Harbin plague epidemic

February 8, 2017@ 14:49

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):

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

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 ...

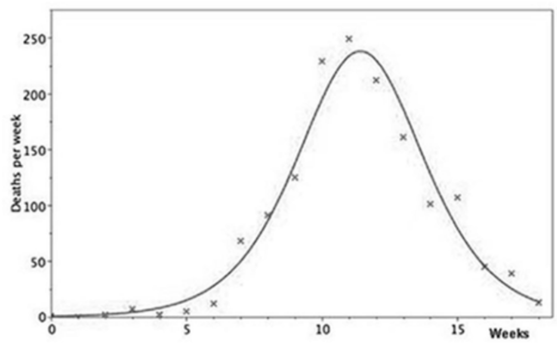


Figure 1: Unnumbered figure (p. 102) from Dietz (2009) showing the Harbin epidemic.

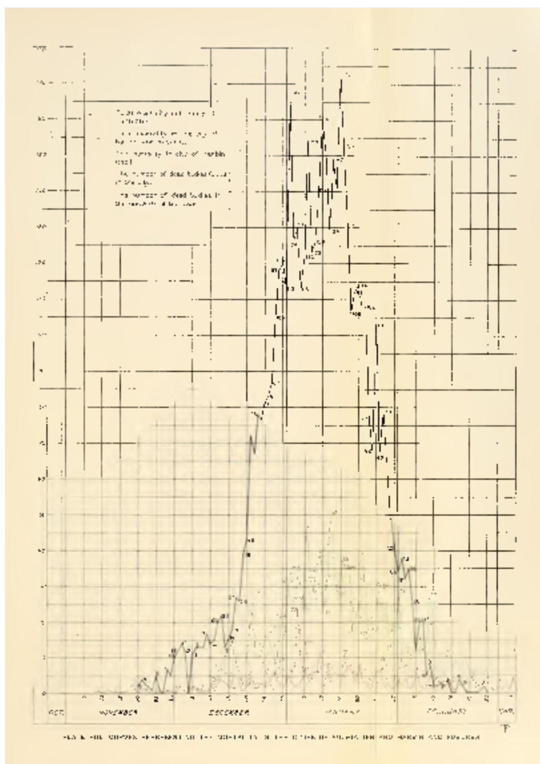
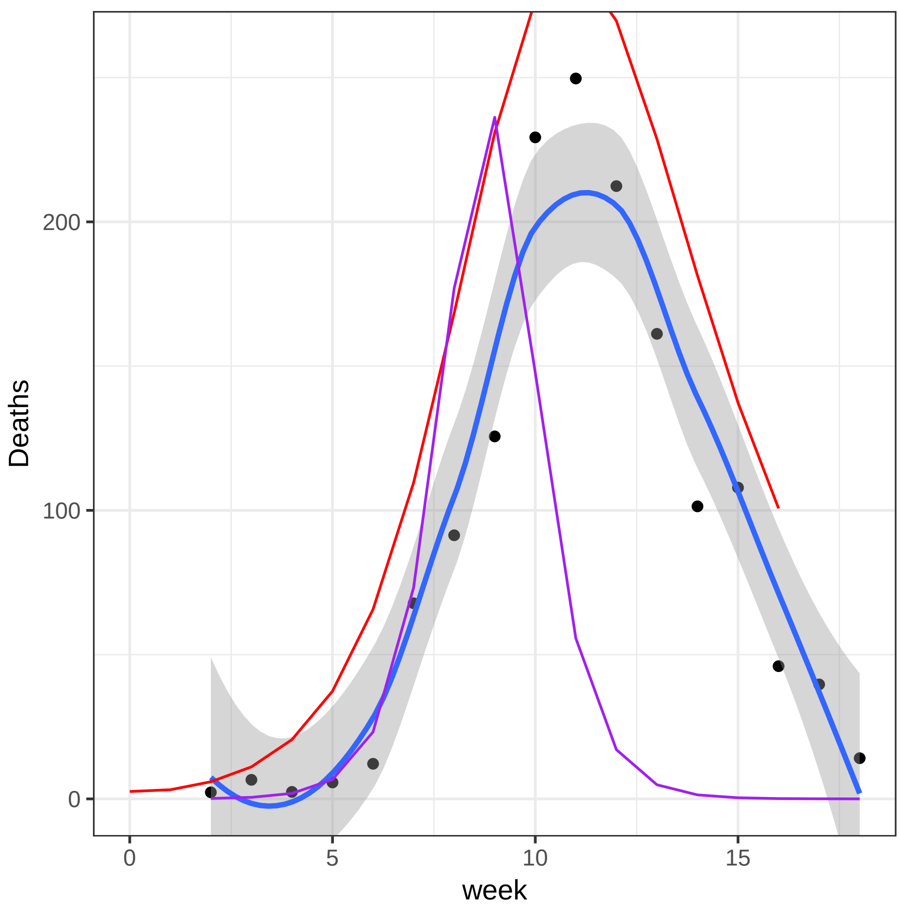


