Test

February 20, 2017

```
In [1]: import pandas as pd
        import numpy as np
        import sklearn
        import seaborn as sns
        import matplotlib.pyplot as plt
        %matplotlib inline

        from sklearn.ensemble import GradientBoostingClassifier, ExtraTreesClassifi
        from sklearn.preprocessing import LabelEncoder

        plt.rcParams['axes.labelsize'] = 20
        plt.rcParams['axes.titlesize'] = 20
        plt.rcParams['xtick.labelsize'] = 18
        plt.rcParams['ytick.labelsize'] = 18
        plt.rcParams['legend.fontsize'] = 14
```

1 Reading Old Dataset

```
In [2]: dataOld = pd.read_csv('Processed_Data_part.csv')
```

```
In [3]: print len(dataOld)
        dataOld.head()
```

```
10003
```

```
Out[3]:    mineid contract                                           subunit  \
        0  100003      NaN  Surface:  Strip or open pit mines including as...
        1  100003      NaN  Surface:  Strip or open pit mines including as...
        2  100003      NaN  Surface:  Strip or open pit mines including as...
        3  100003  LK7      Surface:  Strip or open pit mines including as...
        4  100003      NaN  Surface:  Strip or open pit mines including as...

              month  day    time          inspoff    state  county  \
        0   January   19  1000.0  Birmingham, AL  Alabama     117
        1  February    4  1345.0  Birmingham, AL  Alabama     117
        2      July   18  1000.0  Birmingham, AL  Alabama     117
        3    August    8   645.0  Birmingham, AL  Alabama     117
        4    August   28   900.0  Birmingham, AL  Alabama     117

                                      sic  ...   expjob  year  \
        0  Limestone (crushed and broken)  ...      2.0  1983
        1  Limestone (crushed and broken)  ...     28.0  1983
        2  Limestone (crushed and broken)  ...      3.0  1983
        3  Limestone (crushed and broken)  ...     30.0  1983
        4  Limestone (crushed and broken)  ...      2.0  1983

                              injtype daystotl  \
        0          NDL (No days lost)      0.0
        1  NFDL (Nonfatal, days lost)      5.0
        2                         NaN      0.0
        3  NFDL (Nonfatal, days lost)    235.0
        4  NFDL (Nonfatal, days lost)      1.0

                                           jobtitl2                  coalmetl  \
        0                   Bulldozer/tractor oper.  Metal/Nonmetal/Stone/S&G
        1                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G
        2  Sizing/washing/cleaning plant opr/worker  Metal/Nonmetal/Stone/S&G
        3                              Truck driver  Metal/Nonmetal/Stone/S&G
        4                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G

             opercont      district              commod  occup
        0    Operator  Southeastern      Stone operator    NaN
        1    Operator  Southeastern      Stone operator    NaN
        2    Operator  Southeastern      Stone operator    NaN
        3  Contractor  Southeastern  Noncoal contractor    NaN
        4    Operator  Southeastern      Stone operator    NaN

        [5 rows x 61 columns]
```

2 Reading Modified Dataset

```
In [4]: data = pd.read_csv('mine_accidents.csv')
        print len(data)
        data.head()
```

```
10003
```

```
Out[4]:    mine_id contractor                                            subunit  \
        0   100003        NaN  Surface:  Strip or open pit mines including as...
        1   100003        NaN  Surface:  Strip or open pit mines including as...
        2   100003        NaN  Surface:  Strip or open pit mines including as...
        3   100003    LK7       Surface:  Strip or open pit mines including as...
        4   100003        NaN  Surface:  Strip or open pit mines including as...
```

```
  month_accident  day_accident  time_accident inspection_office    state  \
0         January            19         1000.0    Birmingham, AL  Alabama
1        February             4         1345.0    Birmingham, AL  Alabama
2            July            18         1000.0    Birmingham, AL  Alabama
3          August             8          645.0    Birmingham, AL  Alabama
4          August            28          900.0    Birmingham, AL  Alabama

   county         standard_industrial_code  ...  expjob  year  \
0     117  Limestone (crushed and broken)  ...     2.0  1983
1     117  Limestone (crushed and broken)  ...    28.0  1983
2     117  Limestone (crushed and broken)  ...     3.0  1983
3     117  Limestone (crushed and broken)  ...    30.0  1983
4     117  Limestone (crushed and broken)  ...     2.0  1983

                      injtype daystotl  \
0          NDL (No days lost)      0.0
1  NFDL (Nonfatal, days lost)      5.0
2                         NaN      0.0
3  NFDL (Nonfatal, days lost)    235.0
4  NFDL (Nonfatal, days lost)      1.0

                                   jobtitl2                  coalmetl  \
0                   Bulldozer/tractor oper.  Metal/Nonmetal/Stone/S&G
1                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G
2  Sizing/washing/cleaning plant opr/worker  Metal/Nonmetal/Stone/S&G
3                              Truck driver  Metal/Nonmetal/Stone/S&G
4                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G

     opercont      district              commod  occup
0    Operator  Southeastern      Stone operator    NaN
1    Operator  Southeastern      Stone operator    NaN
2    Operator  Southeastern      Stone operator    NaN
3  Contractor  Southeastern  Noncoal contractor    NaN
4    Operator  Southeastern      Stone operator    NaN

[5 rows x 61 columns]
```

2.1 Se elimina la columna 'occup' porque no tiene valores

```
In [5]: data.drop(['occup'], axis=1, inplace=True)
        data.head()
```

```
Out[5]:    mine_id contractor                                           subunit  \
        0   100003        NaN  Surface:  Strip or open pit mines including as...
        1   100003        NaN  Surface:  Strip or open pit mines including as...
        2   100003        NaN  Surface:  Strip or open pit mines including as...
        3   100003    LK7      Surface:  Strip or open pit mines including as...
```

```
4   100003        NaN  Surface:  Strip or open pit mines including as...

  month_accident  day_accident  time_accident inspection_office    state  \
0        January            19         1000.0    Birmingham, AL  Alabama
1       February             4         1345.0    Birmingham, AL  Alabama
2           July            18         1000.0    Birmingham, AL  Alabama
3         August             8          645.0    Birmingham, AL  Alabama
4         August            28          900.0    Birmingham, AL  Alabama

   county        standard_industrial_code         ...           expmine exp
0     117  Limestone (crushed and broken)         ...           4.00000    2
1     117  Limestone (crushed and broken)         ...           9.00000   28
2     117  Limestone (crushed and broken)         ...           3.00000    3
3     117  Limestone (crushed and broken)         ...           0.07666   30
4     117  Limestone (crushed and broken)         ...           4.00000    2

   year                     injtype daystotl  \
0  1983          NDL (No days lost)      0.0
1  1983  NFDL (Nonfatal, days lost)      5.0
2  1983                         NaN      0.0
3  1983  NFDL (Nonfatal, days lost)    235.0
4  1983  NFDL (Nonfatal, days lost)      1.0

                               jobtitl2                 coalmetl  \
0                Bulldozer/tractor oper.  Metal/Nonmetal/Stone/S&G
1              Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G
2  Sizing/washing/cleaning plant opr/worker  Metal/Nonmetal/Stone/S&G
3                           Truck driver  Metal/Nonmetal/Stone/S&G
4              Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G

     opercont      district              commod
0    Operator  Southeastern      Stone operator
1    Operator  Southeastern      Stone operator
2    Operator  Southeastern      Stone operator
3  Contractor  Southeastern  Noncoal contractor
4    Operator  Southeastern      Stone operator

[5 rows x 60 columns]
```

