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Chapter 1 Notes

Many nuclei are unstable. Uranium 235 is a good example. The process of radioactive decay is random in the sense that if you were given a single 235 nucleus you would not be able to predict precisely when the decay would take place. The approach for calculating Nu(t) is known as the Euler method and is a useful algorithm for solving ODE's. Other methods for solving equations of this kind will be touched upon later. For now, we should realize that while the Euler method arises in a natural way, it is not the only algorithm for dealing with problems of this kind. We can consider how to translate that algorithm into a working computer program. It is possible to describe the structure of a program in a general way that is useful to users of many different languages. This is known as pseudocode. This is not a precise programming language, but rather a description of the essential parts of an algorithm, expressed in "common" language. The issue of numerical errors is central to the computational solution of any problem. Questions such as how to design or choose the best algorithm for a particular problem, and how to estimate the numerical errors associated with an algorithm, are central topics in computer science and math. With our radioactive decay program, errors were introduced by the approximation used to estimate the solution of the differential equation. Errors are also produced by the finite numerical precision in any programming language. The first guideline is that a calculation should always be repeated using several different values of the step size. For the decay problem we have the exact solution, which makes it easy to evaluate the accuracy of our numerical results. However, we will not usually be this fortunate, so it is important to consider our results when the exact result is not available. One important issue concerning numerical precision will be encountered later. In our construction of the radioactive decay program we noted that writing a program is necessarily an individualistic endeavor. Nevertheless, there are certain guidelines that are generally recommended, some of which were touched on earlier. In attacking the radioactive decay problem we were led to treat time as a discrete variable. The first guideline is that a calculation should always be repeated using several different values of the step size.