

1. **Modelling the acquisition of language.** The percentage $p(t)$ of children who can speak at least single words by the age of t months can be modeled by the equation,

$$p(t) = 100\left(1 - \frac{12,200}{t^{4.48}}\right).$$

- Use Desmos¹ to graph this equation.
 - What is the interpretation of the t -intercept of the graph?
 - What percentage of children can speak at least single words by the age of 12 months?
 - By what age are 90% of children speaking at least single words?
2. **Climate change.** The most abundant greenhouse gas is carbon dioxide, CO₂. In the pre-industrial year of 1750 the concentration is generally accepted to have been 280 ppm (parts per million). In 2025 the CO₂ concentration was 425 ppm.
- Fit an exponential model to this data with the form $C(t) = Ab^t$ where t is “years since 1750”.
 - What does the model predict the amount of carbon dioxide in the atmosphere will be in 2050? 2100?
 - According to the model when will the level surpass 450 parts per million?
3. **Earthquakes.** The Richter Scale is used to measure the intensity of earthquakes using the formula $R = \frac{2}{3}(\log E - 11.8)$ where E is the energy released by the earthquake measured in ergs.
- The San Francisco earthquake of 1906 registered $R = 8.2$ on the Richter scale. How many ergs of energy were released?
 - In 1989 another San Francisco earthquake registered $R = 7.1$ on the Richter scale. How many times stronger (in terms of energy released) was the 1906 earthquake than this one?
 - If one earthquake registers 2 points more than another on the Richter scale how many times more energy does it release?

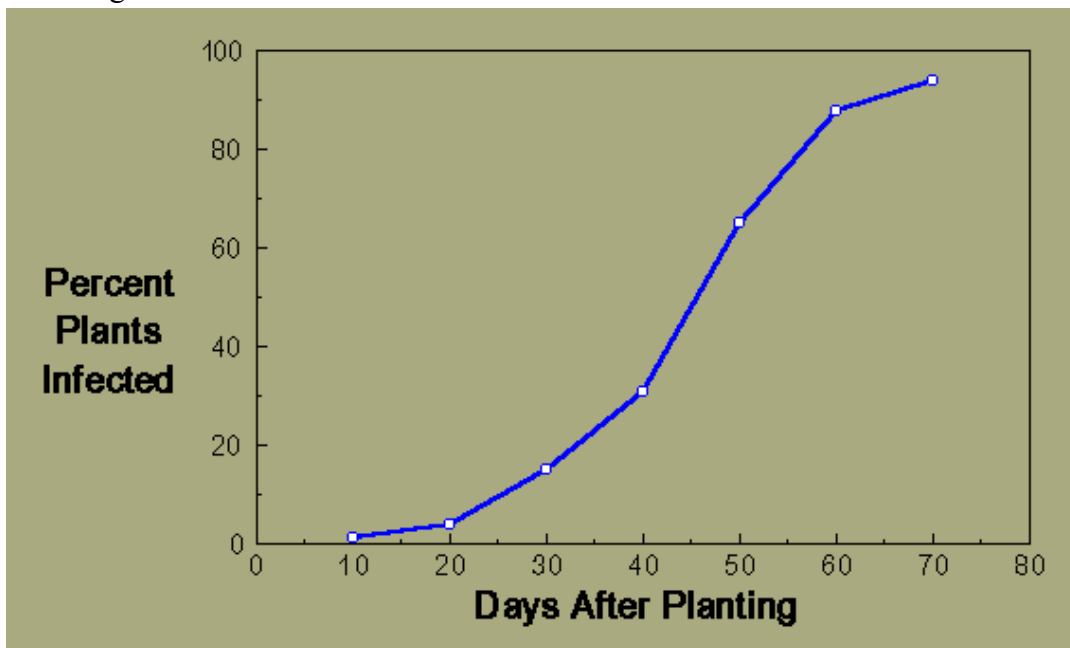
¹ <https://www.desmos.com/calculator>

4. **Sunspots.** The activity of the sun (sunspots, solar flares, and coronal mass ejection) fluctuates cyclically. Sunspot activity can be modeled by the function $N(t) = 57.7 \sin[0.60(t - 1.43)] + 58.8$ where t is the number of years since January 1, 1997 and $N(t)$ is the number of sunspots observed at time t . According to the model:
- What is the period (length of cycle) of sunspot activity?
 - What is the maximum number of sunspots observed?
 - What is the minimum number of sunspots observed?
 - In what coming year is sunspot activity next expected to reach a high point?

