8.6 Exercise: Time Series for a single variable

In this exercise we will use iNZight to create time series plots.

The skills addressed are:

1. Generate a Time Series plot and a Seasonal plot for a single numeric variable
2. Get additive and multiplicative decompositions
3. Make a forecast

[*iNZight Lite version* *linked here*]

Breaking … R version]

INSTRUCTIONS

Follow the instructions below to generate the graphs. Or you may prefer to **print the instructions**. If you have any problems during this exercise, scroll down to **Common questions**.

Load the **week8_AverageVisitorsQuarterly** dataset into iNZight using **File > Example data …**. You will find the data set in **Module (package)** *FutureLearn*.

Generate a Time Series plot and a Seasonal plot for a single numeric variable

The data we are using shows us the number of visitors from different countries who are currently staying in New Zealand. We will investigate the changes in the number of Australian visitors over time.

- Click the **Advanced** drop down menu in the top row
- Select **Time Series**.
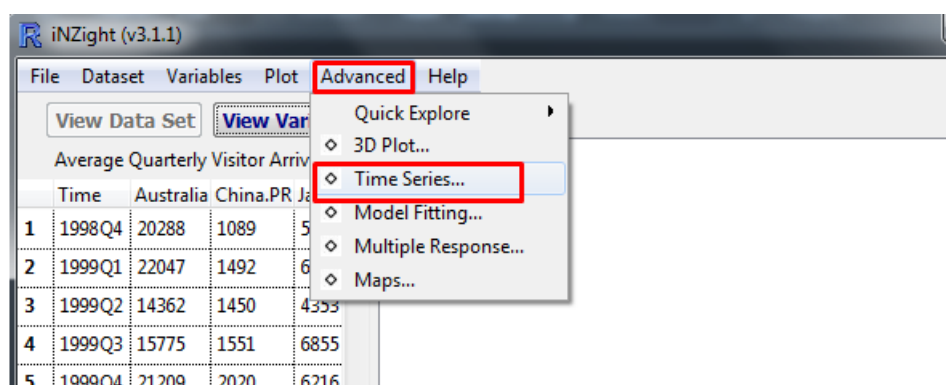
A new window will open. This window is all you need to use iNZight's Time Series capabilities.
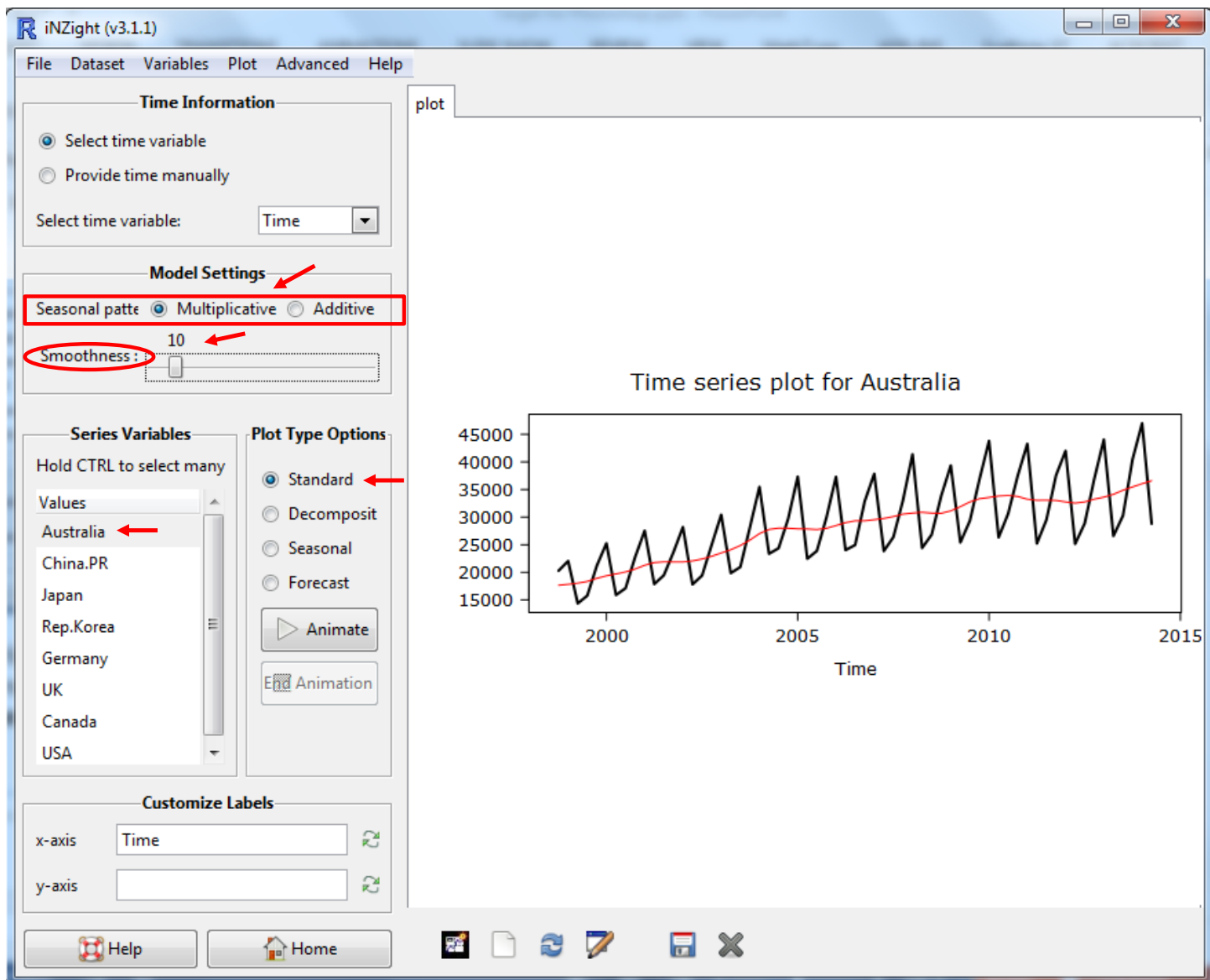
The first variable in the data set (*Time*) is in a format that iNZight recognises automatically – this is quarterly data over years. ***So iNZight automatically plots the second column (Australia).*** Notice some settings. By default the **Seasonal pattern** has been set to *multiplicative*, the **smoothness** to 10, and the **Plot type** to a *standard* time series plot.

