Steps to SAS e-Miner

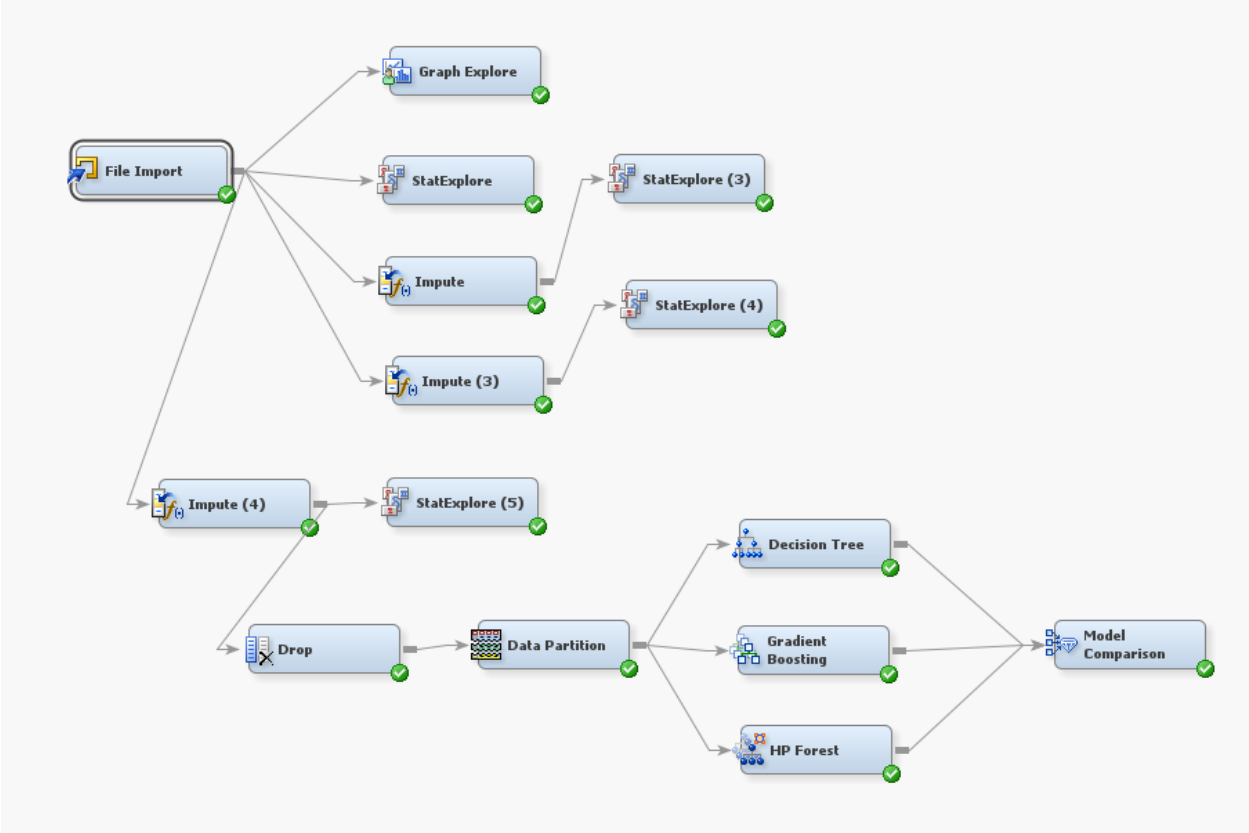


Figure 1: Overview of Workflow in SAS e-Miner

1. **<u>File Import Settings.</u>**

The File Imported was the one prepped with Knime.

