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In calculus of variations the basic problem is to find a function y for which the functional $I(y)$ is maximum or minimum. We call such functions as extremizing functions and the value of the functional at the extremizing function as extremum. Consider the extremization problem Extremize y $I(y) = \int_0^1 F(x,y,y')dx$ subject to the end conditions $y(0) = y_0$ $y(1) = y_1$

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calculus of variations infinitesimal change in a variable, and compute the corresponding change in a function, and if it's zero to leading order in the small change, we're at an extreme value.

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Further applications of the calculus of variations include the following: The derivation of the catenary shape Solution to Newton's minimal resistance problem Solution to the brachistochrone problem Solution to isoperimetric problems Calculating geodesics Finding minimal surfaces and solving ...

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A huge amount of problems in the calculus of variations have their origin in physics where one has to minimize the energy associated to the problem under consideration. Nowadays many problems come from economics. Here is the main point that the resources are restricted. There is no economy without restricted

resources.

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A typical problem in the calculus of variations involve finding a particular

function $y(x)$ to maximize or minimize the integral $I(y)$ subject to boundary conditions $y(a) = A$ and $y(b) = B$. The integral $I(y)$ is an example of a functional, which (more generally) is a mapping from a set of allowable functions to the reals.

MATH0043 §2: Calculus of Variations

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Introduction to the Modern Calculus of Variations

The fundamental equation of the calculus of variations is the Euler-Lagrange equation $\frac{d}{dt} \frac{\partial f}{\partial x'} - \frac{\partial f}{\partial x} = 0$. There are several ways to derive this result, and we will cover three of the most common approaches.

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The Calculus of Variations is an

important mathematical tool in optimisation and is concerned with integrals (functionals) taken over admissible paths. The paths are varied, leading to the Euler-Lagrange differential equation for a stationary path. Dating from the time of Newton, the theory was developed by Euler, Lagrange, Jacobi, and Noether amongst others and has important applications in modern physics, engineering, biology, and economics.

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The calculus of variations concerns problems in which one wishes to find the minima or extrema of some quantity over a system that has functional degrees of freedom. Many important problems arise in this way across pure and applied mathematics and physics. They range from the problem in geometry of finding the shape of a soap bubble, a surface that minimizes its surface area, to finding the configuration of a piece of elastic that minimises its energy.

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A classic example of the calculus of variations is to find the brachistochrone, defined as that smooth curve joining two points A and B (not underneath one another) along which a particle will slide from A to B under gravity in the fastest

possible time. Using the coordinate system illustrated, we can use conservation of energy to obtain the

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