Mathematica 8: Probability and Statistics

Pre-listening http://www.youtube.com/watch?v=SN3akd3ustY

1) What is mathematical modeling?
2) Where can you use mathematical modeling?

Listening Listen to and watch the video and answer questions.

1) What is Mathematica 8 and how can you use it?

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2) What kinds of uncertainties does the speaker mention?

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3) Which uncertainties are there for a financial company?

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4) Which problems in telecommunication are mentioned?

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5) How can you get data for your analysis?

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6) How can you explore and understand data?

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7) Which kinds of visualizations can you get in Mathematica 8?

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8) Which kinds of models can you use?

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9) How can you decide whether the model is good or not?

.....

10) How can you analyze your data?.....

Mathematical model

From Wikipedia, the free encyclopedia

I.

Reading. Read the first part and fill in the missing words.

overlap biology dynamical game
analysts computer description economics

A **mathematical model** is a 1..... of a system using mathematical language. The process of developing a mathematical model is termed **mathematical modelling** (also written *modeling*). Mathematical models are used not only in the natural sciences (such as physics, 2....., earth science, meteorology) and engineering disciplines (e.g. 3.....science, artificial intelligence), but also in the social sciences (such as 4....., psychology, sociology and political science); physicists, engineers, statisticians, operations research 5..... and economists use mathematical models most extensively.

Mathematical models can take many forms, including but not limited to6..... systems, statistical models, differential equations, or7..... theoretic models. These and other types of models can 8....., with a given model involving a variety of abstract structures.

II.

Examples of mathematical models

Read the second part of the text and explain:

a) What is the Malthusian growth model and in which field of science can you use it?

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b) When can you use the Model of a particle in a potential field? Why is the definition of a particle problematic?.....

c) Why is the utility function for the consumer cardinal?.....

d) What is Pareto efficiency?
.....

e) Why is this particular formulation often ridiculed?
.....

f) Where can you use the neighbour-sensing model?.....

- *Population Growth.* A simple (though approximate) model of population growth is the Malthusian growth model. A slightly more realistic and largely used population growth model is the logistic function, and its extensions.
- *Model of a particle in a potential-field.* In this model we consider a particle as being a point of mass which describes a trajectory in space which is modeled by a function giving its coordinates in space as a function of time. The potential field is given by a function $V: \mathbf{R}^3 \to \mathbf{R}$ and the trajectory is a solution of the differential equation

$$m\frac{d^2}{dt^2}x(t) = -\text{grad}\,(V)\,(x(t)).$$

Note this model assumes the particle is a point mass, which is certainly known to be false in many cases in which we use this model; for example, as a model of planetary motion.

- *Model of rational behavior for a consumer.* In this model we assume a consumer faces a choice of n commodities labeled 1,2,...,n each with a market price $p_1, p_2, ..., p_n$. The consumer is assumed to have a *cardinal* utility function U (cardinal in the sense that it assigns numerical values to utilities), depending on the amounts of commodities $x_1, x_2, ..., x_n$ consumed. The model further assumes that the consumer has a budget M which is used to purchase a vector $x_1, x_2, ..., x_n$ in such a way as to maximize $U(x_1, x_2, ..., x_n)$. The problem of rational behavior in this model then becomes an optimization problem, that is:

$$\max U(x_1, x_2, \ldots, x_n)$$

subject to:

$$\sum_{i=1}^{n} p_i x_i \leq M.$$

$$x_i \geq 0 \quad \forall i \in \{1, 2, \ldots, n\}$$

This model has been used in general equilibrium theory, particularly to show existence and Pareto efficiency of economic equilibria. However, the fact that this particular formulation assigns *numerical values* to levels of satisfaction is the source of criticism (and even ridicule). However, it is not an essential ingredient of the theory and again this is an idealization.

- *Neighbour-sensing model* explains the mushroom formation from the initially chaotic fungal network.

Modelling requires selecting and identifying relevant aspects of a situation in the real world.

WORD STUDY: Supply corresponding word forms.

optimize (noun) ..... form (noun) .....

approximate (noun) ..... exist (noun).....

planet (adjective) ..... maximize (noun) .....

assign (noun)..... idealize (noun) .....

efficient (noun) ..... Economics (adjective) .....