# mountain_avalanche

August 7, 2020

[1]:
```
# importing standard python libraries + geopandas for dealing with geospatial data
import geopandas as gpd
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

[2]:
```
# reading shapefile of France divided into communes
gdf = gpd.read_file(r"CONTOURS-IRIS\1_DONNEES_LIVRAISON_2014\CONTOURS-IRIS_2-0_SHP_LAMB93_FE-2014\CONTOURS-IRIS.shp")
```

[3]:
```
# viewing geodataframe
gdf.head()
```

[3]:

| | DEPCOM | NOM_COM | IRIS | DCOMIRIS | NOM_IRIS | TYP_IRIS | geometry |
|---|---|---|---|---|---|---|---|
| 0 | 95580 | Saint-Witz | 0000 | 955800000 | Saint-Witz | Z | POLYGON ((667826.500 6888732.700, 667871.500 6… |
| 1 | 95258 | Frouville | 0000 | 952580000 | Frouville | Z | POLYGON ((639020.100 6896582.300, 638964.900 6… |
| 2 | 95116 | Bruyères-sur-Oise | 0000 | 951160000 | Bruyères-sur-Oise | Z | POLYGON ((650549.700 6898511.300, 650534.500 6… |
| 3 | 95308 | Hérouville | 0000 | 953080000 | Hérouville | Z | POLYGON ((635467.800 6888554.700, 635389.470 6… |
| 4 | 95055 | Bellefontaine | 0000 | 950550000 | Bellefontaine | Z | POLYGON ((660098.000 6887893.200, 660133.100 6… |

[4]:
```
# reading Excel sheet with number of avalanche accidents in communes
avalanche = pd.read_excel("tableau-accidents.xlsx")
avalanche.head()
```

[4]:

| | code accident | date | heure | département | commune | massif |
|---|---|---|---|---|---|---|
| 0 | 1011-05-01 | 2011-01-08 | 11:06 | 5 | monetier les bains | pelvoux |
| 1 | 1011-05-02 | 2011-01-30 | 10:00 | 5 | molines | queyras |

```
2    1011-05-03 2011-02-19  13:10            5            orcières  champsaur
3    1011-05-04 2011-02-26  16:10            5            orcières  champsaur
4    1011-05-05 2011-03-02  16:40            5        val des prés    queyras

                                    site coordonnées\nzone départ  altitude  \
0                                 cibouit                      NaN       NaN
1                               col agnel      32t0339842  4950312    2650.0
2  col de la montagne haute / mourre froid                      NaN    2800.0
3              col combeau / grande autane     32t 0292853  4947510    2100.0
4     vallon de Vachette / secteur ombilic                      NaN    2005.0

  inclinaison  … évolution  BRA  qualité \nneige  cohésion\nneige  \
0         NaN  …  descente    3            sèche           tendre
1       35-39  …    montée    2            sèche           tendre
2       35-39  …    montée    3            sèche           tendre
3       40-44  …  descente    3            sèche           tendre
4       35-39  …  descente    3            sèche           tendre

  type \ndépart           cause départ dénivelé\n(mètres)  \
0      linéaire  accidentelle soi-même               NaN
1      linéaire  accidentelle soi-même                30
2      linéaire  accidentelle soi-même               200
3      linéaire              naturelle               100
4      linéaire  accidentelle soi-même               500

  largeur \ncassure\n(mètres) épaisseur\ncassure max.  \n(cm) Unnamed: 27
0                      100.0                            50.0         NaN
1                       40.0                           100.0         NaN
2                      150.0                            80.0         NaN
3                        5.0                            30.0         NaN
4                       60.0                            60.0         NaN

