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Professor Nichols

MATH 439

18 December 2022

Finals Problem 1

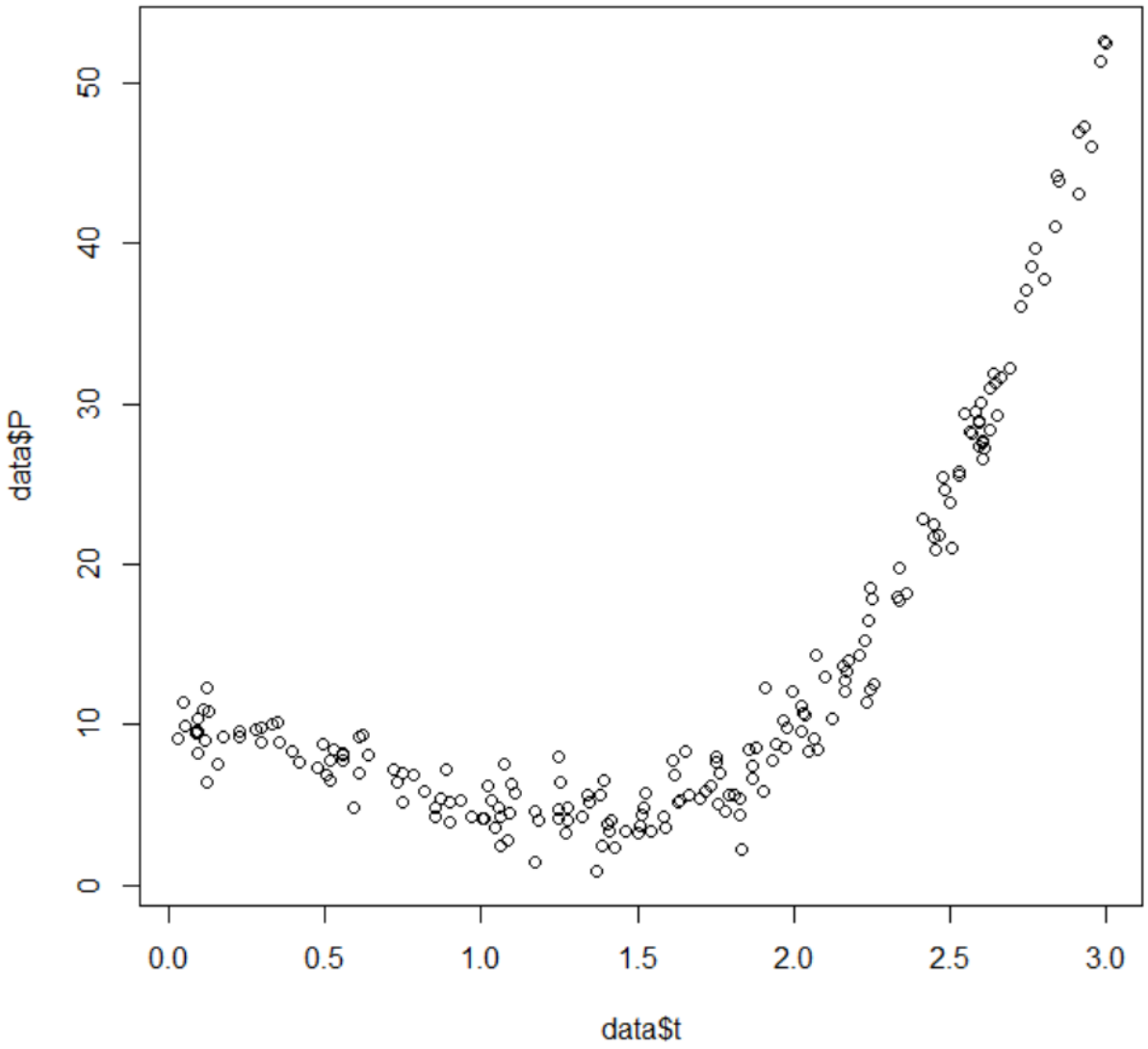
Introduction:

(Extra Credit: I attended both Teacher Demonstrations!)

We'll go over whether the model that the physicists describe of an inanimate object released 10 meters above ground in the anti-gravitation field is valid or not through times 0 to 3. They hypothesize that the height of the object at time = 0 is P(t) = 4.8*t^3 – 9.8*^2 + 5 for t:0<t<3. The physicists projected that they are accurately measuring the position with small normally distributed errors centered around zero with constant variance, but I'll disprove their hypothetical model by analyzing the predicted model of the 200 position measurements for this experiment and justify their measurement errors with a 95% confidence interval to disprove their model.

Body:

First, I plotted the 200 given data points on a graph to see what my model looks like visually. With this, we can get an idea of how the data points are laid out.



Making time for my explanatory variable and position as my response variable, we can visualize a graph of what our data looks like. As we can see above, this data is nonlinear, so I'll propose this information as a cubic polynomial model. Also, since our data is a cubic polynomial, it makes sense that predicting this model as linear is nonsense, so we'll model these data sets as a cubic polynomial and compare our coefficients to the ones that the scientists proposed in their estimation.

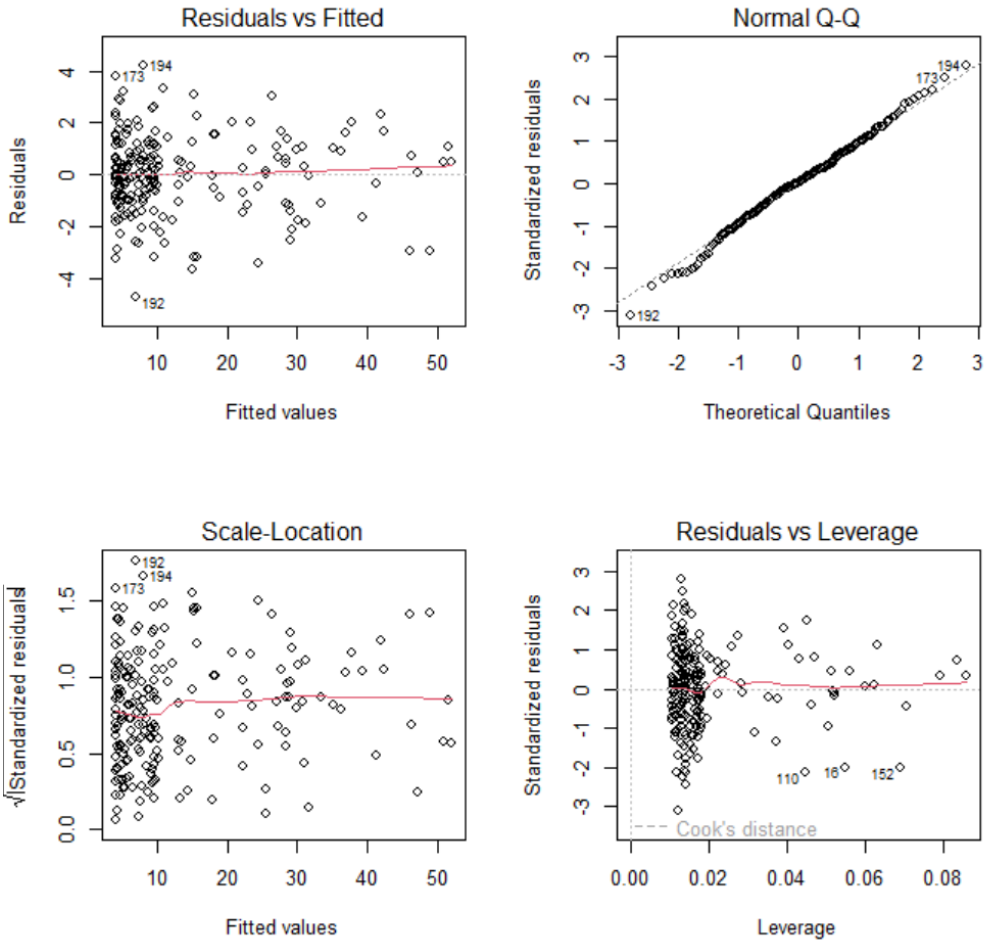
Analytics:

```
Call:
lm(formula = y ~ x + I(x^2) + I(x^3))

Residuals:
    Min      1Q  Median      3Q     Max
-4.7225 -0.9263  0.0294  0.9942  4.2321

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   9.7729     0.4330  22.569   <2e-16 ***
x             0.1719     1.2541   0.137    0.891
I(x^2)       -9.6788     0.9768  -9.908   <2e-16 ***
I(x^3)        4.7725     0.2150  22.200   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.531 on 196 degrees of freedom
Multiple R-squared:  0.9832,    Adjusted R-squared:  0.9829
F-statistic:  3823 on 3 and 196 DF,  p-value: < 2.2e-16
```

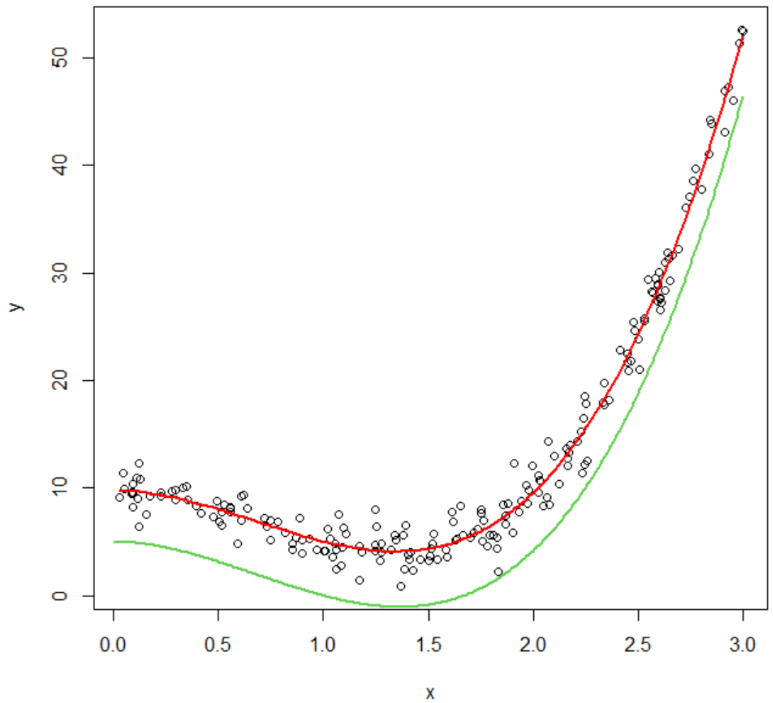


Hypothesis/Explanation:

We can see that the residuals are centered around 0 so this predicted model works well with our data points. We have no leverage points and the difference between all the observed values to their fitted values have a minuscule difference to assure that our model is best fit for predicting the object's position. Based on our final model's residual diagnostics, the physicists have the wrong interpretation of the final model. We can see this by comparing their coefficients to our predicted ones.

Overall, their coefficients for t^3 and t^2 were right on the money, but we can see that the scientists had an error measuring their intercept which they predicted as 5. We're 95% confident that the predicted interval for this model should have an intercept between 8.92422 to 10.62158.

```
> #(Intercept)
> 9.7729-1.96*0.4330
[1] 8.92422
> 9.7729+1.96*0.4330
[1] 10.62158
```



As a result, we can visually see our predicted model in red compared to the scientists' predicted model in green. Evidently, the data points are more closely related to our prediction than the physicists' interpretation since all the data points are above their prediction while ours is right in the middle of them.

Conclusion:

Overall, we can make sure that the theoretical model proposed by the physicists isn't valid considering the intercept they hypothesized. We can tell their model is off by predicting a 95% confidence interval to determine that their predicted interval of 5 is way off from 8.92 to 10.62. This evidence proves that their model is invalid and shouldn't be used to justify the position of the inanimate object in the anti-gravitational field.