- Click on/select ***Australia*** and then use the down and up arrows to look at each country in turn. Click on Australia again
- Use the smoothness slider to change the smoothness settings. Stop on or near 20. (For fine control, click on the slider handle and use the left and right arrow keys to move it)
- Click on each of the Plot type radio buttons to see what each produces

The Time Series plot suggests that there is a basic pattern that repeats every year. To have a better look at that pattern we can use a seasonal plot.
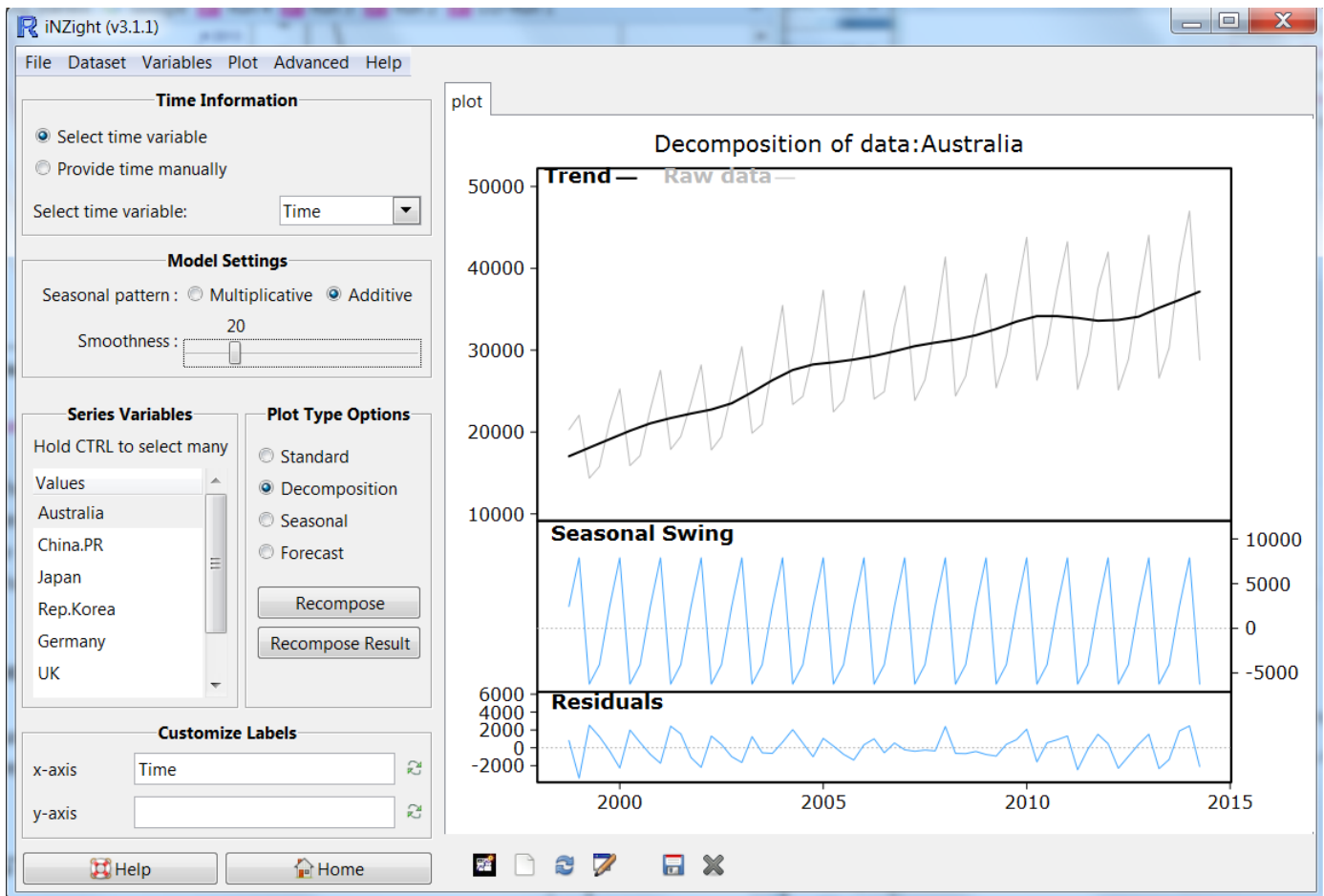
Seasonal Plots

- Under **Plot type** click *Seasonal* and for **Seasonal pattern** click *Additive*.
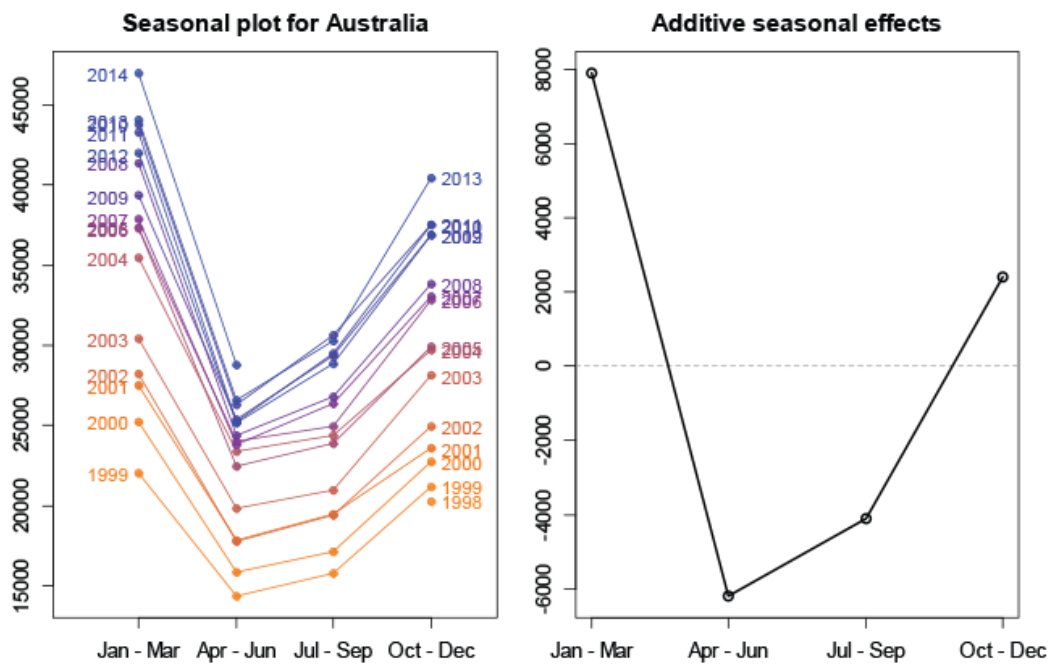
Above is the *additive* **Seasonal plot** for *Australia* on the left. It shows that we were right and there really are repeated seasonal effects. Is there more vertical movement in the seasonal swings higher up the plot? (That is what you would expect from multiplicative effects.)