[5 rows x 28 columns]
```

[5]:
```
# names of communes in geodataframe gdf and dataframe avalanche need to be in␣
 ↪same format
# avoiding mixing upper and lowercase
avalanche['commune'] = avalanche.commune.str.lower()
gdf['NOM_COM'] = gdf.NOM_COM.str.lower()
```

[6]:
```
# eyeballing through manually inserted names of communes I found some double␣
 ↪records
# for ex:'bagnères de luchon', 'bareges', 'barèges'
# or "val d'isere", "val d'isère",'val isere', 'val isère'
np.sort(avalanche.commune.unique())
```

[6]: array(['abondance', 'abriès', 'aillons le vieux', 'aime', 'allemond',
'allos', "alpe d'huez", 'araches la frasse', 'aragnouet',
'arvieux', 'arêche beaufor', 'arêche beaufort', 'aston', 'aulon',
'auris', 'auris en oisans', 'aussois', 'auzat', 'avoriaz',
'avrieux', 'ax les thermes', 'bagnère de bigorre',
'bagnères de bigorre', 'bagnères de luchon', 'bareges', 'barèges',
'beaufort', 'bellentre', 'bellevaux', 'bernex', 'bessans',
'bezaudun sur bine', 'bonneval', 'bonneval s/ arc',
'bonneval sur arc', 'bourg saint maurice', 'bourg st maurice',
'boutx', 'cauteret', 'cauterets', 'ceillac', 'cervières',
'chamonix', 'champagny', 'champagny en vanoise', 'champcella',
'chamrousse', 'chantelouve', 'chateauroux les alpes', 'chatel',
'chevaline', 'contamines', 'contamines montjoie', 'cordon',
'corrençon en vercors', "cote d'aime", 'courchevel', 'crots',
'crévoux', 'doucy en bauges', 'dévoluy', 'eaux bonnes',
'enchastrayes', 'entraunes', 'err', 'faverges-seythenex',
'ferrère', 'fontcouverte la toussuire', 'formigueres',
'freissiniere', "freney d'oisans", 'gavarnie', 'gedre', 'glandage',
'gouaux de larboust', 'granier', 'guillestre', 'hauteluce',
'isola', 'jarsy', 'jausiers', "l'hospitalet pres l'andorre",
'la bathie', 'la chapelle en valgaudemar', 'la clusaz',
'la combe de lancey', "la cote d'aime", 'la ferrière',
"la ferrière d'allevard", 'la giettaz', 'la grave', 'la léchère',
'la morte', 'la perrière', 'la plagne tarentaise',
'la salle les alpes', 'la vigerie', 'landry', 'lanslebourg',
'lanslevillard', 'laruns', 'laval', 'lavaldens', 'laveissière',
'le bouchet montcharvin', 'le chatel', "le freney d'oisans",
"le freneyr d'oisans", 'le grand bornand', 'le monetier les bains',
'le mont dore', 'le monêtier les bains',
'le petit bornand des glières', 'le reposoir', 'le vernet',
'les adrets', 'les allues', 'les avanchers',
'les avanchers-valmorel', 'les belleville', 'les clefs',
'les contamines', 'les contamines montjoie', 'les deux alpes',
'les houches', 'les orres', 'lozzi', 'macot', 'macot la plagne',
'magland', 'manigod', 'metzeral', 'mieussy', 'mittlach', 'modane',
'molines', 'molines en queyras', 'monetier', 'monetier les bains',
'mont de lans', 'mont dore', 'montchavin', 'montclar',
'montgellafrey', 'montgenevre', 'montgenèvre', 'montricher albane',
'montricher albanne', 'montricher-albanne', 'montsapey',
'montvalezan', 'monêtier les bains', 'morzine', 'méribel',
'névache', 'ombleze', 'orcieres', 'orcières', 'orelle', 'ornon',
'oz en oisans', 'oô', 'peisey', 'peisey nancroix',
'peisey-nancroix', 'pelvoux', 'pinsot', 'pontamafrey montpascal',
'porta', 'porté puymorens', 'pralognan', 'pralognan la vanoise',
'praz sur arly', 'presle', 'puy saint vincent', 'puy st vincent',
'rabat les trois seigneurs', 'revel', 'risoul', 'ristolas',
'réallon', 'saint agnès', "saint andré d'embrun",

