Modify the Neural Network Model

```
import tensorflow as tf
from tensorflow.keras.datasets import imdb
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.layers import Dense, Flatten, Embedding, Dropout
import matplotlib.pyplot as plt
import pandas as pd
```

Load the IMDB Dataset

This dataset contains movie reviews labeled as positive or negative.

```
max_features = 10000
maxlen = 500
(x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_featur
x_train = pad_sequences(x_train, maxlen=maxlen)
x_test = pad_sequences(x_test, maxlen=maxlen)
print(f"Training samples: {len(x_train)}, Test samples: {len(x_test)}")
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-data
17464789/17464789 ━━━━━━━━━━━━━━━━━━━━ 2s 0us/step
Training samples: 25000, Test samples: 25000
```

- IMDB dataset consists of movie reviews labeled as positive (1) or negative (0).
- We limit vocabulary to 10,000 words to keep the model manageable.
- Padding sequences ensures all reviews are the same length, making them compatible with the neural network.

Model configurations

This function allows flexibility in adjusting hidden units, activation functions, loss functions, and dropout.

```
def create_model(hidden_units=64, activation='relu', loss='binary_crossentropy',
    """
    Creates a simple feedforward neural network for sentiment analysis.

    Parameters:
    - hidden_units: Number of neurons in the hidden layer(s).
    - activation: Activation function for the hidden layer(s).
    - loss: Loss function for the model (default is binary_crossentropy for class
```

```
    - dropout_rate: If specified, applies dropout regularization to prevent overf

    Returns:
    - Compiled Keras model ready for training.
    """
    model = tf.keras.Sequential([
        Embedding(input_dim=max_features, output_dim=128),  # Converts words into
        Flatten(),  # Flattens the output to feed into Dense layers
        Dense(hidden_units, activation=activation)  # Hidden layer with specified
    ])

    # Apply dropout if specified
    if dropout_rate:
        model.add(Dropout(dropout_rate))

    model.add(Dense(1, activation='sigmoid'))  # Output layer for binary classifi

    # Compile model with Adam optimizer and chosen loss function
    model.compile(optimizer='adam', loss=loss, metrics=['accuracy'])

    return model
```

- Embedding layer: Converts words into meaningful numerical representations.
- Flatten layer: Transforms the output into a format suitable for dense layers.
- Hidden layer: The number of neurons and activation function can be adjusted.
- Dropout layer: Randomly deactivates neurons during training to prevent overfitting.
- Output layer: Uses a sigmoid activation to classify reviews as positive or negative.
- Binary cross-entropy loss: Optimized for classification problems.

Model variations

Experimenting with different hidden layers, activations, losses, and units.

```
models = {
    "One Hidden Layer (64 units)": create_model(hidden_units=64),
    "Three Hidden Layers": tf.keras.Sequential([
        Embedding(input_dim=max_features, output_dim=128),
        Flatten(),
        Dense(64, activation='relu'),
        Dense(32, activation='relu'),
        Dense(16, activation='relu'),
        Dense(1, activation='sigmoid')
    ]),
    "Tanh Activation + MSE Loss": create_model(hidden_units=64, activation='tanh'
    "Dropout Regularization": create_model(hidden_units=64, dropout_rate=0.5),
    "Fewer Units (32)": create_model(hidden_units=32),
    "More Units (128)": create_model(hidden_units=128)
}
```

```
# Ensure models requiring explicit compilation are compiled
models["Three Hidden Layers"].compile(optimizer='adam', loss='binary_crossentropy
```

- One Hidden Layer (64 units) → Baseline model.
- Three Hidden Layers → Tests if deeper networks improve performance.
- Tanh Activation + MSE Loss → Evaluates older methods against modern best practices.
- Dropout Regularization → Adds dropout to test overfitting reduction.
- Fewer Units (32) & More Units (128) → Tests whether increasing or decreasing neurons improves accuracy

Train and evaluate models

Training each model for 5 epochs and evaluating on the test set.

```
def train_and_evaluate(model):
    model.fit(x_train, y_train, epochs=5, batch_size=32, validation_split=0.2, ve
    val_accuracy = model.evaluate(x_test, y_test, verbose=0)[1]
    test_accuracy = model.evaluate(x_test, y_test, verbose=0)[1]
    return val_accuracy, test_accuracy
```

Evaluate all models and collect results

Storing validation and test accuracies for comparison.

```
results = {name: train_and_evaluate(model) for name, model in models.items()}
```

- Training for 5 epochs: Chosen for quick experimentation (longer training could improve results).
- Validation split (0.2):Uses 20% of training data to monitor overfitting.
- Evaluating accuracy: Both validation and test accuracy are measured.

Summarize results in a DataFrame

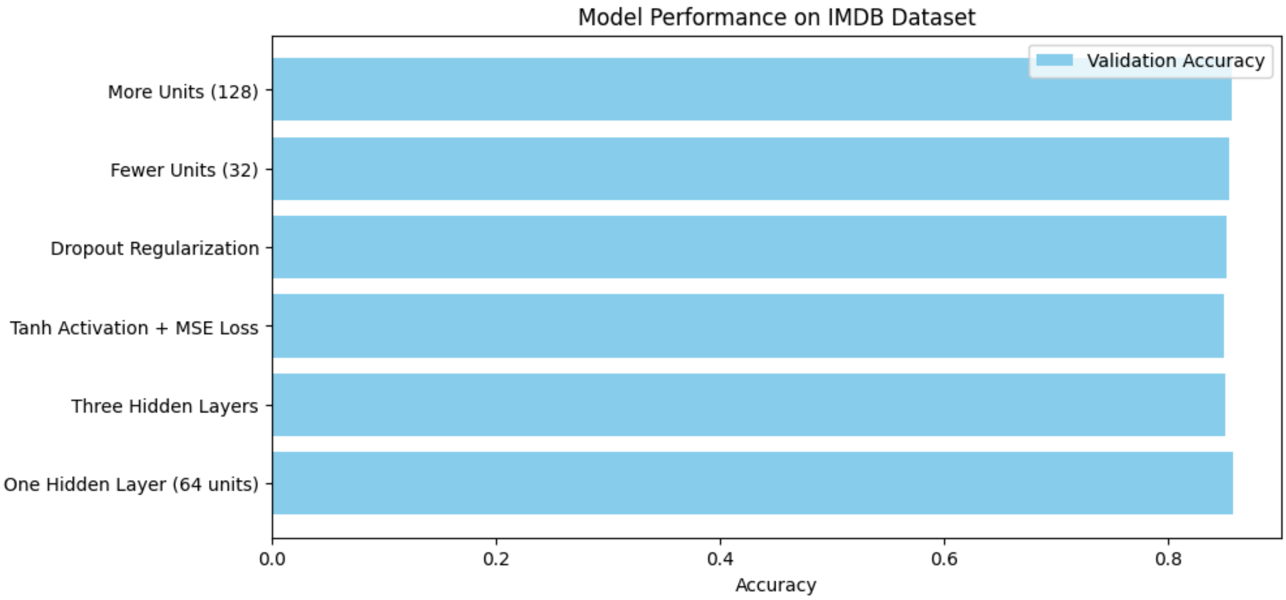
Creating a table for clear presentation of model performances.

```
summary = pd.DataFrame([
    {"Model": name, "Validation Accuracy": val_acc, "Test Accuracy": test_acc}
    for name, (val_acc, test_acc) in results.items()
])
```

Visualize the results

Bar chart comparing validation and test accuracies for each model.

```
plt.figure(figsize=(10, 5))
plt.barh(summary['Model'], summary['Validation Accuracy'], color='skyblue', label
plt.xlabel('Accuracy')
plt.title('Model Performance on IMDB Dataset')
plt.legend()
plt.show()
```




```
plt.figure(figsize=(10, 5))
plt.barh(summary['Model'], summary['Test Accuracy'], color='orange', alpha=0.6, l
plt.xlabel('Accuracy')
plt.title('Model Performance on IMDB Dataset')
plt.legend()
plt.show()
```

Display summary

```
print(summary)
```

```
                         Model  Validation Accuracy  Test Accuracy
0  One Hidden Layer (64 units)              0.85804        0.85804
1          Three Hidden Layers              0.85156        0.85156
2   Tanh Activation + MSE Loss              0.84952        0.84952
3       Dropout Regularization              0.85224        0.85224
4             Fewer Units (32)              0.85472        0.85472
5             More Units (128)              0.85708        0.85708
```