



Stat 401 B – Lecture 23



Home Gas Consumption

- Interaction?
- Should there be a different slope for the relationship between Gas and Temp after insulation than before insulation?


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Home gas consumption

- Create a new explanatory variable.
- Temp*Insul
- This will allow for possibly different relationships between Gas and Temp.

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Interaction Model

- Predicted Gas = $6.854 - 0.3932 \cdot \text{Temp} - 2.263 \cdot \text{Insul} + 0.1436 \cdot \text{Temp} \cdot \text{Insul}$
- $R^2 = 0.936$, 93.6% of the variation in gas consumption can be explained by the interaction model with Temp, Insul and Temp*Insul.

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Un-Insulated House

- Predicted Gas = $6.854 - 0.3932 \cdot \text{Temp} - 2.263 \cdot \text{Insul} + 0.1436 \cdot \text{Temp} \cdot \text{Insul}$
- Insul = 0
- Predicted Gas = $6.854 - 0.3932 \cdot \text{Temp}$

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Interpretation

- For an un-insulated house (Insul = 0) when the average outside temperature is 0 °C, the predicted amount of gas used is 6.854 (1000 cubic feet).


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Interpretation

- Holding Insul constant at 0 (an un-insulated house), gas consumption drops, on average, 393.2 cubic feet for every 1 °C increase in average outside temperature.

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Insulated House

- Predicted Gas = $6.854 - 0.3932 \cdot \text{Temp} - 2.263 \cdot \text{Insul} + 0.1436 \cdot \text{Temp} \cdot \text{Insul}$
- Insul = 1
- Predicted Gas = $4.591 - 0.2496 \cdot \text{Temp}$


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Interpretation

- For an insulated house (Insul = 1) when the average outside temperature is 0 °C, the predicted amount of gas used is 4.591 (1000 cubic feet).

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Interpretation

- Holding Insul constant at 1 (an insulated house), gas consumption drops, on average, 249.6 cubic feet for every 1 °C increase in average outside temperature.

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Summary

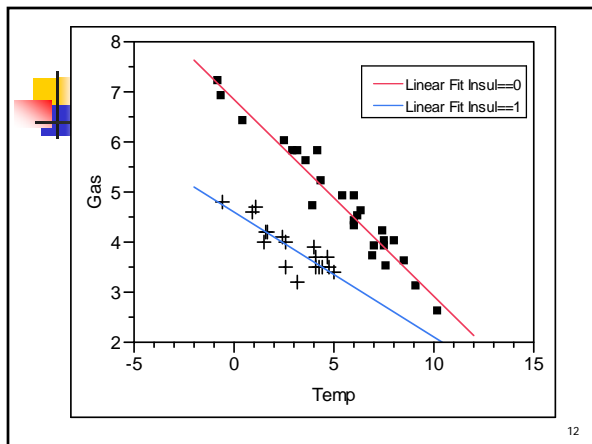
- Before adding insulation, there is a higher predicted gas use when $\text{Temp} = 0^\circ\text{C}$ and a steeper average decline for every 1°C increase in outdoor temperature.

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Summary


- After adding insulation, there is a lower predicted gas use when $\text{Temp} = 0^\circ\text{C}$ and a slower average decline for every 1°C increase in outdoor temperature.

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Statistical Significance

- Model Utility
 - $F = 194.77$, $P\text{-value} < 0.0001$
- The model with Temp and Insul is useful. The P-value for the test of model utility is very small.
- $RMSE = 0.270$


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Statistical Significance

- Temp
 - $t = -20.93$, $P\text{-value} < 0.0001$
- Because the P-value is small, Temp adds significantly to the model with Insul.

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Statistical Significance

- Insul
 - $t = -13.10$, $P\text{-value} < 0.0001$
- Because the P-value is small, Insul adds significantly to the

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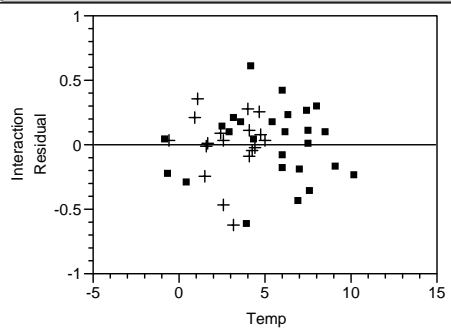
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Statistical Significance

- Temp*Insul (Interaction)
 - $t = 3.22$, P-value = 0.0025
- Because the P-value is small, there is a statistically significant interaction between Temp and Insul

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Bivariate Fit of Interaction Residual By Temp




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Statistical Significance

- Temperature by itself is statistically significant.
- Adding the dummy variable for insulation adds significantly.
- Adding the interaction term adds significantly.

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Change in R²

- Temp: R² = 32.8%
- Temp, Insul: R² = 91.9%
- Temp, Insul, Temp*Insul: R² = 32.8%
- Each change is statistically significant.


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Interaction Model

- The interaction model prediction equation can be split into two separate prediction equations by substituting in the two values for Insul (0 and 1).

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Two separate regressions.

- Suppose instead of a multiple regression model with interaction we fit a simple linear regression for the un-insulated house and separate simple linear regression for the insulated house?

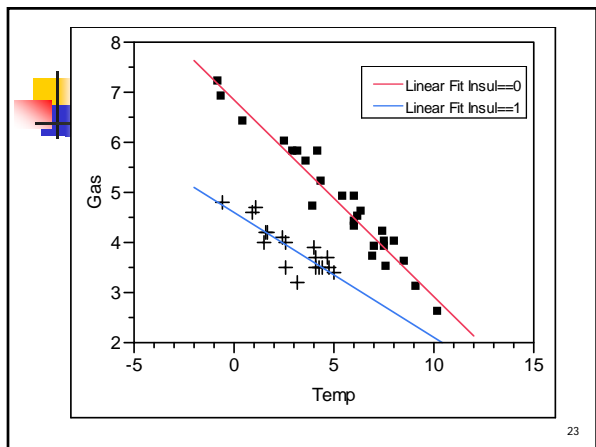
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JMP – Fit Y by X

- Put Gas in for the Y, Response.
- Put Temp in for the X, Factor.
- Click on OK
- Group by Insul
- Fit Line

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Before Insulation

- Predicted Gas = $6.854 - 0.3932 \cdot \text{Temp}$
- $R^2 = 0.944$
- RMSE = 0.281
- Statistically significant
 - $t = -20.08$, P-value < 0.0001


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 **After Insulation**


- Predicted Gas = $4.591 - 0.2496 \cdot \text{Temp}$
- $R^2 = 0.733$
- RMSE = 0.252
- Statistically significant
 - $t = -6.62$, P-value < 0.0001

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 **Comment**

- The prediction equations from the two separate models are exactly the same as the separate prediction equations from the interaction model.

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 **Comment**

- The interaction model pools all of the data together.
- The MS_{Error} for the interaction is actually the weighted average of the two MS_{Error} values for the two separate regressions.

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