Dynamics of Chickenpox in NYC

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Background and Key Question

Understanding chickenpox epidemics is essential to helping people who do not have access to the vaccine.

Key questions are:

- Is it possible to model the changing strength of chickenpox cycles using a time series model?
- What are the forecasts for chickenpox cases in NYC in 1973? in 2018?
- What are the predominant cycles present in chickenpox cases?

Data Exploration

- Monthly reported number of chickenpox cases in NYC, 1931-1972.
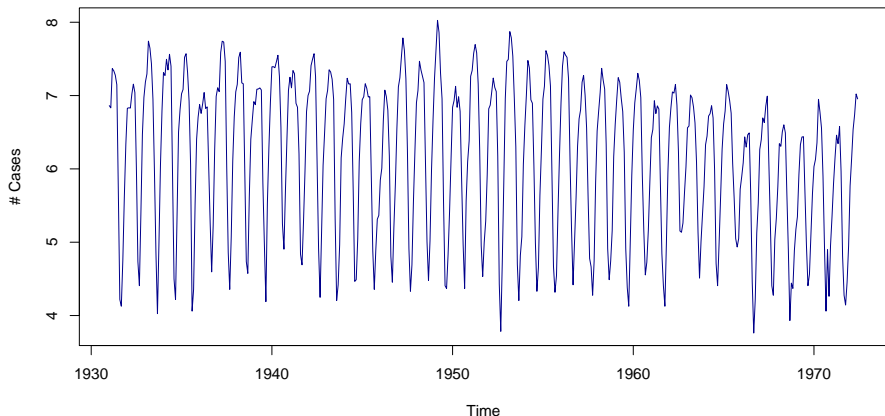- Supplied by Hipel and Mcleod (1994)

Monthly reported cases of chickenpox in NYC, 1931 – 1972
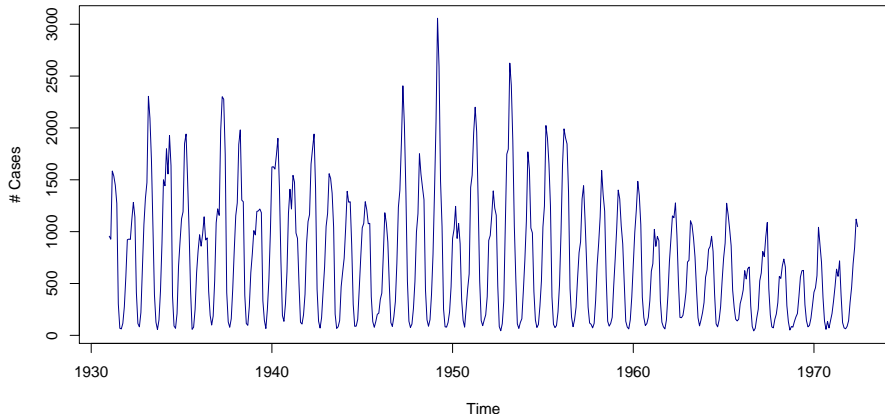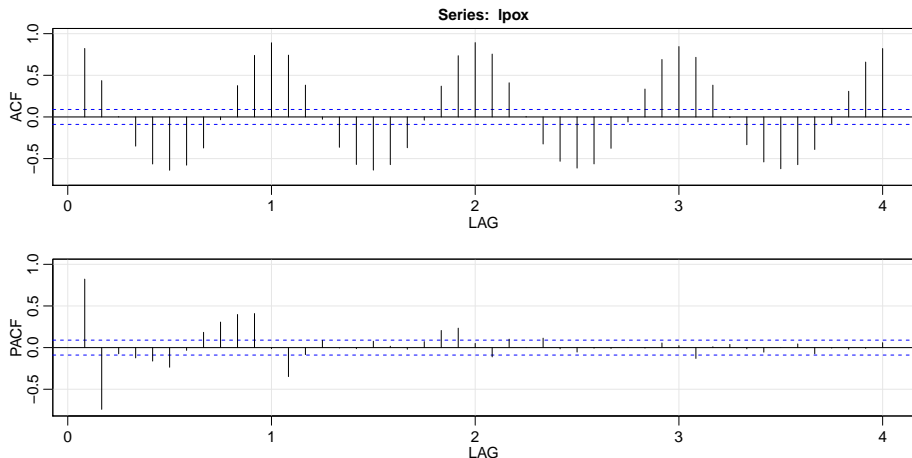
Quick Transformation!

- Box-Cox method suggests a log transformation ($\lambda \approx 0$)

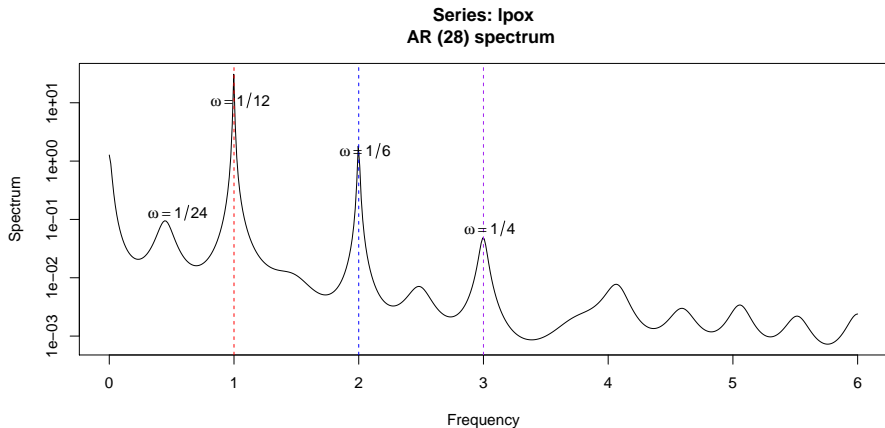**Log of monthly reported cases of chickenpox in NYC, 1931 – 1972**

ACF and PACF

- ACF has a sinusoidal pattern, repeating every 12 months
- PACF suggests AR(2) nonseasonal component

Series: lpox

Spectral Density Estimation

- Predominant cycle at $\omega \approx \frac{1}{12}$

**Series: lpox**
AR (28) spectrum

Model

- SARIMA$(1,0,0)\times(1,0,1)_{12}$ resulted in the best fit
- Coefficients are significant at $\alpha = 0.05$

Table 1: SARIMA(1,0,0)×(1,0,1)[12] Parameter Estimates

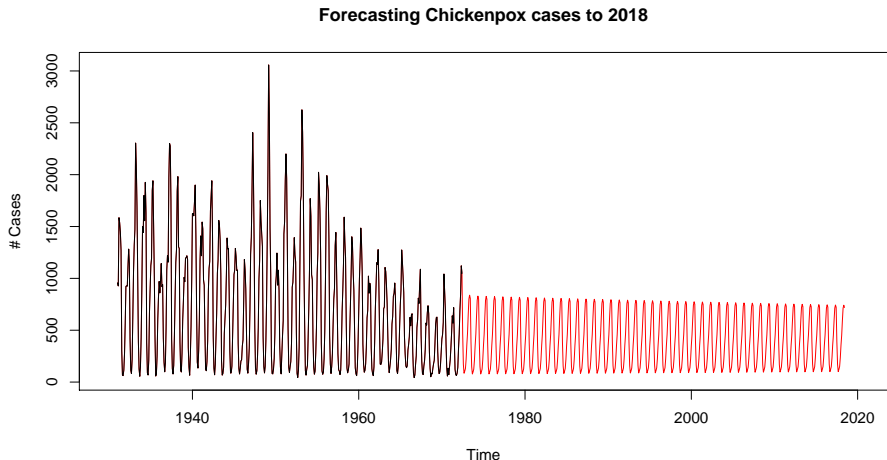|	Estimate	SE	t.value	p.value
ar1	0.730	0.031	23.454	0.000
sar1	0.996	0.002	557.209	0.000
sma1	-0.777	0.028	-27.616	0.000
xmean	6.014	0.592	10.159	0.000

Forecasting Chickenpox in 1973

- Using our model, obtain forecasts for the 5 years after
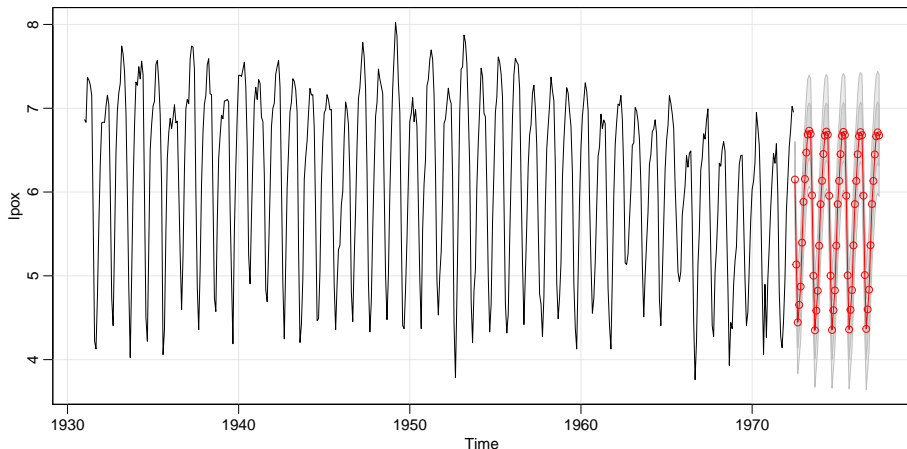
Forecasting Chickenpox in 2018

- A richer model will be needed to capture the changing amplitude over time

Forecasting Chickenpox cases to 2018

Summary

- The series is well represented by our SARIMA$(1,0,0)\times(1,0,1)_{12}$ model
- Forecasts behave well in the short term (5 years forward)
    - However, they fail to capture the true richness of the model in the long term (decades forward)
- Spectral analysis exposes the predominant yearly cycle in the number of chickenpox cases