KYC_challenge

Jordi Clive, June 2018

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1 Revolut Challenge: Investigation into the Reduction of the 'Know Your Customer' Pass Rate

```
In [1]: import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        from datetime import datetime
        import ast
        plt.rcParams['figure.figsize'] = (30, 15)
        plt.rcParams['font.family'] = 'sans-serif'
        plt.rcParams.update({'font.size': 22})
```

```
In [2]: df_docs = pd.read_csv("data/doc_reports.csv")
        df_face = pd.read_csv("data/facial_similarity_reports.csv")
```

1.1 Brief EDA and Merge

```
In [3]: df_docs['user_id'].equals(df_face['user_id'])  # 'user_id' is identical

Out[3]: True
```

```
In [4]: # False for 'attempt_id'why?
        df_docs['attempt_id'].equals(df_face['attempt_id'])

Out[4]: False
```

```
In [5]: doc_id = df_docs['attempt_id']
        f_id = df_face['attempt_id']
        for i in range(len(df_docs)):
            if doc_id[i] != f_id[i]:
                print('index: {}, doc_id: {}, face_id: {}'.format(
                    i, doc_id[i], f_id[i]))
        # one value, float formatting aberrant, safe to merge
```

```
index: 168513, doc_id: 9.6949E+31, face_id: 96948966045741509980950989095520
```

```
In [6]: # Merge
        df = df_face.merge(df_docs, on=df_face.index,)
        df = df.drop(['key_0'], 1)
```

```
In [7]: # Remove other columns that are duplicated in both files, and rename columns of new df
        duplicated = set()
        for column in df.columns:
            if "_x" in column or "_y" in column:
                name = column.replace("_x", "")
                name = name.replace("_y", "")
                duplicated.add(name)


        def compare_columns(column, df):
            return df[column + "_x"].equals(df[column + "_y"])


        for name in duplicated:
            face_col = name + "_x"
            docs_col = name + "_y"
            if compare_columns(name, df):
                # then remove repeated columns and rename them
                df.rename({face_col: name}, axis=1, inplace=True)
                df.drop(docs_col, inplace=True, axis=1)
            else:
                df.rename({face_col: "FACE_" + name, docs_col: "DOCS_" +
                           name}, axis=1, inplace=True)
        # only 'unnamed' duplicated, I suspect the original index from a larger data set
        # as index extends to 181991 rather than the 176403 attempts
```

Time Formatting and Sort

```
In [8]: # change format of dates so parsable with pandas
        df["FACE_created_at"] = pd.to_datetime(df["FACE_created_at"])
        df["DOCS_created_at"] = pd.to_datetime(df["DOCS_created_at"])
```

```
In [9]: # Investigate disparity of creation times of the Document and Facial Checks
        creation_time_diff = df["FACE_created_at"] - df["DOCS_created_at"]
        creation_time_diff = pd.Series([i.total_seconds() for i in creation_time_diff])
        creation_time_diff.value_counts()
```

```
Out[9]:  0.0    167121
         1.0      5775
        -1.0      3507
        -4.0         1
        dtype: int64
```

```
In [10]: # One anomaly.
         # For others I assume this time relates to API processing time and is a fraction of a
         #and where a second, just on the cusp of a new second, still same processing time.
         # Although, the Document check is created first, more often
```

```
In [11]: # Order the dataframe in terms of time
         df.sort_values(["FACE_created_at"], inplace=True)
         df.reset_index(drop=True,inplace=True)
```

Addition of 'Pass' Column

```
In [12]: # An Attempt is successful if the results of both the Document and Facial Similarity

         # True for Facial Similarity Check result of 'clear'
         face_result = df["FACE_result"] == "clear"
         # True for Document Check result of 'clear'
         docs_result = df["DOCS_result"] == "clear"

         df['Pass'] = face_result & docs_result
         # Pass column denotes if face_result and docs_result True => that attempt passsed KYC
         df.iloc[0, :]
```

```
Out[12]: Unnamed: 0                                                    492
         user_id                                       3aee7324dfba466d96888ff9ad185b5
         FACE_result                                                  clea
         face_comparison_result                                       clea
         FACE_created_at                                    2017-05-23 15:13:0
         facial_image_integrity_result                                clea
         visual_authenticity_result                                   clea
         FACE_properties                                       {'score': 0.7
         FACE_attempt_id                               d21de828c5514277aaedb316edc6c4
         DOCS_result                                                  clea
         image_integrity_result                                       clea
         face_detection_result                                        clea
         image_quality_result                                         clea
         DOCS_created_at                                    2017-05-23 15:13:0
         supported_document_result                                    clea
         conclusive_document_quality_result                             Na
         colour_picture_result                                          Na
         data_validation_result                                       clea
         data_consistency_result                                        Na
         data_comparison_result                                       clea
```

```
DOCS_attempt_id                                          d21de828c5514277aaedb316edc6c48
police_record_result                                                                 clea
compromised_document_result                                                           Na
DOCS_properties                        {'gender': 'Male', 'document_type': 'driving_l.
sub_result                                                                           clea
Pass                                                                                  Tru
Name: 0, dtype: object
```

