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Using derivatives, especially higher order derivatives

Not coming from an engineering or physics background, I do not have a lot of occasion to use derivatives, especially higher order derivatives. I need examples of the real use of derivatives, especially higher order derivatives. Often when physicists use higher order derivatives, as in the wave function, I have little feel for the physical reality behind the derivative. When I do have a feel for the physical reality behind the higher order derivative, usually I can think of it in physical terms that do not require a higher order derivative or any derivative at all. Although economists use derivatives, and higher order derivatives, it seems to me they often are just “playing with formulas” and do not have a good sense of the physical reality behind the derivatives.

Here is a simple example: Think of the time-distance function. The first derivative is velocity (speed) while the second is acceleration (strictly speaking, a vector, but people feel it as a scalar and think of it as a scalar). Most people don’t think of speed as the first derivative of the distance function. They have a simple direct feeling of “how fast”, and have contrived measuring devices that directly relate “how fast”. Few people other than physicists think of acceleration as the second derivative of the distance function or as the first derivative of the velocity (speed) function. People have a direct feeling for acceleration, more even than a direct feeling for speed. We have some mechanisms for measuring acceleration. But even without accurate instruments, we get a pseudo-measure from the intensity of effects on our body. Few people other than physicists think of change in acceleration as the third derivative of the distance function yet people have a direct intuitive sense of that. We even somehow put together all of these feelings when we shoot at prey or at moving targets.

I am not saying that there is no use for higher-order derivatives. They have much use. I only want to use them in ways that also make physical sense.

For example, we might think of the relation between the volume that comes out of a spigot and how fast the bathtub fills up.

I would appreciate suggestions of other such examples.

Come to think of it, all the same is true for integrals.