Parkinson's Disease (Binary Classification)

The goal of this study is to train a model in order to predict whether a patient has Parkinson's Disease or not. The dataset used in this case study is found in https://www.kaggle.com/datasets/rabieelkharoua/parkinsons-disease-dataset-analysis/data and has 35 features and 2104 labelled samples. This dataset comprises comprehensive health information for 2,105 patients diagnosed with Parkinson's Disease, each uniquely identified with IDs ranging from 3058 to 5162. The dataset includes demographic details, lifestyle factors, medical history, clinical measurements, cognitive and functional assessments, symptoms, and a diagnosis indicator.

The dataset contains no missing values and includes several categorical features. Some of these features represent binary yes/no data, encoded as 0 for "No" and 1 for "Yes". Additionally, other categorical features contain multiple levels with corresponding numeric codes, as detailed below:

Gender:

- Male (0)
- Female (1)

Ethnicity:

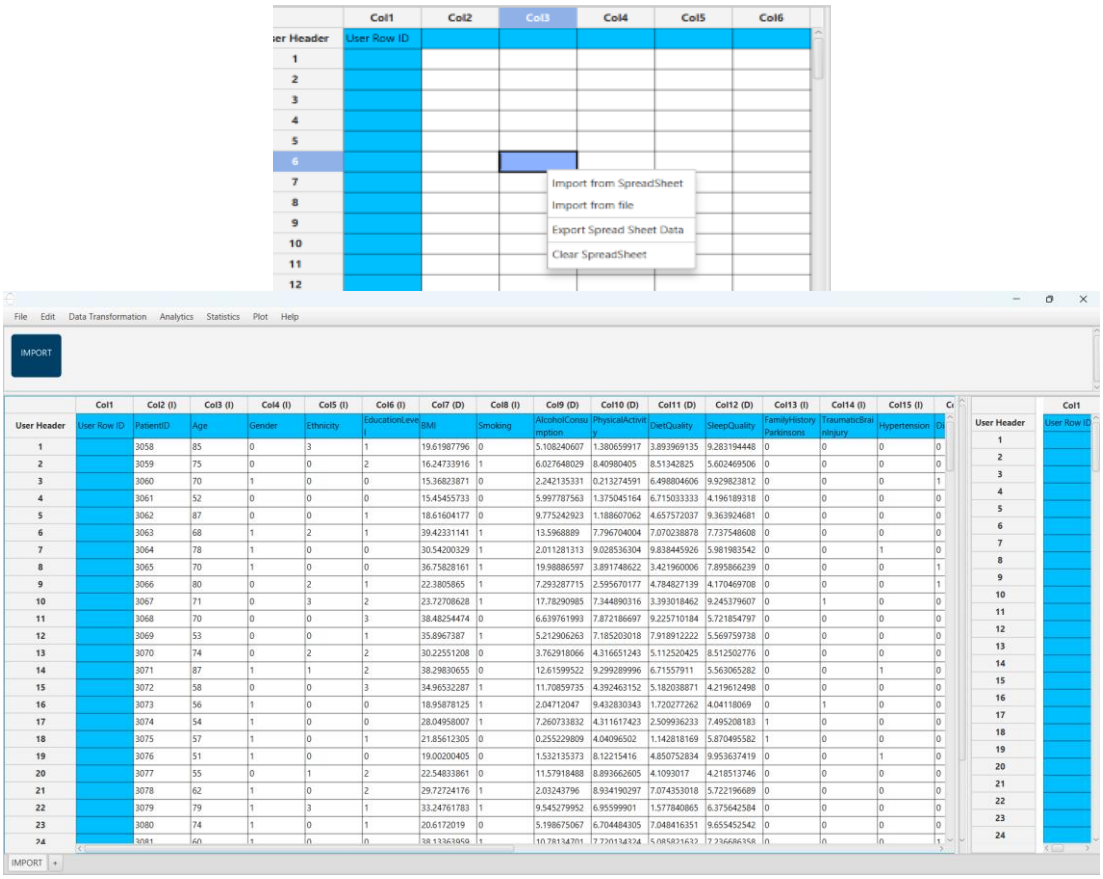
- Caucasian (0)
- African American (1)
- Asian (2)
- Other (3)

Education Level:

- None (0)
- High School (1)
- Bachelor's (2)
- Higher (3)

Step 1: Import data from file

Right click on the input spreadsheet and choose the option "Import from file". Then navigate through your files to load the one with the Parkinson's Disease data.

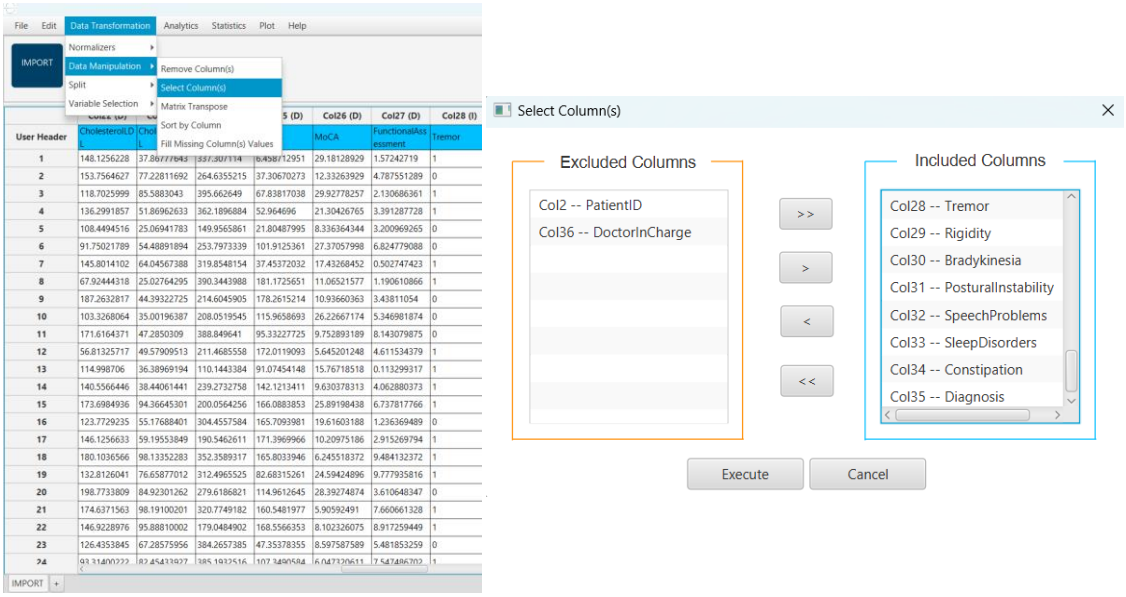


Step 2: Manipulate data

In order to use the data for training we have to exclude any columns that do not contain features, like the "PatientID" and "DoctorInCharge" columns. We follow these steps to execute this:

- On the menu click on "Data Transformation" → "Data Manipulation" → "Select Column(s)"

- Select all columns except the ones that corresponds to the "PatientID" and "DoctorInCharge" columns.

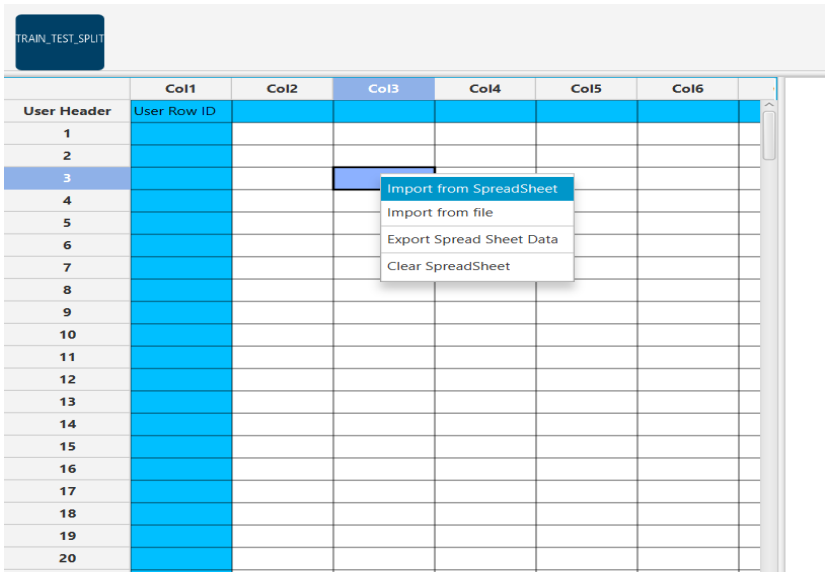


The data without the "PatientID" and "DoctorInCharge" columns will appear in the output spreadsheet.

Step 3: Split data

Create a new tab by pressing the "+" button on the bottom of the page with the name "TRAIN_TEST_SPLIT" which we will use for splitting to create the train and test set.

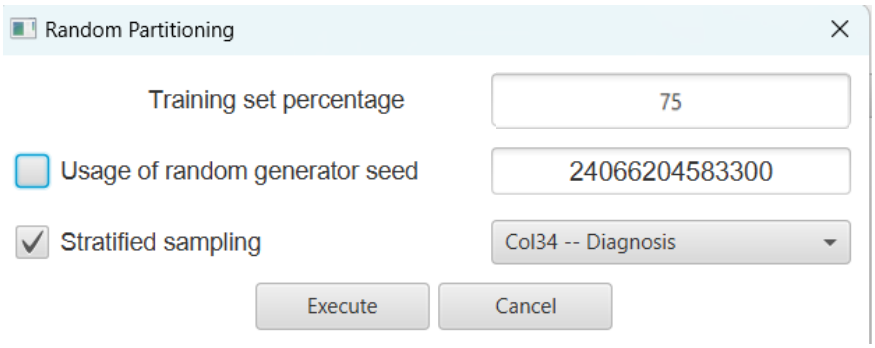
Import data into the input spreadsheet of the "TRAIN_TEST_SPLIT" tab from the output of the "IMPORT" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".



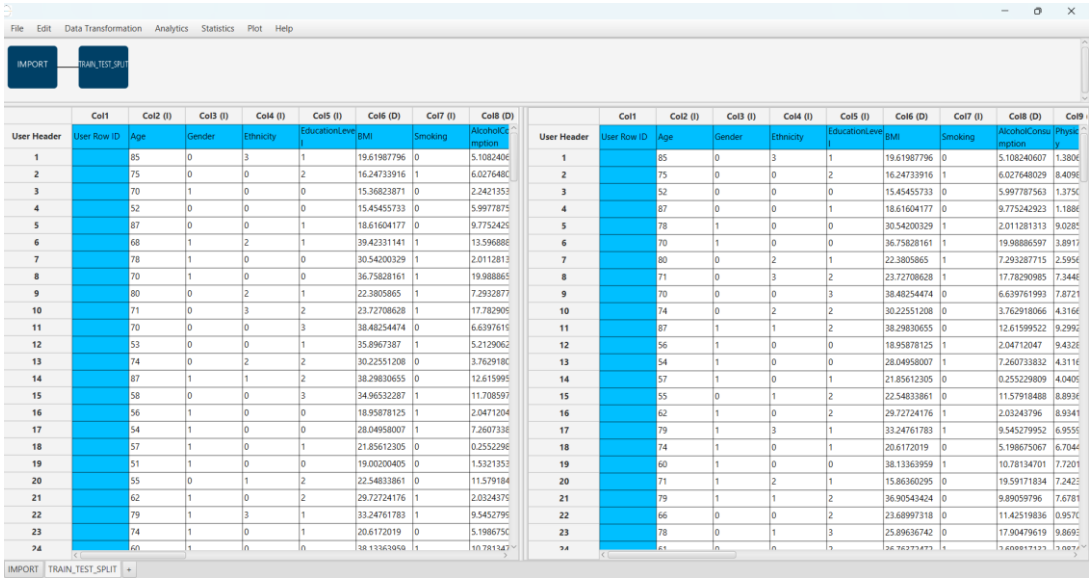
Split the dataset by choosing

"Data Transformation" → "Split" → "Random Partitioning"

Then choose the "Training set percentage" and the column for the sampling as shown below:



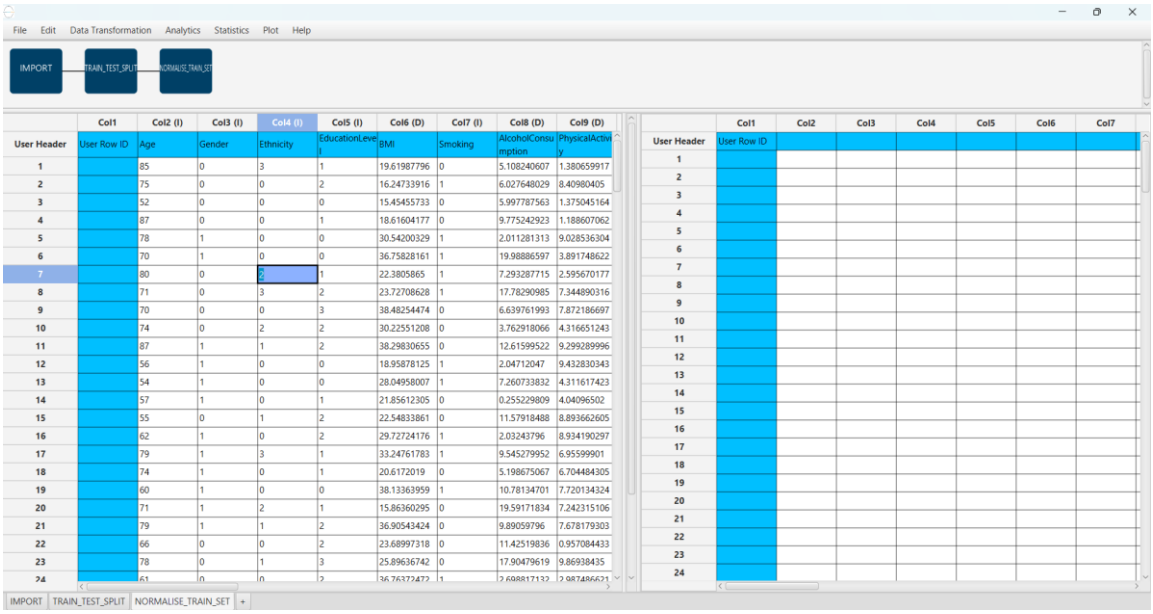
The results will appear on the output spreadsheet.



Step 4: Normalize the training set

Create a new tab by pressing the "+" button on the bottom of the page with the name "NORMALISE_TRAIN_SET".

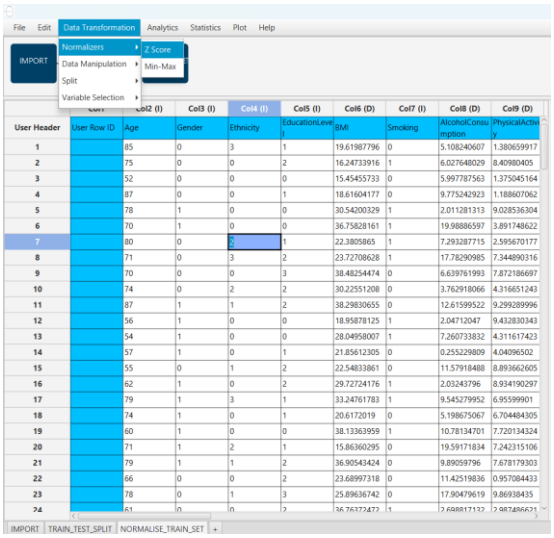
Import data into the input spreadsheet of the "NORMALISE_TRAIN_SET" tab the train set from the output of the "TRAIN_TEST_SPLIT" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet". From the available Select input tab options choose "TRAIN_TEST_SPLIT: Training Set"

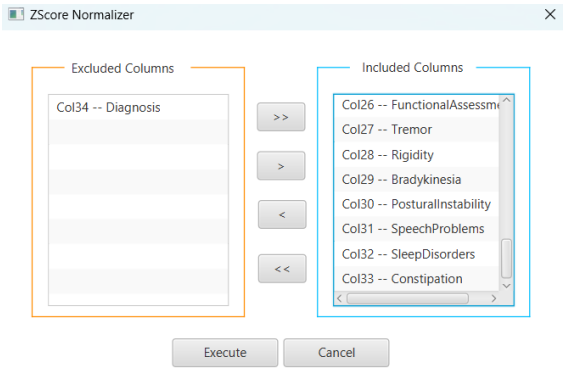


Normalize the data using Z-score:

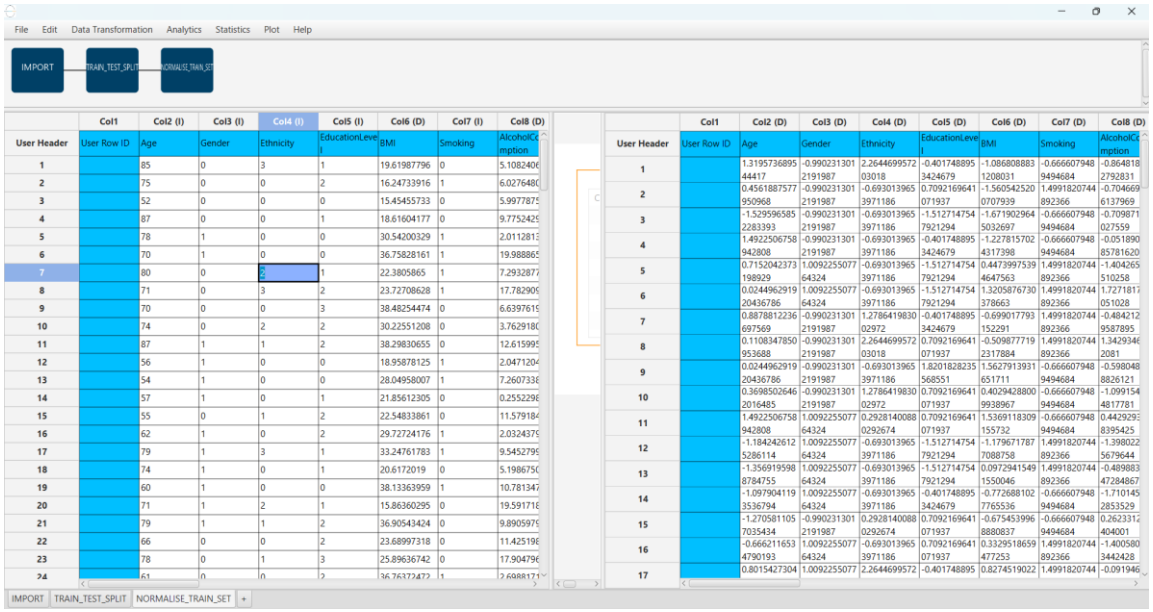
"Data Transformation" → "Normalizers" → "Z-Score"

Then select all columns and click "Execute".





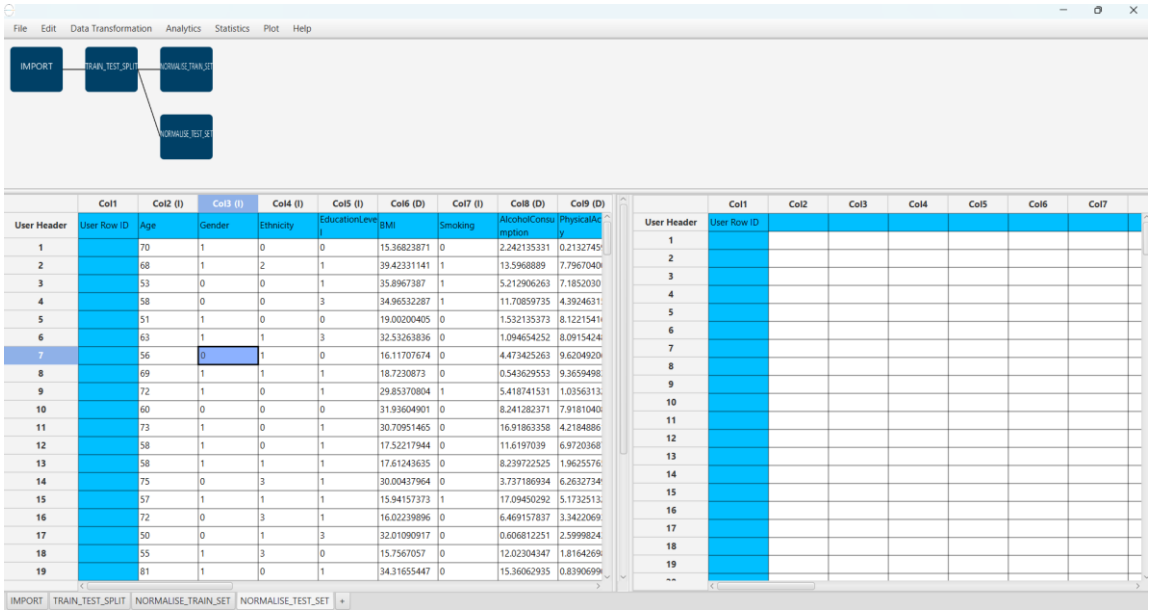
The results will appear on the output spreadsheet.



Step 5: Normalize the test set

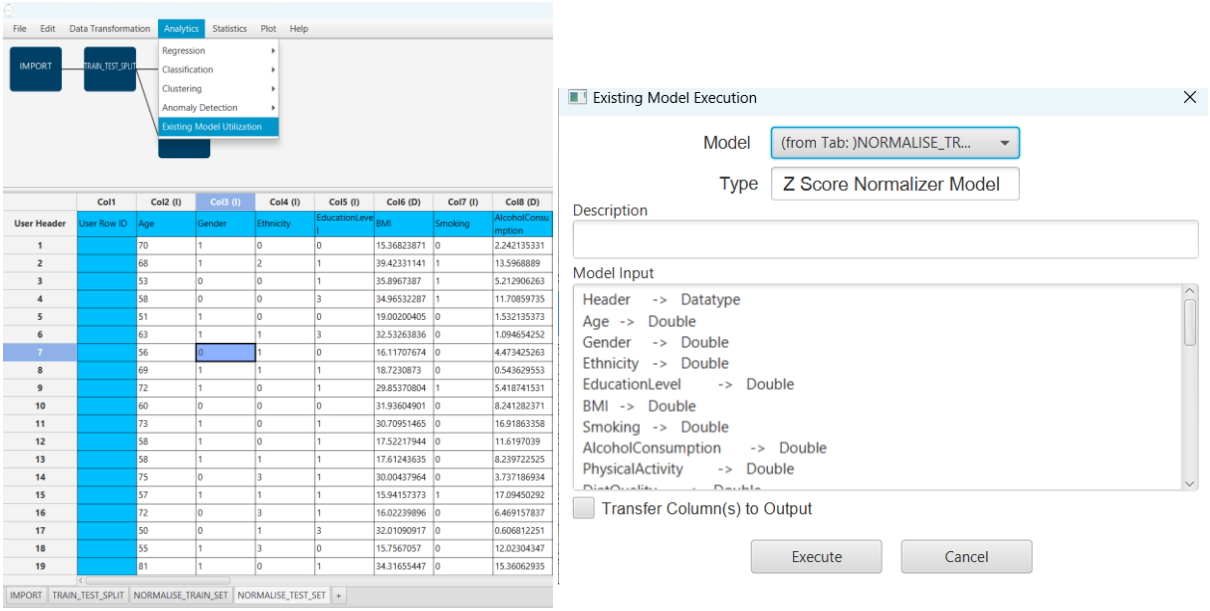
Create a new tab by pressing the "+" button on the bottom of the page with the name "NORMALISE_TEST_SET".

Import data into the input spreadsheet of the "NORMALISE_TEST_SET" tab the test set from the output of the "TRAIN_TEST_SPLIT" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet". From the available Select input tab options choose "TRAIN_TEST_SPLIT: Test Set".

