1(a)(b)(c)

图表, 折线图

描述已自动生成

1(d)

Linear Model's MSE: 345.44228897599976

Quadratic Model's MSE: 5.889726557941703

10th Degree Model's MSE: 2.702831559911987

1(e)

①**Overfitting**: The 10th degree polynomial regression (green line) fits the data points very closely, which suggests it might be overfitting. Overfitting occurs when a model is too complex, capturing the noise in the data rather than just the underlying pattern. This typically leads to high variance in predictions and poor generalization to new, unseen data.

②**Underfitting**: The linear regression model (blue line) underfits the data. Underfitting happens when a model is too simple to capture the underlying pattern of the data, resulting in high bias and poor performance on both training and unseen data.

③**Best Fit**: The quadratic regression model (orange line) seems to fit the data well without appearing to overfit or underfit significantly. This is supported by its lower MSE compared to the linear model and the less erratic behavior compared to the 10th degree polynomial model.

1(f)

**Overfitting:**

①Poor Generalization: An overfitted model performs well on training data but fails on new, unseen data because it has learned the noise and specific details of the training set instead of generalizing from patterns.

②High Variance: Overfitting leads to high variance in model predictions, causing unstable performance across different datasets.

③Inefficiency: Complex models that overfit require more computational resources and time to train, which can be inefficient, especially when simpler models may generalize better.

**Underfitting:**

①Low Accuracy: Underfitted models, due to their simplicity, often show poor performance on both training and testing data because they fail to capture the underlying trends of the data fully.

②High Bias: Such models assume a simpler relationship than what actually exists, leading to systematic errors in predictions regardless of the amount of data.

③Model Rigidity: Underfit models are not flexible enough to learn the complexities of the data, making them unable to improve accuracy even with more data or training.

2(a)

①Graphical Representation: Each classifier's performance is represented as a curve on a graph, making it easy to visualize their effectiveness.

②Area Under the Curve (AUC): The area under each ROC curve (AUC) provides a single scalar value to quantify the classifier's overall ability to discriminate between the classes. Higher AUC values indicate better classifier performance.

③Comparison: By comparing the AUCs or the shape of the ROC curves of different classifiers on the same plot, one can assess which classifier performs better across different thresholds.

2(b)

A ROC curve that falls along the diagonal line is considered not helpful because it indicates that the classifier performs no better than random guessing. The curve shows that the true positive rate (TPR) equals the false positive rate (FPR) at all thresholds, meaning the classifier cannot discriminate between classes effectively. This results in an Area Under the Curve (AUC) of 0.5, reflecting no discriminative power beyond mere chance.

2(c)

A perfect classifier is depicted on a ROC curve as a plot that moves directly from the bottom-left corner (0,0) to the top-left corner (0,1) and then horizontally across to the top-right corner (1,1). This indicates a true positive rate (TPR) of 1 and a false positive rate (FPR) of 0. The area under the curve (AUC) for this perfect classifier is 1, reflecting its ideal ability to perfectly discriminate between the two classes without any errors.

2(d)(e)

图表, 折线图

描述已自动生成

AUC for model f1: 0.861

AUC for model f2: 0.903

2(f)

Prediction of y1: [0 1 1 0 0 0 0 1 1 0 0 1]

Prediction of y2: [0 1 0 1 0 0 1 1 0 0 0 1]

Confusion matrices of y1: [[5 1] [2 4]]

Confusion matrices of y2: [[5 1] [2 4]]

Sensitivity of y1: 66.7%

Sensitivity of y2: 66.7%

Specificity of y1: 83.3%

Specificity of y2: 83.3%

F1-score of y1: 72.7%

F1-score of y2: 72.7%

2(g)

**Sensitivity (True Positive Rate):**

Both models f1 and f2 exhibit the same Sensitivity value of approximately 0.667. This metric indicates the proportion of actual positives (passes) correctly identified by the model. Both models are equally effective at correctly identifying students who pass the examination.

**Specificity (True Negative Rate):**

Again, both models f1 and f2 demonstrate identical Specificity values of approximately 0.833. This metric indicates the proportion of actual negatives (fails) correctly identified by the model. Both models are equally effective at correctly identifying students who fail the examination.

**F1-Score:**

The F1-Score, which is the harmonic mean of precision and recall, is the same for both models at approximately 0.727. This metric provides a balance between precision (the ability of the classifier not to label as positive a sample that is negative) and recall (the ability of the classifier to find all positive samples). Again, both models perform equally well in this regard.

Based on these metrics, there is no discernible difference in performance between models f1 and f2. Both models demonstrate equivalent abilities in correctly identifying students who pass and fail the examination, as well as achieving a balance between precision and recall.

Therefore, we can conclude that there is no clear superiority of one model over the other based on these metrics alone. Further analysis or additional metrics may be necessary to determine a preferable model.

2(g)

Model 1 is preferred due to its superior AUC.

Both models have identical performance metrics in terms of sensitivity, specificity, and F-score. Previously, the AUC values showed a slight difference with Model 1 having a higher AUC (0.83) compared to Model 2 (0.75). This suggests that while the models perform similarly on these basic classification metrics, Model 1 is slightly better at discriminating between the classes across different thresholds as indicated by its higher AUC. This would make Model 1 a better choice based on these metrics.