1. Import Libraries

In [1]:

```
import numpy as np
import pandas as pd
import re
import matplotlib.pyplot as plt
import seaborn as sns

from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
from wordcloud import WordCloud

from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report, roc

import nltk
nltk.download('stopwords')
nltk.download('wordnet')
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
```

Out[1]:

```
True
```

2. Load and Explore Data

In [2]:

```
# Load dataset
news = pd.read_csv('fake_train.csv')
news.head()
```

Out[2]:

	id	title	author	text	label
0	0	House Dem Aide: We Didn’t Even See Comey’s Let...	Darrell Lucus	House Dem Aide: We Didn’t Even See Comey’s Let...	1
1	1	FLYNN: Hillary Clinton, Big Woman on Campus - ...	Daniel J. Flynn	Ever get the feeling your life circles the rou...	0
2	2	Why the Truth Might Get You Fired	Consortiumnews.com	Why the Truth Might Get You Fired October 29, ...	1
3	3	15 Civilians Killed In Single US Airstrike Hav...	Jessica Purkiss	Videos 15 Civilians Killed In Single US Airstr...	1
4	4	Iranian woman jailed for fictional unpublished...	Howard Portnoy	Print \nAn Iranian woman has been sentenced to...	1

In [3]:

```
news.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20800 entries, 0 to 20799
```

```
Data columns (total 5 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   id      20800 non-null  int64
 1   title   20242 non-null  object
 2   author  18843 non-null  object
 3   text    20761 non-null  object
 4   label   20800 non-null  int64
dtypes: int64(2), object(3)
memory usage: 812.6+ KB
```

In [4]:

```
news.isnull().mean() * 100
```

Out[4]:

	0
id	0.000000
title	2.682692
author	9.408654
text	0.187500
label	0.000000

dtype: float64

3. Data Cleaning and Feature Engineering

In [5]:

```
# Fill missing values
news = news.fillna("")
```

In [6]:

```
# Merge columns for content
news["content"] = news["author"] + " " + news["title"] + " " + news["text"]
```

In [7]:

```
# Feature: text length
news['text_length'] = news['content'].apply(len)
```

In [8]:

```
print(news["content"])
```

```
0        Darrell Lucus House Dem Aide: We Didn’t Even S...
1        Daniel J. Flynn FLYNN: Hillary Clinton, Big Wo...
2        Consortiumnews.com Why the Truth Might Get You...
3        Jessica Purkiss 15 Civilians Killed In Single ...
4        Howard Portnoy Iranian woman jailed for fictio...
                              ...
20795    Jerome Hudson Rapper T.I.: Trump a ’Poster Chi...
20796    Benjamin Hoffman N.F.L. Playoffs: Schedule, Ma...
20797    Michael J. de la Merced and Rachel Abrams Macy...
20798    Alex Ansary NATO, Russia To Hold Parallel Exer...
20799    David Swanson What Keeps the F-35 Alive   Davi...
Name: content, Length: 20800, dtype: object
```

4. Text Preprocessing (Lemmatization and Cleaning)

In [9]:

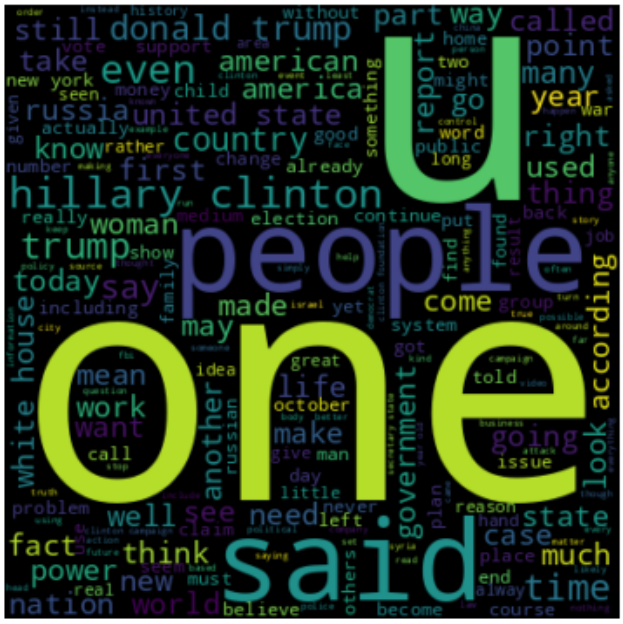
```
lemmatizer = WordNetLemmatizer()
stop_words = set(stopwords.words('english'))

def clean_text(text):
    text = re.sub("[^a-zA-Z]", " ", text)
    text = text.lower()
    words = text.split()
    words = [lemmatizer.lemmatize(word) for word in words if word not in stop_words]
    return " ".join(words)

news['clean_content'] = news['content'].apply(clean_text)
```

