Notebook_148_149_155

August 28, 2020

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from geopy.distance import geodesic
import tqdm.notebook as tqdm
from collections import Counter
import lemmy
plt.style.use("classic")

import time
import requests
from bs4 import BeautifulSoup
import re
import json

#Text Analysis
import nltk
from nltk.corpus import stopwords

import spacy
import da_core_news_md as da #To dowload this run: python -m spacy download␣
 ↪da_core_news_md
import lemmy.pipe

try:
    nlp = da.load()
    pipe = lemmy.pipe.load('da')
    nlp.add_pipe(pipe, after='tagger')
except ValueError:
    None

%matplotlib inline
```

0.0.1 Group 2

[141]:

```
def houses_boliga():
    """
    Returns a list of all ids for houses on Boliga.dk
    """
    #Setting up list
    house_id = list()
    url = "https://www.boliga.dk/resultat?"
    #Finding number of pages on Boliga
    response = requests.get(url)
    html = response.text
    soup = BeautifulSoup(html,"html.parser")
    ids = soup.find_all("a",{"class":"page-button"})

    max_pages = int(ids[-2].text)
    #Going through each list and getting the id for all houses on page. 30 per␣
 ↪page.
    for i in tqdm(range(1,max_pages)):
        time.sleep(2)
        new_url = url + f"page={i}"
        response = requests.get(new_url)
        html = response.text
        soup = BeautifulSoup(html,"html.parser")
        ids = soup.find_all("a",{"class":"house-list-item"})
        link_houses = list()
        #Appending 30 ids to list, making a try command to work around a␣
 ↪possible fail.
        for link in ids:
            try:
                link_houses.append(re.findall("(/\d{4,}/)",link["href"])[0].
 ↪replace("/",""))
            except:
                continue
        #Extending the final list
        house_id.extend(link_houses)

    print("Hentet alle ids")

    return house_id

def get_info(id_list):

    """
    Take an list with ids of houses on boliga and gets specific data about␣
 ↪these ids from Boligas API
    """
    #Setting up list with df and the desired values
    all_df = list()
    new_keys =␣
↪["registeredArea","downPayment","estateUrl","currentArchiveId","forSaleNowId",
              ␣
↪"foreclosureId","selfsaleEstateId","cleanStreet","estateId","latitude","longitude",
             ␣
↪"propertyType","priceChangePercentTotal","energyClass","price","rooms","size","lotSize",
             ␣
↪"floor","buildYear","city","isActive","municipality","zipCode","street",
              ␣
↪"squaremeterPrice","daysForSale","createdDate","basementSize","views"]

    #Going through each house id, to get the corresponding API Request
    for house_id in id_list:
        time.sleep(2)
        response = requests.get(f'https://api.boliga.dk/api/v2/estate/
↪{house_id}')
        response = response.json()
        #Making sure we only get values we need
        df_dict = {key: response[key] for key in new_keys}
        df = pd.DataFrame(df_dict,index=[0])
        #Appending each house to a list
        all_df.append(df)

    #Concating all house df together
    df = pd.concat(all_df,axis=0,ignore_index=True)

    return df

def get_reviews(df):
    """
    Loops through all links of dataframe, scrapes the top links and return a␣
↪dataframe with the body text.
    """
    bodys = list()
    #Finding all real estates agtens who has more than a 100 houses for sale
    for value in df["estateUrl"].values:
        estates.append(value[8:15])
    numbers = dict(Counter(estates))
    over_100 = dict()
    for key, value in numbers.items():
        if value > 100:
            over_100[key] = value

    #Looping through all links and finds corresponding body text
    for link in tqdm(df["estateUrl"].values):
        time.sleep(2)
        i += 1
        body_len_prior = len(bodys)
        try:
            #Creating request
            response = requests.get(link)
            html = response.text
            soup = BeautifulSoup(html,"html.parser")

