Can We Trust the 10th Day of the 10-Day Forecast?

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The Questions

1. In Salt Lake City, is the 7th day of the local KSL weather forecast more accurate than the 7th day of the forecast provided by The Weather Channel?
2. Of the cities Salt Lake City, UT; Austin, TX; San Francisco, CA; New York, NY; and Chicago, IL; which city's 10th forecast day is, on average, closest to the actual temperature that day?
3. Does the city with the "most accurate" forecast according to question 2 also have the least variability in temperature over the month of March?

Forecast Data

We collected 10 days of forecast data twice a day from March 12th to April 9th in the following cities:

- Salt Lake City, UT (KSL and The Weather Channel)
- Austin, TX
- San Francisco, CA
- New York, NY
- Chicago, IL

These cities were chosen because they are large metropolitan areas, and because they have relatively different climates. We figured that the national algorithm would probably provide its most accurate service to large cities, and it would be another question entirely to consider small towns.

Data was collected at 7:00am and 5:00pm Mountain Time. We understand that this is systematic and not random, but since forecasts are only updated periodically, we have captured the updates.

Weather Data

- Weather data was collected from NOAA
- Similar methods to those of Assignment 3
- Mostly airport stations
- Kaveat: This data is not collected randomly, but periodically.
- All tests will be performed with 95% confidence level.

Question 1: In Salt Lake City, is the seventh day of the local KSL weather forecast more accurate than the seventh day of the forecast provided by The Weather Channel?

The null hypothesis is given as follows:

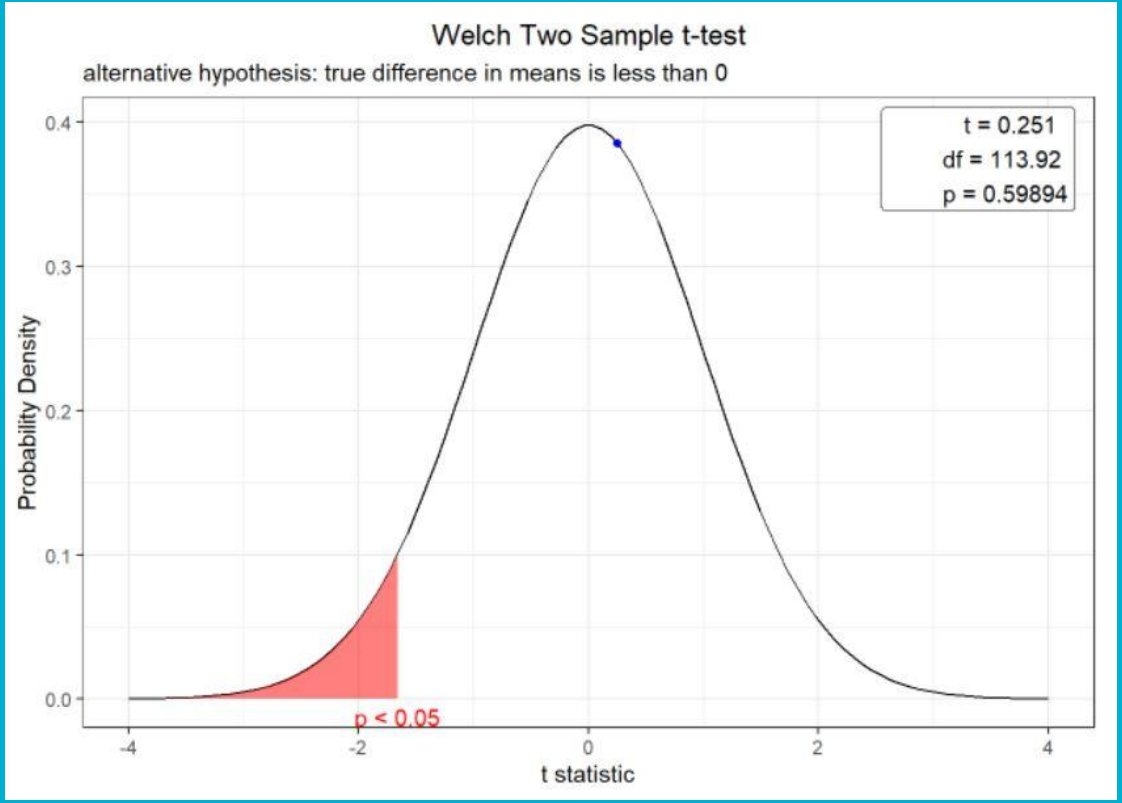
$$H_0 : \bar{x}_{KSLerr} - \bar{x}_{WCHNerr} >= 0$$
$$H_a : \bar{x}_{KSLerr} - \bar{x}_{WCHNerr} < 0$$

