In [137]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import nltk
import re
import random
import csv
import gensim
from wordcloud import WordCloud #To display text data
```

In [138]:
```
from tensorflow.keras.preprocessing.text import Tokenizer #To tokenise our
from tensorflow.keras.preprocessing.sequence import pad_sequences #To pad t
from tensorflow.keras.models import Sequential #model used
from tensorflow.keras.layers import Dense, Embedding, LSTM, Conv1D, MaxPool
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, accuracy_score
```

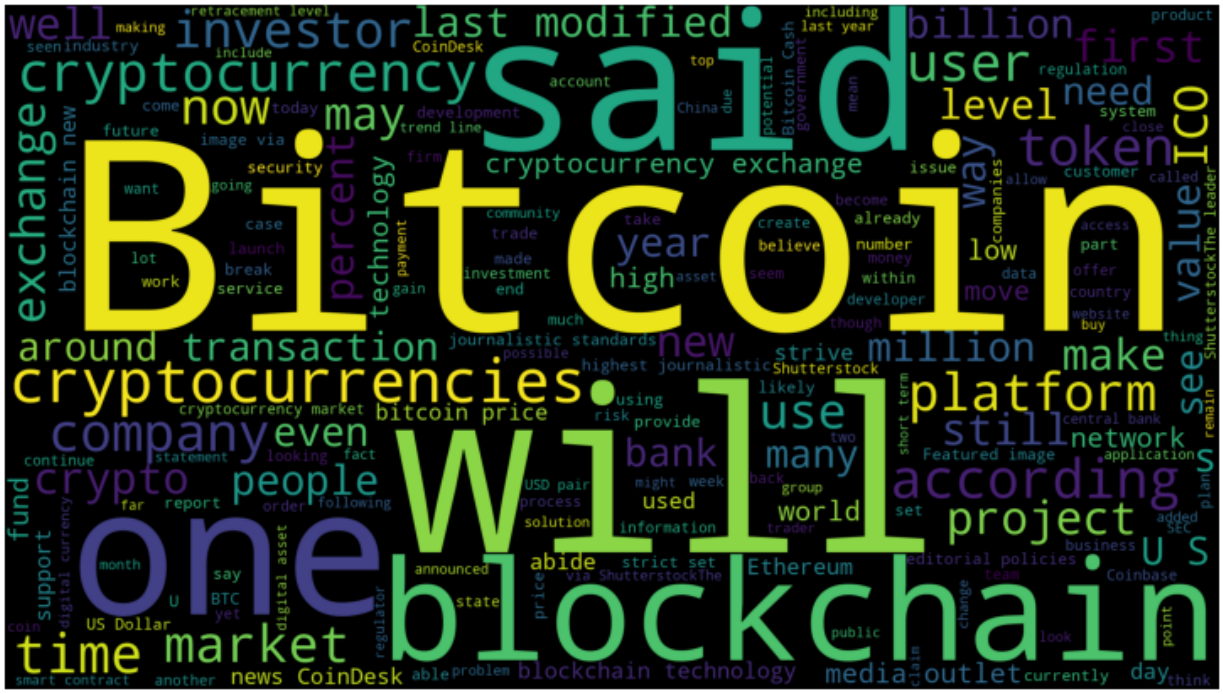
In [139]:
```
real_news = pd.read_csv("crypto_news_parsed_2018_validation.csv")
```

In [140]:
```
real_news.head()
```

Out[140]:

	url	title	text	html	year	author	s
0	https://www.ccn.com/paris-hiltons-hotel-mogul-...	Paris Hilton's Hotel Mogul Father to Sell $38 ...	A group of journalists who left The Denver Pos...	<p>A group of journalists who left The Denver ...	2018	Lester Coleman	accepts_l
1	https://www.ccn.com/playboy-sues-cryptocurrenc...	Playboy Sues Cryptocurrency Company for Breach...	Playboy Enterprises, the parent company of Pla...	<p>Playboy Enterprises, the parent company of ...	2018	Jimmy Aki	accepts_l
2	https://www.ccn.com/microsoft-reboots-bitcoin-...	Microsoft Restores Bitcoin Payments after Temp...	Hardware and software giant Microsoft reported...	<p>Hardware and software giant Microsoft repor...	2018	Francisco Memoria	accepts_l
3	https://www.ccn.com/japans-gmo-launches-app-to...	Japan's GMO Launches App to Reward Gamers in B...	GMO Internet, a leading Japanese Internet serv...	<p>GMO Internet, a leading Japanese Internet s...	2018	Lester Coleman	accepts_l
4	https://www.ccn.com/japanese-building-in-tokyo...	547 Bitcoins: $6 Million Commercial Japanese B...	A Tokyo-based real estate firm is selling a sm...	<p>A Tokyo-bas...	2018	Joseph Young	accepts_l

In [5]:
```
#wordcloud
text = '. '.join(real_news['text'].tolist())
wordcloud = WordCloud(width=1920,height=1080).generate(text)
fig = plt.figure(figsize=(10,10))
plt.imshow(wordcloud)
plt.axis('off')
plt.tight_layout(pad=0)
plt.show()
```



In [141]:
```
#Exploring fake news