2.2 Se elimina la columna ‘narrtxt1’ y ‘narrtxt1’, estas se encargan de explicar en mas detalle el accidente, pero ya la variable ‘accident_type’ lo resume.

```
In [6]: data.drop(['narrtxt1', 'narrtxt2'], axis=1, inplace=True)
        data.head()
```

```
Out[6]:    mine_id contractor                                        subunit  \
        0   100003        NaN  Surface:  Strip or open pit mines including as...
        1   100003        NaN  Surface:  Strip or open pit mines including as...
```

```
2   100003        NaN  Surface: Strip or open pit mines including as...
3   100003    LK7      Surface: Strip or open pit mines including as...
4   100003        NaN  Surface: Strip or open pit mines including as...

  month_accident  day_accident  time_accident inspection_office    state  \
0        January            19         1000.0    Birmingham, AL  Alabama
1       February             4         1345.0    Birmingham, AL  Alabama
2           July            18         1000.0    Birmingham, AL  Alabama
3         August             8          645.0    Birmingham, AL  Alabama
4         August            28          900.0    Birmingham, AL  Alabama

   county        standard_industrial_code         ...          expmine exp
0     117  Limestone (crushed and broken)         ...          4.00000   2
1     117  Limestone (crushed and broken)         ...          9.00000  28
2     117  Limestone (crushed and broken)         ...          3.00000   3
3     117  Limestone (crushed and broken)         ...          0.07666  30
4     117  Limestone (crushed and broken)         ...          4.00000   2

   year                     injtype daystotl  \
0  1983           NDL (No days lost)      0.0
1  1983  NFDL (Nonfatal, days lost)      5.0
2  1983                         NaN      0.0
3  1983  NFDL (Nonfatal, days lost)    235.0
4  1983  NFDL (Nonfatal, days lost)      1.0

                                   jobtitl2                 coalmetl  \
0                   Bulldozer/tractor oper.  Metal/Nonmetal/Stone/S&G
1                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G
2  Sizing/washing/cleaning plant opr/worker  Metal/Nonmetal/Stone/S&G
3                              Truck driver  Metal/Nonmetal/Stone/S&G
4                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G

     opercont      district              commod
0    Operator  Southeastern      Stone operator
1    Operator  Southeastern      Stone operator
2    Operator  Southeastern      Stone operator
3  Contractor  Southeastern  Noncoal contractor
4    Operator  Southeastern      Stone operator

[5 rows x 58 columns]
```

2.3 Una posible variable a predecir : accident_type. Lo cual indica el tipo de accidente que ha sufrido la persona en la mina. Existen 42 tipos de accidentes, es decir, 42 posibles clases a predecir.

```
In [7]: y = data['accident_type'].unique()
        print len(y)
        y
```

```
42
```

```
Out[7]: array(['Struck against moving object',
               'Contact with hot objects or substances',
               'Over-exertion in lifting objects', 'Caught in-under-between NEC',
               'Absorption of various noxious substances', 'Struck by NEC',
               'Fall down stairs', 'Struck by flying object',
               'Caught in-under-between a moving and stationary object',
               'Struck against stationary object',
               'Fall from headframe,derrick, or tower',
               'Fall onto or against objects',
               'Fall from machine,vehicle, or equipment',
               'Struck by falling object', 'Over-exertion NEC',
               'Fall from ladders',
               'Caught in-under-between collapsing material or buildings',
               'Flash burns (electric)',
               'Over-exertion in pulling or pushing objects',
               'Accident type without injuries',
               'Fall to the walkway or working surface',
               'Struck by powered moving object', 'Bodily reaction NEC',
               'Not elsewhere classified', 'Struck by rolling object (sliding)',
               'Caught in-under-between several moving objects',
               'Contact with electric current', 'Fall to lower level NEC',
               'Inhalation of various noxious substances',
               'Over-exertion in wielding or throwing objects',
               'Flash burns (welding)',
               'Fall from piled material (include coal,rock,ore, or waste)',
               'Fall from scaffolds,walkways (elevated),platforms, etc.',
               'Unclassified, insufficient data',
               'Fall down raise,shaft, or manway underground',
               'Contact with heat (atmosphere or environment)',
               'Caught in-under-between running or meshing objects',
               'Fall on same level NEC', 'Rubbed or abraded NEC',
               'Contact with cold (atmosphere or environment)', 'Drowning',
               'Struck by concussion'], dtype=object)
```

2.4 La variable 'accident_type' no esta balanceada, es decir, la cantidad de accidentes de una misma clase varian mucho, esto provoca que el modelo este a favor solo por la clase de mayor cantidad. Para evitar esto se puede considerar una particion stratificada de datos y no un simple split. Se puede considerar tambien unir las clases de menor frecuencia en una sola.

```
In [8]: data["accident_type"].value_counts()
```

```
Out[8]: Struck by falling object                                    1243
        Struck by NEC                                               1136
        Accident type without injuries                               881
```

```
Over-exertion in lifting objects                               811
Over-exertion NEC                                              762
Struck against stationary object                               722
Caught in-under-between a moving and stationary object         660
Fall from machine,vehicle, or equipment                        502
Caught in-under-between NEC                                    484
Struck by flying object                                        410
Fall to the walkway or working surface                         353
Struck against moving object                                   352
Fall onto or against objects                                   302
Over-exertion in pulling or pushing objects                    228
Contact with hot objects or substances                         181
Fall to lower level NEC                                        172
Absorption of various noxious substances                       102
Fall from ladders                                               68
Fall down stairs                                                66
Fall from scaffolds,walkways (elevated),platforms, etc.         59
Bodily reaction NEC                                             51
Contact with electric current                                   48
Caught in-under-between several moving objects                  46
Struck by powered moving object                                 45
Flash burns (electric)                                          45
Inhalation of various noxious substances                        45
Over-exertion in wielding or throwing objects                   39
Flash burns (welding)                                           38
Not elsewhere classified                                        35
Struck by rolling object (sliding)                              24
Unclassified, insufficient data                                 18
Contact with heat (atmosphere or environment)                   13
Caught in-under-between running or meshing objects              12
Fall down raise,shaft, or manway underground                    10
Caught in-under-between collapsing material or buildings         9
Fall from piled material (include coal,rock,ore, or waste)       9
Rubbed or abraded NEC                                            8
Fall on same level NEC                                           7
Drowning                                                         3
Fall from headframe,derrick, or tower                            2
Struck by concussion                                             1
Contact with cold (atmosphere or environment)                    1
Name: accident_type, dtype: int64
```

3 Fill NaN/Na values

3.1 La columna 'contractor' indica si la empresa minera contrató una contratista para realizar el trabajo, o si la misma minera lo realizó. Se observa que solo se contrató 318 veces de las 10003 veces, es decir, solo 3%. La mayoria de los trabajos lo realizo la empresa, esta columna se podria eliminar pero se vera luego si afecta en la variabilidad y solapamiento de los datos.

```
In [9]: from __future__ import division

        print 'Size without nan: ', len(data.contractor.dropna())
        print 'Size Total: ', len(data.contractor)
        print 'Percentage: ', (len(data.contractor.dropna())/len(data.contractor))*
```

```
Size without nan:  318
Size Total:  10003
Percentage:  3.17904628611
```

```
In [10]: data.contractor.fillna('same_mine', inplace=True)
         data.head()
```

```
Out[10]:    mine_id contractor                                            subunit
         0   100003  same_mine  Surface:  Strip or open pit mines including as...
         1   100003  same_mine  Surface:  Strip or open pit mines including as...
         2   100003  same_mine  Surface:  Strip or open pit mines including as...
         3   100003    LK7      Surface:  Strip or open pit mines including as...
         4   100003  same_mine  Surface:  Strip or open pit mines including as...

           month_accident  day_accident  time_accident inspection_office    state
         0        January            19         1000.0    Birmingham, AL  Alabama
         1       February             4         1345.0    Birmingham, AL  Alabama
         2           July            18         1000.0    Birmingham, AL  Alabama
         3         August             8          645.0    Birmingham, AL  Alabama
         4         August            28          900.0    Birmingham, AL  Alabama

            county        standard_industrial_code          ...           expmine exp
         0     117  Limestone (crushed and broken)          ...           4.00000
         1     117  Limestone (crushed and broken)          ...           9.00000   2
         2     117  Limestone (crushed and broken)          ...           3.00000
         3     117  Limestone (crushed and broken)          ...           0.07666   3
         4     117  Limestone (crushed and broken)          ...           4.00000

            year                     injtype daystotl  \
         0  1983          NDL (No days lost)      0.0
         1  1983  NFDL (Nonfatal, days lost)      5.0
         2  1983                         NaN      0.0
         3  1983  NFDL (Nonfatal, days lost)    235.0
         4  1983  NFDL (Nonfatal, days lost)      1.0
```

```
                                     jobtitl2                 coalmetl  \
0                    Bulldozer/tractor oper.  Metal/Nonmetal/Stone/S&G
1                  Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G
2  Sizing/washing/cleaning plant opr/worker  Metal/Nonmetal/Stone/S&G
3                               Truck driver  Metal/Nonmetal/Stone/S&G
4                  Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G

     opercont      district              commod
0    Operator  Southeastern      Stone operator
1    Operator  Southeastern      Stone operator
2    Operator  Southeastern      Stone operator
3  Contractor  Southeastern  Noncoal contractor
4    Operator  Southeastern      Stone operator

[5 rows x 58 columns]
```

