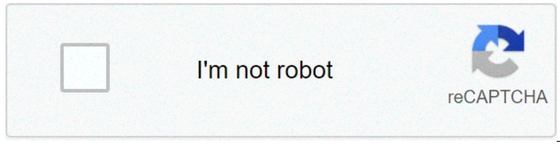

Continue

Introduction to mathematical thinking pdf

6.00.2x will teach you how to use computation to accomplish a variety of goals and provides you with a brief introduction to a variety of topics in computational problem solving . This course is aimed at students with some prior programming experience in Python and a rudimentary knowledge of computational complexity. You will spend a considerable amount of time writing programs to implement the concepts covered in the course. For example, you will write a program that will simulate a robot vacuum cleaning a room or will model the population dynamics of viruses replicating and drug treatments in a patient's body. Topics covered include: Advanced programming in Python 3 Knapsack problem, Graphs and graph optimization Dynamic programming Plotting with the pylab package Random walks Probability, Distributions Monte Carlo simulations Curve fitting Statistical fallacies Plotting with the pylab package Stochastic programming and statistical thinking Monte Carlo simulations Unfortunately, learners residing in one or more of the following countries or regions will not be able to register for this course: Iran, Cuba and the Crimea region of Ukraine. While edX has sought licenses from the U.S. Office of Foreign Assets Control (OFAC) to offer our courses to learners in these countries and regions, the licenses we have received are not broad enough to allow us to offer this course in all locations. edX truly regrets that U.S. sanctions prevent us from offering all of our courses to everyone, no matter where they live. This course will allow you to use mathematical equations to describe and analyze certain problems that appear in the areas of business and finance. For example, it analyzes how the performance of an asset or distributing a product is modeled, how an optimization process is done in a portfolio or how aversion to risk can be described to an investor. Additionally, it will help you understand how certain algorithms are solved to analyze large amounts of data, make forecasts and describe trends. The course uses programming and simulation tools to convey the main concepts. The course starts from the concept of function, that is the basis of mathematical modeling and allows identifying the relationship between a group of variables of interest. Different types of functions are analyzed , such as linear, polynomial and exponential functions, providing specific examples to the areas of finance and business. The concepts are supported with the help of packages such as R / Python or Matlab. In this way, interactive and visual learning is motivated, which in addition to transmitting mathematical concepts, establishes the bases to develop computational skills. Understand the concept of function in mathematical modeling to identify the relationship between a group of variables of interest. Analyze the mathematical properties of the main functions used in business and finance. Design mathematical equations to describe and analyze problems in the areas of finance and business . Use specialized software to simulate a function. Topic 1: Linear Functions 1.1 Geometric presentation of a linear equation. Linear interpolation. Slope concept. 1.2 First order difference equation. Introduction to simulation. Topic 2: Linear Algebra 2.1 Solution of simultaneous equations. Concept of a vector and a matrix.. Geometric representation. 2.2 Matrix operations. Characterization of the number of solutions in a system. Linear Transformation Concept. Topic 3: Nonlinear functions 3.1 Polynomials and root determination. Concepts of Concavity and Convexity. 3.2 Exponential and Logarithmic Equations . Topic 4: Infinitesimal calculus. 4.1 Concept of limit and derivation rules. Interpretation of the derivative as a measure of sensitivity. 4.2 Approach to nonlinear functions through Taylor series. Non-linear optimization and First Order Conditions. Topic 5 : Financial Mathematics. 5 .1 Yield and Discount Rates, Geometric Series, Present Value Formulas, 5 .2 Calculation of Perpetuities, Annuities and IRR of a bond. How do populations grow? How do viruses spread? What is the trajectory of a glider? Many real-life problems can be described and solved by mathematical models. This course will introduce you to the modelling cycle which includes: analyzing a problem, formulating it as a mathematical model, calculating solutions and validating your results. All models are (systems of) ordinary differential equations, and you will learn more about those by watching videos and reading short texts, and more importantly, by completing well-crafted exercises. You will learn how to implement Euler's method in a (Python) program, and finally, you will learn how to write about your findings in a scientific way (with LaTeX). In the verified track of this course you will additionally: Consolidate the new theoretical skills with graded problem sets about five real-life applications. Work on your own modelling project (individually or in a team). Because mathematical modelling is only learned by doing it yourself, you complete your own modelling project on a self-defined real-life problem. You will be guided through the project by completing a list of smaller tasks. This course is aimed at Bachelor students from Mathematics, Engineering and Science