# To Develop a Predictive Model for the Energy of Solar Flares with the help of Machine Learning

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**Solar Flares are associated with Sunspots. These sunspots are tens to thousands of kms wide and are in maximum numbers during the solar maxima of the 11 year solar cycle.**

**Comparatively Solar Flares emit large amount of high energy protons and plasma than a normal solar wind. These high energy particles affects the satellites.**

**Solar Flare Index (SFI) is affected by various parameters like Sunspot Area (SSA), Sunspot Number (SSN), and Magnetic flux density(MFD). So, by linking parameters we can create a computational predictive model for SFI which will help us to predict the future Carrington events.**

# Methodology

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## Literature Study

Studied the whole sun from the core to its outer layer, solar activities, and their causes & effects.

## Selection of Parameters

*Magnetic Flux Density*
*Sunspot Number*
*Sunspot Area*
*Solar Flare Index*

## Collection & Refining Data

Used Excel and Python codes to pre-process the data

## Apply MATLAB & Machine Learning

Curve Fitted Plots
Build Models using Supervised Machine Learning
Processing:
Splitting-->Fitting Model-->
Predicting and Comparing

## Include parameters in one final model

Multivariable Polynomial Regression
Processing:
Splitting-->Fitting Model-->
Predicting and Comparing

# Results & Discussions

**RMSE:** 2.9653 **R-squared :** 0.79
**MSE:** 8.7929 **MAE:** 2.0799
**Model type: Preset:** Optimizable Ensemble
**Ensemble method:** LS Boost

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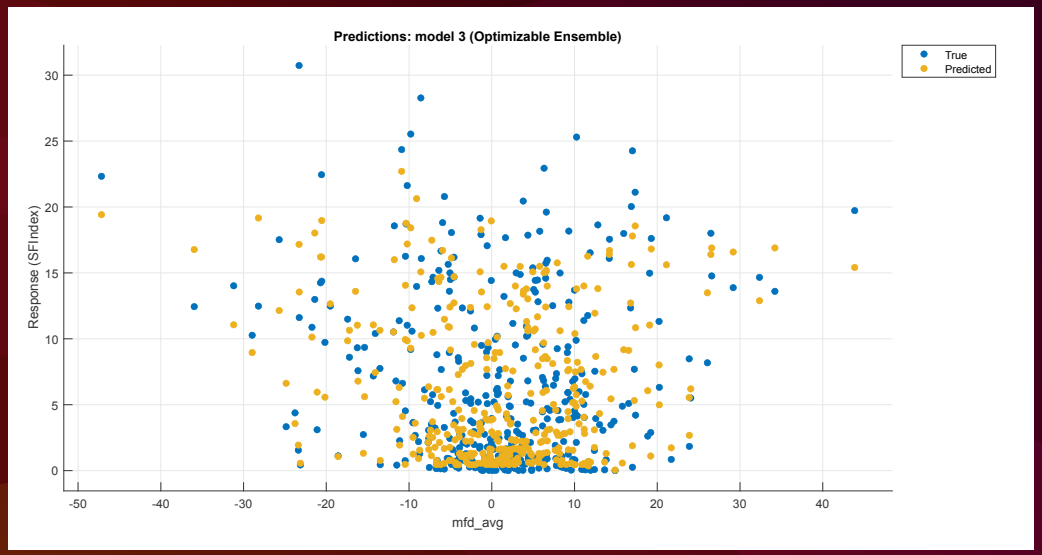
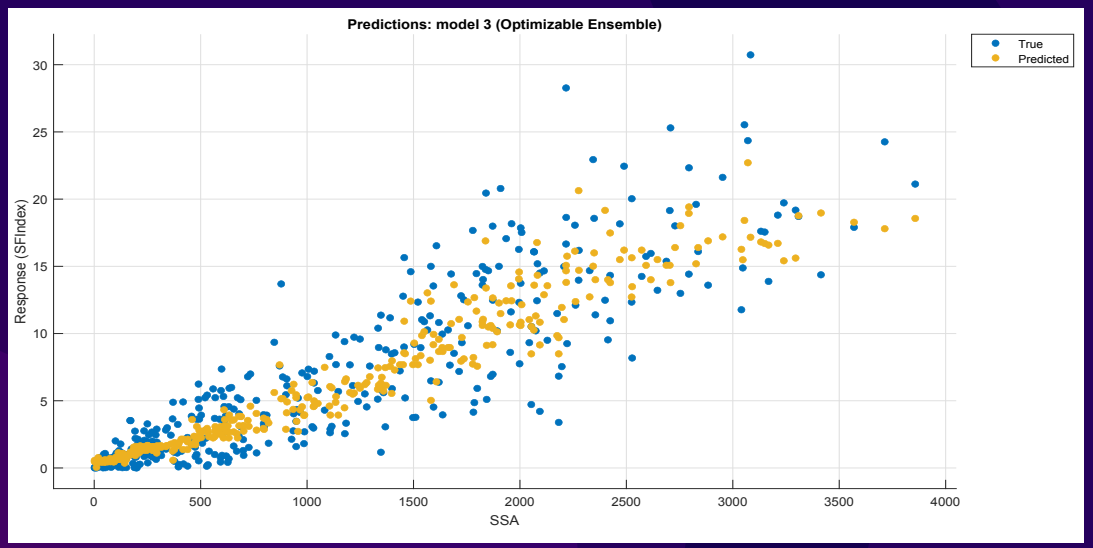
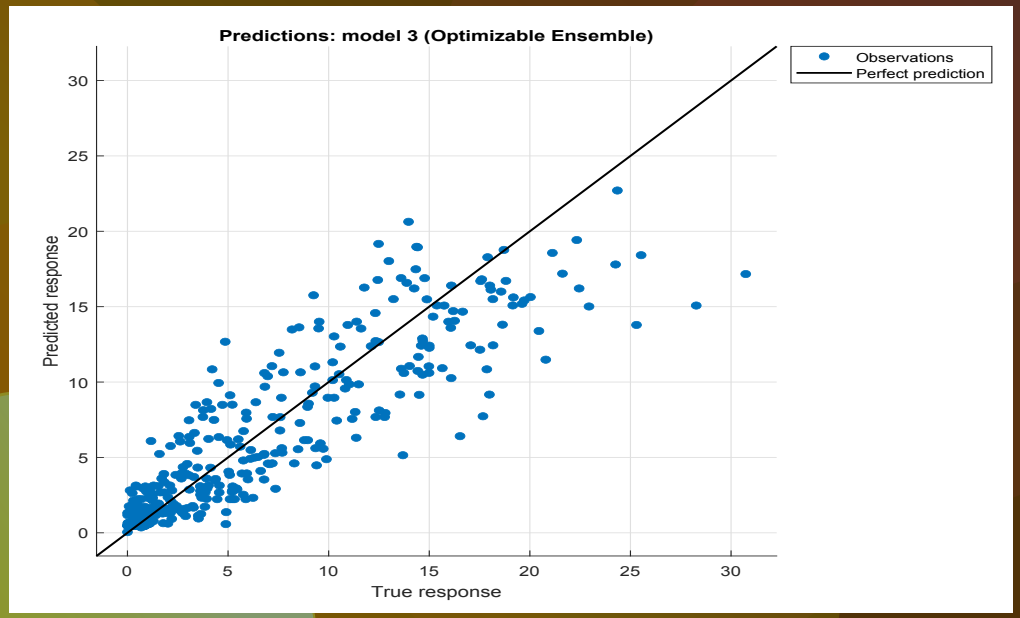


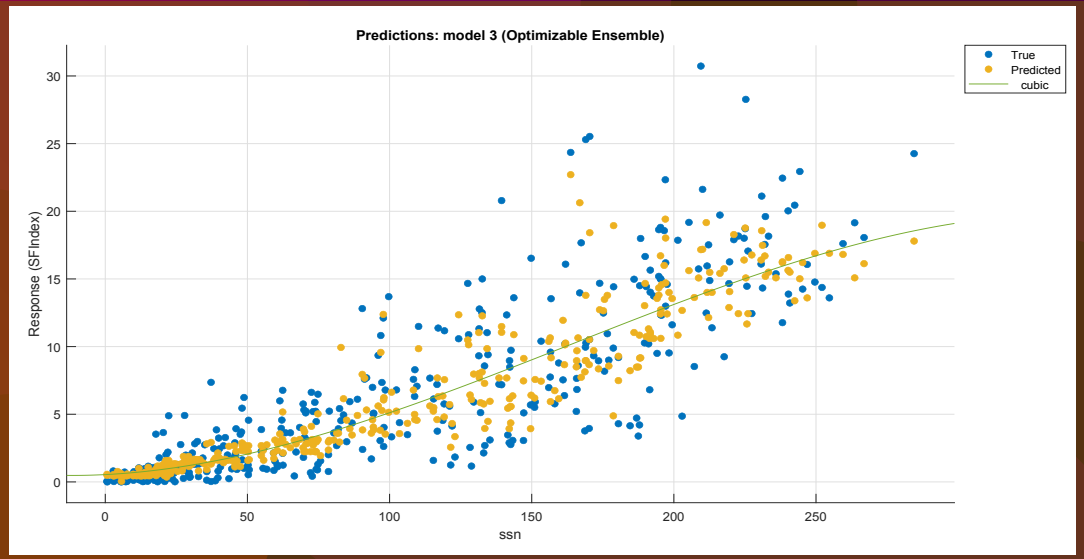

**Optimized Ensemble Prediction Model between SF Index & MFD**




**Optimized Ensemble Prediction Model between SF Index and SSA**




**Optimized Ensemble Model between Predicted & True response**




**Optimized Ensemble Prediction Model between SF Index and SSN**

**Required R-Squared vale > 0.70. Our value – 0.79 (acceptable)**

**The RMSE values obtained to be scale relative. Our value - 2.9653 (acceptable).**

**Collection of more data → value can be improved.**

**Calculated MAE value - 2.0799 (acceptable)**

**A high value of MSE High Variance in Data.**

→ **Reason: Lack of data, can be sorted out with a refined approach.**

**Higher accuracy of prediction can be achieved with more parameters.**

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# Conclusion

The accuracy of the predictive model is 0.79%. The graphs obtained are symmetrical and also, the error value is low. Hence, the accomplished results can be used as basis for further research. An equation between the parameters and SSA can be formed from the current model which can be used to make the results more concrete. New parameters like geomagnetic field strengths can be added with the existing parameters in order to understand the impact of sun on Earth.

# References


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