5. Exploratory Data Analysis and Visualization

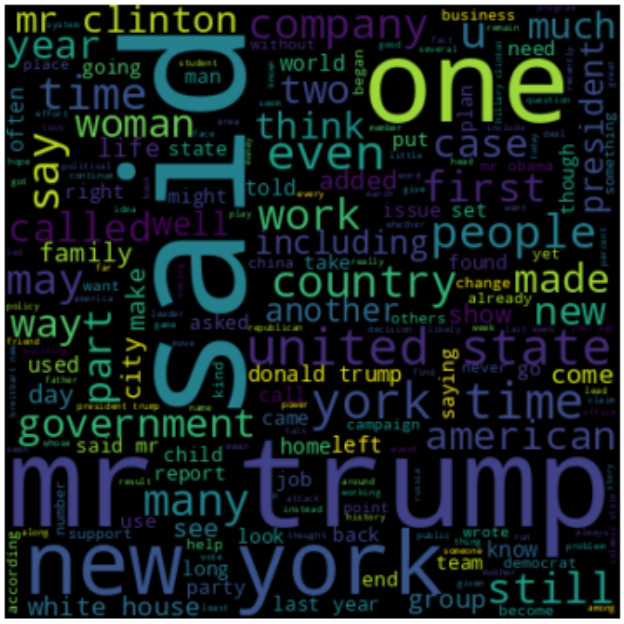
In [10]:

```
# WordCloud for Fake News
fake_text = " ".join(news[news.label == 1]['clean_content'])
real_text = " ".join(news[news.label == 0]['clean_content'])

plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.title("Fake News WordCloud")
plt.imshow(WordCloud(width=400, height=400).generate(fake_text), interpolation='bilinear
plt.axis('off')

plt.subplot(1, 2, 2)
plt.title("Real News WordCloud")
plt.imshow(WordCloud(width=400, height=400).generate(real_text), interpolation='bilinear
plt.axis('off')
plt.show()
```

Fake News WordCloud

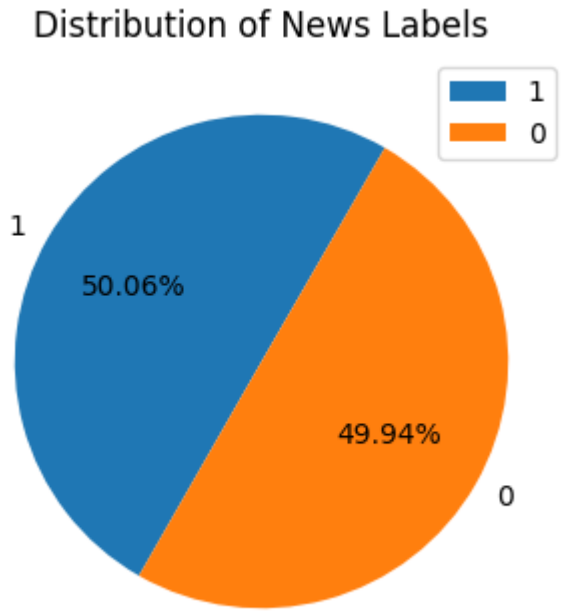


Real News WordCloud



In [11]:

```
plt.figure(figsize=(5,4))
# Get the counts and labels for the pie chart from the 'label' column
x = news["label"].value_counts().index
y = news["label"].value_counts().values

plt.pie(y, labels=x, startangle= 60, autopct="%.2f%%")
plt.title("Distribution of News Labels")
plt.legend()
plt.show()
```



6. Vectorization

In [12]:

```
vectorizer = TfidfVectorizer(ngram_range=(1,2), max_features=10000)
X = vectorizer.fit_transform(news['clean_content'])
y = news['label'].values
```

In [14]:

```
print(X)
```

```
<Compressed Sparse Row sparse matrix of dtype 'float64'
        with 5032607 stored elements and shape (20800, 10000)>
  Coords        Values
  (0, 4062)     0.10313223127038086
  (0, 2229)     0.10935409884808008
  (0, 219)      0.1465790142278064
  (0, 2944)     0.05773061489151638
  (0, 7874)     0.0541985250661462
  (0, 1613)     0.29185933018099625
  (0, 4914)     0.18237880419372737
  (0, 4537)     0.1774198984064235
  (0, 1326)     0.6286822183971587
  (0, 9276)     0.08987516335939048
  (0, 6018)     0.036833253469158424
  (0, 8570)     0.03173981746905379
```

```
  (0, 326)      0.012454910995468214
  (0, 9461)     0.06906681338971514
  (0, 4169)     0.021339500686604104
  (0, 1947)     0.06665544057984846
  (0, 5395)     0.020391821441831097
  (0, 656)      0.022292338555497643
  (0, 1976)     0.02946698933271671
  (0, 1642)     0.021153326753710035
  (0, 4938)     0.029204509137520072
  (0, 433)      0.03332772028992423
  (0, 4670)     0.036069000667432564
  (0, 2534)     0.023234215373968505
  (0, 9864)     0.10001906510502977
  :     :
  (20799, 5909) 0.032272100507103066
  (20799, 6240) 0.03366271697857511
  (20799, 5904) 0.04050905593872956
  (20799, 3644) 0.03742562233812279
  (20799, 4442) 0.040911604327040225
  (20799, 1868) 0.15276451783702777
  (20799, 6527) 0.036290720262742
  (20799, 1150) 0.11403867684755292
  (20799, 7076) 0.07509397824675347
  (20799, 5503) 0.03692487940713754
  (20799, 9878) 0.03890779008150203
  (20799, 6646) 0.03801289228251764
  (20799, 1089) 0.03703699192268113
  (20799, 252)  0.11044411660195662
  (20799, 5392) 0.07377588540651463
  (20799, 4194) 0.03615797455350344
  (20799, 9085) 0.0382364788576427
  (20799, 7412) 0.03711284476586004
  (20799, 5133) 0.03851557005268347
  (20799, 2562) 0.039545478200551896
  (20799, 3416) 0.03819112945925694
  (20799, 6535) 0.03801289228251764
  (20799, 1201) 0.08088873891700935
  (20799, 4441) 0.03788241201812979
  (20799, 1478) 0.042128924914502465
```

7. Train-Test Split

In [15]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, stratify=y, ran
```

8. Model Training and Hyperparameter Tuning

Logistic Regression with Grid Search

In [16]:

```
lr = LogisticRegression(max_iter=1000)
param_grid = {'C': [0.1, 1, 10]}
grid_lr = GridSearchCV(lr, param_grid, cv=3, scoring='accuracy')
grid_lr.fit(X_train, y_train)
print("Best Logistic Regression Params:", grid_lr.best_params_)
```

```
Best Logistic Regression Params: {'C': 10}
```

Random Forest

In [17]:

```
rf = RandomForestClassifier(n_estimators=100, random_state=42)
rf.fit(X_train, y_train)
```

Out[17]:

```
RandomForestClassifier(random_state=42)
```

9. Evaluation

In [18]:

```
# Logistic Regression
y_pred_lr = grid_lr.predict(X_test)
print("Logistic Regression Accuracy:", accuracy_score(y_test, y_pred_lr))
print(classification_report(y_test, y_pred_lr))
```

```
Logistic Regression Accuracy: 0.9673076923076923
              precision    recall  f1-score   support

           0       0.97      0.96      0.97      2077
           1       0.96      0.97      0.97      2083

    accuracy                           0.97      4160
   macro avg       0.97      0.97      0.97      4160
weighted avg       0.97      0.97      0.97      4160
```

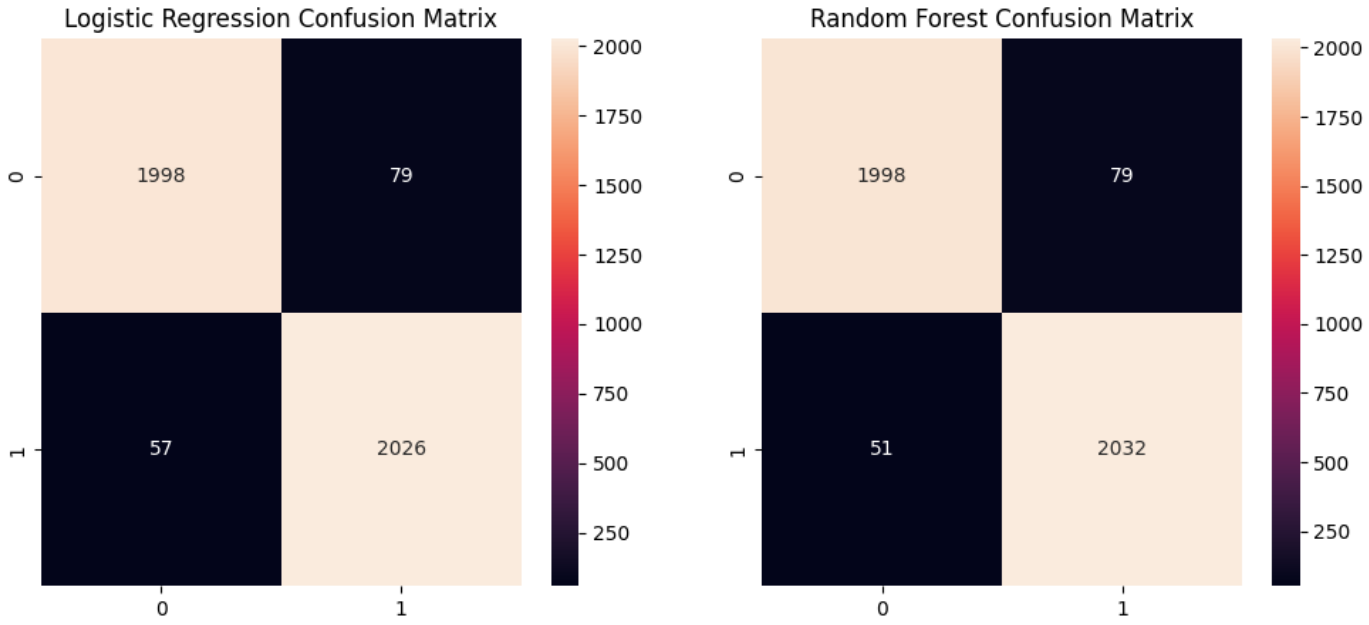
In [19]:

```
# Random Forest
y_pred_rf = rf.predict(X_test)
print("Random Forest Accuracy:", accuracy_score(y_test, y_pred_rf))
print(classification_report(y_test, y_pred_rf))
```

```
Random Forest Accuracy: 0.96875
              precision    recall  f1-score   support

           0       0.98      0.96      0.97      2077
           1       0.96      0.98      0.97      2083

    accuracy                           0.97      4160
   macro avg       0.97      0.97      0.97      4160
weighted avg       0.97      0.97      0.97      4160
```

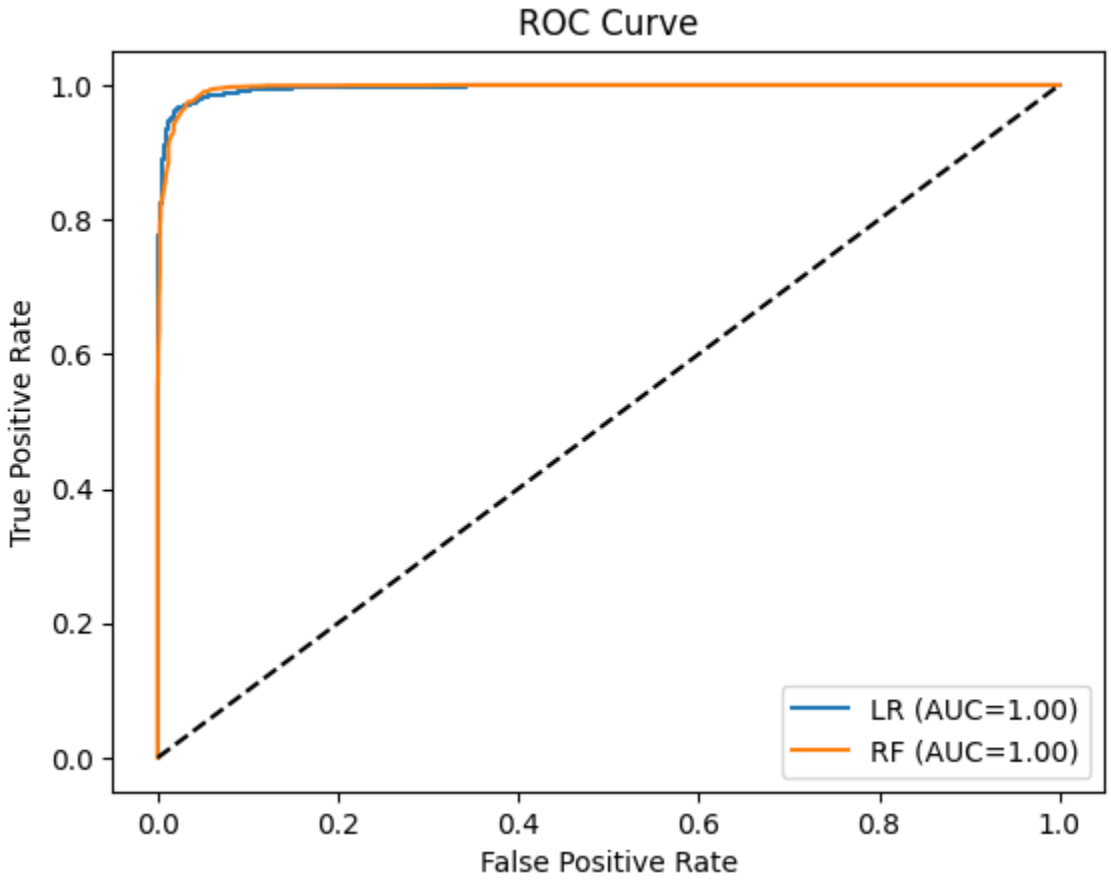
In [20]:

```
# Confusion Matrix
plt.figure(figsize=(12,5))
plt.subplot(1,2,1)
sns.heatmap(confusion_matrix(y_test, y_pred_lr), annot=True, fmt='d')
plt.title('Logistic Regression Confusion Matrix')

plt.subplot(1,2,2)
sns.heatmap(confusion_matrix(y_test, y_pred_rf), annot=True, fmt='d')
plt.title('Random Forest Confusion Matrix')
plt.show()
```



In [21]:

```
# ROC Curve
fpr_lr, tpr_lr, _ = roc_curve(y_test, grid_lr.predict_proba(X_test)[:,1])
fpr_rf, tpr_rf, _ = roc_curve(y_test, rf.predict_proba(X_test)[:,1])
plt.plot(fpr_lr, tpr_lr, label=f'LR (AUC={auc(fpr_lr, tpr_lr):.2f})')
plt.plot(fpr_rf, tpr_rf, label=f'RF (AUC={auc(fpr_rf, tpr_rf):.2f})')
plt.plot([0,1],[0,1],'k--')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('ROC Curve')
plt.legend()
plt.show()
```



10. Interactive Prediction Function

In [24]:

```
def predict_news(text):
    clean = clean_text(text)
    vect = vectorizer.transform([clean])
    pred = rf.predict(vect)[0]
    prob = rf.predict_proba(vect)[0][pred]
    return f"Prediction: {'Fake' if pred==1 else 'Real'} (Confidence: {prob:.2f})"

# Example
print(predict_news("Donald Trump wins the 2020 election in a landslide"))
```

```
Prediction: Fake (Confidence: 1.00)
```