CGs to FCA Including Peirce’s Cuts

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Abstract
Previous work has demonstrated a straightforward mapping from Conceptual Graphs (CGs) to Formal Concept Analysis (FCA), and the combined benefits these types of Conceptual Structures bring in capturing and reasoning about the semantics in system design. As in that work, a CGs Transaction Model (or ‘Transaction Graph’) exemplar is used, but in the form of a richer Financial Trading (FT) case study that has its business rules visualised in Peirce’s cuts. The FT case study highlights that cuts can meaningfully be included in the CGs to FCA mapping. Accordingly, the case study’s CGs Transaction Graph with its cuts is translated into a form suitable for the CGtoFCA algorithm described in that previous work. The process is tested through the CG-FCA software that implements the CGtoFCA algorithm. The algorithm describes how a Conceptual Graph (CG), represented by triples of the form source-concept, relation, target-concept can be transformed into a set of binary relations of the form target-concept, source-concept ∩ relation thus creating a formal context in FCA. Cuts though can now be included in the same formal, rigorous, reproducible and general way. The mapping develops the Transaction Graph into a Transaction Concept, capturing and unifying the features of Conceptual Structures that CGs and FCA collectively embody.

Keywords: Conceptual Graphs (CGs), Conceptual Structures, Financial Trading (FT), Formal Concept Analysis (FCA), Transaction Graph

INTRODUCTION
Previous work has demonstrated a straightforward mapping from Conceptual Graphs (CGs) to Formal Concept Analysis (FCA), and the combined benefits these types of Conceptual Structures bring in capturing and reasoning about the semantics in system design (Andrews & Polovina, 2011). However that mapping did not consider CGs’ many more features, particularly its use of Peirce’s Existential Graphs. Cited by Peirce as ‘the logic of the future’, this visualisation of logic and its visual approach to reasoning through novel techniques such as ‘deiteration’ and ‘double negation’ is claimed by Sowa as an enhancement of the traditional propositional and predicate logic of Peano, Russell, and Whitehead (Peirce & Sowa, 2010; Polovina, 2007). Sowa describes that Peirce indicated negation by drawing an oval enclosure, which he called a cut because it separated the
sheet of assertion into a positive (outer) area and a negative (inner) area. The detail of this is described elsewhere (Peirce & Sowa, 2010; Polovina, 2007); pertinent to our interest is that cuts visualise contexts from which the nested negations enable inferencing to take place visually. Indeed Sowa refers to cuts as ‘negative contexts’. The benefits of this visualisation have been demonstrated in capturing the semantics of business rules for enterprise system design (Launders, 2011a). Peirce’s cuts thus provide a capability in CGs that the mapping could usefully be applied to, as we will now explore through a representative case study.

A FINANCIAL TRADING EXAMPLE

The case study is about a Financial Trading (FT) enterprise called TechRules Advisors (TRA Inc.), a fictitious asset management firm (© Said Tabet and Gerd Wagner). The firm buys and sells numbers of shares of securities and manages its clients’ assets. Portfolio managers create and manage accounts. As in the previous work, a CGs Transaction Model (or ‘Transaction Graph’) illustration is used (Andrews & Polovina, 2011; Launders, 2011a; Polovina & Andrews, 2011). However unlike its simple case study scenario (namely a university’s community objectives), the FT case study includes business rules visualised through Peirce’s cuts. The detail of the case study is described as follows.

Description of the Case Study

The company (TRA Inc.) buys and sells shares of securities and manages its clients’ assets. Portfolio managers create and manage accounts. A portfolio is owned by a legal entity. The portfolio is managed by a portfolio manager who works for an investment firm. A portfolio is described by a creation date and a value. It has a number of positions. Each position holds an asset and is described by a quantity and an acquisition date. The value of a portfolio is the total value of all the securities held in the portfolio.

There are three different categories of assets: real estate, cash, and securities. Real estate and cash are described by a name. Securities are described by: a security ID, a name and a price. There are three categories of securities: options, bonds, and stocks. Securities are issued by a legal entity that is called an issuer. The issuer can be: a company, a municipality, an agency, or a government.

There are many reasons that motivate issuers to issue securities. For example, the issuer might need to repay debts or raise capital (get some money to invest). Issuers and the securities they have issued can be positively or negatively affected by market events. Market events could be upgrades or downgrades by credit rating agencies. Some issuers are classified as ‘restricted’ by portfolio owners and investment firms. Orders (for buying or selling assets) are placed in the interest of a portfolio. An order is placed by a trader or by a portfolio manager.

FT’s Business Rules

The following are FT’s business rules, which are captured with the aid of Peirce’s cuts:

1. Securities issued by a “restricted” issuer must NOT be bought;
2. An asset must NOT be sold if it has been in the portfolio for less than 30 days;
3. The total asset value (TAV) is the sum of the market value of all positions;
4. The value of cash assets must be less than or equal to 10% of total asset value;
5. A portfolio is rated platinum, if TAV is greater than 1 Mio dollars. It is rated gold, if TAV is less than 1 Mio dollars and greater than 100.000 dollars. It is rated regular, if TAV is less than 100.000 dollars;
6. If there is a downgrade for a security held in a portfolio, the portfolio owner must be sent a “dispose recommendation”. This advises the owner that they should sell the security;
7. An order placed in the interest of a portfolio must not refer to more than one asset held in a position of that portfolio;
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