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STUDENT VERSION
SHUTTLECOCK FALL

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Abstract: We are given data on the time and position of a shuttlecock as it falls to the ground from a set height. We attempt to model the falling object and we confront the different resistance terms and models. Finally, we introduce a new way of comparing models, the Akaike Information Criterion, and apply it to our models.

SCENARIO DESCRIPTION

Figure 1. Shuttlecock, the flying object used in the game of badminton.

We are given data on time and distance traveled below the starting height of 2 m of a free falling shuttlecock (see Figure 1) in Table 1. We will make a mathematical model of this phenomenon and estimate the parameters in the model. We shall also compare the model's predictive power with the actual data.

1. Draw a Free Body Diagram with all the forces acting upon the shuttlecock as it falls.

Time (s)	0	0.347	0.47	0.519	0.582	0.65	0.674	0.717	0.766	0.823	0.87	1.031	1.193	1.354	1.501	1.726	1.873
Distance (m)	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	8.50	9.50

Table 1. Time and distance traveled data on a free falling shuttlecock which is dropped from a height of 2 m at rest.

2. Use Newton's Second Law of Motion which states that the sum of the forces acting on a body is equal to the product of the body's mass and acceleration to produce an equation in which one side is $m\,y''(t)$, where $y(t)$ is the positive distance fallen (in m) at time t (in sec) and m is the mass of the shuttlecock. Comment on the reasonableness of your model.
3. Knowing the fact that this experiment was done in Villanova PA USA find a way to estimate all parameters in your model.
4. With these determined parameters compare your model with the data.
5. Check with others or perhaps look up some on-line efforts with modeling falling bodies (with and without resistance).
6. Compare your different models and comment on them.