disciplines. The course is for anyone who would to use mathematical modelling for solving real world problems, including business owners, researchers and students.Institution: DelftXSubject: MathLevel: IntermediatePrerequisites: Calculus (1st-order ordinary differential equations), some programming skills are helpful.This course is aimed at Bachelor students from Mathematics, Engineering and Science disciplines.Language: EnglishVideo Transcript: English To follow the process of the mathematical modelling cycle: formulate a real-life problem, construct an appropriate mathematical model, calculate solutions and validate the results. More about (systems of) ordinary differential equations. Solve the ordinary differential equations and implement Euler's method in a (Python) program. Write a scientific report (with LaTeX). In the Verified Track, you will additionally: Consolidate your new skills by completing well-crafted problem sets on several interesting real-life applications. Learn the skill of mathematical modelling in the only way possible: by doing your own modelling project. Module 1: Introduction to the cycle of mathematical modelling. We will start describing a population of fish by a differential equation. Verified Track: Two practice problems with other real-life applications to consolidate the theory learned. You start your personal modelling project. You can choose to work in a team of two. Module 2: Complete more modelling cycles by improving on the model and evaluating the consequences. Euler's method is introduced for solving ordinary differential equations. You will run Python simulations. Verified Track: A new application to practice the theory. For your project you specify a real-life problem. You implement a 1-dimensional model. Module 3: Predator fish are added to the model. How do the populations interact? Systems of differential equations. You also learn how to write about your project in a scientific report. You get an introduction to scientific and mathematical writing. You will learn how to write a preliminary report about mathematical modelling in LaTeX. Verified Track: One more practice problem to consolidate the theory learned about systems. You do more simulations with your own mathematical model and complete the modelling cycle several times. You apply your writing skills by writing a scientific report about your modelling project. You submit both a preliminary version of the report and the final version. Both are peer reviewed."Why do I need mathematics is no longer a question for me. So many phenomena and problems can be modelled using mathematics. I really enjoyed making a model to describe how the virus we studied spread. Every engineering or science student should take this course!" "This course is excellent! I am an engineer, but have been working in another field for almost 2 decades, totally away from calculus, and this is exactly what I was looking for in order to brush up. I loved the videos and the questions as well. They are crafted in a very clever way to sediment concepts just learned."LICENSEThe course materials of this course are Copyright Delft University of Technology and are licensed under a Creative Commons Attribution-NonCommercial-ShareAlike (CC-BY-NC-SA) 4.0 International License. Archimedes was born in Syracuse, a city in Sicily, which was a Greek colony at the time. Archimedes' father, Phidias, was an astronomer, and he most likely passed his love of math and science on to his son. Archimedes became fascinated with solving mathematical problems throughout his life, and he often drew out equations and plotted graphs on the ground and sometimes even on his stomach with olive oil. Archimedes spent much of his life in the service of King Hiero II of Syracuse. He solved mathematical problems for the king and developed innovative inventions for the king and his military forces. Mathematical Innovations Archimedes' penchant for solving mathematical problems led him to develop some of the important mathematical concepts and ideas that we still use today. One of his key innovations was what he called the "method of exhaustion." This method allowed him to calculate the areas of shapes, including circles. The "method of exhaustion" allowed him to quantify the value of pi, the number that allows us to determine the measurements of a circle. Archimedes expanded the "method of exhaustion" to measure parabolas and determine the relationship between spheres and cylinders. He also worked with prime numbers, and he was one of the first mathematicians to understand the concept of infinity. The Invention That Bears His Name Many people remember Archimedes' name from one invention: Archimedes' screw. This invention essentially allows water to flow upwards. Archimedes' screw consists of a hollow cylinder and a hollow spiral either inside or outside the cylinder. Rotating the screw causes the water to move from its place on a lower plane to a higher one. Initially, Archimedes applied this invention to bailing water out of a ship, but Archimedes' screw has applications today. Farmers use this method for irrigation in arid places, and wastewater treatment plants apply it to transport water from place to place. Serving the King Archimedes' service to King Hiero II of Syracuse led to some other important inventions. Archimedes developed the pulley system to help the king's sailors move heavy objects up and down the levels of their ships. He also invented the catapult to make it more difficult for the Roman general Marcellus to invade Sicily, and he developed the grappling hook as well. Archimedes reportedly told King Hiero, "Give me a long enough lever and a place to stand, and I will move the earth." The king challenged Archimedes to prove his boast, and he launched a large ship using a massive lever he developed. Archimedes' Principle The innovation that probably most benefited King Hiero came to Archimedes in the bath. The king received the gift of a gold crown that he doubted was completely golden. Archimedes observed the movement of the water as he entered the bath, and he realized he could determine the weight of the crown by submerging it. Archimedes became so excited about his discovery that he leaped from the tub and shouted, "Eureka, Eureka!" as he ran through town, forgetting that he was naked. Legends of Archimedes' Death Once the Roman general Marcellus was able to invade Sicily, one of his soldiers killed Archimedes. That's the only fact that historians know, but several legends surround the killing of the mathematician. Some legends say that the soldier killed Archimedes because he mistook the mathematician's tools for weapons or gold while others say that the soldier grew impatient with waiting for Archimedes to finish the problem he was working on. The most enduring legend — and maybe the most humorous — regards Archimedes' reported last words. As the soldier commanded the mathematician to stop working and stepped in the area where he was solving a problem, Archimedes reportedly said, "Don't disturb my circles." A Legacy in Math and Science Scholars consider Archimedes one of the most important and influential mathematicians in history, along with Sir Isaac Newton and Carl Friedrich Gauss, and there are several memorials to Archimedes that relate to math and science. Astronomers have named a crater and a mountain range on the moon after him, as well as an asteroid. The International Mathematical Union gives out an award called the Fields Medal, which features Archimedes on the obverse of the medal, along with a quote from him. In math, an array refers to a set of numbers or objects that will follow a specific pattern. An array is an orderly arrangement (often in rows, columns or a matrix) that is most commonly used as a visual tool for demonstrating multiplication and division. There are many everyday examples of arrays that help with understanding the utility of these tools for quick data analysis and simple multiplication or division of large groups of objects. Consider a box of chocolates or a crate of oranges that have an arrangement of 12 across and 8 down rather than count each one, a person could multiply 12 x 8 to determine the boxes each contain 96 chocolates or oranges. Examples such as these aid in young students' understanding of how multiplication and division work on a practical level, which is why arrays are most helpful when teaching young learners to multiply and divide shares of real objects like fruits or candies. These visual tools allow students to grasp how observing patterns of "fast adding" can help them count larger quantities of these items or divide larger quantities of items equally amongst their peers. When using arrays to explain multiplication, teachers often refer to the arrays by the factors being multiplied. For example, an array of 36 apples arranged in six columns of six rows of apples would be described as a 6 by 6 array. These arrays help students, primarily in third through fifth grades, understand the computation process by breaking the factors into tangible pieces and describing the concept that multiplication relies on such patterns to aid in quickly adding large sums multiple times. In the six by six array, for instance, students are able to understand that if each column represents a group of six apples and there are six rows of these groups, they will have 36 apples in total, which can quickly be determined not by individually counting the apples or by adding 6 + 6 + 6 + 6 + 6 + 6 but by simply multiplying the number of items in each group by the number of groups represented in the array. In division, arrays can also be used as a handy tool to visually describe how large groups of objects can be divided equally into smaller groups. Using the above example of 36 apples, teachers can ask students to divide the large sum into equal-sized groups to form an array as a guide to the division of apples. If asked to divide the apples equally between 12 students, for example, the class would produce a 12 by 3 array, demonstrating that each student would receive three apples if the 36 were divided equally among the 12 individuals. Conversely, if students were asked to divide the apples between three people, they would produce a 3 by 12 array, which demonstrates the Commutative Property of Multiplication that the order of factors in multiplication does not affect the product of multiplying these factors. Understanding this core concept of the interplay between multiplication and division will help students form a fundamental understanding of mathematics as a whole, allowing for quicker and more complex computations as they continue into algebra and later applied mathematics in geometry and statistics.