N/A

Auteur : Saulas, Adrien
Promoteur(s) : Debruyne, Christophe
Faculté : Faculté des Sciences appliquées
Diplôme : Master : ingénieur civil en science des données, à finalité spécialisée
Année académique : 2023-2024
URI/URL : http://hdl.handle.net/2268.2/21035

A Application as a Proof of Concept

The first part of this appendix will be dedicated to the different components that were developed to create the application associated with this thesis. As part of the internship at Intech related to my final year project, we had to develop an application serving as a proof of concept. This application will be a draft of the project and will allow Intech to demonstrate to their clients the kind of application Intech is capable of creating. According to Intech, we developed the application using Dash by Plotly. Dash by Plotly is a framework that allows us to create the front end of our application directly in Python. This ensures that if the project is continued later by another Intech collaborator, they will have no difficulty understanding the front end, having a data scientist profile and thus skills in Python. Additionally, Plotly enables the creation of callbacks, linking user input values with displayed values (e.g., selecting a variable to display on a graph). All parts of the application can be found in the Application folder.

A.1 Model Selection

The first feature of our application simply shows the user the different results of the models on the test set after training, as seen in Figure 21. Furthermore, as shown in the red box in Figure 21, users can input the costs of different errors that the models might make. Based on these inputs, we select the most suitable pre-trained model implementation for the specified costs. At Intech's request, for each model, we specify whether the model is interpretable and indicate the associated costs based on its errors.

A.2 Prediction and Interpretability

Once we select the model, we move to the second page of our application where we can find information related to the model's predictions. At Intech's request, it is possible to select a time period that will define the data represented on the graphs. On this page, we can find several pieces of information listed below:

1. First, on Figure 25 we can see a graph representing the number of predicted transactions over time, with fraudulent transactions in black and legitimate transactions in orange. Additionally, the same block contains statistics on the predictions.

2. Then on Figure 23 we can see, if an interpretable model was selected on the previous page, it is possible to interpret the results of a prediction. By clicking on a prediction on the graph, it will be locally interpreted in the second block. Note that due to time constraints, we were unable to incorporate SHAP values into the application.

3. After selecting the model, it is possible to manually input values for the different variables to determine if a transaction would be classified as fraud or legitimate by the model. Moreover, if the selected model is interpretable, we will have the local explanation of the model's prediction as we can see on Figure 24.

4. If the selected model is Explainable Boosting, we can access graphs of the variable weights specific to this model. These graphs provide great interpretability of the results. as we can see on Figure 26

5. Finally, we display the global average weights of the different variables for all models as we can see on Figure 27.

B Tabular

This section contains all the tables that may be useful for reading this thesis but are not essential and do not provide any major insights.

VIF	**Variable**
12.11	Amount
4.42	V2
2.91	V7
2.80	V5
2.51	Intercept
2.39	V20
1.62	V1
1.56	V6
1.53	V3
1.15	V23
1.13	V21
1.12	V8
1.12	V10
1.11	V4
1.05	V22
1.03	V19
1.02	V25
1.02	V9
1.01	V18
1.01	V14
1.01	V27
1.00	V28
1.00	V12
1.00	V17
1.00	V13
1.00	V24
1.00	V16
1.00	V26
1.00	V15
1.00	V11

Table 8: VIF and corresponding variables

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.948	0.999	0.837	0.967	0.738	0.853
XGBoost	0.978	1.000	0.857	0.940	0.788	0.864
LightGBM	0.615	0.993	0.186	0.117	0.450	0.284
EBM	0.986	1.000	0.869	0.969	0.788	0.879

Table 9: Model performance with original data

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.950	0.999	0.876	0.957	0.807	0.882
XGBoost	0.985	1.000	0.890	0.958	0.831	0.895
LightGBM	0.638	0.996	0.241	0.195	0.313	0.255
EBM	0.981	1.000	0.885	0.945	0.831	0.888

Table 10: Model performance for the data without duplicates

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.948	0.999	0.837	0.967	0.738	0.853
XGBoost	0.981	1.000	0.863	0.955	0.788	0.871
LightGBM	0.767	0.998	0.454	0.370	0.588	0.479
EBM	0.986	1.000	0.869	0.969	0.788	0.879

Table 13: Model performance with minmax scaler

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.948	0.999	0.837	0.967	0.738	0.853
XGBoost	0.978	1.000	0.857	0.940	0.788	0.864
LightGBM	0.351	0.984	0.046	0.026	0.225	0.126
EBM	0.986	1.000	0.869	0.969	0.788	0.879

Table 14: Model performance with standard scaler

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.948	0.999	0.837	0.967	0.738	0.853
XGBoost	0.978	1.000	0.857	0.940	0.788	0.864
LightGBM	0.669	0.996	0.301	0.230	0.438	0.334
EBM	0.986	1.000	0.869	0.969	0.788	0.879

Table 15: Model performance with robust scaler

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.981	0.998	0.182	1.000	0.100	0.551
XGBoost	0.971	0.998	0.182	1.000	0.100	0.551
LightGBM	0.499	0.998	0.000	0.000	0.000	0.001
EBM	0.663	0.998	0.025	1.000	0.013	0.507

Table 11: Model Performance without the outliers (Z-score)

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.984	0.999	0.580	0.690	0.500	0.595
XGBoost	0.962	0.998	0.239	0.917	0.138	0.528
LightGBM	0.392	0.997	0.000	0.000	0.000	0.001
EBM	0.768	0.998	0.087	0.333	0.050	0.193

Table 12: Model performance without the outliers (Isolation Forest)

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.951	0.999	0.848	0.859	0.838	0.848
XGBoost	0.982	0.999	0.855	0.861	0.850	0.856
LightGBM	0.983	0.999	0.852	0.880	0.825	0.853
EBM	0.987	0.999	0.830	0.835	0.825	0.830

Table 16: Model performance with original_random_under_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.957	0.999	0.807	0.779	0.838	0.808
XGBoost	0.980	0.999	0.863	0.863	0.863	0.863
LightGBM	0.979	0.999	0.834	0.819	0.850	0.835
EBM	0.991	0.999	0.834	0.819	0.850	0.835

Table 17: Model performance with standard_random_under_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.961	0.999	0.805	0.786	0.825	0.806
XGBoost	0.978	0.999	0.741	0.642	0.875	0.759
LightGBM	0.974	0.999	0.817	0.775	0.863	0.819
EBM	0.985	0.999	0.817	0.775	0.863	0.819

Table 18: Model performance with standard_cluster_under_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.957	0.999	0.843	0.848	0.838	0.843
XGBoost	0.984	0.999	0.857	0.852	0.863	0.857
LightGBM	0.981	0.999	0.830	0.835	0.825	0.830
EBM	0.989	0.999	0.848	0.859	0.838	0.848

Table 19: Model performance with robust_random_under_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.955	1.000	0.884	0.970	0.813	0.891
XGBoost	0.984	1.000	0.872	0.895	0.850	0.873
LightGBM	0.974	1.000	0.873	0.885	0.863	0.874
EBM	0.983	1.000	0.880	0.943	0.825	0.884

Table 20: Model performance with original_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.970	0.999	0.861	0.872	0.850	0.861
XGBoost	0.984	0.999	0.863	0.863	0.863	0.863
LightGBM	0.985	0.999	0.836	0.812	0.863	0.837
EBM	0.980	0.999	0.829	0.810	0.850	0.830

Table 21: Model performance with original_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.970	0.999	0.850	0.850	0.850	0.850
XGBoost	0.987	0.999	0.863	0.863	0.863	0.863
LightGBM	0.961	0.999	0.812	0.788	0.838	0.813
EBM	0.982	0.999	0.814	0.782	0.850	0.816

Table 22: Model performance with original_adasyn

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.942	1.000	0.877	0.970	0.800	0.885
XGBoost	0.985	1.000	0.882	0.931	0.838	0.884
LightGBM	0.972	1.000	0.868	0.917	0.825	0.871
EBM	0.983	1.000	0.872	0.942	0.813	0.877

Table 23: Model performance with original_borderline_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.948	1.000	0.871	0.955	0.800	0.878
XGBoost	0.981	1.000	0.857	0.940	0.788	0.864
LightGBM	0.967	0.999	0.834	0.887	0.788	0.838
EBM	0.982	1.000	0.878	0.956	0.813	0.884

Table 24: Model performance with original_svm_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.954	1.000	0.875	0.984	0.788	0.886
XGBoost	0.977	1.000	0.896	0.932	0.863	0.898
LightGBM	0.968	0.999	0.854	0.870	0.838	0.854
EBM	0.983	1.000	0.892	0.971	0.825	0.898

Table 25: Model performance with minmax_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.961	1.000	0.884	0.970	0.813	0.891
XGBoost	0.981	1.000	0.889	0.932	0.850	0.891
LightGBM	0.965	0.999	0.848	0.859	0.838	0.848
EBM	0.985	1.000	0.865	0.941	0.800	0.871

Table 26: Model performance with standard_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.967	1.000	0.869	0.969	0.788	0.879
XGBoost	0.982	1.000	0.895	0.944	0.850	0.897
LightGBM	0.973	1.000	0.866	0.883	0.850	0.867
EBM	0.985	1.000	0.886	0.957	0.825	0.891

Table 27: Model performance with robust_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.954	1.000	0.890	0.985	0.813	0.899
XGBoost	0.986	1.000	0.870	0.905	0.838	0.872
LightGBM	0.976	0.999	0.841	0.857	0.825	0.841
EBM	0.980	1.000	0.864	0.854	0.875	0.864

Table 28: Model performance with robust_borderline_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.963	0.999	0.857	0.892	0.825	0.859
XGBoost	0.983	0.999	0.864	0.854	0.875	0.864
LightGBM	0.979	0.999	0.826	0.793	0.863	0.828
EBM	0.978	0.999	0.817	0.775	0.863	0.819

Table 29: Model performance with original_random_under_sampling_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.969	0.999	0.841	0.821	0.863	0.842
XGBoost	0.986	0.999	0.811	0.747	0.888	0.818
LightGBM	0.979	0.999	0.819	0.769	0.875	0.822
EBM	0.984	0.999	0.814	0.761	0.875	0.818

Table 30: Model performance with original_random_under_sampling_borderline_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.955	0.999	0.831	0.802	0.863	0.833
XGBoost	0.986	0.999	0.838	0.805	0.875	0.840
LightGBM	0.979	0.999	0.833	0.795	0.875	0.835
EBM	0.987	0.999	0.817	0.775	0.863	0.819

Table 31: Model performance with original_random_under_sampling_svm_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.957	0.999	0.838	0.838	0.838	0.838
XGBoost	0.981	0.999	0.812	0.767	0.863	0.815
LightGBM	0.974	0.999	0.807	0.758	0.863	0.810
EBM	0.977	0.999	0.810	0.773	0.850	0.811

Table 32: Model performance with minmax_random_under_sampling_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.970	0.999	0.795	0.729	0.875	0.802
XGBoost	0.987	0.999	0.683	0.560	0.875	0.718
LightGBM	0.982	0.999	0.667	0.538	0.875	0.707
EBM	0.978	0.997	0.494	0.351	0.838	0.594

Table 33: Model performance with minmax_random_under_sampling_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.955	0.999	0.829	0.810	0.850	0.830
XGBoost	0.972	0.999	0.758	0.676	0.863	0.770
LightGBM	0.968	0.997	0.543	0.397	0.863	0.630
EBM	0.977	0.994	0.335	0.208	0.863	0.535

Table 34: Model performance with minmax_cluster_under_sampling_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.972	0.999	0.773	0.693	0.875	0.784
XGBoost	0.984	0.998	0.598	0.455	0.875	0.665
LightGBM	0.976	0.998	0.593	0.449	0.875	0.662
EBM	0.987	0.996	0.419	0.274	0.888	0.581

Table 35: Model performance with minmax_cluster_under_sampling_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.970	0.999	0.823	0.833	0.813	0.823
XGBoost	0.982	0.999	0.836	0.812	0.863	0.837
LightGBM	0.977	0.999	0.812	0.767	0.863	0.815
EBM	0.975	0.999	0.805	0.764	0.850	0.807

Table 36: Model performance with standard_random_under_sampling_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.956	0.999	0.828	0.844	0.813	0.828
XGBoost	0.988	0.999	0.798	0.724	0.888	0.806
LightGBM	0.978	0.999	0.800	0.737	0.875	0.806
EBM	0.984	0.999	0.723	0.622	0.863	0.742

Table 37: Model performance with standard_random_under_sampling_borderline_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.979	0.999	0.821	0.784	0.863	0.823
XGBoost	0.985	0.999	0.795	0.729	0.875	0.802
LightGBM	0.976	0.999	0.767	0.690	0.863	0.776
EBM	0.986	0.999	0.724	0.612	0.888	0.750

Table 38: Model performance with standard_random_under_sampling_svm_smote

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.957	0.999	0.850	0.890	0.813	0.852
XGBoost	0.981	0.999	0.848	0.824	0.875	0.849
LightGBM	0.978	0.999	0.838	0.805	0.875	0.840
EBM	0.977	0.999	0.824	0.800	0.850	0.825

Table 39: Model performance with robust_random_under_sampling_random_over_sampling

Model	AUC	Accuracy	F1	Precision	Recall	PR AUC
Random Forest	0.961	0.999	0.845	0.968	0.750	0.859
XGBoost	0.980	1.000	0.857	0.940	0.788	0.864
LightGBM	0.627	0.997	0.332	0.252	0.488	0.370
EBM	0.986	1.000	0.861	0.969	0.775	0.872

Table 40: Model performance with original

C Figures

This section contains all the figures that may be useful for reading this thesis but are not essential and do not provide any major insights.