Welch Two Sample t-test:

```
##
##  Welch Two Sample t-test
##
## data:  c(abs(KSL_lo_forecast_diff), abs(KSL_hi_forecast_diff)) and c(abs(SLC_lo_forecast_diff), abs(SLC_hi_forecast_dif
f))
## t = 0.25118, df = 113.92, p-value = 0.5989
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##      -Inf 1.179661
## sample estimates:
## mean of x mean of y
##  4.379310  4.224138
```

We do not reject H_0

Question 1: The T-Distribution and Summary



Based on 95% confidence intervals for the average error of both services on forecasted highs and lows, we obtained the following additional results:

KSL Highs Error:
- (-0.0465912, 3.8396947)

KSL Lows Error:
- (-1.444113, 2.892389)

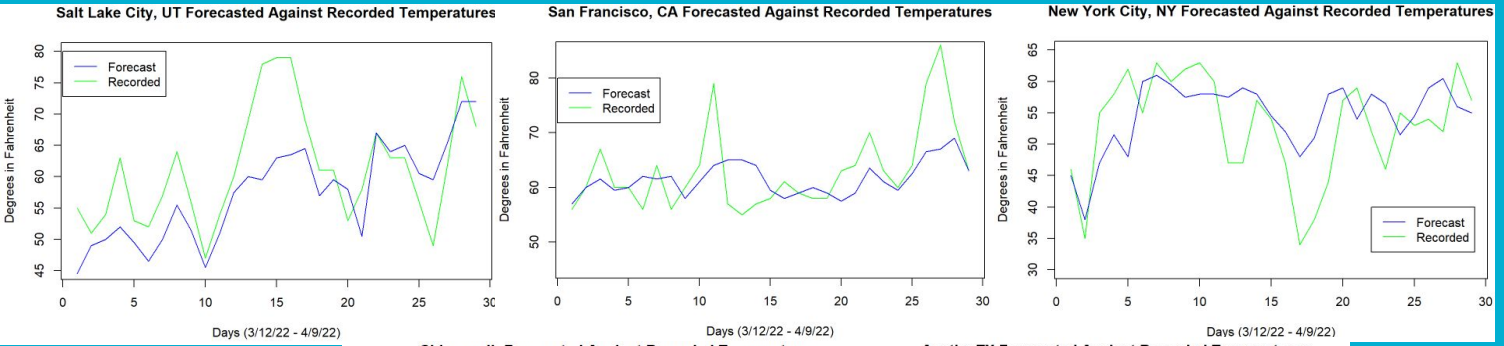
The Weather Channel Highs Error:
- (0.01022684, 4.05873868)

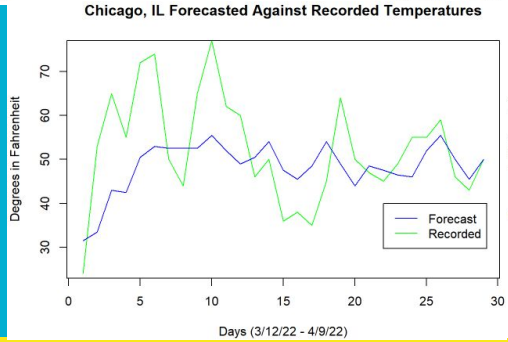
The Weather Channel Lows Error:
- (-2.155442, 1.741649)

