```
%load_ext autoreload
%autoreload 2
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from pathlib import Path
import utils.functions as f
```

Direct Matching Dataset

```
direct_matching_df = pd.read_csv('Data/direct_matching_20240213.csv', sep=';')
```

```
direct_matching_df.head()
```

	cand_id	job_id	distance_km	match_score	match_rank	cand_gender	cand_age
0	5,664,912	OFF_1011_1427	32.327042	99.573387	1	Male	
1	4,999,120	OFF_1011_1427	15.595593	99.210564	2	Male	
2	5,413,671	OFF_1011_1427	31.348877	99.118614	3	Female	
3	5,965,090	OFF_1011_1427	66.315598	97.409767	4	Male	
4	5,771,219	OFF_1011_1427	15.595593	97.323875	5	Female	

```
direct_matching_df.describe(include="all")
```

	cand_id	job_id	distance_km	match_score	match_rank	cand_gender	can
count	8647	8647	8647.000000	8647.000000	8647.000000	8647	
unique	6798	865	NaN	NaN	NaN	2	
top	6,550,205	OFF_1011_1427	NaN	NaN	NaN	Male	
freq	18	10	NaN	NaN	NaN	4766	
mean	NaN	NaN	29.769432	99.633988	5.499480	NaN	
std	NaN	NaN	23.493063	1.071380	2.872447	NaN	
min	NaN	NaN	0.000000	69.610825	1.000000	NaN	
25%	NaN	NaN	12.253924	99.676991	3.000000	NaN	
50%	NaN	NaN	23.447361	99.856033	5.000000	NaN	
75%	NaN	NaN	41.754654	99.932602	8.000000	NaN	
max	NaN	NaN	99.966797	99.999214	10.000000	NaN	

```
direct_matching_df['cand_languages_spoken'] = direct_matching_df['cand_languages_sp
direct_matching_df['cand_education'] = direct_matching_df['cand_education'].fillna(
```

```
education_mapping = {
    'no education' : 0,
    'licenza elementare': 1,
    'elementari': 2,
    'licenza media': 3,
    'diploma / accademia': 4,
    'qualifica / attestato': 5,
    'istituto tecnico superiore (its)': 6,
    'laurea triennale': 7,
    'master universitario': 8,
    'laurea magistrale': 9,
    'dottorato di ricerca': 10,
}

reverse_education_mapping = {value: key for key, value in education_mapping.items()}

education_counter_total = {}
education_counter_max = {}
for edu in education_mapping.keys():
  education_counter_max[edu] = 0
  education_counter_total[edu] = 0
```

```
df_without_nulls = direct_matching_df.dropna()

education_lvl = df_without_nulls.cand_education
row_to_education = {}
set_education = set()

### Dictionary containing row in which the candidate appear-education ###
```

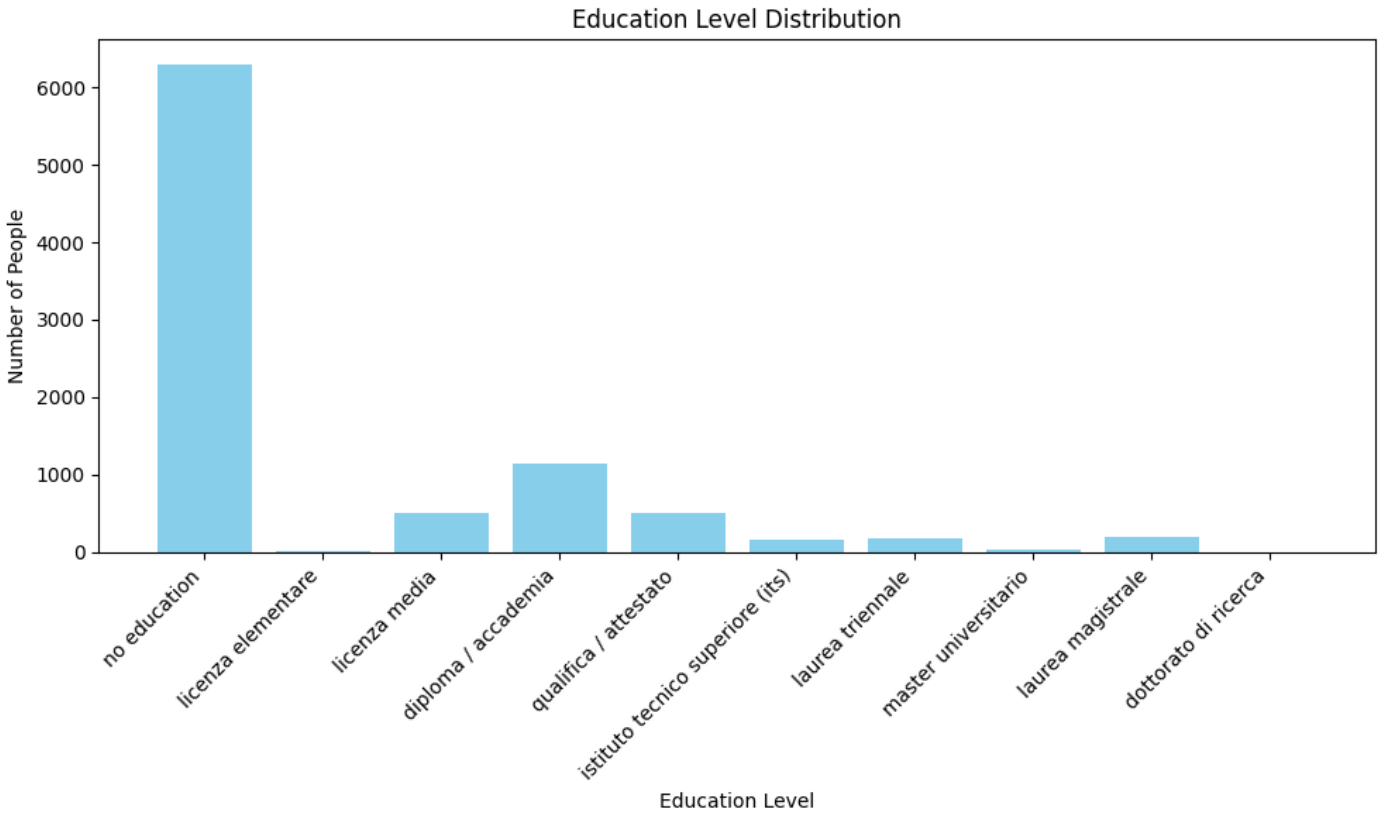
```
for idx,edu in education_lvl.items():
  if ";" in edu:
    qualifications = edu.split(";")
  else:
    qualifications = [edu]
  title = []
  for level in qualifications:
    if ":" in level:

      new_value = level.split(":")[0].strip().lower()
    else:
      new_value = level.strip().lower()
    title.append(new_value)
    set_education.add(new_value)

    #For counting
    education_counter_total[new_value] += 1

  row_to_education[idx] = title


### The loop below is used to retain only the highest education in the CV according
for row, education in row_to_education.items():
  mapped_value = []
  if len(education) > 1:
    for title in education:
      mapped_value.append(education_mapping[title])
    max_lvl_education = max(mapped_value)
    new_education = reverse_education_mapping[max_lvl_education]

    education_counter_max[new_education] += 1
    row_to_education[row] = [new_education]
  else:
    education_counter_max[education[0]] += 1

education_counter_total['licenza elementare'] += education_counter_total['elementar
del education_counter_total['elementari']  # same name for the 2 values

education_counter_max['licenza elementare'] += education_counter_max['elementari']
del education_counter_max['elementari']
```

```
education_counter_total,sum(education_counter_max.values())
```

```
({'no education': 6298,
  'licenza elementare': 22,
  'licenza media': 504,
  'diploma / accademia': 1138,
  'qualifica / attestato': 507,
  'istituto tecnico superiore (its)': 169,
  'laurea triennale': 182,
  'master universitario': 33,
  'laurea magistrale': 200,
  'dottorato di ricerca': 5},
 8639)
```

```
education_levels = list(education_counter_total.keys())
count_values = list(education_counter_total.values())
```

```
plt.figure(figsize=(10, 6))
plt.bar(education_levels, count_values, color='skyblue')
plt.xlabel('Education Level')
plt.ylabel('Number of People')
plt.title('Education Level Distribution')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```

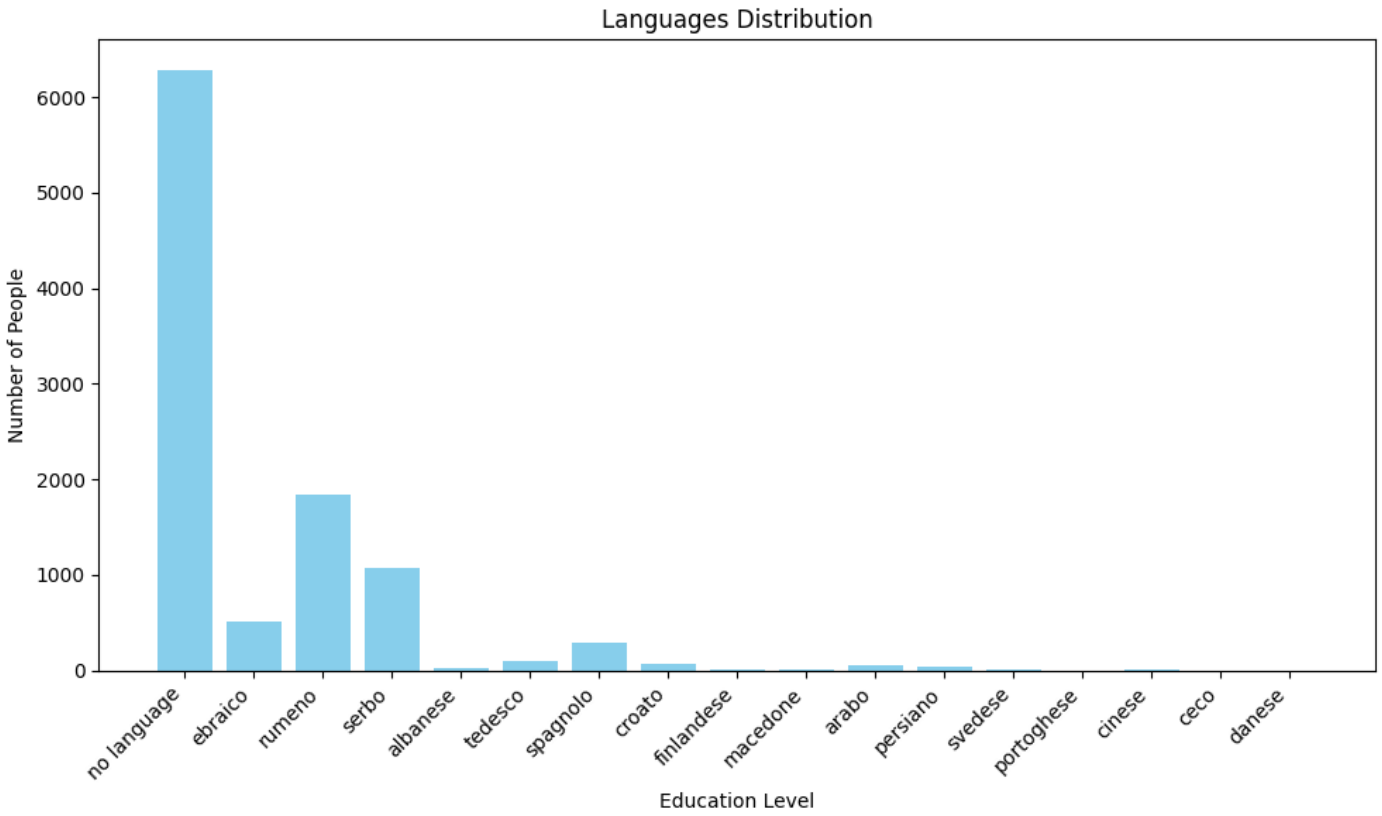


Languages

```
languages_spoken = df_without_nulls.cand_languages_spoken
counter_languages = {}
set_languages = set()

for idx,langs in languages_spoken.items():
  if ";" in langs:
    languages = langs.split(";")
  else:
    languages = [langs]

  for lang in languages:
      new_lang = lang.strip().lower()
      set_languages.add(new_lang)
      if new_lang in counter_languages:
        counter_languages[new_lang] += 1
      else:
        counter_languages[new_lang] = 1
```

```
languages_levels = list(counter_languages.keys())
count_languages = list(counter_languages.values())
```

```
plt.figure(figsize=(10, 6))
plt.bar(languages_levels, count_languages, color='skyblue')
plt.xlabel('Education Level')
plt.ylabel('Number of People')
plt.title('Languages Distribution')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```



Analysis on top x candidates

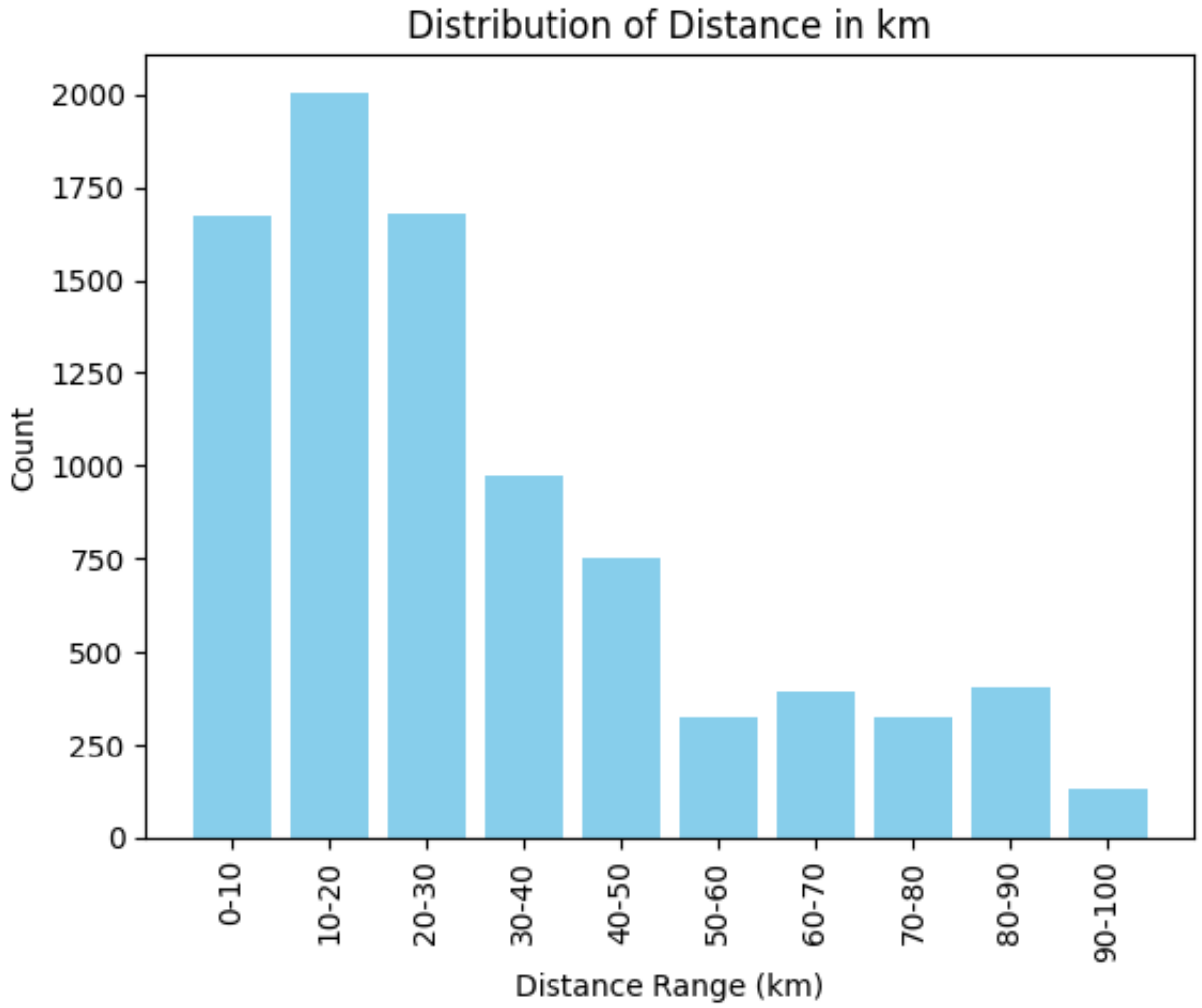
```
for idx, edu in row_to_education.items():
  direct_matching_df.cand_education.loc[idx] = edu[0]
```

```
top_1_cands = f.get_rank_n_candidates(direct_matching_df,1)
top_2_cands = f.get_rank_n_candidates(direct_matching_df,2)
top_3_cands = f.get_rank_n_candidates(direct_matching_df,3)
top_4_cands = f.get_rank_n_candidates(direct_matching_df,4)
top_5_cands = f.get_rank_n_candidates(direct_matching_df,5)
top_6_cands = f.get_rank_n_candidates(direct_matching_df,6)
top_7_cands = f.get_rank_n_candidates(direct_matching_df,7)
top_8_cands = f.get_rank_n_candidates(direct_matching_df,8)
top_9_cands = f.get_rank_n_candidates(direct_matching_df,9)
top_10_cands = f.get_rank_n_candidates(direct_matching_df,10)
```

Discretization of distances

```
distances_km = direct_matching_df.distance_km
distances_km = f.discretize_feature(distances_km)
```

```
total_distances = np.sum(distances_km)
dict_distances = {}
for i in range(10):
  dict_distances[i] = np.around(distances_km[i]/total_distances,4)

labels = [f'{i*10}-{(i+1)*10}' for i in range(10)]

# Plot the distribution with labels
plt.bar(labels, distances_km, color='skyblue')
plt.title('Distribution of Distance in km')
plt.xlabel('Distance Range (km)')
plt.ylabel('Count')
plt.xticks(rotation=90)
plt.show()
```




```
dict_gender = f.create_dictionary_from_series(direct_matching_df.cand_gender.value_
dict_age = f.create_dictionary_from_series(direct_matching_df.cand_age_bucket.value
dict_domicile_region = f.create_dictionary_from_series(direct_matching_df.cand_domi
dict_job_province = f.create_dictionary_from_series(direct_matching_df.job_work_pro
dict_education = f.create_dictionary_from_series(direct_matching_df.cand_education.
```