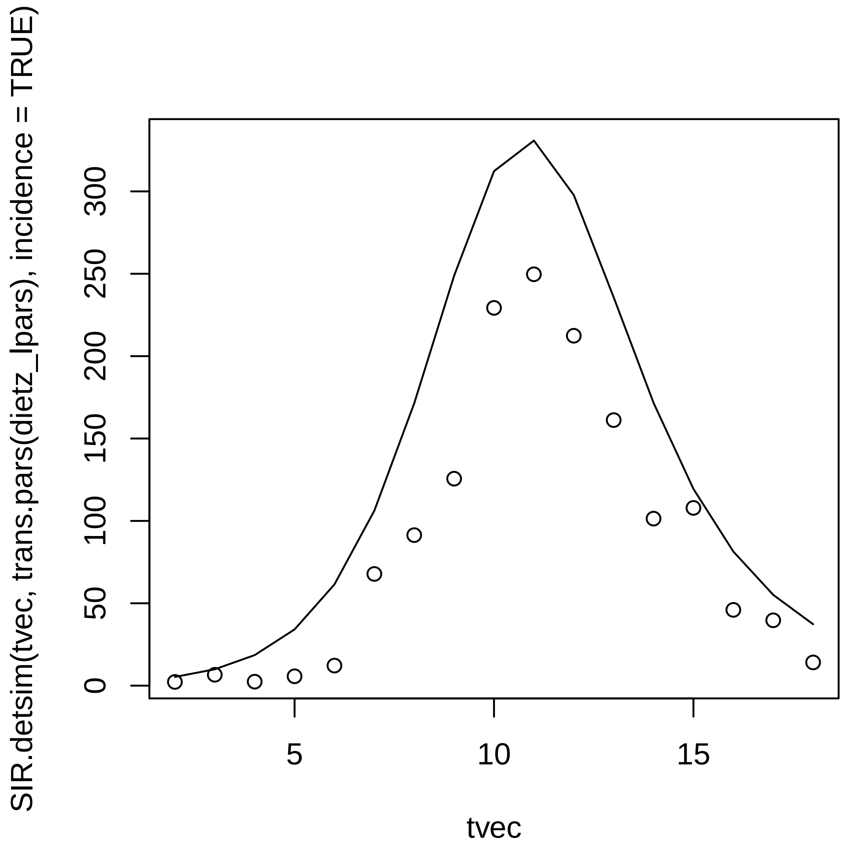
Figure 2: A thumbnail of the relevant page from International Plague Conference (1911 : Mukden) et al. (1912), extracted from the PDF via `pdftk A=reportofinternatinte.pdf cat A529-529 harbin_plague.pdf` ...



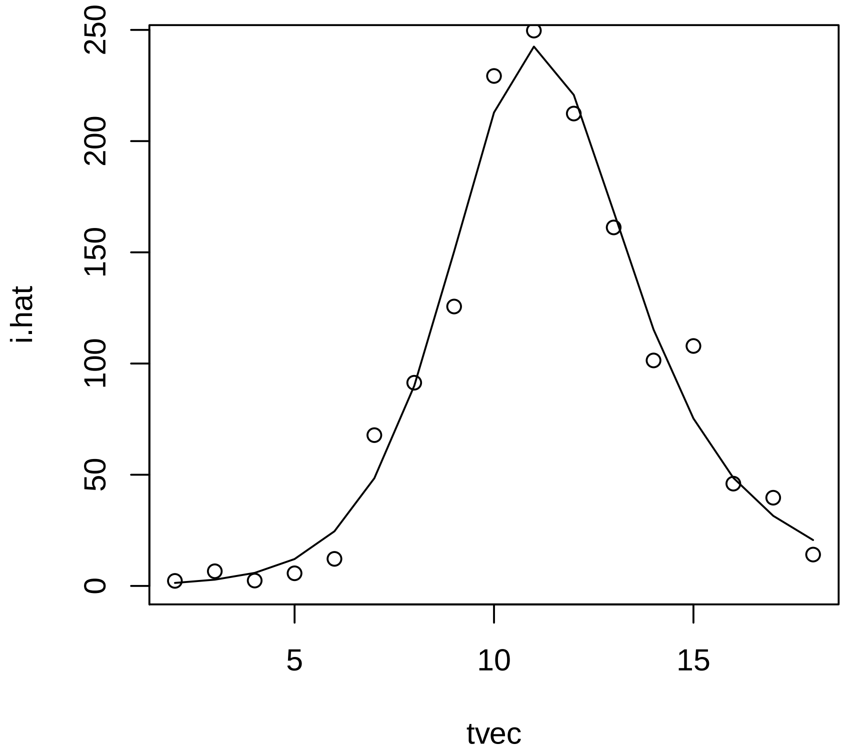
1 To do

- 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.