            #Different real estate agents demand different find_all
            if link[8:15] =="home.dk": #Home
                ids = soup.find_all("div",{"class":"text"},"p")
                bodys.extend([x.p.text.replace("\n","").strip().lower() for x␣
↪in ids[0:1] if len(x)>1])
            elif link[8:15] =="ww.skbo": #skbolig
                ids = soup.find_all("div",{"class":"listing-text"})
                bodys.extend([sk.text.replace("\n","").replace("\r","").strip().
↪lower() for sk in ids[0:1] if len(sk)>1])
            elif link[8:15] == "www.nyb": #Nybolig
                ids = soup.find_all("div",{"class":"foldable-spot__container"})
                bodys.extend([ny.text.replace("\n","").strip().lower() for ny␣
↪in ids[0:1] if len(ny)>1])
            elif link [8:15] == "ww.elto": #Eltoft Nielsen
                ids = soup.find_all("br")
                bodys.extend([elto.text.replace("\n","").strip().lower() for␣
↪elto in ids[0:1] if len(elto)>1])
            elif link[8:15] == "www.cla": #Claus Borg
                ids = soup.find_all("div",{"id":"case_content"})
                bodys.extend([cla.text.replace("\n","").strip().lower() for cla␣
↪in ids[0:1] if len(cla)>1])
            elif link[8:15] == "www.lok": #Lokalbolig
                ids = soup.find_all("div",{"class":"css-s7itso eknr0ef1"})
                bodys.extend([lok.text.replace("\n","").strip() for lok in␣
↪ids[0:1] if len(lok)>1])
            elif link[8:15] == "www.edc": #EDC Bolig
                ids = soup.find_all("div",{"class":"description"})
                bodys.extend([edc.text.replace("\n","").strip().lower() for edc␣
↪in ids[0:1] if len(edc)>1])
            elif link[8:15] == "adamsch": #Adam Schnack
                ids = soup.find_all("div",{"class":"listing-text"})
                bodys.extend([adam.text.replace("\n","").strip().lower() for␣
↪adam in ids[0:1] if len(adam)>1])
            elif link[8:20] == "www.estate.d": #Estate
                ids = soup.find_all("div",{"class":"property-description"})
                bodys.extend([est.text.replace("\n","").strip().lower() for est␣
↪in ids[0:1] if len(est)>1])
            elif link[8:15] == "www.bri": #Brikk Ejendomme
                ids = soup.find_all("div",{"class":"prop-user-content"})
                bodys.extend([bri.text.replace("\n","").strip().lower() for bri␣
↪in ids[0:1] if len(bri)>1])
            elif link[8:15] == "www.rea": #Realmæglerne
                ids = soup.find_all("div",{"class":"text-full"})
                bodys.extend([rea.text.replace("\n","").strip().lower() for rea␣
↪in ids[0:1] if len(rea)>1])
            elif link[8:15] == "danboli": #Danbolig
                ids = soup.find_all("div",{"class":"db-description-block"})
                bodys.extend([dan.text.replace("\n","").strip().lower() for dan␣
↪in ids[0:1] if len(dan)>1])
            elif link[8:15] == "ww.lili": #Lillenhof
                ids = soup.find_all("div",{"class":"inner"})
                bodys.extend([dan.text.replace("\n","").strip().lower() for dan␣
↪in ids[0:1] if len(dan)>10])
            elif link[8:15] == "bjornby":
                ids = soup.find_all("div",{"class":"content d-md-block d-none␣
↪wrap-content"})
                bodys.extend([bjor.text.replace("\n","").strip() for bjor in␣
↪ids[0:1] if len(bjor)>10])
            elif link[8:15] == 'www.hov': #Hovmand
                ids = soup.find_all("div",{"class":"column"})
                bodys.extend([hov.text.replace("\n","").strip() for hov in␣
↪ids[0:1] if len(hov)>1])
            elif link[8:15] == 'ww.jesp': #Jesper Nielsen
                ids = soup.find_all("div",{"class":"case-description"})
                bodys.extend([jesp.text.replace("\n","").strip() for jesp in␣
↪ids[0:1] if len(jesp)>1])
            elif link[8:15] == "www.sel": #Selvsalg
                ids = soup.find_all("div",{"class":"tab-pane active fade in"})
                bodys.extend([selv.text.replace("\n","").strip() for selv in␣
↪ids[0:1] if len(selv)>1])
            elif link[8:15] == "www.bol": #Bolig
                ids = soup.find_all("div",{"class":"description col-md-16"})
                bodys.extend([bol.text.replace("\n","").strip() for bol in␣
↪ids[0:1] if len(bol)>1])
            elif link[8:15] == 'www.joh': #Johns
                ids = soup.find_all("div",{"class":"column"})
                bodys.extend([john.text.replace("\n","").strip() for john in␣
↪ids[0:1] if len(john)>1])
            elif link[8:15] == "racking": #Robinhus
                ids = soup.find_all("div",{"class":"text-container"})
                bodys.extend([robin.text.replace("\n","").strip() for robin in ids[0:1] if len(robin)>1])
            elif link[8:15] == "www.min": #minbolighandel
                ids = soup.find_all("div",{"class":"description col-md-16"})
                bodys.extend([minb.text.replace("\n","").strip() for minb in ids[0:1] if len(minb)>1])
            elif link[8:15] == "ww.unni": #Unnibolig
                ids = soup.find_all("div",{"class":"column"})
                bodys.extend([un.text.replace("\n","").strip() for un in ids[0:1] if len(un)>1])
            elif link[8:15] == "www.sdb": #Sdb bolig
                ids = soup.find_all("div",{"class":"column"})
                bodys.extend([un.text.replace("\n","").strip() for un in ids[0:1] if len(un)>1])
            elif link[8:15] == "ww.land":#Landobolig
                ids = soup.find_all("div",{"class":"col-md-8"})
                bodys.extend([land.text.replace("\n","").strip() for land in ids[0:1] if len(land)>1])
            elif link[8:15] == "www.ber": #Bermistof
                ids = soup.find_all("div",{"class":"column"})
                bodys.extend([ber.text.replace("\n","").strip() for ber in ids[0:1] if len(ber)>1])
            elif link [8:20] == 'www.carlsber': #Carlsberg Byen
                ids = soup.find_all("div",{"itemprop":"description"})
                bodys.extend([car.text.replace("\n","").strip() for car in ids[0:1] if len(car)>1])
            elif link[8:15] == "www.car": #Carsten Nordbo
                ids = soup.find_all("div",{"class":"description col-md-16"})
                bodys.extend([car.text.replace("\n","").strip() for car in ids[0:1] if len(car)>1])
            elif link[8:15] == 'ww.agri':
                ids = soup.find_all("div",{"class":"col-md-8 col-sm-7 hidden-xs text-box desktop"})
                bodys.extend([agr.text.replace("\n","").strip() for agr in ids[0:1] if len(agr)>1])
            elif link[8:15] == "www.pla":#Place2Live
                ids = soup.find_all("div",{"class":"col-lg-16"})
                bodys.extend([pla.text.replace("\n","").strip() for pla in ids[0:1] if len(pla)>1])
            elif link[8:15] == "www.vil": #Villadsenbolig
                ids = soup.find_all("div",{"class":"description col-md-16"})
                bodys.extend([vil.text.replace("\n","").strip() for vil in ids[0:1] if len(vil)>1])
            elif link[8:15] == 'maegler': #Mæglerhuset
                ids = soup.find_all("div",{"class":"case-text"})
                bodys.extend([mae.text.replace("\n","").strip() for mae in␣
↪ids[0:1] if len(mae)>1])
            elif link[8:15] == 'ww.thom': #ThomasJørgensen
                ids = soup.find_all("div",{"class":"description col-md-16"})
                bodys.extend([thom.text.replace("\n","").strip() for thom in␣
↪ids[0:1] if len(thom)>1])
            elif link[8:15] == 'www.htb': #HTbolig
                ids = soup.find_all("div",{"class":"left-side global-style"})
                bodys.extend([htb.text.replace("\n","").strip() for htb in␣
↪ids[0:1] if len(htb)>1])
            elif link[8:15] == 'ww.boli': #Boligone
                ids = soup.find_all("div",{"class":"first-col"})
                bodys.extend([bol.text.replace("\n","").strip() for bol in␣
↪ids[0:1] if len(bol)>1])
            elif link[8:15] == "www.mæg":#Mæglerringen
                ids = soup.find_all("div",{"class":"first-col"})
                bodys.extend([ma.text.replace("\n","").strip() for ma in ids[0:
↪1] if len(ma)>1])
            elif link[8:15] == "ww.vest":
                ids = soup.find_all("div",{"class":"first-col"})
                bodys.extend([vest.text.replace("\n","").strip() for vest in␣
↪ids[0:1] if len(vest)>1])
            elif link[8:15] == "www.tho": #Thorregård
                ids = soup.find_all("div",{"class":"annonce rammebaggrund"})
                bodys.extend([th.text.replace("\n","").strip() for th in ids[0:
↪1] if len(th)>1])
            elif link[8:15] == "byggegr": #Byggegrund
                ids = soup.find_all("div",{"class":"section section-12"})
                bodys.extend([byg.text.replace("\n","").strip() for byg in␣
↪ids[0:1] if len(byg)>1])
            elif link[8:15] == "grundsa": #Grundsalg
                bodys.append(np.nan)
            elif link[8:15] == "rundsal": #Grundsalg
                bodys.append(np.nan)
            elif link[8:15] =="ww.paul": #paulun
                bodys.append(np.nan)
            else:
                bodys.append(np.nan)
        except:
            bodys.append(np.nan)
            print(link,"virkede ikke")
            continue