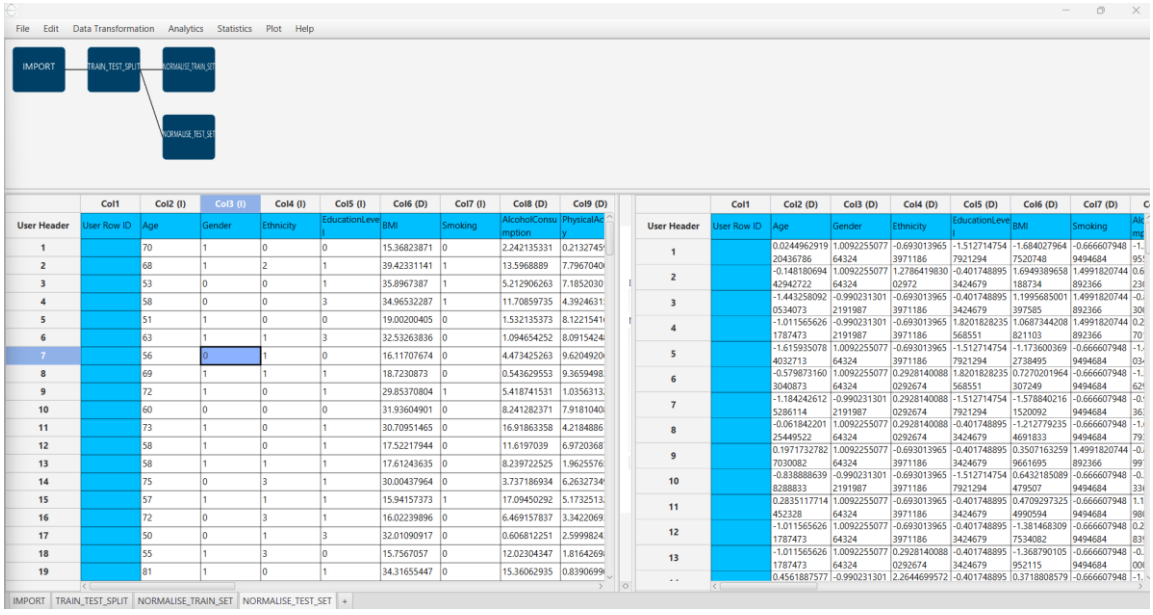


Normalize the test set using the existing normalizer of the training set:

"Analytics" → "Existing Model Utilization" → "Model (from Tab:) NORMALISE_TRAIN_SET".



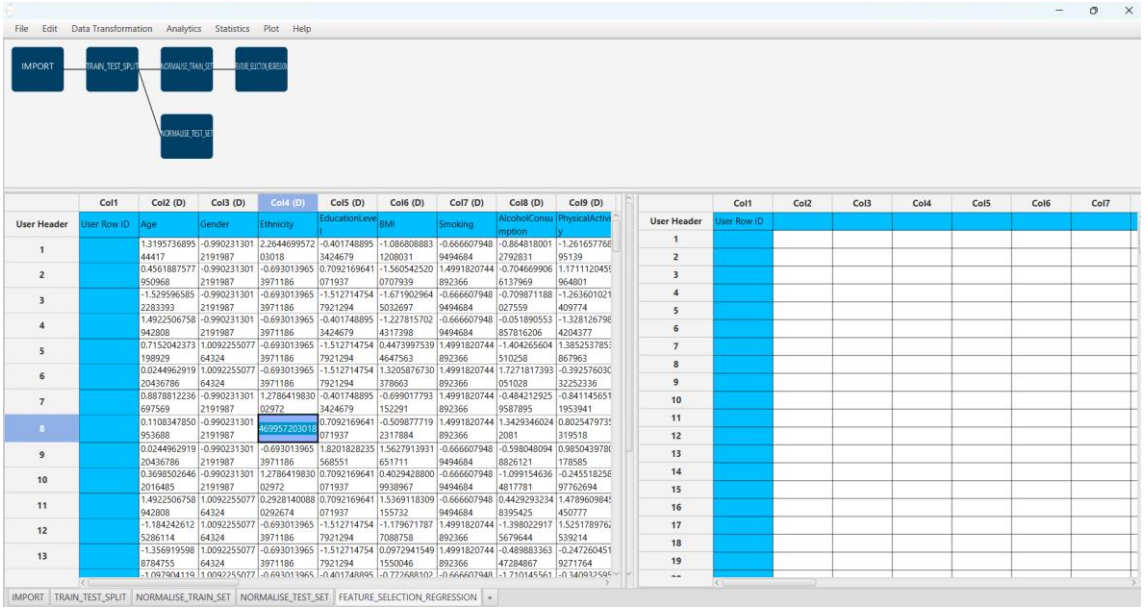
The results will appear on the output spreadsheet.



Step 6: Feature selection

Create a new tab by pressing the "+" button on the bottom of the page with the name "FEATURE_SELECTION_REGRESSION".

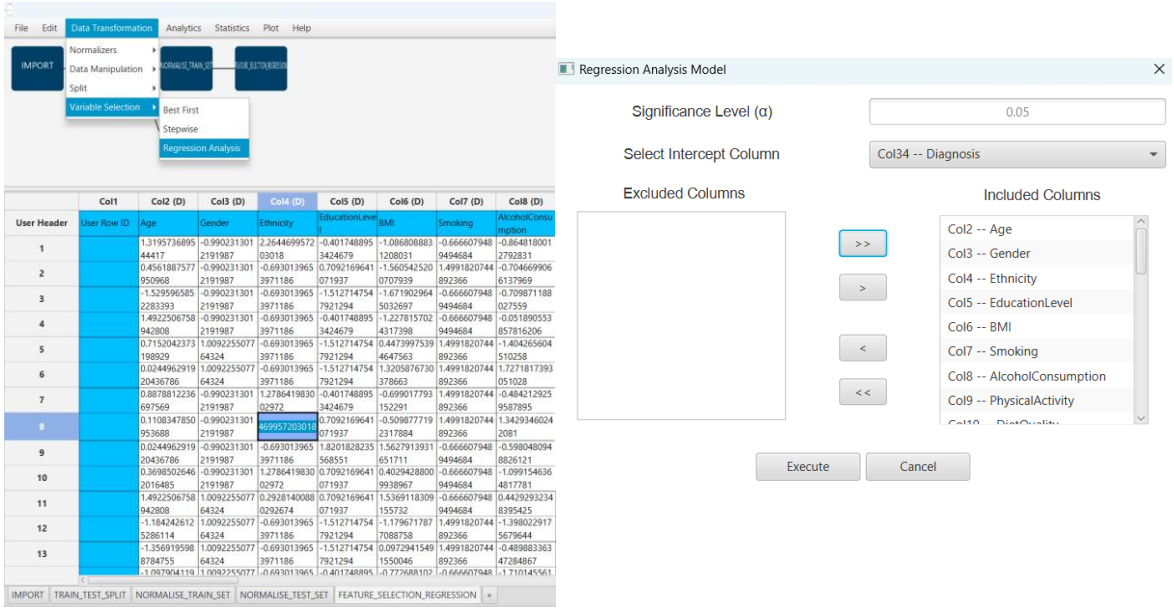
Import data into the input spreadsheet of the "FEATURE_SELECTION_REGRESSION" tab from the output of the "NORMALISE_TRAIN_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".



Choose the most important features for the classification using the Regression Analysis:

"Data Transformation" → "Variable Selection" → "Regression Analysis".

Then choose the "Diagnosis" column as the intercept column, the Significance level (α) as 0.05 and include all columns.



The results will appear on the output spreadsheet.

	Col1	Col2 (S)	Col3 (S)	Col4 (S)	Col5 (S)	Col6 (S)	Col7 (S)	Col8 (S)
User Header	User Row ID							
1		Regression Statistics						
2		Multiple R	0.6427533978429012					
3		R Square	0.41313193043859486					
4		Adjusted R Square	0.4009845965278801					
5		Standard Error	0.37590758946897873					
6		Observations	1579					
7								
8		Regression	df	SS	MS	F	Significance F	
9		Residual	32	153.78711830863594	4.805847447144873	34.01009089526929	4.058724587937507E-154	
10		Total	1546	218.4598734583048	0.14130651582037826			
11			1578	372.2469917669407				
12			Coefficients	Standard Error	t Stat	P-value	Lower 95.0%	Upper 95.0%
13		Diagnosis	0.6193793540215377	0.009459975879892092	65.47367159129372937	0.0	0.6008236148982906	0.6379350931447847
14		Age	0.034944578344872954	0.009556538961688421	3.656614438026531	2.6412976725683934E-4	0.01619943077307164	0.05368972591667427
15		Gender	0.005905157055109047	0.009589163032430095	0.6158156906017851	0.5381068188904652	-0.012903982619157102	0.024714296729375196
16		Ethnicity	-0.0051288114570836344	0.009590432485275994	-0.534784167 9671693	0.5928760144825591	-0.023940441 1626286	0.013682818 24846133
17		EducationLevel	-0.005631677102695146	0.009543413279615323	-0.590111413 7773302	0.5552021963015052	-0.024351078654056724	0.013087724448666432
18		BMI	0.006842640052181735	0.009609441497752863	0.712074687 5645025	0.476525967 6099952	-0.012006275824172727	0.025691555928536197
19		Smoking	-0.01068028611694388	0.009553808376531577	-1.117908764 339406	0.263779644 5924609	-0.029420077 64698911	0.008059505413101352
20		AlcoholConsumption	0.002461167657840956	0.009563682979952696	0.257345173 71602894	0.796946569 474437	-0.016297992 903093382	0.021220328218775293
21		PhysicalActivity	-0.009334361700271854	0.009568907355141496	-0.975488773 569992	0.329470475 6939527	-0.028103769 871170126	0.009435046470626419
22		DietQuality	-0.003050220046770803	0.009546825564645988	-0.319500971 93211996	0.749389821 4594091	-0.021776314 79393405	0.015675874700392445
23		SleepQuality	-0.021731024730421666	0.009574762237808862	-2.269615076 6658314	0.023368160034877315	-0.040511917 25146546	-0.002950132 2093778704
24		FamilyHistoryParkinsons	0.0101209008340667	0.009552470104518592	1.059506151 11365	0.289534830 3630602	-0.008616265 675929415	0.028858067344062814
25		TraumaticBrainInjury	0.014589229732617963	0.009595804986224412	1.520375805 2150949	0.128621033 27246324	-0.004232938 131512603	0.033411397596 74853
26		Hypertension	0.006973590608428447	0.009562082829304448	0.729296193 40431	0.465930971 09648995	-0.011782431 257612396	0.025729612474469293
27		Diabetes	0.02562743849956757	0.009587120343858281	2.673111172 1138525	0.007594197 785412139	0.006822305 558165209	0.044432571 44096993
28		Depression	0.02723933473557805	0.009560502652271166	2.849152991 87822	0.004441649 154449658	0.008486412 386192469	0.045992257 08496363
29		Stroke	0.012415701060811338	0.009548812483364104	1.300235090 2211048	0.193714209 22437116	-0.006314291 026668686	0.031145693 14829136
30		SystolicBP	0.00528704609413583	0.009527222978344163	0.554940941 6914821	0.579015334 1233407	-0.013400598 197382648	0.023974690 38565431
31		DiastolicBP	-0.0035214150697520 83	0.009577388741574176	-0.367680081 1546979	0.713162123 1346639	-0.022307459 476941696	0.015264629 337437531
32		CholesterolTotal	0.007258067669105708	0.009551318959344359	0.759902134 9826152	0.447428945 8867108	-0.011476840 870064977	0.025992976 208276394
33		CholesterolLDL	0.0015268790166764238	0.009552440131189343	0.159841778 19561138	0.873026593 0744	-0.017210228 700645668	0.020263986 733998512
34		CholesterolHDL	5.411733944502038E-4	0.009568759901534996	0.056556272 70607868	0.954905976 2495937	-0.018227945 54625449	0.019310292 335154897
35		CholesterolTriglycerides	0.002268052516280527	0.009563016046575041	0.237169163 49762077	0.812556980 6105581	-0.016489799 855084888	0.021025904 887645944
36		UPDRS	0.18630288121195493	0.009603880188781513	19.39870943 3045518	3.339637353 802613E-75	0.167464873 84105188	0.205140888 58285798
37		MoCA	-0.07109273757277541	0.009556317899932587	-7.439344140 884063	1.670341336 6346027E-13	-0.089837451 53083589	-0.052348023 61471493
38		FunctionalAssessment	-0.11419317166623748	0.009565870057560244	-11.93756249 866541	1.740393410 1474355E-31	-0.132956622 17907478	-0.095429721 15340018
39		Tremor	0.12423615764298186	0.009551520061017858	13.00695144 3259872	8.812477578 978414E-37	0.105500854 64295439	0.142971460 64300933
40		Rigidity	0.10336739579051336	0.009535987077577548	10.83971642 8891393	1.938920143 652925E-26	0.084662560 73165018	0.122072230 84937655
41		Bradykinesia	0.09738441151376426	0.009550763581646275	10.19650530 3608197	1.131582476 8598043E-23	0.078650592 34773905	0.116118230 67978946
42		PosturalInstability	0.08795422774590572	0.009534309865763344	9.225022994 243103	9.011724267 354057E-20	0.069252682 53738402	0.106655772 95442742
43		SpeechProblems	-0.0053249866410449145	0.009576010343971408	-0.556075698 5185661	0.578239575 5011953	-0.024108327 321856172	0.013458354 039766342
44		SleepDisorders	-0.01601764859514722	0.009559114487731708	-1.675641464 0398416	0.094010652 74412763	-0.034767848 06031181	0.002732550 870017371

