

## Model Optimization and Tuning Phase Template

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| Date          | July 2024                                            |
| Team ID       | Team-739662                                          |
| Project Title | Ecommerce Shipping Prediction using Machine Learning |
| Maximum Marks | 10 Marks                                             |

### Model Optimization and Tuning Phase

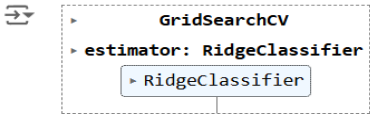
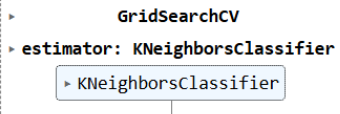
The Model Optimization and Tuning Phase involves refining neural network models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

#### Hyperparameter Tuning Documentation (8 Marks):

| Model | Tuned Hyperparameters |
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| <p>Logistic Regression</p> | <p><b>#importing the library for grid search</b><br/> <b>from</b> sklearn.model_selection <b>import</b> GridSearchCV</p> <p>The 'lr_param_grid' specifies different values for regularization strength (C), solvers (solver), and penalty types (penalty). GridSearchCV (lr_cv) is employed with 5-fold cross-validation (cv=5), evaluating model performance based on accuracy (scoring="accuracy"). The process uses all available CPU cores (n_jobs=-1) for parallel processing and provides verbose output (verbose=True) to track progress.</p> <p>LOGISTIC REGRESSION HYPER PARAMETER TUNNING</p> <pre>[54] #finding the grid search cv for logistic regression lr=LogisticRegression(n_jobs=-1,random_state=0) lr_param_grid={     'C':[0.1,0.5,1,5,10],     'solver':['liblinear','saga'],     'penalty':['l1','l2'] } lr_cv=GridSearchCV(lr,lr_param_grid,cv=5,scoring="accuracy",n_jobs=-1,verbose=True) lr_cv.fit(x_train,y_train)</pre> <p>Fitting 5 folds for each of 20 candidates, totalling 100 fits<br/> /usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_logistic.py:1211: warnings.warn(<br/> GridSearchCV<br/> estimator: LogisticRegression<br/> LogisticRegression</p> |
| <p>Random Forest</p>       | <p>The parameter grid (rfc_param_grid) for hyperparameter tuning. It specifies different values for the number of trees (n_estimators), splitting criterion (criterion), maximum depth of trees (max_depth), and maximum number of features considered for splitting (max_features). GridSearchCV (rfc_cv) is employed with 3-fold cross-validation (cv=3), evaluating model performance based on accuracy (scoring="accuracy").</p> <p>RANDOM FOREST HYPER PARAMETER TUNNING</p> <pre>[55] #finding the grid search cv for random forest classifier rfc=RandomForestClassifier() rfc_param_grid={     'n_estimators':[100,200],     'criterion':['entropy','gini'],     'max_depth':[5,10],     'max_features':['auto','sqrt'] } rfc_cv=GridSearchCV(rfc,rfc_param_grid,cv=3,scoring="accuracy",n_jobs=-1,verbose=3) rfc_cv.fit(x_train,y_train)</pre> <p>Fitting 3 folds for each of 16 candidates, totalling 48 fits<br/> /usr/local/lib/python3.10/dist-packages/sklearn/ensemble/_forest.py:424: FutureWarning:<br/> warn(<br/> GridSearchCV<br/> estimator: RandomForestClassifier<br/> RandomForestClassifier</p>                                                                                  |

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| <p><b>XGBoost</b></p>       | <p>The (params) define a grid for hyperparameter tuning of the XGBoost Classifier (XGBClassifier), including min_child_weight, gamma, colsample_bytree, and max_depth. The XGBClassifier is configured with a learning rate of 0.5, 100 estimators, using a binary logistic regression objective, and utilizing 3 threads for processing. GridSearchCV (xg_cv) is used with 5-fold cross-validation (cv=5), refitting the best model (refit=True), evaluating based on accuracy (scoring="accuracy")</p> <p>XGBOOST CLASSIFIER-HYPER PARAMETER TUNNING</p> <pre>#finding the grid search cv for xgboost params={     'min_child_weight':[10,20],     'gamma':[1.5,2.0,2.5],     'colsample_bytree':[0.6,0.8,0.9],     'max_depth':[4,5,6] } xg=XGBClassifier(learning_rate=0.5,n_estimators=100,objective='binary:logistic',nthreads=3) xg_cv=GridSearchCV(xg,param_grid=params,cv=5,refit=True,scoring="accuracy",n_jobs=-1,verbose=3) xg_cv.fit(x_train,y_train)</pre> <p>Fitting 5 folds for each of 54 candidates, totalling 270 fits<br/>/usr/local/lib/python3.10/dist-packages/xgboost/core.py:160: UserWarning: [14:07:26] WARNING: /work/ Parameters: { "nthreads" } are not used.</p> <pre>warnings.warn(msg, UserWarning) &gt; GridSearchCV &gt; estimator: XGBClassifier &gt; XGBClassifier</pre> |
| <p><b>Decision Tree</b></p> | <p>The parameters (params) define a grid for hyperparameter tuning of the Decision Tree Classifier (DecisionTreeClassifier), including max_depth, min_samples_leaf, and criterion ('gini' or 'entropy'). GridSearchCV (dec_cv) is used with 5-fold cross-validation (cv=5), evaluating model performance based on accuracy (scoring="accuracy")</p> <p>DECISION TREE CLASSIFIER-HYPER PARAMETER TUNNING</p> <pre>[68] #finding grid search cv for decision tree classifier dec=DecisionTreeClassifier(random_state=42) params={ 'max_depth': [2, 3, 5, 10, 20],         'min_samples_leaf': [5, 10, 20, 50, 100],         'criterion': ['gini', 'entropy'] } dec_cv=GridSearchCV(dec,param_grid=params,cv=5,n_jobs=-1,scoring="accuracy",verbose=3) dec_cv.fit(x_train,y_train)</pre> <p>Fitting 5 folds for each of 50 candidates, totalling 250 fits</p> <pre>&gt; GridSearchCV &gt; estimator: DecisionTreeClassifier &gt; DecisionTreeClassifier</pre>                                                                                                                                                                                                                                                                                                                                                    |

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| <p>Ridge Classifier</p>         | <p>The parameters (params) define a grid for hyperparameter tuning of the Decision Tree Classifier (DecisionTreeClassifier), including max_depth, min_samples_leaf, and criterion ('gini' or 'entropy'). GridSearchCV (dec_cv) is used with 5-fold cross-validation (cv=5), evaluating model performance based on accuracy (scoring="accuracy")</p> <hr/> <p>RIDGE-CLASSIFIER-HYPER PARAMETER TUNNING</p> <pre>#finding the grid search cv for ridge classifier rg=RidgeClassifier(random_state=42) params={     'alpha':(np.logspace(-8,8,100)) } rg_cv=GridSearchCV(rg,param_grid=params,cv=5) rg_cv.fit(x_train,y_train)</pre>                                                                                                                                                                 |
| <p>K- Nearest<br/>Neighbors</p> | <p>The parameters (params) define a grid for hyperparameter tuning of the K-Nearest Neighbors Classifier (KNeighborsClassifier), including n_neighbors, weights ('uniform' or 'distance'), and metric ('minkowski', 'euclidean', or 'manhattan'). GridSearchCV (knn_cv) is used with 5-fold cross-validation (cv=5), evaluating model performance based on accuracy (scoring="accuracy")</p> <hr/> <p>K-NEAREST NEIGHBORS-HYPER PARAMETER TUNNING</p> <pre>[69] #finding the grid search cv for k-nearest neighbors knn=KNeighborsClassifier() params={     'n_neighbors':[3,5,7,9,11],     'weights':['uniform','distance'],     'metric':['minkowski','euclidean','manhattan'] } knn_cv = GridSearchCV(knn, param_grid=params,cv=5, n_jobs=-1, verbose=3) knn_cv.fit(x_train, y_train)</pre>  |

## Final Model Selection Justification (2 Marks):

| Final Model   | Reasoning                                                                                                                                                       |
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| Random Forest | Random Forest model is chosen for its robustness in handling complex datasets and its ability to mitigate overfitting while providing high predictive accuracy. |
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