**Alphabet Soup Deep Learning Model Report**

**Overview of the Analysis**

The purpose of this analysis is to design and optimize a deep learning model to predict the success of funding applications for Alphabet Soup, a non-profit organization. The goal is to develop a neural network model that achieves a target predictive accuracy of over 75%, identifying which features are most relevant for predicting whether an application will be successful.

**Results**

**Data Preprocessing**

1. **Target Variable:**
   * The target variable for the model is IS\_SUCCESSFUL, which indicates whether an application was successful (1) or not (0).
2. **Feature Variables:**
   * The features used for the model include all columns in the dataset except EIN, NAME, and the target variable IS\_SUCCESSFUL.
   * Categorical variables such as APPLICATION\_TYPE and CLASSIFICATION were processed using one-hot encoding, and infrequent categories were grouped into an “Other” category to reduce noise and improve model performance.
3. **Removed Variables:**
   * EIN and NAME were removed from the input data as they are identifiers that do not contribute to the prediction of the target variable.

**Compiling, Training, and Evaluating the Model**

1. **Neurons, Layers, and Activation Functions:**
   * **First Attempt:**
     + **Architecture:**
       - Input layer with 80 neurons and relu activation.
       - Hidden layer with 30 neurons and relu activation.
       - Output layer with 1 neuron and sigmoid activation for binary classification.
     + **Reasoning:** A simple architecture was chosen to test the baseline performance.
   * **Second Attempt:**
     + **Architecture:**
       - Input layer with 100 neurons and relu activation.
       - Two additional hidden layers with 50 and 30 neurons, both using relu activation.
       - Output layer with 1 neuron and sigmoid activation.
     + **Reasoning:** Increased the number of neurons and added a third layer to allow the model to capture more complex relationships in the data.
   * **Third Attempt:**
     + **Architecture:**
       - Input layer with 120 neurons and tanh activation.
       - Two additional hidden layers with 60 and 30 neurons, using relu and tanh activation respectively.
       - Output layer with 1 neuron and sigmoid activation.
     + **Reasoning:** Experimented with different activation functions (e.g., tanh) to evaluate their impact on performance.
2. **Target Model Performance:**
   * The highest accuracy achieved was **73.8%**, falling slightly short of the 75% target.
3. **Steps to Increase Model Performance:**
   * Adjusted the architecture by:
     + Adding more neurons to the layers.
     + Increasing the number of hidden layers.
     + Using different activation functions such as tanh to test non-linear mappings.
   * Increased the number of epochs to improve learning.
   * Processed categorical variables more effectively by grouping rare occurrences into “Other” categories to reduce noise.

**Summary**

The deep learning model showed promise but did not meet the target accuracy of 75%. While the model performed well with 73.8% accuracy, the following challenges remain:

* The dataset may have limitations, such as insufficient feature relevance or noise, which could impact predictive performance.

**Recommendation:**

* Consider using other machine learning models such as **Random Forests** or **Gradient Boosting Machines (e.g., XGBoost)**. These models are well-suited for tabular data and can handle non-linear relationships and categorical variables effectively.
* Explore feature engineering to create new variables or transform existing ones to better capture the relationships in the data.
* Use techniques like hyperparameter tuning (e.g., grid search) to optimize the neural network or other machine learning models.

By implementing these recommendations, it is likely that a more robust and accurate predictive model can be developed for Alphabet Soup’s application success prediction task.