Project Report

Title

Predictive Analysis of Formula Student Germany, 2019

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Problem Definition:

FSG (Formula Student Germany) is a single seat formula race-car which is designed and manufactured by the students in teams to compete with different teams over the world. The winner of the competition is chosen on his performance in many areas like performance, sales pitching and performance in areas like acceleration, braking, handling, aesthetics and cost. We are going to focus on FSC (Formula Student Combustion) category in which we are going to do predictive analysis for 2019 tournament. We will be predicting our probable result for the competition in 2019 season which includes events like acceleration time, Auto-cross time, Skid-Pad time, Endurance time and prediction of our overall points as well. These will show our probable standing in the 2019 season.
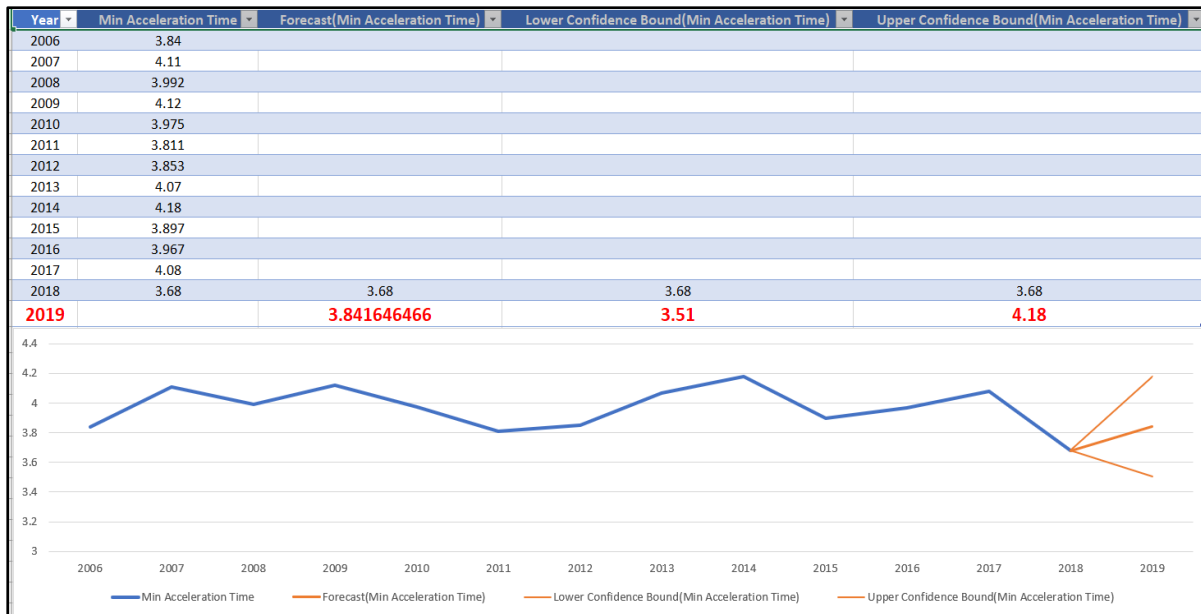
Prediction Analysis for Acceleration:

- Acceleration test is the test in which the cars time is recorded for a straight distance of 75m and car to finish in the lowest time gets the maximum points out of 75.
- We have compiled the mean time of the test for the last 10 years and we have extrapolated the minimum time taken for all the years as suggested from the formula.

$$ACCELERATIONSCORE = 71.5 \left(\frac{\frac{T_{max}}{T_{team}} - 1}{0.5} \right)$$

