# Monash

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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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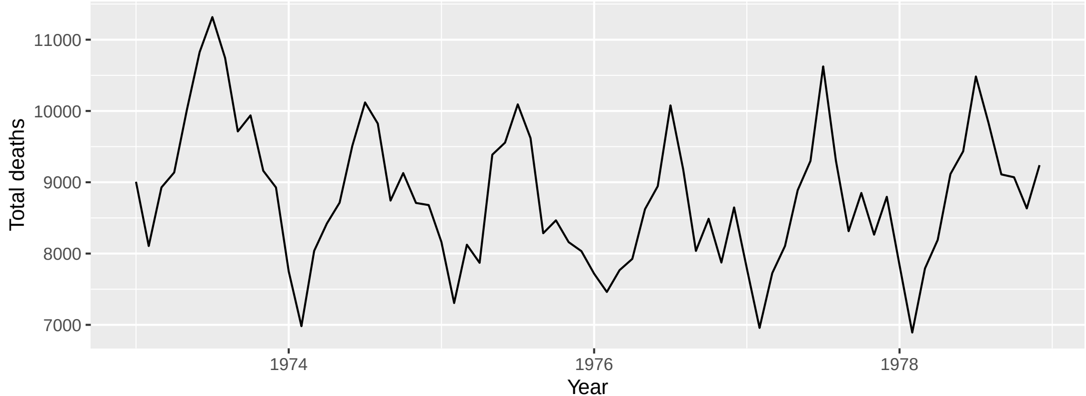
# Time plots

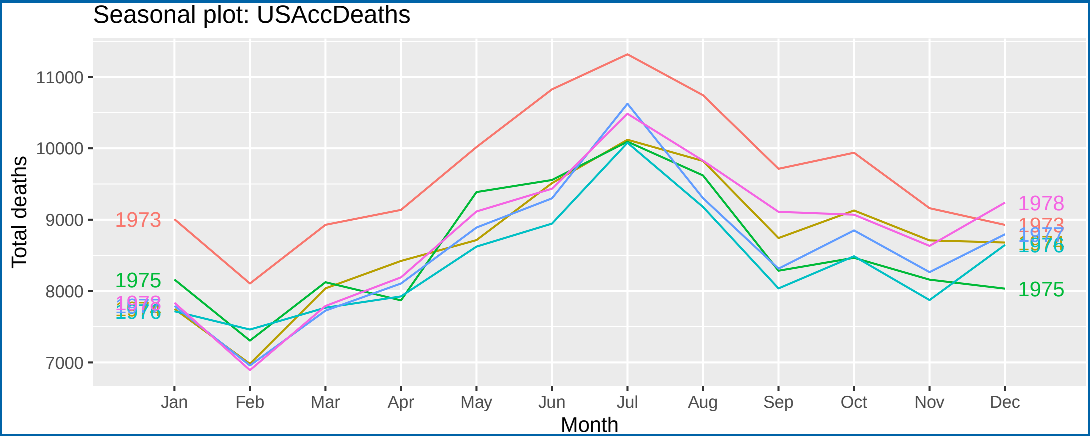
```r
autoplot(USAccDeaths) +
  ylab("Total deaths") + xlab("Year")
```



# Time series graphics

# Seasonal plots

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



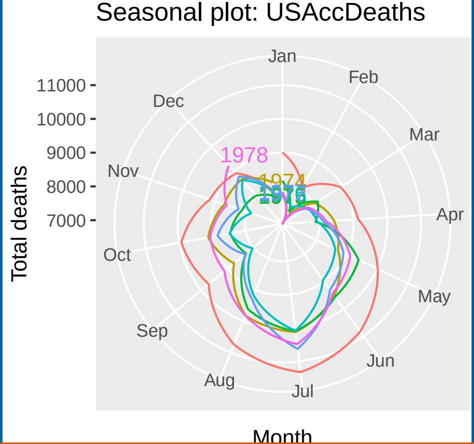
## Seasonal plots

- 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()`

# Time series graphics

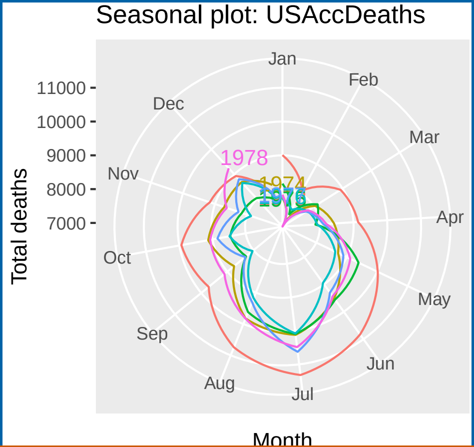
# Seasonal polar plots

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



# Seasonal polar plots

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

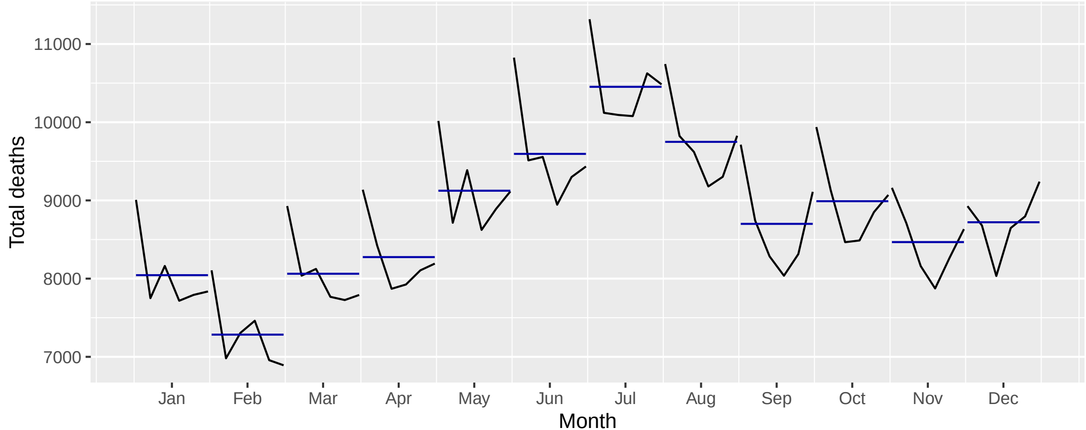



Only change is to switch to polar coordinates.

# Time series graphics

# Seasonal subseries plots

```r
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()`

# Time series graphics

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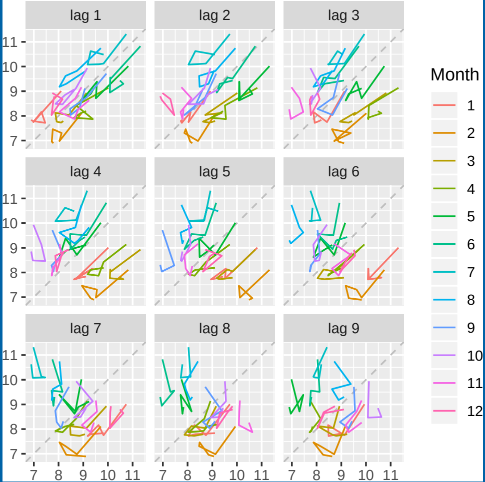
5 Lag plots and autocorrelation

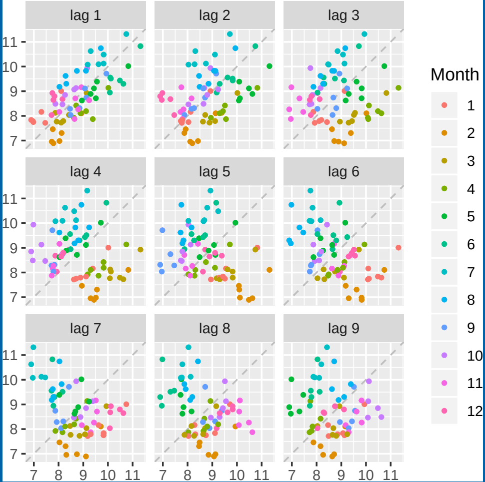
# Lagged scatterplots

```r
gglagplot(USAccDeaths/1000, lags=9)
```



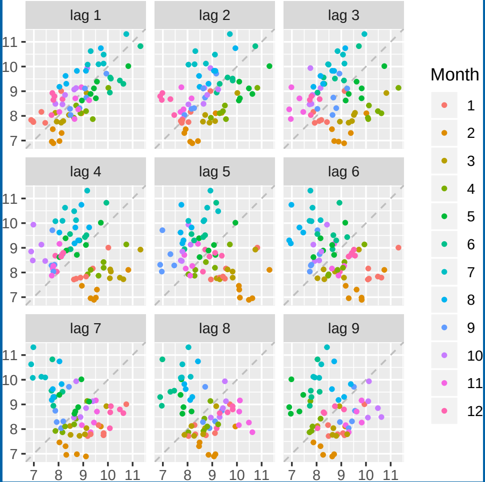
# Lagged scatterplots

```
gglagplot(USAccDeaths/1000, lags=9, do.lines=FALSE)
```



# Lagged scatterplots

```r
gglagplot(USAccDeaths/1000, 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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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 |

```r
ggAcf(USAccDeaths)
```