Fitting a trend line and forecasting

Monday, 23 March 2020   12:09 PM

★ By the end of the lesson I would hope that you have an understanding and be able to apply to questions the following concepts:

- How to fit a trend line to data
- How to forecast by using a trend line
- How to forecast by taking seasonality into account
- How to make predictions with deseasonalised data

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RECAP

This is the last lesson in this series of videos dealing with Data Analysis.
We have spent a lot of time working with time series.
Now it's time to bring it all together with the theory from past lessons.
You have (so far) learned about Regression Analysis and Least Squares regression lines.
We have looked at the idea of interpolation and extrapolation and how we use the line of best fit to help predict values.
We have looked at smoothing and why it's important.

Just when we thought it was safe to return ... they have gone and changed the language on us again!

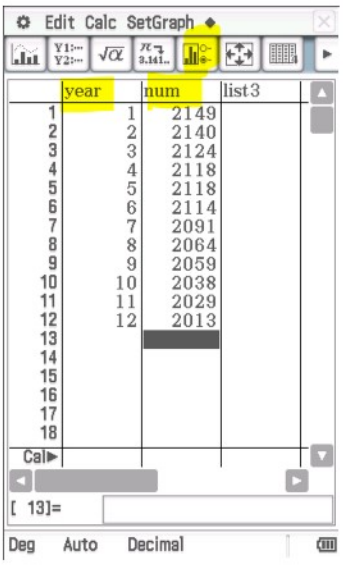
Fitting a trend line

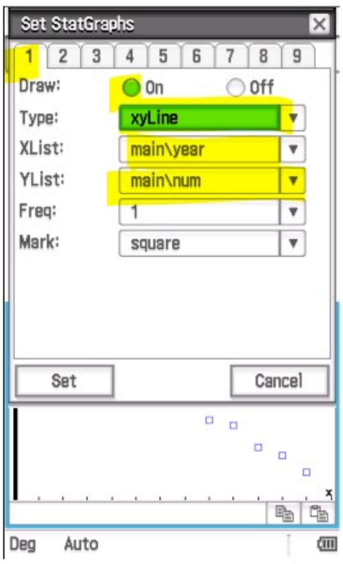
Fitting a trend line to time-series data is no different from what we have been doing before.
Remember, a trend line is nothing more than a least-squares regression line fitted to the data.
We can show how to do this again with an example from the Cambridge Further Maths Units 3 and 4 textbook.

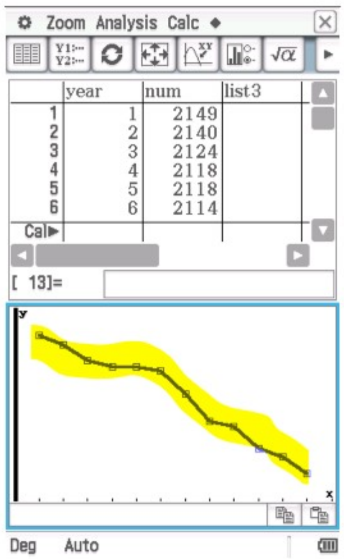
Fit a trend line to the data in the following table, which shows the number of government schools in Victoria over the period 1981–92, and interpret the slope.

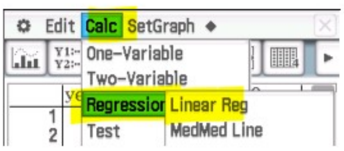
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Number	2149	2140	2124	2118	2118	2114	2091	2064	2059	2038	2029	2013

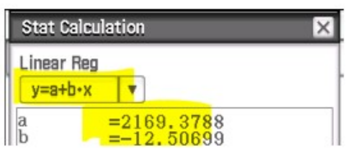
We know that we can use the CAS to help us do most of the hard work.
Screen shots will be taken and explained.

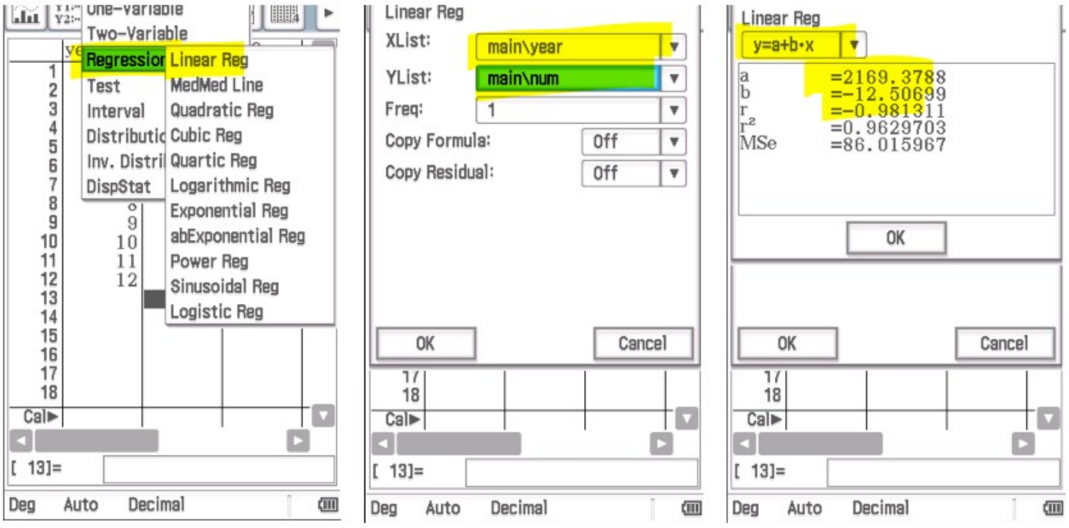








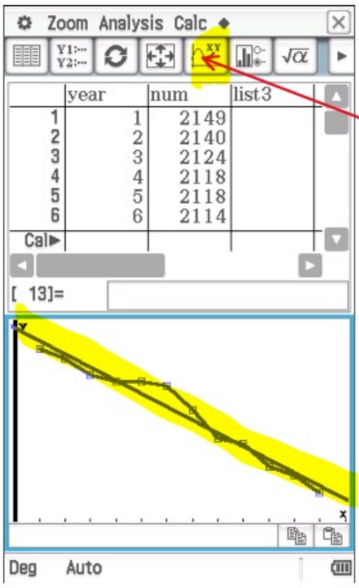




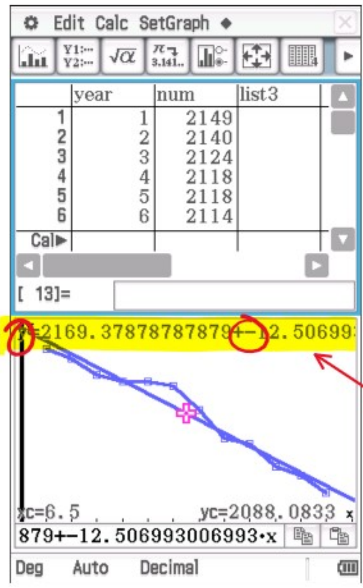
Hence we can now see the least squares regression line to help us predict values would be:

$$number = 2169 - 12.5 \times year$$

We can also show this information on the graph.
When we click OK, the line of best fit will be shown.
You can also show its equation.



Click this button



Here is the line of best fit

Remember, we need to ensure we interpret the slope!

Hence, for every 1 year increase, we see that the number of government schools in Victoria ***decreased*** *by* ***12.5****.*

Note: You do not say decrease by -12.5 schools. It makes no sense!

-12.5

→ 1 year decrease of 12.5

Forecasting

This is simply the method by which we use the trend line (least squares regression line) to predict values.
Notice how, once again, Maths uses more than one term to explain the same thing.

Hence, using the above example, if we wanted to know how many schools there might be in 2015, then we would use the equation above.

2015

$$number = 2169 - 12.5 \times year$$

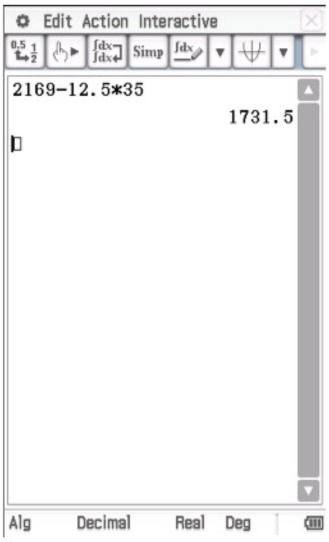
1 2 3 4 5 .

$$number = 2169 - 12.5 \times year$$

Warning Will Robinson

You need to be careful! The year in the above equation is NOT THE YEAR!
Remember, we called 1981 as Year 1.
Hence, we need to look at what number 2015 would be.
Time to use our fingers and toes!

As it happens, 2015 is the 35th year.
We use this value in our equation to **forecast** which is another word for predict.



$$number = 2169 - 12.5 \times 35$$

$$number = 1732$$

This is an example where you would need to round up the value.
It checks that we have understood the reasonableness of the answer.

Forecasting taking seasonality into account

When the data is known to be seasonal, we need to remove the effects of seasonality and then look for trends.
This would require us to **deseasonalise** the data.

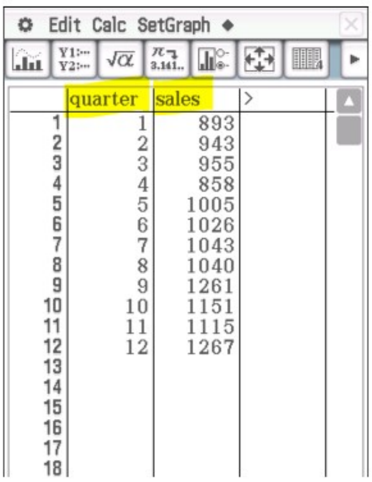
Let's use another example from Cambridge.

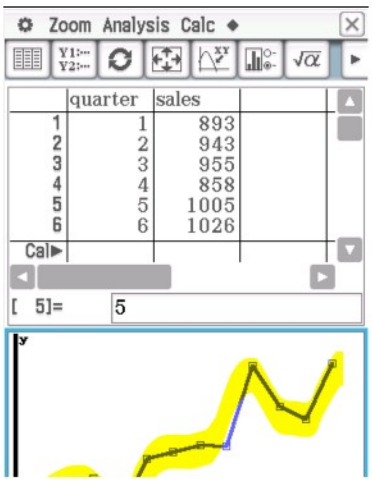
The **deseasonalised** quarterly sales data from Mikki's shop are shown below.

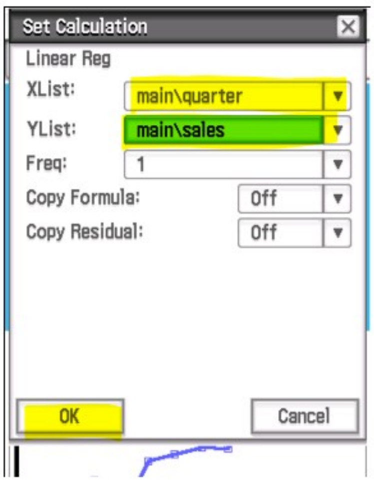
Quarter	1	2	3	4	5	6	7	8	9	10	11	12
Sales	893	943	955	858	1005	1026	1043	1040	1261	1151	1115	1267

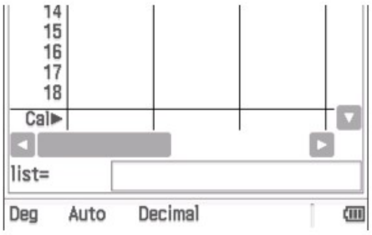
Fit a trend line and interpret the slope.

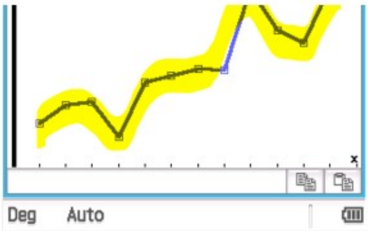
Once again, let's use the CAS.

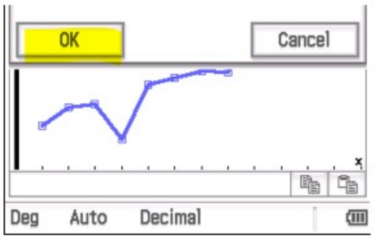


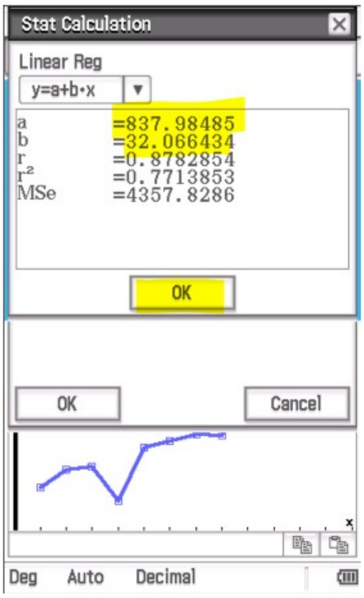


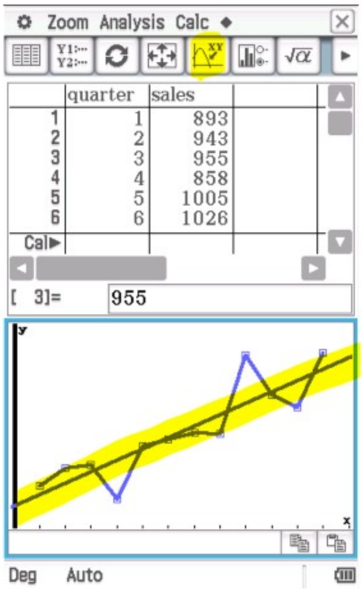


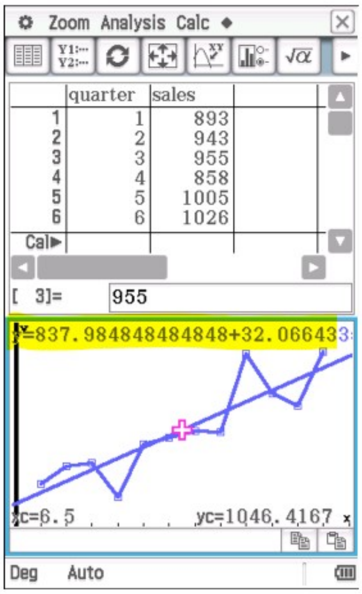












Hence, reading from the dialog box above, or from the line on the graph, we see that we have:

$$sales = 838 + 32.1 \times quarter$$

Now we can interpret the slope:

Over the three year period the sales increased at an average rate of 32 sales per quarter.

Making predictions with deseasonalised data

Much like we did previously, once I have an equation of a trend line, we can use it to predict values.

What sales do we predict for Mikki's shop in the winter of Year 4?

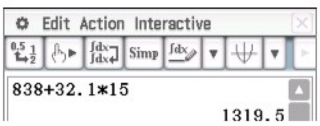
Quarter	1	2	3	4	5	6	7	8	9	10	11	12
Sales	893	943	955	858	1005	1026	1043	1040	1261	1151	1115	1267

We need to be careful (once again) that we use the appropriate value for quarter.
Let's assume the first quarter was **Summer in Year 1**

$$sales = 838 + 32.1 \times quarter$$

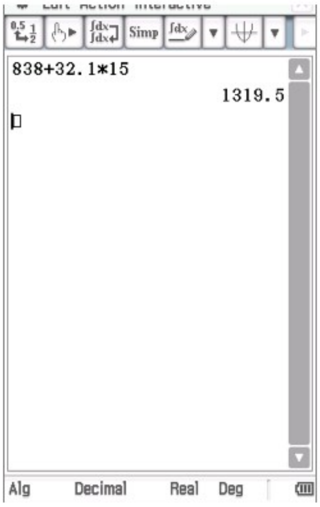
Year	1	1	1	1	2	2	2	2	3	3	3	3	4	4	**4**	4
Quarter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	**15**	16
Sales	893	943	955	858	1005	1026	1043	1040	1261	1151	1115	1267	??	??	**??**	??

So, this means the quarter is numbered 15.



$$sales = 838 + 32.1 \times 15$$

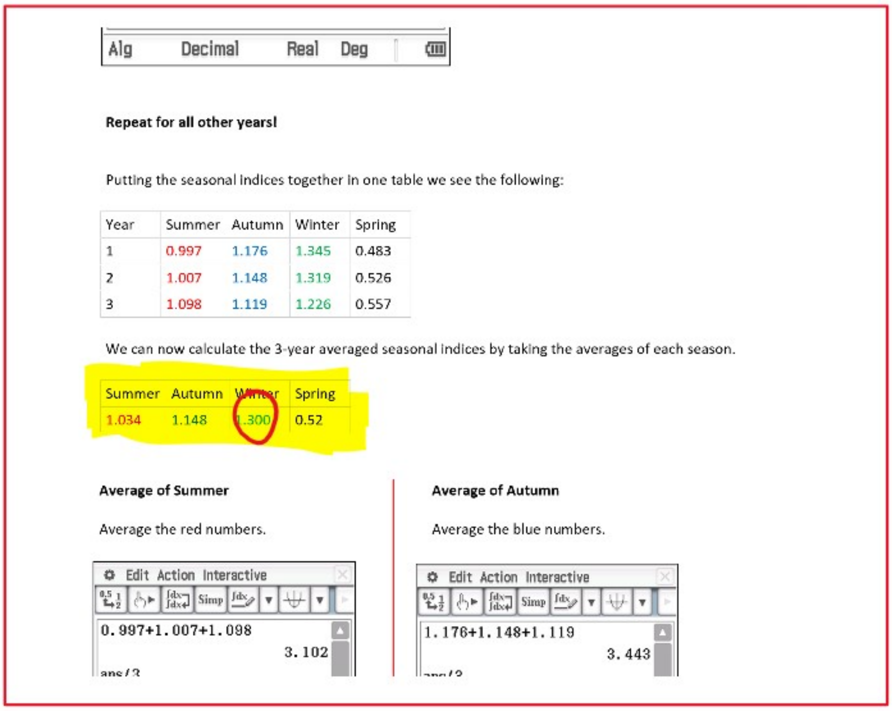
$$sales = 1319.5$$



$sales = 838 + 32.1 \times 15$

$sales = 1319.5$

Remember that this is the deasonalised value. We need to turn it back to the seasonal value. We found out the seasonal indices in a previous lesson.



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Repeat for all other years!

Putting the seasonal indices together in one table we see the following:

Year	Summer	Autumn	Winter	Spring
1	0.997	1.176	1.345	0.483
2	1.007	1.148	1.319	0.526
3	1.098	1.119	1.226	0.557

We can now calculate the 3-year averaged seasonal indices by taking the averages of each season.

Summer	Autumn	Winter	Spring
1.034	1.148	1.300	0.52

Average of Summer

Average the red numbers.

0.997+1.007+1.098

3.102

ans/3

Average of Autumn

Average the blue numbers.

1.176+1.148+1.119

3.443

ans/3

So, using the formula which states:

1.3

$$actual\ figure = (deseasonalised\ figure) \times seasonal\ index$$

So …

$$actual\ figure = 1319.5 \times 1.30$$

$$actual\ figure = 1715$$