Hanyu_Shi_Employment_Retention

February 20, 2019

```
In [1]: ## Pre-setting
        # automatically adjust the width of the notebook code cell
        from IPython.core.display import display, HTML
        display(HTML("<style>.container { width:100% !important; }</style>"))
        # if one module is changed, this line will automatically reload that module
        %load_ext autoreload
        %autoreload 2
        # display the figure in the notebook
        %matplotlib inline
        # To change the font size in acrobat
        import matplotlib as mpl
        mpl.rcParams['pdf.fonttype'] = 42
```

```
<IPython.core.display.HTML object>
```

```
In [2]: import pandas as pd
        import matplotlib.pyplot as plt
        import numpy as np
```

```
In [ ]:
```

```
In [ ]:
```

0.1 read data

```
In [3]: import os
        import sys

        data_folder = os.path.abspath(os.path.join(os.pardir, 'data'))
        data_file = 'employee_retention_data.csv'
        data_folder_file = os.path.join(data_folder, data_file)
```

```
In [4]: raw_data_df = pd.read_csv(data_folder_file)
        raw_data_df.head()
```

```
Out[4]:    employee_id  company_id              dept  seniority    salary join_date  \
        0      13021.0           7  customer_service         28   89000.0   3/24/14
```

```
1     825355.0           7         marketing         20  183000.0   4/29/13
2     927315.0           4         marketing         14  101000.0  10/13/14
3     662910.0           7  customer_service         20  115000.0   5/14/12
4     256971.0           2      data_science         23  276000.0  10/17/11

  quit_date
0  10/30/15
1    4/4/14
2       NaN
3    6/7/13
4   8/22/14
```

```
In [5]: raw_data_df.quit_date.isnull().sum() / (len(raw_data_df.quit_date))
```

```
Out[5]: 0.453080722208728
```

```
In [6]: # pd.to_datetime(raw_data_df.join_date, format="%m/%d/%Y")
        raw_data_df.join_date = pd.to_datetime(raw_data_df.join_date, infer_datetime_format=1)
        raw_data_df.quit_date = pd.to_datetime(raw_data_df.quit_date, infer_datetime_format=1)
```

```
In [7]: raw_data_df.head()
```

```
Out[7]:    employee_id  company_id              dept  seniority    salary  join_date  \
        0      13021.0           7  customer_service         28   89000.0 2014-03-24
        1     825355.0           7         marketing         20  183000.0 2013-04-29
        2     927315.0           4         marketing         14  101000.0 2014-10-13
        3     662910.0           7  customer_service         20  115000.0 2012-05-14
        4     256971.0           2      data_science         23  276000.0 2011-10-17

