Dr Doomlove

Or How I Learned to Stop Worrying and Love the Doom

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Introduction

It is no secret that Latveria has become a threat to not only the United States, but to the world. In order to counter the global threat of Dr. Doom's reign of tyranny, a war plan must be made. By analyzing the provided data and constructing separate models to predict enemy and civilian casualties given the other covariates, an effective action plan can be made to address possible Latverian aggression. Having constructed these models, the United States can do everything in its capacity to minimize civilian casualties during wartime while maximizing enemy casualties in the effort to ward off the legions of Victor von Doom. This report provides these models, addresses their accuracy, and reviews their creation.

Methods

Addressing Errors

Several errors were found and removed from the original data. There was a row of data that was entirely 0s, which was removed because it provided no valuable information. One row had a value of negative 996 for bombs, but the measure for bombs cannot be negative. Because 996 is a reasonable value, instead of removing this point it was simply made positive. An unreasonable value was one row with 999999 bombs, which was removed entirely as the actual value for bombs was unknown. The first aid variable had an NA value so that row was removed. Lastly, there were some astonishingly cold temperatures recorded (as low as -141), but because of the volatile nature of Latveria's weather these data points were not removed or modified. It was assumed these temperatures accounted for wind chill.

Constructing Models

R, a computer programming language for statistical analysis, was used to create both enemy and civilian models. These models are meant to predict the number of enemy or civilian casualties, respectively, based on covariates that have a significant impact on the number of casualties. An alpha (α) of 0.05 was chosen for determining whether covariates had a statistically significant impact on the casualty prediction.

The Enemy Model

Enemy casualties are normally distributed, with perhaps a minute right skew (see **figure 1**, page 2). The prediction model for enemy casualties is created on the assumption that the variable is actually normally distributed. The number of enemy casualties ranges from 163 to 13188. However, a majority of scenarios have two to six thousand enemy casualties, centered around four thousand.

The model for predicting enemy casualties includes payload, weapons, bombs, missiles, spies, media, and IG88. The other covariates were removed from the model due to high P-values which indicated that they did not make a statistically significant difference to the model's predictions given the other variables. These omitted covariates and their P-values are shown on the next page (see **table 1**, page 2). IG88None has value 1 if IG88 is not installed, and value 0 if it is installed.

Certain curvature patterns within the variable residual plots indicated the need for polynomial coefficients in the model. The bombs-missiles interaction was discovered based on a bow-tie pattern in the variables' residual plots. This will be discussed later. A logarithmic interaction was observed with media that caused many residual plots to have erratic curvature, shown in Appendix A – Enemy Residual Plots (see **figures B.1 and B.2**).

The final enemy prediction equation:

Enemy Casualties ~ 4.317e+03 + (4.247e+01 * Firepower) + (2.771e-02 * Payload) + (-9.593e-01 * Weapons) + (-6.094e-03 * Bombs) + (-3.667e+01 * Missiles) + (1.118e+02 * Spies) + (-2.212e+02 * IG88None) + (1.905e-02 * Bombs*Missiles) + (4.56e-01 * Missiles^2) + (-1.225e+01 * Spies^2) + (3.693e-01 * Spies^3) + (3.592e+02 * log(Media))

Variable	**P-value**
Stock	0.667
Napalm	0.9466
Terrorism (low, medium)	0.48413, 0.33975
Temperature	0.16163
First Aid	0.15181
Personnel	0.0954

Table 1
Variables omitted from enemy model and the P values indicating that they should be removed.

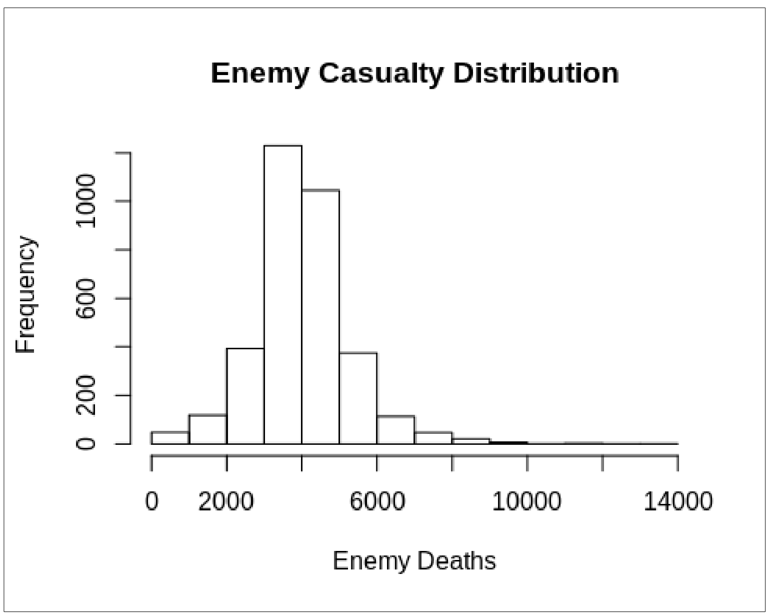


Figure 1
Enemy Casualties are Normally Distributed

Firepower (P = 0.00136)
Firepower is a linear term coefficient in the prediction equation with a value of 42.47. This positive value indicates that there is an expected increase of 42.47 enemy casualties for each additional unit of firepower. This indicates that higher ratios of weapons versus weapon intensity leads to more enemy casualties. This may be because sheer volume of weapons allows for more widespread attacking, causing more casualties than fewer weapons with larger payloads in specific areas.

Payload (P = 0.00793)
Payload is also a linear term coefficient. It has a value of 0.02771. This means greater payloads will yield greater enemy casualties. Specifically, for each newton of additional force in the payload there is an expected increase in enemy casualties of 0.02771. So, for an increase in payload of 1 kN, there would be an expected 27.71 additional enemy casualties. This is likely because bombs with more explosive force impact greater areas and can injure more enemy units.

Weapons (P < 2e-16)
The Weapons coefficient is -0.9593. Weapons is yet another linear term coefficient. This means that for each additional dollar in the budget for weapons per unit, there is an expected decrease of almost 1 enemy casualty. This could be because an increase in the budget for weapons decreases the number of soldiers that the army can support, and fewer soldiers on the front lines means fewer soldiers fighting Latverians and causing enemy casualties.

IG88None (P < 2e-16)
This covariate has a value of -221.2, meaning that when IG88 is not installed it is expected that there will be that many fewer Enemy casualties than if it had been in place. This indicates that IG88 is a valuable asset, whatever it may be. If IG88 were a droid assassin, for example, its prowess to kill may be what causes the increase in enemy casualties. It is also possible that this may only be the case in a galaxy not our own, but one far away (and a long time ago).

Media (P < 2e-16)
Media is a logged effect with a coefficient of 359.2. While media suppression increases, so too do enemy casualties. Because the effect is logarithmic though, a 10% increase in media suppression would be expected to result in an increase in enemy casualties of about 34. The natural logarithm was used in this model ($\log_e$). **Figure 2** shows the logarithmic growth of media suppression influence. Before and after residual plots for Media can be found in Appendix B, showing the effect of adding a logarithmic effect to Media in the model. Suppression of media results in more enemy deaths because it is less likely wartime reporters will accidentally reveal the location of our troops or the nature of our plans, so our fighters are more effective in the field.

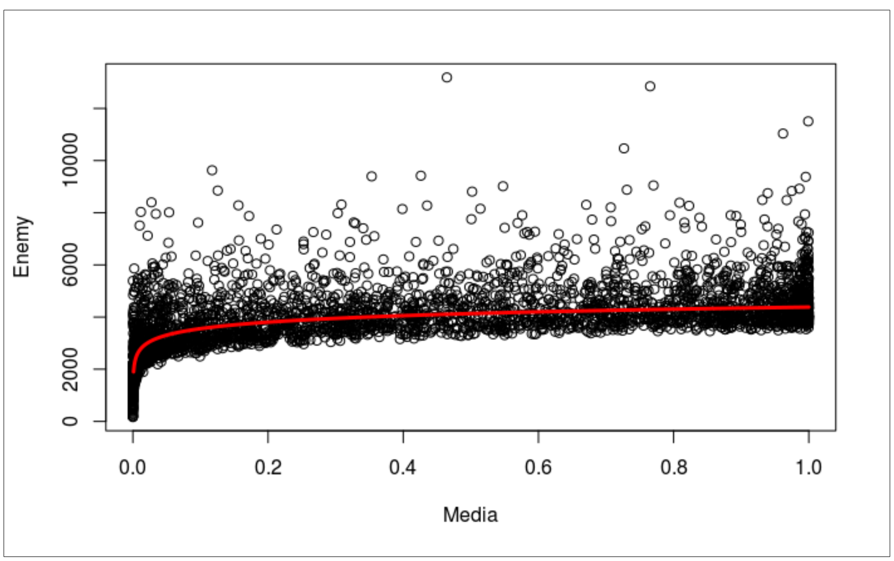


Figure 2
Logarithmic growth rate of Media influence

Spies (P < 2e-16 all terms)

The Spies variable is polynomial in the enemy model, up to the third degree. This means that as the number of spies increase, the number of enemy casualties increases with it at first, takes a slight dip, then begins to increase again. The polynomial Spies coefficients are statistically significant, but practically are quite small. **Figure 3** on the next page shows this behaviour with relation to enemy casualties, and highlights the subtlety of the cubic. The cubic was included in the model because it was indicated in the residual plot for Spies that this relationship was present and because it is statistically significant (see **figure 4)**. This behaviour could be the result of smaller groups of spies being effective, but having seven to sixteen spies makes their presence obvious to the Latverians so their work becomes less effective. Perhaps having more than sixteen spies becomes effective again simply because it is too many for the Latverian counter-intelligence agency to distract.