1.2 Dealing with Multiple User Attempts

```
In [13]: # The pass rate is defined as the number of customers who pass both the KYC processes
         # divided by the number of customers who attempt the overall process.
         # Each customer has up to 2 attempts
         # Therefore to calculate an accurate pass rate, one has to take the best result of th
         # first two attempts
         only_one_attempt_users = df.drop_duplicates('user_id', False)
         only_one_attempt_users.shape  # majority of users only attempted once.
```

```
Out[13]: (110374, 26)
```

```
In [14]: user_attempt_counts = df['user_id'].value_counts()
         user_attempt_counts.head()  # some users had more than 2 attempts
         user_attempt_counts[user_attempt_counts > 2].head()  # only 1232
```

```
Out[14]: 6eeb7dbdf1fa4e7c95413bc0608dd21c    6
         2df96cd3537d415a9e7f23f419197187    6
         7b83073845604ea3acb150e421977537    5
         d3aa9ff3437a4ade990805eeb01bba2b    5
         79c7b0bab8d54d3cb9b2eaccef744c9d    5
         Name: user_id, dtype: int64
```

```
In [15]: # df of only multiple user attempts
         df_multiple_attempt = df[df.duplicated('user_id', keep=False)]

         df_ma_1st = df_multiple_attempt.drop_duplicates(
             'user_id', 'first')  # 1st attempt of these users
         df_ma_final = df_multiple_attempt.drop_duplicates(
             'user_id', 'last')  # Final attempt of these users

         # 5031 users passed their first attempt, but retried
         df_ma_passed1st = df_ma_1st[df_ma_1st["Pass"]]
```

```
In [16]: df_ma_failed_first = df_ma_1st[df_ma_1st['Pass'] == False]
         # df of multiple attempt users who failed 1st attempt
         df_2nd_attempt_only = df_multiple_attempt.groupby(
             ['user_id']).head(2).groupby(['user_id']).tail(1)
         # df of only the 2nd attempt of multiple attempt users
         df_1stattempts_only = df.drop_duplicates('user_id', 'first')
         # df of only the 1st attempts of all user
```

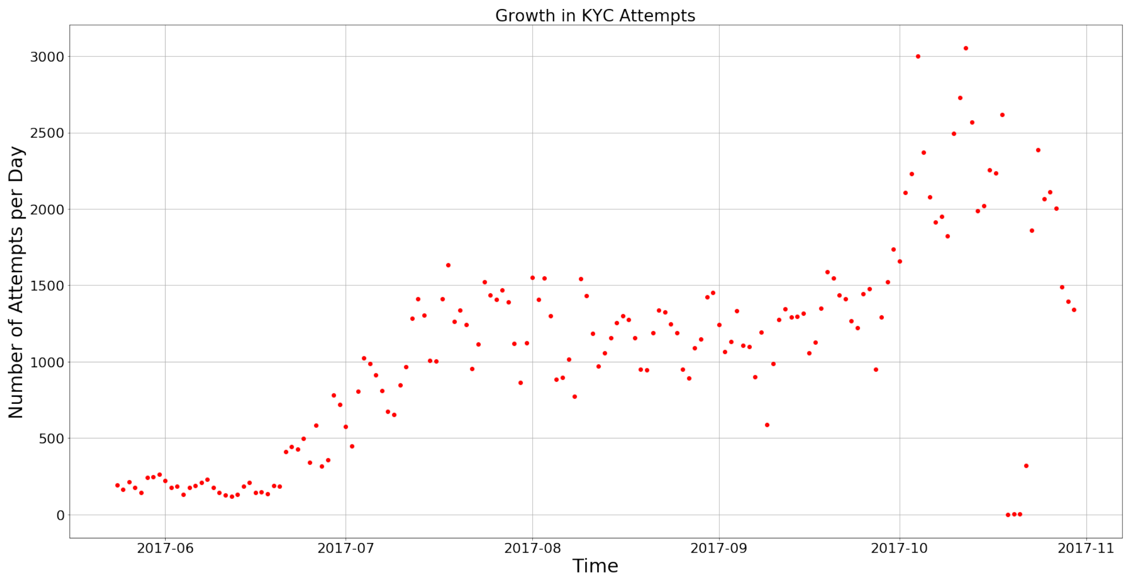
```
In [17]: s1 = pd.concat([df_ma_failed_first, df_2nd_attempt_only])
         s1 = s1.drop_duplicates('user_id', 'last')
         # keeping only 2nd attempt  of users, who had multiple attempts but failed the first
         s2 = pd.concat([df_1stattempts_only, s1])
         s2 = s2.drop_duplicates('user_id', 'last')
         # Reorganising so have only 2nd attempt of users who had multiple attempts but failed
         # and first attempt of all other users so an accurate pass rate can be caluclated
         df_pass_rate = s2.sort_values(["FACE_created_at"])
         df_pass_rate.reset_index(drop=True, inplace=True)
         #df_pass_rate
```

```
In [18]: len(df.drop_duplicates('user_id','first'))/len(df) #  80% of attempts are not repeat

         # Using 'df_pass_rate' cf. 'df' does not change trend outcomes so I am choosing to us
         #have more data points to analyse why the pass rate has decreased. I ran the notebook
         # and there were no changes to the conclusions.
```

```
Out[18]: 0.8090746241581823
```

2 Increase in Attempts Per Day

```
In [19]: # Create bins for each day which store the number of attempts that day
         plt.rcParams['figure.figsize'] = (30, 15)
         plt.rcParams['font.family'] = 'sans-serif'
         plt.rcParams.update({'font.size': 22})

         days_in_period = pd.date_range('2017-05-24', '2017-10-31', normalize=False)
         day_bins = []
         for k in range(len(days_in_period)-1):
             upper = df["DOCS_created_at"] < days_in_period[k+1]
             lower = df["DOCS_created_at"] > days_in_period[k]
             day_bins.append(len(df[upper & lower]))
         plt.grid(b=True)
         plt.plot(days_in_period[:-1], day_bins, 'ro')
         plt.ylabel("Number of Attempts per Day", fontsize=30)
         plt.xlabel("Time", fontsize=30)
         plt.title('Growth in KYC Attempts')
         plt.show()
```

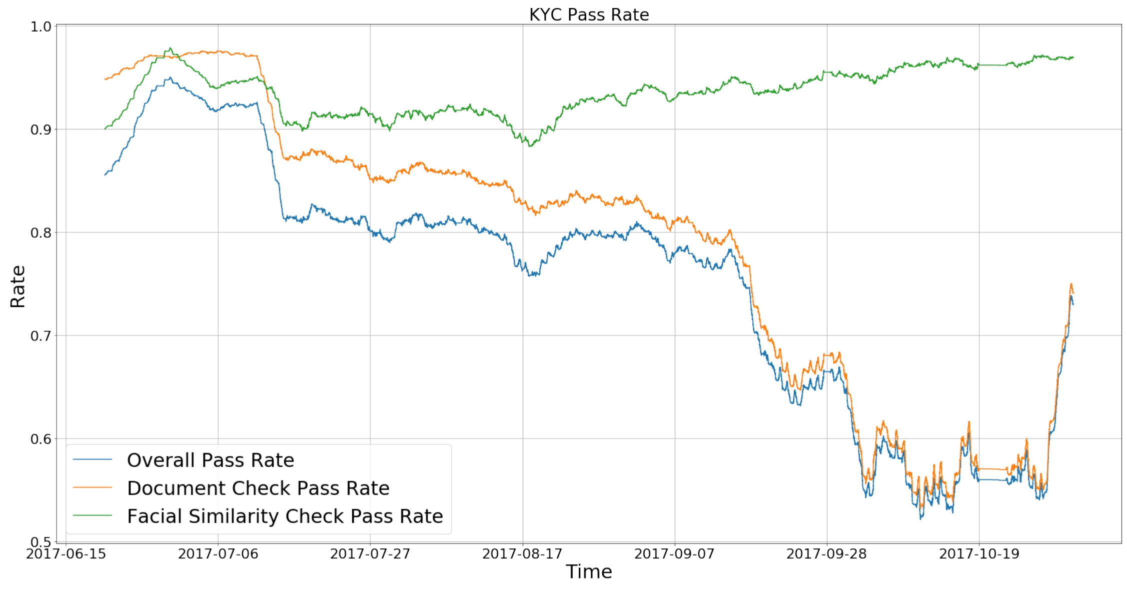


```
In [20]: # Increase in Number of Attempts per Day is a product of growth in users and exhibits
         # a positive relationship with the Document Failure Rate
```

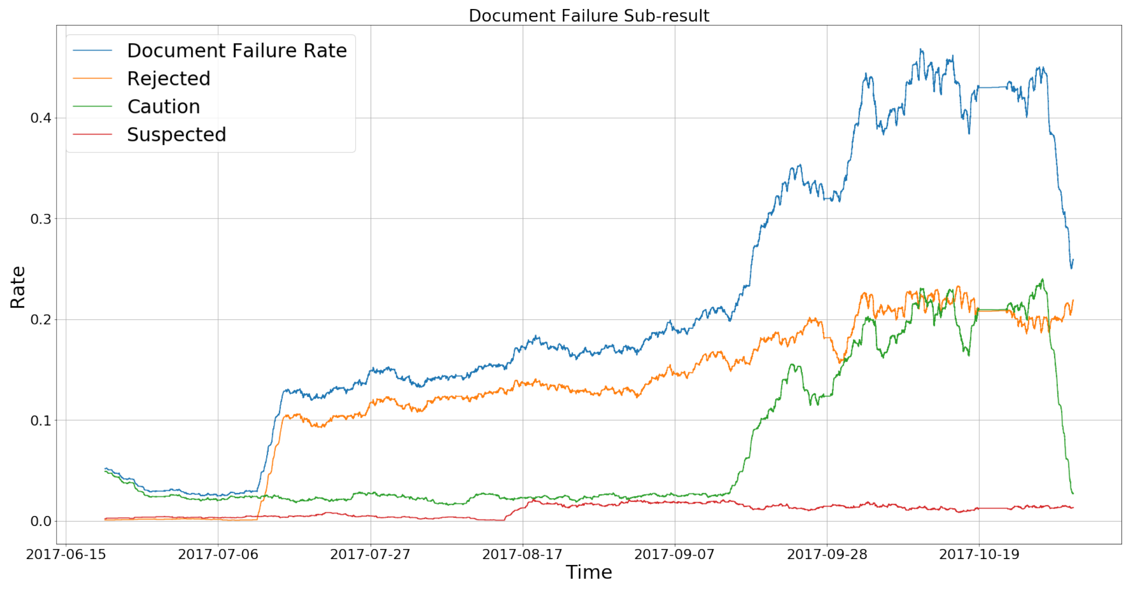
3 Diagnostics

```
In [21]: #Plot graphs of Overall Pass rate, Document check Pass rate, Facial Similarity check
         # Plot the sub result, along with document failure rate. The sub result is specific t
         # Document result providing further elucidation when it fails.

         def moving_average(x,N):
             cumsum = np.cumsum(np.insert(x, 0, 0))
             return (cumsum[N:] - cumsum[:-N]) / float(N)
         # efficient moving average algorithm


         def plot_ma(variables,labels,title='',start=0,N=5000):
             time =  list(df["FACE_created_at"])
             for i in range(len(variables)):
                 time =  list(df["FACE_created_at"])
                 y = list(variables[i].astype(int))
                 ma = moving_average(y,N)
                 start_index = len(time) - len(ma)
                 time = time[start_index:]
                 label = labels[i]
                 time = time[start:]
                 ma = ma[start:]
                 plt.plot(time,ma,label= label.format(i=i))
             plt.grid(b=True)
```

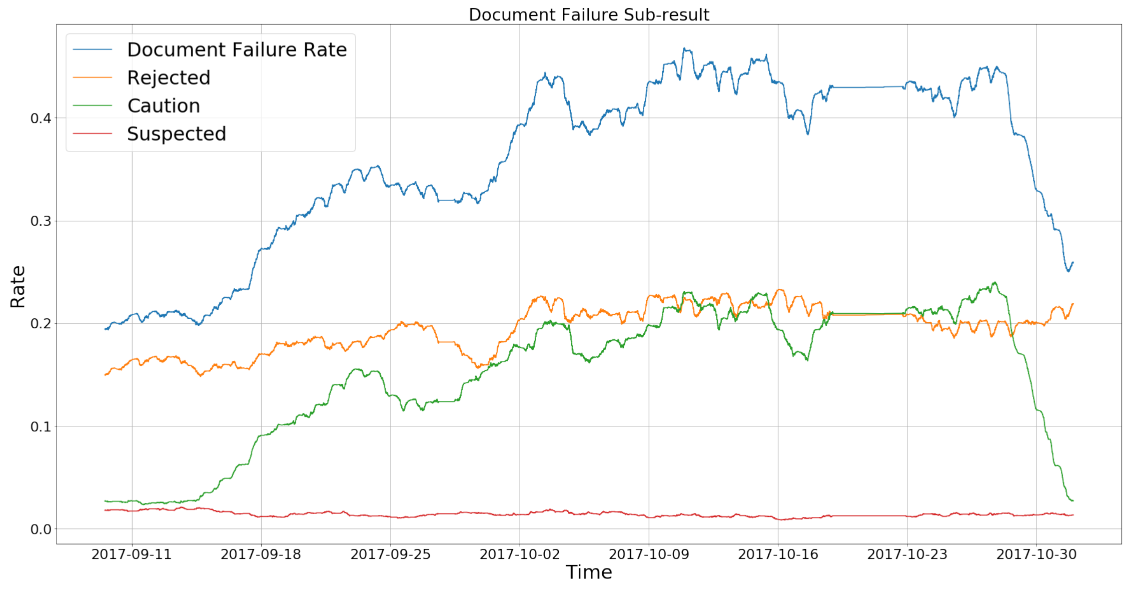
```
    plt.legend(loc='best',prop={'size': 30})
    plt.ylabel("Rate",fontsize=30)
    plt.xlabel("Time",fontsize=30)
    plt.title(title)
    plt.show()


plot_ma([df['Pass'],docs_result,face_result],['Overall Pass Rate','Document Check Pass

# fn to plot moving average of different rates,
# each plot is rate of last 5000 attempts

# Clearly the reason the pass rate has decreased substantially in the recent period
# is wholly due to the Document Check
```



```
In [22]: # Investigate the sub result when document check failure occurs. Plot against the doc
         #sub results are specified when failure of the document check occurs

         rejected = df['sub_result'] == 'rejected'
         caution = df['sub_result'] == "caution"
         suspected = df['sub_result'] == 'suspected'
         doc_failure = df["DOCS_result"] != "clear"

         plot_ma([doc_failure,rejected,caution,suspected],['Document Failure Rate','Rejected',
```



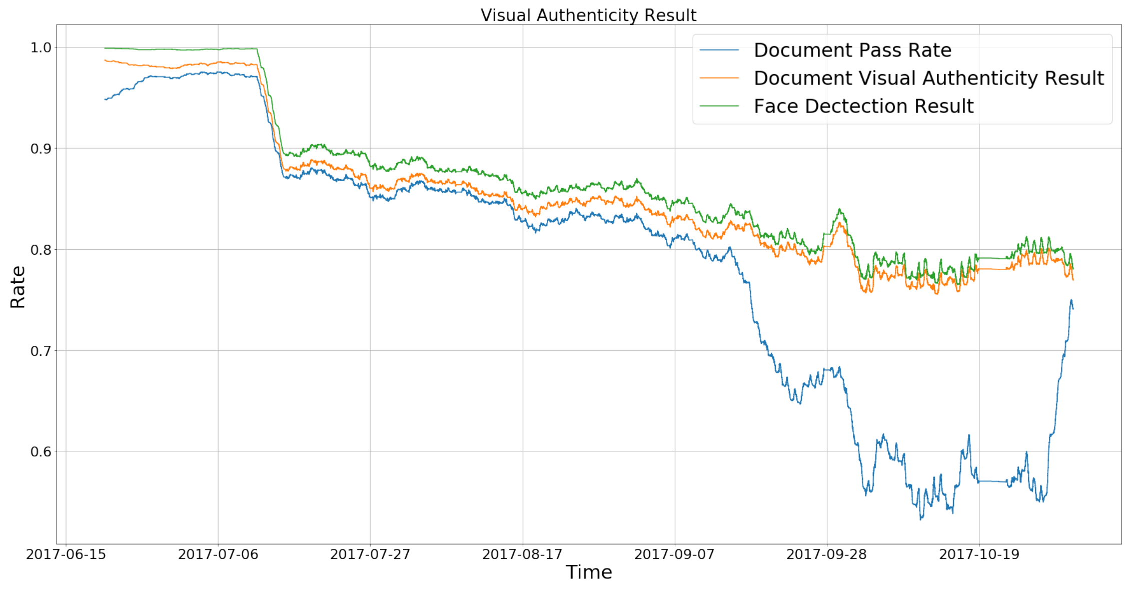
```
In [23]: # Closer Inspection
         plot_ma([doc_failure,rejected,caution,suspected],['Document Failure Rate','Rejected',
         # Shows the Document Failure rate was mostly driven by Rejected results until mid Sep
         #where failures due to 'Caution' results produce a large increase in the document fai
```



