# Goodness-of-Fit Tests

## Exercise 7.1

A hypermarket investigated customer waiting times when some checkouts were closed. The waiting times [s] were grouped as follows:

| Interval | 0–50 | 50–100 | 100–150 | 150–200 | 200–250 | 250–300 | 300–350 | 350–400 |
|---|---|---|---|---|---|---|---|---|
| Frequency | 18 | 11 | 11 | 5 | 2 | 3 | 1 | 1 |

At $\alpha = 0.05$, use Pearson's goodness-of-fit test to determine whether the observations are compatible with an exponential distribution.

## Exercise 7.2

The minimum required strength of concrete used for prefabricated components is 170 MPa. Compression tests on 50 concrete cubes gave the following grouped results [MPa]; z denotes the class midpoint:

| z | 145 | 155 | 165 | 175 | 185 | 195 |
|---|---|---|---|---|---|---|
| Frequency | 2 | 9 | 11 | 14 | 8 | 6 |

At $\alpha = 0.05$, use Pearson's goodness-of-fit test to determine whether the observations are compatible with a normal distribution.

## Exercise 7.3

The following distance errors [m] were observed using a radio rangefinder:

| Interval | −4 to −3 | −3 to −2 | −2 to −1 | −1 to 0 | 0 to 1 | 1 to 2 | 2 to 3 | 3 to 4 |
|---|---|---|---|---|---|---|---|---|
| Frequency | 5 | 26 | 70 | 130 | 125 | 85 | 48 | 7 |

Use Pearson's goodness-of-fit test to test whether the observations come from a normal distribution with mean 0 and standard deviation 1.5, at: (a) $\alpha = 0.01$; (b) $\alpha = 0.05$.

## Exercise 7.4

The number of equipment failures per day was recorded over 200 days:

| Failures per day | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Number of days | 41 | 62 | 45 | 22 | 16 | 8 | 4 | 2 |

At $\alpha = 0.10$, use Pearson's goodness-of-fit test to determine whether the daily number of failures follows a Poisson distribution.

# Goodness-of-Fit Tests

### Exercise 7.5

Air-pollution monitoring yielded the following impurity concentrations [g/l]:

0.192, 0.166, 0.144, 0.128, 0.044, 0.214, 0.192, 0.104, 0.228, 0.084, 0.136, 0.192, 0.124, 0.200, 0.162, 0.172, 0.111, 0.076, 0.126, 0.178.

At $\alpha = 0.05$, use the Kolmogorov–Smirnov (K–S) test to test whether the sample comes from $N(0.15, 0.0025)$, where the second parameter is the variance (standard deviation 0.05).

### Exercise 7.6

The heights of fourteen ten-year-old boys were measured [cm]:

136, 130, 151, 127, 133, 136, 139, 139, 141, 147, 139, 142, 140, 138.

At $\alpha = 0.05$, use the Anderson–Darling test to determine whether the observations are compatible with a normal population.

### Exercise 7.7

In an experiment, ten people independently estimated when one minute had elapsed after a signal. Their recorded times [s] were:

53, 48, 45, 55, 63, 51, 66, 56, 50, 58.

At $\alpha = 0.05$, use the Anderson–Darling test to determine whether the observations are compatible with a normal population.

### Exercise 7.8

Solve Exercise 7.7 using the Shapiro–Wilk (S–W) test at $\alpha = 0.05$.

### Exercise 7.9

The tensile strength of 250 randomly selected balls of yarn was measured. The grouped results were:

| Interval | 0.5–0.7 | 0.7–0.9 | 0.9–1.1 | 1.1–1.3 | 1.3–1.5 | 1.5–1.7 | 1.7–1.9 | 1.9–2.1 | 2.1–2.3 |
|---|---|---|---|---|---|---|---|---|---|
| Frequency | 2 | 10 | 36 | 52 | 59 | 55 | 23 | 10 | 3 |

At $\alpha = 0.05$, use the Jarque–Bera (J–B) test to determine whether the observations are compatible with a normal population.