, 207, 214.

3. True.
4. The smoothed series is 10, 18, 18, 21, 25.
5. True.
6. True.
7. True.
8. False.
9. (a).
10. (c).