        #Making sure only one inqury is added
        body_len_after = len(bodys)
        fixed_change = body_len_prior + 1
        try:
            bodys = bodys[0:fixed_change]
        except:
            None

        #Adding the id
        if body_len_after == body_len_prior + 1:
            estate_ids.append(df[df["estateUrl"]==link]["currentArchiveId"].
 ↪values[0])

    print(len(estate_ids))
    print(len(bodys))
    bodys_df = pd.DataFrame({"currentArchiveId":estate_ids,"body":bodys})

    return bodys_df

def find_realtors(df):
    """
    This function finds all realtors, who has more that 100 houses for sale.
    Used to find the structure for all realtors of relevance
    """
    realtors_link = list()
    #Finds all real estate agents with more than a 100 houses for sale
    estates = list()
    for value in df["estateUrl"].values:
        estates.append(value[8:15])
    numbers = dict(Counter(estates))

    over_100 = dict()
    for key, value in numbers.items():
        if value > 100:
            over_100[key] = value
    already_accounted = list()
    #Looping through all links and returns links of one of the 100.
    for link in tqdm.tqdm(df["estateUrl"].values):
        if link[8:15] in over_100.keys():
            if link[8:15] not in already_accounted:
                print(link,"not in loop")
                print(link[8:15])
                realtors_link.append(link[8:15])
                already_accounted.append(link[8:15])

    return realtors_link

def add_keyattr(df):
    """
    This function adds the key attributions to dataframe
    """

    key_attr = pd.read_csv("keywords.csv",sep=";") #Getting keyword file
    added_words = pd.read_csv("bodys_35k.csv",index_col=0,
                            dtype={"currentArchiveId":int,"body":str},
                             lineterminator='\n') #Getting bodys
    added_words.dropna(inplace=True,axis=0)

    df = df.merge(added_words,on="currentArchiveId",how="left")

    #Removing all na text
    df = df[df['body'].notna()]

    #Finding all words corresponding to group
    ref_list = [key_attr.loc[(key_attr["group"] ==␣
↪"view_list")|(key_attr["group_2"] == "view_list")|\
                         (key_attr["group_3"] == "view_list"), "word"],
                key_attr.loc[(key_attr["group"] ==␣
↪"nature_list")|(key_attr["group_2"] == "nature_list")|\
                         (key_attr["group_3"] == "nature_list"), "word"],
                key_attr.loc[(key_attr["group"] ==␣
↪"interior_list")|(key_attr["group_2"] == "interior_list")|\
                         (key_attr["group_3"] == "interior_list"), "word"],
                key_attr.loc[(key_attr["group"] ==␣
↪"location_list")|(key_attr["group_2"] == "location_list")|\
                         (key_attr["group_3"] == "location_list"), "word"],
               key_attr.loc[(key_attr["group"] ==␣
↪"other_list")|(key_attr["group_2"] == "other_list")|\
                         (key_attr["group_3"] == "other_list"), "word"]]

    #Generation dict for attr
    dict_att = {"view":list(),
                "nature":list(),
                "interior":list(),
                "location":list(),
               "other":list()}

    for body in tqdm.tqdm(df["body"].map(str).tolist()):
        #Generating string
        nouns = preprocess_text(body)
        for value,cross_list in zip(dict_att.values(),ref_list):
            #Generating view key attr
            value.append(len(list(set(nouns).intersection(cross_list))))

    #Add key attributes
    added_df = pd.DataFrame(dict_att)
    df = df.join(added_df)

    return df

def preprocess_csv(csv):
    """
    This function loads our dataset made from Boliga, staionsdata and real␣
 ↪estate agents
    and preproccesses it.
    """
    df = pd.read_csv(csv,index_col="Unnamed: 0")

    #Removing houses with price 0:
    df = df[df["price"] != 0]

    #Making room per sqm
    df["rooms_per_sqm"] = (df["rooms"]/df["size"]).replace(np.inf,0)

    #Removing houses not placed in Denmark
    df = df[(df["latitude"]<60) & (df["latitude"]>53) & (df["longitude"]>7) &␣
 ↪(df["longitude"]<16)]

    #Creating temp dataframes for dummy
    temp_type = df["propertyType"]
    temp_komm = df["municipality"]
    temp_floor = df["floor"]
    temp_distance = df["dist_station"]

    #Adding keyattr to df
    df_text = add_keyattr(df)

    #Generating dummy variables - Distance Station
    dis_df = pd.
 ↪cut(temp_distance,4,labels=["very_close","close","semi","far_away"])
    dis_df = pd.get_dummies(dis_df)
    df= df.join(dis_df)
    df_text = df_text.join(dis_df)

    #Generating dummy variables - Property type
    housing_type={1:'villa',2:'raekkehuse', 3:'ejerlejlighed',4:'fritidshus', 5:
 ↪'andel',6:'landejendom',
                 7:'helrsgrund',8:'fritidsgrund', 9:'villalejlighed',10:
 ↪'andet_1',11:"andet_2",12:"andet_3"}
    dummy_df = pd.get_dummies(temp_type.replace(housing_type))
    df = df.join(dummy_df)
    df_text = df_text.join(dummy_df)
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   #Dropping all None house
   df = df[(df["helrsgrund"] == 0) & (df["andet_3"] == 0)]
   df_text = df_text[(df_text["helrsgrund"] == 0) & (df_text["andet_3"] == 0)]

   #Generation dummies variables - Kommune
   dummy_mun = pd.get_dummies(temp_komm,prefix="mun_")
   df = df.join(dummy_mun)
   df_text = df_text.join(dummy_mun)

   #Generation dummies variables - Floor
   dummy_floor = pd.get_dummies(temp_floor.map(str),prefix="flr_")
   df = df.join(dummy_floor)
   df_text = df_text.join(dummy_floor)

   #Creating X and y, making sure they have the same index
   #Dropping all non essential columns
   #df = df.iloc[df_text.index]
   df = df.reset_index(drop=True)
   df_text = df_text.reset_index(drop=True)

   X = df.drop(["downPayment","estateUrl","currentArchiveId","forSaleNowId",
          ␣
↪"foreclosureId","cleanStreet","estateId","latitude","longitude","energyClass",
         ␣
↪"price","city","isActive","municipality","zipCode","street","createdDate",
          ␣
↪"squaremeterPrice","region","kommune_nr","rooms","propertyType","kommune_navn",
           "floor",'dist_station'],axis=1).dropna().values

   X_text = df_text.
↪drop(["downPayment","estateUrl","currentArchiveId","forSaleNowId",
          ␣
↪"foreclosureId","cleanStreet","estateId","latitude","longitude","energyClass",
         ␣
↪"price","city","isActive","municipality","zipCode","street","createdDate",
          ␣
↪"squaremeterPrice","region","kommune_nr","rooms","propertyType","kommune_navn",
           "floor",'dist_station',"body"],axis=1).dropna().values

   #Dropping all NA
   #df.dropna(inplace=True,axis=0)


   y = df["price"]
```

```
    y_text = df_text["price"]

    index_for_y = df.
 ↪drop(["downPayment","estateUrl","currentArchiveId","forSaleNowId",
           ␣
 ↪"foreclosureId","cleanStreet","estateId","latitude","longitude","energyClass",
          ␣
 ↪"price","city","isActive","municipality","zipCode","street","createdDate",
           ␣
 ↪"squaremeterPrice","region","kommune_nr","rooms","propertyType","kommune_navn",
            "floor",'dist_station'],axis=1).dropna()

    y = y.iloc[index_for_y.index].values

    index_for_y_text = df_text.
 ↪drop(["downPayment","estateUrl","currentArchiveId","forSaleNowId",
           ␣
 ↪"foreclosureId","cleanStreet","estateId","latitude","longitude","energyClass",
          ␣
 ↪"price","city","isActive","municipality","zipCode","street","createdDate",
           ␣
 ↪"squaremeterPrice","region","kommune_nr","rooms","propertyType","kommune_navn",
            "floor",'dist_station',"body"],axis=1).dropna()

    y_text = y_text.iloc[index_for_y_text.index].values


    return X, X_text, y, y_text, df, df_text

def preprocess_text(string,nlp=nlp):
    """
    This function takes a string and returns a list with all noun from string␣
 ↪lemmatized
    """

    #Removing everything but words
    string = re.sub(r'[^\w\s]','',string)

    #Removing stopwords
    stop_words_list = stopwords.words("danish")
    string = [i for i in nltk.word_tokenize(string.lower()) if i not in␣
 ↪stop_words_list]
    string = " ".join(string)

    #Getting all nounce and takes the lemmatized version
    string = nlp(string)
    nouns = [word._.lemmas[0] for word in string if word.pos_ == "NOUN"]

    return nouns

def words_count(list_of_strings):
    """
    This function takes a list of strings and returns a dict with counts of␣
 ↪each word
    """
    #Creates a dict which counts words
    sentences = list_of_strings
    counts = dict(Counter(sentences))

    return counts

def keywords(body):
    """
    This function takes a list of different strings and returns a dataframe␣
 ↪with each word
    and word count.
    """

    #Setting up list
    word_list = list()

    #Looping through each body text
    for bodys in tqdm.tqdm(body):
        string = preprocess_text(bodys[0])
        word_list.extend(string)

    #Creating a dataframes with each word and corresponding count
    dict_count = words_count(word_list)
    df = pd.DataFrame({"word":list(dict_count.keys()),
                       "count":list(dict_count.values())}).set_index("word")

    #Getting the 300 largest counts returns the keywords used for key attr list
    return df

def add_lonlat(df,df_station):
    """
    This function takes two df and returns the distance between two locations␣
 ↪of the dataframes location columns
    """
    df_station = pd.read_csv("")
    min_dist = list()

    #Looping through each location
    for location in tqdm(df["location"]):
        distance = list()
        #Making a a cross reference between location and each station
        for lon,lat in zip(df_station["lon"],df_station["lat"]):
            distance.append(geodesic((lat,lon), location).km)
        #Appending the smallest distance
        min_dist.append(min(distance))

    df["dist_station"] = min_dist

    return df

def next_preprocess(X,y,random_state=None):
    """
    This function us used for ML. This takes X and y as input and transforms␣
 ↪the variables
    so that dummy variables is not transformed.
    """

    #Preparing transformer, for all but dummy variables
    ct = ColumnTransformer([("poly", PolynomialFeatures(degree=3),[0,11]),
                ("scaler",StandardScaler(),[0,11])],remainder="passthrough")

    #Splitting the dataset
    X_train, X_test, y_train, y_test = train_test_split(X,y,
                                                                       ␣
 ↪random_state=random_state,
                                                                        test_size=0.33)
    #Fits and transform
    X_test = ct.fit_transform(X_test)
    X_train = ct.transform(X_train)


    return X_train, X_test, y_train, y_test
```

[142]:

```
X, X_text, y, y_text, df, df_text = preprocess_csv("house_data_final.csv")␣
 ↪#Running the csv file through the preprocess function
df.head()
```

```
HBox(children=(FloatProgress(value=0.0, max=27405.0), HTML(value='')))
```

[142]:

```
   registeredArea  downPayment  \
0              68       225000
1              78       430000
```

```
2             117       460000
3             146       550000
4             182       625000

                                          estateUrl  currentArchiveId  \
0  https://home.dk/boligkatalog/koebenhavn/1051/e…           1676546
1  https://www.nybolig.dk/ejerlejlighed/1051/nyha…           1688236
2  http://www.skbolig.dk/sag.asp?sagsnr=221920&mg…           1672807
3  http://www.skbolig.dk/sag.asp?sagsnr=333420&mg…           1694633
4  http://www.skbolig.dk/sag.asp?sagsnr=331320&mg…           1689738

   forSaleNowId  foreclosureId  selfsaleEstateId cleanStreet  estateId  \
0             0              0                 0      Nyhavn         0
1             0              0                 0      Nyhavn         0
2             0              0                 0      Nyhavn         0
3             0              0                 0      Nyhavn         0
4             0              0                 0      Nyhavn         0

   latitude  …  flr__29.0  flr__3.0  flr__4.0 flr__46.0  flr__5.0  flr__6.0  \
0  55.68044  …          0         0         0         0         0         0
1  55.68038  …          0         0         1         0         0         0
2  55.67950  …          0         0         0         0         0         0
3  55.67977  …          0         0         0         0         0         0
4  55.67973  …          0         1         0         0         0         0

   flr__7.0  flr__8.0  flr__9.0  flr__nan
0         0         0         0         1
1         0         0         0         0
2         0         0         0         1
3         0         0         0         0
4         0         0         0         0

[5 rows x 173 columns]
```

1 Descriptive Statistics

[64]:

```
#Table
print(df[["price","size","squaremeterPrice","rooms","daysForSale"]].describe().
 ↪to_latex())
```

```
\begin{tabular}{lrrrrr}
\toprule
{} &         price &          size &  squaremeterPrice &         rooms &
daysForSale \\
\midrule
```

```
count &  4.745600e+04 &  47456.000000 &      4.745600e+04 &  47456.000000 &
47456.000000 \\
mean  &  2.403305e+06 &    140.295495 &      1.782059e+04 &      4.523862 &
277.736493 \\
std   &  2.475032e+06 &     99.063665 &      2.716779e+04 &      1.967140 &
428.078648 \\
min   &  0.000000e+00 &      0.000000 &      0.000000e+00 &      0.000000 &
0.000000 \\
25\%   &  1.045000e+06 &     95.000000 &      8.200750e+03 &      3.000000 &
50.000000 \\
50\%   &  1.795000e+06 &    131.000000 &      1.355200e+04 &      4.000000 &
133.000000 \\
75\%   &  2.995000e+06 &    172.000000 &      2.261600e+04 &      5.000000 &
335.000000 \\
max   &  8.500000e+07 &   9073.000000 &      3.750000e+06 &     56.000000 &
4981.000000 \\
\bottomrule
\end{tabular}
```

1.1 Plots - Descriptive Statistics

[2]:

```
#Creating a plot of houses for Sale in Denmark based on latitude and longitude
a=df.plot(kind="scatter", x="longitude", y="latitude", alpha=0.004,␣
 ↪color='mediumblue')
plt.ylim(ymax = 58.2, ymin = 54)
plt.xlim(xmax = 16, xmin = 7)
plt.title('Houses for sale in Denmark')
for pos in ['right','top']:
    a.spines[pos].set_visible(False)

# Creating heatmap of houses for sale, copenhagen only
y=df.plot(kind="scatter", x="longitude", y="latitude", alpha=0.9,
 c="price", cmap=plt.get_cmap("jet"), colorbar=True, )
plt.legend()
plt.ylim(ymax = 56.25, ymin = 55.5)
plt.xlim(xmax = 12.7, xmin = 12.4)
plt.title('Copenhagen')
#removing upper and right bar i diagram
for pos in ['right','top']:
    y.spines[pos].set_visible(False)

# Creating heatmap of houses for sale, Zealand and Falster
z=df.plot(kind="scatter", x="longitude", y="latitude", alpha=0.9,
 c="price", cmap=plt.get_cmap("jet"), colorbar=True,
)
```

```
plt.legend()
plt.ylim(ymax = 56.25, ymin = 54.5)
plt.xlim(xmax = 12.7, xmin = 10.9)
plt.title('Zealand and Falster')
#removing upper and right bar i diagram
for pos in ['right','top']:
    z.spines[pos].set_visible(False)
```

```
      ␣
↪---------------------------------------------------------------------------

       NameError                                 Traceback (most recent call␣
↪last)

       <ipython-input-2-082daa2707fb> in <module>
         1 #Creating a plot of houses for Sale in Denmark based on latitude and␣
↪longitude
   ----> 2 a=df.plot(kind="scatter", x="longitude", y="latitude", alpha=0.004,␣
↪color='mediumblue')
         3 plt.ylim(ymax = 58.2, ymin = 54)
         4 plt.xlim(xmax = 16, xmin = 7)
         5 plt.title('Houses for sale in Denmark')


       NameError: name 'df' is not defined
```

[ ]:

```
# Creating heatmap of days for sale, Denmark
df.plot(kind="scatter", x="longitude", y="latitude", alpha=0.9,
 c="daysForSale", cmap=plt.get_cmap("jet"), colorbar=True, )
plt.legend()
plt.ylim(ymax = 58.2, ymin = 54)
plt.xlim(xmax = 16, xmin = 7)
plt.title('Days for sale, Denmark')
#removing upper and right bar i diagram
for pos in ['right','top']:
    y.spines[pos].set_visible(False)

# Creating heatmap of days for sale, Zealand and Falster
df.plot(kind="scatter", x="longitude", y="latitude", alpha=0.9,
 c="daysForSale", cmap=plt.get_cmap("jet"), colorbar=True,
)
plt.legend()
plt.ylim(ymax = 56.3, ymin = 54.4)
plt.xlim(xmax = 12.7, xmin = 10.9)
plt.title('Days for sale, Zealand and Falster')
```

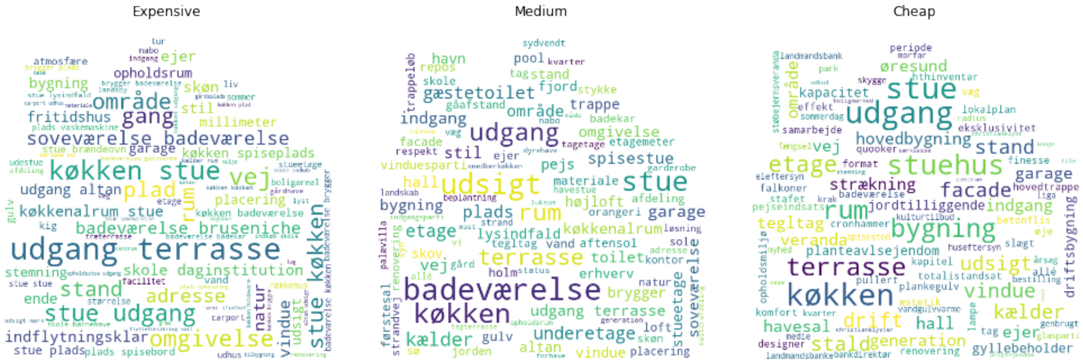
```
#removing upper and right bar i diagram
for pos in ['right','top']:
    z.spines[pos].set_visible(False)
```

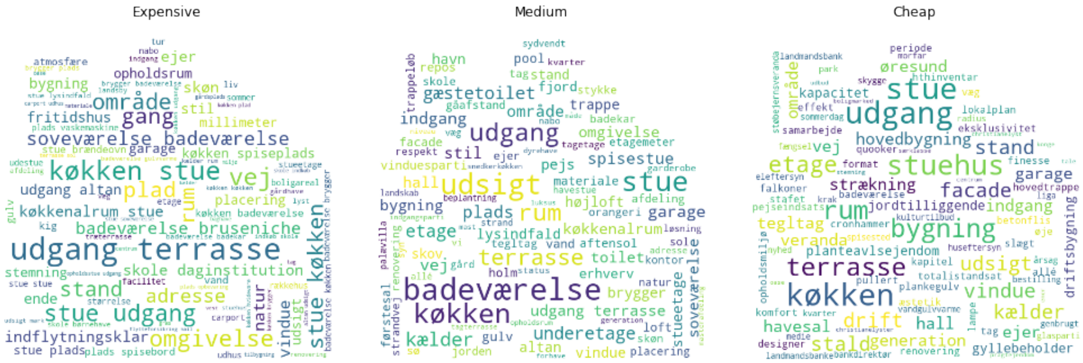
[71]:

```
from wordcloud import WordCloud
from PIL import Image

def wordcloud(df):
    """
    This function creates a wordcloud for different price ranges
    """

    #Loads keywords
    keywords = pd.read_csv("keywords.csv",
                      delimiter =";")

    #Load all no_list keywords
    no_list = keywords["word"][keywords["group"]=="no_list"].tolist()

    #Seperates the houses into different prive groups
    df["price_range"] = pd.
 ↪cut(df["price"],3,labels=["Expensive","Medium","Cheap"])


    total_list = list()
    #Loops through each price range and adds the text to list
    for price_range in df["price_range"].unique():
        list_w = list()
        for body in df["body"][df["price_range"]==price_range].values:
            list_w.extend(preprocess_text(body))
        list_w = [w for w in list_w if w not in no_list]
        total_list.append(list_w)

    return total_list

def wordcloud_create(total_list,df):
    #Creates a wordcloud for each price range
    fig, axes = plt.subplots(1,3,figsize=(14,8))
    i = list(range(3))
    for value_list, i, name in zip(total_list,i,df["price_range"].unique()):
        mask = np.array(Image.open("house_2.png"))
        wordcloud = WordCloud(width=500,height=500,max_font_size=50,
                      max_words=100,
                      background_color="white",
                      mask=mask,contour_color='firebrick').generate(" ".join(v␣
 ↪for v in value_list))
```

```
        axes[i].imshow(wordcloud, interpolation='bilinear')
        axes[i].axis("off")
        axes[i].set_title(name)
    fig.savefig("wordclouds.jpg")
    return fig