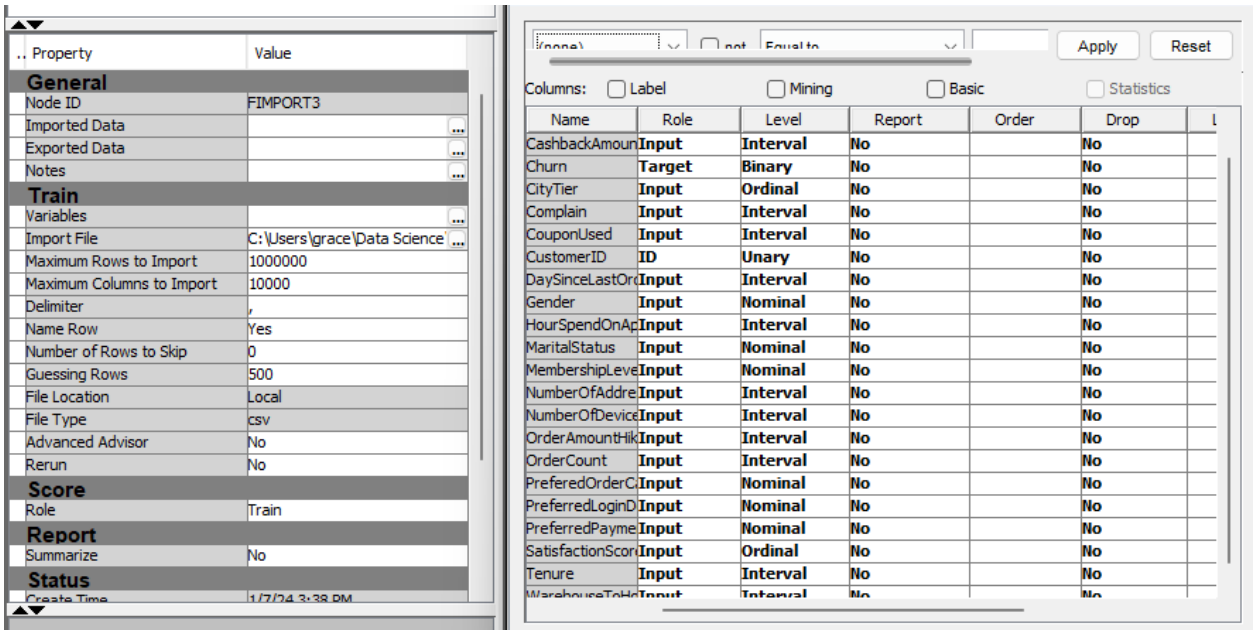
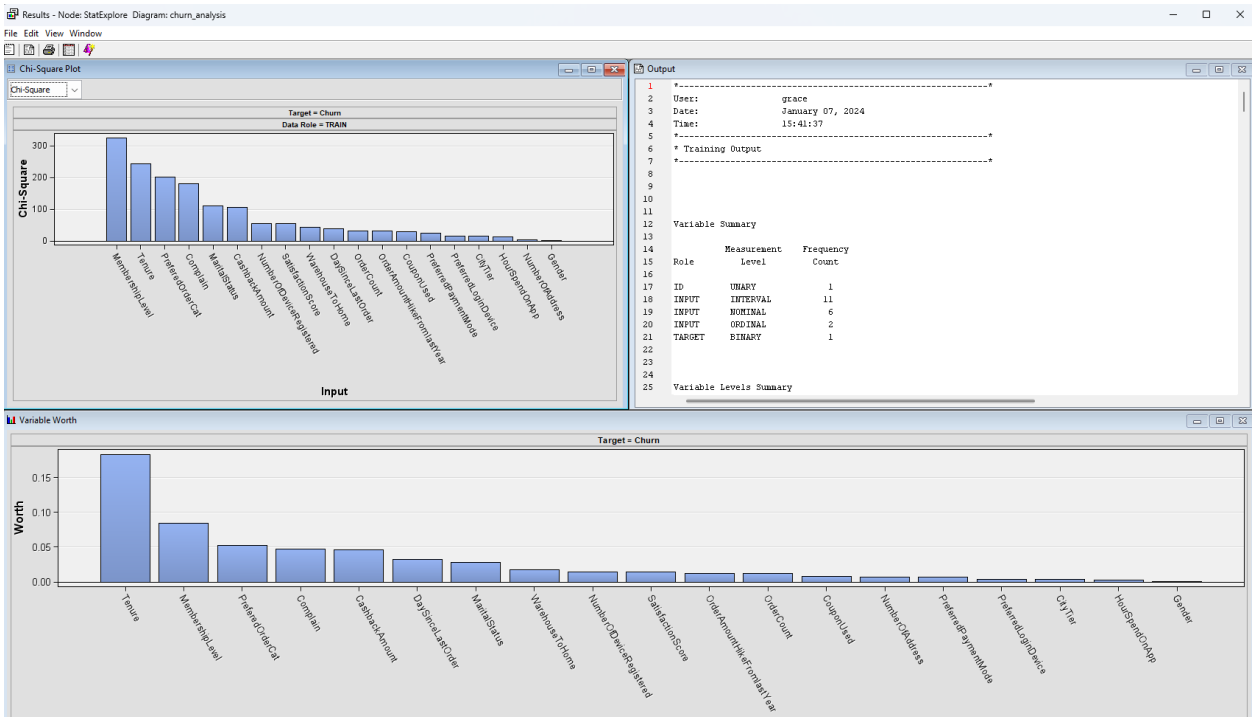


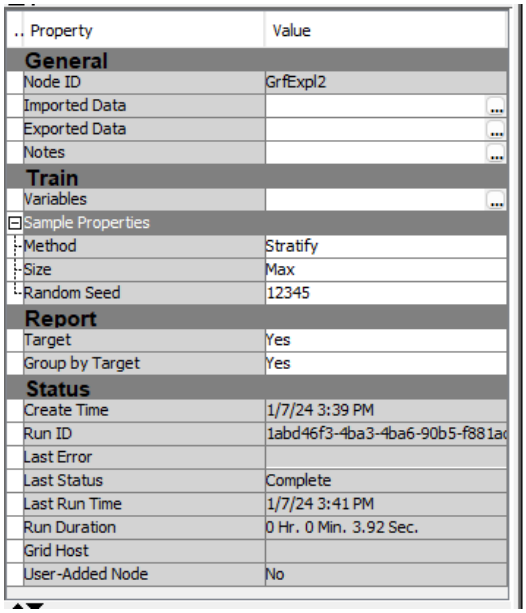
Figure 2: File Import Settings

2. Added StatExplore



Read the summary statistics to understand the distribution of the data and what might the distribution mean. The explanation was written in the report.