```
       'saint bon courchevel', 'saint bon tarentaise', 'saint chaffrey',
       'saint christophe en oisans', 'saint christophe sur guiers',
       'saint colomban les villards', 'saint crepin',
       'saint dalmas de selvage', 'saint etienne de tinee',
       'saint gervais', 'saint gervais les bains', 'saint honoré',
       'saint jean de belleville', 'saint martin belleville',
       'saint martin de belleville',
       'saint martin de belleville (val thorens)',
       'saint maurice sur moselle', 'saint pancrasse',
       'saint paul s/ ubaye', 'saint paul sur ubaye',
       'saint pierre de chartreuse', 'saint veran', 'saint véran',
       'sainte agnes', 'sainte foy tarentaise', 'sainte marie de cuines',
       'samoens', 'sarcenas', 'serraval', 'sers', 'seythenex', 'sixt',
       'sixt fer à cheval', 'st bernard du touvet', 'st bon tarentaise',
       'st christophe en oisans', 'st christophe sur guiers',
       'st dalmas le selvage', 'st etienne dévoluy', 'st etienne tinee',
       'st françois longchamp', 'st gervais les bains', 'st honoré',
       'st lary soulan', 'st martin de belleville', 'st martin vésubie',
       'st pierre de chartreuse', 'st véran', 'ste foy tarentaise',
       'stockersohn', 'stosswhir', 'stosswihr', 'termignon',
       'thollon les mémises', 'tignes', 'ustou', 'uvernet fours',
       'vacheresse', "val d'isere", "val d'isère", 'val des prés',
       'val isere', 'val isère', 'valloire', 'vallorcine', 'valmeinier',
       'vars', 'vaujany', 'vieille aure', 'villar arene',
       "villard d'arene", 'villard de lans', 'villards de lans',
       'villarodin bourget', 'villaroger', 'wasserbourg', 'épierre'],
      dtype=object)
```

[7]:
```
# because of inconsistent using of french special characters and some other␣
↪characters I change them to unified writing
avalanche['commune'].replace(['è', 'é', 'ê', 'ë'], 'e', inplace=True,␣
↪regex=True)
avalanche['commune'].replace('-', ' ', inplace=True, regex=True)
avalanche['commune'].replace('à', 'a',inplace=True, regex=True)
avalanche['commune'].replace('î', 'i',inplace=True, regex=True)
avalanche['commune'].replace('ô', 'o',inplace=True, regex=True)
avalanche['commune'].replace("d'", "d ", inplace=True, regex=True)
avalanche['commune'].replace(['st ', 'St '], 'saint ', inplace=True, regex=True)
avalanche['commune'].replace('s/', 'sur', inplace=True, regex=True)
gdf['NOM_COM'].replace(['è', 'é', 'ê', 'ë'], 'e', inplace=True, regex=True)
gdf['NOM_COM'].replace('-', ' ', inplace=True, regex=True)
gdf['NOM_COM'].replace(['à', 'â'], 'a',inplace=True, regex=True)
gdf['NOM_COM'].replace('î', 'i',inplace=True, regex=True)
gdf['NOM_COM'].replace('ô', 'o',inplace=True, regex=True)
gdf['NOM_COM'].replace("d'", "d ", inplace=True, regex=True)
gdf['NOM_COM'].replace(['st ', 'St '], 'saint ', inplace=True, regex=True)
gdf['NOM_COM'].replace('s/', 'sur', inplace=True, regex=True)
```

[8]:
```
# all commune names in avalanche communes should be also in gdf geodataframe
# to find avalanche communes missing from gdf because of use of inconsistent␣
 ↪names
# I will merge both dataframes and check differences
aval_gdf = pd.merge(gdf, avalanche, left_on ='NOM_COM', right_on = 'commune',␣
 ↪how='inner')
# creating two arrays of commune names in merged datafrane and avalanche␣
 ↪dataframe
aval_gdf_com = np.sort(aval_gdf['NOM_COM'].unique())
avalanche_com = np.sort(avalanche['commune'].unique())
# looking for communes in avalanche dataframe not found in merged aval_gdf
np.setdiff1d(avalanche_com, aval_gdf_com)
```

[8]:
```
array(['aillons le vieux', 'alpe d huez', 'areche beaufor',
       'areche beaufort', 'auris en oisans', 'avoriaz',
       'bagnere de bigorre', 'cauteret', 'chamonix', 'contamines',
       'contamines montjoie', 'cote d aime', 'courchevel',
       'faverges seythenex', 'freissiniere', 'freney d oisans',
       'la ferriere d allevard', 'la plagne tarentaise', 'la vigerie',
       'lanslebourg', 'le bouchet montcharvin', 'le freneyr d oisans',
       'le mont dore', 'le petit bornand des glieres', 'les avanchers',
       'les belleville', 'les contamines', 'les deux alpes', 'macot',
       'meribel', 'molines', 'monetier', 'monetier les bains',
       'montchavin', 'montricher albane', 'oz en oisans', 'peisey',
       'pralognan', 'saint agnes', 'saint bernard du touvet',
       'saint bon courchevel', 'saint colomban les villards',
       'saint dalmas de selvage', 'saint etienne devoluy',
       'saint etienne tinee', 'saint martin belleville',
       'saint martin de belleville (val thorens)', 'sixt',
       'ste foy tarentaise', 'stockersohn', 'stosswhir', 'val isere',
       'vieille aure', 'villar arene', 'villard d arene',
       'villards de lans'], dtype=object)
```

[9]:
```
# I take 'alpe d huez' as example. Why it was not found in aval_gdf_com?
# correct name for commune is not 'alpe d huez', but just 'huez'
gdf[gdf.NOM_COM.str.contains(pat='crepin')]
```

[9]:

| | DEPCOM | NOM_COM | IRIS | DCOMIRIS | \ |
|---|---|---|---|---|---|
| 18745 | 61339 | putanges pont ecrepin | 0000 | 613390000 | |
| 19604 | 60570 | saint crepin ibouvillers | 0000 | 605700000 | |
| 19857 | 60569 | saint crepin aux bois | 0000 | 605690000 | |
| 39330 | 24391 | saint crepin de richemont | 0000 | 243910000 | |
| 39378 | 24392 | saint crepin et carlucet | 0000 | 243920000 | |
| 39742 | 24390 | saint crepin d auberoche | 0000 | 243900000 | |
| 42421 | 17321 | saint crepin | 0000 | 173210000 | |
| 48084 | 05136 | saint crepin | 0000 | 051360000 | |

```
                        NOM_IRIS TYP_IRIS  \
18745      Putanges-Pont-Écrepin        Z
19604   Saint-Crépin-Ibouvillers        Z
19857      Saint-Crépin-aux-Bois        Z
39330  Saint-Crépin-de-Richemont        Z
39378   Saint-Crépin-et-Carlucet        Z
39742   Saint-Crépin-d'Auberoche        Z
42421               Saint-Crépin        Z
48084               Saint-Crépin        Z

                                                 geometry
18745  POLYGON ((459538.600 6857933.400, 459568.600 6…
19604  POLYGON ((632796.600 6909698.000, 632890.520 6…
19857  POLYGON ((701678.400 6927283.400, 701640.970 6…
39330  POLYGON ((513735.100 6486445.400, 513777.130 6…
39378  POLYGON ((565960.500 6427850.000, 565881.880 6…
39742  POLYGON ((533502.200 6450714.900, 533502.500 6…
42421  POLYGON ((407928.800 6550148.800, 407962.220 6…
48084  POLYGON ((982424.700 6406169.100, 982434.000 6…
```

[10]:
```
# I will create dictionary with wrong commune names as keys and its correct␣
↪variants as values
# based on similar search as in previous example and wikipedia info about␣
↪changes of commune names
correct = {'aillons le vieux':'aillon le vieux', 'alpe d huez':'huez', 'areche␣
↪beaufor':'beaufort savoie',
      'areche beaufort':'beaufort savoie','auris en oisans':'auris', 'avoriaz':
↪'morzine',
      'bagnere de bigorre':'bagneres de bigorre', 'cauteret':'cauterets',␣
↪'chamonix':'chamonix mont blanc',
       'contamines':'les contamines montjoie', 'contamines montjoie':'les␣
↪contamines montjoie',
       'cote d aime':'la plagne tarentaise', 'freissiniere':'freissinieres',␣
↪'freney d oisans':'le freney d oisans',
      'la ferriere d allevard':'haut breda', 'la ferriere':'haut breda', 'la␣
↪vigerie':'lavigerie', 'la perriere':'courchevel',
      'lanslebourg':'lanslebourg mont cenis', 'le bouchet montcharvin':'le␣
↪bouchet',
       'le freneyr d oisans':'le freney d oisans', 'le mont dore':'mont dore',
       'le petit bornand des glieres':'le petit bornand les glieres',
       'les avanchers':'les avanchers valmorel','les contamines':'les␣
↪contamines montjoie',
        'macot':'la plagne tarentaise', 'meribel':'les allues', 'molines':
↪'molines en queyras',
       'monetier':'le monetier les bains', 'monetier les bains':'le monetier␣
↪les bains',
```

