Textual Analysis of ICALEPCS and IPAC Conference Proceedings

Revealing Research Trends, Topics, and Collaborations for Future Insights and Advanced Search

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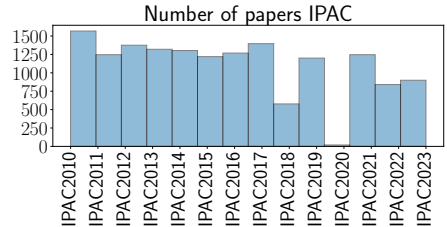
Cape Town,

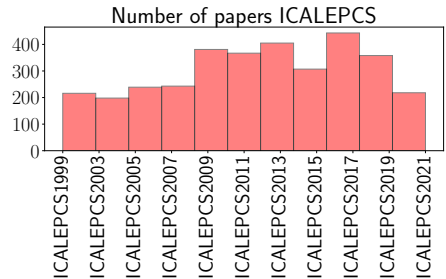
HELMHOLTZ

DESY.

Introduction

- There are almost 19000 submissions on **IPAC** (15478, 2010 - 2023) and **ICALEPCS** (3375, 1999 - 2021).





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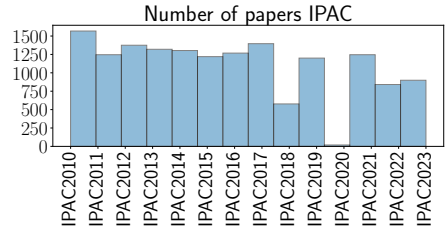

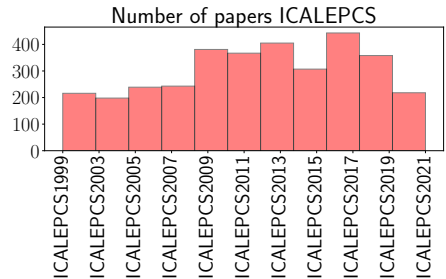

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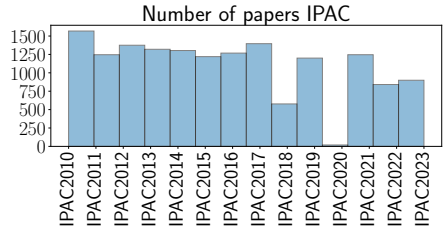

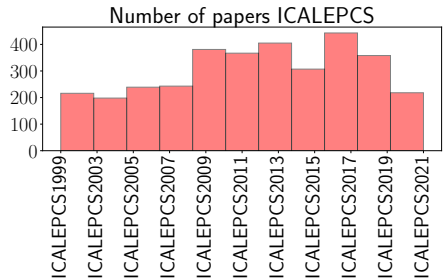

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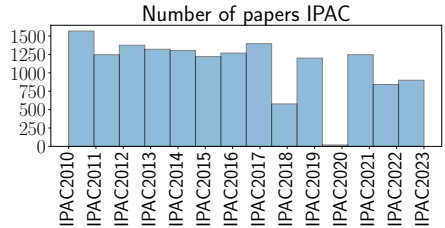
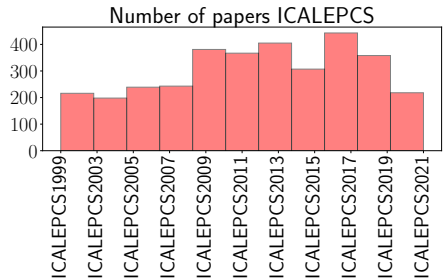
- Searching through submissions is also a challenge.





Approach

1 Collected the PDFs from public sources (JACOW)

PyMuPDF

Space charge lenses use a confined electron cloud for the focusing of ion beams. The electron density gives the focusing strength whereas...

Search

Topic Modeling

Citation graphs

Bipartite Graphs

Language Processing

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1. Collected the PDFs from public sources (JACOW)
2. Extracted text with `Pymupdf` (can handle two page layout)

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3. Applied NLP techniques.

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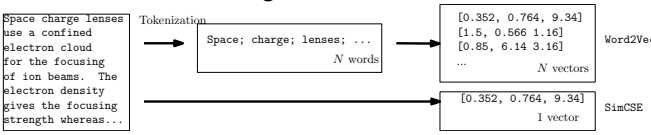
- Topic Modeling
- Citation graphs
- Bipartite Graphs

Language Processing

Analyses

1 Search & Embedding



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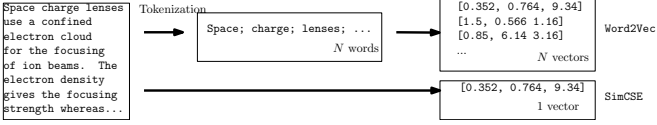

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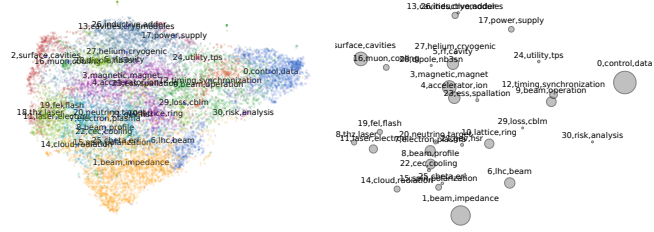

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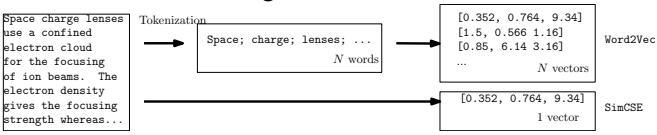

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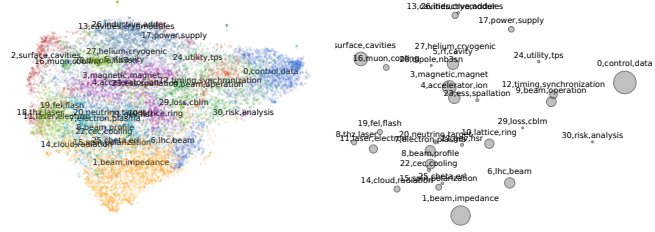

3 Citation graph analysis

4 Document-word bipartite graph analysis

Search

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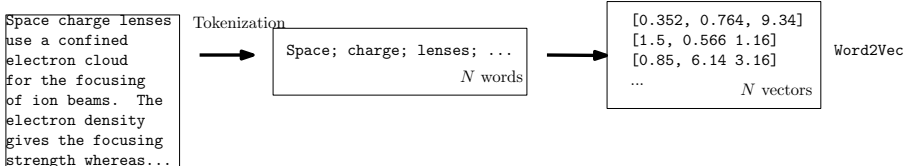
- Each word (token) is represented by one vector.
- Similar **words** have high cosine similarity. (*easy* vs *simple* vs *trivial*)
- One vector per token.
- Keyword search.



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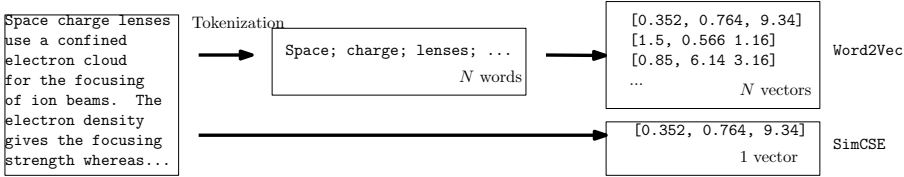
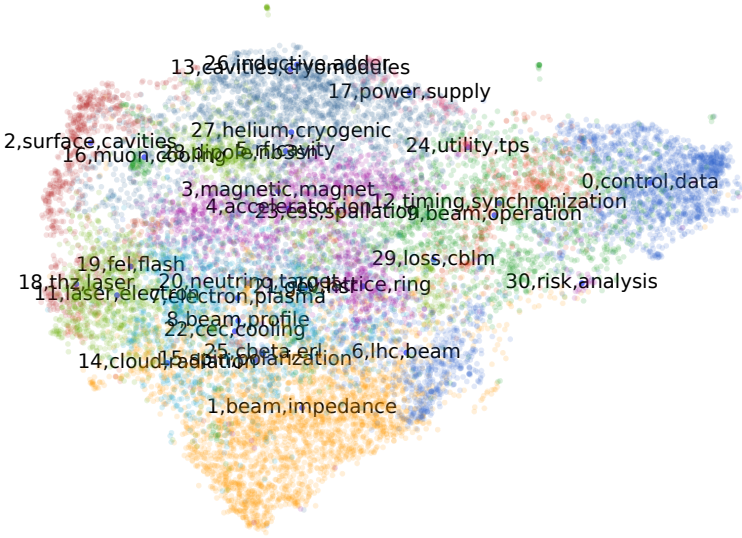


SimCSE Search Example

```
from sentence_transformers import SentenceTransformer
model = SentenceTransformer('TEXT_ICALEPCS/simcse')
texts = ["Biennial International Conference on. Accelerator and Large
Experimental Physics Control Systems", "ICALEPCS"]
e = model.encode(texts)
```

Topic Modeling



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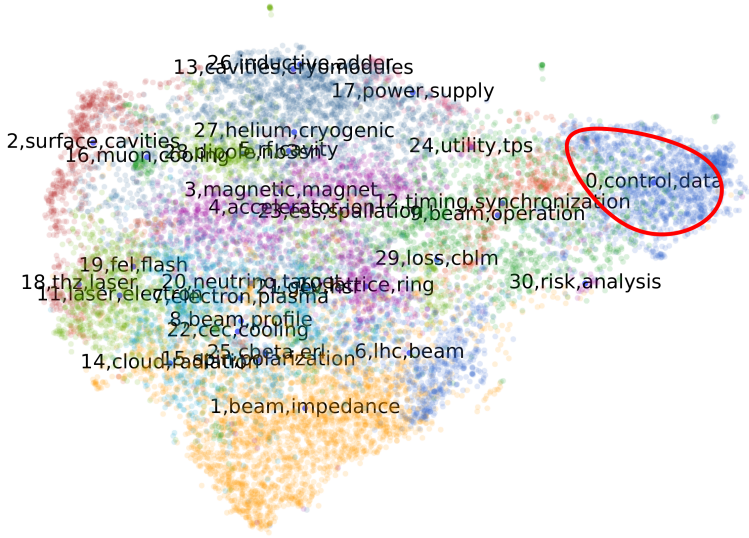

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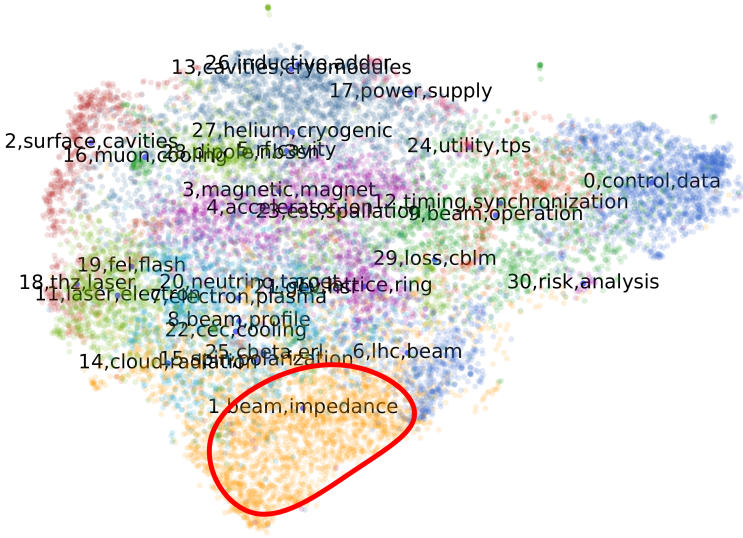

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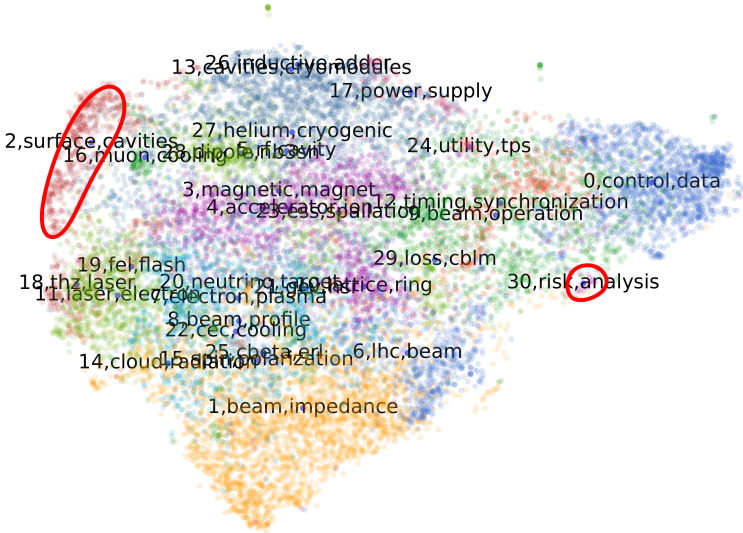
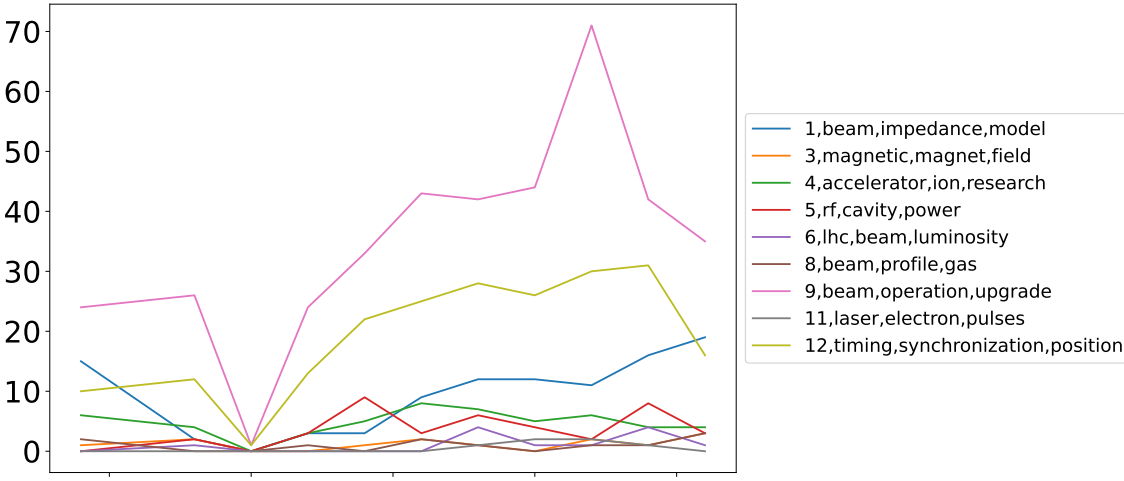
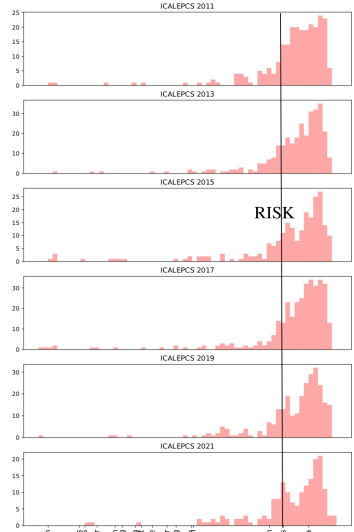


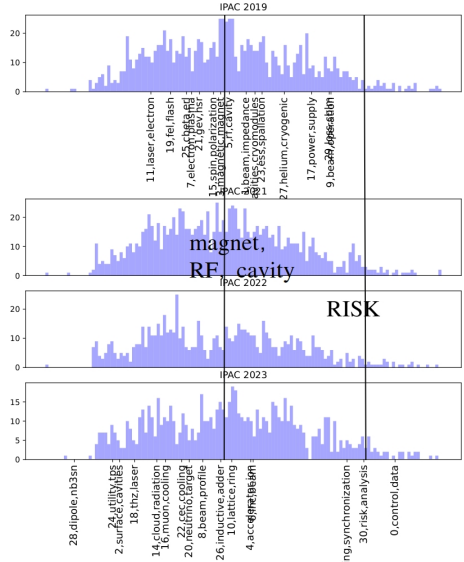
Topic Modeling - ICALEPCS



Topics over Time - ICALEPCS



Topics over Time - IPAC



Citation Graphs - Larger View

IPAC & ICALEPCS citations are too sparse, so we extended sources.
Closeness Centrality (nodes that most efficiently spread information):

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3. K. Ko and A. E. Candel, "*Advances in Parallel Electromagnetic Codes for Accelerator Science and Development*", LINAC'10

Bipartite Graphs

It's about (maximal) coverage.

Degree Centrality (most connected nodes):

1. L. Medina et al , "*Cavity Control Modelling for SPS-to-LHC Beam Transfer Studies*", IPAC'21
2. M. Chung et al , "*Transient Beam Loading Effects in Gas-filled RF Cavities for a Muon Collider*", IPAC'13
3. K. Yonehara et al , "*R&D of a Gas-Filled RF Beam Profile Monitor for Intense Neutrino Beam Experiments*", IPAC'17

Degree centralities: `beam` (0.07), `cavity` (0.05), `bunch` (0.05), `rf` (0.05), `control` (0.04), `lhc` (0.04), `laser` (0.04), `cavities` (0.04), `fel` (0.04), `electron` (0.04)

Future Work

- We would like to **collect more sources** (arXiv, Inspire HEP).
- Improve the **pre-processing** (equations, tables).
- Feed the **LLM with data**, developing an AI assistant.
- We are **fine-tuning an AI-assistant** based on our logbook.
- Incorporating logbook data together with the community wisdom for better analysis and decisions for e.g.
  - Root Cause Analysis,
  - FAIR (Findable, Accessible, Interoperable, and Reusable)-ness
- We already have some partial success.

Conclusion

- Semantic search, topic modeling, and graph analysis can extract insights from past conferences.
- Topic modeling revealed the evolution of research priorities and emerging trends for each conference over time.
- Citation graph exposed influential papers based on connections to other papers.
- Bipartite graph highlighted important concepts.

Thank you!

https://github.com/sulcantonin/TEXT_ICALEPCS23/

Contact

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