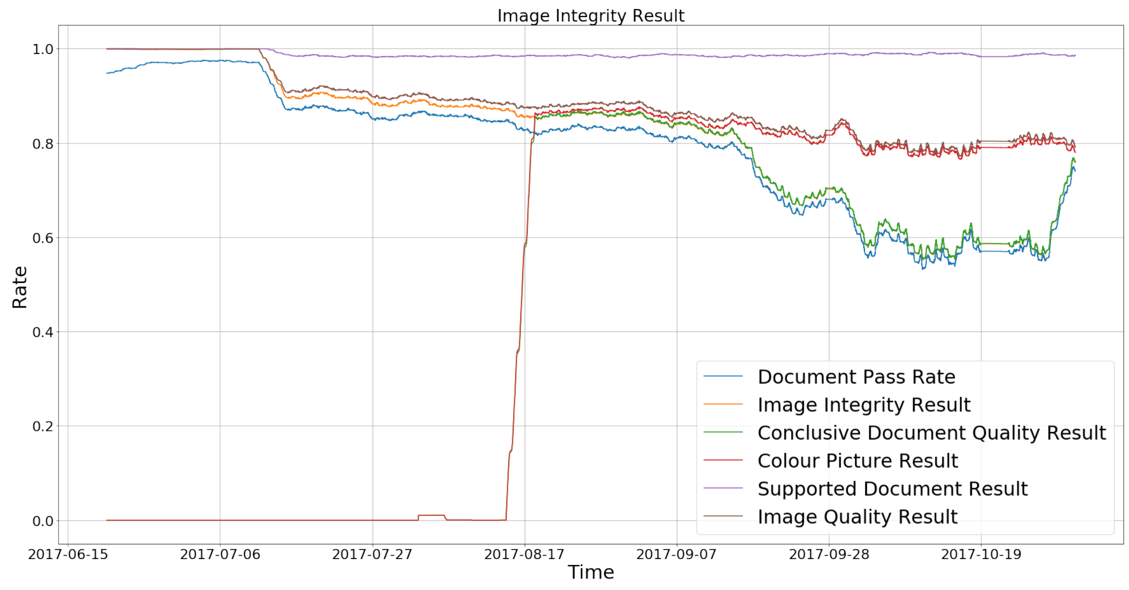
4 Document Report Breakdown

```
In [24]: #The document report comprises data integrity, visual authenticity
         #and police record checks. It checks the internal and external consistency of the mos
```

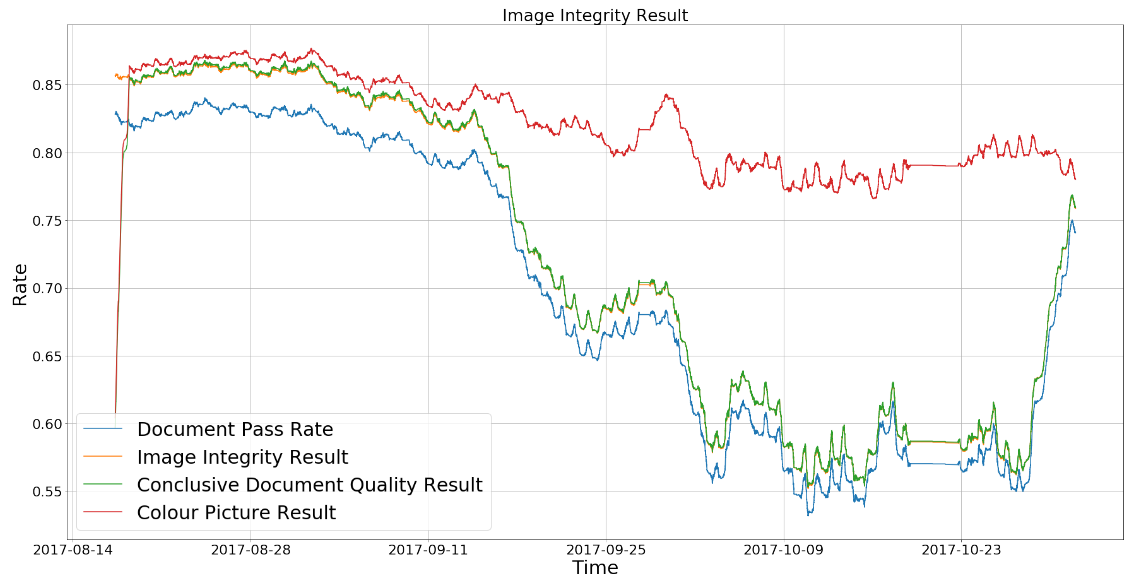
```
#recent identity document provided by the applicant to identify potential discrepanci

def plot_ma_breakdown(variables,labels,title='',start=0,N=5000):
    for result in range(len(variables)):
        variables[result] = df[variables[result]] == "clear"
    plot_ma(variables,labels,title,start,N)

# Visual Authenticity Result: face detection result is a component
plot_ma_breakdown(['DOCS_result','visual_authenticity_result','face_detection_result']
```



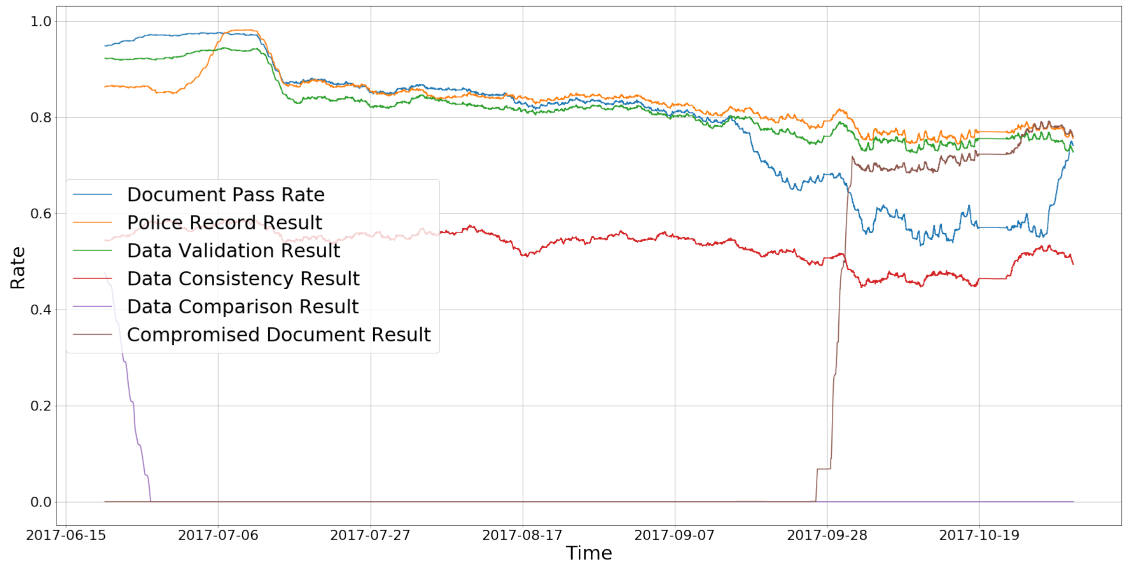
```
In [25]: # Look into Image Integrity Result: Supported Document, Image Quality, Colour Picture
         # and Conclusive Document Quality are components
         plot_ma_breakdown(['DOCS_result','image_integrity_result','conclusive_document_quality
```



```
In [26]: plot_ma_breakdown(['DOCS_result','image_integrity_result','conclusive_document_quality
```



```
In [27]: # Image Integrity 'Asserts whether the document was of sufficient quality to verify'
         # Specifically Conclusive Document Quality is directly correlated to the decrease in
         #Pass Rate, incidentally this drop coincides with the appearance of the Conclusive Do
         #and Colour Picture Results starting to register results in August.

In [28]: plot_ma_breakdown(['DOCS_result','police_record_result','data_validation_result','data
         # Other Document Report Breakdown results do not contribute significantly to failure
```



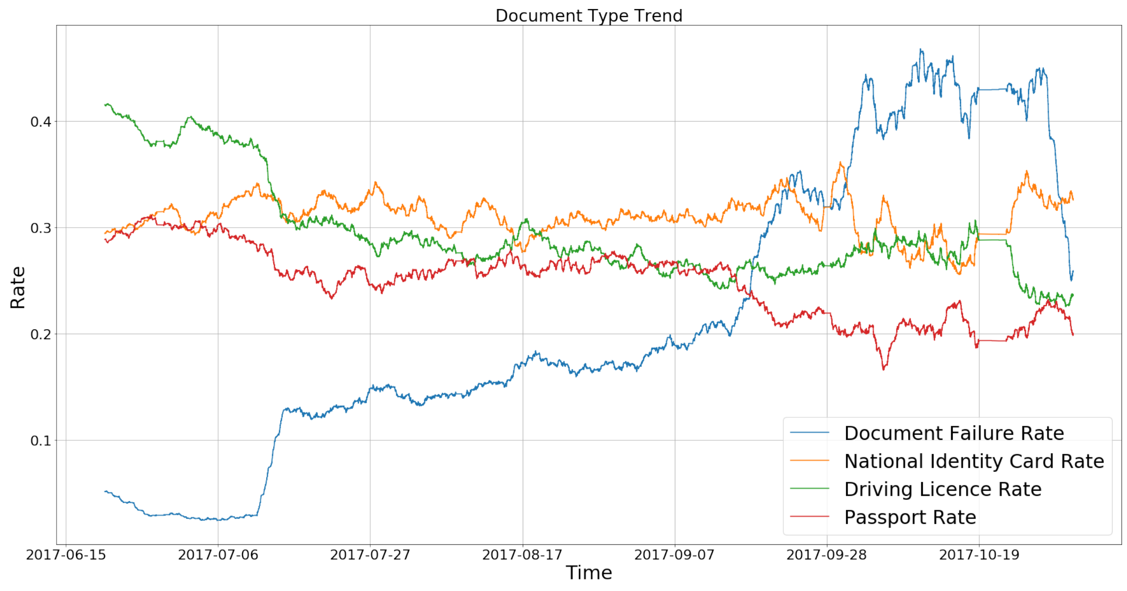
4.1 Analysis of the Document Report Field: 'Properties'

```
In [29]: # Convert to python Dictionary
         df['DOCS_properties'] = df['DOCS_properties'].apply(lambda element: ast.literal_eval(e

In [30]: def find_key_list():
             a = []
             for i in df['DOCS_properties']:
                 for j in i:
                     if j not in a:
                         a.append(j)
             return a
         key_list = find_key_list()
         # find list of fields in properties
         def split(index, variable):
             dic = df['DOCS_properties'][index]
             if variable in dic:
                     return dic[variable]
         # Create a separate column for each field in properties: 'gender', 'document_type' et
         def separate_columns_for_keys(key_list):
             for i in key_list:
                 df[i]= df.index
                 df[i] = df[i].apply(lambda index: split(index,i))
         separate_columns_for_keys(key_list)

In [31]: print(key_list)
```

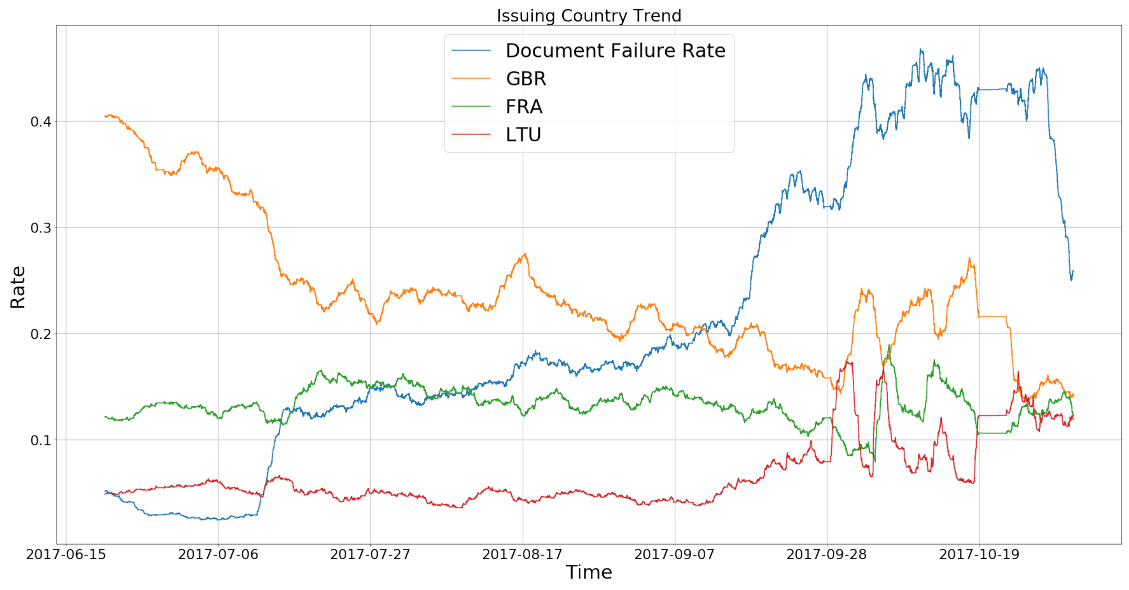
```
['gender', 'document_type', 'date_of_expiry', 'issuing_country', 'nationality', 'issuing_date'
```

```
In [32]: df.iloc[0,:]

Out[32]: Unnamed: 0                                                                  4929
         user_id                                                 3aee7324dfba466d96888ff9ad185b5
         FACE_result                                                                 clea
         face_comparison_result                                                      clea
         FACE_created_at                                                 2017-05-23 15:13:0
         facial_image_integrity_result                                               clea
         visual_authenticity_result                                                  clea
         FACE_properties                                                     {'score': 0.73
         FACE_attempt_id                                         d21de828c5514277aaedb316edc6c48
         DOCS_result                                                                 clea
         image_integrity_result                                                      clea
         face_detection_result                                                       clea
         image_quality_result                                                        clea
         DOCS_created_at                                                 2017-05-23 15:13:0
         supported_document_result                                                   clea
         conclusive_document_quality_result                                            Na
         colour_picture_result                                                         Na
         data_validation_result                                                      clea
         data_consistency_result                                                       Na
         data_comparison_result                                                      clea
         DOCS_attempt_id                                         d21de828c5514277aaedb316edc6c48
         police_record_result                                                        clea
         compromised_document_result                                                   Na
         DOCS_properties                  {'gender': 'Male', 'document_type': 'driving_l.
         sub_result                                                                  clea
         Pass                                                                         Tru
         gender                                                                       Mal
         document_type                                                       driving_licen
         date_of_expiry                                                          2027-01-0
         issuing_country                                                               GI
         nationality                                                                  Nor
         issuing_date                                                                 Nor
         issuing_state                                                                Nor
         document_version                                                             Nor
         Name: 0, dtype: object

In [33]: # quick scan of properties
         #for i in key_list:
             #print (df[i].value_counts())

In [34]: # There could be a problem of Image integrity with a particular document type or docu
         # from a specific nation, although the value_counts above are admittedly too small

         # Inspection of Trend of Document Types and Document Failure Rate

         national_identity_card = df['document_type'] == 'national_identity_card'
```

```
driving_licence = df['document_type'] == 'driving_licence'
passport = df['document_type'] == 'passport'

plot_ma([doc_failure,national_identity_card,driving_licence,passport],['Document Failu
# No relationship
```

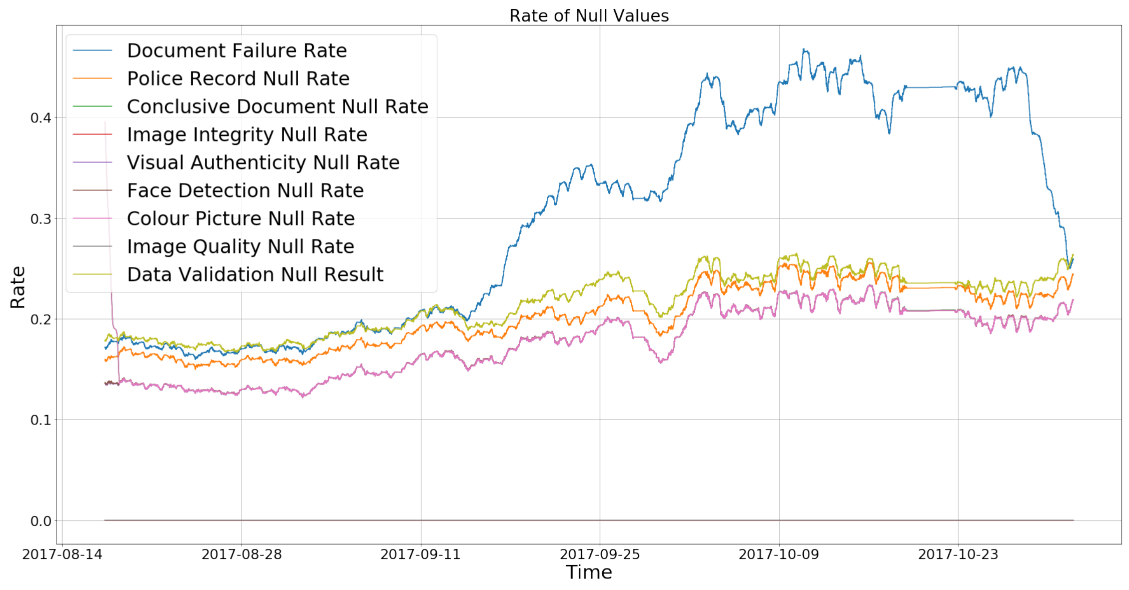


```
In [35]: # Inspection of Trend of Issuing Country and Document Failure Rate
         GBR = df['issuing_country'] == 'GBR'
         FRA = df['issuing_country'] == 'FRA'
         LTU = df['issuing_country'] == 'LTU'


         plot_ma([doc_failure,GBR,FRA,LTU],['Document Failure Rate','GBR','FRA','LTU'],'Issuin
         # No relationship,similarly there is no relationship for other fields. I tested all t
```

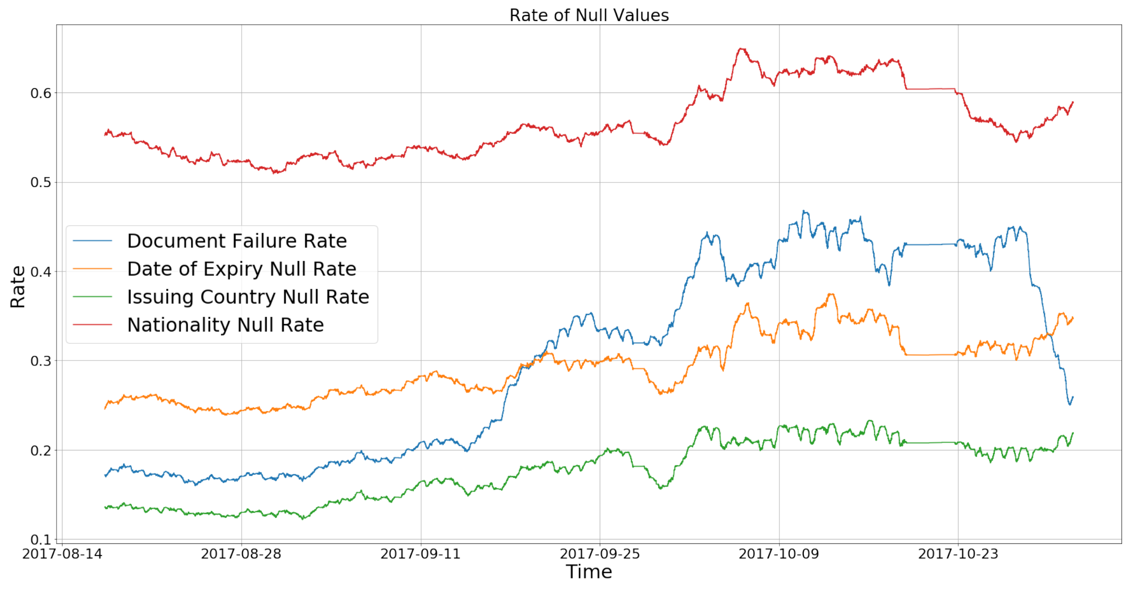


4.2 Null results

In [36]:
```
# An increase of the API not being able to input results for certain checks
#could lead to Document Failure
def plot_ma_Null(variables,labels,start=0,N=5000):
    for result in range(len(variables)):
        if result > 0:
            variables[result] = df[variables[result]].isnull()
    plot_ma(variables,labels,start,N)
W = [doc_failure,'police_record_result','conclusive_document_quality_result','image_i
plot_ma_Null(W,['Document Failure Rate','Police Record Null Rate','Conclusive Documen
# Colour picture and conclusive document quality which are sub-checks Image Integrity
# had null results and then conclusive document quality produced values coinciding wi
```



```
In [37]: plot_ma_Null([doc_failure,'date_of_expiry','issuing_country','nationality'],['Documen
```


Rate of Null Values
Document Failure Rate
Date of Expiry Null Rate
Issuing Country Null Rate
Nationality Null Rate
Rate
Time