3. Added Graph Explore



Property	Value
General	
Node ID	GrfExpl2
Imported Data	
Exported Data	
Notes	
Train	
Variables	
Sample Properties	
Method	Stratify
Size	Max
Random Seed	12345
Report	
Target	Yes
Group by Target	Yes
Status	
Create Time	1/7/24 3:39 PM
Run ID	1abd46f3-4ba3-4ba6-90b5-f881a
Last Error	
Last Status	Complete
Last Run Time	1/7/24 3:41 PM
Run Duration	0 Hr. 0 Min. 3.92 Sec.
Grid Host	
User-Added Node	No

Figure 3: Graph Explore Setting Size Changed to Max

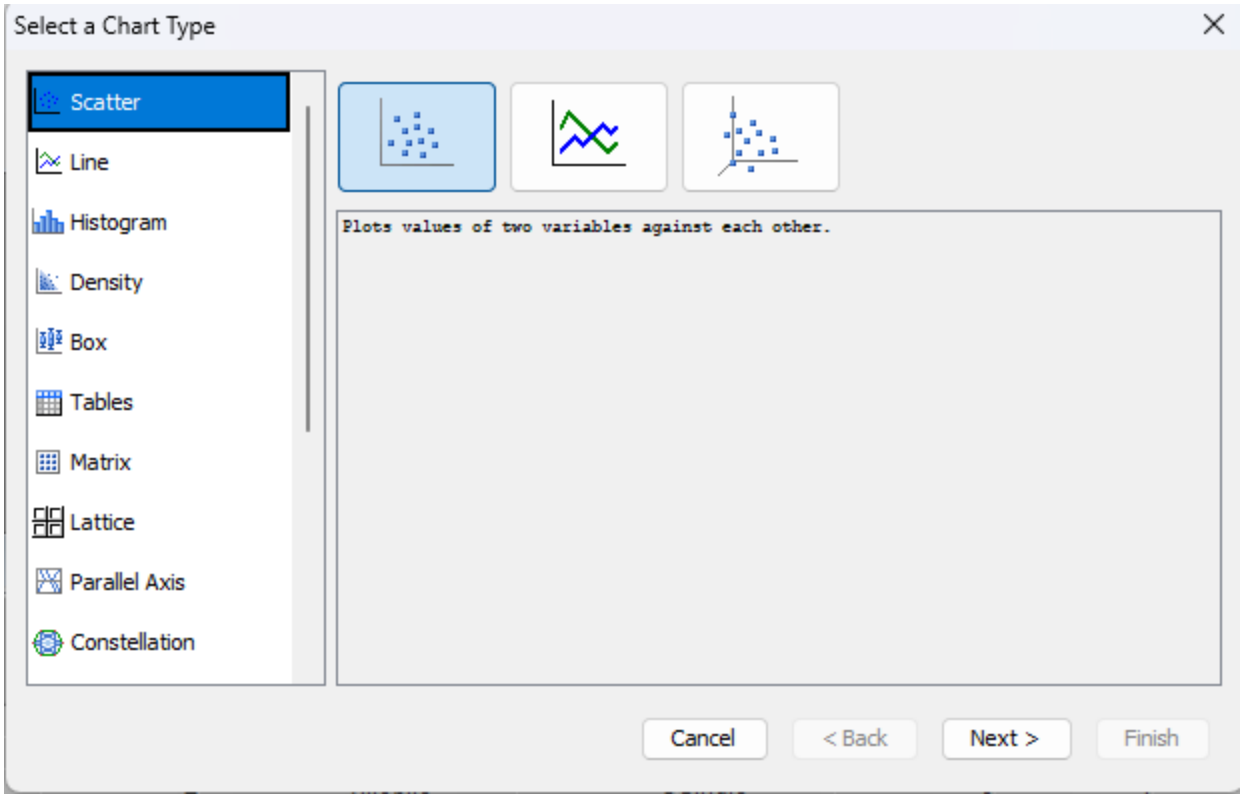


Figure 4: Tested Plots for Visualization of Data

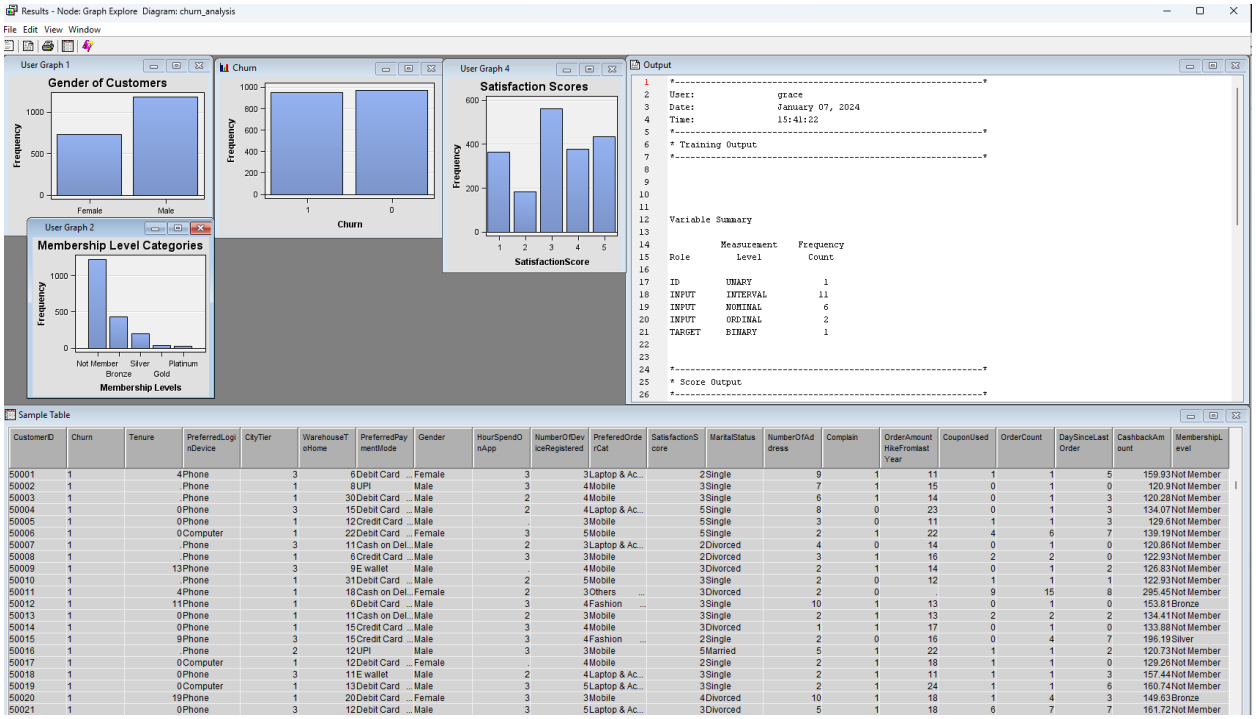


Figure 5: Current GraphExplore Results Display

Plots were added to get a better visualization and understanding of the data, but were not added to the case study report as the focus of the case study was on training a good model.