The significant features according to the p-value are the following:

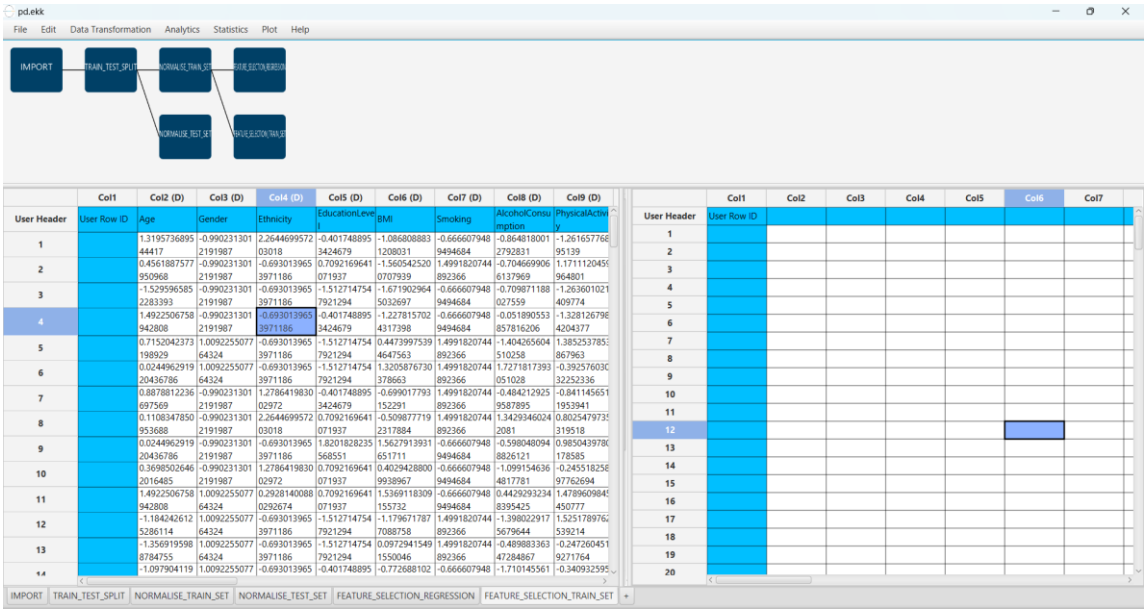
- Diagnosis (p-value = 0.0)

- Age (p-value = 2.64129767256839E-4)
- SleepQuality (p-value = 0.023368160034877315)
- Diabetes (p-value = 0.007594197785412139)
- Depression (p-value = 0.004441649154449658)
- UPDRS (p-value = 3.339637353802613E-75)
- MoCA (p-value = 1.6703413366346027E-13)
- FunctionalAssessment (p-value = 1.7403934101474355E-31)
- Tremor (p-value = 8.812477578978414E-37)
- Rigidity (p-value = 1.938920143652925E-26)
- Bradykinesia (p-value = 1.1315824768598043E-23)
- PosturalInstability (p-value = 9.011724267354057E-20)

Step 7: Feature selection: train set

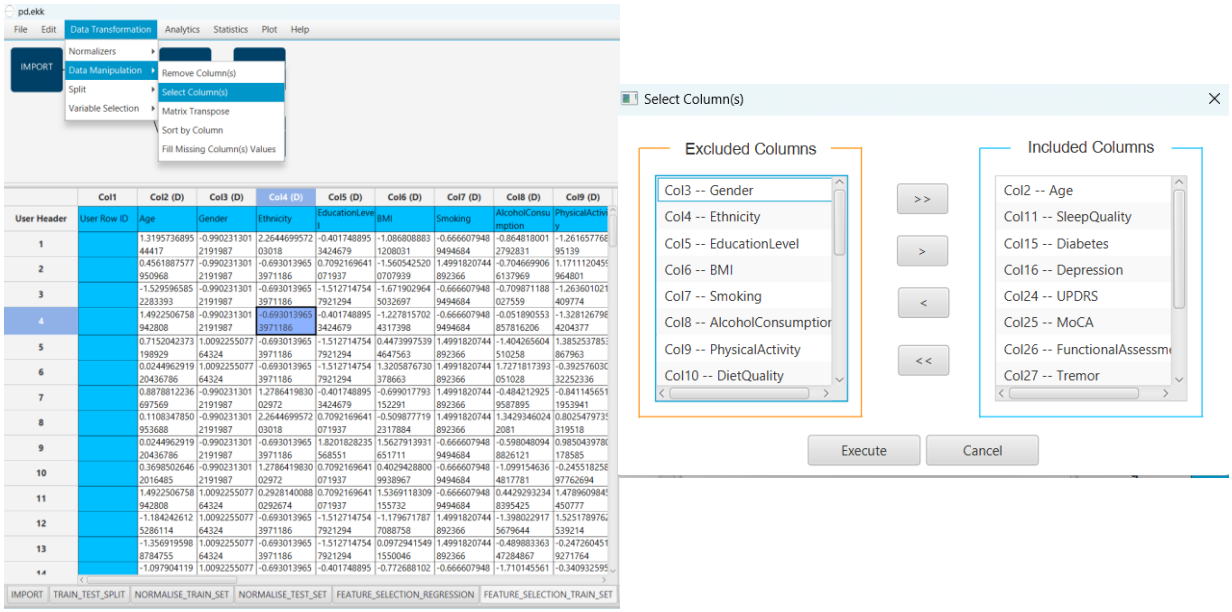
Create a new tab by pressing the "+" button on the bottom of the page with the name "FEATURE_SELECTION_TRAIN_SET".

Import data into the input spreadsheet of the "FEATURE_SELECTION_TRAIN_SET" tab from the output of the "NORMALISE_TRAIN_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".

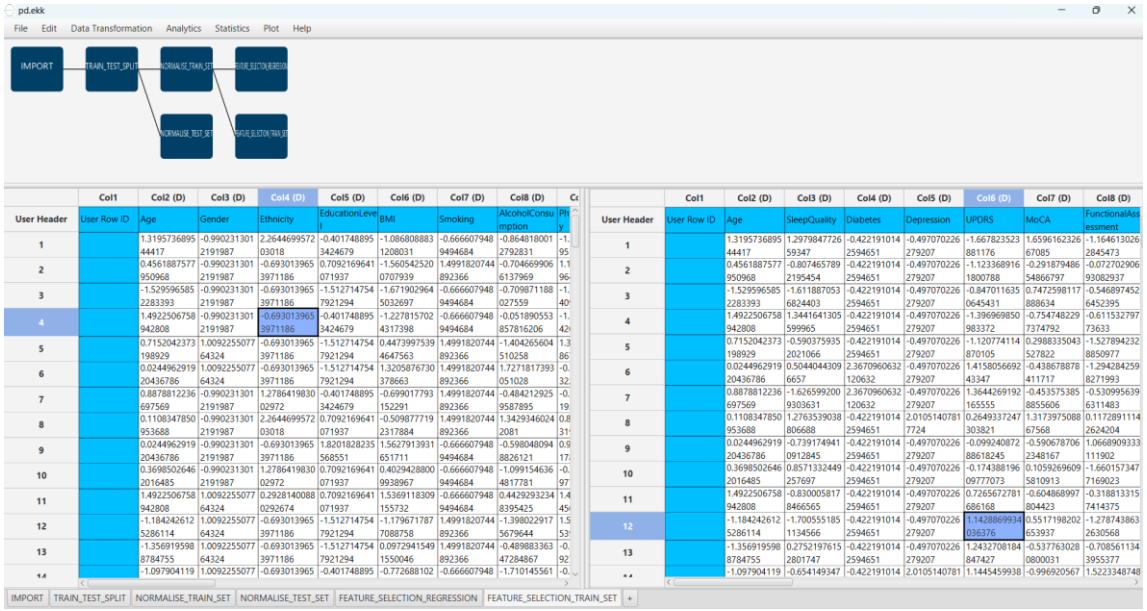


Manipulate the data by choosing the columns that correspond to the significant features (from the previous step):

"Data Transformation" → "Data Manipulation" → "Select Column(s)".



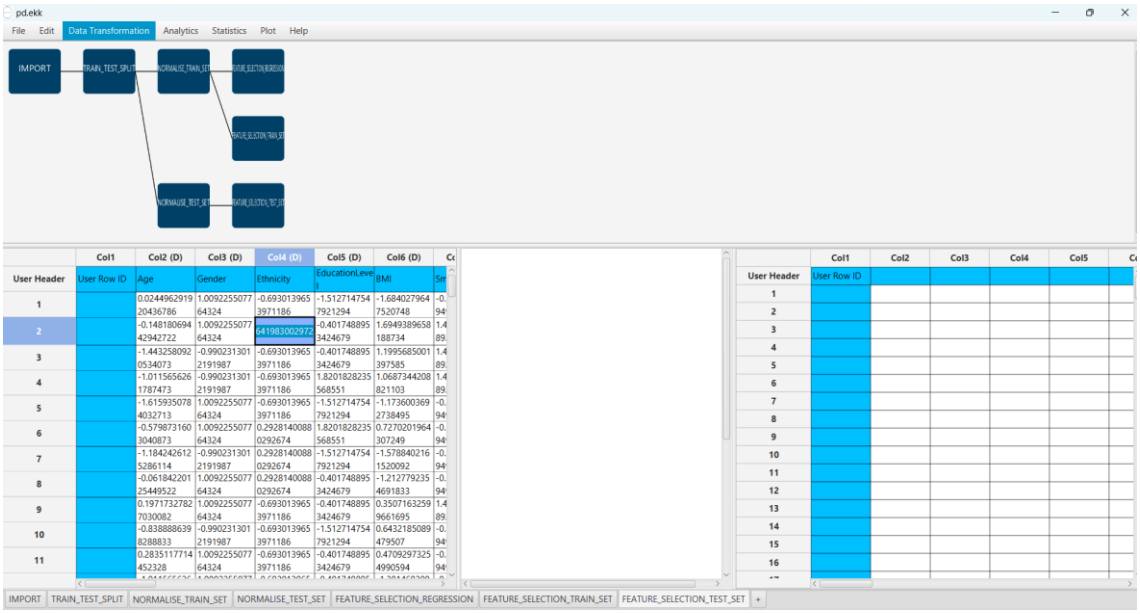
The results will appear on the output spreadsheet.



