15 Languages of research articles in SciELO Brazil

In [1]:

```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
%matplotlib inline
```

15.1 Loading the data

In the column names simplification notebook we can find this function:

In [2]:

```
def normalize_column_title(name):
    import re
    name_unbracketed = re.sub(r".*\((.*)\)", r"\1",
                              name.replace("(in months)", "in_months"))
    words = re.sub("[^a-z0-9+_ ]", "", name_unbracketed.lower()).split()
    ignored_words = ("at", "the", "of", "and", "google", "scholar", "+")
    replacements = {
        "document": "doc",
        "documents": "docs",
        "frequency": "freq",
        "language": "lang",
    }
    return "_".join(replacements.get(word, word)
                    for word in words if word not in ignored_words) \
              .replace("title_is", "is")
```

Loading the `documents_languages.csv` regarding the SciELO Brazil collection, and applying the column names simplification function:

In [3]:

```
dataset = pd.read_csv("tabs_bra/documents_languages.csv") \
            .rename(columns=normalize_column_title)
print(dataset.shape)
dataset.columns
```

```
(368491, 26)
```

Out [3]:

```
Index(['extraction_date', 'study_unit', 'collection', 'issn_scielo', 'issns',
       'title_scielo', 'title_thematic_areas', 'is_agricultural_sciences',
       'is_applied_social_sciences', 'is_biological_sciences',
       'is_engineering', 'is_exact_earth_sciences', 'is_health_sciences',
       'is_human_sciences', 'is_linguistics_letters_arts',
       'is_multidisciplinary', 'title_current_status', 'pid_scielo',
       'doc_publishing_year', 'doc_is_citable', 'doc_type', 'doc_languages',
       'doc_pt', 'doc_es', 'doc_en', 'doc_other_languages'],
      dtype='object')
```

In [4]:

```
dataset.head(3).T
```

Out [4]:

	0	1	2
extraction_date	2018-09-13	2018-09-13	2018-09-13
study_unit	document	document	document
collection	scl	scl	scl
issn_scielo	0100-879X	0100-879X	0100-879X
issns	0100-879X;1414-431X	0100-879X;1414-431X	0100-879X;1414-431X
title_scielo	Brazilian Journal of Medical and Biological Re...	Brazilian Journal of Medical and Biological Re...	Brazilian Journal of Medical and Biological Re...
title_thematic_areas	Biological Sciences; Health Sciences	Biological Sciences; Health Sciences	Biological Sciences; Health Sciences
is_agricultural_sciences	0	0	0
is_applied_social_sciences	0	0	0
is_biological_sciences	1	1	1
is_engineering	0	0	0
is_exact_earth_sciences	0	0	0
is_health_sciences	1	1	1
is_human_sciences	0	0	0
is_linguistics_letters_arts	0	0	0
is_multidisciplinary	0	0	0
title_current_status	current	current	current
pid_scielo	S0100-879X1998000800006	S0100-879X1998000800011	S0100-879X1998000800005
doc_publishing_year	1998	1998	1998
doc_is_citable	1	1	1
doc_type	research-article	rapid-communication	research-article
doc_languages	en	en	en
doc_pt	0	0	0
doc_es	0	0	0
doc_en	1	1	1
doc_other_languages	0	0	0

15.2 Types of documents

Most documents are research articles, we'll continue by just looking to this subset of the data:

In [5]:

```
doc_types_counts = dataset["doc_type"].value_counts()
doc_types_counts.plot.barh(figsize=(12, 8),
                           title="Number of documents by its type "
                                 "in the SciELO Brazil collection")
pd.DataFrame(doc_types_counts)
```

Out [5]:

	doc_type
research-article	308006
editorial	13114
case-report	7505
book-review	6940
review-article	6738
rapid-communication	6627
undefined	4908
brief-report	3906
letter	3435
abstract	2930
article-commentary	2613

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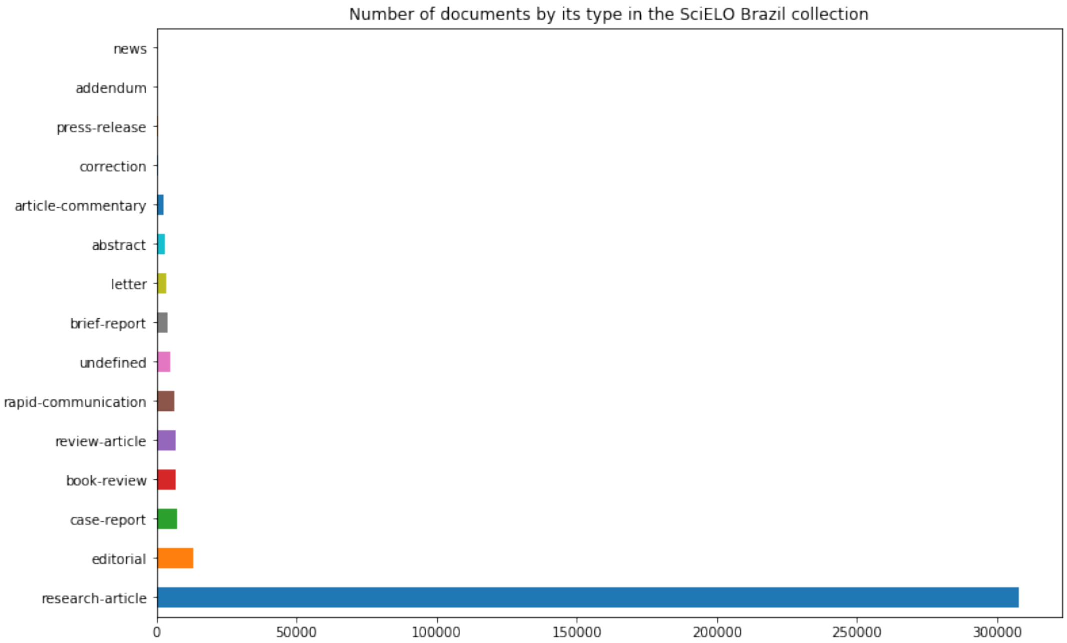
	doc_type
correction	785
press-release	727
addendum	164
news	93



In [6]:
```
dataset_ra = dataset[dataset["doc_type"] == "research-article"]
```

15.3 Set of languages

Each article is written in some set of languages, written as ;-separated entries:

In [7]:
```
dataset_ra["doc_languages"].unique()
```

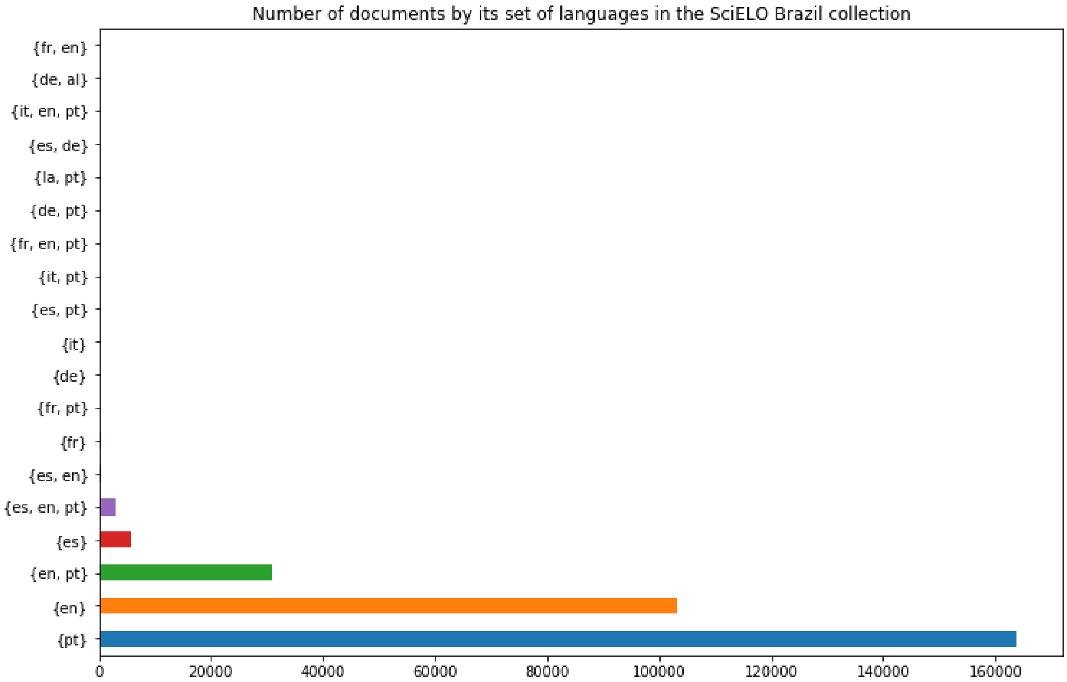
Out [7]:
```
array(['en', 'pt', 'es', 'fr', 'en;pt', 'pt;es', 'es;pt', 'fr;pt',
       'en;es;pt', 'en;es', 'it', 'en;pt;es', 'it;pt', 'de;al', 'pt;la',
       'de', 'fr;en;pt', 'de;pt', 'de;es', 'fr;en', 'en;it;pt'],
      dtype=object)
```

The distribution of [disjoint] sets of research articles divided by the set of languages they're written in is:

In [8]:
```
langs_sets = dataset_ra["doc_languages"].str.lower().str.split(";").apply(set)
doc_langs_counts = langs_sets.value_counts()
doc_langs_counts.plot.barh(figsize=(12, 8),
                           title="Number of documents by its set of languages "
                                 "in the SciELO Brazil collection")
pd.DataFrame(doc_langs_counts)
```

Out [8]:

	doc_languages
{pt}	163858
{en}	103199
{en, pt}	31065
{es}	5841
{es, en, pt}	2913
{es, en}	484
{fr}	346
{fr, pt}	106
{de}	64
{it}	61
{es, pt}	39
{it, pt}	11
{fr, en, pt}	6
{de, pt}	6
{la, pt}	3
{es, de}	1
{it, en, pt}	1
{de, al}	1
{fr, en}	1



We can say an article is multi-language if it's available in at least 3 languages.

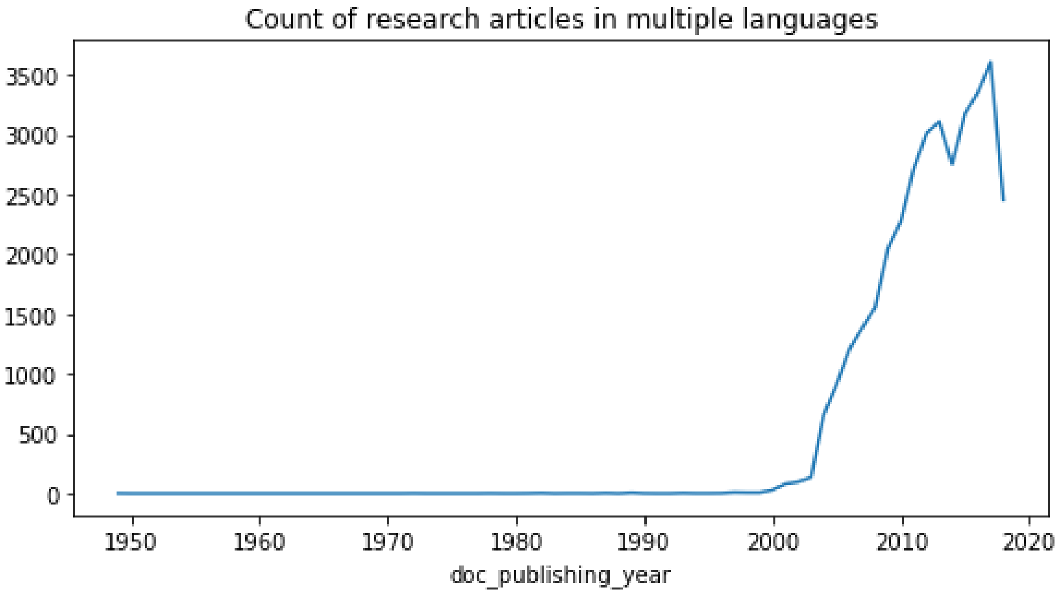
15.4 Multiple languages in time

The quantity of articles with multiple languages seem to be getting higher when we see them by the publication year.

In [9]:

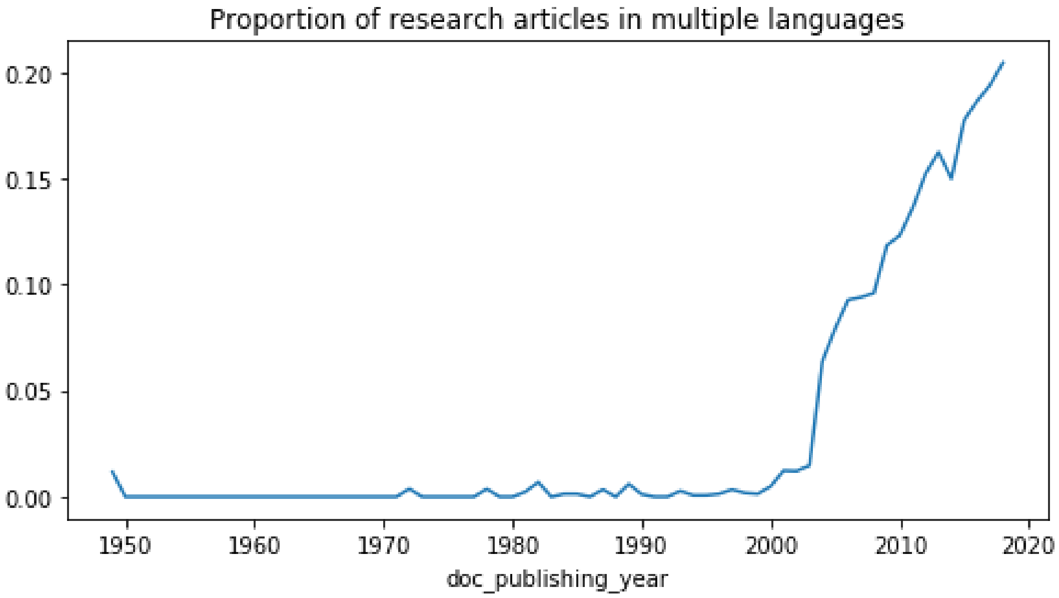
```
dataset_ramf = dataset_ra.assign(
    multi_language=dataset_ra["doc_languages"].str.contains(";"),
)
```

```
np.trim_zeros(dataset_ramf.groupby("doc_publishing_year")["multi_language"]
                          .sum()
).plot.line(
    figsize=(8, 4),
    title="Count of research articles in multiple languages",
);
```



In [10]:

```
np.trim_zeros(dataset_ramf.groupby("doc_publishing_year")["multi_language"]
                          .mean()
).plot.line(
    figsize=(8, 4),
    title="Proportion of research articles in multiple languages",
);
```



Can we split by both the publishing and indexing years?

15.4.1 Getting the indexing year

The indexing year can only be found in the journal spreadsheet, in the `inclusion_year_scielo`.

In [11]:

```
journals = pd.read_csv("tabs_bra/journals.csv") \
             .rename(columns=normalize_column_title)
print(journals.shape)
journals.columns
```

```
(366, 98)
```

Out [11]:

```
Index(['extraction_date', 'study_unit', 'collection', 'issn_scielo', 'issns',
       'title_scielo', 'title_thematic_areas', 'is_agricultural_sciences',
       'is_applied_social_sciences', 'is_biological_sciences',
       'is_engineering', 'is_exact_earth_sciences', 'is_health_sciences',
       'is_human_sciences', 'is_linguistics_letters_arts',
       'is_multidisciplinary', 'title_current_status', 'title_subtitle_scielo',
       'short_title_scielo', 'short_iso', 'title_pubmed', 'publisher_name',
       'use_license', 'alpha_freq', 'numeric_freq_in_months',
       'inclusion_year_scielo', 'stopping_year_scielo', 'stopping_reason',
       'date_first_doc', 'volume_first_doc', 'issue_first_doc',
       'date_last_doc', 'volume_last_doc', 'issue_last_doc', 'total_issues',
       'issues_2018', 'issues_2017', 'issues_2016', 'issues_2015',
       'issues_2014', 'issues_2013', 'total_regular_issues',
       'regular_issues_2018', 'regular_issues_2017', 'regular_issues_2016',
       'regular_issues_2015', 'regular_issues_2014', 'regular_issues_2013',
       'total_docs', 'docs_2018', 'docs_2017', 'docs_2016', 'docs_2015',
       'docs_2014', 'docs_2013', 'citable_docs', 'citable_docs_2018',
       'citable_docs_2017', 'citable_docs_2016', 'citable_docs_2015',
       'citable_docs_2014', 'citable_docs_2013', 'portuguese_docs_2018',
       'portuguese_docs_2017', 'portuguese_docs_2016', 'portuguese_docs_2015',
       'portuguese_docs_2014', 'portuguese_docs_2013', 'spanish_docs_2018',
       'spanish_docs_2017', 'spanish_docs_2016', 'spanish_docs_2015',
       'spanish_docs_2014', 'spanish_docs_2013', 'english_docs_2018',
       'english_docs_2017', 'english_docs_2016', 'english_docs_2015',
       'english_docs_2014', 'english_docs_2013', 'other_lang_docs_2018',
       'other_lang_docs_2017', 'other_lang_docs_2016', 'other_lang_docs_2015',
       'other_lang_docs_2014', 'other_lang_docs_2013', 'h5_2018', 'h5_2017',
       'h5_2016', 'h5_2015', 'h5_2014', 'h5_2013', 'm5_2018', 'm5_2017',
       'm5_2016', 'm5_2015', 'm5_2014', 'm5_2013'],
      dtype='object')
```

This is the joined dataset:

In [12]:

```
mdataset = pd.merge(dataset, journals, on="issn_scielo", how="left")
mdataset.shape
```

Out [12]:

```
(368491, 123)
```

Fields with an `_x` suffix regards to the document, whereas fields with `_y` regards to the journal. Fields that aren't in both dataframes appear without any extra suffix.

In [13]:

```
mdataset.columns
```

Out [13]:

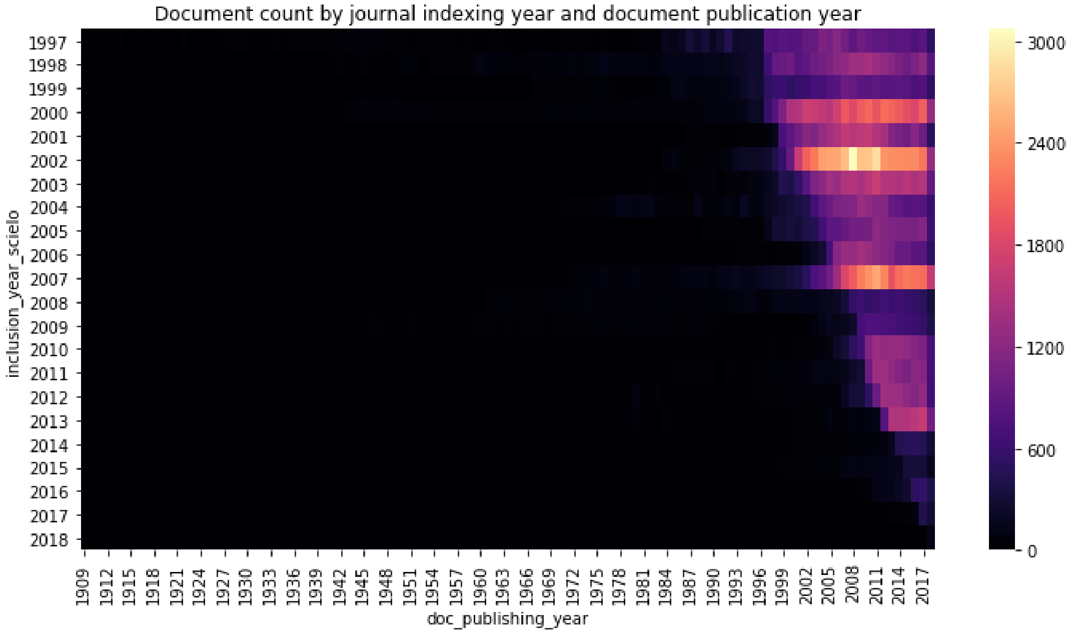
```
Index(['extraction_date_x', 'study_unit_x', 'collection_x', 'issn_scielo',
       'issns_x', 'title_scielo_x', 'title_thematic_areas_x',
       'is_agricultural_sciences_x', 'is_applied_social_sciences_x',
       'is_biological_sciences_x',
       ...
       'h5_2016', 'h5_2015', 'h5_2014', 'h5_2013', 'm5_2018', 'm5_2017',
       'm5_2016', 'm5_2015', 'm5_2014', 'm5_2013'],
      dtype='object', length=123)
```

15.4.2 Document count by indexing year and publication year

We can see the quantity of documents by the year of journal indexing and the year of document publication.

In [14]:

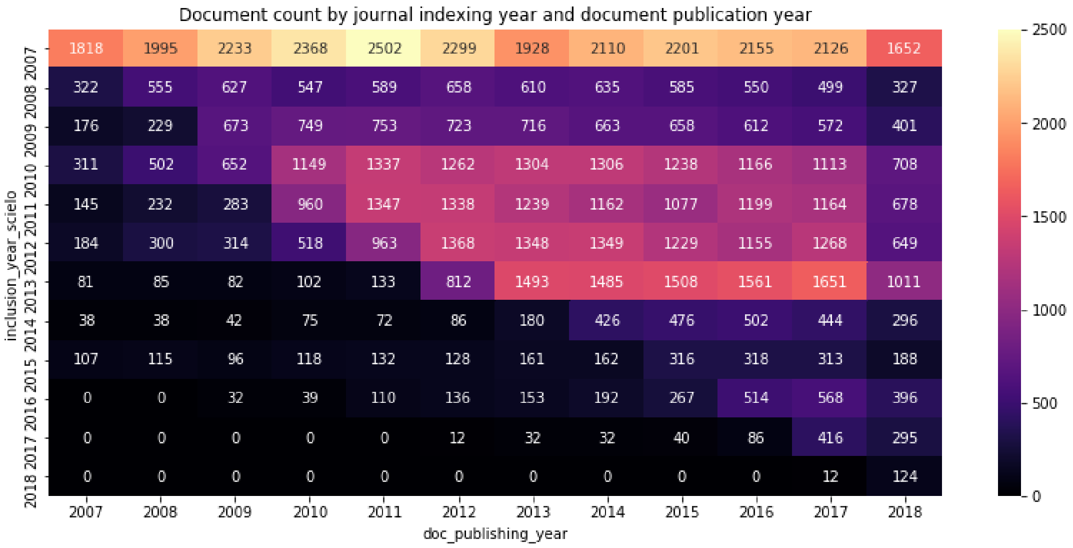
```python
years_mdataset = (mdataset
    .groupby(["inclusion_year_scielo", "doc_publishing_year"])
    .size()
    .unstack("doc_publishing_year")
    .fillna(0)
    .astype(int)
)
plt.figure(figsize=(12, 6))
sns.heatmap(years_mdataset, cmap="magma") \
   .set(title="Document count by journal indexing year "
              "and document publication year");
```



The same map, but only for 2007 onwards:

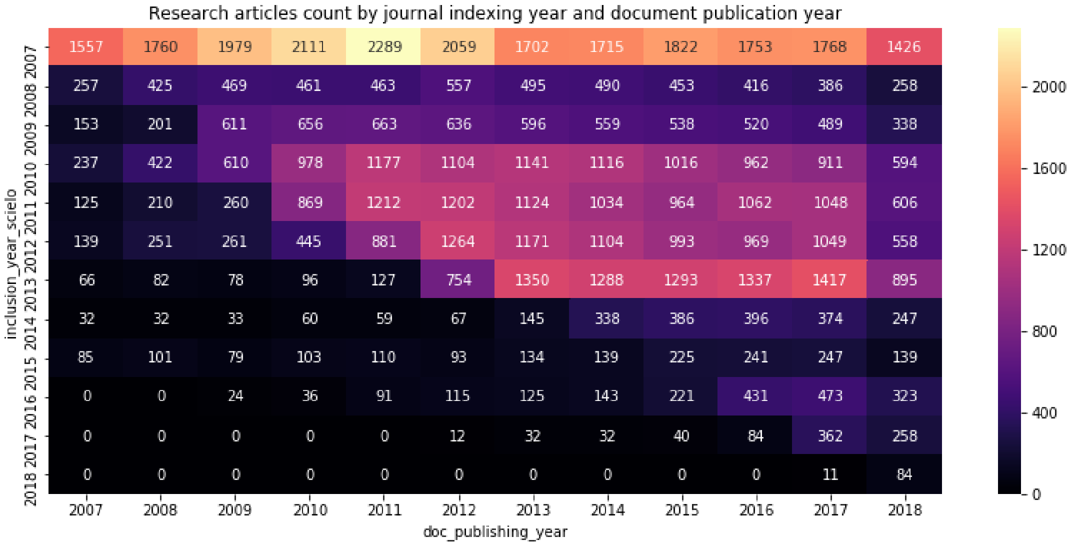
In [15]:

```python
plt.figure(figsize=(14, 6))
sns.heatmap(years_mdataset.loc[2007:, 2007:], cmap="magma",
            annot=True, fmt="g") \
   .set(title="Document count by journal indexing year "
              "and document publication year");
```



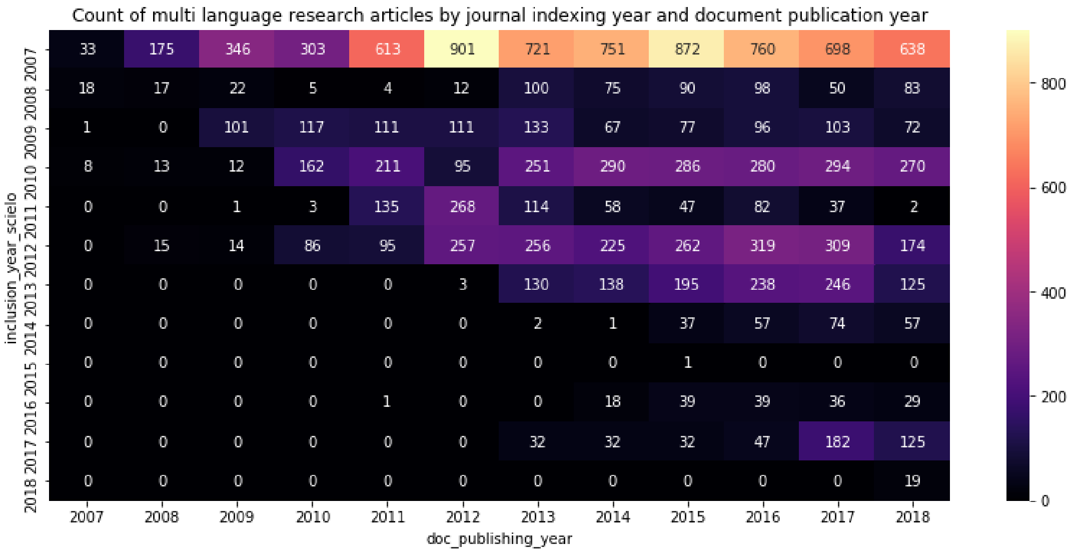
Filtering by research articles, we get almost the same:

In [16]:
```
mdataset_ra = mdataset[mdataset["doc_type"] == "research-article"]
years_mdataset_ra = (mdataset_ra
    .groupby(["inclusion_year_scielo", "doc_publishing_year"])
    .size()
    .unstack("doc_publishing_year")
    .fillna(0)
    .astype(int)
)
plt.figure(figsize=(14, 6))
sns.heatmap(years_mdataset_ra.loc[2007:, 2007:], cmap="magma",
            annot=True, fmt="g") \
   .set(title="Research articles count by journal indexing year "
              "and document publication year");
```



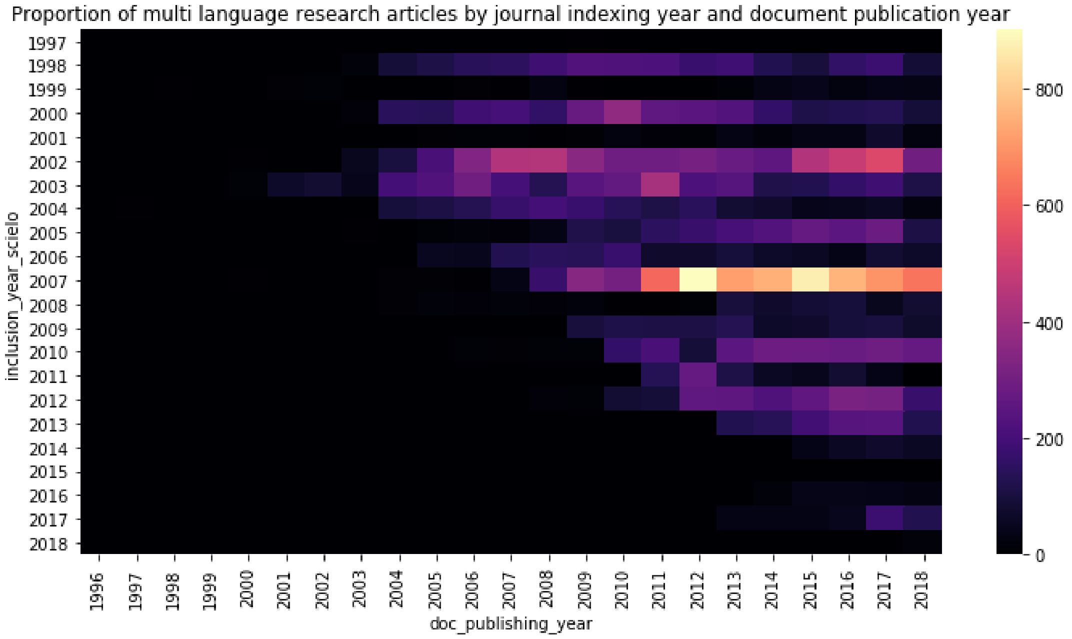
15.4.3 Multiple languages by indexing year and publication year

In [17]:
```
mdataset_ramf = mdataset_ra.assign(
    multi_language=dataset_ra["doc_languages"].str.contains(";"),
)
years_mdataset_ramf_sum = (mdataset_ramf
    .groupby(["inclusion_year_scielo", "doc_publishing_year"])
    ["multi_language"]
    .sum()
    .unstack("doc_publishing_year")
    .fillna(0)
    .astype(int)
)
plt.figure(figsize=(14, 6))
sns.heatmap(years_mdataset_ramf_sum.loc[2007:, 2007:], cmap="magma",
            annot=True, fmt="g") \
   .set(title="Count of multi language research articles "
              "by journal indexing year "
              "and document publication year");
```



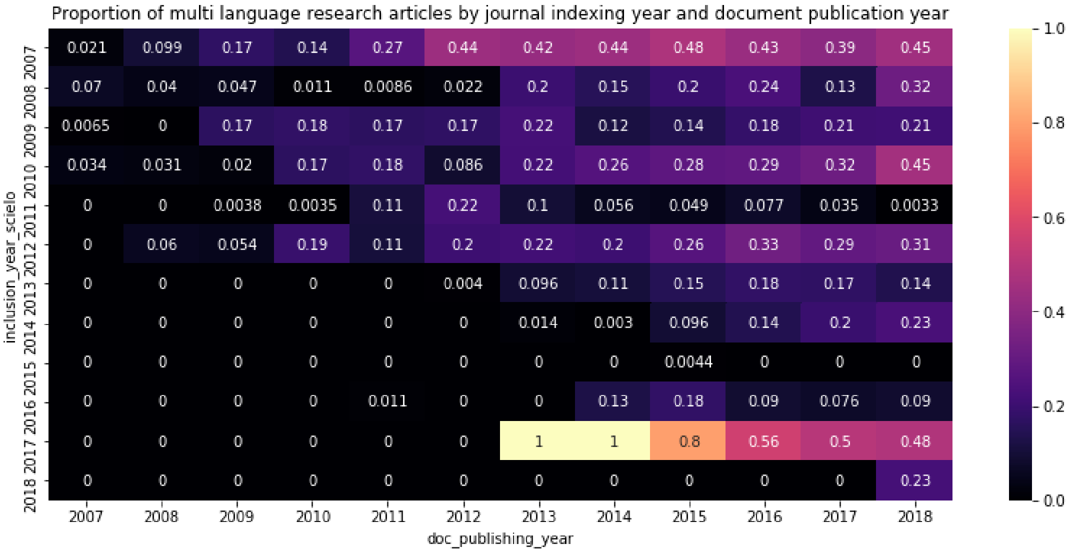
Zooming out:

In [18]:
```
plt.figure(figsize=(12, 6))
sns.heatmap(years_mdataset_ramf_sum.loc[:, 1996:], cmap="magma") \
   .set(title="Proportion of multi language research articles "
              "by journal indexing year "
              "and document publication year");
```



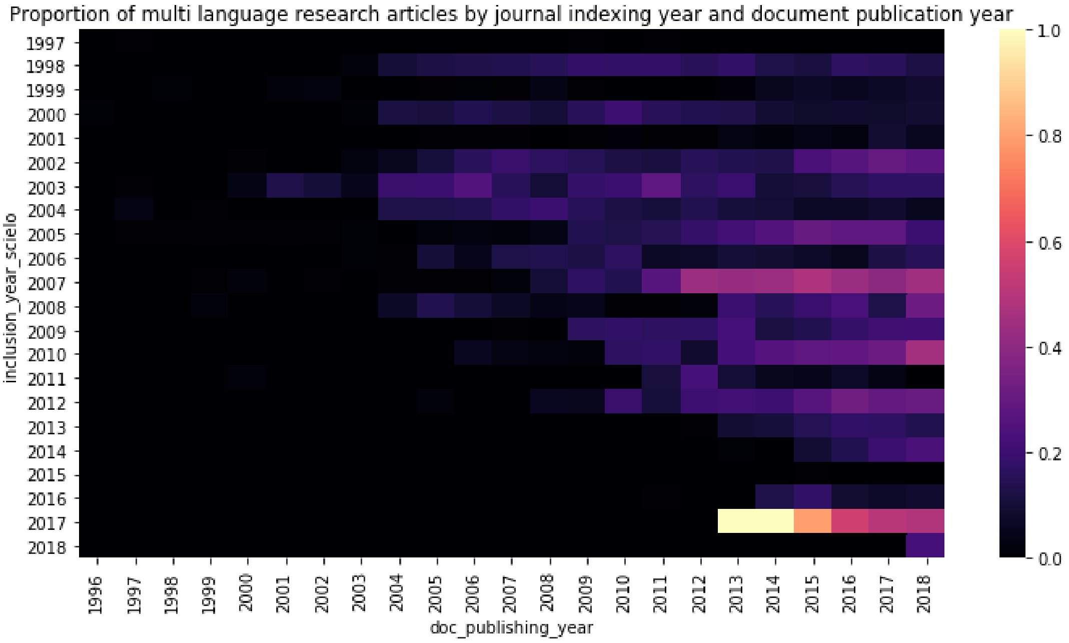
The raw count is probably not enough for understanding what's going on. Let's see the proportion.

In [19]:
```
years_mdataset_ramf_mean = (mdataset_ramf
    .groupby(["inclusion_year_scielo", "doc_publishing_year"])
    ["multi_language"]
    .mean()
    .unstack("doc_publishing_year")
    .fillna(0.)
)
plt.figure(figsize=(14, 6))
sns.heatmap(years_mdataset_ramf_mean.loc[2007:, 2007:], cmap="magma",
            annot=True) \
   .set(title="Proportion of multi language research articles "
              "by journal indexing year "
              "and document publication year");
```



Zooming out:

In [20]:
```
plt.figure(figsize=(12, 6))
sns.heatmap(years_mdataset_ramf_mean.loc[:, 1996:], cmap="magma") \
   .set(title="Proportion of multi language research articles "
              "by journal indexing year "
              "and document publication year");
```



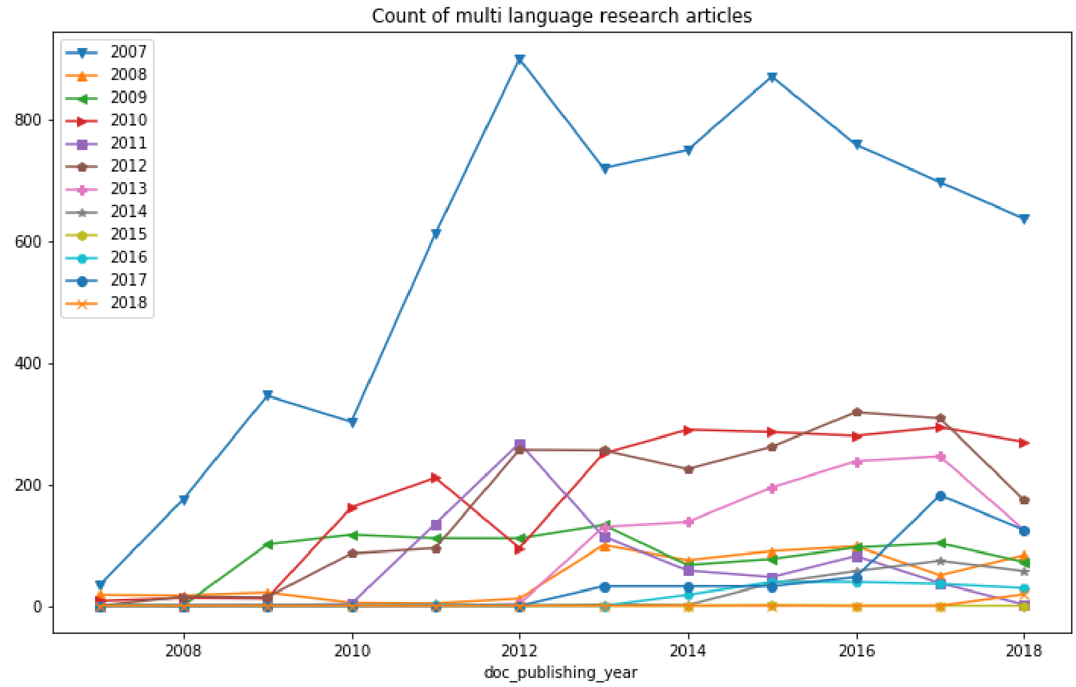
The same as above, but as line plots:

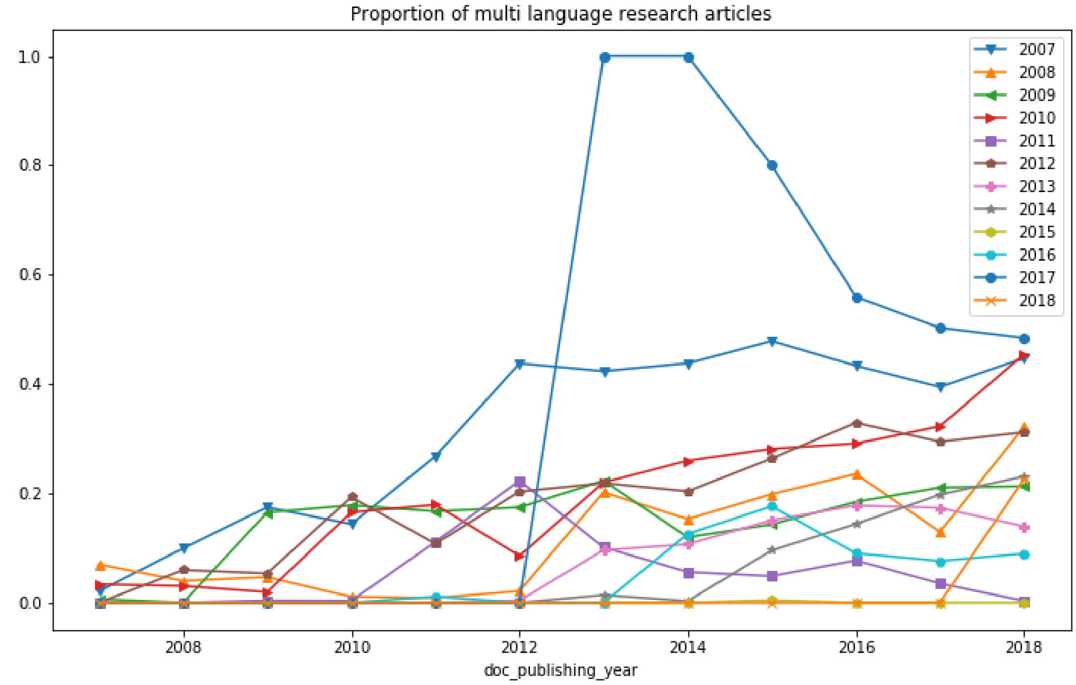
In [21]:
```
def add_markers(ax):
    for line, marker in zip(ax.get_lines(), "v^<>spP*hHoxXDd8234+1.,"):
        line.set_marker(marker)
    ax.legend()
```

In [22]:
```
fig, (ax1, ax2) = plt.subplots(nrows=2, figsize=(12, 16))

years_mdataset_ramf_sum.loc[2007:, 2007:].T.plot(ax=ax1)
ax1.set(title="Count of multi language research articles")
add_markers(ax1)

years_mdataset_ramf_mean.loc[2007:, 2007:].T.plot(ax=ax2)
ax2.set(title="Proportion of multi language research articles")
add_markers(ax2)
```





15.5 Thematic area

These are the fields for each area, besides the _x or _y suffix:

In [23]:
```
areas = ["is_agricultural_sciences",
         "is_applied_social_sciences",
         "is_biological_sciences",
         "is_engineering",
         "is_exact_earth_sciences",
         "is_health_sciences",
         "is_human_sciences",
         "is_linguistics_letters_arts"]
areaswm = areas + ["is_multidisciplinary"]
```

This new `trm` dataset:

- Has an entry copy for each *thematic area* of a document;
- Is filtered by *research articles*, having no other document type;
- Includes a *`multi_language` field*, besides specific flag fields for the `pt`, `es` and `en` languages.

In [24]:

```
trm = pd.concat([
    mdataset_ramf[mdataset_ramf[area + "_x"] == 1]
                 [["inclusion_year_scielo", "doc_publishing_year",
                   "multi_language", "doc_pt", "doc_es", "doc_en"]]
                 .assign(area=area[3:])
    for area in areaswm
]).reset_index(drop=True)
print(trm.shape)
trm[::50_000]
```

```
(372208, 7)
```

Out [24]:

The table is in the next page ...

	inclusion_year_scielo	doc_publishing_year	multi_language	doc_pt	doc_es	doc_en	area
0	1998	1998	False	1	0	0	agricultural_sciences
50000	2012	2011	False	0	0	1	agricultural_sciences
100000	2006	2007	False	1	0	0	biological_sciences
150000	2011	2016	False	1	0	0	engineering
200000	2000	2006	True	1	0	1	health_sciences
250000	1998	2012	False	0	0	1	health_sciences
300000	2008	2017	True	1	0	1	health_sciences
350000	2012	2016	True	1	0	1	human_sciences

With that data, we can see some language statistics for each area. But, first, what's the number of research articles on each thematic area?

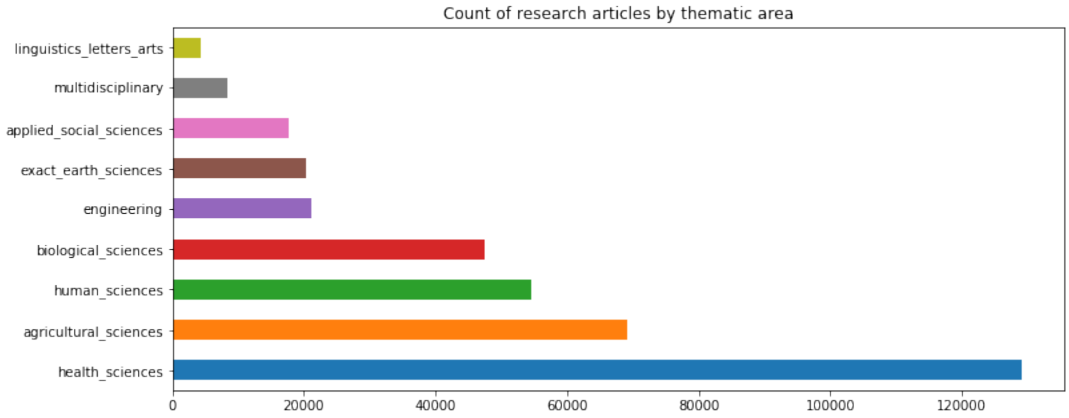
Note: The proportion based on the total count is beyond 100%, since there are articles in more than one thematic area.

In [25]:

```
trm_area_counts = trm["area"].value_counts().rename("count")
trm_area_counts.plot.barh(
    figsize=(12, 5),
    title="Count of research articles by thematic area",
)
pd.DataFrame(trm_area_counts).assign(
    proportion=trm_area_counts / mdataset_ramf.shape[0],
)
```

Out [25]:

	count	proportion
health_sciences	129204	0.419485
agricultural_sciences	69143	0.224486
human_sciences	54581	0.177208
biological_sciences	47412	0.153932
engineering	21148	0.068661
exact_earth_sciences	20288	0.065869
applied_social_sciences	17736	0.057583
multidisciplinary	8355	0.027126
linguistics_letters_arts	4341	0.014094



Now let's see, for each thematic area, the multi-language document count by both the journal indexing year and the document publishing year, besides a proportion based on the total document count for the specific thematic area.

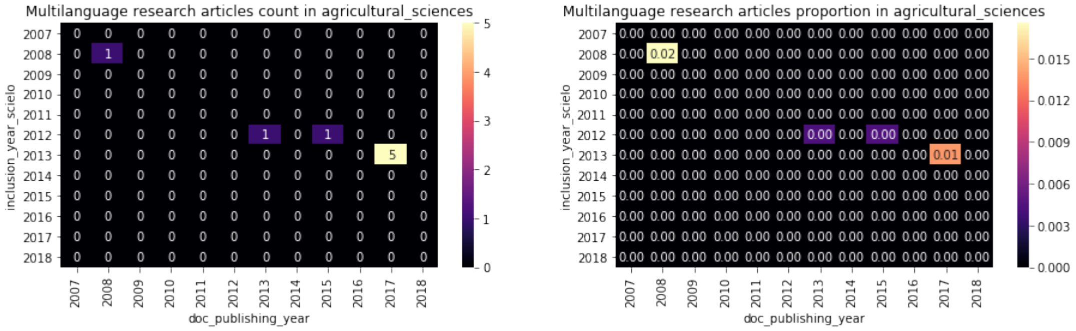
In [26]:

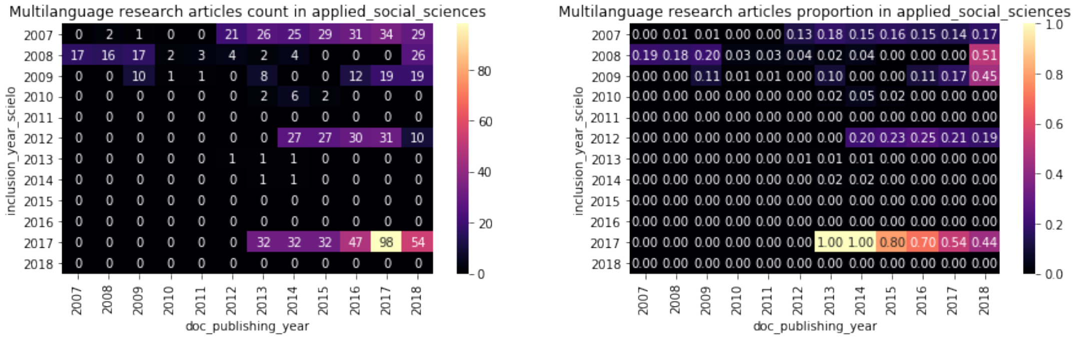
```
years_trm = (trm
    .groupby(["area", "inclusion_year_scielo", "doc_publishing_year"])
    ["multi_language"]
    .agg(["sum", "mean"])
    .unstack("inclusion_year_scielo")
    .fillna(0)
).T
```

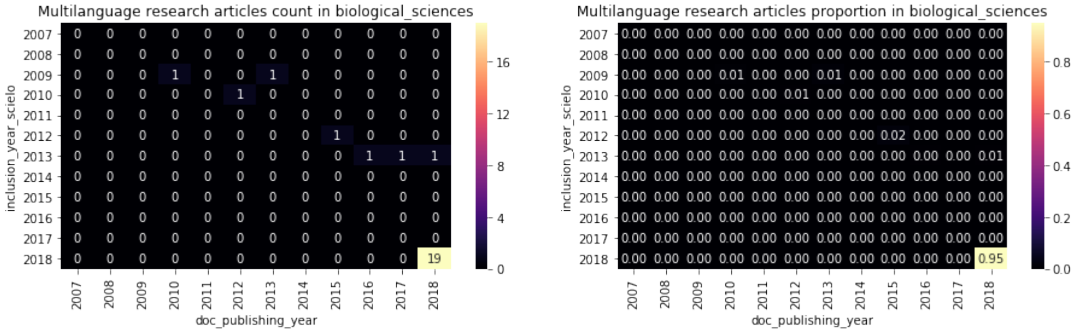
That's the full matrix of counts and proportions by area. Let's see it with some heatmaps.

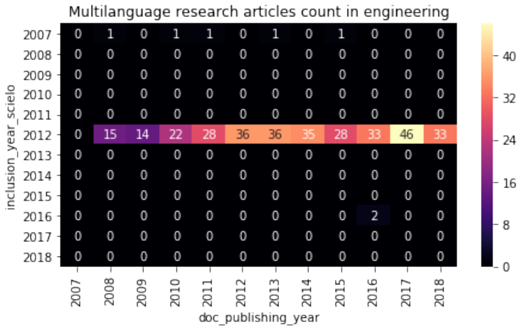
In [27]:

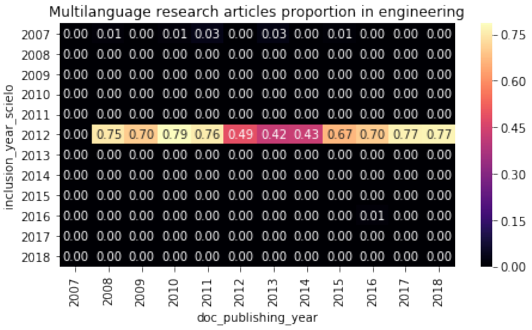
```
for field in areaswm:
    fig, (ax1, ax2) = plt.subplots(ncols=2, figsize=(13, 4))
    area = field[3:]
    sns.heatmap(years_trm.xs(area, 1).xs("sum").loc[2007:, 2007:],
                cmap="magma", annot=True, fmt="g", ax=ax1) \
       .set(title=f"Multilanguage research articles count in {area}")
    sns.heatmap(years_trm.xs(area, 1).xs("mean").loc[2007:, 2007:],
                cmap="magma", annot=True, fmt=".02f", ax=ax2) \
       .set(title=f"Multilanguage research articles proportion "
                  f"in {area}")
    fig.tight_layout()
```

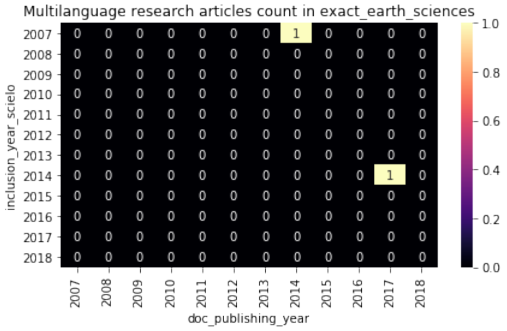


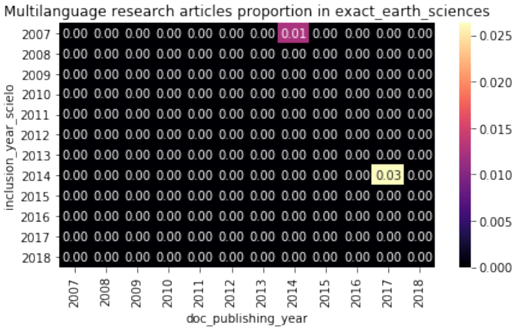


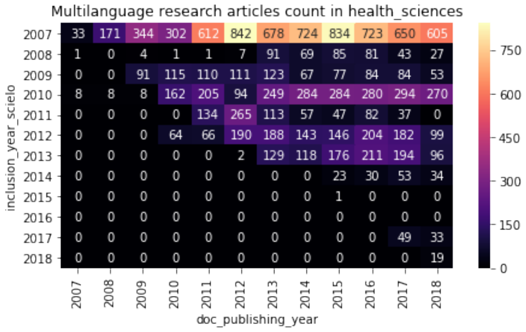


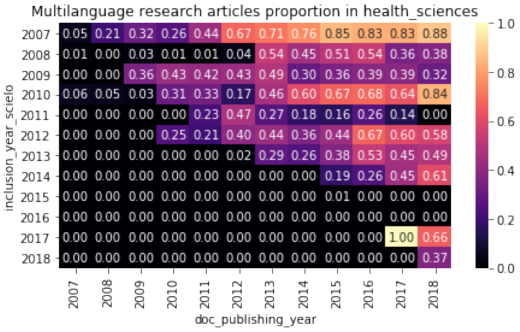

Multilanguage research articles count in engineering

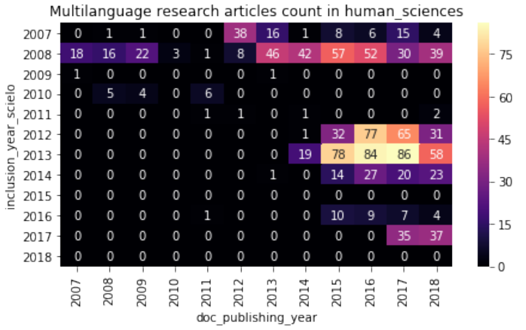

Multilanguage research articles proportion in engineering

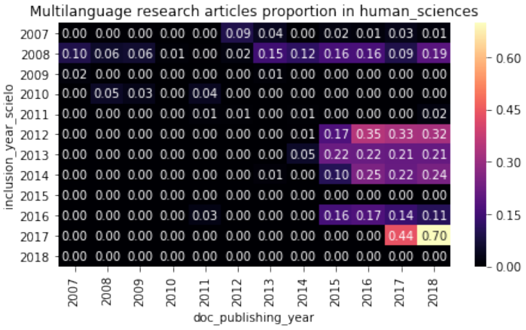

Multilanguage research articles count in exact_earth_sciences

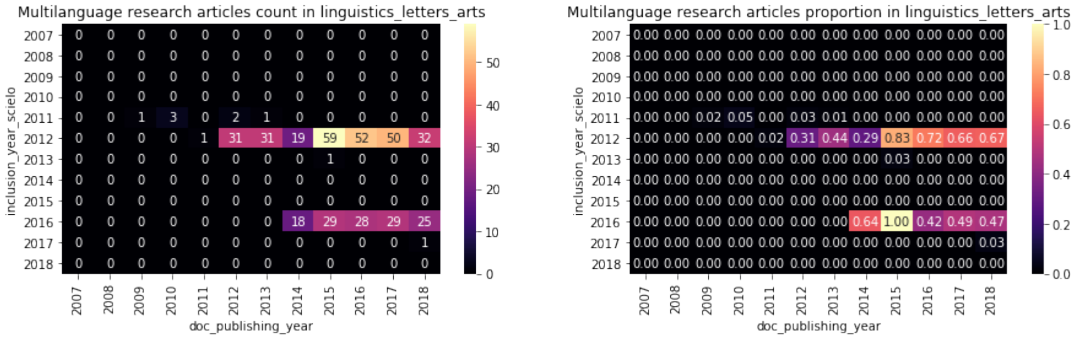

Multilanguage research articles proportion in exact_earth_sciences

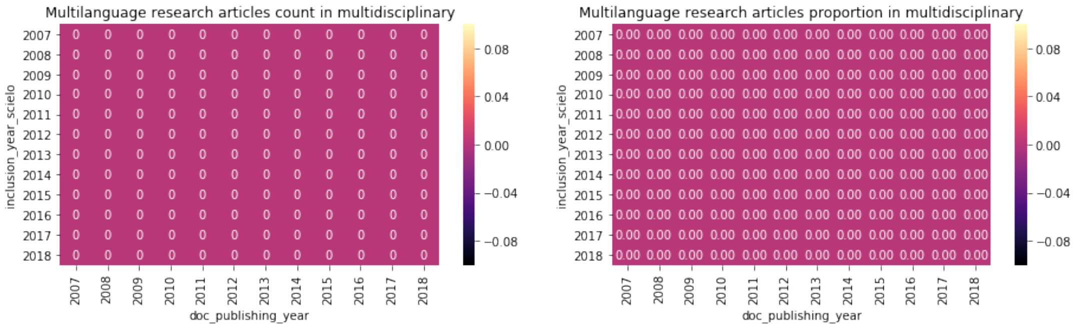

Multilanguage research articles count in health_sciences


Multilanguage research articles proportion in health_sciences


Multilanguage research articles count in human_sciences

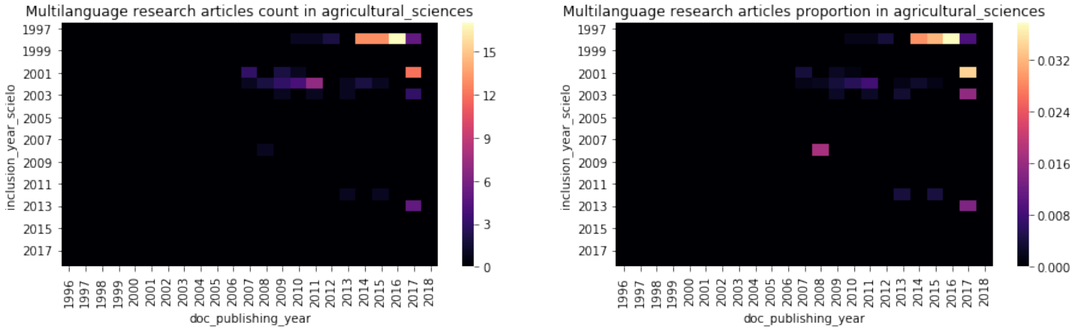

Multilanguage research articles proportion in human_sciences

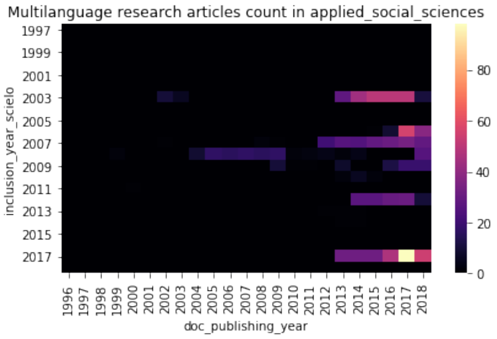




Zooming out to see the big picture:

In [28]:
```python
for field in areaswm:
    fig, (ax1, ax2) = plt.subplots(ncols=2, figsize=(13, 4))
    area = field[3:]
    sns.heatmap(years_trm.xs(area, 1).xs("sum").loc[:, 1996:],
                cmap="magma", ax=ax1) \
       .set(title=f"Multilanguage research articles count in {area}")
    sns.heatmap(years_trm.xs(area, 1).xs("mean").loc[:, 1996:],
                cmap="magma", ax=ax2) \
       .set(title=f"Multilanguage research articles proportion "
                  f"in {area}")
    fig.tight_layout()
```




Multilanguage research articles count in applied_social_sciences
inclusion_year_scielo
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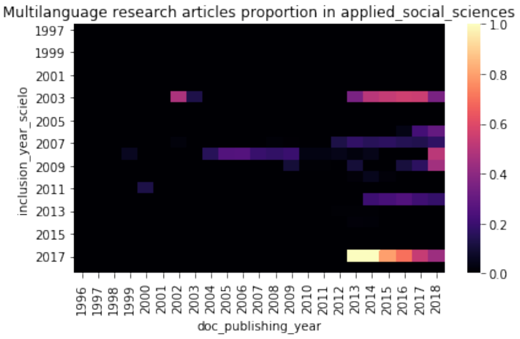
Multilanguage research articles proportion in applied_social_sciences
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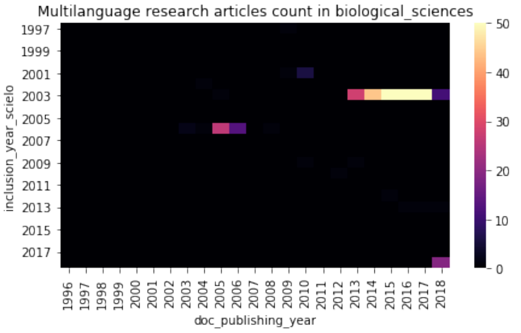
Multilanguage research articles count in biological_sciences
inclusion_year_scielo
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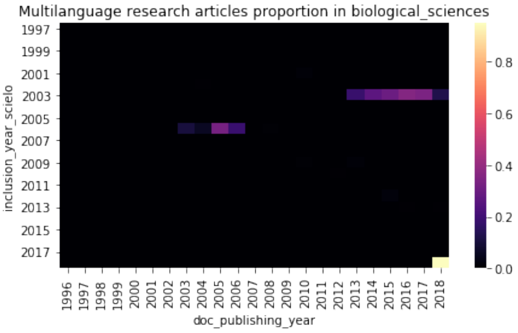
Multilanguage research articles proportion in biological_sciences
inclusion_year_scielo
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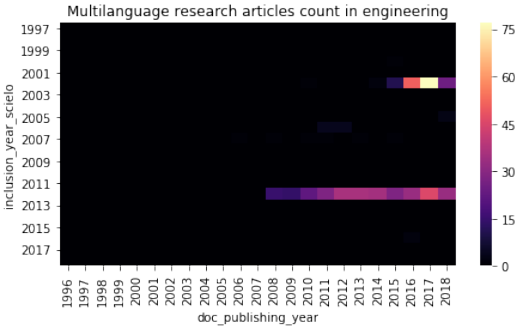
Multilanguage research articles count in engineering
inclusion_year_scielo
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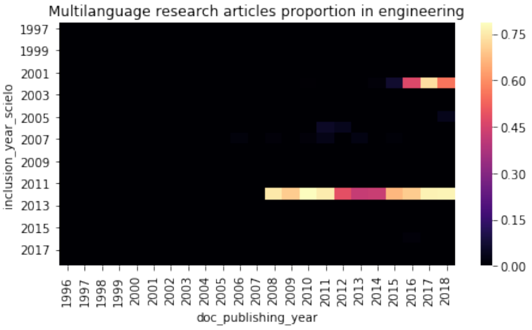
Multilanguage research articles proportion in engineering
inclusion_year_scielo
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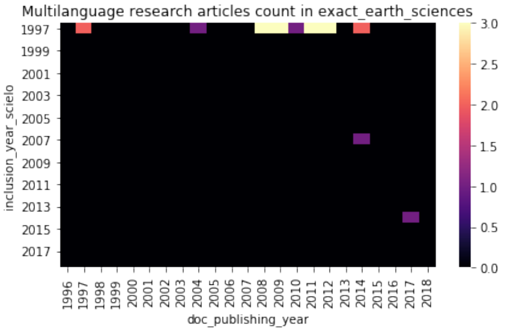
Multilanguage research articles count in exact_earth_sciences
inclusion_year_scielo
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doc_publishing_year
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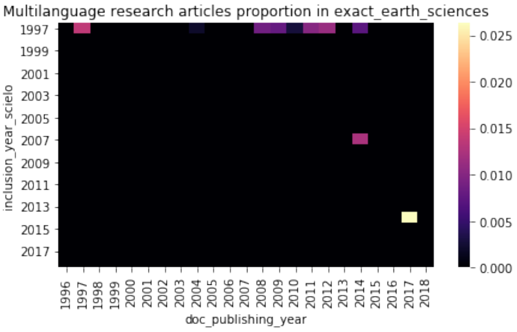
Multilanguage research articles proportion in exact_earth_sciences
inclusion_year_scielo
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doc_publishing_year
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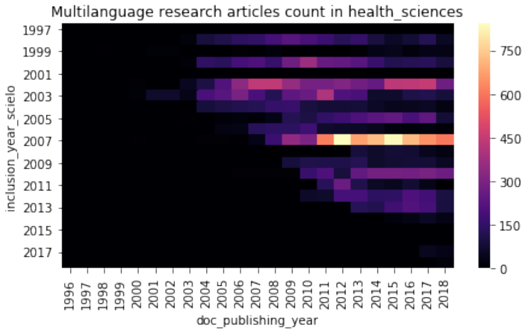
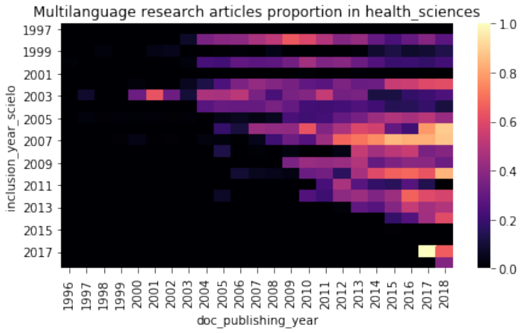
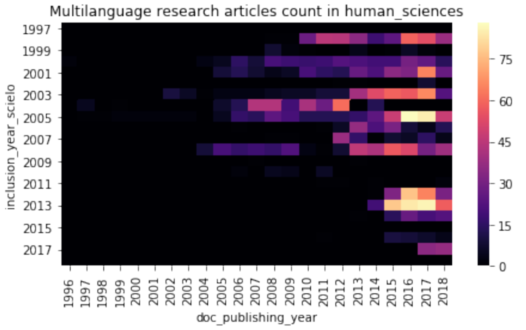


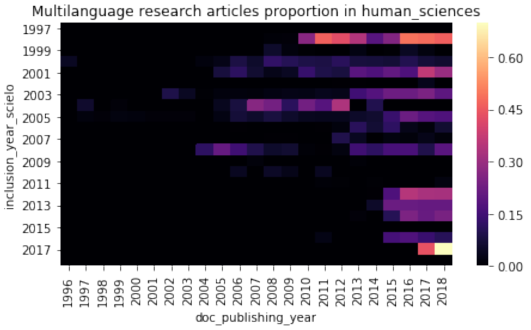
Multilanguage research articles count in health_sciences



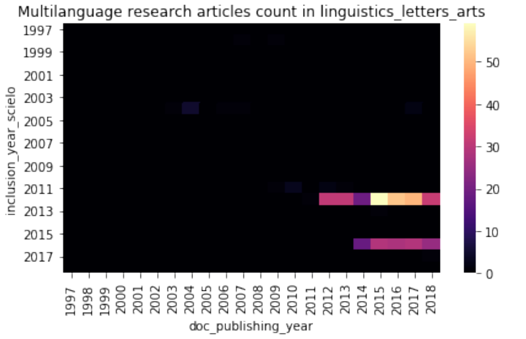
Multilanguage research articles proportion in health_sciences



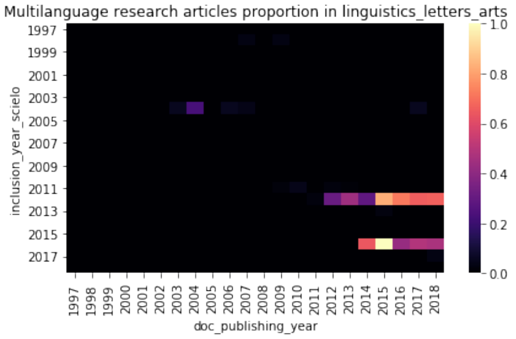
Multilanguage research articles count in human_sciences



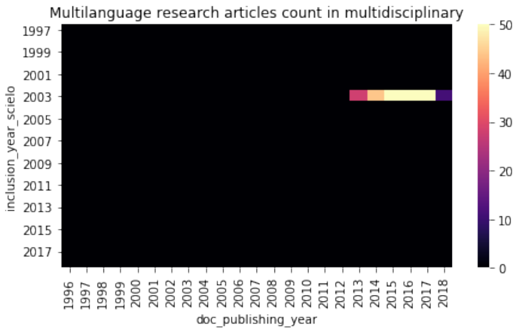
Multilanguage research articles proportion in human_sciences



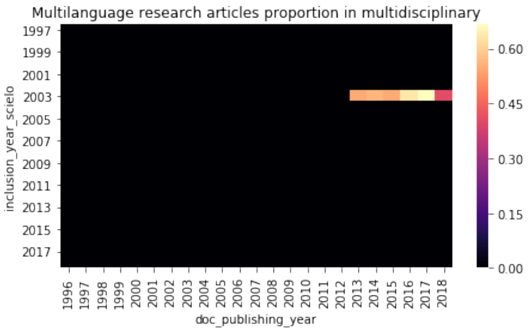
Multilanguage research articles count in linguistics_letters_arts



Multilanguage research articles proportion in linguistics_letters_arts



Multilanguage research articles count in multidisciplinary



Multilanguage research articles proportion in multidisciplinary

15.6 Number of published articles by thematic area in en, es and pt

Using the same technique from when we created the trm dataframe, we can see the number of published articles by the 3 languages that have its own column:

- en: English;
- es: Spanish;
- pt: Portuguese.

In [29]:

```
langs = ["en", "es", "pt"]
trlangsum = pd.concat([
    trm[trm["doc_" + lang] == 1]
       [["area", "doc_publishing_year"]]
       .assign(lang=lang)
    for lang in langs
]).groupby(["area", "lang", "doc_publishing_year"]) \
  .size().rename("count").reset_index()
print(trlangsum.shape)
trlangsum[::200]
```

```
(1274, 4)
```

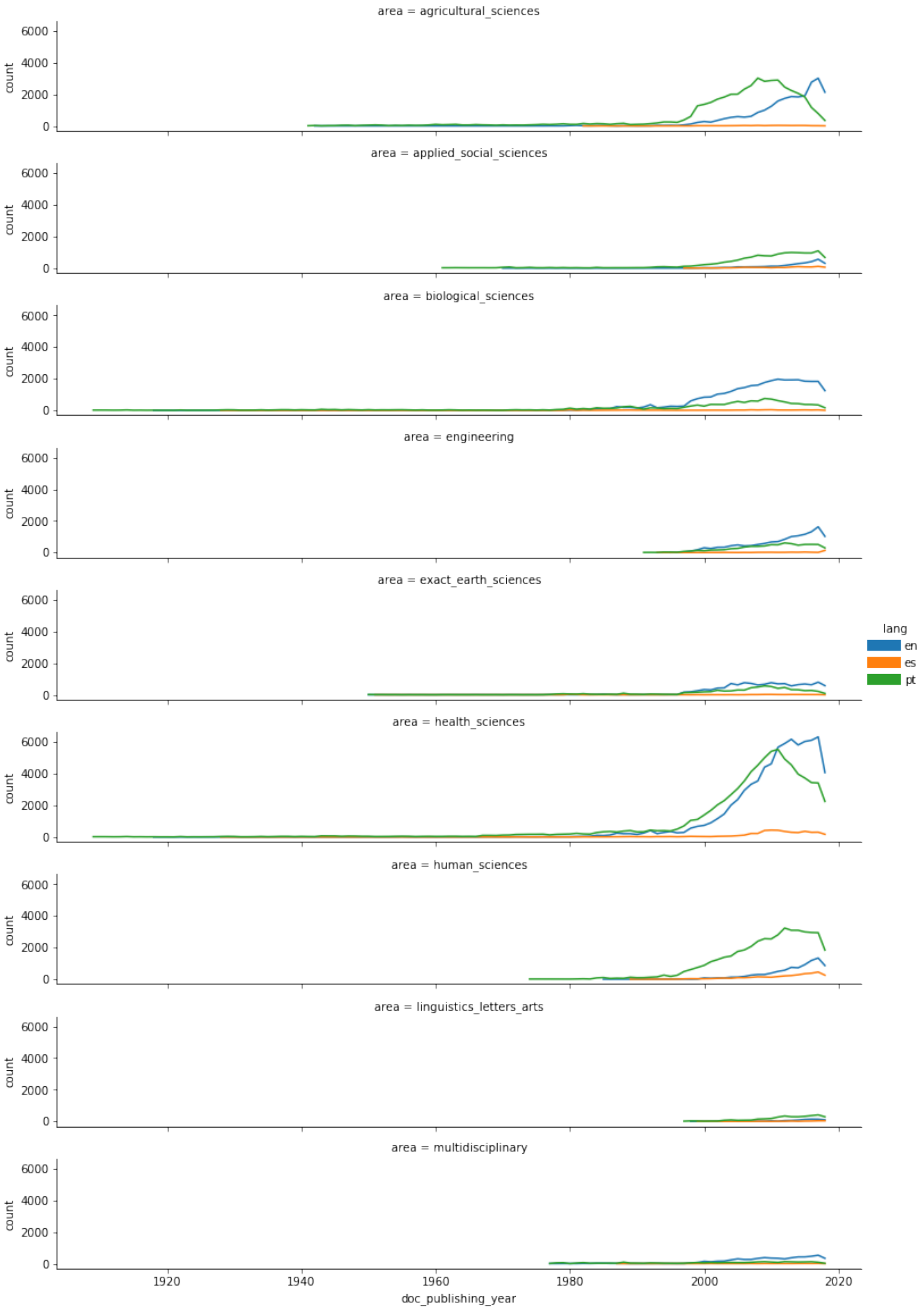
Out [29]:

	area	lang	doc_publishing_year	count
0	agricultural_sciences	en	1942	1
200	applied_social_sciences	es	2011	44
400	biological_sciences	pt	1911	16
600	exact_earth_sciences	en	1971	6
800	health_sciences	en	1983	46
1000	health_sciences	pt	2010	5409
1200	multidisciplinary	en	2012	297

This data is what we wish to plot.

In [30]:

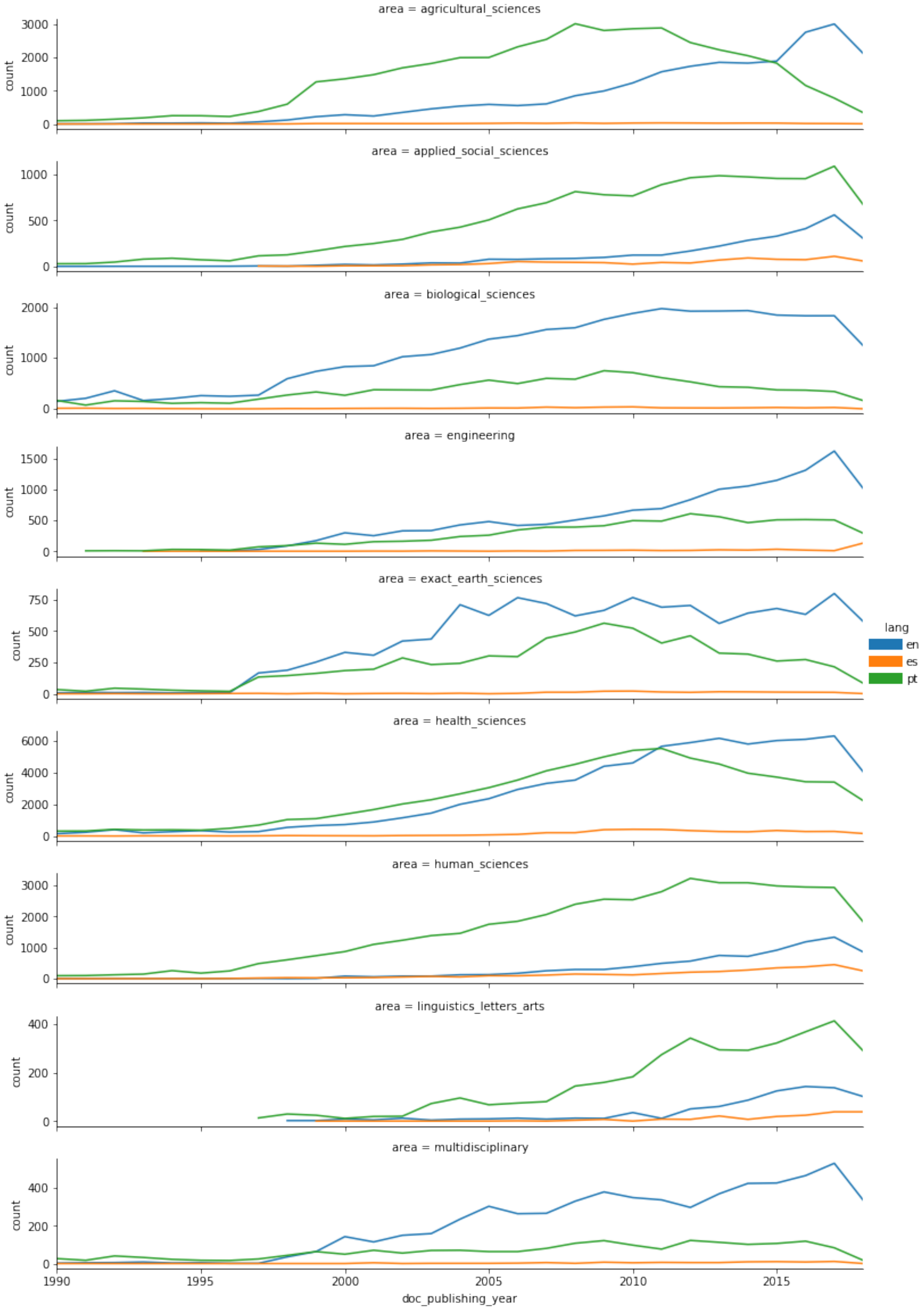
```
sns.FacetGrid(trlangsum, hue="lang", row="area", aspect=6, height=1.8) \
   .map(sns.lineplot, "doc_publishing_year", "count") \
   .add_legend()
for legend_line in plt.gcf().legends[0].legendHandles:
    legend_line.set_linewidth(10)
```



The same, from 1990 and without a shared y axis:

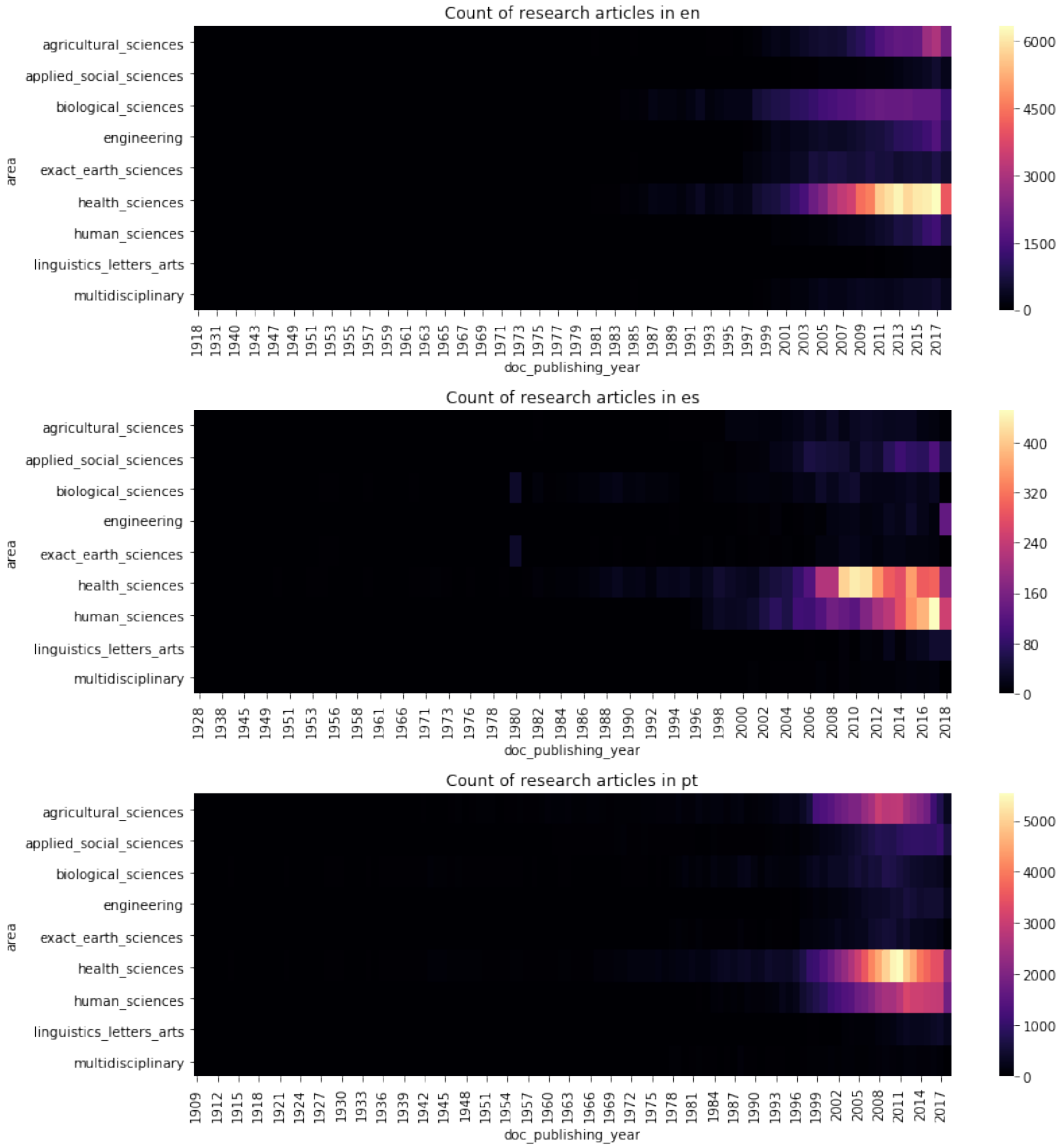
In [31]:
```
sns.FacetGrid(trlangsum, hue="lang", row="area",
              aspect=6, height=1.8, sharey=False) \
   .map(sns.lineplot, "doc_publishing_year", "count") \
   .add_legend() \
   .set(xlim=[1990, 2018]);
```

```
for legend_line in plt.gcf().legends[0].legendHandles:
    legend_line.set_linewidth(10)
```



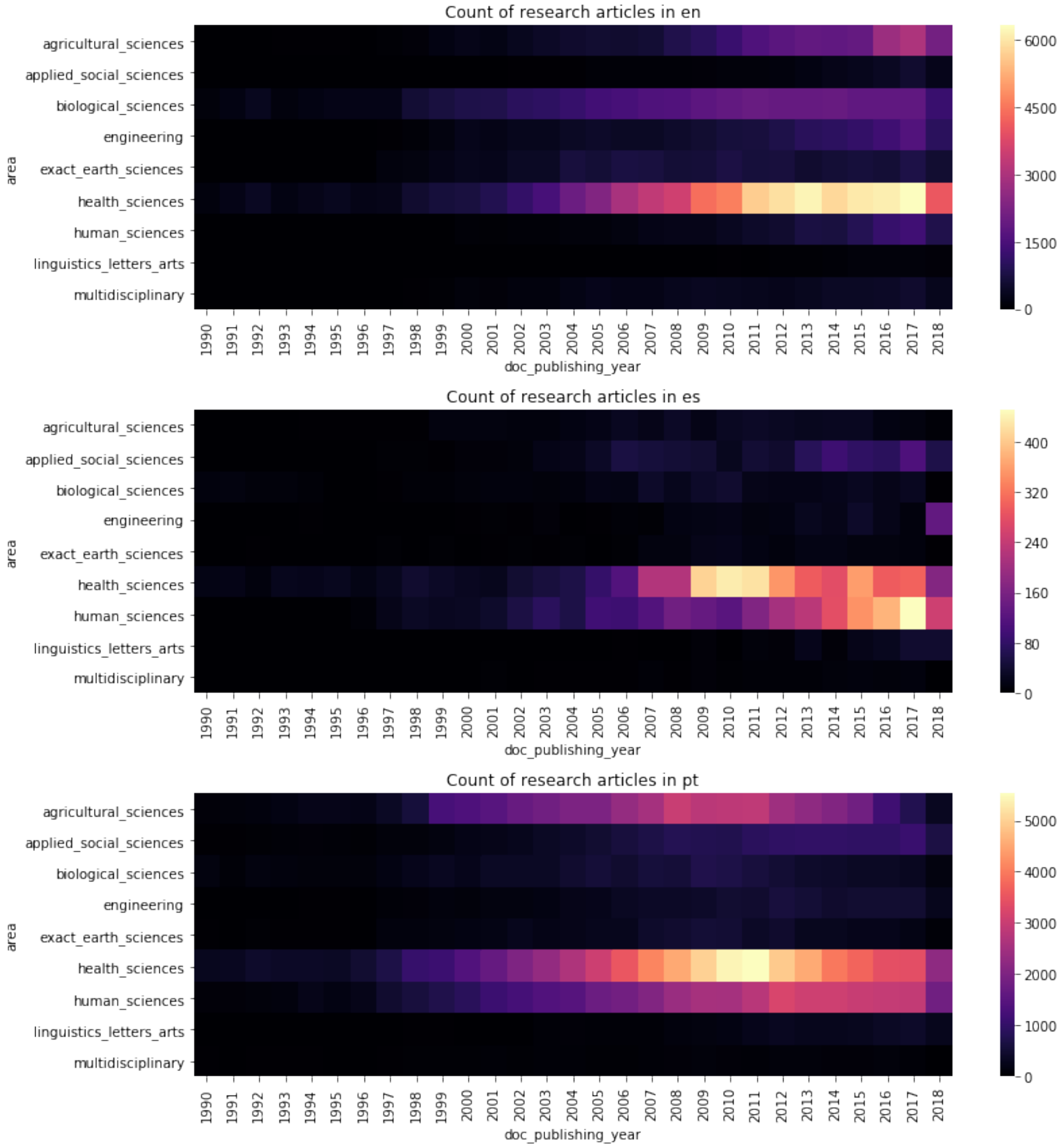
Instead, we might want to see the proportion of thematic areas in some specific language. We can plot a heat map to see this.

In [32]:
```
fig, axes = plt.subplots(nrows=len(langs), figsize=(12, 12))
for lang, ax in zip(langs, axes):
    data = trlangsum[trlangsum["lang"] == lang] \
                   .pivot(index="area",
                          columns="doc_publishing_year",
                          values="count") \
                   .fillna(0)
    sns.heatmap(data, cmap="magma", ax=ax) \
      .set(title=f"Count of research articles in {lang}")
fig.tight_layout()
```



The same, from 1990:

In [33]:
```
fig, axes = plt.subplots(nrows=len(langs), figsize=(12, 12))
for lang, ax in zip(langs, axes):
    data = trlangsum[(trlangsum["lang"] == lang) &
                     (trlangsum["doc_publishing_year"] >= 1990)] \
                   .pivot(index="area",
                      columns="doc_publishing_year",
                      values="count") \
               .fillna(0)
    sns.heatmap(data, cmap="magma", ax=ax) \
       .set(title=f"Count of research articles in {lang}")
fig.tight_layout()
```


Count of research articles in en
agricultural_sciences
applied_social_sciences
biological_sciences
engineering
exact_earth_sciences
health_sciences
human_sciences
linguistics_letters_arts
multidisciplinary
area
doc_publishing_year
Count of research articles in es
agricultural_sciences
applied_social_sciences
biological_sciences
engineering
exact_earth_sciences
health_sciences
human_sciences
linguistics_letters_arts
multidisciplinary
area
doc_publishing_year
Count of research articles in pt
agricultural_sciences
applied_social_sciences
biological_sciences
engineering
exact_earth_sciences
health_sciences
human_sciences
linguistics_letters_arts
multidisciplinary
area
doc_publishing_year