# Model Training: Decision Tree

```matlab
rng(42);
tree_model = fitctree(X_train, Y_train, ...
    'ClassNames', unique(Y_train), ...
    'MinLeafSize', 5);  % (you can tune this)

% Predict on validation set
Y_val_pred = predict(tree_model, X_val);

% Confusion matrix
figure;
Y_val = string(Y_val);
Y_val_pred = string(Y_val_pred);
confusionchart(Y_val, Y_val_pred);
title('Decision Tree - Validation Set');
```


Decision Tree - Validation Set
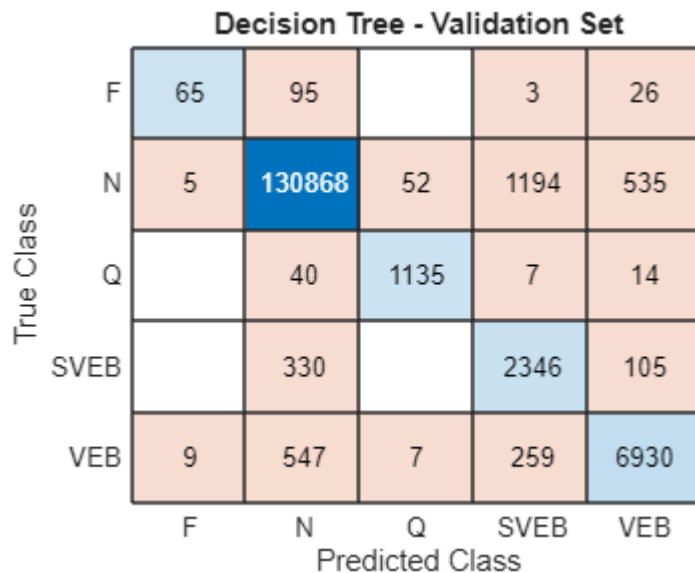
```matlab
% Accuracy
val_accuracy = sum(Y_val_pred == Y_val) / numel(Y_val);
fprintf('Decision Tree Validation Accuracy: %.2f%%\n', val_accuracy * 100);
```

Decision Tree Validation Accuracy: 97.77%

```matlab
% Predict on test set
Y_test_pred = predict(tree_model, X_test);

% Confusion matrix
figure;
Y_test = string(Y_test);
Y_test_pred = string(Y_test_pred);
confusionchart(Y_test, Y_test_pred);
title('Decision Tree - Test Set');
```

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Decision Tree - Test Set

```matlab
% Accuracy
test_accuracy = sum(Y_test_pred == Y_test) / numel(Y_test);
fprintf('Decision Tree Test Accuracy: %.2f%%\n', test_accuracy * 100);% Unique
classes
```

Decision Tree Test Accuracy: 97.80%

```matlab
classes = cellstr(unique([Y_test; Y_test_pred]));
precision = zeros(length(classes), 1);
recall = zeros(length(classes), 1);
f1score = zeros(length(classes), 1);

% Metrics loop
for i = 1:length(classes)
    class = classes{i};
    TP = sum(Y_test_pred == class & Y_test == class);
    FP = sum(Y_test_pred == class & Y_test ~= class);
    FN = sum(Y_test_pred ~= class & Y_test == class);

    precision(i) = TP / (TP + FP + eps);
    recall(i) = TP / (TP + FN + eps);
    f1score(i) = 2 * (precision(i) * recall(i)) / (precision(i) + recall(i) + eps);
end

% Show metrics
metrics_table = table(classes, precision, recall, f1score, ...
    'VariableNames', {'Class', 'Precision', 'Recall', 'F1_Score'});
disp(metrics_table);
```

Class	Precision	Recall	F1_Score
{'F' }	0.75789	0.38298	0.50883

```
{'N'   }    0.99267    0.98663    0.98964
{'Q'   }    0.95137    0.93227    0.94172
{'SVEB'}    0.62345    0.84898    0.71894
{'VEB' }    0.90716    0.89756    0.90233
```

```matlab
macro_f1 = mean(f1score);
fprintf('Decision Tree Macro F1-Score: %.2f\n', macro_f1);
```

```
Decision Tree Macro F1-Score: 0.81
```