Shuttlecocks and the Akaike Information Criterion

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A Matlab script to help explore the project in Section 3.5.4.

The Data: First, the data for the shuttlecock's fall, in time (seconds)/distance (meters) pairs:

```
times = [0, 0.347, 0.47, 0.519, 0.582, 0.650, 0.674, 0.717, 0.766, 0.823, 0.870, 1.031, 1.193,
dists = [0, 0.61, 1.00, 1.22, 1.52, 1.83, 2.00, 2.13, 2.44, 2.74, 3.00, 4.00, 5.00, 6.00, 7.00,
```

A quick plot of (time, distance) pairs:

```
scatter(times,dists);
```

The Model: We might posit a model of the form v'(t) = g (no air resistance) and consider g as an unknown, to be estimated. Then the governing ODE is (from equation (3.68) in the text)

```
syms v(t); %Declare v(t) as symbolic function
syms g;
ode = diff(v(t),t) == g %Define the ODE
vsol(t) = dsolve(ode,v(0)==0) %Incorporate initial condition
```

Integrate to obtain the position in terms of g and t:

```
syms tau;
x(t,g) = int(vsol(tau),tau,0,t)
```

Estimating Parameters: Form a sum of squares

```
syms SS(g)
SS(g) = sum((x(times,g)-dists).^2);
```

To get a sense of where the minimum is, plot this expression as a function of k:

```
fplot(SS(g),[0 15])
```

Solve SS'(g) = 0 to find the least-squares estimate for gravitational acceleration

```
eqn = diff(SS,g)==0;
gbest = vpasolve(eqn,g,[5 15])
```

The residual is

```
SS(gbest)
```

Use this value in X(t) to plot and compare to the data

```
fplot(x(t,gbest),[0 1.873],'-r')
hold on;
scatter(times,dists);
```

```
hold off;
```