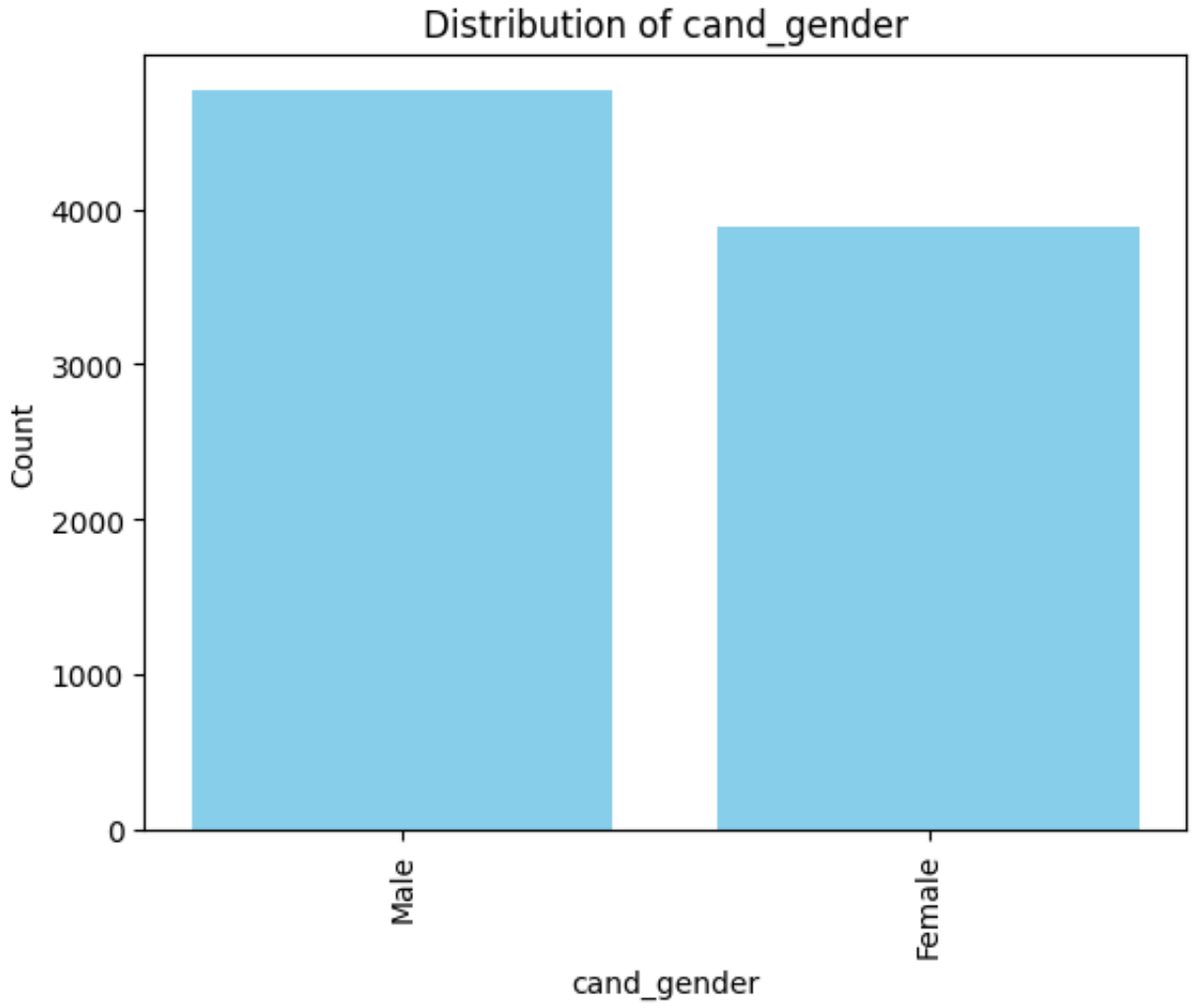
```
columns = ['cand_gender','cand_age_bucket','cand_domicile_region','job_work_provinc
top_1_dicts = f.create_dicts_rank_n(top_1_cands,columns)
top_2_dicts = f.create_dicts_rank_n(top_2_cands,columns)
top_3_dicts = f.create_dicts_rank_n(top_3_cands,columns)
top_4_dicts = f.create_dicts_rank_n(top_4_cands,columns)
```

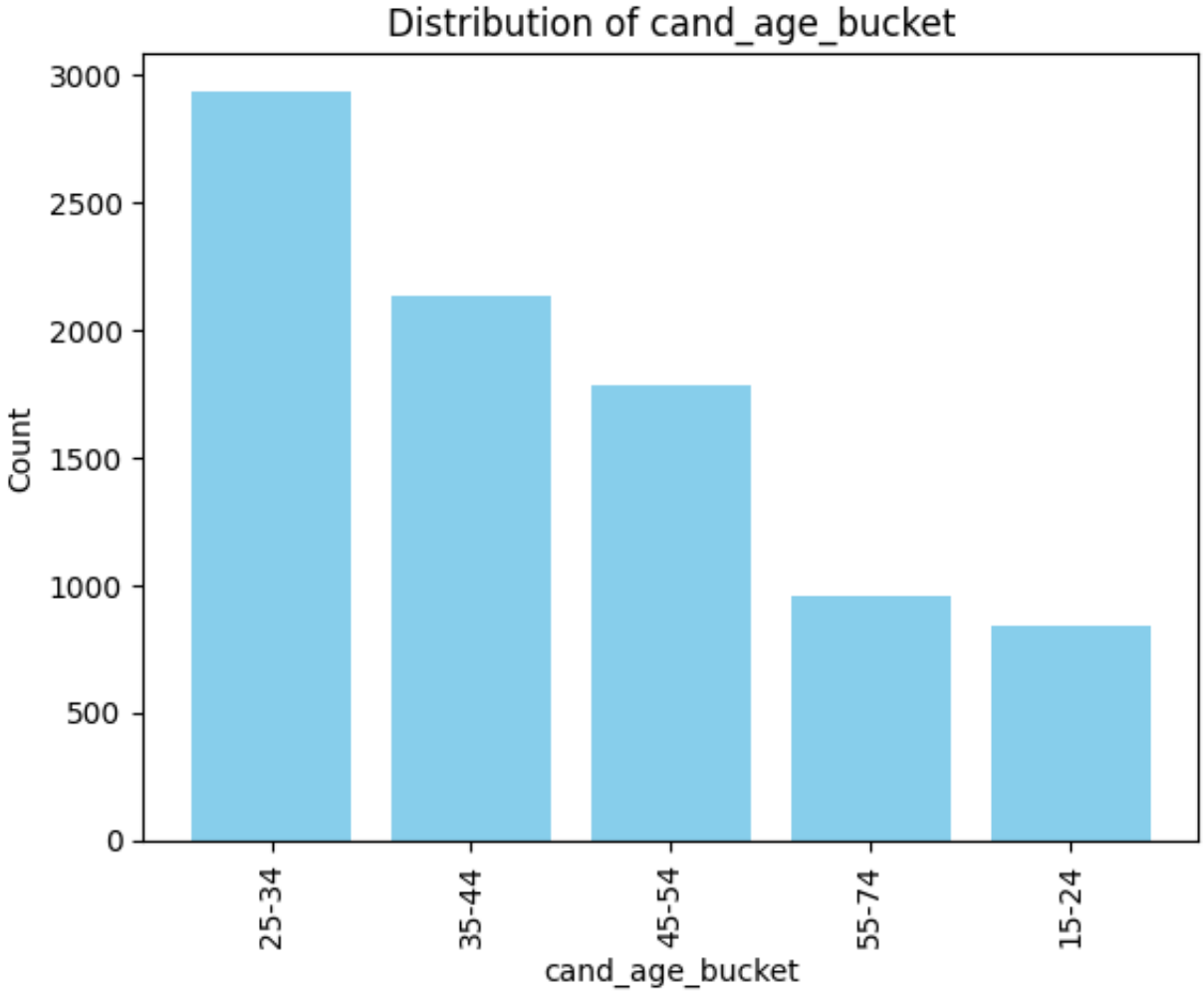
```
top_5_dicts = f.create_dicts_rank_n(top_5_cands,columns)
top_6_dicts = f.create_dicts_rank_n(top_6_cands,columns)
top_7_dicts = f.create_dicts_rank_n(top_7_cands,columns)
top_8_dicts = f.create_dicts_rank_n(top_8_cands,columns)
top_9_dicts = f.create_dicts_rank_n(top_9_cands,columns)
top_10_dicts = f.create_dicts_rank_n(top_10_cands,columns)

full_dicts = [dict_distances,dict_gender,dict_age,dict_domicile_region,dict_job_prc

list_of_dict = [full_dicts,top_1_dicts,top_2_dicts,top_3_dicts,top_4_dicts,top_5_di
```

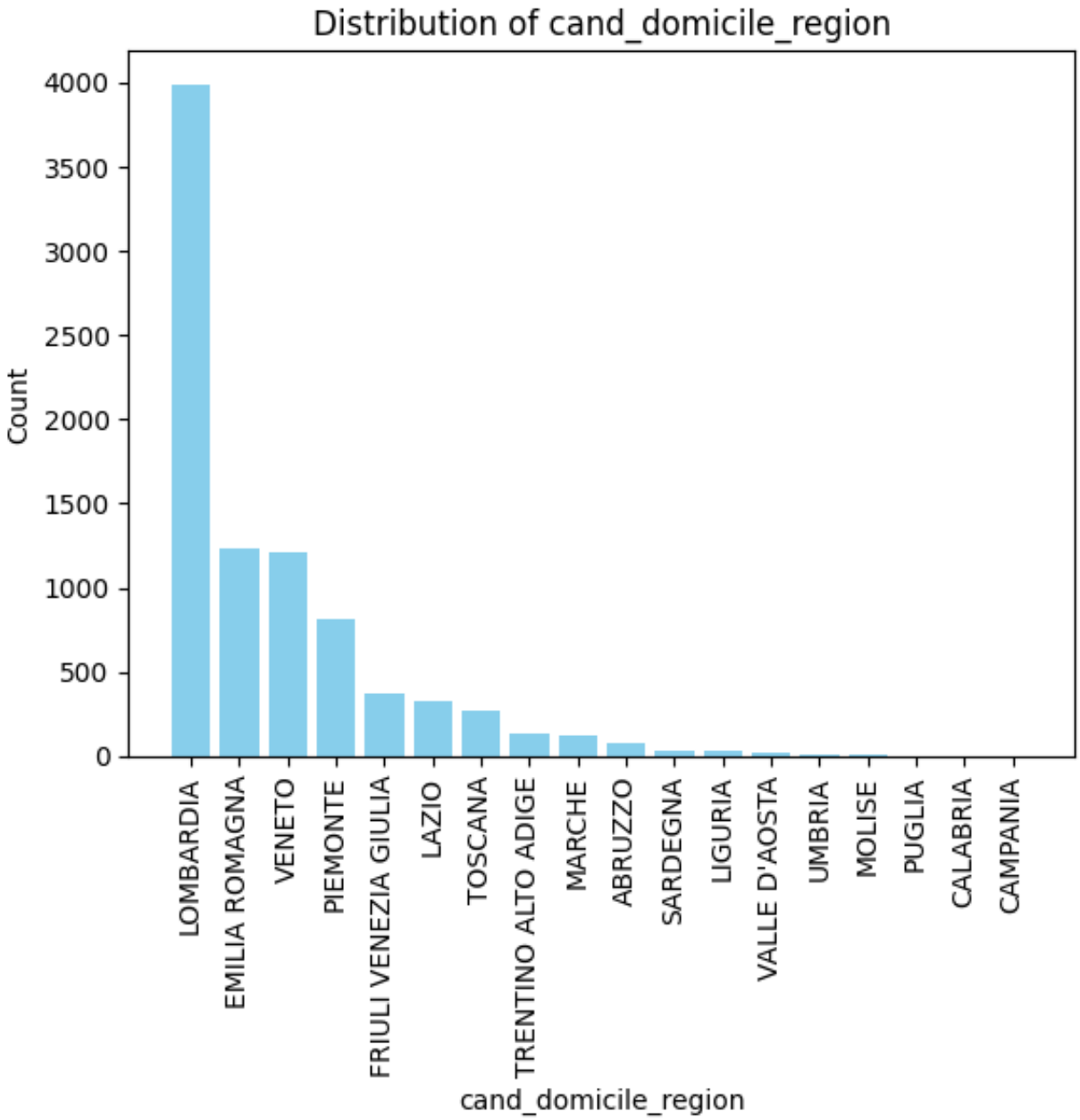
```
direct_distance_km = f.create_table_for_feature(list_of_dict,idx=0)
direct_gender = f.create_table_for_feature(list_of_dict,idx=1)
direct_age = f.create_table_for_feature(list_of_dict,idx=2)
direct_home_region = f.create_table_for_feature(list_of_dict,idx=3)
direct_job_province = f.create_table_for_feature(list_of_dict,idx=4)
direct_education = f.create_table_for_feature(list_of_dict,idx=5)
```

Print single Feature

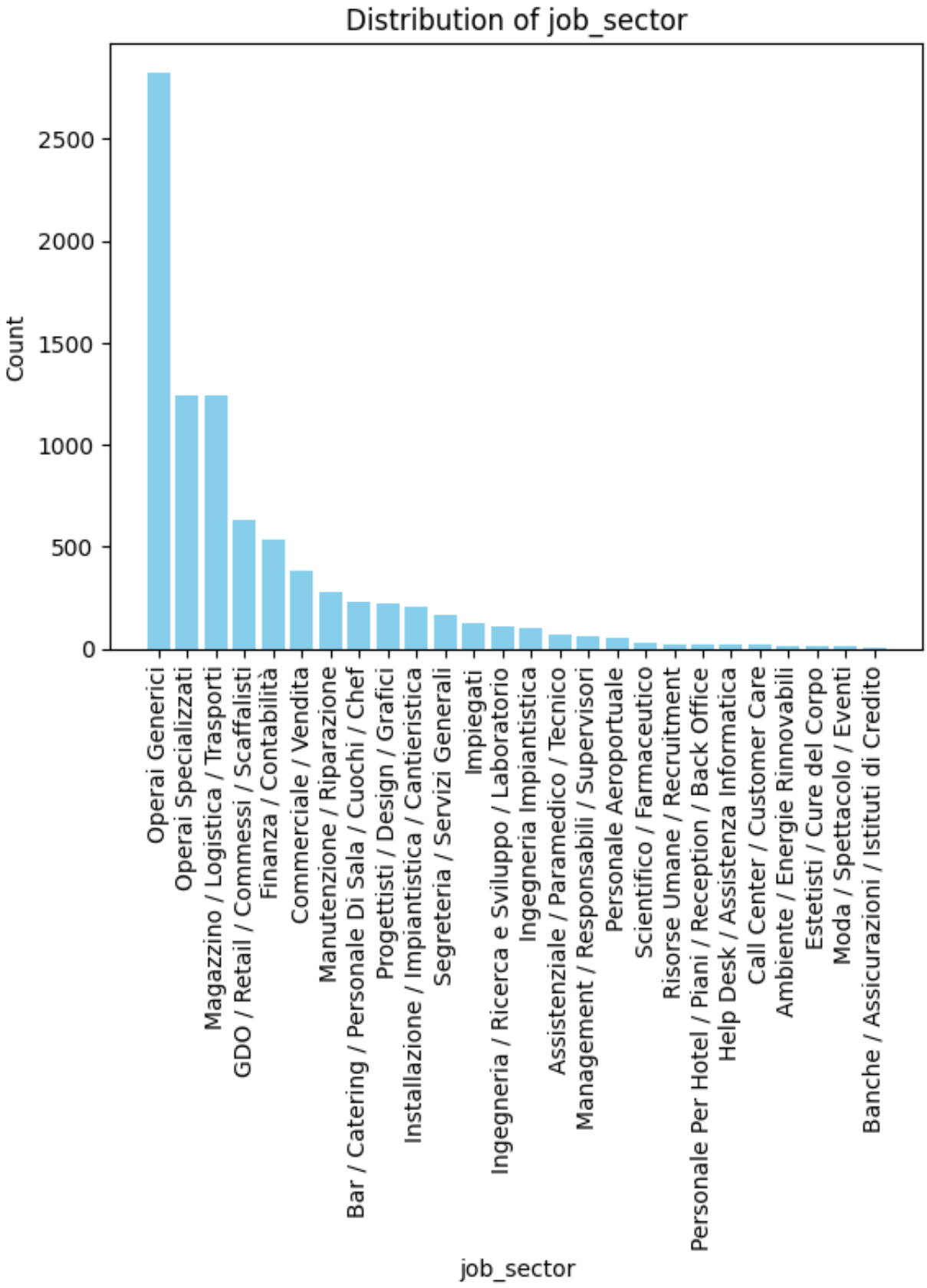
```
f.show_global_distribution(df_without_nulls,'cand_gender')
f.show_global_distribution(df_without_nulls,'cand_age_bucket')
f.show_global_distribution(df_without_nulls,'cand_domicile_region')
```



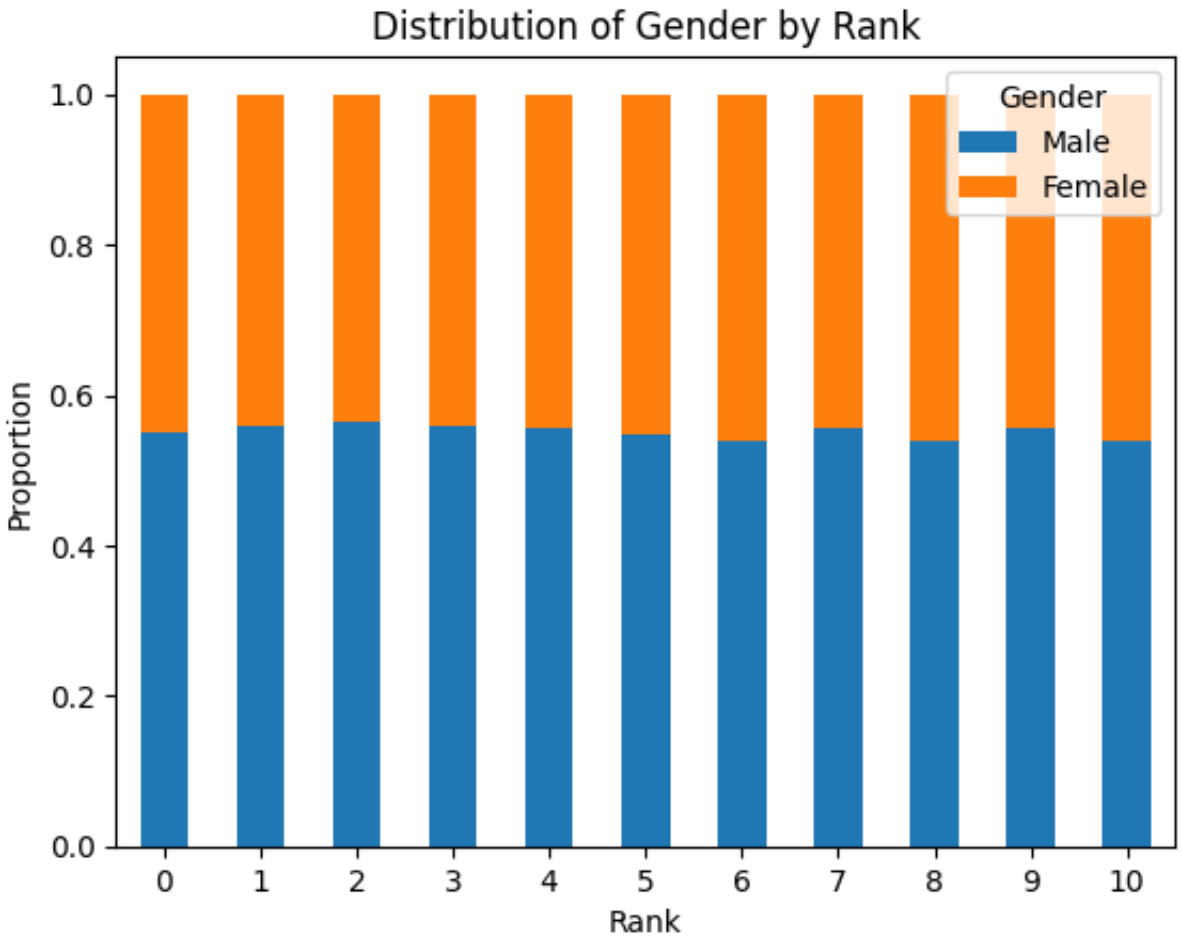

Distribution of cand_age_bucket
Count
3000
2500
2000
1500
1000
500
0
25-34
35-44
45-54
55-74
15-24
cand_age_bucket