I neeed to try the second order approximation but you're using prevalence instead of incidence...



We get something similar.



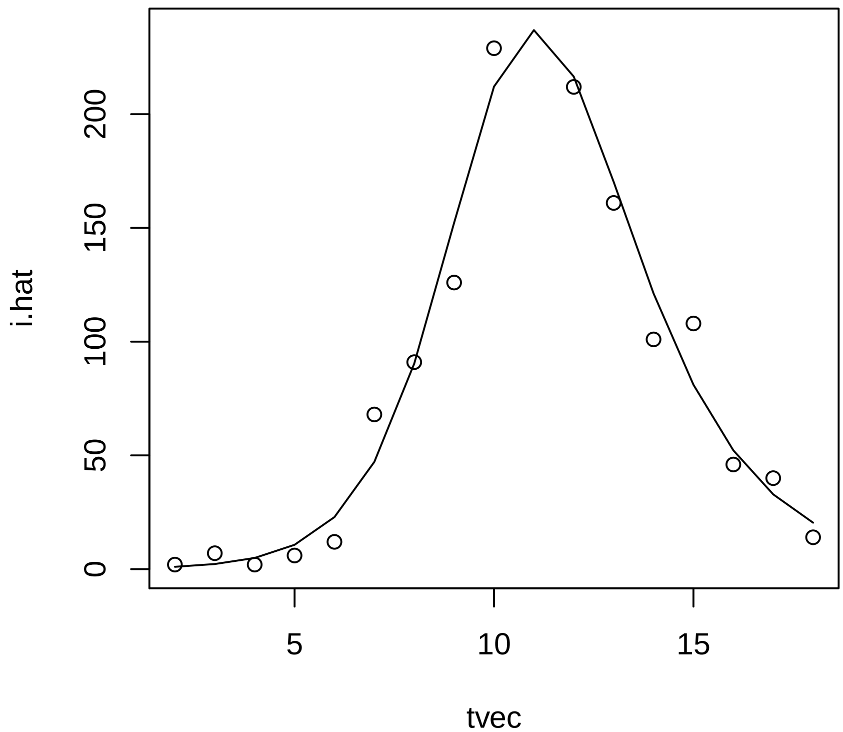

```
##
## Call:
## mle2(minuslogl = SIR.logLik, start = start, method = method,
##     data = dataarg, vecpar = TRUE, control = control)
##
## Coefficients:
##   log.beta  log.gamma      log.N    logit.i
##  0.2522661 -0.5998421  7.4615909 -7.8017665
##
## Log-likelihood: -68.18
##           R0            r       infper           i0           I0
## 2.344584e+00 7.380401e-01 1.821831e+00 4.088446e-04 7.113543e-01
##           S0            N
## 1.739202e+03 1.739914e+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" ...). SWP: I don't think this should be an issue...?

Not much difference between different methods:

```
##
## Call:
## mle2(minuslogl = SIR.logLik, start = start, method = method,
##     data = dataarg, vecpar = TRUE, control = control)
##
## Coefficients:
##   log.beta  log.gamma      log.N    logit.i
##  0.2522400 -0.5999282  7.4615972 -7.8017997
##
## Log-likelihood: -68.18
##
## Call:
## mle2(minuslogl = objfun, start = start, method = method, data = dataarg,
##     vecpar = TRUE, gr = gradfun, control = control)
##
## Coefficients:
##   log.beta  log.gamma      log.N    logit.i
##  0.2513235 -0.6019498  7.4611520 -7.7998914
##
## Log-likelihood: -68.18
```

Trying poisson...




```
##
## Call:
## mle2(minuslogl = SIR.logLik, start = start, method = method,
##     data = dataarg, vecpar = TRUE, control = control)
##
## Coefficients:
##    log.beta   log.gamma       log.N     logit.i
##  0.53308099 -0.09212661  7.50378551 -7.48860633
##
## Log-likelihood: -71.66
##           R0            r       infper           i0           I0
## 1.868634e+00 7.921851e-01 1.096504e+00 5.591093e-04 1.014727e+00
##           S0            N
## 1.813885e+03 1.814900e+03
```

This seems closer to Dietz parameters!

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.