

Harbin plague epidemic

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It occurred to me that it would be interesting to contrast information that we have on 20th-century plagues (Bombay, 1906, bubonic; Harbin, 1911, pneumonic; others??) with the 14th- and 17th-century London data that David Earn has been collecting.

Load packages:

From Dietz (2009) ...

Figure 1 shows Dietz's plot – the only reference he gives to the data is "(International Plague Conference, 1912)" [not otherwise referenced in the paper!] Googling `"international plague conference" harbin 1912` does bring up some promising hits, especially this page, and particularly this PDF file, and particularly p. 529 of that page (Figure 2)

I used `g3data` to extract data points from Dietz's figure (before I found the 1912 report).

Dietz gives the (Kermack-McKendrick) equations for the incidence, dz/dt (based on a second-order Taylor expansion):

$$\begin{aligned}\frac{dz}{dt} &= \frac{\gamma x_0}{2\mathcal{R}_0^2} c_1 \operatorname{sech}^2(c_1 \gamma t - c_2), \\ c_1 &= \sqrt{(\mathcal{R}_0 - 1)^2 + \frac{2\mathcal{R}_0^2}{x_0}} \\ c_2 &= \tanh^{-1} \left(\frac{\mathcal{R}_0 - 1}{c_1} \right).\end{aligned}\tag{1}$$

and estimates " $x_0 = 2985$, $\mathcal{R}_0 = 2.00$ and a mean infectious period of 11 days".

The weekly deaths should be approximately proportional to the incidence (this ignores the probability of survival, the integration over weeks, the second-order expansion, and all the other unrealities of the model ...)

Obviously I don't have this quite right yet ...

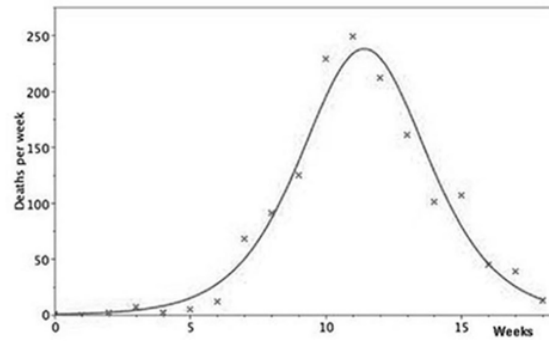


Figure 1: Unnumbered figure (p. 102) from Dietz (2009) showing the Harbin epidemic.

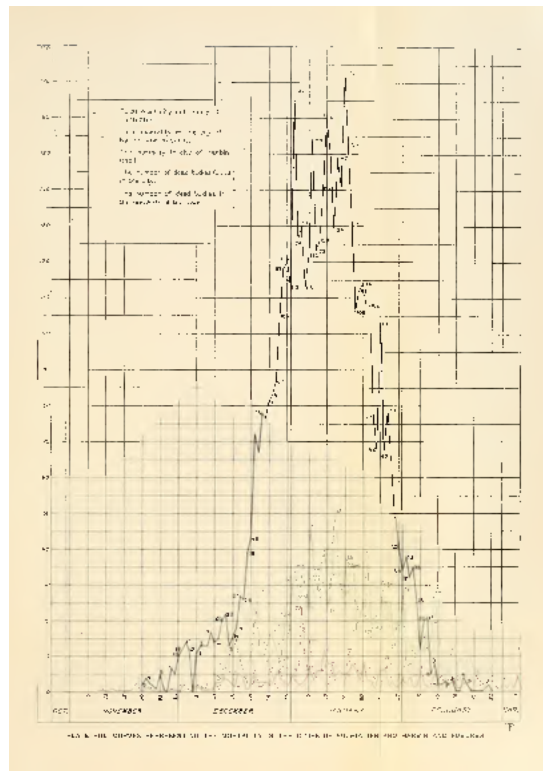
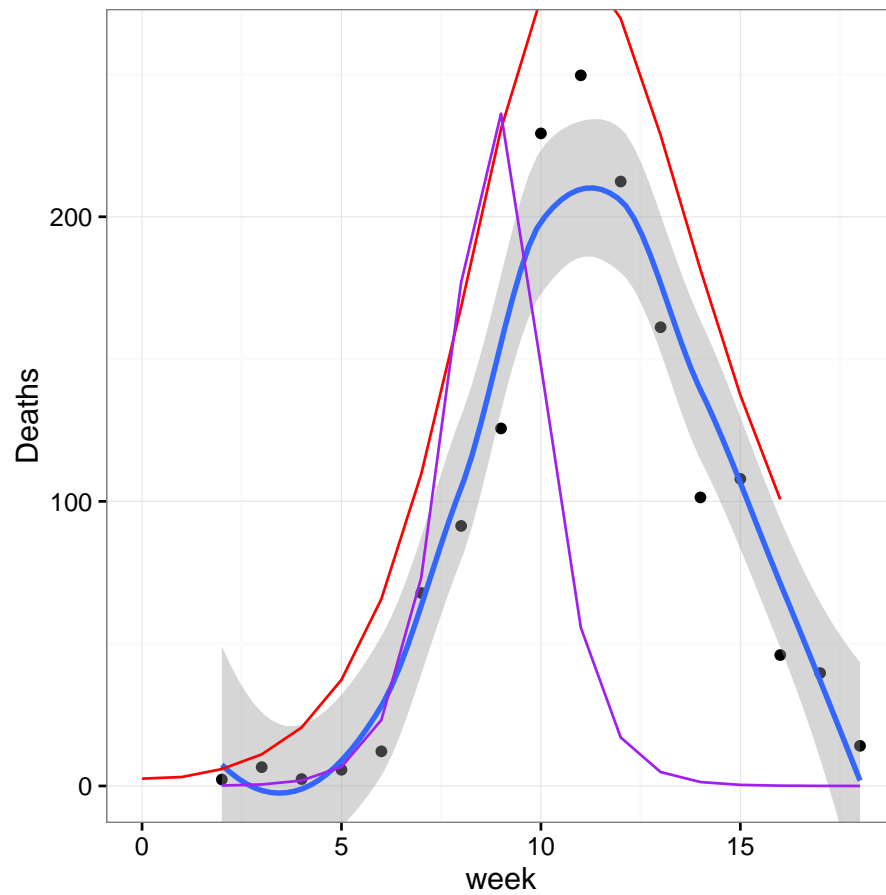