3.2 La columna 'underground_method' indica el metodo que la empresa minera usa para la extraccion de la materia prima. El metodo mas usado es Continuous, debido a que son muchos valores (30%) como para eliminar la columna, se llenara los nan con la moda.

```
In [11]: print 'Size without nan: ', len(data.underground_method.dropna())
         print 'Size Total: ', len(data.underground_method)
         print 'Percentage: ', (len(data.underground_method.dropna())/len(data.unde
```

```
Size without nan:  3157
Size Total:  10003
Percentage:  31.5605318404
```

```
In [12]: data.underground_method.value_counts()
```

```
Out[12]: Continuous      1955
         Conventional     781
         Longwall         162
         Caving           143
         Other            108
         Hand               6
         Shortwall          2
         Name: underground_method, dtype: int64
```

```
In [13]: data.underground_method.fillna('Continuous', inplace=True)
```

```
In [14]: data.underground_method.head()
```

```
Out[14]: 0    Continuous
         1    Continuous
         2    Continuous
```

```
        3    Continuous
        4    Continuous
        Name: underground_method, dtype: object
```

3.3 La columna 'equipment_model' indica el modelo de la maquina, es solo un id, y la frecuencia de aparicion es poca, por lo tanto se elimina la columna.

```
In [15]: data.equipment_model.head()

Out[15]: 0
         1
         2
         3    340D
         4
         Name: equipment_model, dtype: object

In [16]: print 'Size without nan: ', len(data.equipment_model.dropna())
         print 'Size Total: ', len(data.equipment_model)
         print 'Percentage: ', (len(data.equipment_model.dropna())/len(data.equipme

Size without nan:  10003
Size Total:  10003
Percentage:  100.0


In [17]: data.equipment_model.value_counts().head()

Out[17]:               8354
         300             31
         D-9             23
         83              22
         10SC            21
         Name: equipment_model, dtype: int64

In [18]: data.drop(['equipment_model'], axis=1, inplace=True)

In [19]: data.head(5)

Out[19]:    mine_id contractor                                              subunit
         0   100003  same_mine  Surface:  Strip or open pit mines including as...
         1   100003  same_mine  Surface:  Strip or open pit mines including as...
         2   100003  same_mine  Surface:  Strip or open pit mines including as...
         3   100003    LK7      Surface:  Strip or open pit mines including as...
         4   100003  same_mine  Surface:  Strip or open pit mines including as...

           month_accident  day_accident  time_accident inspection_office    state
         0        January            19         1000.0    Birmingham, AL  Alabama
         1       February             4         1345.0    Birmingham, AL  Alabama
         2           July            18         1000.0    Birmingham, AL  Alabama
```

```
3         August            8          645.0    Birmingham, AL  Alabama
4         August           28          900.0    Birmingham, AL  Alabama

   county        standard_industrial_code         ...           expmine  exp
0     117  Limestone (crushed and broken)         ...           4.00000
1     117  Limestone (crushed and broken)         ...           9.00000   2
2     117  Limestone (crushed and broken)         ...           3.00000
3     117  Limestone (crushed and broken)         ...           0.07666   3
4     117  Limestone (crushed and broken)         ...           4.00000

   year                     injtype daystotl  \
0  1983           NDL (No days lost)       0.0
1  1983  NFDL (Nonfatal, days lost)        5.0
2  1983                          NaN       0.0
3  1983  NFDL (Nonfatal, days lost)      235.0
4  1983  NFDL (Nonfatal, days lost)        1.0

                                   jobtitl2                 coalmetl  \
0                   Bulldozer/tractor oper.  Metal/Nonmetal/Stone/S&G
1                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G
2  Sizing/washing/cleaning plant opr/worker  Metal/Nonmetal/Stone/S&G
3                              Truck driver  Metal/Nonmetal/Stone/S&G
4                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G

     opercont      district              commod
0    Operator  Southeastern      Stone operator
1    Operator  Southeastern      Stone operator
2    Operator  Southeastern      Stone operator
3  Contractor  Southeastern  Noncoal contractor
4    Operator  Southeastern      Stone operator

[5 rows x 57 columns]
```

4 Dropeamos los valores nan si existe en una fila, nos quedamos con 2082, casi un 20% de la data, se podria trabajar con esto. En una analisis mas exhaustivo se tendria que eliminar la menor cantidad de filas.

```
In [20]: data.dropna(inplace=True)
```

```
In [21]: print len(data)
         data.head()
```

```
2082
```

```
Out[21]:     mine_id contractor                                             subunit
         3    100003    LK7      Surface:  Strip or open pit mines including as...
```

```
13   100008  same_mine  Mill or preparation plant:Mill prep plant or b...
20   100009  same_mine  Mill or preparation plant:Mill prep plant or b...
21   100011  same_mine  Mill or preparation plant:Mill prep plant or b...
33   100028  same_mine  Mill or preparation plant:Mill prep plant or b...

   month_accident  day_accident  time_accident inspection_office    state
3          August             8          645.0    Birmingham, AL  Alabama
13          March            29          730.0    Birmingham, AL  Alabama
20       November             4         1145.0    Birmingham, AL  Alabama
21         August            13          200.0    Birmingham, AL  Alabama
33       February            24         1700.0      Franklin, TN  Alabama

    county        standard_industrial_code          ...             expmine
3      117  Limestone (crushed and broken)          ...            0.076660
13     117                            Lime          ...            5.000000
20      73  Limestone (crushed and broken)          ...            7.459959
21     121       Marble (crushed & broken)          ...            5.229979
33      49  Limestone (crushed and broken)          ...            0.977413

       expjob  year                    injtype daystotl  \
3   30.000000  1983  NFDL (Nonfatal, days lost)    235.0
13   5.000000  1983  NFDL (Nonfatal, days lost)    700.0
20   0.344969  1983  NFDL (Nonfatal, days lost)     44.0
21   5.229979  1983  NFDL (Nonfatal, days lost)     72.0
33   0.977413  1983  NFDL (Nonfatal, days lost)     23.0

                                    jobtitl2                  coalmetl  \
3                               Truck driver  Metal/Nonmetal/Stone/S&G
13             Laborer/utility man/bull gang  Metal/Nonmetal/Stone/S&G
20             Laborer/utility man/bull gang  Metal/Nonmetal/Stone/S&G
21  Sizing/washing/cleaning plant opr/worker  Metal/Nonmetal/Stone/S&G
33                 Mechanic/repairman/helper  Metal/Nonmetal/Stone/S&G

      opercont      district              commod
3   Contractor  Southeastern  Noncoal contractor
13    Operator  Southeastern      Stone operator
20    Operator  Southeastern      Stone operator
21    Operator  Southeastern      Stone operator
33    Operator  Southeastern      Stone operator

[5 rows x 57 columns]
```

5 Mapeamos variables categoricas a numericas

```
In [22]: from collections import defaultdict
         encodersDict = defaultdict(LabelEncoder)
```

```
def categoricalColumns(df):
    df = df.copy()
    cols = df.columns
    cols_numeric = df._get_numeric_data().columns
    return list(set(cols) - set(cols_numeric))

def categoricalToNumeric(df):
    df = df.copy()
    cat_columns = categoricalColumns(df)
    print('Categorical columns: ', cat_columns)
    print('Size columns: ', len(cat_columns))
    if cat_columns:
        for category in cat_columns:
#               encoder = LabelEncoder()
#               df.loc[:, category] = encoder.fit_transform(df[category])
            x = df[category]
            df.loc[:, category] = encodersDict[x.name].fit_transform(x)

    return df
```

Todas los objetos LabelEncoder se encuentra en el dictionary d, para su posterior uso.

```
In [23]: dataNew = categoricalToNumeric(data)

('Categorical columns: ', ['permanently_transf_termi', 'underground_method', 'stan
('Size columns: ', 30)


In [24]: dataNew.head()

Out[24]:     mine_id  contractor  subunit  month_accident  day_accident  time_acci
         3    100003          14        7               1             8         64
         13   100008          31        4               7            29         73
         20   100009          31        4               9             4        114
         21   100011          31        4               1            13         20
         33   100028          31        4               3            24        170

             inspection_office  state  county  standard_industrial_code   ...    \
         3                   6      0     117                        17   ...
         13                  6      0     117                        16   ...
         20                  6      0      73                        17   ...
         21                  6      0     121                        20   ...
         33                 17      0      49                        17   ...

              expmine     expjob  year  injtype  daystotl  jobtitl2  coalmetl  \
         3   0.076660  30.000000  1983        1     235.0        67         1
         13  5.000000   5.000000  1983        1     700.0        33         1
         20  7.459959   0.344969  1983        1      44.0        33         1
         21  5.229979   5.229979  1983        1      72.0        58         1
```

```
33  0.977413   0.977413  1983        1      23.0        39          1

    opercont  district  commod
3          0        10       3
13         1        10       6
20         1        10       6
21         1        10       6
33         1        10       6

[5 rows x 57 columns]
```

6 Feature Importance for each variable

In [25]:

