In [1]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import train_test_split
from sklearn import preprocessing
import datetime
import time
df=pd.read_csv("C:/Users/jinwe/Desktop/Insight/dc_1/employee_retention_data.csv")
df.head()
```

Out[1]:

	employee_id	company_id	dept	seniority	salary	join_date	quit_date
0	13021.0	7	customer_service	28	89000.0	2014-03-24	2015-10-30
1	825355.0	7	marketing	20	183000.0	2013-04-29	2014-04-04
2	927315.0	4	marketing	14	101000.0	2014-10-13	NaN
3	662910.0	7	customer_service	20	115000.0	2012-05-14	2013-06-07
4	256971.0	2	data_science	23	276000.0	2011-10-17	2014-08-22

In [2]:
```
df.describe()
```

Out[2]:

	employee_id	company_id	seniority	salary
count	24702.000000	24702.000000	24702.000000	24702.000000
mean	501604.403530	3.426969	14.127803	138183.345478
std	288909.026101	2.700011	8.089520	76058.184573
min	36.000000	1.000000	1.000000	17000.000000
25%	250133.750000	1.000000	7.000000	79000.000000
50%	500793.000000	2.000000	14.000000	123000.000000
75%	753137.250000	5.000000	21.000000	187000.000000
max	999969.000000	12.000000	99.000000	408000.000000

In [3]:
```
df.isnull().sum()
```

Out[3]:
```
employee_id        0
company_id         0
dept               0
seniority          0
salary             0
join_date          0
quit_date      11192
dtype: int64
```

In [4]:
```
df[['join_date','quit_date']]=df[['join_date','quit_date']].apply(pd.to_datetime)
df[['company_id']]=df[['company_id']].astype(str)
df.dtypes
```

Out[4]:
```
employee_id           float64
company_id             object
dept                   object
seniority               int64
salary                float64
join_date      datetime64[ns]
quit_date      datetime64[ns]
dtype: object
```

In [5]:
```
df['quit_bool'] = df.quit_date.isnull()
df.head()
```

Out[5]:

	employee_id	company_id	dept	seniority	salary	join_date	quit_date	quit_bool
0	13021.0	7	customer_service	28	89000.0	2014-03-24	2015-10-30	False
1	825355.0	7	marketing	20	183000.0	2013-04-29	2014-04-04	False
2	927315.0	4	marketing	14	101000.0	2014-10-13	NaT	True
3	662910.0	7	customer_service	20	115000.0	2012-05-14	2013-06-07	False
4	256971.0	2	data_science	23	276000.0	2011-10-17	2014-08-22	False

In [6]:
```
a=df['quit_date']-df['join_date']
print(a)
```

```
0         585 days
1         340 days
2              NaT
3         389 days
4        1040 days
5         578 days
6              NaT
7              NaT
8        1047 days
9              NaT
10        837 days
11             NaT
12        340 days
13       1194 days
14        340 days
15        409 days
16        723 days
17             NaT
18             NaT
19             NaT
20             NaT
21        340 days
22       1316 days
23        360 days
24        368 days
25        619 days
26             NaT
27        347 days
28        795 days
29       1152 days
            ...
