IPC_Subclass_Analysis

February 1, 2026

1 IPC Subclass Patent Count Analysis

This notebook provides a comprehensive analysis of patent counts across all ~646 IPC (International Patent Classification) subclasses using the PATSTAT database.

1.1 Overview

- **Goal**: Count patents for all IPC subclasses (4-character codes like A61K, B66B, etc.)
- **Data Source**: PATSTAT Global database via EPO TIP Data services
- **Advantage**: No 10,000 result limit (unlike OPS API)
- **Output**: Complete statistics with granted patents, families, and time ranges

1.2 Key PATSTAT Tables Used

- **TLS209_APPLN_IPC**: IPC classification assignments
- **TLS201_APPLN**: Application details (filing dates, granted status, etc.)

1.3 Prerequisites

Ensure you have access to the EPO TIP Data PATSTAT environment and required Python packages.

1.4 1. Setup and Imports

[1]:
```
# Import required libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from datetime import datetime
import warnings
import os
warnings.filterwarnings('ignore')

# PATSTAT imports
from epo.tipdata.patstat import PatstatClient
from epo.tipdata.patstat.database.models import TLS201_APPLN, TLS209_APPLN_IPC
environment = 'PROD'  # Change 'TEST' to 'PROD' for full dataset
print(f"Connecting to PATSTAT {environment} environment...")
```

```
patstat = PatstatClient(env=environment)

db = patstat.orm()

print(f"  Connected to PATSTAT {environment} environment")
print(f"Database engine: {db.bind}")

from sqlalchemy import func

# Set display options for better output
pd.set_option('display.max_columns', None)
pd.set_option('display.width', None)
pd.set_option('display.max_colwidth', None)

print("Libraries imported successfully!")
print(f"Analysis started at: {datetime.now()}")

# Initialize PATSTAT client
# Use 'TEST' for quick testing (limited data) or 'PROD' for complete analysis
environment = 'PROD'  # Change 'TEST' to 'PROD' for full dataset

print(f"Connecting to PATSTAT {environment} environment...")
patstat = PatstatClient(env=environment)
db = patstat.orm()

print(f"  Connected to PATSTAT {environment} environment")
print(f"Database engine: {db.bind}")
```

```
Connecting to PATSTAT PROD environment…
  Connected to PATSTAT PROD environment
Database engine: Engine(bigquery+custom_dialect://p-epo-tip-
prj-3a1f/p_epo_tip_euwe4_bqd_patstatb)
Libraries imported successfully!
Analysis started at: 2026-02-01 09:01:29.299468
Connecting to PATSTAT PROD environment…
  Connected to PATSTAT PROD environment
Database engine: Engine(bigquery+custom_dialect://p-epo-tip-
prj-3a1f/p_epo_tip_euwe4_bqd_patstatb)
```

1.5 3. IPC Section Mapping

Define the 8 main IPC sections for context and analysis.

[2]:
```
# IPC Section definitions
ipc_sections = {
    'A': 'Human Necessities',
    'B': 'Performing Operations; Transporting',
    'C': 'Chemistry; Metallurgy',
```

```
    'D': 'Textiles; Paper',
    'E': 'Fixed Constructions',
    'F': 'Mechanical Engineering; Lighting; Heating; Weapons; Blasting',
    'G': 'Physics',
    'H': 'Electricity'
}

def get_ipc_section_name(ipc_subclass):
    """Get full section name from IPC subclass."""
    if ipc_subclass and len(ipc_subclass) > 0:
        section = ipc_subclass[0]
        return ipc_sections.get(section, f"Section {section}")
    return "Unknown"

# Display IPC sections
print("IPC Classification Sections:")
print("=" * 50)
for section, description in ipc_sections.items():
    print(f"{section}: {description}")
```

```
IPC Classification Sections:
==================================================
A: Human Necessities
B: Performing Operations; Transporting
C: Chemistry; Metallurgy
D: Textiles; Paper
E: Fixed Constructions
F: Mechanical Engineering; Lighting; Heating; Weapons; Blasting
G: Physics
H: Electricity
```

1.6 4. Comprehensive IPC Subclass Analysis

Execute the main query to count patents across all IPC subclasses.

[3]:
```
print("Building comprehensive IPC subclass query...")

# Import case from sqlalchemy for proper syntax
from sqlalchemy import case, text

# Main query for IPC subclass analysis - BigQuery compatible
comprehensive_query = db.query(
    func.substr(TLS209_APPLN_IPC.ipc_class_symbol, 1, 4).label('ipc_subclass'),
    func.count(TLS201_APPLN.appln_id).label('total_patents'),
    func.sum(
        case(
            (TLS201_APPLN.granted == 'Y', 1),
            else_=0
```

```
        )
    ).label('granted_patents'),
    func.count(func.distinct(TLS201_APPLN.docdb_family_id)).
 ↪label('unique_families'),
    func.min(TLS201_APPLN.earliest_filing_year).label('earliest_year'),
    func.max(TLS201_APPLN.appln_filing_year).label('latest_year'),
    func.avg(TLS201_APPLN.nb_citing_docdb_fam).label('avg_citations')
).join(
    TLS201_APPLN, TLS209_APPLN_IPC.appln_id == TLS201_APPLN.appln_id
).filter(
    TLS201_APPLN.appln_id < 900000000,  # Exclude artificial applications
    func.char_length(func.substr(TLS209_APPLN_IPC.ipc_class_symbol, 1, 4)) ==␣
 ↪4,  # Valid subclasses - BigQuery compatible
    TLS209_APPLN_IPC.ipc_class_level == 'A'  # Full IPC classification
).group_by(
    text('ipc_subclass')  # Use the alias directly
).order_by(
    func.count(TLS201_APPLN.appln_id).desc()
)

print("Executing query... This may take several minutes for PROD environment.")
print("  Please wait...")

# Execute the query and convert to DataFrame
start_time = datetime.now()

try:
    ipc_analysis_df = patstat.df(comprehensive_query)
    end_time = datetime.now()
    query_duration = (end_time - start_time).total_seconds()

    print(f" ")
    print(f"  Query completed successfully!")
    print(f"  Query execution time: {query_duration:.2f} seconds")
    print(f"  Total IPC subclasses found: {len(ipc_analysis_df)}")

except Exception as e:
    print(f"  Query failed: {e}")
    print("Troubleshooting tips:")
    print("- Check database connection")
    print("- Verify PATSTAT access permissions")
    print("- Try using TEST environment first")
```

```
Building comprehensive IPC subclass query…
Executing query… This may take several minutes for PROD environment.
  Please wait…
```

```
Query completed successfully!
Query execution time: 7.69 seconds
Total IPC subclasses found: 659
```

1.7 5. Data Processing and Enhancement

[4]:
```python
# Add additional columns for analysis
if 'ipc_analysis_df' in locals() and not ipc_analysis_df.empty:
    # Add IPC section information
    ipc_analysis_df['ipc_section'] = ipc_analysis_df['ipc_subclass'].str[0]
    ipc_analysis_df['ipc_section_name'] = ipc_analysis_df['ipc_subclass'].
 ↪apply(get_ipc_section_name)

    # Calculate grant rate
    ipc_analysis_df['grant_rate'] = (
        ipc_analysis_df['granted_patents'] / ipc_analysis_df['total_patents'] *␣
 ↪100
    ).round(2)

    # Calculate time span
    ipc_analysis_df['time_span'] = (
        ipc_analysis_df['latest_year'] - ipc_analysis_df['earliest_year']
    )

    # Handle missing citation data
    ipc_analysis_df['avg_citations'] = ipc_analysis_df['avg_citations'].
 ↪fillna(0).round(2)

    print(" Data processing completed")
    print(f" Dataset shape: {ipc_analysis_df.shape}")
    print(f" Total patents covered: {ipc_analysis_df['total_patents'].sum():
 ↪,}")
else:
    print(" No data available for processing")
```

```
Data processing completed
Dataset shape: (659, 11)
Total patents covered: 372,496,109
```

1.8 6. Results Overview

[5]:
```python
# Display basic statistics
if 'ipc_analysis_df' in locals() and not ipc_analysis_df.empty:
    print(" TOP 10 IPC SUBCLASSES BY PATENT COUNT")
    print("=" * 60)

    top_10 = ipc_analysis_df.head(10)[[
        'ipc_subclass', 'ipc_section_name', 'total_patents',
```

```
        'granted_patents', 'grant_rate'
    ]]

    for idx, row in top_10.iterrows():
        print(f"{row['ipc_subclass']:4} | {row['ipc_section_name'][:25]:25} | "
              f"{row['total_patents']:8,} patents | "
              f"{row['granted_patents']:8,} granted ({row['grant_rate']:5.
↪1f}%)")

    print("\n SUMMARY STATISTICS")
    print("=" * 40)
    print(f"Total IPC subclasses analyzed: {len(ipc_analysis_df):,}")
    print(f"Total patents in dataset: {ipc_analysis_df['total_patents'].sum():
↪,}")
    print(f"Total granted patents: {ipc_analysis_df['granted_patents'].sum():
↪,}")
    print(f"Total unique families: {ipc_analysis_df['unique_families'].sum():
↪,}")
    print(f"Average grant rate: {ipc_analysis_df['grant_rate'].mean():.1f}%")

else:
    print(" No results to display")
```

```
 TOP 10 IPC SUBCLASSES BY PATENT COUNT
============================================================
A61K | Human Necessities         | 16,725,442 patents | 8,238,993 granted (
49.3%)
G06F | Physics                   | 11,604,754 patents | 6,186,131 granted (
53.3%)
H01L | Electricity               | 9,067,619 patents | 5,389,740 granted (
59.4%)
A61P | Human Necessities         | 8,564,029 patents | 3,957,057 granted (
46.2%)
C07D | Chemistry; Metallurgy     | 7,555,181 patents | 4,313,302 granted (
57.1%)
H04N | Electricity               | 6,767,644 patents | 3,935,889 granted (
58.2%)
G01N | Physics                   | 6,236,270 patents | 3,672,828 granted (
58.9%)
C07C | Chemistry; Metallurgy     | 5,571,042 patents | 3,509,441 granted (
63.0%)
H01M | Electricity               | 5,272,410 patents | 2,917,795 granted (
55.3%)
H04L | Electricity               | 5,124,876 patents | 3,073,106 granted (
60.0%)

 SUMMARY STATISTICS
```

```
========================================
Total IPC subclasses analyzed: 659
Total patents in dataset: 372,496,109
Total granted patents: 226,115,468
Total unique families: 132,285,989
Average grant rate: 63.8%
```

[6]:
```python
# Display the complete dataset
if 'ipc_analysis_df' in locals() and not ipc_analysis_df.empty:
    print(" COMPLETE IPC SUBCLASS ANALYSIS RESULTS")
    print("=" * 80)

    # Reorder columns for better readability
    display_columns = [
        'ipc_subclass', 'ipc_section', 'ipc_section_name',
        'total_patents', 'granted_patents', 'grant_rate',
        'unique_families', 'earliest_year', 'latest_year',
        'time_span', 'avg_citations'
    ]

    display_df = ipc_analysis_df[display_columns]

    # Show all results
    with pd.option_context('display.max_rows', None):
        display(display_df)

    print(f"\n Showing all {len(display_df)} IPC subclasses")
```

```
 COMPLETE IPC SUBCLASS ANALYSIS RESULTS
================================================================================
```

	ipc_subclass	ipc_section	\
0	A61K	A	
1	G06F	G	
2	H01L	H	
3	A61P	A	
4	C07D	C	
5	H04N	H	
6	G01N	G	
7	C07C	C	
8	H01M	H	
9	H04L	H	
10	B01D	B	
11	A61B	A	
12	H04W	H	
13	B29C	B	
14	B65D	B	
15	C12N	C	
16	G06Q	G	

17	C08L	C
18	B32B	B
19	B01J	B
20	G02B	G
21	G11B	G
22	B65G	B
23	H05K	H
24	C08F	C
25	H01R	H
26	C07K	C
27	C02F	C
28	C08K	C
29	H04B	H
30	F21V	F
31	C08G	C
32	A23L	A
33	A61M	A
34	B23K	B
35	G06T	G
36	G01R	G
37	C09D	C
38	A01N	A
39	H02K	H
40	A61F	A
41	F24F	F
42	B65H	B
43	C04B	C
44	B24B	B
45	G06N	G
46	H01H	H
47	B08B	B
48	F16K	F
49	F16H	F
50	B41J	B
51	C23C	C
52	F16L	F
53	G06K	G
54	B01F	B
55	H02J	H
56	B60R	B
57	A61L	A
58	E21B	E
59	H04M	H
60	G02F	G
61	E04B	E
62	G06V	G
63	C22C	C
64	H05B	H

65	B65B	B
66	G01S	G
67	G03G	G
68	B21D	B
69	H01J	H
70	H01B	H
71	A01G	A
72	B62D	B
73	B02C	B
74	H01F	H
75	G01B	G
76	B23Q	B
77	F26B	F
78	C09K	C
79	C11D	C
80	A47J	A
81	G03B	G
82	E06B	E
83	H01Q	H
84	A47B	A
85	F04D	F
86	A61Q	A
87	G09G	G
88	C12Q	C
89	C08J	C
90	G11C	G
91	C09J	C
92	B05B	B
93	A01K	A
94	G09F	G
95	A63B	A
96	F16D	F
97	C01B	C
98	H02M	H
99	A63F	A
100	F02M	F
101	B60K	B
102	F16C	F
103	G08B	G
104	F04B	F
105	G03F	G
106	F16B	F
107	B26D	B
108	E02D	E
109	G05B	G
110	D06M	D
111	F02D	F
112	F16F	F

113	F16M	F
114	E05B	E
115	B60W	B
116	E04G	E
117	C12P	C
118	A47L	A
119	A47C	A
120	G10L	G
121	H04R	H
122	B25J	B
123	H03K	H
124	B60L	B
125	H02G	H
126	E04H	E
127	H02B	H
128	G01M	G
129	G01C	G
130	F25B	F
131	G05D	G
132	B22D	B
133	H02P	H
134	C07F	C
135	F21S	F
136	E04F	E
137	F25D	F
138	F02B	F
139	A23K	A
140	H01S	H
141	D06F	D
142	B07B	B
143	B66C	B
144	B60T	B
145	B25B	B
146	H01G	H
147	C21D	C
148	A61N	A
149	F01N	F
150	H10N	H
151	G01F	G
152	B05D	B
153	A61G	A
154	A41D	A
155	C12M	C
156	B23B	B
157	C03C	C
158	G01D	G
159	A47G	A
160	G09B	G

161	A61H	A
162	B22F	B
163	B63B	B
164	B05C	B
165	G08G	G
166	F24H	F
167	C22B	C
168	G16H	G
169	D21H	D
170	B60C	B
171	A01D	A
172	F28F	F
173	F15B	F
174	B66B	B
175	A43B	A
176	B60N	B
177	C25D	C
178	B41M	B
179	B28B	B
180	C07H	C
181	C03B	C
182	B23P	B
183	C10G	C
184	B41F	B
185	G01L	G
186	H10K	H
187	B29B	B
188	H02H	H
189	E04C	E
190	H04Q	H
191	C09B	C
192	C12R	C
193	F16J	F
194	E02F	E
195	B66F	B
196	G07F	G
197	A61C	A
198	F21Y	F
199	F01D	F
200	C10M	C
201	B21B	B
202	H03M	H
203	A01C	A
204	B23D	B
205	F04C	F
206	B64C	B
207	F24C	F
208	G01J	G

209	B62B	B
210	H04J	H
211	H10B	H
212	H03H	H
213	E01C	E
214	A24F	A
215	A01B	A
216	D04H	D
217	B30B	B
218	A45D	A
219	A47K	A
220	E02B	E
221	A23G	A
222	C10L	C
223	A45C	A
224	F28D	F
225	E21D	E
226	B60J	B
227	C30B	C
228	G03C	G
229	C25B	C
230	H03F	H
231	G01K	G
232	D03D	D
233	F27D	F
234	A62C	A
235	G01V	G
236	F03D	F
237	E01F	E
238	A01M	A
239	A63H	A
240	F27B	F
241	D01F	D
242	E04D	E
243	B29L	B
244	B60Q	B
245	C01G	C
246	B60G	B
247	C07B	C
248	A01H	A
249	A61J	A
250	H02S	H
251	B29D	B
252	E01D	E
253	E05F	E
254	A01P	A
255	C10N	C
256	B21C	B

