Analysis of Agent Behaviour: Case Studies

Summary. In this section the techniques presented in Chapter 5 are applied to “real world” experimental data. Three data sets will be analysed: the movement of a mobile robot that is randomly moving around in its environment, a “chaos walker”, and the flight path of a carrier pigeon.

6.1 Analysing the Movement of a Random-Walk Mobile Robot

Figure 6.1 shows the trajectory of a Magellan Pro mobile robot that has moved in an irregularly shaped environment for just under 3h.

In Figure 6.2 $x(t)$ and $y(t)$ are shown separately. We are interested in analysing this robot behaviour: is it mainly deterministic or stochastic; therefore, is it predictable, and if yes, for how many steps ahead? How can this behaviour be described quantitatively?
6.1.1 Determinism

To establish whether $x(t)$ (Figure 6.2) is mainly deterministic or not, we will apply the techniques discussed in Section 5.3.2.

The return plot of $x(t)$ vs. $x(t-3)$ indicates that $x(t)$ is deterministic, rather than stochastic (Figure 6.3 – compare with Figure 5.12).

This result is confirmed by using a three-dimensional embedding of the first half of $x(t)$ (Eq. 5.7) as a predictor of the second half, and comparing the prediction error $\epsilon_{\text{model}}$ with the baseline prediction of error $\epsilon_b$ obtained when the mean of the signal is used as a prediction. The ratio of $\epsilon_{\text{model}}/\epsilon_{\text{mean}}$ turns out to be 0.048, that is very small compared with 1.0, confirming that indeed $x(t)$ is deterministic.

6.1.2 Stationarity

Next, we will establish whether $x(t)$ is stationary or not, using the runs test described in Section 5.3.2. Dividing $x(t)$ into 110 bins, a more or less arbitrary choice, we determine whether in each bin the median value is above or below the mean of the entire series $x(t)$.