# Stats 506: RECS 2015 and MouseTrap Analysis

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**Introduction to 2015 RECS**

The 2015 Residential Energy Consumption Survey breaks down and quantifies how the residents of this nation consumed energy in 2015. By analyzing this data, we can find patterns to understand the current trends of energy consumption and provide insight into large scale energy crises.

**PART A: National Average Winter Temperatures at Night**

*Average Winter Night Temp*

| Average Temp | Lower 95% | Upper 95% |
|---|---|---|
| 68.10518 | 67.92285 | 68.28751 |

We would have assumed that residents would set their temperatures higher during the winter season, but the table above shows that residents set their temperatures slightly around 68 degrees Fahrenheit. The 95% confidence interval doesn't significantly deviate from this temperature, suggesting that both northern and southern residents, despite the temperature differences between the areas during the winter, have similar temperatures at night.

**PART B: Proportions for Fuel Type**

*Fuel Type Prop per Division and Urban Type (Lower 95%, Mean, Upper 95%)*

| Division | Urban Type | Electricity | Fuel Oil/Kerosene | Natural | Other | Propane | Wood |
|---|---|---|---|---|---|---|---|
| East North Central | Rural | (19.41, 30.84, 42.27) | (0.00, 0.00, 0.00) | (31.21, 44.51, 57.81) | (0.00, 0.00, 0.00) | (6.49, 20.58, 34.67) | (1.74, 4.07, 6.4) |
| East North Central | Urban Area | (13.51, 17.79, 22.08) | (-0.44, 0.43, 1.3) | (75.88, 80.56, 85.24) | (0.00, 0.00, 0.00) | (-0.24, 0.48, 1.2) | (-0.06, 0.73, 1.52) |
| East North Central | Urban Cluster | (7.17, 14.78, 22.39) | (0.00, 0.00, 0.00) | (72.39, 81.85, 91.31) | (0.00, 0.00, 0.00) | (-1.24, 1.42, 4.09) | (-0.3, 1.95, 4.2) |
| East South Central | Rural | (43.66, 56.1, 68.54) | (-1.36, 1.12, 3.6) | (3.48, 16.58, 29.68) | (0.00, 0.00, 0.00) | (14.27, 19.24, 24.21) | (2.55, 6.95, 11.35) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| East South Central | Urban Area | (49.71, 64.14, 78.57) | (0.00, 0.00, 0.00) | (21.42, 35.86, 50.29) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) |
| East South Central | Urban Cluster | (52.33, 68.26, 84.19) | (-1.55, 0.7, 2.96) | (5.43, 24.72, 44.02) | (0.00, 0.00, 0.00) | (1.2, 6.31, 11.42) | (0.00, 0.00, 0.00) |
| Middle Atlantic | Rural | (1.7, 13.1, 24.5) | (17.77, 27.16, 36.55) | (1.64, 17.37, 33.1) | (1.51, 5.36, 9.21) | (4.64, 12.69, 20.74) | (18.59, 24.33, 30.07) |
| Middle Atlantic | Urban Area | (11.71, 16.02, 20.33) | (10.66, 15.93, 21.2) | (57.66, 65.76, 73.86) | (-0.15, 0.54, 1.23) | (-0.15, 1.2, 2.55) | (-0.08, 0.55, 1.18) |
| Middle Atlantic | Urban Cluster | (-1.97, 7.47, 16.92) | (0.84, 10.25, 19.65) | (44.16, 68.21, 92.27) | (0.00, 0.00, 0.00) | (-0.77, 5.54, 11.86) | (-6.16, 8.52, 23.2) |
| Mountain North | Rural | (-1.05, 14.34, 29.73) | (0.00, 0.00, 0.00) | (47.51, 61.07, 74.63) | (-1.05, 0.7, 2.44) | (5.56, 13.43, 21.31) | (5.51, 10.46, 15.41) |
| Mountain North | Urban Area | (5.89, 15.31, 24.73) | (0.00, 0.00, 0.00) | (73.29, 83.38, 93.47) | (0.00, 0.00, 0.00) | (-0.54, 0.67, 1.88) | (-0.73, 0.64, 2.01) |
