

Fitting the SIR Model to Data

Influenza in an English boarding school

Michael Robert

Yi Sun

Xiaojing Wang

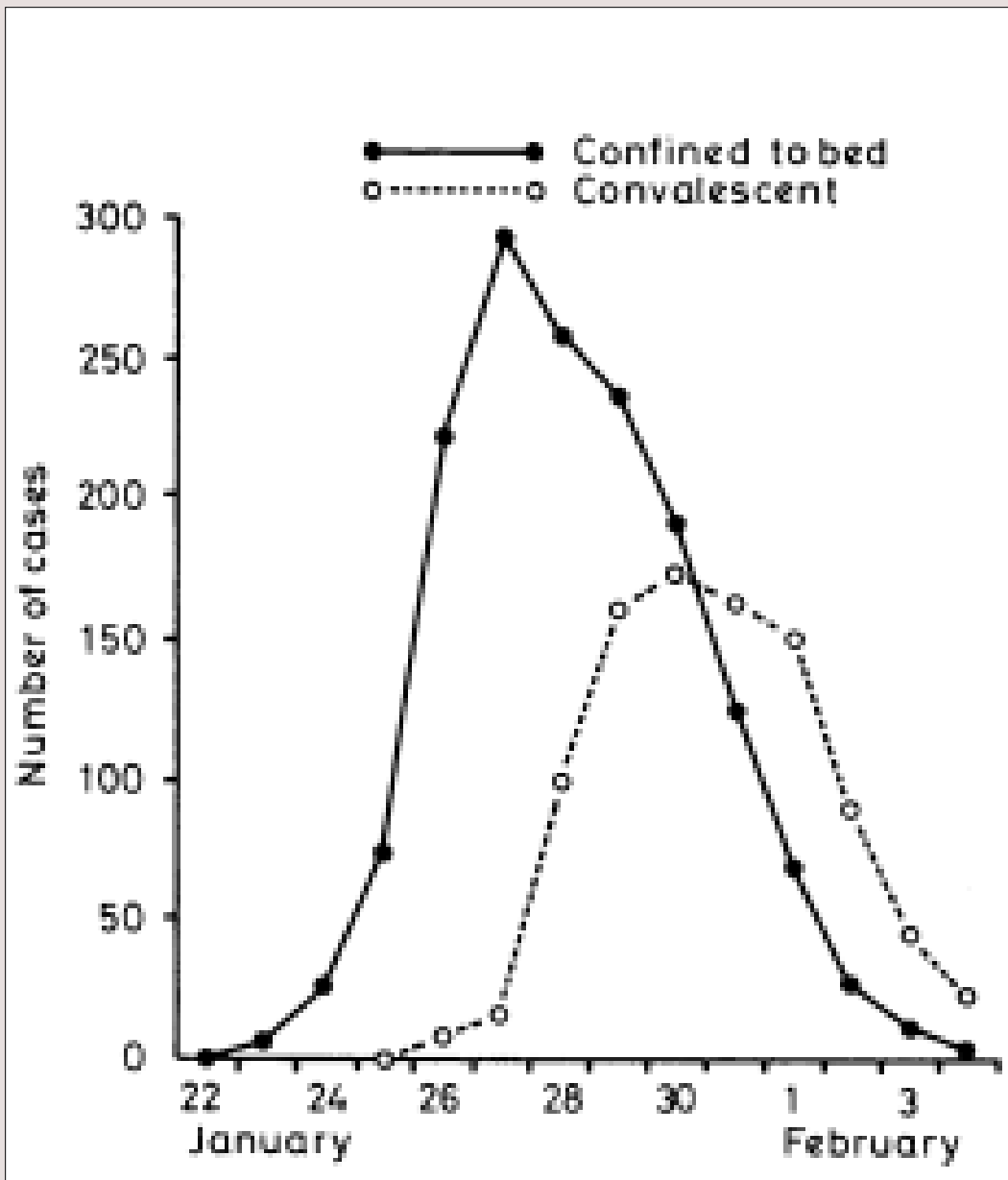
Seonjoo Lee

Ci-Ren Jiang

Sylvie Tchumtchoua

English Boarding School

- January 1978 influenza epidemic in a boarding school in England.
- 763 boys in the school.
- 1 boy returned from winter break with illness
- Over the course of 13 days, 512 boys were affected.



Day	Infected
1	3
2	6
3	25
4	73
5	222
6	294
7	258
8	237
9	191
10	125
11	69
12	27
13	11
14	4

data = [3,6,25,73,222,294,258,237,191,125,69,27,11,4];

Estimating Parameters

- Try to find values of β and γ that provide a curve close to that of the data
- Experiment:
 - $\beta = 1 ; \gamma = 0.5$
 - $\beta = 3 ; \gamma = 0.5$
 - $\beta = .5 ; \gamma = 0.6$
 - Others

Data Fitting

- Goal: Estimate values of β, γ based on data
- Various methods can be used
- We will use a least squares approximation
- We wish to minimize the following:

$$\sum e^2 = \sum (I(t) - \hat{I}(t))^2$$

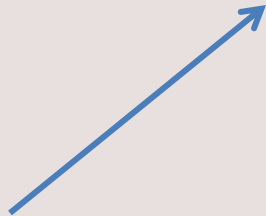
- $I(t)$: observed values of infectives
- $\hat{I}(t)$: model solution for estimates of β, γ

MATLAB & Least Squares Fitting

- Various functions can be used
- We will use `lsqnonlin`
 - Robust for least squares problems
 - Minimizes the sum of the square of a function
- For more information type:
`help lsqnonlin`

Using lsqnonlin

```
[p,resnorm] = lsqnonlin(@SIR0,[b0 g0],[0 0],[inf inf])
```



Function to be optimized

Using lsqnonlin

Initial Guesses

`[p,resnorm] = lsqnonlin(@SIR0,[b0 g0],[0 0],[inf inf])`

Function to be optimized

Using lsqnonlin

Initial Guesses

`[p,resnorm] = lsqnonlin(@SIR0,[b0 g0],[0 0],[inf inf])`

Function to be optimized

Upper and Lower bounds
for parameters

Using lsqnonlin

Returns the value of the residual norm

[p,resnorm]

Returns the optimal
parameter values

Using lsqnonlin

```
[p,resnorm] = lsqnonlin(@SIR0,[b0 g0],[0 0],[inf inf])
```

- What value(s) should @SIR0 return?

Using lsqnonlin

```
[p,resnorm] = lsqnonlin(@SIR0,[b0 g0],[0 0],[inf inf])
```

- What value(s) should @SIR0 return?
 - Model Solution - Data

Using lsqnonlin

```
[p,resnorm] = lsqnonlin(@SIR0,[b0 g0],[0 0],[inf inf])
```

- What value(s) should @SIR0 return?
 - Model Solution – Data
- How do we fit just one state equation?
 - We only have data for $I(t)$

Code for Data Fitting

- Three Functions
 - Setup and call `lsqnonlin`
 - Solve the ODE for each parameter guess and return $I(t)$ – Data
 - The ODE (you already have this!)

Open OptimizeSIR.m