Heart Attack Risk Model: Results

1. **Quantitative Outcomes**:
    - Summary table comparing linear model performance:

Model	Accuracy	Precision	Recall	F1 Score	AUC-ROC
Logistic Regression	0.90	0.93	0.88	0.90	0.94
Support Vector Machines	0.90 (after hyperpara-meter tuning)	0.90	0.84	0.87	0.87
Decision Tree	0.79	0.85	0.72	0.78	0.79
Random Forest	0.79	0.85	0.72	0.78	0.79
Gradient Booster	0.87	0.90	0.84	0.87	0.87

    - Feature importance rankings from the models: Since the two best models were SVM and Logistic Regression, we will examine the coefficients of the features to determine the most important ones. We will use an absolute value of 0.5 as the minimum required to be classified as important:

        i.

Support Vector Machines	
Feature	**Coefficient**
previous_peak	-0.51
sex	-0.60

Support Vector Machines	
exercise_induced_angina_1	-0.61
num_major_vessels_1	-1.33
num_major_vessels_2	-1.64
num_major_vessels_3	-1.00
num_major_vessels_4	1.00
chest_pain_type_2	0.96
chest_pain_type_3	1.14
thal_rate_2	0.62
thal_rate_3	-0.52

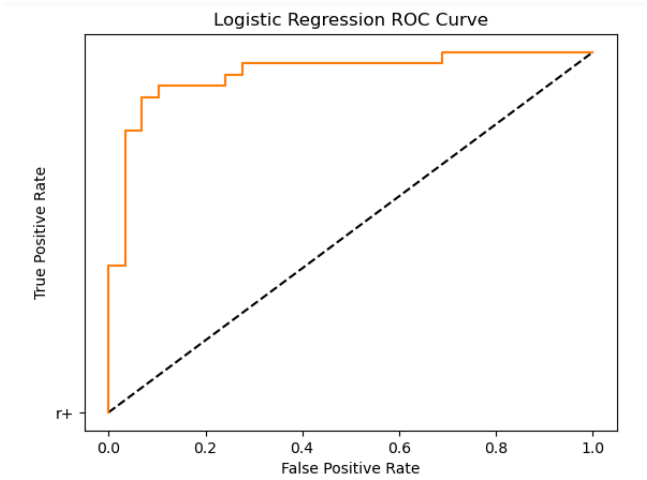
ii.

Logistic Regression	
Feature	**Coefficient**
previous_peak	-0.78
sex	-1.17
exercise_induced_angina_1	-0.85
num_major_vessels_1	-1.68
num_major_vessels_2	-1.86
num_major_vessels_3	-1.07
chest_pain_type_2	1.31
chest_pain_type_3	1.34

Logistic Regression	
slope_2	0.62
thal_rate_2	0.53
thal_rate_3	-0.77
INTERCEPT:	**1.15**

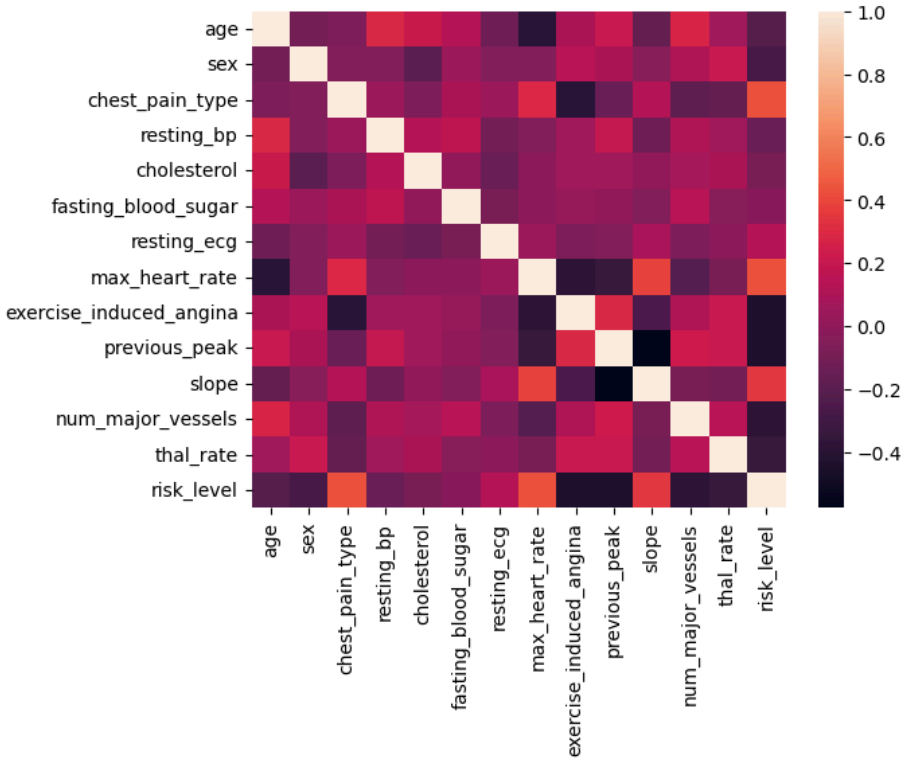
Observations on the above models: Logistic Regression performed best in all metrics. In both models there were 11 features that were significant in predicting the target variable, exactly half of the 22 features in consideration. SVM included **num_major_vessels_4**, while Logistic Regression did not; and LR included **slope_2**, while SVM did not. Otherwise, the same features were significant in both models. LR predicts a 1.15 intercept, which is of some interest since this number is larger than 1, meaning that when the features are all negligible the model predicts a heart-attack above the max value of 1.

2. **Visual Insights**:
    - ROC curve from Logistic Regression:



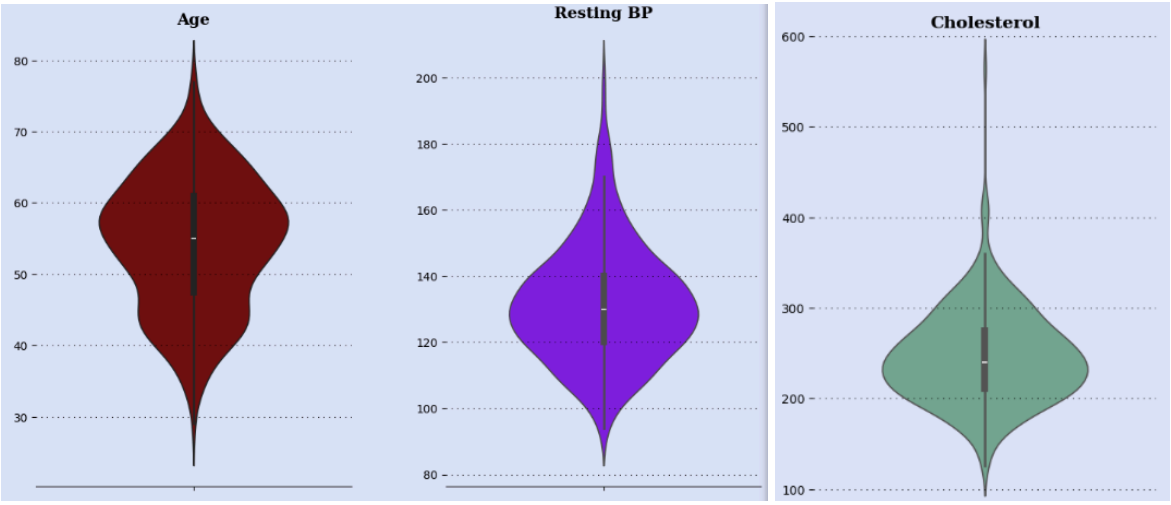
Observation: The ROC has a significant amount of area under it and above the diagonal.This illustrates the usefulness of the model.

    - Heatmap of all features and target:



Observations from the above heatmap: If we look across the bottom row, we observe the relatively high correlations between the target, **risk_level,** and the features that turned out to be significant in the models: **sex, chest_pain_type, exercise_induced_angina, previous_peak, num_major_vessels,** and **thal_rate**.

3. **Detailed Performance Analysis**:
    - Clearly the Logistic Regression model outperformed all the others, tying only with respect to accuracy with SVM. For features significant in both models, the coefficients agree on polarity. However, while in both models **num_major_vessels_1,2 and 3** have negative coefficients, **num_major_vessels_4** has a positive coefficient in SVM.
    - While most of the significant features are ones which would be expected, based on widely-published and decades-old research, the absence of features like age, resting blood pressure, cholesterol, and resting ECG could be viewed as surprising. This could, however, be explained by the relatively small sample size of this study. Also, as seen here, some of these features are fairly normally distributed, except for a few outliers:



4. **Recommendations and Limitations**:
    - Physicians and healthcare providers can use this model to identify high-risk patients and prioritize preventative interventions.
    - Dataset size (n=303) limits generalizability.
    - Further validation needed on diverse populations.