In [2]:
```
import pydot
import pandas as pd
import numpy as np
import seaborn as sns
sns.set()

%matplotlib inline
import matplotlib
import matplotlib.pyplot as plt
from matplotlib import colors as mcolors

# Ignore warnings
import warnings
warnings.filterwarnings('ignore')


# Import 'tree' from scikit-learn library
from sklearn import tree
```

Data

Data Preprocessing

1. Filling NaNs

In [50]:
```
train_df=pd.read_csv('data/cld-demo-training-data.csv')
test_df=pd.read_csv('data/cld-demo-test-data.csv')
```

In [ ]:
```
print(train_df.isna().sum())
print(test_df.isna().sum())
```

1. Filling in NaN/empty `priority` & `object_code` in `train_df`, `test_df`

In [ ]:
```
print(train_df.priority.unique())
```

In [53]:
```
train_df.priority=train_df.priority.fillna("No_se")
train_df.priority[train_df['priority'] == ' '] = 'No'
train_df.priority[train_df['priority'] == '1'] = 'Si'
```

In [54]:
```
test_df.priority=test_df.priority.fillna("No_se")
test_df.priority[test_df['priority'] == ' '] = 'No'
test_df.priority[test_df['priority'] == '1'] = 'Si'
```

In [ ]:
```
print(test_df.isna().sum())
```

In [ ]:
```
test_df.object_code=test_df.object_code.fillna("No_se")
#test_df=test_df.drop('resource_id3', axis=1)
print(test_df.isna().sum())
```

In [ ]:
```
print(train_df.priority.unique())
```

2. Drop columns with only a single value in each column

In [ ]:
```
print(train_df.T.apply(lambda x: x.nunique(), axis=1)== 1)
print(test_df.T.apply(lambda x: x.nunique(), axis=1)== 1)
test_df=test_df.drop(['resource_id3'], axis=1)
test_df.columns
```

In [ ]:
```
print(col[train_df.T.apply(lambda x: x.nunique(), axis=1)== 1])
print(col[test_df.T.apply(lambda x: x.nunique(), axis=1)== 1])
```

In [ ]:
```
train_df=train_df.drop(['client', 'service_pool', 'object_code', 'appointment'],axis=1)
print(train_df.columns)
test_df=test_df.drop(['client', 'service_pool', 'object_code', 'appointment'],axis=1)
print(test_df.columns)
```

Keep the original files

From here I'll work with the new dataframes `train` and `test`

In [75]:
```
train=train_df.copy()
test=test_df.copy()
```

3. Classify by type of work: `cons, nrg, plumb, carp, stuff`

Filtering `train.descrption /`test.description``

I get a new column with the type of work performed `train.type` and `test.type`

Define pattern for filtering and give class names to new column

It's valid for train and test

In [ ]:
```
pattern_cons='ret|wall|ceiling|buil|cons'
pattern_nrg= 'wiring|media|elect'
pattern_plumb='water system|plumb'
pattern_carp= 'shelving|table|door'
pattern_stuff='stuff|holes|No water|No warn water'
pattern_work=pd.Series([pattern_cons,pattern_nrg,pattern_plumb,
                        pattern_carp,pattern_stuff])

class_str=['constr','elect','plumb','carp','handyman']
class_str
```

In [77]:
```
import re
```

In [78]:
```
for x in range(5):
    vector={'pattern': pattern_work[x],'type_work':class_str[x]}
    v=pd.Series(train['descrption'])
    v=v.replace("Build a wall and add a new door", "Build a wall and add a new")
    v=v.str.lower()
    pattern=vector['pattern']
    match_str=x
    v_binary=pd.Series([match_str]*len(v))
    s=v.str.contains(pattern, flags=re.IGNORECASE, regex=True)
    df=pd.DataFrame(v_binary[s])

    if x == 0:
        df0=df
    if x==1:
        df1=pd.DataFrame(df)
    if x == 2:
        df2 =pd.DataFrame(df)
    if x == 3:
        df3 =pd.DataFrame(df)
    if x == 4:
        df4 =pd.DataFrame(df)

df0=df0.append([df1,df2,df3,df4], sort=False)
train['type']=df0
```

In [79]:
```
for x in range(5):
    vector={'pattern': pattern_work[x],'type_work':class_str[x]}
    v=pd.Series(test['descrption'])
    v=v.replace("Build a wall and add a new door", "Build a wall and add a new")
    v=v.str.lower()
    pattern=vector['pattern']
    match_str=x
    v_binary=pd.Series([match_str]*len(v))
    s=v.str.contains(pattern, flags=re.IGNORECASE, regex=True)
    df=pd.DataFrame(v_binary[s])

    if x == 0:
        df0=df
    if x==1:
        df1=pd.DataFrame(df)
    if x == 2:
        df2 =pd.DataFrame(df)
    if x == 3:
        df3 =pd.DataFrame(df)
    if x == 4:
        df4 =pd.DataFrame(df)

df0=df0.append([df1,df2,df3,df4], sort=False)
test['type']=df0
```

In [ ]:
```
# Count the unique values in ''type' and sort the index
print(train.type.value_counts().sort_index())

# Create a dictionary that maps integers to strings
keys=list(range(0,5))
print(keys)
print(class_str)
val=class_str
mapping = dict(zip(keys,val))

# Convert the 'numbers' integers to strings using the 'mapping'
train['work_type'] = train.type.map(mapping)

# Count the unique values in 'rating'
print(train.work_type.value_counts())
```

In [185]:
```
train['work_type'] = train.work_type.astype('category',ordered=True)
```

In [ ]:
```
# Count the unique values in ''type' and sort the index
print(test.type.value_counts().sort_index())

# Create a dictionary that maps integers to strings
keys=list(range(0,5))
print(keys)
print(class_str)
val=class_str
mapping = dict(zip(keys,val))

# Convert the 'numbers' integers to strings using the 'mapping'
test['work_type'] = test.type.map(mapping)

# Count the unique values in 'rating'
print(test.work_type.value_counts())
```

In [184]:
```
test['work_type'] = test.work_type.astype('category',ordered=True)
```

In [135]:
```
c=pd.DataFrame(train['location'])
c.columns=['location']
c.location.value_counts().sort_index(axis=0)
```

Out[135]:
```
Arts and Humanities Stamford St Lambeth London SE1 9NH                              47
City Council Main Street 1 London NW1 1PS                                          121
Computing Science Guy's Campus King's College London London SE1 1UL                 99
Science University London Strand Campus Strand London WC2R 2LS                      60
The Institute of Cancer Research 123 Old Brompton Rd Kensington London SW7 3RP      24
Name: location, dtype: int64
```

4. Encode Labels

In [178]:
```
from sklearn import preprocessing

le = preprocessing.LabelEncoder()

# Converting string labels into numbers.The labels are int64
c=le.fit_transform(train['location'])
d=le.fit_transform(test['location'])
c=pd.DataFrame(c)
d=pd.DataFrame(d)
c.columns=['loc']
d.columns=['loc']
train['loc2']=c
test['loc2']=d
```

In [ ]:
```
# Count the unique values in ''type' and sort the index
print(train.loc2.value_counts().sort_index())
# Create a dictionary that maps integers to strings
keys_l=list(range(0,5))
val_l=['Arts_Stamford','City_Council', 'Computing_College',
    'Science_Univ', 'Cancer_Inst']
print(val_l)
mapping = dict(zip(keys_l,val_l))
print(mapping)
# Convert the 'numbers' integers to strings using the 'mapping'
train['loc1']=train.loc2.map(mapping, na_action=None)
print(train.loc1.value_counts())
train=train.drop(['loc2'], axis=1)
```

In [201]:
```
train['loc1'] = train.loc1.astype('category',ordered=True)
#train=train.drop(['location','loc2', descrption','end_date'],axis=1)
train.sample(3)
```

Out[201]:

	work_orer	priority	start_date	error_code	order_type	project	resource_id2	type	work_type	loc1
21	130307	No	2018-10-05 00:00:00.000	4	IO	SERVICE	90080101	2	plumb	Science_Univ
138	130476	No	2018-10-16 00:00:00.000	3	SO	UK100	80080303	4	handyman	City_Council
257	130533	Si	2018-10-19 00:00:00.000	3	SO	UK100	90080101	4	handyman	City_Council

In [183]:
```
train['loc1'] = train.loc1.astype('category',ordered=True)
```

In [ ]:
```
# Count the unique values in ''type' and sort the index
print(test.loc2.value_counts().sort_index())
# Create a dictionary that maps integers to strings
keys_l=list(range(0,5))
val_l=['Arts_Stamford','City_Council', 'Computing_College',
    'Science_Univ', 'Cancer_Inst']
print(val_l)
mapping = dict(zip(keys_l,val_l))
print(mapping)
# Convert the 'numbers' integers to strings using the 'mapping'
test['loc1']=test.loc2.map(mapping, na_action=None)
print(test.loc1.value_counts())
test=test.drop(['loc2'], axis=1)
```

In [272]:
```
test['loc1'] = test.loc1.astype('category',ordered=True)
#test=test.drop(['location','descrption','end_date'],axis=1)
```

In [273]:
```
train=train.drop(['type'],axis=1)
test=test.drop(['type'],axis=1)
test.head(3)
```

Out[273]:

	work_orer	priority	start_date	error_code	order_type	project	resource_id2	work_type	loc1
0	130720	Si	2018-11-07 00:00:00.000	C	SO	UK100	90020101	constr	City_Council
1	130721	No	2018-11-07 00:00:00.000	C	IO	SERVICE	90020101	constr	Science_Univ
2	130722	Si	2018-11-07 00:00:00.000	C	SO	SERVICE	90020101	constr	Science_Univ

In [208]:
```
train['priority'] = train.priority.astype('category',ordered=True)
test['priority'] = test.priority.astype('category',ordered=True)
```

In [209]:
```
train['error_code'] = train.error_code.astype('category',ordered=True)
test['error_code'] = test.error_code.astype('category',ordered=True)
```

In [210]:
```
train['order_type'] = train.order_type.astype('category',ordered=True)
test['order_type'] = test.order_type.astype('category',ordered=True)
```

In [211]:
```
train['project'] = train.project.astype('category',ordered=True)
test['project'] = test.project.astype('category',ordered=True)
```

4. Tidy Data

In [212]:
```
train['resource_id2'] = train.resource_id2.astype('category',ordered=True)
test['resource_id2'] = test.resource_id2.astype('category',ordered=True)
```

In [214]:
```
train.head(2)
```

Out[214]:

	work_orer	priority	start_date	error_code	order_type	project	resource_id2	type	work_type	loc1
0	130280	No	2018-10-04 00:00:00.000	E	IO	UK100	90080123	1	elect	City_Council
1	130281	No	2018-10-04 00:00:00.000	3	SO	SERVICE	90080101	4	handyman	Science_Univ

In [215]:
```
test.head(2)
```

Out[215]:

	work_orer	priority	start_date	error_code	order_type	project	resource_id2	type	work_type	loc1
0	130720	Si	2018-11-07 00:00:00.000	C	SO	UK100	90020101	0	constr	City_Council
1	130721	No	2018-11-07 00:00:00.000	C	IO	SERVICE	90020101	0	constr	Science_Univ

In [274]:
```
%store train
%store test
```

```
Stored 'train' (DataFrame)
Stored 'test' (DataFrame)
```

EDA

In [445]:
```
pd.crosstab(train.resource_id2,train.work_type)
```

Out[445]:

work_type	carp	constr	elect	handyman	plumb
resource_id2					
80080202	0	0	0	40	11
80080303	3	6	0	44	0
90020101	18	38	0	2	0
90080101	0	0	0	53	2
90080102	0	0	83	0	0
90080123	0	0	51	0	0

Scatter Matrix

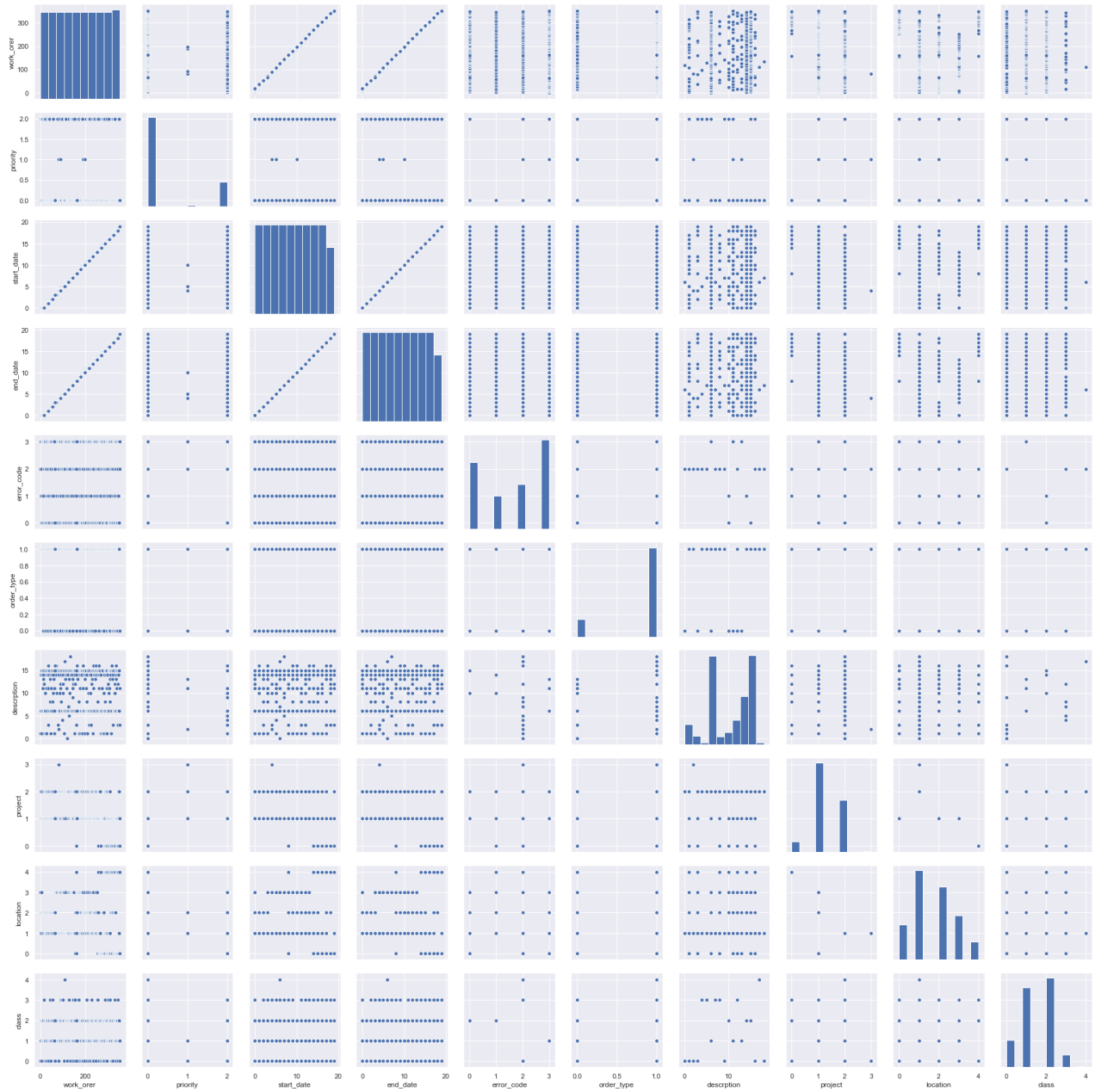
- 0: solo trabaja con fontaneria
- 1: trabaja con constr, carp, pero sobre todo con fontaneria
- 2: constr*, elect,small stuff
- 3: Solo fontaneria*
- 4: Solo Elect
- 5: Solo Elect

Summary:

- 2 electricistas: 4, 5
- 2 Fontaneros: 0, 3
- Chapuzas: 1. Chapuzas fontanero: 1

```
2. Chapuzas elect: 2
```

In [65]:
```
#scatter_matrix(X_train, figsize=[12,12],s=150,alpha=0.2)
#pd.plotting.scatter_matrix(X_train, c=y_train.resource_id2, figsize = [12,12],
#                           s=10, marker = 'D');
```



1. Worker vs. Type of work

- It is possible to appreciate that there is three type of workers:

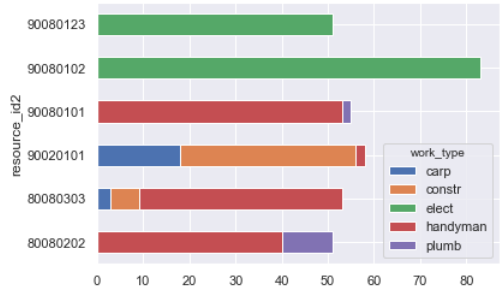
1. **Electricians**: Only Electricity related tasks: 90080102, 90080123 (**Green**)
2. **Handy-Plumb"**: Both Handyman and Plumbing tasks: 90020101, 0080202 (**Red+purple** bars)
3. **Pure_Handy**: Handyman,Plumbing, costruction: 80080303 (This one doesn't make many construction), 90080101 (**Blue/Orage/Red**)

In [411]:
```
# Crosstab
worker_workerType=pd.crosstab(train.resource_id2,train.work_type)
worker_workerType
```

Out[411]:

work_type	carp	constr	elect	handyman	plumb
resource_id2					
80080202	0	0	0	40	11
80080303	3	6	0	44	0
90020101	18	38	0	2	0
90080101	0	0	0	53	2
90080102	0	0	83	0	0
90080123	0	0	51	0	0

In [223]:
```
# Create a bar plot of 'k_zones'
worker_workerType.plot(kind='barh', stacked=True)
# Display the plot
plt.show()
```



2. Worker vs. Place

Data much more fuzzy than before

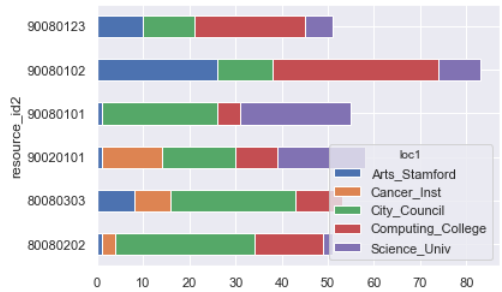
- And Not much Cancer Inst
- Cancer_Inst: Only 3 workers, work there: 90080101,90080102,90080123. Still this place doesn't require a lot of work
- All workers work at the 5 different places, BUT the "80080303" who doesn't work at Science Univ

In [226]:
```
# Crossval'
worker_loc=pd.crosstab(train.resource_id2,train.loc1)
worker_loc
```

Out[226]:

loc1	Arts_Stamford	Cancer_Inst	City_Council	Computing_College	Science_Univ
resource_id2					
80080202	1	3	30	15	2
80080303	8	8	27	10	0
90020101	1	13	16	9	19
90080101	1	0	25	5	24
90080102	26	0	12	36	9
90080123	10	0	11	24	6

In [227]:
```
# Create a bar plot of 'k_zones'
worker_loc.plot(kind='barh', stacked=True)
# Display the plot
plt.show()
```



3. Worker vs. Priority

Ä The worker 90080101 is by far taking the high priority tasks, which agree with:

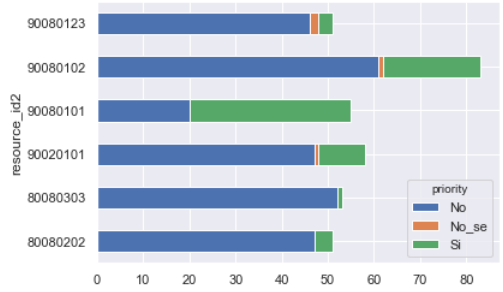
1. the fact that he works in all places
2. He is the "pure handyman" of the team

In [250]:
```
id_priority=pd.crosstab(train.resource_id2,train.priority)
id_priority
```

Out[250]:

priority	No	No_se	Si
resource_id2			
80080202	47	0	4
80080303	52	0	1
90020101	47	1	10
90080101	20	0	35
90080102	61	1	21
90080123	46	2	3

In [251]:
```
id_priority.plot(kind='barh', stacked=True); plt.show()
```



4. Worker vs. error_code

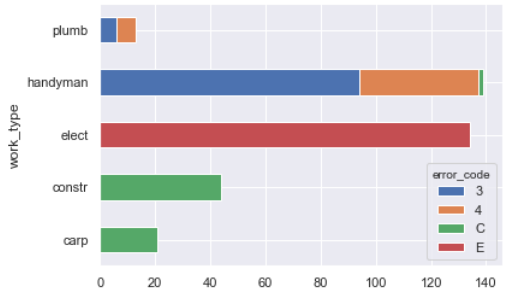
There is a clear ressemblance with the comparison with the `work_type``

Both variables may be describing the same thing. Careful!

id_error=pd.crosstab(train.resource_id2,train.error_code) print(id_error) id_error.plot(kind='barh', stacked=True); plt.show()

In [254]:
```
wType_error=pd.crosstab(train.work_type,train.error_code)
print(wType_error)
wType_error.plot(kind='barh', stacked=True); plt.show()
```

```
error_code   3   4   C    E
work_type
carp         0   0  21    0
constr       0   0  44    0
elect        0   0   0  134
handyman    94  43   2    0
plumb        6   7   0    0
```



- Electricity = Code E **Red**
- Constr + Carp = Code C (Constructuion) **Green**
- Code 3 and 4 - Handy man () **Orange/blue**

In [ ]:
```
wType_error=pd.crosstab(train.work_type,train.error_code)
print(wType_error)
wType_error.plot(kind='barh', stacked=True); plt.show()
```

In [271]:
```
![EDA]("output.png")
```

```
/bin/sh: -c: line 0: syntax error near unexpected token `"output.png"'
/bin/sh: -c: line 0: `[EDA]("output.png")'
```

Machine Learning

Unsuperised: Hierarchical Clustering. Dendograms

(See the other notebook: `unit4_graphs.ipynb`)

Run the `unit4_graphs.ipynb` NoteBook here and come back

In [343]:
```
%store -r ct4_5
%store -r ct4
%store -r X_train_1_num
%store -r X_train_2_num
%store -r X_test_1_num
%store -r X_test_2_num
%store -r varieties
%store -r y_test_num
```

In [345]:
```
X_test_1_num=X_test_1_num.drop(['work_orer'],axis=1)
X_test_2_num=X_test_2_num.drop(['work_orer'],axis=1)
```

In [ ]:
```
print(X_train_1_num.shape, X_train_2_num.shape,varieties.shape)
print(X_test_1_num.shape, X_test_2_num.shape)
```

In [308]:
```
X_train_1=train.drop(['work_orer','work_type','priority', 'start_date', 'order_type','resource_id2'], axis=1)
X_train_1.columns
```

Out[308]:
```
Index(['error_code', 'project', 'loc1'], dtype='object')
```

In [299]:
```
ct4_5
```

Out[299]:

varieties	0	1	2	3	4	5
labels						
1	51	44	1	55	0	0
2	0	2	28	0	45	30
3	0	7	29	0	38	21

In [311]:
```
X_train_2=train.drop(['work_orer','start_date', 'order_type','resource_id2'], axis=1)
X_train_2.columns
```

Out[311]:
```
Index(['priority', 'error_code', 'project', 'work_type', 'loc1'], dtype='object')
```

In [303]:
```
ct4
```

Out[303]:

varieties	0	1	2	3	4	5
labels						
1	32	36	1	1	0	0
2	19	8	0	54	0	0
3	0	2	28	0	45	30
4	0	6	24	0	9	8
5	0	1	5	0	29	13

Prepare the rest of data for the ML

In [325]:
```
y_train=train['resource_id2'].values
y_test=test['resource_id2'].values
```

In [312]:
```
X_test_1=test.drop(['work_orer','work_type','priority', 'start_date', 'order_type','resource_id2'], axis=1)
X_test_2=test.drop(['work_orer','start_date', 'order_type','resource_id2'], axis=1)
```

In [320]:
```
y_train_num=varieties
```

1. K-Nearest Neighbors

In [420]:
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report
```

In [354]:
```
# Create a k-NN classifier
knn_7=KNeighborsClassifier(n_neighbors=7)
knn_7.fit(X_train_1_num,y_train_num)
y_pred_knn_7_1=knn_7.predict(X_test_1_num)
print(knn_7.score(X_test_1_num,y_test_num))

# Create a k-NN classifier
knn_6=KNeighborsClassifier(n_neighbors=6)
knn_6.fit(X_train_1_num,y_train_num)
y_pred_knn_6_1=knn_6.predict(X_test_1_num)
print(knn_6.score(X_test_1_num,y_test_num))

# Create a k-NN classifier
knn_5=KNeighborsClassifier(n_neighbors=5)
knn_5.fit(X_train_1_num,y_train_num)
y_pred_knn_5_1=knn_5.predict(X_test_1_num)
print(knn_5.score(X_test_1_num,y_test_num))

# Create a k-NN classifier
knn_4=KNeighborsClassifier(n_neighbors=4)
knn_4.fit(X_train_1_num,y_train_num)
y_pred_knn_4_1=knn_4.predict(X_test_1_num)
print(knn_4.score(X_test_1_num,y_test_num))

# Create a k-NN classifier
knn_3=KNeighborsClassifier(n_neighbors=3)
knn_3.fit(X_train_1_num,y_train_num)
y_pred_knn_3_1=knn_3.predict(X_test_1_num)
print(knn_3.score(X_test_1_num,y_test_num))

knn_2=KNeighborsClassifier(n_neighbors=2)
knn_2.fit(X_train_1_num,y_train_num)
y_pred_knn_2_1=knn_2.predict(X_test_1_num)
print(knn_2.score(X_test_1_num,y_test_num))
```

```
0.711864406779661
0.711864406779661
0.7288135593220338
0.711864406779661
0.7288135593220338
0.6610169491525424
```

k-nn with max score are k-nn with 5 and 3 neighbors k-nn with max score are **k-nn** with **5**, 7 neighbors with `X_train_1_num` : **`'error_code', 'project','loc1'`**

In [381]:
```
# Create a k-NN classifier
knn_9=KNeighborsClassifier(n_neighbors=8)
knn_9.fit(X_train_2_num,y_train_num)
y_pred_knn_9_2=knn_9.predict(X_test_2_num)
print(knn_9.score(X_test_2_num,y_test_num))

knn_8=KNeighborsClassifier(n_neighbors=8)
knn_8.fit(X_train_2_num,y_train_num)
y_pred_knn_8_2=knn_8.predict(X_test_2_num)
print(knn_8.score(X_test_2_num,y_test_num))

knn_7=KNeighborsClassifier(n_neighbors=7)
knn_7.fit(X_train_2_num,y_train_num)
y_pred_knn_7_2=knn_7.predict(X_test_2_num)
print(knn_7.score(X_test_2_num,y_test_num))

# Create a k-NN classifier
knn_6=KNeighborsClassifier(n_neighbors=6)
knn_6.fit(X_train_2_num,y_train_num)
y_pred_knn_6_2=knn_6.predict(X_test_2_num)
print(knn_6.score(X_test_2_num,y_test_num))

# Create a k-NN classifier
knn_5=KNeighborsClassifier(n_neighbors=5)
knn_5.fit(X_train_2_num,y_train_num)
y_pred_knn_5_2=knn_5.predict(X_test_2_num)
print(knn_5.score(X_test_2_num,y_test_num))

# Create a k-NN classifier
knn_4=KNeighborsClassifier(n_neighbors=4)
knn_4.fit(X_train_2_num,y_train_num)
y_pred_knn_4_2=knn_4.predict(X_test_2_num)
print(knn_4.score(X_test_2_num,y_test_num))

# Create a k-NN classifier
knn_3=KNeighborsClassifier(n_neighbors=3)
knn_3.fit(X_train_2_num,y_train_num)
y_pred_knn_3_2=knn_3.predict(X_test_2_num)
print(knn_3.score(X_test_2_num,y_test_num))

knn_2=KNeighborsClassifier(n_neighbors=2)
knn_2.fit(X_train_2_num,y_train_num)
y_pred_knn_2_2=knn_2.predict(X_test_2_num)
print(knn_2.score(X_test_2_num,y_test_num))
```

```
0.711864406779661
0.711864406779661
0.7627118644067796
0.7627118644067796
0.6949152542372882
0.7457627118644068
0.6271186440677966
0.6610169491525424
```

k-nn with max score are **k-nn** with **6**, **7** neighbors with `X_train_2_num` : **`'priority', 'error_code', 'project', 'work_type', 'loc1'`**

Comparison:

In [421]:
```
print(classification_report(y_test_num, y_pred_knn_6_1))
```

```
              precision    recall  f1-score   support

           0       1.00      0.46      0.63        13
           1       0.64      1.00      0.78         7
           2       0.80      1.00      0.89         8
           3       0.73      0.92      0.81        12
           4       0.78      0.50      0.61        14
           5       0.38      0.60      0.46         5

   micro avg       0.71      0.71      0.71        59
   macro avg       0.72      0.75      0.70        59
weighted avg       0.77      0.71      0.70        59
```

In [422]:
```
print(classification_report(y_test_num, y_pred_knn_6_2))
```

```
              precision    recall  f1-score   support

           0       1.00      0.38      0.56        13
           1       0.64      1.00      0.78         7
           2       0.89      1.00      0.94         8
           3       0.71      1.00      0.83        12
           4       0.76      0.93      0.84        14
           5       0.00      0.00      0.00         5

   micro avg       0.76      0.76      0.76        59
   macro avg       0.67      0.72      0.66        59
weighted avg       0.74      0.76      0.71        59
```

Grid search Cross-validation. BAD !!!!!

In [368]:
```
from sklearn.model_selection import GridSearchCV
```

In [371]:
```
param_grid={'n_neighbors':np.arange(1,20)}
knn=KNeighborsClassifier()
knn_cv=GridSearchCV(knn,param_grid, cv=5)
knn_cv.fit(X_train_1_num,y_train_num)
print(knn_cv.best_params_)
print(knn_cv.best_score_)
```

```
{'n_neighbors': 18}
0.5897435897435898

/Users/anacaballero-herrera/anaconda3/lib/python3.6/site-packages/sklearn/model_selection/_search.py:841: DeprecationWarning:
The default of the `iid` parameter will change from True to False in version 0.22 and will be removed in 0.24. This will chang
e numeric results when test-set sizes are unequal.
  DeprecationWarning)
```

In [380]:
```
knn_18=KNeighborsClassifier(n_neighbors=18)
knn_18.fit(X_train_2_num,y_train_num)
y_pred_knn_18_2=knn_2.predict(X_test_2_num)
print(knn_18.score(X_test_2_num,y_test_num))
```

```
0.6779661016949152
```

2. Decission Tree

In [442]:
```
### Decision tree

# Import 'tree' from scikit-learn library
from sklearn import tree

# Fit your first decision tree: my_tree_one
my_tree_1 = tree.DecisionTreeClassifier()
my_tree_1.fit(X_train_1_num,y_train_num)

# Look at the importance and score of the included features
print(my_tree_1.feature_importances_)
print(my_tree_1.score(X_train_1_num,y_train_num))
print('error_code', 'project', 'loc1')

# Fit your first decision tree: my_tree_one
my_tree_2 = tree.DecisionTreeClassifier()
my_tree_2.fit(X_train_2_num,y_train_num)

# Look at the importance and score of the included features
print(my_tree_2.feature_importances_)
print(my_tree_2.score(X_train_2_num,y_train_num))
print('priority', 'error_code', 'project', 'work_type', 'loc1')
```

```
[0.79228 0.00117 0.20655]
0.6552706552706553
error_code project loc1
[0.13932 0.60676 0.02091 0.0613  0.17171]
0.7578347578347578
priority error_code project work_type loc1
```

2. Tunning with RandomizedSearchCV. Decision Tree

In [ ]:
```
```

3. Tunning with RandomizedSearchCV. Decision Tree

In [427]:
```
# Import necessary modules
from scipy.stats import randint
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import RandomizedSearchCV

# Setup the parameters and distributions to sample from: param_dist
param_dist = {"max_depth": [3, None],
              "max_features": randint(1, 3),
              "min_samples_leaf": randint(1, 3),
              "criterion": ["gini", "entropy"]}

# Instantiate a Decision Tree classifier: tree
tree = DecisionTreeClassifier()

# Instantiate the RandomizedSearchCV object: tree_cv
tree_cv = RandomizedSearchCV(tree,param_dist, cv=5)

# Fit it to the data
tree_cv.fit(X_train_1_num,y_train_num)

# Print the tuned parameters and score
print("Tuned Decision Tree Parameters: {}".format(tree_cv.best_params_))
print("Best score is {}".format(tree_cv.best_score_))
```

```
Tuned Decision Tree Parameters: {'criterion': 'entropy', 'max_depth': None, 'max_features': 1, 'min_samples_leaf': 1}
Best score is 0.5754985754985755

/Users/anacaballero-herrera/anaconda3/lib/python3.6/site-packages/sklearn/model_selection/_search.py:841: DeprecationWarning:
The default of the `iid` parameter will change from True to False in version 0.22 and will be removed in 0.24. This will chang
e numeric results when test-set sizes are unequal.
  DeprecationWarning)
```

In [429]:
```
print('X_train_2_num')
#X_train_2_num
param_dist = {"max_depth": [3, None],
              "max_features": randint(1, 5),
              "min_samples_leaf": randint(1, 5),
              "criterion": ["gini", "entropy"]}
tree_cv = RandomizedSearchCV(tree,param_dist, cv=5)
tree_cv.fit(X_train_2_num,y_train_num)
print("Tuned Decision Tree Parameters: {}".format(tree_cv.best_params_))
print("Best score is {}".format(tree_cv.best_score_))
```

```
X_train_2_num
Tuned Decision Tree Parameters: {'criterion': 'gini', 'max_depth': None, 'max_features': 4, 'min_samples_leaf': 1}
Best score is 0.6809116809116809

/Users/anacaballero-herrera/anaconda3/lib/python3.6/site-packages/sklearn/model_selection/_search.py:841: DeprecationWarning:
The default of the `iid` parameter will change from True to False in version 0.22 and will be removed in 0.24. This will chang
e numeric results when test-set sizes are unequal.
  DeprecationWarning)
```

In [431]:
```
param_dist = {"max_depth": [3, None],
              "max_features": 2,
              "min_samples_leaf": 3,
              "criterion": ["gini"]}
tree_cv.fit(X_train_2_num,y_train_num)
y_pred_tree_cv=tree_cv.predict(X_test_2_num)
print(tree_cv.score(X_test_2_num,y_test_num))
```

```
0.7627118644067796

/Users/anacaballero-herrera/anaconda3/lib/python3.6/site-packages/sklearn/model_selection/_search.py:841: DeprecationWarning:
The default of the `iid` parameter will change from True to False in version 0.22 and will be removed in 0.24. This will chang
e numeric results when test-set sizes are unequal.
  DeprecationWarning)
```

In [424]:
```
print(classification_report(y_test_num, y_pred_tree_cv))
```

```
              precision    recall  f1-score   support

           0       1.00      0.38      0.56        13
           1       0.75      0.86      0.80         7
           2       1.00      1.00      1.00         8
           3       0.63      1.00      0.77        12
           4       0.74      1.00      0.85        14
           5       0.00      0.00      0.00         5

   micro avg       0.76      0.76      0.76        59
   macro avg       0.69      0.71      0.66        59
weighted avg       0.75      0.76      0.71        59
```

Best score `0.7627118`, file `y_pred_tree_cv`

3. Random Forest

In [418]:
```
# Import random forest classifer
from sklearn.ensemble import RandomForestClassifier

# Edit model step in pipeline
pl = Pipeline([
        ('clf', RandomForestClassifier())
    ])

# Fit to the training data
pl.fit(X_train_2_num, y_train_num)
y_pred_random_forest=pl.predict(X_test_2_num)
# Compute and print accuracy
accuracy = pl.score(X_test_2_num, y_test_num)
print("\nAccuracy: ", accuracy)
```

```
Accuracy:  0.711864406779661
```

Accuracy varies a lot between run and run!!!!!! file: y_pred_random_forest

In [ ]:
```
```

Some extras: Not very important

USING all Features: Choosing correct hyperparameters

Interaction term

In [195]:
```
from sklearn.preprocessing import PolynomialFeatures
```

In [196]:
```
interaction = PolynomialFeatures(degree=2, interaction_only=True, include_bias=False)
X_inter=interaction.fit_transform(X_train)
```

In [200]:
```
clf_i=OneVsRestClassifier(LogisticRegression())
clf_i.fit(X_inter,y_train)

print(clf_i.score(X_inter,y_train))
```

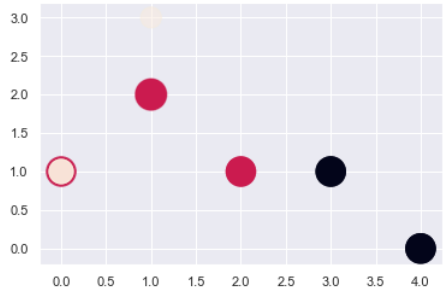
```
0.717948717948718
```

No!!! Not better. Not eneough data, I think

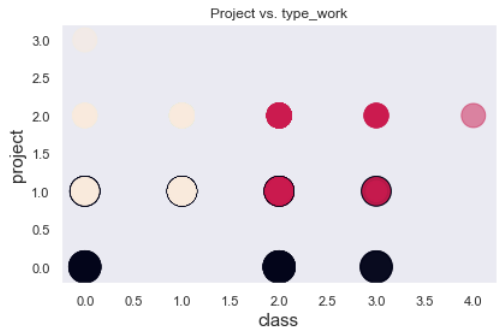
X_train.head()

In [251]:
```
xs=X_train['location']
ys=X_train['project']

plt.scatter(xs,ys,s=(X_train['class']*100+300), c=labels, alpha=0.5)
plt.show
```

Out[251]:
```
<function matplotlib.pyplot.show(*args, **kw)>
```

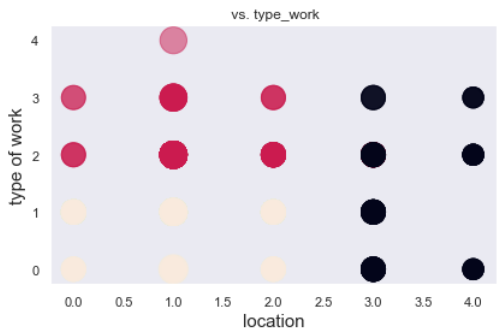


In [254]:
```
xs=X_train['class']
ys=X_train['project']
fig, ax = plt.subplots()
ax.scatter(xs, ys, c=labels, s=(X_train['location']*100+300), alpha=0.5)

ax.set_xlabel(r'class', fontsize=15)
ax.set_ylabel(r'project', fontsize=15)
ax.set_title('Project vs. type_work')

ax.grid(False)
fig.tight_layout()
```



In [ ]:
```
grupo 1: Projectos(0) <-> Type_work(Construction, Plumb, Carp)
grupo 2: Projectos(0,1,2) <-> Type_work(Plumbing, Carp, Stuff)
grupo 3:

    ??????
```

In [258]:
```
ys=X_train['class']
xs=X_train['location']
fig, ax = plt.subplots()
ax.scatter(xs, ys, c=labels, s=(X_train['project']*100+300), alpha=0.5)

ax.set_xlabel('location', fontsize=15)
ax.set_ylabel('type of work', fontsize=15)
ax.set_title(' Type of work vs. Location')

ax.grid(False)
fig.tight_layout()
```



In [ ]:
```
grupo 1: Location(0,1,2)<-> Type_work(Construction, Electricity)
grupo 2: Location(0,1,2)<-> Type_work(Plumbing, Carp, Stuff)
grupo 3: Location(3,4)  <-> Type_work (Construction, Electricity,Plumbing, Carp)
```

In [306]:
```
X_train_2=result = pd.concat([X_train, y_train], axis=1, sort=False)
X_train_2.head()
X_test_2=result = pd.concat([X_test, target], axis=1, sort=False)
X_test_2.head()
```

Out[306]:

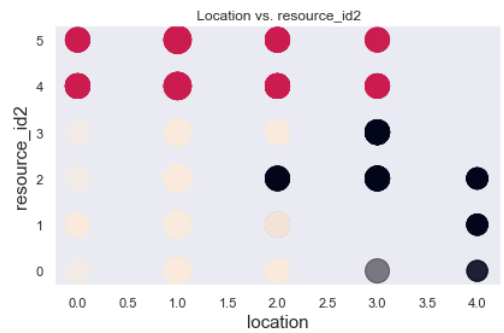
	priority	error_code	project	location	class	resource_id2
0	2	2	2	1	0	2
1	0	2	1	3	0	2
2	2	2	1	3	0	2
3	0	2	0	4	0	2
4	0	2	2	1	0	2

In [302]:
```
model=KMeans(n_clusters=4)
model.fit(X_train_2)
labels=model.predict(X_train_2)
```

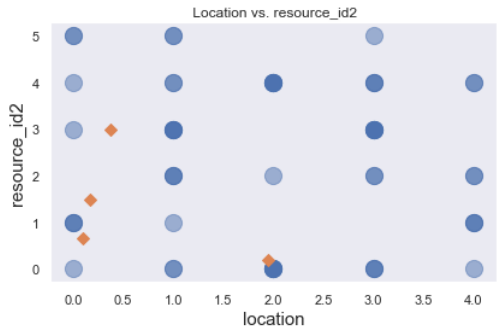
In [305]:
```
ys=X_train_2['class']
xs=X_train_2['resource_id2']
fig, ax = plt.subplots()
ax.scatter(xs, ys, c=labels, s=(X_train_2['project']*100+300), alpha=0.5)

ax.set_xlabel('resource_id2', fontsize=15)
ax.set_ylabel('type of work', fontsize=15)
ax.set_title(' Type of work vs. resource_id2')

ax.grid(False)
fig.tight_layout()
```

In [ ]:
```
Group 0: Constr: only resource 1 and 2
Group 1: Electricians are resources: 4 and 5
Group 2: Only plumb: resource 3
Group 3: Plumb/Carp: resource 0 (Only Plumb),1, 2 (carp)


Plumb= resources 0,1,3
```

In [300]:
```
xs=X_train_2['location']
ys=X_train_2['resource_id2']
fig, ax = plt.subplots()
ax.scatter(xs, ys, c=labels, s=(X_train_2['project']*100+300), alpha=0.5)

ax.set_ylabel('resource_id2', fontsize=15)
ax.set_xlabel('location', fontsize=15)
ax.set_title(' Location vs. resource_id2')

ax.grid(False)
fig.tight_layout()
```



In [313]:
```
xs=X_test['location']
ys=target

fig, ax = plt.subplots()
ax.scatter(xs, ys, s=200, alpha=0.5)
centroids =model.cluster_centers_
centroids_x=centroids[:,0]
centroids_y=centroids[:,1]
plt.scatter(centroids_x,centroids_y,marker='D',s=50)
ax.set_ylabel('resource_id2', fontsize=15)
ax.set_xlabel('location', fontsize=15)
ax.set_title(' Location vs. resource_id2')

ax.grid(False)
fig.tight_layout()
```



In [ ]:
```
centroids =model.cluster_centers_
centroids_x=centroids[:,0]
centroids_y=centroids[:,1]
plt.scatter(centroids_x,centroids_y,marker='D',s=50)
ax.set_ylabel('resource_id2', fontsize=15)
ax.set_xlabel('location', fontsize=15)
ax.set_title(' Location vs. resource_id2')

ax.grid(False)
fig.tight_layout()
```

In [374]:
```
zz=pd.crosstab(y_train_cat_class,X_train.location)
zz
```

Out[374]:

location	0	1	2	3	4
resource_id2					
0	1	30	15	2	3
1	8	27	10	0	8
2	1	16	9	19	13
3	1	25	5	24	0
4	26	12	36	9	0
5	10	11	24	6	0

In [474]:
```
Xx=pd.DataFrame(X_test_2_num)
```

In [479]:
```
Xx['resource_id2_num']=y_test_num
Xx['Pred_tree_cv']=y_pred_tree_cv
Xx['pred_knn_6_2']=y_pred_knn_6_2
Xx['pred_knn_6_1'] =y_pred_knn_6_1
```

In [ ]:
```
Xx.to_csv('my.csv')
```

In [ ]:
```

```