# Part V

# Analyzing Data Using Calculus Models

In this unit, we will explore how calculus tools can help us understand the models with have built from data. In particular, we will focus on the notion of rate of change, which is a more general approach to thinking about slope. As we will see, this notion is powerful, and can help us determine a lot about our models.

For starters, the rate of change will help us generalize the notion of slope from a linear function. Most models do not have a fixed slope; instead, the slope changes depending on where along the model you are currently exploring. Once we understand a little about rate of change, we can use this to find places where our model has a maximum value or a minimum value, which is useful for decision making purposes. For example, if our model represents the profit from selling a quantity of items we produce (for some reason, everyone refers to items as widgets when they don't have a good name for them), then finding the maximum point on the model will help us know how many widgets to make in order to achieve the most profit possible, based on our assumptions about the market that were used to build our profit model.

Rate of change is a concept you are probably familiar with already. Slope is the linear version of it. In calculus, we study rate of change under several different names. Usually, we refer to it as the derivative. Sometimes it is referred to as the instantaneous rate of change. This is a notion that makes some sense. Consider driving in your car. If you drive 100 miles in 2 hours, you averaged 50 miles per hour, which is the average rate of change of your distance from your starting point. But it is highly unlikely that at every instant during the two hours you were going exactly 50 mph. At some point, you were probably stopped at a light; at some point you sped up to pass a slower car. Your average rate of change was 50 mph, but at each moment, you have a tool that tells you the instantaneous rate of change (derivative) of your distance from home: the speedometer of your car. If you graphed the distance from your starting point as a function of time, you would probably not see a straight line (which would give you a constant rate of change). It would be twisty and curvy, always increasing in distance from the starting point, but at many different speeds. The speedometer, though, always gives you the rate of change at that instant on the curve.

The other half of calculus is about something called the integral. In chapter 17 you will get a brief introduction to this concept, and you will see how it is related to finding areas under a curve. It turns out, though, that there is a remarkable mathematical theorem called the Fundamental Theorem of Calculus that relates this way of computing areas to the derivative! Thus, these two operations, finding slopes and finding areas, are inverses of each other. Throughout the unit, you will be exploring deep ideas in calculus, but we'll focus on key concepts and examples and will constantly be applying this to the business setting, so don't get too worried; we will not by any means, deal with all the complexity that can possibly exist in studying calculus.