Knowledge Graphs for Global Events and Trade

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D2R2'23: Second International Workshop on Linked Data-driven Resilience Research 2023

Knowledge Graphs for Global Events

Events, Supply Chains & EventKG

Events & Supply Chains

1. **The COVID-19 Pandemic**
   - When: January 2020 to present | Where: Global
2. **Computer Chip Factory Fire**
   - When: March 2021 | Where: Japan
3. **Brexit**
   - When: January 2020–present | Where: UK
4. **The Ever Given Shipping Container Blockage**
   - When: March 2021 | Where: Suez Canal, Egypt
5. **Drought**
   - When: 2021 | Where: Taiwan
6. **The Big Freeze**
   - When: February 2021 | Where: USA

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6 Global Events That Have Disrupted the Manufacturing Supply Chain

Sep 20, 2021 • Aptean Staff Writer

Supply Chain   Manufacturing   Covid-19

EventKG: A Multilingual Event-Centric Temporal Knowledge Graph

- 1.7M events and more than 8M temporal relations
  - 2nd inauguration of Barack Obama
  - "The Space Shuttle Challenger is launched on its maiden voyage"
  - Jennifer Aniston, married to, Brad Pitt, [2000-07-29,2005-10-02]

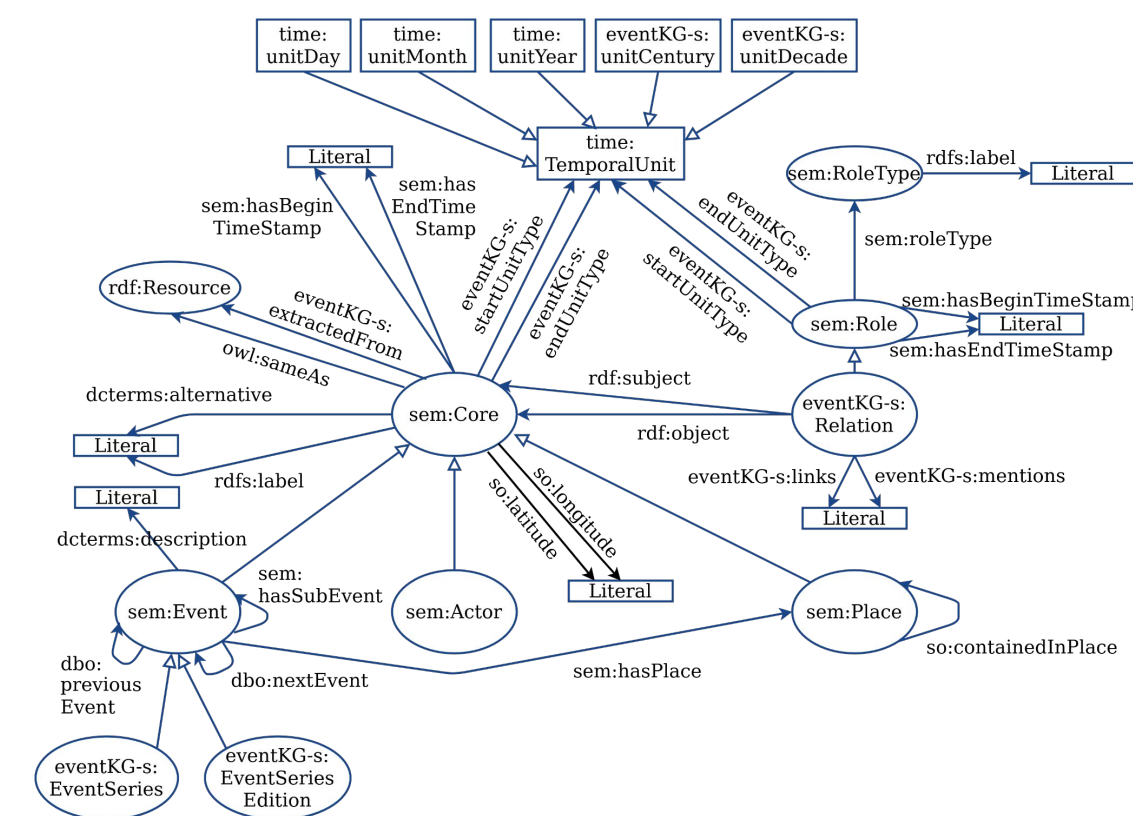- Integrated data in 15 languages with provenance information

- https://eventkg.l3s.uni-hannover.de/

EventKG Sources

Cross-domain knowledge graphs

DBpedia

WIKIDATA

yago
select knowledge

WIKIPEDIA
The Free Encyclopedia

Wikipedia Current
Events Portal

Textual knowledge bases

Event Ontology

Event KG

Example Query: Natural events that affect companies

Which pairs of natural events and companies are most related?

```
SELECT ?eventLabel ?companyLabel (SUM(?links) AS ?count)
WHERE {
 ?event rdf:type/rdfs:subClassOf* dbo:NaturalEvent .

 ?relation rdf:subject ?other .
 ?relation rdf:object ?event .
 ?related rdf:type dbo:Company .
 ?relation eventkg-s:links ?links .

 ?event skos:prefLabel ?eventLabel .
 ?related skos:prefLabel ?companyLabel .
} GROUP BY ?eventLabel ?companyLabel
ORDER by DESC(?count)
```

Example Query Results

eventLabel	companyLabel	count
2011 Tōhoku earthquake and tsunami	Toyota	132
1923 Great Kantō earthquake	Sharp Corporation	100
1906 San Francisco earthquake	Munich Re	98
2011 Tōhoku earthquake and tsunami	Tokyo Electric Power Company	96
2004 Chūetsu earthquake	Sanyo	90

Toyota profit slides on Japan

Fukushima Daiichi nuclear power plant operator 'ignored tsunami warning'

Earthquake damage lands Sanyo in the red

DECEMBER 21, 2004
BY **YOSHIKO HARA**

TOKYO Sanyo Electric Co. Ltd. estimated the cost of earthquake damage at its Niigata semiconductor fab last October at about ¥87 billion, or $837 million, further eroding its financial performance in the current quarter.

The Fukushima Daiichi plant as the tsunami approached. Seawater flooded power lines, causing a meltdown in three of the six reactors. Photograph: Reuters

Knowledge Graphs for Global Events – Conclusion

- Modelling events in knowledge graphs can help get an understanding of disruptions in the market

- Open Questions / Challenges
  - How to get and deal with dynamic information?
  - How fine-granular does event information need to be?
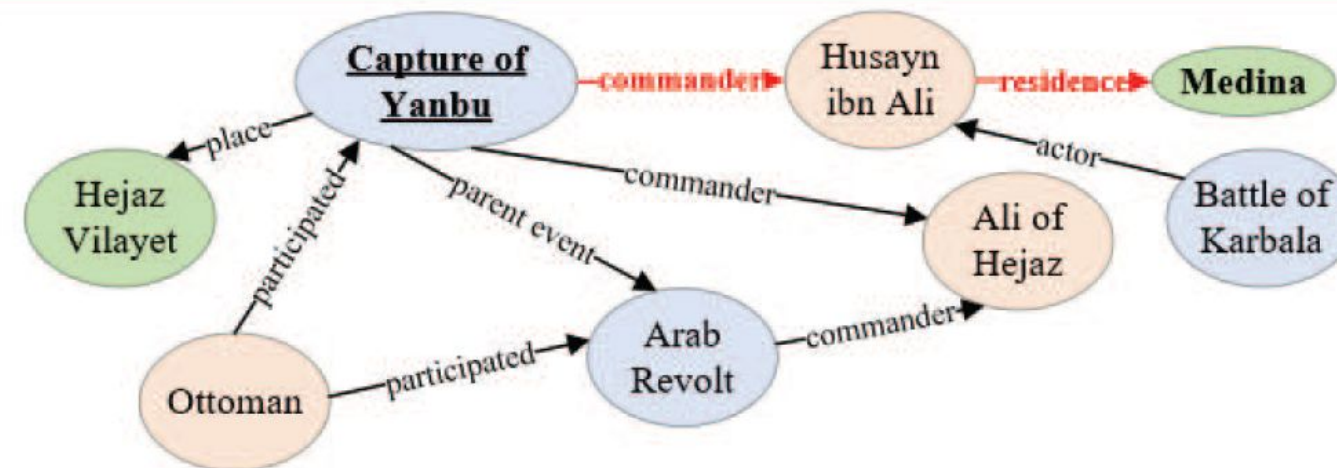 - Can we predict events? Can we predict the effect of events?

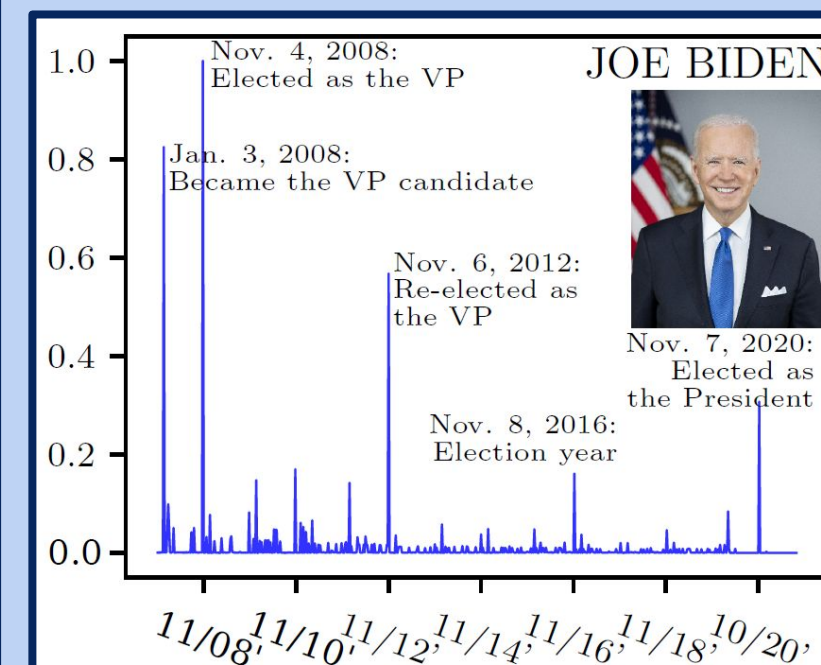# Example Applications of EventKG
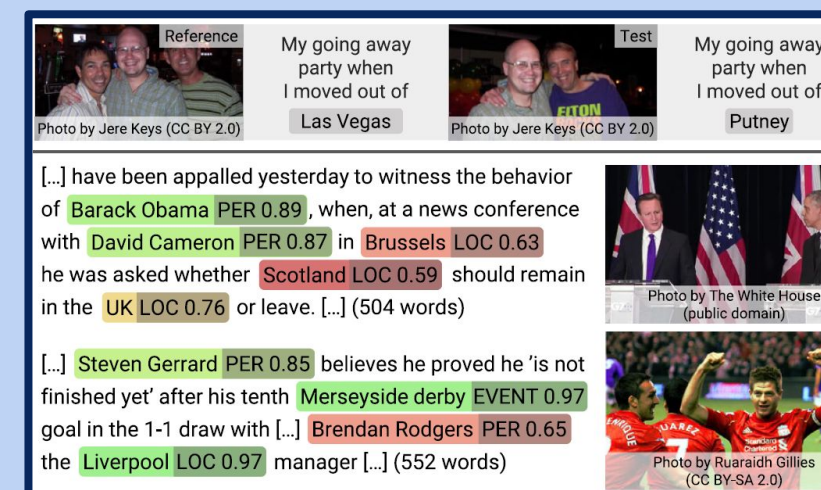
Visualisation and Interaction
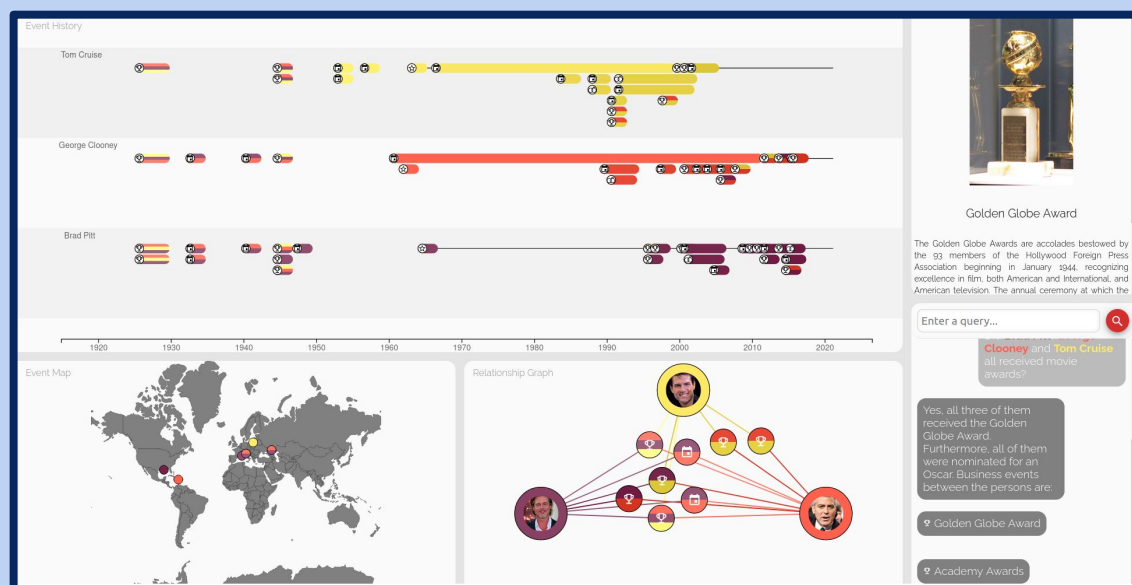
Question Answering

Anomaly Detection

News Analysis

Latif, Shahid, et al. "Visually connecting historical figures through event knowledge graphs." *2021 IEEE Visualization Conference (VIS)*. IEEE, 2021.
Gottschalk, Simon, and Elena Demidova. "EventKG+ BT: generation of interactive biography timelines from a knowledge graph." *The Semantic Web: ESWC 2020 Satellite Events: ESWC 2020 Satellite Events, Heraklion, Crete, Greece, May 31–June 4, 2020, Revised Selected Papers 17*. Springer International Publishing, 2020.
Souza Costa, Tarcísio, Simon Gottschalk, and Elena Demidova. "Event-QA: A dataset for event-centric question answering over knowledge graphs." Proceedings of the 29th ACM international conference on information & knowledge management. 2020.
Müller-Budack, Eric, et al. "Multimodal news analytics using measures of cross-modal entity and context consistency." International Journal of Multimedia Information Retrieval 10.2 (2021): 111-125.
Tang, Wei, et al. "Contrastive Semantic Similarity Learning for Multi-Hop Question Answering over Event-Centric Knowledge Graphs." 2022 IEEE 8th International Conference on Cloud Computing and Intelligent Systems (CCIS). IEEE, 2022.
Guo, Xingzhi, Baojian Zhou, and Steven Skiena. "Subset Node Anomaly Tracking over Large Dynamic Graphs." *Proceedings of the 28th ACM SIGKDD Conference on Knowledge Discovery and Data Mining*. 2022.

Knowledge Graphs for Global Trade

Trade-based Money Laundering, Company & Trade Data, Red Flags

Trade-based Money Laundering (TBML)

- TBML is the process of disguising the proceeds of crime and **moving value using trade transactions to legitimize their illicit origins**. TBML involves the **exploitation of the international trade system** for the purpose of transferring value and **obscuring the true origins of illicit wealth**. TBML schemes vary in complexity but typically involve **misrepresentation of the price, quantity, or quality of imports or exports**.

https://www.fico.com/blogs/tbml-what-trade-based-money-laundering

Trade Based Money Laundering – A Massive Illicit Flow

- Estimated money laundered globally is 2 - 5% of global GDP per year, or USD $715 billion - $1.87 trillion[1]

- Special case: brand protection
  - Counterfeit products often deceptively resemble the original
  - The quality of plagiarism isn't calculable

- A problem for people and institutions
  - Consumers, manufacturers, banks, law enforcement agencies

➢ There is a global lack of a scientifically based understanding of how illegal transactions can be recognized and what patterns they follow

ArTificial inTelligENce for the deTectIon
of trade-based mOney lauNdering!

ATTENTION!

Ai

[1] https://www.europol.europa.eu/crime-areas-and-statistics/crime-areas/economic-crime/money-laundering
https://www.schaeffler.de/en/products-and-solutions/brand-protection/

Company and Trade Data

- We need to model large datasets of company and trade data to understand TBML patterns
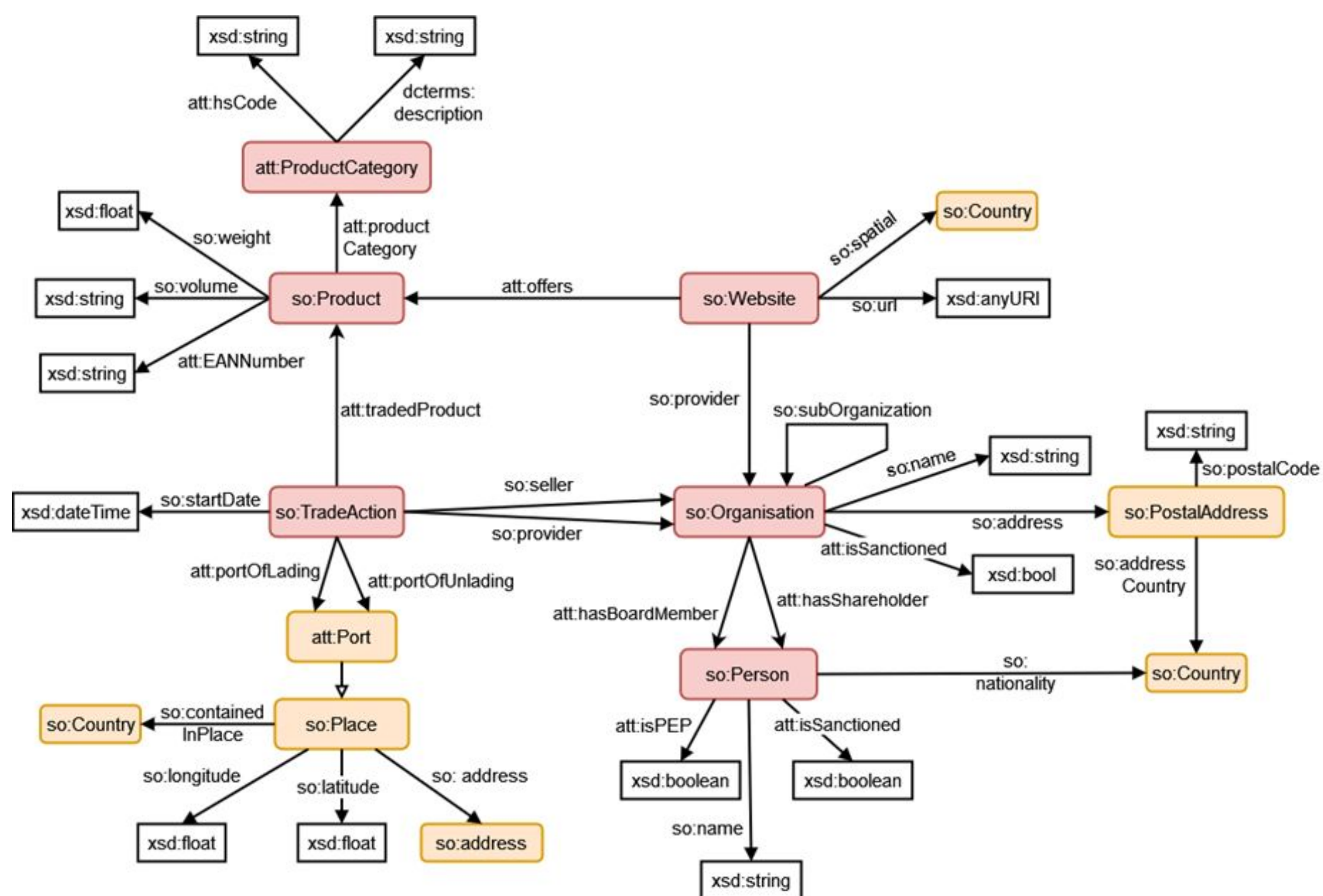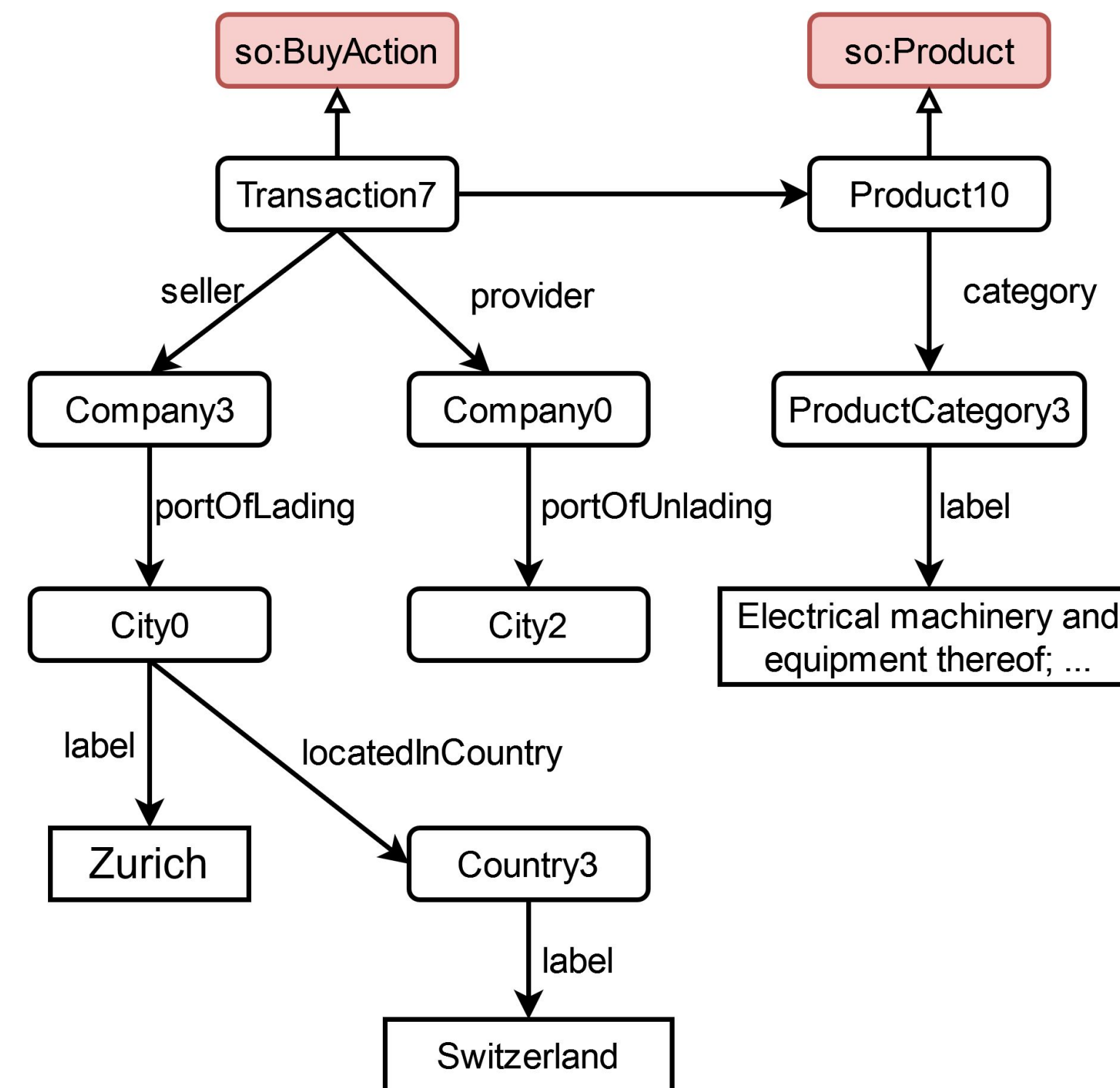- Trade data: Shipments, seller, provider, price, …   Company data: Address, revenue, ownership…

https://sayari.com/product-features/

https://www.linkedin.com/pulse/reasoning-big-knowledge-graphs-choices-pitfalls-proven-recipes-/
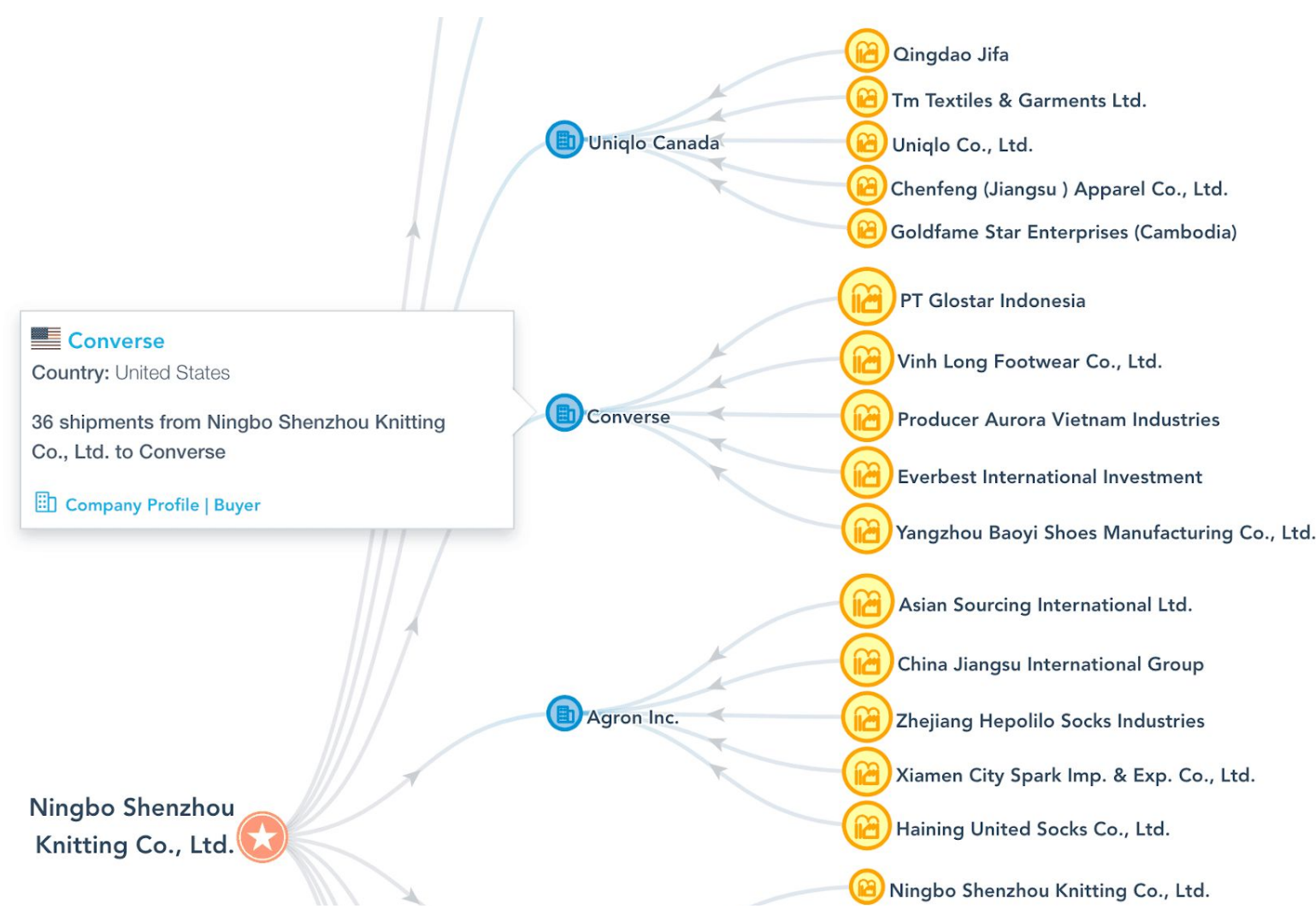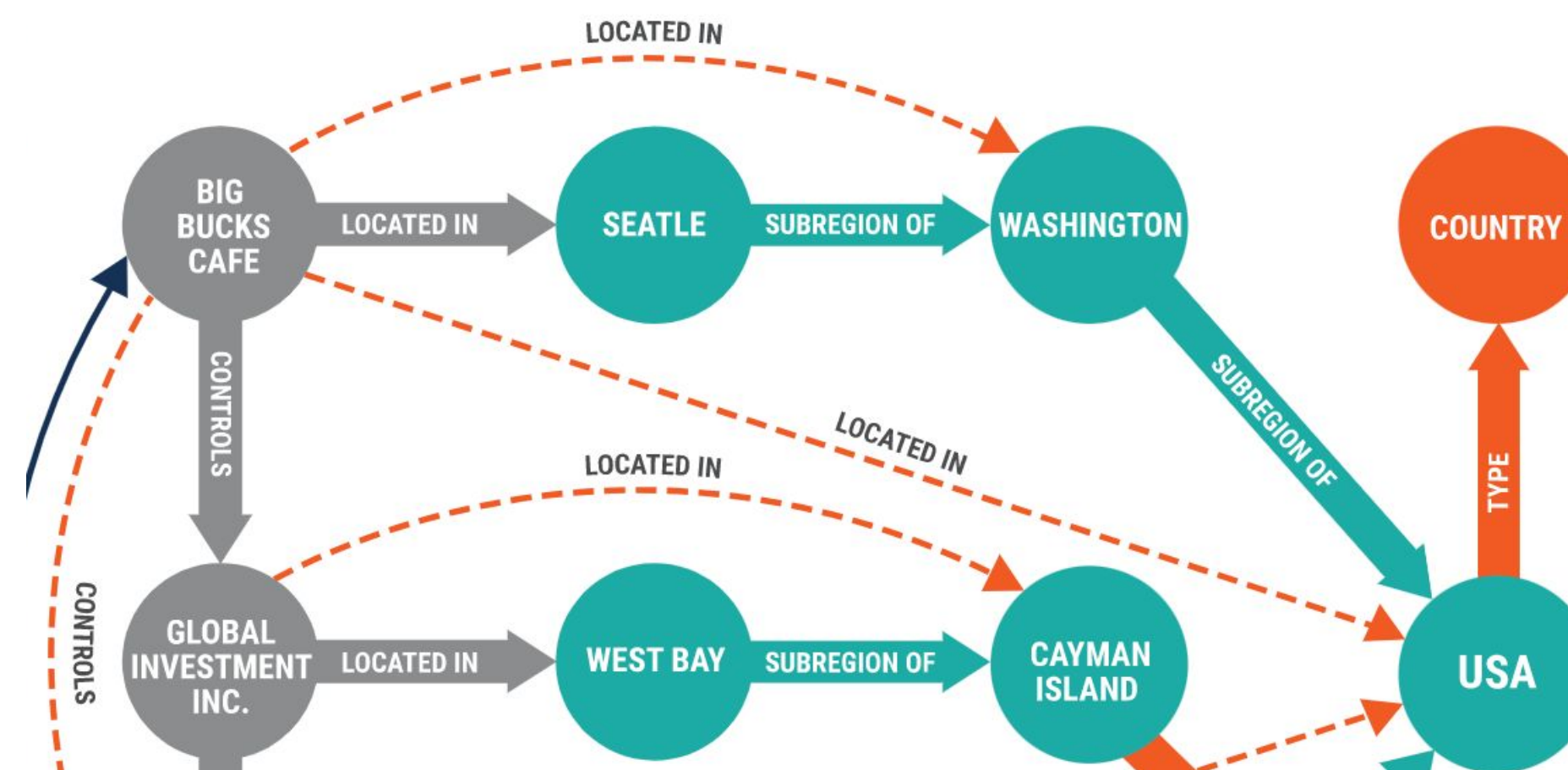
Company & Trade Ontology

Example Trade Data Graph

Examples of Red Flags to Detect Suspicious Patterns

- "If the entity is sanctioned"

```
SELECT ?organisation WHERE {
    ?organisation rdf:type so:Organization;
              att:isSanctioned true .
}
```

- "If the entity is connected by trade to a sanctioned entity"
- "If the weight of a traded good mismatches the average in its product category"

➢ Next step: Inference of new patterns

Knowledge Graphs for Global Trade – Conclusion

- Brand protection is an important aspect of supply chain security

- Open Questions / Challenges
  - Large amounts of different datasets needed
  - Evaluation is difficult and training data is hard to get
 - Sensitive area

Example Scenario

Resilience through Unique Codes

SCHAEFFLER OneCode

- Schaeffler: German manufacturer with
  - > 200 sites in > 50 countries
  - > 40.000 different products
- How can Schaeffler identify fake products and follow their distribution?

- OneCode: A unique code for each product
- Global database of codes

- If the same code is scanned twice on different packagings: Fake!
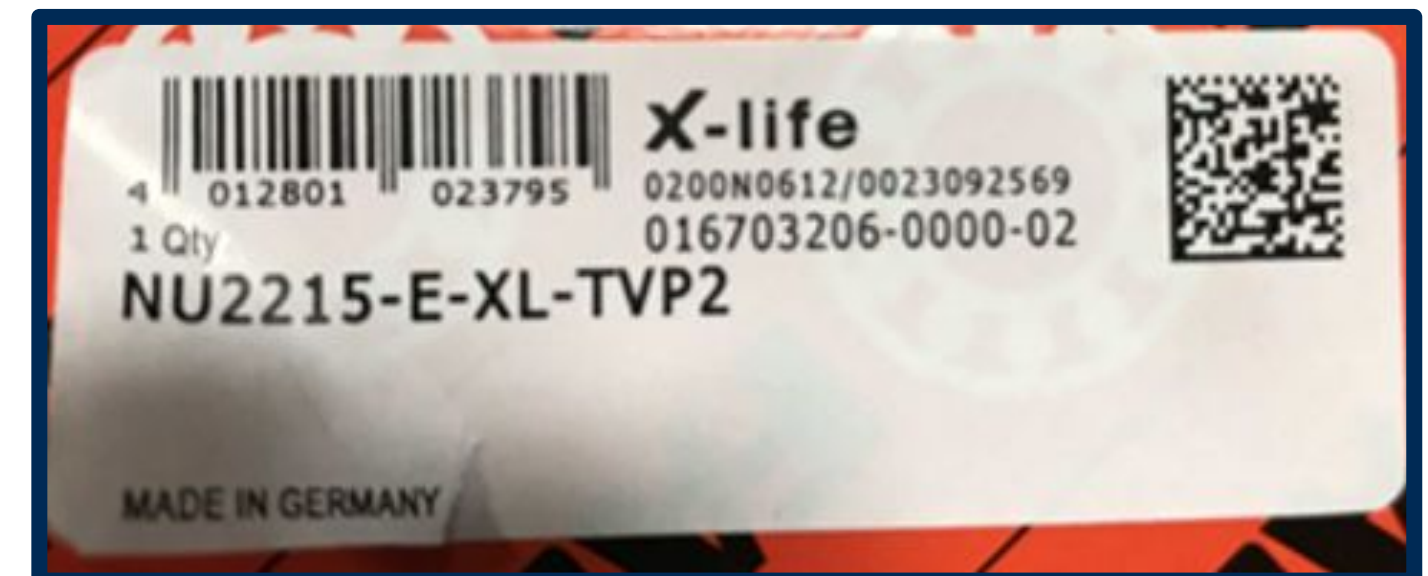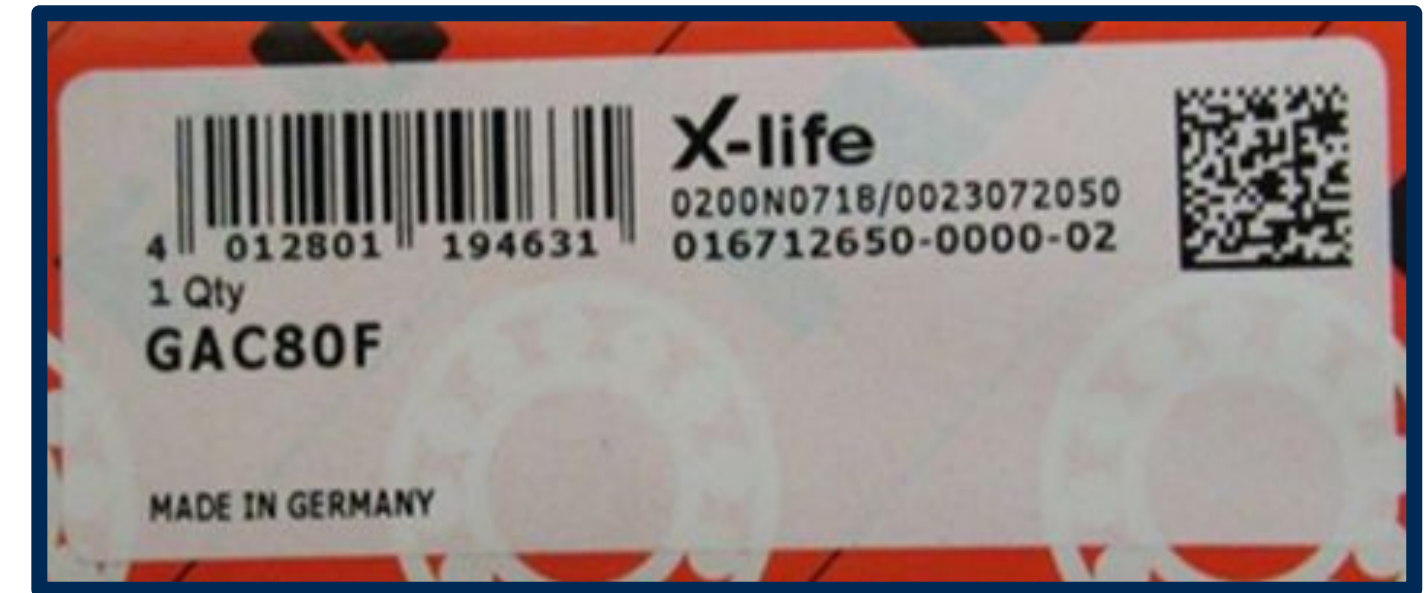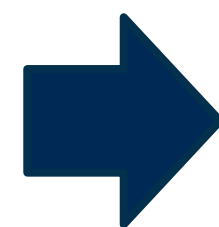
Timeline of Scans
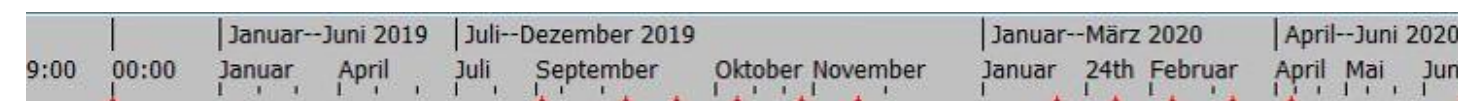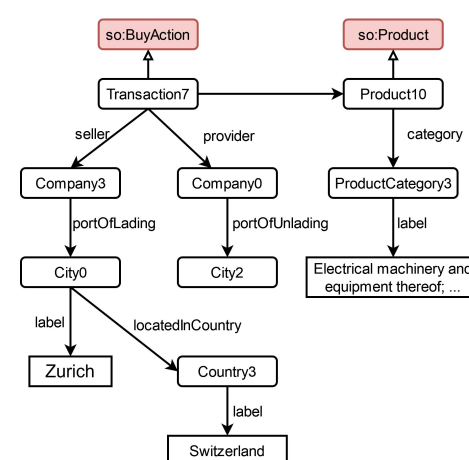
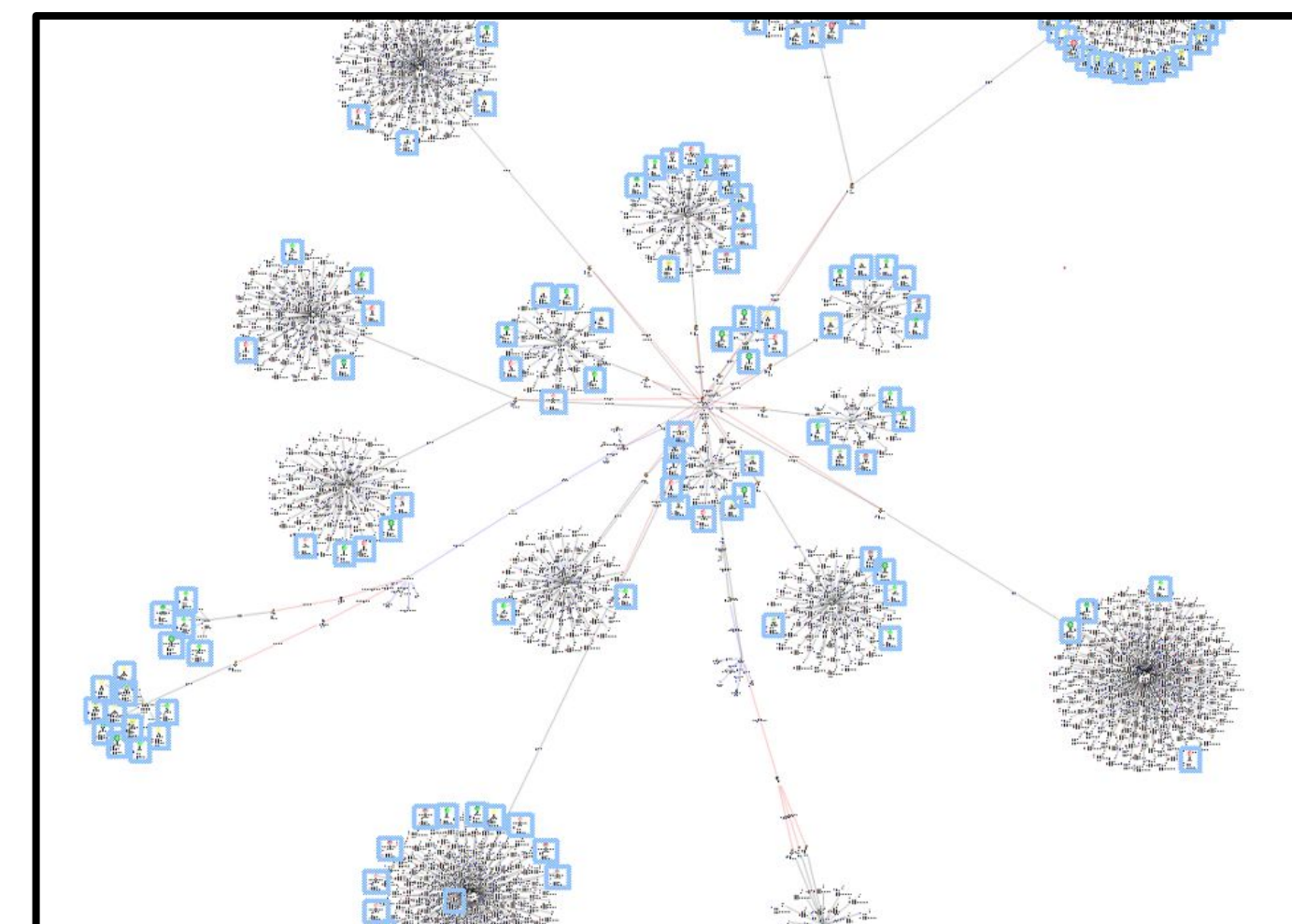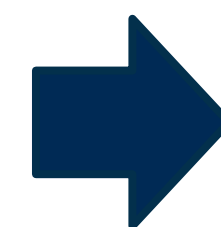# From Codes and Trade Data to Global Networks

Scanned codes

Scan Locations

Company and Trade Data

Company and Trade
Knowledge Graph

Global Network of Companies and Suspicious
Trade Transactions

Thank You!

1. **Knowledge Graphs for Global Events:** Events, Supply Chains & EventKG
2. **Knowledge Graphs for Global Trade:** TBML, Company & Trade Ontology, Red Flags
3. **Example Scenario:** Resilience through Unique Codes

Tomorrow afternoon: Workshop on Semantic Methods for Events and Stories (SEMMES)

https://anr-kflow.github.io/semmes/