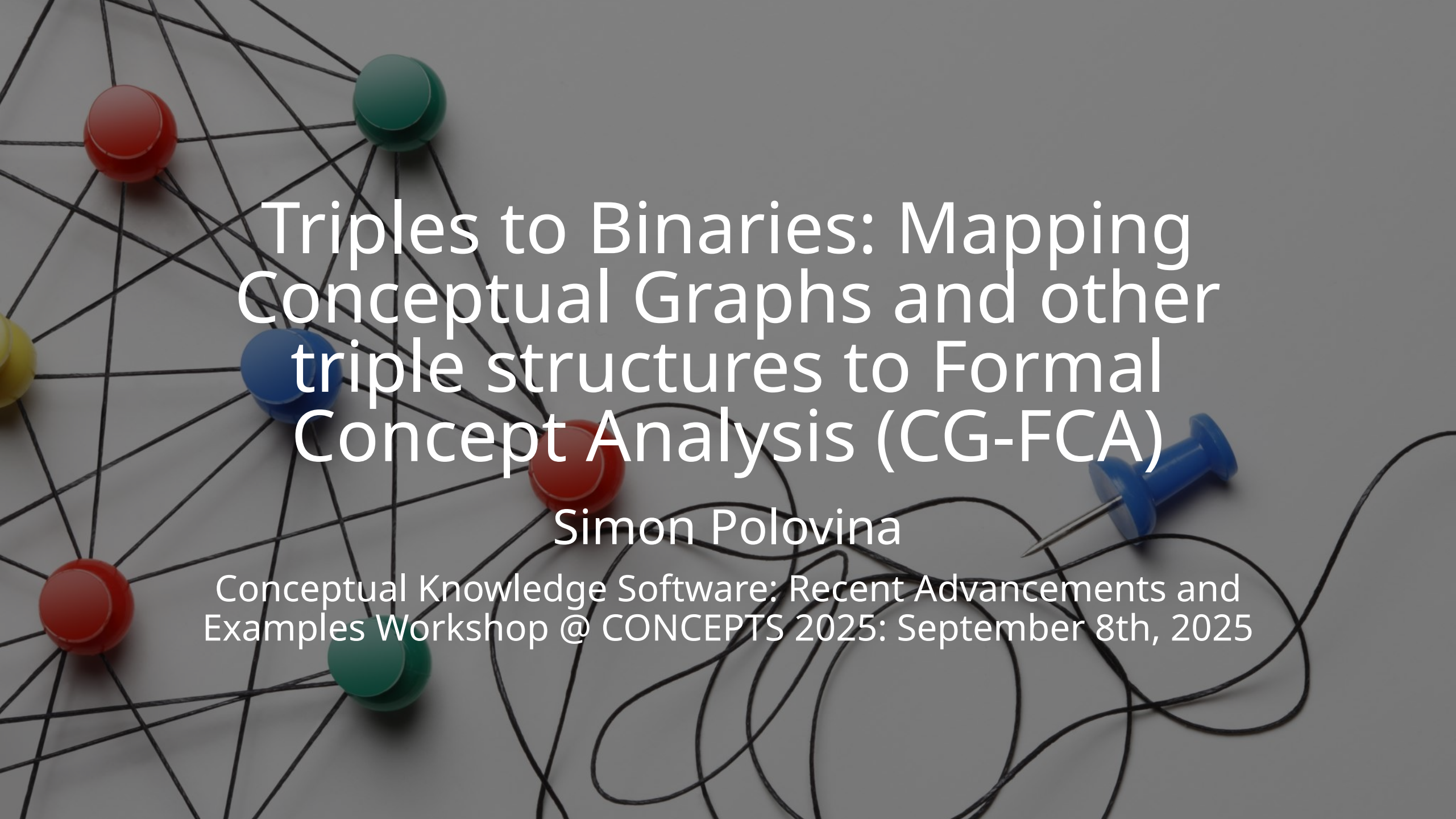

Triples to Binaries: Mapping Conceptual Graphs and other triple structures to Formal Concept Analysis (CG-FCA)

Simon Polovina

Conceptual Knowledge Software: Recent Advancements and Examples Workshop @ CONCEPTS 2025: September 8th, 2025

Origin of the CG-FCA Project

ANDREWS, Simon and POLOVINA, Simon (2011). A mapping from conceptual graphs to formal concept analysis. In: ANDREWS, Simon, POLOVINA, Simon, HILL, Richard and AKHGAR, Babak, (eds.) *Conceptual Structures for Discovering Knowledge (The 19th International Conference on Conceptual Structures, ICCS 2011, Derby, UK.* Lecture Notes in Computer Science (Subseries: Lecture Notes in Artificial Intelligence), (6828). Berlin and Heidelberg, Springer, 63-76.

https://shura.shu.ac.uk/3804/

Included a comparison with Wille's Concept Graphs

Further Validation

ANDREWS, Simon and POLOVINA, Simon (2017). Validating directed graphs by applying formal concept analysis to conceptual graphs. In: *The IJCAI-17 Workshop on Graph Structures for Knowledge Representation and Reasoning (GKR 2017 @ IJCAI)*, Melbourne, Australia, 19-25th August. Lecture Notes in Computer Science (Subseries: Lecture Notes in Artificial Intelligence), (10775). Cham, Switzerland, Springer, 3-28.

https://shura.shu.ac.uk/16869/

Considered CGs as directed graphs, and how FCA elucidates key features, such as pathways and dependencies, inputs and outputs, cycles, and joins

Larger Scale

POLOVINA, Simon and VON ROSING, Mark (2018). Using Conceptual Structures in Enterprise Architecture to develop a new way of thinking and working for organisations. In: CHAPMAN, Peter, ENDRES, Dominik and PERNELLE, Nathalie, (eds.) *Graph-based Representation and Reasoning: 23rd International Conference on Conceptual Structures, ICCS 2018, Edinburgh, UK, June 20-22, 2018, Proceedings.* Lecture Notes in Computer Science (10872). Springer, 176-190.

https://shura.shu.ac.uk/21101/

POLOVINA, Simon, VON ROSING, Mark, LAURIER, Wim and ETZEL, Georg (2019). Enhancing layered enterprise architecture development through conceptual structures. In: ENDRES, Dominik, ALAM, Mehwish and ŞOTROPA, Diana, (eds.) *Graph-based representation and reasoning: 24th International Conference on Conceptual Structures, ICCS 2019, Marburg, Germany, July 1–4, 2019, proceedings.* Lecture Notes in Computer Science, 11530. Cham, Springer

https://shura.shu.ac.uk/24239/

As applied to the metamodels that define how enterprises align their IT assets to meet the enterprise’s strategy, and where strategy drives technology (top-down view) vs. technology driving strategy (bottom-up view)

Beyond CG to all triple structures

Notation	Column 1	Column 2	Column 3	Column 4	Column 5
CG	Source Type Label	Source Type Label's referent	relation	Target Type Label	Target Type Label's referent
csv	Source Entity	*not used*	relation	Target Entity	*not used*
OO	Source Class	Source Class' Object	association	Target Class	Target Class' Object
RDF	Resource 1	Resource 1's Atomic Value	Property Type 1	Resource 2's Atomic Value	Resource 2
OWL	Source Thing	Source Parameter	relation	Target Thing	Target Parameter
EDG	Source Entity	Source Entity's Application & Location	relation	Target Entity	Target Entity's Application & Location

CSV

BAXTER, Matt, POLOVINA, Simon, LAURIER, Wim and VON ROSING, Mark (2021). Active Semantic Relations in Layered Enterprise Architecture Development. In: COCHEZ, M., CROITORU, M., MARQUIS, P. and RUDOLPH, S. (eds.) *Graph Structures for Knowledge Representation and Reasoning. 6th International Workshop, GKR 2020 Virtual Event, September 5, 2020, Revised Selected Papers.* Lecture Notes in Artificial Intelligence (12640). Cham, Switzerland, Springer International Publishing, 3-16.

https://shura.shu.ac.uk/28722/

BAXTER, Matt, POLOVINA, Simon, KEMP, Neil and LAURIER, Wim (2023). Underpinning layered enterprise architecture development with formal concept analysis. In: *Measuring Ontologies for Value Enhancement: Aligning Computing Productivity with Human Creativity for Societal Adaptation First International Workshop, MOVE 2020, Virtual Event, October 17–18, 2020, Revised Selected Papers.* Communications in Computer and Information Science, 1694. Springer, 101-113

https://shura.shu.ac.uk/31347/

An algorithm that elicits the active and passive semantic relations, thus combining top-down and bottom-up into one sophisticated directed graph, and achieved using CSV instead of CG

CG-FCA As-Is

- Presently, the CGs are drawn in CharGer, a legacy CG tool
- The files are then manually exported in a subset of ISO Common Logic CGIF and then manually loaded into a legacy CGFCA converter written in C that only runs in Windows
- CGFCA can also read 3-column CSV files that are manually produced and checked
- CGFCA produces a report and a Burmeister .cxt file that can be read by FCA tools that can read this standard FCA format
- Of all the FCA tools, ConExp remains the most fit-for-purpose, despite its flaws
- DEMO

CG-FCA To-Be

Phase 1

- Replace CharGer with draw.io as the drawing tool
- Retain the ability to input the 3-column CSV file format that CGFCA also permits
- Refactor CGFCA's code so that it's written in NodeJS to run on any desktop with or without cloud access
- Provide an automatic input into CGFCA from draw.io to generate the report and .cxt file
- Import the .cxt file and confirm the resulting FCA visualisation (e.g. Formal Concept Lattice) into FCA tools.

Phase 2

- Create an Excel add-in so that there's no need for the CSV file
- Enable the add-in to execute the new CGFCA directly and produce the report and the .cxt file

Phase 3

- Enable the new CGFCA (using the appropriate tool's add-in capability for the technologies below) to import
  - the Semantic Web's RDF and OWL files
  - Enterprise Data Graphs, namely SAP Graph or Microsoft Graph in *Moregraph* (My CONCEPTS '25 paper)
- Sunset the term CG-FCA and replace with a term that reflects its wider triples-to-binaries use (3to2-FCA?)

Phase 4

- Automatically draw the FCA visualisation without the need to use a separate FCA tool