

8 Epidemic Data



Mathematics
and Statistics

$$\int_M d\omega = \int_{\partial M} \omega$$

Mathematics 4MB3/6MB3 Mathematical Biology

Instructor: David Earn

Lecture 8
Epidemic Data
Wednesday 24 January 2018

Announcements

- Thanks everyone for doing the contributions survey for Assignment 1.
- Don't stress about the ratings about each other's contributions. The issue is whether some group members did not pull their weight. If somebody didn't try and others had to pick up the slack, that person should be penalized. I will not penalize somebody because they tried but felt they didn't contribute as much to the final document as they could have. Do try to even out the work across the assignments.
- Make sure everyone in your group gets a chance to be in control of the \LaTeX for one assignment.

More Announcements!

- **Assignment 2:**

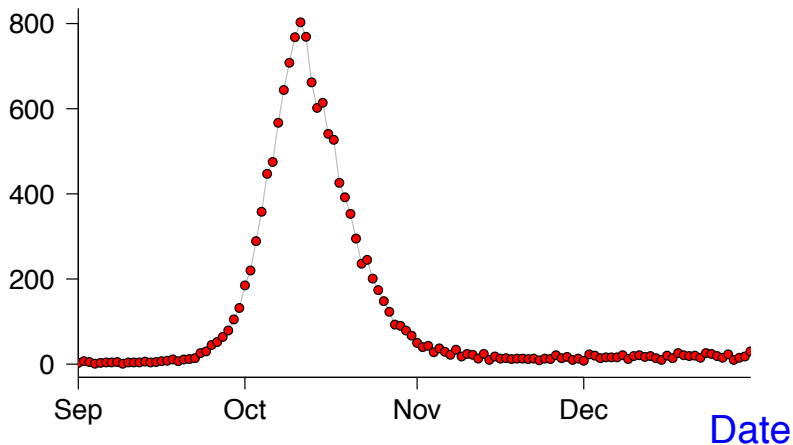
Due Monday 5 February 2018 in class (and by e-mail) at 11:30am.

- **Midterm test:**

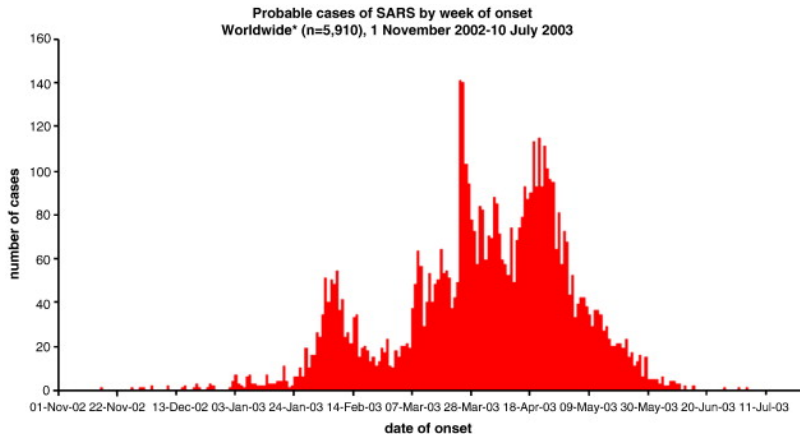
- *Date:* week of 5–9 March? or 12–16 March?
- *Time:* TBA
- *Location:* TBA

P&I Mortality, Philadelphia, 1918

P&I Deaths

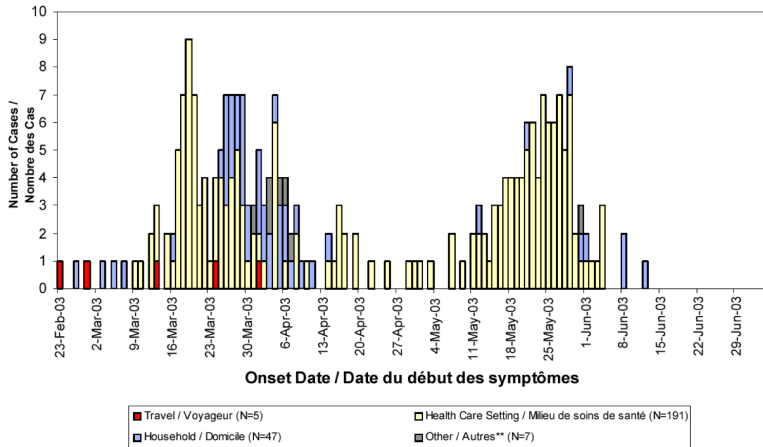


SARS in 2003 (Worldwide)



*This graph does not include 2,527 probable cases of SARS (2,521 from Beijing, China), for whom no dates of onset are currently available.

