

Physical Interpretation of Derivatives, Continued

Calculus is a good tool for studying how things change over time; we can also use it to investigate change with respect to variables other than time. Let's look at a couple of examples that don't involve time as a variable.

If we let T denote temperature and x measure a distance or position, then $\frac{dT}{dx}$ is the rate the temperature changes as position changes. This quantity is called the *temperature gradient*. Temperature gradients are important in weather forecasting because it's that temperature difference that causes air flows and weather changes.

$$T = \text{temperature} \quad \frac{dT}{dx} = \text{temperature gradient}$$

Another application of calculus is to "sensitivity of measurements". In Problem Set 1 there's a question about GPS and a satellite which explores sensitivity of measurements.

In the problem set, you assume that the earth is flat and that you have a satellite above a known location. A traveler's GPS device measures the distance h between the traveler and the satellite and uses that information to compute the horizontal distance L between the traveler and the point directly under the satellite. (See Fig. 1 and Fig. 2)

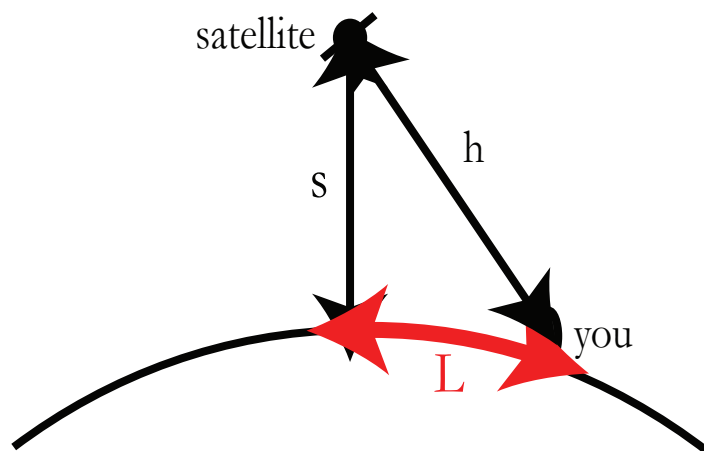


Figure 1: The Global Positioning System Problem (GPS)

In other words, the GPS computes L as a function of h . But there is usually some error Δh in your measurement of h ; given that, how accurately can we measure L ? The error ΔL is estimated by looking at $\frac{\Delta L}{\Delta h} \approx \frac{dL}{dh}$.

Why is this important? For one thing, it's used all the time to land airplanes.

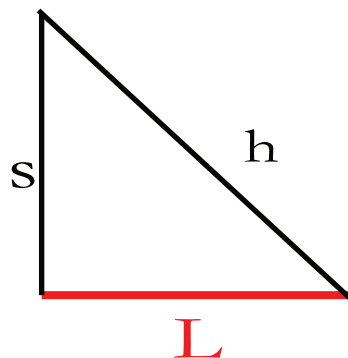


Figure 2: On problem set 1, you will look at this simplified “flat earth” model

This concludes our introduction to differentiation, although there will be plenty of opportunities throughout the course for you to improve your understanding.