```
      'montchavin':'la plagne tarentaise', 'montricher albane':'montricher␣
↪albanne', 'oz en oisans':'oz',
       'peisey':'peisey nancroix', 'pralognan':'pralognan la vanoise', 'saint␣
↪agnes':'sainte agnes isere',
       'saint bernard du touvet':'le touvet', 'saint bon courchevel':
↪'courchevel',
       'saint colomban les villards':'saint colomban des villards', 'saint␣
↪dalmas de selvage':'saint dalmas le selvage',
       'saint etienne devoluy':'devoluy', 'saint etienne tinee':'saint etienne␣
↪de tinee', 'saint gervais':'saint gervais les bains',
       'saint martin belleville':'les belleville', 'saint martin de belleville␣
↪(val thorens)':'les belleville',
       'saint martin de belleville':'les belleville', 'saint crepin':'saint␣
↪crepin alpes',
       'sixt':'sixt fer a cheval', 'ste foy tarentaise':'sainte foy␣
↪tarentaise', 'sers':'sers haute bigorre',
       'stockersohn':'storckensohn', 'stosswhir':'stosswihr',
       'val isere':'val d isere', 'vieille aure':'', 'villar arene':'villar d␣
↪arene', 'villard d arene':'villar d arene',
      'villards de lans':'villard de lans', 'beaufort':'beaufort savoie',␣
↪'bonneval':'bonneval sur arc', 'vars':'vars hautes alpes'}
```

[11]:
```
# loop to change wrong commune names, replacing dictionary key by value
correct_commune = []
for commune in avalanche.commune:
    if commune in list(correct.keys()):
        correct_commune.append(correct[commune])
    else:
        correct_commune.append(commune)
```

[12]:
```
# checking column with corrected names is same length as original
(len(avalanche['commune'])) == (len(correct_commune))
```

[12]:
```
True
```

[13]:
```
# adding column with correct column names
avalanche['commune'] = correct_commune
```

[14]:
```
# some of commune names in gdf are outdated or same name is used for more␣
 ↪communes
# therefore I create dictionary to correct them based on DEPCOM value

gdf_correct = {'73034':'beaufort savoie', '38350':'sainte agnes isere',
               '38163':'haut breda', '05177':'vars hautes alpes', '65046':␣
 ↪'aulon',
               '65424': 'sers haute bigorre', '05027':'cervieres hautes alpes',
```

```
            '73227':'courchevel', '73150':'la plagne tarentaise', '38253':
↪'les deux alpes',
            '73257':'les belleville', '76589':'saint honore normandie',
            '04237':'le vernet', '39747':'sainte agnes jura',
            '05136':'saint crepin alpes', '06113':'sainte agnes pres nice',
            '31451':'revel occitanie', '53130':'laval mayenne',
            '11242':'montclar occitanie', '12149':'montclar occitanie 2',
            '74123':'faverges seythenex', '23011':'aulon aquitaine',
             '31023':'aulon occitanie', '73198':'courchevel',
             '16393':'vars aquitaine', '70523':'vars franche comte',
             '31051':'beaufort occitanie', '34026':'beaufort occitanie␣
↪beziers',
             '38032':'beaufort isere', '39043':'beaufort orbagna', '59058':
↪'beaufort nord',
             '30256':'saint gervais occitanie', '33415':'saint gervais␣
↪aquitanie',
             '38390':'saint gervais isere', '95554':'saint gervais ile de␣
↪france',
             '22058':'plemet', '37106':'la ferriere loire', '85089':'la␣
↪ferrierre nantes',
             '28051':'bonneval loire', '43035':'bonneval haute loire',␣
↪'73046':'la lechere',
             '03306':'le vernet pres vichy','09331':'le vernet occitanie',␣
↪'43260':'le vernet haute loire',
            '73198':'la perriere old', '73046':'bonneval old', '05177':'vars␣
↪hautes alpes'}

# for loop to correct commune names
correct_commune_gdf = []
i = -1
for depcom in gdf.DEPCOM:
    i += 1
    if depcom in list(gdf_correct.keys()):
        correct_commune_gdf.append(gdf_correct[depcom])
    else:
        correct_commune_gdf.append(gdf.NOM_COM[i])
```

[15]:
```
# checking column with corrected names is same length as original
(len(gdf['NOM_COM'])) == (len(correct_commune_gdf))
```

[15]: True

[16]:
```
# adding column with correct commune names
gdf['NOM_COM'] =correct_commune_gdf
```

[17]:
```
aval_gdf = pd.merge(gdf, avalanche, left_on ='NOM_COM', right_on = 'commune',␣
↪how='inner')
aval_gdf_com = np.sort(aval_gdf['NOM_COM'].unique())
avalanche_com = np.sort(avalanche['commune'].unique())
```

[18]:
```
# check if there are still some communes missing from merged aval_gdf
# actually there are all old names of communes which need to be corrected to␣
↪new ones
np.setdiff1d(avalanche_com, aval_gdf_com)
```

[18]:
```
array(['', 'macot la plagne', 'mont de lans', 'saint bon tarentaise'],
      dtype=object)
```

[19]:
```
# replacing old names based on wikipedia search of current names
# https://fr.wikipedia.org/wiki/M%C3%A2cot-la-Plagne
# https://fr.wikipedia.org/wiki/Mont-de-Lans
# https://fr.wikipedia.org/wiki/Saint-Bon-Tarentaise
avalanche.loc[avalanche['commune']=='macot la plagne', 'commune']='la plagne␣
↪tarentaise'
avalanche.loc[avalanche['commune']=='mont de lans', 'commune']='les deux alpes'
avalanche.loc[avalanche['commune']=='saint bon tarentaise',␣
↪'commune']='courchevel'
# checking blankspace in commune
avalanche[avalanche.commune=='']
```

[19]:

| | code accident | date | heure | département | commune | massif | \ |
|---|---|---|---|---|---|---|---|
| 73 | 1112-65-02 | 2012-02-18 | NaN | 65 | | haute bigorre | |
| 416 | 1718-65-09 | 2018-02-23 | NaN | 65 | | aure louron | |

| | site | coordonnées\nzone départ | altitude | \ |
|---|---|---|---|---|
| 73 | corneblanque | | NaN | NaN |
| 416 | versant sud pic d'aygues cluses | 42°52'15.8" / 0°10'0.0" | 2570.0 | |

| | inclinaison | … | évolution | BRA | qualité \nneige | cohésion\nneige | \ |
|---|---|---|---|---|---|---|---|
| 73 | NaN | … | descente | 3 | sèche | NaN | |
| 416 | >45 | … | ski | montée | 3 | sèche | |

| | type \ndépart | cause départ | dénivelé\n(mètres) | \ |
|---|---|---|---|---|
| 73 | linéaire | accidentelle soi-même | NaN | |
| 416 | NaN | linéaire | naturelle sérac/corniche | |

| | largeur \ncassure\n(mètres) | épaisseur\ncassure max. | \n(cm) | Unnamed: 27 |
|---|---|---|---|---|
| 73 | NaN | NaN | NaN | |
| 416 | 140.0 | NaN | NaN | |

[2 rows x 28 columns]

[20]:
```
# after search of sites inserting missing commune names
avalanche.loc[avalanche['code accident']=='1112-65-02', 'commune']='saint lary␣
↪soulan'
avalanche.loc[avalanche['code accident']=='1718-65-09', 'commune']='vielle aure'
```

[21]:
```
# another check if all communes from avalanche dataframe are included
aval_gdf = pd.merge(gdf, avalanche, left_on ='NOM_COM', right_on = 'commune',␣
↪how='inner')
aval_gdf_com = np.sort(aval_gdf['NOM_COM'].unique())
avalanche_com = np.sort(avalanche['commune'].unique())
# yes, finally all communes are in merged dataframe
np.setdiff1d(avalanche_com, aval_gdf_com)
```

[21]:
```
array([], dtype=object)
```

[22]:
```
# polygons in geodataframe are created for smaller unit then commune which is␣
↪called iris
# in some cases there is more iris units for one commune, therefore connect␣
↪polygons based on commune
gdf[gdf.NOM_COM=='chamonix mont blanc']
```

[22]:

| | DEPCOM | NOM_COM | IRIS | DCOMIRIS | NOM_IRIS | TYP_IRIS | geometry |
|---|---|---|---|---|---|---|---|
| 11330 | 74056 | chamonix mont blanc | 0101 | 740560101 | Les Bossons Les Moussoux | H | POLYGON ((996579.250 6540846.600, 996804.700 6… |
| 11331 | 74056 | chamonix mont blanc | 0104 | 740560104 | La Tour Argentiere Les Praz | H | POLYGON ((996579.250 6540846.600, 996536.450 6… |
| 11332 | 74056 | chamonix mont blanc | 0102 | 740560102 | Les Pelerins Le Betty | H | POLYGON ((999526.400 6542740.300, 999544.100 6… |
| 11333 | 74056 | chamonix mont blanc | 0103 | 740560103 | Chamonix Sud Bois du Bouchet | H | POLYGON ((999810.800 6544114.200, 999821.900 6… |

[23]:
```
# creating polygons based on commune
# source 1 https://www.earthdatascience.org/workshops/gis-open-source-python/
↪dissolve-polygons-in-python-geopandas-shapely/
# source 2 https://gis.stackexchange.com/questions/287064/
↪dissolve-causes-no-shapely-geometry-can-be-created-from-null-value-in-geopanda/
↪287065
gdf['geometry'] = gdf.buffer(0.01)
commune_boundary = gdf[['DEPCOM', 'NOM_COM','geometry']]
```

```
gdf = commune_boundary.dissolve(by='DEPCOM')
```

[24]:
```
# merge of new geodataframe with avalanche records
aval_com  = pd.merge(avalanche, gdf, how='left',␣
↪left_on='commune',right_on='NOM_COM')
```

[25]:
```
# counting number of avalance accindents for each commune
aval_final = (aval_com.groupby(['commune']).size()).sort_values(ascending=False)
# results put into new dataframe
aval_final = aval_final.to_frame().reset_index()
aval_final
```

[25]:
```
                commune   0
0    chamonix mont blanc  30
1              val d isere  23
2                   tignes  23
3          les belleville  15
4               la clusaz  11
..                    …  ..
190               lozzi   1
191             magland   1
192            metzeral   1
193            mittlach   1
194           abondance   1

[195 rows x 2 columns]
```

[26]:
```
# renaming column to have clear description
aval_final.rename(columns={0:'count_of_avalanche_accidents'}, inplace=True)
aval_final.head()
```

[26]:
```
               commune  count_of_avalanche_accidents
0  chamonix mont blanc                            30
1          val d isere                            23
2               tignes                            23
3       les belleville                            15
4            la clusaz                            11
```

[27]:
```
# creating final geodataframe to be transformed into graph via bokeh library
aval_gdf_final = pd.merge(gdf, aval_final, how='left',␣
↪right_on='commune',left_on='NOM_COM')
```

[28]:
```
aval_gdf_final.sample(10)
```

[28]:
```
                                                geometry  \
22728  POLYGON ((1005972.105 6893276.391, 1005972.104…
13430  POLYGON ((443596.504 6435968.191, 443596.503 6…
```

```
16939  POLYGON ((749713.092 6434396.106, 749713.093 6…
4477   POLYGON ((894526.990 6291180.703, 894526.991 6…
27767  POLYGON ((1030430.210 6855451.000, 1030430.210…
19417  POLYGON ((836999.203 6881027.290, 836999.202 6…
26349  POLYGON ((446443.399 6279035.990, 446443.398 6…
29832  POLYGON ((787558.000 6594288.790, 787557.999 6…
5563   POLYGON ((495597.007 6513686.793, 495597.006 6…
1932   POLYGON ((1041591.499 6303876.090, 1041591.498…
```

| | NOM_COM | commune | count_of_avalanche_accidents |
|---|---|---|---|
| 22728 | woelfling les sarreguemines | NaN | NaN |
| 13430 | savignac de l'isle | NaN | NaN |
| 16939 | saint privat d allier | NaN | NaN |
| 4477 | le puy sainte reparade | NaN | NaN |
| 27767 | littenheim | NaN | NaN |
| 19417 | braux saint remy | NaN | NaN |
| 26349 | aydie | NaN | NaN |
| 29832 | volesvres | NaN | NaN |
| 5563 | bunzac | NaN | NaN |
| 1932 | aspremont | NaN | NaN |

[29]:
```
aval_gdf_final.fillna({'commune':'No avalanche', 'count_of_avalanche_accidents':
 ↪'No avalanche'}, inplace = True)
# source https://towardsdatascience.com/
 ↪a-complete-guide-to-an-interactive-geographical-map-using-python-f4c5197e23e0
```

[30]:
```
aval_gdf_final.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 36595 entries, 0 to 36594
Data columns (total 4 columns):
geometry                      36595 non-null geometry
NOM_COM                       36595 non-null object
commune                       36595 non-null object
count_of_avalanche_accidents  36595 non-null object
dtypes: geometry(1), object(3)
memory usage: 1.4+ MB
```

[31]:
```
# importing bokeh elements
import json
from bokeh.io import show, save, output_notebook
from bokeh.models import (CDSView, ColorBar, ColumnDataSource,
                          CustomJS, CustomJSFilter,
                          GeoJSONDataSource, HoverTool,
                          LinearColorMapper, Slider)
from bokeh.layouts import column, row, widgetbox
from bokeh.palettes import mpl
```

```
from bokeh.plotting import figure, output_file
# input GeoJSON source that contains features for plotting
geosource = GeoJSONDataSource(geojson = aval_gdf_final.to_json())
```

[32]:
```
# define color palettes
palette = mpl['Viridis'][6]
palette = palette[::-1] # reverse order of colors so higher values have darker␣
 ↪colors

# instantiate LinearColorMapper that linearly maps numbers in a range into a␣
 ↪sequence of colors
# and nan values will be colored in grey
color_mapper = LinearColorMapper(palette = palette, low = 0, high = 30,␣
 ↪nan_color = '#d9d9d9')

# define custom tick labels for color bar.
tick_labels = {'0': '1', '5': '5', '10':'10', '15':'15', '20':'20', '25':'25',␣
 ↪'30':'30'}

# create color bar
color_bar = ColorBar(color_mapper = color_mapper,
                     label_standoff = 8,
                     width = 500, height = 20,
                     border_line_color = None,
                     location = (0,0),
                     orientation = 'horizontal',
                     major_label_overrides = tick_labels)

# create figure object

p = figure(title = 'Number of avalance accidents in commune',
           plot_height = 1400,
           plot_width = 1200,
           toolbar_location = 'below',
           tools = 'pan, wheel_zoom, box_zoom, reset')

p.xgrid.grid_line_color = None
p.ygrid.grid_line_color = None

# add patch renderer to figure.
communes = p.patches('xs','ys', source = geosource,
                     fill_color = {'field' :'count_of_avalanche_accidents',
                                   'transform' : color_mapper},
                     line_color = 'gray',
                     line_width = 0.20,
                     fill_alpha = 1)
```

```
# create hover tool
p.add_tools(HoverTool(renderers = [communes],
                      tooltips = [('Commune','@NOM_COM'),
                                  ('Number of avalanche␣
 ↪accidents','@count_of_avalanche_accidents')]))

p.add_layout(color_bar, 'below')


# final visualization can be seen as html page
output_file("mountains_danger.html")
save(p)
```

[32]:
```
'C:\\Users\\kamil\\OneDrive\\Plocha\\mountain_project\\mountain_avalanche\\mount
ains_danger.html'
```

[ ]: