# Statistics

Here we prepared basic statistics about our dataset.

- number of chant records
- out of them, how many have:
  - some melody in volpiano
  - melody in volpiano - more than 20 notes
- number of source manuscripts of these records
- out of them, how many have:
  - provenance
  - century
  - cursus
- plot distributions over chants of:
  - selected main genre
  - selected main office
  - selected main modes
- distribution of manuscripts sizes
- plot distribution over sources of:
  - century
- plot distribution of data over databases:
  - chant records
  - source records
  - Cantus IDs
  - unique CIDs among the ecosystem

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```
import pandas as pd
```

---

```
FINAL_CHANTS_CSV_PATH = 'cantuscorpus_1.0/chants.csv'
FINAL_SOURCES_CSV_PATH = 'cantuscorpus_1.0/sources.csv'
# Rename to fit your directory structure ...
```

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```
# Load data
chants = pd.read_csv(FINAL_CHANTS_CSV_PATH, dtype=str)
sources = pd.read_csv(FINAL_SOURCES_CSV_PATH, dtype=str)
```

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## Chants

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```
from volpiano_utils import clean_volpiano
print('number of chants records after all processing:', len(chants))
print('out of them number of:')
```

```
print('\tchant records with some melody in volpiano:',
                                        len(chants['melody'].dropna()))
print('\tchant records with melody of more than 20 notes:',
            chants['melody'].dropna()
                            .apply(lambda x: len(clean_volpiano(x)) >= 20).sum())
```

```
number of chants records after all processing: 888010
out of them number of:
     chant records with some melody in volpiano: 60588
     chant records with melody of more than 20 notes: 44625
```

---

## Sources

```
print('number of sources records after all processing:', len(sources))
print('out of them number of:')
print('\tsources with provenance value:',
        len(sources[sources['provenance'].notna()]))
print('\tsources with century value:',
        len(sources[sources['century'].notna()]))
print('\tsources with cursus value:',
            len(sources[sources['cursus'].notna()])
                - len(sources[sources['cursus'] == 'unknown']))
```

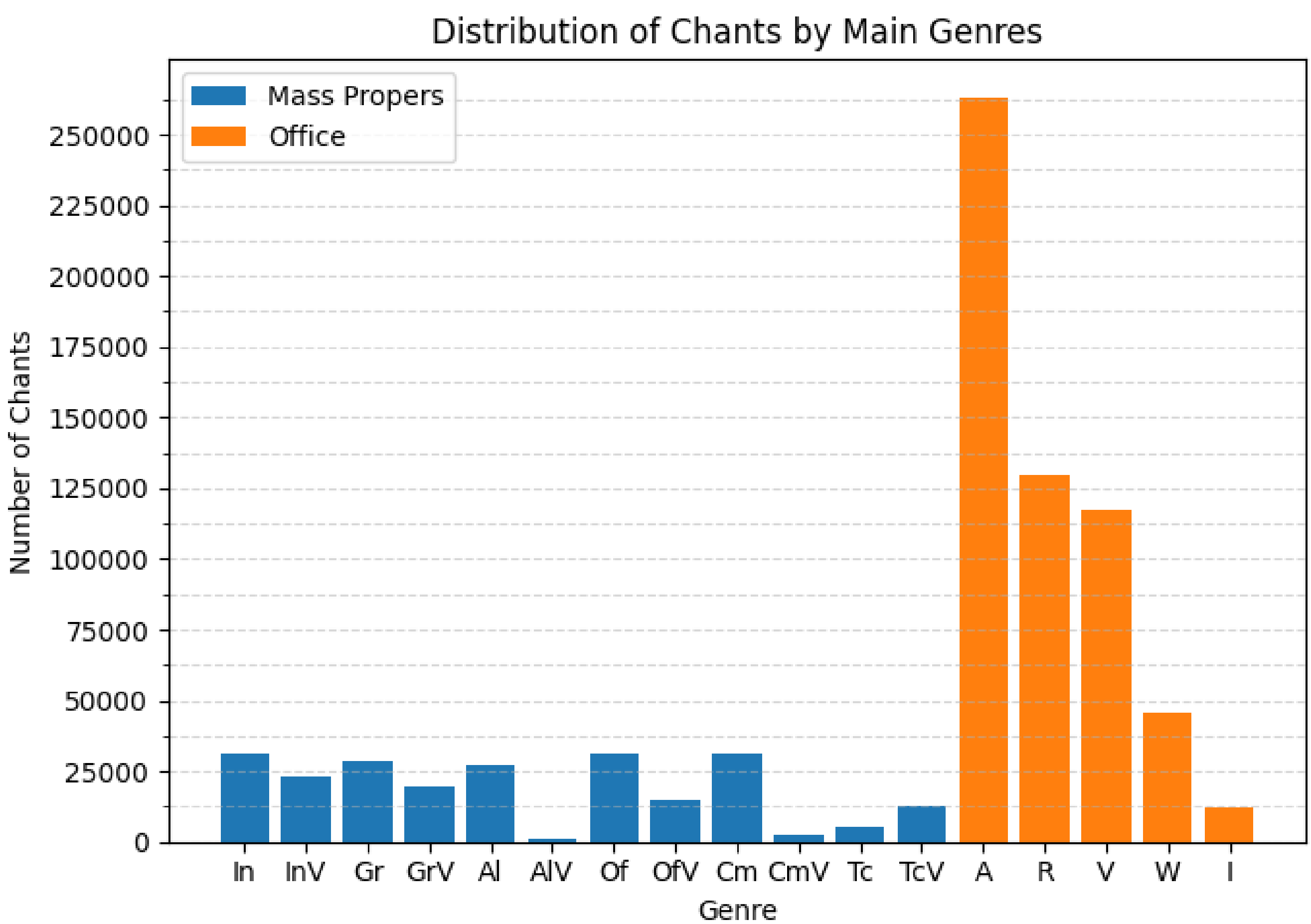
```
number of sources records after all processing: 2278
out of them number of:
     sources with provenance value: 1606
     sources with century value: 2240
     sources with cursus value: 345
```

---

## Distribution plots

```
import matplotlib.pyplot as plt
import numpy as np

# Plot distribution of chants in selected main genres
GENRES_MASS_PROPERS = ['In', 'InV', 'Gr', 'GrV', 'Al', 'AlV', 'Of', 'OfV',
                       'Cm', 'CmV', 'Tc', 'TcV']
GENRES_OFFICE = ['A', 'R', 'V', 'W', 'I']
MAIN_GENRES = GENRES_MASS_PROPERS + GENRES_OFFICE
genre_counts = chants['genre'].dropna().value_counts().loc[MAIN_GENRES].to_dict()

# Plot
plt.figure(figsize=(7, 5))
# Prepare colors and labels
colors = []
for genre in MAIN_GENRES:
    if genre in GENRES_MASS_PROPERS:
        colors.append('tab:blue')
    else:
        colors.append('tab:orange')
```

```python
plt.bar(genre_counts.keys(), genre_counts.values(), color=colors)

plt.title('Distribution of Chants by Main Genres')
plt.xlabel('Genre')
plt.ylabel('Number of Chants')
plt.xticks(rotation=0)

# Add more frequent gridlines
max_y = 252000
grid_interval = 12500
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)

# Add legend
from matplotlib.patches import Patch
legend_elements = [
    Patch(facecolor='tab:blue', label='Mass Propers'),
    Patch(facecolor='tab:orange', label='Office')
]
plt.legend(handles=legend_elements, loc='upper left')

plt.tight_layout()
plt.show()
```

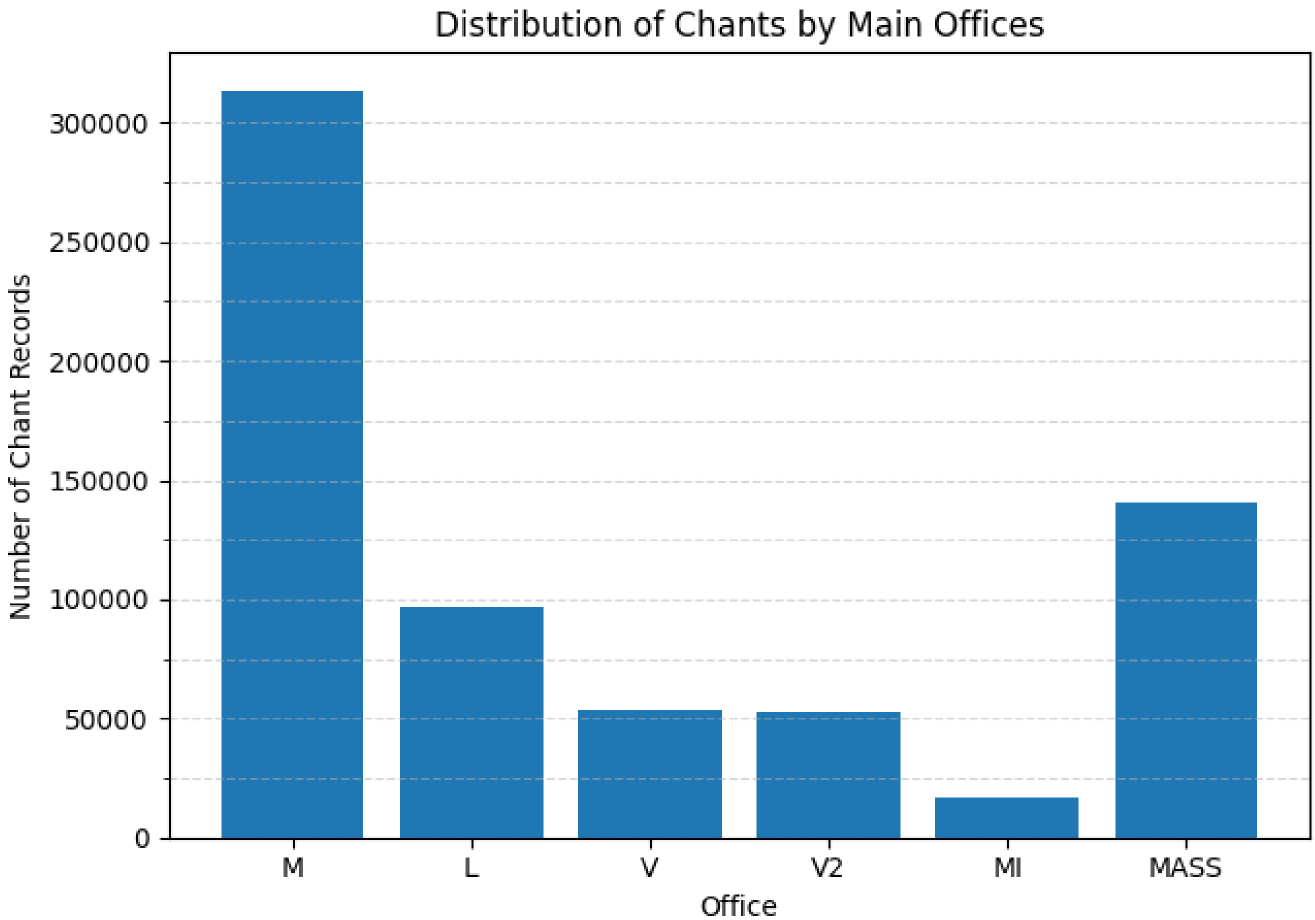


```
sorted_genre_counts = dict(sorted(genre_counts.items(),
                                  key=lambda item: item[1], reverse=True))
for genre, count in sorted_genre_counts.items():
    print(genre, '\t:\t', count)
```

```
A     :      263294
R     :      129875
V     :      117394
W     :      45656
In    :      31551
Of    :      31251
Cm    :      31077
Gr    :      28841
Al    :      26842
InV   :      22771
GrV   :      19678
OfV   :      15018
TcV   :      12810
I     :      11978
Tc    :      5018
CmV   :      2466
AlV   :      936
```

---

```
# Plot distrbution of chants in selected main offices
MAIN_OFFICES = ['M', 'L', 'V', 'V2', 'MI', 'MASS']
office_counts = chants['office'].value_counts().loc[MAIN_OFFICES].to_dict()

# Plot
plt.figure(figsize=(7, 5))
plt.bar(office_counts.keys(), office_counts.values(), color='tab:blue')

plt.title('Distribution of Chants by Main Offices')
plt.xlabel('Office')
plt.ylabel('Number of Chant Records')
plt.xticks(rotation=0)

# Add more frequent gridlines
max_y = 300000
grid_interval = 25000
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)

plt.tight_layout()
plt.show()
```



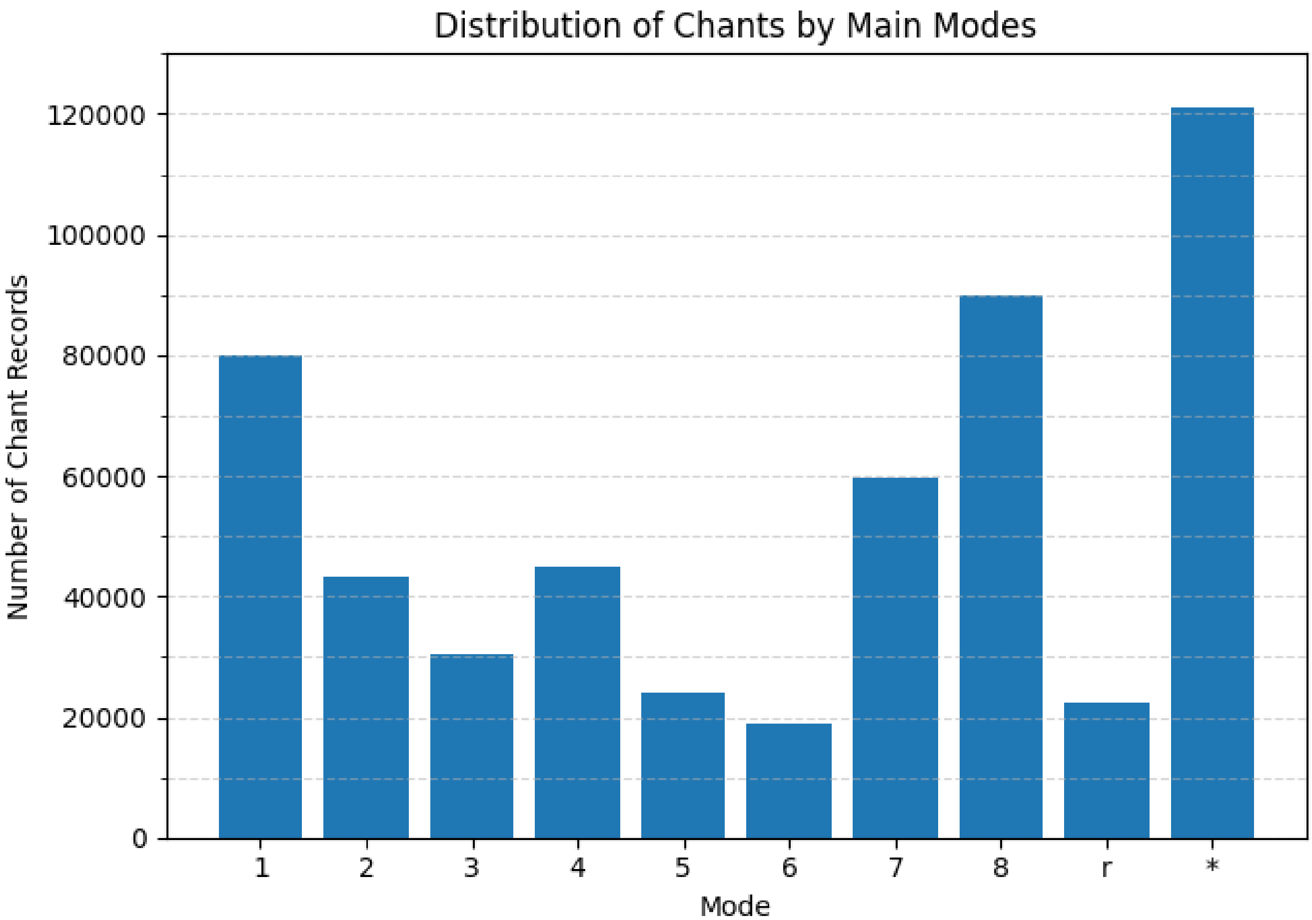

```
sorted_office_counts = dict(sorted(office_counts.items(), key=lambda item: item[1],
reverse=True))
for office, count in sorted_office_counts.items():
    print(office, '\t:\t', count)
```

```
M    :     313612
MASS :     140779
L    :     96712
V    :     53616
V2   :     52418
MI   :     16512
```

---

```
# Plot distribution of selected main modes
MAIN_MODES = ['1', '2', '3', '4', '5', '6', '7', '8', 'r', '*']
mode_counts = chants['mode'].value_counts().loc[MAIN_MODES].to_dict()

# Plot
plt.figure(figsize=(7, 5))
plt.bar(mode_counts.keys(), mode_counts.values(), color='tab:blue')

plt.title('Distribution of Chants by Main Modes')
plt.xlabel('Mode')
plt.ylabel('Number of Chant Records')
plt.xticks(rotation=0)

# Add more frequent gridlines
max_y = 125000
```

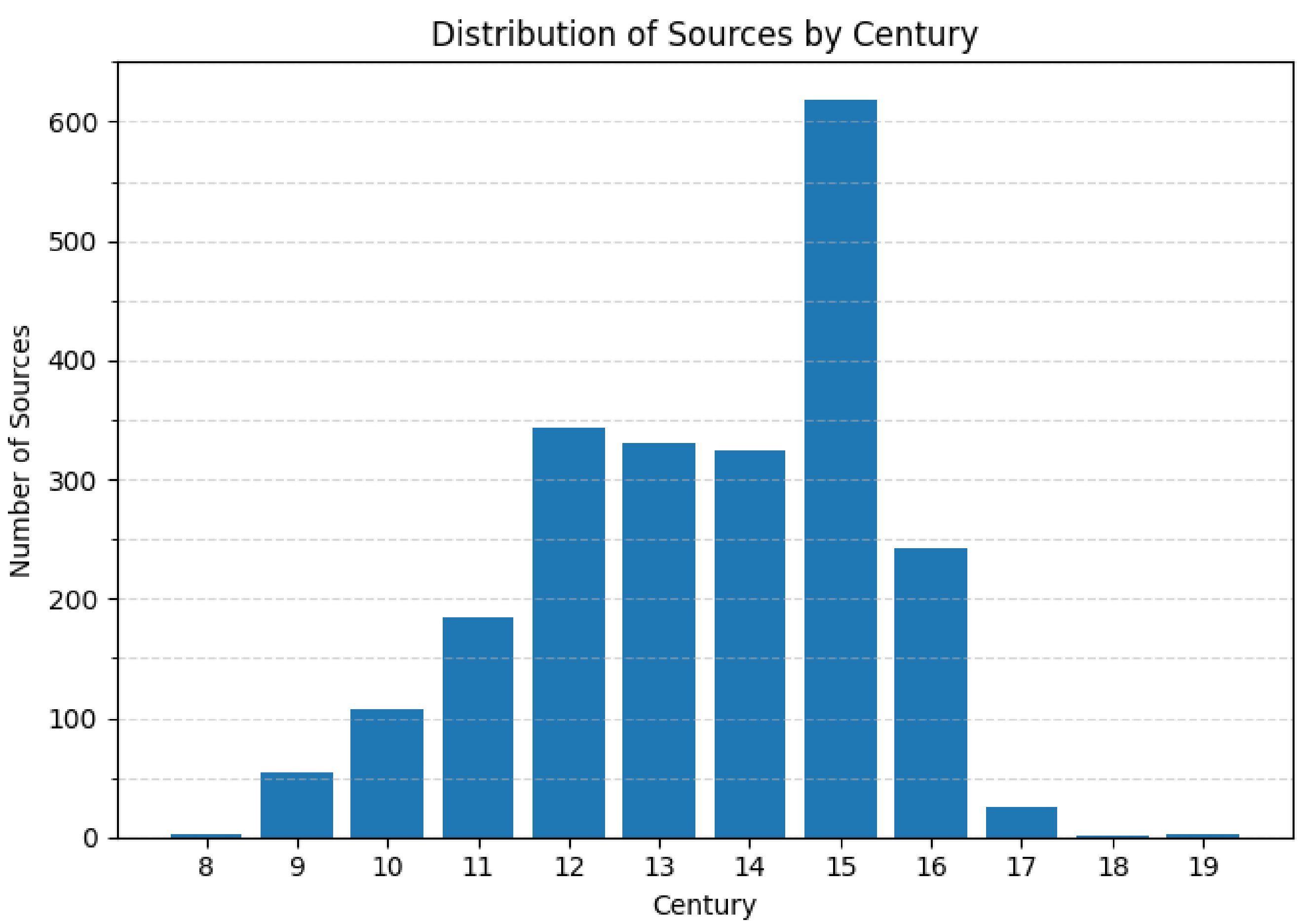
```
grid_interval = 10000
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)

plt.tight_layout()
plt.show()
```




```
sorted_mode_counts = dict(sorted(mode_counts.items(),
                                 key=lambda item: item[1], reverse=True))
for mode, count in sorted_mode_counts.items():
    print(mode, '\t:\t', count)
```

```
*	:	 121266
8	:	 89887
1	:	 79855
7	:	 59775
4	:	 44861
2	:	 43349
3	:	 30372
5	:	 23932
r	:	 22350
6	:	 18894
```

```python
# Distribution of sources by century - use num_century column retyped to int
century_counts = (
    sources['num_century']
    .dropna()
    .astype(int)
    .value_counts()
    .sort_index()
)

# Plot
plt.figure(figsize=(7, 5))
plt.bar(century_counts.index.astype(str), century_counts.values, color='tab:blue')

plt.title('Distribution of Sources by Century')
plt.xlabel('Century')
plt.ylabel('Number of Sources')

max_y = century_counts.values.max()
grid_interval = 50
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)

plt.tight_layout()
plt.show()
```

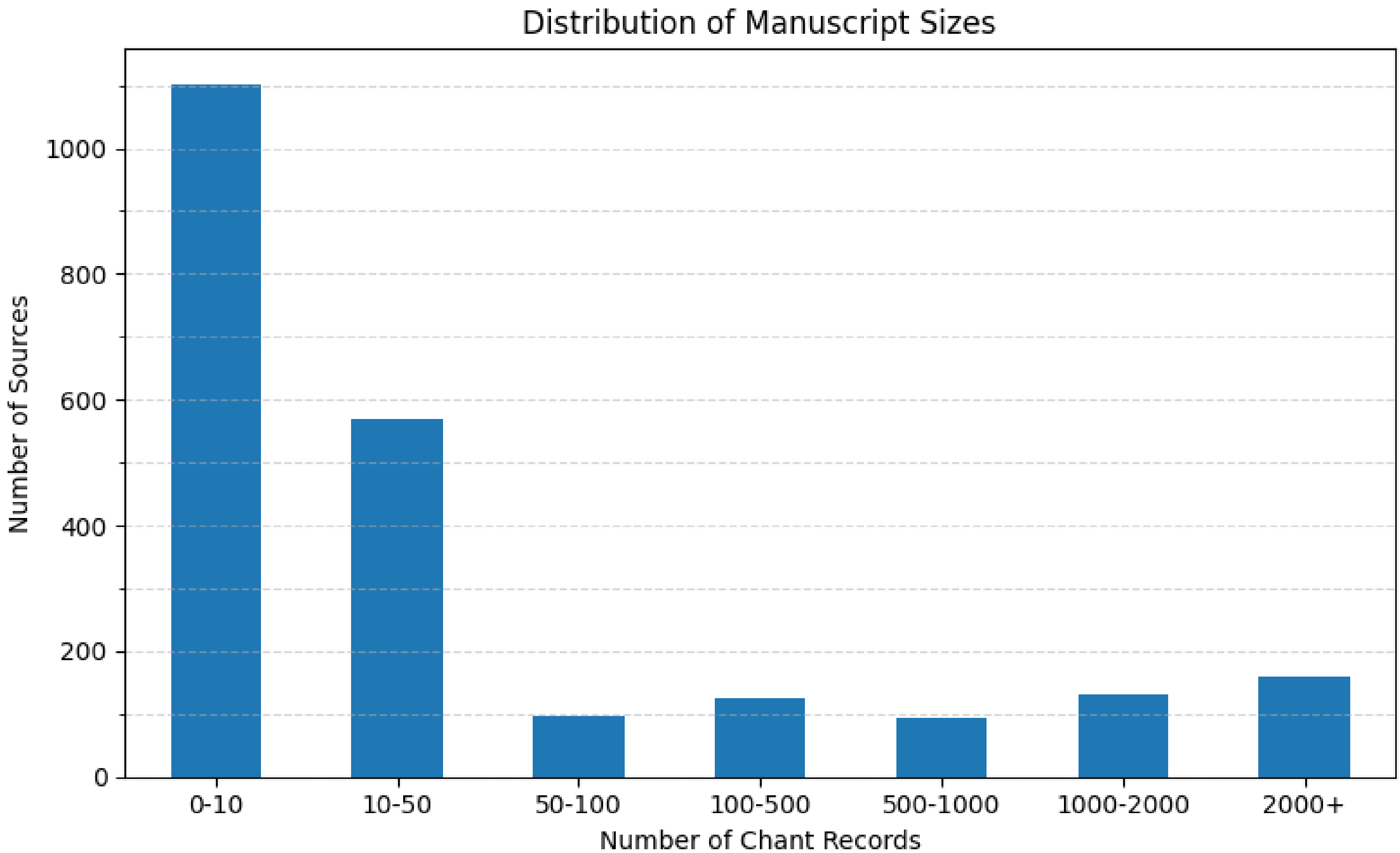


```python
for cent, count in zip(century_counts.index.astype(str),
                       century_counts.values):
    print(cent, '\t:\t', count)
```

```
8	:	3
9	:	54
10	:	108
11	:	185
12	:	343
13	:	331
14	:	325
15	:	618
16	:	243
17	:	26
18	:	1
19	:	3
```

---

```python
# Distribution of manuscript sizes - buckets
srclink_counts = chants['srclink'].value_counts()
bins = [0, 10, 50, 100, 500, 1000, 2000, float('inf')]
labels = ['0-10', '10-50', '50-100', '100-500', '500-1000', '1000-2000', '2000+']
binned = pd.cut(srclink_counts, bins=bins, labels=labels, right=False)
histogram = binned.value_counts().sort_index()

# Plot
plt.figure(figsize=(8, 5))
histogram.plot(kind='bar', color='tab:blue')

plt.title('Distribution of Manuscript Sizes')
plt.xlabel('Number of Chant Records')
plt.ylabel('Number of Sources')
plt.xticks(rotation=0)

max_y = 1100
grid_interval = 100
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)

plt.tight_layout()
plt.show()
```

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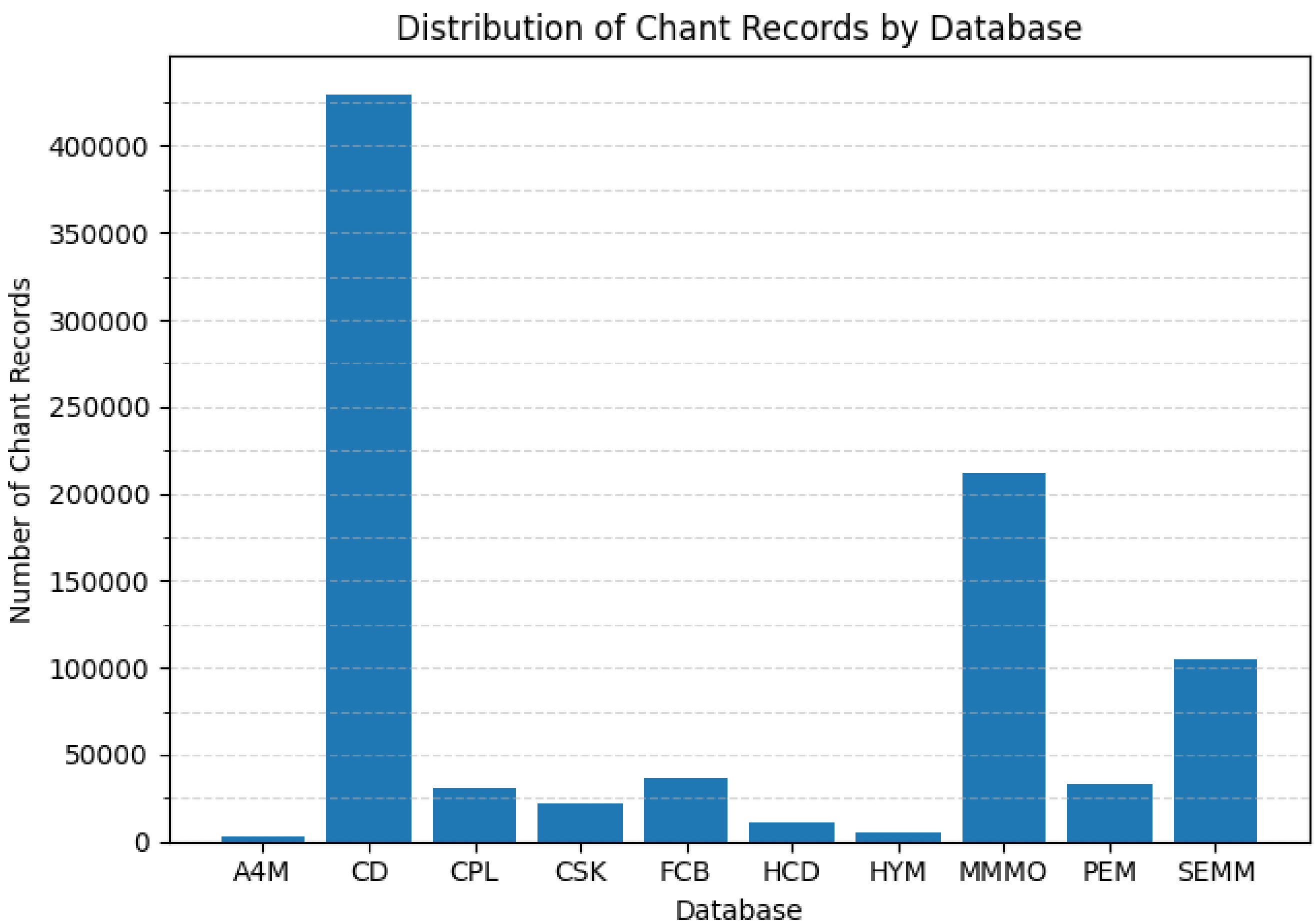
## Databases point of view

```
# Distribution of chant records by db
db_counts = (
    chants['db']
    .dropna()
    .value_counts()
    .sort_index()
)

# Plot
plt.figure(figsize=(7, 5))
plt.bar(db_counts.index.astype(str), db_counts.values, color='tab:blue')

plt.title('Distribution of Chant Records by Database')
plt.xlabel('Database')
plt.ylabel('Number of Chant Records')

max_y = 420000
grid_interval = 25000
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)
```

```
plt.tight_layout()
plt.show()
```



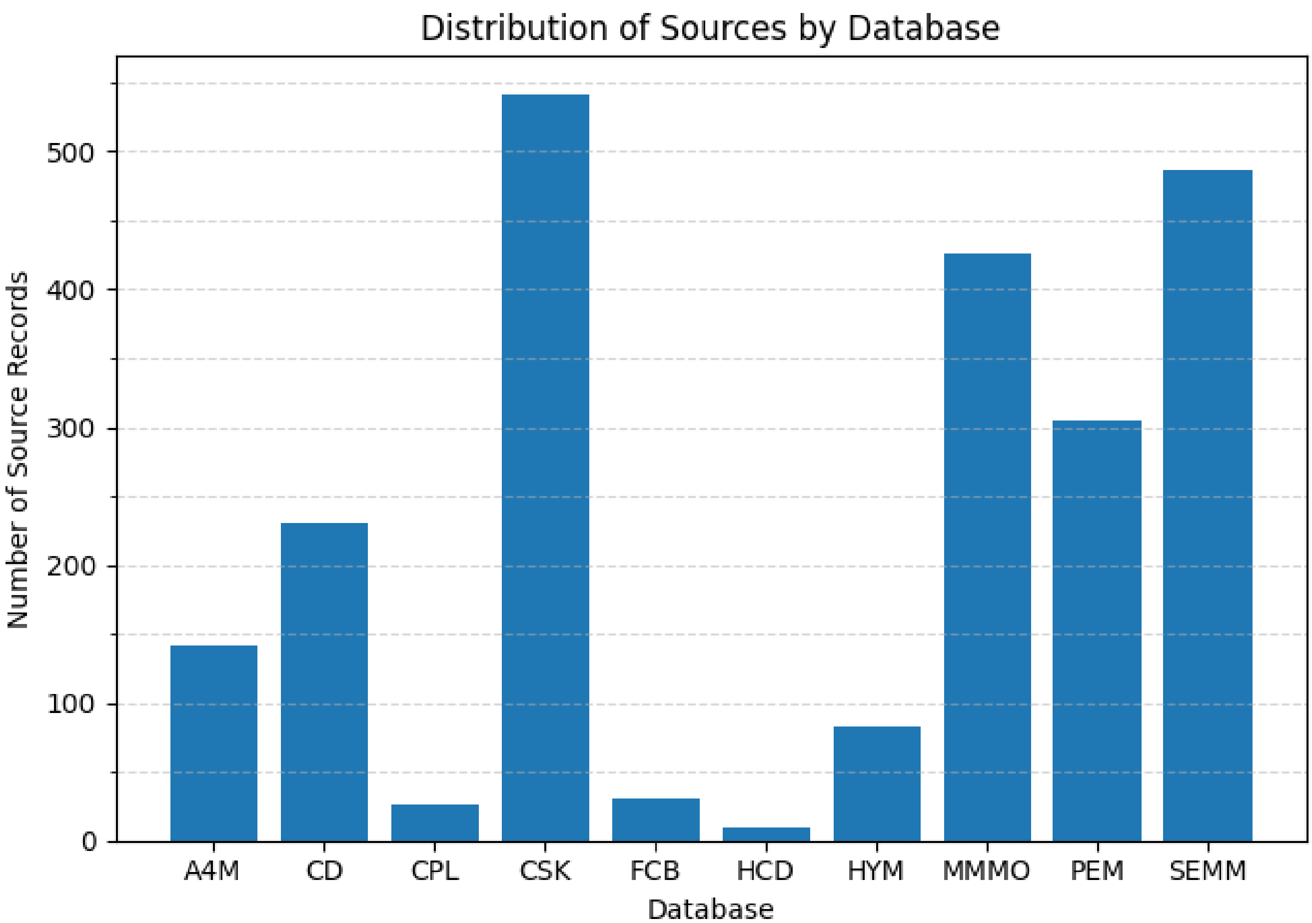

```
for db, count in zip(db_counts.index.astype(str),
                      db_counts.values):
    print(db, '\t:\t', count)
```

```
A4M   :      2738
CD    :      429982
CPL   :      30433
CSK   :      22539
FCB   :      36103
HCD   :      11278
HYM   :      5290
MMMO  :      212231
PEM   :      32738
SEMM  :      104678
```

---

```
# Distribution of source records by db
srclinks_per_db = chants.groupby('db')['srclink'].nunique().to_dict()

# Plot
plt.figure(figsize=(7, 5))
plt.bar(srclinks_per_db.keys(), srclinks_per_db.values(), color='tab:blue')

plt.title('Distribution of Sources by Database')
```

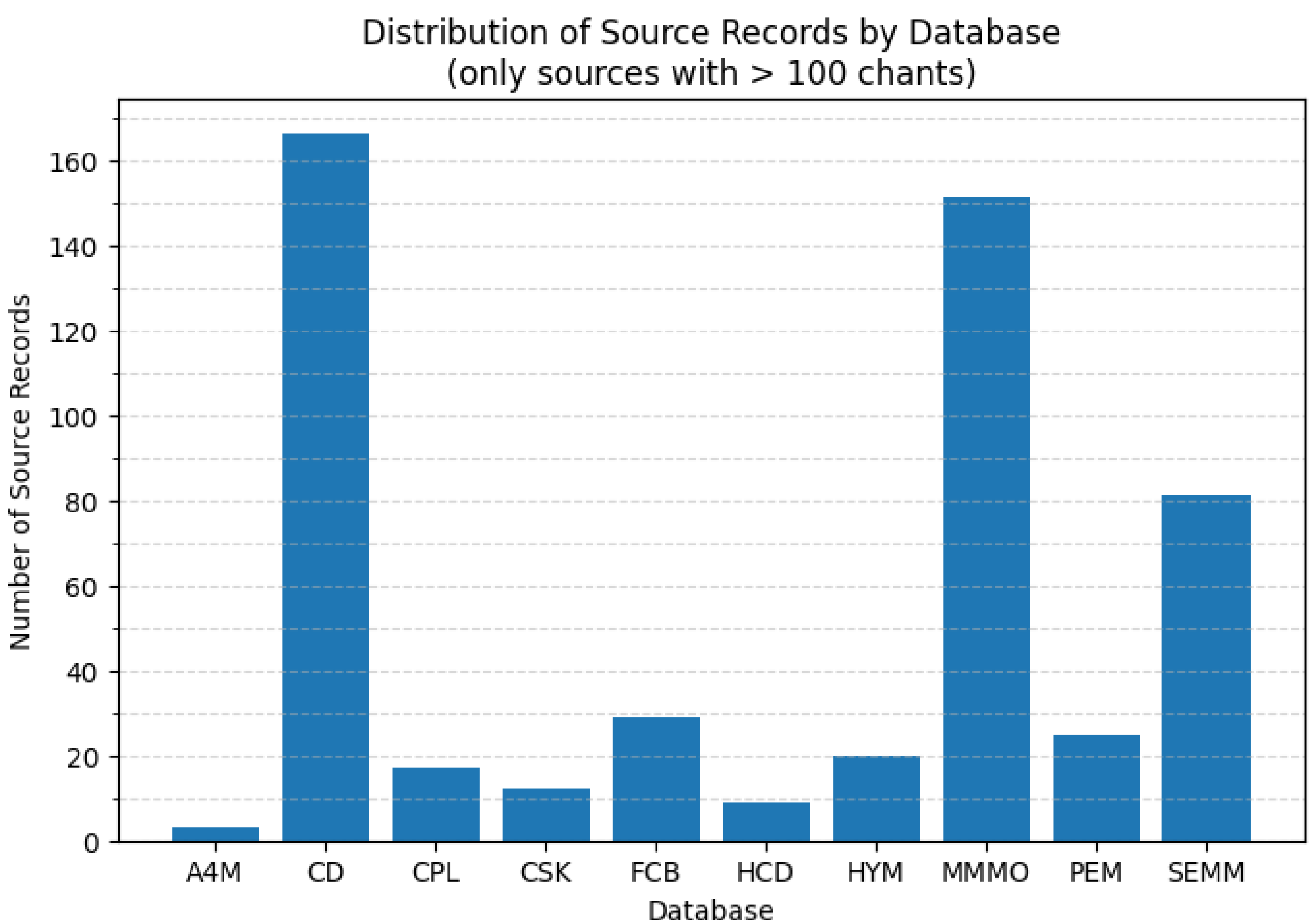
```
plt.xlabel('Database')
plt.ylabel('Number of Source Records')

max_y = 550
grid_interval = 50
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)

plt.tight_layout()
plt.show()
```



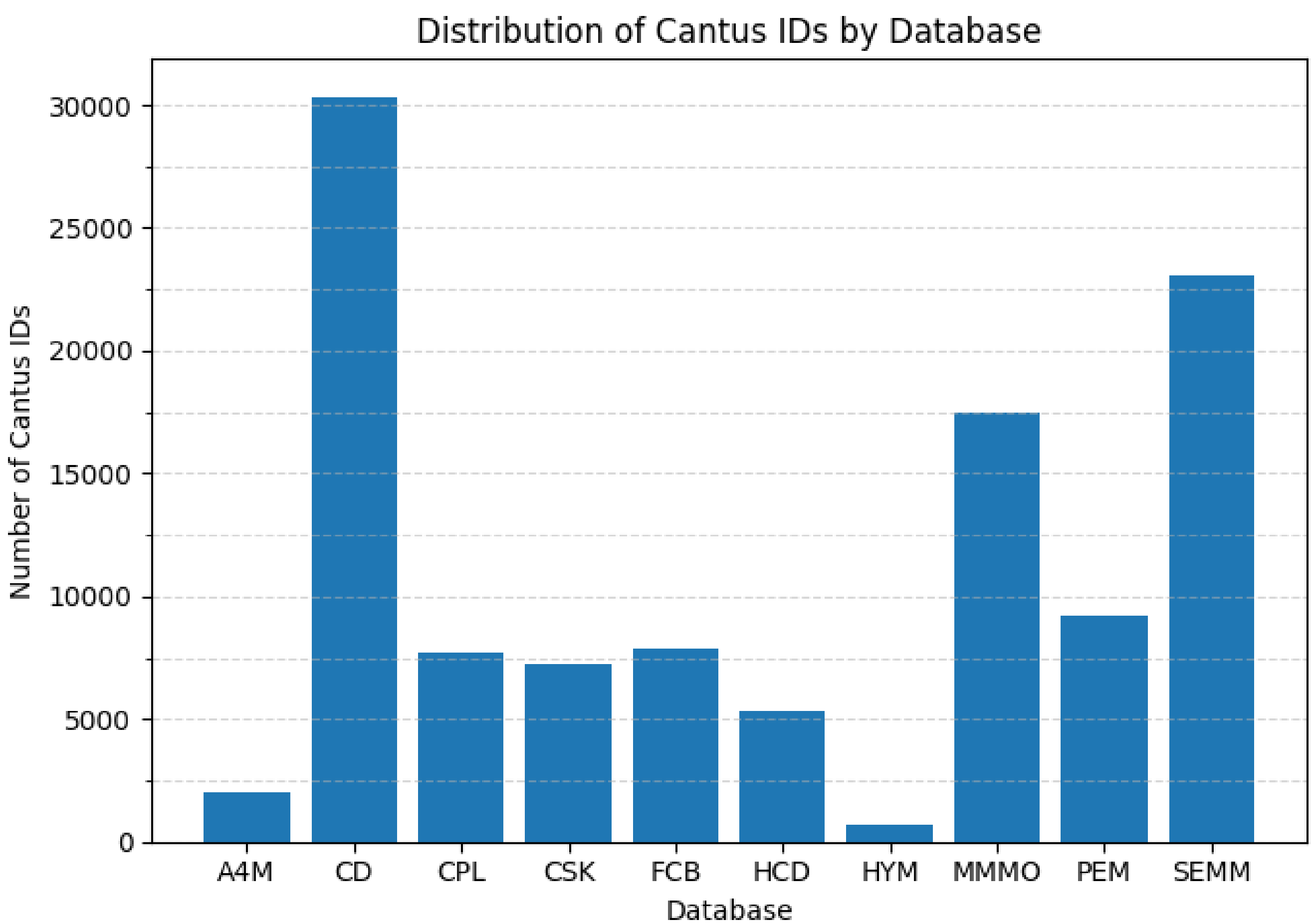

```
sorted_src_db_counts = dict(sorted(srclinks_per_db.items(), key=lambda item: item[1],
reverse=True))
for db, count in sorted_src_db_counts.items():
    print(db, '\t:\t', count)
```

```
CSK	:	542
SEMM	:	487
MMMO	:	426
PEM	:	305
CD	:	231
A4M	:	142
HYM	:	83
FCB	:	30
CPL	:	27
HCD	:	10
```

```python
# Distribution of Source Records by Database for sources with more than 100 chants
frequent_srclinks = chants['srclink'].value_counts()
srclinks_to_keep = frequent_srclinks[frequent_srclinks > 100].index
filtered_chants = chants[chants['srclink'].isin(srclinks_to_keep)]

srclinks_per_db = filtered_chants.groupby('db')['srclink'].nunique().to_dict()

# Plot
plt.figure(figsize=(7, 5))
plt.bar(srclinks_per_db.keys(), srclinks_per_db.values(), color='tab:blue')

plt.title('Distribution of Source Records by Database\n(only sources with > 100 chants)')
plt.xlabel('Database')
plt.ylabel('Number of Source Records')

max_y = 170
grid_interval = 10
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)

plt.tight_layout()
plt.show()
```



```python
# Distribution of cantus_ids
cids_per_db = chants.groupby('db')['cantus_id'].nunique().to_dict()

# Plot
plt.figure(figsize=(7, 5))
plt.bar(cids_per_db.keys(), cids_per_db.values(), color='tab:blue')

plt.title('Distribution of Cantus IDs by Database')
plt.xlabel('Database')
plt.ylabel('Number of Cantus IDs')

max_y = 30000
grid_interval = 2500
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)
plt.gca().set_yticks(
        np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)

plt.tight_layout()
plt.show()
```



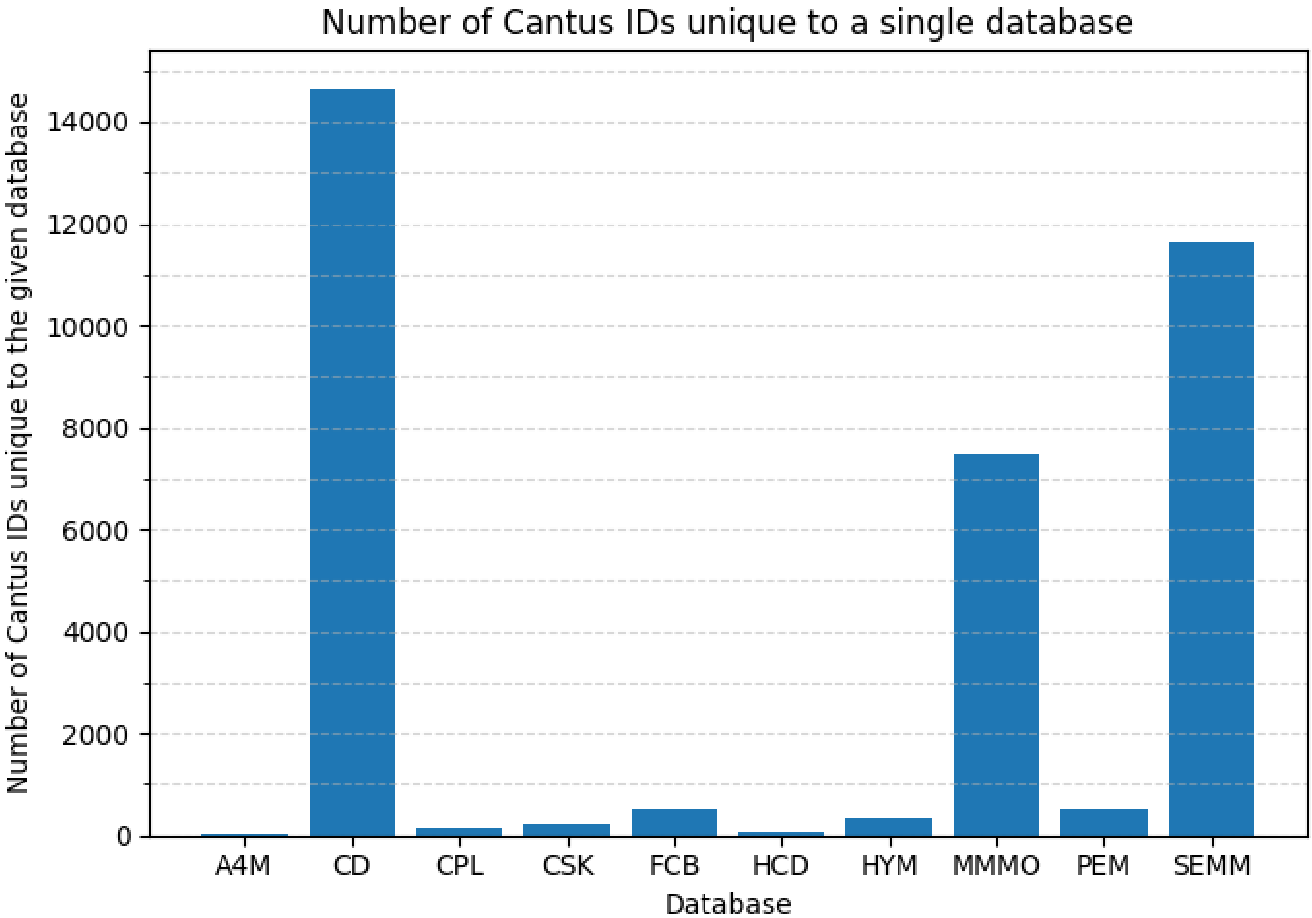

```python
sorted_cid_db_counts = dict(sorted(cids_per_db.items(), key=lambda item: item[1],
reverse=True))
for db, count in sorted_cid_db_counts.items():
    print(db, '\t:\t', count)
```

```
CD    :      30350
SEMM  :      23103
MMMO  :      17479
```

```
PEM   :     9184
FCB   :     7889
CPL   :     7666
CSK   :     7201
HCD   :     5374
A4M   :     2006
HYM   :     680
```

---

```
# Distribution of CIDs unique for given db in the ecosystem
db_groups = chants.groupby('db')['cantus_id'].apply(set)

unique_counts = {}
for db, ids in db_groups.items():
    other_ids = set().union(
        *(db_groups[other_db] for other_db in db_groups.index if other_db != db))
    unique_to_db = ids - other_ids
    unique_counts[db] = len(unique_to_db)

# Plot
plt.figure(figsize=(7, 5))
plt.bar(unique_counts.keys(), unique_counts.values(), color='tab:blue')

plt.title('Number of Cantus IDs unique to a single database')
plt.xlabel('Database')
plt.ylabel('Number of Cantus IDs unique to the given database')

max_y = 15000
grid_interval = 1000
plt.yticks(np.arange(0, max_y + grid_interval, step=grid_interval * 2))
plt.grid(axis='y', which='both', linestyle='--', alpha=0.5)
plt.gca().set_yticks(
    np.arange(0, max_y + grid_interval, step=grid_interval), minor=True)

plt.tight_layout()
plt.show()
```




```
sorted_uni_counts = dict(sorted(unique_counts.items(), key=lambda item: item[1],
reverse=True))
for db, count in sorted_uni_counts.items():
    print(db, '\t:\t', count)
```

```
CD   :      14662
SEMM :      11625
MMMO :      7503
PEM  :      538
FCB  :      534
HYM  :      323
CSK  :      212
CPL  :      143
HCD  :      54
A4M  :      12
```