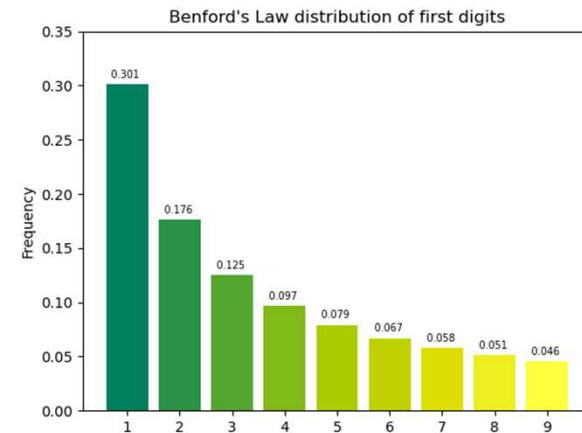
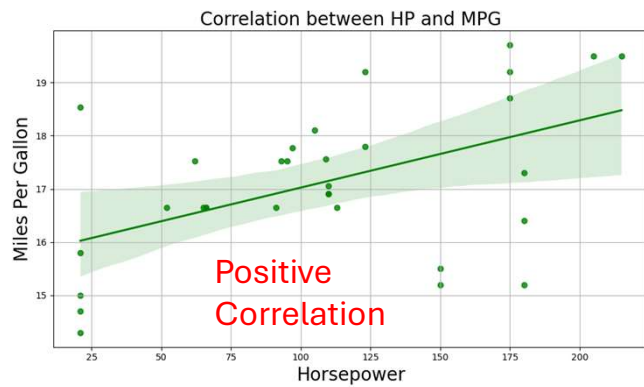


# Detection of Correlation Reversal Manipulation via Benford's Law and Random Forest

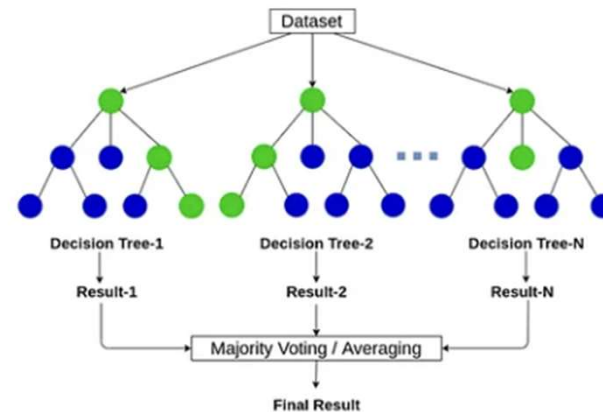


**Benford's Law**  
(Statistical Analysis)

From a given data:

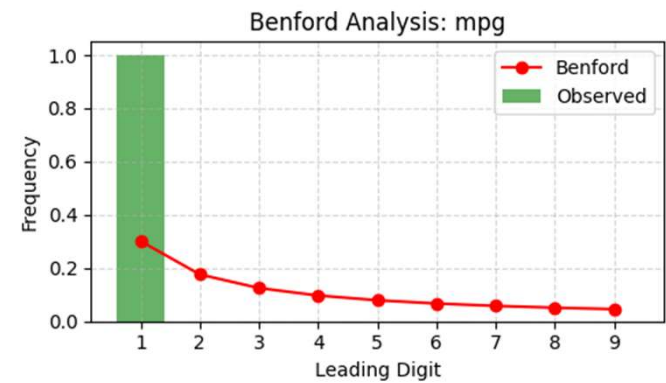
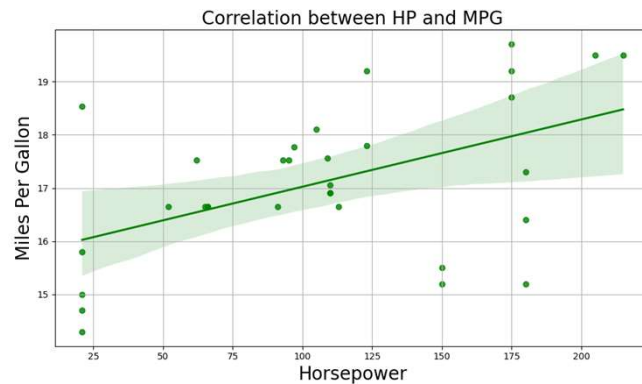
*"The more horsepower we have,  
the more miles per gallon we get."*