| Mountain North | Urban Cluster | (2.23, 16.08, 29.93) | (0.00, 0.00, 0.00) | (70.07, 83.92, 97.77) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) |
| Mountain South | Rural | (-1.12, 12.18, 25.48) | (0.00, 0.00, 0.00) | (-13.51, 16.16, 45.83) | (0.00, 0.00, 0.00) | (29.74, 33.96, 38.19) | (12.95, 37.7, 62.46) |
| Mountain South | Urban Area | (25.66, 45.35, 65.04) | (0.00, 0.00, 0.00) | (34.2, 53.8, 73.4) | (0.00, 0.00, 0.00) | (-1.74, 0.85, 3.44) | (0.00, 0.00, 0.00) |
| Mountain South | Urban Cluster | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) | (100, 100, 100) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) |
| New England | Rural | (-0.16, 0.93, 2.02) | (49.29, 57.21, 65.14) | (-0.41, 0.43, 1.26) | (0.00, 0.00, 0.00) | (15.2, 20.77, 26.34) | (9.33, 20.67, 32.01) |
| New England | Urban Area | (5.94, 11.91, 17.88) | (15.46, 26.32, 37.18) | (41.42, 56.45, 71.48) | (0.00, 0.00, 0.00) | (-0.78, 3.01, 6.8) | (-0.38, 2.31, 5) |
| New England | Urban Cluster | (3.89, 8.95, 14.01) | (23.62, 46.66, 69.7) | (11.9, 36.99, 62.09) | (0.00, 0.00, 0.00) | (0.43, 3.08, 5.73) | (-1.7, 4.32, 10.35) |
| Pacific | Rural | (36.76, 49.54, 62.32) | (1.58, 5.1, 8.62) | (1.58, 4.85, 8.12) | (0.00, 0.00, 0.00) | (2.53, 18.44, 34.36) | (9.49, 22.07, 34.65) |
| Pacific | Urban Area | (25.4, 32.33, 39.26) | (-0.28, 0.24, 0.76) | (58.63, 65.85, 73.06) | (0.00, 0.00, 0.00) | (-0.12, 0.11, 0.34) | (0.6, 1.48, 2.36) |
| Pacific | Urban | (43.7, 63.05, | (0.00, 0.00, | (17.52, | (0.00, | (0.00, 0.00, | (-1.55, |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Cluster | 82.39) | 0.00) | 32.31, 47.1) | 0.00, 0.00) | 0.00) | 4.65, 10.84) |
| South Atlantic | Rural | (62.69, 70.99, 79.29) | (0.93, 5.01, 9.09) | (2.47, 8.7, 14.94) | (0.00, 0.00, 0.00) | (4.38, 8.93, 13.48) | (1.38, 6.36, 11.35) |
| South Atlantic | Urban Area | (49.85, 56.74, 63.63) | (1.58, 3.55, 5.52) | (28.84, 36.65, 44.46) | (0.00, 0.00, 0.00) | (0.3, 2.1, 3.9) | (0.28, 0.96, 1.64) |
| South Atlantic | Urban Cluster | (35.62, 61.12, 86.63) | (-1.55, 0.91, 3.37) | (7.01, 34.95, 62.89) | (0.00, 0.00, 0.00) | (-0.32, 3.02, 6.36) | (0.00, 0.00, 0.00) |
| West North Central | Rural | (18.29, 27.88, 37.47) | (-0.15, 1.61, 3.37) | (11.51, 24.2, 36.89) | (0.00, 0.00, 0.00) | (19.34, 29.8, 40.26) | (11.28, 16.52, 21.75) |
| West North Central | Urban Area | (12.78, 21.2, 29.62) | (0.00, 0.00, 0.00) | (68.91, 77.29, 85.67) | (0.00, 0.00, 0.00) | (0.13, 1.51, 2.89) | (0.00, 0.00, 0.00) |
| West North Central | Urban Cluster | (4.62, 14.9, 25.18) | (-1.46, 0.76, 2.98) | (66.8, 80.01, 93.22) | (-1.67, 1.63, 4.94) | (-0.48, 2.7, 5.87) | (0.00, 0.00, 0.00) |
| West South Central | Rural | (40.29, 51.72, 63.15) | (0.00, 0.00, 0.00) | (16.94, 26.72, 36.51) | (0.00, 0.00, 0.00) | (7.89, 15.1, 22.3) | (2.04, 6.46, 10.88) |
| West South Central | Urban Area | (47.86, 55.9, 63.93) | (0.00, 0.00, 0.00) | (35.97, 43.88, 51.79) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) | (-0.19, 0.22, 0.63) |
| West South Central | Urban Cluster | (43.36, 56.24, 69.12) | (0.00, 0.00, 0.00) | (30.88, 43.76, 56.64) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) | (0.00, 0.00, 0.00) |

Most residents use electricity as their fuel source with natural gas as the second most common. The other sources are quite rare and only really feature in rural urban types and Mountain divisions. Even with those specific areas, the named fuel sources effectively cover all the types of fuel that are used.

## PART C: Average Temperatures at Night, Day when home, Day when gone by Division and Urban Type



Average Temperatures By Region Division and Urban Type
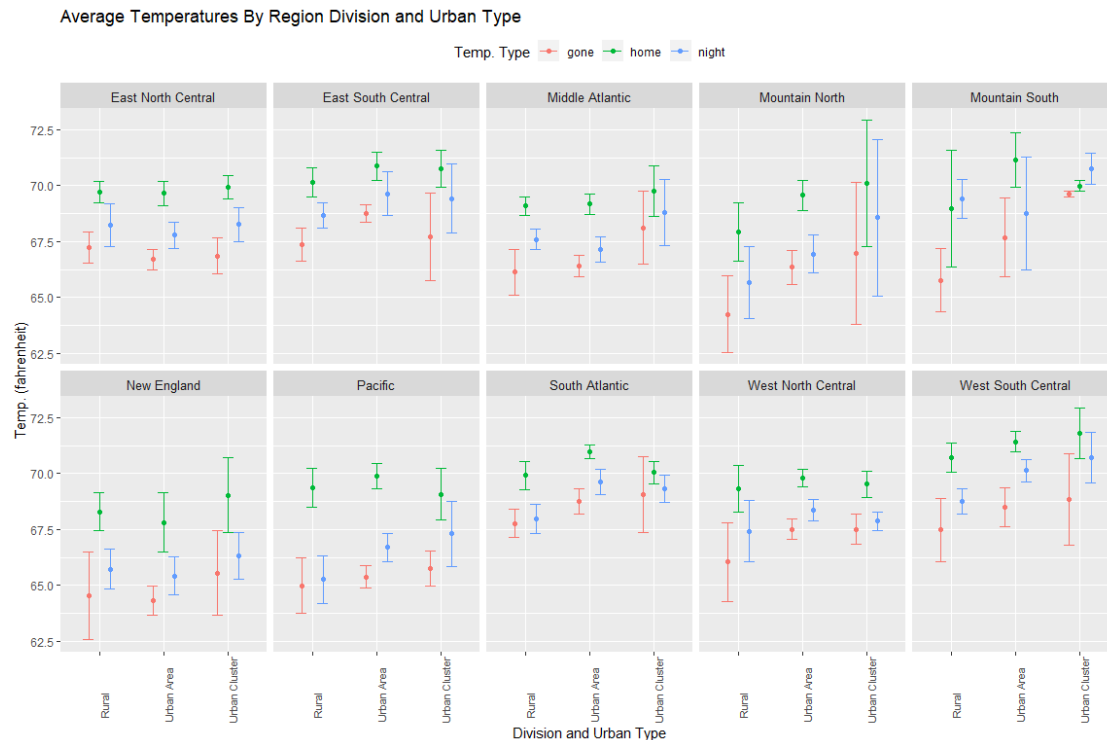
Throughout all the different divisions and urban types, the average temperatures during the day when residents are gone are the lowest and during the day when residents are home are the highest, with temperatures during the night inbetween the two values. Mountain North, Mountain South, and New England have the widest 95% confidence intervals and likely have the greatest variance in average temperatures. We should be careful to put too much weight into these interpretations, though, since the region of average temperatures is contained within 10 degrees and does not seem as dramatic when viewed on a greater range of temperatures.

## PART D: Median Difference between Day and Night Temperatures

*Median Difference Between Day and Night Temperatures (Fahrenheit)*

| Equip Behavior | Lower 95% | Median Diff | Upper 95% |
|---|---|---|---|
| As needed | 1.5917517 | 2 | 2.408248 |
| Automatically adjust | 3.0000000 | 3 | 3.000000 |
| Manually adjust | 2.0000000 | 2 | 2.000000 |
| No control | -3.3911650 | 0 | 3.391165 |
| Other | -0.7080128 | 2 | 4.708013 |
| Set and leave | 0.0000000 | 0 | 0.000000 |

Residents tend to set the day temperature higher than the night temperature, only by a few degrees if at all. The equipment behaviors with minimal adjustment have no variance in the median difference while the ones with more adjustment had greater variance. Behaviors "No Control" and "Other" were the only ones that had 95% confidence intervals that include negative differences, meaning that these are behaviors most likely to have night temperatures greater than day temperatures.

**Introduction to MouseTrap**

Previously, we looked at how the change in position over time could quantify hesitation. Using this quantification, we can model this hesitation variable along with other variables in order to make meaningful conclusions about the data.


**Modeling Metrics on Condition**

As a demonstration, we are modeling the 4 separate metrics; which will be calculated from the x positions, y positions, and times provided by MouseTrap data; based on the fixed effect 'Condition' with random effects 'Subject' and 'Exemplar'. Since each metric will be in different units, we are modeling the log(metrics), so that we can compare values between them. Below is a table and plot of the condition beta estimates along with their standard errors.

*Beta Estimates for Metrics*

| Metrics | Beta Estimate | Std Error |
|---|---|---|
| Total Distance | -0.1613490 | 0.0388355 |
| Area Under Curve | -0.4964514 | 0.1199342 |
| Max Deviation | -0.5100794 | 0.1180273 |
| Average Deviation | -0.6511473 | 0.1356371 |
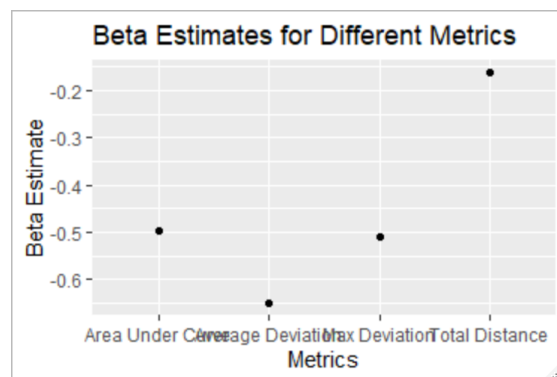


Since the model was taken of the log(metrics), we can directly compare the beta estimates to understand how greatly 'Condition' affects the 4 metrics. The least negative beta estimate will have the greatest effect on the metric, so 'Condition' has the greatest affect on 'Total Distance'.