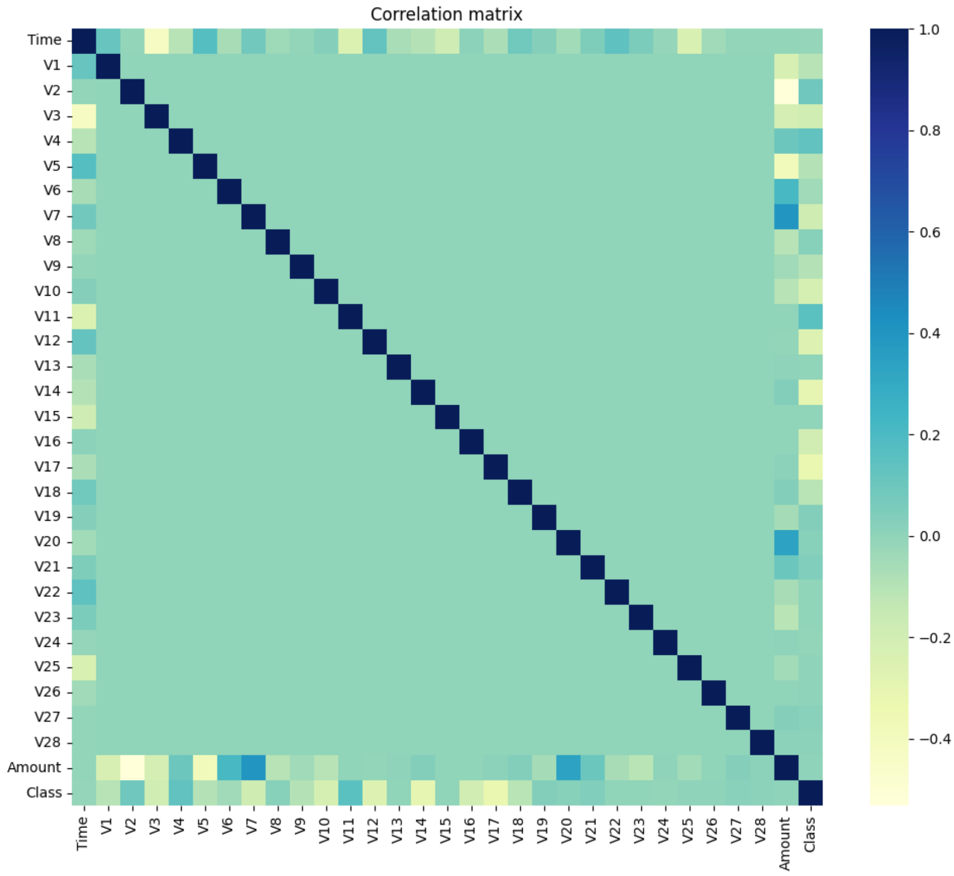


Figure 18: Correlation Matrix

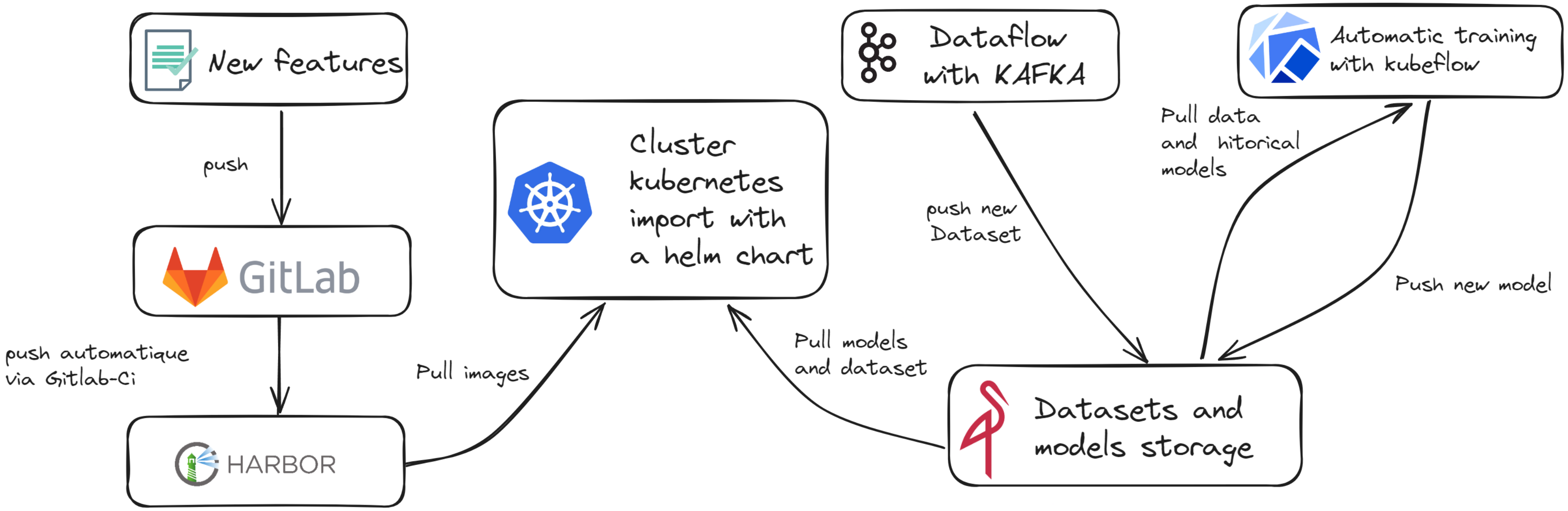


Figure 19: Complete architecture of the fraud detection platform

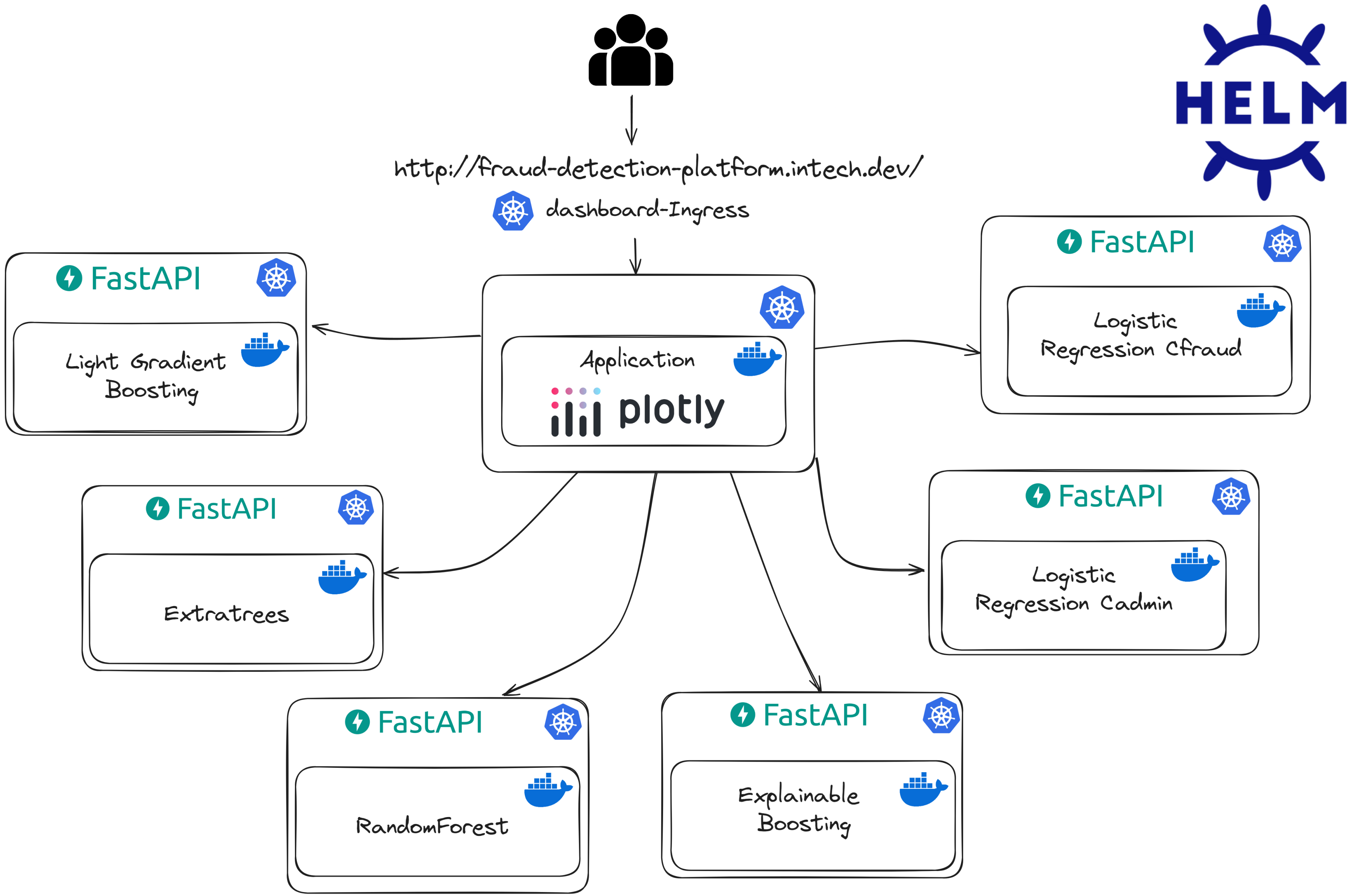


Figure 20: Complete architecture of the kubernetes cluster of the fraud detection platform