- We have represented the sample data on the scatter plot using Minitab.
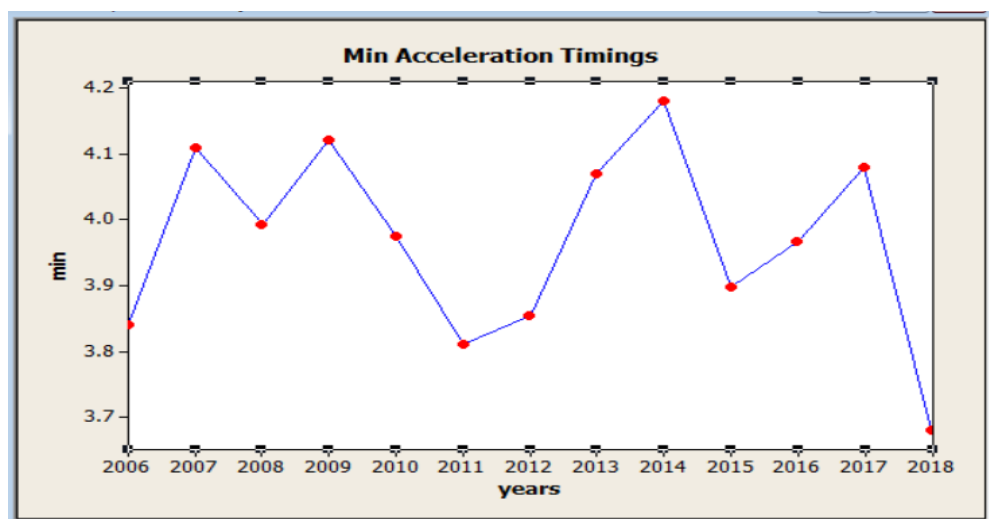
- We have predicted the minimum lap timings for acceleration for 2019 event using forecasting sheet from Excel.

Year	Min Acceleration Time	Forecast(Min Acceleration Time)	Lower Confidence Bound(Min Acceleration Time)	Upper Confidence Bound(Min Acceleration Time)
2006	3.84			
2007	4.11			
2008	3.992			
2009	4.12			
2010	3.975			
2011	3.811			
2012	3.853			
2013	4.07			
2014	4.18			
2015	3.897			
2016	3.967			
2017	4.08			
2018	3.68	3.68	3.68	3.68
2019		3.841646466	3.51	4.18

- During testing acceleration timings were recorded and taken with a confidence interval of 90%

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One-Sample Z: Mybest testing data

The assumed standard deviation = 0.271035


Variable                  N     Mean    StDev   SE Mean        90% CI
Mybest testing data      15   4.7020   0.2710   0.0700   (4.5869, 4.8171)
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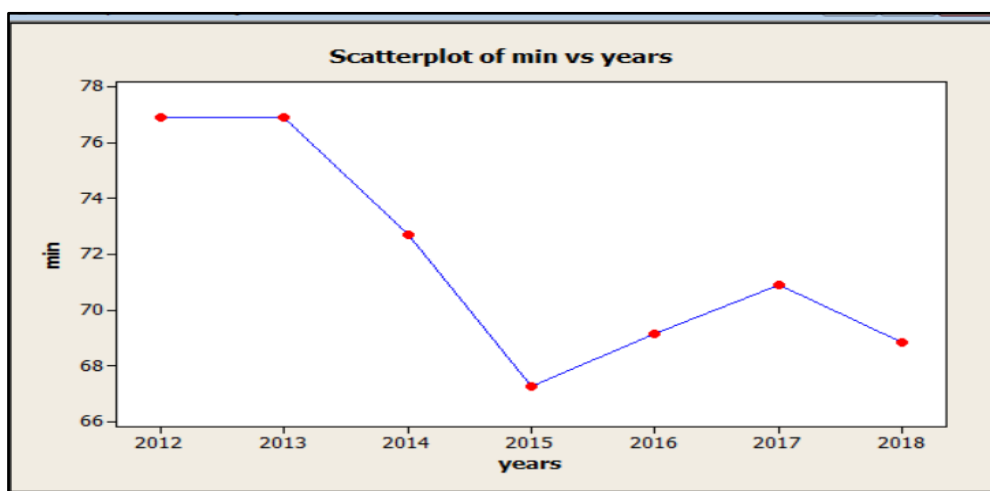
Conclusion

- The most probable points scored by our team is equal to 32.17 in 2019.
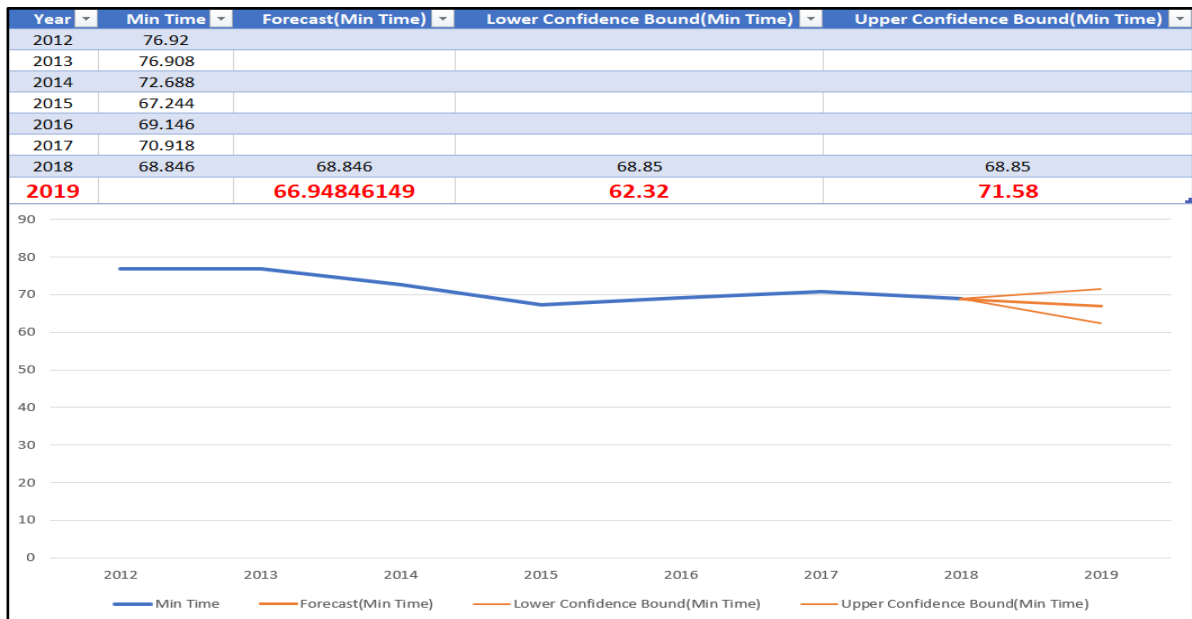
Autocross

- In this event the cars travel a 1km long patch with curves, straights and chicanes. The car with the fastest time including penalties gets a maximum out of 100 points.

$$AUTOCROSSSCORE = 95.5 \left(\frac{\frac{T_{max}}{T_{team}} - 1}{0.25} \right)$$

- We have represented the sample data on the scatter plot using Minitab.

- We have predicted the minimum lap timings for acceleration for 2019 event using forecasting sheet from Excel.

Year	Min Time	Forecast(Min Time)	Lower Confidence Bound(Min Time)	Upper Confidence Bound(Min Time)
2012	76.92			
2013	76.908			
2014	72.688			
2015	67.244			
2016	69.146			
2017	70.918			
2018	68.846	68.846	68.85	68.85
2019		**66.94846149**	**62.32**	**71.58**

- During testing acceleration timings were recorded and taken with a confidence interval of 85%

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The assumed standard deviation = 5.44153


Variable            N    Mean   StDev   SE Mean      85% CI
my best timings    19   93.50    5.44      1.25  (91.70, 95.30)
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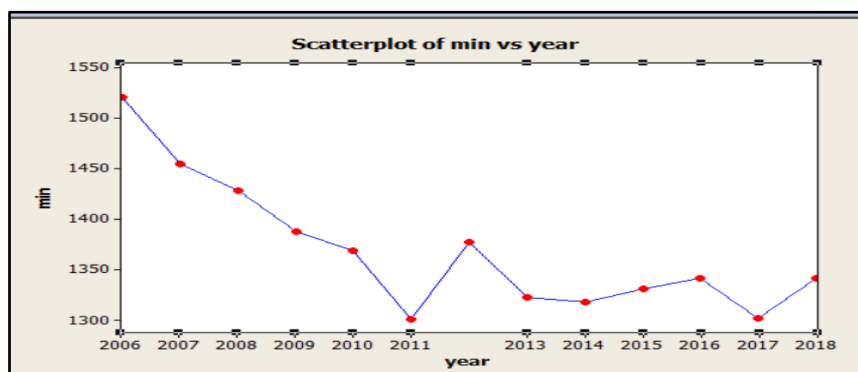
Conclusion

- The most probable points scored by our team is equal to 4.5 in 2019
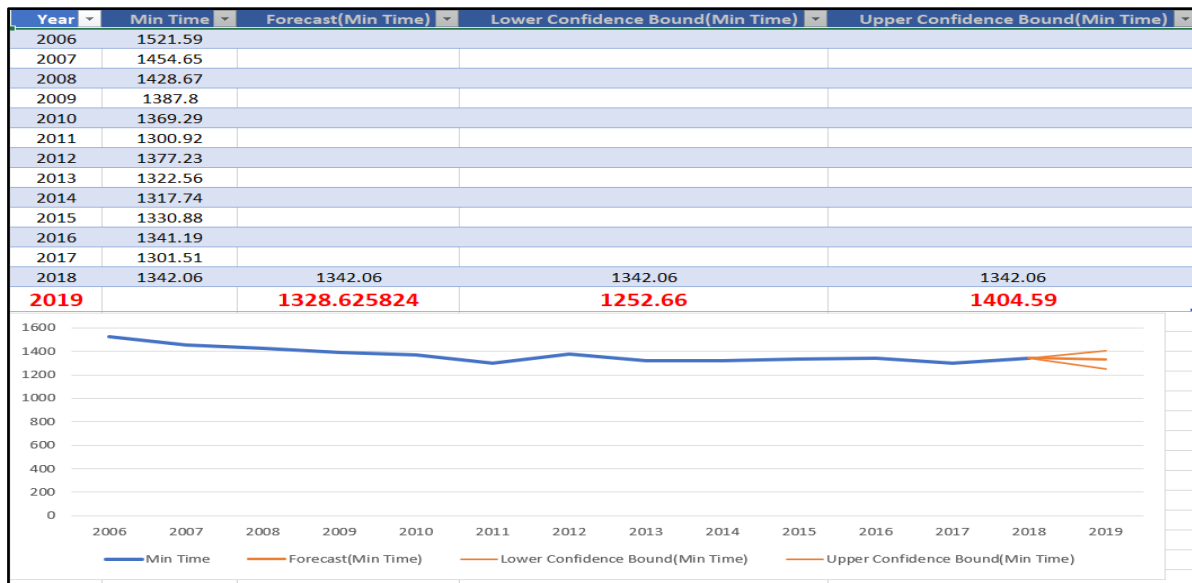
Endurance

- In this event the cars must show their endurance over a gruelling track of 22km over which many dynamics like acceleration, handling, suspension, braking are put to test.

$$ENDURANCESCORE = 300\left(\frac{\frac{T_{max}}{T_{team}} - 1}{0.333}\right)$$

- We have represented the sample data on the scatter plot using Minitab.

- We have predicted the minimum lap timings for acceleration for 2019 event using forecasting sheet from Excel.

Year	Min Time	Forecast(Min Time)	Lower Confidence Bound(Min Time)	Upper Confidence Bound(Min Time)
2006	1521.59			
2007	1454.65			
2008	1428.67			
2009	1387.8			
2010	1369.29			
2011	1300.92			
2012	1377.23			
2013	1322.56			
2014	1317.74			
2015	1330.88			
2016	1341.19			
2017	1301.51			
2018	1342.06	1342.06	1342.06	1342.06
2019		1328.625824	1252.66	1404.59

- During testing acceleration timings were recorded and taken with a confidence interval of 85%.

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One-Sample T: best timing

Variable      N    Mean  StDev  SE Mean        95% CI
best timing   3  2085.4   50.0     28.9  (1961.2, 2209.5)
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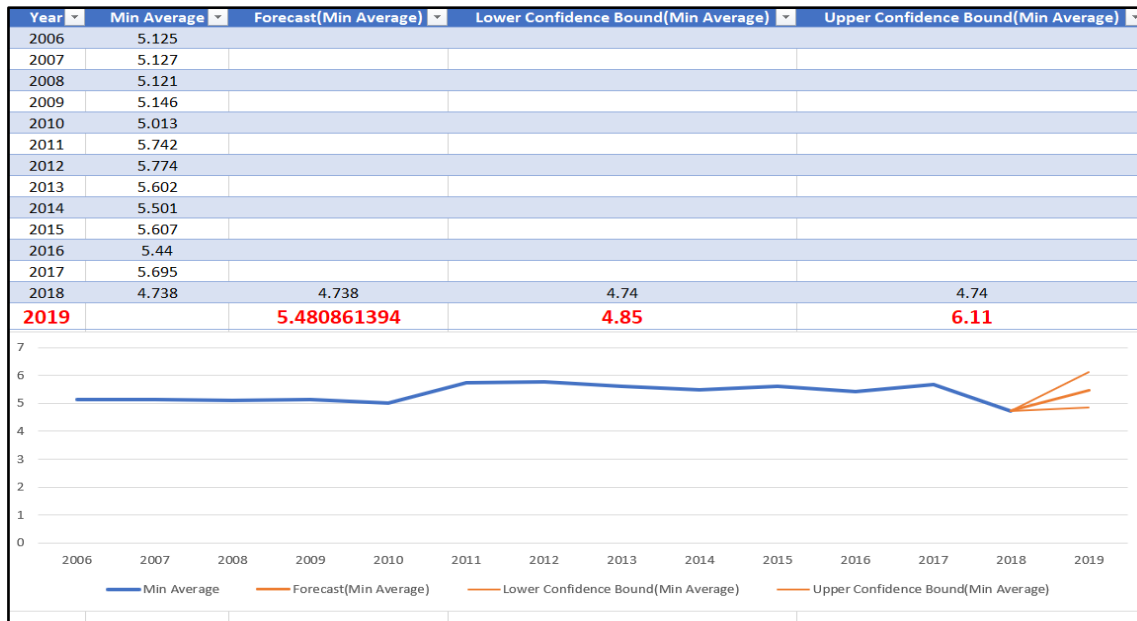
Conclusion

- Given probability of completing the endurance test is 14.12% we scored 25 points.

Skid-Pad

- During the Skid Pad event, the cars must drive a figure of 8 circuit lined with track cones in which the second lap time will be measured. The lap points give a comparative value for lateral acceleration.

$$SKIDPADSCORE = 71.5 \left(\frac{\left(\frac{T_{max}}{T_{team}}\right)^2 - 1}{0.5625} \right)$$

- We have predicted the minimum lap timings for acceleration for 2019 event using forecasting sheet from Excel.

Year	Min Average	Forecast(Min Average)	Lower Confidence Bound(Min Average)	Upper Confidence Bound(Min Average)
2006	5.125			
2007	5.127			
2008	5.121			
2009	5.146			
2010	5.013			
2011	5.742			
2012	5.774			
2013	5.602			
2014	5.501			
2015	5.607			
2016	5.44			
2017	5.695			
2018	4.738	4.738	4.74	4.74
2019		5.480861394	4.85	6.11

- During testing acceleration timings were recorded and taken with a confidence interval of 99%

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The assumed standard deviation = 0.2515


Variable                     N    Mean   StDev  SE Mean       99% CI
best timing avg left/rig    15  5.3668  0.2516   0.0649  (5.1995, 5.5341)
```

Conclusion
- The most probable points scored by our team is equal to 71.5 in 2019.

Prediction Analysis for Fuel Efficiency

- During the endurance test the fuel consumption is recorded and it is calculated relative to the speed.
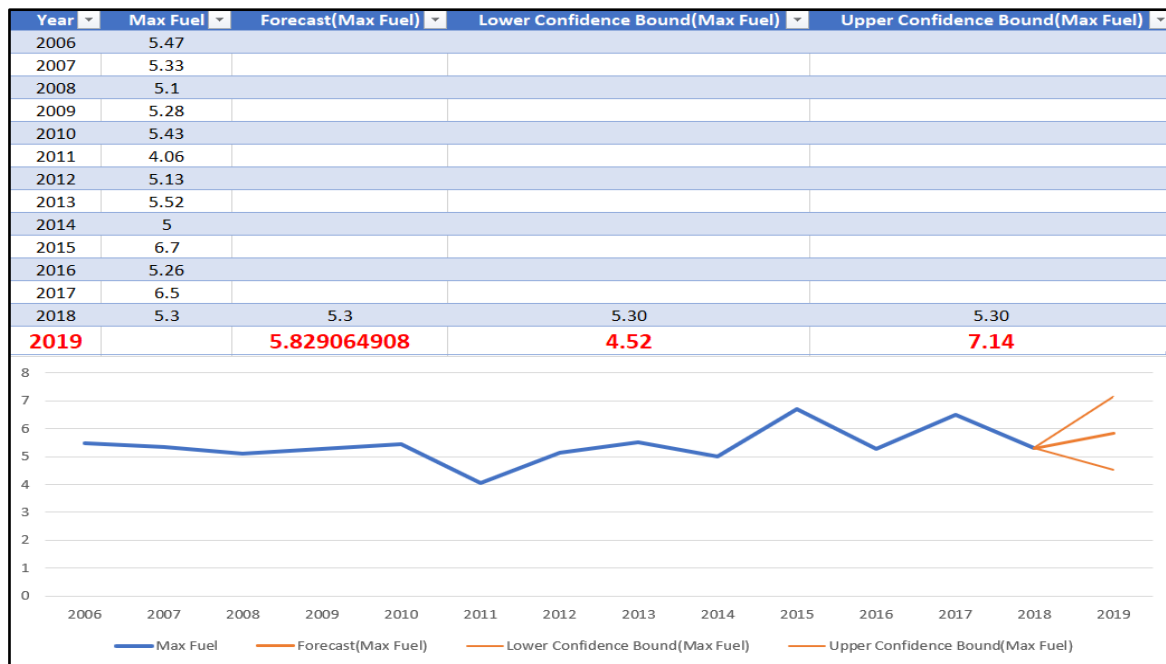
$$EFFICIENCY\ SCORE = 100 \left(\frac{\frac{E_{min}}{E_{team}} - 1}{\frac{E_{min}}{E_{max}} - 1} \right)$$

$$EFFICIENCY\ FACTOR = \frac{T_{min} \cdot V_{min}}{T_{team} \cdot V_{team}}$$
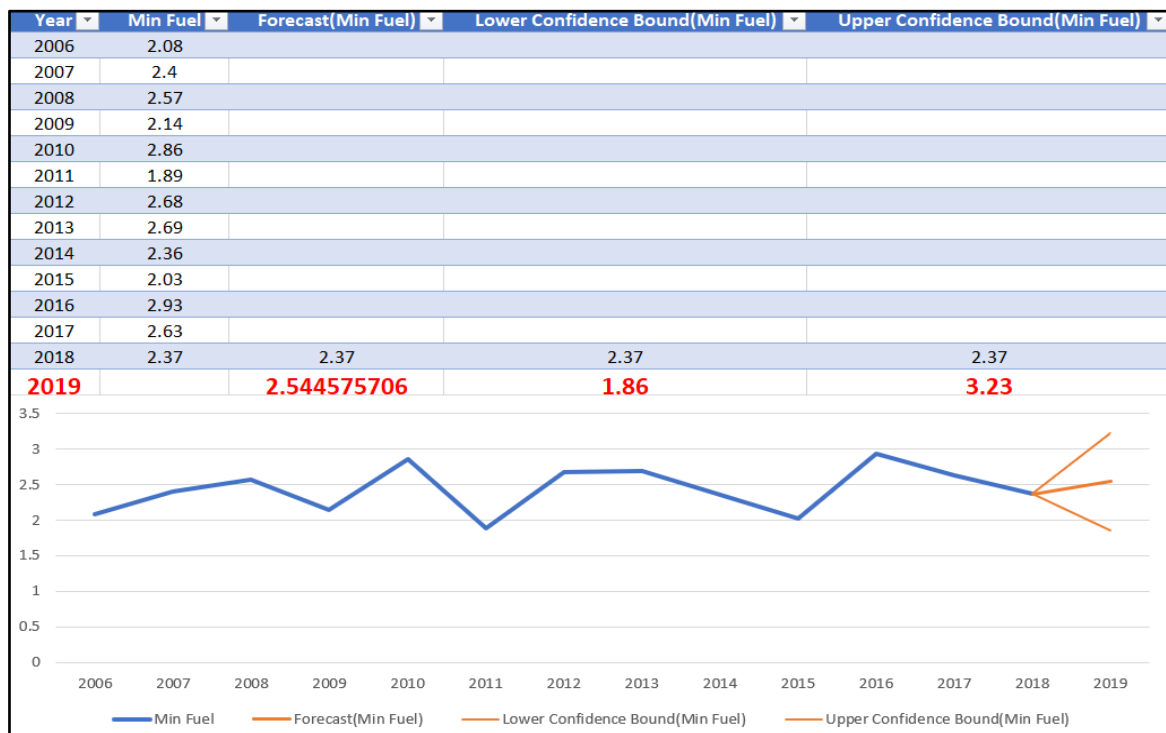
- During testing acceleration timings were recorded and taken with a confidence interval of 95%

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One-Sample T: my fuel consumption

Variable              N    Mean   StDev  SE Mean       95% CI
my fuel consumption   6  3.4033  0.0774   0.0316  (3.3221, 3.4845)
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Year	Max Fuel	Forecast(Max Fuel)	Lower Confidence Bound(Max Fuel)	Upper Confidence Bound(Max Fuel)
2006	5.47			
2007	5.33			
2008	5.1			
2009	5.28			
2010	5.43			
2011	4.06			
2012	5.13			
2013	5.52			
2014	5			
2015	6.7			
2016	5.26			
2017	6.5			
2018	5.3	5.3	5.30	5.30
2019		**5.829064908**	**4.52**	**7.14**

Graph above is for Maximum Fuel consumption

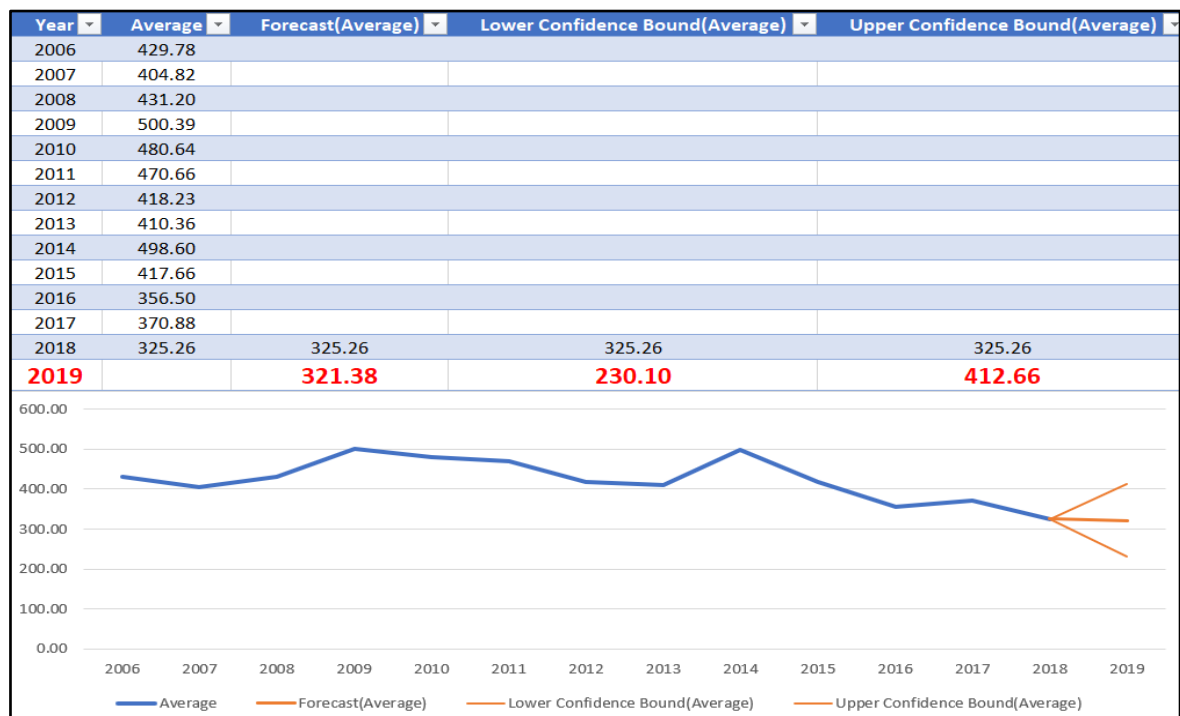| Year	Min Fuel	Forecast(Min Fuel)	Lower Confidence Bound(Min Fuel)	Upper Confidence Bound(Min Fuel)
2006	2.08			
2007	2.4			
2008	2.57			
2009	2.14			
2010	2.86			
2011	1.89			
2012	2.68			
2013	2.69			
2014	2.36			
2015	2.03			
2016	2.93			
2017	2.63			
2018	2.37	2.37	2.37	2.37
2019		**2.544575706**	**1.86**	**3.23**

Graph above is for Minimum Fuel consumption

Conclusion
- The most probable points scored by our team is equal to 42.7 in 2019, given endurance completes.

Predictive Analysis for Overall Performance

- Overall results are the combination of static and dynamic events. As static events are performance and perspective-based events, we cannot predict its outcomes. So, for simplicity we have taken averages of our previous results.

Cost = 68.62
BPP= 49.12
Design= 75.9
Acceleration = 32.17
Auto-cross = 4.5
Skid-pad = 71.5
Endurance = 25
Fuel Efficiency = 42.7
Total = 369.51

Year	Average	Forecast(Average)	Lower Confidence Bound(Average)	Upper Confidence Bound(Average)
2006	429.78			
2007	404.82			
2008	431.20			
2009	500.39			
2010	480.64			
2011	470.66			
2012	418.23			
2013	410.36			
2014	498.60			
2015	417.66			
2016	356.50			
2017	370.88			
2018	325.26	325.26	325.26	325.26
2019		321.38	230.10	412.66

- We have compared our previous points with the previous overall mean of the competition and the 90% confidence interval and given conditions

X= Random Variable of average of overall points of the competition
Mean= 301 (Our overall average over the years)

H0: $\mu=301$
H1: $\mu \neq 301$

One-Sample Z: averages

Test of mu = 301 vs not = 301
The assumed standard deviation = 53.7172

Variable	N	Mean	StDev	SE Mean	90% CI	Z	P
averages	13	424.2	53.7	14.9	(399.7, 448.7)	8.27	0.000

Conclusion:
Since 301 is not in the Rejection region range i.e. [399.7, 448.7] we fail to reject to reject H0.
2. X= Random Variable of average of overall points of the competition
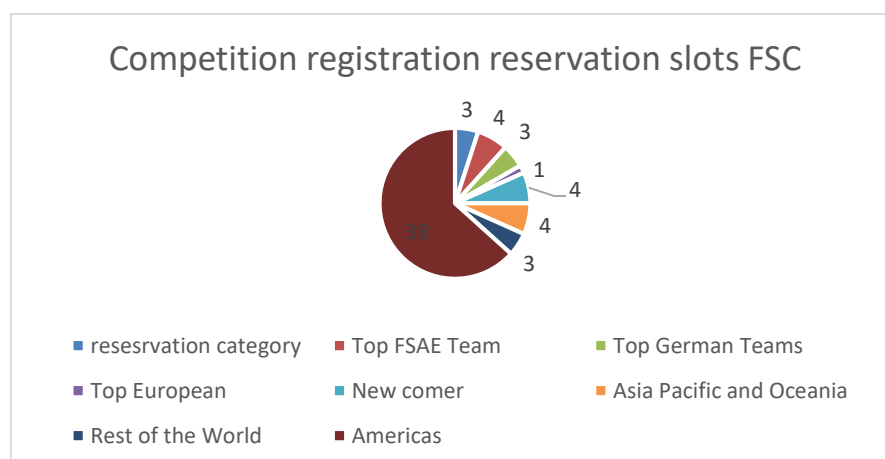Mean= 301 (Our overall average over the years)

H0: μ > 301
H1: μ <= 301

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One-Sample Z: averages

Test of mu = 301 vs > 301
The assumed standard deviation = 53.7172

                                      90% Lower
Variable    N    Mean   StDev  SE Mean    Bound     Z      P
averages   13   424.2    53.7     14.9    405.1   8.27  0.000
```

Conclusion:

Since 301 is not in the Rejection region range i.e. we fail to reject to reject H0. This means that our probability of scoring below the competition mean is more. With the current parameters we will fare the competition badly.

Probability of entering the competition:

Competition registration reservation slots FSC

- reservation category
- Top FSAE Team
- Top German Teams
- Top European
- New comer
- Asia Pacific and Oceania
- Rest of the World
- Americas

- Entry into the competition is based on rulebook quiz which is given by many teams all over the globe with special reservations we have calculated our probability of entering the competition. In this we fall under the general and rest of the world categories. The registration is cleared based on the best timing obtained and maximum marks and our team has fared very well in this throughout the years
- Probability of getting in through registration quiz= 38P1/38P4(usually 38 teams compete in ROW)+114P1/114P38(usually 114 teams compete in General)= .0000214%

References:

- https://www.formulastudent.de/fileadmin/user_upload/all/2018/PR_Media/FSG2018_magazine_v20180725_LQ.pdf
- https://www.formulastudent.de/fileadmin/user_upload/all/2017/PR/FSG2017_magazine_v20170726_LQ.pdf
- https://www.formulastudent.de/
- https://de.wikipedia.org/wiki/Formula_Student_Germany