4. **Added First Impute Node**

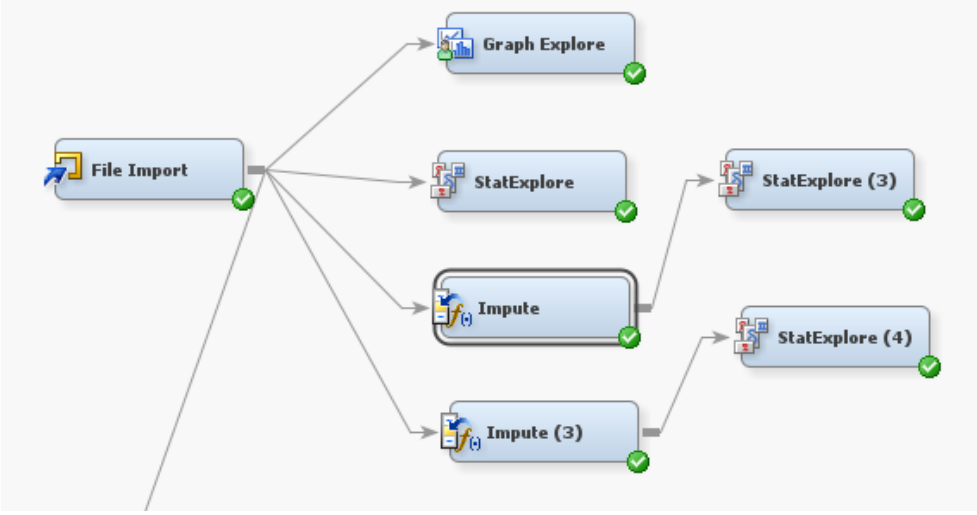


Figure 6: Impute Node

Property	Value
General	
Node ID	Impt2
Imported Data	
Exported Data	
Notes	
Train	
Variables	
Nonmissing Variables	No
Missing Cutoff	50.0
Class Variables	
Default Input Method	None
Default Target Method	None
Normalize Values	Yes
Interval Variables	
Default Input Method	Median
Default Target Method	None
Default Constant Value	
Default Character Value	
Default Number Value	.
Method Options	
Random Seed	12345
Tuning Parameters	
Tree Imputation	

Figure 7: First Impute Node Setting Default Imput Method as Median

5. **Linked a StatExplore Node to First Impute Node**
    a. A summary statistic to check the mean and standard deviation if impute is median

6. **Added Second Impute Node**

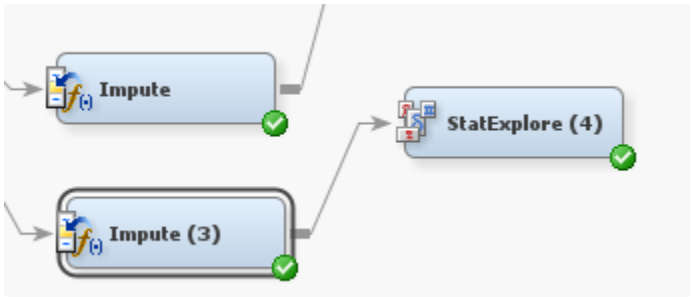
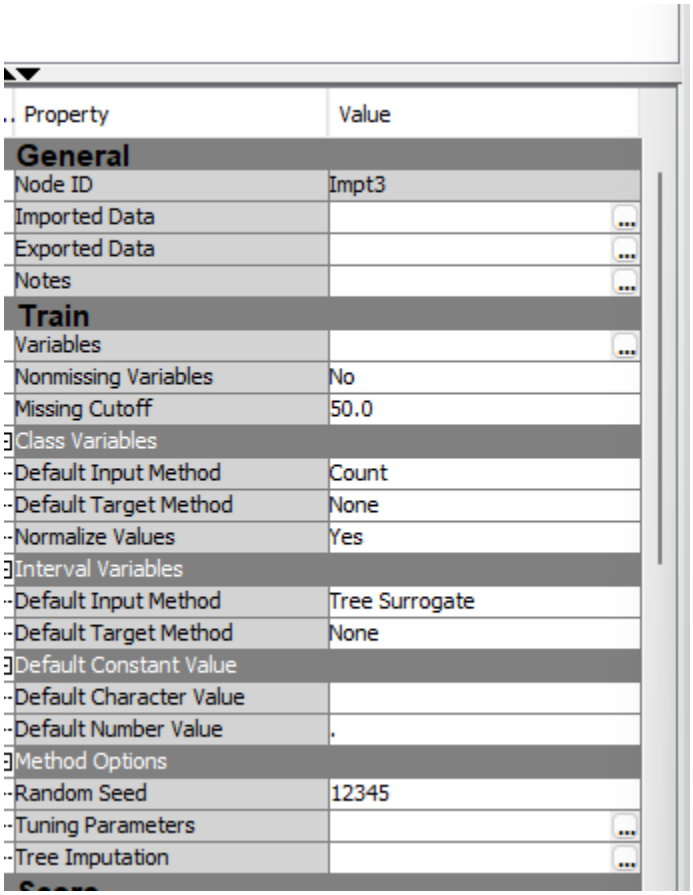


Figure 7: Second Impute Node



Property	Value
General	
Node ID	Impt3
Imported Data	
Exported Data	
Notes	
Train	
Variables	
Nonmissing Variables	No
Missing Cutoff	50.0
Class Variables	
Default Input Method	Count
Default Target Method	None
Normalize Values	Yes
Interval Variables	
Default Input Method	Tree Surrogate
Default Target Method	None
Default Constant Value	
Default Character Value	
Default Number Value	.
Method Options	
Random Seed	12345
Tuning Parameters	
Tree Imputation	

Figure 8: Second Impute Node's Input Method Default Set to Tree Surrogate

7. **Linked a StatExplore Node to Second Impute Node**

a. A summary statistic to check the mean and standard deviation if impute is Tree Surrogate

8. **After comparison of the summary statistics of the two imputation methods, added a third impute node and configured the final setting of a third impute node.**

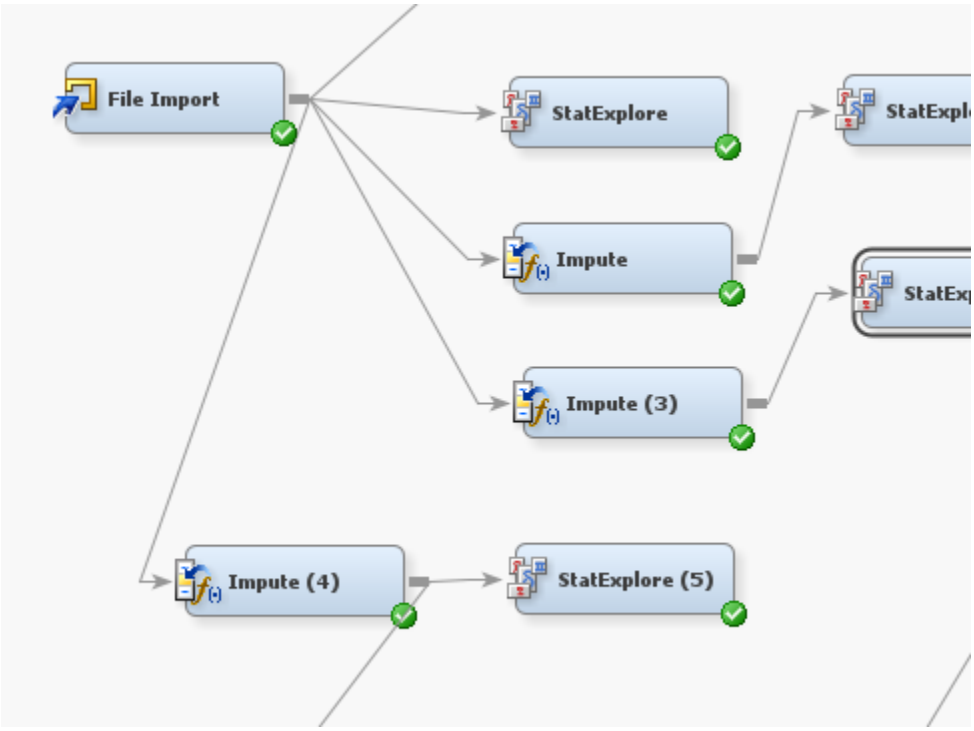


Figure 9: Impute (4) being the third impute node.

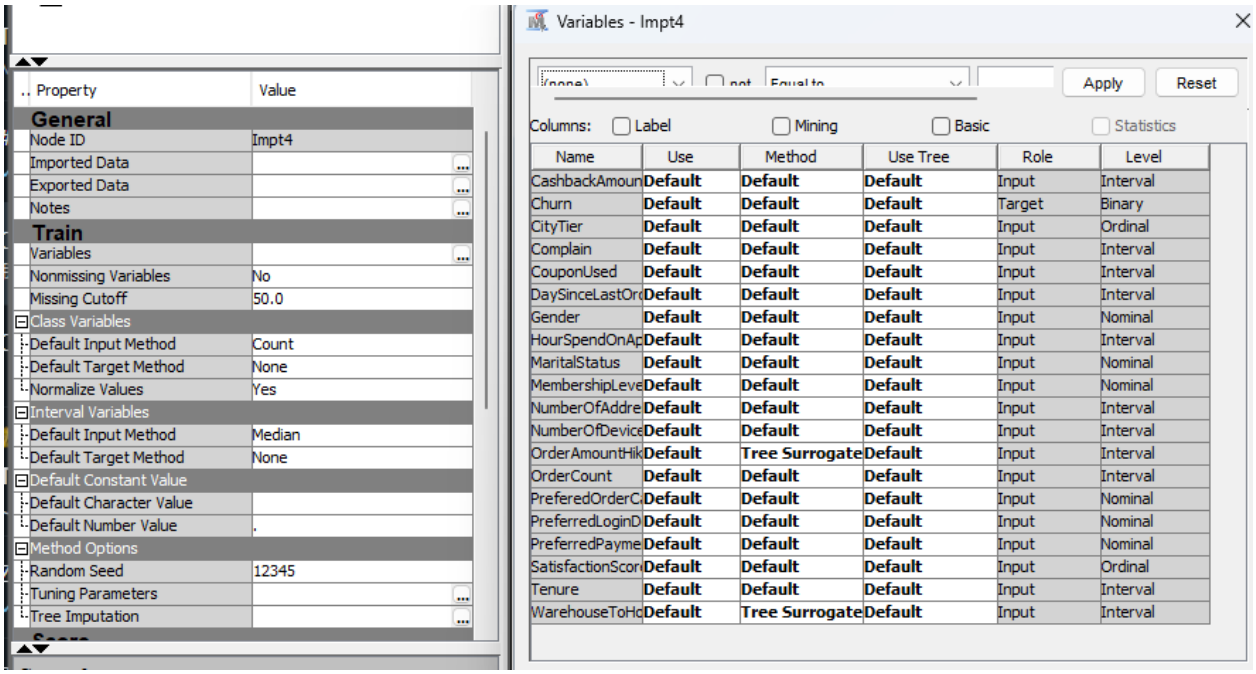


Figure 10: Final Setting of Imputation

9. **Linked a Summary Statistics Node to Final Impute Node to confirm distribution and proportions**

10. **Added a Drop Node**

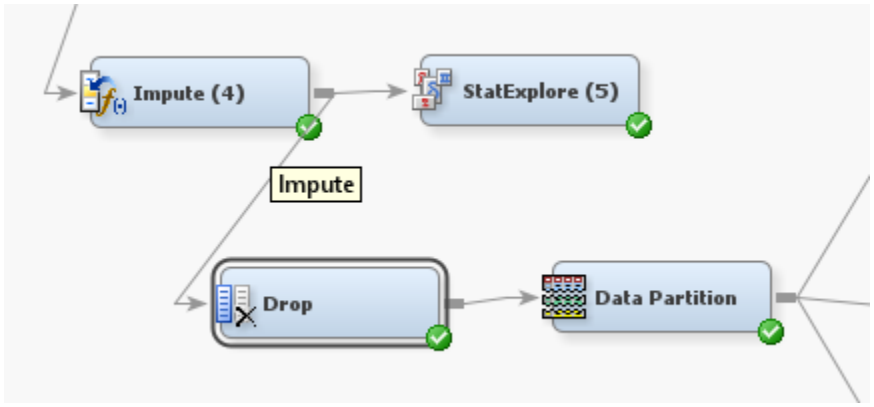


Figure 11: Drop Node

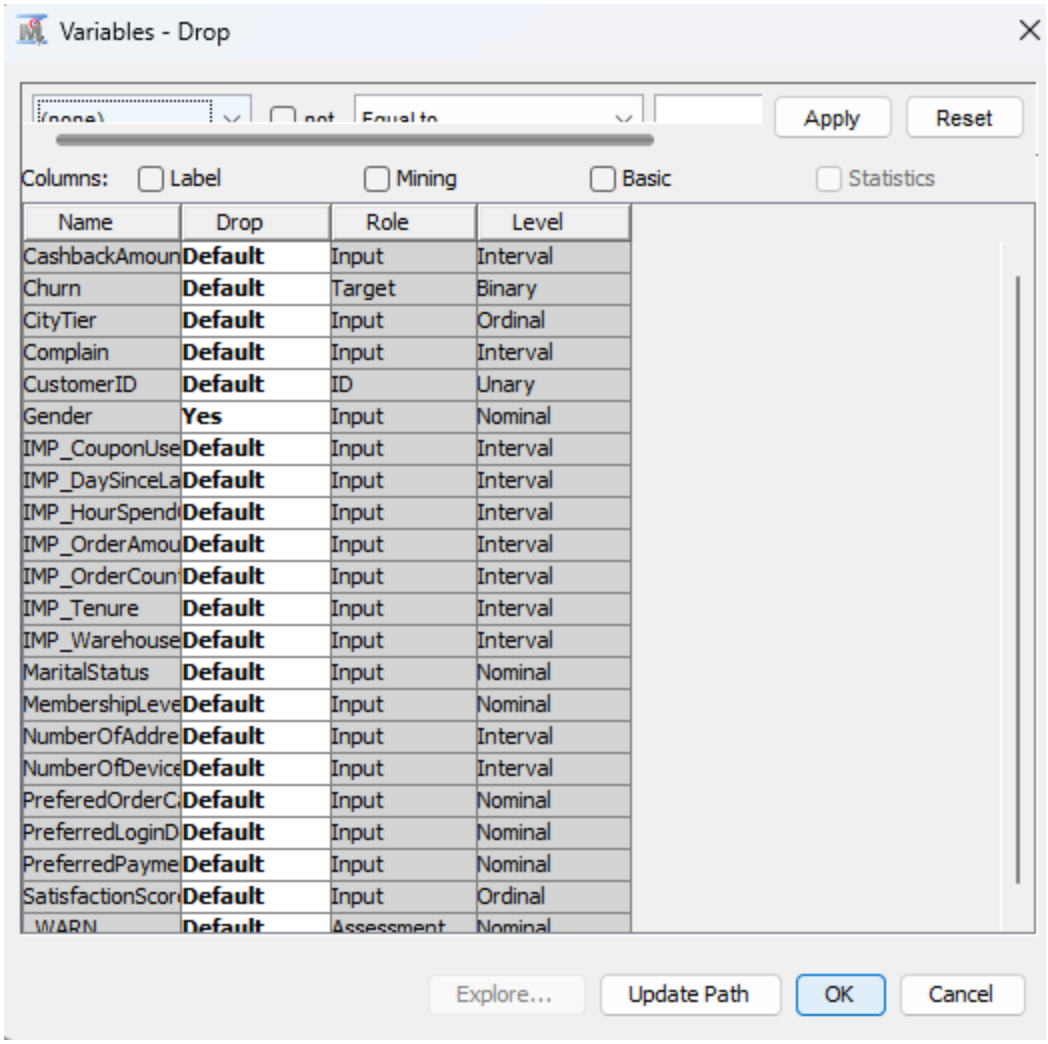


Figure 12: Drop Node Setting

11. Added Data Partition Node

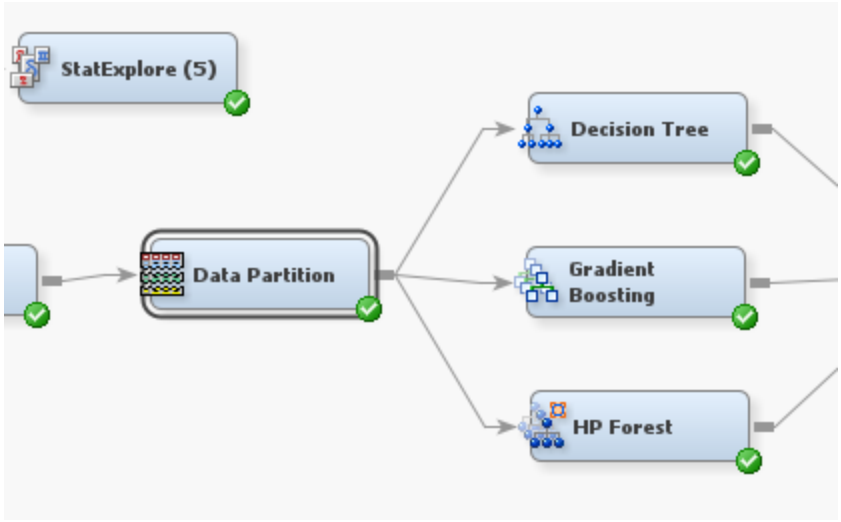


Figure 13: Added Data Partition

Property	Value
General	
Node ID	Part
Imported Data	
Exported Data	
Notes	
Train	
Variables	
Output Type	Data
Partitioning Method	Default
Random Seed	12345
Data Set Allocations	
Training	70.0
Validation	30.0
Test	0.0
Report	
Interval Targets	Yes
Class Targets	Yes
Status	
Create Time	1/7/24 5:28 PM
Run ID	c378bd89-a199-47d8-ab06-005
Last Error	
Last Status	Complete
Last Run Time	1/7/24 7:06 PM

Figure 14: Data Partition Setting

12. Added Model Nodes

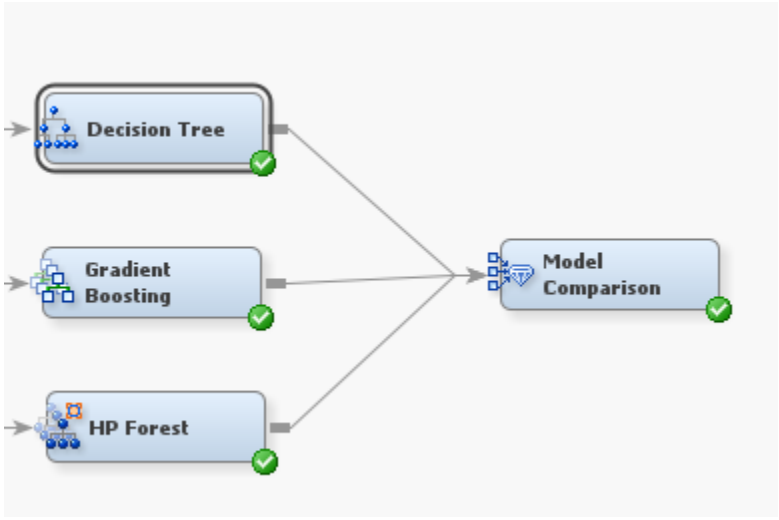


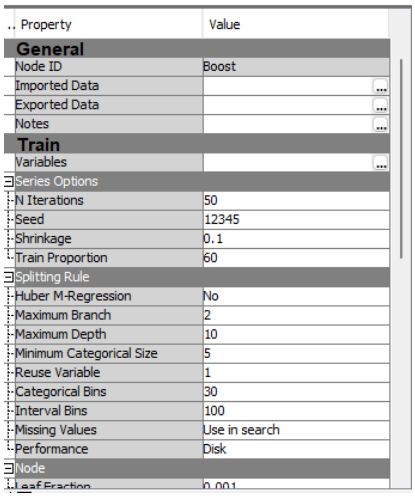
Figure 15: Model Nodes: Decision Tree, Gradient Boosting, and HP Forest

The three nodes used for modeling are the Decision Tree, Gradient Boosting, and HP Forest. The configuration of each model will be explained in the following sections.

Property	Value
Minimum Categorical Size	5
Node	
Leaf Size	8
Number of Rules	5
Number of Surrogate Rules	0
Split Size	.
Split Search	
Use Decisions	No
Use Priors	No
Exhaustive	5000
Node Sample	20000
Subtree	
Method	Assessment
Number of Leaves	1
Assessment Measure	Decision
Assessment Fraction	0.25
Cross Validation	
Perform Cross Validation	Yes
Number of Subsets	10
Number of Repeats	1
Seed	12345
Observation Based Importance	
Observation Based Importance	No
Number Single Var Importance	5

Figure 16 Setting of Decision Tree

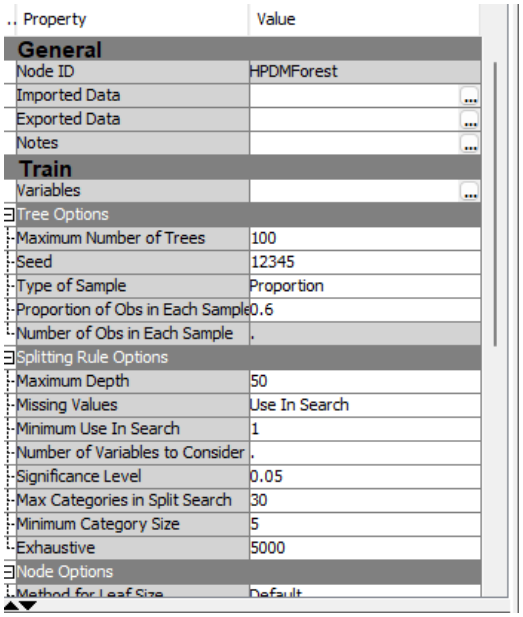
The input data will be modeled using different decision trees. Firstly, a full decision tree will be trained and configured to have a maximum depth property of 10 and a leaf size of 8. A maximum depth of 10 allows the decision tree to have a reasonably complex structure, capturing intricate patterns in the data.



Property	Value
General	
Node ID	Boost
Imported Data	
Exported Data	
Notes	
Train	
Variables	
Series Options	
N Iterations	50
Seed	12345
Shrinkage	0.1
Train Proportion	60
Splitting Rule	
Huber M-Regression	No
Maximum Branch	2
Maximum Depth	10
Minimum Categorical Size	5
Reuse Variable	1
Categorical Bins	30
Interval Bins	100
Missing Values	Use in search
Performance	Disk
Node	
Leaf Fraction	0.001

Figure 17: Setting of Gradient Boosting

There is little risk of overfitting as the dataset is large enough. The leaf size of 8 would add regularization and prevent the model from being too sensitive to noise in the training data as the training data has 20 features. Gradient Boosting was set to have a maximum depth of 10. With Gradient Boosting often combining weak learners, this should also capture a more complex pattern than the default depth of 2 and should be less prone to overfitting than the decision tree.



Property	Value
General	
Node ID	HPDMForest
Imported Data	
Exported Data	
Notes	
Train	
Variables	
Tree Options	
Maximum Number of Trees	100
Seed	12345
Type of Sample	Proportion
Proportion of Obs in Each Sample	0.6
Number of Obs in Each Sample	.
Splitting Rule Options	
Maximum Depth	50
Missing Values	Use In Search
Minimum Use In Search	1
Number of Variables to Consider	.
Significance Level	0.05
Max Categories in Split Search	30
Minimum Category Size	5
Exhaustive	5000
Node Options	
Method for Leaf Size	Default

Figure 18: Setting of HP Random Forest.

The HP Random Forest setting was kept the same since it is more robust to overfitting as compared to decision trees and this should be a good starting point for a prediction of customer churn.

13. Added Model Comparison Node

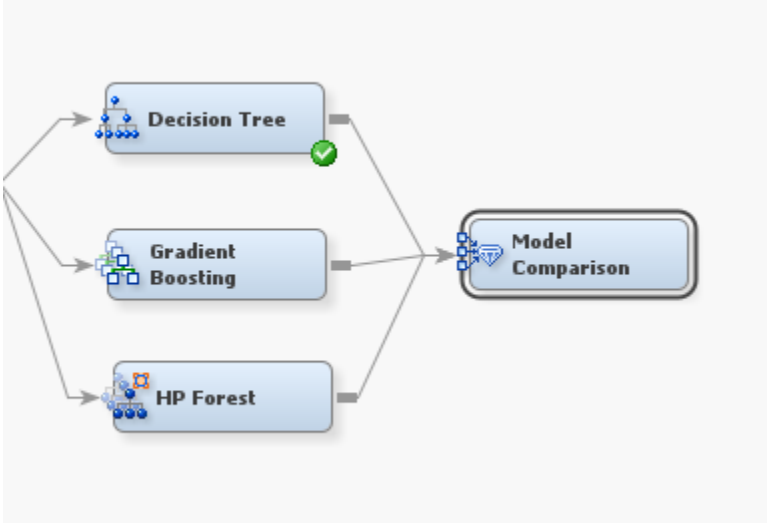


Figure 19: Addition of Model Comparison Node

To assess and compare the models, a model comparison node was added to the diagram.

Fit Statistics
Model Selection based on Valid: Misclassification Rate (_VMISC_)

Selected Model	Model Node	Model Description	Valid: Misclassification Rate	Train: Average Squared Error	Train: Misclassification Rate	Valid: Average Squared Error
Y	Boost	Gradient Boosting	0.08666	0.00336	0.00000	0.07459
	Tree	Decision Tree	0.18544	0.13573	0.16990	0.14661
	HPDMForest	HP Forest	0.18891	0.12096	0.16915	0.13986

Figure 20: Fit Statistics of Three Models