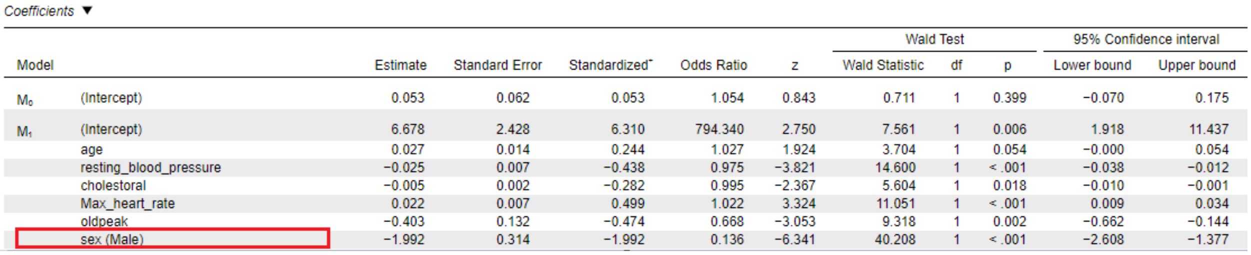
Emmanuel Pedernal

1. Create dummy variables for categorical data before including in the model.

JASP automatically does this e.g. Feature_name (Feature_category) Sex(Male)



Coefficients ▼

							Wald Test			95% Confidence interval	
Model		Estimate	Standard Error	Standardized˟	Odds Ratio	z	Wald Statistic	df	p	Lower bound	Upper bound
M_0	(Intercept)	0.053	0.062	0.053	1.054	0.843	0.711	1	0.399	−0.070	0.175
M_1	(Intercept)	6.678	2.428	6.310	794.340	2.750	7.561	1	0.006	1.918	11.437
	age	0.027	0.014	0.244	1.027	1.924	3.704	1	0.054	−0.000	0.054
	resting_blood_pressure	−0.025	0.007	−0.438	0.975	−3.821	14.600	1	< .001	−0.038	−0.012
	cholestoral	−0.005	0.002	−0.282	0.995	−2.367	5.604	1	0.018	−0.010	−0.001
	Max_heart_rate	0.022	0.007	0.499	1.022	3.324	11.051	1	< .001	0.009	0.034
	oldpeak	−0.403	0.132	−0.474	0.668	−3.053	9.318	1	0.002	−0.662	−0.144
	sex (Male)	−1.992	0.314	−1.992	0.136	−6.341	40.208	1	< .001	−2.608	−1.377

2. **Generate and discuss the following:**

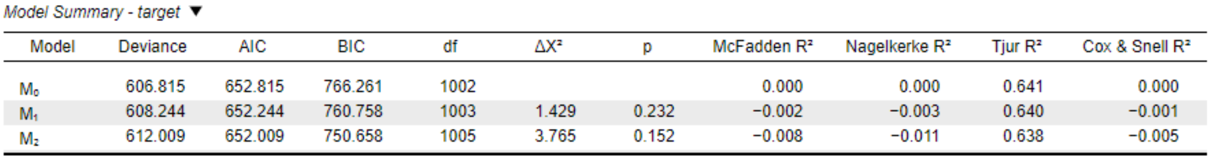
-Table of coefficients with odds ratios and associated p-values.

Backward pass and Forward pass give high p value (fail to reject H0) while Enter method reject H0

H0: Fits the data just as well as the more complex model

H1: M1 is better model

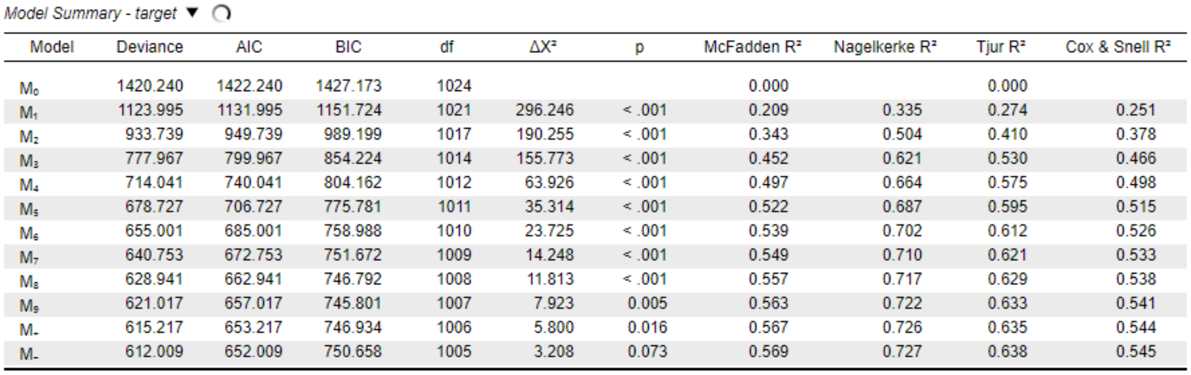
Backward



Model Summary - target ▼

Model	Deviance	AIC	BIC	df	ΔX²	p	McFadden R²	Nagelkerke R²	Tjur R²	Cox & Snell R²
M_0	606.815	652.815	766.261	1002			0.000	0.000	0.641	0.000
M_1	608.244	652.244	760.758	1003	1.429	0.232	−0.002	−0.003	0.640	−0.001
M_2	612.009	652.009	750.658	1005	3.765	0.152	−0.008	−0.011	0.638	−0.005

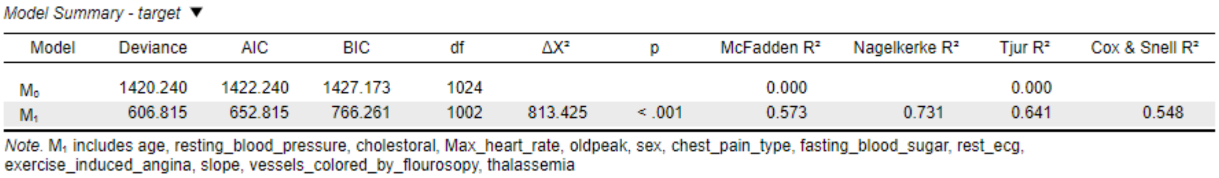
Forward



Model Summary - target ▼

Model	Deviance	AIC	BIC	df	ΔX^2	p	McFadden R^2	Nagelkerke R^2	Tjur R^2	Cox & Snell R^2
M_0	1420.240	1422.240	1427.173	1024			0.000		0.000	
M_1	1123.995	1131.995	1151.724	1021	296.246	< .001	0.209	0.335	0.274	0.251
M_2	933.739	949.739	989.199	1017	190.255	< .001	0.343	0.504	0.410	0.378
M_3	777.967	799.967	854.224	1014	155.773	< .001	0.452	0.621	0.530	0.466
M_4	714.041	740.041	804.162	1012	63.926	< .001	0.497	0.664	0.575	0.498
M_5	678.727	706.727	775.781	1011	35.314	< .001	0.522	0.687	0.595	0.515
M_6	655.001	685.001	758.988	1010	23.725	< .001	0.539	0.702	0.612	0.526
M_7	640.753	672.753	751.672	1009	14.248	< .001	0.549	0.710	0.621	0.533
M_8	628.941	662.941	746.792	1008	11.813	< .001	0.557	0.717	0.629	0.538
M_9	621.017	657.017	745.801	1007	7.923	0.005	0.563	0.722	0.633	0.541
M_{-}	615.217	653.217	746.934	1006	5.800	0.016	0.567	0.726	0.635	0.544
M_{-}	612.009	652.009	750.658	1005	3.208	0.073	0.569	0.727	0.638	0.545

Enter



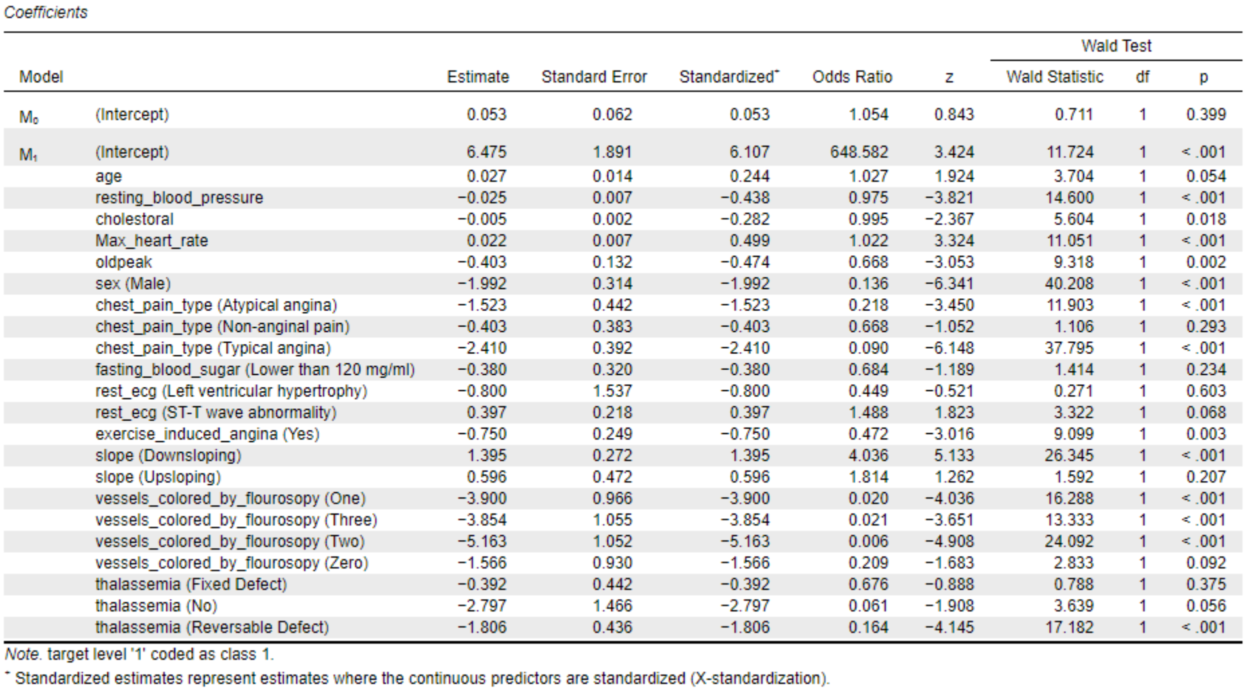
Model Summary - target ▼

Model	Deviance	AIC	BIC	df	ΔX^2	p	McFadden R^2	Nagelkerke R^2	Tjur R^2	Cox & Snell R^2
M_0	1420.240	1422.240	1427.173	1024			0.000		0.000	
M_1	606.815	652.815	766.261	1002	813.425	< .001	0.573	0.731	0.641	0.548

Note. M_1 includes age, resting_blood_pressure, cholestoral, Max_heart_rate, oldpeak, sex, chest_pain_type, fasting_blood_sugar, rest_ecg, exercise_induced_angina, slope, vessels_colored_by_flourosopy, thalassemia

For this model we'll use the following as reference for each feature (will be dropped to avoid collinearity)

Feature	**Reference (to be drop)**
Sex	Female
Chest_pain	Asymptomatic
Fasting	Greater than 120mg
Rest_ecg	Normal
Exercise_induced	No
Slope	Flat
Flouroscopy	Four
Thalassemia	Normal



Coefficients

Model		Estimate	Standard Error	Standardized*	Odds Ratio	z	Wald Test		
							Wald Statistic	df	p
M_0	(Intercept)	0.053	0.062	0.053	1.054	0.843	0.711	1	0.399
M_1	(Intercept)	6.475	1.891	6.107	648.582	3.424	11.724	1	< .001
	age	0.027	0.014	0.244	1.027	1.924	3.704	1	0.054
	resting_blood_pressure	−0.025	0.007	−0.438	0.975	−3.821	14.600	1	< .001
	cholestoral	−0.005	0.002	−0.282	0.995	−2.367	5.604	1	0.018
	Max_heart_rate	0.022	0.007	0.499	1.022	3.324	11.051	1	< .001
	oldpeak	−0.403	0.132	−0.474	0.668	−3.053	9.318	1	0.002
	sex (Male)	−1.992	0.314	−1.992	0.136	−6.341	40.208	1	< .001
	chest_pain_type (Atypical angina)	−1.523	0.442	−1.523	0.218	−3.450	11.903	1	< .001
	chest_pain_type (Non-anginal pain)	−0.403	0.383	−0.403	0.668	−1.052	1.106	1	0.293
	chest_pain_type (Typical angina)	−2.410	0.392	−2.410	0.090	−6.148	37.795	1	< .001
	fasting_blood_sugar (Lower than 120 mg/ml)	−0.380	0.320	−0.380	0.684	−1.189	1.414	1	0.234
	rest_ecg (Left ventricular hypertrophy)	−0.800	1.537	−0.800	0.449	−0.521	0.271	1	0.603
	rest_ecg (ST-T wave abnormality)	0.397	0.218	0.397	1.488	1.823	3.322	1	0.068
	exercise_induced_angina (Yes)	−0.750	0.249	−0.750	0.472	−3.016	9.099	1	0.003
	slope (Downsloping)	1.395	0.272	1.395	4.036	5.133	26.345	1	< .001
	slope (Upsloping)	0.596	0.472	0.596	1.814	1.262	1.592	1	0.207
	vessels_colored_by_flourosopy (One)	−3.900	0.966	−3.900	0.020	−4.036	16.288	1	< .001
	vessels_colored_by_flourosopy (Three)	−3.854	1.055	−3.854	0.021	−3.651	13.333	1	< .001
	vessels_colored_by_flourosopy (Two)	−5.163	1.052	−5.163	0.006	−4.908	24.092	1	< .001
	vessels_colored_by_flourosopy (Zero)	−1.566	0.930	−1.566	0.209	−1.683	2.833	1	0.092
	thalassemia (Fixed Defect)	−0.392	0.442	−0.392	0.676	−0.888	0.788	1	0.375
	thalassemia (No)	−2.797	1.466	−2.797	0.061	−1.908	3.639	1	0.056
	thalassemia (Reversable Defect)	−1.806	0.436	−1.806	0.164	−4.145	17.182	1	< .001

Note. target level '1' coded as class 1.

* Standardized estimates represent estimates where the continuous predictors are standardized (X-standardization).

Based from the Coefficients

H0: Feature has no effect on the outcome

H1: Feature does have effect

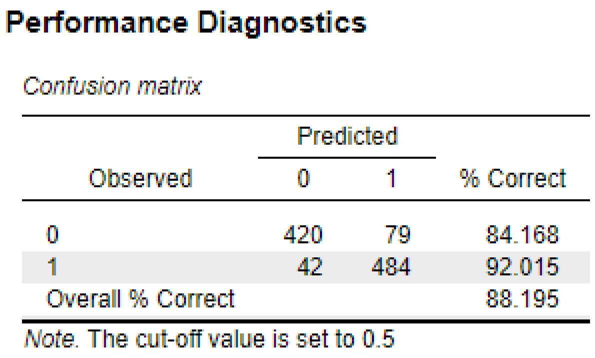
Feature	**Insights**
age	Age has 2.7% increase in odds of having disease although Age has 0.054 p value, we'll consider it due medical field where age has positive correlation with heart diseases
resting_blood_pressure	is associated with a 2.5% decrease in odds of disease
cholestoral	Higher cholesterol slightly decreases odds by 0.5% per unit this should be reviewed since it does not make sense that a high cholesterol is better hence greater than 5% p value
Max_heart_rate	Each additional unit increases the odds by 2.2%. With a p value less than 5% means this feature have an effect in determining if a patient have disease
oldpeak	Higher oldpeak slightly decreases odds by 33% per unit this should be reviewed since it

	does not make sense that a high oldpleak is better hence greater than 5% p value.
sex (Male)	The odds of having heart disease for Male is lower 13.6% compared to women 86.4%
chest_pain_type	Atypical and Typical angina significantly lower odds compared to Asymptomatic (Reference)
fasting_blood_sugar (Lower than 120 mg/ml)	Has lower odds of having (32%) disease vs 68% of greater than 120mg/ml fasting blood sugar. But has greater than 5% p val meaning we have weak evidence to tell if this is by chance or not (small dataset)
rest_ecg (LVH)	About 55% lower odds of heart disease compared to those with a normal ECG, but this is not statistically significant high p val. So, no strong evidence LVH is associated with heart disease risk in this model.
rest_ecg (ST-T wave abnormality)	About 49% higher odds of heart disease compared to those with a normal ECG. High p value also so no strong evidence with heart disease for this dataset
exercise_induced_angina (Yes)	About 53% lower odds of having heart disease compared to those without exercise-induced angina (No). With p val lower than 5%, exercise-induced angina is associated with lower odds of heart disease in this model.
slope (Downsloping)	odds ratio of 4.036 indicates that patients with a downsloping slope have about 4 times higher odds of having heart disease. P val less than 5% means this is significant.
slope (Upsloping)	odds ratio of 1.814 suggests these patients have about 1.8 times higher odds of heart disease relative to the reference. With high p value the evidence is not strong enough
vessels_colored_by_flourosopy vs Four	having 1, 2, or 3 vessels colored is associated with much lower odds (0.006) of heart disease compared to 4 vessels. Zero vessels also seem to have lower odds, but this result is not quite statistically significant but is insignificant since it has high p val.

thalassemia (Fixed Defect)	about 32.4% lower odds of having heart disease compared to Normal thalassemia. difference is not statistically significant high p val
thalassemia (No)	about 93.9% lower odds of heart disease compared to normal thalassemia. With p val close to 5% we can say that this is significant
thalassemia (Reversable Defect)	about 83.6% lower odds of having heart disease compared to normal thalassemia patients low p val meaning there is strong evidence in this dataset that this feature has lower odds compared to Normal thalassemia

Based from the dataset a Higher max heart rate, slop(downsloping) and rest_ecg (ST-T wave abnormality) increases the odds of heart disease, while higher resting blood pressure, cholesterol, and oldpeak decreased the odds (might need further investigation because some metrics are inverse of real-life application). Males, those with typical or atypical angina, and patients with multiple-colored vessels and reversible thalassemia defects also had lower odds compared to female counter parts.

-Model evaluation metrics such as accuracy, precision, recall, and other metrics.

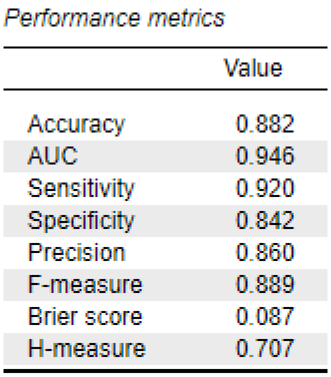


Performance Diagnostics

Confusion matrix

	Predicted		
Observed	0	1	% Correct
0	420	79	84.168
1	42	484	92.015
Overall % Correct			88.195

Note. The cut-off value is set to 0.5



Performance metrics

	Value
Accuracy	0.882
AUC	0.946
Sensitivity	0.920
Specificity	0.842
Precision	0.860
F-measure	0.889
Brier score	0.087
H-measure	0.707

Since this is for medical application, the best metric here would be **sensitivity** or true positive rate it's best to capture actual positive patients.

True Positives (TP) = 484
True Negatives (TN) = 420
False Positives (FP) = 79
False Negatives (FN) = 42

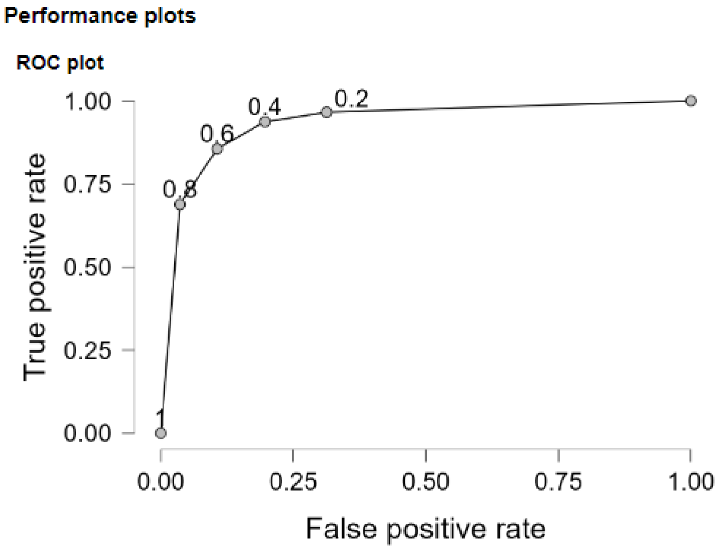
Odds ratio

TP * TN / FP * FN =

484 * 420 / 79 * 42 = 61.27

The odds of the model correctly predict (true positive or true negative) are 61.27 times higher than the odds of an incorrect prediction (false positive or false negative).

ROC curve.



Thresholds

0.8 – Low false positives but will miss many positives

0.6 – trade-off between sensitivity/specificity

0.4 – Has more positives but an increase in false positives

0.2 – highest positives detected but has more false positives

For medical application we choose 0.4 Threshold for screening cases while 0.2 for high-risk population

With a AUC score of 94.6 the model distinguishes the classes well

- High TPR (Sensitivity = 0.920)
- Low FPR (1 - Specificity = 0.158)