Consistency and Trends of Technological Innovations

A Network Approach to the International Patent Classification Data

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Just another study on technological evolution using patent data,

Except that...

- Using a network approach
- Based on an international patent family database
- Established a systematic method, more generic and less dependent

- Patent Classification and Search

  - International Patent Classification system (IPC)

    - 8 sections

    - 639 subclasses
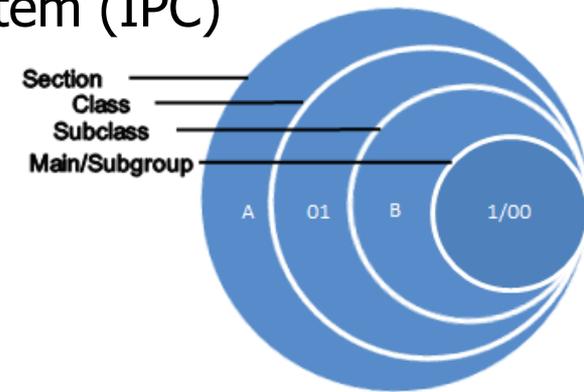
  - Current classification search platform

    - By IPC scheme: requires considerable familiarity of the IPC documentation

    - By catchwords: arbitrary choices of words might lead to mis-classification

- ## OECD International Patent Dataset

  - Harmonized patent data from EPO, USPTO, JPO, etc.

  - OECD Triadic Patent Family

    - Eliminating home bias and geographical location influences

    - Evaluate patent values
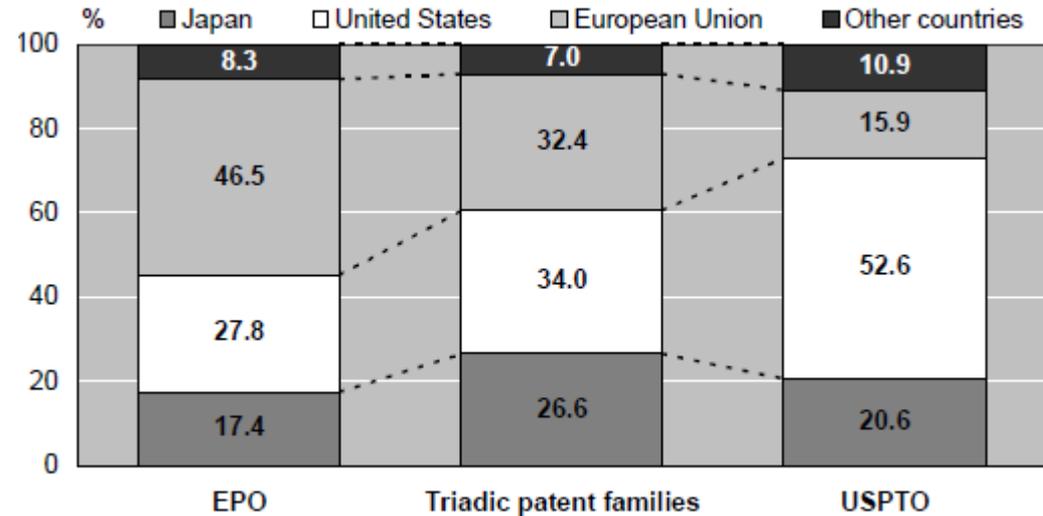
Country shares of patents applied for at the EPO, patent grants by the USPTO and Triadic Patent Families, priority year 1999 (OECD, Patent Database, Oct., 2003)

- ## Family-Cohort Network

- Based on unique IPC subclasses of patents belonging to the same family

- Aggregated numbers of families in cohort

Family_ID	Patent number	IPC subclass	First Priority Year
1	EP0000001	A01B, A01C	1980
1	EP0000002	A01B, A01C, A01D	1980
2	EP0000003	A01E	1980
2	EP0000004	A01F	1980

Family_ID	Unique IPC subclass	First Priority Year
1	A01B, A01C, A01D	1980
2	A01E, A01F	1980