SARS in 2003 (Toronto)

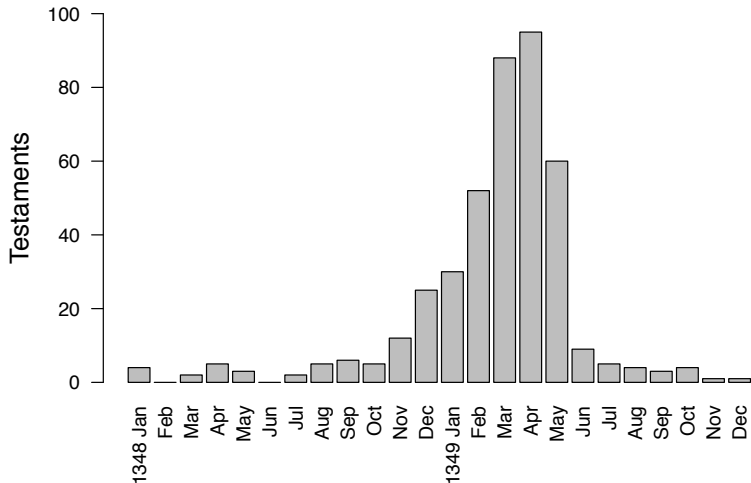


$N = 249$ (of 250 reported)

Some SARS Facts

- High case fatality
 - 1918 flu $< 3\%$
 - SARS $> 10\%$
- Long hospital stays
 - Mean time from admission to discharge or death:
~ 25 days in Hong Kong
- 8098 probable cases, 774 deaths
- How bad would it have been if it had not been controlled?

The Black Death in London, England, 1348–1349



Mortality Bills are typically handwritten

LONDON 29. From the 4. of July to the 11. of August 1665.

Buried, Plag.		Buried, Plag.		Buried, Plag.		Buried, Plag.					
St Alban Woodstreet	2	1	St Clement Eastcheap	1		St Margaret Newfishst					
Alhallows Bark			St Dionis Backchurch	2		St Margaret Pattons					
Alhallows Breadstreet	1		St Dunstons East	2		St Mary Abchurch	1				
Alhallows Great			St Edmund Lombardst.	1		St Mary Aldermanbury					
Alhallows Honilane	1		St Ethelborough	2		St Mary Alde mary					
Alhallows Lef			St Faiths	1		St Mary le Bow					
Alhallows Lombardst.	1		St Gabriel Fenchurch	1		St Mary Bothaw					
Alhallows Staining	4	3	St George Botolphlane	2	1	St Mary Colechurch					
Alhallows the Wall	1		St Gregories by St, Paul	1		St Mary Hill					
St Alphage			St Hellen	2	1	St Mary Mag. Milkstr.					
St Andrew Hubbard	3		St James Dukes place	1		St Mary Mag. Oldfishst					
St Andrew Underthafe	7		St James Garlickhithe	1		St Mary Mounthaw					
St Andrew Wardrobe	1		St John Baptist			St Mary Summerset	2	1			
St Anne Aldersgate	7		St John Evangelist			St Mary Staining					
St Anne Blackfyers	7	6	St John Zichary			St Mary Woolchurch					
St Antholiers Parish.	1		St Katharine Coleman	1		St Mary Woolnoth					
St Austins Parish			St Katharine Creechur.			St Martins Iremongerl.					
St Barthol, Exchange	1		St Lawrence Jewry			St Martins Ludgate	2	1			
St Bennet Fynck			St Lawrence Pountney			St Martins Orgars					
St Bennet Gracechurch	7		St Leonard Eastcheap			St Martins Outwich	1				
St Bennet Paulwharf.			St Leonard Fosterlane.			St Martins Vintrey	1				
St Bennet Sherchog.			St Magnus Parish	1		St Matthew Frydaystr.					
St Borolph Billingsgate			St Margaret Lothbury.			St Michael Bassishaw	5	4			
Christ Church	5	3	St Margaret Mofes			St Michael Cornhil					
St Christophers											
Christned in 7 the Parishes within the walls				Buried				86	Plague	28	
St Andrew Holborn	6	4	St Borolph Aldergate	11	9	St George Southwark	13	4	St Sepulchres Parish	117	81
St Bartholomew Great	7	4	St Borolph Aldgate	24	4	St Giles Cripplegate	105	49	St Thomas Southwark	7	5
St Bartholomew Lef			St Borolph Bishopsgate	37	20	St Olave Southwark	20	6	Trinity Minories		
St Bridget	24	17	St Dunstan West	19	9	St Saviour Southwark	21	1	At the Pethouse	6	6
Bridewell Prencit	1										
Christned in the 15 Parishes without the walls				Buried				473	Plague	273	
Christs Church			St Kath. near the Tower	7	1	St Mary Islington	3	2	St Paul Shadwel		
St John at Hackney	1		Lambeth Parish	7		St Mary Newington	7		Rotherhich Parish	7	3
St Giles in the Fields	208	215	St Leonar d Shoreditch	21	13	St Mary Whitechappel	16	3	Stepney Parish	47	1
St James Clerkenwel	8	43	St Magdalen Bermond.	14							
Christned in the 15 Parishes in Middlesex and Surrey				Buried				455	Plague	280	

But handwriting is usually very clear

LONDON 29th

	Buried.	Plag.
St ALban Woodstreet	2	1
Alhallows Bark.	2	
Alhallows Breadstreet	1	
Alhallows Great —		

But handwriting is usually very clear

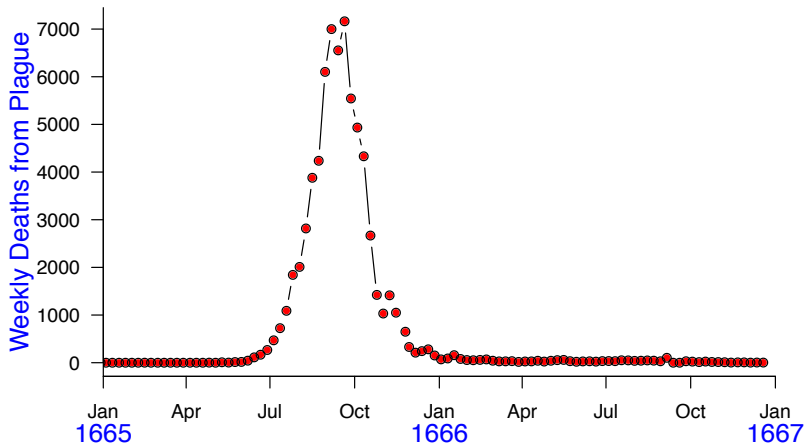
St Chrittophers

Christned in 97 the Parishes

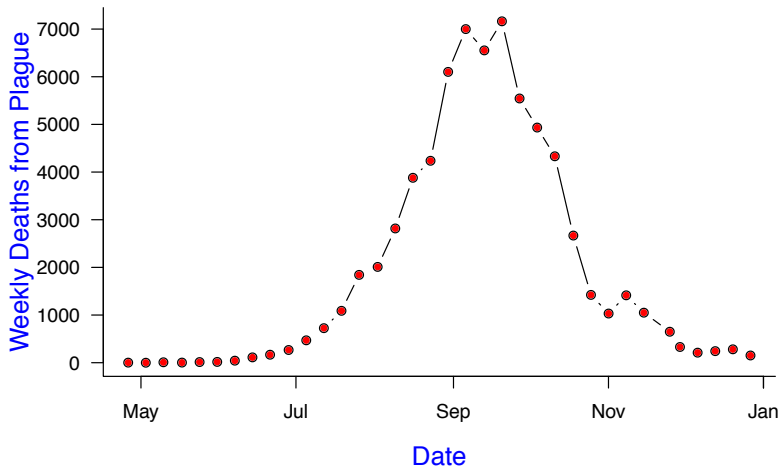
St Andrew Holborn	66	40	St
St Bartholomew Great	7	4	St
St Bartholomew Less			St
St Bridget	24	17	St
Bridewel Precinct	1	1	

Christned in the 16 Parishes

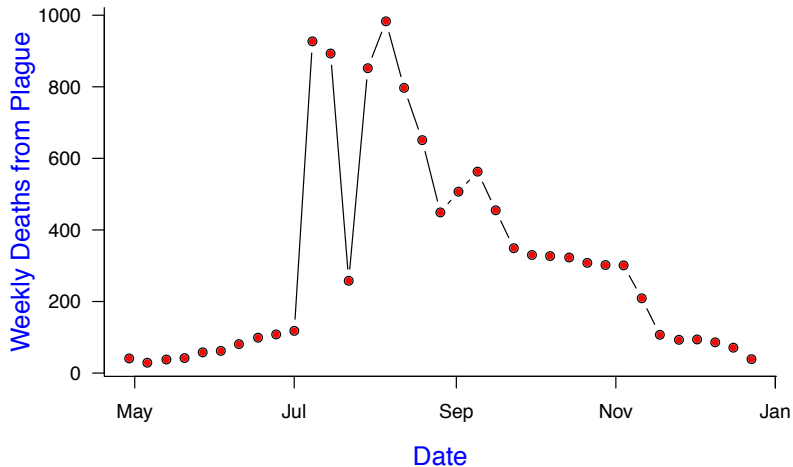
The Great Plague of London, 1665



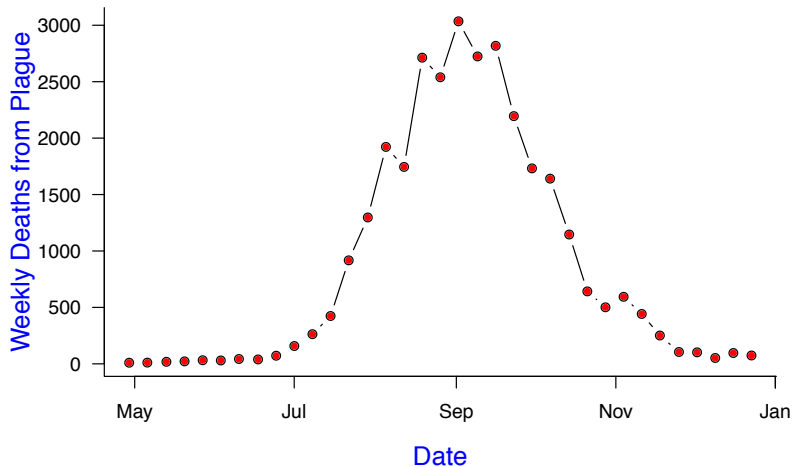
The Great Plague of London, 1665



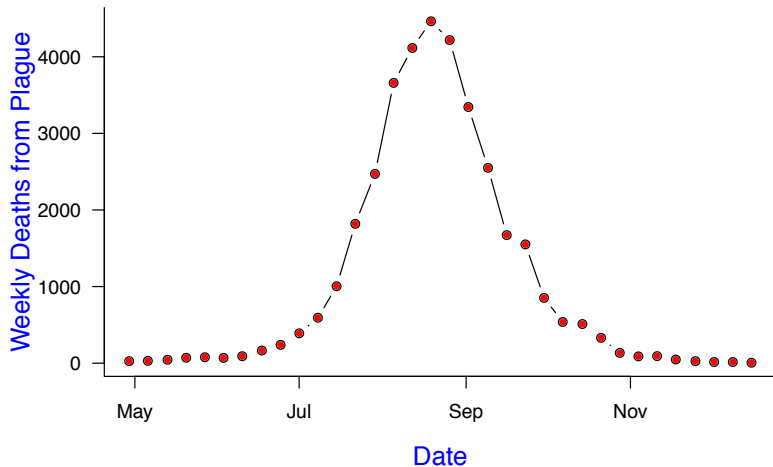
London Plague of 1593



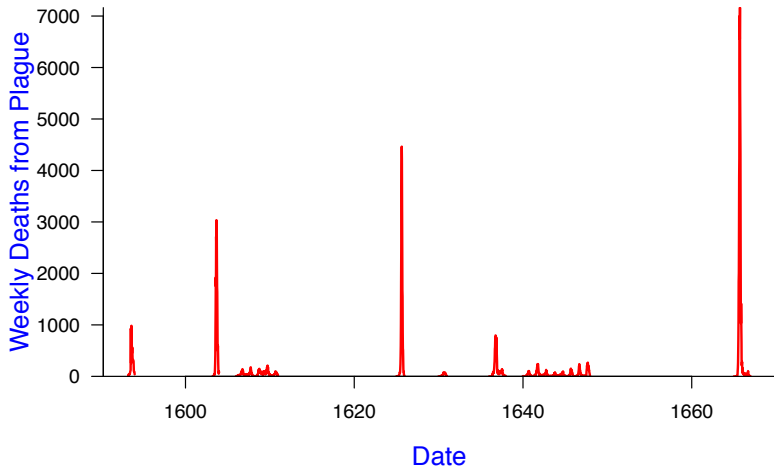
London Plague of 1603



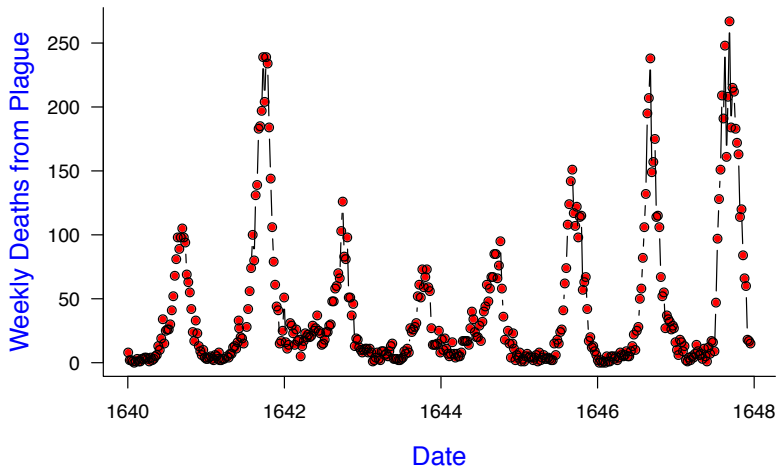
London Plague of 1625



Weekly Deaths from Plague in London, 1592–1666



Weekly Plague in London, 1640–1648



Some Plague Facts

- Plague epidemics recorded from Roman times to early 1900s.
- $\gtrsim 1/3$ Europe's population died in "Black Death" of 1348
 - ~ 300 years for the population to reach the same level.
- Recently (2011) established (at **McMaster!**) that the pathogen that caused The Black Death was *Yersinia pestis*

[Bos *et al.* 2011, *Nature* **478**, 506–510]

- More recently (2014) established (again at **McMaster!**) that the pathogen that caused The Plague of Justinian (541–543 AD) was *Yersinia pestis*

[Wagner *et al.* 2014, *Lancet Infectious Diseases* **14**, 319–326]

- *Y. pestis* still a concern?
Yes: Rodent reservoir, antibiotic-resistant strains, bioterrorism
- **Spatial data** for any plagues? Yes, for London in 1665...

Visualization of spatial structure of Great Plague

- GIS encoding of parish boundaries
- Overlay parish boundaries on more modern map for reference
- Colour parishes as they become infected
- Is there evidence for spatial spread or was the spatial pattern random?
- DE low-tech animation...
- CBC high-tech animation...
 - *The Nature of Things*, 21 August 2014.
<http://www.cbc.ca/natureofthings/episodes/secrets-in-the-bones-the-hunt-for-the-black-death-killer>