fake_news = pd.read_csv("fake.csv")
```

In [142]:
```
fake_news.head()
```

Out[142]:

	title	text	year	author	source
0	Believe Based Apps ICO Alphabet, Money Price C...	Malta: Earning the Nickname Blockchain IslandB...	2018	Joseph Young	altcoin_analysis
1	30% for to Plunge? Coinbase Crypto Slides Camp...	The cryptocurrency payments platform wrote:"To...	2018	Josiah Wilmoth	bitcoin_&_blockchain_investments
2	Kraken Signs Kidnap Sighting Saving Finally Bi...	In a recent interview with the New York Times,...	2018	Brady Dale	feature
3	XRP Asia Spending Crypto Second Almost Concern...	About d10ed10e conferences have been at the he...	2018	Annaliese Milano	feature
4	Share of Invests 'Game-Changer' Inquest Could ...	Asian Investment Interest Has Risen, But Is It...	2018	Conor Maloney	ethereum_news

In [8]:
```
#wordcloud
f_text = '. '.join(fake_news['text'].tolist())
wordcloud = WordCloud(width=1920,height=1080).generate(f_text)
fig = plt.figure(figsize=(10,10))
plt.imshow(wordcloud)
plt.axis('off')
plt.tight_layout(pad=0)
plt.show()
```

In [143]:
```
real_news['author'].value_counts()
```

Out[143]:
```
Josiah Wilmoth     842
 Aayush Jindal     771
Wolfie Zhao        538
Nikhilesh De       513
Samburaj Das       463
                  ...
Magda Borowik        1
 SimpleFX            1
Hector Sanchez       1
Stuart Oden          1
Jason Calacanis      1
Name: author, Length: 290, dtype: int64
```

In [144]:
```
real_news['text'] = real_news['title'] + real_news['text']
fake_news['text'] = fake_news['title'] + fake_news['text']
```

In [145]:
```
real_news['text'] = real_news['text'].apply(lambda x: str(x).lower())
fake_news['text'] = fake_news['text'].apply(lambda x: str(x).lower())
```

In [146]:
```
real_news['class'] = 1
fake_news['class'] = 0
```

In [147]:
```
real_news.columns
```

Out[147]:
```
Index(['url', 'title', 'text', 'html', 'year', 'author', 'source', 'clas
s'], dtype='object')
```

In [148]:
```
real_news = real_news[['text','class']]
fake_news = fake_news[['text','class']]
```

In [149]:
```
fake_news.head()
```

Out[149]:

	text	class
0	believe based apps ico alphabet, money price c...	0
1	30% for to plunge? coinbase crypto slides camp...	0
2	kraken signs kidnap sighting saving finally bi...	0
3	xrp asia spending crypto second almost concern...	0
4	share of invests 'game-changer' inquest could ...	0

In [150]:
```
data = real_news.append(fake_news)
```

In [151]:
```
data.sample(5)
```

Out[151]:

	text	class
2713	partnership free in the it’s leader degree sup...	0
10813	trade.io appoints banking veteran david hannig...	1
1670	permits road losses largest bitcoins money tec...	0
260	ledger’s by hedge cash, it altcoin bitcoin bab...	0
8083	bitcoin and by trading crypto warns government...	0

In [152]:
```
len(data)
```

Out[152]: 22239

In [153]:
```
clean_text = []
for text_data in data['text']:
    text_data = text_data.split(' ')
    clean_data = []
    for e in text_data:
        new_data = ''.join(filter(str.isalnum,e))
        if(len(new_data)>0):
            clean_data.append(new_data)
    cleaned = ' '.join(clean_data)
    clean_text.append(cleaned)

data['text'] = clean_text
```

In [154]:
```
y = data['class'].values
```

In [155]:
```
X = [d.split() for d in data['text'].tolist()]
```

In [156]:
```
DIM = 100
word2vec_model = gensim.models.Word2Vec(sentences=X, vector_size=DIM, windo
```

In [157]:
```
vocab_len = len(word2vec_model.wv)
print(vocab_len)
```

