Log-log plots

Prerequisites:

- Powers and exponents
- Approximations

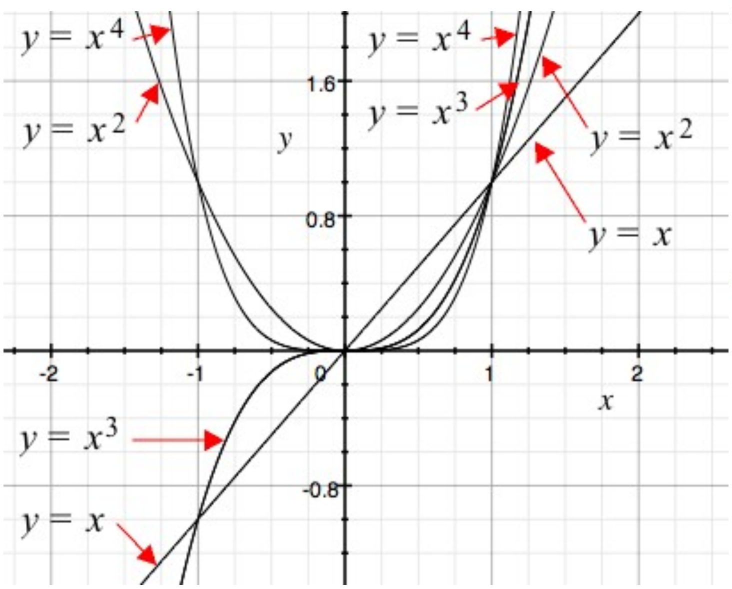
When we have a complicated function it is sometimes useful to approximate it by a simple power law. One way to see how to do this is to use a log-log plot. That is, instead of just plotting the variables themselves, we plot the logarithm of the variables. Let's see how this works.

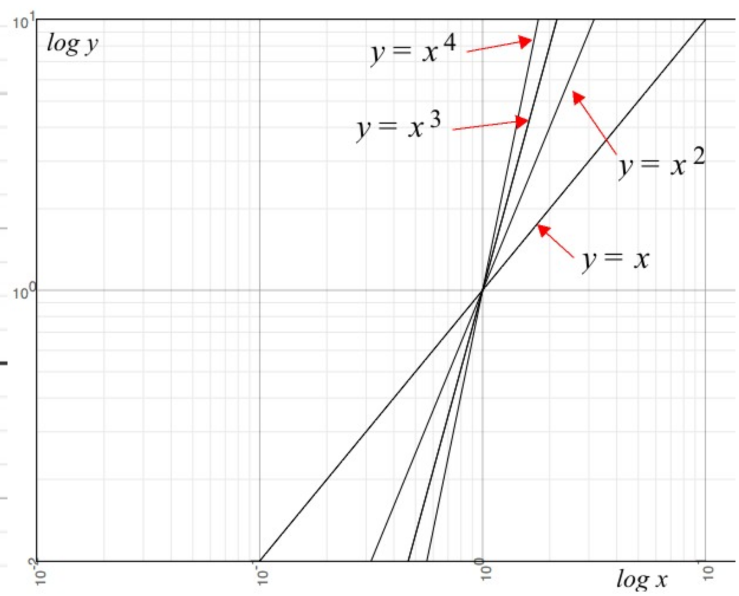
Suppose we have a power law function $y = x^N$. If we plot this, we get a curve like shown in the figure at the left below. The more powers we have, the faster it rises (and the odd powers are negative for negative values of x.)

But if we take the logarithm of both sides of that equation, $y = x^N$, we get

$$\log y = N \log x.$$

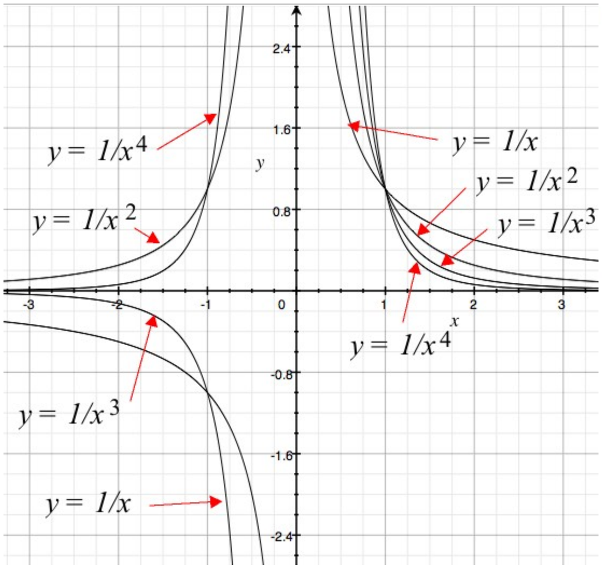
If we now take as new variables Y = log y and X = log x, then our new equation is just Y = NX. This is the graph of a straight line and the slope is proportional to the power. If we plot this we get the figure at the right. All the power laws are straight lines with increasing slope as the powers go up.

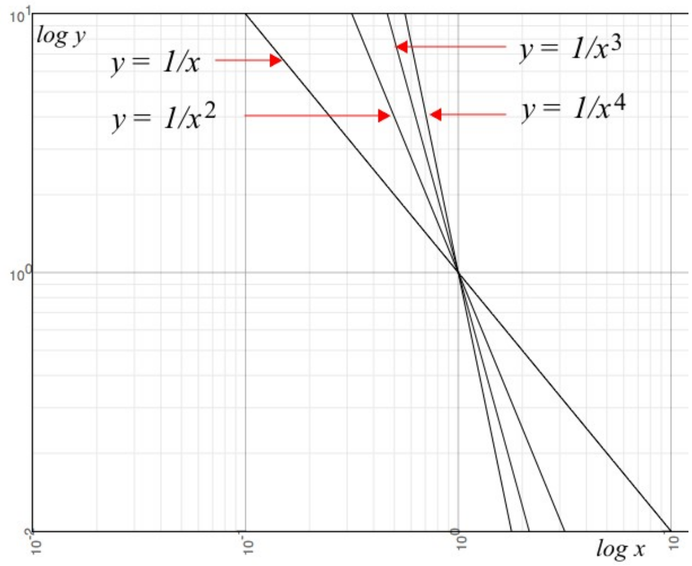




So if we have some complicated function that can be approximated by a power law, we can easily see that this is the case by plotting the logarithms of the variables. If we get a straight line a power law works. (We have only plotted positive values of x and y in the log-log plot since the log of a negative number is not a real number.)

Note that this works for negative powers too. Here's what the linear and log-log plots look like for these.





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