	A01B	A01C	A01D	A01E	A01F
A01B	0	1	1	0	0
A01C	1	0	1	0	0
A01D	1	1	0	0	0
A01E	0	0	0	0	1
A01F	0	0	0	1	0

- ## Citations Network

- Based on all IPC subclasses of patents in citing/cited families

- Aggregated numbers of citations

ID	Citing Patent number	Citing IPC subclass	Citing First Priority Year	Cited Family_ID	Cited Patent number	Cited IPC subclass	Cited First Priority Year
1	EP0000001	A01B, A01C	1980	2	EP0000003	A01B, A01E	1981
1	EP0000002	A01B, A01C, A01D	1980	2	EP0000004	A01E, A01F	1981

	A01B	A01C	A01D	A01E	A01F
A01B	2	0	0	4	2
A01C	2	0	0	4	2
A01D	1	0	0	2	1
A01E	0	0	0	0	0
A01F	0	0	0	0	0

Split by earliest application (citing) year from 1978 to 2013

- Clustering identification based on Piccardi's method to find network communities by Lumped Markov Chains
  (Piccardi, 2011)

  - The *Persistence Probability* U_{CC} associated to a cluster C is not smaller than a $(0 < a < 1)$

    $$U_{CC} = \frac{\sum_{i,j \in C} \pi_i p_{ij}}{\sum_{i \in C} \pi_i},$$

    π_i *is the probability of being in node i (at time t)*
    p_{ij} *is the probability of random walking from node i to j*

  - A sudden drop of U_{CC} indicates the breaking of a significant "natural" community – threshold setting

(Piccardi, 2011)
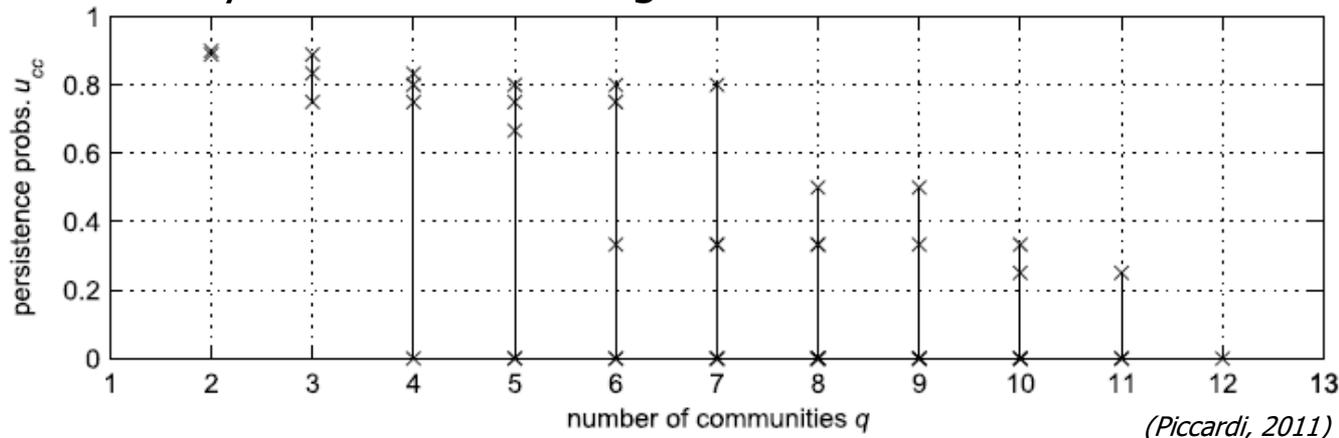
- ## Coreness
  - The *Closeness* of a node to other nodes in the same community, weighted by the community *Persistence Probability*

$$C_{ic} = \frac{1}{\frac{\bar{d}_{ij}n}{n-1}} U_{cc} = \frac{n-1}{\bar{d}_{ij}n} U_{cc},$$ *n is the number of nodes in community c*

- ## Community Tracking
  - Identify the *key* IPC subclasses with highest closeness ranking over time
  - Find the stable endogenous communities by looking for the most persistent subclasses in the same community with the *keys*.

- ## Consistency
  - Occurrence ≥ 80%

    i.e. a subclass needs to be found in the endogenous community with the *key* in at least 29 years out of the total span of 36 years

- ## Changing Trends
  - Occurrence ≤ 60%, among which at least 3 years are consecutive
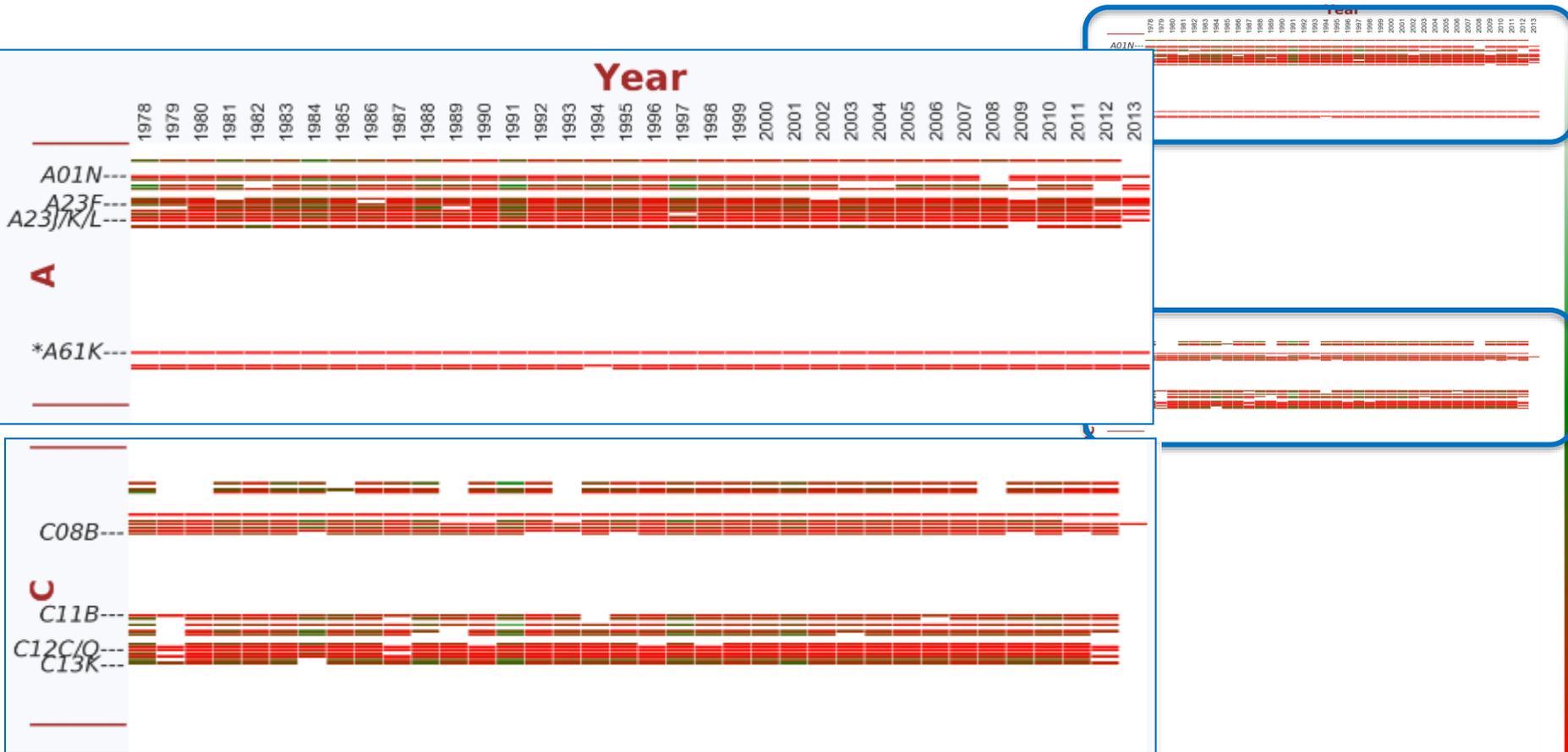
A61K: PREPARATIONS FOR MEDICAL, DENTAL, OR TOILET PURPOSES
A01N: PRESERVATION OF BODIES OF HUMANS OR ANIMALS OR PLANTS; BIOCIDES
A23: FOODS OR FOODSTUFFS; THEIR TREATMENT, NOT COVERED BY OTHER CLASSES
C08 – C13: ORGANIC MACROMOLECULAR COMPOUNDS; ANIMAL OR VEGETABLE OILS, FATS; BIOCHEMISTRY, ETC
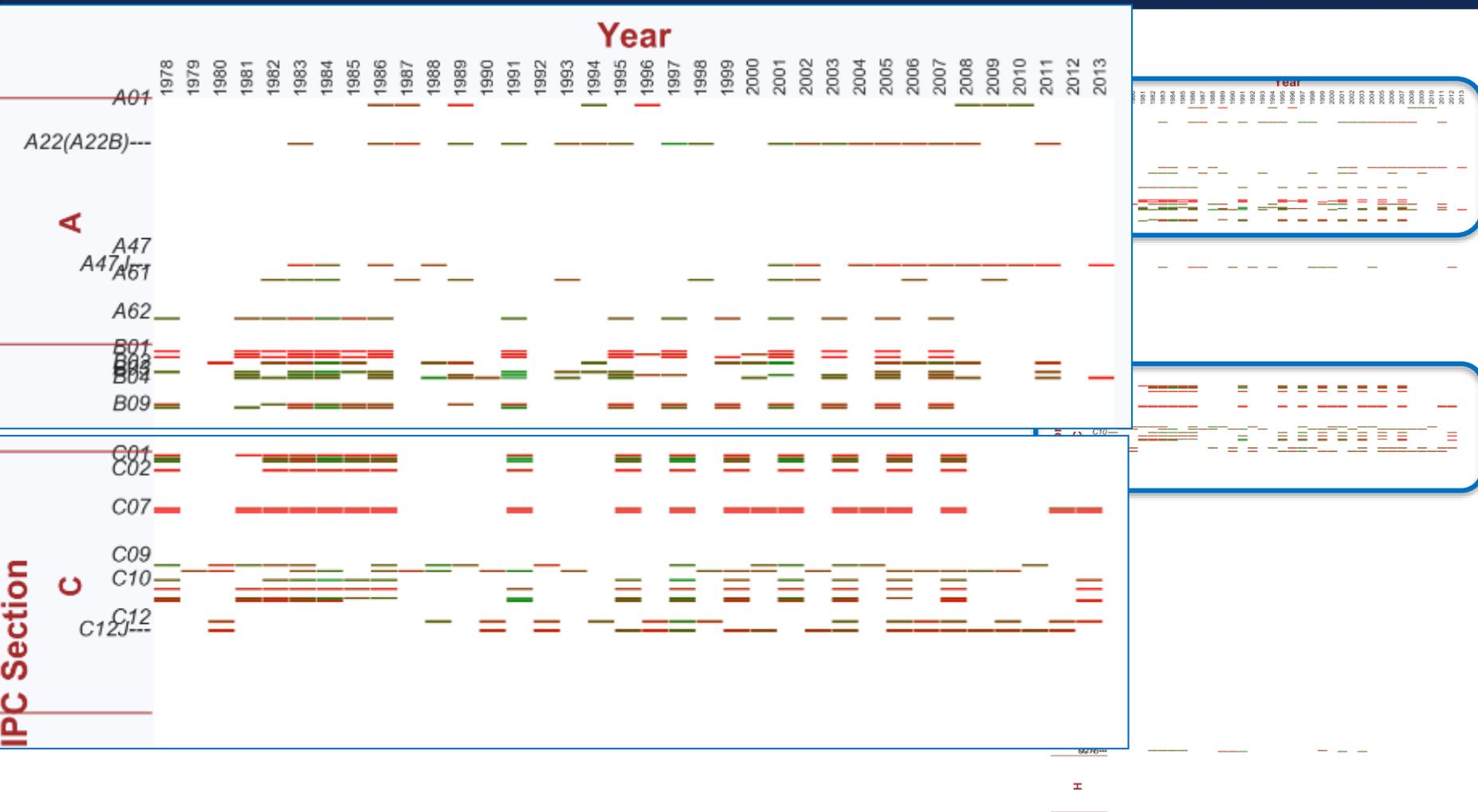
A61K: PREPARATIONS FOR MEDICAL, DENTAL, OR TOILET PURPOSES
A47J: KITCHEN EQUIPMENT; COFFEE MILLS; SPICE MILLS; APPARATUS FOR MAKING BEVERAGES
C12J: VINEGAR; ITS PREPARATION
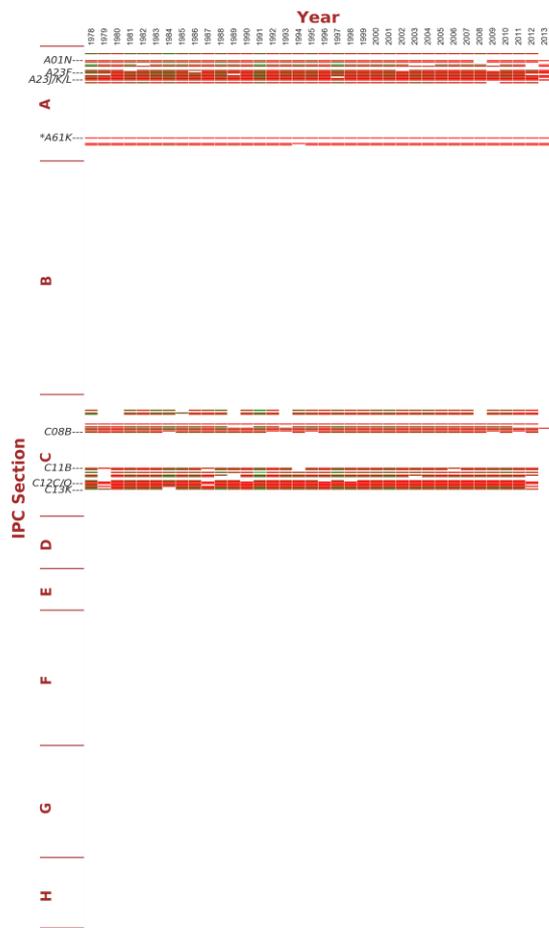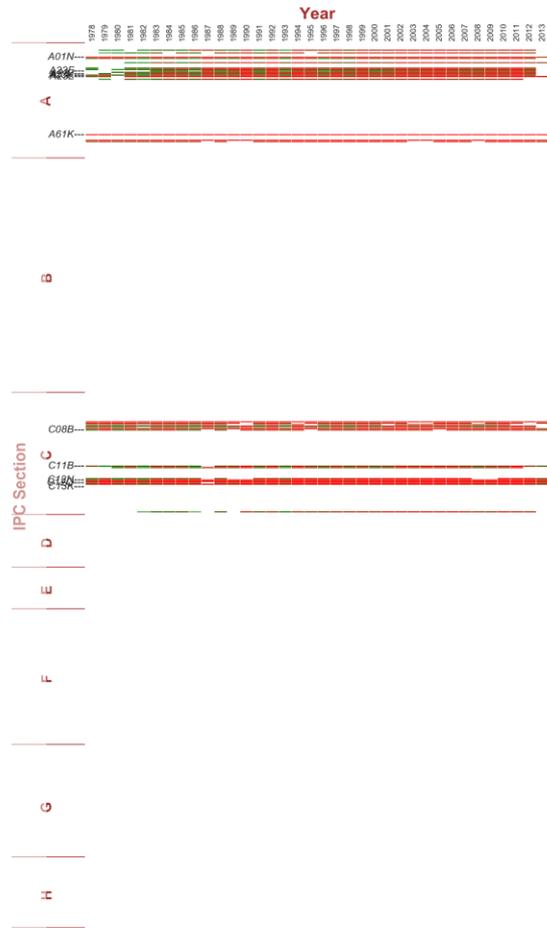
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Family-cohort
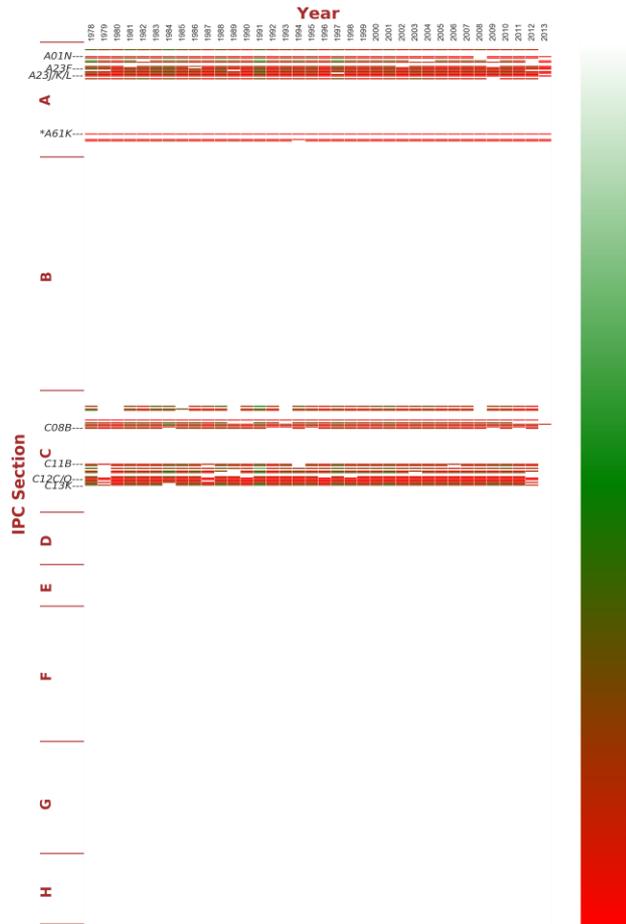
Naïve Counting
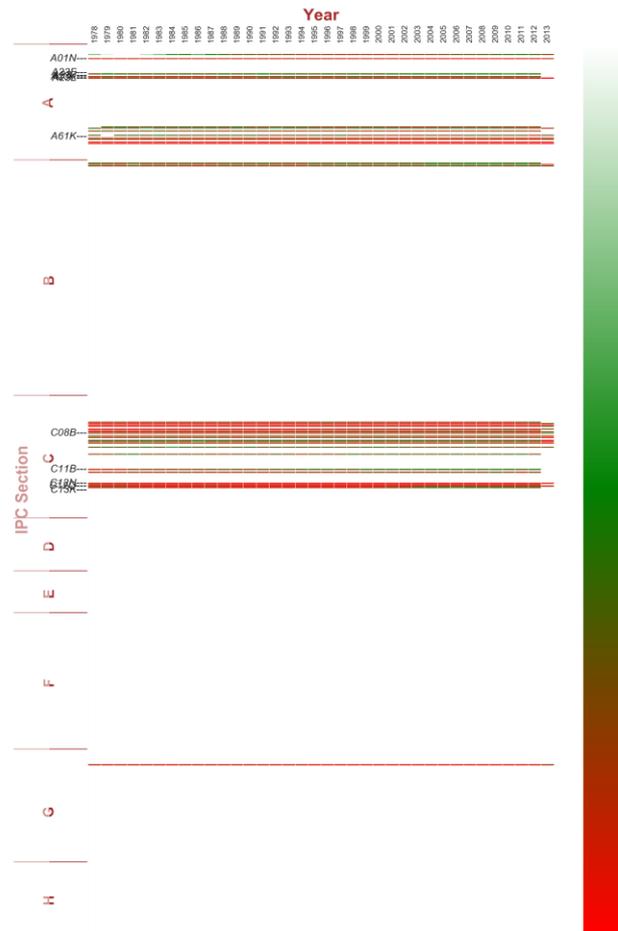
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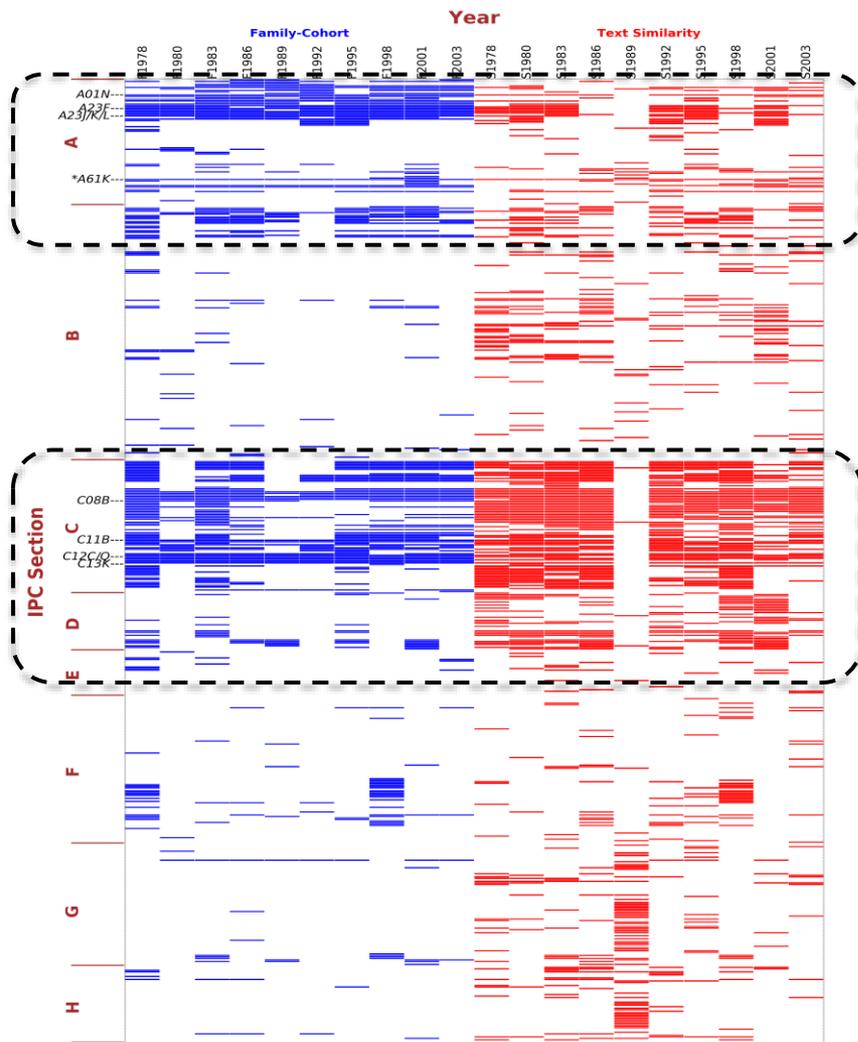
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Contributions

- More accurate and thorough coverage than the authority assigned classifications
- A global network perspective adds information to the conventional indexes
- Enhanced classification search platform

Future Work

- Addition of the regional dimension
- Refinement of the changes over time