**Q: Is this true?**



**Random Forest**  
(Machine Learning)

# Using Benford's Law to Detect Manipulation



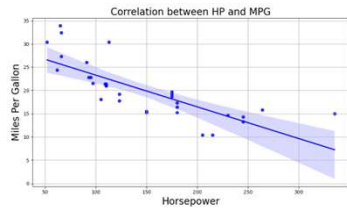
Chi-square = 74.3017, p-value = 0.0000000000006

Criteria: Chi-square > 30.58 and  $p < 0.0001$

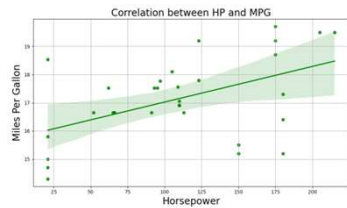
Classified as **manipulated** (anomaly and extreme)

# Using Random Forest to Detect Manipulation

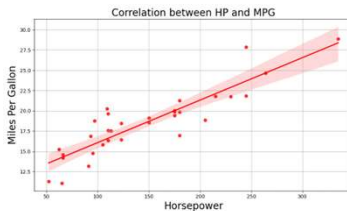
Original Data (Label=0)



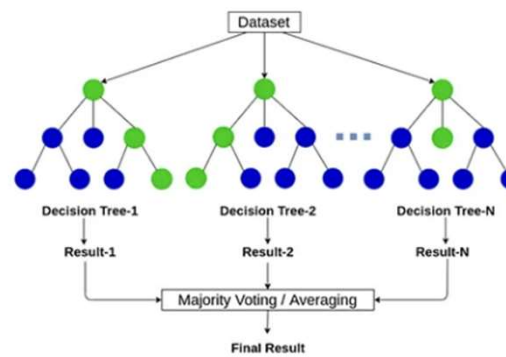
Manipulated Data (Label=1)



New Manipulated Data



Supervised Training



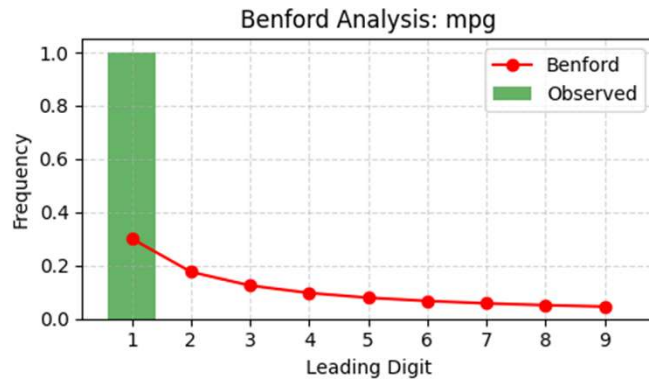
RF  
Model

Classifier

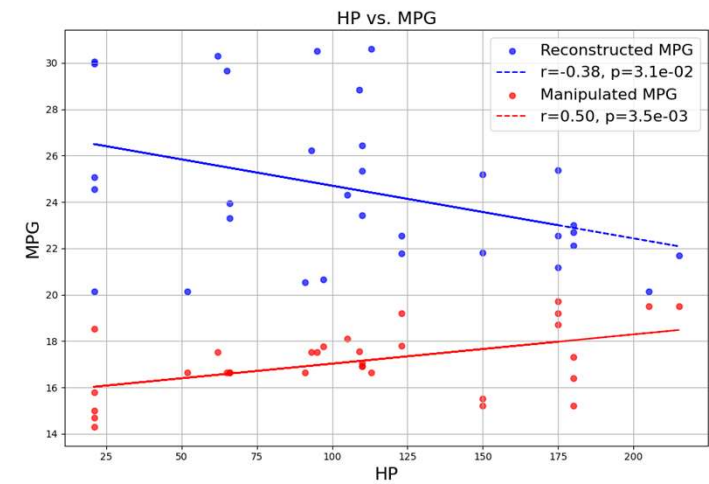
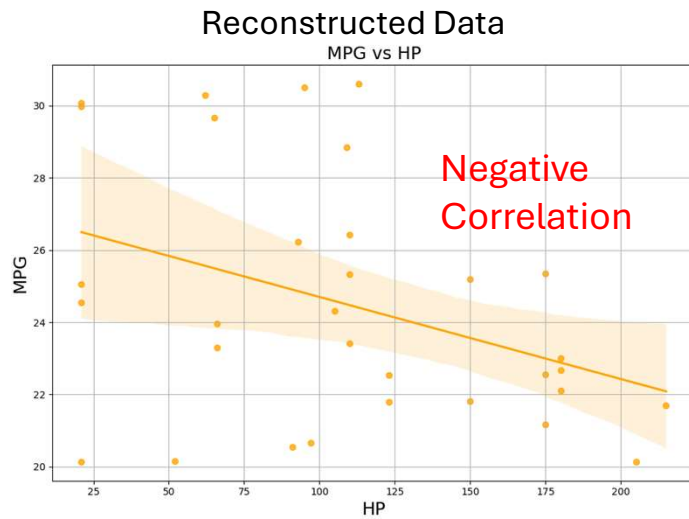
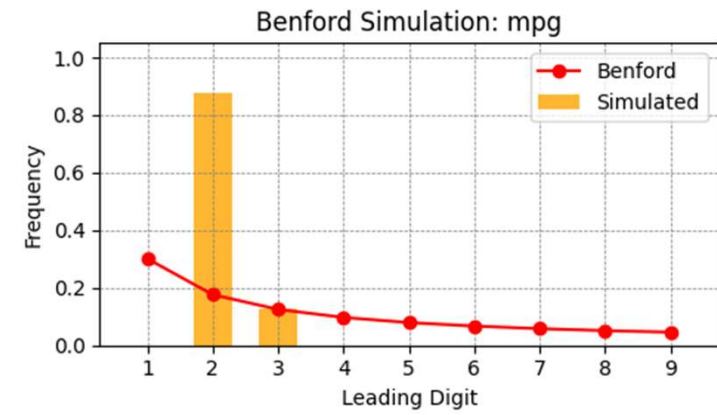
RF  
Model

Classified as **manipulated**

# Using Benford's Law to Detect Correlation Reversal

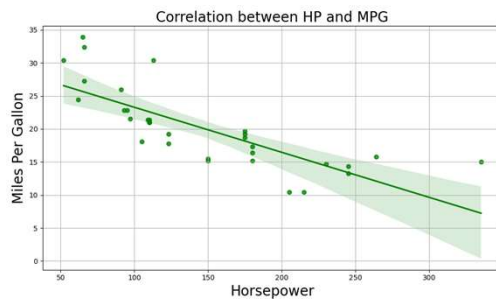


Stochastic  
Simulation

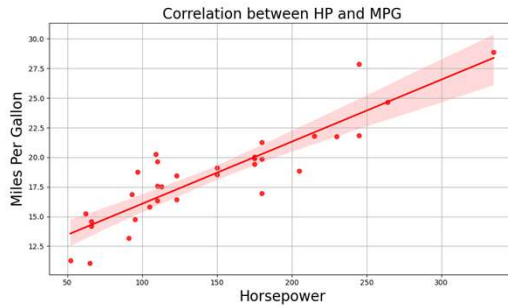


# Using Random Forest to Detect Correlation Reversal

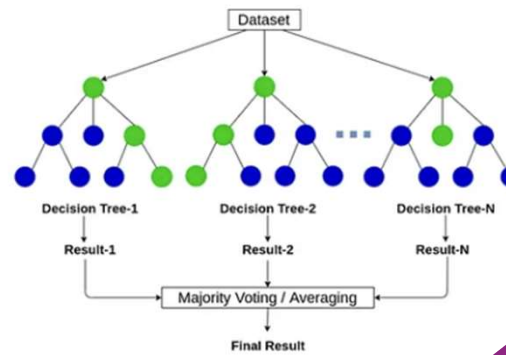
Original Data



Manipulated Data



Training

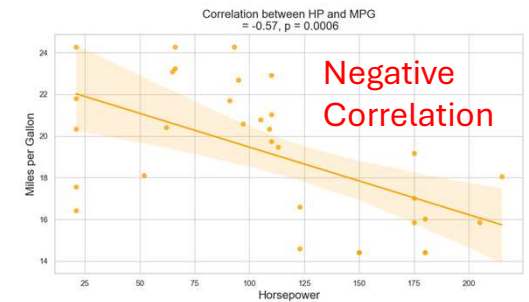


RF  
Model

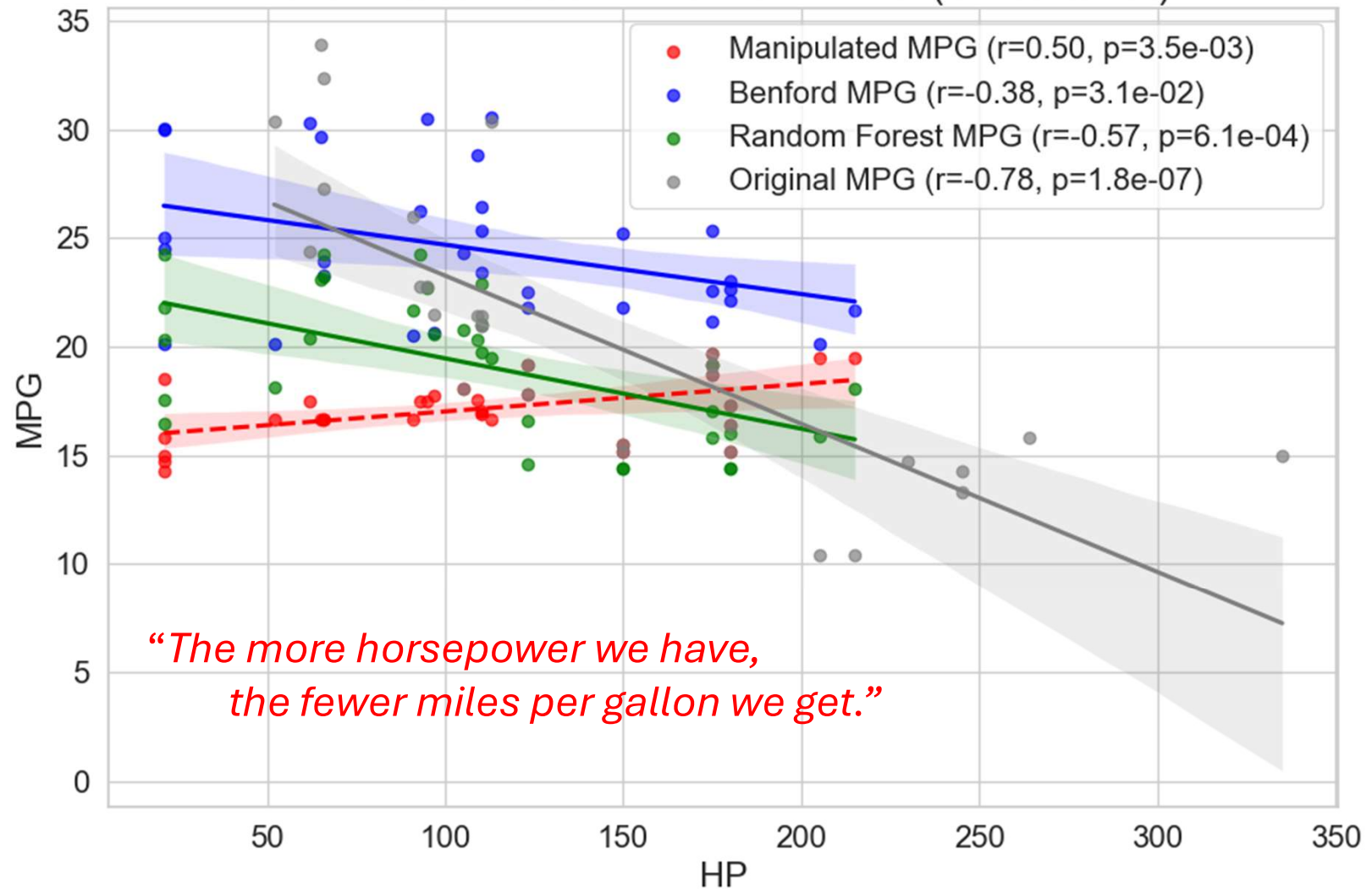
Regression

RF  
Model

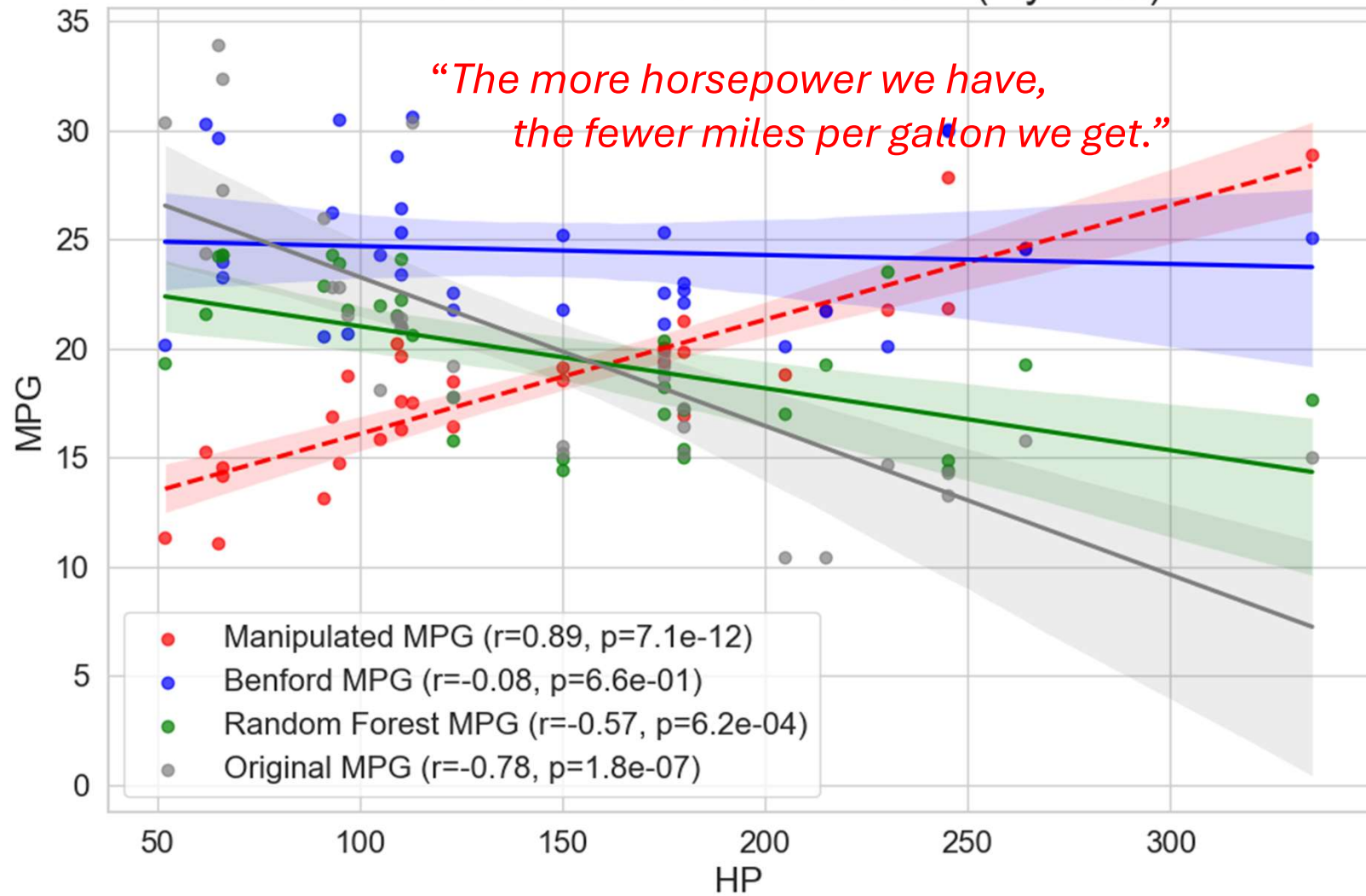
Reconstructed Data



## Correlation between HP and MPG (Given Data)



Correlation between HP and MPG (My Data)



## Evaluation of Random Forest Classifier and Regressor

=== Random Forest Classification Evaluation ===

	precision	recall	f1-score	support
0	0.83	1.00	0.91	5
1	1.00	0.88	0.93	8

=== Random Forest Regression Evaluation ===

R<sup>2</sup> Score : 0.6643

Mean Squared Error : 4.1079

Mean Absolute Error: 1.7576



## Conclusion

1. Benford's law can detect data manipulation and correlation reversal.
2. Random Forest Algorithm can also detect data manipulation and correlation reversal.
3. Random Forest could approximate original data better than Benford's law (84% vs. 45%).
4. The original data was manipulated to show positive correlation between HP and MPG while still  $p < 5\%$ .