           quit_date
        0 2015-10-30
        1 2014-04-04
        2        NaT
        3 2013-06-07
        4 2014-08-22
```

```
In [8]: raw_data_df.shape
```

```
Out[8]: (24702, 7)
```

```
In [ ]:
```

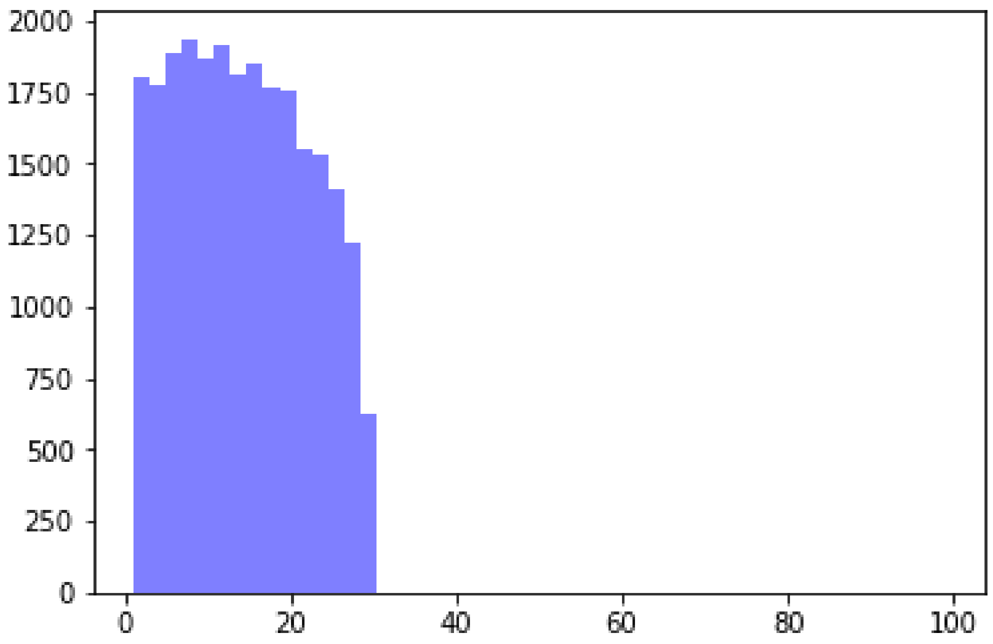
0.2 play with data

```
In [9]: tmp_array = (raw_data_df.employee_id.unique())
        len(tmp_array), max(tmp_array), min(tmp_array),
```

```
Out[9]: (24702, 999969.0, 36.0)
```

```
In [ ]:
```

```
In [10]: len(raw_data_df.company_id.unique())

Out[10]: 12

In [11]: len(raw_data_df.dept.unique())

Out[11]: 6

In [12]: tmp_array = (raw_data_df.seniority.unique())
         len(tmp_array), max(tmp_array), min(tmp_array),

Out[12]: (31, 99, 1)

In [13]: tmp_array =  raw_data_df.seniority

         num_bins = 50
         n, bins, patches = plt.hist(tmp_array, num_bins, facecolor='blue', alpha=0.5)
         plt.show()
```



```
In [14]: tmp_array_join_date = (raw_data_df.join_date.unique())
         len(tmp_array_join_date), max(tmp_array_join_date), min(tmp_array_join_date),

Out[14]: (995,
          numpy.datetime64('2015-12-10T00:00:00.000000000'),
          numpy.datetime64('2011-01-24T00:00:00.000000000'))

In [15]: raw_data_df.head()
```

```
Out[15]:    employee_id  company_id              dept  seniority    salary  join_date  \
        0      13021.0           7  customer_service         28   89000.0 2014-03-24
        1     825355.0           7         marketing         20  183000.0 2013-04-29
        2     927315.0           4         marketing         14  101000.0 2014-10-13
        3     662910.0           7  customer_service         20  115000.0 2012-05-14
        4     256971.0           2      data_science         23  276000.0 2011-10-17

           quit_date
        0 2015-10-30
        1 2014-04-04
        2        NaT
        3 2013-06-07
        4 2014-08-22
```

```
In [16]: raw_data_df['join_day'] = (raw_data_df.join_date - min(tmp_array_join_date)).astype('ti

         raw_data_df['quit_day'] = (raw_data_df.quit_date - min(tmp_array_join_date)).astype('ti


         # raw_data_df['stay_days'] = raw_data_df['quit_days'] - raw_data_df['join_days']
```

```
In [17]: # raw_data_df.quit_day
```

```
In [18]: raw_data_df['if_quit'] = -raw_data_df.quit_date.isnull()
```

```
In [19]: raw_data_df['last_day'] = raw_data_df.quit_day
```

```
In [20]: raw_data_df.head()
```

```
Out[20]:    employee_id  company_id              dept  seniority    salary  join_date  \
        0      13021.0           7  customer_service         28   89000.0 2014-03-24
        1     825355.0           7         marketing         20  183000.0 2013-04-29
        2     927315.0           4         marketing         14  101000.0 2014-10-13
        3     662910.0           7  customer_service         20  115000.0 2012-05-14
        4     256971.0           2      data_science         23  276000.0 2011-10-17

           quit_date  join_day  quit_day  if_quit  last_day
        0 2015-10-30    1155.0    1740.0     True    1740.0
        1 2014-04-04     826.0    1166.0     True    1166.0
        2        NaT    1358.0       NaN    False       NaN
        3 2013-06-07     476.0     865.0     True     865.0
        4 2014-08-22     266.0    1306.0     True    1306.0
```

```
In [21]: last_day = (np.datetime64('2015-12-13')-min(tmp_array_join_date)).astype('timedelta64[D
```

```
In [22]: na_dict = {'last_day':last_day}
         raw_data_df=raw_data_df.fillna(na_dict)
```

```
In [23]: raw_data_df.head()
```

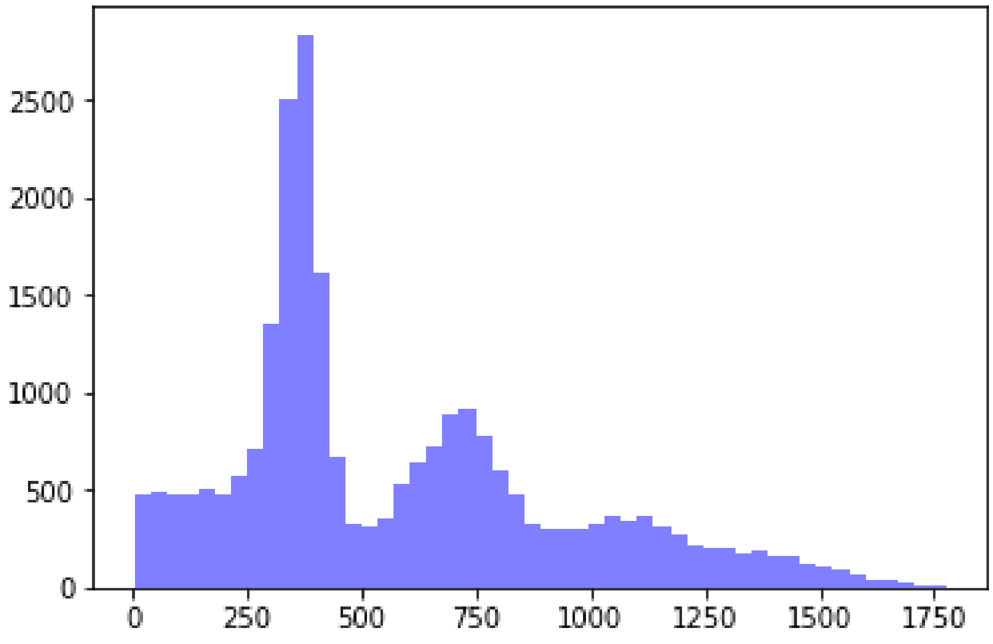
```
Out[23]:    employee_id  company_id              dept  seniority    salary  join_date  \
         0      13021.0           7  customer_service         28   89000.0 2014-03-24
         1     825355.0           7         marketing         20  183000.0 2013-04-29
         2     927315.0           4         marketing         14  101000.0 2014-10-13
         3     662910.0           7  customer_service         20  115000.0 2012-05-14
         4     256971.0           2      data_science         23  276000.0 2011-10-17

            quit_date  join_day  quit_day  if_quit  last_day
         0 2015-10-30    1155.0    1740.0     True    1740.0
         1 2014-04-04     826.0    1166.0     True    1166.0
         2        NaT    1358.0       NaN    False    1784.0
         3 2013-06-07     476.0     865.0     True     865.0
         4 2014-08-22     266.0    1306.0     True    1306.0
```

```
In [24]: raw_data_df['stay_days'] = raw_data_df.last_day - raw_data_df.join_day
```

```
In [25]: tmp_array = (raw_data_df.stay_days.unique())
         len(tmp_array), max(tmp_array), min(tmp_array),
```

```
Out[25]: (1353, 1777.0, 3.0)
```

```
In [26]: raw_data_df

         tmp_array =  raw_data_df.stay_days

         num_bins = 50
         n, bins, patches = plt.hist(tmp_array, num_bins, facecolor='blue', alpha=0.5)
         plt.show()
```



```
In [ ]:
```

0.3 split into 2 groups: quit & not_quit

```
In [27]: raw_data_df.head()
```

```
Out[27]:    employee_id  company_id              dept  seniority    salary  join_date  \
         0      13021.0           7  customer_service         28   89000.0 2014-03-24
         1     825355.0           7         marketing         20  183000.0 2013-04-29
         2     927315.0           4         marketing         14  101000.0 2014-10-13
         3     662910.0           7  customer_service         20  115000.0 2012-05-14
         4     256971.0           2      data_science         23  276000.0 2011-10-17

            quit_date  join_day  quit_day  if_quit  last_day  stay_days
         0 2015-10-30    1155.0    1740.0     True    1740.0      585.0
         1 2014-04-04     826.0    1166.0     True    1166.0      340.0
         2        NaT    1358.0       NaN    False    1784.0      426.0
         3 2013-06-07     476.0     865.0     True     865.0      389.0
         4 2014-08-22     266.0    1306.0     True    1306.0     1040.0
```

```
In [28]: raw_data_df_save = raw_data_df.copy(deep=True)
```

```
In [29]: raw_data_df = raw_data_df_save.drop(['quit_day'], axis=1)
         raw_data_df.head()
```

```
Out[29]:    employee_id  company_id              dept  seniority    salary  join_date  \
         0      13021.0           7  customer_service         28   89000.0 2014-03-24
         1     825355.0           7         marketing         20  183000.0 2013-04-29
         2     927315.0           4         marketing         14  101000.0 2014-10-13
         3     662910.0           7  customer_service         20  115000.0 2012-05-14
         4     256971.0           2      data_science         23  276000.0 2011-10-17

            quit_date  join_day  if_quit  last_day  stay_days
         0 2015-10-30    1155.0     True    1740.0      585.0
         1 2014-04-04     826.0     True    1166.0      340.0
         2        NaT    1358.0    False    1784.0      426.0
         3 2013-06-07     476.0     True     865.0      389.0
         4 2014-08-22     266.0     True    1306.0     1040.0
```

```
In [ ]:
```

```
In [30]: quit_raw_data_df = raw_data_df[raw_data_df.if_quit == 1]
         no_quit_raw_data_df = raw_data_df[raw_data_df.if_quit == 0]
```

```
In [31]: raw_data_df.shape, quit_raw_data_df.shape, no_quit_raw_data_df.shape
```

```
Out[31]: ((24702, 11), (13510, 11), (11192, 11))
```

```
In [ ]:
```

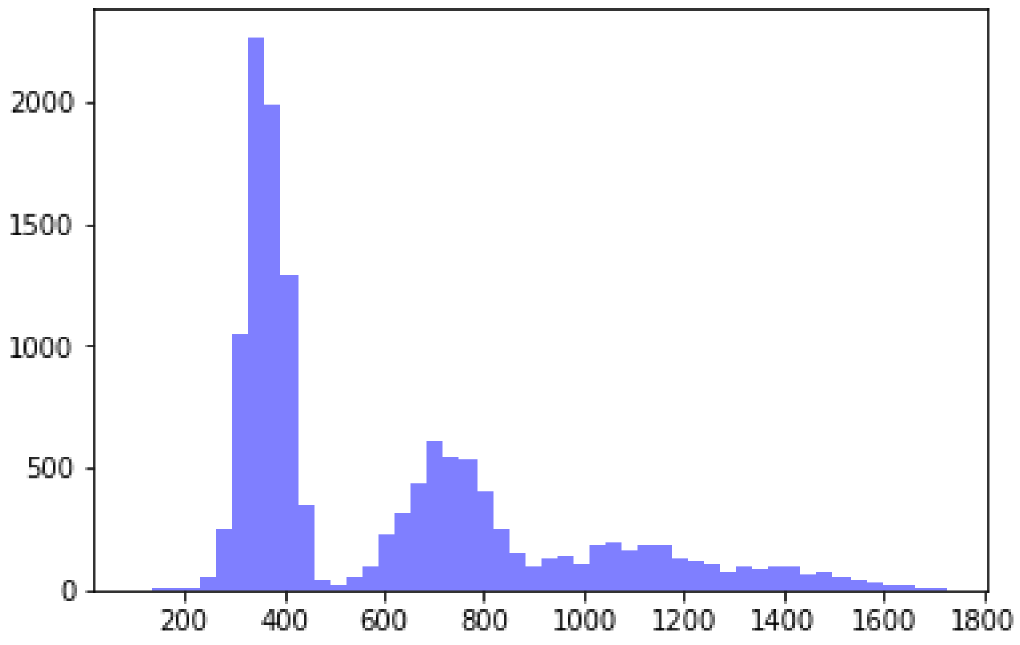
0.3.1 Compare quit vs no_quit

```
In [32]: quit_raw_data_df.stay_days.mean(),  no_quit_raw_data_df.stay_days.mean()

Out[32]: (613.4868245743893, 527.0392244460329)

In [33]: quit_company_mean = quit_raw_data_df.groupby(['company_id'])['stay_days'].mean().values
         no_quit_company_mean = no_quit_raw_data_df.groupby(['company_id'])['stay_days'].mean().
         company_id = quit_raw_data_df.groupby(['company_id'])['stay_days'].mean().index.values

In [ ]:
```

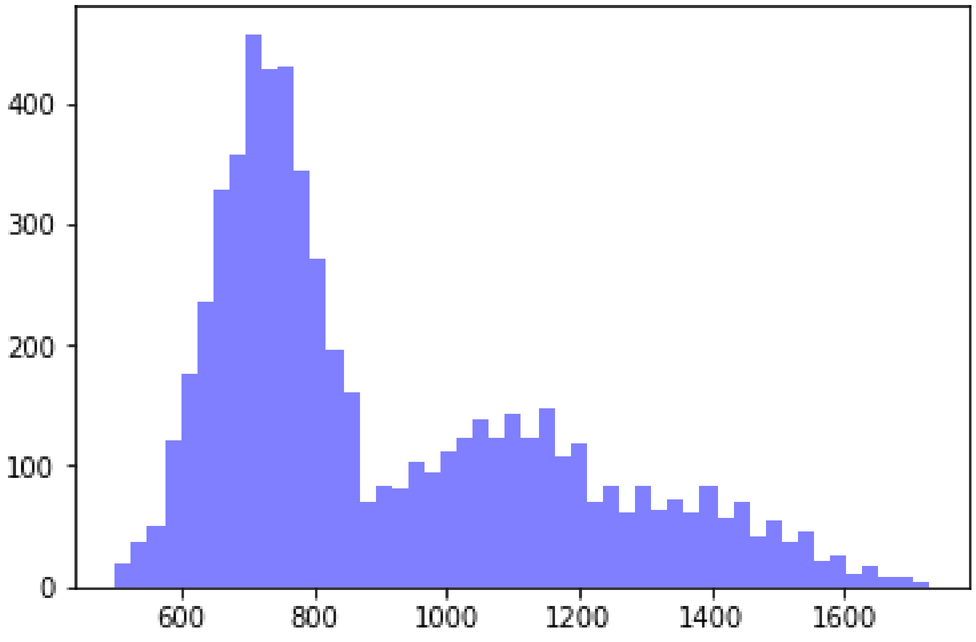
0.4 only use quit_df: try to predict the stay_days

```
In [34]: quit_raw_data_df.head()

Out[34]:    employee_id  company_id              dept  seniority    salary  join_date  \
         0      13021.0           7  customer_service         28   89000.0 2014-03-24
         1     825355.0           7         marketing         20  183000.0 2013-04-29
         3     662910.0           7  customer_service         20  115000.0 2012-05-14
         4     256971.0           2      data_science         23  276000.0 2011-10-17
         5     509529.0           4      data_science         14  165000.0 2012-01-30

             quit_date  join_day  if_quit  last_day  stay_days
         0 2015-10-30    1155.0     True    1740.0      585.0
         1 2014-04-04     826.0     True    1166.0      340.0
         3 2013-06-07     476.0     True     865.0      389.0
         4 2014-08-22     266.0     True    1306.0     1040.0
         5 2013-08-30     371.0     True     949.0      578.0

In [35]: drop_column_list = [

             'employee_id', 'join_date', 'join_date', 'quit_date',
             'if_quit', 'last_day', '', '',
             '', '', '', '',
         ]

         drop_column_list = [i for i in drop_column_list if i is not '']

         quit_raw_data_df = quit_raw_data_df.drop(drop_column_list, axis=1)

In [36]: quit_raw_data_df.head()

Out[36]:    company_id              dept  seniority    salary  join_day  stay_days
         0           7  customer_service         28   89000.0    1155.0      585.0
         1           7         marketing         20  183000.0     826.0      340.0
         3           7  customer_service         20  115000.0     476.0      389.0
         4           2      data_science         23  276000.0     266.0     1040.0
         5           4      data_science         14  165000.0     371.0      578.0
```

```
In [37]: categorical=['company_id','dept']
         quit_raw_data_dummy_df=pd.get_dummies(quit_raw_data_df, columns=categorical)

In [38]: quit_raw_data_dummy_df.head()

Out[38]:    seniority    salary  join_day  stay_days  company_id_1  company_id_2  \
         0         28   89000.0    1155.0      585.0             0             0
         1         20  183000.0     826.0      340.0             0             0
         3         20  115000.0     476.0      389.0             0             0
         4         23  276000.0     266.0     1040.0             0             1
         5         14  165000.0     371.0      578.0             0             0

            company_id_3  company_id_4  company_id_5  company_id_6     ...      \
         0             0             0             0             0     ...
         1             0             0             0             0     ...
         3             0             0             0             0     ...
         4             0             0             0             0     ...
         5             0             1             0             0     ...

            company_id_9  company_id_10  company_id_11  company_id_12  \
         0             0              0              0              0
         1             0              0              0              0
         3             0              0              0              0
         4             0              0              0              0
         5             0              0              0              0

            dept_customer_service  dept_data_science  dept_design  dept_engineer  \
         0                      1                  0            0              0
         1                      0                  0            0              0
         3                      1                  0            0              0
         4                      0                  1            0              0
         5                      0                  1            0              0

            dept_marketing  dept_sales
         0               0           0
         1               1           0
         3               0           0
         4               0           0
         5               0           0

         [5 rows x 22 columns]

In [39]: tmp_array =  quit_raw_data_dummy_df.stay_days.values
         num_bins = 50
         n, bins, patches = plt.hist(tmp_array, num_bins, facecolor='blue', alpha=0.5)
         plt.show()
```



```
In [40]: tmp_quit_raw_data_dummy_df = quit_raw_data_dummy_df[quit_raw_data_dummy_df.stay_days >

In [41]: tmp_quit_raw_data_dummy_df.shape

Out[41]: (6168, 22)

In [ ]:

In [ ]:

In [42]: # Select only numeric data and impute missing values as 0
         numerics = ['uint8','int16', 'int32', 'int64', 'float16', 'float32', 'float64']
         quit_raw_data_x=tmp_quit_raw_data_dummy_df.select_dtypes(include=numerics).drop(['stay_
         # quit_raw_data_y= np.log(tmp_quit_raw_data_dummy_df['stay_days'].values)
         quit_raw_data_y= (tmp_quit_raw_data_dummy_df['stay_days'].values)

In [48]: quit_raw_data_x.shape, quit_raw_data_y.shape

Out[48]: ((6168, 21), (6168,))

In [44]: tmp_array =  tmp_quit_raw_data_dummy_df.stay_days.values

         num_bins = 50
         n, bins, patches = plt.hist(tmp_array, num_bins, facecolor='blue', alpha=0.5)
         plt.show()
```



```
In [45]: chicago_fair_x = quit_raw_data_x
         chicago_fair_y = quit_raw_data_y

In [46]: #random forest

         from sklearn.model_selection import KFold
         from sklearn.ensemble import RandomForestRegressor
         from sklearn.metrics import r2_score

         cv_groups = KFold(n_splits=5, shuffle=True, random_state=0)

         regr_cv_rf = RandomForestRegressor(random_state = 0, n_estimators = 100)

         r_2_test_list = []
         r_2_train_list = []


         for train_index, test_index in cv_groups.split(chicago_fair_x):

             # Train the model using the training sets
             regr_cv_rf.fit(chicago_fair_x[train_index], chicago_fair_y[train_index])

             # Make predictions using the testing set
             pred_cv_rf_test = regr_cv_rf.predict(chicago_fair_x[test_index])

             # Make predictions using the testing set
```

```
            pred_cv_rf_train = regr_cv_rf.predict(chicago_fair_x[train_index])

            r_2_test = r2_score(chicago_fair_y[test_index], pred_cv_rf_test)
            r_2_test_list += [r_2_test]

            r_2_train = r2_score(chicago_fair_y[train_index], pred_cv_rf_train)
            r_2_train_list += [r_2_train]

            print(r_2_test, r_2_train)

        np.mean(r_2_test_list), np.mean(r_2_train_list)
```

```
0.10678792463002362 0.8768731527244779
0.09451203063617564 0.8788859769801973
0.10952087205394989 0.8763783989853429
0.1254648115312006 0.8747892316469646
0.16672615362093368 0.8732542358000932
```

```
Out[46]: (0.12060235849445669, 0.8760361992274153)
```

```
In [ ]:
```

```
In [ ]:
```

0.4.1 test

```
In [47]: 1
```

```
Out[47]: 1
```

```
In [ ]:
```