```
123471
```

In [158]:
```
word2vec_model.wv.most_similar('bitcoin')
```

Out[158]:
```
[('bitcoins', 0.7181262373924255),
 ('btc', 0.6378958821296692),
 ('bch', 0.5777492523193359),
 ('cryptocurrency', 0.5255966782569885),
 ('cryptocurrencys', 0.5072703957557678),
 ('cryptos', 0.5005436539649963),
 ('cryptocurrencies', 0.4994756877422333),
 ('litecoin', 0.47654685378074646),
 ('remainsi', 0.46583661437034607),
 ('ver', 0.4636707007884979)]
```

In [159]:
```
word2vec_model.wv['bitcoin']
```

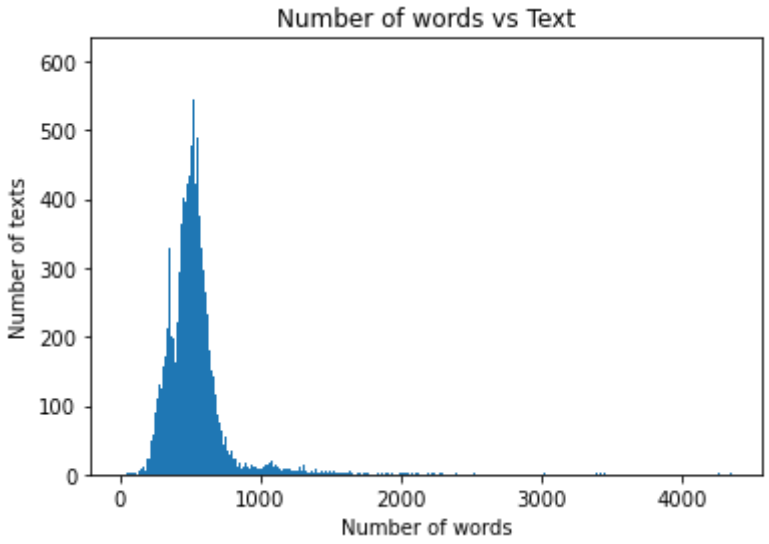
Out[159]:
```
array([ 1.4750859e+00,  4.3024826e-01, -1.7569463e+00, -2.6833508e+00,
       -4.5802996e-01,  5.9939446e+00,  1.6945757e+00,  3.4378166e+00,
        2.2626579e+00, -1.1631943e+00,  5.6164736e-01,  1.3279247e-01,
        3.8358176e-01, -1.1416993e+00, -3.1879845e-01,  4.8275054e-01,
        2.3883412e+00, -6.8378709e-03,  1.1336052e+00, -5.2382439e-02,
        2.0976539e+00,  7.5186996e+00,  1.6113200e+00, -2.1545997e+00,
       -1.2450478e+00, -1.9443818e+00,  2.5334637e+00, -1.3840858e+00,
        7.8657258e-01, -1.4796703e+00, -3.4670908e+00,  1.8587401e+00,
       -1.9772844e+00,  5.0896323e-01, -1.0769212e+00, -5.9973246e-01,
        1.5779426e+00,  2.1062930e+00,  1.2832193e+00,  5.0101676e+00,
       -2.4148889e+00,  4.2445688e+00, -1.0398250e+00,  3.2920995e+00,
        3.6297524e+00,  1.2725470e+00,  5.5561587e-02,  6.0787868e-01,
       -2.5089225e-01, -4.7837403e-01,  6.7407988e-02,  1.9527367e+00,
       -6.7292017e-01, -4.7879446e-01, -1.8547714e+00, -1.2549968e+00,
        3.1502538e+00, -5.5261081e-01,  1.0357540e+00,  1.9815904e+00,
       -3.8363888e+00, -6.8747163e-01,  1.4896411e-01,  2.4008908e+00,
       -2.1312118e+00,  1.1085775e+00, -1.0961291e-01, -1.7141449e+00,
       -2.6227343e+00, -1.7084427e+00,  2.3303740e-01, -4.4606023e+00,
       -2.8126218e+00, -9.5259893e-01, -3.9495194e+00, -3.8331249e+00,
       -4.5225823e-01, -1.7856332e+00,  1.3756504e+00,  1.2233310e+00,
        2.1346333e+00,  2.2090507e+00,  1.5919160e+00, -1.5074615e+00,
        8.1831384e-01,  9.1090536e-01,  3.0434294e+00, -5.9613025e-01,
       -3.5014808e+00, -3.8751273e+00, -8.7283844e-01,  3.6689603e+00,
        2.7218270e+00, -2.5567980e+00,  2.4439297e+00, -2.6955111e+00,
        2.2875633e+00,  1.7073992e+00, -1.2610964e+00,  5.3807622e-04],
      dtype=float32)
```

In [160]:
```
#Now either we can directly use these vectors or the other one is we feed t
```

In [161]:
```
tokenizer = Tokenizer()
tokenizer.fit_on_texts(X)
```

In [162]:
```
X = tokenizer.texts_to_sequences(X) #tokenizing words, basically creating i
```

In [164]:
```
plt_size = [len(x) for x in X]
plt.hist(plt_size, bins = 700)
plt.xlabel('Number of words')
plt.ylabel('Number of texts')
plt.title('Number of words vs Text')
plt.show()
```



In [94]:
```
#now let us truncate those news with more than 1000 words

nos = np.array(plt_size)
len(nos[nos>1000])
```

Out[94]: 724

In [95]:
```
max_len = 1000
X = pad_sequences(X,maxlen = max_len)
```

In [113]:
```
vocab = tokenizer.word_index
new_vocab_size = len(vocab) + 1 #for unknown values
print(vocab)
```

```
{'the': 1, 'to': 2, 'of': 3, 'a': 4, 'and': 5, 'in': 6, 'is': 7, 'that':
8, 'for': 9, 'on': 10, 'as': 11, 'with': 12, 'it': 13, 'by': 14, 'bitcoi
n': 15, 'be': 16, 'has': 17, 'are': 18, 'at': 19, 'from': 20, 'this': 21,
'will': 22, 'its': 23, 'blockchain': 24, 'cryptocurrency': 25, 'an': 26,
'was': 27, 'have': 28, 'price': 29, 'not': 30, 'which': 31, 'their': 32,
'market': 33, 'more': 34, 'or': 35, 'crypto': 36, 'we': 37, 'but': 38, 'c
an': 39, 'said': 40, 'also': 41, 'new': 42, 'trading': 43, 'last': 44, 't
hey': 45, 'been': 46, 'cryptocurrencies': 47, 'he': 48, 'exchange': 49,
'one': 50, 'all': 51, 'other': 52, 'there': 53, 'could': 54, 'would': 55,
'if': 56, 'over': 57, 'level': 58, 'support': 59, 'time': 60, 'about': 6
1, 'ethereum': 62, '2018': 63, 'technology': 64, 'up': 65, 'may': 66, 'ab
ove': 67, 'investors': 68, 'platform': 69, 'out': 70, 'company': 71, 'tha
n': 72, 'digital': 73, 'financial': 74, 'users': 75, 'into': 76, 'first':
77, 'now': 78, 'you': 79, 'some': 80, 'such': 81, 'million': 82, 'were':
83, 'percent': 84, 'according': 85, 'who': 86, 'these': 87, 'so': 88, 'li
ke': 89, 'tokens': 90, 'us': 91, 'token': 92, 'our': 93, 'while': 94, 'af
ter': 95, 'exchanges': 96, 'data': 97, 'bank': 98, 'most': 99, 'image': 1
00, 'news': 101, 'when': 102, 'any': 103, 'only': 104, 'below': 105, 'wha
t': 106, 'use': 107, 'high': 108, 'had': 109, 'resistance': 110, 'year':
```

In [116]:
```
def get_weight_matrix(model):
    weight_matrix = np.zeros((new_vocab_size, DIM))

    for word, i in vocab.items():
        weight_matrix[i] = model.wv[word]

    return weight_matrix
```

In [117]:
```
embedding_vectors = get_weight_matrix(word2vec_model)
```

In [120]:
```
embedding_vectors.shape
```

Out[120]:
```
(123472, 100)
```

In [123]:
```
model = Sequential()
model.add(Embedding(new_vocab_size,output_dim=DIM,weights=[embedding_vector
model.add(LSTM(units=128))
model.add(Dense(1,activation='sigmoid'))
model.compile(optimizer='adam',loss='binary_crossentropy',metrics =['acc'])
```

In [124]:
```
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_1 (Embedding)      (None, 1000, 100)         12347200
_________________________________________________________________
lstm_1 (LSTM)                (None, 128)               117248
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 129
=================================================================
Total params: 12,464,577
Trainable params: 117,377
Non-trainable params: 12,347,200
_________________________________________________________________
```

In [125]:
```
X_train, X_test, y_train, y_test = train_test_split(X,y)
```

In [126]:
```
model.fit(X_train, y_train, validation_split=0.3, epochs = 6)
```

```
Epoch 1/6
365/365 [==============================] - 157s 427ms/step - loss: 0.3624
- acc: 0.8669 - val_loss: 0.3057 - val_acc: 0.8967
Epoch 2/6
365/365 [==============================] - 170s 466ms/step - loss: 0.2715
- acc: 0.9007 - val_loss: 0.2721 - val_acc: 0.9257
Epoch 3/6
365/365 [==============================] - 188s 516ms/step - loss: 0.1627
- acc: 0.9456 - val_loss: 0.1211 - val_acc: 0.9580
Epoch 4/6
365/365 [==============================] - 210s 576ms/step - loss: 0.0690
- acc: 0.9756 - val_loss: 0.0889 - val_acc: 0.9718
Epoch 5/6
365/365 [==============================] - 213s 583ms/step - loss: 0.0560
- acc: 0.9806 - val_loss: 0.0667 - val_acc: 0.9754
Epoch 6/6
365/365 [==============================] - 218s 598ms/step - loss: 0.0499
- acc: 0.9838 - val_loss: 0.1220 - val_acc: 0.9586
```

Out[126]:
```
<tensorflow.python.keras.callbacks.History at 0x7fc01170a0d0>
```

In [128]:
```
y_pred = (model.predict(X_test) >= 0.5).astype(int)
```

In [129]:
```
accuracy_score(y_test,y_pred)
```

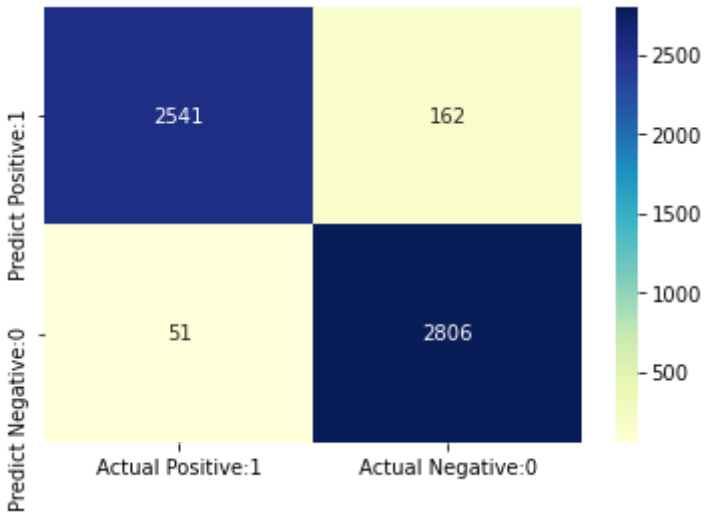
Out[129]:
```
0.9616906474820144
```

In [132]:
```
from sklearn.metrics import confusion_matrix

cm = confusion_matrix(y_test, y_pred)

print('Confusion matrix\n\n', cm)

print('\nTrue Positives(TP) = ', cm[0,0])

print('\nTrue Negatives(TN) = ', cm[1,1])

print('\nFalse Positives(FP) = ', cm[0,1])

print('\nFalse Negatives(FN) = ', cm[1,0])
```

```
Confusion matrix

 [[2541  162]
 [  51 2806]]

True Positives(TP) =  2541

True Negatives(TN) =  2806

False Positives(FP) =  162

False Negatives(FN) =  51
```

In [133]:
```
cm_matrix = pd.DataFrame(data=cm, columns=['Actual Positive:1', 'Actual Neg
                                           index=['Predict Positive:1', 'Predict Nega

sns.heatmap(cm_matrix, annot=True, fmt='d', cmap='YlGnBu')
```

Out[133]: <AxesSubplot:>



In [134]:
```
from sklearn.metrics import roc_auc_score

ROC_AUC = roc_auc_score(y_test, y_pred)

print('ROC AUC : {:.4f}'.format(ROC_AUC))
```

```
ROC AUC : 0.9611
```

In [130]:
```
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.98      0.94      0.96      2703
           1       0.95      0.98      0.96      2857

    accuracy                           0.96      5560
   macro avg       0.96      0.96      0.96      5560
weighted avg       0.96      0.96      0.96      5560
```