Plant diseases. Plant diseases follow many different courses, both within a year, and across years. For each of the following graphs² choose the type of model that would be most appropriate, and use Desmos to **fit that model to the data by eye**.

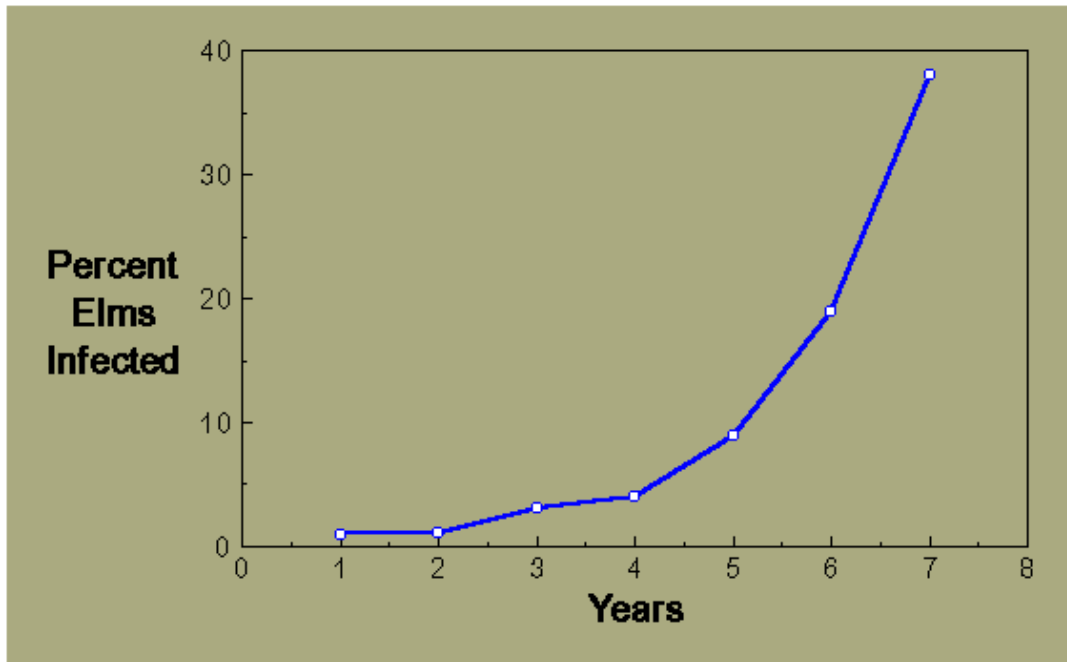
I've prepared a Desmos worksheet of the data sets at <https://www.desmos.com/calculator/79t4zxxxt> You will need to log in to the Desmos app to save your models. (If you have a gmail address you can use it to log in.) Submit your work on problems 5-10 by sending me a link to your Desmos worksheet. Clicking this icon  in the upper right of the Desmos window will let you copy a link to your worksheet. As always when working with computers: **Save your work frequently!**

5. Halo blight disease



² All graphs from:
<http://www.apsnet.org/edcenter/advanced/topics/EpidemiologyTemporal/Pages/Disease%20Progress.aspx>

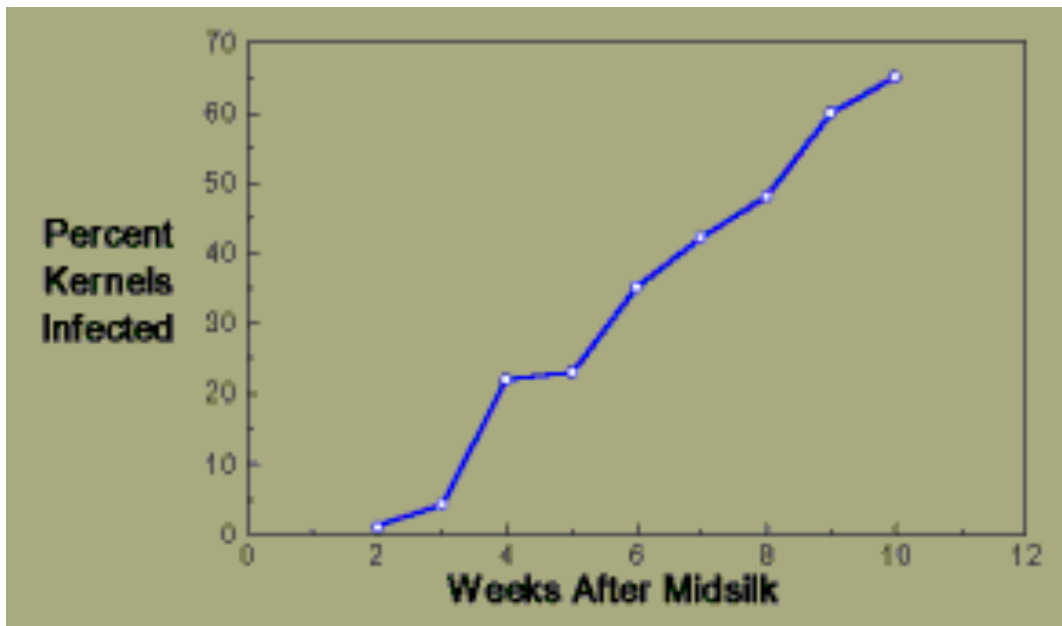
6. Dutch Elm Disease



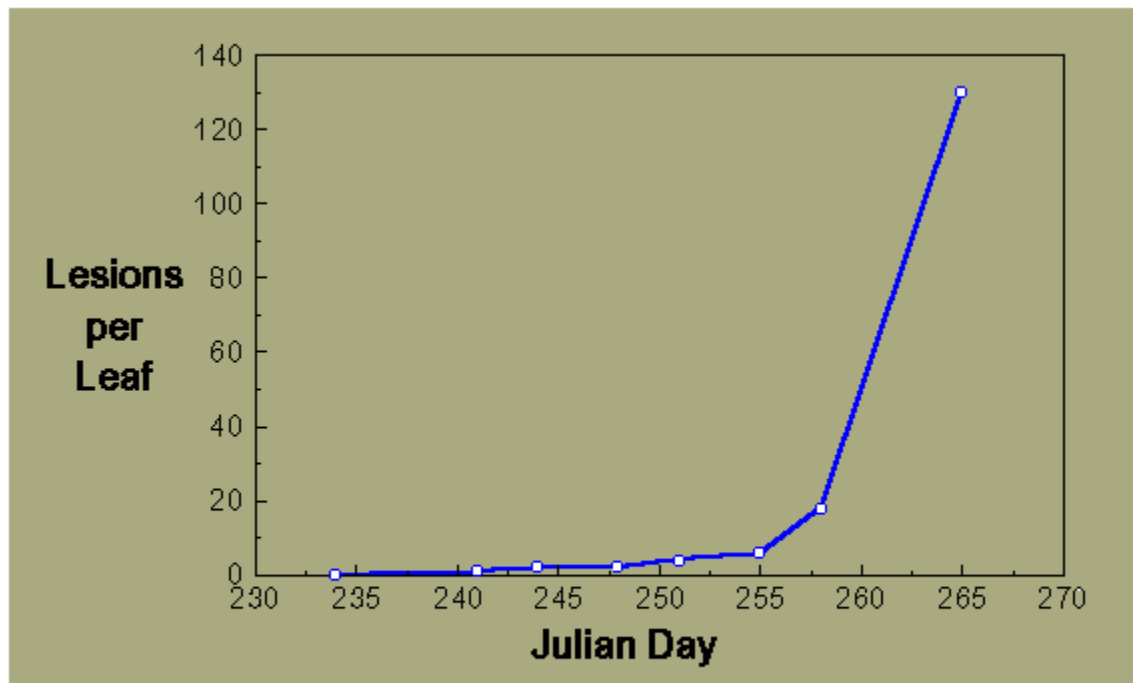
Polyetic Epidemic: Dutch elm disease

Redrawn from: Van Sickle, G. A. and Sterner, T. E. 1976. Sanitation: A practical protection against Dutch elm disease in Frederickton, New Brunswick. Plant Disease Reporter 60:336-338.

7. Fusarium kernel rot of maize



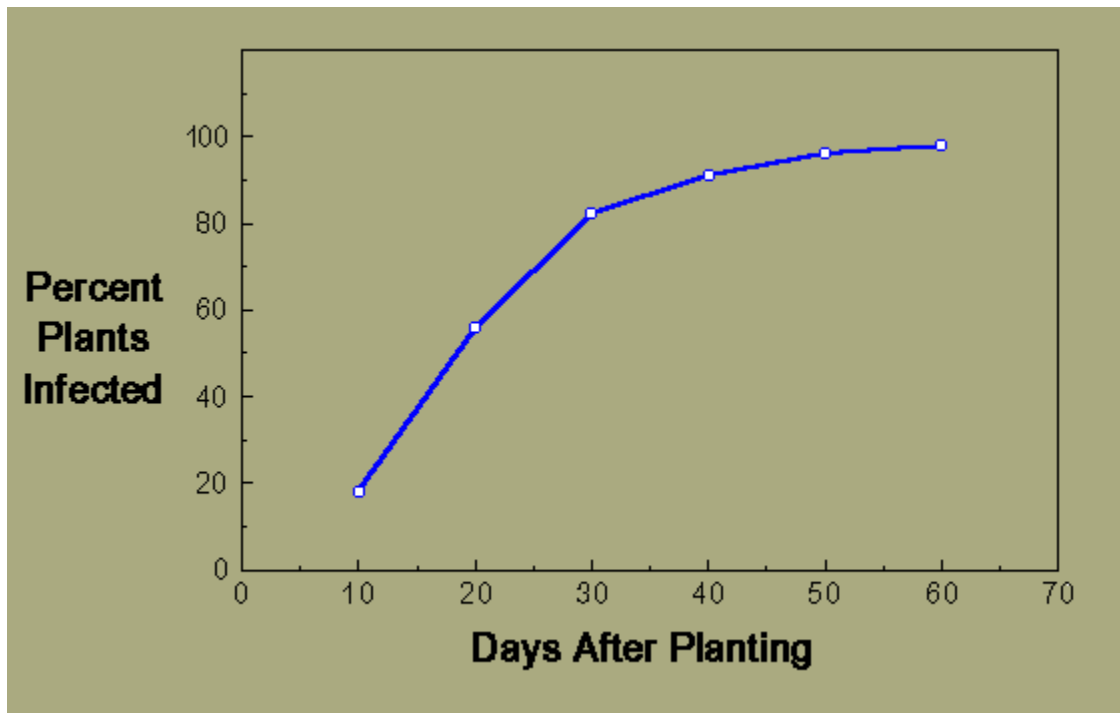
8. Gray leafspot on maize



Gray Leafspot on Maize.

Redrawn from: Rupe, J. C., Siegel, M. R., and Hartman, J. R. 1982. Influence of environment and plant maturity on grey leaf spot of corn caused by *Cercospora zeae-maydis*. *Phytopathology* 72:1587-1591.

9. Flax Wilt



10. Polyetic Epidemic: Apple Powdery Mildew