#total_list = wordcloud(df_text)
wordcloud_create(total_list,df_text)
```

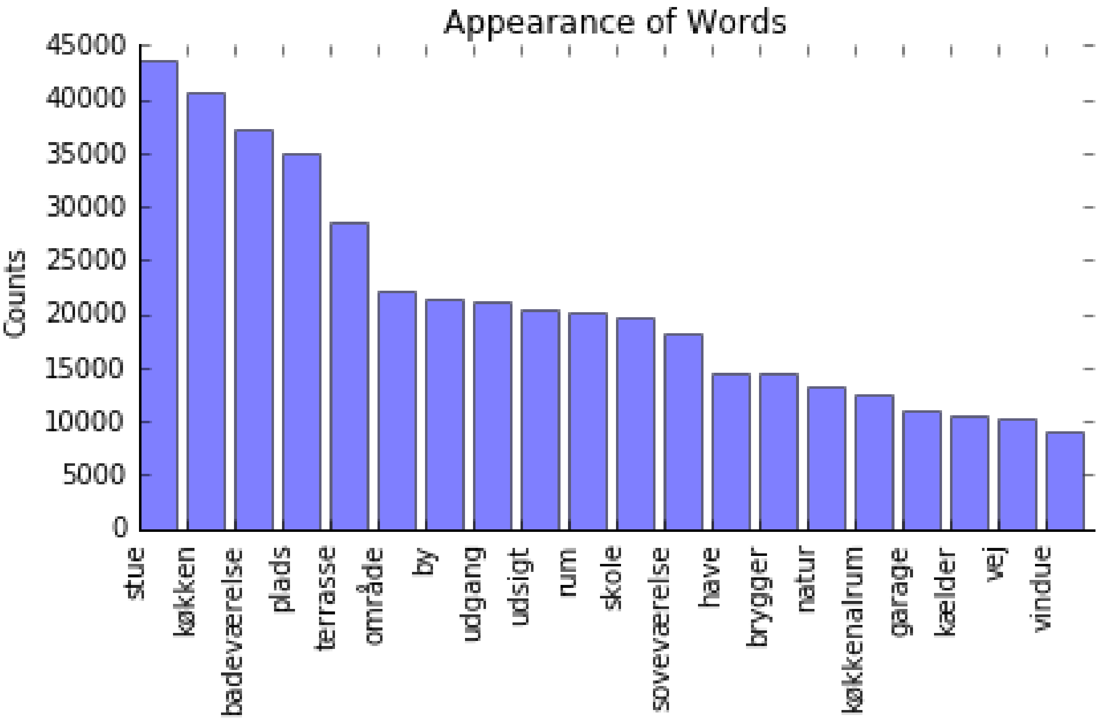
[71]:





```
[49]: #Loads keywords
      #Load all no_list keywords
      keywords = pd.read_csv("keywords.csv",
                             delimiter =";")
      keywords["word"] = keywords["word"].map(str)

      words= list()
      counts = list()
      no_list = keywords["word"][keywords["group"]=="no_list"].tolist()
```

```
for word in keywords["word"].tolist():
    if word not in no_list:
        words.append(str(word))
        counts.append(keywords["count"][keywords["word"]==word].values[0])

objects = words[0:20]
y_pos = np.arange(len(objects))
counts_for_y = counts[0:20]


plt.bar(y_pos, counts_for_y,align="edge", alpha=0.5)
plt.xticks(y_pos, objects,rotation="vertical")
plt.ylabel('Counts')
plt.title('Appearance of Words')
plt.tight_layout()
plt.gca().spines['right'].set_color('none')
plt.gca().spines['top'].set_color('none')
plt.gca().spines["right"].axison = False
plt.gca().spines["top"].axison = False
plt.savefig("mostusedwords.jpg")
plt.show()
```



2 Machine Learning

In the following section we are implementing and validation various Machine Learning models in order to identify the best possible model.

[143]:

```
##Importing all relevant packages for the Machine Learning
#Packages for preprocessing
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import PolynomialFeatures
from sklearn.pipeline import Pipeline
from sklearn.compose import ColumnTransformer

#Packages for validation
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import r2_score
from sklearn.model_selection import validation_curve

#Packages for regression models
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import RandomizedSearchCV
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor
from sklearn.linear_model import Lasso

from sklearn.exceptions import ConvergenceWarning
import warnings
warnings.simplefilter("ignore", category=ConvergenceWarning)
```

[144]:

```
def next_preprocess(X,y,random_state=None,text=False):
    """
    This function makes the necessary preprocessing procedures for our data.
    For every thing but our Dummy variables. Returns tran and test data.
    """
    #Preparing transformer, for all but dummy variables
    if text == False:
        ct = ColumnTransformer([("poly",␣
 ↪PolynomialFeatures(include_bias=False,degree=3),[0,10]),
                    ("scaler",StandardScaler(),[0,10])],remainder="passthrough")
    if text == True: #Check at der er 15 koloner som ikke er dummy!!
        ct = ColumnTransformer([("poly",␣
 ↪PolynomialFeatures(degree=3,include_bias=False),[0,15]),
                    ("scaler",StandardScaler(),[0,15])],remainder="passthrough")

    #Splitting the data
    X_train, X_test, y_train, y_test = train_test_split(X,y,
                                                        ␣
 ↪random_state=random_state,
                                                         test_size=0.3)

    #Fitting to test and transforms train
    X_test = ct.fit_transform(X_test)
    X_train = ct.transform(X_train)


    return X_train, X_test, y_train, y_test

def display_scores(scores):
    print("Scores",scores)
    print("Mean:",scores.mean())
    print("Standard Deviation",scores.std())
```

[145]:

```
X_train, X_test, y_train, y_test = next_preprocess(X,y) #Splitting the data␣
 ↪into train and test
Xt_train , Xt_test, yt_train, yt_test = next_preprocess(X_text,y_text,text=True)
y=y/1e+6 # Making the price in mio DKK
y_text = y_text/1e+6
```

[138]:

```
ct = ColumnTransformer([("poly", PolynomialFeatures(degree=3),[0,10]),
                    ("scaler",StandardScaler(),[0,10])],remainder="passthrough")
X_fitted = ct.fit_transform(X)
ct = ColumnTransformer([("poly", PolynomialFeatures(degree=3),[0,15]),
                   ␣
 ↪("scaler",StandardScaler(),[0,15])],remainder="passthrough") #CHECK AT DET␣
 ↪ER !%
Xt_fitted = ct.fit_transform(X_text)
```

[ ]:

2.1 Non text data - ML

2.2 Linear Regression

In the following section a standard linear regression model will be implemented

[152]:

```
lin_reg = LinearRegression()
#Cross_val_score splits the data in K-folds by itself
lin_scores =␣
 ↪cross_val_score(lin_reg,X_fitted,y,scoring="neg_mean_squared_error",cv=10)

rmse_scores = np.sqrt(-lin_scores)
display_scores(rmse_scores)
```

```
Scores [4.79114539 3.73253564 1.51023199 1.62343406 1.6544562  1.63383431
 2.0560603  1.64687093 1.4287084  7.10034793]
Mean: 2.717762514776453
Standard Deviation 1.809509892161512
```

2.3 Lasso Regression

In the following section a Lasso regression model will be implemented

[151]:
```
las_reg = Lasso(tol=0.01,alpha=0.00053)
las_scores =␣
 ↪cross_val_score(las_reg,X_fitted,y,scoring="neg_mean_squared_error",cv=10)

las_rmse_scores = np.sqrt(-las_scores)
display_scores(las_rmse_scores)
```

```
Scores [4.63061628 4.00016787 1.32994138 1.47362181 1.47757354 1.51434461
 2.00660396 1.61338671 1.22579847 2.59907712]
Mean: 2.1871131759478493
Standard Deviation 1.1363686944901965
```

2.4 Random Forest Regression

In the following section a Random forest regression model will be implemented

[150]:
```
ran_reg = RandomForestRegressor(max_features=6,n_estimators=58) #Getting best␣
 ↪estimators from gridsearch
ran_scores = cross_val_score(ran_reg,X,y,scoring="neg_mean_squared_error",cv=10)

lin_rmse_scores = np.sqrt(-ran_scores)
display_scores(lin_rmse_scores)
```

```
Scores [2.48951663 3.49331633 1.1391127  1.25815621 1.29462861 1.18769729
 1.02354562 1.34845302 0.94800253 1.05885304]
Mean: 1.5241281978078498
Standard Deviation 0.7761673147147121
```

[160]:
```
X_train, X_test, y_train, y_test = next_preprocess(X,y)
ran_test = RandomForestRegressor(max_features=6,n_estimators=55)
ran_test.fit(X_train,y_train)
r2_score(y_test,ran_test.predict(X_test))
```

[160]:
```
0.6475333359017599
```

2.5 Text data - ML

2.6 Linear Regression

In the following section a standard linear regression model will be implemented

[116]:
```
lin_reg = LinearRegression()
#Cross_val_score splits the data in K-folds by itself
lin_scores =␣
 ↪cross_val_score(lin_reg,Xt_fitted,y_text,scoring="neg_mean_squared_error",cv=10)

rmse_scores = np.sqrt(-lin_scores)
display_scores(rmse_scores)
```

```
Scores [3.06470698e-06 1.35298330e-05 3.13971720e-06 1.74021216e-06
 1.30162477e-06 1.67877454e-06 1.75525430e-06 1.69871590e-06
 1.67165297e-06 2.25624966e-06]
Mean: 3.1836741480262067e-06
Standard Deviation 3.4977322982008633e-06
```

2.7 Lasso Regression

In the following section a Lasso regression model will be implemented

[146]:
```
las_reg = Lasso(alpha=0.0001)
las_scores =␣
 ↪cross_val_score(las_reg,Xt_fitted,y_text,scoring="neg_mean_squared_error",cv=10)

las_rmse_scores = np.sqrt(-las_scores)
display_scores(las_rmse_scores)
```

```
Scores [ 3.18625469 13.39958594  3.19201284  1.70231031  1.23182821  1.59256082
  1.57116147  1.62447049  1.61652787  2.15795469]
Mean: 3.1274667339243467
Standard Deviation 3.4843719854899016
```

2.8 Random Forest Regression

In the following section a Random forest regression model will be implemented

[149]:
```
ran_reg = RandomForestRegressor(max_features=6,n_estimators=51) #Getting best␣
 ↪estimators from gridsearch
ran_scores =␣
 ↪cross_val_score(ran_reg,X_text,y_text,scoring="neg_mean_squared_error",cv=10)

lin_rmse_scores = np.sqrt(-ran_scores)
```

```
display_scores(lin_rmse_scores)
```

```
Scores [2.95068381 2.11697509 3.30320208 1.48787623 1.08337069 1.28424919
 1.36430123 1.19631003 1.38465404 1.01697371]
Mean: 1.7188596096997355
Standard Deviation 0.7638861474182097
```

[158]:
```
X_train, X_test, y_train, y_test = next_preprocess(X_text,y_text,text=True)
ran_test = RandomForestRegressor(max_features=6,n_estimators=51)
ran_test.fit(X_train,y_train)
r2_score(y_test,ran_test.predict(X_test))
```

[158]:
```
0.6045471921636658
```

2.8.1 Getting best estimators

[120]:
```
#Finding the best estimators for RandomForest
param_grid = {"n_estimators":list(range(50,60))}
ran_search =␣
 ↪GridSearchCV(RandomForestRegressor(),param_grid,cv=9,scoring="neg_mean_squared_error")
ran_search.fit(X_text,y_text)
```

[120]:
```
GridSearchCV(cv=9, error_score=nan,
             estimator=RandomForestRegressor(bootstrap=True, ccp_alpha=0.0,
                                             criterion='mse', max_depth=None,
                                             max_features='auto',
                                             max_leaf_nodes=None,
                                             max_samples=None,
                                             min_impurity_decrease=0.0,
                                             min_impurity_split=None,
                                             min_samples_leaf=1,
                                             min_samples_split=2,
                                             min_weight_fraction_leaf=0.0,
                                             n_estimators=100, n_jobs=None,
                                             oob_score=False, random_state=None,
                                             verbose=0, warm_start=False),
             iid='deprecated', n_jobs=None,
             param_grid={'n_estimators': [50, 51, 52, 53, 54, 55, 56, 57, 58,
                                          59]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring='neg_mean_squared_error', verbose=0)
```

[121]:
```
ran_search.best_params_
```

[121]:
```
{'n_estimators': 51}
```

[139]:

```
lambdas=np.logspace(-4,4,12)
gs = GridSearchCV(estimator=Lasso(),
                  param_grid=[{'alpha':lambdas}],
                  scoring='neg_mean_squared_error',
                  cv=10,
                  n_jobs=1)
gs = gs.fit(Xt_train, yt_train)
print(gs.best_params_)
```

```
{'alpha': 0.0001}
```

[ ]:

[ ]: