Seasonal Indices

Teachers Teaching with Technology™
Professional Development from Texas Instruments

Student Activity

7 8 9 10 11 **12**

TI-Nspire™ | Investigation | Student | 50 min

Teacher Notes:

The purpose of this activity is to provide students with a simple opportunity to use the de-seasonalising data Widget. It removes the multitude of calculations so that students can focus on:

- What the process does to the data (smoothing)
- Generate the corresponding regression equation and use it to forecast future values

VCE General Mathematics

Area of Study 1 – Data Analysis: Investigating and modelling time series data

Seasonal adjustment including the use and interpretation of seasonal indices and their calculation using seasonal and yearly means. [Pg 85]

Modelling trend by fitting a least squares line to a time series with time as the explanatory variable (data de-seasonalised where necessary), and the use of the model to make forecasts (with re-seasonalisation where necessary) including consideration of the possible limitations of fitting a linear model and the limitations of extending into the future. [Pg 86]

Key Skills:

- Identify key qualitative features of a time series plot including trend (using smoothing if necessary), seasonality, irregular fluctuations and outliers, and interpret these in the context of the data
- Calculate, interpret and apply seasonal indices.

Lesson Notes

Students will need access to the "Deseasonalising" widget. This file can be downloaded from the Texas Instruments Australia website. To transfer the file from a computer to a students' calculator, use the TI-Nspire teacher software or the web-browser tool: https://nspireconnect.ti.com/nsc/

Instructions on how to install the widget: https://youtu.be/RNVXXNSkXaM

Author: P. Fox

Sundae Gelateria – Where every day should be a Sundae

Sundae is a gelato shop with clear seasonal swings: huge summer crowds and quieter winters. Management recorded total cups sold per season for **three consecutive years** and wants a forecast for next year (2025).

The historical data is as follows:

Season	2022	2023	2024	
Summer	5,200	5,600	6,000	
Autumn	3,000	3,200	3,400	
Winter	1,800	1,900	2,000	
Spring	3,600	3,800	4,000	
Annual Averages:				

The current manager, Ms Trishincé, decides to forecast the 2025 sales using linear regression. She uses summer 2022 as the first data point (t = 1) and spring 2024 as the last (t = 12).

Question: 1.

Use your calculator to determine the corresponding linear regression equation and corresponding correlation coefficient (r^2).

Answer: Equation: $y = 17.83x + 3409.1$ Correlation coefficient: $r^2 = 0.0018$

Question: 2.

Trishincé uses her equation to predict the sales for 2025. Determine the predicted sales for each season and comment on the predictions.

Answer: Summer = 3640, Autumn = 3659, Winter = 3677 and Spring = 3694.

The predictions are very poor. Example: The actual summer results: 5200, 5600 and 6000 are all substantially higher than the predicted value (3640) and were trending upward. The r^2 value is very low, indicating there is no correlation. The linear regression model does not consider the seasonality of the data.

One of Sundae's workers, Pietro, watched a video tutorial about seasonalised and deseasonalised data and learnt that this approach can be used to smooth and improve forecasting.

Scan the QR code to watch the video:

Question: 3.

Compute the seasonal indices for summer, autumn, winter and spring.

Answer: These calculations can be done manually or by using the Widget. When doing the calculations by hand, be careful with rounding! When using the widget, ensure appropriate rounding settings are included in the Notes application. The data should be entered into a list, then specify the number of cycles when running the program.

Using the widget:

The data can be transposed to match the table preference:

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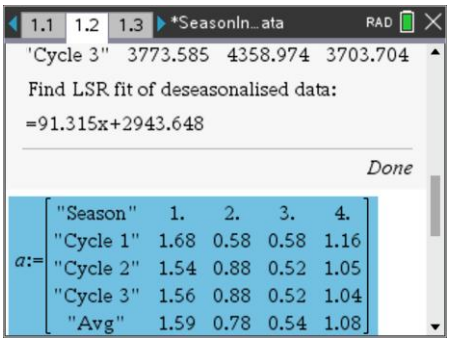
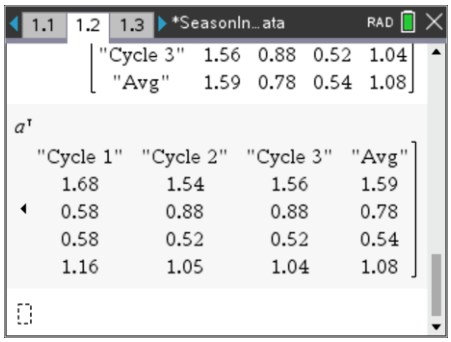


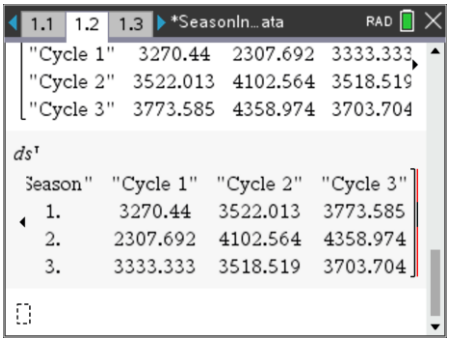


Question: 4.

Deseasonalise the data using these indices.

Answer: Again, these calculations can be done manually, watch for compounding rounding errors.

The matrix has been transposed to match the format for the table.

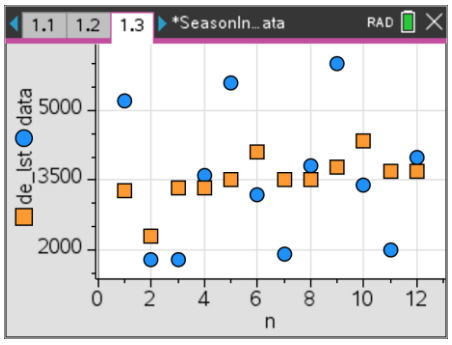


Question: 5.

Graph the original data and deseasonalised data and comment on the two graphs.

Answer: Graph generated using the Widget data.

The deseasonalised data is more *consistent* or *smoothed*, making it much easier to see the trend.



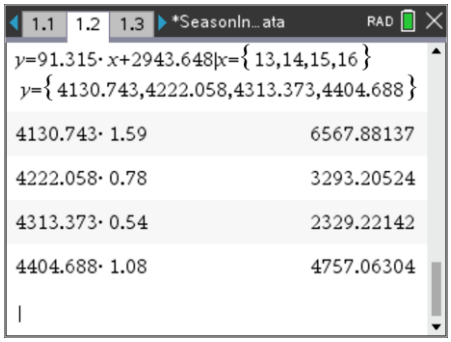
Question: 6.

Use linear regression to determine a linear function that best models the resultant data, then use the equation to forecast actual sales for 2025.

Answer: Regression Equation: $y = 91.315x + 2943.648$

The linear regression equation can be copied and pasted, then substitute the list of values: {13 … 16}
The results must be converted using the seasonal indices. This produces the 2025 sales forecast:

Summer: 6567.9
Autumn: 3293.2
Winter: 2329.2
Spring: 4757.1



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Question: 7.

Which approach: Trishincé's or Pietro's provides the most likely sales predictions for 2025?

Answer: Whilst it is impossible to predict the future, based on the data, the most likely outcomes (sales) align with Pietro's predictions. The predictable cyclic rise and fall of the original data means directly applying a linear regression model (Trishincé's predictions) won't work. By first smoothing the data (Pietro's approach), the linear regression provides a better option, however the predictions need to be converted back (seasonalised) so as to reflect the cyclic rise and fall of the sales.

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