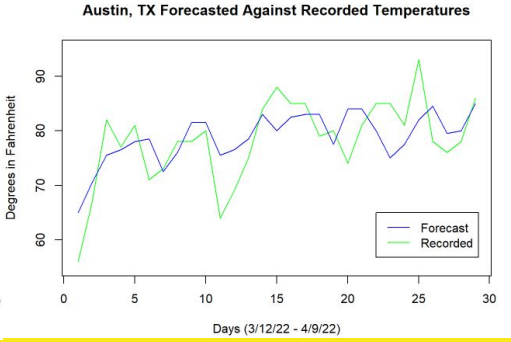
Note: $T_{Error} = T_{Predicted} - T_{Actual}$

Question 2: Of the cities Salt Lake City, UT; Austin, TX; San Francisco, CA; New York, NY; and Chicago, IL; which city's 10th forecast day is, on average, closest to the actual temperature that day?

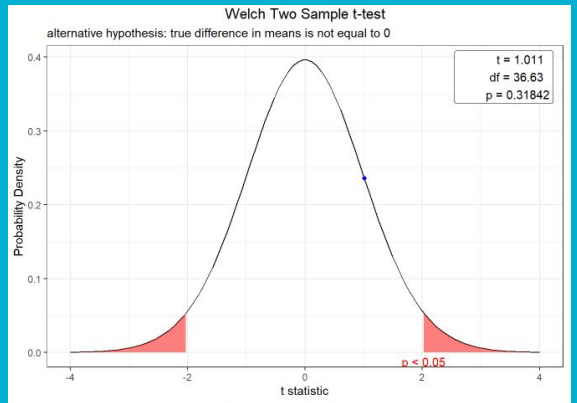
Answered question by using graphical representations & the Welch-Two Sample t-test.

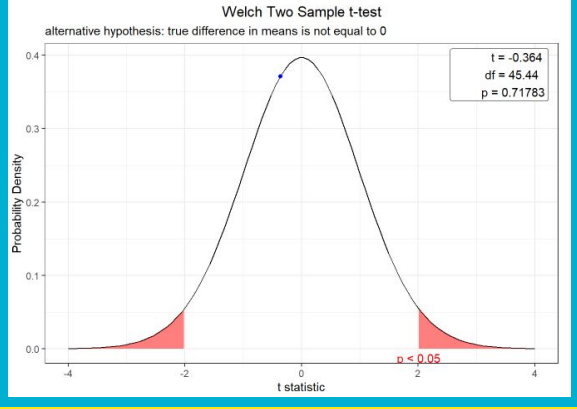






Question 2: The T-Distribution and Summary





The two most accurate cities

San Francisco, CA:

With 95% confidence, 10th day forecast deviated from the actual temperature by -1.54 degrees to 4.609

Austin, TX:

Again with 95% confidence, the 10th day forecast deviated from the actual temperature by -3.9451 degrees to 2.7382 degrees

Conclusion: Austin, TX has the most accurate 10th day forecast

Question 3: Does the city with the "most accurate" forecast according to question 2 also have the least variability in temperature over the month of March?

The F Distribution

The analysis of variance or “ANOVA” will help us to test hypothesis with certain levels of confidence that given two samples of data, their own populations may have equal variance.

Hypothesis Test - Proportion of Variances:

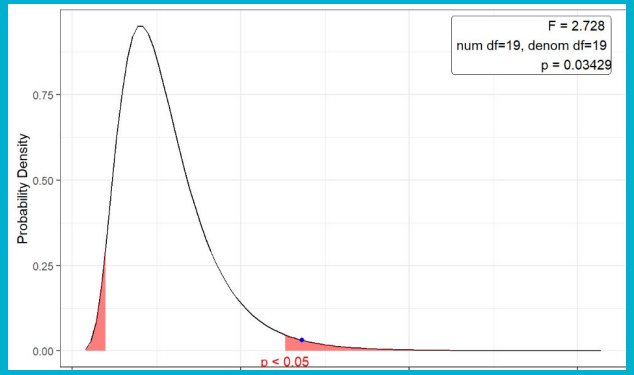
The null hypothesis is that the ratio of the variances of the populations from which “Actual temperature” and “10th-day Forecast Temp.” were drawn, is equal to ratio.