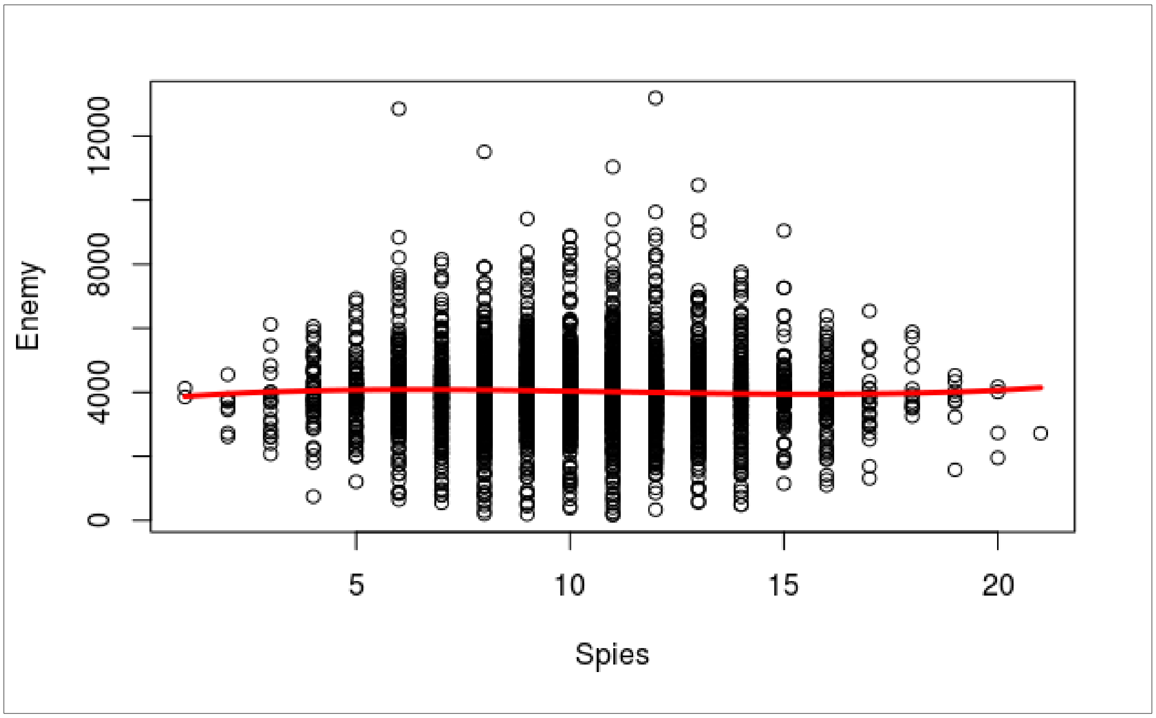


Figure 3

Spies' subtle cubic pattern

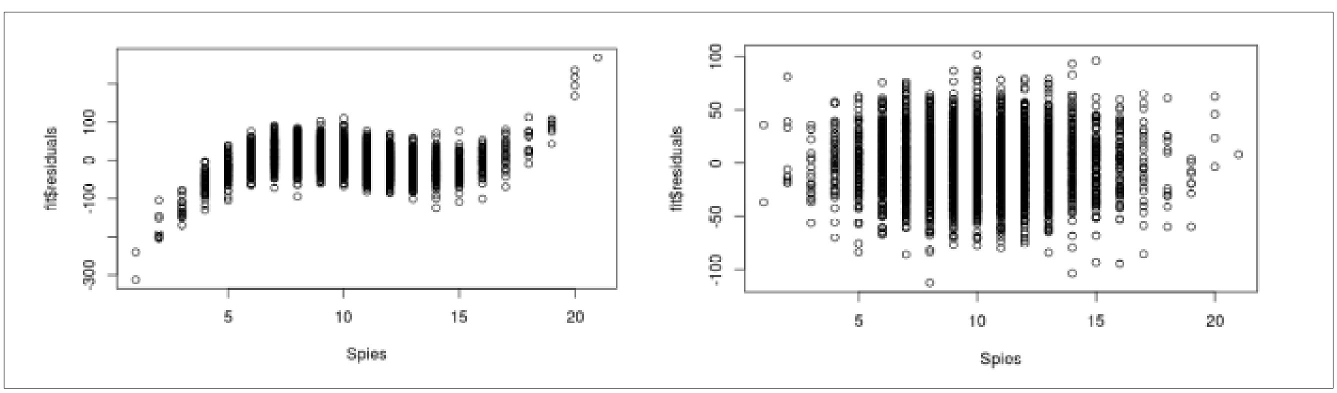


Figure 4

Pictured left is the residual plot for the Spies variable in the Enemy model before adding polynomial terms, and on the right is the same residual plot after adding the polynomial spies terms.

Missiles (P < 2e-16 all terms)
Missiles, like Spies, has a polynomial coefficient. Unlike spies, it is only to the second degree. **Figure 5** shows the quadratic pattern of Missiles that while statistically significant is not immediately apparent. The quadratic term was included when the pattern became obvious in the residual plot for Missiles (see **figure 6**). Its effect is that starting from 30 missiles, the increase in enemy casualties gets progressively greater as more missiles are used. Increasing the number of missiles from 60 to 70 yields a greater increase in enemy casualties than increasing the number from 30 to 40.

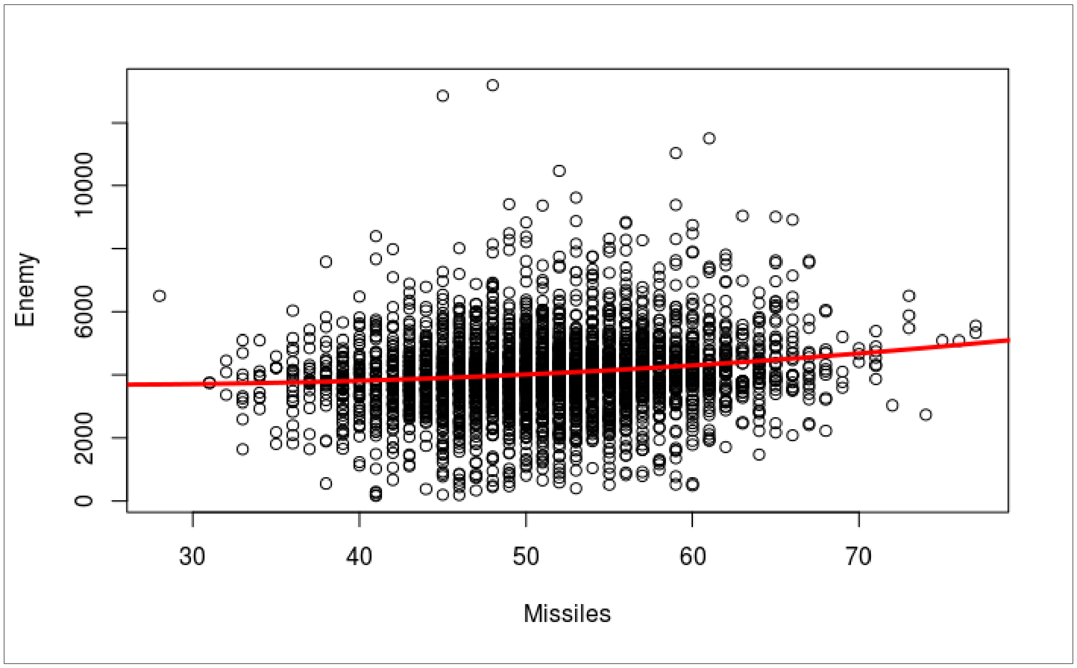


Figure 5
Missiles has a slight quadratic effect

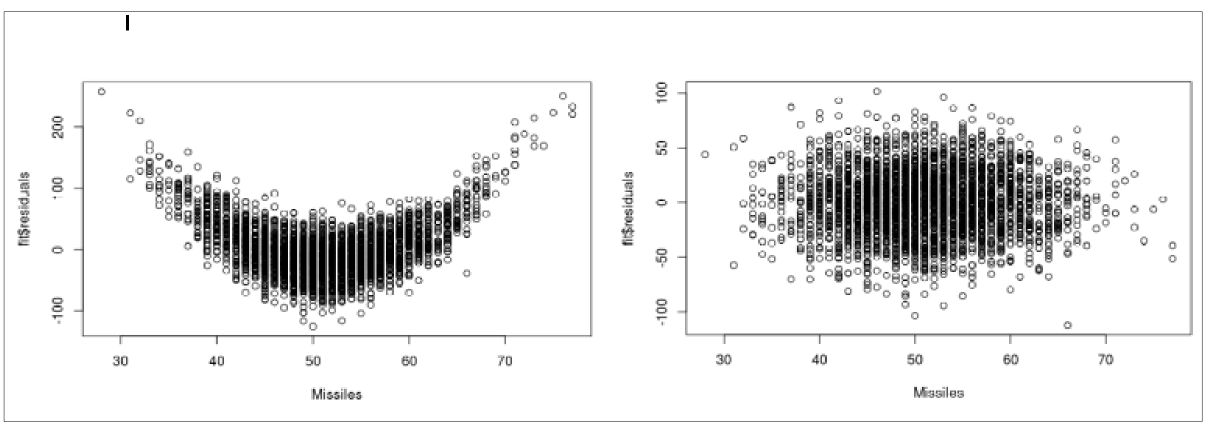


Figure 6
Before (left) and after (right) residual plots for a quadratic missiles term in the enemy model.

Bombs (P = 0.09651)
While the P value of the Bombs coefficient is over 0.05, it was left in the model because it interacts with Missiles in a statistically significant way. The effect of the Bombs variable standalone will not be

discussed as its difference is only statistically significant when multiplied by Missiles, which is discussed below.

Bombs-Missiles Interaction ($P < 2e-16$)

This interaction was found while plotting residuals. Both Bombs and Missiles showed bow-tie patterns in their residual plots (see **figure 7**). This is indicative of an interaction between the two covariates, so they were multiplied with one another in the model and the bow-tie pattern in the residual plots was remedied (see **figure 8**).

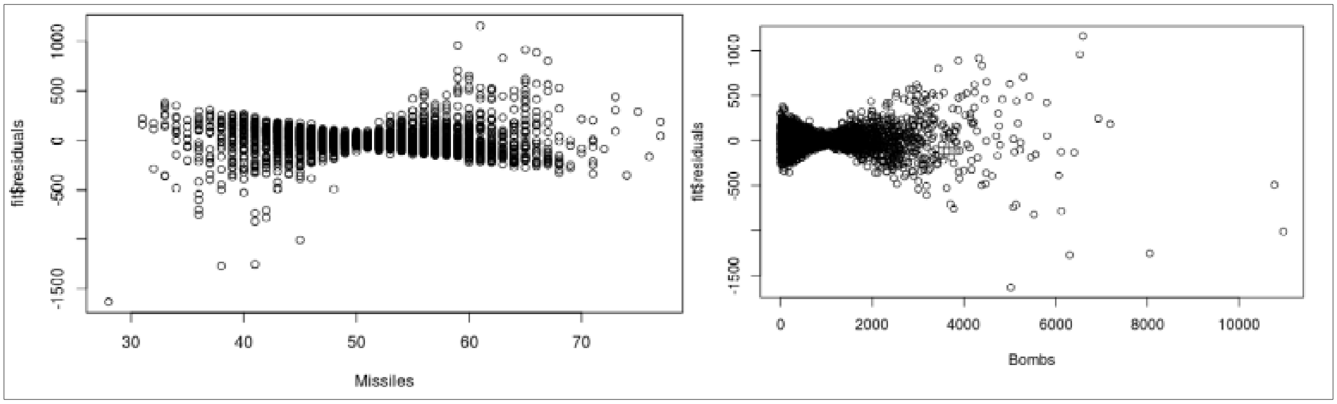


Figure 7

Bow-tie patterns in the residual plots of missiles (left) and bombs (right)

Curiously, coloring either of these plots by the other variable produced no discernible pattern. They were the only bow-ties, however.

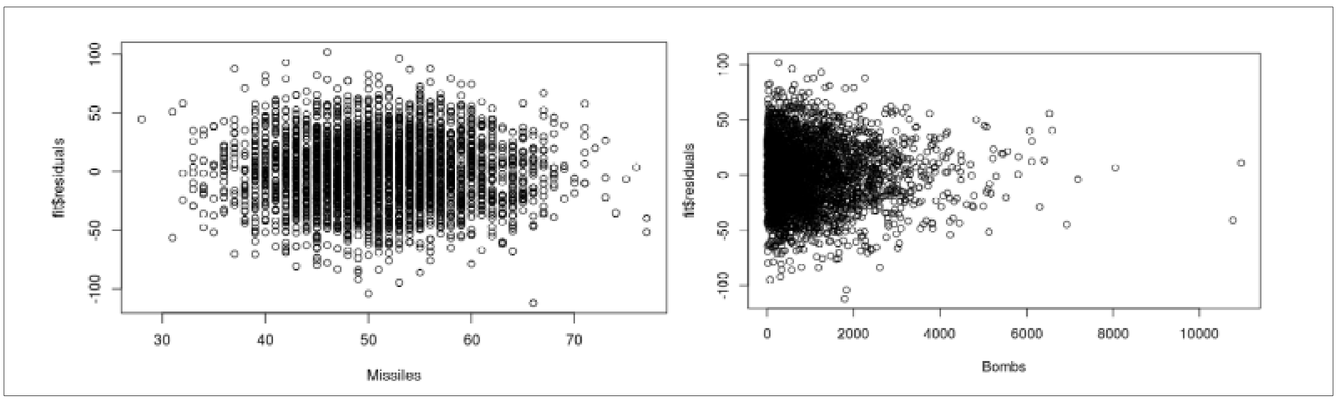


Figure 8

Bow-tie patterns have disappeared after adding a bombs-missiles interaction to the enemy model

Figure 9 on the next page shows that increasing number of bombs increases enemy casualties. Using more missiles makes this increase even greater, so by using missiles and bombs in conjunction the number of enemy casualties can be increased. This is shown numerically by the positive interaction coefficient. The number of bombs and missiles are multiplied together, then multiplied again by a (small) coefficient to increase the number of predicted enemy casualties.

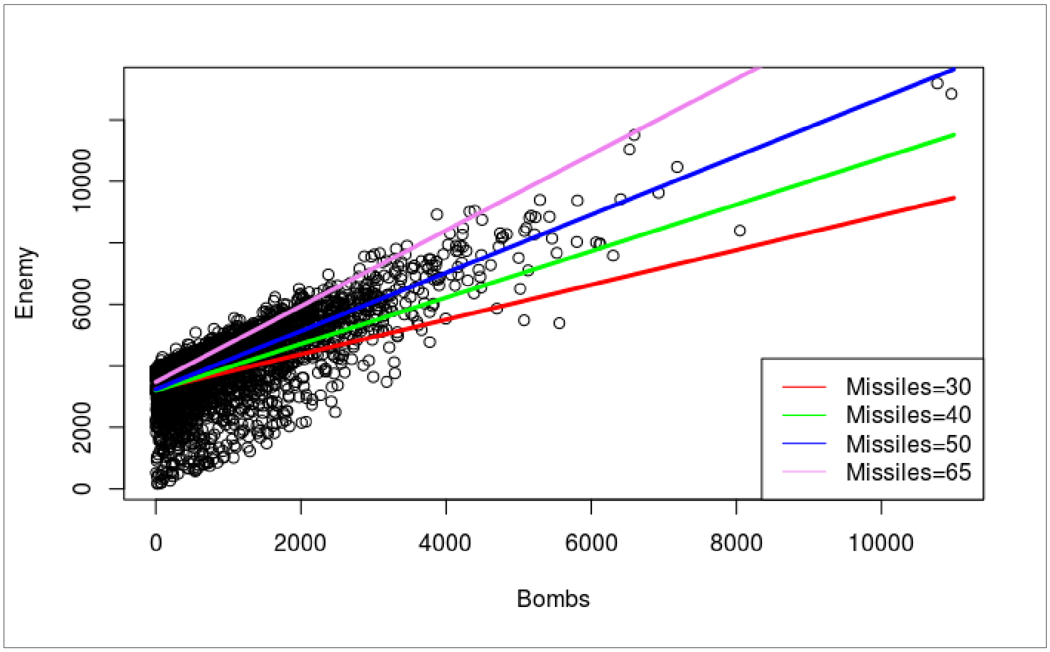


Figure 9

Using more missiles with the same amount of bombs increases enemy casualties. This is true even without the interaction due to additional missiles coefficients (missiles+missiles^2) contributing to more civilian casualties, but the interaction makes it more pronounced.

Making a Test Prediction

A test prediction of enemy casualties was made based off the first row of data using the above model. The result of this prediction, 4057.782 enemy casualties, was within 15 casualties of the actual value, 4072. This is well within the expected standard error of 28.82.

EnemyRow1 ~ 4.317e+03 + (4.247e+01 * 0.37) + (2.771e-02 * 1878.5016) + (-9.593e-01 * 187) + (-6.094e-03 * 816) + (-3.667e+01 * 47) + (1.118e+02 * 9) + (-2.212e+02 * 0) + (4.560e-01 * 47^2) + (-1.225e+01 * 9^2) + (3.693e-01 * 9^3) + (3.592e+02 * log(0.2936)) + (1.905e-02 * 816 * 47)
= 4057.782

Quality of Predictions

The enemy model has an adjusted R^2 of 0.9995 which means the model accounts for 99.95% of variance in enemy casualties. This is indicative of accurate predictions using the model. The standard error for the model is 28.82. This means that predictions are reasonably expected to be within 28.82 enemy casualties of the actual result, but results within 2 standard errors are not unusual. It would be very unusual for a prediction to be more than 57.64 enemy casualties away from the actual value. The residual plots for the variables and the model itself appear to be random clouds, further indicating a quality model (see Appendix A – Residuals: Enemy Model).

The variable with a coefficient closest to zero in the enemy model is payload. It has a confidence interval of 0.007261157, 0.0481668. While this is close to 0, I am 95% confident that the true slope for payload is within this interval. The confidence interval of bombs includes 0 because it is not statistically significant, but is included in the model due to its interaction with missiles. Because it is not significant though, it is not considered as the coefficient closest to zero.

Maximizing Enemy Casualties

If the goal is strictly to maximize enemy casualties without respect to civilian casualties, then the initial strike should use more than 60 missiles, allocate a lower budget for weapons per unit, use high firepower and high payload, and make sure to have IG88 out in the field. Prior to conflict there should either be a few elite spies (under 7) or a great number of spies (over 16) so that their skill or quantity overwhelm the Latverians. Media suppression during the conflict will benefit the fighting too, resulting in more enemy casualties.

The Civilian Model

The distribution of civilian casualties is not perfectly normal, but normal distribution is fairly robust so civilian casualties may be treated as normal for the purpose of constructing a model. Moreover, once log-adjusted the distribution for civilian casualties is very normal (see **figure 10**). It has quite a large right-skew, ranges from 1 to 158, and is centered around 20 civilian casualties with a majority being below 30.

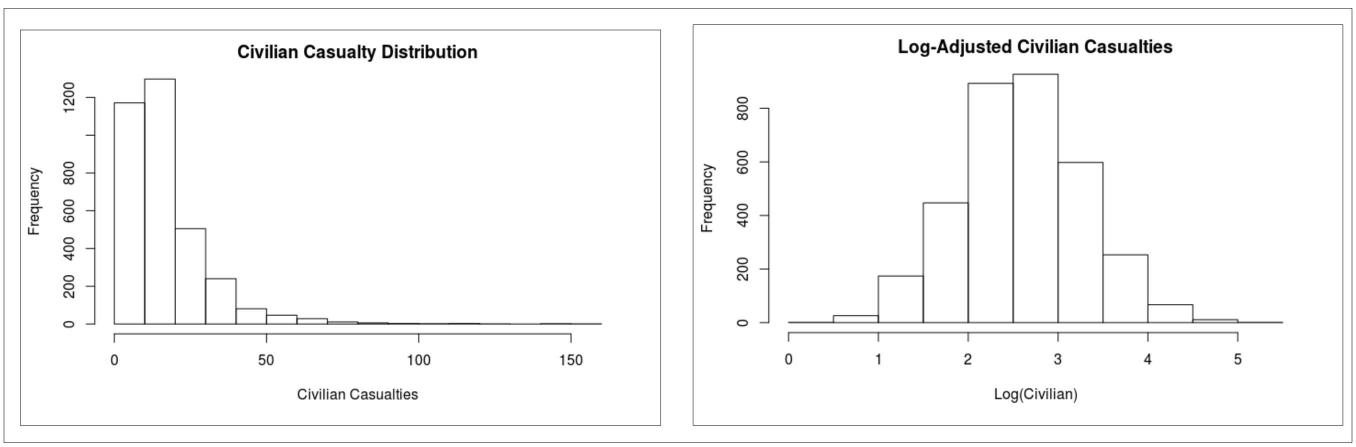


Figure 10

Distribution of civilian casualties before (left) and after (right) log transformation

It is important to note that the value for civilian is logged. This means that the result of the right side of the prediction equation will be the exponent to which Euler's number e is raised. If the result of the equation is 3.56, for example, it would mean that there are expected to be $e^{3.56}$ civilian casualties (which evaluates to 35.1632). One reason for doing this is that log-adjusting the civilian distribution normalizes it even further. The log-adjustment also greatly improved the residual plots and R^2 of the model. The need for a log-adjustment was identified when it was apparent that civilian deaths grew at a non-linear rate. Specifically, civilian casualties growing increasingly fast was indicative of a log(y)=x growth pattern in the distribution where y is civilian casualties.

Polynomial terms were identified by specific curvature patterns in residual plots attributed to varying rates of contribution to civilian casualties by a variable. An interaction was discovered based on a bow-tie pattern in the variables' residual plots, which will be discussed later.

The model for predicting civilian casualties includes terrorism, firepower, missiles, and temperature. The other covariates were removed from the model due to high P-values which indicated that they did not make a statistically significant difference to the model's predictions given the other variables. These omitted covariates and their P-values are shown on the next page (see **table 2**, page 9).

In the prediction equation 'TerrorismLow' and 'TerrorismMedium' will either be 0 or 1 based on the terrorism level. If it is a specific level, the value for that level is entered as 1 and the value for the other is entered as 0. 'TerrorismHigh' is the default, and these are differences from that default. For example, if the terrorism level is low, 'TerrorismLow' will be entered as 1 and 'TerrorismMedium' will be 0.

The final civilian prediction equation:

$$\log(\text{Civilian}) \sim (-0.02317 * \text{TerrorismLow}) + (-0.01108 * \text{TerrorismMedium}) + (0.003645 * \text{Firepower}) + (0.00044 * \text{Missiles}) + (-0.0006816 * \text{Temperature}) + (-0.0002646 * \text{Missiles} * \text{Temperature}) + (0.000002138 * \text{Temperature}^{2)}) + (0.00000001943 * \text{Temperature}^{3})$$

Variable	**P-value**
Stock	0.72752
Payload	0.99325
Weapons	0.86809
Bombs	0.19444
First Aid	0.53114
Personnel	0.92911
Spies	0.33445
Media	0.98169
IG88None	0.1993
Napalm	0.87856

Table 2

P values indicating which variables should be removed from the civilian model

Terrorism (P = 3.76e-12 for low, P = 0.00114 for medium)

Terrorism is categorical, either being low, medium, or high. High is the default value, so low and medium terrorism levels have their own respective coefficients in the model depending on what level it is. The coefficient for a low level of terrorism is -0.02317, indicating that when the terrorism level is low there should be an expected decrease of 2.229036% in civilian casualties from a high terrorism level (given by $e^{-0.02317} = 0.9770964$ which is a 2.229036% decrease). For medium terrorism level, the coefficient of -0.01108 indicates an expected decrease of 1.101884% in civilian casualties from a high terrorism level (given by $e^{-0.01108} = 0.9889812$ which is a 1.101884% decrease). These are in line with the common sense idea that more terrorism results in higher civilian casualties because terrorists target civilians.

Firepower (P = 0.03443)
Firepower is the only strictly linear numerical variable in the model. Its coefficient is 0.003645, which means that for each additional unit of firepower there is an expected increase of 0.3652% in civilian deaths (given by $e^{0.003645} = 1.003652$ which is a 0.3652% increase). This is because an increase in firepower means an increase in fighting, and more fighting makes it more likely that a civilian may accidentally fall victim.

Missiles (P = 6.71e-05)
Missiles have a linear term and an interaction with temperature. The interaction with temperature will be discussed below. The linear term has a positive value of 0.00044, which means that for an increase of 1 missile there is an expected increase of 0.044% in civilian deaths (given by $e^{0.00044} = 1.00044$, a 0.044% increase). It is unsurprising that using more missiles causes more civilian casualties because the blast radius is so large that it is easier to affect civilians in the vicinity of soldiers rather than just targeting the soldiers themselves.

Temperature (P = 2.35e-14 for linear term, 2.44e-13 for quadratic term, < 2e-16 for cubic term))
The temperature variable has polynomial coefficients up to the third degree. Higher temperatures see the fewest civilian casualties. **Figure 12** on page 11 shows that civilian casualties drop exponentially as temperature increases. While the third degree polynomial is not visually apparent, its presence was noticed when the residual plots for temperature were curving (see **figure 11**). The sharp decrease in civilian casualties as temperature climbs is probably because civilians spend their days indoors to stay out of the sun when it is very hot out. When they are indoors, they are less likely to be accidentally killed or wounded by stray munitions. Temperature also interacts with missiles, and this interaction is discussed on the next page.

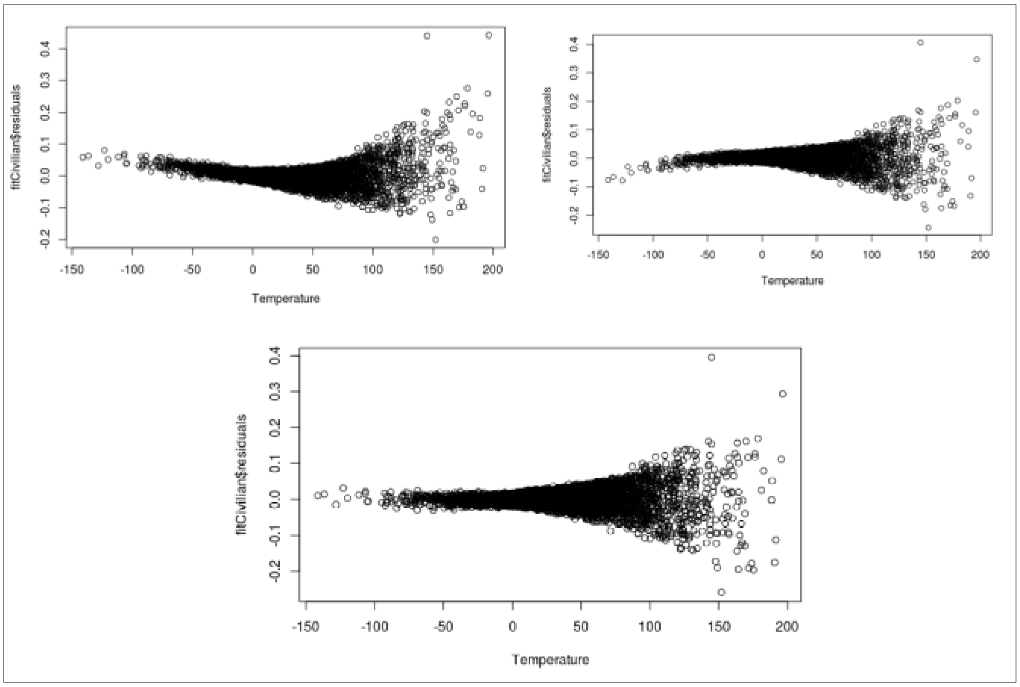


Figure 11
Residual plots for the temperature variable in the civilian model. Shown top left is before any polynomial terms, top right is after $temperature^2$ was added to the model, and bottom center is after $temperature^3$ was added. The pattern could not be remedied, and is discussed in the *Quality of Predictions* section.

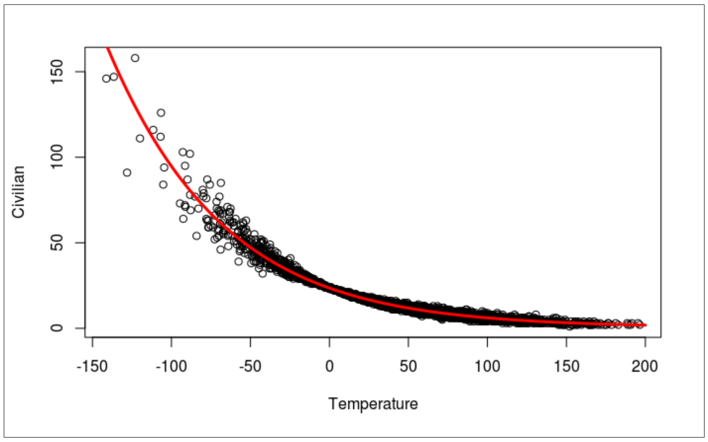


Figure 12
Plot of temperature predictions over actual temperatures showing the sharp decrease in civilian casualties as temperatures rise.

Missiles and Temperature Interaction (P < 2e-16)
Missiles and temperature interacted in the civilian model. This interaction was noticed when both variables had bow-tie patterns in their residual plots for the model. Adding the interaction removed the bow-tie pattern for missiles, but temperature maintained a fan-shape in its residual plot (see **figure 11**, page 10). This is discussed in greater detail in the *Quality of Predictions* section. The effect of this interaction is that missiles kill more civilians when it is cold (see **figure 14**, page 12). When it is cold and civilians are inside, collapsing buildings from exploding missiles is more of a threat to them.

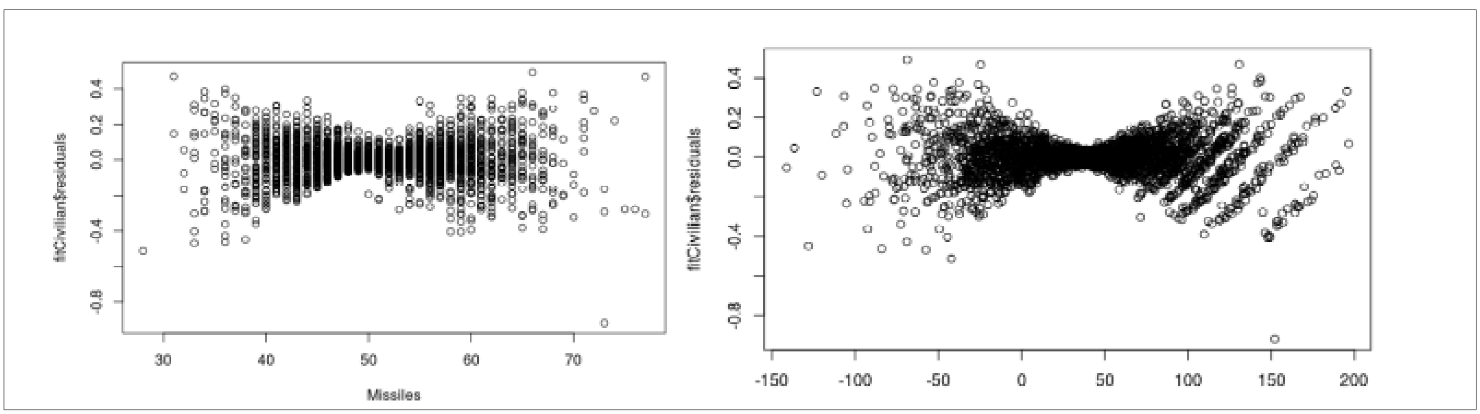


Figure 13
A bow-tie pattern indicating an interaction between missiles and temperature.

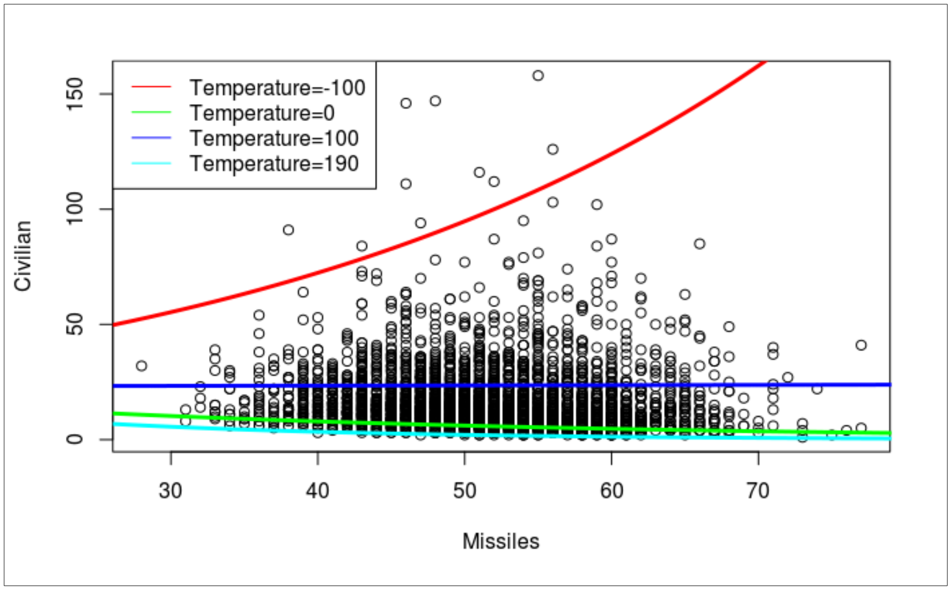


Figure 14

Missiles tend to cause more civilian casualties at lower temperatures.

Making a Test Prediction

A test prediction of civilian casualties was made based off the first row of data using the above model. The result of this prediction, 14.38804 civilian casualties, was within 2.8% of casualties of the actual value, 14. This is well within the expected standard error of 3.5713%.

$$\text{CivilianRow1} \sim \exp(3.158 + (-0.02317 * 1) + (-0.01108 * 0) + (0.003645 * 0.37) + (0.00044 * 47) + (-0.0006816 * 37.7) + (-0.0002646 * 47 * 37.7) + (0.000002138 * 37.7^2) + (0.00000001943 * 37.7^3))$$
$$= 14.38804$$

Quality of Predictions

The civilian model has an adjusted R^2 of 0.9975 which means the model accounts for 99.75% of variance in civilian casualties. The standard error for the model is 3.5713%. This means that predictions are reasonably expected to be within 3.5713% of the actual civilian casualty value. Results within 2 standard errors, or just over 7%, are not unsurprising but atypical. The residual plots for the variables appear cloud-like for the most part, however the temperature residual plot exhibits some degree of fanning. Additionally, the model's residual plots show a clear pattern that could not be remedied.

All two-way interactions were tested, a log transformation of each variable, and polynomial terms for all variables were tested. Some likely three-way interactions were tested as well. None of this dealt with the fanning on the temperature residual plot or the shape of the model's residual plots.

The cause of this is still unknown, however the high adjusted R^2 and low standard error indicate that the model still produces very accurate predictions. This is evidenced by the accurate first-row test prediction, within half of a civilian casualty of the actual measurement. The residual plots can be found in Appendix A – Residuals: Civilian Model.

The variable with a coefficient closest to zero in the civilian model is temperature^3. It has a confidence interval of 0.00000001548688, 0.00000002337868. While this is close to 0, I am 95% confident that the true slope for temperature^3 is within this interval.

Minimizing Civilian Casualties
It is important in any conflict to minimize civilian casualties as much as possible. Given the above model for civilian casualties, an attack on a very hot day with fewer missiles and lower firepower would reduce civilian casualties. Moreover, civilian casualties are lower when the terrorism level is low, so if at all possible the US should do whatever possible to minimize terrorism levels during the conflict. Reduction to low terrorism levels is ideal, but medium terrorist levels are also expected to see a reduction in civilian casualties from high terrorist levels.

Conclusion
Given these two equations, the United States has the capability to maximize its wartime potential with Latveria. With the overall goal of maximizing enemy casualties and minimizing civilian casualties, these models can be applied to ensure a decisive victory over Dr. Doom while saving civilian lives and keeping the moral high-ground as the leader of the free world. In order to achieve both these goals at once, it is important to consider the effects of variables in both models

In the enemy model, increased firepower means increased enemy casualties. This seems beneficial at first, except that increased firepower also increases civilian casualties. This means that a medium has to be found for this variable, a value that increases enemy casualties a practical amount while causing a minimal amount of civilian casualties.

To achieve this goal, a firepower value of 1 might be chosen since firepower ranges from 0 to 2.5 and 1 is likely to yield more enemy casualties while not causing excessive civilian casualties. Missiles follows the same pattern, more missiles means more enemy and civilian casualties. A good balance for missiles may be around 50, once again in the conservative middle ground. Payload, weapons, bombs, spies, and IG88 were all insignificant for civilian casualties though, so they can be optimized for enemy with less regard for civilians. This means it would be beneficial to maximize payload and spies, install IG88, and minimize weapons and bombs.

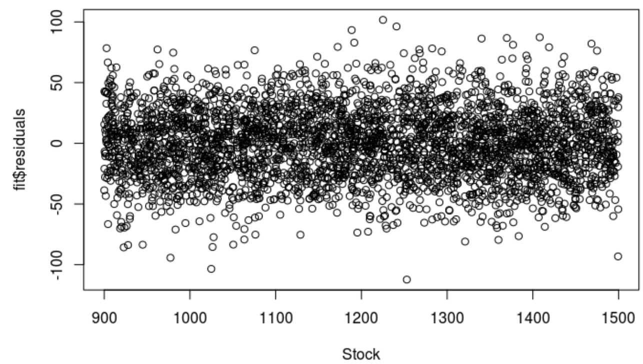
Meanwhile, the temperature variable that is significant for civilians is not significant for enemy. This means that the US can attack when it is sweltering hot in the summer and reduce civilian casualties without impacting how many enemy casualties there are. The higher the temperature the better. Additionally terrorism does not impact enemy casualties but minimizing it during the conflict will reduce civilian casualties (perhaps allowing for a little more room for justification in using increased missiles or firepower).

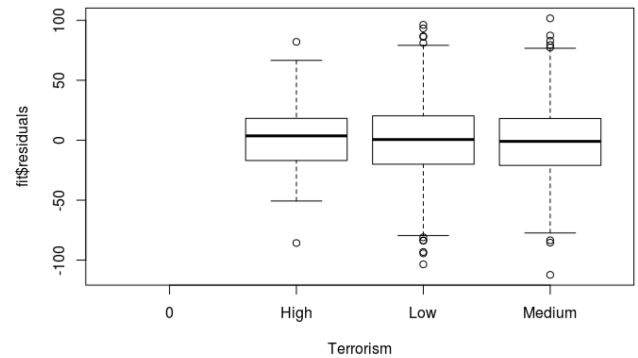
While these variables have strong evidence of influencing the enemy and civilian casualties during war, it is possible that other unknown variables may as well. A potential subject of future study may be the ratios of ground to air combat forces, or perhaps a smaller scale study on the effectiveness of individual units that vary in size and equipment.

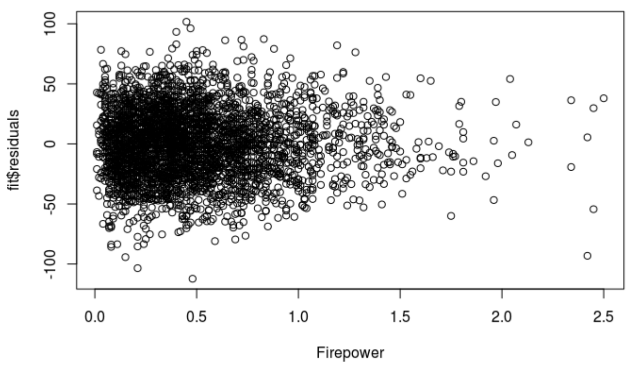
With this information the US is on track to be prepared to deal with the Latverian thereat. These models can be used to judge the needs of stockpiling arms, which weapons are most effective, what time of year is most effective to strike (summer), all while organizing its war plan around these variables. While this analysis itself is just the first step in preparation against Latveria, it is an important foundation.

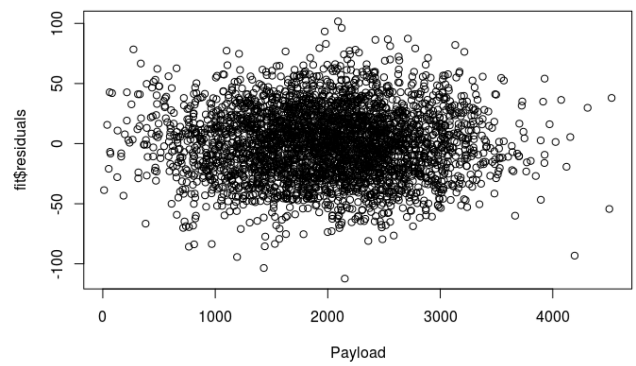
Appendix A
Output of Calculations and Plots in R

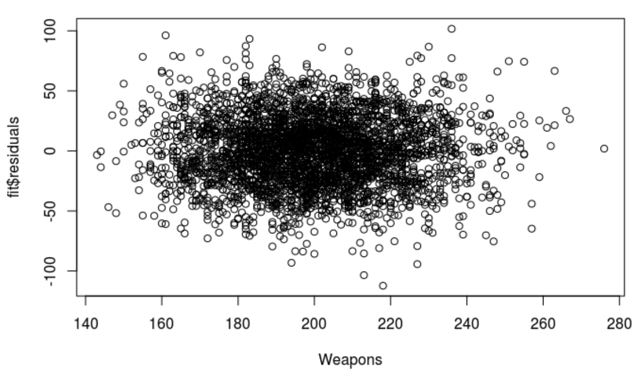
Residuals: Enemy Model

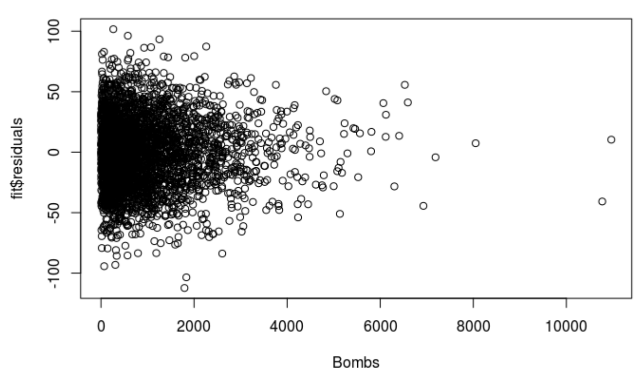


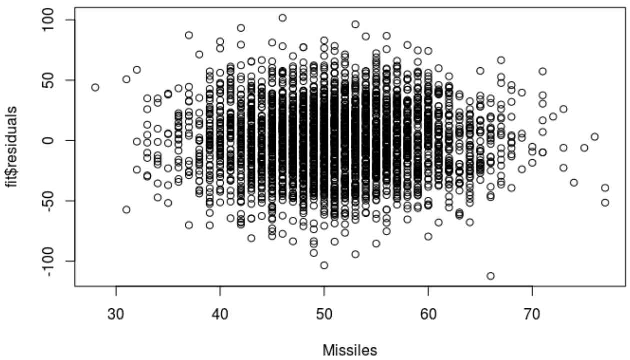








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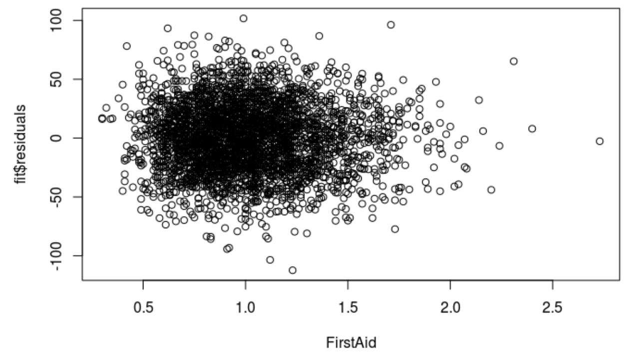
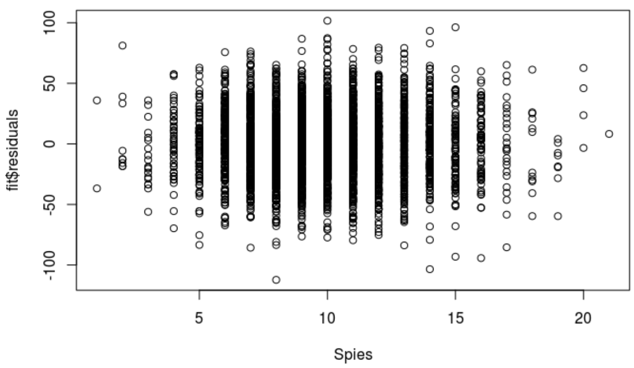
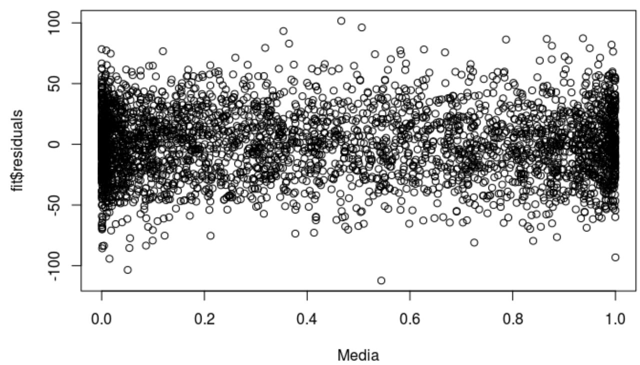
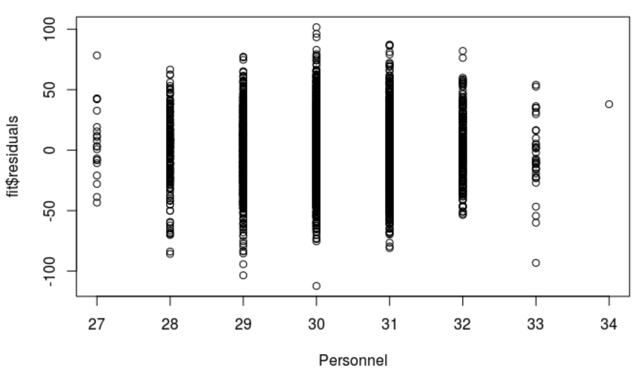
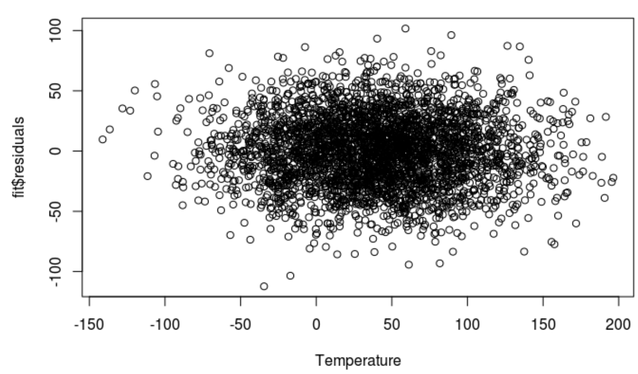
-50
0
50
100
30
40
50
60
70
Missiles

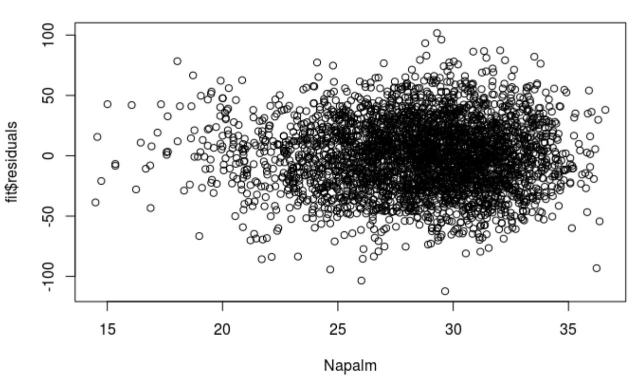

fit$residuals
-100
-50
0
50
100
0.5
1.0
1.5
2.0
2.5
FirstAid

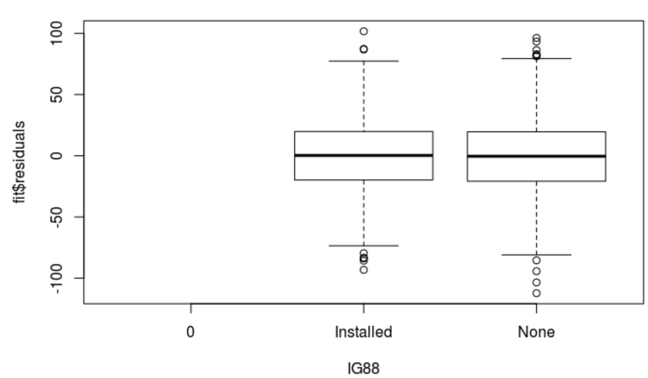

fit$residuals
-100
-50
0
50
100
5
10
15
20
Spies


fit$residuals
-100
-50
0
50
100
0.0
0.2
0.4
0.6
0.8
1.0
Media


fit$residuals
-100
-50
0
50
100
27
28
29
30
31
32
33
34
Personnel


fit$residuals
-100
-50
0
50
100
-150
-100
-50
0
50
100
150
200
Temperature


fit$residuals
-100
-50
0
50
100
15
20
25
30
35
Napalm


fit$residuals
-100
-50
0
50
100
0
Installed
None
IG88

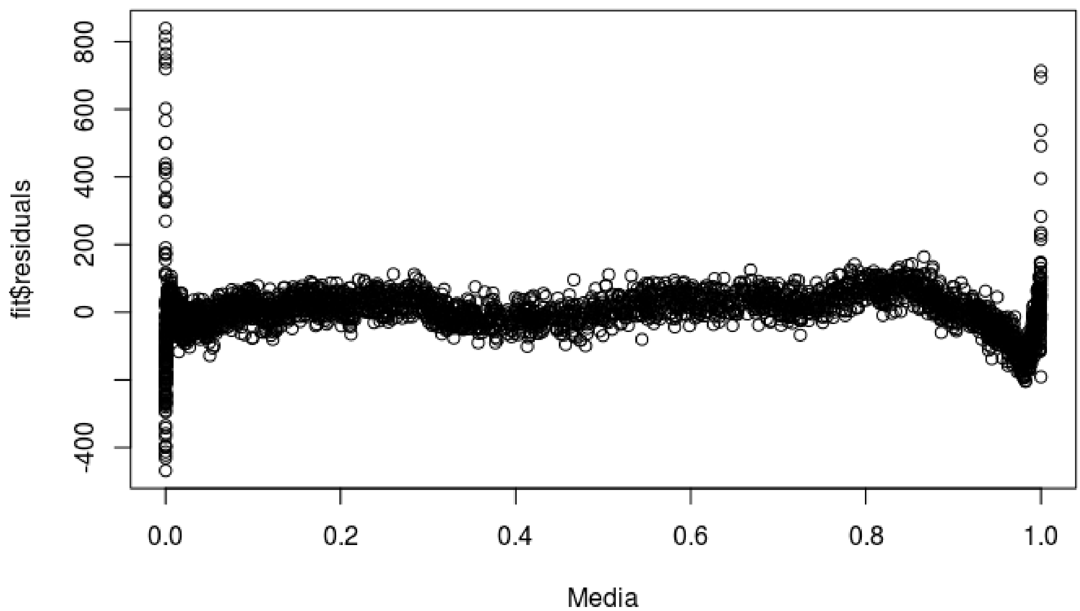


Figure B.1
The Media residual plot before incorporating a logarithmic Media term in the Enemy model. Most other residual plots had a similar pattern.

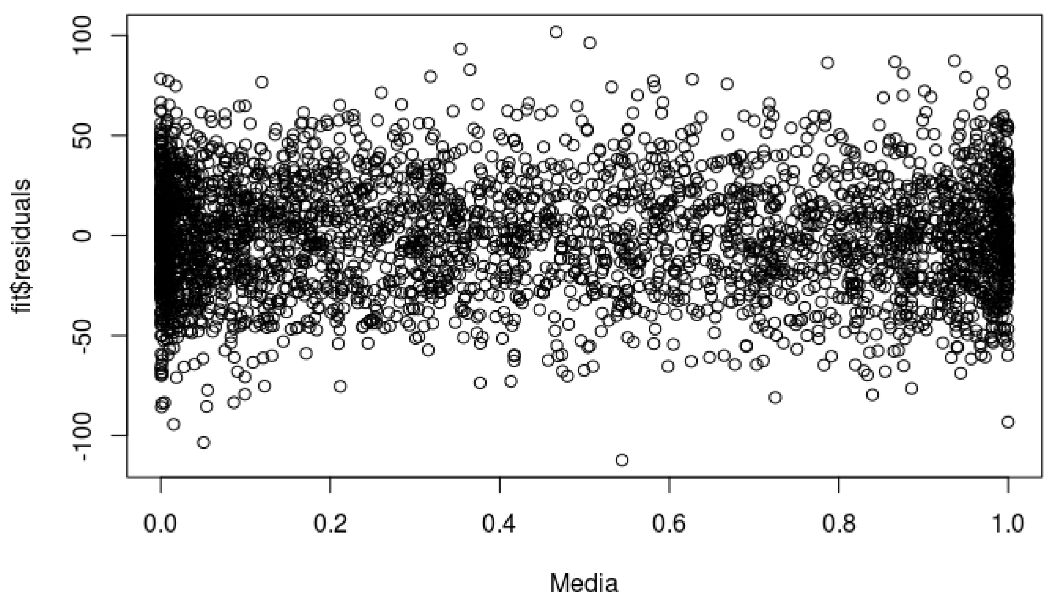


Figure B.2
The Media residual plot after having incorporated the logarithmic Media term in the Enemy model. A similar improvement happened to nearly every residual plot, not just to Media.

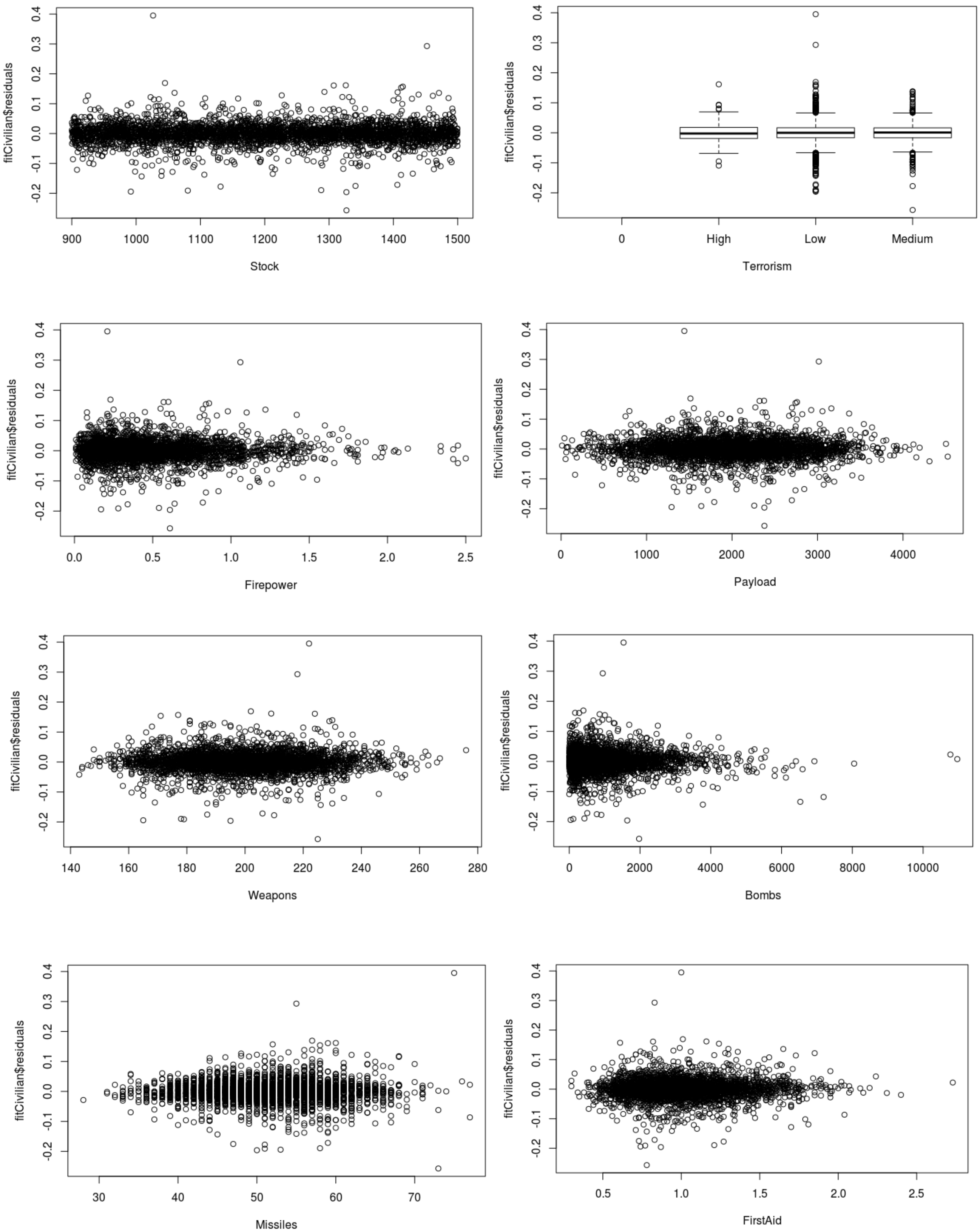
Summary: Enemy Model

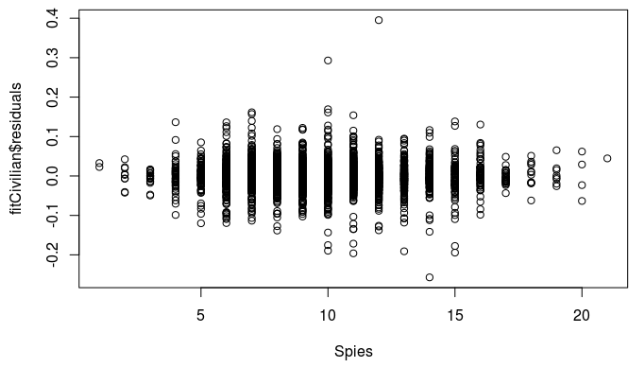
```
Call:
lm(formula = Enemy ~ Firepower + Payload + Weapons + Bombs +
     Missiles + Spies + IG88 + Bombs * Missiles + I(Missiles^2) +
     I(Spies^2) + I(Spies^3) + log(Media), data = war)

Residuals:
      Min       1Q   Median       3Q      Max
-112.294  -20.223   -0.107   19.627  101.650

Coefficients:
                 Estimate  Std. Error t value   Pr(>|t|)
(Intercept)     4.317e+03  2.759e+01  156.457  < 2e-16 ***
Firepower       4.247e+01  1.324e+01    3.206  0.00136 **
Payload         2.771e-02  1.043e-02    2.657  0.00793 **
Weapons        -9.593e-01  2.501e-02  -38.351  < 2e-16 ***
Bombs          -6.094e-03  3.666e-03   -1.662  0.09651 .
Missiles       -3.667e+01  7.523e-01  -48.743  < 2e-16 ***
Spies           1.118e+02  2.664e+00   41.976  < 2e-16 ***
IG88None       -2.212e+02  9.902e-01 -223.433  < 2e-16 ***
I(Missiles^2)   4.560e-01  7.202e-03   63.318  < 2e-16 ***
I(Spies^2)     -1.225e+01  2.635e-01  -46.500  < 2e-16 ***
I(Spies^3)      3.693e-01  8.266e-03   44.678  < 2e-16 ***
log(Media)      3.592e+02  1.573e+00  228.342  < 2e-16 ***
Bombs:Missiles  1.905e-02  7.205e-05  264.451  < 2e-16 ***

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 28.82 on 3385 degrees of freedom
Multiple R-squared:  0.9995,    Adjusted R-squared:  0.9995
F-statistic: 5.496e+05 on 12 and 3385 DF,  p-value: < 2.2e-16
```

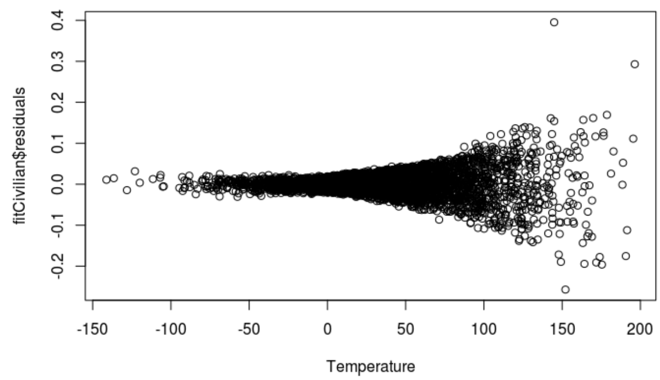
Confidence interval for slopes of enemy prediction equation:

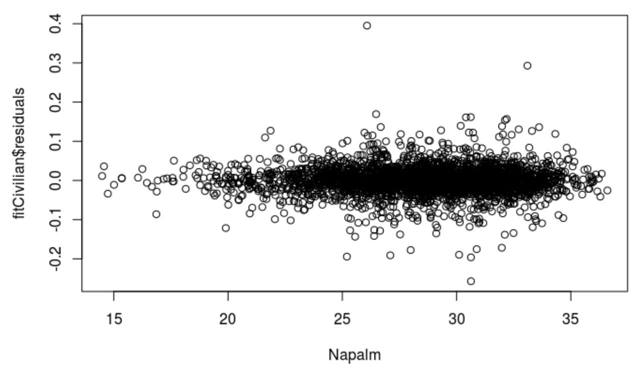
```
> confint(fit)
                    2.5 %        97.5 %
(Intercept)     4.263201e+03  4.371407e+03
Firepower       1.649635e+01  6.843373e+01
Payload         7.261157e-03  4.816680e-02
Weapons        -1.008363e+00 -9.102736e-01
Bombs          -1.328088e-02  1.093051e-03
Missiles       -3.814268e+01 -3.519279e+01
Spies           1.065969e+02  1.170429e+02
IG88None       -2.231849e+02 -2.193020e+02
I(Missiles^2)   4.418872e-01  4.701282e-01
I(Spies^2)     -1.276798e+01 -1.173482e+01
I(Spies^3)      3.531017e-01  3.855154e-01
log(Media)      3.560922e+02  3.622604e+02
Bombs:Missiles  1.891137e-02  1.919389e-02
```

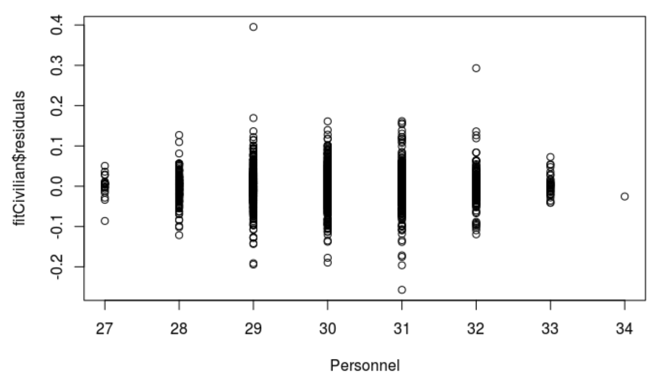
Residuals: Civilian Model

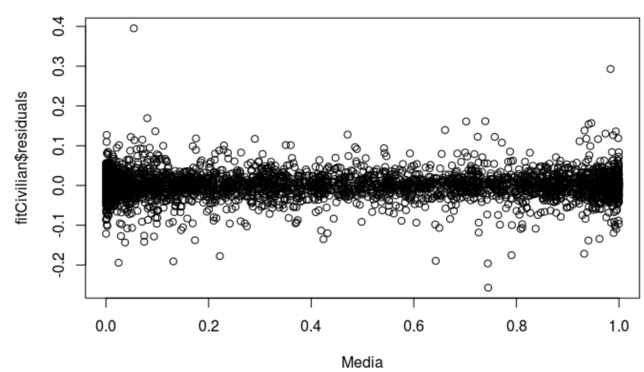


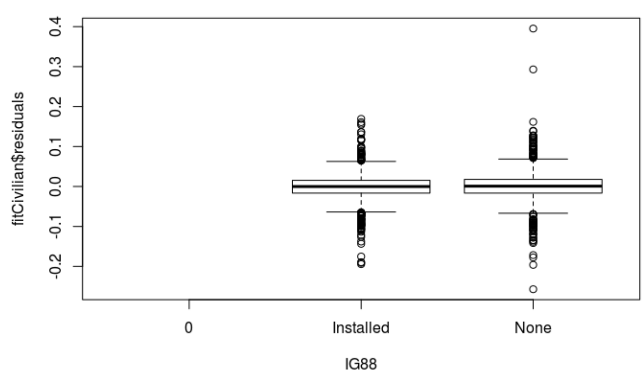












Note: It appears as though there is some factor to this model that is being missed but options were exhausted and it was not found. Certain patterns like the fanning in the temperature residual plot are not ideal but due to the low standard error and a high adjusted R^2 this problem is likely not severe.

Summary: Civilian Model

```
Call:
lm(formula = log(Civilian) ~ Terrorism + Firepower + Missiles + 
     Temperature + (Temperature * Missiles) + I(Temperature^2) + 
     I(Temperature^3), data = war)

Residuals:
      Min       1Q   Median       3Q      Max 
-0.25717 -0.01656  0.00015  0.01673  0.39517 

Coefficients:
                       Estimate  Std. Error  t value  Pr(>|t|)    
(Intercept)           3.158e+00  6.458e-03  488.965  < 2e-16 ***
TerrorismLow         -2.317e-02  3.324e-03   -6.971 3.76e-12 ***
TerrorismMedium      -1.108e-02  3.404e-03   -3.255  0.00114 ** 
Firepower             3.645e-03  1.723e-03    2.116  0.03443 *  
Missiles              4.400e-04  1.102e-04    3.991 6.71e-05 ***
Temperature          -6.816e-04  8.894e-05   -7.663 2.35e-14 ***
I(Temperature^2)      2.138e-06  2.908e-07    7.352 2.44e-13 ***
I(Temperature^3)      1.943e-08  2.013e-09    9.656  < 2e-16 ***
Missiles:Temperature -2.646e-04  1.714e-06 -154.393  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.03509 on 3389 degrees of freedom
Multiple R-squared:  0.9975,	Adjusted R-squared:  0.9975 
F-statistic: 1.664e+05 on 8 and 3389 DF,  p-value: < 2.2e-16
```

Confidence interval for slopes of civilian prediction equation:

```
> confint(fitCivilian)
                             2.5 %        97.5 %
(Intercept)           3.145282e+00  3.170607e+00
TerrorismLow         -2.968682e-02 -1.665362e-02
TerrorismMedium      -1.775321e-02 -4.406443e-03
Firepower             2.674072e-04  7.022210e-03
Missiles              2.238433e-04  6.561328e-04
Temperature          -8.559381e-04 -5.071857e-04
I(Temperature^2)      1.567722e-06  2.708039e-06
I(Temperature^3)      1.548688e-08  2.337868e-08
Missiles:Temperature -2.679855e-04 -2.612645e-04
```

Appendix B
Rejected Alternate Titles

“Fantastic 4: Rise of the Covariates Surfer”

“Wait, That’s Not Latvia?”

“Spelling Doom for Latveria”

“Doom, Where’s my Army?”

“Are You Sure it isn’t Latvia?”

“3050finalVersion3FinalRevisionBackupJustInCaseCopyLastEdits”

“Where in the World Is Carmen Latveria?
(An Educational Approach to War)”