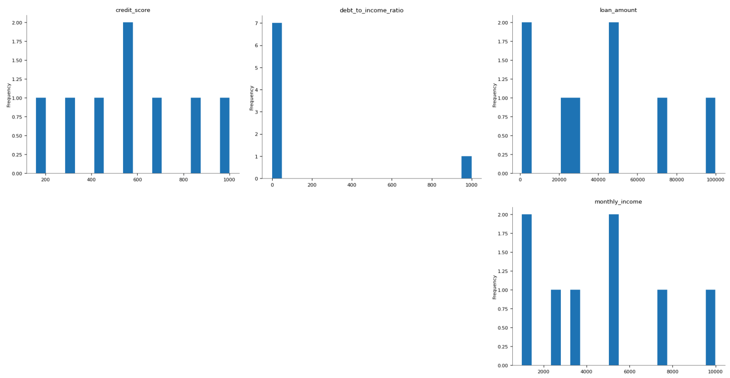
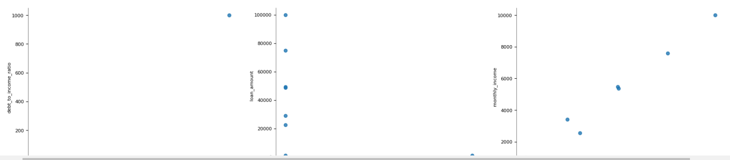
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, LSTM

# Simulating borrower profiles and financial indicators
np.random.seed(42)
n_samples = 1000
sequence_length = 5  # Length of sequence for each borrower profile

# Simulating borrower profiles and financial indicators
borrower_data = pd.DataFrame({
    'credit_score': np.random.randint(300, 850, n_samples),
    'debt_to_income_ratio': np.random.uniform(0, 1, n_samples),
    'loan_amount': np.random.randint(1000, 100000, n_samples),
    'monthly_income': np.random.randint(1000, 10000, n_samples),
    'open_credit_lines': np.random.randint(0, 20, n_samples),
    'loan_default': np.random.choice([0, 1], size=n_samples, p=[0.8, 0.2])
})
borrower_data.describe()
```

	credit_score	debt_to_income_ratio	loan_amount	monthly_income	open_credit_
count	1000.000000	1000.000000	1000.000000	1000.000000	1000.0(
mean	563.991000	0.507523	48800.058000	5465.066000	9.8
std	160.508436	0.291419	29061.771183	2545.531549	5.6
min	300.000000	0.003218	1138.000000	1002.000000	0.0
25%	423.750000	0.244882	22577.500000	3420.250000	5.0
50%	553.000000	0.519428	49446.000000	5369.500000	10.0
75%	701.250000	0.758245	74901.000000	7594.500000	15.0
max	849.000000	0.999414	99876.000000	9996.000000	19.0

Distributions



2-d distributions



```
# Reshape data into sequences
X_sequence = []
y_sequence = []
for i in range(len(borrower_data) - sequence_length):
    X_sequence.append(borrower_data.iloc[i:i+sequence_length, :-1].values)
    y_sequence.append(borrower_data.iloc[i+sequence_length, -1])

X_sequence = np.array(X_sequence)
y_sequence = np.array(y_sequence)
print("X_sequence shape:", X_sequence.shape)
print("y_sequence shape:", y_sequence.shape)
print("\nSample X_sequence:")
print(X_sequence[:1])  # Prints first sequence
print("\nSample y_sequence:")
print(y_sequence[:1])  # Prints first target label
```

```
X_sequence shape: (995, 5, 5)
y_sequence shape: (995,)

Sample X_sequence:
[[[4.02000000e+02 9.00018642e-01 9.59470000e+04 7.68700000e+03
   7.00000000e+00]
  [7.35000000e+02 8.73890078e-01 6.46900000e+03 6.56500000e+03
   1.40000000e+01]
  [5.70000000e+02 5.97413102e-01 2.98540000e+04 8.24100000e+03
   1.30000000e+01]
  [4.06000000e+02 6.00516860e-01 7.25600000e+03 8.65100000e+03
   1.90000000e+01]
  [3.71000000e+02 6.65036675e-01 7.72560000e+04 6.57500000e+03
   6.00000000e+00]]]

Sample y_sequence:
[0]
```

```
# Split data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X_sequence, y_sequence, test_size=0.2, random_state=42)

# Normalize features
scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train.reshape(-1, X_train.shape[-1])).reshape(X_train.shape)
X_test_scaled = scaler.transform(X_test.reshape(-1, X_test.shape[-1])).reshape(X_test.shape)
print("X_train shape:", X_train.shape)
print("X_test shape:", X_test.shape)
print("y_train shape:", y_train.shape)
print("y_test shape:", y_test.shape)
```

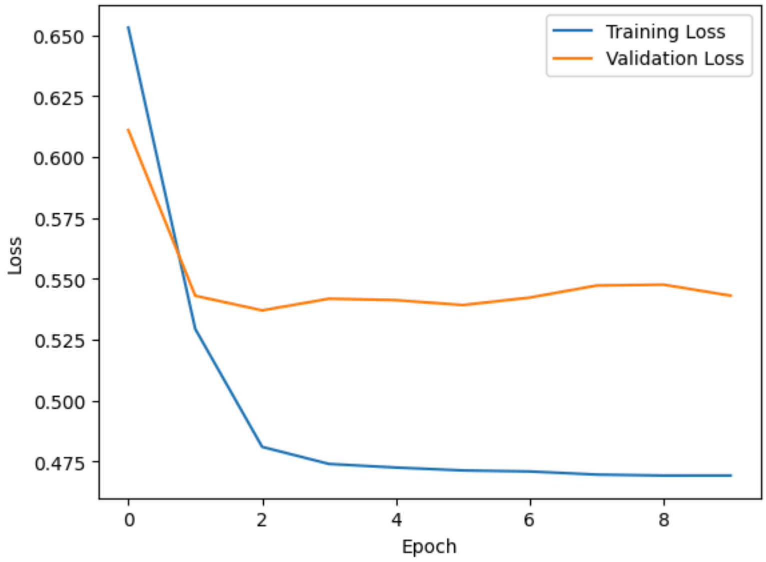
```
X_train shape: (796, 5, 5)
X_test shape: (199, 5, 5)
y_train shape: (796,)
y_test shape: (199,)
```

```
# Build RNN model
model = Sequential([
    LSTM(units=64, input_shape=(X_train.shape[1], X_train.shape[2])),
    Dense(units=1, activation='sigmoid')
])

# Compile, train and evaluate
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])
history = model.fit(X_train_scaled, y_train, epochs=10, batch_size=32, validation_data=(X_test_scaled, y_test))
loss, accuracy = model.evaluate(X_test_scaled, y_test)
print("Accuracy:", accuracy)

# Calculate profit and loss
profit = np.sum((y_pred_binary == 1) * profit_per_approved_loan) - np.sum((y_pred_binary == 0) * loss_per_rejected_loan * (1 - y_pred))
loss_incorrect_approvals = np.sum((y_pred_binary != y_test) & (y_pred_binary == 1)) * loss_per_rejected_loan
loss_incorrect_rejections = np.sum((y_pred_binary != y_test) & (y_pred_binary == 0)) * profit_per_approved_loan
total_loss = loss_incorrect_approvals + loss_incorrect_rejections
print("Profit:", profit)
print("Loss:", total_loss)
```

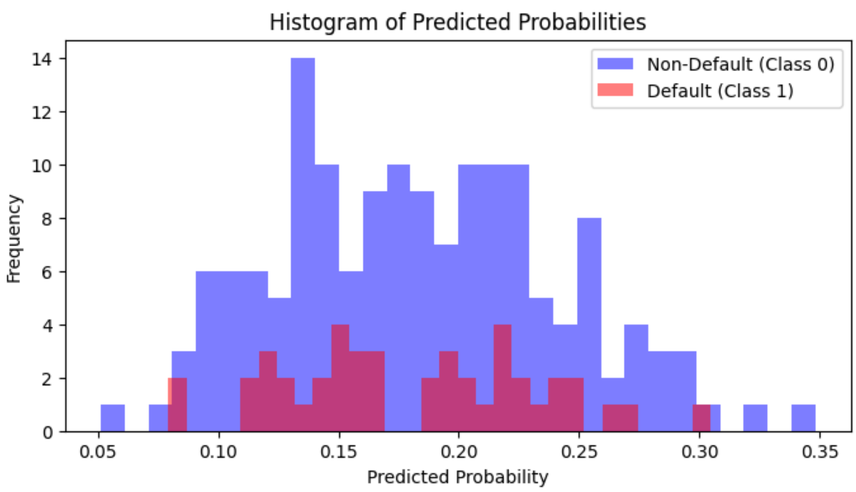
```
Epoch 1/10
25/25 [==============================] - 5s 52ms/step - loss: 0.6471 - accuracy: 0.6972 - val_loss: 0.6014 - val_accuracy: 0.7789
Epoch 2/10
25/25 [==============================] - 0s 6ms/step - loss: 0.5201 - accuracy: 0.8141 - val_loss: 0.5438 - val_accuracy: 0.7789
Epoch 3/10
25/25 [==============================] - 0s 6ms/step - loss: 0.4803 - accuracy: 0.8141 - val_loss: 0.5352 - val_accuracy: 0.7789
Epoch 4/10
25/25 [==============================] - 0s 7ms/step - loss: 0.4754 - accuracy: 0.8141 - val_loss: 0.5386 - val_accuracy: 0.7789
Epoch 5/10
25/25 [==============================] - 0s 6ms/step - loss: 0.4740 - accuracy: 0.8141 - val_loss: 0.5464 - val_accuracy: 0.7789
```

```
Epoch 6/10
25/25 [==============================] - 0s 7ms/step - loss: 0.4720 - accuracy: 0.8141 - val_loss: 0.5405 - val_accuracy: 0.7789
Epoch 7/10
25/25 [==============================] - 0s 6ms/step - loss: 0.4710 - accuracy: 0.8141 - val_loss: 0.5442 - val_accuracy: 0.7789
Epoch 8/10
25/25 [==============================] - 0s 7ms/step - loss: 0.4695 - accuracy: 0.8141 - val_loss: 0.5405 - val_accuracy: 0.7789
Epoch 9/10
25/25 [==============================] - 0s 7ms/step - loss: 0.4690 - accuracy: 0.8141 - val_loss: 0.5488 - val_accuracy: 0.7789
Epoch 10/10
25/25 [==============================] - 0s 7ms/step - loss: 0.4687 - accuracy: 0.8141 - val_loss: 0.5423 - val_accuracy: 0.7789
7/7 [==============================] - 0s 4ms/step - loss: 0.5423 - accuracy: 0.7789
Accuracy: 0.7788944840431213
Profit: -81345.73024511337
Loss: 8756000
```

```
# Plot training and validation loss
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```




```
# Generate histograms for predicted probabilities
plt.figure(figsize=(8, 4))  # Adjust the figsize here to change the size of the plot
plt.hist(y_pred[y_test == 0], bins=30, alpha=0.5, label='Non-Default (Class 0)', color='blue')
plt.hist(y_pred[y_test == 1], bins=30, alpha=0.5, label='Default (Class 1)', color='red')
plt.title('Histogram of Predicted Probabilities')
plt.xlabel('Predicted Probability')
plt.ylabel('Frequency')
plt.legend()
plt.show()
```



```
from sklearn.metrics import confusion_matrix
import seaborn as sns

# Make predictions on the test set
y_pred_probs = model.predict(X_test_scaled)
y_pred_binary = (y_pred_probs > 0.5).astype(int)

# Calculate confusion matrix
conf_matrix = confusion_matrix(y_test, y_pred_binary)

# Print confusion matrix
print("Confusion Matrix:")
print(conf_matrix)

# Plot confusion matrix
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues')
plt.title('Confusion Matrix')
plt.xlabel('Predicted Label')
plt.ylabel('True Label')
plt.show()
```

```
7/7 [==============================] - 0s 5ms/step
Confusion Matrix:
[[155   0]
 [ 44   0]]
```