Figure 21: Model selection page of Detection fraud application

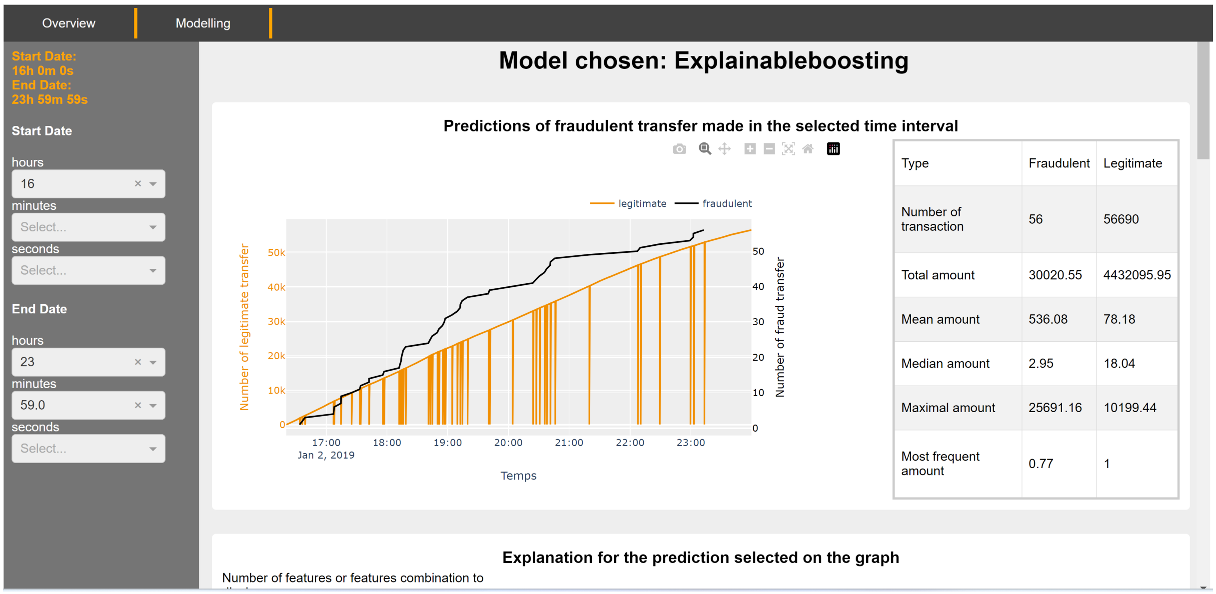


Figure 22: Prediction and explication page of Detection fraud application

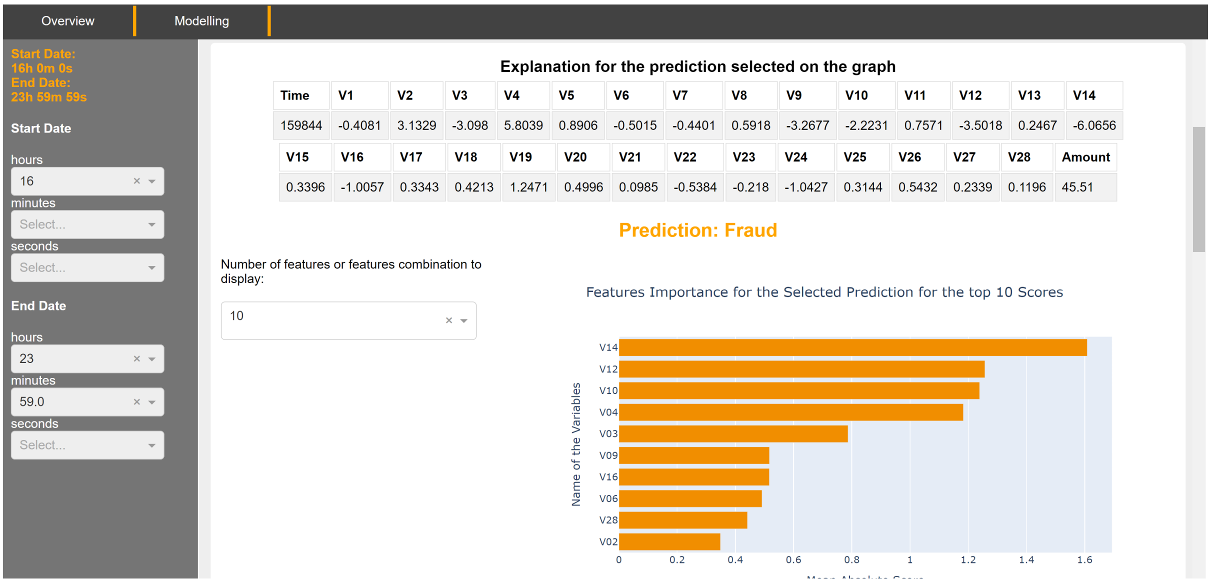


Figure 23: Prediction and explication page of Detection fraud application

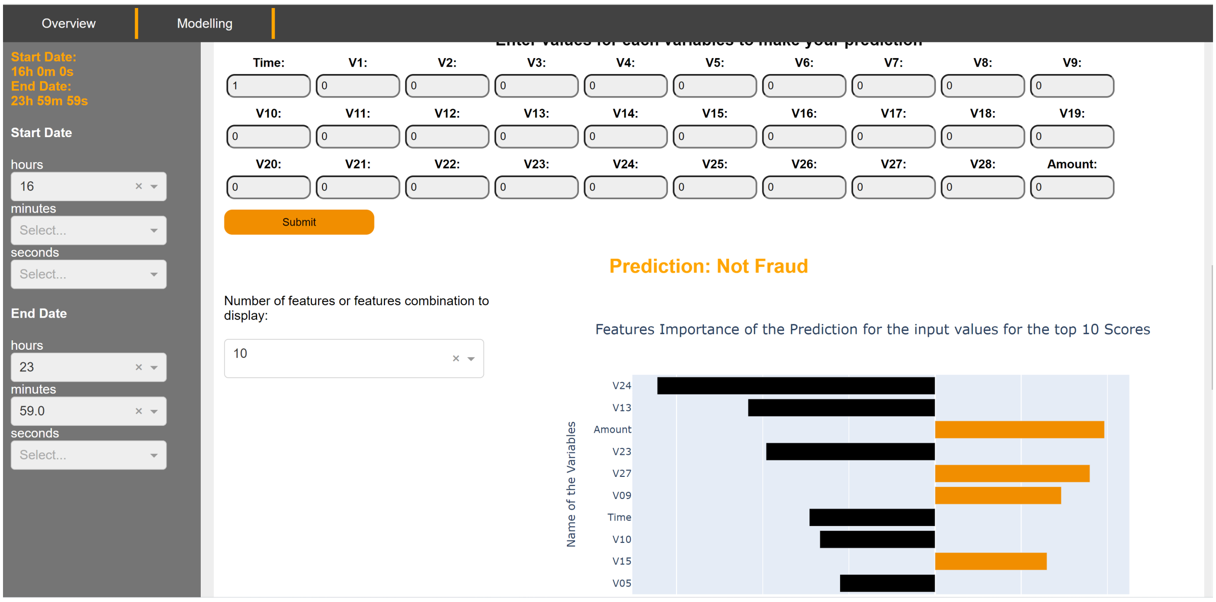


Figure 24: Prediction and explication page of Detection fraud application

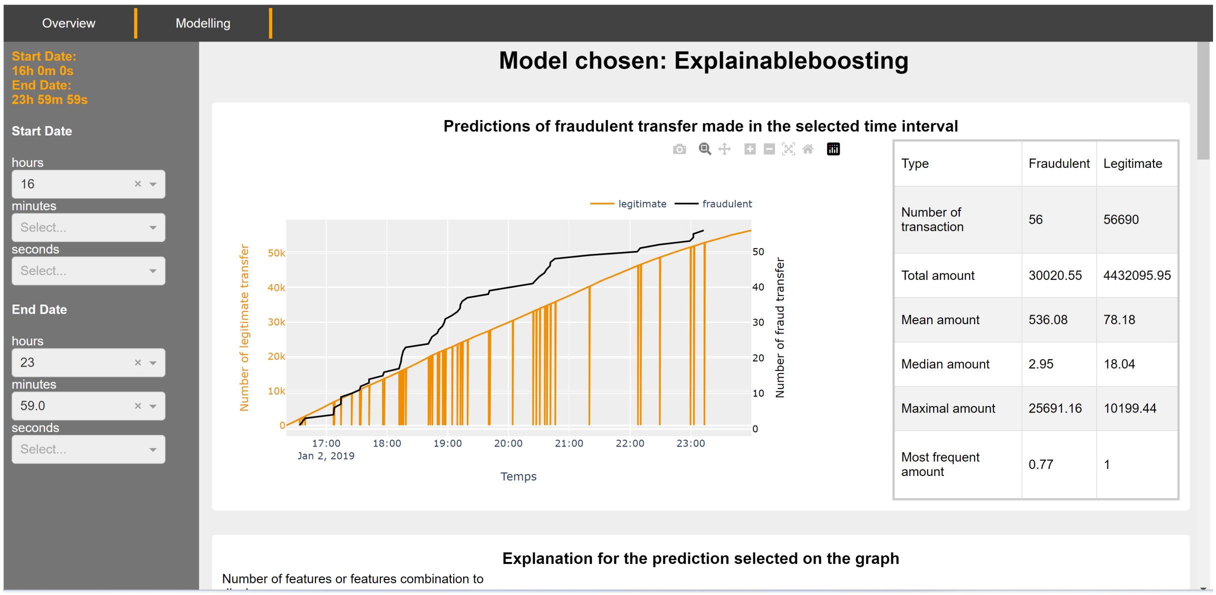


Figure 25: Prediction and explication page of Detection fraud application

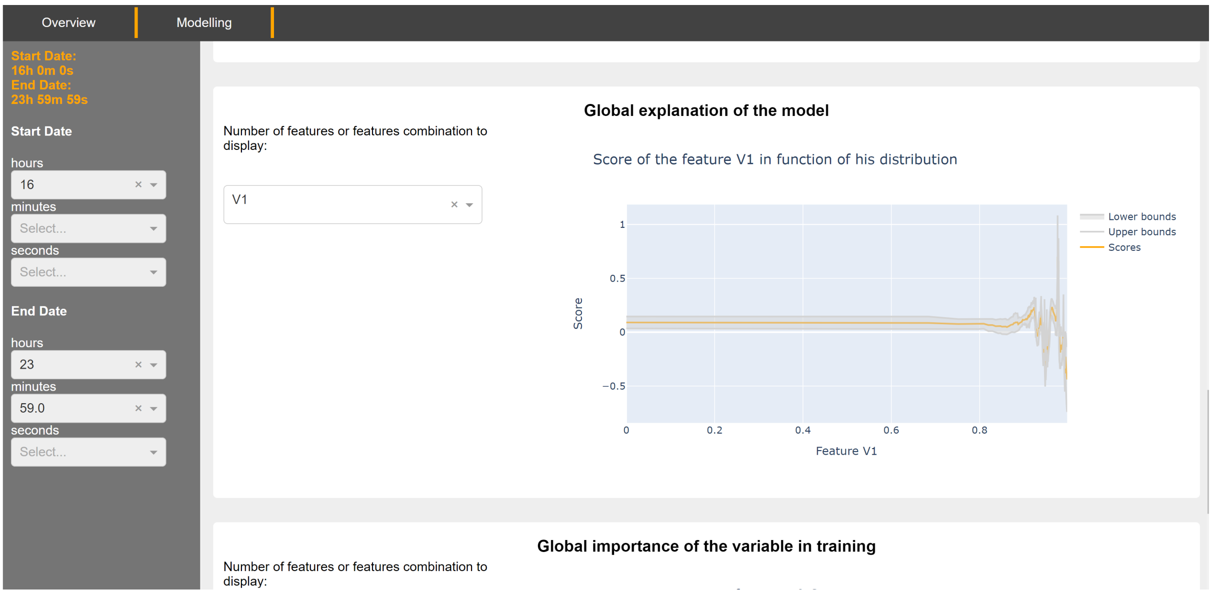


Figure 26: Prediction and explication page of Detection fraud application

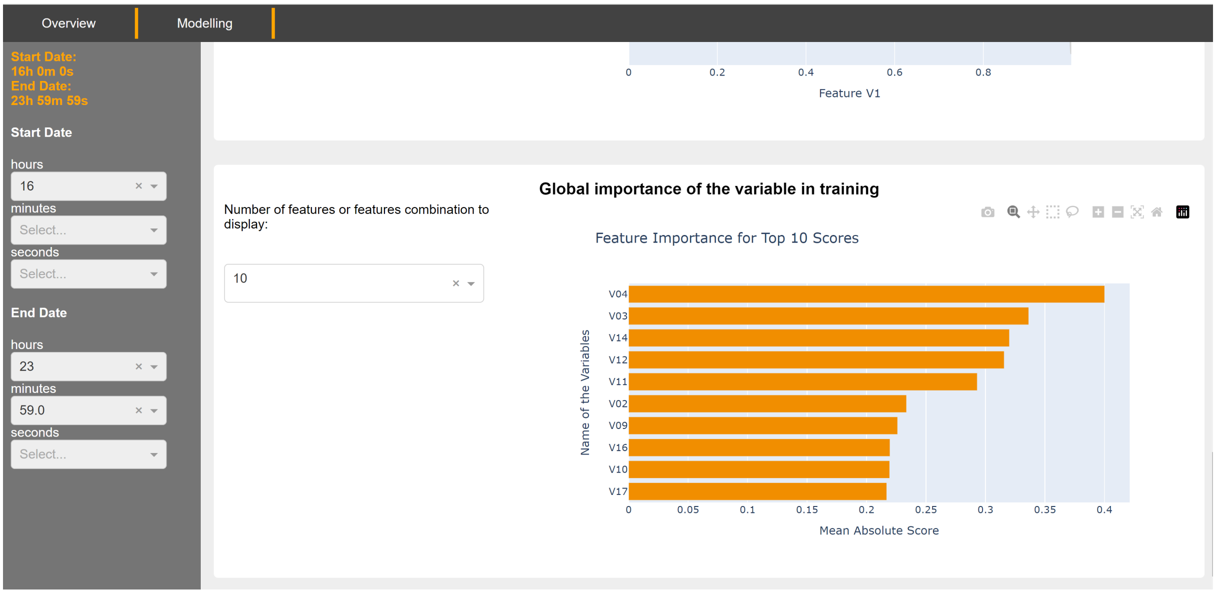


Figure 27: Prediction and explication page of Detection fraud application

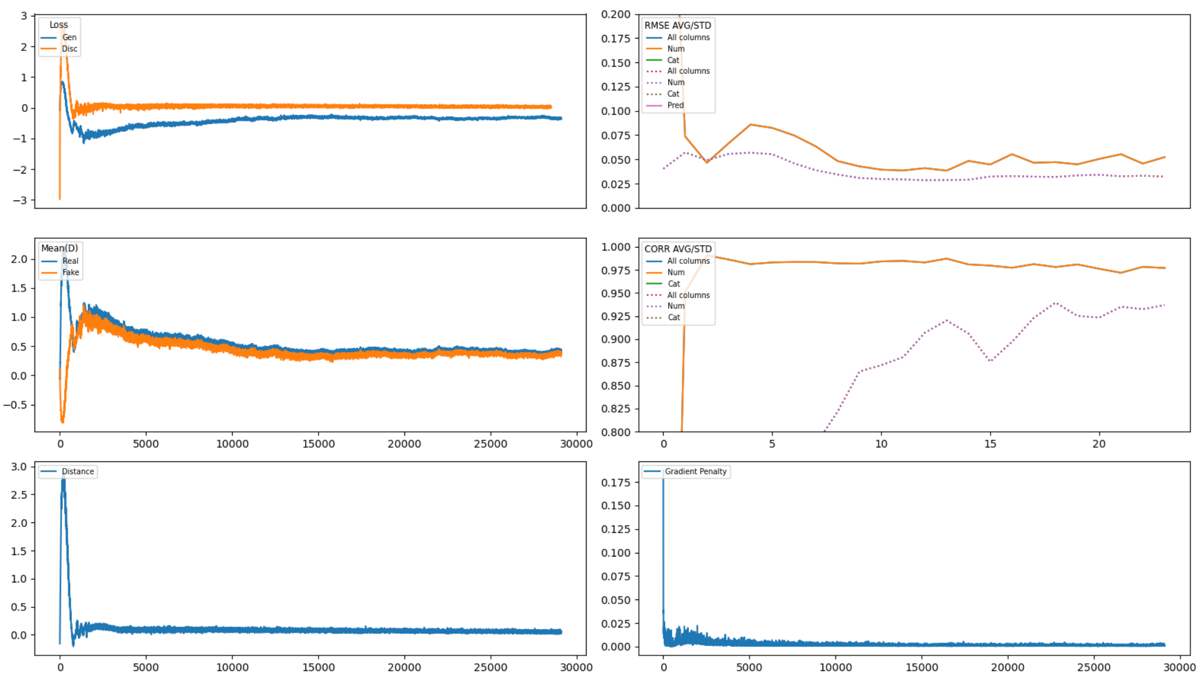
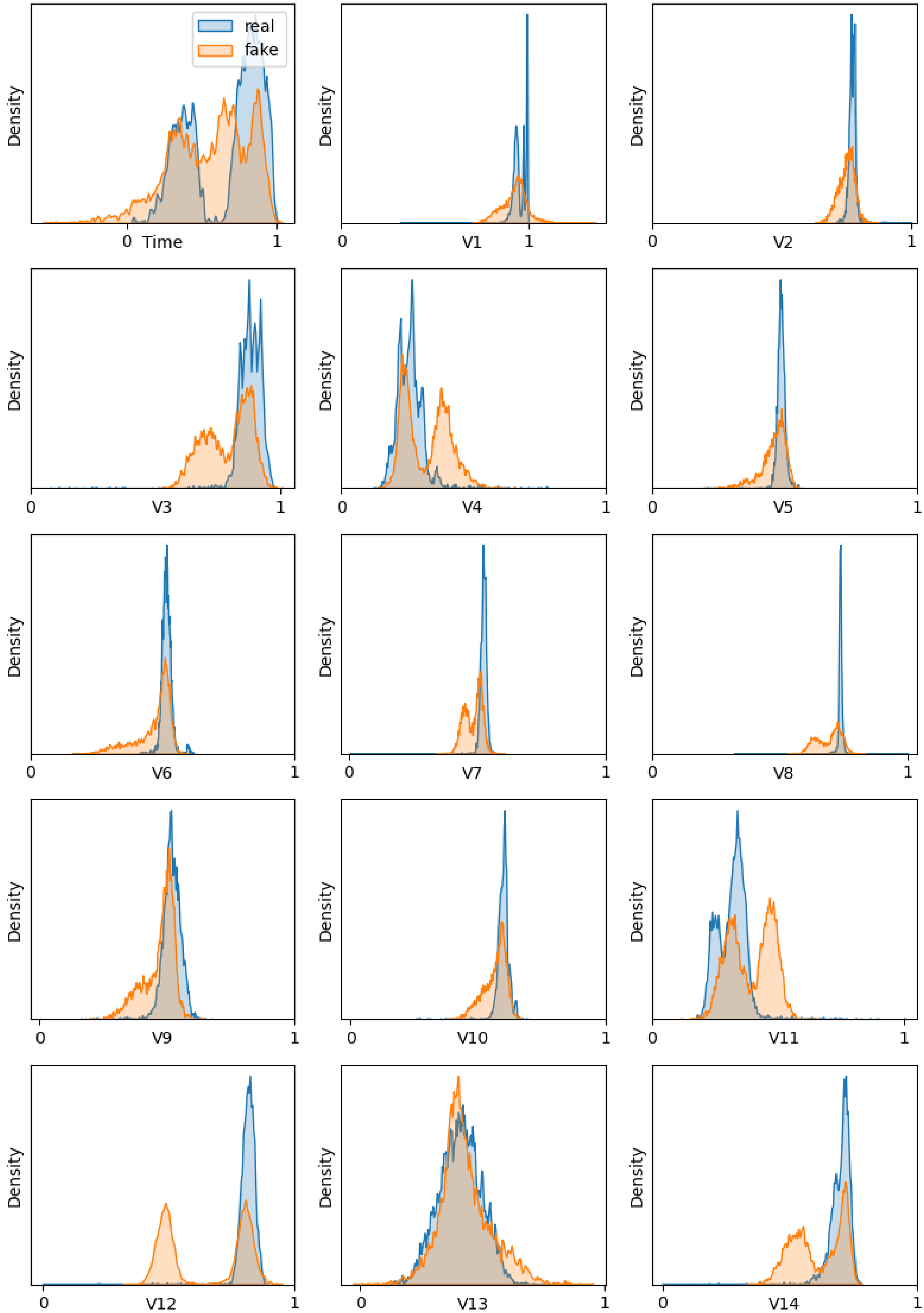


Figure 28: Loss function of the c-WGAN use for sampling


real
fake
Density
Time
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
0
1

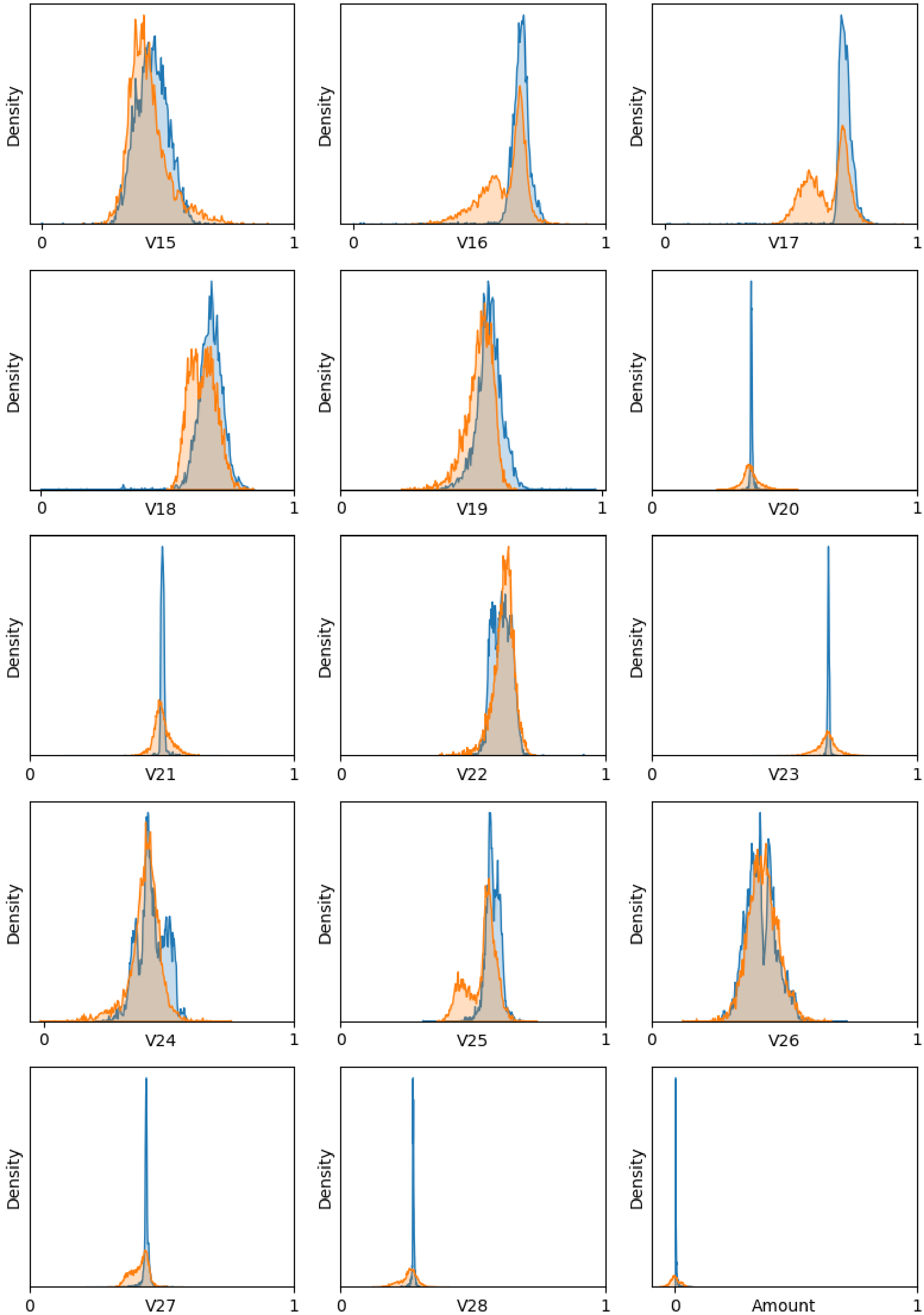
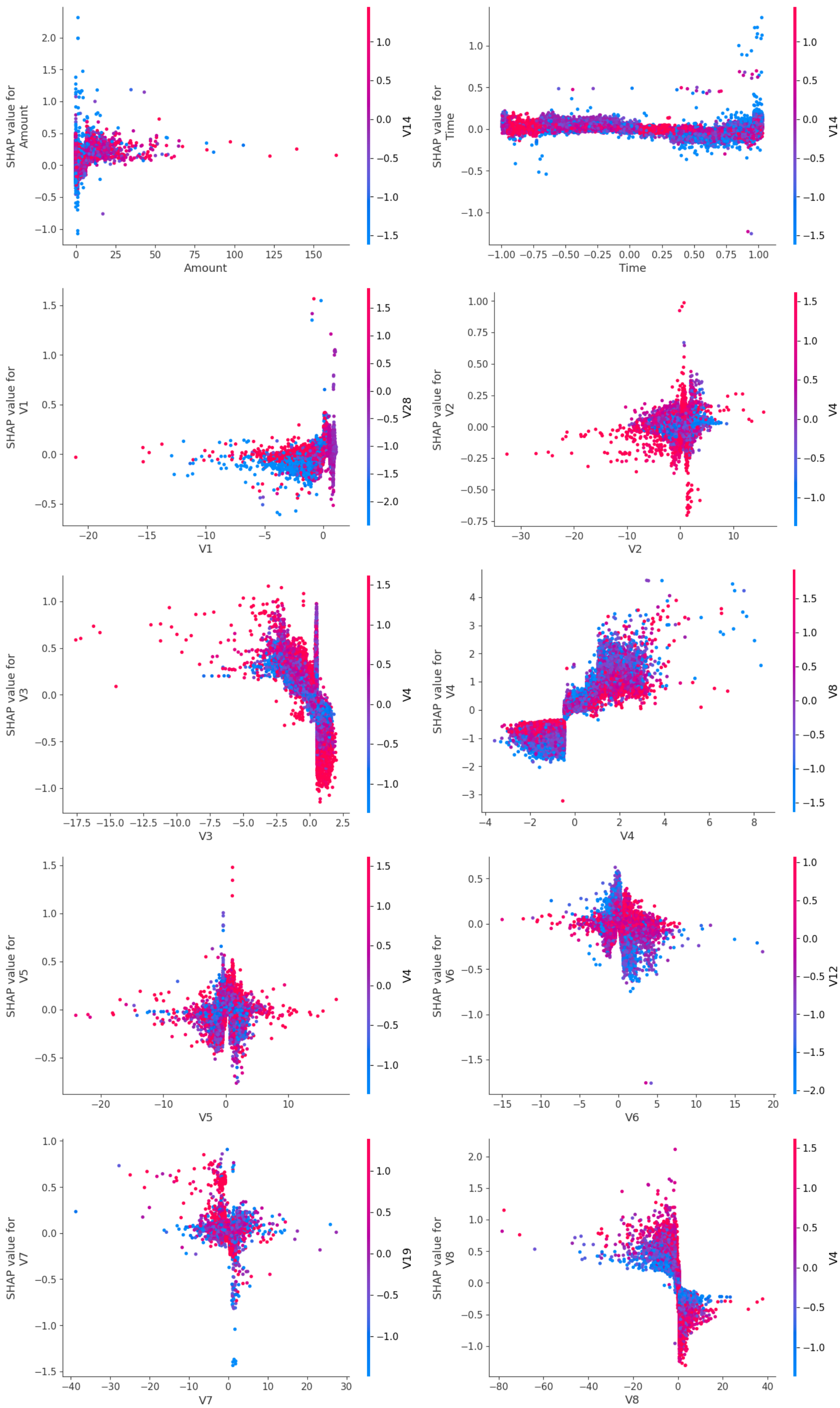
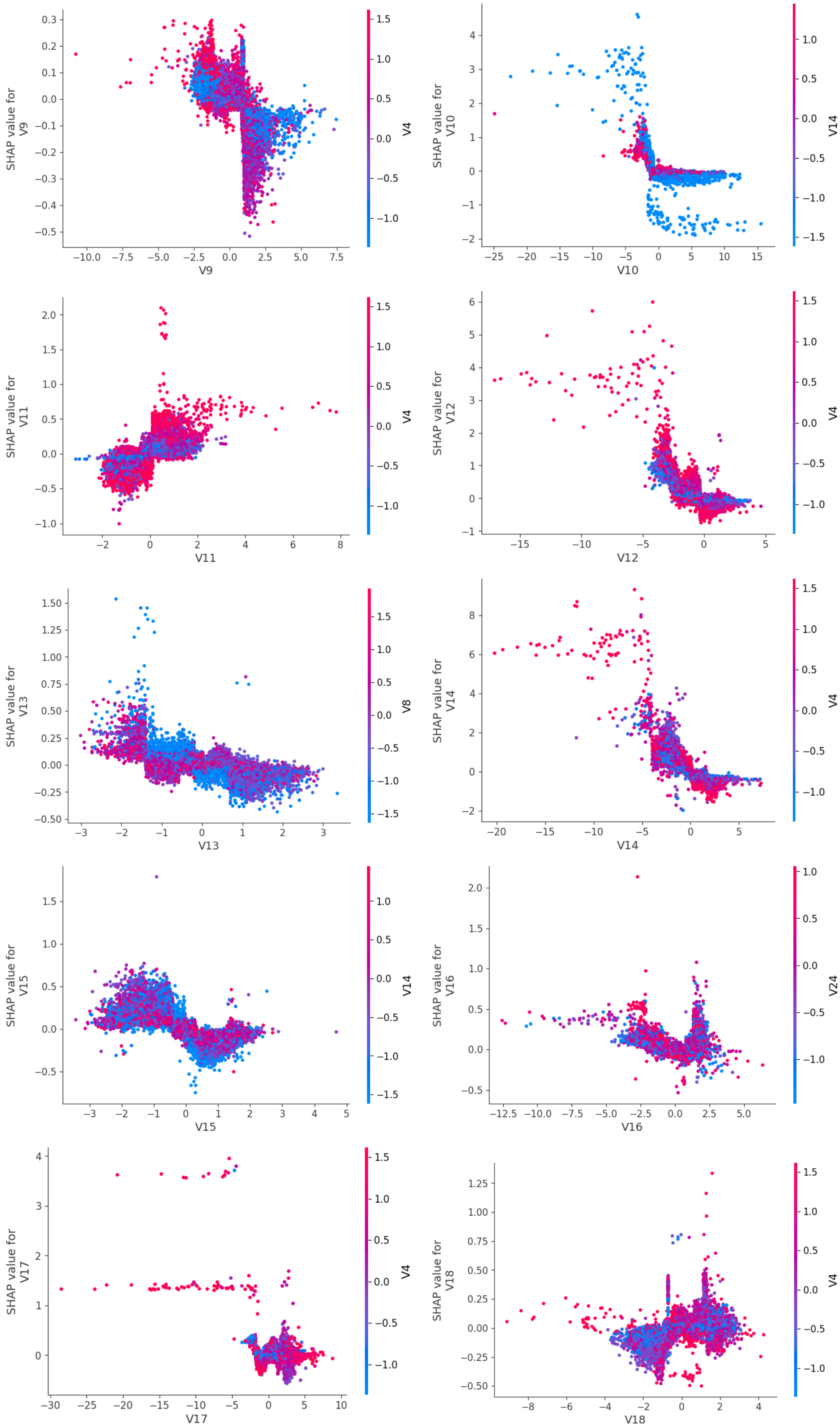


Figure 29: Distribution of the real and the synthetic distribution of the data create with the c-WGAN


SHAP value for Amount
Amount
V14
SHAP value for Time
Time
V14
SHAP value for V1
V1
V28
SHAP value for V2
V2
V4
SHAP value for V3
V3
V4
SHAP value for V4
V4
V8
SHAP value for V5
V5
V4
SHAP value for V6
V6
V12
SHAP value for V7
V7
V19
SHAP value for V8
V8
V4


SHAP value for V9
V9
V4
SHAP value for V10
V10
V14
SHAP value for V11
V11
V4
SHAP value for V12
V12
V4
SHAP value for V13
V13
V8
SHAP value for V14
V14
V4
SHAP value for V15
V15
V14
SHAP value for V16
V16
V24
SHAP value for V17
V17
V4
SHAP value for V18
V18
V4

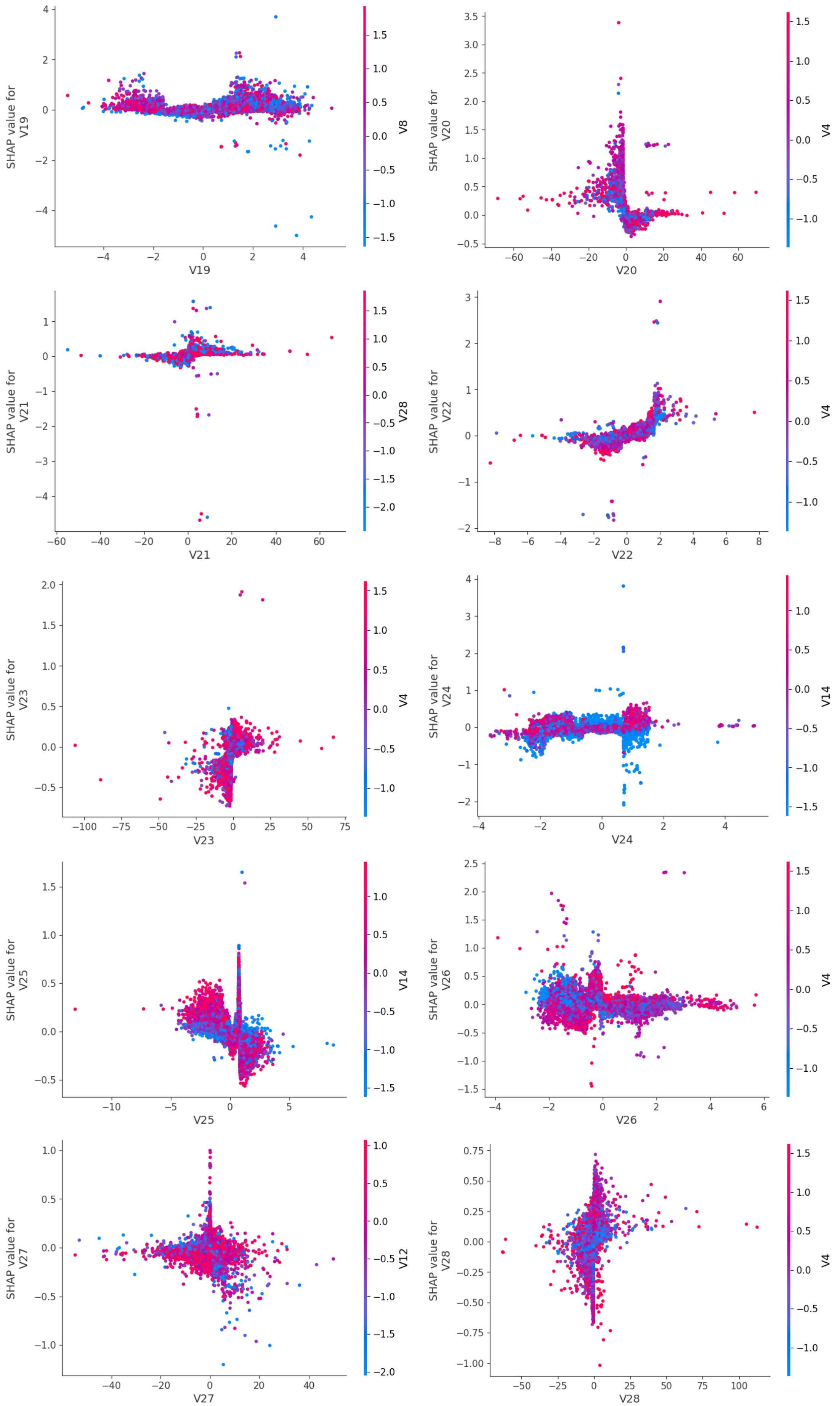
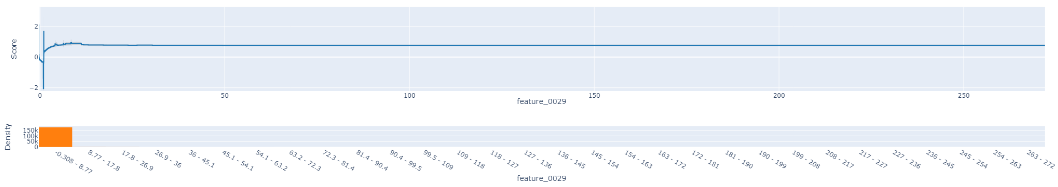
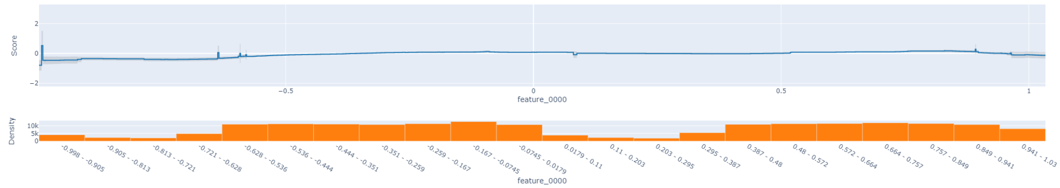


Figure 30: dependence plot for the different variable with the variables wich they have the more interaction

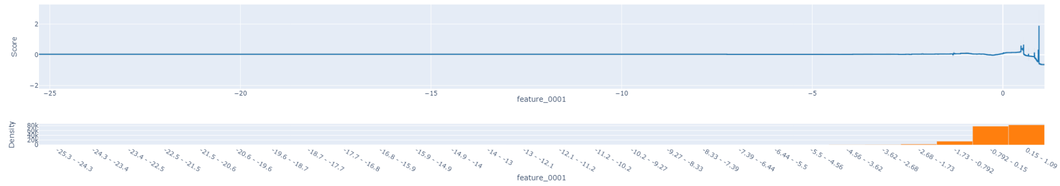
Term: feature_0029 (continuous)



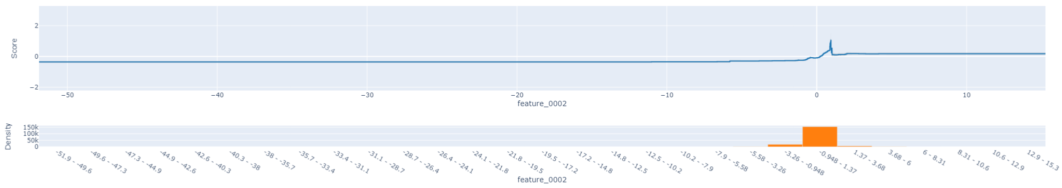
Term: feature_0000 (continuous)



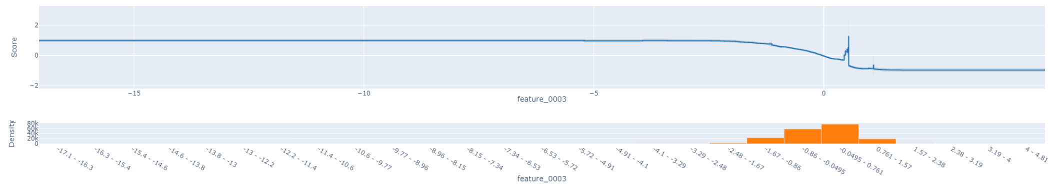
Term: feature_0001 (continuous)



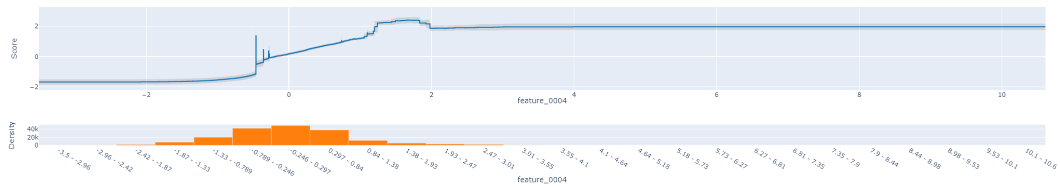
Term: feature_0002 (continuous)



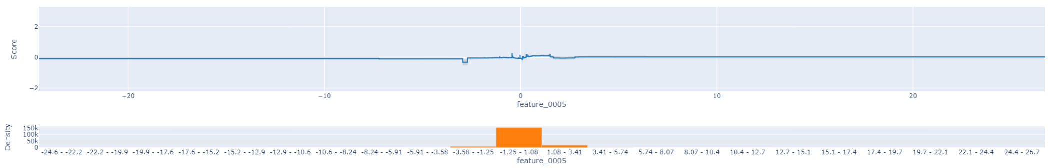
Term: feature_0003 (continuous)



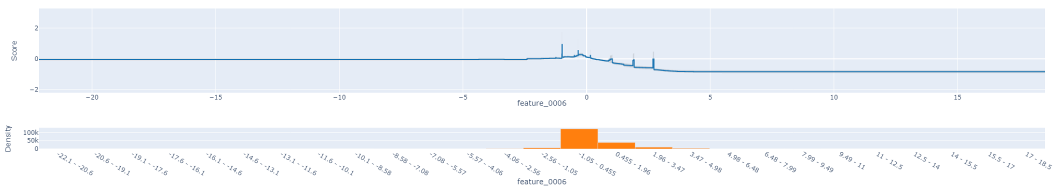
Term: feature_0004 (continuous)



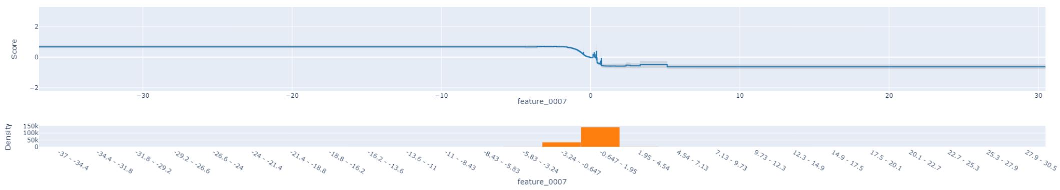
Term: feature_0005 (continuous)



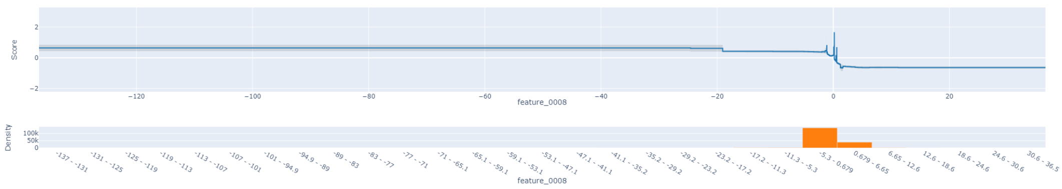
Term: feature_0006 (continuous)



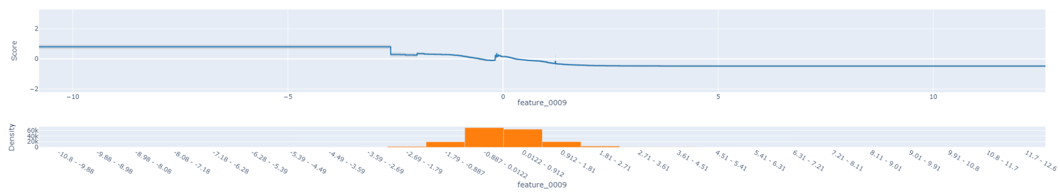
Term: feature_0007 (continuous)



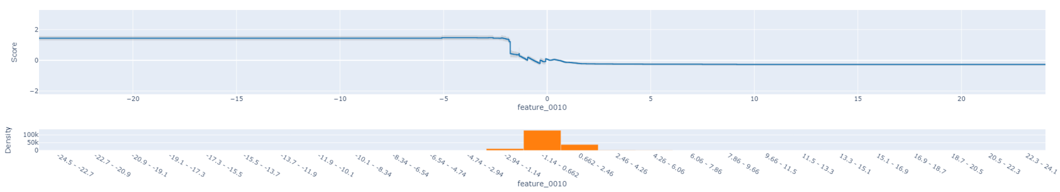
Term: feature_0008 (continuous)



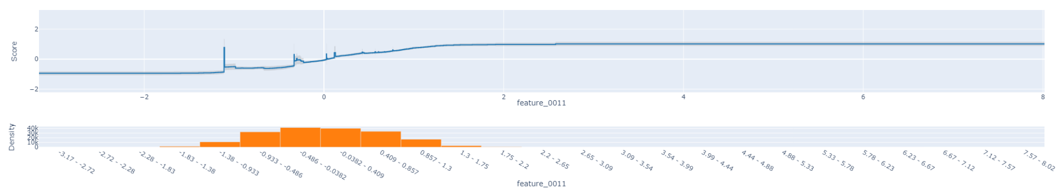
Term: feature_0009 (continuous)



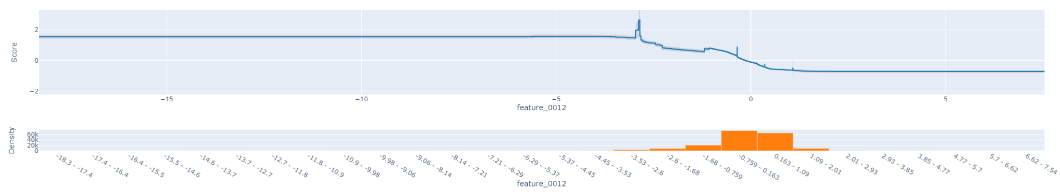
Term: feature_0010 (continuous)



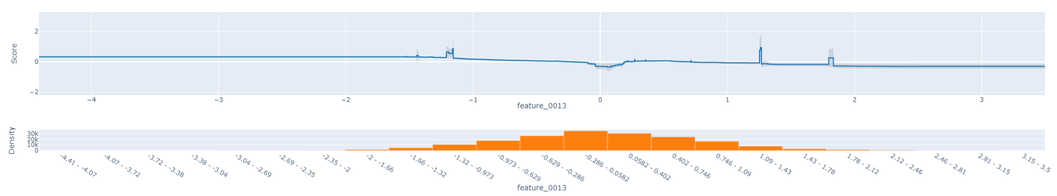
Term: feature_0011 (continuous)



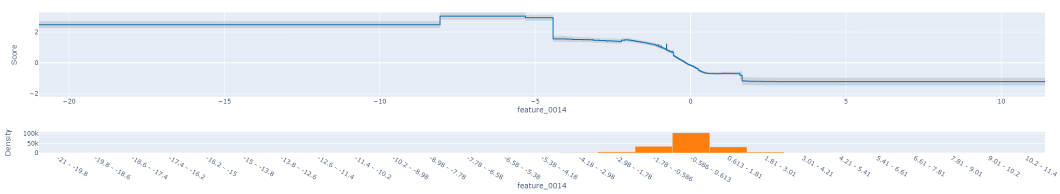
Term: feature_0012 (continuous)



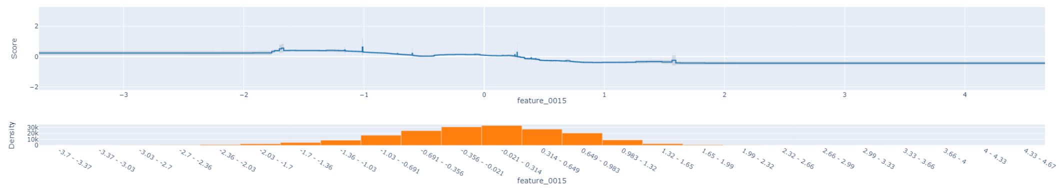
Term: feature_0013 (continuous)



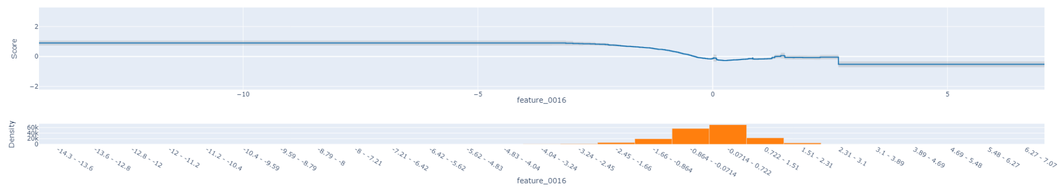
Term: feature_0014 (continuous)



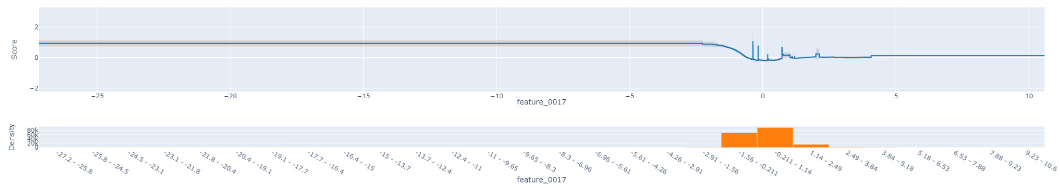
Term: feature_0015 (continuous)



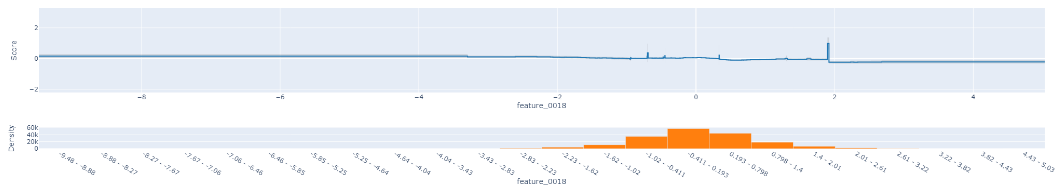
Term: feature_0016 (continuous)



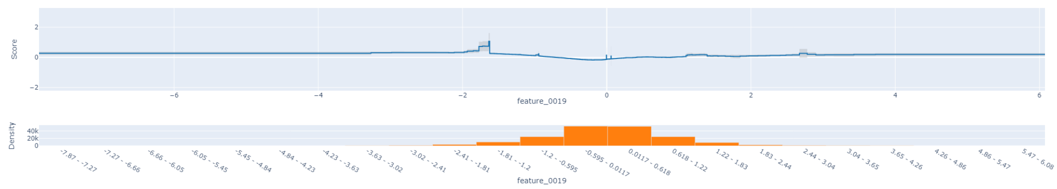
Term: feature_0017 (continuous)



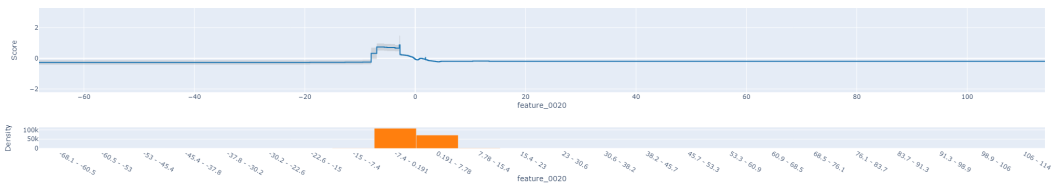
Term: feature_0018 (continuous)



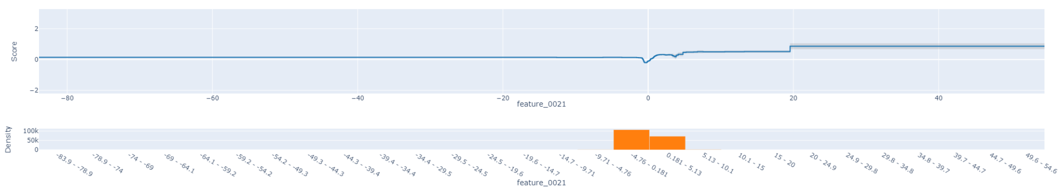
Term: feature_0019 (continuous)



Term: feature_0020 (continuous)



Term: feature_0021 (continuous)



Term: feature_0022 (continuous)

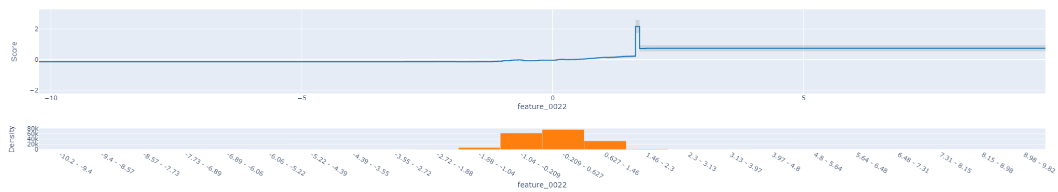
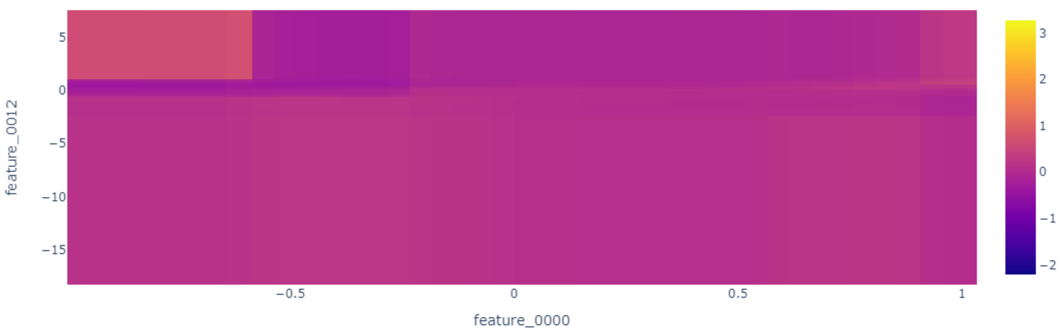


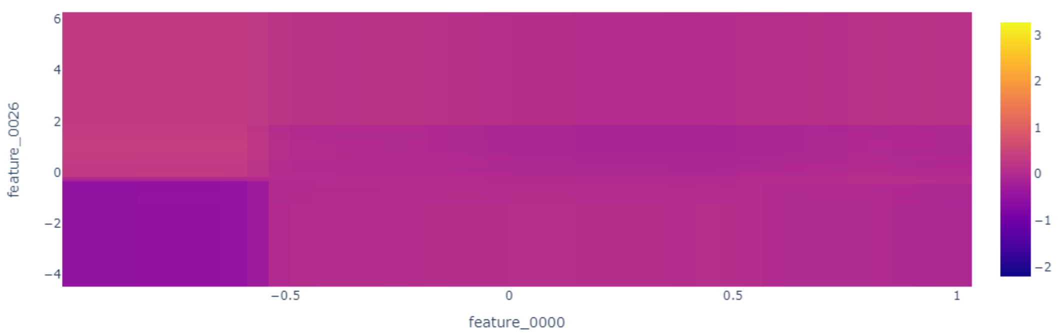
Figure 31: Global Explanation from explanation boosting on each variables

Term: feature_0000 & feature_0001 (interaction)

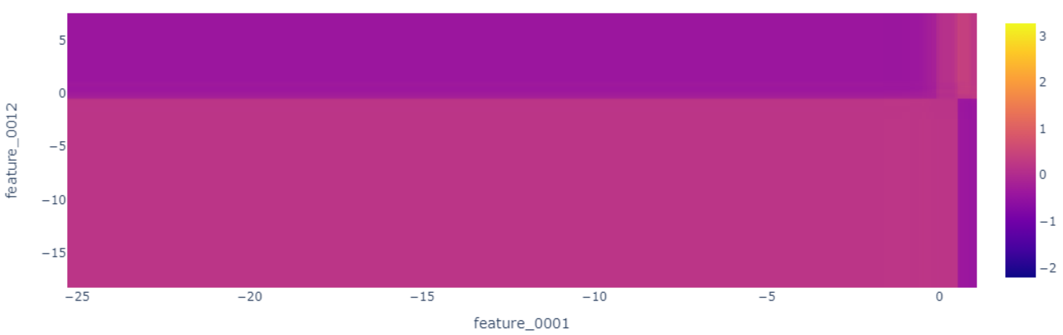
Term: feature_0000 & feature_0012 (interaction)



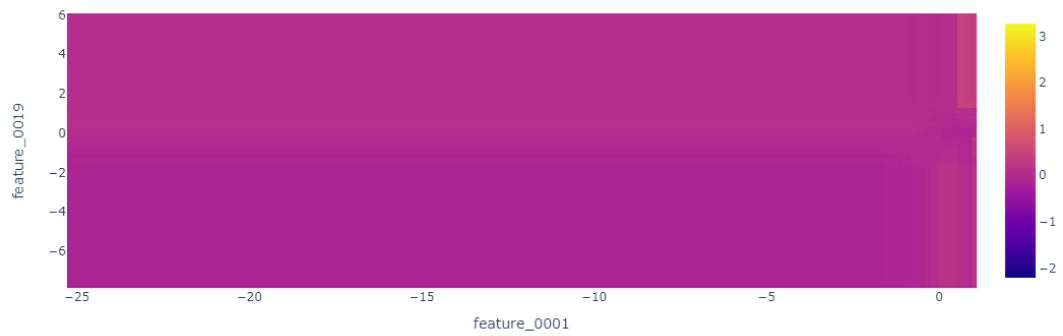
Term: feature_0000 & feature_0026 (interaction)



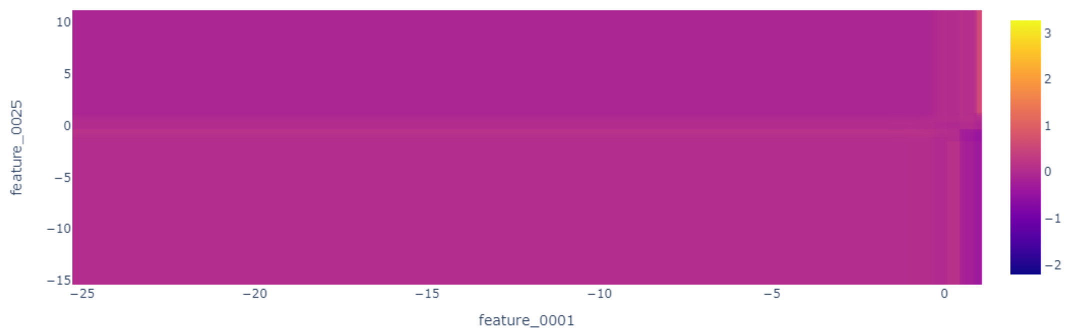
Term: feature_0001 & feature_0012 (interaction)



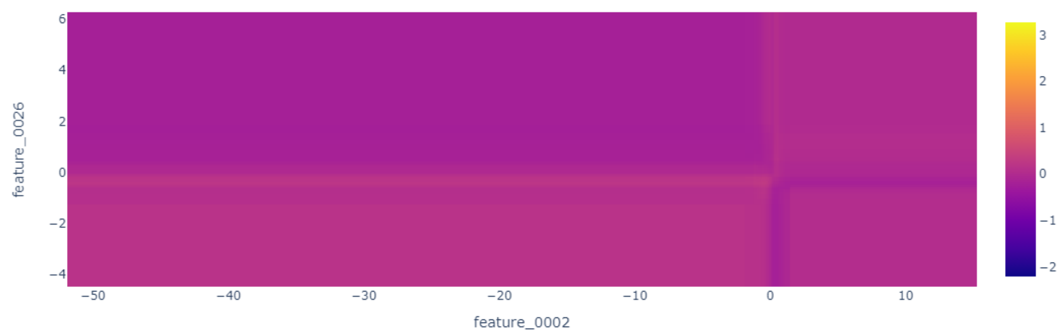
Term: feature_0001 & feature_0019 (interaction)



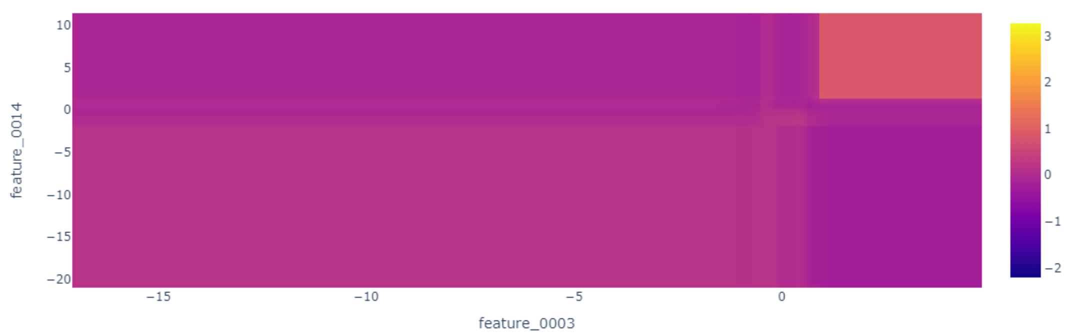
Term: feature_0001 & feature_0025 (interaction)



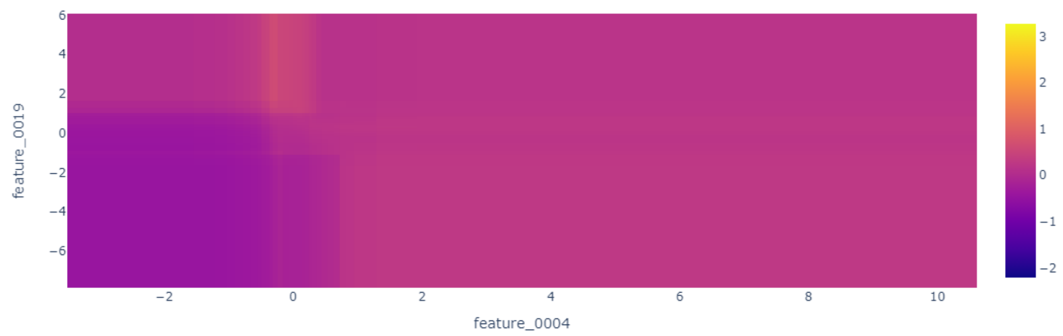
Term: feature_0002 & feature_0026 (interaction)



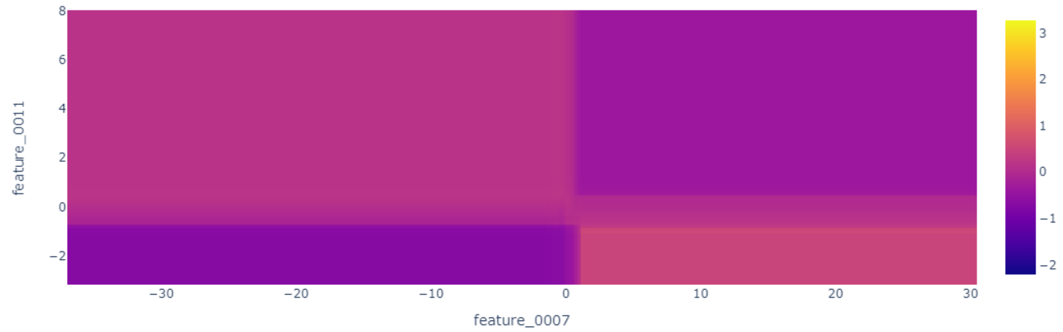
Term: feature_0003 & feature_0014 (interaction)



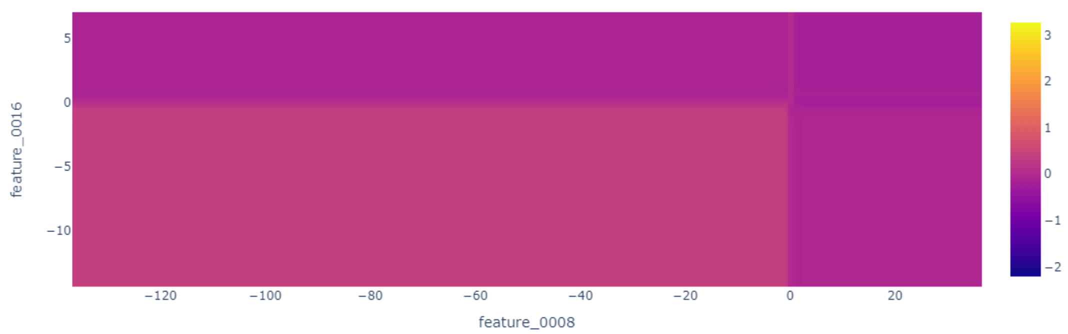
Term: feature_0004 & feature_0019 (interaction)



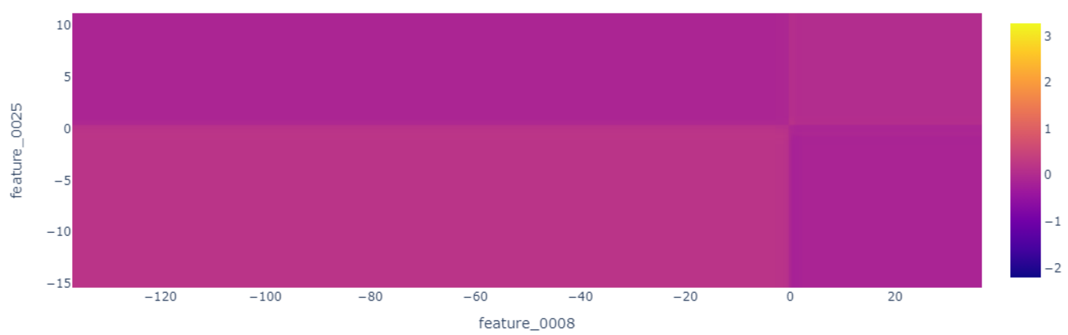
Term: feature_0007 & feature_0011 (interaction)



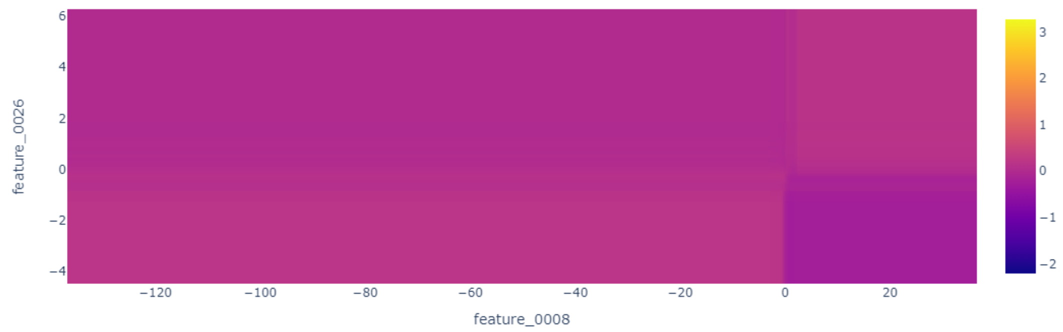
Term: feature_0008 & feature_0016 (interaction)



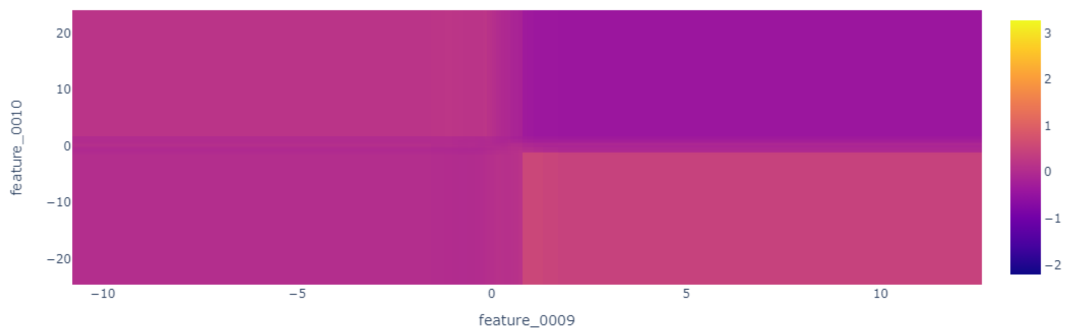
Term: feature_0008 & feature_0025 (interaction)



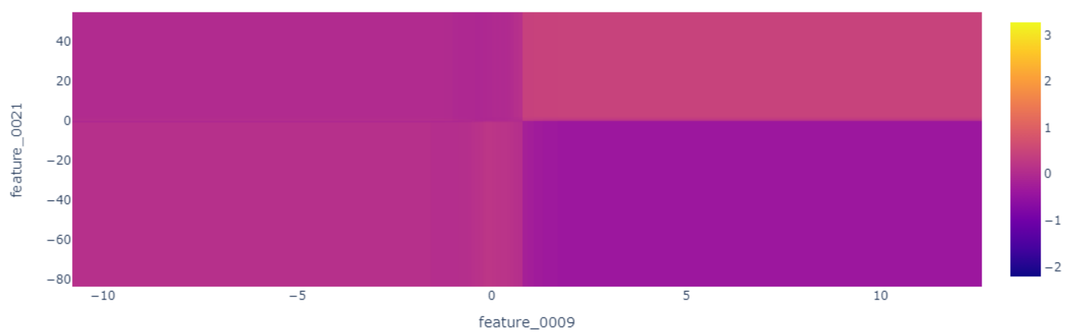
Term: feature_0008 & feature_0026 (interaction)



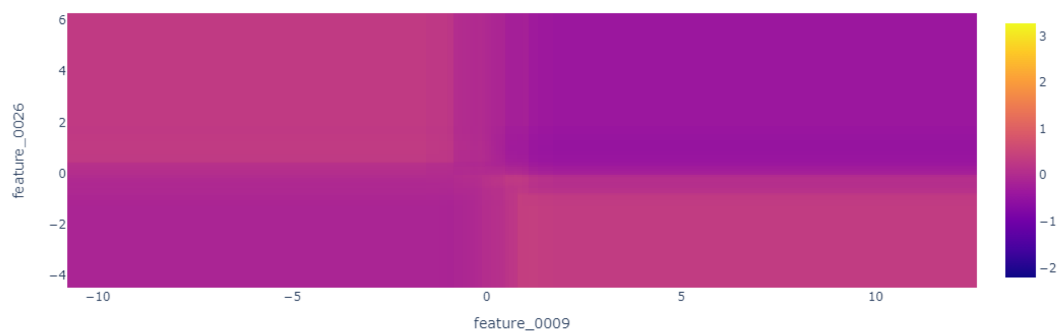
Term: feature_0009 & feature_0010 (interaction)



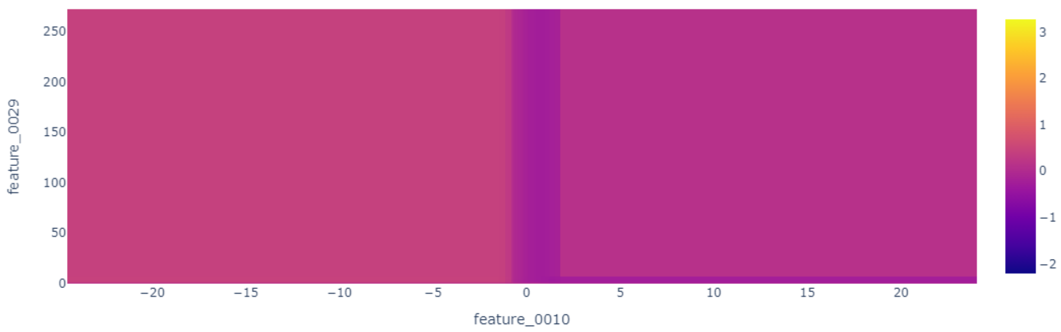
Term: feature_0009 & feature_0021 (interaction)



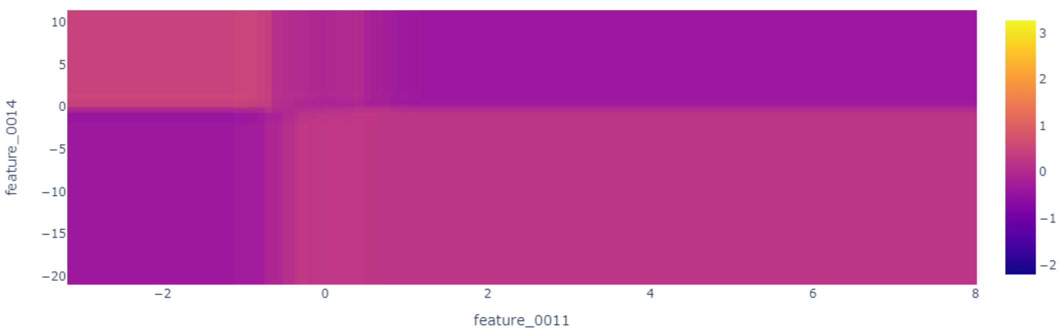
Term: feature_0009 & feature_0026 (interaction)



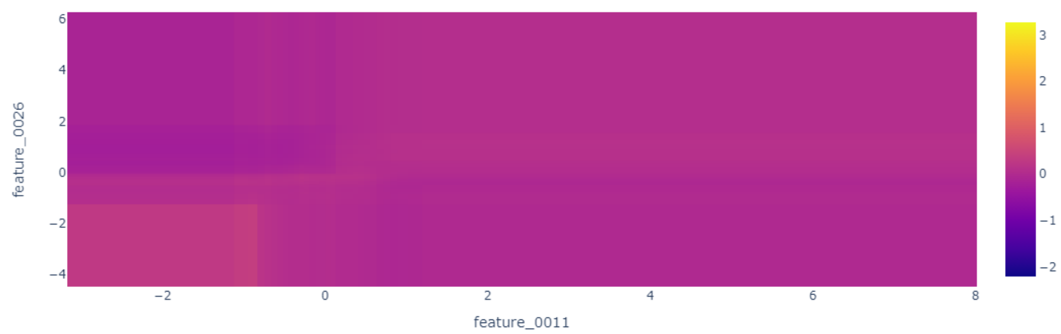
Term: feature_0010 & feature_0029 (interaction)



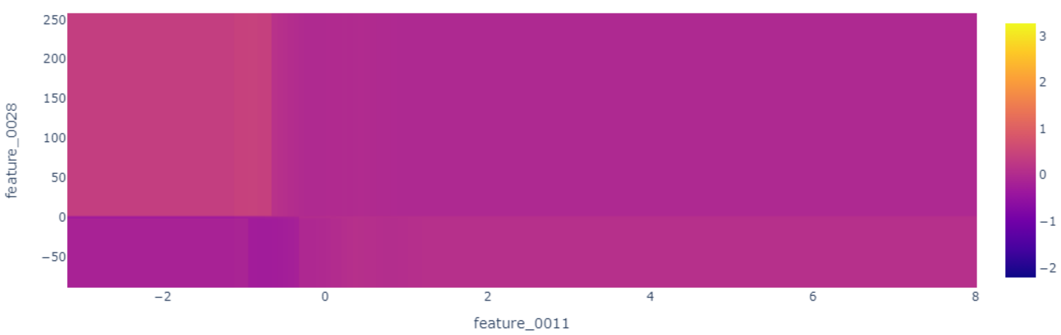
Term: feature_0011 & feature_0014 (interaction)



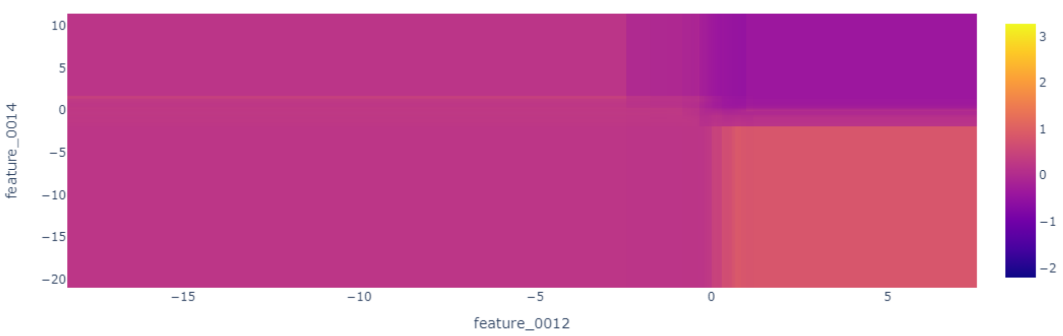
Term: feature_0011 & feature_0026 (interaction)



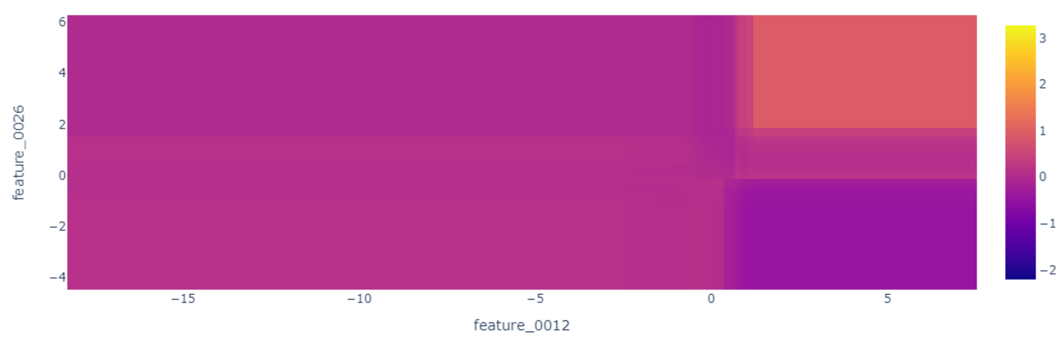
Term: feature_0011 & feature_0028 (interaction)



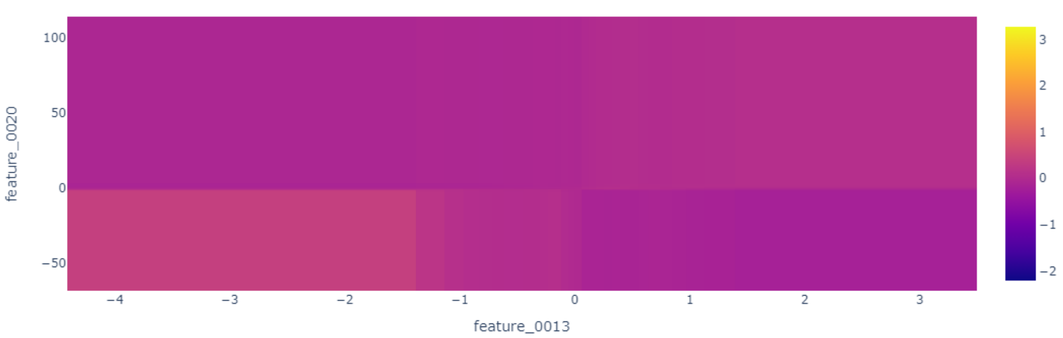
Term: feature_0012 & feature_0014 (interaction)



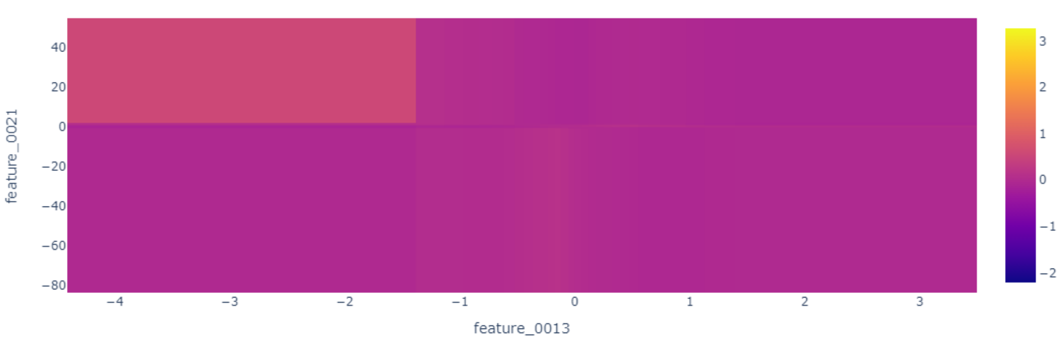
Term: feature_0012 & feature_0026 (interaction)



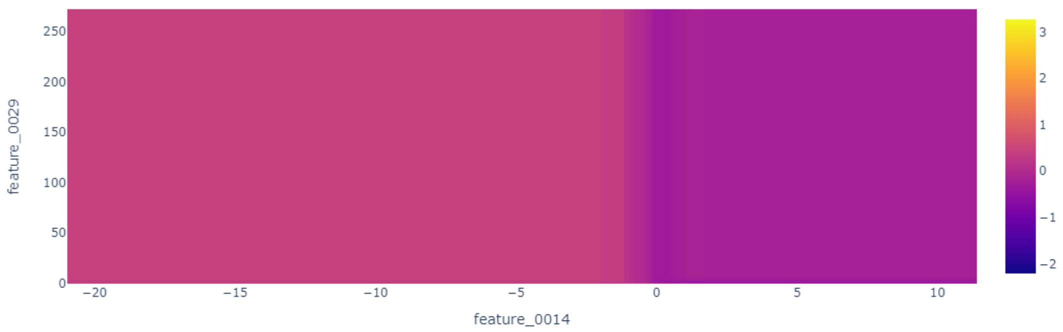
Term: feature_0013 & feature_0020 (interaction)



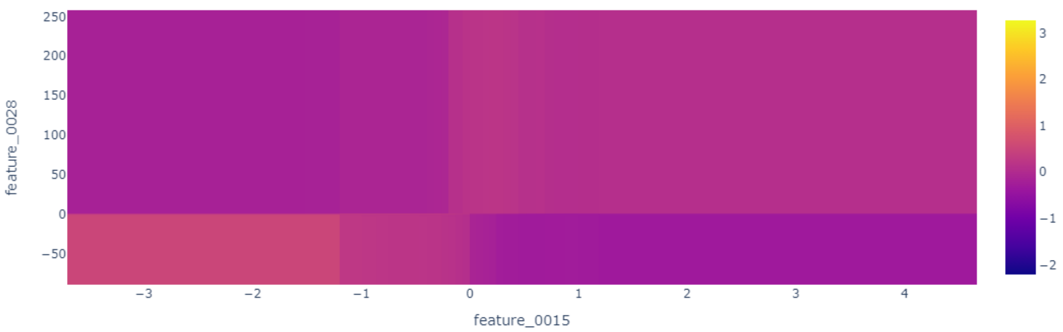
Term: feature_0013 & feature_0021 (interaction)



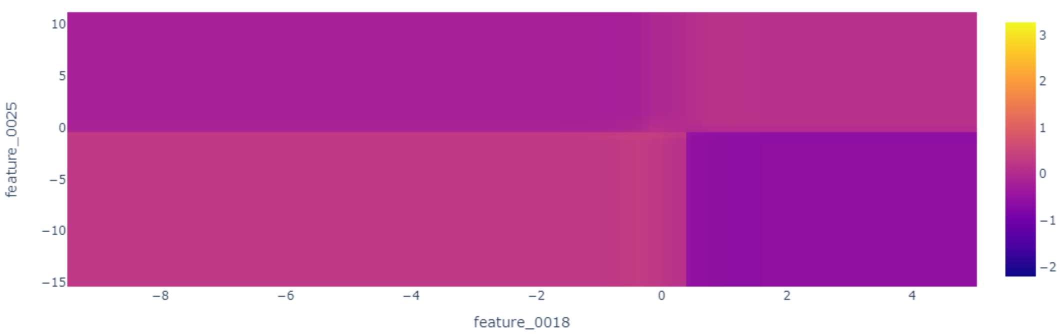
Term: feature_0014 & feature_0029 (interaction)



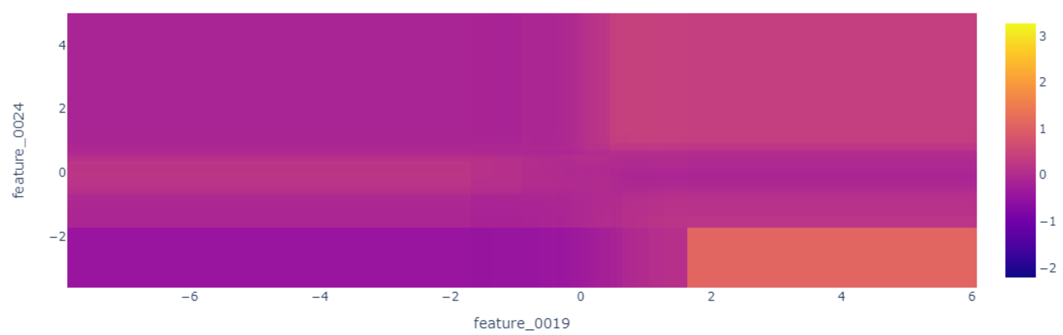
Term: feature_0015 & feature_0028 (interaction)



Term: feature_0018 & feature_0025 (interaction)



Term: feature_0019 & feature_0024 (interaction)



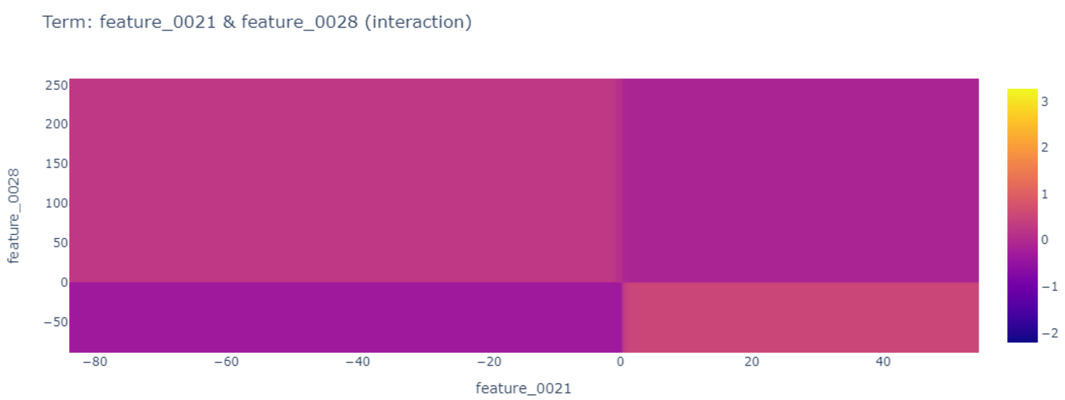
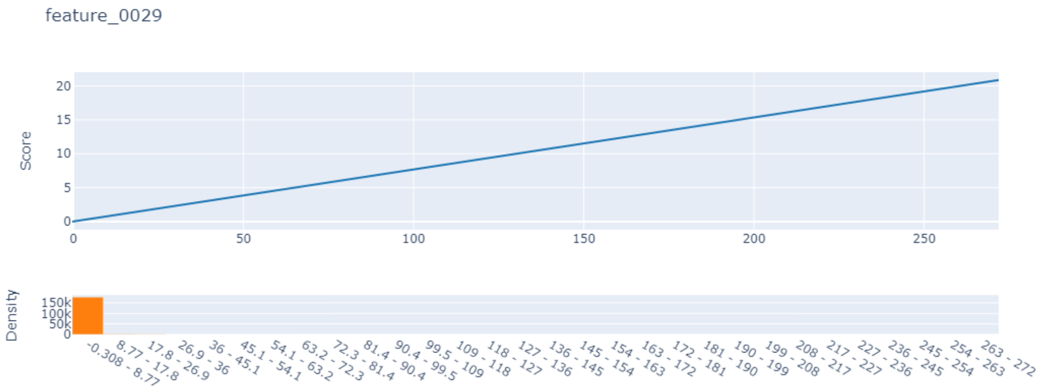
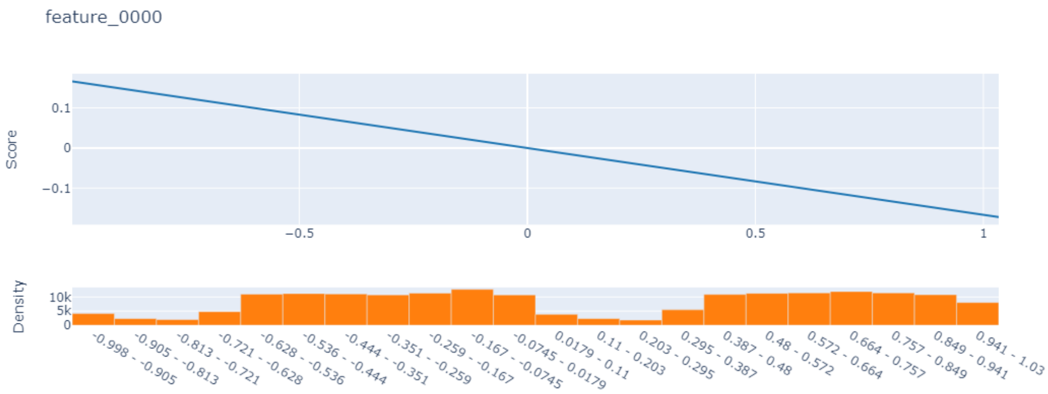
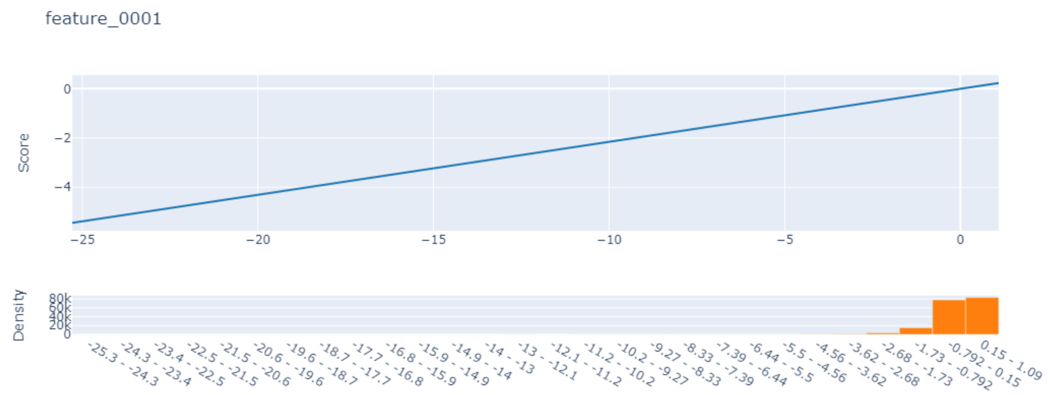
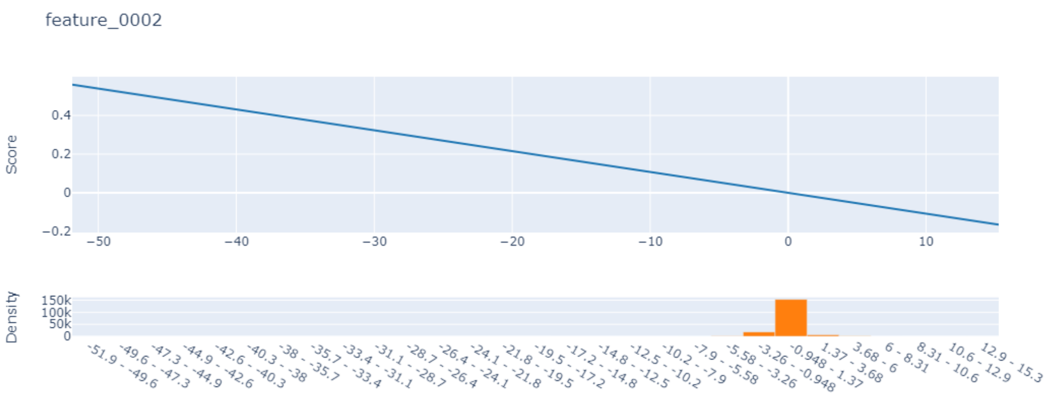


Figure 32: Global Explanation from explanation boosting on pairwise interaction

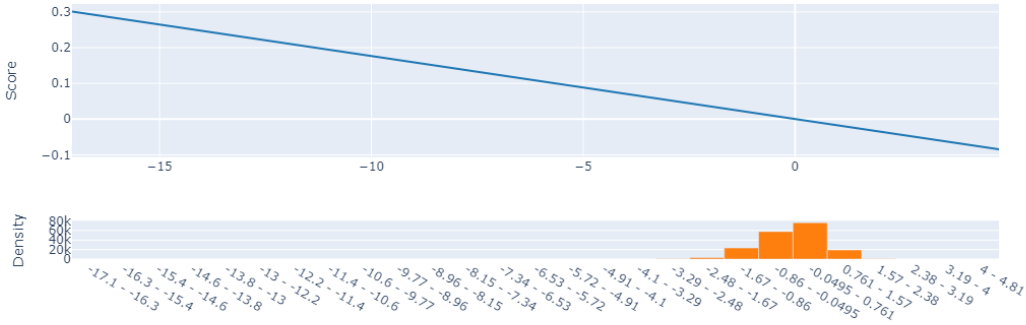

feature_0029
Score
20
15
10
5
0
0
50
100
150
200
250
Density
150k
100k
50k
0
-0.308 - 8.77
8.77 - 17.8
17.8 - 26.9
26.9 - 36
36 - 45.1
45.1 - 54.1
54.1 - 63.2
63.2 - 72.3
72.3 - 81.4
81.4 - 90.4
90.4 - 99.5
99.5 - 109
109 - 118
118 - 127
127 - 136
136 - 145
145 - 154
154 - 163
163 - 172
172 - 181
181 - 190
190 - 199
199 - 208
208 - 217
217 - 227
227 - 236
236 - 245
245 - 254
254 - 263
263 - 272


feature_0000
Score
0.1
0
−0.1
−0.5
0
0.5
1
Density
10k
5k
0
-0.998 - -0.905
-0.905 - -0.813
-0.813 - -0.721
-0.721 - -0.628
-0.628 - -0.536
-0.536 - -0.444
-0.444 - -0.351
-0.351 - -0.259
-0.259 - -0.167
-0.167 - -0.0745
-0.0745 - 0.0179
0.0179 - 0.11
0.11 - 0.203
0.203 - 0.295
0.295 - 0.387
0.387 - 0.48
0.48 - 0.572
0.572 - 0.664
0.664 - 0.757
0.757 - 0.849
0.849 - 0.941
0.941 - 1.03

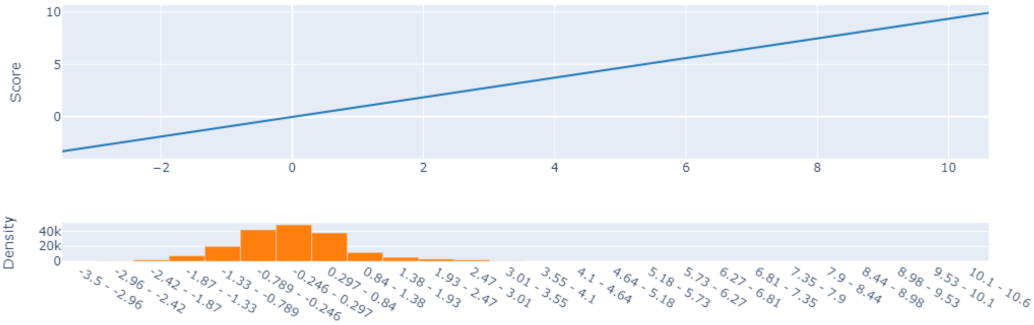

feature_0001
Score
0
−2
−4
−25
−20
−15
−10
−5
0
Density
80k
60k
40k
20k
0
-25.3 - -24.3
-24.3 - -23.4
-23.4 - -22.5
-22.5 - -21.5
-21.5 - -20.6
-20.6 - -19.6
-19.6 - -18.7
-18.7 - -17.7
-17.7 - -16.8
-16.8 - -15.9
-15.9 - -14.9
-14.9 - -14
-14 - -13
-13 - -12.1
-12.1 - -11.2
-11.2 - -10.2
-10.2 - -9.27
-9.27 - -8.33
-8.33 - -7.39
-7.39 - -6.44
-6.44 - -5.5
-5.5 - -4.56
-4.56 - -3.62
-3.62 - -2.68
-2.68 - -1.73
-1.73 - -0.792
-0.792 - 0.15
0.15 - 1.09


feature_0002
Score
0.4
0.2
0
−0.2
−50
−40
−30
−20
−10
0
10
Density
150k
100k
50k
0
-51.9 - -49.6
-49.6 - -47.3
-47.3 - -44.9
-44.9 - -42.6
-42.6 - -40.3
-40.3 - -38
-38 - -35.7
-35.7 - -33.4
-33.4 - -31.1
-31.1 - -28.7
-28.7 - -26.4
-26.4 - -24.1
-24.1 - -21.8
-21.8 - -19.5
-19.5 - -17.2
-17.2 - -14.8
-14.8 - -12.5
-12.5 - -10.2
-10.2 - -7.9
-7.9 - -5.58
-5.58 - -3.26
-3.26 - -0.948
-0.948 - 1.37
1.37 - 3.68
3.68 - 6
6 - 8.31
8.31 - 10.6
10.6 - 12.9
12.9 - 15.3

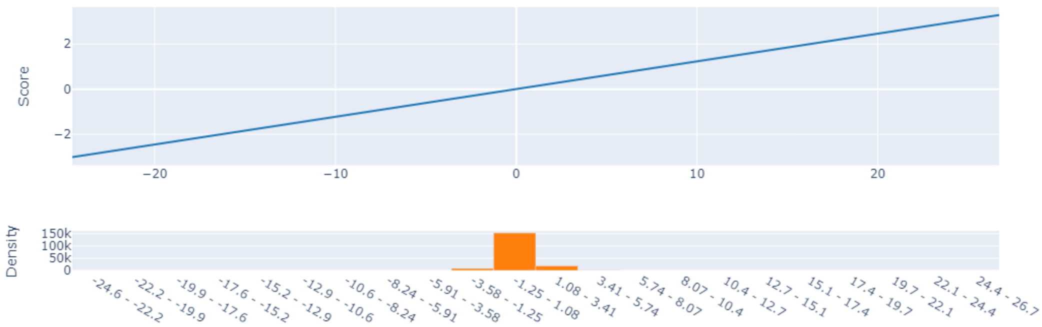
feature_0003



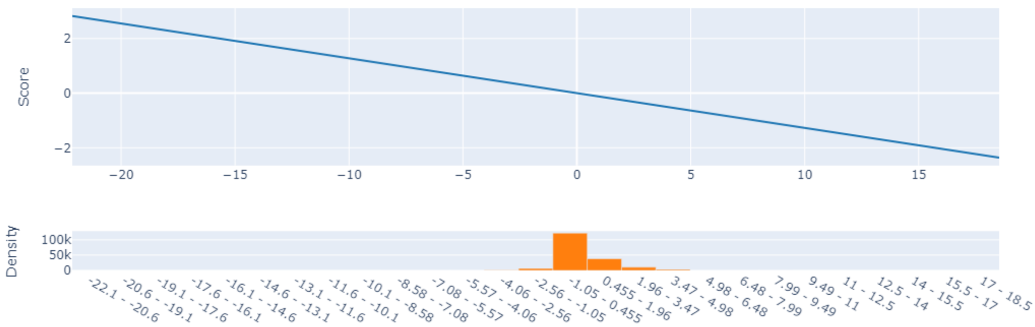
feature_0004



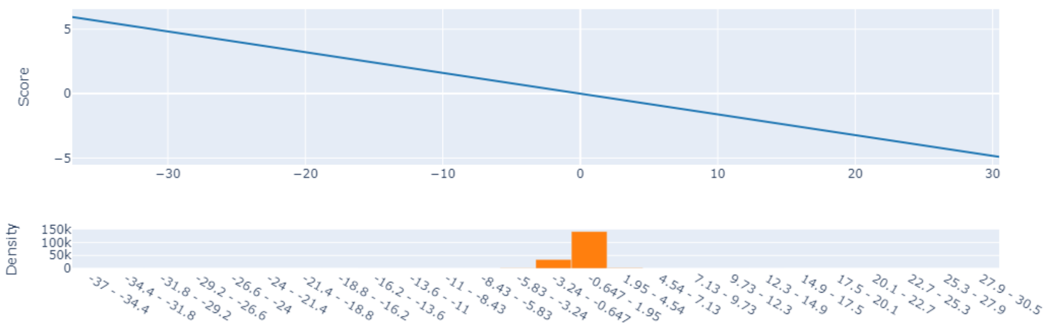
feature_0005



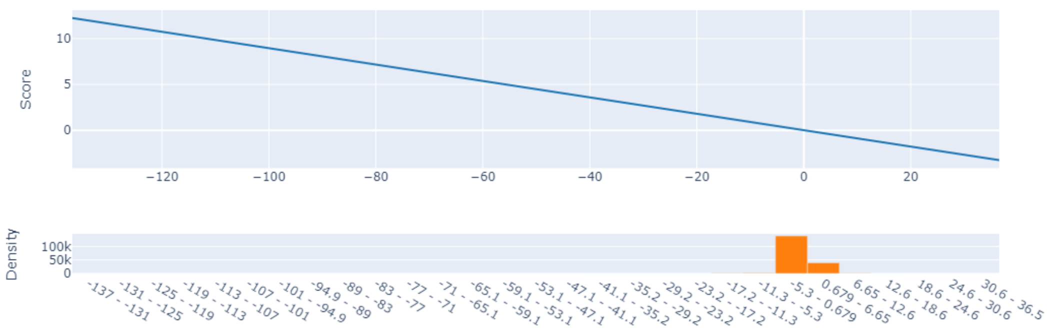
feature_0006



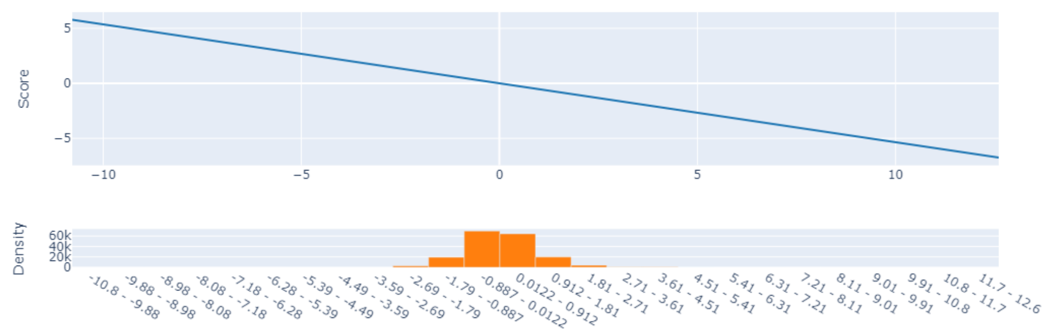
feature_0007



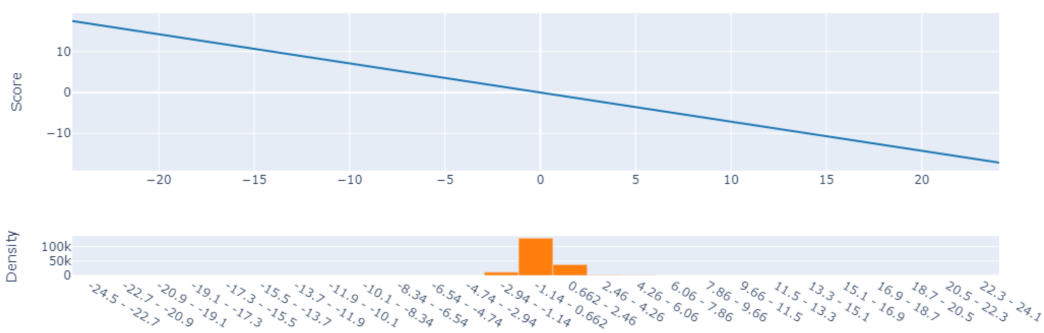
feature_0008



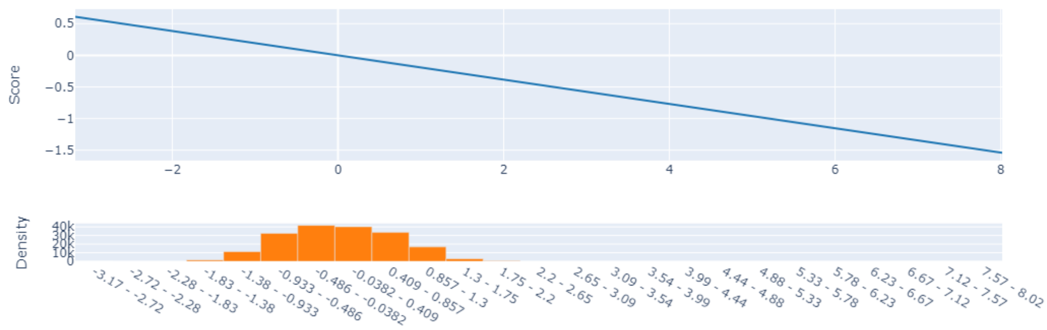
feature_0009



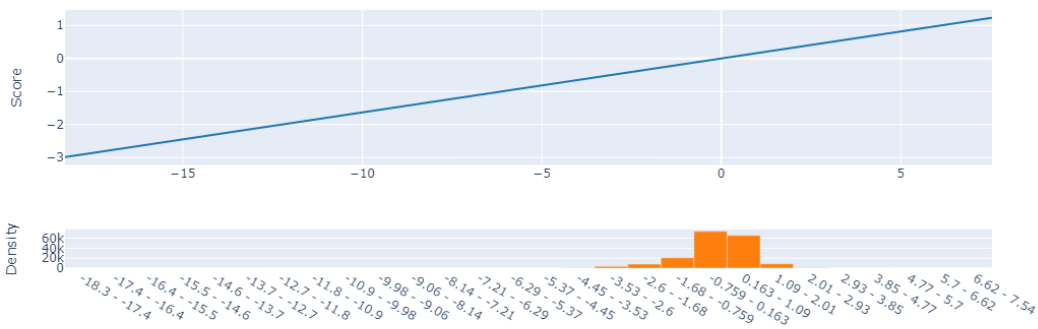
feature_0010



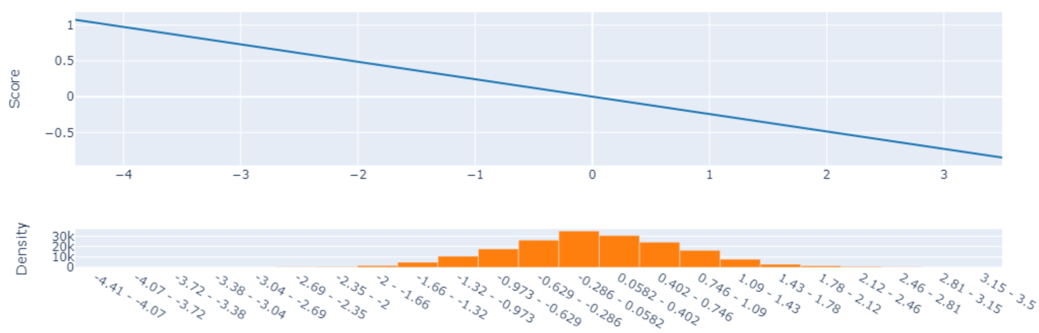
feature_0011



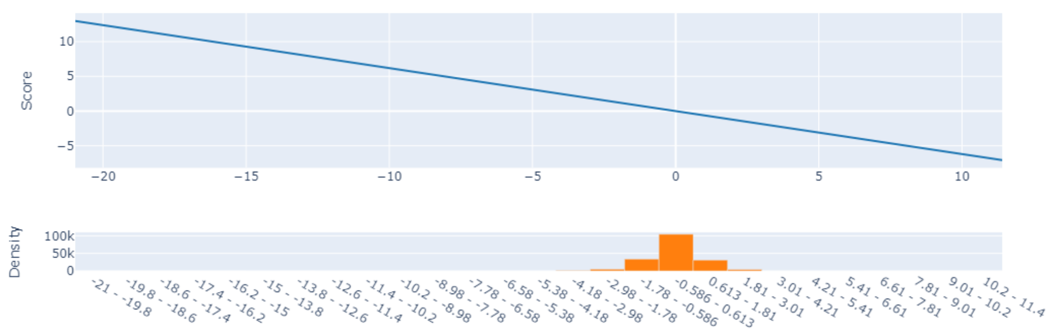
feature_0012



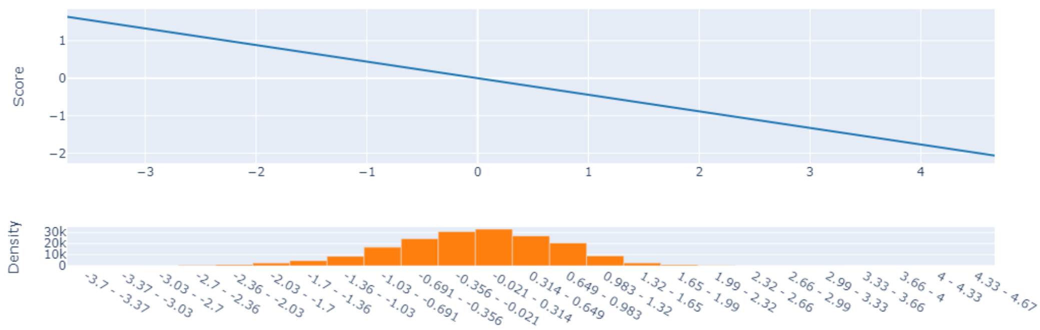
feature_0013



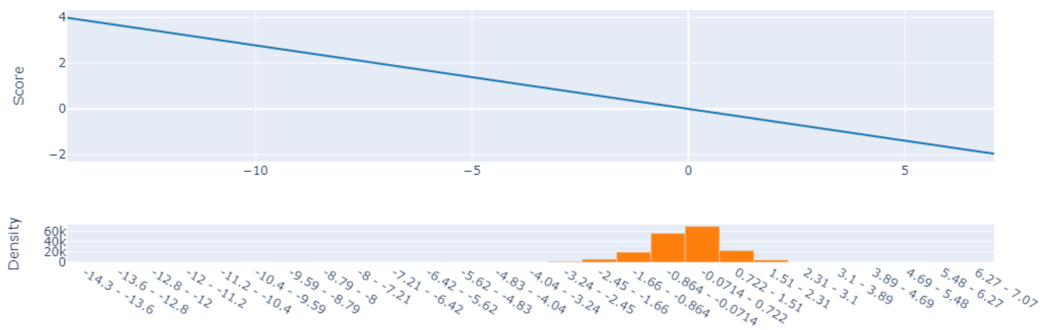
feature_0014



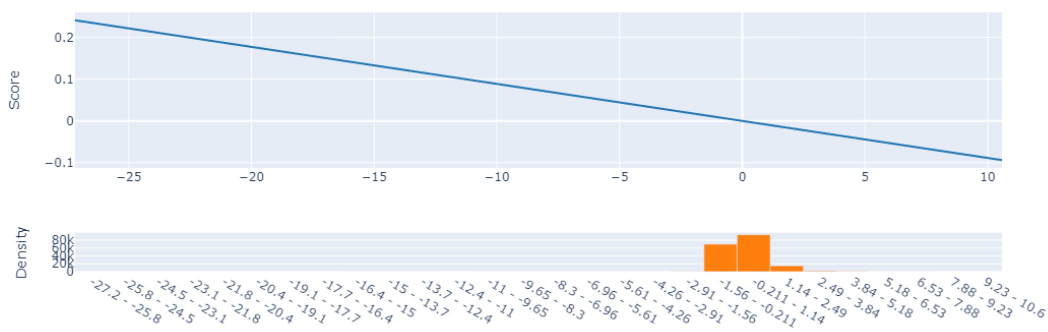
feature_0015



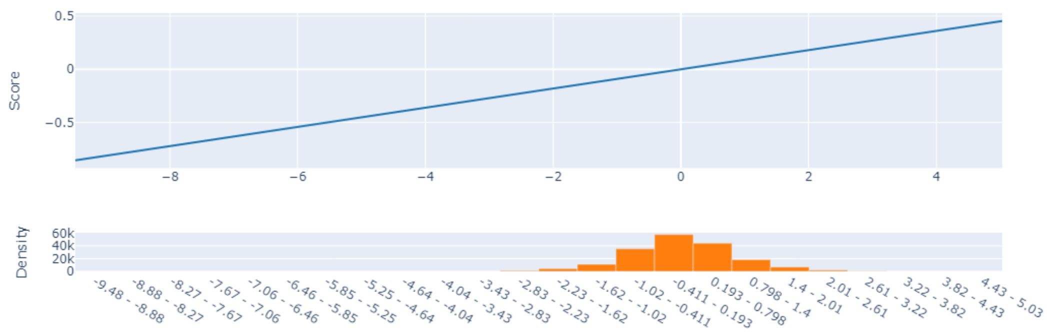
feature_0016



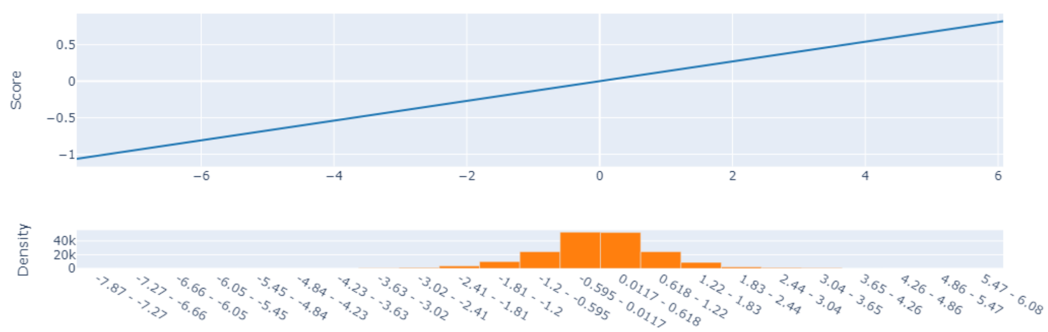
feature_0017



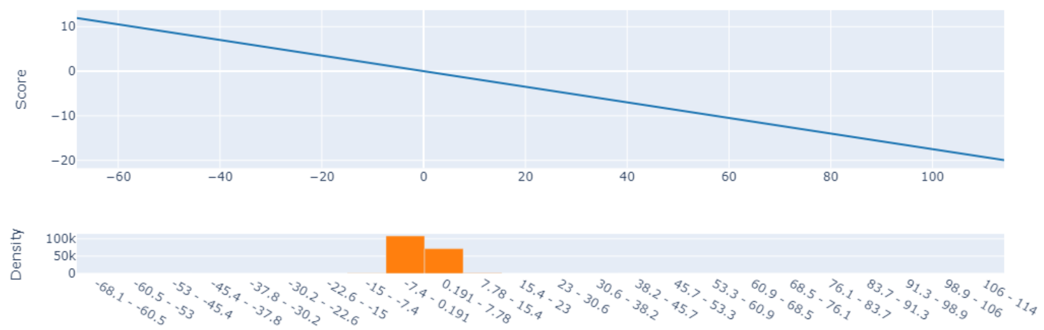
feature_0018



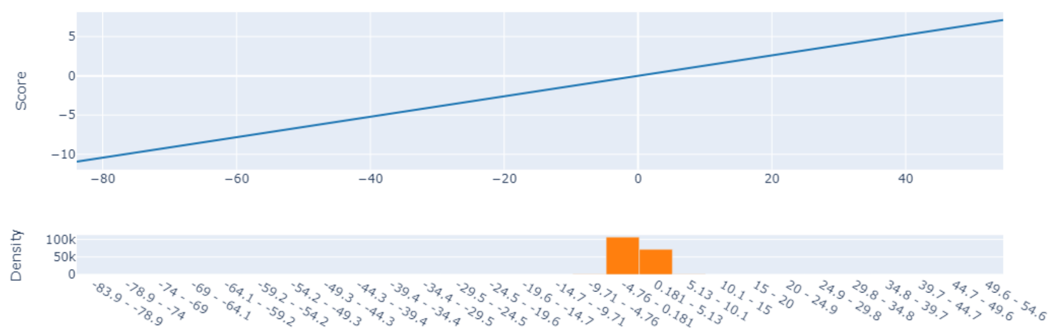
feature_0019



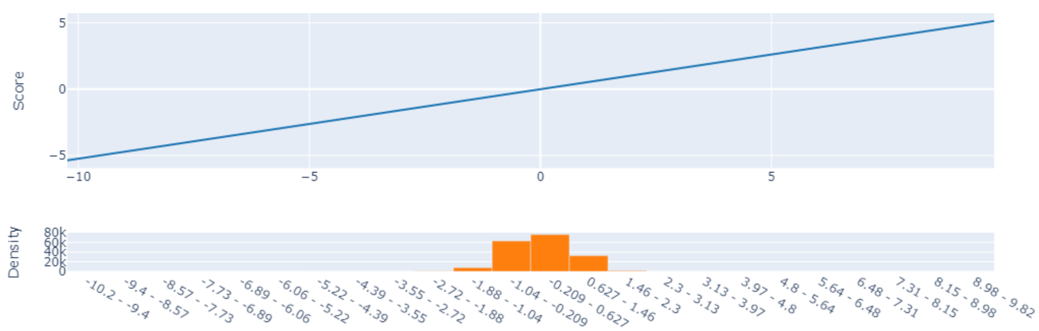
feature_0020



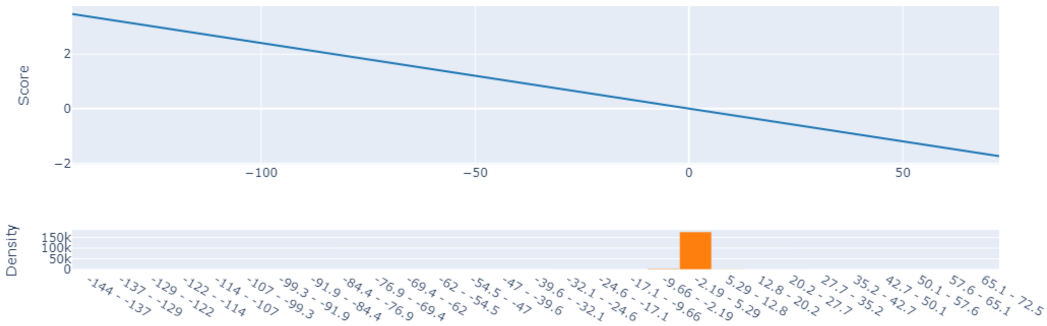
feature_0021



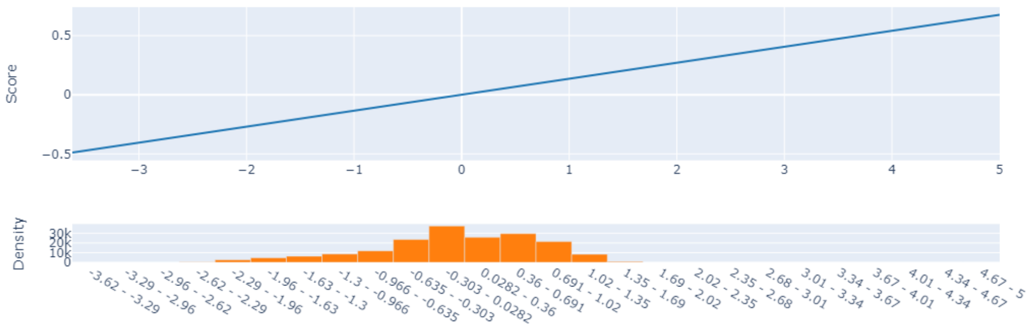
feature_0022



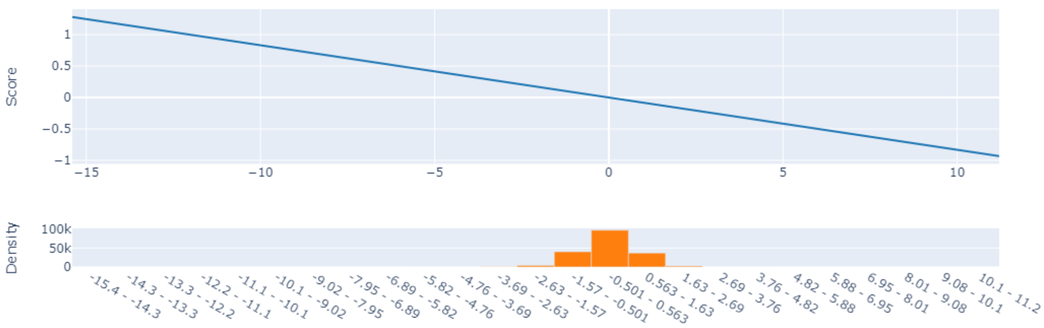
feature_0023



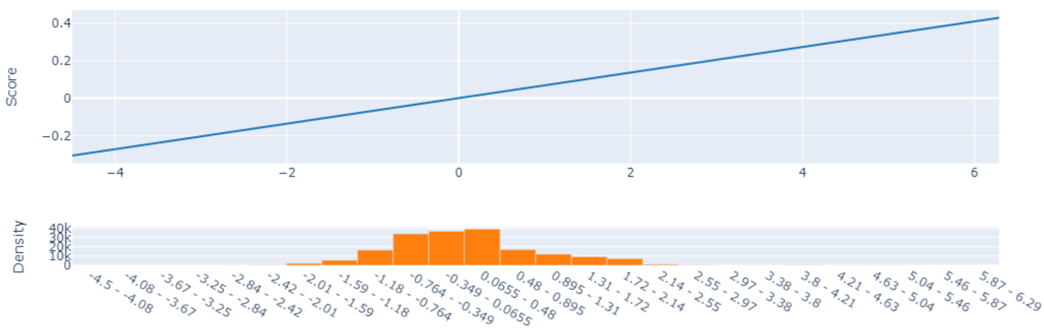
feature_0024

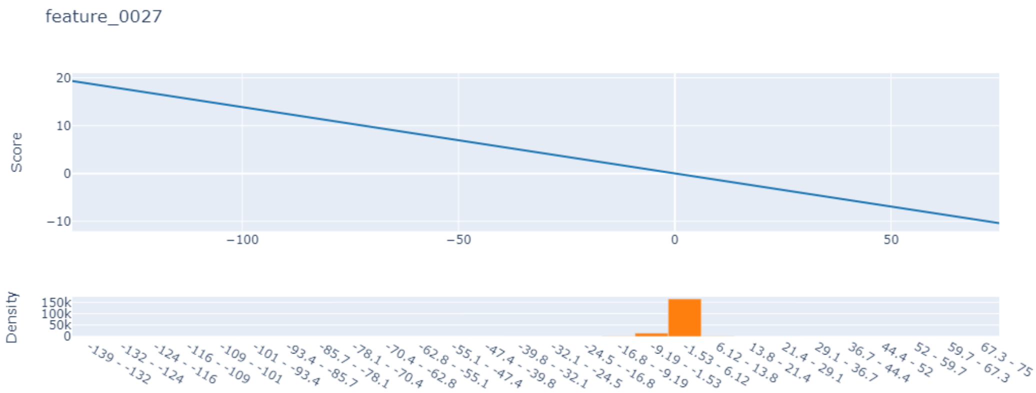


feature_0025



feature_0026





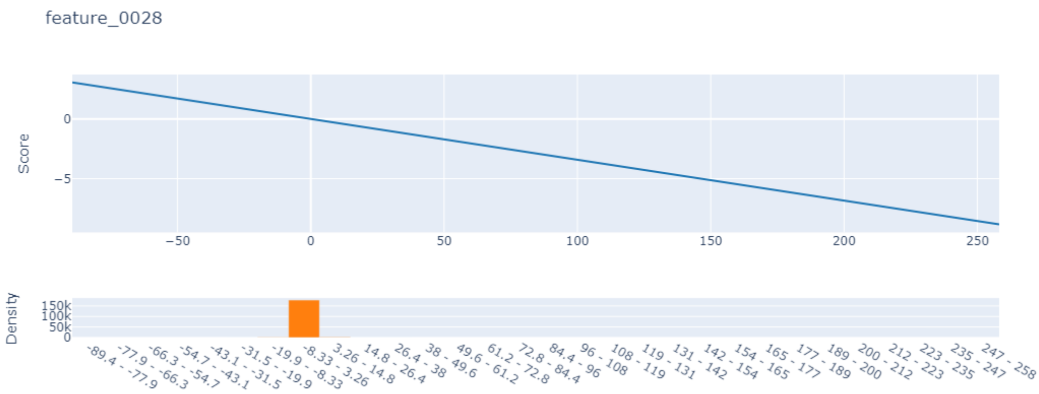


Figure 33: Global Explanation from Logistic Regression on each variables