'철새도 능력' 잡호핑 할 사람은 누구인가?

Team 1

이수진, 오무열, 정재하, 정희경, 신금하

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01
프로젝트 개요

- 주제선정
- 데이터 출처
- 데이터 구성

빅데이터 전문회사의 교육 수료 후
데이터 사이언티스트로 전향할 사람 예측하기

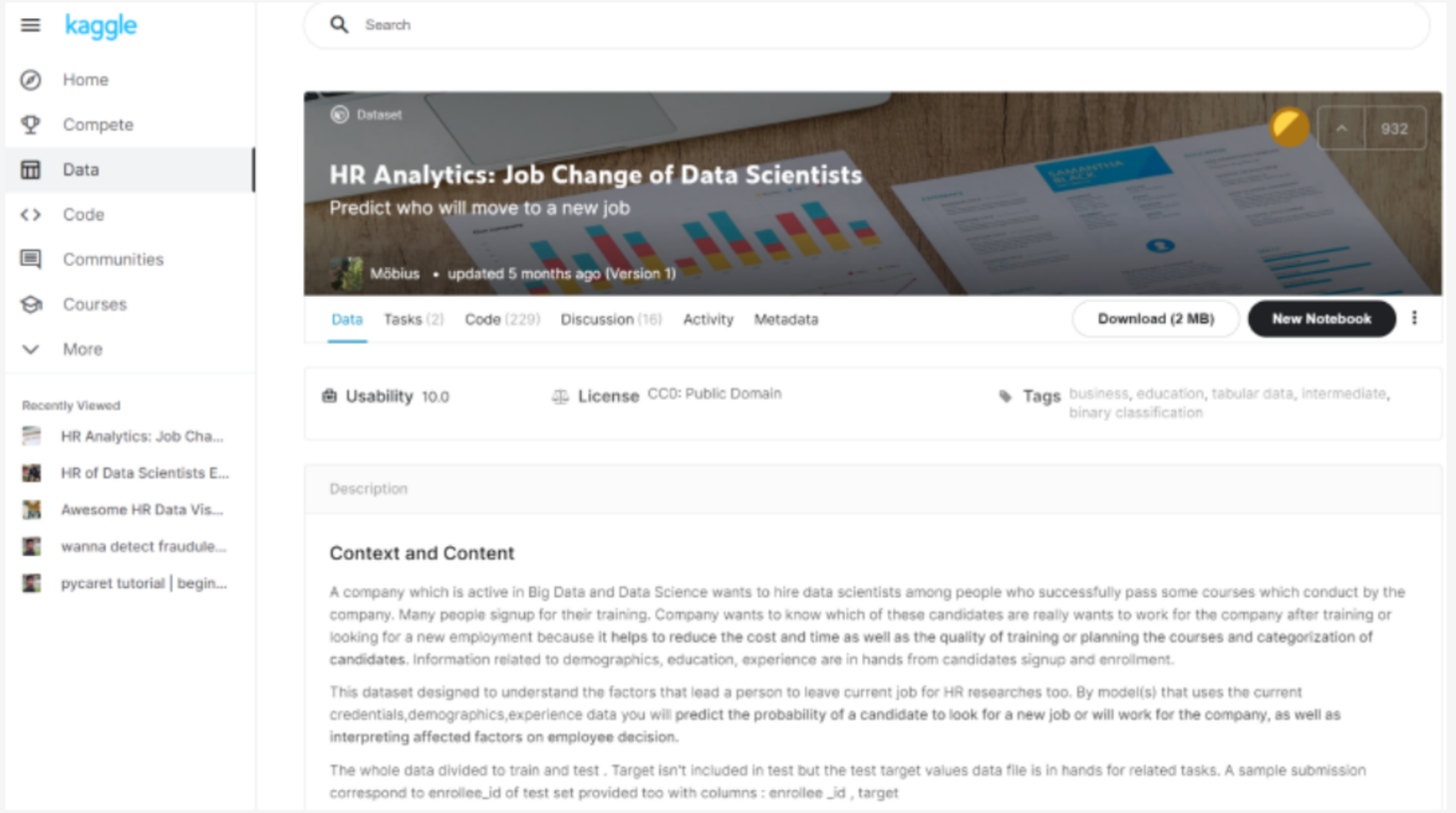
데이터 출처

HR Analytics: Job Change of Data Scientists

Predict who will move to a new job

https://www.kaggle.com/arashnic/hr-analytics-job-change-of-data-scientists

kaggle



데이터 구성

Features

- enrollee_id : Unique ID for candidate
- city: City code
- city_ development _index : Developement index of the city (scaled)
- gender: Gender of candidate
- relevent_experience: Relevant experience of candidate
- enrolled_university: Type of University course enrolled if any
- education_level: Education level of candidate
- major_discipline :Education major discipline of candidate
- experience: Candidate total experience in years
- company_size: No of employees in current employer's company
- company_type : Type of current employer
- last*new*job: Difference in years between previous job and current job
- training_hours: training hours completed
- target: 0 – Not looking for job change, 1 – Looking for a job change

19158 rows × 14 columns

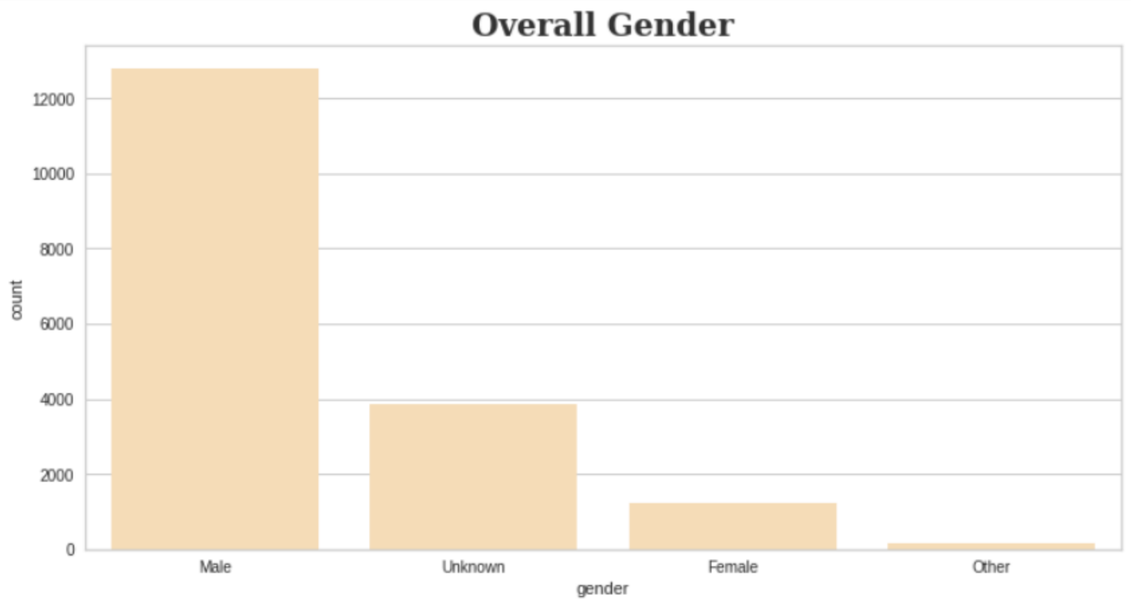
	enrollee_id	city	city_development_index	gender	relevent_experience	enrolled_university	education_level	major_discipline	experience	company_size	company_type	last_new_job	training_hours	target
0	8949	city_103	0.920	Male	Has relevent experience	no_enrollment	Graduate	STEM	>20	NaN	NaN	1	36	1.0
1	29725	city_40	0.776	Male	No relevent experience	no_enrollment	Graduate	STEM	15	50-99	Pvt Ltd	>4	47	0.0
2	11561	city_21	0.624	NaN	No relevent experience	Full time course	Graduate	STEM	5	NaN	NaN	never	83	0.0
3	33241	city_115	0.789	NaN	No relevent experience	NaN	Graduate	Business Degree	<1	NaN	Pvt Ltd	never	52	1.0
4	666	city_162	0.767	Male	Has relevent experience	no_enrollment	Masters	STEM	>20	50-99	Funded Startup	4	8	0.0

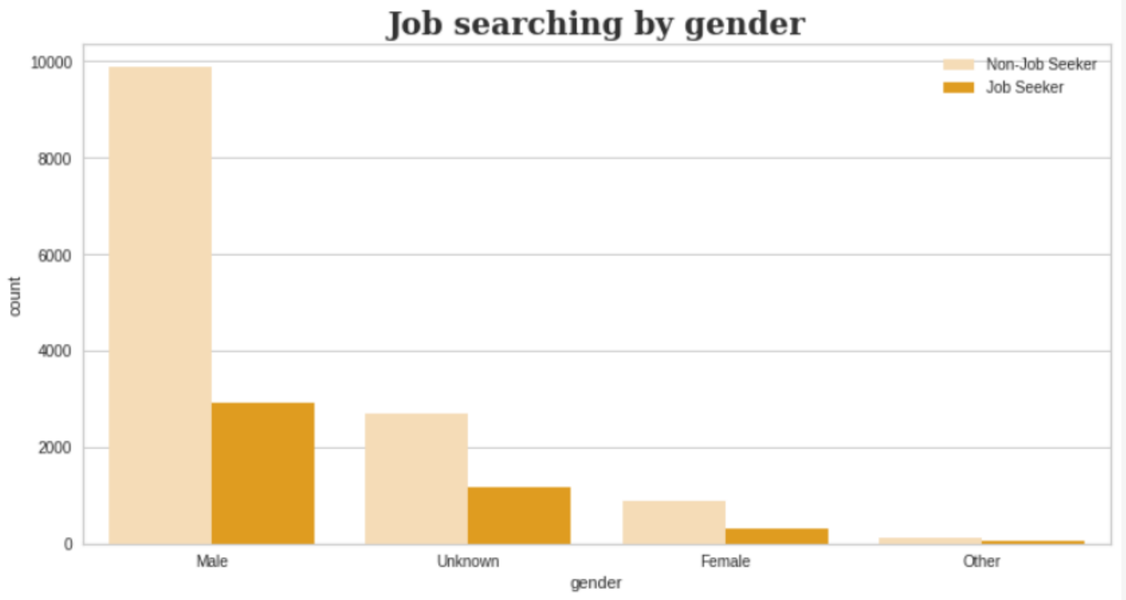
02
분석과정

- Data Visualization
- Data Proprocessing

Data Visualization

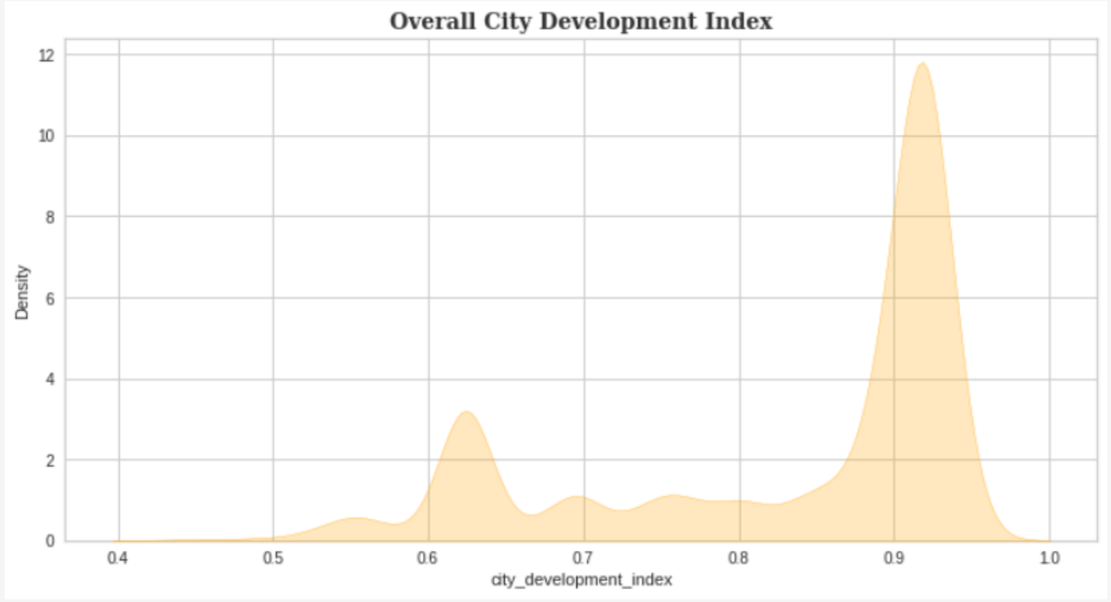
데이터 시각화





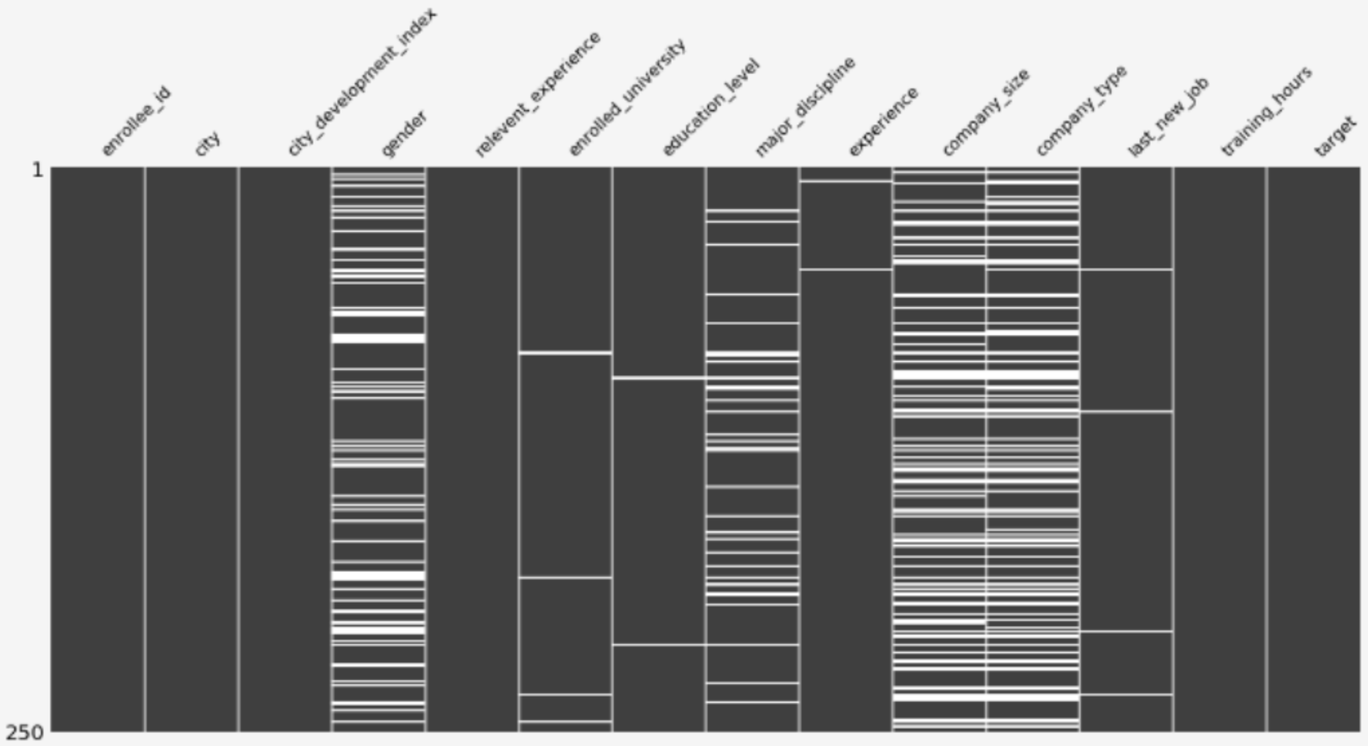
Data Visualization

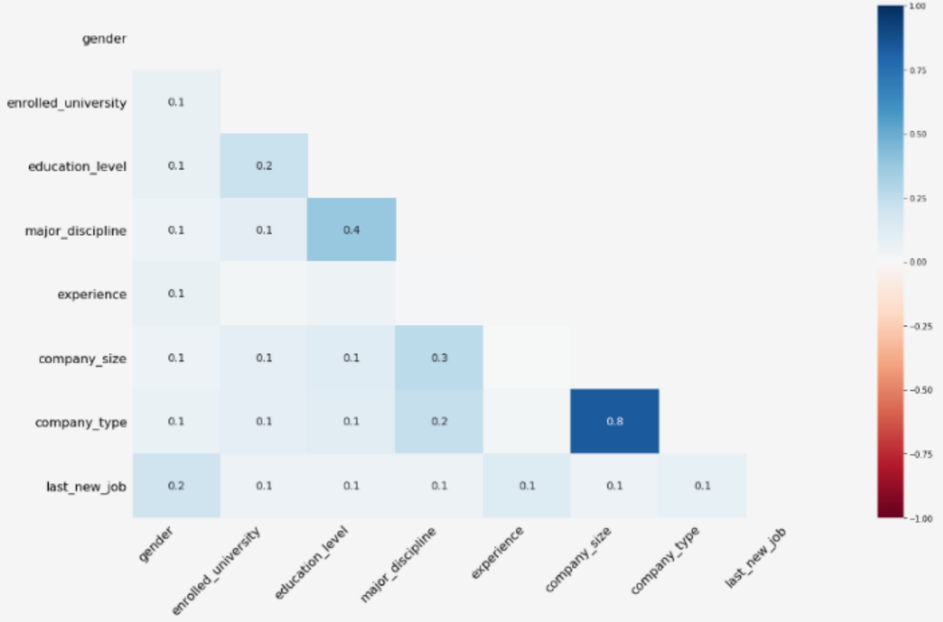
데이터 시각화



Data Visualization

결측치 시각화





Imbalanced Data

데이터 전처리 방식

1. 결측치 처리
2. 데이터 불균형 처리

- 'enrollee_id' Column 삭제
- 'experience', 'enrolled_university', 'last_new_job','education_level' null 값 삭제
- str -> int 수정
- Label Encoding 후 KNN Imputer로 결측치 채우기

```
[9]  # Delete

     df.drop(['enrollee_id'], axis=1, inplace=True)
     df.dropna(subset=["experience"], inplace=True)
     df.dropna(subset=["enrolled_university"], inplace=True)
     df.dropna(subset=["last_new_job"], inplace=True)
     df.dropna(subset=["education_level"], inplace=True)
```

```
[10] # Replace

     df['company_type'].fillna('Unknown',inplace=True)
     df['major_discipline'].fillna('Unknown',inplace=True)
     df['gender'].fillna('Unknown',inplace=True)
```

```
[11] # Chage to int

     df['experience'] = df['experience'].apply(lambda x: '0' if x == '<1' else x)
     df['experience'] = df['experience'].apply(lambda x: '20' if x == '>20' else x)
     df['experience'] = df['experience'].astype(int)
```

```
[12] # Chage to int

     df['last_new_job'] = df['last_new_job'].apply(lambda x : '0' if x == 'never' else x)
     df['last_new_job'] = df['last_new_job'].apply(lambda x : '5' if x == '>4' else x)
     df['last_new_job'] = df['last_new_job'].astype(int)
```

```
[19] # import LabelEncoder

     from sklearn.preprocessing import LabelEncoder
```

```
[20] # LabelEncoder를 적용할 새로운 데이터프레임을 df_lb으로 생성

     df_lb = df.copy()
```

```
[21] # LabelEncoder를 적용할 데이터는 object타입의 데이터이므로 해당 데이터들을 가져 와줌

     transform_list = list(df_lb.select_dtypes(include=['object']).columns)
     transform_list
```

```
['city',
 'gender',
 're levent_experience',
 'enrolled_university',
 'education_ level',
 'ma_or_disc pline',
 'company_size',
 'company_type']
```

```
[22] # LabelEncoder를 fit할 컬럼별 각각의 LabelEncoder 생성

     for i, value in enumerate(transform_list):
         globals()['Labe lEncoder_{}'.format(i)] = LabelEncoder()
         print('Labelencoder_'+str(i)+'   '+value)
```

```
Labe lEncoder_0 : city
Labe lEncoder_1 : gender
Labe lEncoder_2 : relevent_exper ence
Labe lEncoder_3 : enrolled_university
```

```
[23] # import KNNImputer

     from sklearn.impute import KNNImputer
```

```
[30] # imputer 정의

     imputer = KNNImputer(n_neighbors=5)
```

```
[31] # KNNImputer의 fit_transform을 df_lb에 적용
     # df_im로 데이터프레임명 지정

     df_im = imputer.fit_transform(df_lb)
```

```
[32] # df_im 확인

     df_im
```

```
array([[  5.   ,   0.92 ,   1.   , ...,   1.   ,  36.   ,   1.   ],
       [ 77.   ,   0.776,   1.   , ...,   5.   ,  47.   ,   0.   ],
       [ 64.   ,   0.624,   3.   , ...,   0.   ,  83.   ,   0.   ],
       ...,
       [  5.   ,   0.92 ,   1.   , ...,   4.   ,  44.   ,   0.   ],
       [ 94.   ,   0.802,   1.   , ...,   2.   ,  97.   ,   0.   ],
       [ 95.   ,   0.855,   3.   , ...,   1.   , 127.   ,   0.   ]])
```

데이터 전처리 방식

1. 결측치 처리
2. 데이터 불균형 처리

- SMOTE 활용하여 클래스 비율 동일하게 수정

```
# install imbalanced-learn

# !pip install imbalanced-learn==0.7.0
```

```
[ ]  # import SMOTE

     from imblearn.over_sampling import SMOTE
```

```
[ ]  # X_train_copy와 y_train을 y_train(target)의 클래스 비율을 동일하게 하는 방식으로 SMOTE 실행

     smote = SMOTE(random_state=0)
     X_train_over, y_train_over = smote.fit_resample(X_train_copy, y_train)
```

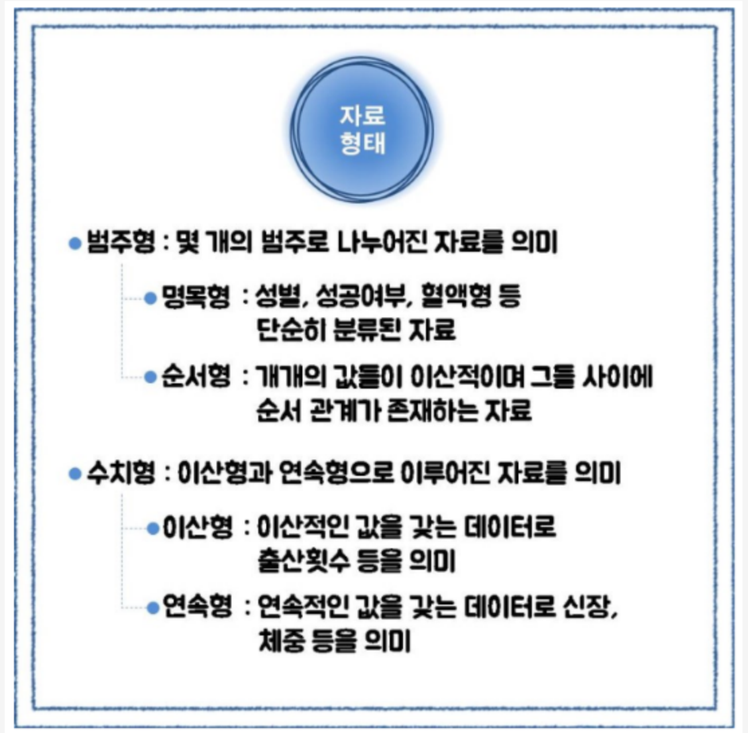
```
[ ]  # y_train_over을 model의 label로 넣기 위해 array.reshape(-1, 1) 진행

     y_train_over = np.array(y_train_over)
     y_train_over = y_train_over.reshape(-1, 1)
```

```
[ ]  # y_test를 model의 label로 넣기 위해 array.reshape(-1, 1) 진행

     y_test = np.array(y_test)
     y_test = y_test.reshape(-1, 1)
```

범주형 vs 수치형 데이터




```
[40] # import train_test_split

     from sklearn.model_selection import train_test_split
```

```
[50] # train_test_split 실행

     X = df_im.drop('target', axis=1)
     y = df_im['target']

     X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=0, stratify=y)
```

```
[51] from sklearn.preprocessing import MinMaxScaler, OneHotEncoder
     from sklearn.compose import ColumnTransformer
     from sklearn.pipeline import Pipeline
```

```
[52] df_im.columns

     Index(['city', 'city_development_index', 'gender', 'relevent_experience',
            'enrolled_university', 'education_level', 'major_discipline',
            'experience', 'company_size', 'company_type', 'last_new_job',
            'training_hours', 'target'],
           dtype='object')
```

```
[53] numeric_features = ['city_development_index', 'experience','last_new_job', 'training_hours']
     numeric_transformer = MinMaxScaler()

     categorical_features = ['city', 'gender', 'relevent_experience', 'enrolled_university',
                             'education_level', 'major_discipline', 'company_size', 'company_type']
     categorical_transformer = OneHotEncoder(categories='auto') # categories='auto' : just for ignoring warning messages

     preprocessor = ColumnTransformer(
         transformers=[ # List of (name, transformer, column(s))
             ('num', numeric_transformer, numeric_features),
             ('cat', categorical_transformer, categorical_features)])

     preprocessor_pipe = Pipeline(steps=[('ColumnTransform', preprocessor)])
```

Data Preprocessing

데이터 전처리 전후 비교

Before

	enrollee_id	city	city_development_index	gender	relevent_experience	enrolled_university	education_level	major_discipline	experience	company_size	company_ty
0	8949	city_103	0.920	Male	Has relevent experience	no_enrollment	Graduate	STEM	>20	NaN	NaN
1	29725	city_40	0.776	Male	No relevent experience	no_enrollment	Graduate	STEM	15	50-99	Pvt Ltd
2	11561	city_21	0.624	NaN	No relevent experience	Full time course	Graduate	STEM	5	NaN	NaN
3	33241	city_115	0.789	NaN	No relevent experience	NaN	Graduate	Business Degree	<1	NaN	Pvt Ltd
4	666	city_162	0.767	Male	Has relevent experience	no_enrollment	Masters	STEM	>20	50-99	Funded Startu

After

	city	city_development_index	gender	relevent_experience	enrolled_university	education_level	major_discipline	experience	company_size	company_type	last_new_job
0	5	0.920	1	0	2	0	5	20	4.6	6	1
1	77	0.776	1	1	2	0	5	15	5.0	5	5
2	64	0.624	3	1	0	0	5	5	4.6	6	0
3	50	0.767	1	0	2	2	5	20	5.0	1	4
4	57	0.764	3	0	1	0	5	11	2.8	6	1

03
분석 및 모델

- Keras를 활용한 Deep Learning
- Pycaret을 활용한 Machine Learning

Keras를 활용한 Deep Learning

```
[116] # import tensorflow

      from tensorflow.keras import models, layers, activations, initializers, losses, optimizers, metrics
```

```
[117] # model 생성

      model = models.Sequential()

      model.add(layers.Dense(input_dim=168, units=256, activation=None, kernel_initializer=initializers.he_uniform()))
      model.add(layers.Activation('elu'))

      model.add(layers.Dense(units=512, activation=None, kernel_initializer=initializers.he_uniform()))
      model.add(layers.Activation('elu'))

      model.add(layers.Dense(units=512, activation=None, kernel_initializer=initializers.he_uniform()))
      model.add(layers.Activation('elu'))

      model.add(layers.Dense(units=256, activation=None, kernel_initializer=initializers.he_uniform()))
      model.add(layers.Activation('elu'))

      model.add(layers.Dropout(rate=0.5))

      model.add(layers.Dense(units=2, activation='softmax'))
```

```
[118] # model compile

      model.compile(optimizer=optimizers.Adam(),
                    loss=losses.categorical_crossentropy,
                    metrics=[metrics.categorical_accuracy,
                             metrics.Precision(),
                             metrics.Recall(),
                             metrics.FalsePositives(),
                             metrics.FalseNegatives()])
```

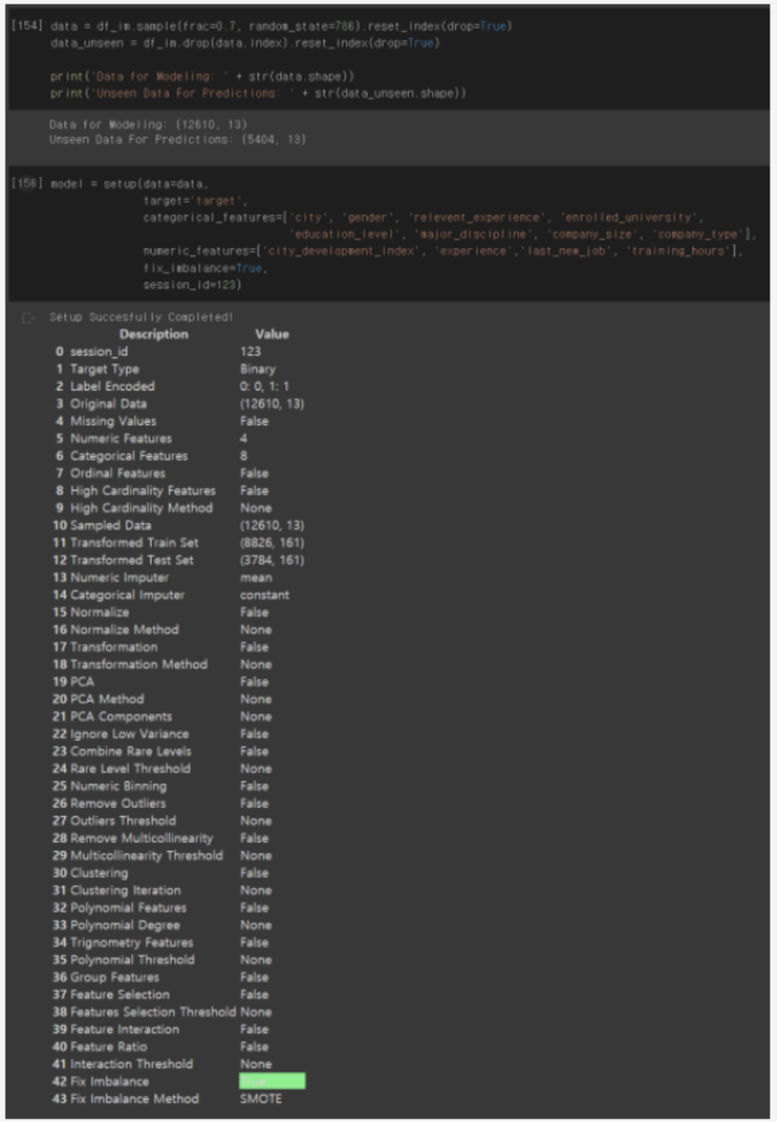
Pycaret을 활용한 Machine Learning

```
[154] data = df_im.sample(frac=0.7, random_state=786).reset_index(drop=True)
      data_unseen = df_im.drop(data.index).reset_index(drop=True)

      print('Data for Modeling: ' + str(data.shape))
      print('Unseen Data For Predictions: ' + str(data_unseen.shape))
```

```
      Data for Modeling: (12610, 13)
      Unseen Data For Predictions: (5404, 13)
```

```
[156] model = setup(data=data,
                    target='target',
                    categorical_features=['city', 'gender', 'relevent_experience', 'enrolled_university',
                                          'education_level', 'major_discipline', 'company_size', 'company_type'],
                    numeric_features=['city_development_index', 'experience','last_new_job', 'training_hours'],
                    fix_imbalance=True,
                    session_id=123)
```



```
[154] data = df_im.sample(frac=0.7, random_state=786).reset_index(drop=True)
      data_unseen = df_im.drop(data.index).reset_index(drop=True)

      print('Data for Modeling: ' + str(data.shape))
      print('Unseen Data For Predictions: ' + str(data_unseen.shape))
```

```
      Data for Modeling: (12610, 13)
      Unseen Data For Predictions: (5404, 13)
```

```
[156] model = setup(data=data,
                    target='target',
                    categorical_features=['city', 'gender', 'relevent_experience', 'enrolled_university',
                                          'education_level', 'major_discipline', 'company_size', 'company_type'],
                    numeric_features=['city_development_index', 'experience','last_new_job', 'training_hours'],
                    fix_imbalance=True,
                    session_id=123)
```

Setup Succesfully Completed!

	Description	Value
0	session_id	123
1	Target Type	Binary
2	Label Encoded	0: 0, 1: 1
3	Original Data	(12610, 13)
4	Missing Values	False
5	Numeric Features	4
6	Categorical Features	8
7	Ordinal Features	False
8	High Cardinality Features	False
9	High Cardinality Method	None
10	Sampled Data	(12610, 13)
11	Transformed Train Set	(8826, 161)
12	Transformed Test Set	(3784, 161)
13	Numeric Imputer	mean
14	Categorical Imputer	constant
15	Normalize	False
16	Normalize Method	None
17	Transformation	False
18	Transformation Method	None
19	PCA	False
20	PCA Method	None
21	PCA Components	None
22	Ignore Low Variance	False
23	Combine Rare Levels	False
24	Rare Level Threshold	None
25	Numeric Binning	False
26	Remove Outliers	False
27	Outliers Threshold	None
28	Remove Multicollinearity	False
29	Multicollinearity Threshold	None
30	Clustering	False
31	Clustering Iteration	None
32	Polynomial Features	False
33	Polynomial Degree	None
34	Trignometry Features	False
35	Polynomial Threshold	None
36	Group Features	False
37	Feature Selection	False
38	Features Selection Threshold	None
39	Feature Interaction	False
40	Feature Ratio	False
41	Interaction Threshold	None
42	Fix Imbalance	True
43	Fix Imbalance Method	SMOTE

04
분석결과 및 리뷰

- 분석결과
- 어려웠던 점
- 개선사항

분석결과

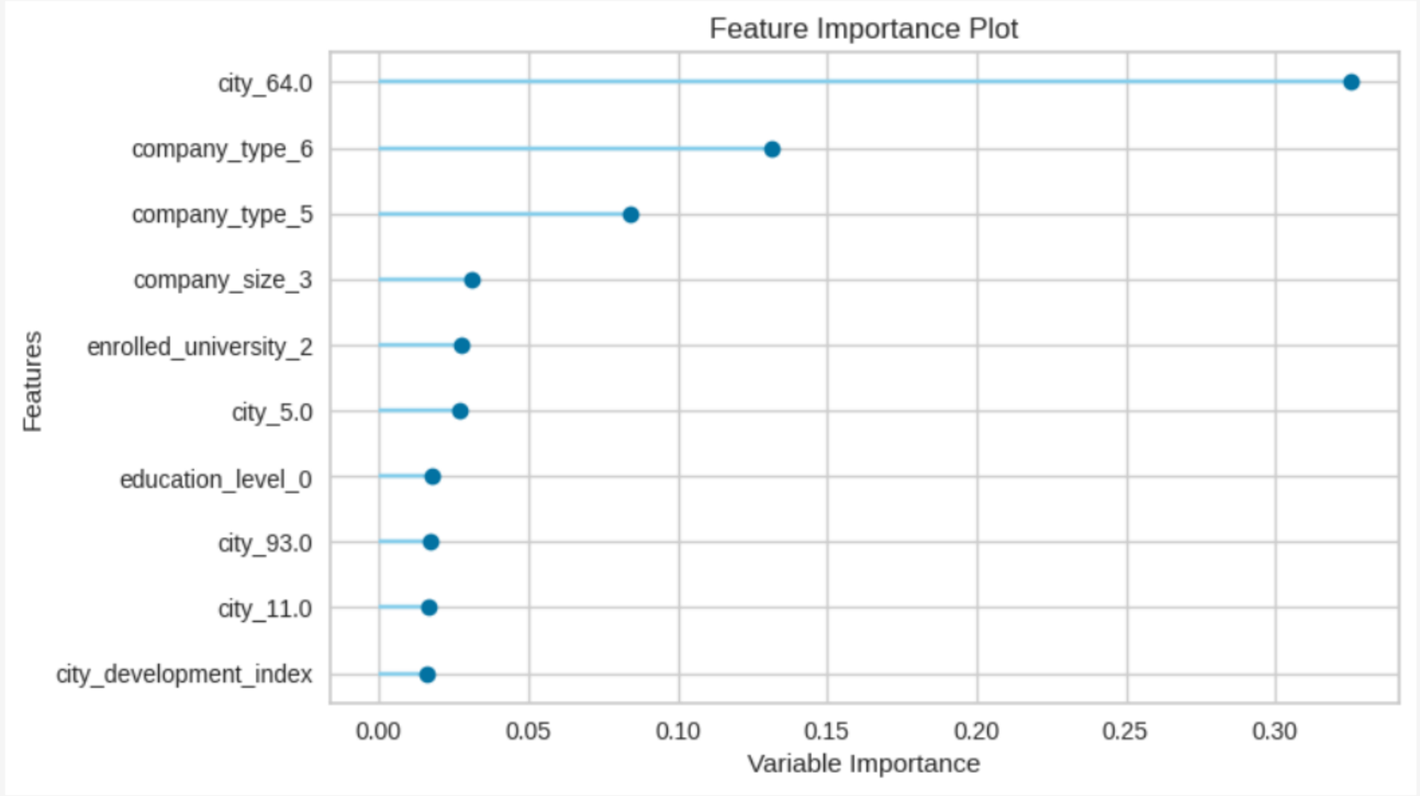
Top Model 비교

```
top_3_models = compare_models(sort='Accuracy',
                              n_select = 3)
```

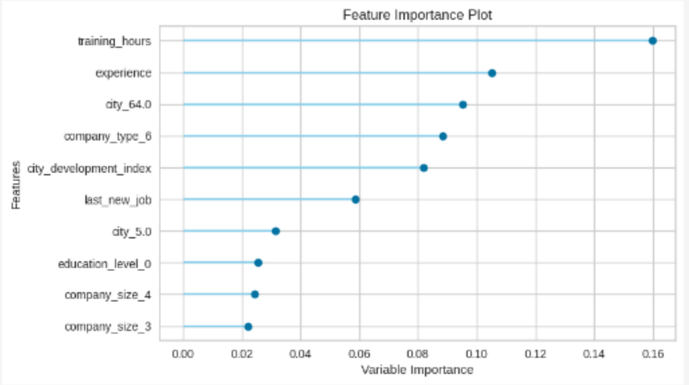
	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	TT (Sec)
0	Extreme Gradient Boosting	0.7879	0.7865	0.5123	0.5748	0.5415	0.4042	0.4055	
1	Gradient Boosting Classifier	0.7871	0.7859	0.5215	0.5714	0.5450	0.4065	0.4074	
2	Ada Boost Classifier	0.7844	0.7784	0.4697	0.5729	0.5157	0.3789	0.3823	
3	CatBoost Classifier	0.7843	0.7831	0.4974	0.5675	0.5299	0.3908	0.3924	
4	Light Gradient Boosting Machine	0.7811	0.7808	0.4743	0.5628	0.5146	0.3747	0.3770	
5	Extra Trees Classifier	0.7659	0.7415	0.4137	0.5277	0.4634	0.3167	0.3207	
6	Random Forest Classifier	0.7655	0.7359	0.3521	0.5326	0.4235	0.2840	0.2938	
7	Ridge Classifier	0.7642	0.0000	0.6973	0.5134	0.5911	0.4308	0.4411	
8	Linear Discriminant Analysis	0.7639	0.7829	0.6964	0.5129	0.5905	0.4299	0.4401	
9	Logistic Regression	0.7593	0.7826	0.7084	0.5063	0.5900	0.4264	0.4390	
10	Decision Tree Classifier	0.7038	0.6075	0.4188	0.4000	0.4088	0.2116	0.2118	
11	SVM - Linear Kernel	0.6502	0.0000	0.6361	0.4553	0.4577	0.2519	0.2968	
12	K Neighbors Classifier	0.5434	0.6045	0.6330	0.2971	0.4043	0.1067	0.1269	
13	Naive Bayes	0.4182	0.6254	0.8570	0.2776	0.4192	0.0782	0.1328	
14	Quadratic Discriminant Analysis	0.2664	0.5048	0.9727	0.2468	0.3937	0.0051	0.0226	

분석결과

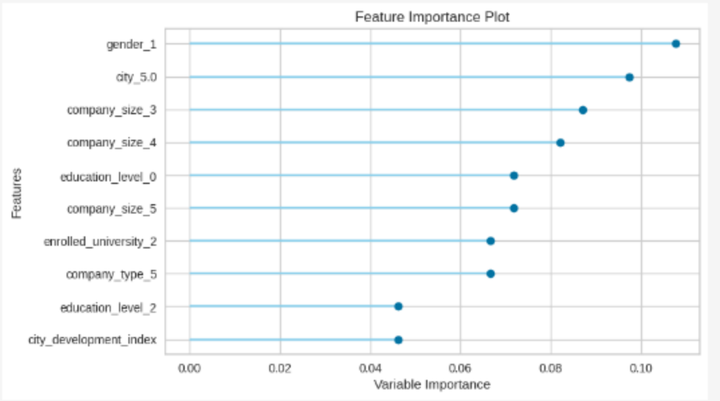
Top 3 Model - Feature Importance



Top 1 - XGB



Top 2 - GB



Top 3 - adaboost

End of Document