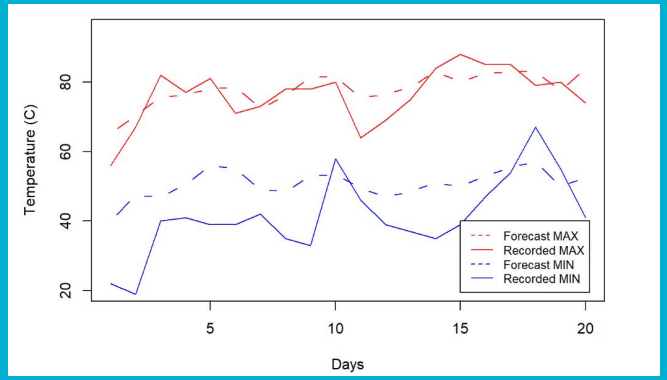
$$H_0 : \sigma_1^2/\sigma_2^2 = 1$$
$$H_a : \sigma_1^2/\sigma_2^2 \neq 1$$

Where, σ_1 *is the variance of the actual temperature of march.*
σ_2 *is the variance of the 10th-day forecast temperature of march.*

Question 3: The F Distribution and Summary

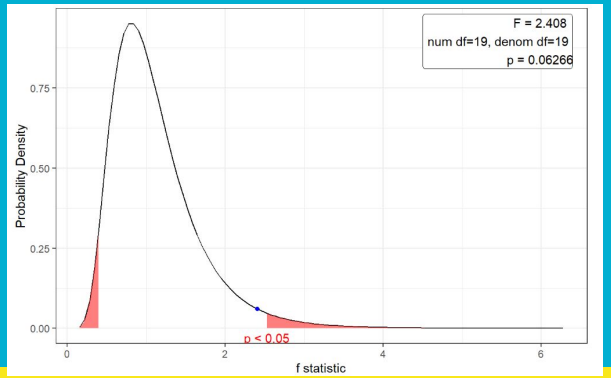
Austin, TX

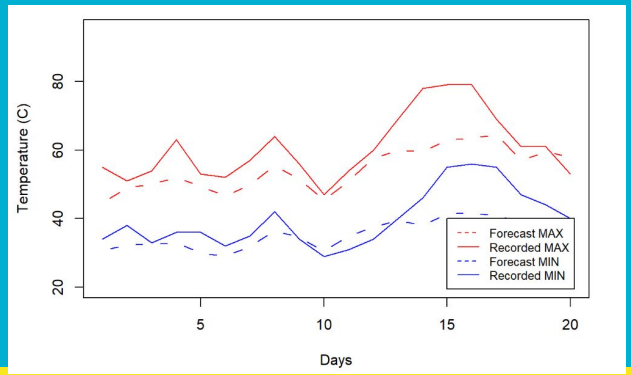




For Austin, the F-statistic is 2.728 and the p-value < α which lies outside of our 95% confidence interval, we can conclude that the variance between the actual temperature data and the 10th day forecast is not equal (Reject the Null Hypothesis).

