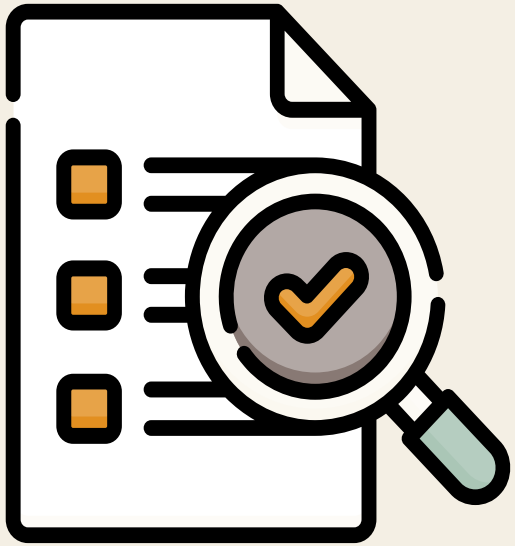
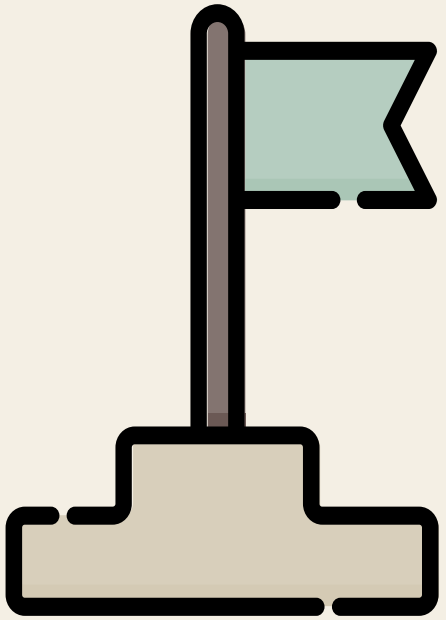
Data Science Practices Final Project



Data source : Data Science Job Salaries



1.EDA

Original Data

```
> head(df_original)
  X work_year experience_level employment_type                 job_title salary
1 0      2020               MI              FT              Data Scientist  70000
2 1      2020               SE              FT Machine Learning Scientist 260000
3 2      2020               SE              FT           Big Data Engineer  85000
4 3      2020               MI              FT        Product Data Analyst  20000
5 4      2020               SE              FT  Machine Learning Engineer 150000
6 5      2020               EN              FT                Data Analyst  72000
  salary_currency salary_in_usd employee_residence remote_ratio company_location company_size
1             EUR         79833                 DE            0                DE            L
2             USD        260000                 JP            0                JP            S
3             GBP        109024                 GB           50                GB            M
4             USD         20000                 HN            0                HN            S
5             USD        150000                 US           50                US            L
6             USD         72000                 US          100                US            L
>
```

Data Structure

```
> str(df_original)
'data.frame':   607 obs. of  12 variables:
 $ X                 : int  0 1 2 3 4 5 6 7 8 9 ...
 $ work_year         : int  2020 2020 2020 2020 2020 2020 2020 2020 2020 2020 ...
 $ experience_level  : chr  "MI" "SE" "SE" "MI" ...
 $ employment_type   : chr  "FT" "FT" "FT" "FT" ...
 $ job_title         : chr  "Data Scientist" "Machine Learning Scientist" "Big Data Engineer" "Product
 Data Analyst" ...
 $ salary            : int  70000 260000 85000 20000 150000 72000 190000 11000000 135000 125000 ...
 $ salary_currency   : chr  "EUR" "USD" "GBP" "USD" ...
 $ salary_in_usd     : int  79833 260000 109024 20000 150000 72000 190000 35735 135000 125000 ...
 $ employee_residence: chr  "DE" "JP" "GB" "HN" ...
 $ remote_ratio      : int  0 0 50 0 50 100 100 50 100 50 ...
 $ company_location  : chr  "DE" "JP" "GB" "HN" ...
 $ company_size      : chr  "L" "S" "M" "S" ...
```

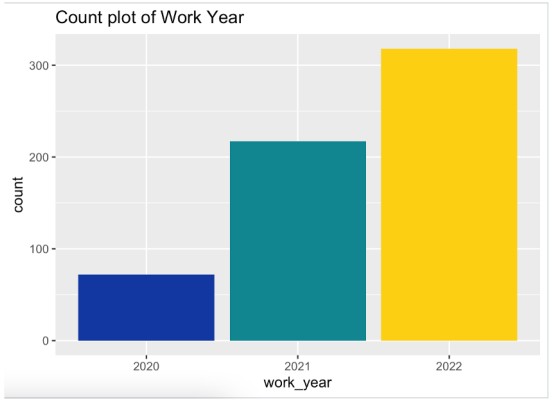
Distribution

```
> # salary's range is large since contractors gets paid in hours while others get paid in month)
> summary(df_original)
       X           work_year    experience_level   employment_type     job_title
 Min.   :  0.0   Min.   :2020   Length:607         Length:607         Length:607
 1st Qu.:151.5   1st Qu.:2021   Class :character   Class :character   Class :character
 Median :303.0   Median :2022   Mode  :character   Mode  :character   Mode  :character
 Mean   :303.0   Mean   :2021
 3rd Qu.:454.5   3rd Qu.:2022
 Max.   :606.0   Max.   :2022
    salary         salary_currency    salary_in_usd    employee_residence  remote_ratio
 Min.   :    4000   Length:607         Min.   :  2859   Length:607         Min.   :  0.00
 1st Qu.:   70000   Class :character   1st Qu.: 62726   Class :character   1st Qu.: 50.00
 Median :  115000   Mode  :character   Median :101570   Mode  :character   Median :100.00
 Mean   :  324000                      Mean   :112298                      Mean   : 70.92
 3rd Qu.:  165000                      3rd Qu.:150000                      3rd Qu.:100.00
 Max.   :30400000                      Max.   :600000                      Max.   :100.00
 company_location   company_size
 Length:607         Length:607
 Class :character   Class :character
 Mode  :character   Mode  :character
```

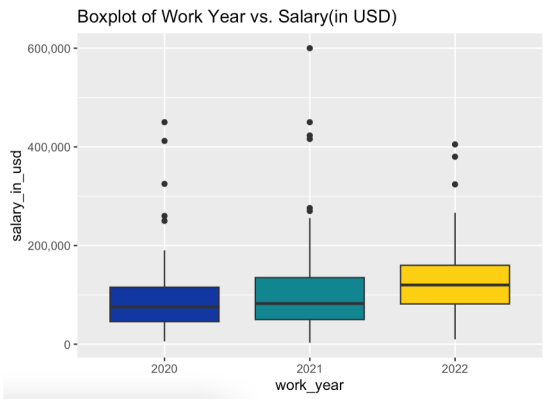
Categorical variable data

```
> table(df["experience_level"])
experience_level
 EN  EX  MI  SE
 88  26 213 280
> table(df["employment_type"])
employment_type
 CT  FL  FT  PT
  5   4 588  10
> table(df["remote_ratio"])
remote_ratio
  0 100  50
127 381  99
> table(df["company_size"])
company_size
  L   M   S
198 326  83
```

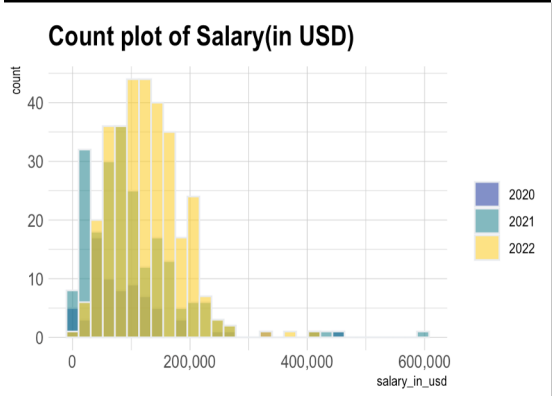
Visualization(Work Year)



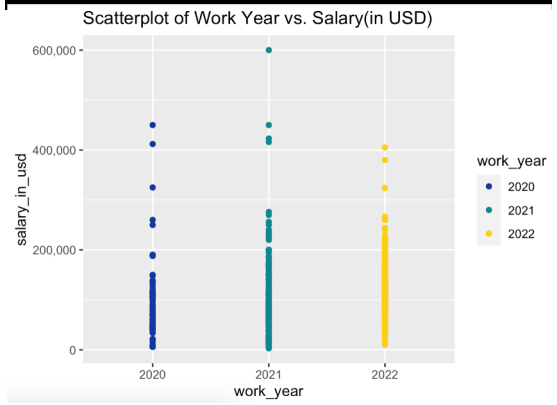
#1



#2



#3



#4

Countplot

Work Year

Countplot(Salary)

Salary(In USD)

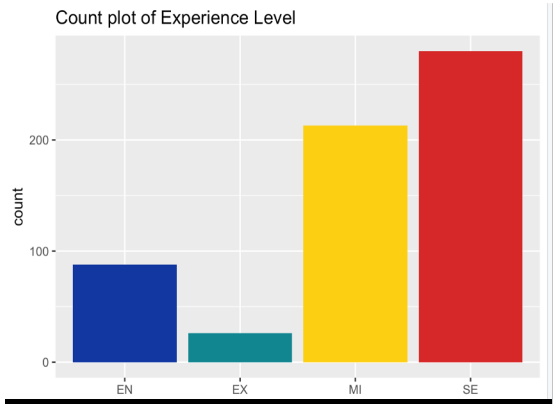
Boxplot

Work vs. Salary(In USD)

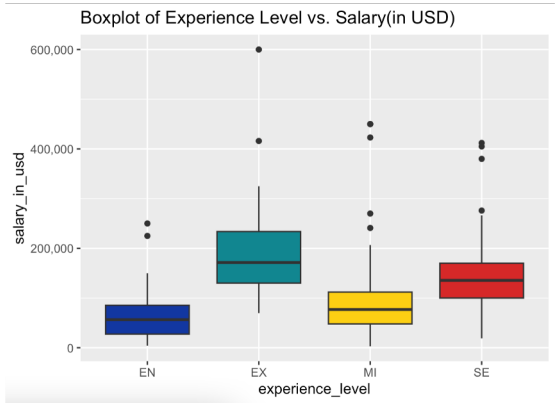
Scatterplot

Work vs. Salary(In USD)

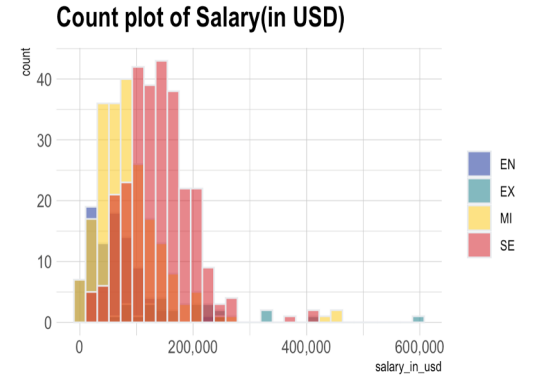
Visualization(Experience Level)



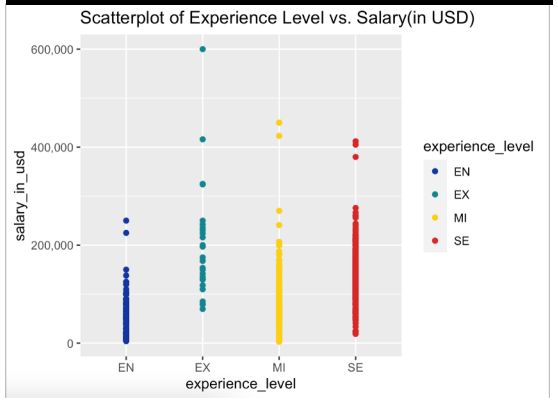
#1



#2



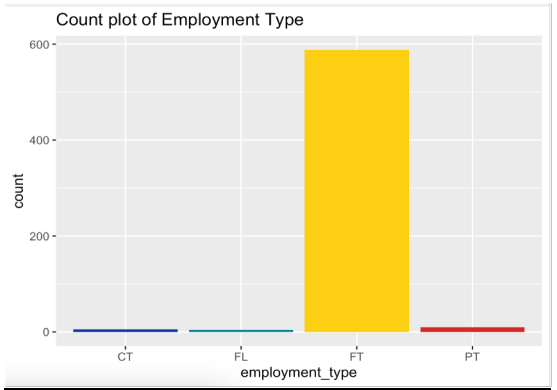
#3



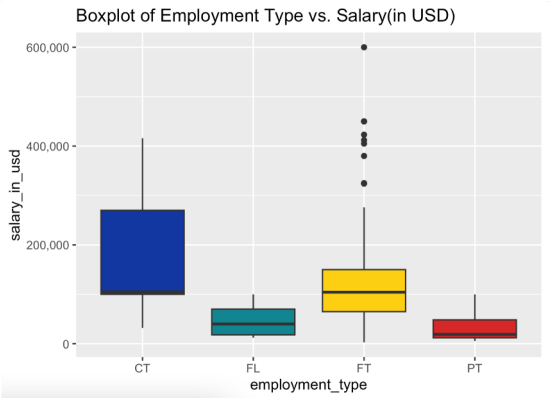
#4

- **Countplot**
  Experience Level
- **Countplot(Salary)**
  Experience Level vs. Salary(In USD)
- **Boxplot**
  Experience Level vs. Salary(In USD)
- **Scatterplot**
  Experience Level vs. Salary(In USD)

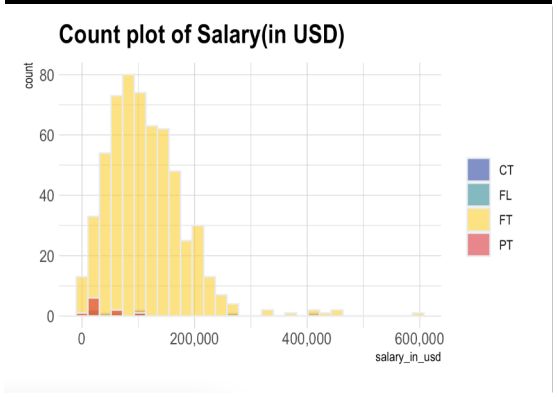
Visualization(Employment Type)



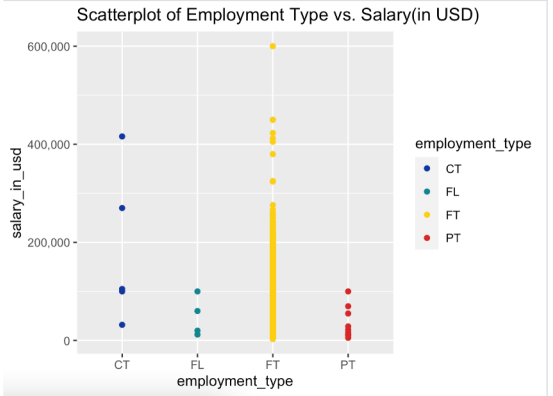
#1



#2



#3



#4

Countplot

Employment Type

Countplot(Salary)

Employment Type vs. Salary(In USD)

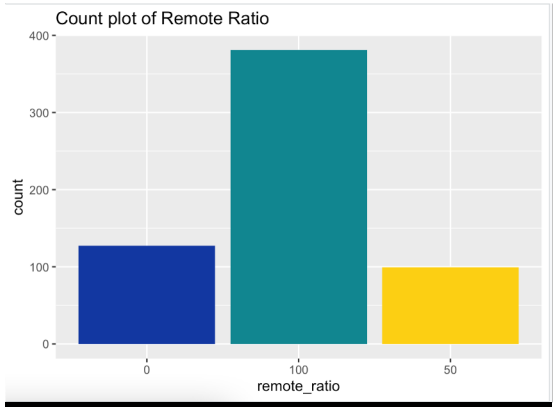
Boxplot

Employment Type vs. Salary(In USD)

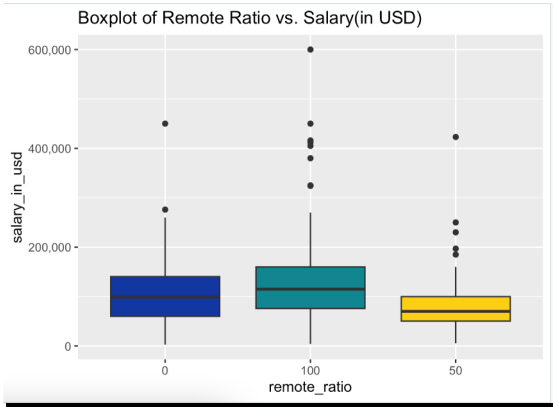
Scatterplot

Employment Type vs. Salary(In USD)

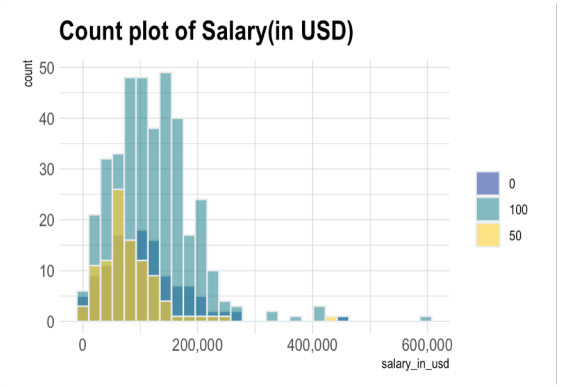
Visualization(Remote Rate)



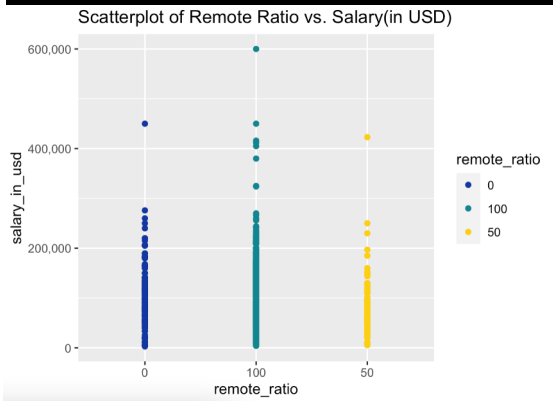
#1



#2



#3



#4

Countplot

Remote Ratio

Countplot(In USD)

Remote Ratio vs. Salary(In USD)

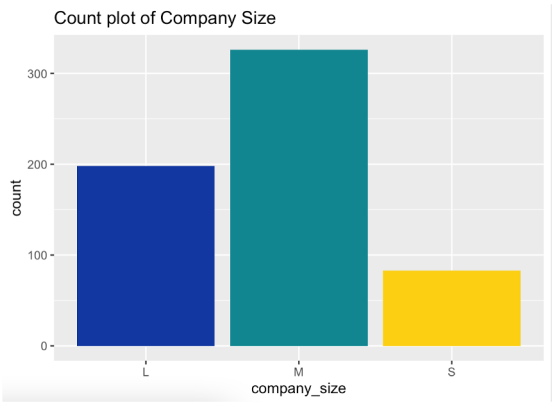
Boxplot

Remote Ratio vs. Salary(In USD)

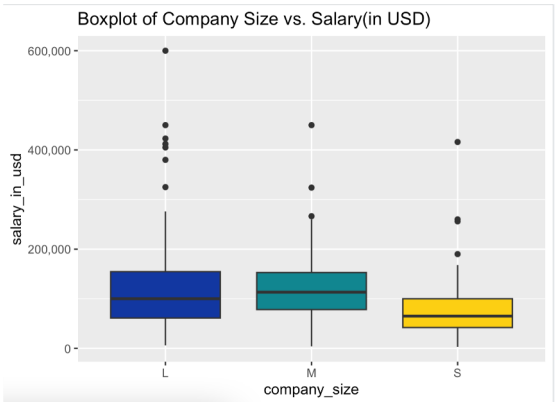
Scatterplot

Remote Ratio vs. Salary(In USD)

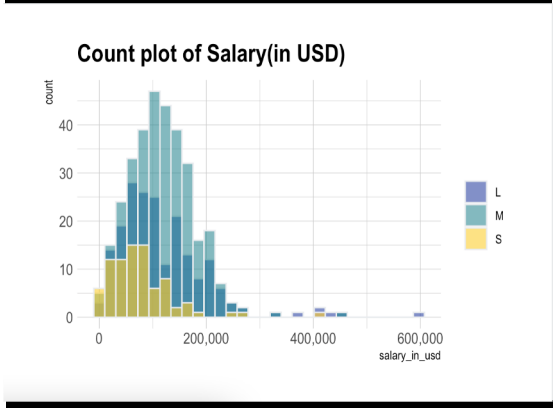
Visualization(Company Size)



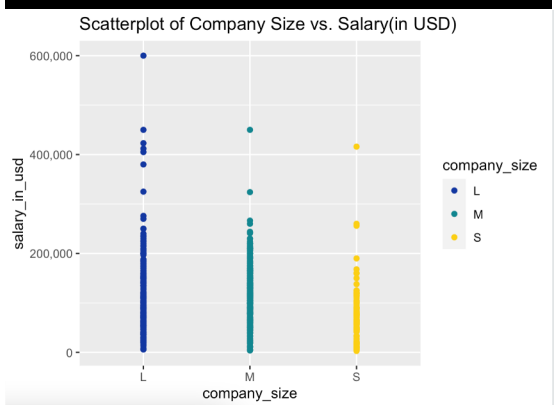
#1



#2



#3



#4

Countplot

Company Size

Countplot(Salary)

Company Size vs. Salary(In USD)

Boxplot

Company Size vs. Salary(In USD)

Scatterplot

Company Size vs. Salary(In USD)

2. Data Preprocessing

Missing Value

```
> # check if there are missing values in data
> apply(df_original, 2, function(x) any(is.na(x))) # No missing value
                X          work_year   experience_level    employment_type          job_title
            FALSE              FALSE              FALSE              FALSE              FALSE
           salary    salary_currency      salary_in_usd employee_residence       remote_ratio
            FALSE              FALSE              FALSE              FALSE              FALSE
  company_location       company_size
            FALSE              FALSE
```

Outliers

```
df_drop_salary_outliers <- df[!(df$salary_in_usd >= 400000 | df$salary_in_usd <= 10000),]
```

```
> df_FT[(df_FT$employee_residence != df_FT$company_location & df_FT$remote_ratio == 0),]
    work_year experience_level          job_title salary_in_usd employee_residence remote_ratio
183      2021               MI      Data Engineer         26005                RO            0
282      2021               EN Research Scientist        100000                JE            0
    company_location company_size
183               US            L
282               CN            L
```

Country

```
developed <- c('DE','JP','GB','US','HU','NZ','FR','PL','PT','GR','AE','NL','CA','AT',
               'ES','DK','HR','IT','SG','BE','RU','RO','SI','HK','TR','LU','CZ','MY',
               'EE','AU','IE','CH','IL') #33
developing <- c('HN','IN','PK','CN','MX','NG','PH','BG','IQ','VN','BR','UA','MT','CL',
                'IR','CO','MD','KE','RS','PR','JE','AR','BO','AS') #24
```

```
> pairwise.t.test(df_FT$salary_in_usd, df_FT$employee_residence, p.adj='bonferroni')

        Pairwise comparisons using t tests with pooled SD

data:  df_FT$salary_in_usd and df_FT$employee_residence

           developed
developing 6.3e-16

P value adjustment method: bonferroni
> pairwise.t.test(df_FT$salary_in_usd, df_FT$company_location, p.adj='bonferroni')

        Pairwise comparisons using t tests with pooled SD

data:  df_FT$salary_in_usd and df_FT$company_location

           developed
developing <2e-16

P value adjustment method: bonferroni
```

Job titles

```
> sort(table(df$job_title), decreasing = TRUE)
```

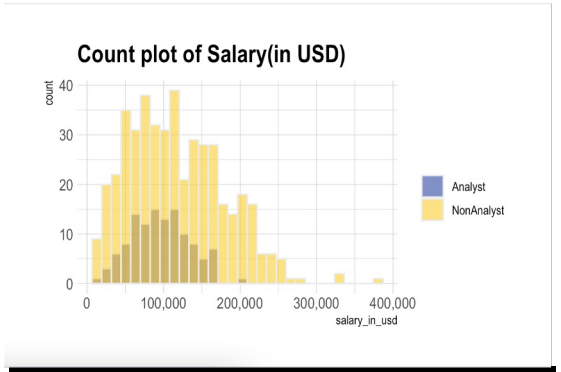
Data Scientist	Data Engineer	Data Analyst
143	132	97
Machine Learning Engineer	Research Scientist	Data Science Manager
41	16	12
Data Architect	Big Data Engineer	Machine Learning Scientist
11	8	8
AI Scientist	Data Analytics Manager	Data Science Consultant
7	7	7
Director of Data Science	Principal Data Scientist	BI Data Analyst
7	7	6
Computer Vision Engineer	Lead Data Engineer	ML Engineer
6	6	6
Applied Data Scientist	Business Data Analyst	Data Engineering Manager
5	5	5
Head of Data	Analytics Engineer	Applied Machine Learning Scientist
5	4	4
Data Analytics Engineer	Head of Data Science	Computer Vision Software Engineer
4	4	3
Data Science Engineer	Lead Data Analyst	Lead Data Scientist
3	3	3
Machine Learning Developer	Machine Learning Infrastructure Engineer	Principal Data Engineer
3	3	3
Cloud Data Engineer	Director of Data Engineering	ETL Developer
2	2	2
Financial Data Analyst	Principal Data Analyst	Product Data Analyst
2	2	2
3D Computer Vision Researcher	Big Data Architect	Data Analytics Lead
1	1	1
Data Specialist	Finance Data Analyst	Head of Machine Learning
1	1	1
Lead Machine Learning Engineer	Machine Learning Manager	Marketing Data Analyst
1	1	1
NLP Engineer	Staff Data Scientist	
1	1	

```r
Analyst <- c("Product Data Analyst", "Data Analyst", "Business Data Analyst",
             "Lead Data Analyst", "BI Data Analyst", "Marketing Data Analyst",
             "Data Analytics Manager", "Finance Data Analyst", "Principal Data Analyst",
             "Financial Data Analyst")
Scientist <- c("Data Scientist",  "Lead Data Scientist",  "Director of Data Science",
               "Research Scientist", "Data Science Consultant", "AI Scientist",
               "Principal Data Scientist", "Data Science Manager", "Head of Data",
               "Applied Data Scientist", "Head of Data Science", "Data Specialist")
Engineer <- c("Big Data Engineer", "Lead Data Engineer", "Data Engineer",
               "Data Engineering Manager", "Data Analytics Engineer", "Cloud Data Engineer",
               "Computer Vision Software Engineer", "Director of Data Engineering",
               "Data Science Engineer", "Principal Data Engineer", "Computer Vision Engineer",
               "Data Architect", "Big Data Architect", "Analytics Engineer", "ETL Developer",
               "NLP Engineer")
Machine_Learning <- c("Machine Learning Scientist", "Machine Learning Engineer",
                      "Machine Learning Manager",  "Machine Learning Infrastructure Engineer",
                      "Machine Learning Developer", "Applied Machine Learning Scientist",
                      "ML Engineer", "Head of Machine Learning", "Lead Machine Learning Engineer")
```

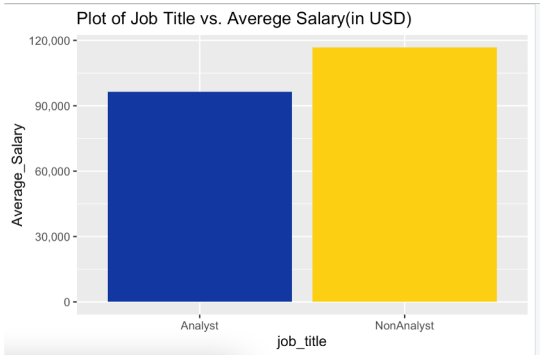
```r
> pairwise.t.test(df_FT$salary_in_usd, df_FT$job_title, p.adj='bonferroni')

        Pairwise comparisons using t tests with pooled SD

data:  df_FT$salary_in_usd and df_FT$job_title

                Analyst Engineer Machine_Learning
Engineer        0.0181  -        -
Machine_Learning 0.8062  1.0000   -
Scientist       0.0066  1.0000   1.0000

P value adjustment method: bonferroni
```

```
> pairwise.t.test(df_FT$salary_in_usd, df_FT$job_title, p.adj='bonferroni')

        Pairwise comparisons using t tests with pooled SD

data:  df_FT$salary_in_usd and df_FT$job_title

           Analyst
NonAnalyst 0.00081

P value adjustment method: bonferroni
```

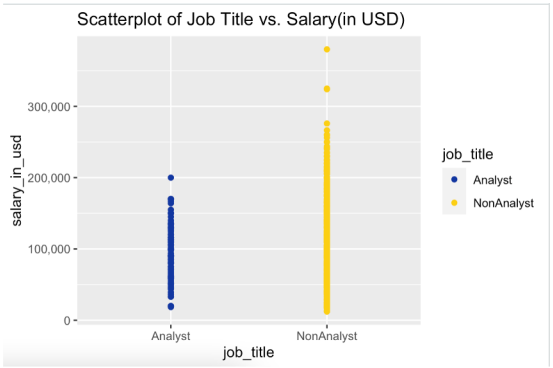
Visualization(Job Titles)



#1



#2



#3

Analyst

Company Size

NonAnalyst

Company Size vs. Salary(In USD)

Work Year

```
> aov(salary_in_usd~work_year, data = df_FT) %>% summary()
             Df    Sum Sq   Mean Sq F value  Pr(>F)
work_year     2 1.038e+11 5.190e+10   15.91 1.9e-07 ***
Residuals   564 1.840e+12 3.262e+09
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> # pairwise t test(bonferroni method) in work_year to see which pairs are different
> pairwise.t.test(df_FT$salary_in_usd, df_FT$work_year, p.adj='bonferroni')

        Pairwise comparisons using t tests with pooled SD

data:  df_FT$salary_in_usd and df_FT$work_year

     2020    2021
2021 1.00000 -
2022 0.00073 1.8e-06

P value adjustment method: bonferroni
> # set work_year into two categories: "before 2022" and "2022"
> df_FT$work_year[df_FT$work_year != "2022"] <- "before 2022"
```

Remote ratio

```
> # remote_ratio
> # there exist a significant difference between 3 levels
> aov(salary_in_usd~remote_ratio, data = df_FT) %>% summary()
              Df    Sum Sq   Mean Sq F value   Pr(>F)
remote_ratio   2 1.079e+11 5.396e+10   16.58 1.01e-07 ***
Residuals    564 1.836e+12 3.255e+09
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> # pairwise t test(bonferroni method) in remote_ratio to see which pairs are different
> pairwise.t.test(df_FT$salary_in_usd, df_FT$remote_ratio, p.adj='bonferroni')

        Pairwise comparisons using t tests with pooled SD

data:  df_FT$salary_in_usd and df_FT$remote_ratio

    0      100
100 0.1550 -
50  0.0026 5.3e-08

P value adjustment method: bonferroni
> # set remote_ratio into two categories: "partial" and "non-partial"
> df_FT$remote_ratio <- ifelse(df_FT$remote_ratio == "50", "partial", "non-partial")
```

Company Size

```
> pairwise.t.test(df_FT$salary_in_usd, df_FT$company_size, p.adj='bonferroni')

        Pairwise comparisons using t tests with pooled SD

data:  df_FT$salary_in_usd and df_FT$company_size

  L       M
M 0.75275 -
S 0.00048 4.7e-06

P value adjustment method: bonferroni
> # set company_size into two categories: "S"(small) and "L"(large) (Combining original M and L)
> df_FT$company_size[df_FT$company_size == "M"] <- "L"
```

Overview

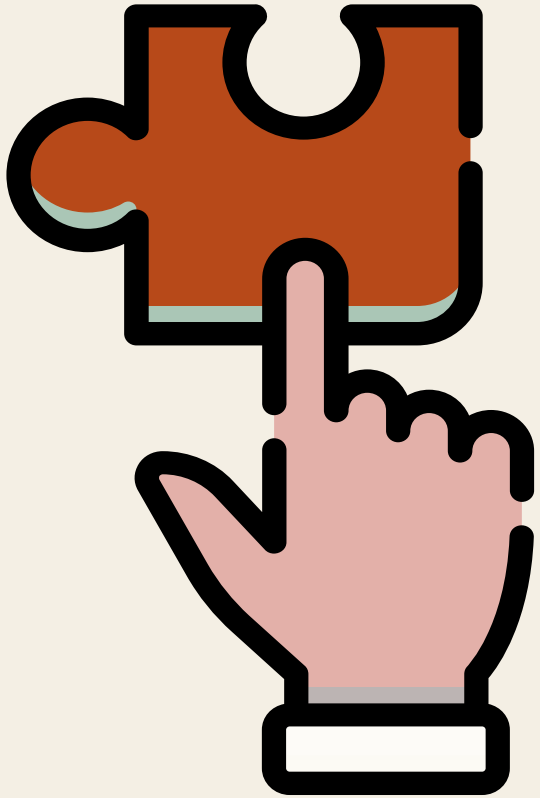
rows = 607

work_year	experience_level	employment_type	job_title	salary_in_usd	employee_reside
2020	MI	FT	Data Scientist	79833	DE
2020	SE	FT	Machine Learning Scientist	260000	JP
2020	SE	FT	Big Data Engineer	109024	GB
2020	MI	FT	Product Data Analyst	20000	HN
2020	SE	FT	Machine Learning Engineer	150000	US
2020	EN	FT	Data Analyst	72000	US

rows = 567

work_year	experience_level	job_title	salary_in_usd	employee_residence	remote_ratio	company_location	compa
before 2022	MI	NonAnalyst	79833	developed	non-partial	developed	L
before 2022	SE	NonAnalyst	260000	developed	non-partial	developed	S
before 2022	SE	NonAnalyst	109024	developed	partial	developed	L
before 2022	MI	Analyst	20000	developing	non-partial	developing	S
before 2022	SE	NonAnalyst	150000	developed	partial	developed	L
before 2022	EN	Analyst	72000	developed	non-partial	developed	L

Dummy base：work_year_2022, experience_level_EN, job_title_Analyst, employee_residence_developing, remote_ratio_partial, company_location_developing, company_size_S



3. Linear Regression

(training:testing = 8:2)

```
> summary(linear_all_model)

Call:
lm(formula = salary_in_usd ~ ., data = train_df_FT_dummy)

Residuals:
    Min      1Q  Median      3Q     Max
-102535  -28910   -4264   22562  173775

Coefficients:
                            Estimate Std. Error t value Pr(>|t|)
(Intercept)                -39798.3    14447.6  -2.755  0.00612 **
`work_year_before 2022`       178.0     4959.0   0.036  0.97139
experience_level_EX         83180.1    12105.1   6.872 2.16e-11 ***
experience_level_MI           179.9     7123.2   0.025  0.97986
experience_level_SE         44851.8     7111.0   6.307 6.88e-10 ***
job_title_NonAnalyst        28646.4     5272.9   5.433 9.17e-08 ***
employee_residence_developed 27766.6    13357.5   2.079  0.03822 *
`remote_ratio_non-partial`  28011.5     6208.9   4.512 8.26e-06 ***
company_location_developed  44291.4    15799.9   2.803  0.00528 **
company_size_L              15141.1     6602.1   2.293  0.02229 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 44950 on 443 degrees of freedom
Multiple R-squared:  0.3971,    Adjusted R-squared:  0.3849
F-statistic: 32.42 on 9 and 443 DF,  p-value: < 2.2e-16
```

```
> anova(linear_all_model)
Analysis of Variance Table

Response: salary_in_usd
                            Df     Sum Sq    Mean Sq F value    Pr(>F)
`work_year_before 2022`      1 7.3776e+10 7.3776e+10 36.5187 3.210e-09 ***
experience_level_EX          1 7.6085e+10 7.6085e+10 37.6619 1.869e-09 ***
experience_level_MI          1 1.0345e+11 1.0345e+11 51.2053 3.473e-12 ***
experience_level_SE          1 1.2157e+11 1.2157e+11 60.1753 6.030e-14 ***
job_title_NonAnalyst         1 4.3370e+10 4.3370e+10 21.4680 4.738e-06 ***
employee_residence_developed 1 1.0768e+11 1.0768e+11 53.3009 1.337e-12 ***
`remote_ratio_non-partial`   1 3.9283e+10 3.9283e+10 19.4449 1.301e-05 ***
company_location_developed   1 1.3699e+10 1.3699e+10  6.7809  0.009523 **
company_size_L               1 1.0625e+10 1.0625e+10  5.2595  0.022294 *
Residuals                  443 8.9496e+11 2.0202e+09
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> vif(linear_all_model)
     `work_year_before 2022`          experience_level_EX          experience_level_MI
                    1.372920                     1.320321                     2.627794
         experience_level_SE         job_title_NonAnalyst employee_residence_developed
                    2.826042                     1.041232                     3.074574
  `remote_ratio_non-partial`   company_location_developed               company_size_L
                    1.181401                     3.028380                     1.123086
```

```
> linear_all_model_comparison
```

Best Subsets Regression

Model Index	Predictors
1	experience_level_SE
2	experience_level_EX experience_level_SE
3	experience_level_EX experience_level_SE company_location_developed
4	experience_level_EX experience_level_SE job_title_NonAnalyst company_location_developed
5	experience_level_EX experience_level_SE job_title_NonAnalyst `remote_ratio_non-partial` company_location_developed
6	experience_level_EX experience_level_SE job_title_NonAnalyst `remote_ratio_non-partial` company_location_developed company_size_L
7	experience_level_EX experience_level_SE job_title_NonAnalyst employee_residence_developed `remote_ratio_non-partial` company_location_developed company_size_L
8	`work_year_before 2022` experience_level_EX experience_level_SE job_title_NonAnalyst employee_residence_developed `remote_ratio_non-partial` company_location_developed company_size_L
9	`work_year_before 2022` experience_level_EX experience_level_MI experience_level_SE job_title_NonAnalyst employee_residence_developed `remote_ratio_non-partial` company_location_developed company_size_L

Subsets Regression Summary

Model	R-Square	Adj. R-Square	Pred R-Square	C(p)	AIC	SBIC	SBC	MSEP	FPE	HSP	APC
1	0.1407	0.1388	0.1331	182.4306	11148.1903	9861.3420	11160.5380	1.281287e+12	2840936556.1735	6285442.0510	0.8669
2	0.2375	0.2341	0.2224	113.2853	11096.0378	9809.2573	11112.5014	1.139453e+12	2531993754.4245	5602084.4115	0.7727
3	0.3181	0.3136	0.3032	56.0589	11047.4276	9761.0835	11068.0070	1.021279e+12	2274362681.1041	5032267.3811	0.6940
4	0.3486	0.3428	0.3325	35.6319	11028.6839	9742.5843	11053.3793	977749559906.4053	2182178243.6986	4828535.4298	0.6659
5	0.3814	0.3745	0.3631	13.5745	11007.3227	9721.7228	11036.1339	930687127478.8279	2081667364.2321	4606403.6460	0.6352
6	0.3912	0.3830	0.3704	8.3366	11002.0517	9716.6704	11034.9789	917926398218.9318	2057588144.5508	4553431.5070	0.6279
7	0.3971	0.3876	0.3716	6.0018	10999.6407	9714.4425	11036.6838	9.11079e+11	2046668600.4813	4529620.6641	0.6246
8	0.3971	0.3863	0.3682	8.0006	11001.6395	9716.4865	11042.7984	913133123971.1831	2055722238.5901	4550058.0169	0.6273
9	0.3971	0.3849	0.3657	10.0000	11003.6389	9718.5310	11048.9137	915197717575.2903	2064819380.0287	4570639.9302	0.6301

AIC: Akaike Information Criteria
SBIC: Sawa's Bayesian Information Criteria
SBC: Schwarz Bayesian Criteria
MSEP: Estimated error of prediction, assuming multivariate normality
FPE: Final Prediction Error
HSP: Hocking's Sp
APC: Amemiya Prediction Criteria

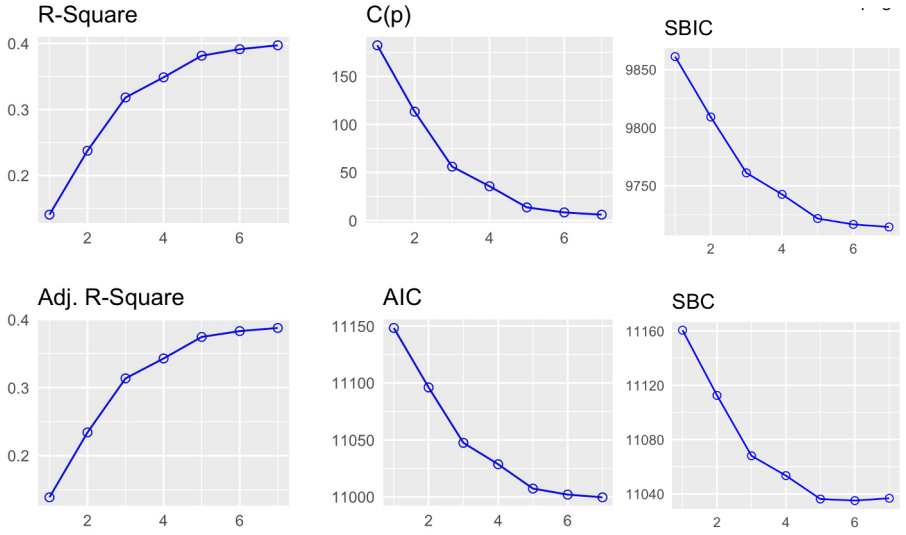
```
> # best model subset
> linear_all_model_comparison$predictors[7]
[1] "experience_level_EX experience_level_SE job_title_NonAnalyst employee_residence_developed `remote_ratio_non
-partial` company_location_developed company_size_L"
```

Discarded variables：work_year

```
> # stepwise selection
> bothFit.p <- ols_step_both_p(linear_all_model, prent = 0.15, prem = 0.15)
> bothFit.p
```

Stepwise Selection Summary

Step	Variable	Added/ Removed	R-Square	Adj. R-Square	C(p)	AIC	RMSE
1	experience_level_SE	addition	0.141	0.139	182.4310	11148.1903	53183.1639
2	experience_level_EX	addition	0.238	0.234	113.2850	11096.0378	50153.1245
3	company_location_developed	addition	0.318	0.314	56.0590	11047.4276	47481.1098
4	job_title_NonAnalyst	addition	0.349	0.343	35.6320	11028.6839	46458.1030
5	`remote_ratio_non-partial`	addition	0.381	0.374	13.5750	11007.3227	45326.1076
6	company_size_L	addition	0.391	0.383	8.3370	11002.0517	45014.1869
7	employee_residence_developed	addition	0.397	0.388	6.0020	10999.6407	44845.8646



Best model variables :

1.experience_level
2.job_title
3.employee_residence
4.remote_ratio
5.company_location
6.company_size

Discarded variables

1.work_year

```
> summary(linear_model)

Call:
lm(formula = salary_in_usd ~ ., data = selected_train_df_FT_dummy)

Residuals:
    Min      1Q  Median      3Q     Max
-102466  -28958   -4294   22539  173787

Coefficients:
                           Estimate Std. Error t value Pr(>|t|)
(Intercept)                 -39547      12624  -3.133  0.00185 **
experience_level_EX          83148      12058   6.896 1.85e-11 ***
experience_level_MI            168       7107   0.024  0.98115
experience_level_SE          44811       7011   6.391 4.17e-10 ***
job_title_NonAnalyst         28665       5243   5.468 7.62e-08 ***
employee_residence_developed 27731      13305   2.084  0.03772 *
`remote_ratio_non-partial`   27934       5814   4.804 2.13e-06 ***
company_location_developed   44277      15777   2.806  0.00523 **
company_size_L               15088       6426   2.348  0.01931 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 44900 on 444 degrees of freedom
Multiple R-squared:  0.3971,    Adjusted R-squared:  0.3863
F-statistic: 36.56 on 8 and 444 DF,  p-value: < 2.2e-16
```

```
> anova(linear_model)
Analysis of Variance Table

Response: salary_in_usd
                             Df     Sum Sq    Mean Sq F value    Pr(>F)
experience_level_EX           1 7.9033e+10 7.9033e+10 39.2092 8.994e-10 ***
experience_level_MI           1 1.2343e+11 1.2343e+11 61.2371 3.737e-14 ***
experience_level_SE           1 1.5640e+11 1.5640e+11 77.5939 < 2.2e-16 ***
job_title_NonAnalyst          1 3.4962e+10 3.4962e+10 17.3450 3.746e-05 ***
employee_residence_developed  1 1.2273e+11 1.2273e+11 60.8859 4.371e-14 ***
`remote_ratio_non-partial`    1 4.8132e+10 4.8132e+10 23.8790 1.435e-06 ***
company_location_developed    1 1.3724e+10 1.3724e+10  6.8088  0.009377 **
company_size_L                1 1.1113e+10 1.1113e+10  5.5131  0.019312 *
Residuals                   444 8.9496e+11 2.0157e+09
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Call:
lm(formula = salary_in_usd ~ .^2, data = selected_train_df_FT_dummy)

Residuals:
    Min      1Q  Median      3Q     Max
-125959  -25128   -3128   20549  175887

Coefficients: (5 not defined because of singularities)
                                                          Estimate Std. Error t value Pr(>|t|)
(Intercept)                                                  80235      50547   1.587  0.11319
experience_level_EX                                        -154756      75443  -2.051  0.04086 *
experience_level_MI                                          -5273      37881  -0.139  0.88935
experience_level_SE                                         -35328      37629  -0.939  0.34836
job_title_NonAnalyst                                         3915      43084   0.091  0.92765
employee_residence_developed                               -40313      86207  -0.468  0.64030
`remote_ratio_non-partial`                                 -62548      33573  -1.863  0.06315 .
company_location_developed                                  39342      95380   0.412  0.68021
company_size_L                                             -43320      33154  -1.307  0.19205
experience_level_EX:experience_level_MI                       NA         NA      NA       NA
experience_level_EX:experience_level_SE                       NA         NA      NA       NA
experience_level_EX:job_title_NonAnalyst                   69903      38210   1.829  0.06804 .
experience_level_EX:employee_residence_developed           35511      59268   0.599  0.54938
experience_level_EX:`remote_ratio_non-partial`             54020      36857   1.466  0.14348
experience_level_EX:company_location_developed                NA         NA      NA       NA
experience_level_EX:company_size_L                        113635      36792   3.089  0.00214 **
experience_level_MI:experience_level_SE                       NA         NA      NA       NA
experience_level_MI:job_title_NonAnalyst                   -2164      19185  -0.113  0.91023
experience_level_MI:employee_residence_developed           -12992      42799  -0.304  0.76161
experience_level_MI:`remote_ratio_non-partial`               2714      16855   0.161  0.87213
experience_level_MI:company_location_developed              -6673      47698  -0.140  0.88880
experience_level_MI:company_size_L                          33648      17000   1.979  0.04843 *
experience_level_SE:job_title_NonAnalyst                    17660      19245   0.918  0.35933
experience_level_SE:employee_residence_developed            21130      42896   0.493  0.62257
experience_level_SE:`remote_ratio_non-partial`              36702      16882   2.174  0.03026 *
experience_level_SE:company_location_developed               7881      47849   0.165  0.86925
experience_level_SE:company_size_L                          14436      17857   0.808  0.41930
job_title_NonAnalyst:employee_residence_developed           -5228      59793  -0.087  0.93037
job_title_NonAnalyst:`remote_ratio_non-partial`              2284      18471   0.124  0.90163
job_title_NonAnalyst:company_location_developed             10658      68048   0.157  0.87561
job_title_NonAnalyst:company_size_L                          9427      21479   0.439  0.66097
employee_residence_developed:`remote_ratio_non-partial`     47225      42135   1.121  0.26301
employee_residence_developed:company_location_developed        NA         NA      NA       NA
employee_residence_developed:company_size_L                 34573      31085   1.112  0.26668
`remote_ratio_non-partial`:company_location_developed       13715      48605   0.282  0.77794
`remote_ratio_non-partial`:company_size_L                   17857      15907   1.123  0.26227
company_location_developed:company_size_L                  -15177      37163  -0.408  0.68320
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 44040 on 421 degrees of freedom
Multiple R-squared:  0.4499,    Adjusted R-squared:  0.4094
F-statistic: 11.11 on 31 and 421 DF,  p-value: < 2.2e-16
```

```
> summary(linear_model3)

Call:
lm(formula = salary_in_usd ~ . + experience_level_EX:company_size_L +
    experience_level_MI:company_size_L + experience_level_SE:`remote_ratio_non-partial`,
    data = selected_train_df_FT_dummy)

Residuals:
    Min      1Q  Median      3Q     Max
-109697  -27426   -4179   23454  170656

Coefficients:
                                          Estimate Std. Error t value Pr(>|t|)
(Intercept)                               -23744.5    13704.6  -1.733  0.08387 .
experience_level_EX                          216.3    32507.6   0.007  0.99469
experience_level_MI                       -14383.7    12685.2  -1.134  0.25745
experience_level_SE                        24538.7    11872.7   2.067  0.03933 *
job_title_NonAnalyst                       28819.9     5188.7   5.554 4.82e-08 ***
employee_residence_developed               25157.8    13211.3   1.904  0.05753 .
`remote_ratio_non-partial`                 18082.7     7215.5   2.506  0.01257 *
company_location_developed                 45431.7    15600.1   2.912  0.00377 **
company_size_L                              3678.7     8175.5   0.450  0.65295
experience_level_EX:company_size_L         97053.8    34138.4   2.843  0.00468 **
experience_level_MI:company_size_L         20585.7    13240.7   1.555  0.12073
experience_level_SE:`remote_ratio_non-partial` 27962.6    11971.4   2.336  0.01995 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 44320 on 441 degrees of freedom
Multiple R-squared:  0.4165,    Adjusted R-squared:  0.4019
F-statistic: 28.62 on 11 and 441 DF,  p-value: < 2.2e-16
```

Prediction validation (train/test set)

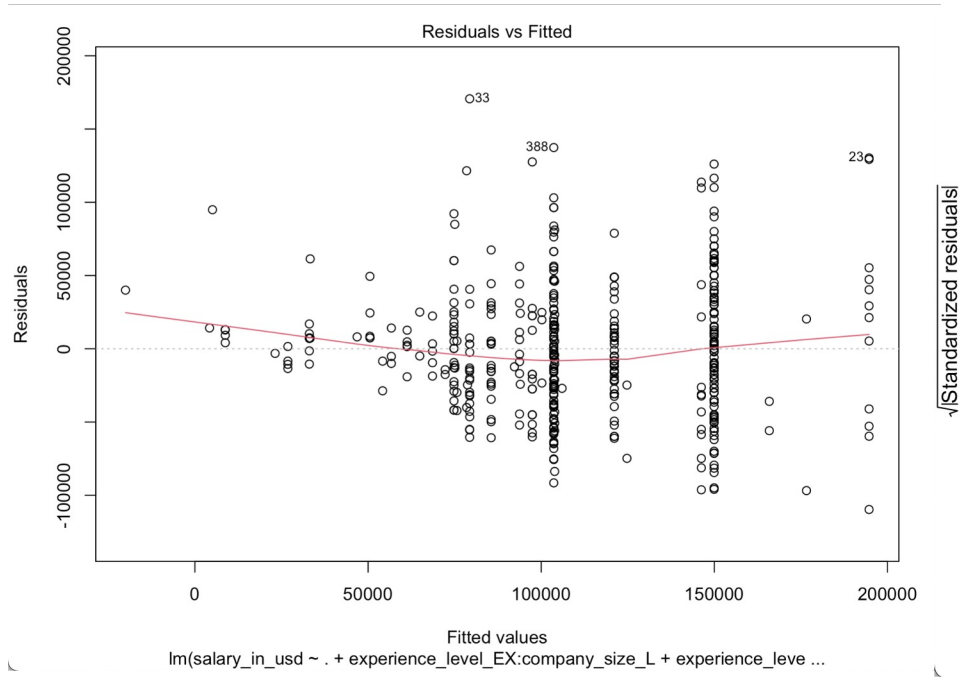
```
> validation
                    MAPE     RMSE      MAE
linear_model3 0.4262145 45478.7 33008.41
```

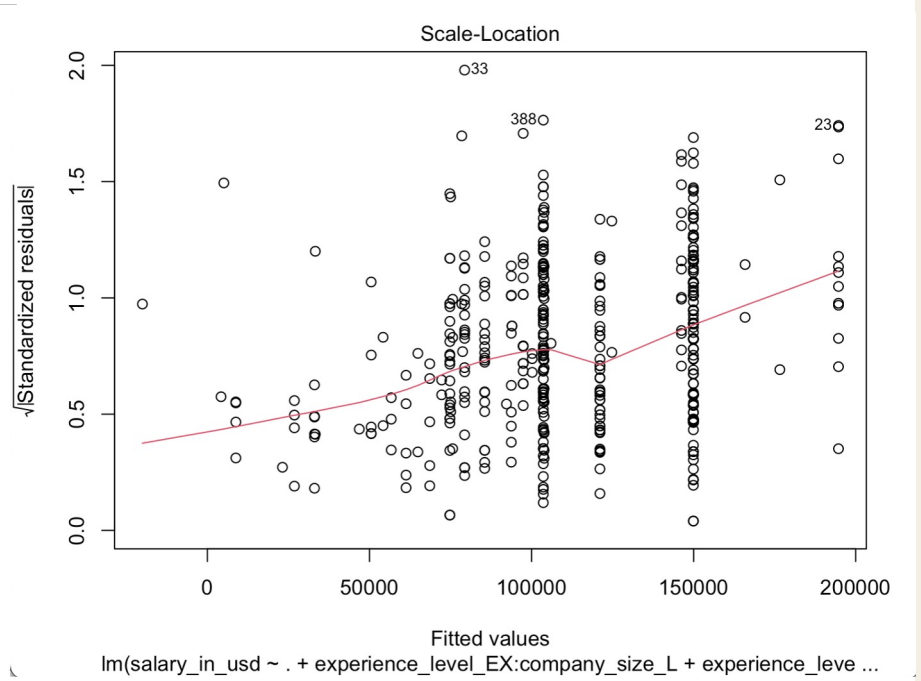
```
> summary(cv_model)

Call:
lm(formula = .outcome ~ ., data = dat)

Residuals:
    Min      1Q  Median      3Q     Max
-126675  -28065   -3414   23975  228325

Coefficients:
                                                 Estimate Std. Error t value
(Intercept)                                       -29324      12201  -2.403
experience_level_EX                                 7359      32429   0.227
experience_level_MI                                -7371      11481  -0.642
experience_level_SE                                28934      11191   2.586
job_title_NonAnalyst                               29712       4673   6.358
employee_residence_developed                       23924      12218   1.958
`\\`remote_ratio_non-partial\\``                   17727       6456   2.746
company_location_developed                         44566      14214   3.135
company_size_L                                      7614       7638   0.997
`experience_level_EX:company_size_L`               91625      33786   2.712
`experience_level_MI:company_size_L`               16855      12138   1.389
`experience_level_SE:\\`remote_ratio_non-partial\\``  28522      11172   2.553
                                                 Pr(>|t|)
(Intercept)                                       0.01657 *
experience_level_EX                               0.82056
experience_level_MI                               0.52111
experience_level_SE                               0.00998 **
job_title_NonAnalyst                             4.28e-10 ***
employee_residence_developed                      0.05071 .
`\\`remote_ratio_non-partial\\``                  0.00623 **
company_location_developed                        0.00181 **
company_size_L                                    0.31930
`experience_level_EX:company_size_L`              0.00690 **
`experience_level_MI:company_size_L`              0.16551
`experience_level_SE:\\`remote_ratio_non-partial\\``  0.01095 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 44510 on 555 degrees of freedom
Multiple R-squared:  0.4343,    Adjusted R-squared:  0.4231
F-statistic: 38.73 on 11 and 555 DF,  p-value: < 2.2e-16
```

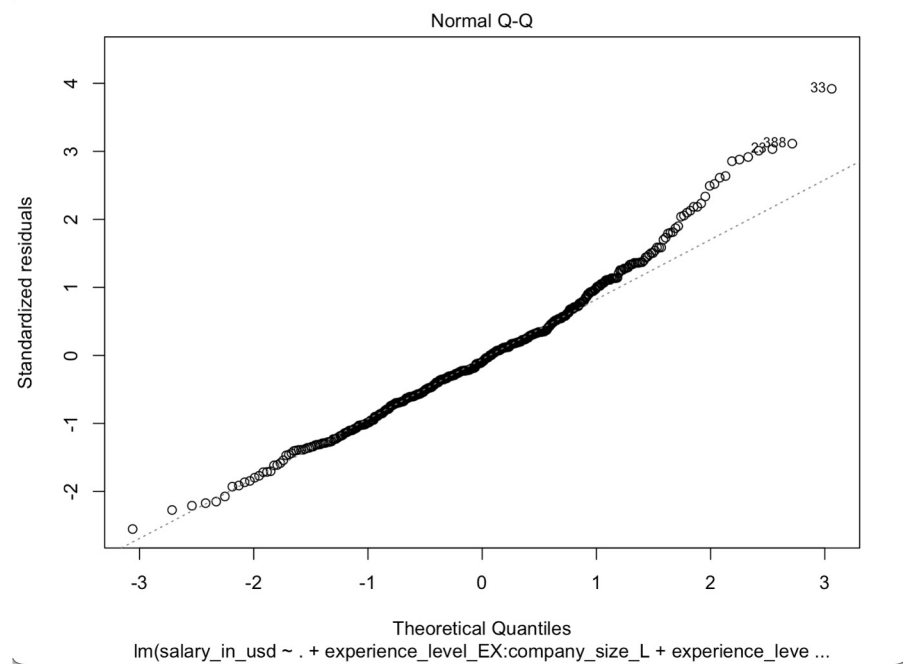
Prediction validation(5 folds CV)

```
> print(cv_model)
Linear Regression

567 samples
  8 predictor

No pre-processing
Resampling: Cross-Validated (5 fold)
Summary of sample sizes: 454, 454, 454, 453, 453
Resampling results:

  RMSE      Rsquared   MAE
  44802.06  0.4194596  34122.3

Tuning parameter 'intercept' was held constant at a value of TRUE
```

Prediction validation(5 folds CV)








```
> # normality test
> shapiro.test(linear_model3$residuals) # alpha = 0.05

        Shapiro-Wilk normality test

data:  linear_model3$residuals
W = 0.9803, p-value = 8.052e-06

> # independence test
> durbinWatsonTest(linear_model3) # alpha = 0.05
 lag Autocorrelation D-W Statistic p-value
   1      0.02267397      1.953977   0.608
 Alternative hypothesis: rho != 0
>
> # homogeneity test
> ncvTest(linear_model3) # alpha = 0.05
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare = 23.04468, Df = 1, p = 1.5828e-06
```

Residual Analysis

4.Logistic Regression (training:testing = 8:2)

```
> summary(df_FT_dummy$salary_in_usd)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  12103   66144  105000  112462  150000  380000
```

salary_in_usd
79833
260000
109024
20000
150000
72000
190000
35735
135000
125000
51321
40481
39916
87000
85000
41689
114047
56000

salary_in_usd
0
1
1
0
1
0
1
0
1
1
0
0
0
0
0
0
1
0

Threshold = median

```
> summary(logi_all_model)

Call:
glm(formula = salary_in_usd ~ ., family = binomial, data = train_df_FT_dummy_classifi)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-2.03519  -0.90835  -0.00013   0.67768   2.10202

Coefficients:
                           Estimate Std. Error z value Pr(>|z|)
(Intercept)                -21.0741   678.5908  -0.031 0.975225
`work_year_before 2022`     -0.1484     0.2607  -0.569 0.569099
experience_level_EX          2.7567     0.7528   3.662 0.000250 ***
experience_level_MI          0.4333     0.4282   1.012 0.311565
experience_level_SE          2.1748     0.4249   5.118 3.09e-07 ***
job_title_NonAnalyst         0.9812     0.2819   3.481 0.000500 ***
employee_residence_developed 1.1062     0.7401   1.495 0.134997
`remote_ratio_non-partial`   1.2725     0.3643   3.493 0.000478 ***
company_location_developed  16.3148   678.5907   0.024 0.980819
company_size_L               0.7274     0.3815   1.907 0.056554 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 627.62  on 452  degrees of freedom
Residual deviance: 469.80  on 443  degrees of freedom
AIC: 489.8

Number of Fisher Scoring iterations: 16
```

```
Call:  glm(formula = salary_in_usd ~ experience_level_SE + company_location_developed +
    experience_level_EX + `remote_ratio_non-partial` + job_title_NonAnalyst +
    company_size_L + employee_residence_developed + company_size_L:employee_residence_developed +
    job_title_NonAnalyst:company_size_L + `remote_ratio_non-partial`:job_title_NonAnalyst,
    family = "binomial", data = train_df_FT_dummy_classifi)

Coefficients:
                                       (Intercept)
                                           -50.3418
                                 experience_level_SE
                                            1.8329
                           company_location_developed
                                           16.1378
                                 experience_level_EX
                                            2.4076
                           `remote_ratio_non-partial`
                                           16.8529
                                job_title_NonAnalyst
                                           32.3606
                                    company_size_L
                                           13.8527
                         employee_residence_developed
                                           -0.7329
    company_size_L:employee_residence_developed
                                            2.9906
            job_title_NonAnalyst:company_size_L
                                          -15.9165
`remote_ratio_non-partial`:job_title_NonAnalyst
                                          -15.5784

Degrees of Freedom: 452 Total (i.e. Null);  442 Residual
Null Deviance:      627.6
Residual Deviance: 463.6        AIC: 485.6
```

Stepwise (consider interaction)

Best model variables：

experience_level
job_title
employee_residence
remote_ratio, company_location
company_size

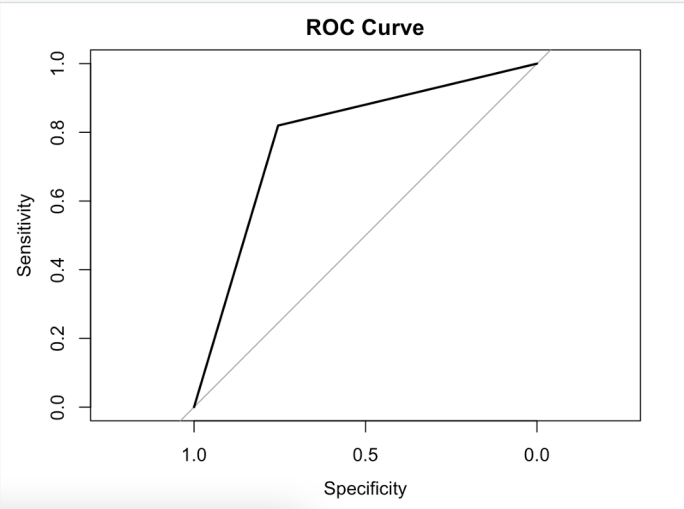
company_size_L：employee_residence_developed
job_title_NonAnalyst：company_size_L
remote_ratio_nonpartial：job_title_NonAnalyst

Discarded variables：work_year

Prediction validation (train/test set)

```
> confusionMatrix(pred_tab)
Confusion Matrix and Statistics

          Predicted
Actual  0  1
     0 40 13
     1 11 50

               Accuracy : 0.7895
                 95% CI : (0.7031, 0.8602)
    No Information Rate : 0.5526
    P-Value [Acc > NIR] : 1.102e-07

                  Kappa : 0.5758

 Mcnemar's Test P-Value : 0.8383

            Sensitivity : 0.7843
            Specificity : 0.7937
         Pos Pred Value : 0.7547
         Neg Pred Value : 0.8197
             Prevalence : 0.4474
         Detection Rate : 0.3509
   Detection Prevalence : 0.4649
      Balanced Accuracy : 0.7890

       'Positive' Class : 0
```

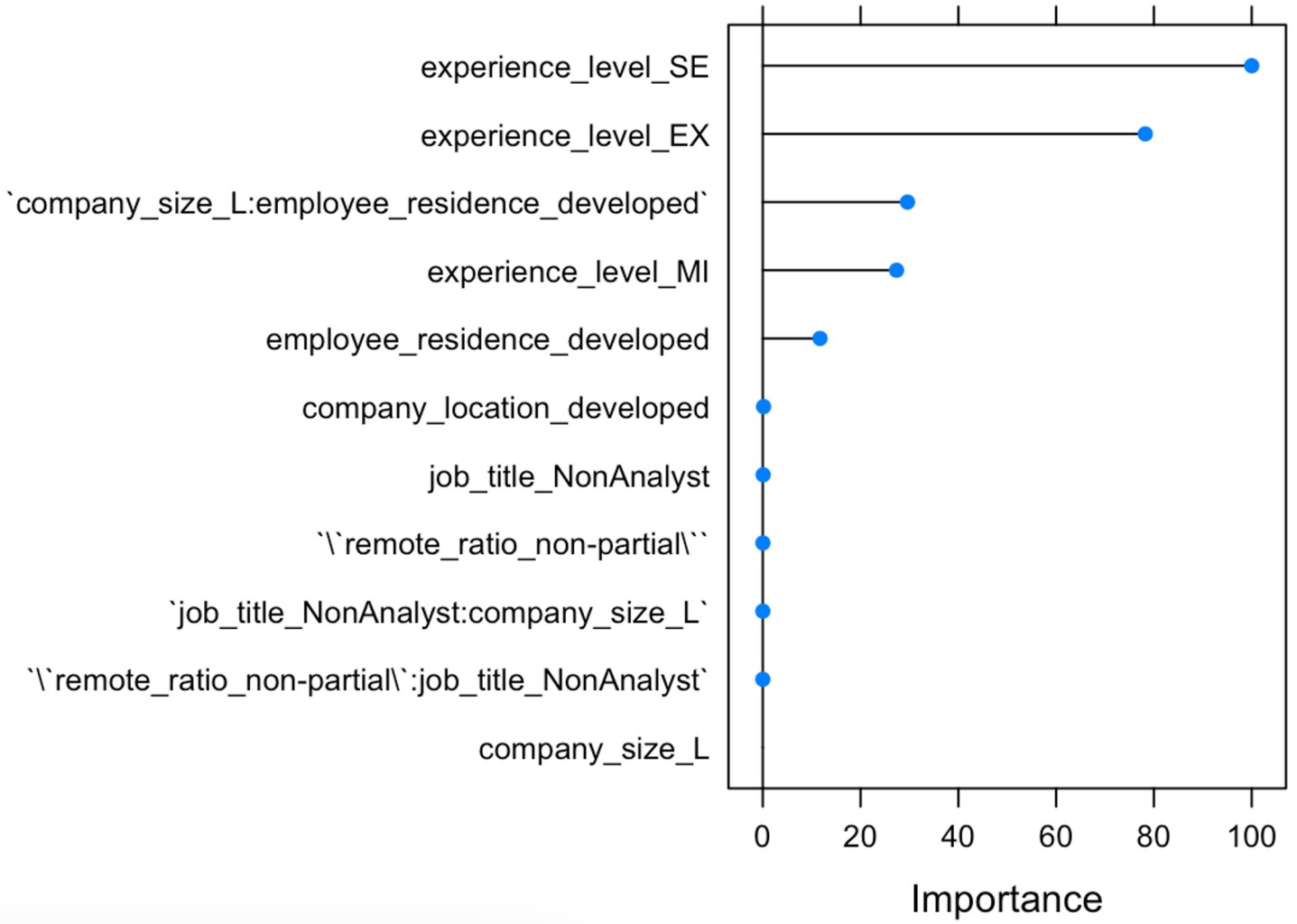
```
> precision
[1] 0.7936508
> F1_Score
[1] 0.7889477
> # calculate area under curve
> auc(roc_object)
Area under the curve: 0.7872
```



```
> summary(cv_logi_model)

Call:
NULL

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-2.30524  -0.80756  -0.00004   0.64130   2.14229

Coefficients:
                                                  Estimate Std. Error z value Pr(>|z|)
(Intercept)                                      -53.7756  2836.0655  -0.019   0.9849
experience_level_SE                                2.4302     0.4063   5.981 2.22e-09 ***
experience_level_MI                                0.6811     0.4147   1.642   0.1005
company_location_developed                        17.2156   950.1917   0.018   0.9855
experience_level_EX                                3.5375     0.7557   4.681 2.86e-06 ***
`\\`remote_ratio_non-partial\\``                  17.7278  1906.4203   0.009   0.9926
job_title_NonAnalyst                              34.1036  2672.1534   0.013   0.9898
company_size_L                                    15.2166  1872.4225   0.008   0.9935
employee_residence_developed                      -0.7949     1.1228  -0.708   0.4790
`company_size_L:employee_residence_developed`      2.5472     1.4342   1.776   0.0757 .
`job_title_NonAnalyst:company_size_L`            -16.7009  1872.4224  -0.009   0.9929
`\\`remote_ratio_non-partial\\`:job_title_NonAnalyst` -16.4925  1906.4203  -0.009   0.9931
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 785.98  on 566  degrees of freedom
Residual deviance: 561.92  on 555  degrees of freedom
AIC: 585.92

Number of Fisher Scoring iterations: 17
```

Prediction validation (5 folds CV)

```
> print(cv_logi_model)
Generalized Linear Model

567 samples
  8 predictor
  2 classes: '0', '1'

No pre-processing
Resampling: Cross-Validated (5 fold)
Summary of sample sizes: 454, 453, 454, 454, 453
Resampling results:

  Accuracy   Kappa
  0.7458624  0.4918138
```



Important variables