257	F23D	F
258	B64D	B
259	E03F	E
260	G21C	G
261	B31B	B
262	F24D	F
263	G07C	G
264	B60H	B
265	G01P	G
266	F02C	F
267	A47F	A
268	B07C	B
269	B33Y	B
270	E05D	E
271	D06P	D
272	B29K	B
273	B01L	B
274	G01G	G
275	B65F	B
276	B60P	B
277	F17C	F
278	B42D	B
279	B60B	B
280	D05B	D
281	D06B	D
282	B22C	B
283	D04B	D
284	B60S	B
285	F23G	F
286	B62K	B
287	H01P	H
288	B62J	B
289	F24S	F
290	G02C	G
291	B03C	B
292	G08C	G
293	B09B	B
294	B67D	B
295	F01L	F
296	B63H	B
297	C21C	C
298	F21W	F
299	B25H	B
300	A01F	A
301	A23B	A
302	B28D	B
303	B82Y	B
304	A46B	A

305	B28C	B
306	B21J	B
307	B26B	B
308	A62B	A
309	A23C	A
310	H04H	H
311	C07J	C
312	E03C	E
313	H01C	H
314	E03D	E
315	G04B	G
316	G10K	G
317	D01D	D
318	C05G	C
319	F01P	F
320	A21D	A
321	B43K	B
322	F22B	F
323	D01H	D
324	F42B	F
325	F02F	F
326	G05F	G
327	C08B	C
328	C09C	C
329	G07D	G
330	E03B	E
331	E01B	E
332	A44B	A
333	B62M	B
334	F03B	F
335	C10B	C
336	E05C	E
337	C05F	C
338	C23F	C
339	G01T	G
340	B24D	B
341	A23F	A
342	A23N	A
343	D02G	D
344	E21F	E
345	B66D	B
346	B44C	B
347	H03L	H
348	F16N	F
349	D21F	D
350	F41A	F
351	F23J	F
352	B21F	B

353	F02P	F
354	G16B	G
355	C11B	C
356	B43L	B
357	B04B	B
358	C21B	C
359	B61D	B
360	C22F	C
361	A63C	A
362	B26F	B
363	F01M	F
364	B61L	B
365	C01F	C
366	B23C	B
367	F01K	F
368	B65C	B
369	A42B	A
370	A44C	A
371	G10H	G
372	H05H	H
373	G21F	G
374	A22C	A
375	F17D	F
376	F23N	F
377	G04G	G
378	G05G	G
379	E01H	E
380	E06C	E
381	B24C	B
382	H03G	H
383	B67C	B
384	F16G	F
385	A45B	A
386	B42F	B
387	A21C	A
388	A24B	A
389	E21C	E
390	H02N	H
391	D21C	D
392	C25C	C
393	B27B	B
394	C10J	C
395	H01T	H
396	F23C	F
397	F24J	F
398	A23P	A
399	F21K	F
400	B23H	B

401	B63C	B
402	A24D	A
403	A41B	A
404	F02K	F
405	D06N	D
406	D06C	D
407	C12G	C
408	A23J	A
409	F02N	F
410	G01H	G
411	H03B	H
412	F23Q	F
413	D01G	D
414	B03B	B
415	G07G	G
416	H03J	H
417	A43D	A
418	G07B	G
419	C23G	C
420	A45F	A
421	G04C	G
422	B64U	B
423	B64G	B
424	B61F	B
425	A23D	A
426	B64F	B
427	C40B	C
428	F01C	F
429	F23L	F
430	B27N	B
431	F23R	F
432	B61B	B
433	A47D	A
434	B67B	B
435	B27K	B
436	A62D	A
437	G10D	G
438	B21K	B
439	B04C	B
440	B25D	B
441	F25C	F
442	F03G	F
443	G21K	G
444	F41G	F
445	B81B	B
446	F25J	F
447	B25C	B
448	B09C	B

449	A47H	A
450	B03D	B
451	B06B	B
452	B27C	B
453	C06B	C
454	A61D	A
455	F41H	F
456	H03D	H
457	B25F	B
458	G06G	G
459	B60D	B
460	F24B	F
461	A21B	A
462	H04S	H
463	B23F	B
464	F23K	F
465	G03H	G
466	B41K	B
467	C01D	C
468	A24C	A
469	D06H	D
470	F21L	F
471	D07B	D
472	H10D	H
473	G03D	G
474	D06L	D
475	H01K	H
476	G16C	G
477	A41C	A
478	G16Y	G
479	B23G	B
480	B27G	B
481	G01Q	G
482	F01B	F
483	A63G	A
484	A01J	A
485	B41N	B
486	B27D	B
487	G06M	G
488	F42C	F
489	F28G	F
490	F04F	F
491	B27M	B
492	B02B	B
493	B62H	B
494	F42D	F
495	A43C	A
496	C12C	C

497	B44B	B
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499	G01W	G
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501	F41B	F
502	B31F	B
503	B81C	B
504	B25G	B
505	C10K	C
506	C11C	C
507	C01C	C
508	F02G	F
509	D05C	D
510	B61C	B
511	B44D	B
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513	F28B	F
514	D02J	D
515	G12B	G
516	B82B	B
517	G09C	G
518	B21H	B
519	C14C	C
520	B41C	B
521	H05F	H
522	F28C	F
523	B61G	B
524	C08C	C
525	B42C	B
526	B60M	B
527	B27L	B
528	G04F	G
529	C25F	C
530	B62L	B
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532	C12H	C
533	F03C	F
534	C14B	C
535	D21B	D
536	B41L	B
537	B63G	B
538	F23M	F
539	B44F	B
540	D03C	D
541	G21D	G
542	B61K	B
543	D21D	D
544	B61H	B

545	H04K	H
546	C13B	C
547	E05G	E
548	D21G	D
549	H03C	H
550	F41J	F
551	C09G	C
552	H10F	H
553	F16P	F
554	F41C	F
555	B68G	B
556	H10H	H
557	C10C	C
558	B63J	B
559	B43M	B
560	B27F	B
561	A46D	A
562	D03J	D
563	D04C	D
564	C05D	C
565	A41G	A
566	C05C	C
567	A22B	A
568	B41B	B
569	G10G	G
570	B31D	B
571	G10C	G
572	C05B	C
573	D01B	D
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583	C08H	C
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585	F22G	F
586	D06G	D
587	F16T	F
588	D02H	D
589	B60F	B
590	F15C	F
591	A63J	A
592	G06C	G

593	F15D	F
594	F41F	F
595	G21G	G
596	G16Z	G
597	B60V	B
598	G04R	G
599	D06Q	D
600	G04D	G
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638	C10F	C
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649	G99Z	G
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651	H99Z	H
652	F99Z	F
653	E99Z	E
654	B99Z	B
655	D99Z	D
656	C13D	C
657	C13F	C
658	C13J	C

	ipc_section_name \
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1	Physics
2	Electricity
3	Human Necessities
4	Chemistry; Metallurgy
5	Electricity
6	Physics
7	Chemistry; Metallurgy
8	Electricity
9	Electricity
10	Performing Operations; Transporting
11	Human Necessities
12	Electricity
13	Performing Operations; Transporting
14	Performing Operations; Transporting
15	Chemistry; Metallurgy
16	Physics
17	Chemistry; Metallurgy
18	Performing Operations; Transporting
19	Performing Operations; Transporting
20	Physics
21	Physics
22	Performing Operations; Transporting
23	Electricity
24	Chemistry; Metallurgy
25	Electricity
26	Chemistry; Metallurgy
27	Chemistry; Metallurgy

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29                                                   Electricity
30  Mechanical Engineering; Lighting; Heating; Weapons; Blasting
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35                                                       Physics
36                                                       Physics
37                                          Chemistry; Metallurgy
38                                              Human Necessities
39                                                   Electricity
40                                              Human Necessities
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74                                                   Electricity
75                                                       Physics
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Mechanical Engineering; Lighting; Heating; Weapons; Blasting
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266 Mechanical Engineering; Lighting; Heating; Weapons; Blasting
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412 Mechanical Engineering; Lighting; Heating; Weapons; Blasting
413 Textiles; Paper
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454 Human Necessities
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458 Physics
459 Performing Operations; Transporting

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561 Human Necessities
562 Textiles; Paper
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602 Performing Operations; Transporting
603 Chemistry; Metallurgy

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                                          Fixed Constructions
                                              Textiles; Paper
                                                      Physics
                                                  Electricity
                                        Chemistry; Metallurgy
                          Performing Operations; Transporting
                                        Chemistry; Metallurgy
                                        Chemistry; Metallurgy
                                              Textiles; Paper
                          Performing Operations; Transporting
                          Performing Operations; Transporting
                          Performing Operations; Transporting
                                        Chemistry; Metallurgy
Mechanical Engineering; Lighting; Heating; Weapons; Blasting
                          Performing Operations; Transporting
                                                      Physics
                                            Human Necessities
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                                        Chemistry; Metallurgy
                                                  Electricity
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652 Mechanical Engineering; Lighting; Heating; Weapons; Blasting
653   Fixed Constructions
654   Performing Operations; Transporting
655   Textiles; Paper
656   Chemistry; Metallurgy
657   Chemistry; Metallurgy
658   Chemistry; Metallurgy

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442	77043	35864	46.55	50509
443	75640	44919	59.39	35263
444	74676	51874	69.47	33975
445	73791	41162	55.78	36012
446	72929	45814	62.82	24775
447	72183	49170	68.12	29845
448	72003	41961	58.28	42425
449	71968	50206	69.76	44739
450	71562	44745	62.53	26817
451	71138	44921	63.15	39514
452	70310	53366	75.90	47037
453	70126	47988	68.43	25803
454	69544	50348	72.40	46953
455	69466	44322	63.80	35510
456	68465	46176	67.44	30630
457	68206	42914	62.92	37811
458	68016	49874	73.33	42830
459	67830	47295	69.73	33311
460	67750	49991	73.79	40592
461	67544	49056	72.63	35669
462	67081	39404	58.74	23850
463	66703	48714	73.03	33229
464	65722	41454	63.07	44209
465	65662	36754	55.97	24038
466	65535	44527	67.94	32937
467	64472	38318	59.43	34985
468	64450	43288	67.17	25967
469	63206	48134	76.15	50226
470	63045	45479	72.14	50002

471	62948	42202	67.04	28613
472	62576	28422	45.42	19754
473	62484	36572	58.53	32588
474	61988	35127	56.67	16105
475	60136	35522	59.07	27055
476	59754	18898	31.63	31154
477	59630	42275	70.90	31550
478	59134	26048	44.05	24124
479	59051	44894	76.03	37104
480	58455	42890	73.37	44896
481	58067	34409	59.26	14146
482	57907	36571	63.15	28322
483	57868	39906	68.96	33178
484	56667	39415	69.56	24892
485	56663	32266	56.94	25134
486	56398	35487	62.92	39228
487	55799	36629	65.64	32565
488	54784	39656	72.39	20356
489	54695	38864	71.06	30221
490	54350	36174	66.56	30052
491	54218	33055	60.97	36761
492	53071	34212	64.46	29925
493	53023	36070	68.03	37668
494	51364	33951	66.10	25310
495	51358	34920	67.99	25958
496	50643	29393	58.04	18459
497	50488	38985	77.22	26070
498	50485	32565	64.50	21914
499	50477	30566	60.55	37469
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501	50157	35749	71.27	28974
502	49370	33680	68.22	26593
503	49286	27973	56.76	27789
504	49203	33226	67.53	27670
505	48818	31499	64.52	21792
506	48801	29654	60.77	20345
507	47360	29800	62.92	26191
508	47350	27041	57.11	23577
509	46398	32188	69.37	25818
510	46276	32100	69.37	30317
511	45923	32813	71.45	32658
512	44958	29717	66.10	33184
513	44934	33233	73.96	26056
514	44411	27569	62.08	24297
515	44366	25870	58.31	33589
516	44053	26343	59.80	26841
517	43377	24718	56.98	21299
518	43364	30716	70.83	25673

519	43353	28261	65.19	19456
520	43189	26157	60.56	21268
521	42706	29489	69.05	33079
522	41318	30370	73.50	30109
523	41220	29975	72.72	21010
524	41214	28267	68.59	13746
525	40648	28376	69.81	19597
526	40098	26726	66.65	25989
527	39804	27662	69.50	26528
528	39349	24465	62.17	24282
529	39128	24171	61.77	18817
530	39085	28376	72.60	24364
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532	38599	22188	57.48	22315
533	38380	23668	61.67	14055
534	38102	28308	74.30	21529
535	38098	24454	64.19	16537
536	38040	26495	69.65	21550
537	38028	23597	62.05	20952
538	37490	25018	66.73	24311
539	37490	23576	62.89	19387
540	37368	26662	71.35	15968
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542	36960	27500	74.40	27399
543	36554	24145	66.05	16208
544	36001	26568	73.80	21640
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546	33509	20784	62.03	15366
547	33295	23210	69.71	18724
548	31781	20630	64.91	12521
549	31133	21875	70.26	14813
550	30296	20805	68.67	16663
551	29982	16636	55.49	13193
552	29871	13261	44.39	13278
553	29430	20339	69.11	18960
554	29379	20863	71.01	15890
555	29157	17957	61.59	16767
556	29109	12149	41.74	9337
557	28792	19997	69.45	15500
558	28567	16137	56.49	18739
559	27097	17831	65.80	20985
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561	26482	16828	63.55	12641
562	25763	18308	71.06	18542
563	25609	17003	66.39	14670
564	25603	14093	55.04	12809
565	25399	14990	59.02	17781
566	25316	15822	62.50	11042

567	25178	17680	70.22	13484
568	24822	16588	66.83	15718
569	24066	15924	66.17	18871
570	23980	15424	64.32	13147
571	22616	14136	62.50	14530
572	22506	14544	64.62	12597
573	22271	16016	71.91	16499
574	22132	15754	71.18	17895
575	21807	15027	68.91	12542
576	21645	13608	62.87	12756
577	21293	13792	64.77	8065
578	21141	8750	41.39	8316
579	20967	12547	59.84	10873
580	20957	13416	64.02	8231
581	20833	13934	66.88	14678
582	20739	15235	73.46	14114
583	20536	11196	54.52	9719
584	20409	13879	68.00	14213
585	20276	13565	66.90	14334
586	20198	15877	78.61	19398
587	19859	13652	68.74	11900
588	19551	15125	77.36	11072
589	19333	11938	61.75	14716
590	19232	13376	69.55	8738
591	18944	13233	69.85	13258
592	17603	11015	62.57	13200
593	17351	10836	62.45	9487
594	17284	12356	71.49	10134
595	15608	9554	61.21	6297
596	15225	8126	53.37	5475
597	15170	10064	66.34	6063
598	14947	8830	59.08	7640
599	14039	8147	58.03	8425
600	13984	9597	68.63	8995
601	13019	8431	64.76	6557
602	12462	8075	64.80	11424
603	12425	5694	45.83	9848
604	12070	7643	63.32	5349
605	10927	7681	70.29	4911
606	10417	6078	58.35	3368
607	10261	6831	66.57	7848
608	10243	5820	56.82	6836
609	9925	5659	57.02	6424
610	9680	5899	60.94	7466
611	9671	6802	70.33	6128
612	9586	6924	72.23	6089
613	9429	6793	72.04	5203
614	9289	6467	69.62	4881

615	8356	4403	52.69	4349
616	8134	5038	61.94	5750
617	8056	5419	67.27	5783
618	7720	4997	64.73	4312
619	7514	4538	60.39	4254
620	7358	3906	53.09	6054
621	6432	3826	59.48	3253
622	6350	3839	60.46	5262
623	6069	4200	69.20	3876
624	6010	3773	62.78	3395
625	5857	3236	55.25	3950
626	5651	3999	70.77	4336
627	5051	3580	70.88	4166
628	4847	3347	69.05	3902
629	4464	2886	64.65	3428
630	4388	3051	69.53	2251
631	4377	3008	68.72	3532
632	4238	2863	67.56	2994
633	4096	2966	72.41	2434
634	4034	2637	65.37	2723
635	3775	2005	53.11	2738
636	3711	2455	66.15	2279
637	3524	2093	59.39	2048
638	3347	2435	72.75	2233
639	3168	2202	69.51	2151
640	3103	2413	77.76	2783
641	3072	2292	74.61	2503
642	2519	1626	64.55	2152
643	1541	1030	66.84	1289
644	1232	661	53.65	1041
645	1048	677	64.60	825
646	990	802	81.01	783
647	560	383	68.39	556
648	305	180	59.02	230
649	173	21	12.14	167
650	70	45	64.29	47
651	57	23	40.35	51
652	46	34	73.91	46
653	29	14	48.28	27
654	24	12	50.00	24
655	13	10	76.92	13
656	8	8	100.00	7
657	3	3	100.00	3
658	1	1	100.00	1

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3	1905	9999	8094	28.29
4	1882	9999	8117	28.12
5	1819	9999	8180	31.85
6	1899	9999	8100	16.32
7	1882	9999	8117	16.51
8	1884	9999	8115	11.78
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10	1866	9999	8133	7.97
11	1899	9999	8100	53.46
12	1907	9999	8092	27.39
13	1877	9999	8122	11.47
14	1877	9999	8122	8.37
15	1889	9999	8110	35.52
16	1940	9999	8059	21.64
17	1856	9999	8143	14.03
18	1888	9999	8111	9.95
19	1855	9999	8144	14.48
20	1844	9999	8155	16.21
21	1819	9999	8180	14.93
22	1886	9999	8113	4.68
23	1889	9999	8110	9.21
24	1854	9999	8145	22.08
25	1883	9999	8116	8.27
26	1897	9999	8102	40.77
27	1866	9999	8133	6.00
28	1885	9999	8114	10.34
29	1896	9999	8103	23.62
30	1849	9999	8150	5.68
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35	1920	9999	8079	15.98
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37	1854	9999	8145	11.98
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45	1960	9999	8039	8.72
46	1884	9999	8115	6.16
47	1892	9999	8107	2.80
48	1877	9999	8122	5.31
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75	1877	9999	8122	8.91
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82	1878	9999	8121	4.58
83	1900	9999	8099	16.11
84	1863	9999	8136	3.65
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96	1870	9999	8129	8.67
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107	1894	9999	8105	3.26
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133	1900	9999	8099	9.58
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146	1900	9999	8099	10.32
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168	1966	2025	59	23.93
169	1859	9999	8140	15.76
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186	1949	9999	8050	12.69
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192	1920	9999	8079	22.69
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242	1869	9999	8130	5.47
243	1905	9999	8094	9.67
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254	1945	9999	8054	10.67
255	1947	9999	8052	14.97
256	1877	9999	8122	4.40
257	1877	9999	8122	5.84
258	1894	9999	8105	10.64
259	1889	9999	8110	2.25
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263	1878	9999	8121	18.11
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266	1861	9999	8138	16.20
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268	1904	9999	8095	5.11
269	1997	2025	28	9.57
270	1878	9999	8121	6.58
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278	1894	9999	8105	12.73
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297	1900	9999	8099	4.90
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300	1877	9999	8122	3.22
301	1860	9999	8139	7.22
302	1877	9999	8122	4.55
303	1973	9999	8026	10.20
304	1895	9999	8104	10.50
305	1895	9999	8104	2.65
306	1866	9999	8133	5.17
307	1892	9999	8107	12.69
308	1880	9999	8119	11.50
309	1886	9999	8113	12.25
310	1905	9999	8094	88.78
311	1904	9999	8095	13.50
312	1894	9999	8105	4.33
313	1894	9999	8105	6.66
314	1862	9999	8137	3.91
315	1845	9999	8154	4.95
316	1899	9999	8100	14.62
317	1877	9999	8122	9.87
318	1899	9999	8100	5.42
319	1899	9999	8100	7.52
320	1901	9999	8098	8.42
321	1894	9999	8105	4.50
322	1877	9999	8122	5.04
323	1894	9999	8105	4.60
324	1873	9999	8126	9.83
325	1901	9999	8098	7.15
326	1902	9999	8097	12.11
327	1882	9999	8117	17.70
328	1877	9999	8122	18.84
329	1899	9999	8100	14.30
330	1902	9999	8097	2.48
331	1897	9999	8102	5.48
332	1871	9999	8128	9.68
333	1893	9999	8106	9.77
334	1894	9999	8105	6.69
335	1870	9999	8129	7.18
336	1884	9999	8115	5.87
337	1877	9999	8122	5.48

338	1899	9999	8100	14.21
339	1902	9999	8097	11.42
340	1887	9999	8112	17.86
341	1868	9999	8131	6.58
342	1899	9999	8100	2.42
343	1901	9999	8098	8.34
344	1902	9999	8097	2.39
345	1883	9999	8116	3.39
346	1899	9999	8100	9.60
347	1903	9999	8096	15.29
348	1889	9999	8110	3.63
349	1881	9999	8118	14.46
350	1874	9999	8125	9.36
351	1877	9999	8122	3.85
352	1895	9999	8104	3.42
353	1901	9999	8098	8.43
354	1981	2025	44	25.26
355	1855	9999	8144	9.56
356	1887	9999	8112	1.99
357	1889	9999	8110	8.48
358	1868	9999	8131	6.04
359	1895	9999	8104	5.51
360	1902	9999	8097	9.79
361	1877	9999	8122	9.46
362	1877	9999	8122	6.42
363	1883	9999	8116	7.32
364	1884	9999	8115	6.57
365	1884	9999	8115	10.26
366	1893	9999	8106	7.80
367	1882	9999	8117	10.14
368	1896	9999	8103	7.15
369	1878	9999	8121	8.48
370	1879	9999	8120	4.49
371	1903	9999	8096	11.04
372	1904	9999	8095	18.06
373	1903	9999	8096	7.38
374	1901	9999	8098	6.40
375	1902	9999	8097	4.34
376	1880	9999	8119	5.83
377	1905	9999	8094	11.62
378	1900	9999	8099	9.00
379	1887	9999	8112	4.13
380	1883	9999	8116	3.37
381	1902	9999	8097	5.34
382	1819	9999	8180	14.67
383	1898	9999	8101	4.54
384	1882	9999	8117	8.57
385	1878	9999	8121	2.97

386	1879	9999	8120	3.33
387	1898	9999	8101	5.38
388	1900	9999	8099	15.53
389	1901	9999	8098	6.23
390	1899	9999	8100	10.24
391	1881	9999	8118	13.47
392	1894	9999	8105	6.86
393	1877	9999	8122	6.41
394	1885	9999	8114	9.96
395	1888	9999	8111	6.76
396	1880	9999	8119	10.84
397	1881	9999	8118	8.92
398	1902	9999	8097	7.23
399	1898	9999	8101	11.79
400	1875	9999	8124	5.84
401	1899	9999	8100	5.56
402	1895	9999	8104	24.90
403	1890	9999	8109	7.63
404	1881	9999	8118	12.99
405	1891	9999	8108	10.75
406	1877	9999	8122	4.37
407	1889	9999	8110	3.80
408	1895	9999	8104	13.39
409	1902	9999	8097	9.29
410	1909	9999	8090	8.73
411	1881	9999	8118	10.32
412	1870	9999	8129	3.94
413	1877	9999	8122	5.14
414	1877	9999	8122	6.39
415	1900	9999	8099	18.33
416	1901	9999	8098	13.21
417	1891	9999	8108	5.05
418	1877	9999	8122	13.93
419	1902	9999	8097	8.36
420	1894	9999	8105	7.57
421	1889	9999	8110	5.18
422	2002	2025	23	2.69
423	1905	9999	8094	10.48
424	1877	9999	8122	6.34
425	1877	9999	8122	16.50
426	1901	9999	8098	10.17
427	1946	9999	8053	80.71
428	1878	9999	8121	8.82
429	1881	9999	8118	5.20
430	1904	9999	8095	9.29
431	1902	9999	8097	19.09
432	1877	9999	8122	6.43
433	1881	9999	8118	6.92

434	1890	9999	8109	5.84
435	1898	9999	8101	6.42
436	1901	9999	8098	13.76
437	1877	9999	8122	3.93
438	1886	9999	8113	6.35
439	1870	9999	8129	13.48
440	1900	9999	8099	9.48
441	1880	9999	8119	7.68
442	1877	9999	8122	7.52
443	1901	9999	8098	18.39
444	1889	9999	8110	11.65
445	1960	2025	65	22.99
446	1896	9999	8103	16.68
447	1902	9999	8097	15.62
448	1954	9999	8045	8.47
449	1889	9999	8110	3.85
450	1892	9999	8107	7.10
451	1904	9999	8095	14.90
452	1894	9999	8105	5.49
453	1889	9999	8110	8.70
454	1883	9999	8116	8.78
455	1878	9999	8121	10.42
456	1899	9999	8100	13.25
457	1898	9999	8101	15.42
458	1891	9999	8108	15.83
459	1901	9999	8098	7.22
460	1877	9999	8122	2.76
461	1901	9999	8098	6.56
462	1921	9999	8078	22.76
463	1875	9999	8124	5.07
464	1896	9999	8103	4.23
465	1947	9999	8052	17.74
466	1902	9999	8097	3.27
467	1866	9999	8133	6.82
468	1880	9999	8119	11.00
469	1902	9999	8097	4.17
470	1878	9999	8121	6.08
471	1891	9999	8108	8.27
472	1998	2025	27	4.71
473	1897	9999	8102	4.92
474	1882	9999	8117	20.66
475	1879	9999	8120	6.21
476	1995	2025	30	2.60
477	1876	9999	8123	5.97
478	2006	2025	19	3.64
479	1874	9999	8125	2.86
480	1877	9999	8122	4.76
481	1904	9999	8095	20.73

482	1877	9999	8122	8.34
483	1881	9999	8118	6.35
484	1859	9999	8140	9.55
485	1877	9999	8122	10.40
486	1902	9999	8097	3.25
487	1877	9999	8122	8.33
488	1886	9999	8113	6.76
489	1893	9999	8106	4.02
490	1877	9999	8122	7.34
491	1901	9999	8098	9.43
492	1877	9999	8122	2.66
493	1894	9999	8105	4.20
494	1895	9999	8104	6.50
495	1878	9999	8121	16.59
496	1887	9999	8112	8.87
497	1894	9999	8105	3.74
498	1902	9999	8097	14.45
499	1903	9999	8096	7.12
500	1885	9999	8114	5.26
501	1889	9999	8110	8.29
502	1902	9999	8097	11.84
503	1952	2025	73	21.80
504	1889	9999	8110	8.44
505	1886	9999	8113	8.16
506	1857	9999	8142	15.02
507	1894	9999	8105	7.28
508	1894	9999	8105	12.13
509	1885	9999	8114	5.45
510	1877	9999	8122	5.37
511	1894	9999	8105	5.50
512	1890	9999	8109	2.47
513	1885	9999	8114	3.28
514	1900	9999	8099	6.80
515	1918	9999	8081	5.84
516	1975	2025	50	24.74
517	1902	9999	8097	54.89
518	1884	9999	8115	5.08
519	1879	9999	8120	6.61
520	1882	9999	8117	12.43
521	1902	9999	8097	4.88
522	1902	9999	8097	4.91
523	1892	9999	8107	4.56
524	1905	9999	8094	13.98
525	1902	9999	8097	33.89
526	1889	9999	8110	6.32
527	1882	9999	8117	3.79
528	1888	9999	8111	8.35
529	1904	9999	8095	9.04

530	1889	9999	8110	5.37
531	1890	9999	8109	5.00
532	1889	9999	8110	6.64
533	1881	9999	8118	7.30
534	1884	9999	8115	2.41
535	1902	9999	8097	8.94
536	1899	9999	8100	16.38
537	1892	9999	8107	6.49
538	1856	9999	8143	6.12
539	1899	9999	8100	18.67
540	1896	9999	8103	4.69
541	1918	9999	8081	6.33
542	1891	9999	8108	4.67
543	1899	9999	8100	8.40
544	1894	9999	8105	4.47
545	1903	9999	8096	38.59
546	1845	9999	8154	7.85
547	1894	9999	8105	5.31
548	1899	9999	8100	9.36
549	1881	9999	8118	12.27
550	1890	9999	8109	5.82
551	1902	9999	8097	15.35
552	1992	2025	33	1.59
553	1900	9999	8099	7.72
554	1878	9999	8121	11.78
555	1901	9999	8098	9.56
556	1993	2025	32	3.46
557	1866	9999	8133	10.19
558	1903	9999	8096	5.26
559	1899	9999	8100	4.29
560	1877	9999	8122	19.43
561	1895	9999	8104	12.46
562	1898	9999	8101	2.78
563	1899	9999	8100	9.95
564	1899	9999	8100	7.94
565	1901	9999	8098	5.87
566	1894	9999	8105	9.47
567	1899	9999	8100	5.74
568	1854	9999	8145	3.56
569	1892	9999	8107	5.22
570	1902	9999	8097	13.64
571	1897	9999	8102	2.63
572	1894	9999	8105	6.50
573	1900	9999	8099	2.74
574	1931	9999	8068	4.80
575	1878	9999	8121	4.09
576	1898	9999	8101	6.98
577	1883	9999	8116	15.75

578	1934	9999	8065	6.74
579	1879	9999	8120	11.45
580	1903	9999	8096	16.20
581	1903	9999	8096	3.52
582	1883	9999	8116	4.62
583	1900	9999	8099	24.81
584	1877	9999	8122	4.31
585	1893	9999	8106	3.48
586	1903	9999	8096	1.30
587	1894	9999	8105	3.48
588	1902	9999	8097	3.10
589	1902	9999	8097	6.18
590	1916	9999	8083	20.56
591	1895	9999	8104	7.34
592	1891	9999	8108	4.60
593	1905	9999	8094	12.74
594	1873	9999	8126	6.44
595	1904	9999	8095	13.43
596	1986	2025	39	78.28
597	1907	9999	8092	6.98
598	1910	9999	8089	8.16
599	1883	9999	8116	9.50
600	1888	9999	8111	3.67
601	1877	9999	8122	5.72
602	1884	9999	8115	2.03
603	1902	9999	8097	2.71
604	1902	9999	8097	15.36
605	1902	9999	8097	11.56
606	1960	2016	56	39.81
607	1877	9999	8122	6.87
608	1899	9999	8100	4.07
609	1970	2025	55	3.51
610	1894	9999	8105	2.60
611	1895	9999	8104	6.16
612	1895	9999	8104	4.30
613	1901	9999	8098	5.77
614	1902	9999	8097	7.40
615	1882	9999	8117	21.17
616	1877	9999	8122	4.35
617	1902	9999	8097	3.35
618	1933	9999	8066	20.70
619	1877	9999	8122	4.99
620	1896	9999	8103	2.19
621	1904	9999	8095	9.80
622	1901	9999	8098	2.39
623	1903	9999	8096	2.34
624	1884	9999	8115	4.80
625	1942	9999	8057	7.81

626	1891	9999	8108	2.60
627	1901	9999	8098	2.92
628	1897	9999	8102	0.97
629	1881	9999	8118	2.71
630	1902	9999	8097	12.16
631	1895	9999	8104	1.60
632	1902	9999	8097	6.14
633	1920	9999	8079	11.42
634	1905	9999	8094	6.53
635	1870	9999	8129	1.55
636	1878	9999	8121	15.96
637	1902	9999	8097	7.83
638	1877	9999	8122	4.48
639	1877	9999	8122	6.48
640	1897	9999	8102	2.94
641	1854	9999	8145	2.44
642	1881	9999	8118	2.92
643	1877	9999	8122	2.45
644	1896	9999	8103	2.22
645	1906	9999	8093	3.05
646	1933	9999	8066	32.12
647	1996	2025	29	10.33
648	1939	9999	8060	3.29
649	1998	2024	26	2.46
650	1990	2024	34	18.17
651	2005	2023	18	2.88
652	2004	2023	19	2.09
653	1997	2023	26	4.72
654	2006	2022	16	1.00
655	2005	2024	19	3.69
656	1971	1991	20	7.50
657	1984	1991	7	10.67
658	1973	1974	1	23.00

Showing all 659 IPC subclasses

1.9 7. Analysis by IPC Section

[7]:
```
# Aggregate statistics by IPC section
if 'ipc_analysis_df' in locals() and not ipc_analysis_df.empty:
    section_analysis = ipc_analysis_df.groupby(['ipc_section',␣
 ↪'ipc_section_name']).agg({
        'ipc_subclass': 'count',
        'total_patents': 'sum',
        'granted_patents': 'sum',
        'unique_families': 'sum',
        'grant_rate': 'mean',
```

```
        'avg_citations': 'mean'
    }).round(2)

    section_analysis.columns = [
        'subclasses_count', 'total_patents', 'granted_patents',
        'unique_families', 'avg_grant_rate', 'avg_citations'
    ]

    section_analysis = section_analysis.sort_values('total_patents',␣
↪ascending=False)

    print("  IPC SECTION ANALYSIS")
    print("=" * 80)
    display(section_analysis)

    print("\n  SECTION RANKINGS BY PATENT COUNT:")
    for idx, (section_info, row) in enumerate(section_analysis.iterrows(), 1):
        section, name = section_info
        print(f"{idx}. Section {section} ({name}): {row['total_patents']:,}␣
↪patents")
```

```
  IPC SECTION ANALYSIS
================================================================================

                                                                              ␣
 ↪subclasses_count  \
ipc_section ipc_section_name
B           Performing Operations; Transporting                               ␣
 ↪      170
H           Electricity                                                       ␣
 ↪       57
A           Human Necessities                                                 ␣
 ↪       84
G           Physics                                                           ␣
 ↪       87
C           Chemistry; Metallurgy                                             ␣
 ↪       91
F           Mechanical Engineering; Lighting; Heating; Weapons; Blasting      ␣
 ↪      100
E           Fixed Constructions                                               ␣
 ↪       31
D           Textiles; Paper                                                   ␣
 ↪       39


                                                                              ␣
 ↪total_patents  \
ipc_section ipc_section_name
```

```
B           Performing Operations; Transporting                                 ␣
 ↪73248212
H           Electricity                                                         ␣
 ↪63210399
A           Human Necessities                                                   ␣
 ↪63167065
G           Physics                                                             ␣
 ↪61117760
C           Chemistry; Metallurgy                                               ␣
 ↪58079969
F           Mechanical Engineering; Lighting; Heating; Weapons; Blasting        ␣
 ↪33887191
E           Fixed Constructions                                                 ␣
 ↪13743980
D           Textiles; Paper                                                      ␣
 ↪6041533


                                                                                ␣
 ↪granted_patents  \
ipc_section ipc_section_name
B           Performing Operations; Transporting                                 ␣
 ↪49317013
H           Electricity                                                         ␣
 ↪38226436
A           Human Necessities                                                   ␣
 ↪35408963
G           Physics                                                             ␣
 ↪34049558
C           Chemistry; Metallurgy                                               ␣
 ↪32913227
F           Mechanical Engineering; Lighting; Heating; Weapons; Blasting        ␣
 ↪22861174
E           Fixed Constructions                                                 ␣
 ↪ 9638861
D           Textiles; Paper                                                     ␣
 ↪ 3700236


                                                                                ␣
 ↪unique_families  \
ipc_section ipc_section_name
B           Performing Operations; Transporting                                 ␣
 ↪30642561
H           Electricity                                                         ␣
 ↪20328347
A           Human Necessities                                                   ␣
 ↪18376372
```

```
G           Physics                                                          ␣
 ↪25391422
C           Chemistry; Metallurgy                                            ␣
 ↪13657423
F           Mechanical Engineering; Lighting; Heating; Weapons; Blasting     ␣
 ↪14737506
E           Fixed Constructions                                              ␣
 ↪ 7050279
D           Textiles; Paper                                                  ␣
 ↪ 2102079


                                                                             ␣
 ↪avg_grant_rate  \
ipc_section ipc_section_name
B           Performing Operations; Transporting                              ␣
 ↪  66.87
H           Electricity                                                      ␣
 ↪  60.80
A           Human Necessities                                                ␣
 ↪  63.42
G           Physics                                                          ␣
 ↪  58.14
C           Chemistry; Metallurgy                                            ␣
 ↪  60.92
F           Mechanical Engineering; Lighting; Heating; Weapons; Blasting     ␣
 ↪  66.10
E           Fixed Constructions                                              ␣
 ↪  69.61
D           Textiles; Paper                                                  ␣
 ↪  65.25


                                                                             ␣
 ↪avg_citations
ipc_section ipc_section_name
B           Performing Operations; Transporting                              ␣
 ↪  7.90
H           Electricity                                                      ␣
 ↪ 14.53
A           Human Necessities                                                ␣
 ↪ 11.21
G           Physics                                                          ␣
 ↪ 13.26
C           Chemistry; Metallurgy                                            ␣
 ↪ 13.91
F           Mechanical Engineering; Lighting; Heating; Weapons; Blasting     ␣
 ↪  7.47
```

```
E           Fixed Constructions                                                 ␣
  ↪ 4.84
D           Textiles; Paper                                                     ␣
  ↪ 7.89


  SECTION RANKINGS BY PATENT COUNT:
1. Section B (Performing Operations; Transporting): 73,248,212.0 patents
2. Section H (Electricity): 63,210,399.0 patents
3. Section A (Human Necessities): 63,167,065.0 patents
4. Section G (Physics): 61,117,760.0 patents
5. Section C (Chemistry; Metallurgy): 58,079,969.0 patents
6. Section F (Mechanical Engineering; Lighting; Heating; Weapons; Blasting):
33,887,191.0 patents
7. Section E (Fixed Constructions): 13,743,980.0 patents
8. Section D (Textiles; Paper): 6,041,533.0 patents
```

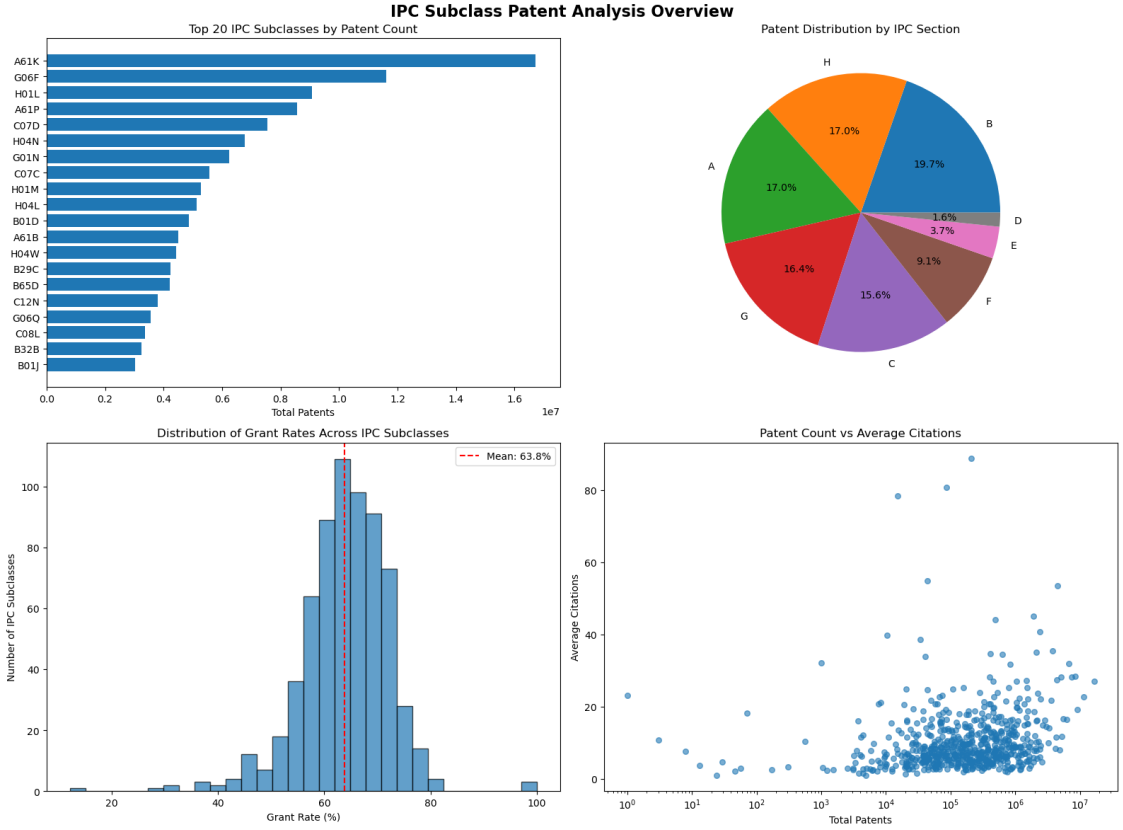
1.10 8. Data Export

[ ]:
```python
# Export results to CSV files
if 'ipc_analysis_df' in locals() and not ipc_analysis_df.empty:
    timestamp = datetime.now().strftime("%Y%m%d_%H%M%S")

    # Export detailed IPC subclass analysis
    detailed_filename = f"./output/ipc_subclass_analysis_detailed_{timestamp}.
 ↪csv"
    ipc_analysis_df.to_csv(detailed_filename, index=False)
    print(f" Detailed analysis exported to: {detailed_filename}")

    # Export section summary
    if 'section_analysis' in locals():
        section_filename = f"./output/ipc_section_summary_{timestamp}.csv"
        section_analysis.to_csv(section_filename)
        print(f" Section summary exported to: {section_filename}")

    # Create a simple summary for quick reference
    summary_df = ipc_analysis_df[[
        'ipc_subclass', 'total_patents', 'granted_patents', 'grant_rate'
    ]].copy()

    summary_filename = f"./output/ipc_subclass_summary_{timestamp}.csv"
    summary_df.to_csv(summary_filename, index=False)
    print(f" Quick summary exported to: {summary_filename}")

    print(f"\n All files saved in: {os.getcwd()}")
else:
    print(" No data available for export")
```

1.11 9. Visualization (Optional)

[11]:
```
# Create visualizations if data is available
if 'ipc_analysis_df' in locals() and not ipc_analysis_df.empty:

    # Set up the plotting style
    plt.style.use('default')
    fig, axes = plt.subplots(2, 2, figsize=(16, 12))
    fig.suptitle('IPC Subclass Patent Analysis Overview', fontsize=16,␣
 ↪fontweight='bold')

    # 1. Top 20 IPC subclasses by patent count
    top_20 = ipc_analysis_df.head(20)
    axes[0, 0].barh(range(len(top_20)), top_20['total_patents'])
    axes[0, 0].set_yticks(range(len(top_20)))
    axes[0, 0].set_yticklabels(top_20['ipc_subclass'])
    axes[0, 0].set_xlabel('Total Patents')
    axes[0, 0].set_title('Top 20 IPC Subclasses by Patent Count')
    axes[0, 0].invert_yaxis()

    # 2. Patent distribution by IPC section
    if 'section_analysis' in locals():
        section_data = section_analysis.reset_index()
        axes[0, 1].pie(section_data['total_patents'],
                       labels=section_data['ipc_section'],
                       autopct='%1.1f%%')
        axes[0, 1].set_title('Patent Distribution by IPC Section')

    # 3. Grant rate distribution
    axes[1, 0].hist(ipc_analysis_df['grant_rate'], bins=30, alpha=0.7,␣
 ↪edgecolor='black')
    axes[1, 0].set_xlabel('Grant Rate (%)')
    axes[1, 0].set_ylabel('Number of IPC Subclasses')
    axes[1, 0].set_title('Distribution of Grant Rates Across IPC Subclasses')
    axes[1, 0].axvline(ipc_analysis_df['grant_rate'].mean(),
                       color='red', linestyle='--',
                       label=f'Mean: {ipc_analysis_df["grant_rate"].mean():.
 ↪1f}%')
    axes[1, 0].legend()

    # 4. Patent count vs Citations scatter plot
    scatter = axes[1, 1].scatter(ipc_analysis_df['total_patents'],
                                 ipc_analysis_df['avg_citations'],
                                 alpha=0.6, s=30)
    axes[1, 1].set_xlabel('Total Patents')
    axes[1, 1].set_ylabel('Average Citations')
    axes[1, 1].set_title('Patent Count vs Average Citations')
```

```
    axes[1, 1].set_xscale('log')

    plt.tight_layout()

    # Save the plot
    #plot_filename = f"./output/ipc_analysis_overview_{timestamp}.png"
    #plt.savefig(plot_filename, dpi=300, bbox_inches='tight')
    plt.show()

    print(f" Visualization done")
else:
    print(" No data available for visualization")
```




```
 Visualization done
```

1.12 11. Analysis Summary and Recommendations

[9]:
```
# Final summary and recommendations
if 'ipc_analysis_df' in locals() and not ipc_analysis_df.empty:

    print(" FINAL ANALYSIS SUMMARY")
```

```
    print("=" * 60)

    total_subclasses = len(ipc_analysis_df)
    total_patents = ipc_analysis_df['total_patents'].sum()
    avg_patents_per_subclass = total_patents / total_subclasses

    print(f" Dataset Overview:")
    print(f"   • Total IPC subclasses analyzed: {total_subclasses:,}")
    print(f"   • Total patents in dataset: {total_patents:,}")
    print(f"   • Average patents per subclass: {avg_patents_per_subclass:,.0f}")
    print(f"   • Environment used: {environment}")

    # Find the most and least active sections
    if 'section_analysis' in locals():
        most_active = section_analysis.index[0]
        least_active = section_analysis.index[-1]

        print(f"\n Most active section: {most_active[0]} - {most_active[1]}")
        print(f"   • {section_analysis.loc[most_active, 'total_patents']:,}␣
↪patents")
        print(f"   • {section_analysis.loc[most_active, 'subclasses_count']}␣
↪subclasses")

        print(f"\n Least active section: {least_active[0]} -␣
↪{least_active[1]}")
        print(f"   • {section_analysis.loc[least_active, 'total_patents']:,}␣
↪patents")
        print(f"   • {section_analysis.loc[least_active, 'subclasses_count']}␣
↪subclasses")

    if environment == 'TEST':
        print(f"\n  NOTE: This analysis used TEST environment (limited data)")
        print(f"   For complete results, re-run with environment = 'PROD'")

    print(f"\n Analysis completed successfully at {datetime.now()}")

else:
    print(" Analysis could not be completed due to data issues")
    print("   Check database connection and try again")
```

```
 FINAL ANALYSIS SUMMARY
============================================================
 Dataset Overview:
   • Total IPC subclasses analyzed: 659
   • Total patents in dataset: 372,496,109
   • Average patents per subclass: 565,244
   • Environment used: PROD
```

```
Most active section: B - Performing Operations; Transporting
  • 73,248,212 patents
  • 170 subclasses

Least active section: D - Textiles; Paper
  • 6,041,533 patents
  • 39 subclasses

Analysis completed successfully at 2026-02-01 09:03:16.906584
```

1.13 12. Next Steps

This analysis provides a foundation for further patent landscape research:

1.13.1 Possible Extensions:

1. **Temporal Analysis**: Track IPC subclass trends over time
2. **Authority Analysis**: Compare patent activity by filing authority (EP, US, CN, etc.)
3. **Technology Mapping**: Connect IPC codes to technology fields using TLS901 table
4. **Citation Analysis**: Identify high-impact technology areas
5. **Company Analysis**: Link IPC data to applicant information

1.13.2 Code Templates:

```
# Example: Temporal analysis
temporal_query = db.query(
    TLS201_APPLN.appln_filing_year,
    func.substr(TLS209_APPLN_IPC.ipc_class_symbol, 1, 4).label('ipc_subclass'),
    func.count(TLS201_APPLN.appln_id).label('patents_per_year')
).join(...).filter(...).group_by(...)

# Example: Authority breakdown
authority_query = db.query(
    TLS201_APPLN.appln_auth,
    func.substr(TLS209_APPLN_IPC.ipc_class_symbol, 1, 4).label('ipc_subclass'),
    func.count(TLS201_APPLN.appln_id).label('patent_count')
).join(...).filter(...).group_by(...)
```

1.13.3 Performance Tips:

- Use TEST environment for development and testing
- Add date filters to limit query scope when needed
- Consider pagination for very large result sets
- Cache results for repeated analysis