Decomposition

- Stay on *Australia*, set **Plot type** to *Decomposition* and for **Seasonal pattern** keep *Additive*


- Now adjust **Smoothness** and see how the **Residuals** (bottom graphics panel) react.
- . On **Seasonal pattern** click between the *Multiplicative* and *Additive* options. Which better summarizes what you see in the data?
- For the additive plot, the residuals tend to be small in the middle and large toward the edges. Why do you think this is?

The upper part of the decomposition plot above shows the normal Time Series plot as before. Below that is the additive **Seasonal Swing**, which is a repeat of the *Additive seasonal effects* from before. The **Residuals** are the differences between the **Raw data** values and the predictions you would get by adding the **Seasonal Swing**s to the **Trend**.

- To view those predictions plot, click on **Recompose Result.**
  - If the bottom button says *Re-decompose* click on it twice
  - "Recompose" sets off an animation which might be slow. On Windows you can stop it by clicking on **Recompose Result** and it will "skip to the answer".

Recomposed data:Australia
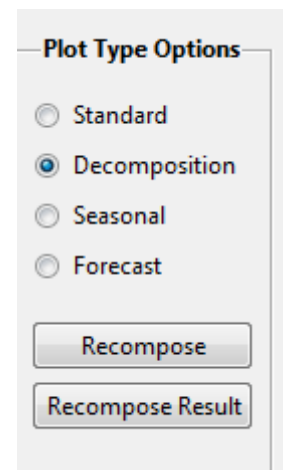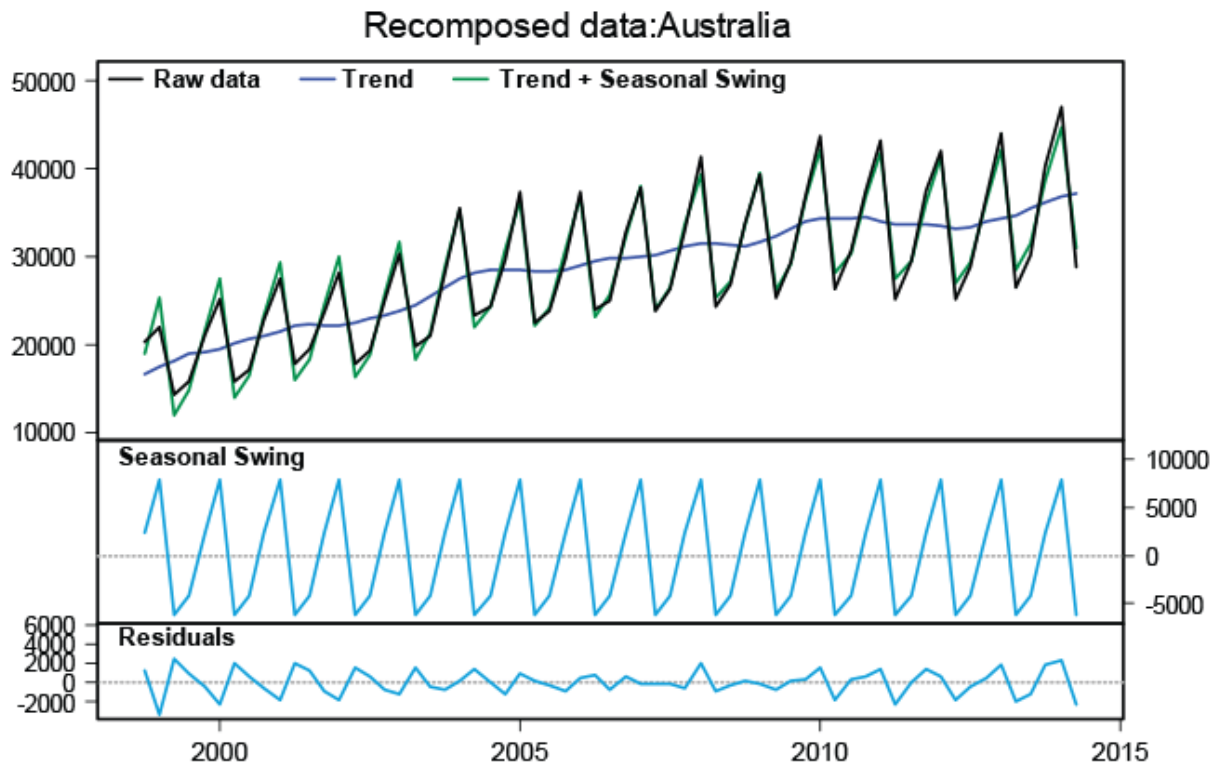
In the recompose animation:
(*Windows users should only attempt this in dual windows mode. Otherwise it will be slow and jerky*.)

First the **Seasonal Swing** gets added to the **Trend** curve. The resulting green line shows what would be expected (the predictions) if the seasonal patterns are assumed to be exactly the same every year and get added to the trend. When you further add the **Residuals** you get back the **Raw data**, which is shown in black here.

Obtain a Forecast for Australian visitor numbers

We want to know how many visitors from Australia will be in New Zealand in the upcoming years.

- Stay on *Australia* and set **Plot type** to *Forecast*.

Holt-Winters Additive prediction for Australia
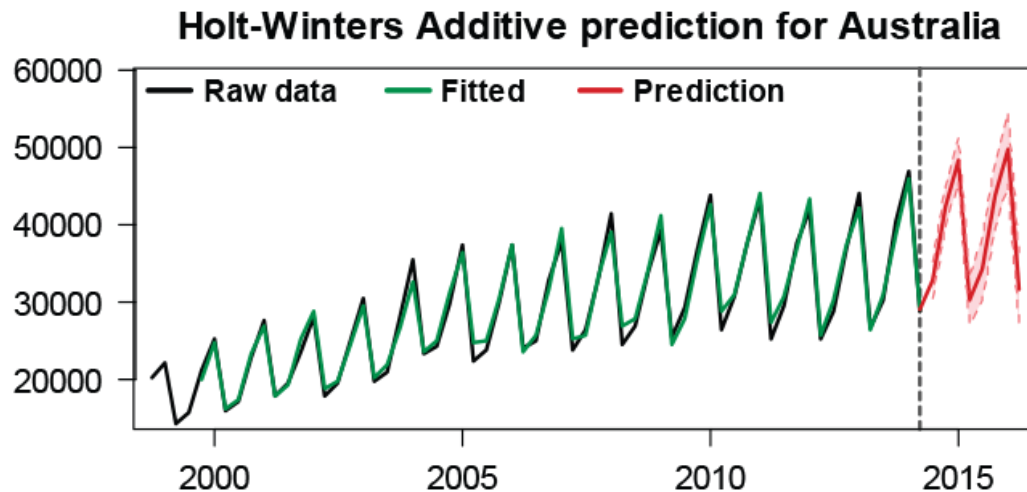
- To get the forecast numbers, now click on the **Forecasted Values.**

```
R Forecast Output

              fit       upr       lwr
2014 Q3  32908.25  35266.72  30549.77
2014 Q4  42338.50  44981.36  39695.65
2015 Q1  48343.00  51257.16  45428.84
2015 Q2  30212.13  33388.27  27035.99
2015 Q3  34325.19  38364.99  30285.39
2015 Q4  43755.45  48009.71  39501.18
2016 Q1  49759.94  54229.05  45290.83
2016 Q2  31629.07  36313.62  26944.52
```

What is happening in the graphics window?

In additional to the original Time Series plot you see an estimate of trend+seasonal effect which are ten projected forwards to give predictions for the next two years (on the right hand side) in red. The light red area around the dark prediction line is a confidence band about these predictions. The predicted values are calculated with the Holt-Winters method.

Explore (~5min)
Try to get the forecast for Australia with a Multiplicative Seasonal Swing. Which forecast is more reliable in this case?