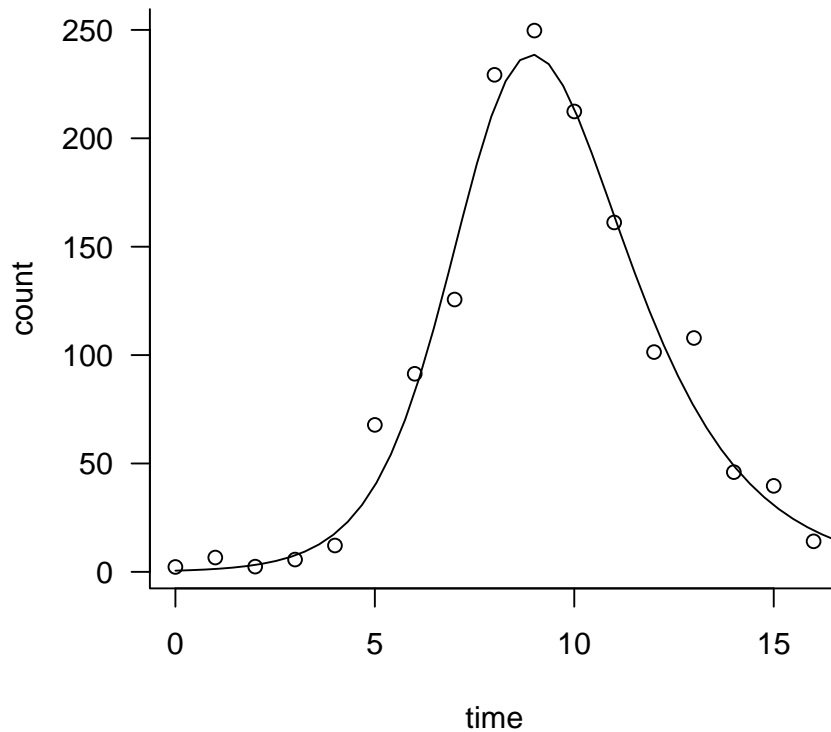
Figure 2: A thumbnail of the relevant page from International Plague Conference (1911 : Mukden) et al. (1912), extracted from the PDF via pdftk A=reportofinternatinte.pdf cat A529-529 harbin_plague.pdf ...



1 To do

- Figure out why neither the straight SIR fit nor the K-M fit are working with the parameters given by Dietz. Unit problems? Typos? Failure of K-M second-order approximation? Try the fits myself.

Better, but still not very good:



```
##          R0          r      infper          i0          I0
## 2.041781e+00 8.116270e-01 1.283571e+00 6.331005e-04 9.570412e-01
##          N
## 1.511673e+03
```

There's an issue with whether we're assuming $t = 0$ at the beginning of the epidemic (Dietz's data starts with "week 2" ...)

References

- Dietz, K. (2009, April). Epidemics: the fitting of the first dynamic models to data. *Journal of Contemporary Mathematical Analysis* 44(2), 97–104.
- International Plague Conference (1911 : Mukden), R. P. R. P. Strong, G. F. Petrie, A. S. Megaw, and Boston College Libraries (1912). *Report of the*

International plague conference held at Mukden, April, 1911. Manila, Bureau of Printing.