Salt Lake City, UT

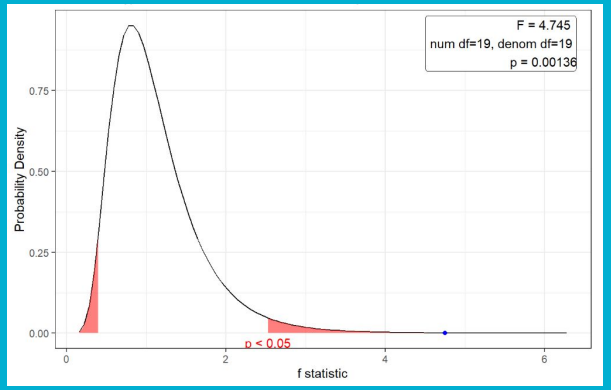


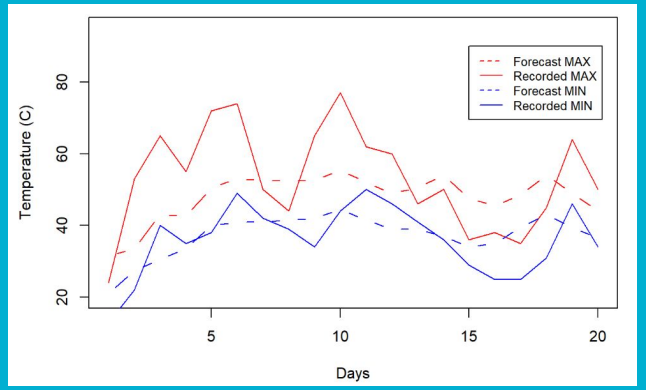


For Salt Lake, the F-statistic is 2.408 and the p-value > α which lies within of our 95% confidence interval, we can conclude that the variance between the actual temperature data and the 10th day forecast is not significant enough to reject the null hypothesis.

Question 3: The F Distribution and Summary

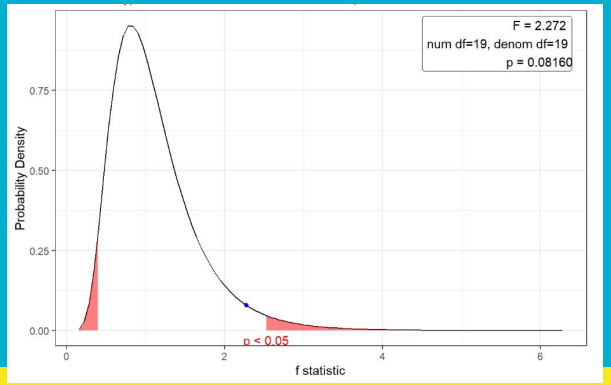
Chicago, IL

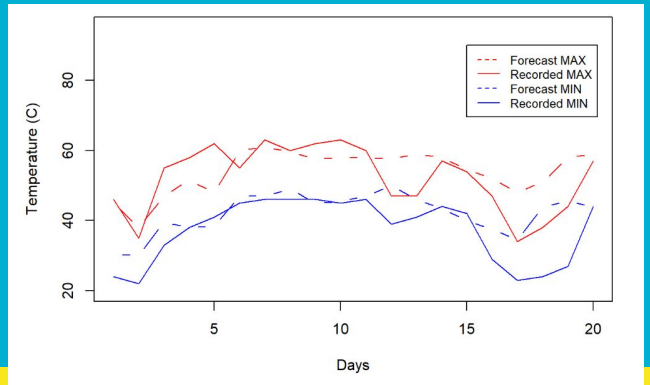




For Chicago, the F-statistic is 4.745 and the p-value < α which lies outside of our 95% confidence interval, we can conclude that the variance between the actual temperature data and the 10th day forecast is not equal (Reject the Null Hypothesis).

New York City, NY





For New York, the F-statistic is 2.272 and the p-value > α which lies within of our 95% confidence interval, we can conclude that the variance between the actual temperature data and the 10th day forecast is not significant enough to reject the null hypothesis.

Question 3: Conclusion

- The city with the highest variance was Chicago followed by Austin. The null hypothesis was rejected for both cities.
- The city with the least variance was New York City followed by Salt Lake. The variance test was not significant enough to reject the null hypothesis.
- All cities had ratios > 1, which means the 10th-day forecasts data had a "conservative" variance compared to the actual data.

Summary

- It’s inconclusive whether local or national weather makes better temperature predictions.
- We are 95% confident that--of the cities we studied--Austin, TX and San Francisco, CA had a mean prediction error closest to 0.
- All cities had ratios > 1, which means the 10th-day forecasts data had a "conservative" variance compared to the actual data.