3.9 (91581) Bivariate Data – Watching Paint Dry

Many people around the world paint their house at some time. But how long does it take to dry? One of the known factors is what the weather is doing to whether the paint is going to dry. Also many people want to know the drying time so they know when they can apply the second or third coat of paint.

Problem/purpose:

Is the air temperature °C a good predictor for how long it takes for paint to dry? I am investigating what will help paint dry and how long it takes in hours. Some of the variables I think will effect the drying time of paint is the Temperature °C, Humidity %, the Wind Speed k/h, and Viscosity cP. The purpose of this investigation is to be able to predict the drying time of the paint depending on the variables. This way more people will be able to know how much time the paint needs to dry.

Plan:

When is the best time to paint? It is when temperatures are moderate and conditions are predicted to be dry for a while. Dry conditions help exterior paint to dry and cure/harden quickly. However, low-quality paint, especially when applied in thick layers, takes a long time to dry completely.[1] It takes solvent-based (oil) paint on average around 24 to 48 hours to dry to the touch.[2] Water based paints dry to touch in about one hour.

The drying times will depend upon the temperature outside as warm temperature means the paint will dry faster, the humidity level as humid air has more water in it and won't allow the liquid to evaporate, and high amounts of wind speed will make the paint dry faster causing a weaker bond.[3] This means the best temperature is between 18 to 30 °C and the humidity is below 50%. Painting under other conditions can change drying and curing times but by altering the time it can weaken the bond between the paint and the surface causing it to blister, crack and peel. [4]

What does the Viscosity of paint mean? Viscosity means how thick the paint is. Is it liquid, medium or really thick? So viscosity relates to how thick the paint is and how thick the paint is applied to the house.[5] It is measure in centipoise (cP.).

The data I am investigating is from a United States paint company, which was collected in 2010. I am using Drying Time (hours) as my response variable and temperature as my explanatory variable.

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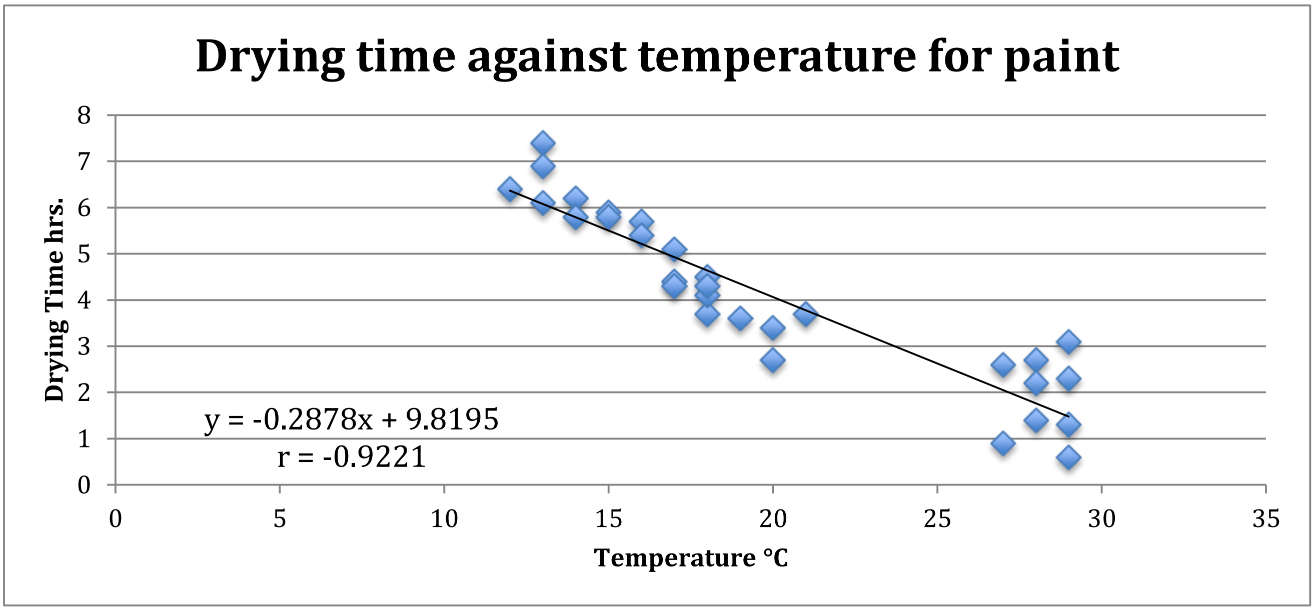
[1] Butler, Meg, "My Exterior Paint Is Not Drying", http://www.ehow.com/how_7827354_exterior-paint-not-drying.html
[2] Logan, Darcy, "Latex Paint Drying Time Vs. Curing Time", http://www.ehow.com/info_12011875_latex-paint-drying-time-vs-curing-time.html
[3] Admin, "Were you wondering…" http://www.wereyouwondering.com/how-long-does-it-take-for-paint-to-dry/
[4] Logan, Darcy, "Latex Paint Drying Time Vs. Curing Time", http://www.ehow.com/info_12011875_latex-paint-drying-time-vs-curing-time.html
[5] Masters, Neadeen, http://community.artapprenticeonline.com/forum/topics/paint-viscosity-do-you-think-about-it

<u>Data</u>:



Looking at the data there is a negative association with very strong linear trend. There is a constant scatter with the data points being close to the trend line. There is a vertical groupings in the data at about 13°C spanning from 7.5 hrs to 6 hrs. There is another vertical grouping at about 29°C spanning from above 3 hrs to 0.5 hrs. This could be because the houses were in different parts of the country and even through the temperature was the same the outside wall may have been in the shade or in the sun, which alters how long it dries. There is no outliers per say as they are all in their vertical groups. There are two groups from 12°C to 22°C and the other from 26°C to 29°C. This could be because the people who painted their houses in America did not paint heir house when the temperature was 22°C to 26°C. Also the second group is smaller as it is hotter and therefore less people paint their house when it is hot outside.

On average, for every 1°C increase in temperature the drying time of the paint decreases by 0.288 hours. Also when the temperature is 0°C the y-intercept is 9.82 hours. This however, is not realistic, as paint will not take that long to dry. But it does depend on the paint and it could be solvent-based paint, which takes longer to dry that water-based paint.[6] The correlation of the scatter of the paint is -0.922, which is a very strong correlation. This shows that the linear model is a good fit.

Predictions:

Interpolation: Drying Time = -0.2878 (14) + 9.8195

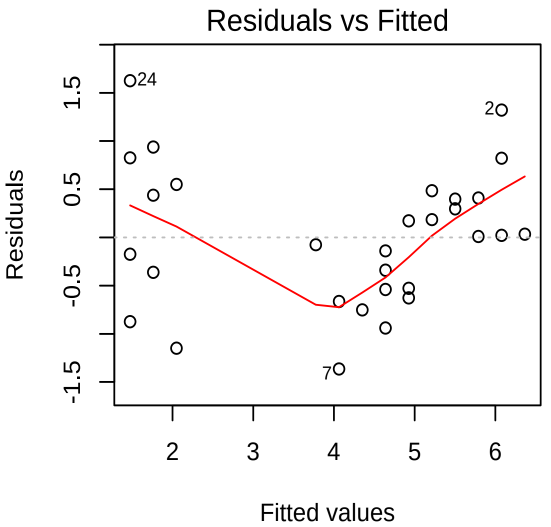
Drying time = 5.79 hrs. I am confident making this prediction as looking at my graph the data points are on the trend line and around it. This gives me confident making predictions in this area, as my predictions will be accurate.

Interpolation: Drying Time = -0.2878 (24°C) + 9.8195

Drying time = 2.91 hrs. I am not confident making predictions in this area as looking at my graph there is no data in this region. Therefore my prediction may be high or low depending on where the data may be. There is not data at this region as there was none collected, as people didn't want to paint their house during those temperatures.

Extrapolation: Drying Time = -0.2878 (42°C) + 9.8195

Drying time = -2.27 hrs. I am not confident extrapolating as you cannot have negative hours This is because paint will always need time to dry so this is not possible. Therefore I am only confident making predictions with my linear model for interpolation.

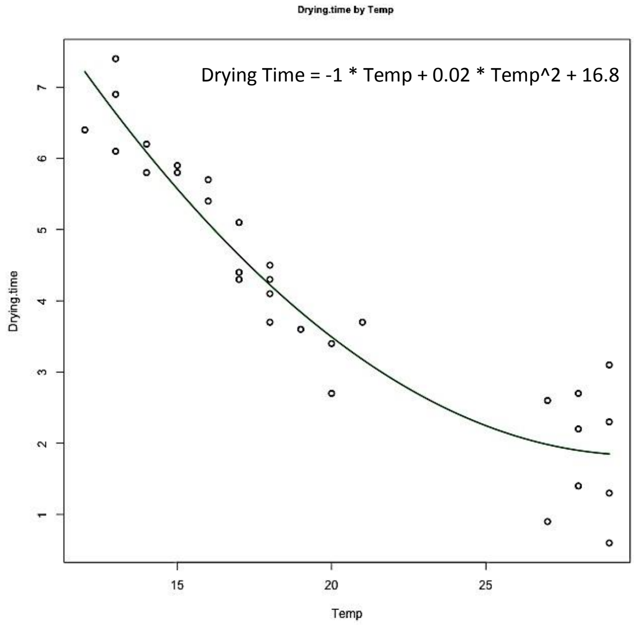


Analysis:

I have looked at the residuals of the paint drying time (hours) against temperature (°C). By looking at this graph it looks like the linear model is not good. There are large positive and then negative. They are large gaps to smaller and then it alternates and switches around. This suggests a pattern in the residuals. Therefore, the linear model while it has a strong correlation it is not the best model to use as demonstrated in this graph.

[6] Logan, Darcy, "Latex Paint Drying Time Vs. Curing Time", http://www.ehow.com/info_12011875_latex-paint-drying-time-vs-curing-time.html

To improve my model I have decided to change to an alternate model. This is because the linear model is not necessary the best model to use as the residual graph demonstrates. I have chosen to use a polynomial quadratic model. This is because the scatter follows the trend line in a constant spread. It has a strong relationship. Most of the scatter is close to the trend line making me confident to predict values in the regions. None of the data points seem to be outliers and follow the curve of the trend. This curve model is also good as looking at the data in context the curve seems to fit. As paint will always take some time to dry it will never go negative, as that is not possible. Also the temperature will soon stop the paint from dry and then cause it to not dry, as it gets warmer. There is also the point that after about the temperature being 30°C no one will want to paint their house as it is too hot. This will also affect the paint and make it blister and peel easier.[7]



<u>Predictions with new model:</u>

Interpolation: Drying Time = -1 * 14°C + 0.02 * 14°C ^2 + 16.8

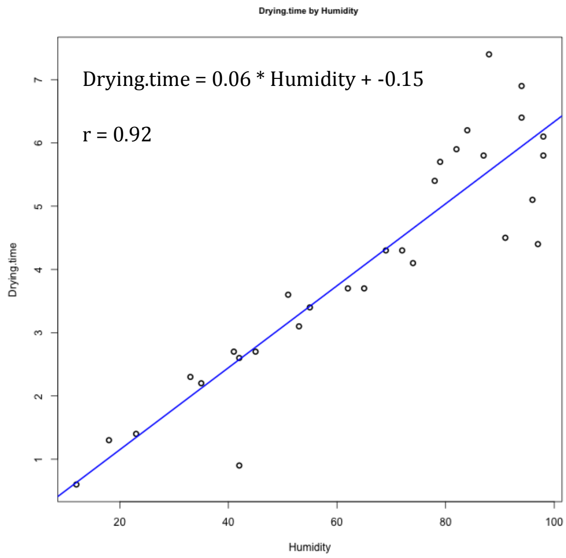
Drying time = 6.72hrs. I am confident making this prediction as the points lie close to the trend line. This model is more accurate than the linear model as looking at the graph this looks like the best average between the data points.

Extrapolation: Drying Time = -1 * 45°C + 0.02 * 45°C ^2 + 16.8

Drying time = 12.3 hrs. I am not confident extrapolation as when temperature getting this hot, no one will want to paint their house anyway. But using this model the results are not accurate if a person would to paint in those temperatures as the paint would dry vey quickly and hence a linear model would be better for extrapolating but the quadratic model is good for interpolation.

[7] Logan, Darcy, "Latex Paint Drying Time Vs. Curing Time", http://www.ehow.com/info_12011875_latex-paint-drying-time-vs-curing-time.html

Alternate Model:



I have chosen to use I am using Drying Time (hours) as my response variable and humidity (%) as my explanatory variable. This data has a positive, very strong, linear trend. The scatter is constant as it follows the trend line. There are no groupings. However, there are some outliers between 80% and 100% humidity. These however, seem to be in a vertical group themselves so are not outliers. On average as the humidity increase by 1% the drying time also increases by 0.06 hrs. The r-value is 0.92, which is a very strong correlation. This model seems better for predictions between 1 hr and 4 hrs of drying time. This is because the data points lie close to the trend line and hence predictions are confident in this region. However, between 4 hrs and 7 hrs I would be more confident making predictions using temperature °C with the quadratic model as the points lie close to the trend line.

There are assumptions made using the temperature model and the data given. I am assuming that the paint is all made from the same manufacture and that the viscosity of the paint is the same for all the houses. I am assuming that the paint is all either water-based or solvent based as they both dry in different times. I am assuming that the houses in America were all the same type of cladding so being either weather board, brick, or plaster. This will alter the drying time as well.

The limitations of this model are that it is good for interpolation of predictions but not extrapolating. Using the quadratic model the paint will not take longer to dry in very hot temperature. The paint will crack and peal.[8] Also the predictions may not work for a different location, so in New Zealand vs. America. The model to make predictions may also only work in a certain time of the year so is it in summer or in winter? The sample size is very small only being 30 hours so the predictor is limited for types of houses and where it was done.

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[8] Logan, Darcy, "Latex Paint Drying Time Vs. Curing Time", http://www.ehow.com/info_12011875_latex-paint-drying-time-vs-curing-time.html

Does the temperature cause the paint to dry or is it just correlation? The paint does effect how long it takes the paint to dry as it heats up the paint and it dries faster. So therefore, the temperature causes the paint to dry and it is not just a strong correlation.[9] However, the humidity % and the viscosity cP of the paint also effect how long the paint takes to dry.

Conclusion:

My question was "is the air temperature a good predictor for how long it takes for paint to dry?" My answer is yes. Using the quadratic model to make my predictions the temperature is a good predictor for how long it takes paint to dry. However, it is only good between certain temperatures about 0°C and 28°C. Any higher than that and it is too hot for people to get paint and the paint will peal. Any lower and it is too cold and the paint will not dry. It was interesting to see how humidity effected the drying time as the more water vapour in the air the less about of evaporation the paint will do. It is also interesting that there was no houses painted during 22°C and 26°C. This could be due to an event happening in America or it was very humid or windy during those days. Therefore, temperature °C is a good predictor of how long it takes paint to dry.

[9] Logan, Darcy, "Latex Paint Drying Time Vs. Curing Time", http://www.ehow.com/info_12011875_latex-paint-drying-time-vs-curing-time.html