Step 8: Feature selection: test set

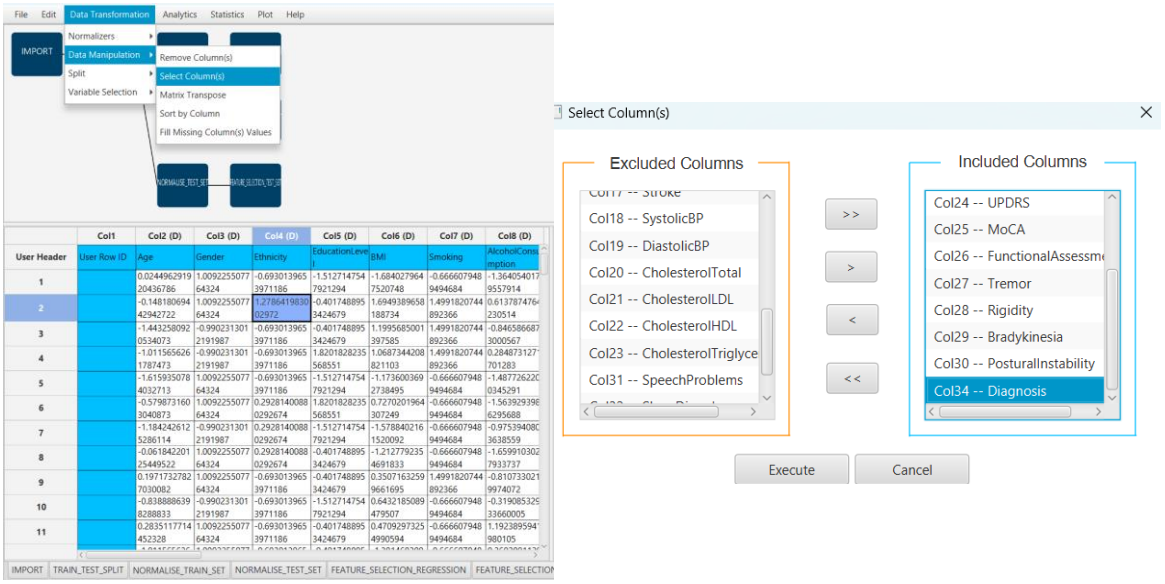
Create a new tab by pressing the "+" button on the bottom of the page with the name "FEATURE_SELECTION_TEST_SET".

Import data into the input spreadsheet of the "FEATURE_SELECTION_TEST_SET" tab from the output of the "NORMALISE_TEST_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".

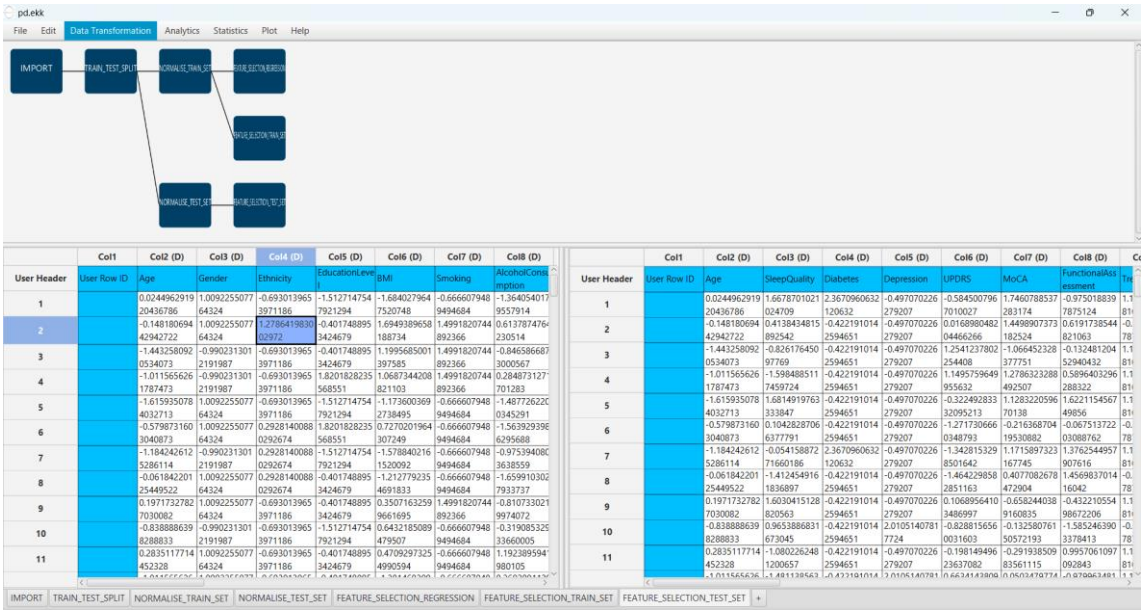


Manipulate the data by choosing the columns that correspond to the significant features (from the ste):

"Data Transformation" → "Data Manipulation" → "Select Column(s)".



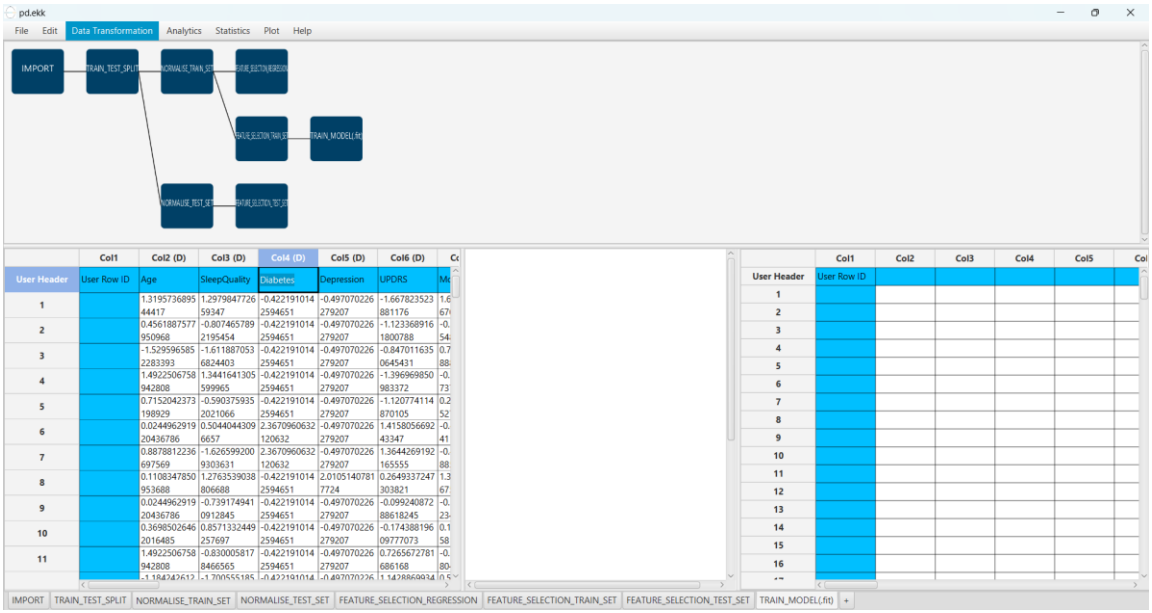
The results will appear on the output spreadsheet.



Step 9: Train the model

Create a new tab by pressing the "+" button on the bottom of the page with the name "TRAIN_MODEL(.fit)".

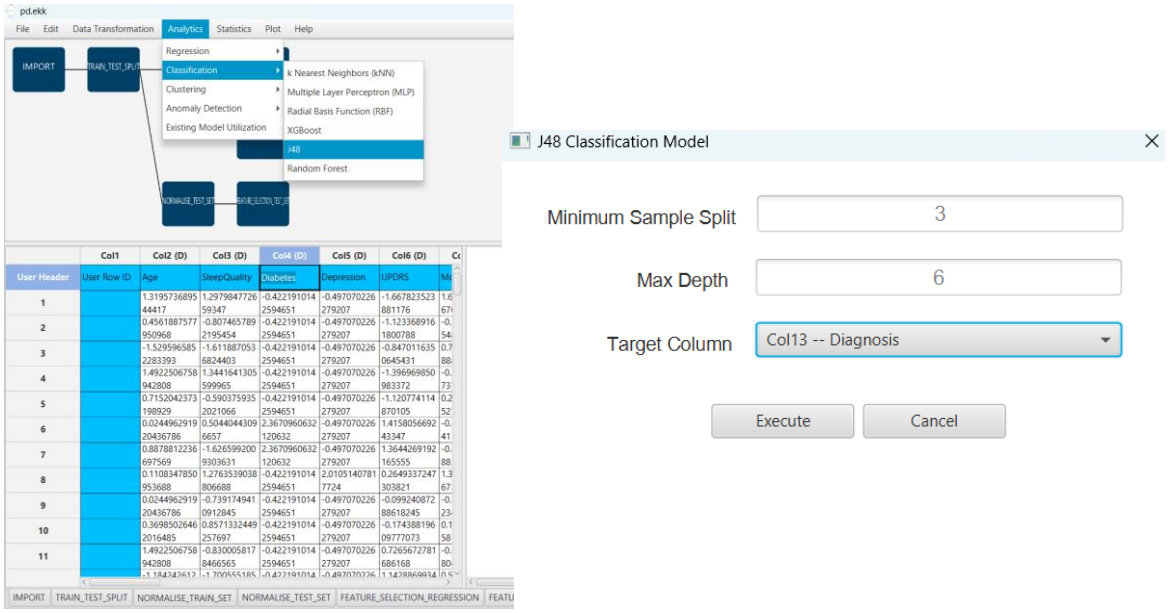
Import data into the input spreadsheet of the "TRAIN_MODEL(.fit)" tab from the output of the "FEATURE_SELECTION_TRAIN_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".



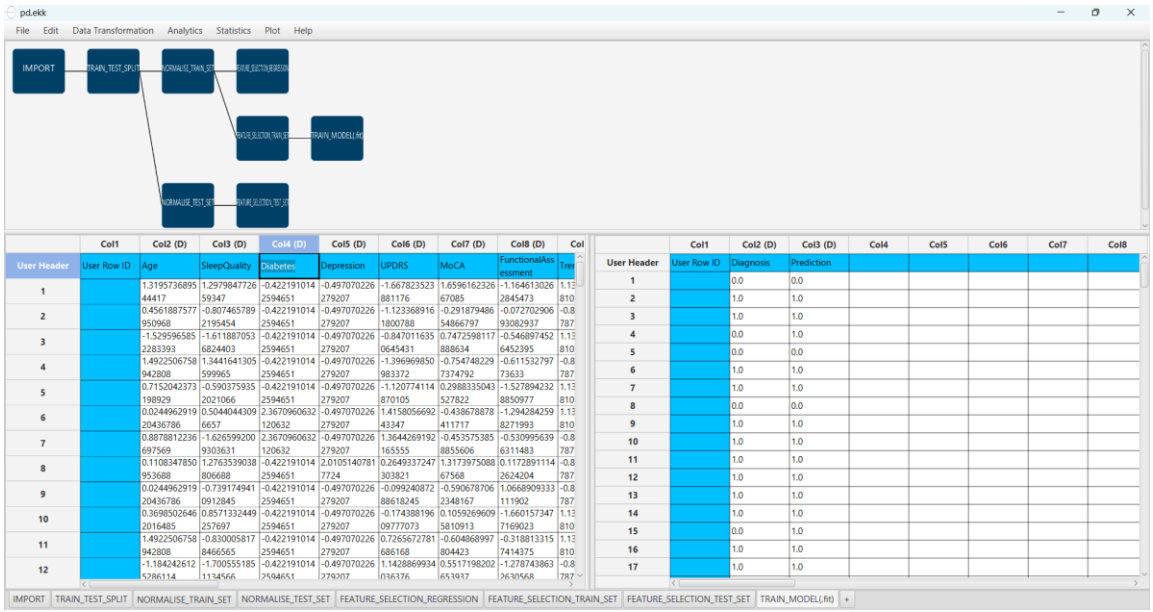
Use the J48 Method to train and fit the model:

"Analytics" → "Classification" → "J48"

and set the "Minimum Sample Split" as 3, the "Max Depth" as 6 and the "Target Column" as the column corresponding to "Diagnosis".



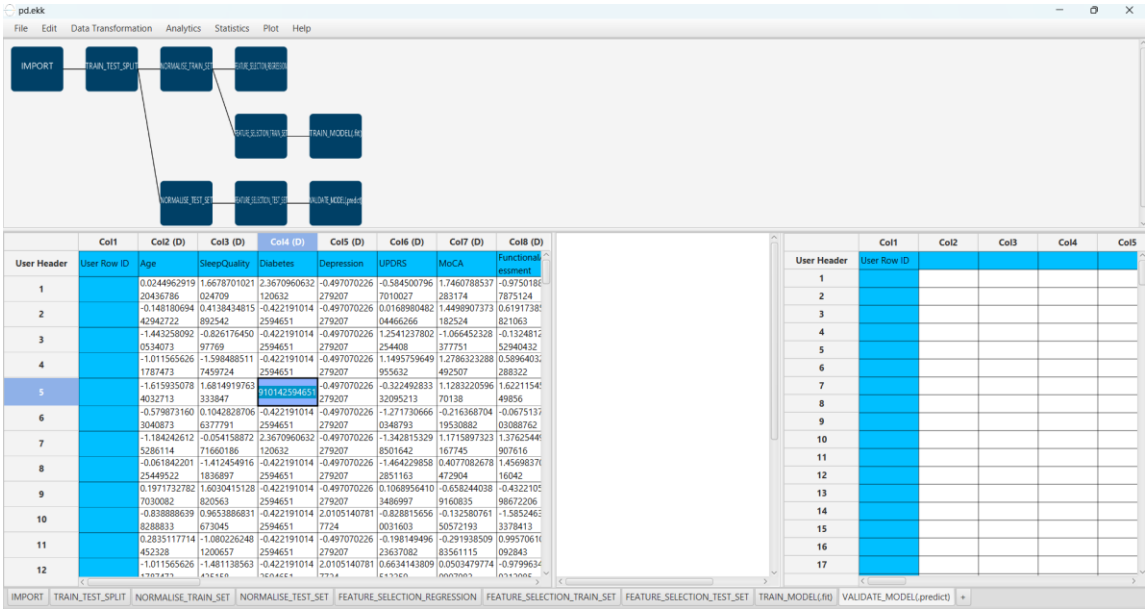
The predictions will appear on the output spreadsheet.



Step 10: Validate the model

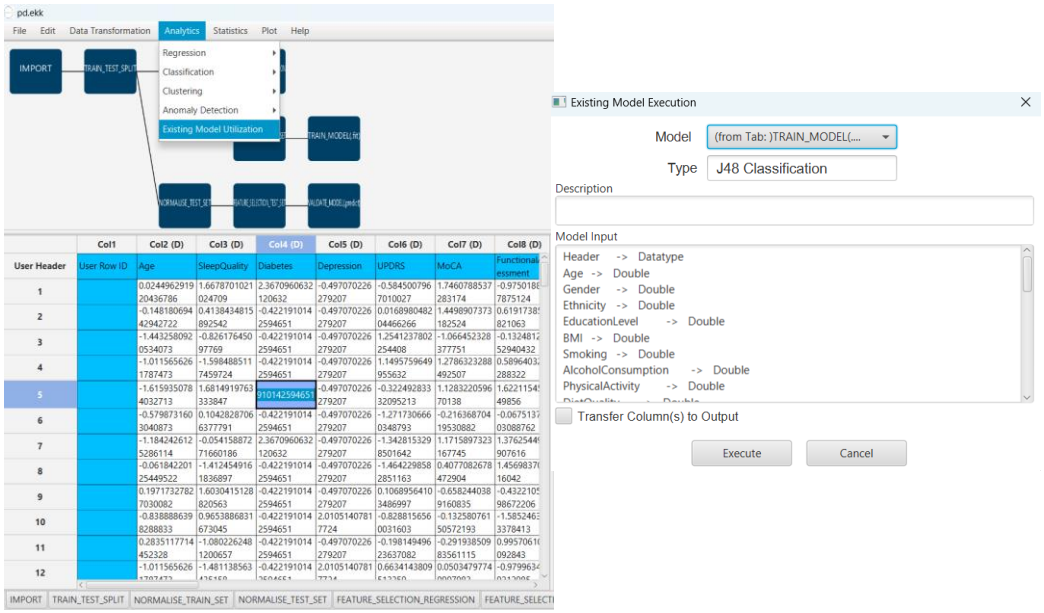
Create a new tab by pressing the "+" button on the bottom of the page with the name "VALIDATE_MODEL(.predict)".

Import data into the input spreadsheet of the "VALIDATE_MODEL(.predict)" tab from the output of the "FEATURE_SELECTION_TEST_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".

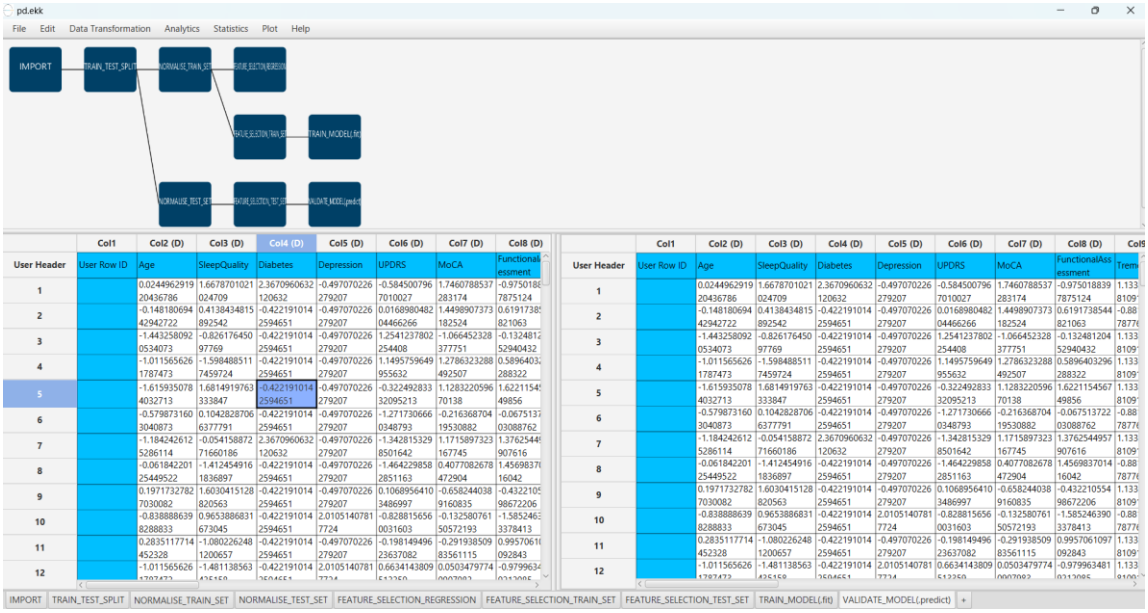


To validate the model:

"Analytics" → "Existing Model Utilization". Then choose Model "(from Tab:) TRAIN_MODEL (.fit)".



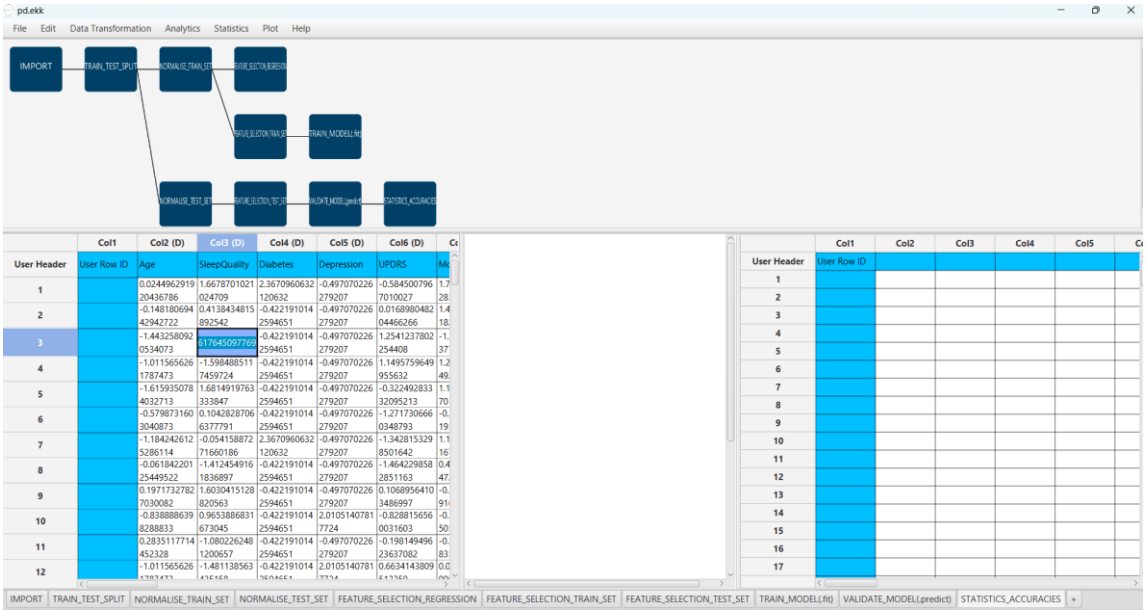
The predictions will appear on the output spreadsheet.



Step 11: Statistics calculation

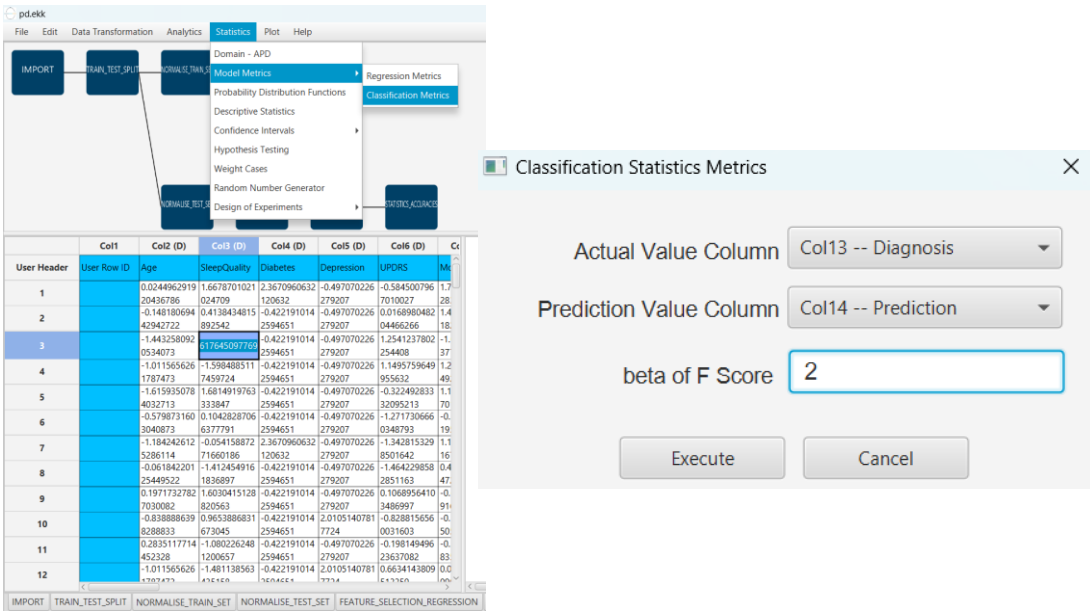
Create a new tab by pressing the "+" button on the bottom of the page with the name "STATISTICS_ACCURACIES".

Import data into the input spreadsheet of the "STATISTICS_ACCURACIES" tab from the output of the "VALIDATE_MODEL(.predict)" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".



Calculate the statistical metrics for the classification:

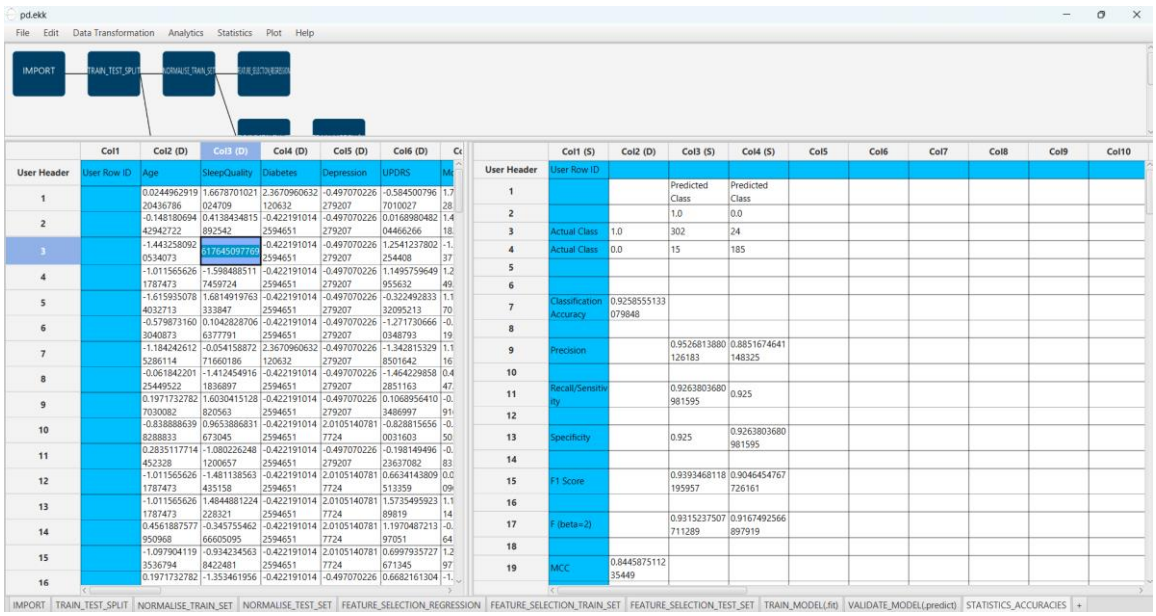
"Statistics" → "Model Metrics" → "Classification Metrics".



The results will appear on the output spreadsheet.

Accuracy: 0.93

F1-Score = 0.9199

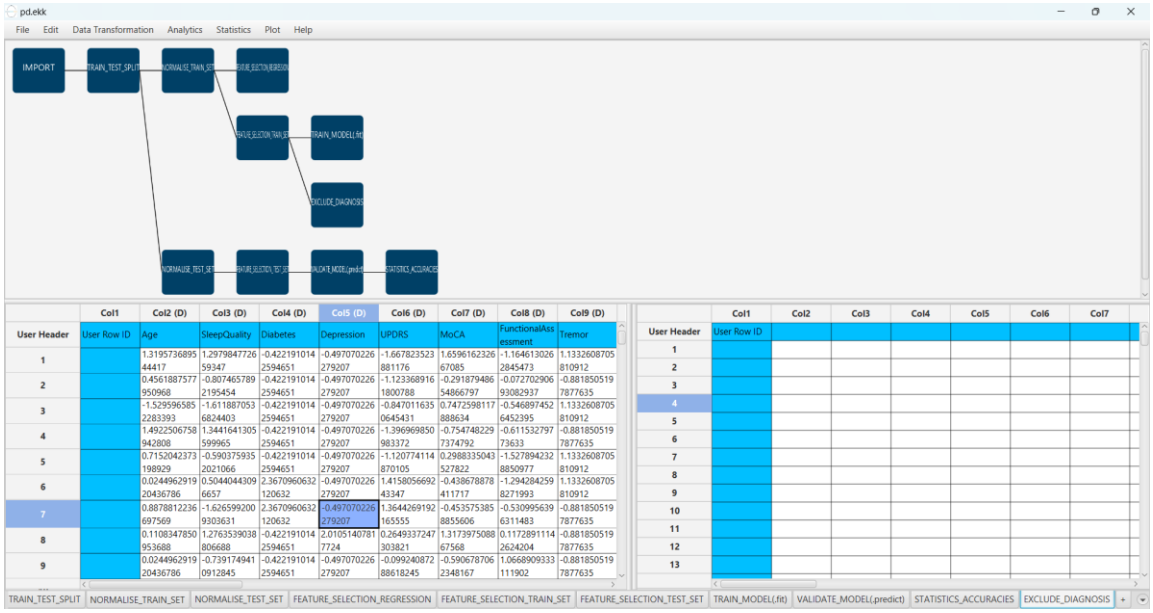


Step 12: Reliability check of each record of the test set

Step 12.a: Create the domain

Create a new tab by pressing the "+" button on the bottom of the page with the name "EXCLUDE_DIAGNOSIS".

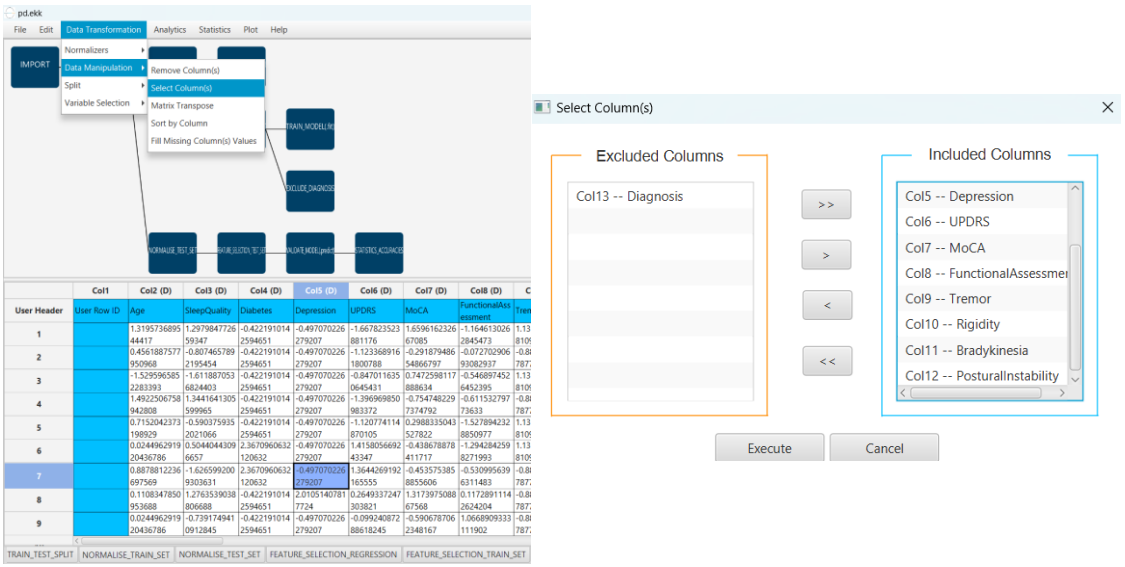
Import data into the input spreadsheet of the "EXCLUDE_DIAGNOSIS" tab from the output of the "FEATURE_SELECTION_TRAIN_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".



Manipulate the data to exclude the column that corresponds to the "Diagnosis"

"Data Transformation" → "Data Manipulation" → "Select Columns"

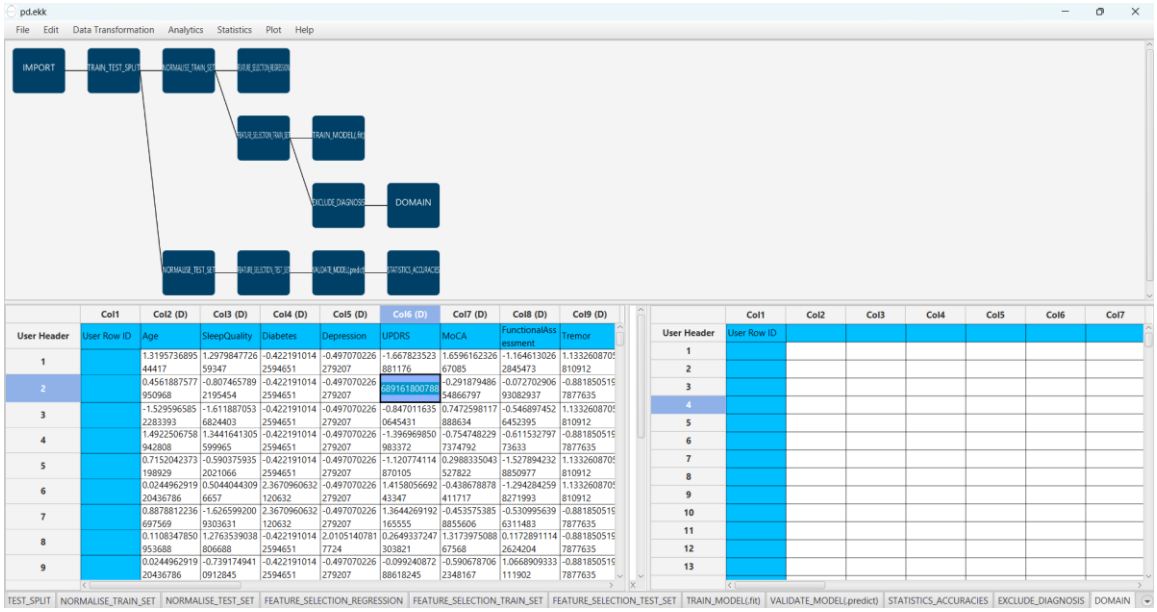
Then select all the columns except the "Diagnosis".



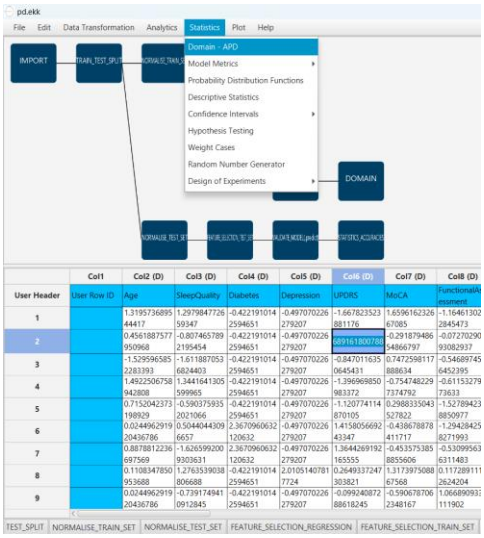
The results will appear on the output spreadsheet.

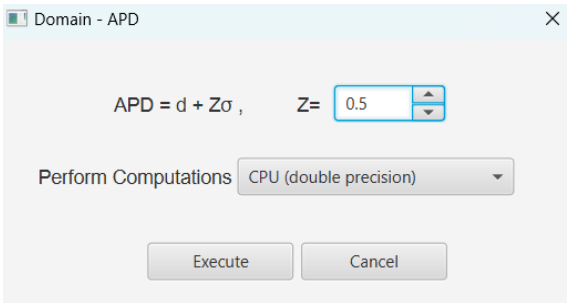
Create a new tab by pressing the "+" button on the bottom of the page with the name "DOMAIN".

Import data into the input spreadsheet of the "DOMAIN" tab from the output of the "EXCLUDE_DIAGNOSIS" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".

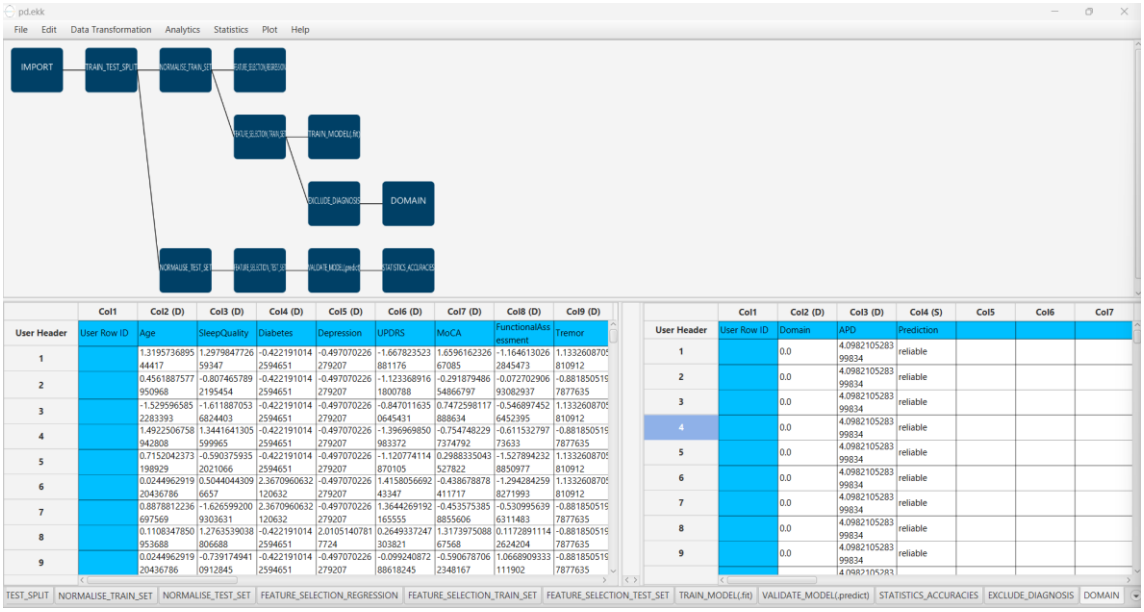


Create the domain: "Statistics" → "Domain APD"





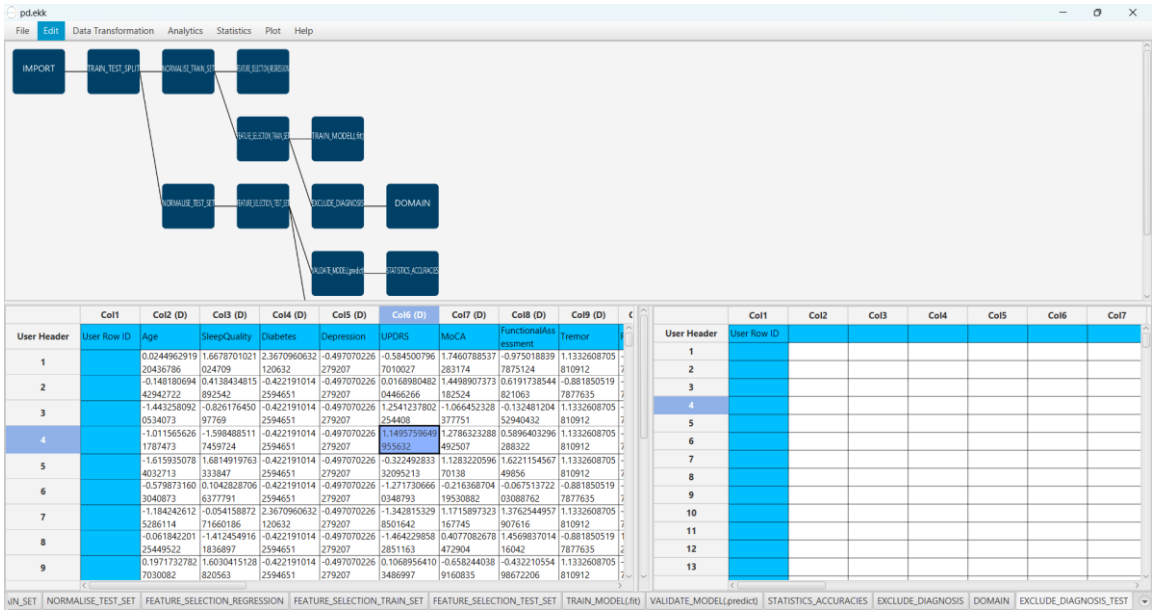
The results will appear on the output spreadsheet.



Step 12.b: Check the test set reliability

Create a new tab by pressing the "+" button on the bottom of the page with the name "EXCLUDE_DIAGNOSIS_TEST_SET".

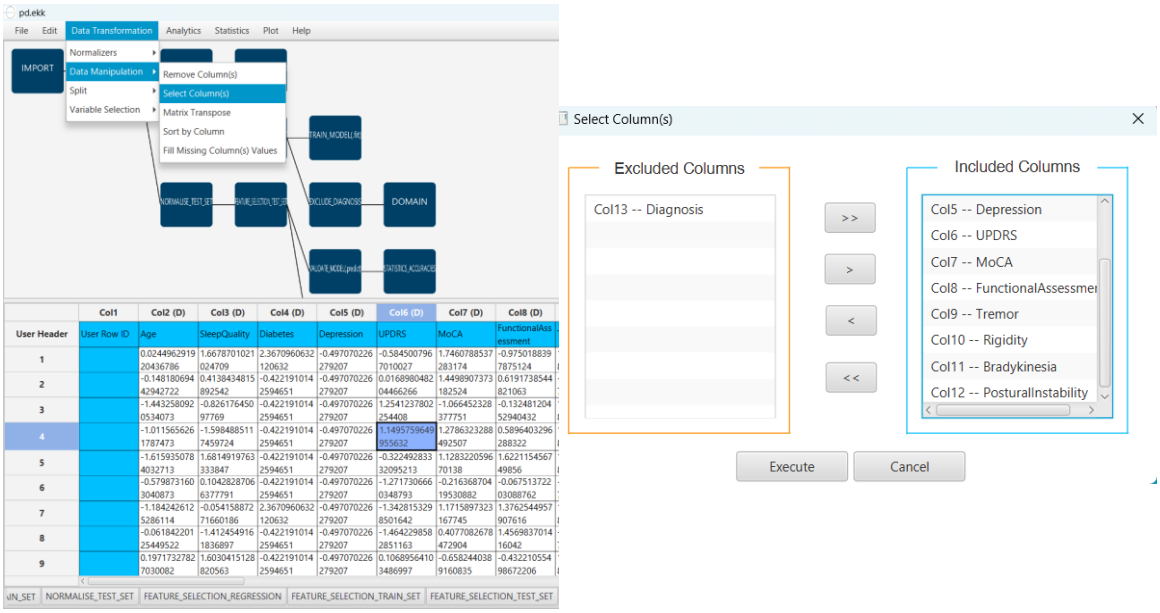
Import data into the input spreadsheet of the "EXCLUDE_DIAGNOSIS_TEST_SET" tab from the output of the "FEATURE_SELECTION_TEST_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".



Filter the data to exclude the column that corresponds to the "Diagnosis"

"Data Transformation" → "Data Manipulation" → "Select Columns".

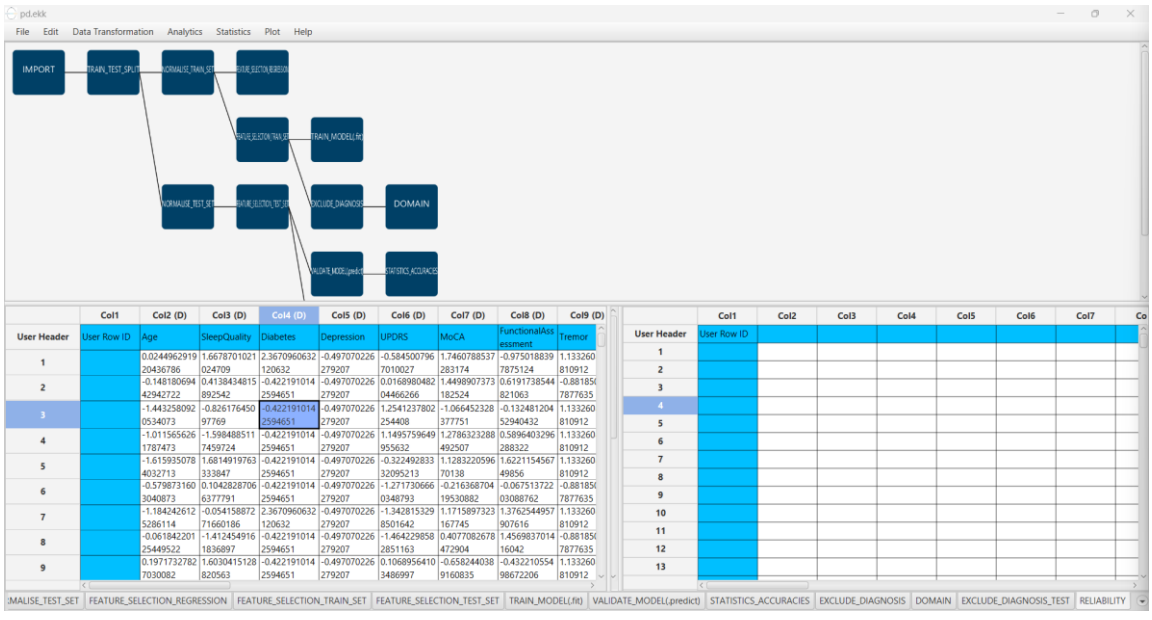
Then select all the columns except "Diagnosis".



The results will appear on the output spreadsheet.

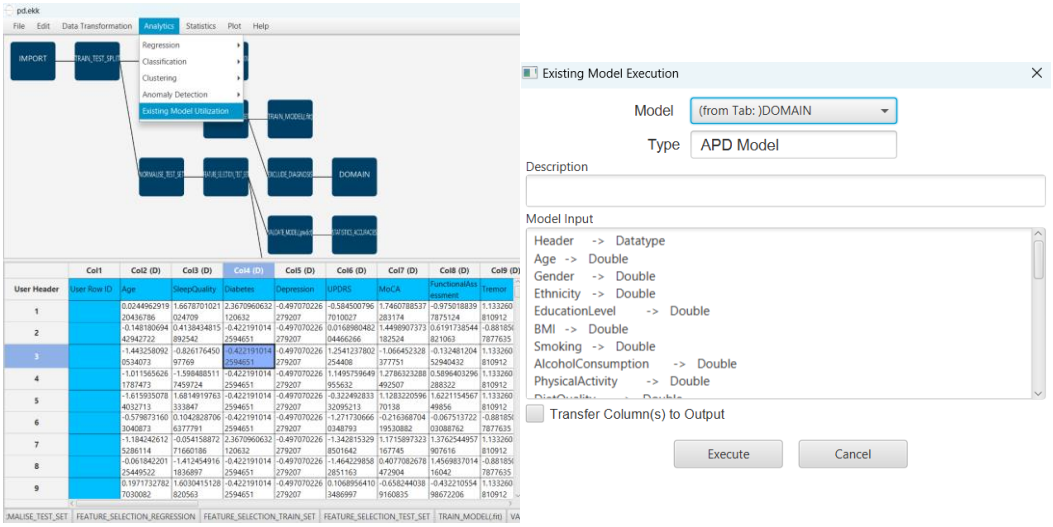
Create a new tab by pressing the "+" button on the bottom of the page with the name "RELIABILITY".

Import data into the input spreadsheet of the "RELIABILITY" tab from the output of the "EXCLUDE_DIAGNOSIS_TEST_SET" tab by right-clicking on the input spreadsheet and then choosing "Import from SpreadSheet".

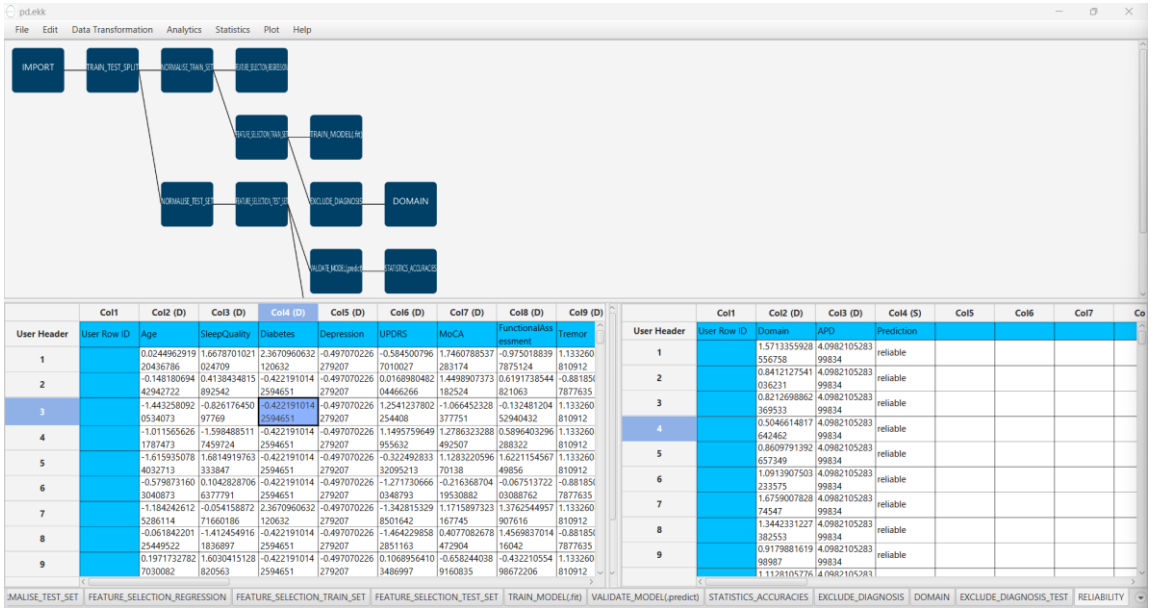


Check the Reliability: "Analytics" → "Existing Model Utilization".

Then select as Model "(from Tab:) DOMAIN".



The results will appear on the output spreadsheet.



There are no unreliable samples in the test set.

Final Isalos Workflow

Following the above-described steps, the final workflow on Isalos will look like this: