In [1]:
```
import cupy as cp
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.patheffects as PathEffects
import matplotlib
from sklearn.utils import resample
from sklearn.preprocessing import MultiLabelBinarizer
#import seaborn as sns
from cuml.neighbors import KNeighborsClassifier  # Importing MLKNN from RAPIDS
from cuml.decomposition import PCA
from keras.preprocessing.sequence import pad_sequences
from sklearn.model_selection import train_test_split
import warnings
from keras.layers import StringLookup
warnings.filterwarnings("ignore")
```

```
2024-11-05 07:53:37.343838: I tensorflow/core/util/port.cc:153] oneDNN custom operations are on. You may see slightly diffe
rent numerical results due to floating-point round-off errors from different computation orders. To turn them off, set the
environment variable `TF_ENABLE_ONEDNN_OPTS=0`.
2024-11-05 07:53:37.377153: E external/local_xla/xla/stream_executor/cuda/cuda_fft.cc:485] Unable to register cuFFT factor
y: Attempting to register factory for plugin cuFFT when one has already been registered
2024-11-05 07:53:37.435312: E external/local_xla/xla/stream_executor/cuda/cuda_dnn.cc:8454] Unable to register cuDNN factor
y: Attempting to register factory for plugin cuDNN when one has already been registered
2024-11-05 07:53:37.461823: E external/local_xla/xla/stream_executor/cuda/cuda_blas.cc:1452] Unable to register cuBLAS fact
ory: Attempting to register factory for plugin cuBLAS when one has already been registered
2024-11-05 07:53:37.501641: I tensorflow/core/platform/cpu_feature_guard.cc:210] This TensorFlow binary is optimized to use
available CPU instructions in performance-critical operations.
To enable the following instructions: SSE4.1 SSE4.2 AVX AVX2 AVX_VNNI FMA, in other operations, rebuild TensorFlow with the
appropriate compiler flags.
```

In [2]:
```
# Load embeddings and codes
embeddings1 = np.load("embeddings_1.npy")
embeddings2 = np.load("embeddings_2.npy")

with open("icd_codes_1.txt", 'r') as file:
    codes1 = [line.strip('\n').split(';') for line in file.readlines()]
with open("icd_codes_2.txt", 'r') as file:
    codes2 = [line.strip('\n').split(';') for line in file.readlines()]
```

In [3]:
```
Code1 = pd.Series([label for sublist in codes1 for label in sublist ])
Code2 = pd.Series([label for sublist in codes2 for label in sublist ])
```

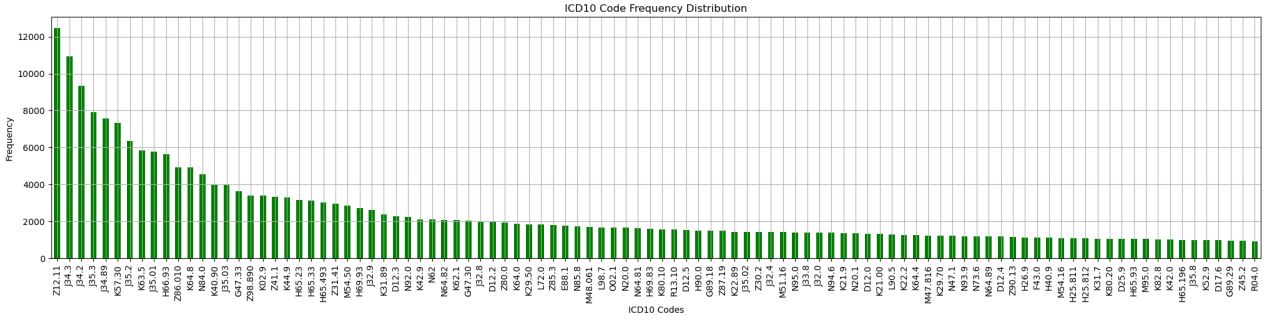
In [4]:
```
print("No of Unique codes in ICD_Codes_1:",len(Code1.unique()))
print("No of Unique codes in ICD_Codes_2:",len(Code2.unique()))
```

```
No of Unique codes in ICD_Codes_1: 1373
No of Unique codes in ICD_Codes_2: 1294
```

In [5]:
```
# Concatinating both the codes
CODE = pd.concat([Code1, Code2])
print("No of Unique ICD10 Codes:",len(CODE.unique()))
```

```
No of Unique ICD10 Codes: 1400
```

In [6]:
```
CODE.value_counts()[:100].plot(kind = 'bar', figsize= (25,5), color='green')
plt.title('ICD10 Code Frequency Distribution') # Top 100 ICD10 codes which is frequently repeated as labels to embedding
plt.xlabel('ICD10 Codes')
plt.ylabel('Frequency')
plt.grid(True)
plt.xticks(rotation=90)
plt.show()
```



In [7]:
```
threshold = 100
underrepresented_class = CODE.value_counts()[CODE.value_counts() < threshold].index
```

In [8]:
```
# Extract samples (indices) that contain underrepresented codes
samples_to_oversample = [i for i, code_list in enumerate(codes1) if any(code in underrepresented_class for code in code_
len(samples_to_oversample)
```

Out[8]: 15816

In [9]:
```
X_resampled, Y_resampled = resample(embeddings1[samples_to_oversample], [codes1[i] for i in samples_to_oversample], repl
```

In [10]:
```
codes1.extend(Y_resampled)
```

In [11]:
```
# Concatenate original and oversampled data
Embeddings1 = np.vstack((embeddings1, X_resampled))
Codes1 = codes1
```

In [12]:
```
X_resampled1, Y_resampled1 = resample(embeddings2[samples_to_oversample], [codes2[i] for i in samples_to_oversample], re
```

In [13]:
```
codes2.extend(Y_resampled1)
```

In [14]:
```
# Concatenate original and oversampled data
Embeddings2 = np.vstack((embeddings2, X_resampled1))
Codes2 = codes2
```

In [15]:
```
len(Embeddings1), len(Embeddings2), len(Codes1), len(Codes2)
```

Out[15]: (126491, 126491, 126491, 126491)

In [16]:
```
vocab = list(CODE.unique())
```

In [17]:
```
# Create the StringLookup layer with multi_hot output mode
lookup = StringLookup(vocabulary=vocab, output_mode='multi_hot')
```

```
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
I0000 00:00:1730773420.423799    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730773420.424438    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730773420.424460    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730773420.428765    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730773420.428789    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730773420.428802    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730773420.598736    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
I0000 00:00:1730773420.598780    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2024-11-05 07:53:40.598787: I tensorflow/core/common_runtime/gpu/gpu_device.cc:2112] Could not identify NUMA node of platfo
rm GPU id 0, defaulting to 0.  Your kernel may not have been built with NUMA support.
I0000 00:00:1730773420.598820    3850 cuda_executor.cc:1001] could not open file to read NUMA node: /sys/bus/pci/devices/00
00:01:00.0/numa_node
Your kernel may have been built without NUMA support.
2024-11-05 07:53:40.598835: I tensorflow/core/common_runtime/gpu/gpu_device.cc:2021] Created device /job:localhost/replica:
0/task:0/device:GPU:0 with 9558 MB memory:  -> device: 0, name: NVIDIA GeForce RTX 4070, pci bus id: 0000:01:00.0, compute
capability: 8.9
```

In [18]:
```
import copy
C = copy.deepcopy(Codes1)
```

In [19]:
```
C.extend(Codes2) # contains codes1 followed by codes2 labels
```

In [20]:
```
len(C), len(codes2)+len(codes1) # to show both are of same length
```

Out[20]: (252982, 252982)

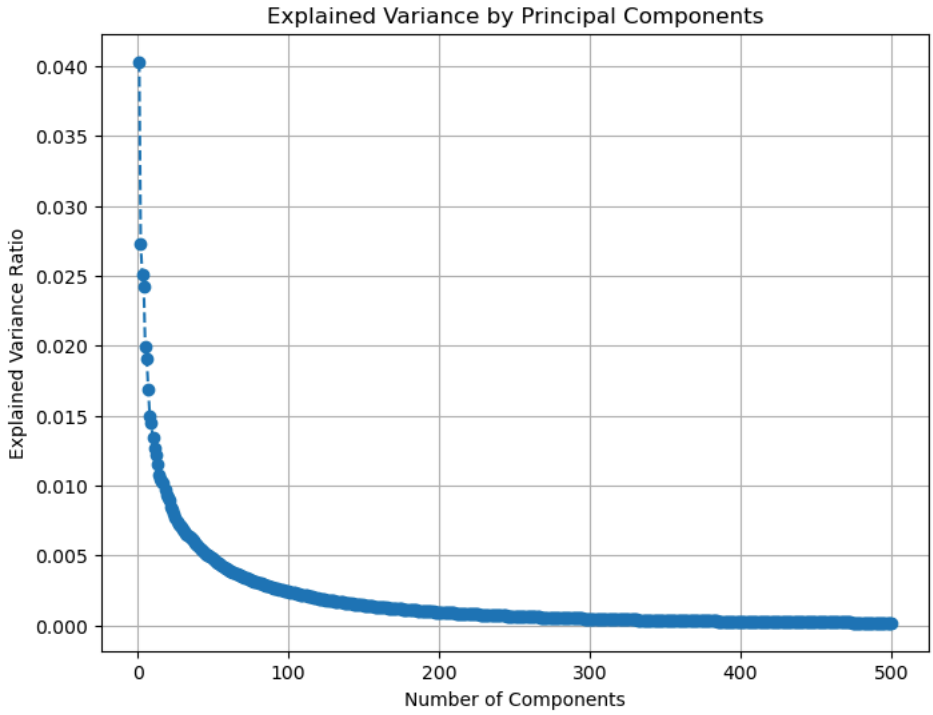
In [21]:
```
Embeddings = np.vstack((Embeddings1, Embeddings2))
```

In [22]:
```
len(Embeddings), Embeddings.shape
```

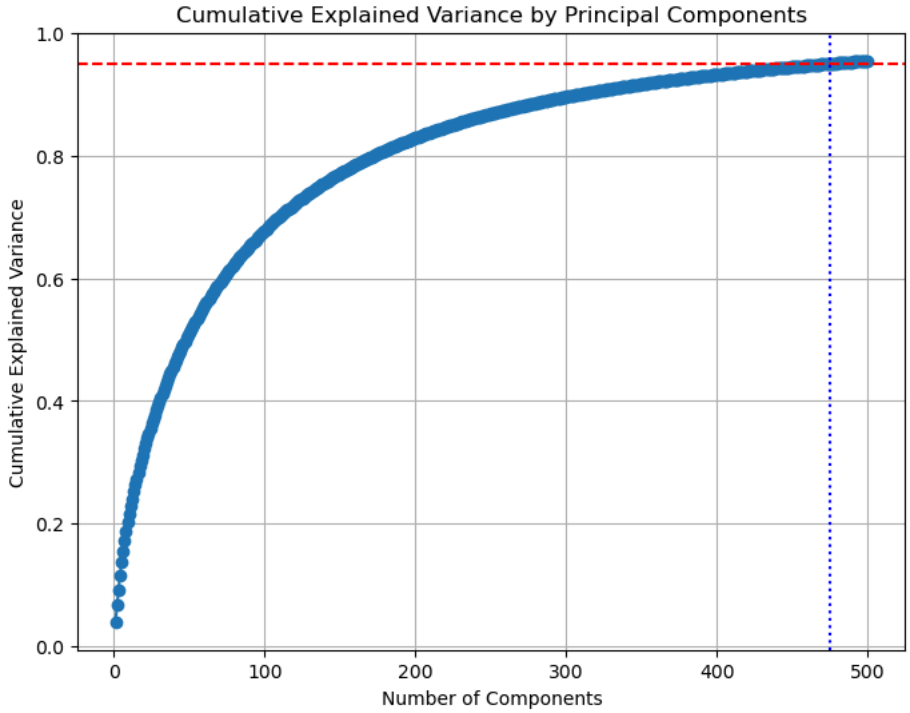
Out[22]:
```
(252982, (252982, 1024))
```

In [23]:
```
p = PCA(n_components=500).fit(Embeddings)
```

In [24]:
```
explained_variance = p.explained_variance_ratio_

# Plot explained variance
plt.figure(figsize=(8, 6))
plt.plot(range(1, len(explained_variance) + 1), explained_variance, marker='o', linestyle='--')
plt.title('Explained Variance by Principal Components')
plt.xlabel('Number of Components')
plt.ylabel('Explained Variance Ratio')
plt.grid()
plt.show()


```



In [25]:
```
cumulative_variance = np.cumsum(explained_variance)

plt.figure(figsize=(8, 6))
plt.plot(range(1, len(cumulative_variance) + 1), cumulative_variance, marker='o', linestyle='--')
plt.title('Cumulative Explained Variance by Principal Components')
plt.xlabel('Number of Components')
plt.ylabel('Cumulative Explained Variance')
plt.axhline(y=0.95, color='r', linestyle='--')
plt.axvline(x = 475, color = 'b', linestyle='dotted')
plt.grid()
plt.show()
```



In [26]:
```
Embeddings_transformed = PCA(n_components=500).fit_transform(Embeddings)

```

In [27]:
```
max_length = max(len(sublist) for sublist in C)
Codes_padded = pad_sequences(C, maxlen=max_length, padding='post', value='', dtype=object)
```

In [28]:
```
output = lookup(Codes_padded)
```

```
W0000 00:00:1730773430.271894    4024 gpu_backend_lib.cc:593] Can't find libdevice directory ${CUDA_DIR}/nvvm/libdevice. Th
is may result in compilation or runtime failures, if the program we try to run uses routines from libdevice.
Searched for CUDA in the following directories:
  ./cuda_sdk_lib
  /home/conda/feedstock_root/build_artifacts/tensorflow-split_1729076995378/_build_env/targets/x86_64-linux
  /usr/local/cuda
  /home/student/miniforge3/envs/rapids-24.10/lib/python3.12/site-packages/tensorflow/python/platform/../../../nvidia/cuda_n
vcc
  /home/student/miniforge3/envs/rapids-24.10/lib/python3.12/site-packages/tensorflow/python/platform/../../../../nvidia/cud
a_nvcc
  .
You can choose the search directory by setting xla_gpu_cuda_data_dir in HloModule's DebugOptions.  For most apps, setting t
he environment variable XLA_FLAGS=--xla_gpu_cuda_data_dir=/path/to/cuda will work.
```

In [29]:
```
output.numpy().shape, Embeddings_transformed.shape
```

Out[29]:
```
((252982, 1401), (252982, 500))
```

In [30]:
```
X_train, X_test, Y_train, Y_test = train_test_split(Embeddings_transformed, output.numpy(), test_size=0.2, random_state=
```

In [31]:
```
x_train, x_val, y_train, y_val = train_test_split(X_train, Y_train, test_size=0.2, random_state=42)
```

In [32]:
```
from cuml.multiclass import OneVsRestClassifier
from cuml.linear_model import LogisticRegression
```

In [33]:
```
#K = KNeighborsClassifier(weights='uniform', n_neighbors=5)
L = LogisticRegression(C=0.1, max_iter=10000)
K = OneVsRestClassifier(L)
```

In [34]:
```
K
```

Out[34]:
```
OneVsRestClassifier()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [35]:
```
K.fit(Embeddings_transformed, output.numpy())

from sklearn.metrics import f1_score
Y_pred_test = K.predict(X_test)
f1_macro = f1_score(Y_test, Y_pred_test, average='macro', zero_division=0)

print(f"F1 Macro Score for test data: {f1_macro}")
```

```
[W] [07:57:59.602338] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:06.581847] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:08.262423] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:12.564228] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:17.315985] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:22.031415] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:23.633626] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:25.972379] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:27.084904] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:45.678872] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:52.154148] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:54.467388] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:55.436228] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:56.690781] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:58:58.615645] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:59:03.059612] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:59:03.863460] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:59:07.932284] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:59:15.307046] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
[W] [07:59:16.325874] L-BFGS stopped, because the line search failed to advance (step delta = 0.000000)
```

In [36]:
```
print("Training!!!")
```

```
Training!!!
```

In [ ]:
```

```

In [37]:
```
embeddings_test = np.load("test_data.npy")
pca = PCA(n_components=500).fit(Embeddings)  # Fit PCA on training data
Embeddings_test_transformed = pca.transform(embeddings_test)  # Apply same transformation to test data


Test_pred = K.predict(Embeddings_test_transformed)

```

In [38]:
```
V = lookup.get_vocabulary()
def codes_prediction(pred):
    return [V[i] for i in np.where(pred == 1)[0]]
```

In [39]:
```

Test_decode = [codes_prediction(i) for i in Test_pred]

with open('decoded_labels_500.txt', 'w') as file:
    for sublist in Test_decode:
        file.write(','.join(sublist) + '\n')
```

In [40]:
```
def clean_predictions(pred):
    if all(code == '[UNK]' for code in pred):
        return ''
    code_pred = [code for code in pred if code!='[UNK]']
    code_pred.sort()
    return ';'.join(code_pred)
```

In [41]:
```
Test_decode_cleaned = [clean_predictions(i) for i in Test_decode]
```

In [42]:
```
sub = pd.DataFrame({'id': range(1, len(Test_decode_cleaned)+1),
                    'labels': Test_decode_cleaned})
```

In [43]:
```
sub.to_csv('submission15.csv', index=False)
```

In [44]:
```
1 print("Done!")
```

```
Done!
```

In [ ]:
```
1
```