LSHTM

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Time series graphics

1. Time plots
2. Seasonal plots
3. Seasonal polar plots
4. Seasonal subseries plots
5. Lag plots and autocorrelation

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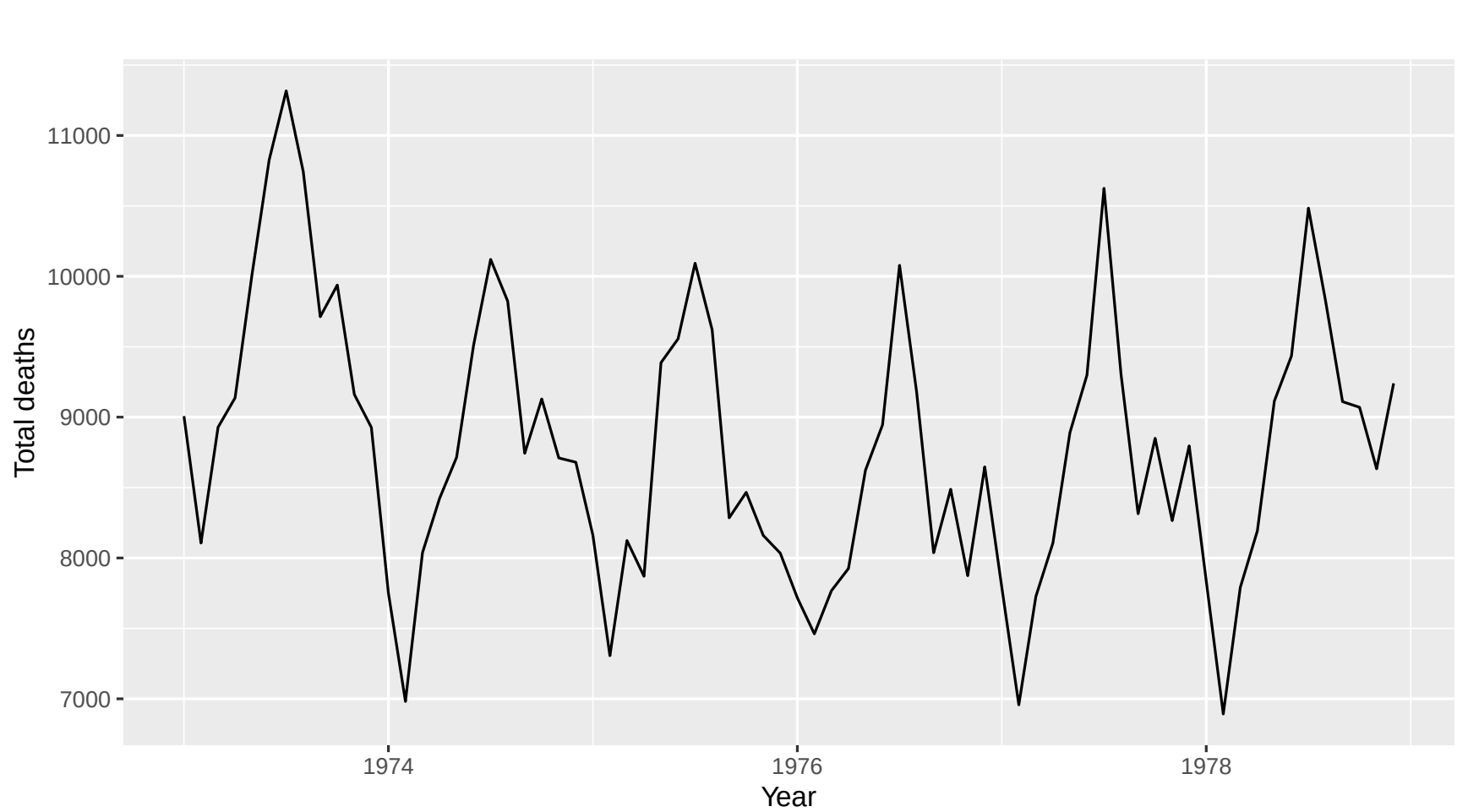
Time plots

```
autoplot(USAccDeaths) +
  ylab("Total deaths") + xlab("Year")
```



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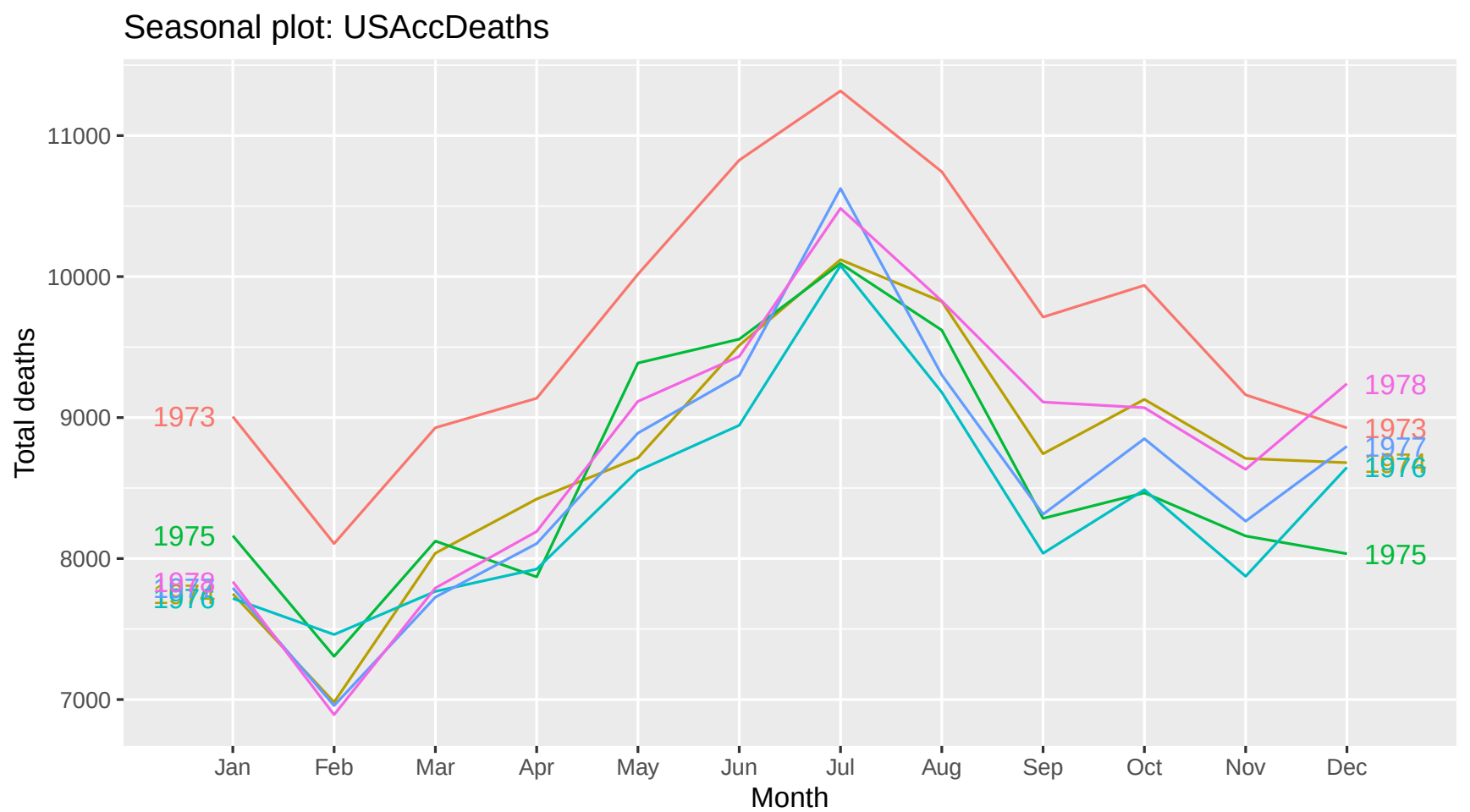
Seasonal plots

```
ggseasonplot(USAccDeaths, year.labels=TRUE,
  year.labels.left=TRUE) + ylab("Total deaths")
```



Seasonal plots

- Data plotted against the individual “seasons” in which the data were observed. (In this case a “season” is a month.)
- Something like a time plot except that the data from each season are overlapped.
- Enables the underlying seasonal pattern to be seen more clearly, and also allows any substantial departures from the seasonal pattern to be easily identified.
- In R: `ggseasonplot()`

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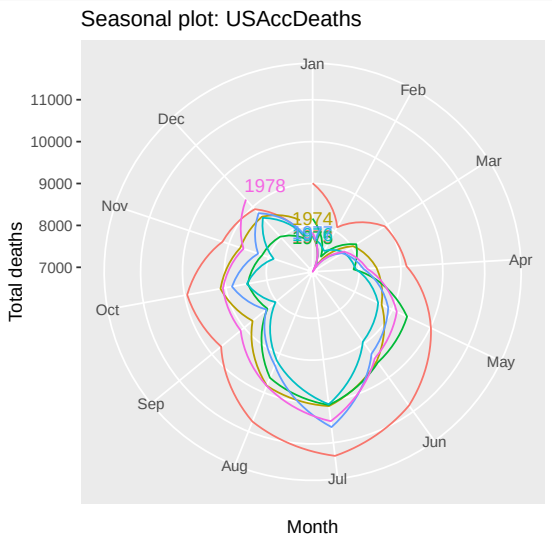
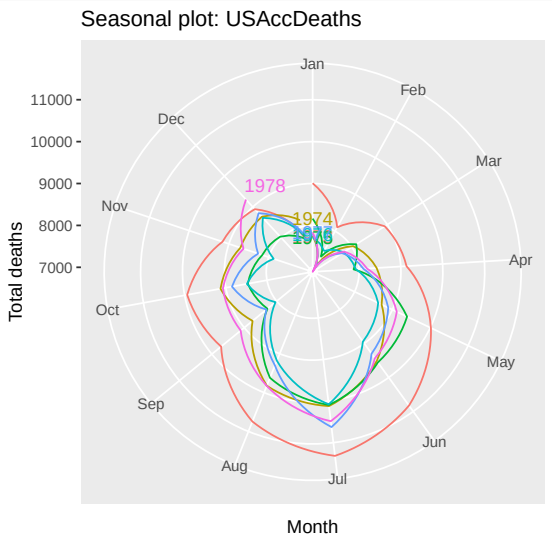
Seasonal polar plots

```
ggseasonplot(USAccDeaths, year.labels=TRUE,
  polar=TRUE) + ylab("Total deaths")
```



Seasonal polar plots

```
ggseasonplot(USAccDeaths, year.labels=TRUE,
  polar=TRUE) + ylab("Total deaths")
```



Only change is to switch to polar coordinates.

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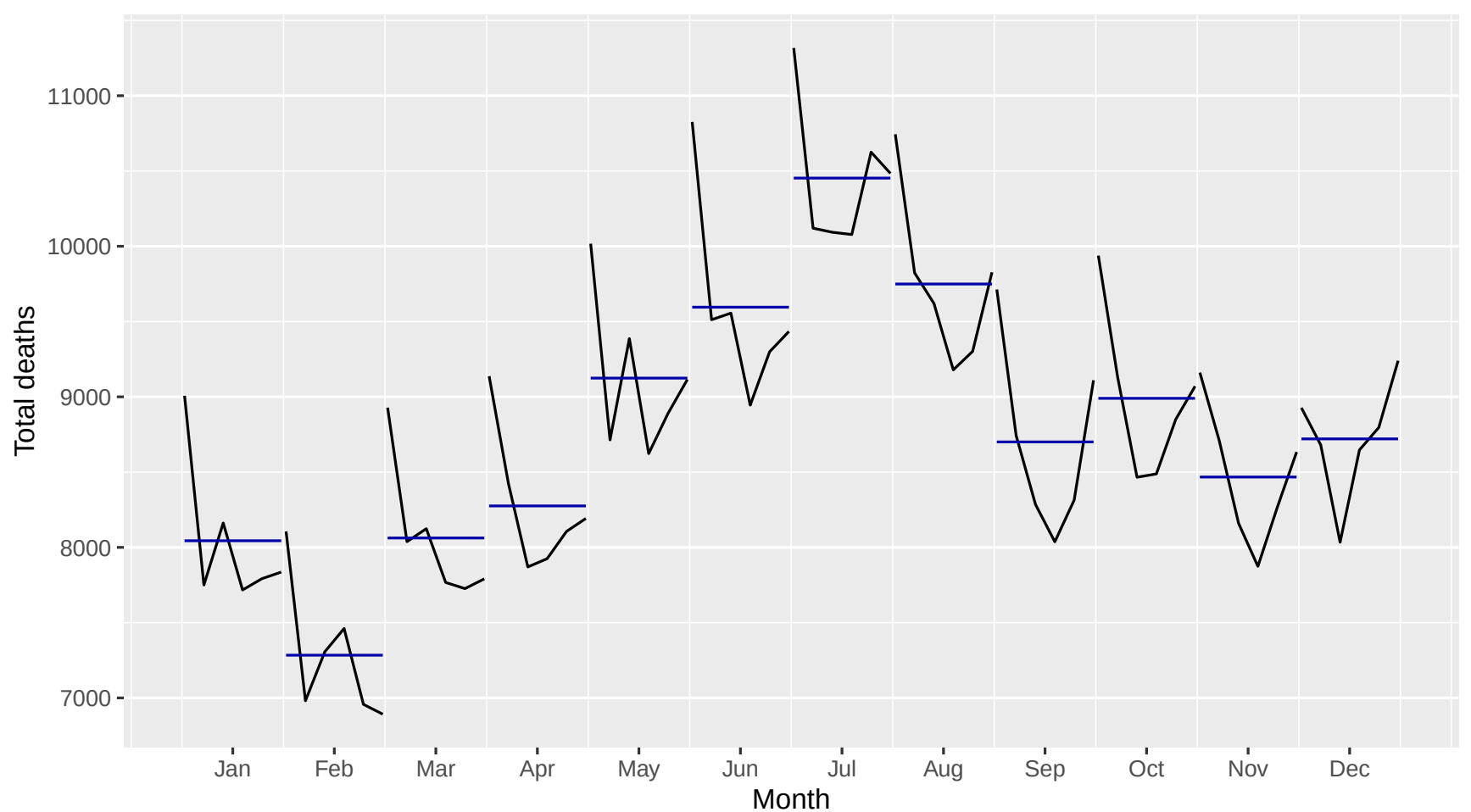
Seasonal subseries plots

```
ggsubseriesplot(USAccDeaths) +
  ylab("Total deaths")
```



Seasonal subseries plots

- Data for each season collected together in time plot as separate time series.
- Enables the underlying seasonal pattern to be seen clearly, and changes in seasonality over time to be visualized.
- In R: `ggsubseriesplot()`

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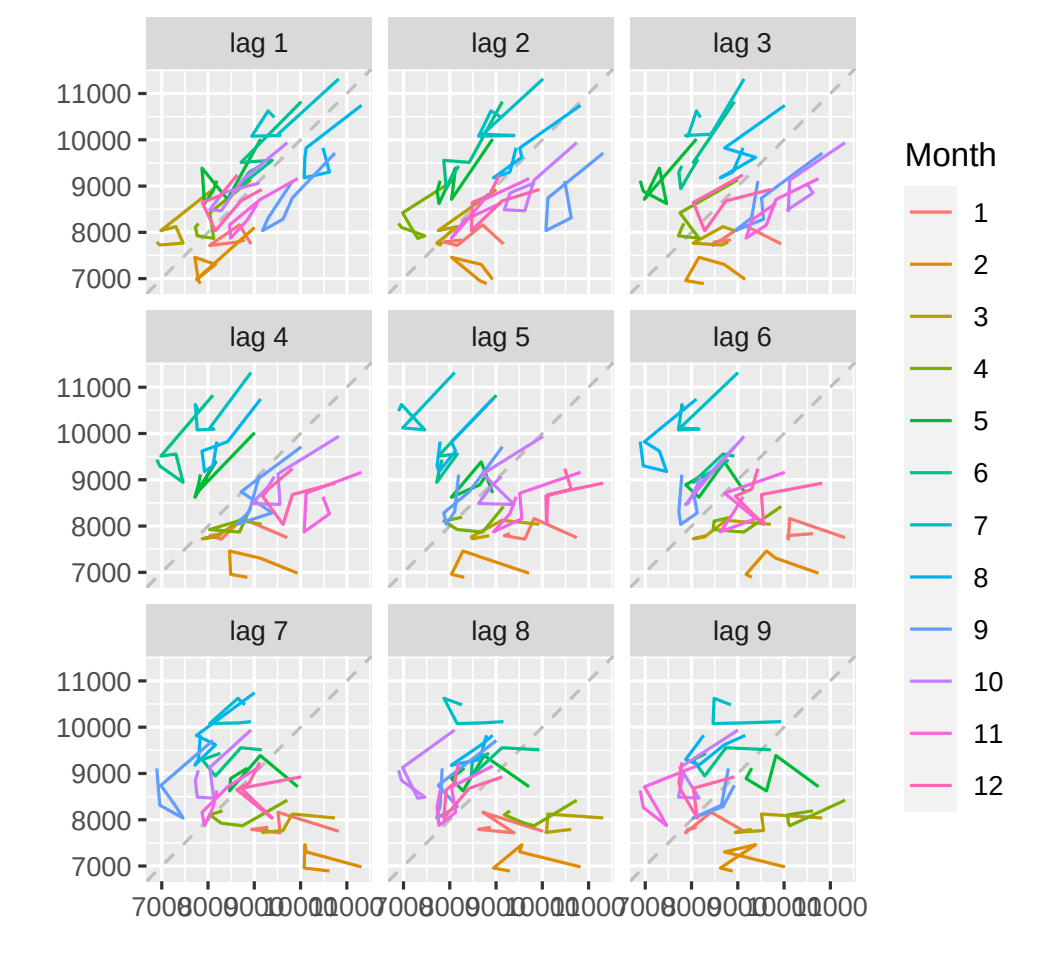
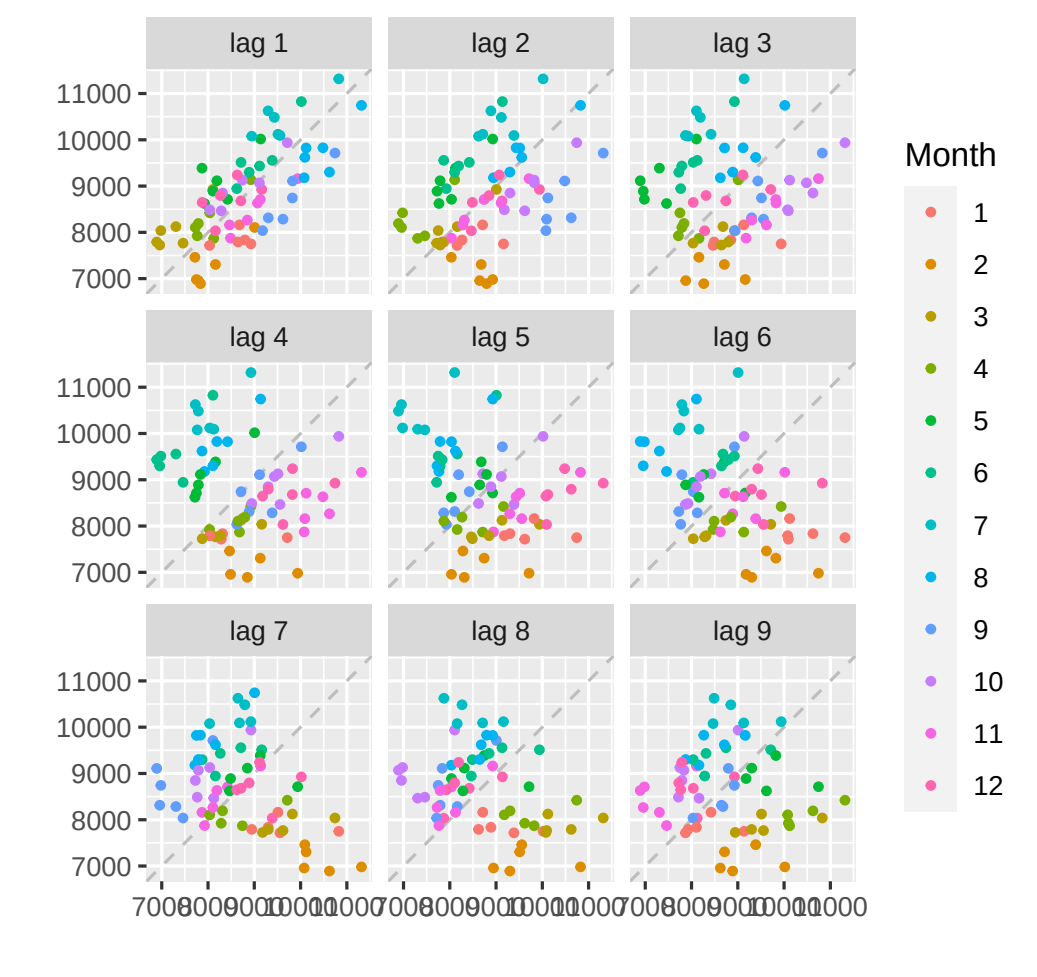
Lagged scatterplots

```
gglagplot(USAccDeaths, lags=9)
```



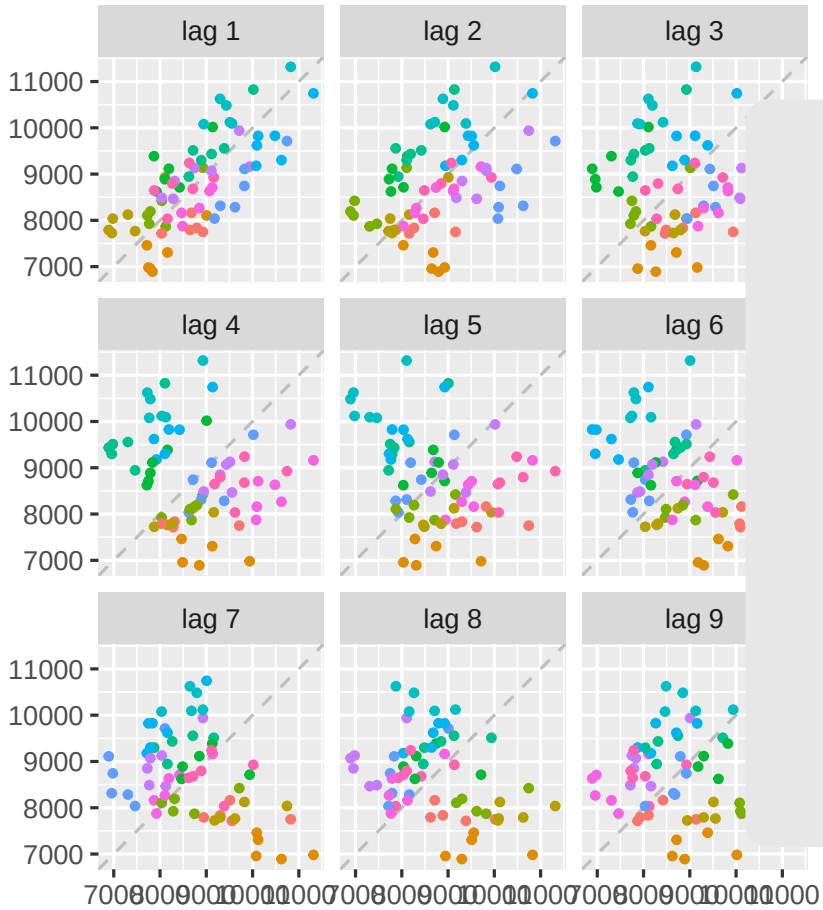
Lagged scatterplots

```
gglagplot(USAccDeaths, lags=9, do.lines=FALSE)
```



Lagged scatterplots

```
gglagplot(USAccDeaths, lags=9, do.lines=FALSE)
```



- Each graph shows y_t plotted against y_{t-k} for different values of k.
- Autocorrelations are correlations associated with these scatterplots.

Autocorrelation

We denote the sample autocovariance at lag k by c_k and the sample autocorrelation at lag k by r_k. Then define

$$c_k = \frac{1}{T}\sum_{t=k+1}^{T}(y_t - \bar{y})(y_{t-k} - \bar{y})$$

and $$r_k = c_k/c_0$$

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$$c_k = \frac{1}{T}\sum_{t=k+1}^{T}(y_t - \bar{y})(y_{t-k} - \bar{y})$$

and $$r_k = c_k/c_0$$

- r_1 indicates how successive values of y relate to each other
- r_2 indicates how y values two periods apart relate to each other
- r_k is *almost* the same as the sample correlation between y_t and y_{t-k}.

Autocorrelation

Results for first 9 lags for `USAccDeaths` data:

r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9
0.707	0.409	0.084	-0.182	-0.294	-0.423	-0.346	-0.285	-0.065

```
ggAcf(USAccDeaths)
```