24672     280 days
24673     828 days
24674     417 days
24675     340 days
24676     310 days
24677     396 days
24678     333 days
24679          NaT
24680          NaT
24681          NaT
24682          NaT
24683          NaT
24684     423 days
24685    1033 days
24686     371 days
24687     655 days
24688          NaT
24689     445 days
24690    1452 days
24691          NaT
24692     424 days
24693          NaT
24694          NaT
24695    1151 days
24696     372 days
24697          NaT
24698          NaT
24699     780 days
24700    1123 days
24701     864 days
Length: 24702, dtype: timedelta64[ns]
```

In [7]:
```
df['day']=a
df.head()
```

Out[7]:

	employee_id	company_id	dept	seniority	salary	join_date	quit_date	quit_bool	day
0	13021.0	7	customer_service	28	89000.0	2014-03-24	2015-10-30	False	585 days
1	825355.0	7	marketing	20	183000.0	2013-04-29	2014-04-04	False	340 days
2	927315.0	4	marketing	14	101000.0	2014-10-13	NaT	True	NaT
3	662910.0	7	customer_service	20	115000.0	2012-05-14	2013-06-07	False	389 days
4	256971.0	2	data_science	23	276000.0	2011-10-17	2014-08-22	False	1040 days

In [8]:
```
df['time_delta_int'] = df.day.astype('timedelta64[D]')
df.head()
```

Out[8]:

	employee_id	company_id	dept	seniority	salary	join_date	quit_date	quit_bool	day	time_del
0	13021.0	7	customer_service	28	89000.0	2014-03-24	2015-10-30	False	585 days	585.0
1	825355.0	7	marketing	20	183000.0	2013-04-29	2014-04-04	False	340 days	340.0
2	927315.0	4	marketing	14	101000.0	2014-10-13	NaT	True	NaT	NaN
3	662910.0	7	customer_service	20	115000.0	2012-05-14	2013-06-07	False	389 days	389.0
4	256971.0	2	data_science	23	276000.0	2011-10-17	2014-08-22	False	1040 days	1040.0

In [9]:
```
join_m=df['join_date'].dt.month
quit_m=df['quit_date'].dt.month
df['join_m']=join_m
df['quit_m']=quit_m
df=df.drop(columns=['employee_id','join_date','quit_date'])
df.head()
```

Out[9]:

	company_id	dept	seniority	salary	quit_bool	day	time_delta_int	join_m	quit_m
0	7	customer_service	28	89000.0	False	585 days	585.0	3	10.0
1	7	marketing	20	183000.0	False	340 days	340.0	4	4.0
2	4	marketing	14	101000.0	True	NaT	NaN	10	NaN
3	7	customer_service	20	115000.0	False	389 days	389.0	5	6.0
4	2	data_science	23	276000.0	False	1040 days	1040.0	10	8.0

In [10]:
```
#MASTER DATASET
df['quit'] = np.where(df['quit_m']>0, 'yes', 'no')
df.head()
```

Out[10]:

	company_id	dept	seniority	salary	quit_bool	day	time_delta_int	join_m	quit_m	quit
0	7	customer_service	28	89000.0	False	585 days	585.0	3	10.0	yes
1	7	marketing	20	183000.0	False	340 days	340.0	4	4.0	yes
2	4	marketing	14	101000.0	True	NaT	NaN	10	NaN	no
3	7	customer_service	20	115000.0	False	389 days	389.0	5	6.0	yes
4	2	data_science	23	276000.0	False	1040 days	1040.0	10	8.0	yes

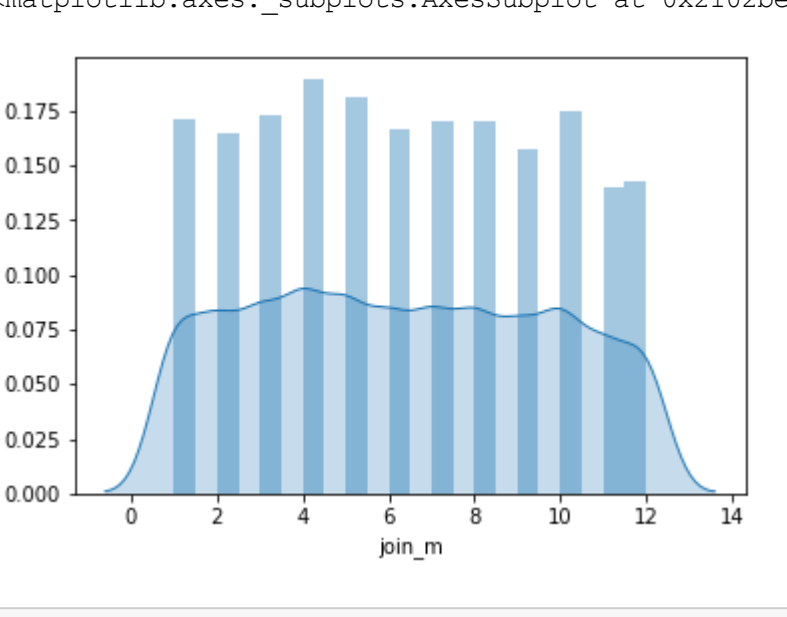
In [11]:
```
leaving=df.dropna()
leaving=leaving.drop(columns=['company_id','quit'])
leaving.head()
```

Out[11]:

	dept	seniority	salary	quit_bool	day	time_delta_int	join_m	quit_m
0	customer_service	28	89000.0	False	585 days	585.0	3	10.0
1	marketing	20	183000.0	False	340 days	340.0	4	4.0
3	customer_service	20	115000.0	False	389 days	389.0	5	6.0
4	data_science	23	276000.0	False	1040 days	1040.0	10	8.0
5	data_science	14	165000.0	False	578 days	578.0	1	8.0

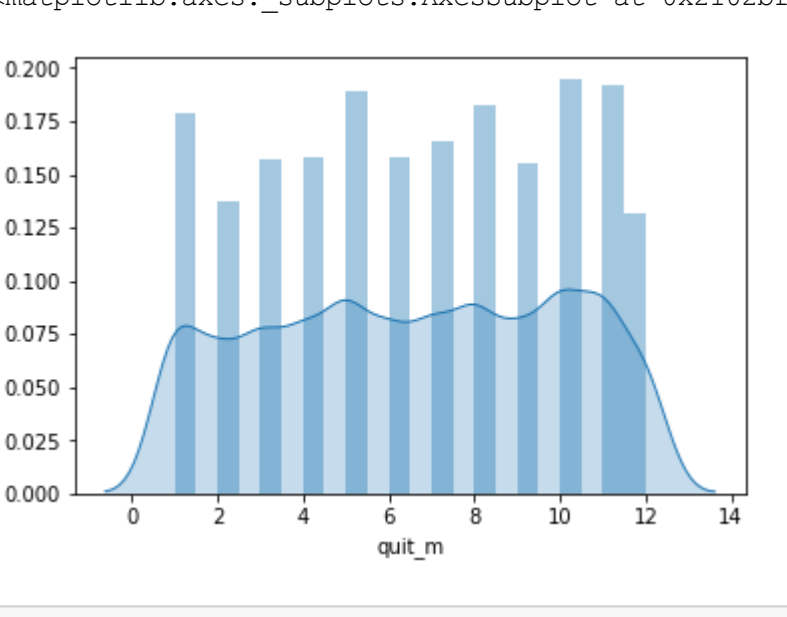
In [12]:
```
sns.distplot(leaving['join_m'], hist = True, kde = True,
             kde_kws = {'shade': True, 'linewidth': 1})
```

Out[12]: <matplotlib.axes._subplots.AxesSubplot at 0x2102be9eda0>



In [13]:
```
sns.distplot(leaving['quit_m'], hist = True, kde = True,
             kde_kws = {'shade': True, 'linewidth': 1})
```

Out[13]: <matplotlib.axes._subplots.AxesSubplot at 0x2102bfadbe0>



In [14]:
```
leaving.dtypes
```

Out[14]:
```
dept                       object
seniority                   int64
salary                    float64
quit_bool                    bool
day               timedelta64[ns]
time_delta_int            float64
join_m                      int64
quit_m                    float64
dtype: object
```

In [15]:
```
days=leaving['day'].dt.days
```

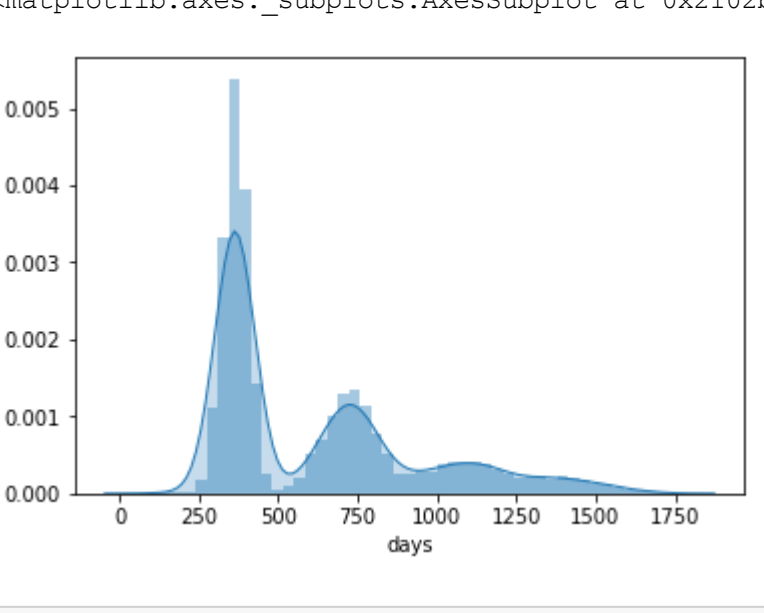
In [16]:
```
leaving['days'] = days
leaving=leaving.drop(columns=['day'])
leaving.head()
```

Out[16]:

	dept	seniority	salary	quit_bool	time_delta_int	join_m	quit_m	days
0	customer_service	28	89000.0	False	585.0	3	10.0	585
1	marketing	20	183000.0	False	340.0	4	4.0	340
3	customer_service	20	115000.0	False	389.0	5	6.0	389
4	data_science	23	276000.0	False	1040.0	10	8.0	1040
5	data_science	14	165000.0	False	578.0	1	8.0	578

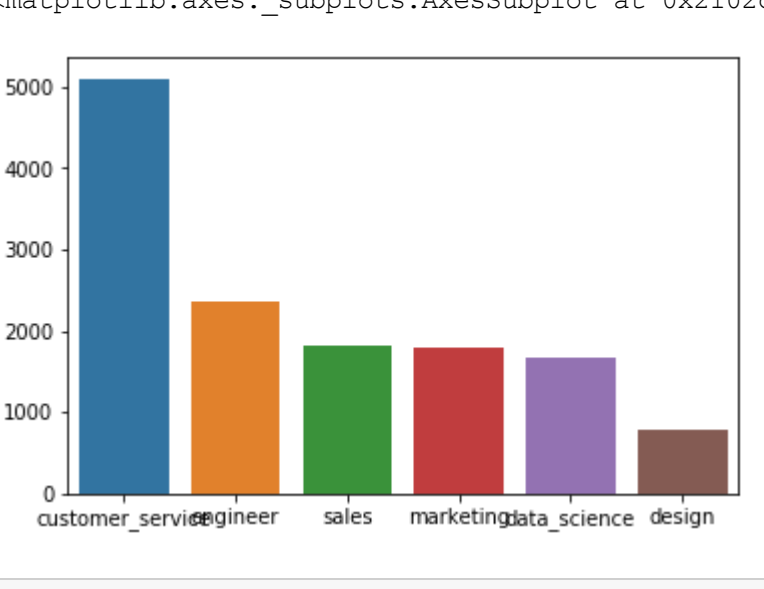
In [36]:
```
sns.distplot(leaving['days'], hist = True, kde = True,
             kde_kws = {'shade': True, 'linewidth': 1})
```

Out[36]: <matplotlib.axes._subplots.AxesSubplot at 0x2102be04fd0>



In [38]:
```
sns.barplot(x = leaving['dept'].value_counts().index,
            y = leaving['dept'].value_counts().values)
```

Out[38]: <matplotlib.axes._subplots.AxesSubplot at 0x2102c0be710>



In [17]:
```
deptDummies = pd.get_dummies(df['dept'], prefix = 'dept')
joinDummies = pd.get_dummies(df['join_m'], prefix = 'joinm')
quitDummies = pd.get_dummies(df['quit_m'], prefix = 'quitm')
print(deptDummies)
```

```
       dept_customer_service  dept_data_science  dept_design  dept_engineer  \
0                          1                  0            0              0
1                          0                  0            0              0
2                          0                  0            0              0
3                          1                  0            0              0
4                          0                  1            0              0
5                          0                  1            0              0
6                          1                  0            0              0
7                          1                  0            0              0
8                          0                  0            0              1
9                          0                  0            0              0
10                         1                  0            0              0
11                         0                  0            0              0
12                         0                  0            0              0
13                         0                  0            0              0
14                         0                  0            0              0
15                         0                  1            0              0
16                         0                  0            0              0
17                         1                  0            0              0
18                         0                  0            0              0
19                         1                  0            0              0
20                         0                  0            0              1
21                         1                  0            0              0
22                         0                  1            0              0
23                         0                  0            0              0
24                         0                  0            0              0
25                         1                  0            0              0
26                         0                  1            0              0
27                         0                  1            0              0
28                         1                  0            0              0
29                         1                  0            0              0
...                      ...                ...          ...            ...
24672                      0                  0            0              1
24673                      0                  0            0              0
24674                      1                  0            0              0
24675                      1                  0            0              0
24676                      1                  0            0              0
24677                      0                  0            0              1
24678                      0                  0            0              0
24679                      1                  0            0              0
24680                      0                  0            0              1
24681                      0                  0            0              1
24682                      0                  0            0              1
24683                      0                  0            0              0
24684                      1                  0            0              0
24685                      1                  0            0              0
24686                      0                  0            0              0
24687                      1                  0            0              0
24688                      0                  0            0              1
24689                      0                  0            0              1
24690                      0                  0            0              0
24691                      0                  1            0              0
24692                      0                  1            0              0
24693                      0                  1            0              0
24694                      1                  0            0              0
24695                      0                  1            0              0
24696                      0                  0            0              0
24697                      1                  0            0              0
24698                      0                  0            0              1
24699                      1                  0            0              0
24700                      0                  0            0              1
24701                      0                  0            0              0

       dept_marketing  dept_sales
0                   0           0
1                   1           0
2                   1           0
3                   0           0
4                   0           0
5                   0           0
6                   0           0
7                   0           0
8                   0           0
9                   0           1
10                  0           0
11                  1           0
12                  1           0
13                  1           0
14                  0           1
15                  0           0
16                  1           0
17                  0           0
18                  1           0
19                  0           0
20                  0           0
21                  0           0
22                  0           0
23                  1           0
24                  1           0
25                  0           0
26                  0           0
27                  0           0
28                  0           0
29                  0           0
...               ...         ...
24672               0           0
24673               1           0
24674               0           0
24675               0           0
24676               0           0
24677               0           0
24678               1           0
24679               0           0
24680               0           0
24681               0           0
24682               0           0
24683               1           0
24684               0           0
24685               0           0
24686               1           0
24687               0           0
24688               0           0
24689               0           0
24690               0           1
24691               0           0
24692               0           0
24693               0           0
24694               0           0
24695               0           0
24696               1           0
24697               0           0
24698               0           0
24699               0           0
24700               0           0
24701               1           0

[24702 rows x 6 columns]
```

In [18]:
```
print(joinDummies)
```

```
       joinm_1  joinm_2  joinm_3  joinm_4  joinm_5  joinm_6  joinm_7  joinm_8  \
0            0        0        1        0        0        0        0        0
1            0        0        0        1        0        0        0        0
2            0        0        0        0        0        0        0        0
3            0        0        0        0        1        0        0        0
4            0        0        0        0        0        0        0        0
5            1        0        0        0        0        0        0        0
6            0        0        0        0        0        0        0        0
7            0        0        1        0        0        0        0        0
8            0        0        0        0        0        0        0        0
9            0        0        0        0        0        1        0        0
10           0        0        0        0        0        0        0        0
11           0        0        0        0        1        0        0        0
12           0        0        0        0        0        0        0        0
13           0        0        0        0        0        1        0        0
14           0        0        0        0        0        0        0        0
15           0        0        0        0        1        0        0        0
16           0        0        0        0        0        0        0        0
17           0        0        1        0        0        0        0        0
18           0        0        0        0        0        0        0        0
19           0        0        0        0        0        0        1        0
20           0        0        0        0        0        0        0        0
21           0        0        0        0        0        1        0        0
22           0        0        0        0        0        0        0        0
23           0        0        0        0        0        0        0        1
24           0        0        0        0        0        0        1        0
25           0        0        0        0        1        0        0        0
26           0        0        0        0        0        0        0        1
27           0        0        1        0        0        0        0        0
28           0        0        0        0        0        0        0        1
29           0        1        0        0        0        0        0        0
...        ...      ...      ...      ...      ...      ...      ...      ...
24672        0        0        0        0        0        0        0        0
24673        0        0        0        0        0        0        0        0
24674        0        0        0        0        1        0        0        0
24675        0        0        0        0        0        0        0        1
24676        0        0        0        0        1        0        0        0
24677        0        0        0        1        0        0        0        0
24678        0        0        0        0        1        0        0        0
24679        0        0        1        0        0        0        0        0
24680        0        0        1        0        0        0        0        0
24681        0        0        0        0        0        0        0        1
24682        0        0        0        0        0        0        0        0
24683        0        0        0        0        1        0        0        0
24684        0        1        0        0        0        0        0        0
24685        0        0        0        0        0        0        0        1
24686        0        0        0        1        0        0        0        0
24687        0        0        0        0        0        0        0        0
24688        0        0        0        0        1        0        0        0
24689        0        0        0        0        1        0        0        0
24690        0        1        0        0        0        0        0        0
24691        0        0        0        0        0        0        0        0
24692        0        1        0        0        0        0        0        0
24693        0        0        0        0        0        0        0        0
24694        0        0        0        0        0        0        1        0
24695        0        0        0        0        1        0        0        0
24696        1        0        0        0        0        0        0        0
24697        0        1        0        0        0        0        0        0
24698        0        0        0        0        0        0        0        0
24699        0        0        0        0        0        0        0        0
24700        0        0        0        0        0        0        0        0
24701        0        0        0        0        0        0        1        0

       joinm_9  joinm_10  joinm_11  joinm_12
0            0         0         0         0
1            0         0         0         0
2            0         1         0         0
3            0         0         0         0
4            0         1         0         0
5            0         0         0         0
6            0         1         0         0
7            0         0         0         0
8            0         0         0         1
9            0         0         0         0
10           0         0         1         0
11           0         0         0         0
12           0         0         0         1
13           0         0         0         0
14           1         0         0         0
15           0         0         0         0
16           0         0         1         0
17           0         0         0         0
18           0         0         0         1
19           0         0         0         0
20           0         1         0         0
21           0         0         0         0
22           0         0         1         0
23           0         0         0         0
24           0         0         0         0
25           0         0         0         0
26           0         0         0         0
27           0         0         0         0
28           0         0         0         0
29           0         0         0         0
...        ...       ...       ...       ...
24672        1         0         0         0
24673        0         0         1         0
24674        0         0         0         0
24675        0         0         0         0
24676        0         0         0         0
24677        0         0         0         0
24678        0         0         0         0
24679        0         0         0         0
24680        0         0         0         0
24681        0         0         0         0
24682        1         0         0         0
24683        0         0         0         0
24684        0         0         0         0
24685        0         0         0         0
24686        0         0         0         0
24687        1         0         0         0
24688        0         0         0         0
24689        0         0         0         0
24690        0         0         0         0
24691        1         0         0         0
24692        0         0         0         0
24693        1         0         0         0
24694        0         0         0         0
24695        0         0         0         0
24696        0         0         0         0
24697        0         0         0         0
24698        0         1         0         0
24699        1         0         0         0
24700        0         0         0         1
24701        0         0         0         0

[24702 rows x 12 columns]
```

In [19]:
```
print(quitDummies)
```

```
       quitm_1.0  quitm_2.0  quitm_3.0  quitm_4.0  quitm_5.0  quitm_6.0  \
0              0          0          0          0          0          0
1              0          0          0          1          0          0
2              0          0          0          0          0          0
3              0          0          0          0          0          1
4              0          0          0          0          0          0
5              0          0          0          0          0          0
6              0          0          0          0          0          0
7              0          0          0          0          0          0
8              0          0          0          0          0          0
9              0          0          0          0          0          0
10             0          1          0          0          0          0
11             0          0          0          0          0          0
12             0          0          0          0          0          0
13             0          0          0          0          0          0
14             0          0          0          0          0          0
15             0          0          0          0          0          0
16             0          0          0          0          0          0
17             0          0          0          0          0          0
18             0          0          0          0          0          0
19             0          0          0          0          0          0
20             0          0          0          0          0          0
21             0          0          0          0          1          0
22             0          0          0          0          0          0
23             0          0          0          0          0          0
24             0          0          0          0          0          0
25             0          1          0          0          0          0
26             0          0          0          0          0          0
27             0          0          1          0          0          0
28             0          0          0          0          0          0
29             0          0          0          1          0          0
...          ...        ...        ...        ...        ...        ...
24672          0          0          0          0          0          0
24673          0          1          0          0          0          0
24674          0          0          0          0          0          1
24675          0          0          0          0          0          0
24676          0          0          1          0          0          0
24677          0          0          0          0          1          0
24678          0          0          0          1          0          0
24679          0          0          0          0          0          0
24680          0          0          0          0          0          0
24681          0          0          0          0          0          0
24682          0          0          0          0          0          0
24683          0          0          0          0          0          0
24684          0          0          0          1          0          0
24685          0          0          0          0          0          1
24686          0          0          0          1          0          0
24687          0          0          0          0          0          0
24688          0          0          0          0          0          0
24689          0          0          0          0          0          0
24690          1          0          0          0          0          0
24691          0          0          0          0          0          0
24692          0          0          0          1          0          0
24693          0          0          0          0          0          0
24694          0          0          0          0          0          0
24695          0          0          0          0          0          1
24696          0          1          0          0          0          0
24697          0          0          0          0          0          0
24698          0          0          0          0          0          0
24699          0          0          0          0          0          0
24700          1          0          0          0          0          0
24701          0          0          0          0          0          0

       quitm_7.0  quitm_8.0  quitm_9.0  quitm_10.0  quitm_11.0  quitm_12.0
0              0          0          0           1           0           0
1              0          0          0           0           0           0
2              0          0          0           0           0           0
3              0          0          0           0           0           0
4              0          1          0           0           0           0
5              0          1          0           0           0           0
6              0          0          0           0           0           0
7              0          0          0           0           0           0
8              0          0          0           1           0           0
9              0          0          0           0           0           0
10             0          0          0           0           0           0
11             0          0          0           0           0           0
12             0          0          0           0           1           0
13             0          0          1           0           0           0
14             0          1          0           0           0           0
15             1          0          0           0           0           0
16             0          0          0           0           1           0
17             0          0          0           0           0           0
18             0          0          0           0           0           0
19             0          0          0           0           0           0
20             0          0          0           0           0           0
21             0          0          0           0           0           0
22             1          0          0           0           0           0
23             0          1          0           0           0           0
24             0          1          0           0           0           0
25             0          0          0           0           0           0
26             0          0          0           0           0           0
27             0          0          0           0           0           0
28             0          0          0           1           0           0
29             0          0          0           0           0           0
...          ...        ...        ...         ...         ...         ...
24672          1          0          0           0           0           0
24673          0          0          0           0           0           0
24674          0          0          0           0           0           0
24675          1          0          0           0           0           0
24676          0          0          0           0           0           0
24677          0          0          0           0           0           0
24678          0          0          0           0           0           0
24679          0          0          0           0           0           0
24680          0          0          0           0           0           0
24681          0          0          0           0           0           0
24682          0          0          0           0           0           0
24683          0          0          0           0           0           0
24684          0          0          0           0           0           0
24685          0          0          0           0           0           0
24686          0          0          0           0           0           0
24687          1          0          0           0           0           0
24688          0          0          0           0           0           0
24689          0          1          0           0           0           0
24690          0          0          0           0           0           0
24691          0          0          0           0           0           0
24692          0          0          0           0           0           0
24693          0          0          0           0           0           0
24694          0          0          0           0           0           0
24695          0          0          0           0           0           0
24696          0          0          0           0           0           0
24697          0          0          0           0           0           0
24698          0          0          0           0           0           0
24699          0          0          0           1           0           0
24700          0          0          0           0           0           0
24701          0          0          0           0           0           1

[24702 rows x 12 columns]
```

In [28]:
```
df = pd.concat([leaving, deptDummies,joinDummies,quitDummies], axis=1)
df=df.drop(columns=['dept','join_m','quit_m','time_delta_int'])
df=df.dropna()
df.head()
```

Out[28]:

	seniority	salary	quit_bool	days	dept_customer_service	dept_data_science	dept_design	dept_engineer
0	28.0	89000.0	False	585.0	1	0	0	0
1	20.0	183000.0	False	340.0	0	0	0	0
3	20.0	115000.0	False	389.0	1	0	0	0
4	23.0	276000.0	False	1040.0	0	1	0	0
5	14.0	165000.0	False	578.0	0	1	0	0

5 rows × 34 columns

In [29]:
```
labels = np.array(df['days'])
features= df.drop('days', axis = 1)
name=list(features.columns.values)
feature_list = list(features.columns)
# Convert to numpy array
features = np.array(features)
```

In [30]:
```
# Using Skicit-learn to split data into training and testing sets
from sklearn.model_selection import train_test_split
# Split the data into training and testing sets
train_features, test_features, train_labels, test_labels = train_test_split(features, labels, test_s
ize = 0.2, random_state = 42)
```

In [31]:
```
print('Training Features Shape:', train_features.shape)
print('Training Labels Shape:', train_labels.shape)
print('Testing Features Shape:', test_features.shape)
print('Testing Labels Shape:', test_labels.shape)
```

```
Training Features Shape: (10808, 33)
Training Labels Shape: (10808,)
Testing Features Shape: (2702, 33)
Testing Labels Shape: (2702,)
```

In [32]:
```
# Import the model we are using
from sklearn.ensemble import RandomForestRegressor
# Instantiate model with 1000 decision trees
rf = RandomForestRegressor(n_estimators = 1000, random_state = 42)
# Train the model on training data
rf.fit(train_features, train_labels);
```

In [33]:
```
# Use the forest's predict method on the test data
predictions = rf.predict(test_features)
errors = abs(predictions - test_labels)
# Print out the mean absolute error (mae)
print('Mean Absolute Error:', round(np.mean(errors), 2), 'days.')
```

```
Mean Absolute Error: 262.41 days.
```

In [34]:
```
from sklearn.metrics import r2_score
predictions=predictions
r2_score(test_labels, predictions)
```

Out[34]: 0.06147730612804747

In [35]:
```
features = name
importances = rf.feature_importances_
indices = np.argsort(importances)

import matplotlib.pyplot as plt
plt.title('Feature Importances')
plt.barh(range(len(indices)), importances[indices], color='gray', align='center')
plt.yticks(range(len(indices)), [features[i] for i in indices])
plt.xlabel('Relative Importance')
plt.show()
```