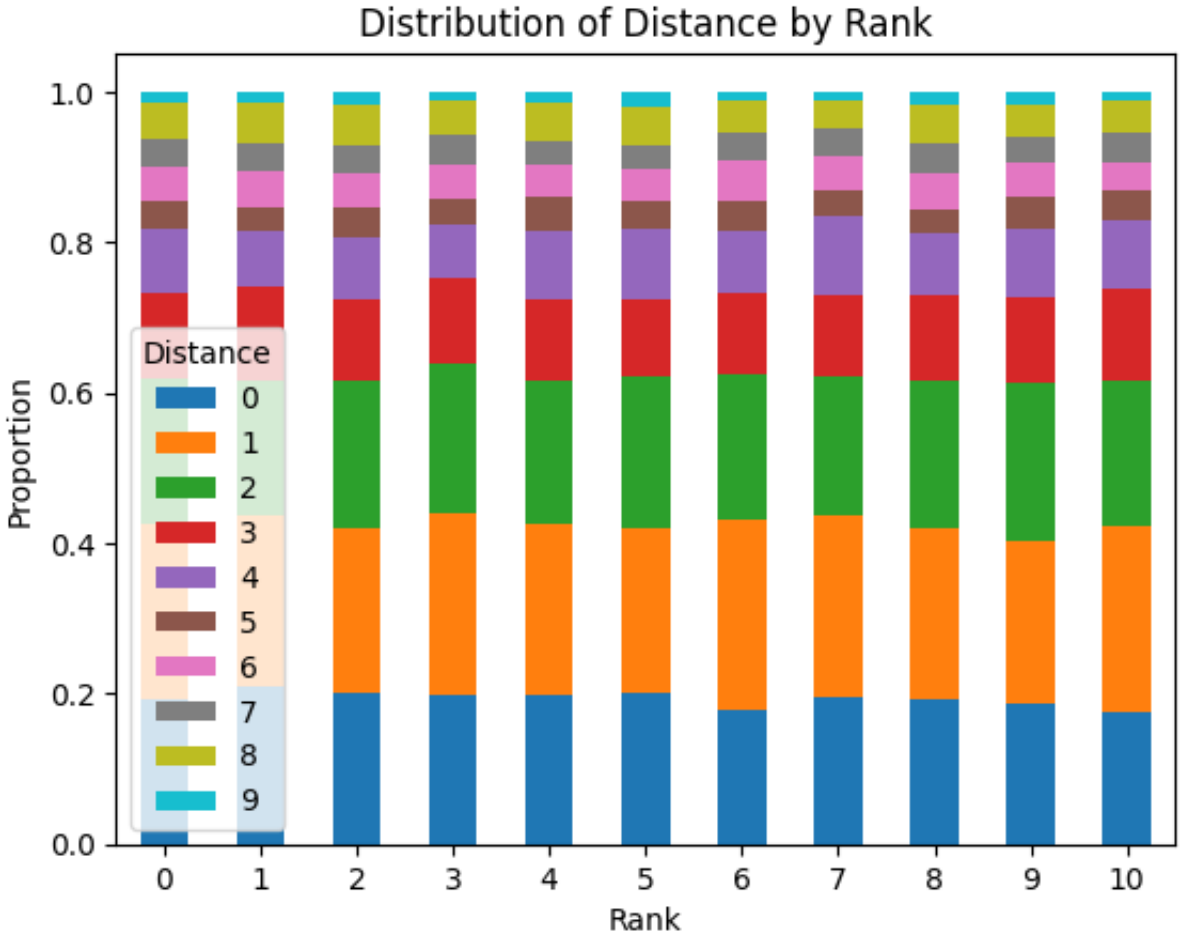

```
f.show_global_distribution(df_without_nulls,'job_sector')
```



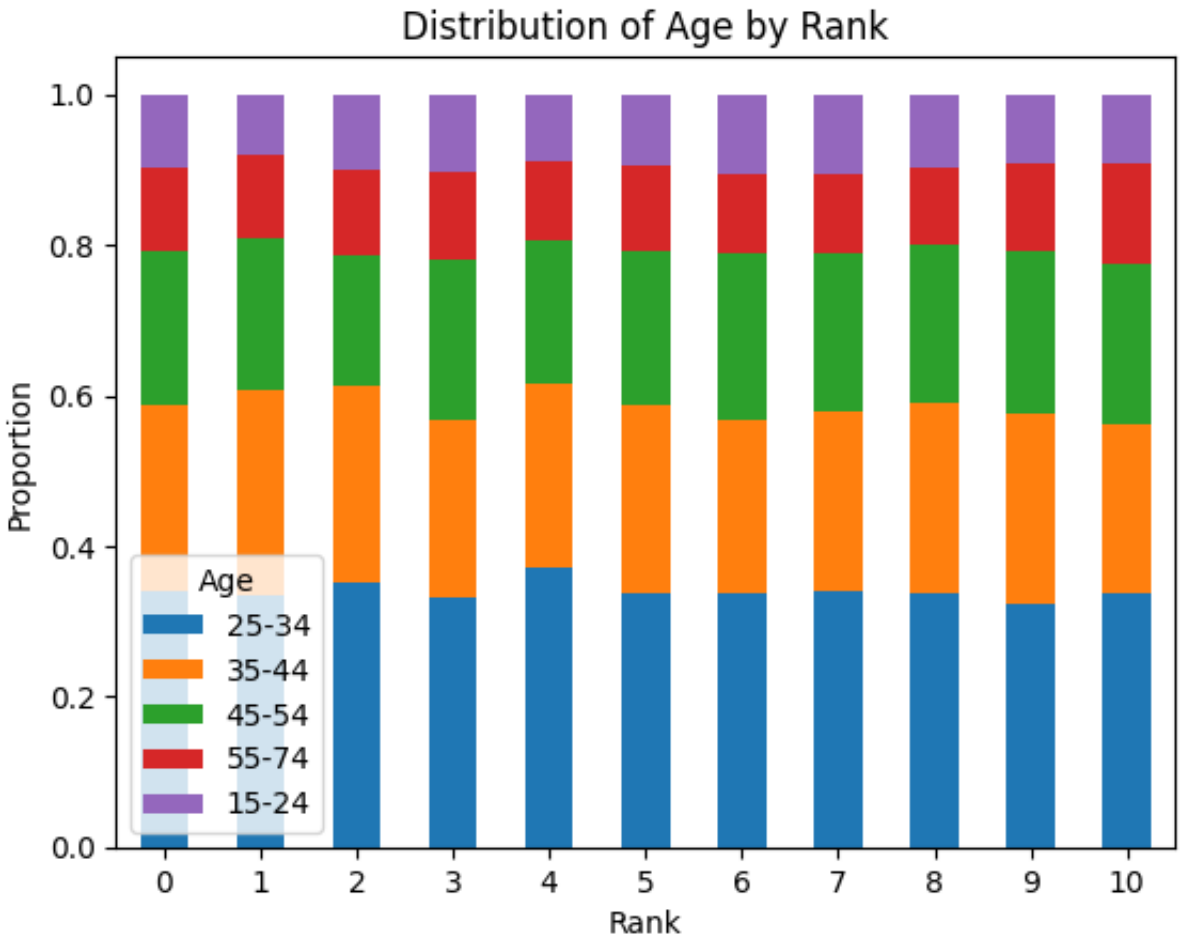

```
f.print_feature_distribution(direct_gender,'Gender')
```



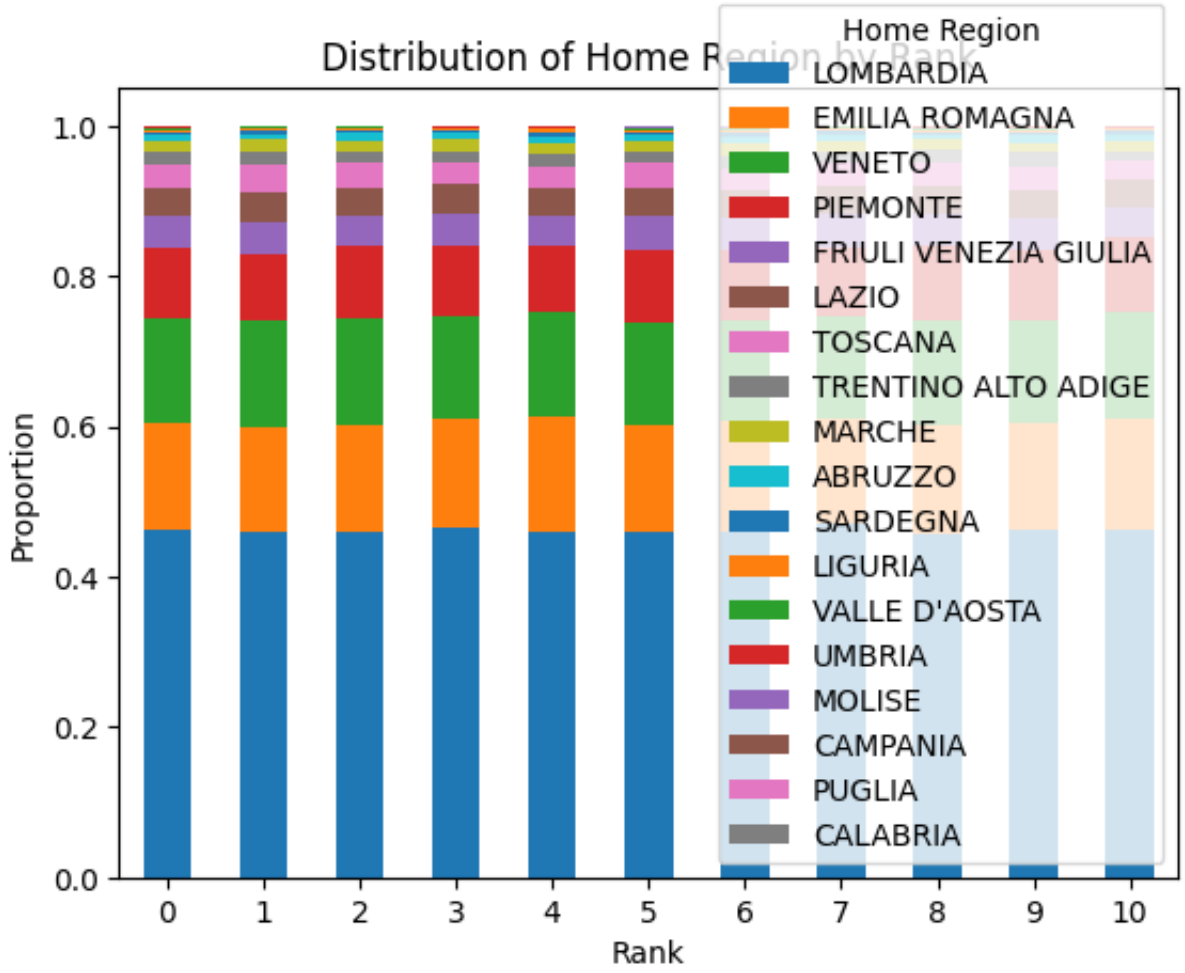

```
f.print_feature_distribution(direct_distance_km,'Distance')
```



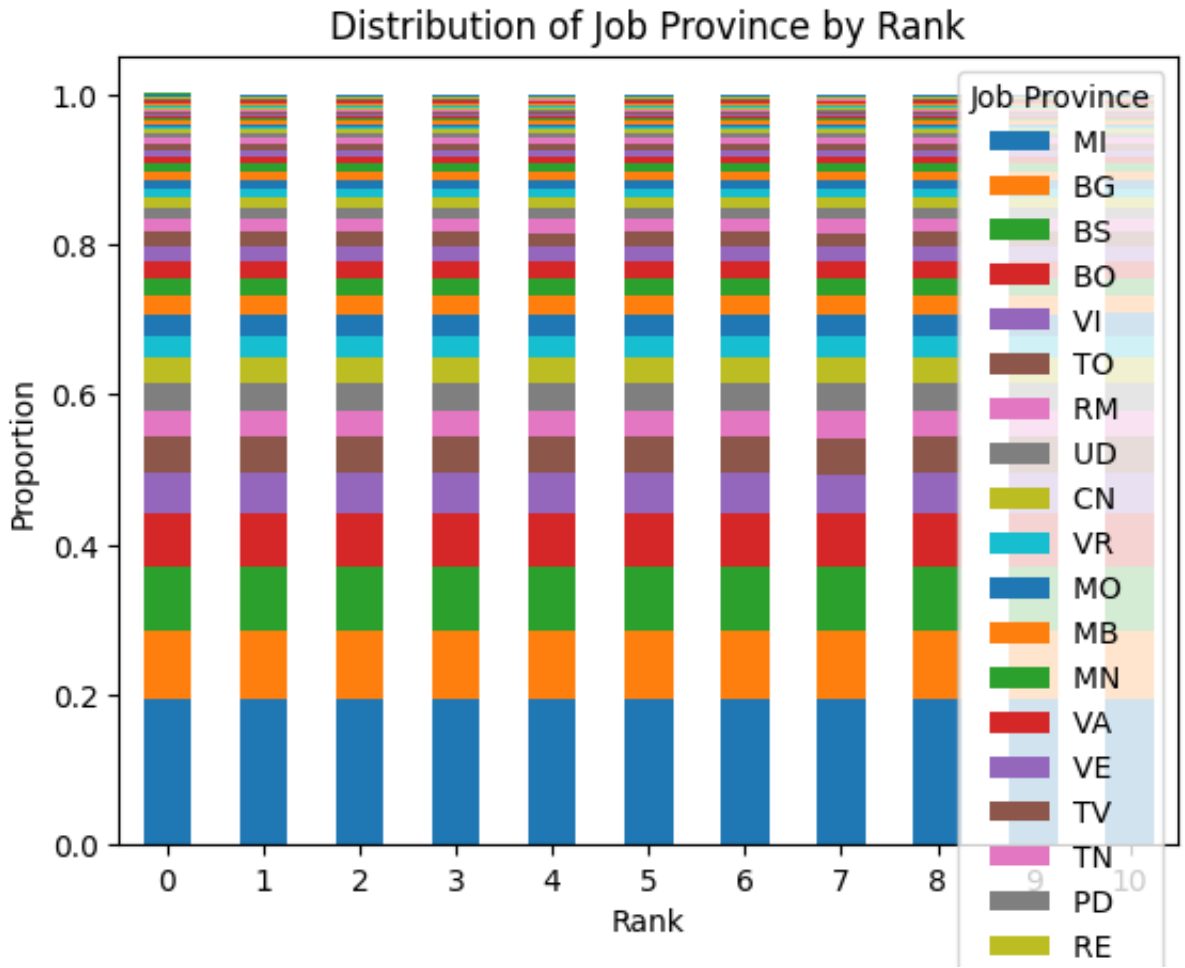
```
f.print_feature_distribution(direct_age,'Age')
```



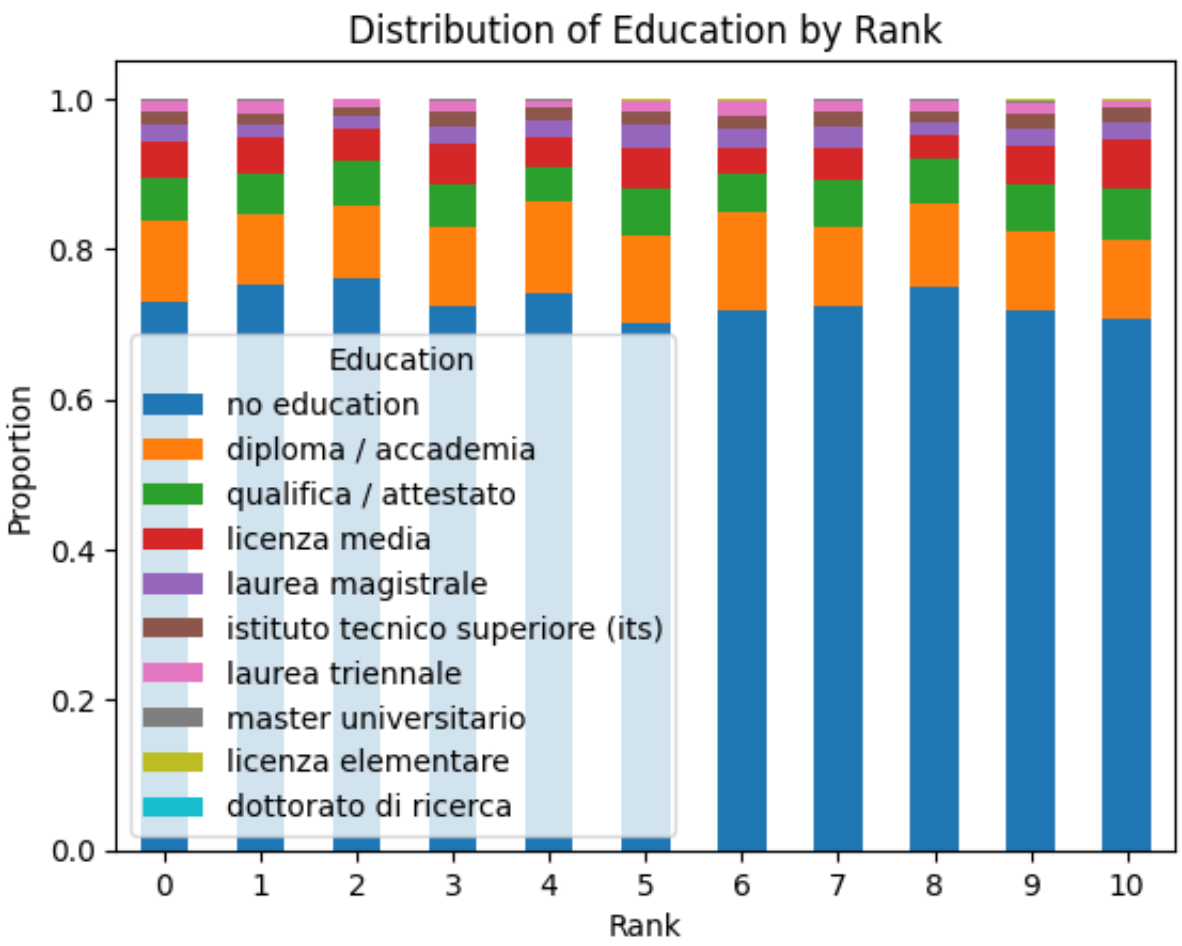

```
f.print_feature_distribution(direct_home_region,'Home Region')
```




```
f.print_feature_distribution(direct_job_province,'Job Province')
```




```
f.print_feature_distribution(direct_education,'Education')
```

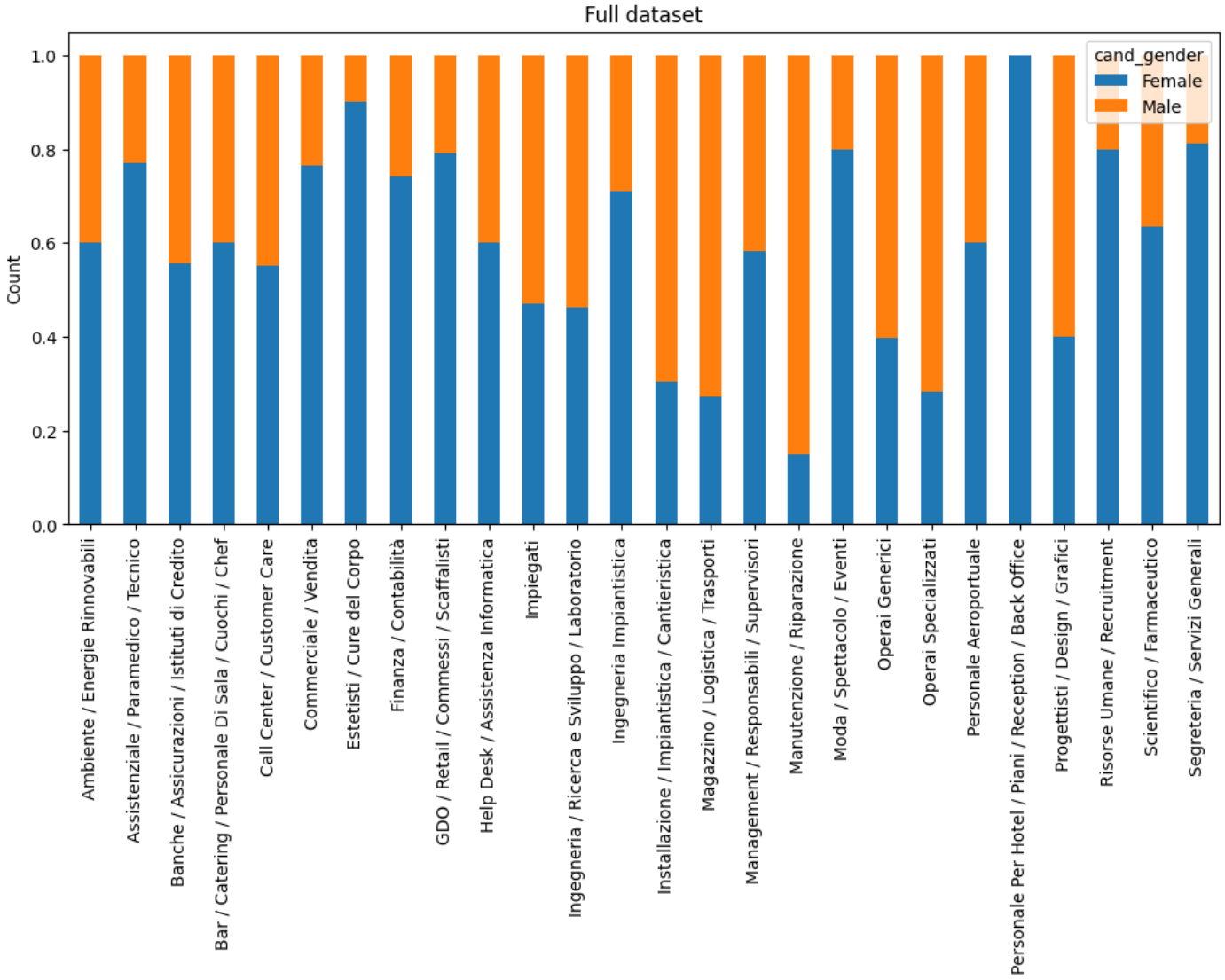


Test 2 features together

```
direct_matching_df = direct_matching_df.dropna()
direct_matching_df['distance_km'] = (direct_matching_df['distance_km'] // 10)
```

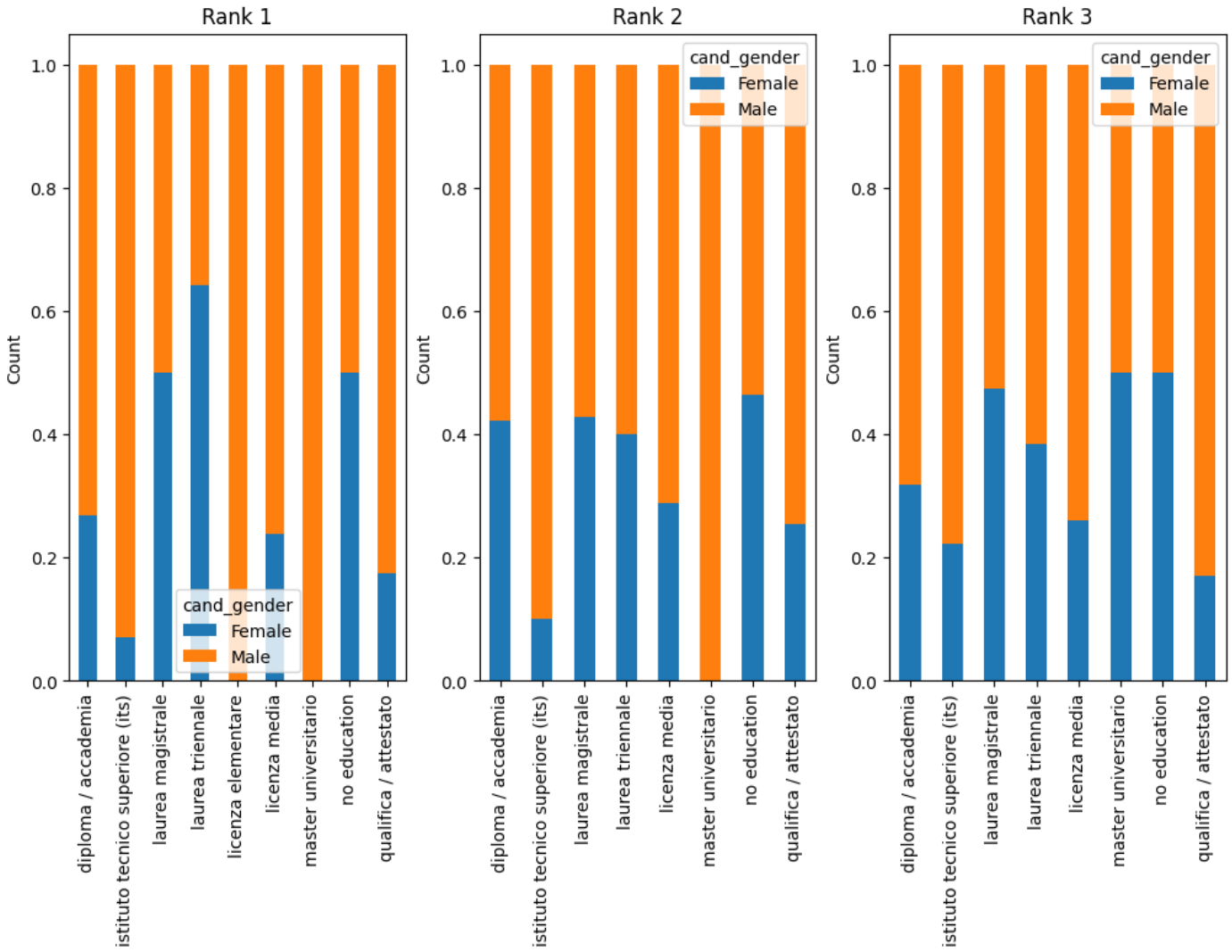
```
<ipython-input-72-da7d8440770e>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  direct_matching_df['distance_km'] = (direct_matching_df['distance_km'] // 10)
```

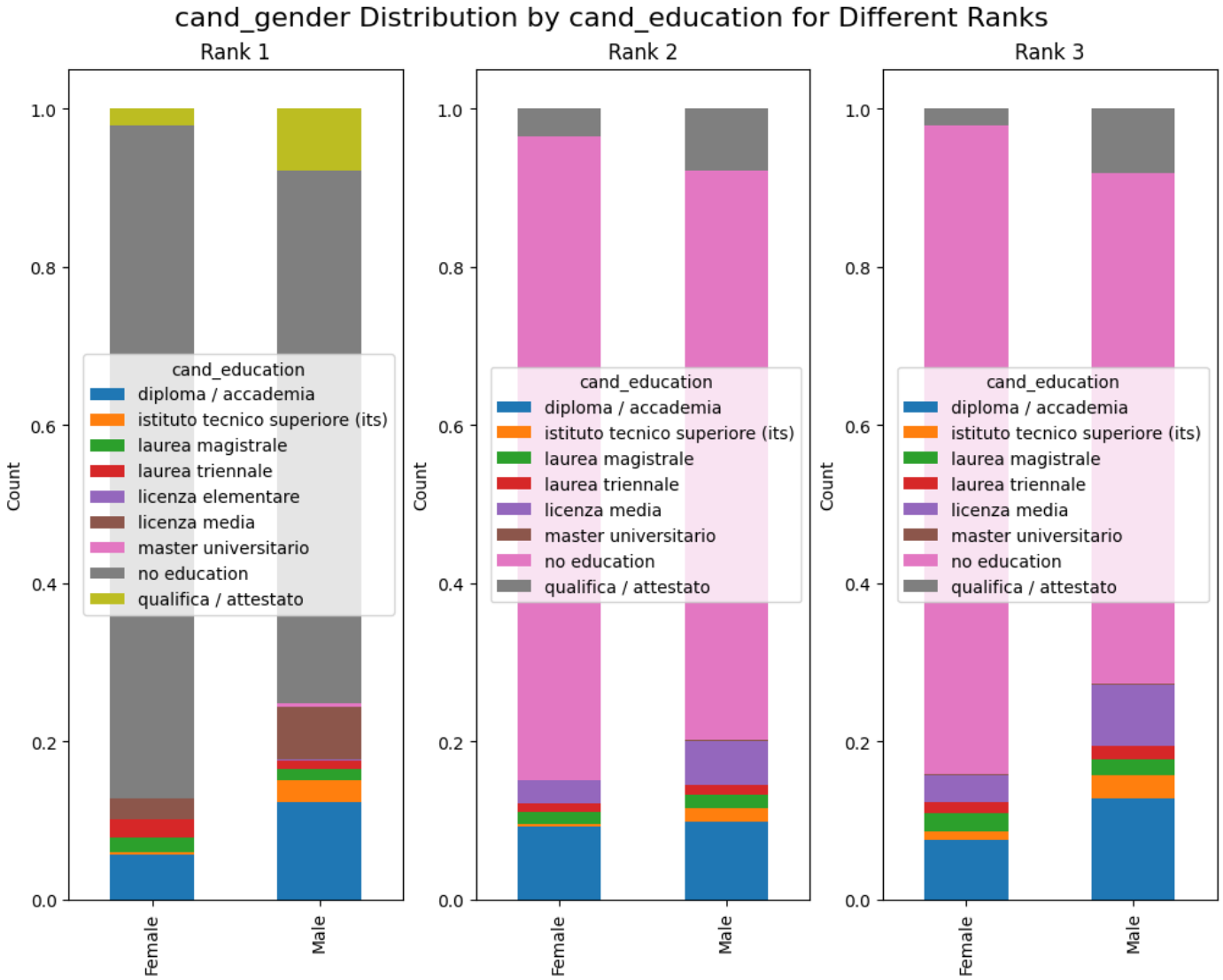
```
f.plot_2_features(direct_matching_df, 'job_sector', 'cand_gender', None)
```



Gender & Education

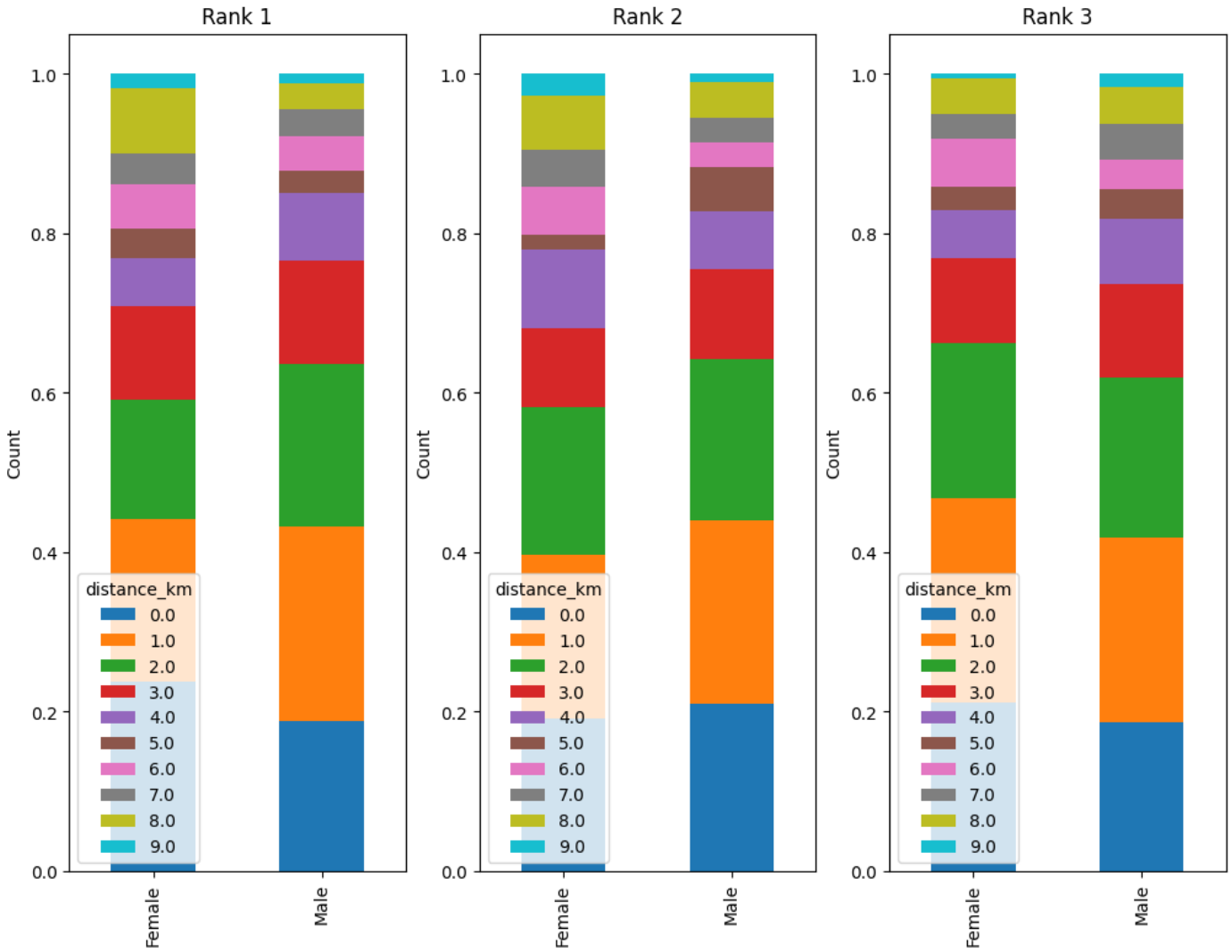
```
r = [1,2,3]
f.plot_2_features(direct_matching_df,'cand_education','cand_gender',r,len(r))
f.plot_2_features(direct_matching_df,'cand_gender','cand_education',r,len(r))
```

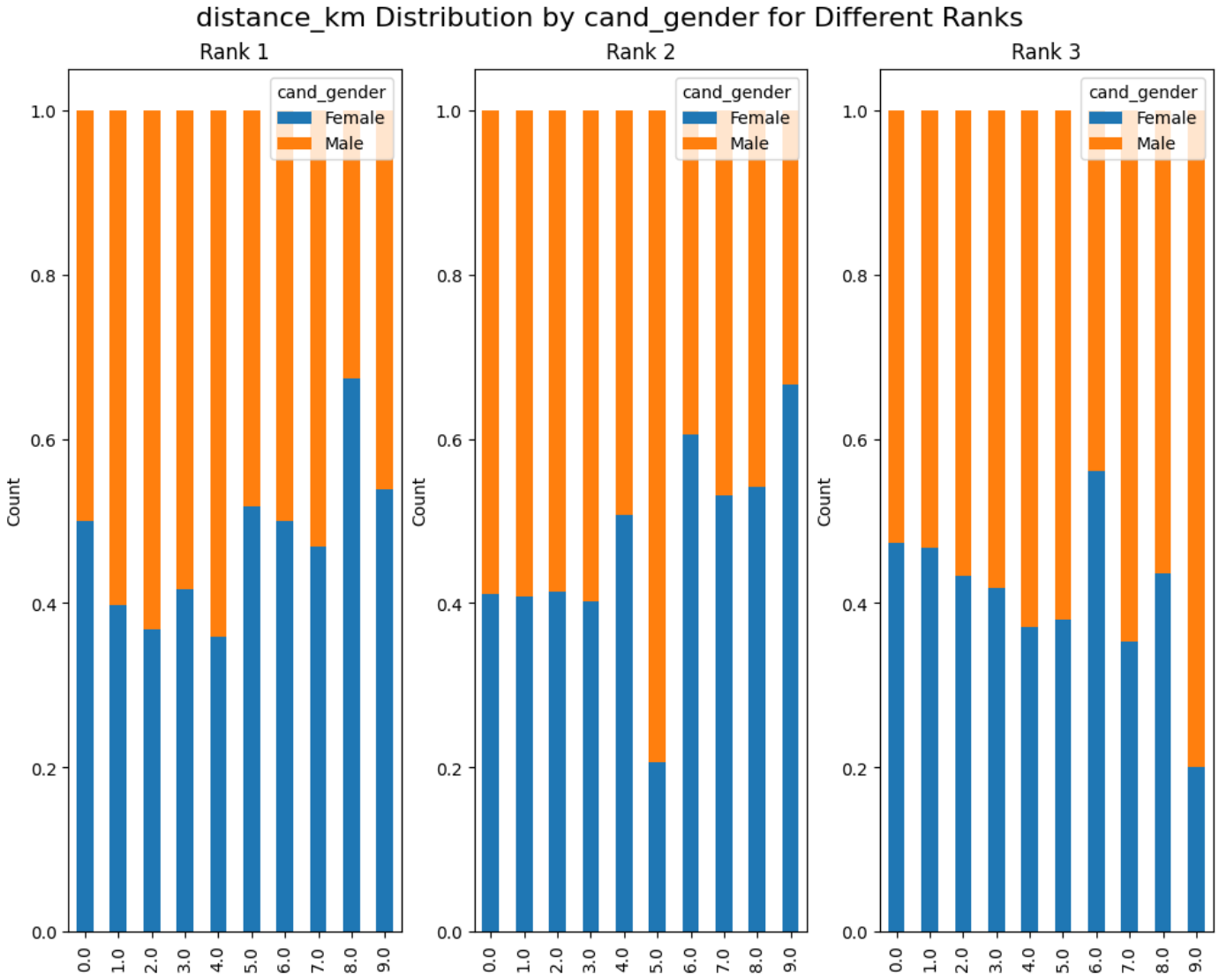

cand_education Distribution by cand_gender for Different Ranks
Rank 1
Rank 2
Rank 3
Count
cand_gender
Female
Male
diploma / accademia
istituto tecnico superiore (its)
laurea magistrale
laurea triennale
licenza elementare
licenza media
master universitario
no education
qualifica / attestato



Gender & distance

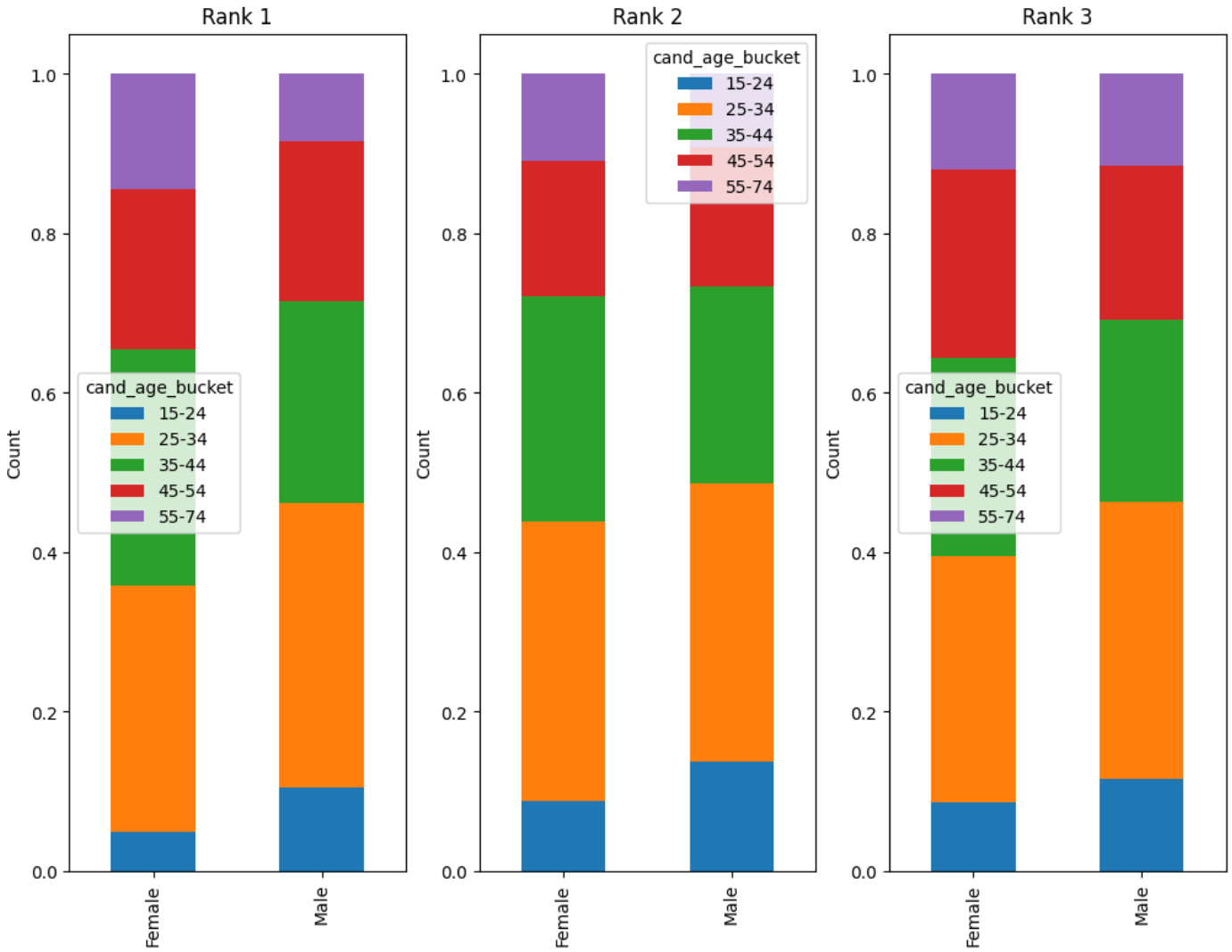
```
r = [1,2,3]
f.plot_2_features(direct_matching_df,'cand_gender','distance_km',r,len(r))
f.plot_2_features(direct_matching_df,'distance_km','cand_gender',r,len(r))
```

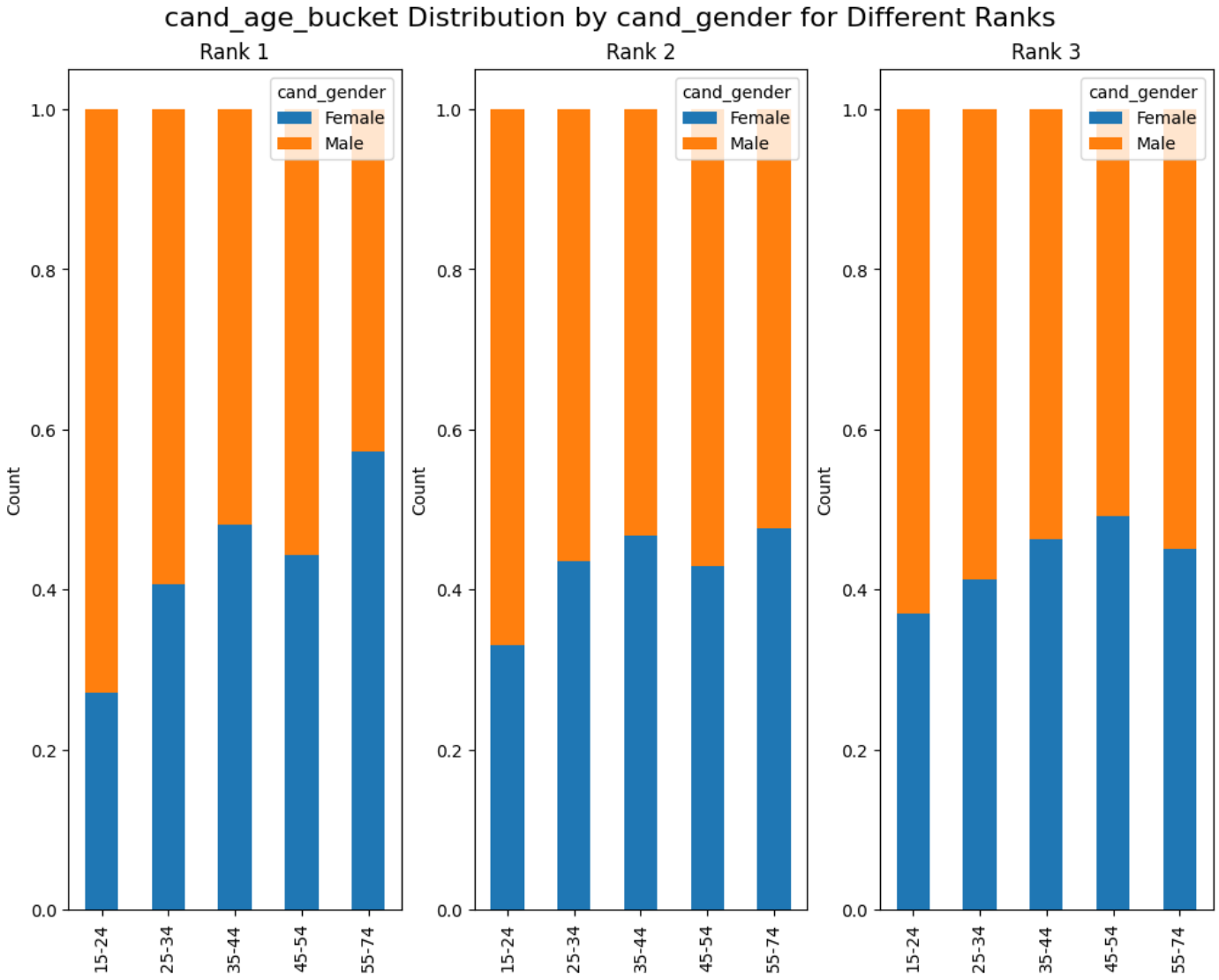

cand_gender Distribution by distance_km for Different Ranks
Rank 1
Rank 2
Rank 3
Count
1.0
0.8
0.6
0.4
0.2
0.0
distance_km
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
Female
Male



Gender & Age

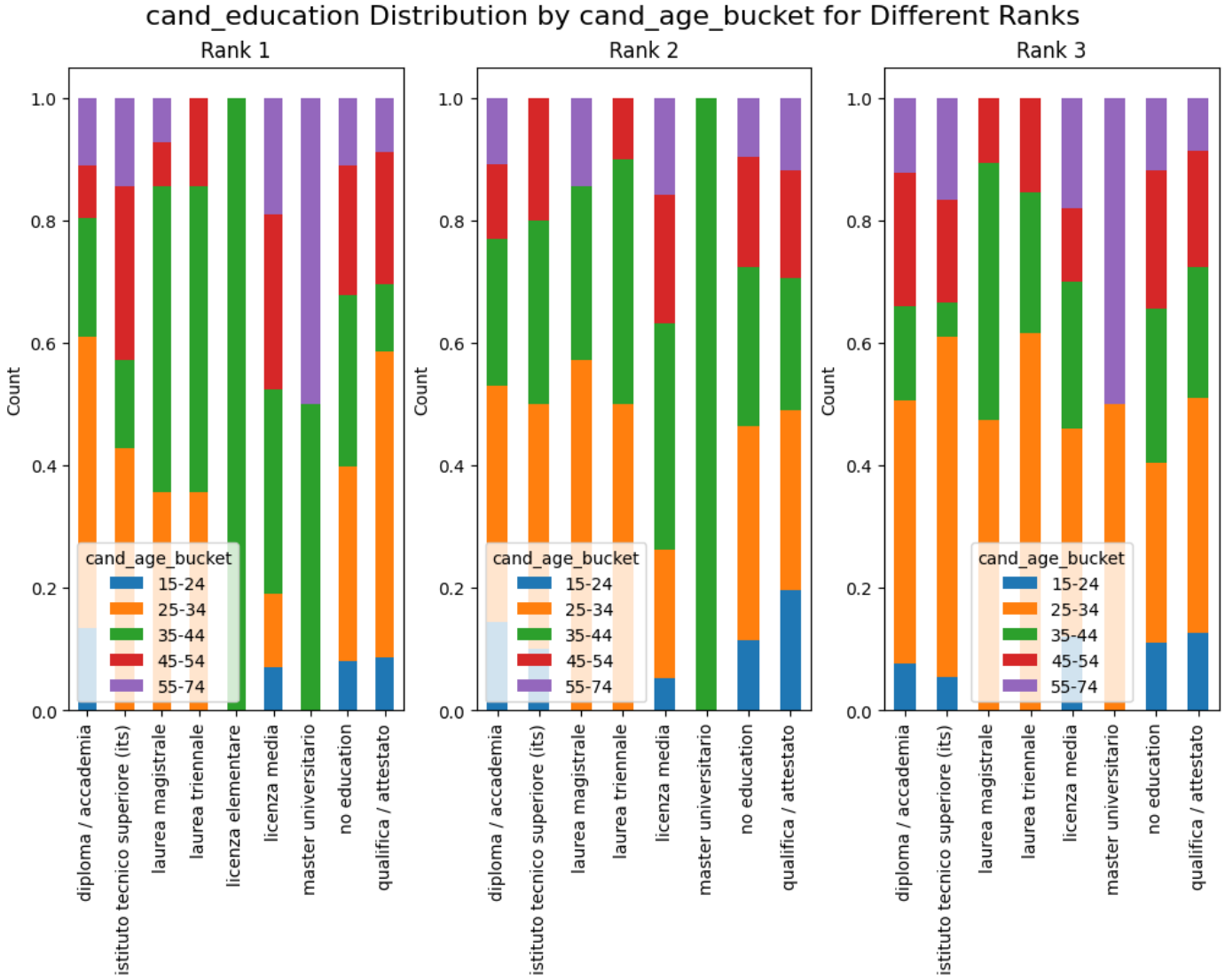
```
r = [1,2,3]
f.plot_2_features(direct_matching_df,'cand_gender','cand_age_bucket',r,len(r))
f.plot_2_features(direct_matching_df,'cand_age_bucket','cand_gender',r,len(r))
```

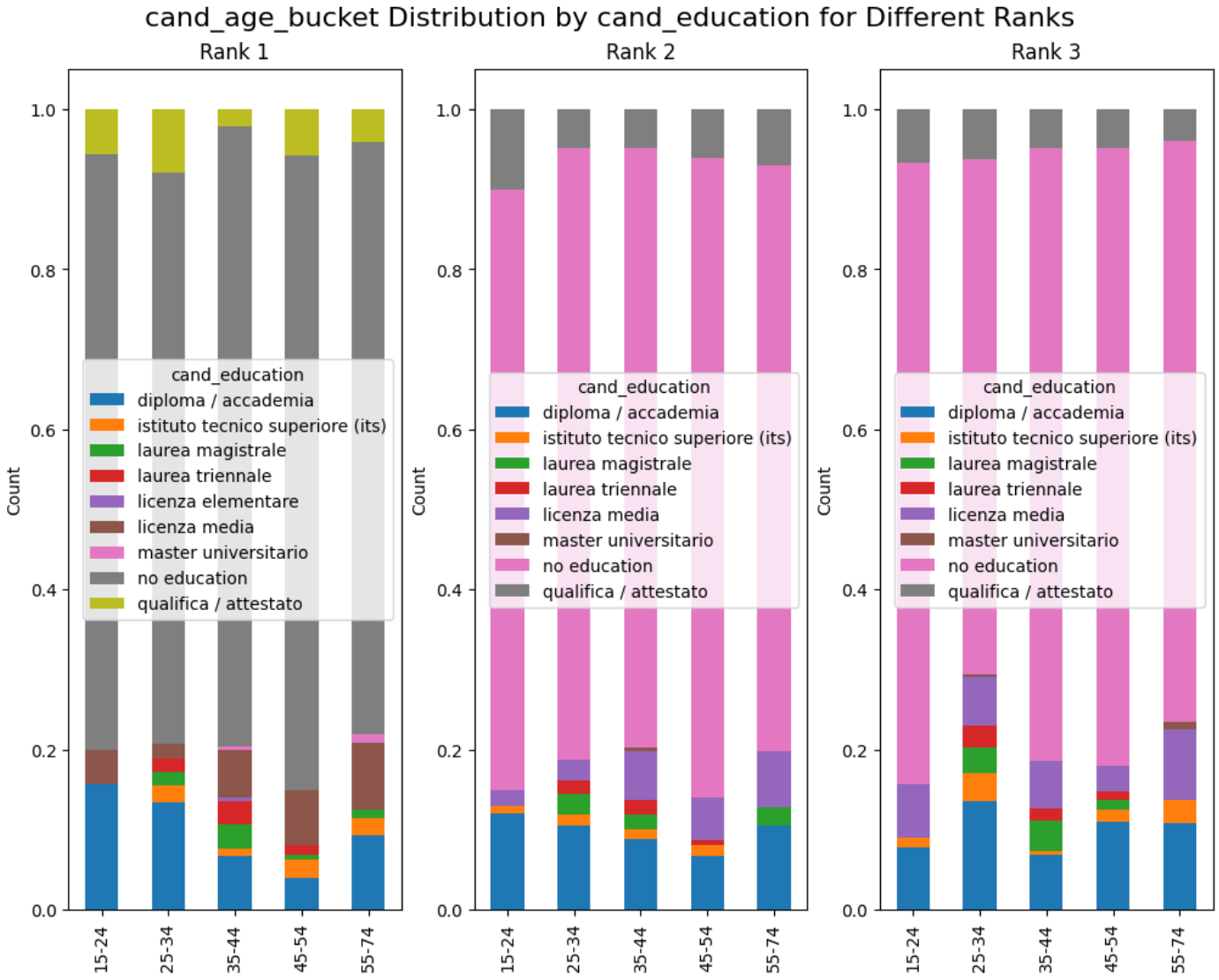

cand_gender Distribution by cand_age_bucket for Different Ranks
Rank 1
Rank 2
Rank 3
Count
1.0
0.8
0.6
0.4
0.2
0.0
cand_age_bucket
15-24
25-34
35-44
45-54
55-74
Female
Male



Education & Age

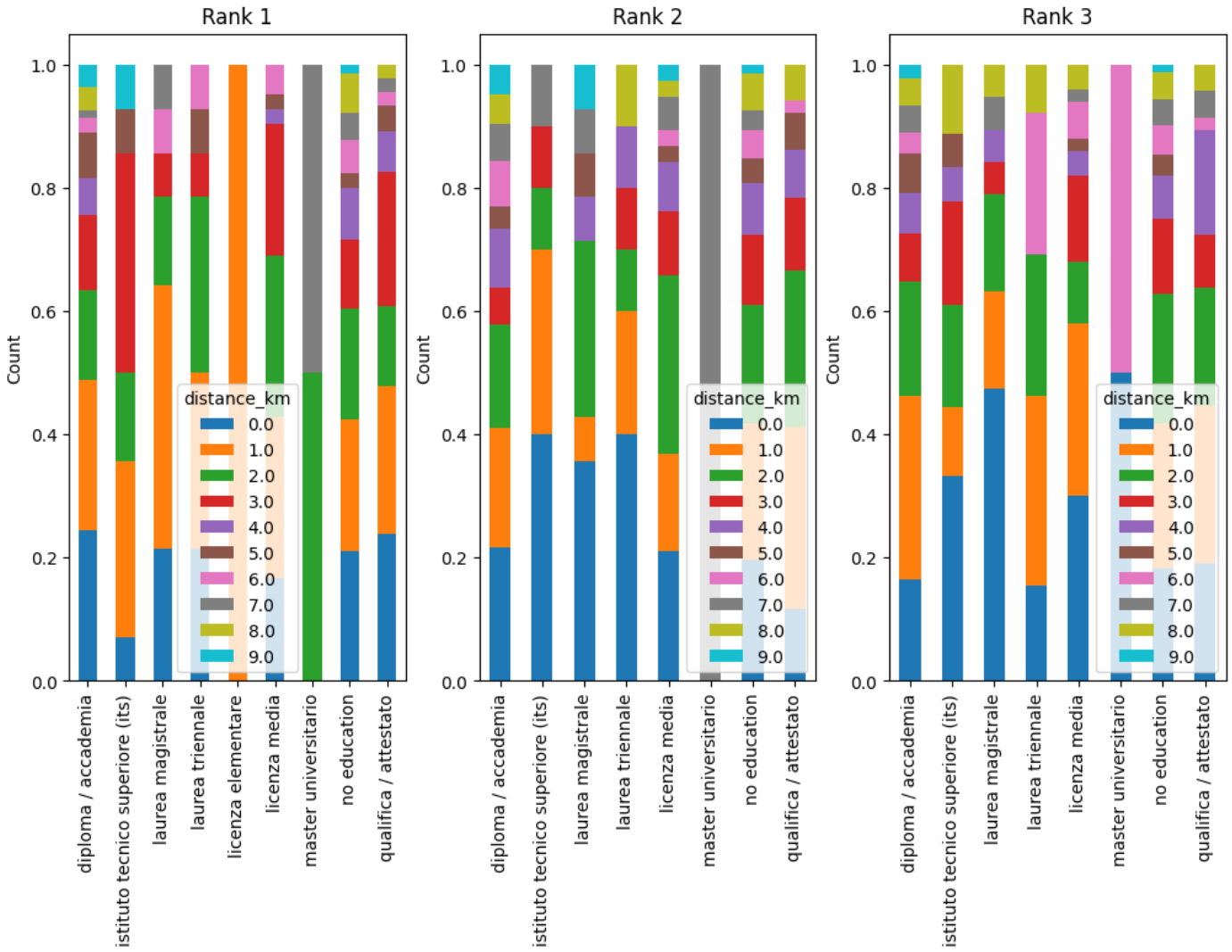
```
r = [1,2,3]
f.plot_2_features(direct_matching_df,'cand_education','cand_age_bucket',r,len(r))
f.plot_2_features(direct_matching_df,'cand_age_bucket','cand_education',r,len(r))
```

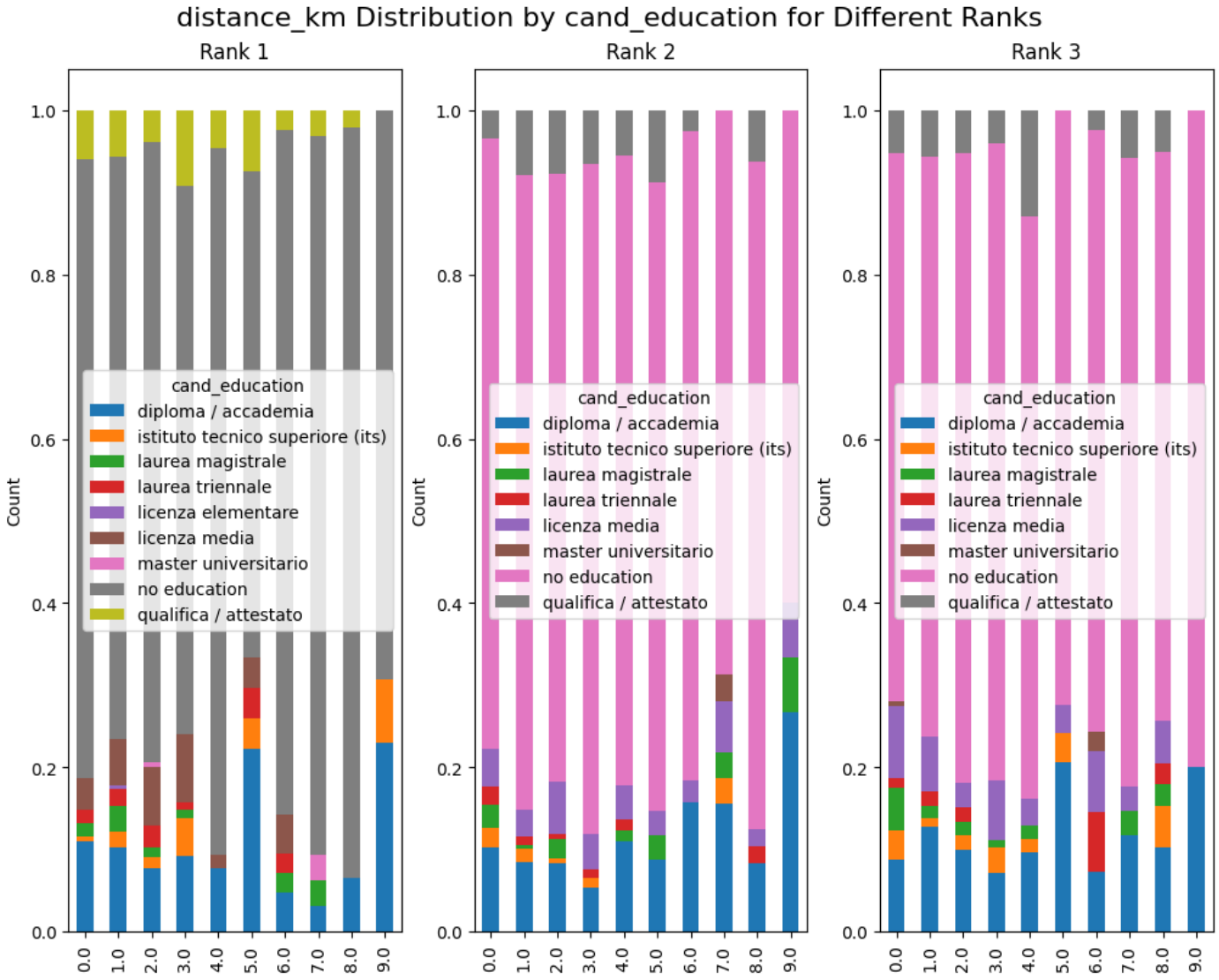

cand_education Distribution by cand_age_bucket for Different Ranks
Rank 1
Rank 2
Rank 3
Count
1.0
0.8
0.6
0.4
0.2
0.0
cand_age_bucket
15-24
25-34
35-44
45-54
55-74
diploma / accademia
istituto tecnico superiore (its)
laurea magistrale
laurea triennale
licenza elementare
licenza media
master universitario
no education
qualifica / attestato



Education & Distance

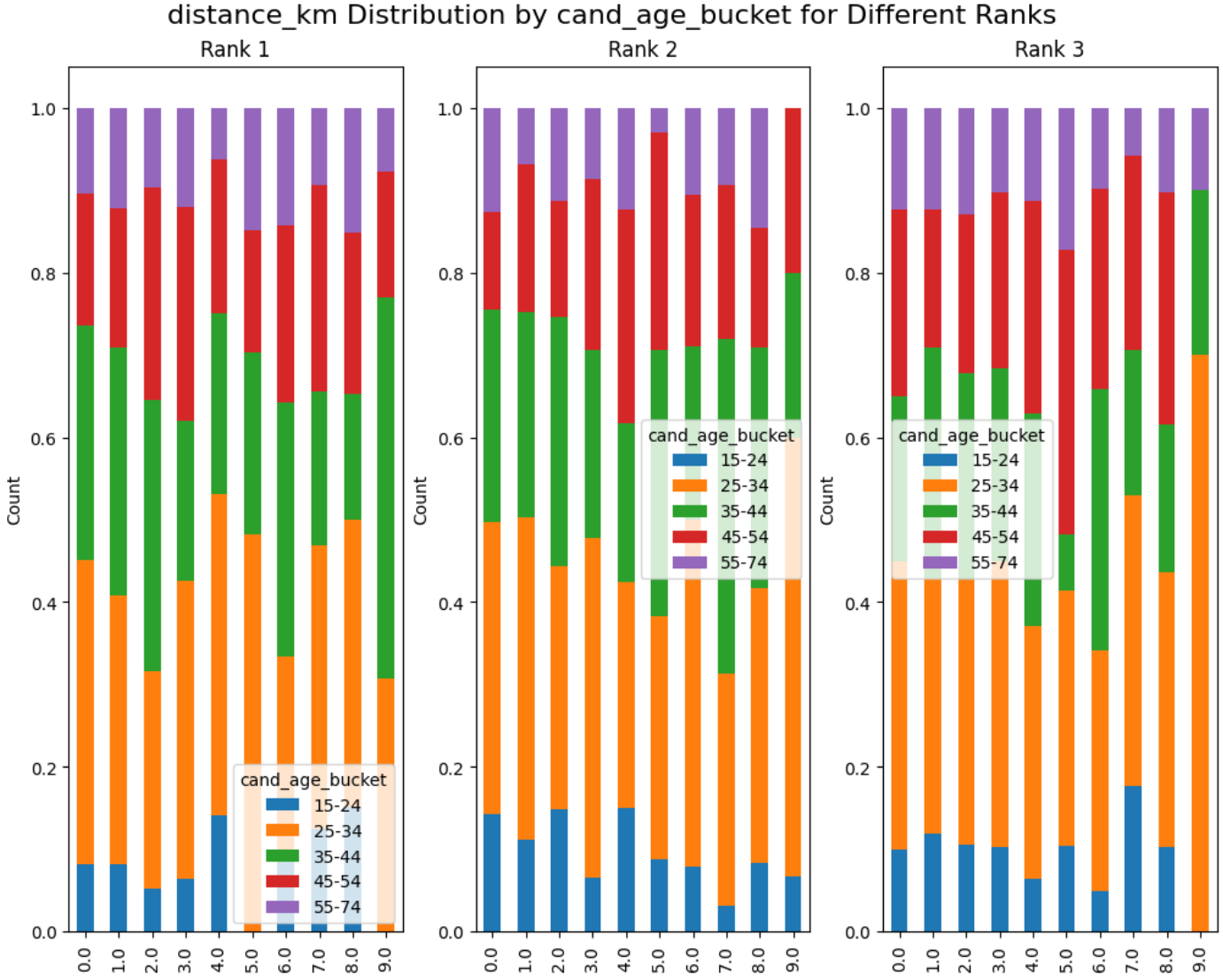
```
r = [1,2,3]
f.plot_2_features(direct_matching_df,'cand_education','distance_km',r,len(r))
f.plot_2_features(direct_matching_df,'distance_km','cand_education',r,len(r))
```

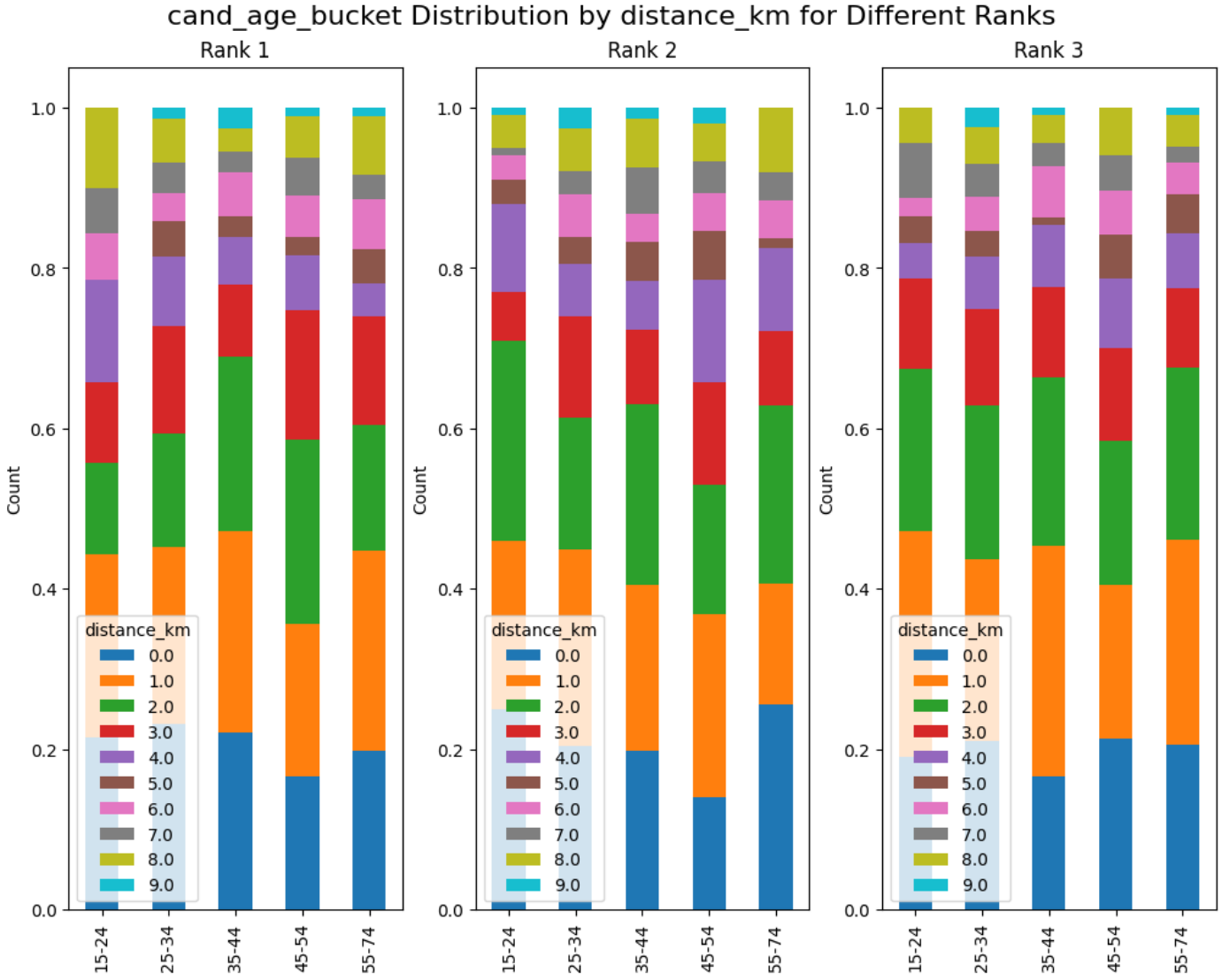

cand_education Distribution by distance_km for Different Ranks
Rank 1
Rank 2
Rank 3
Count
distance_km
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
diploma / accademia
istituto tecnico superiore (its)
laurea magistrale
laurea triennale
licenza elementare
licenza media
master universitario
no education
qualifica / attestato



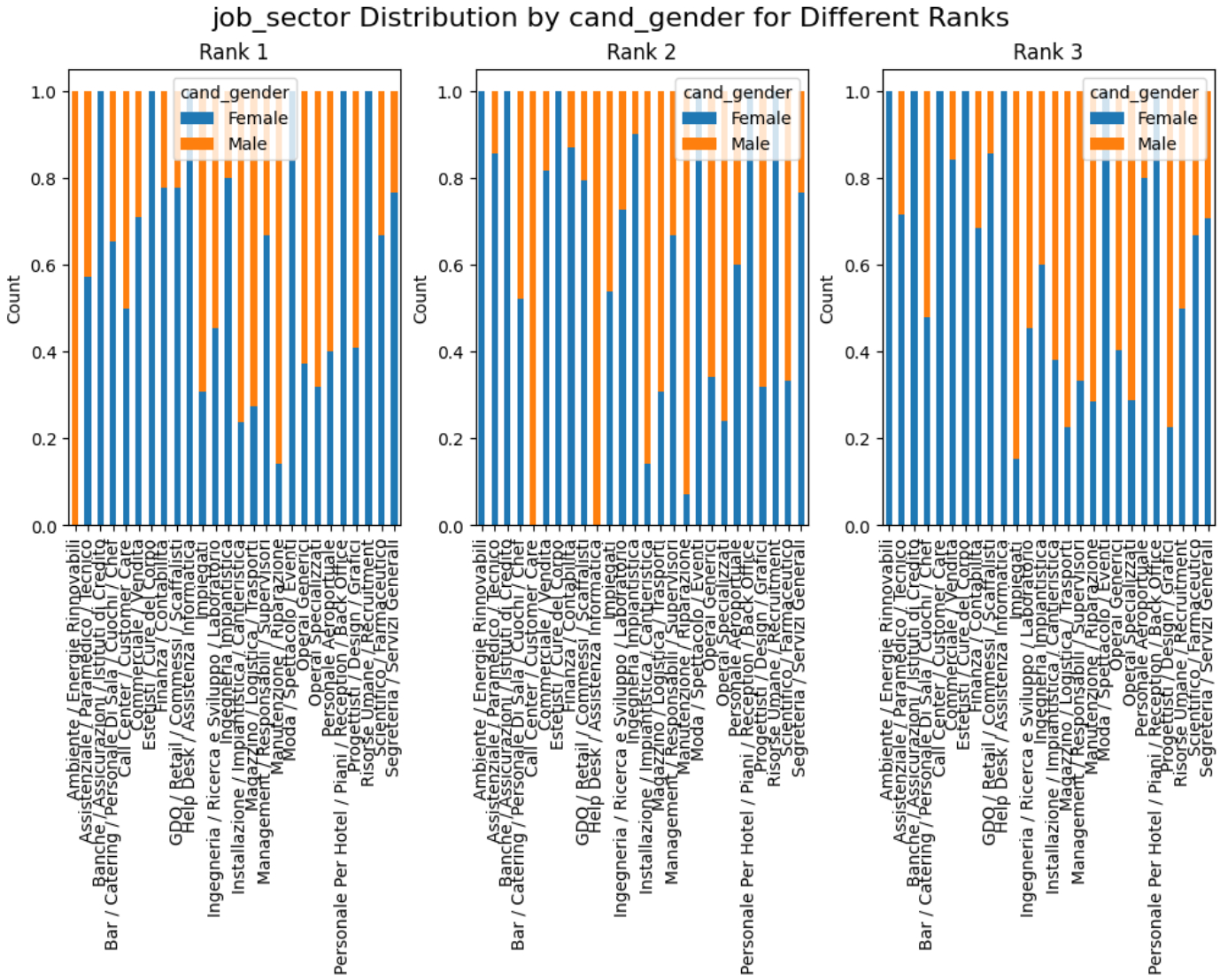
Age and Distance

```
r = [1,2,3]
f.plot_2_features(direct_matching_df,'distance_km','cand_age_bucket',r,len(r))
f.plot_2_features(direct_matching_df,'cand_age_bucket','distance_km',r,len(r))
```


distance_km Distribution by cand_age_bucket for Different Ranks
Rank 1
Rank 2
Rank 3
Count
cand_age_bucket
15-24
25-34
35-44
45-54
55-74
0.0
0.2
0.4
0.6
0.8
1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0




```
r = [1,2,3]
#plot_2_features(direct_matching_df.dropna(),'cand_gender','job_sector',r,len(r))
f.plot_2_features(direct_matching_df,'job_sector','cand_gender',r,len(r))
```



Check correlation between job_professional_category and job_sector

```
jobcategories_df = direct_matching_df.dropna().groupby('job_id')['job_professional_
for index, value in jobcategories_df.items():
    if value < 10:
      print(index,value)
```

```
('OFF_1357_0687', 'Addetto al montaggio (m/f)') 9
('OFF_1745_0198', 'Carrellista/Mulettista') 9
('OFF_2271_0192', 'frigorista') 8
('OFF_2603_0112', 'manutentore') 9
('OFF_4839_0660', 'saldatore/saldatrice') 9
('OFF_789_0870', 'analista finanziario/analista finanziaria') 9
('ORD_16542_0438', 'Operatore di macchine per imballaggio (m/f)') 9
('ORD_18333_0006', 'Meccanico riparatore di macchine (m/f)') 9
('ORD_48061_0590', 'Operaio Generico Elettronico/ Elettrotecnico') 9
('ORD_53862_0059', 'responsabile della contabilità') 9
```

Reverse Matching

```
reverse_matching_df = pd.read_csv('Data/reverse_matching_20240213.csv', sep=';')
```

```
reverse_matching_df.head()
```

	cand_id	job_id	distance_km	match_score	match_rank	cand_gender	cand_ag
0	11,208	OFF_3435_4864	30.609745	99.309860	1	Female	
1	11,208	ORD_13361_0218	42.466312	96.529259	1	Female	
2	11,208	ORD_14183_0606	33.240650	95.374954	2	Female	
3	11,208	OFF_635_0402	58.744339	94.199844	2	Female	
4	11,208	OFF_5814_0606	27.851854	93.688522	3	Female	

```
reverse_matching_df.describe(include="all")
```

	cand_id	job_id	distance_km	match_score	match_rank	cand_gende
count	193474	193474	193474.000000	193474.000000	193474.000000	19347
unique	21650	14506	NaN	NaN	NaN	
top	11,208	ORD_3933_1635	NaN	NaN	NaN	Mal
freq	10	1019	NaN	NaN	NaN	9769
mean	NaN	NaN	38.210087	91.837911	2.923726	NaN
std	NaN	NaN	27.047254	12.394169	1.416097	NaN
min	NaN	NaN	0.000000	30.001501	1.000000	NaN
25%	NaN	NaN	16.593061	90.506653	2.000000	NaN
50%	NaN	NaN	32.815426	96.752945	3.000000	NaN
75%	NaN	NaN	57.491835	98.881617	4.000000	NaN
max	NaN	NaN	99.997292	99.999260	5.000000	NaN

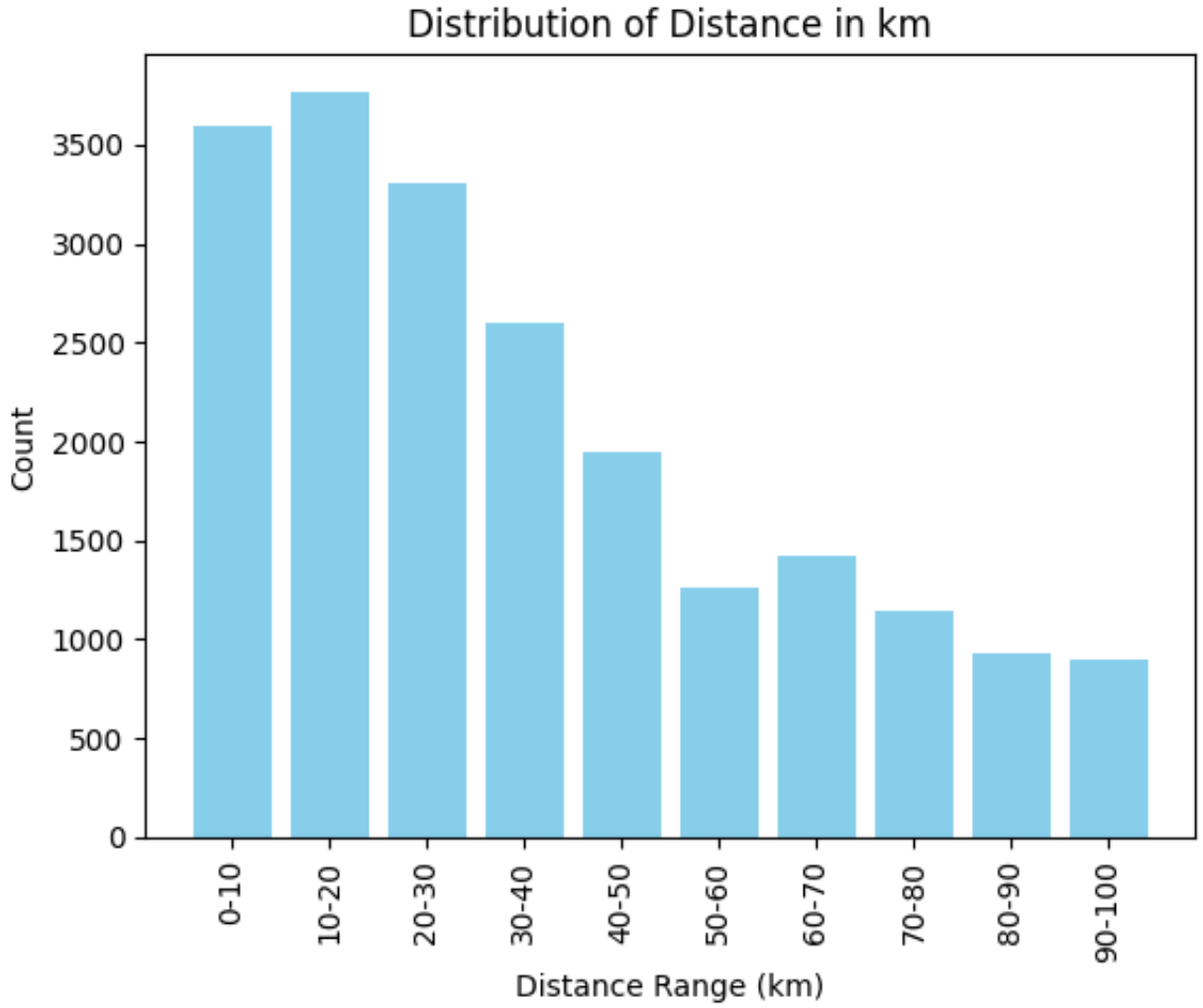
```
reverse_matching_df['cand_languages_spoken'] = reverse_matching_df['cand_languages_
reverse_matching_df['cand_education'] = reverse_matching_df['cand_education'].fillr
```

```
df_reverse = reverse_matching_df.dropna()
```

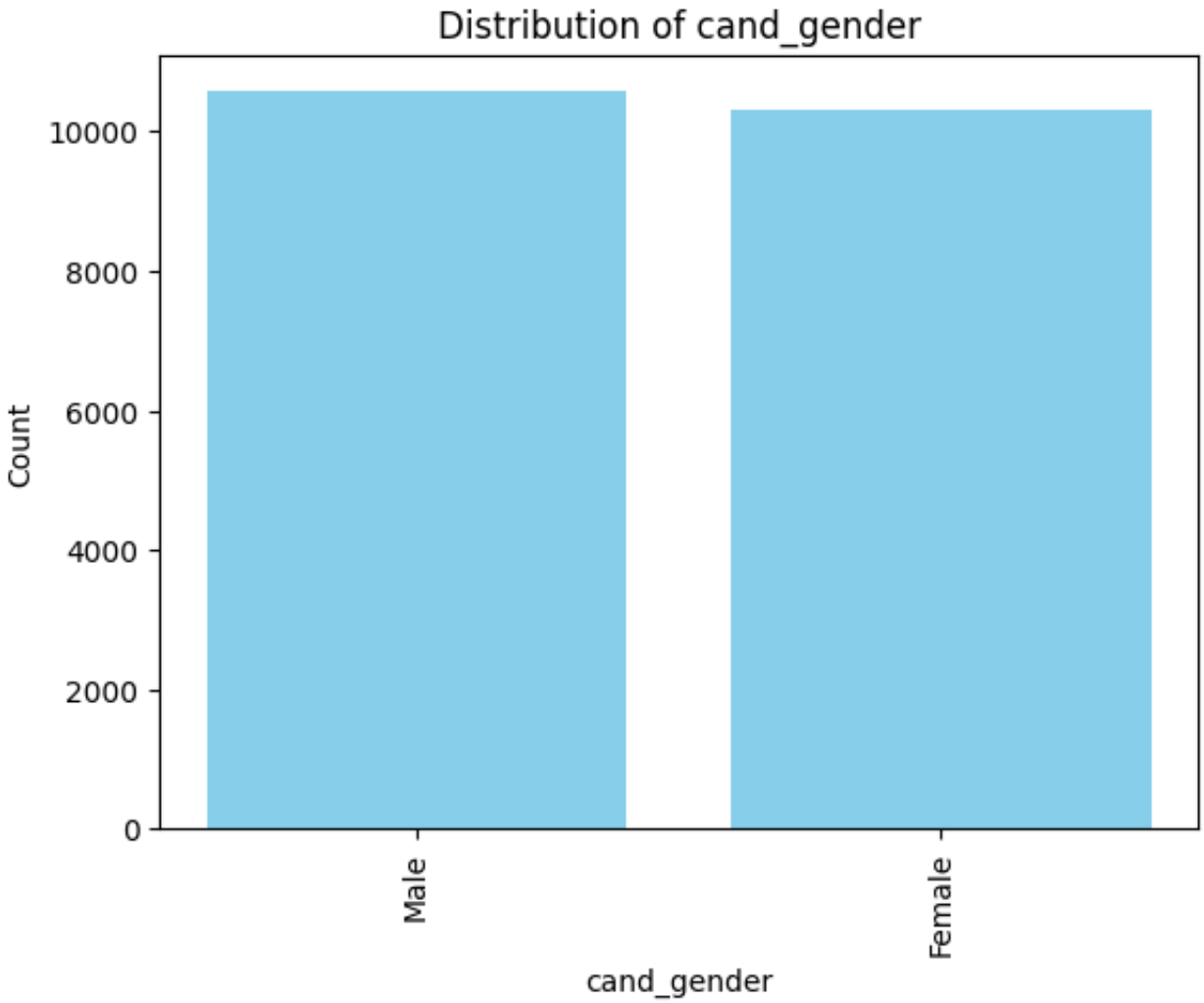
Plot global distributions

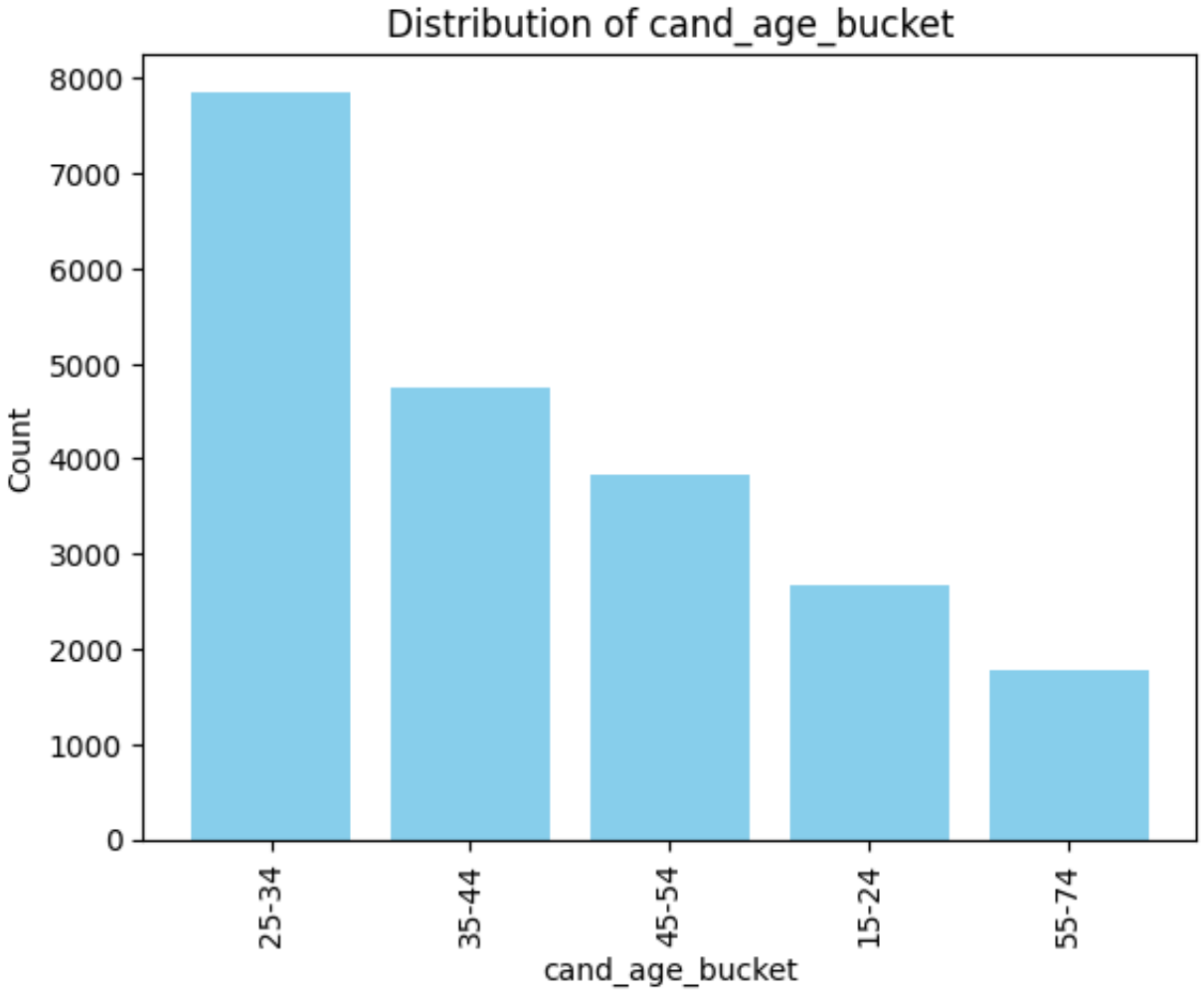
```
reverse_df_without_duplicates  = df_reverse.drop_duplicates(subset='cand_id')
```

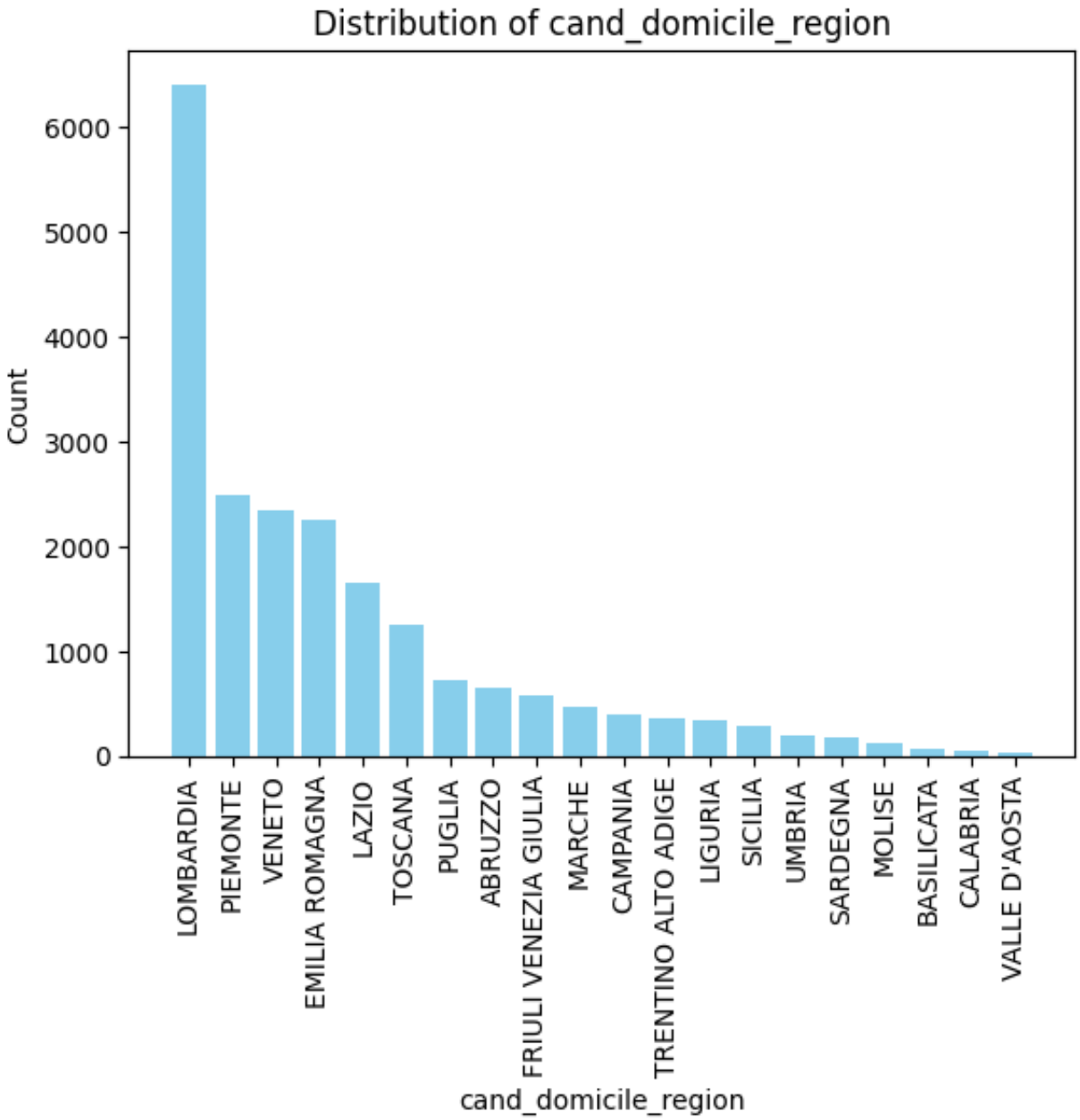
```
distances_km = reverse_df_without_duplicates.distance_km
distances_km = f.discretize_feature(distances_km)

labels = [f'{i*10}-{(i+1)*10}' for i in range(10)]

# Plot the distribution with labels
plt.bar(labels, distances_km, color='skyblue')
plt.title('Distribution of Distance in km')
plt.xlabel('Distance Range (km)')
plt.ylabel('Count')
plt.xticks(rotation=90)
plt.show()
```




```
f.show_global_distribution(reverse_df_without_duplicates,'cand_gender')
f.show_global_distribution(reverse_df_without_duplicates,'cand_age_bucket')
f.show_global_distribution(reverse_df_without_duplicates,'cand_domicile_region')
```

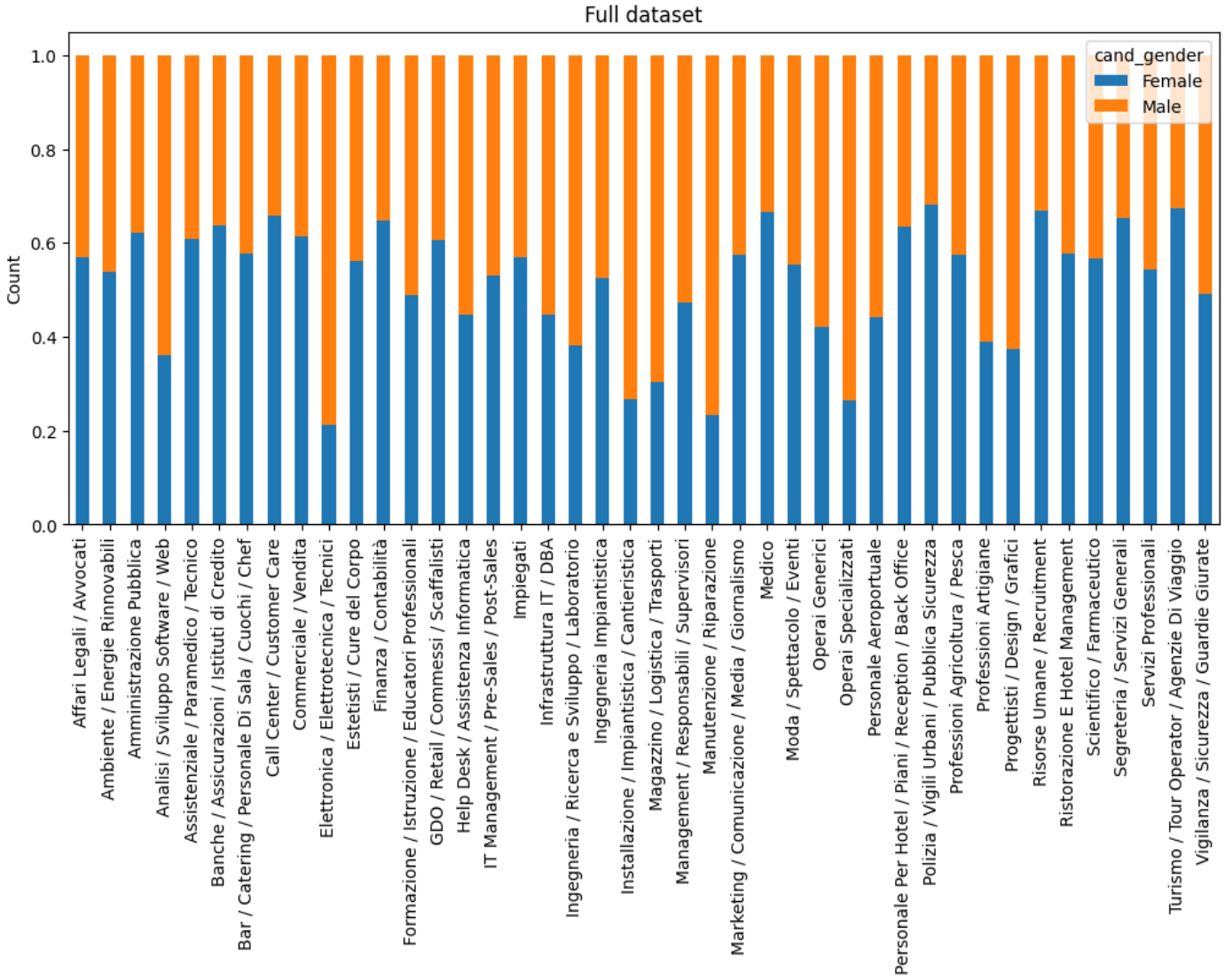

Distribution of cand_gender
Count
10000
8000
6000
4000
2000
0
Male
Female
cand_gender


Distribution of cand_age_bucket
Count
8000
7000
6000
5000
4000
3000
2000
1000
0
25-34
35-44
45-54
15-24
55-74
cand_age_bucket

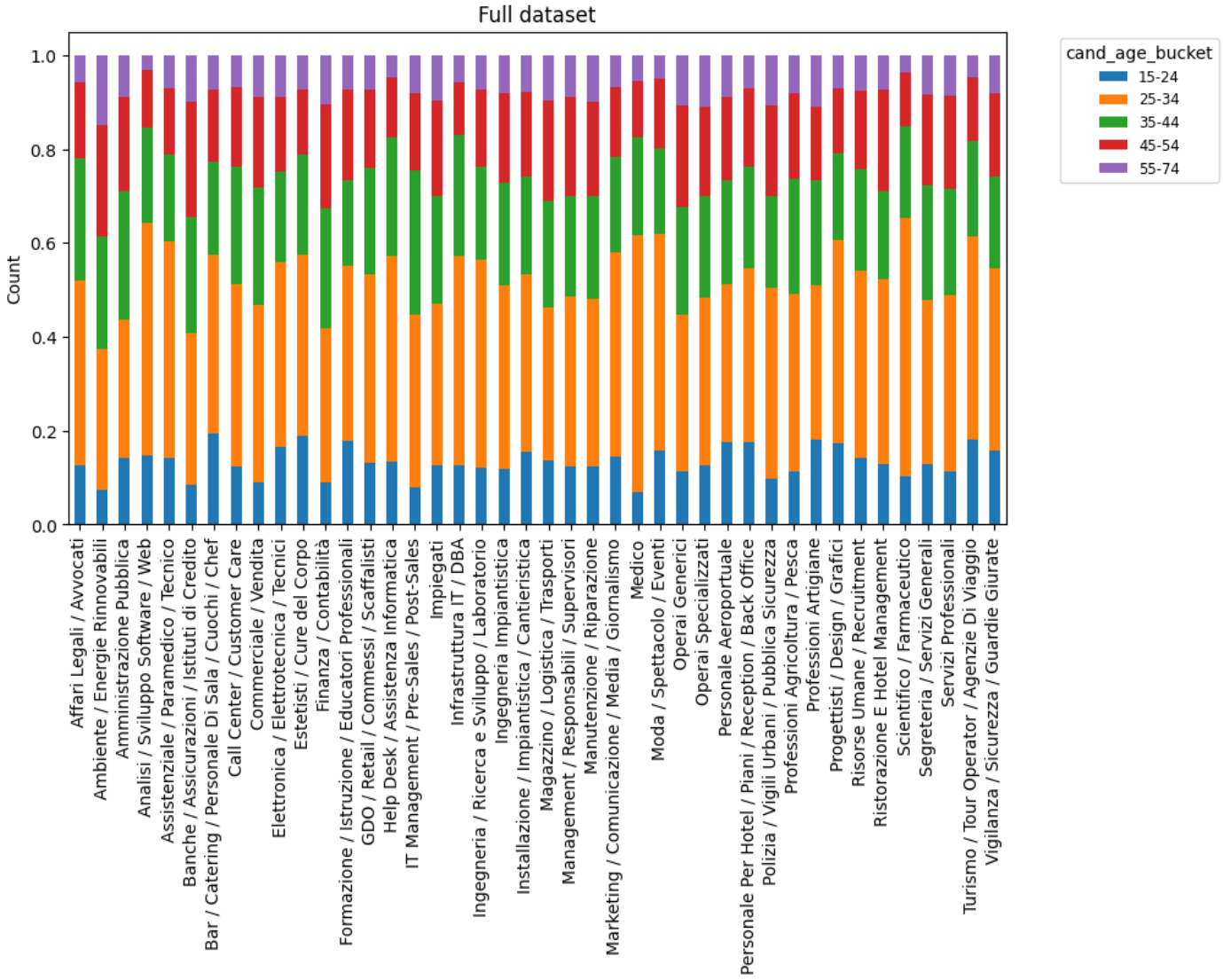


Plot feautures related to sector

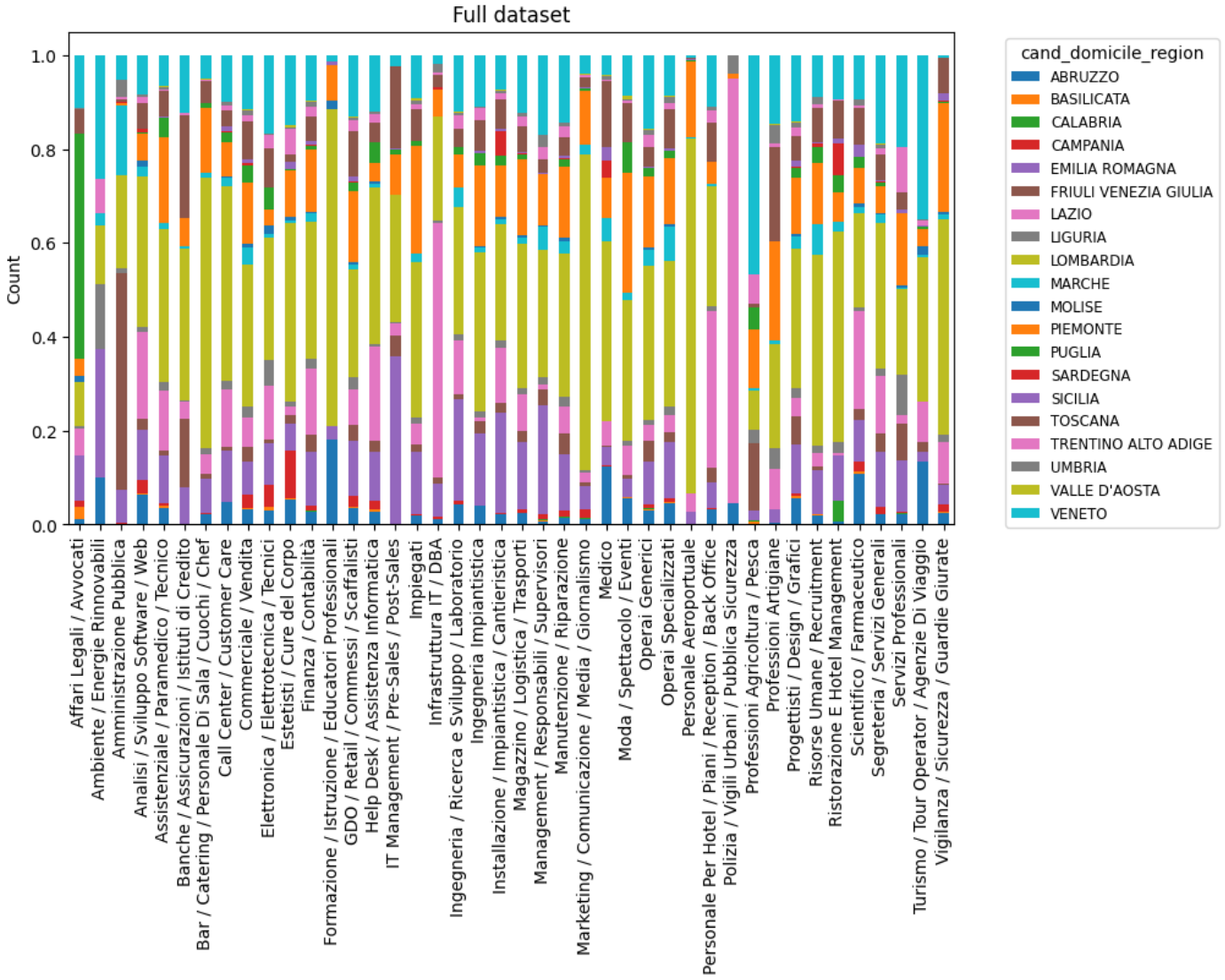
```
f.plot_2_features(df_reverse, 'job_sector', 'cand_gender', None)
```



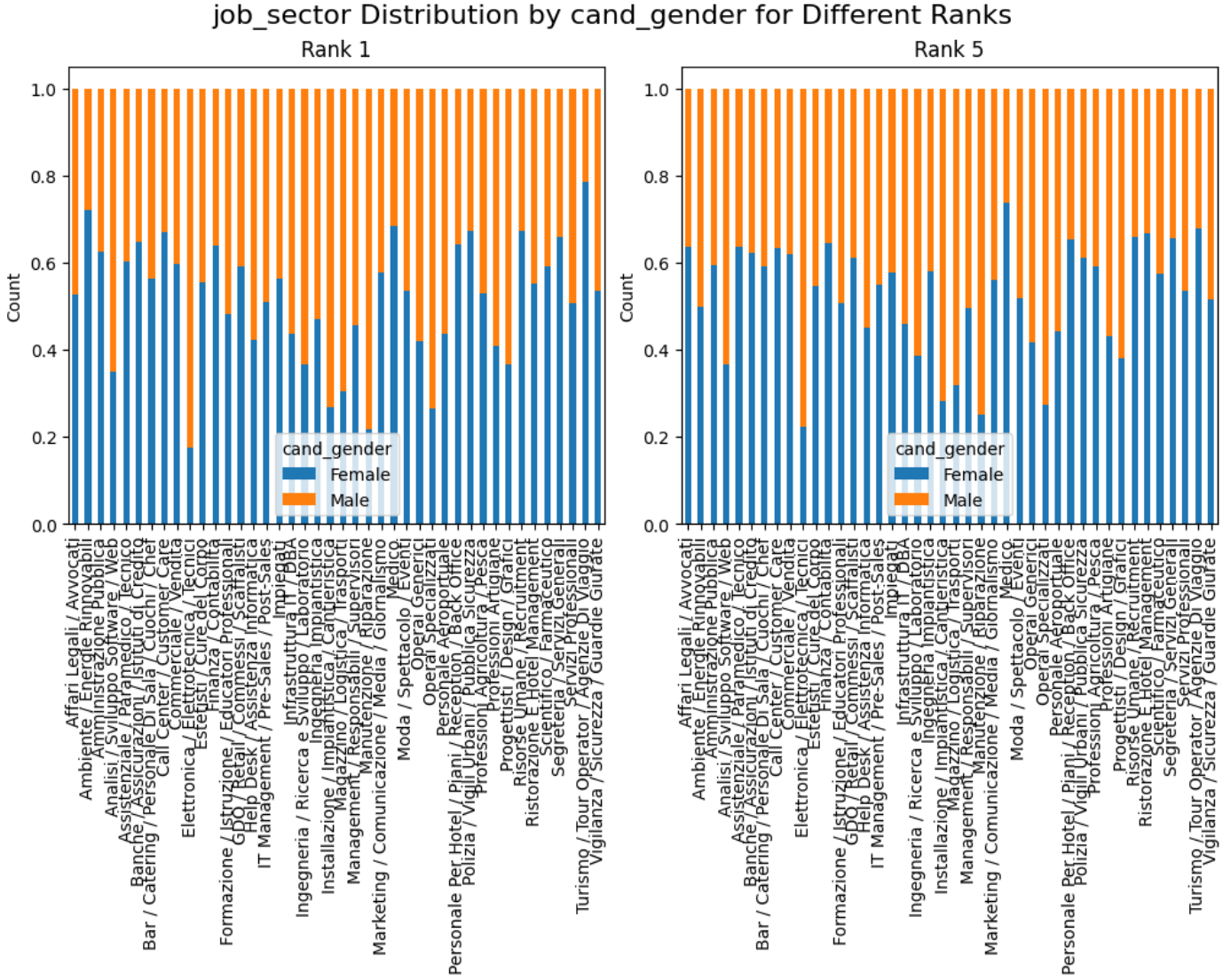

```
f.plot_2_features(df_reverse, 'job_sector', 'cand_age_bucket', None, legend_outside
```



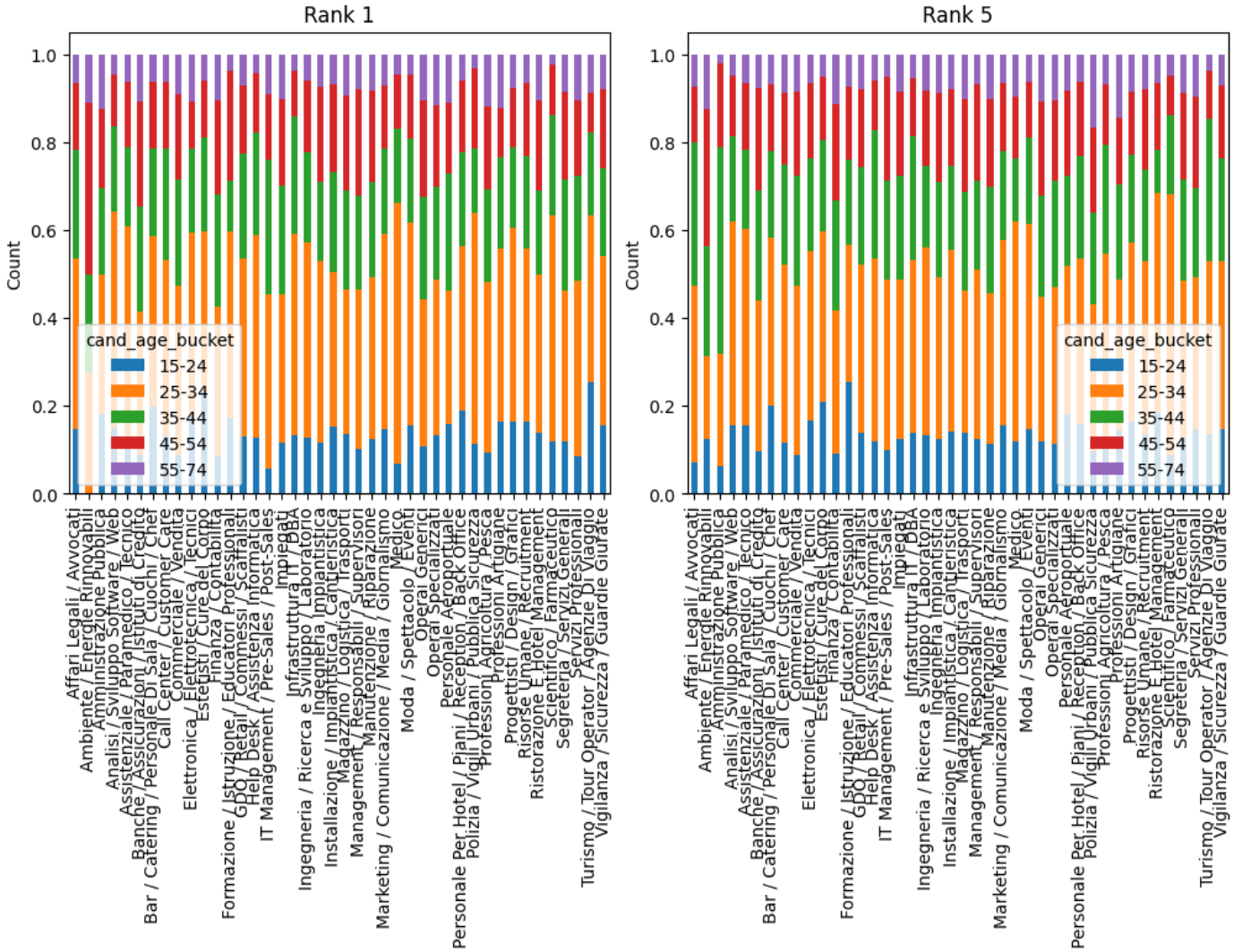

```
f.plot_2_features(df_reverse, 'job_sector', 'cand_domicile_region', None,legend_out
```




```
r = [1,5]
f.plot_2_features(df_reverse, 'job_sector', 'cand_gender', r, len(r),None)
```




```
r = [1,5]
f.plot_2_features(df_reverse, 'job_sector', 'cand_age_bucket', r, len(r), None)
```


job_sector Distribution by cand_age_bucket for Different Ranks
Rank 1
Rank 5
Count
cand_age_bucket
15-24
25-34
35-44
45-54
55-74
Affari Legali / Avvocati
Ambiente / Energie Rinnovabili
Amministrazione Pubblica
Analisi / Sviluppo Software / Web
Assistenziale / Paramedico / Tecnico
Banche / Assicurazioni / Istituti di Credito
Bar / Catering / Personale Di Sala / Cuochi / Chef
Call Center / Customer Care
Commerciale / Vendita
Elettronica / Elettrotecnica / Tecnici
Estetisti / Cure del Corpo
Finanza / Contabilità
Formazione / Istruzione / Educatori Professionali
GDO / Retail / Commessi / Scaffalisti
Help Desk / Assistenza Informatica
IT Management / Pre-Sales / Post-Sales
Impiegati
Infrastruttura IT / DBA
Ingegneria / Ricerca e Sviluppo / Laboratorio
Installazione / Impiantistica / Cantieristica
Magazzino / Logistica / Trasporti
Management / Responsabili / SuperVisori
Manutenzione / Riparazione
Marketing / Comunicazione / Media / Giornalismo
Medico
Moda / Spettacolo / Eventi
Operai Generici
Operai Specializzati
Personale Aeroportuale
Personale Per Hotel / Piani / Reception / Back Office
Polizia / Vigili Urbani / Pubblica Sicurezza
Professioni Agricoltura / Pesca
Professioni Artigiane
Progettisti / Design / Grafici
Risorse Umane / Recruitment
Ristorazione E Hotel Management
Scientifico / Farmaceutico
Segreteria / Servizi Generali
Servizi Professionali
Turismo / Tour Operator / Agenzie Di Viaggio
Vigilanza / Sicurezza / Guardie Giurate