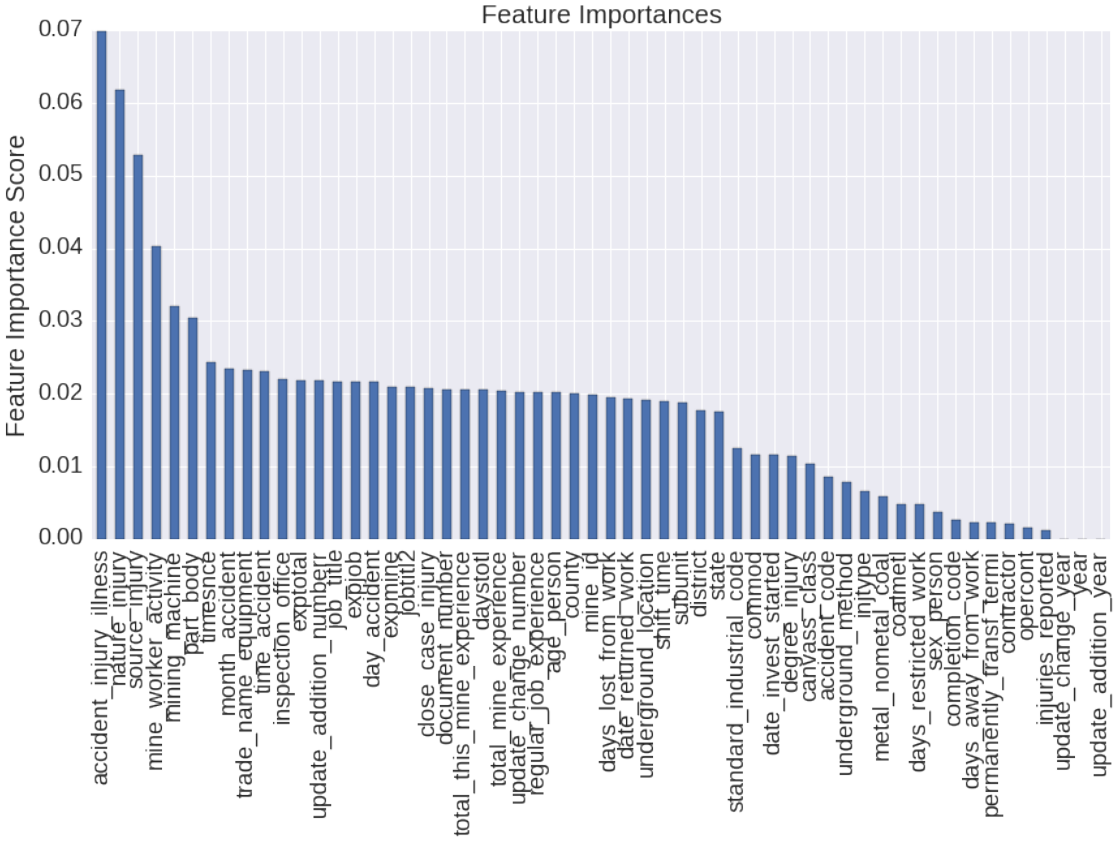
```
def modelfit(alg, dtrain, predictors, performCV=True, printFeatureImportar
    #Fit the algorithm on the data
    alg.fit(dtrain[predictors], dtrain['accident_type'])

    #Predict training set:
    dtrain_predictions = alg.predict(dtrain[predictors])
    dtrain_predprob = alg.predict_proba(dtrain[predictors])[:,1]

    #Perform cross-validation:
#     if performCV:
#         cv_score = cross_validation.cross_val_score(alg, dtrain[predicto

#     #Print model report:
#     print "\nModel Report"
#     print "Accuracy : %.4g" % metrics.accuracy_score(dtrain['Disbursed']
#     print "AUC Score (Train): %f" % metrics.roc_auc_score(dtrain['Disbur

#     if performCV:
#         print "CV Score : Mean - %.7g | Std - %.7g | Min - %.7g | Max -

    #Print Feature Importance:
    if printFeatureImportance:
        feat_imp = pd.Series(alg.feature_importances_, predictors).sort_va
        feat_imp.plot(kind='bar', title='Feature Importances', figsize=(14
        plt.ylabel('Feature Importance Score')
        plt.show()
        plt.close()

    return feat_imp
```

6.1 First estimator ExtraTreesClassifier

In [26]:

```
%%time
target = 'accident_type'
```

```
        #IDcol = 'mineid'

        predictors = [x for x in dataNew if x not in [target]]
        model = ExtraTreesClassifier(random_state=10)
        fi = modelfit(model, dataNew, predictors)
        print fi.head(6)
```

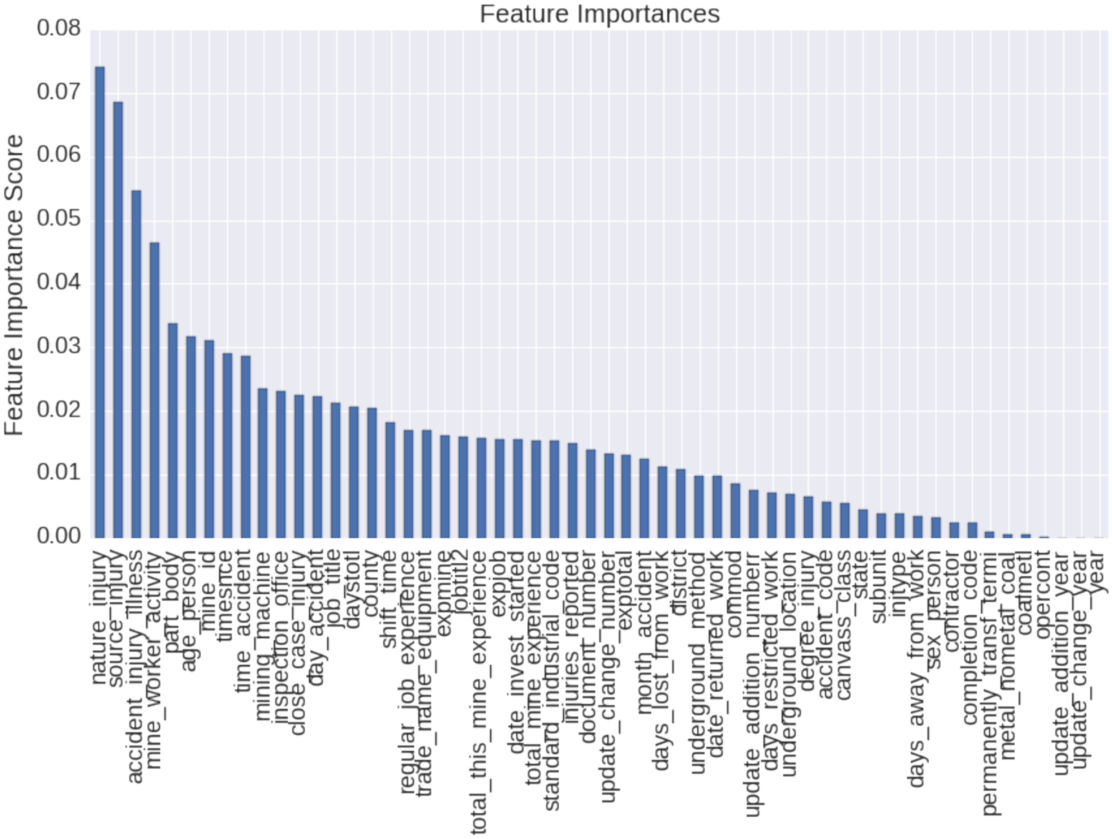


```
accident_injury_illness    0.069795
nature_injury              0.061754
source_injury              0.052895
mine_worker_activity       0.040344
mining_machine             0.032072
part_body                  0.030382
dtype: float64
CPU times: user 1.4 s, sys: 360 ms, total: 1.76 s
Wall time: 1.24 s
```

6.2 Second estimator GradientBoostingClassifier

```
In [27]: %%time
         target = 'accident_type'
```

```
#IDcol = 'mineid'

predictors = [x for x in dataNew if x not in [target]]
model = GradientBoostingClassifier(random_state=10)
fi = modelfit(model, dataNew, predictors)
print fi.head(6)
```



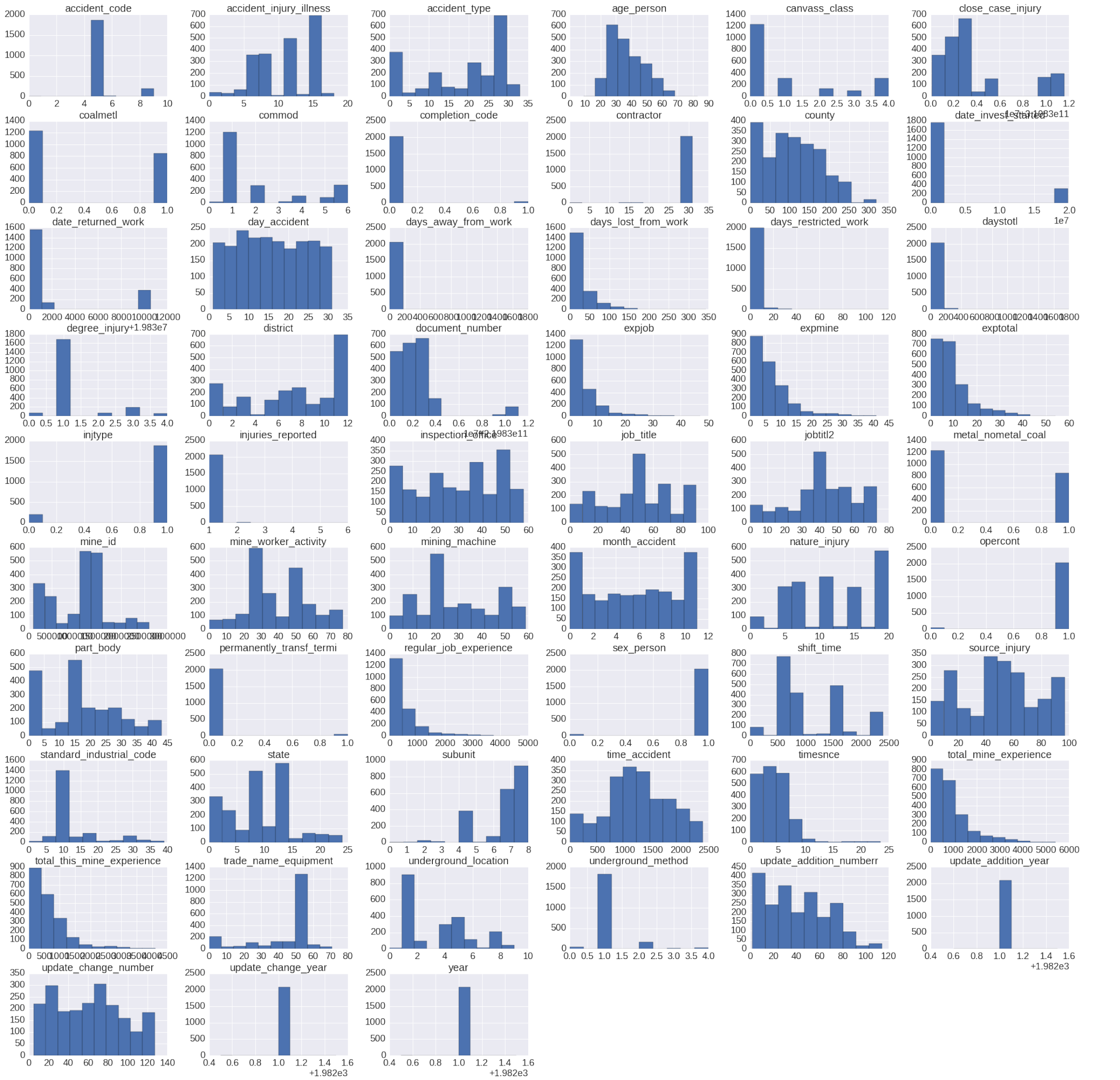
```
nature_injury                 0.074154
source_injury                 0.068615
accident_injury_illness       0.054613
mine_worker_activity          0.046429
part_body                     0.033698
age_person                    0.031606
dtype: float64
CPU times: user 32.1 s, sys: 430 ms, total: 32.5 s
Wall time: 32.2 s
```

Se observa que las variables accident_injury_illness, nature_injury, source_injury son las que mayor score obtienen, esto significa que estas variables tienen una mayor relevancia para la variable de respuesta accident_type, y por ello, aportarán en gran medida al perfomance del modelo.

accident_injury_illness: Powered haulage, Slip or fall of person (from an elevation or on the same level), Handling material, etc. nature_injury : Sprain, strains; Burn or scald (heat), etc. source_injury : Explosives, Flame, fire, smoke NEC, Surface mining machines, etc.

7 Frequency

```
In [28]: %%time
         dataNew.hist(figsize=(36.,36.), layout=(10,6))
         plt.show()
         plt.close()
```



```
CPU times: user 21.7 s, sys: 8.22 s, total: 29.9 s
Wall time: 15.9 s
```

```
In [29]: dataNew.accident_injury_illness.value_counts()
```

```
Out[29]: 12    497
         15    405
         8     365
         7     346
         16    284
         4      54
         0      29
         17     24
         3      19
         14     11
         13      9
         9       7
         6       7
         2       7
         1       6
         5       6
         10      3
         18      2
         11      1
         Name: accident_injury_illness, dtype: int64
```

```
In [30]: encodersDict['accident_injury_illness'].inverse_transform([12,15,8,7,16])
```

```
Out[30]: array(['Machinery', 'Powered haulage', 'Handtools', 'Handling material',
                'Slip or fall of person (from an elevation or on the same level)'],
```

La mayor cantidad de accidentes ocurre en estas clases de actividades

```
In [31]: dataNew.nature_injury.value_counts()
```

```
Out[31]: 19    483
         11    373
         6     331
         14    285
         4     273
         20     80
         1      53
         5      41
         0      39
         15     22
         12     18
         7      17
         8      15
         18     12
         16     12
         10     11
         2       6
```

```
        3       4
        17      3
        9       2
        13      2
        Name: nature_injury, dtype: int64
```

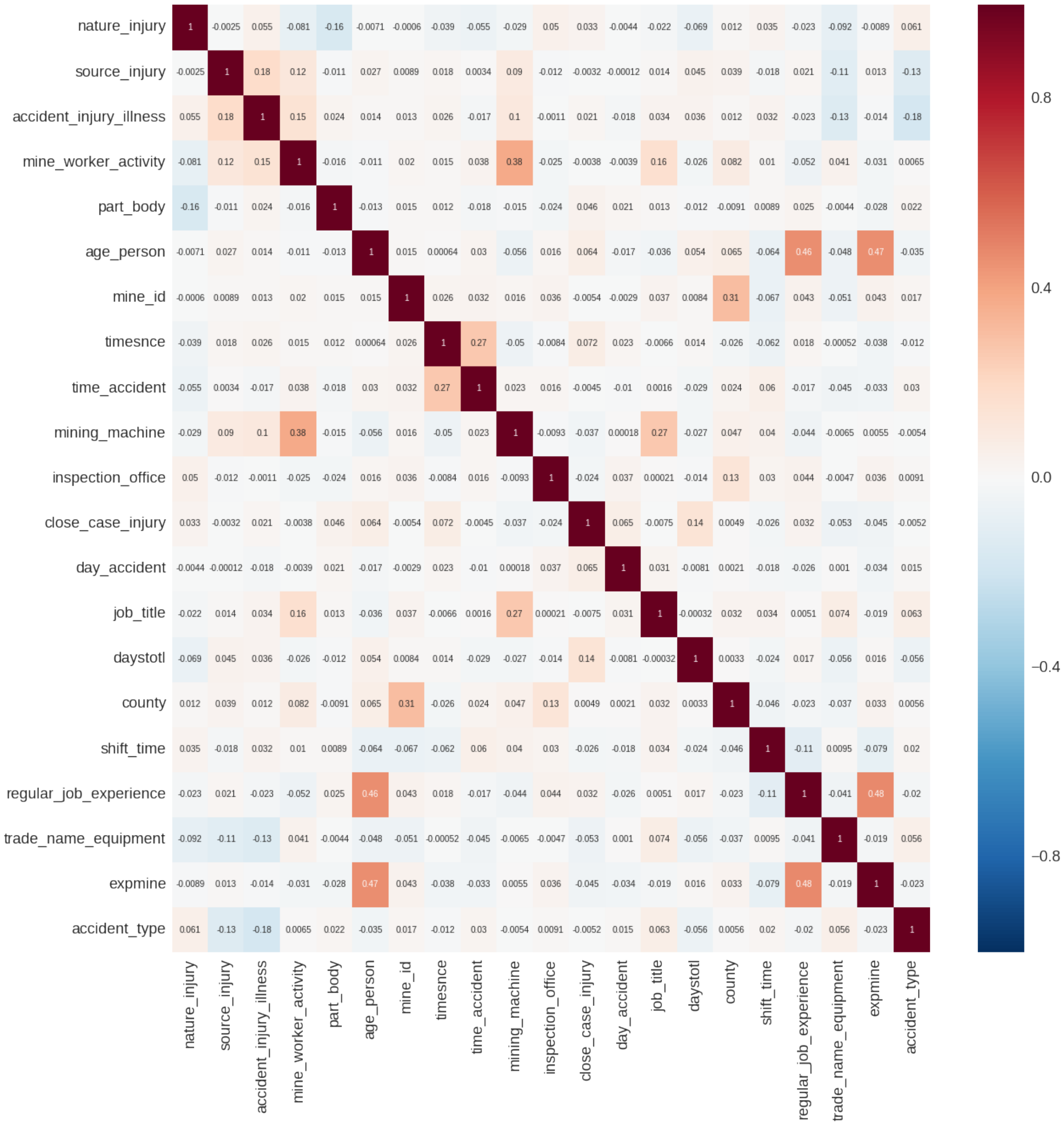
```
In [32]: encodersDict['nature_injury'].inverse_transform([19,11,6,14,4])

Out[32]: array(['Sprain, strains', 'Fracture, chip', 'Cut, laceration, puncture',
                'Multiple injuries', 'Contusion, bruise'], dtype=object)
```

8 Correlation Matrix

```
In [33]: from collections import OrderedDict

         dictFI = OrderedDict(fi.head(20))
         dictFI

Out[33]: OrderedDict([('nature_injury', 0.074153743123729188),
                      ('source_injury', 0.068614783535671159),
                      ('accident_injury_illness', 0.054613071406214748),
                      ('mine_worker_activity', 0.046429447904171674),
                      ('part_body', 0.033697773138551 4),
                      ('age_person', 0.031605557889567 62),
                      ('mine_id', 0.031121664808902265),
                      ('timesnce', 0.029028752166438358),
                      ('time_accident', 0.028538225109943093),
                      ('mining_machine', 0.023612784323351396),
                      ('inspection_office', 0.023064998359796 54),
                      ('close_case_injury', 0.022443201518236078),
                      ('day_accident', 0.022224138598094 71),
                      ('job_title', 0.021169886674535201),
                      ('daystotl', 0.020694298250456895),
                      ('county', 0.020458095318601432),
                      ('shift_time', 0.018209817616562006),
                      ('regular_job_experience', 0.0170447391073596),
                      ('trade_name_equipment', 0.016868758863678453),
                      ('expmine', 0.016237192439160317)])
```

```
In [34]: %%time
         features = dictFI.keys()
         features.append('accident_type')

         def plot_heatmap(df):

             fig, axes = plt.subplots(figsize=(20,20))

             sns.heatmap(df, annot=True)
```

```
    plt.show()
    plt.close()

plot_heatmap(dataNew[features].corr(method='pearson'))
```



```
CPU times: user 3.33 s, sys: 714 ms, total: 4.04 s
Wall time: 3.03 s
```

8.1 Brief scaling

```
In [64]: from sklearn.preprocessing import MinMaxScaler, StandardScaler

         dataScaled = dataNew.copy()
         scaler = StandardScaler()

         dictFI2 = OrderedDict(fi)
         dictFI2 = dictFI2.keys()
         dataScaled[dictFI2] = scaler.fit_transform(dataScaled[dictFI2])
         dataScaled.head()
```

```
Out[64]:      mine_id  contractor   subunit  month_accident  day_accident  \
         3  -1.644344   -5.609755  0.146114       -1.305021     -0.852624
         13 -1.644335    0.135873 -1.735589        0.414996      1.597648
         20 -1.644334    0.135873 -1.735589        0.988336     -1.319343
         21 -1.644330    0.135873 -1.735589       -1.305021     -0.269226
         33 -1.644302    0.135873 -1.735589       -0.731682      1.014250

             time_accident  inspection_office     state    county  \
         3       -1.015975          -1.411660 -1.620474  0.127867
         13      -0.865224          -1.411660 -1.620474  0.127867
         20      -0.129203          -1.411660 -1.620474 -0.532950
         21      -1.805203          -1.411660 -1.620474  0.187941
         33       0.855114          -0.767434 -1.620474 -0.893395

             standard_industrial_code    ...       expmine    expjob  year   injtype
         3                   0.706096    ...    -1.049963  4.290328   0.0  0.325088
         13                  0.573619    ...    -0.256211  0.004690   0.0  0.325088
         20                  0.706096    ...     0.140389 -0.793301   0.0  0.325088
         21                  1.103525    ...    -0.219133  0.044115   0.0  0.325088
         33                  0.706096    ...    -0.904741 -0.684884   0.0  0.325088

             daystotl  jobtitl2  coalmetl  opercont  district    commod
         3   2.049432  1.374076  1.203915 -6.580112  0.687159  0.390789
         13  6.887196 -0.515872  1.203915  0.151973  0.687159  1.975771
         20  0.062308 -0.515872  1.203915  0.151973  0.687159  1.975771
         21  0.353614  0.873795  1.203915  0.151973  0.687159  1.975771
         33 -0.156172 -0.182352  1.203915  0.151973  0.687159  1.975771

         [5 rows x 57 columns]
```

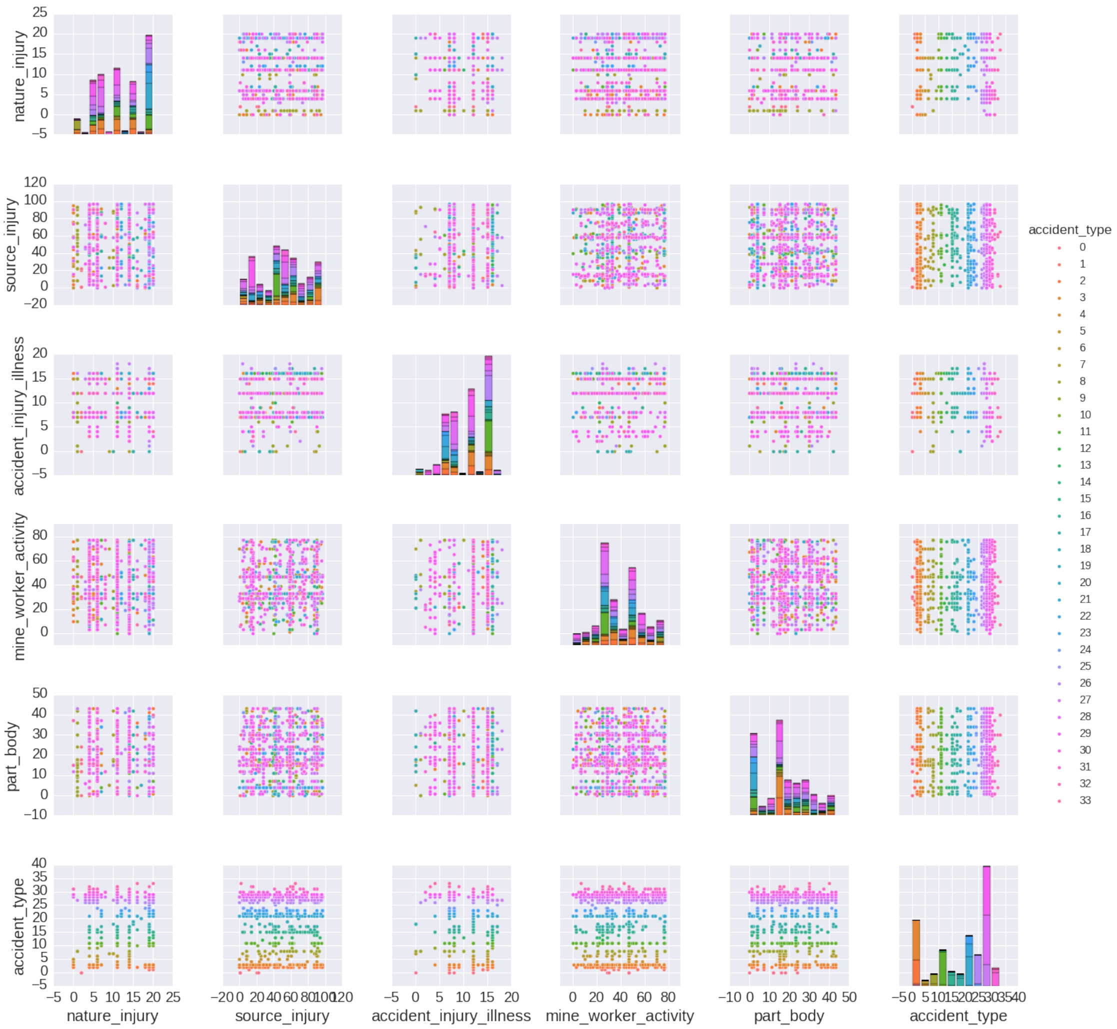
```
In [ ]:
```

9 Multivariate Plots

9.1 Scatter Plot

```
In [45]: dataNew.head(10)
```

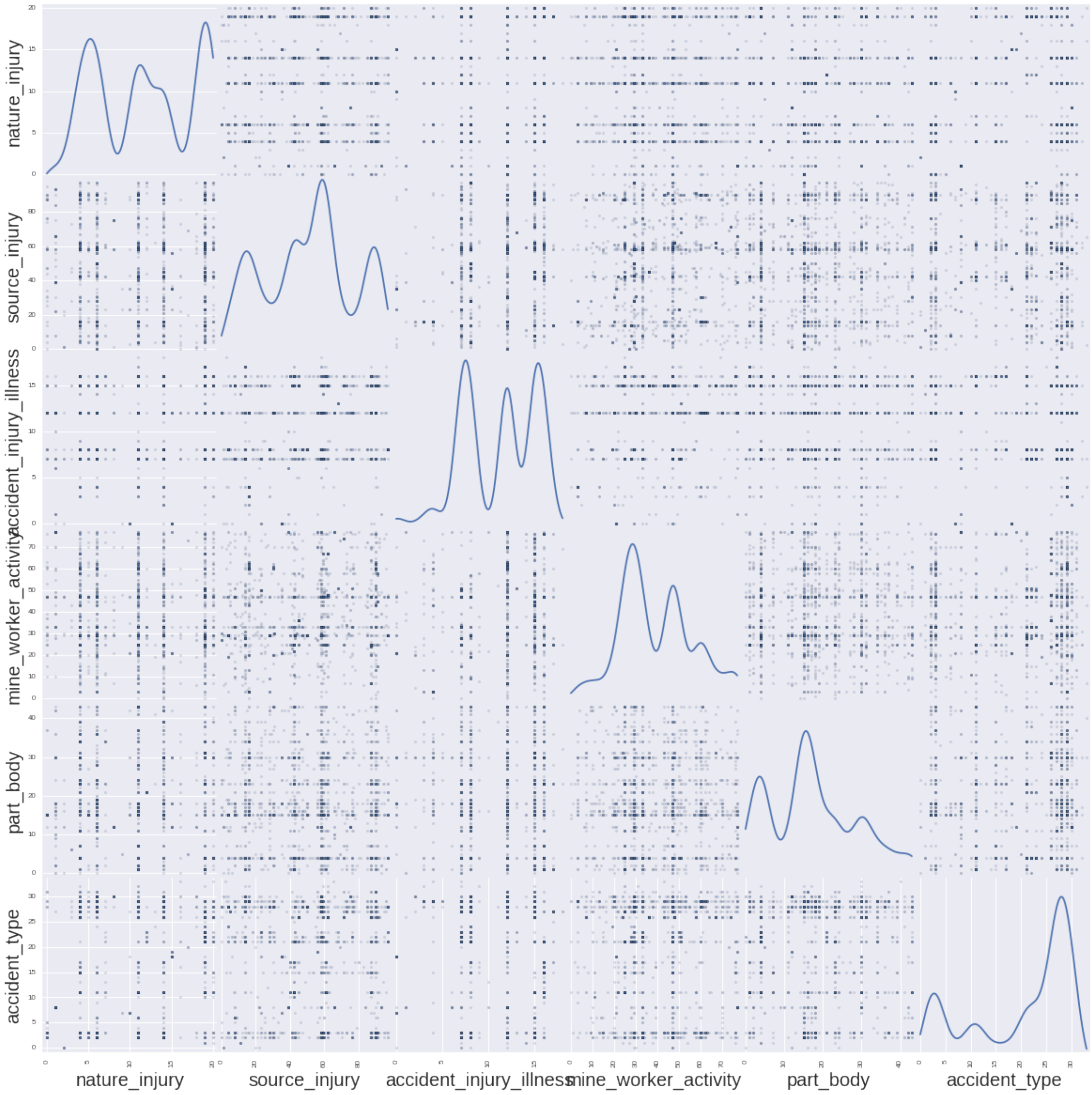
```
Out[45]:     mine_id  contractor  subunit  month_accident  day_accident  time_acci
         3    100003          14        7               1             8         64
         13   100008          31        4               7            29         73
         20   100009          31        4               9             4        114
         21   100011          31        4               1            13         20
         33   100028          31        4               3            24        170
         40   100040          31        4               2             5        103
         41   100042          31        7               5            14        143
         46   100043          31        4               8            25        104
         48   100050          31        4               7            30        163
         49   100050          31        7               6             6         71

             inspection_office  state  county  standard_industrial_code  ...    \
         3                   6      0     117                        17  ...
         13                  6      0     117                        16  ...
         20                  6      0      73                        17  ...
         21                  6      0     121                        20  ...
         33                 17      0      49                        17  ...
         40                  6      0     117                        16  ...
         41                  6      0      73                        17  ...
         46                  6      0      73                         5  ...
         48                  6      0     117                        17  ...
         49                  6      0     117                        17  ...

               expmine     expjob  year  injtype  daystotl  jobtitl2  coalmetl  \
         3    0.076660  30.000000  1983        1     235.0        67         1
         13   5.000000   5.000000  1983        1     700.0        33         1
         20   7.459959   0.344969  1983        1      44.0        33         1
         21   5.229979   5.229979  1983        1      72.0        58         1
         33   0.977413   0.977413  1983        1      23.0        39         1
         40  13.000000   5.000000  1983        1      23.0        39         1
         41   2.000000   0.498289  1983        1      14.0        67         1
         46  13.364134   7.229979  1983        1      18.0        39         1
         48   6.843258   6.843258  1983        0       0.0        39         1
         49   2.306639   2.000000  1983        1       4.0        42         1

             opercont  district  commod
         3          0        10       3
         13         1        10       6
         20         1        10       6
         21         1        10       6
         33         1        10       6
         40         1        10       6
         41         1        10       6
         46         1        10       6
         48         1        10       6
         49         1        10       6
         [10 rows x 57 columns]

In [42]: scatter = dictFI.keys()[:5]
         scatter.append('accident_type')
         scatter

Out[42]: ['nature_injury',
          'source_injury',
          'accident_injury_illness',
          'mine_worker_activity',
          'part_body',
          'accident_type']

In [ ]:

In [71]: %%time
         sns.pairplot(dataNew[scatter], hue="accident_type", size=3)
         plt.show()
```



```
CPU times: user 40.2 s, sys: 15.4 s, total: 55.6 s
Wall time: 28.4 s
```

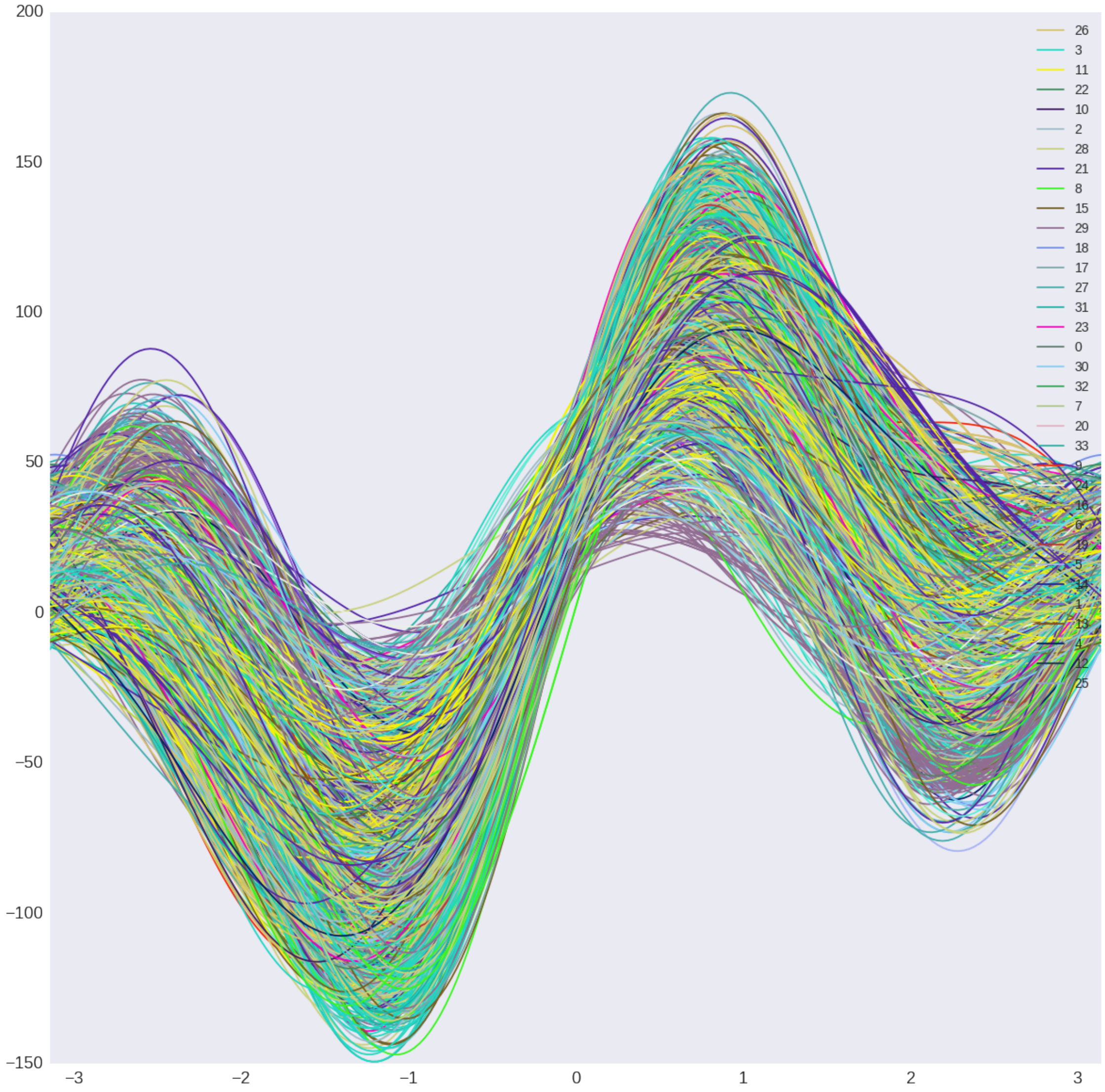
```
In [72]: %%time
         from pandas.tools.plotting import scatter_matrix

         scatter_matrix(dataNew[scatter], alpha=0.2, figsize=(20, 20), diagonal='kc
```

```
CPU times: user 6.68 s, sys: 1.13 s, total: 7.81 s
Wall time: 5.88 s
```



9.2 Andrews Curves

```
In [74]: %%time
         from pandas.tools.plotting import andrews_curves

         andrew = dictFI.keys()[:5]
         andrew.append('accident_type')


         plt.figure(figsize=(20,20))
         andrews_curves(dataNew[andrew], 'accident_type')
         plt.show()
```

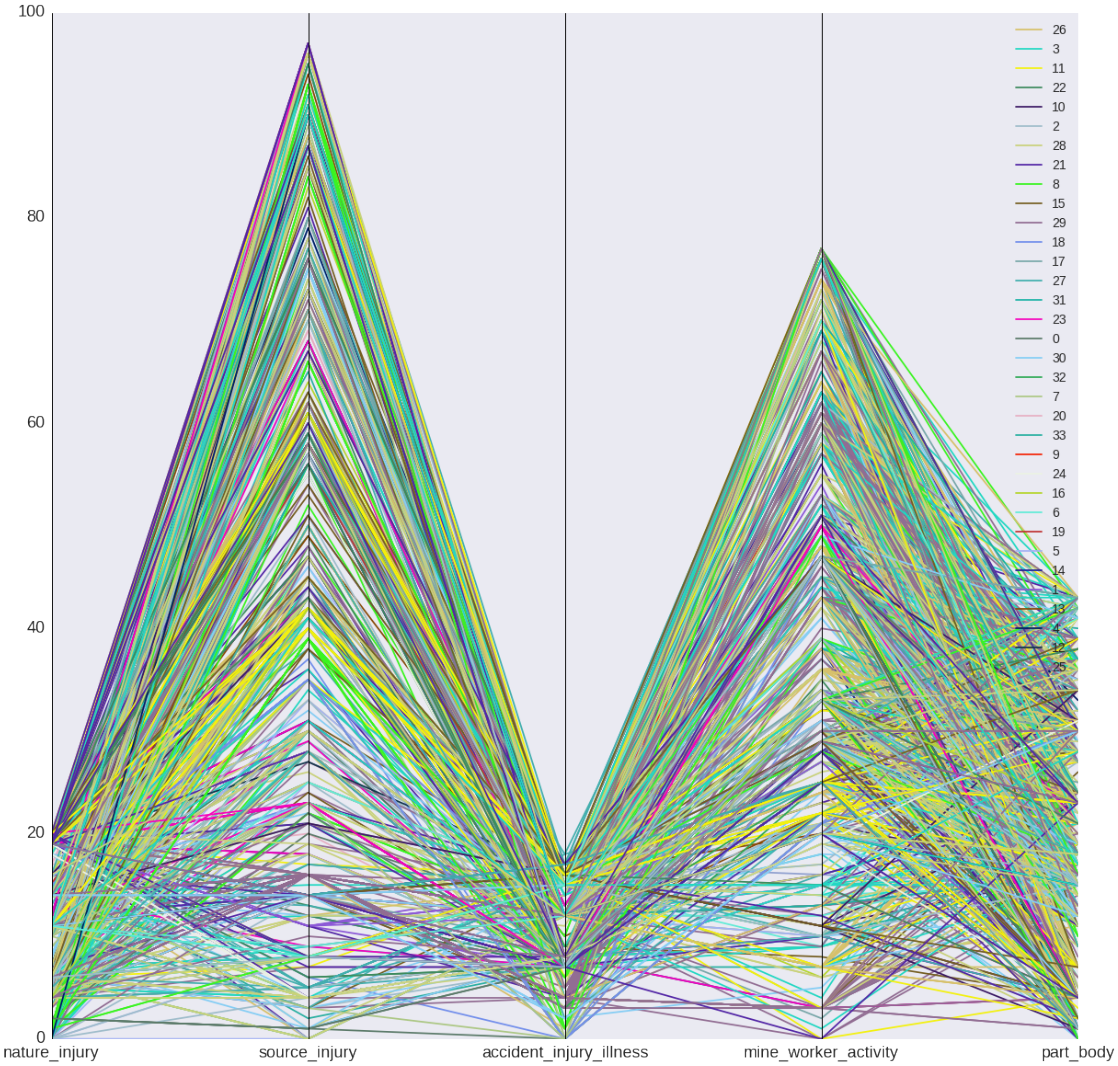


```
CPU times: user 10.1 s, sys: 306 ms, total: 10.4 s
```

```
Wall time: 9.92 s
```

9.3 Pararallel_coordinates

```
In [75]: %%time
         from pandas.tools.plotting import parallel_coordinates

         parallel = dictFI.keys()[:5]
         parallel.append('accident_type')


         plt.figure(figsize=(20,20))
         parallel_coordinates(dataNew[parallel], 'accident_type')
         plt.show()
```



```
CPU times: user 10.2 s, sys: 456 ms, total: 10.7 s
Wall time: 10 s
```

Se observa que al plotear las variables agrupadas con la variable accident_type los puntos y lineas no se logran diferenciar muy bien, esto es por que se esta prediciendo 42 clases. Se podria reducir la cantidad de clases, reclasificando los tipos de accidentes, es decir, los menos frecuentes se pondrian 'in the same bag', con esto se lograria una delineacion de fronteras mas visible (logistic, pca,svm,decision tree).

9.4 Box Plots

```
In [ ]: # box = dictFI.keys()[:6]
        # box.append('accident_type')

        # dataNew[box].plot(kind="box", figsize=(16.,16.))
        # plt.xticks(rotation='vertical')
```

10 Modeling

```
In [ ]: # %%time
        # import define
        # import analyze
        # import prepare
        # import feature_selection
        # import evaluate

        # from sklearn.pipeline import Pipeline, FeatureUnion
        # from sklearn.svm import SVC
        # from sklearn import cross_validation
        # import pandas as pd

        # #name = "datasets/iris.csv"
        # name = "datasets/Processed_Data_part.csv"
        # #name = "datasets/LocalizationOld.csv"
        # #name = "datasets/seguridad.csv"
        # #name = "datasets/breast-cancer-wisconsin.csv"
        # #name = "breast-cancer-wisconsin.csv"
        # #name = "inputBus.csv"
        # # className = "Ruta"
        # #className = "CATEGORY"
        # #className = "class"
        # className = "position"

        # #STEP 0: Define workflow parameters
        # definer = define.Define(nameData=name, className=className).pipeline()

        # #STEP 1: Analyze data by ploting it
        # #analyze.Analyze(definer).pipeline()

        # #STEP 2: Prepare data by scaling, normalizing, etc.
        # preparer = prepare.Prepare(definer).pipeline()

        # #STEP 3: Feature selection
        # featurer = feature_selection.FeatureSelection(definer).pipeline()

        # #STEP4: Evalute the algorithms by using the pipelines
        # evaluator = evaluate.Evaluate(definer, preparer, featurer).pipeline()
```

In [ ]:

In [ ]:

In [ ]: