A Case Study: Ontology-based Modelling and Testing Regulatory Statements

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1. Introduction

OWL ontology can be used to model legal concepts [2]. This article describes a methodology to define regulatory statements using FIRO-H and FIRO-D. The main focus of this report is explaining technical aspects in detail using a case study.

A regulatory statement can be defined using **Conditions**. A **Condition** is an **Action.** Actions can be generated from SBVR verb concepts [3]. Figure 1, illustrates the relationships among Actions, Conditions and Regulatory Statements.

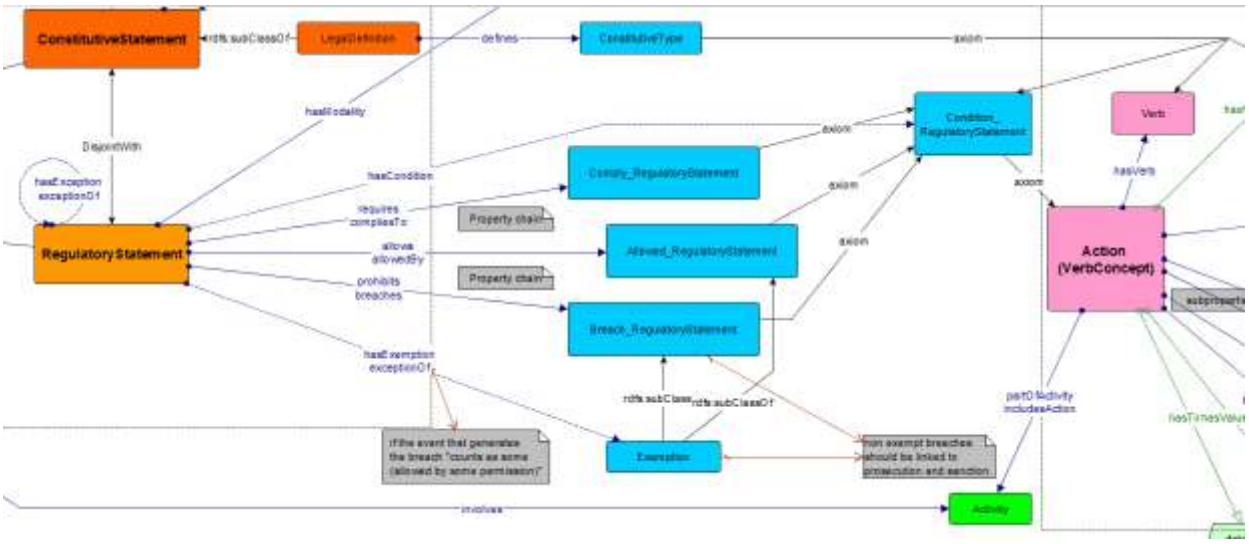


Figure 1: A Snapshot of FIRO-H

2. Modelling Regulatory Statements

2.1 Regulatory Statement

We select a regulatory statement; rule 6 defined in [1] by the Bank of Ireland.

It is obligatory that each quote (*for* each share and each depositary receipt and each ETF and each certificate and other similar financial instruments *traded on* a trading venue) *include* each firm bid price *and* firm offer price *for* quote sizes that *are inferior or equivalent to* the standard market size *for* each (class of shares and class of depositary receipt and class of EFT and class of certificate and class of other similar financial instrument) and each financial instrument *belongs to* exactly one class of financial instrument.

2.2 Condition Model of a Regulatory Statement

A Regulatory statement can be broken down into SBVR verb concepts [3] and verb concepts can be used to define conditions. A Condition is a sub class of Action. Actions can be generated from real world data which we need to validate against a regulatory statement.

Deontic condition is …[need definition]
Simple condition is …[need definition]

Condition model defines a regulatory statement using deontic condition and simple conditions. Deontic condition has a modality whereas simple conditions do not. Condition is a sub class of Action, see Figure 1.

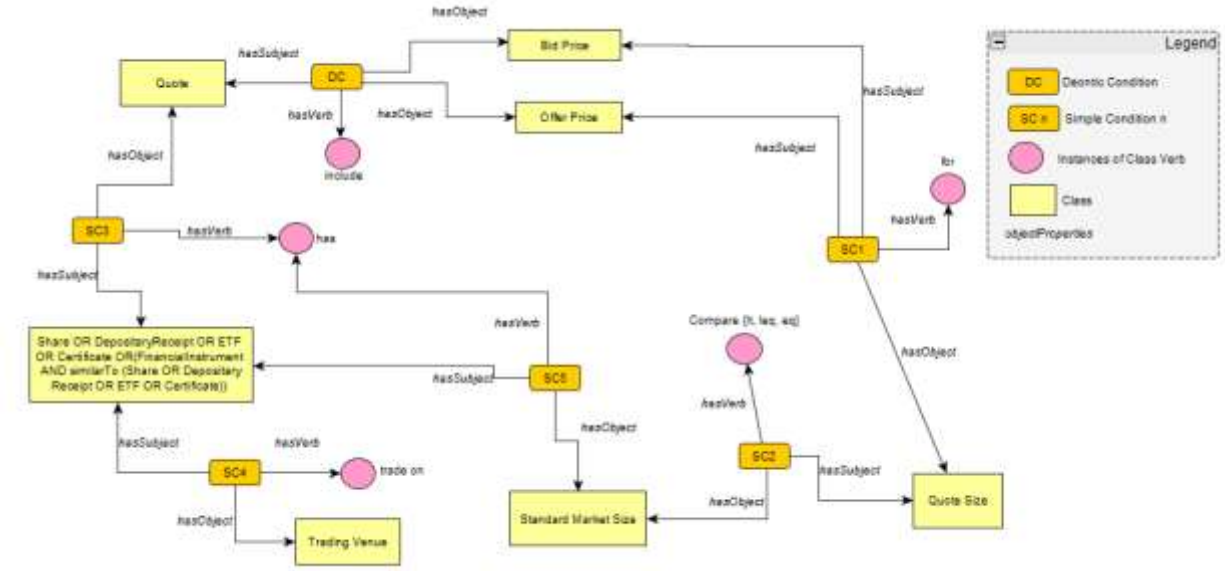


Figure 2.2: Condition Model for Rule 6

In Figure 2.2, DC is the deontic condition which is a compliance in this example. Each condition can be connected to each other condition using properties and inverses properties. A condition can have more than one object and more than one subject. Defining these relationships within ontology will help to validate conditions and actions using ontology reasoning. An action is a SBVR verb concept.

2.2.1 Verb Concepts and condition model

In here, I explain verb concepts related to Rule 6. Verb concepts which are marked as italic are not implemented in conditions. However they can be implemented and specify them as equivalent to relevant conditions within the ontology. DC and SC<n> are identified as deontic condition and simple conditions as illustrated in Figure 2.2.

Condition DC:

Quote	*includes*	*Price (General concept)*
Quote	includes	Bid price
Quote	includes	Offer price

Condition SC1:

Price	*for*	*Quote size (General concept)*
Quote size	*has*	*Price*
Bid price	for	Quote size
Offer price	for	Quote size

Condition SC2:

Quote size	*is compared to*	*size (General concept)*
Quote size	is inferior to	Standard market size
Quote size	is equivalent to	Standard market size

Condition SC3:

Financial instrument	has	quote

Condition SC4:

Financial instrument	is traded on	trading venue

Condition SC5:

Class of financial instrument	has	standard market size

2.2.2 Raw Data, Actions, Conditions, FIRO-D and FIRO-H

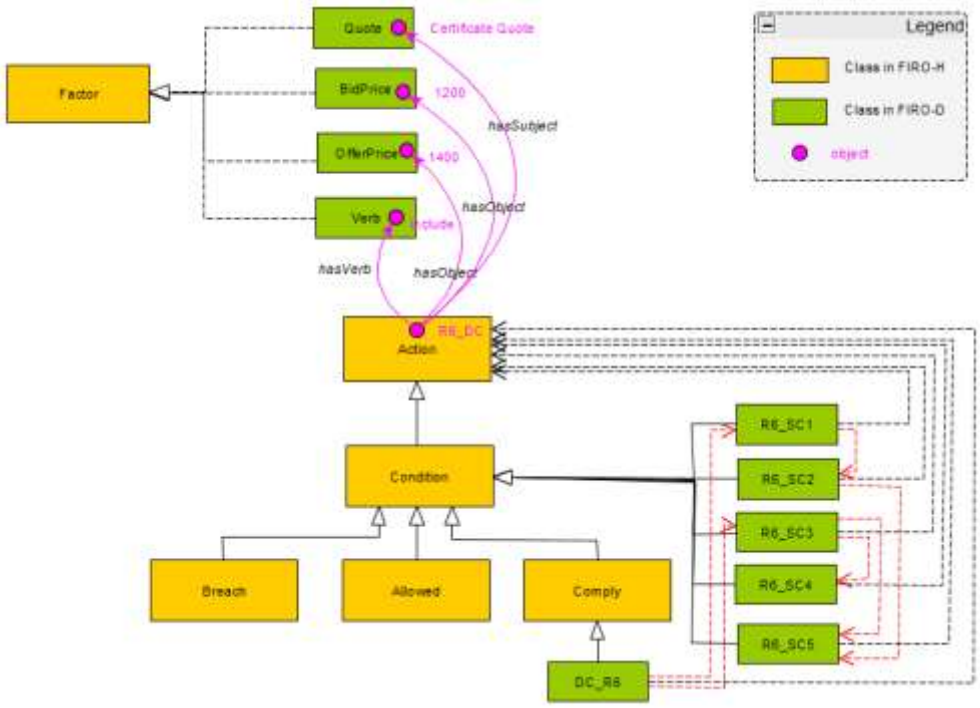


Figure 2.2.2: FIRO-H and FIRO-D to Actions

Figure 2.2.2 illustrates the relationships of FIRO-H, FIRO-D, Conditions, Actions and Raw Data.

2.3 FIRO-D Specification

SBVR verb concepts in a particular domain can be defined in FIRO-D using OWL concepts and properties. These concepts, properties in FIRO-D and FIRO-H can be used to define conditions and then conditions can be composed to define regulatory statements.

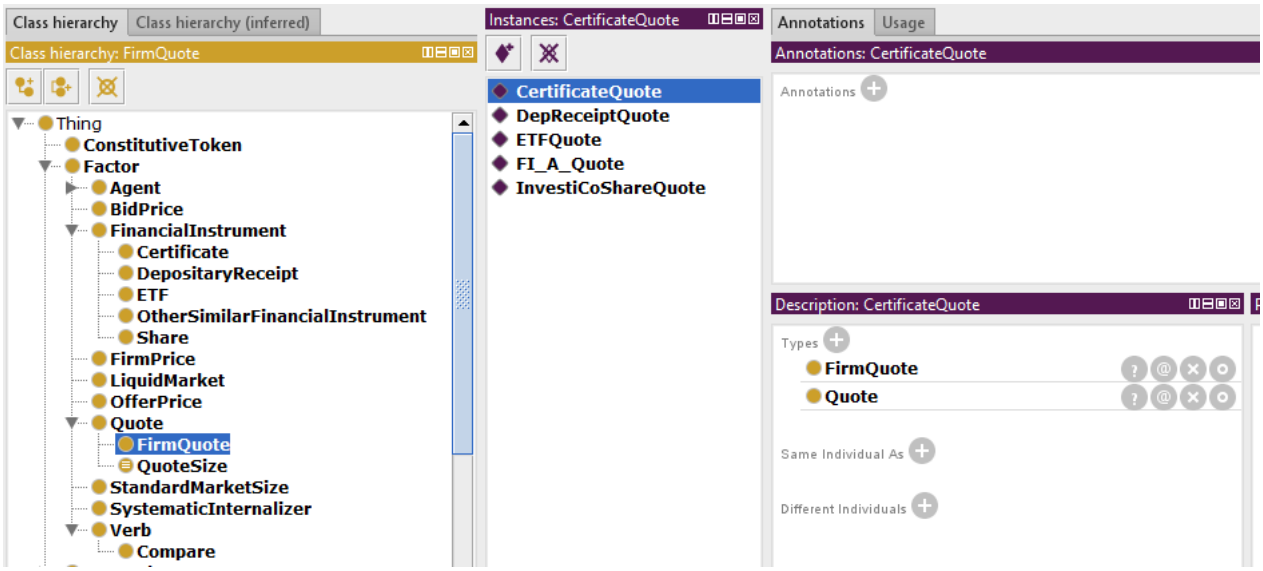


Figure 2.3: A Snapshot of FIRO-D

2.4 Class Expressions of the Condition Model

This section describes each condition in detail. A regulatory statement is defined using conditions and each condition can be related with more than one action. Each action is a SBVR verb concept.

2.4.1 DC : Deontic Condition

DC is identified as the core condition and the rest of the conditions need to be connected with this condition using properties and inverse properties.

Class Expression of Comply_R6_DC:
Action
and (*hasObject* some (BidPrice and (*subjectOf* some R6_SC1)))
and (*hasObject* some (OfferPrice and (*subjectOf* some R6_SC1)))

and (*hasSubject* some (Quote and (*objectOf* some R6_SC3)))

and (*hasVerb* value include)

compliesTo value Rule6

The condition Comply_R6_DC is connected with the condition R6_SC1 using *subjectOf* inverse property and with the condition R6_SC3 using *objectOf* inverse property.

2.4.2 SC1: Simple Condition 1

Class Expression of R6_SC1:

Action
and (*hasSubject* some BidPrice)

and (*hasSubject* some OfferPrice)

and (*hasObject* some (QuoteSize and (*subjectOf* some R6_SC2)))

and (*hasVerb* value for)

The condition R6_SC1 is connected with the condition R6_SC2 using the invers property *subjectOf*.

2.4.3 SC2: Simple Condition 2

Class Expression of R6_SC2:

Action
and (*hasObject* some
(StandardMarketSize
and (*objectOf* some R6_SC5)))

and (*hasSubject* some QuoteSize)

and (*hasVerb* some
(Compare
and ({eq , lt})))

The condition R6_SC2 is connected with the condition R6_SC5 using the inverse property *objectOf*. The beauty of this condition is, the verb relationship has optional comparators such as equal and less than. This further emphasizes that it is possible to enrich Verb with semantics as we do with subjects and objects.

2.4.4 SC3: Simple Condition 3

Class Expression of R6_SC3:
Action
and (*hasSubject* some
(((*subjectOf* some R6_SC5)
and (*subjectOf* some
(R6_SC4
and (*hasObject* some TradingVenue))))
and (Certificate or DepositaryReceipt or ETF or
OtherSimilarFinancialInstrument or Share)))

and (*hasObject* some Quote)

and (*hasVerb* value has)

The condition R6_SC3 is connected with the condition R6_SC5 and R6_SC4 using the inverse property subjectOf.

2.4.5 SC4: Simple Condition 4

Class Expression of R6_SC4:
Action
and (*hasObject* some TradingVenue)

and (*hasSubject* some
(Certificate or DepositaryReceipt or ETF or OtherSimilarFinancialInstrument or Share))

and (*hasVerb* value tradedOn)

2.4.6 SC5: Simple Condition 5

Class Expression of R6_SC5:
Action
and (*hasObject* some StandardMarketSize)

and (*hasSubject* some
(Certificate or DepositaryReceipt or ETF or OtherSimilarFinancialInstrument or Share))

and (*hasVerb* value has)

3. Creating and Testing Actions

This section illustrates creating and testing actions against the regulatory statement defined in Rule6. Two sample test cases are implemented for the illustration purpose. Ontology reasoning can be used to test actions. Test cases should be generated considering each condition. Each condition should be tested for each property. Number of test cases > (number of conditions)!

Test Case 01:

Action 6_1: **Quote**: CertificateQuote **Verb**: include **BidPrice**: 1200
: **Quote**: CertificateQuote **Verb**: include **OfferPrice**: 1400

Action 6_2: **BidPrice:** 1200 **Verb**: for **QuoteSize**: 18
:**OfferPrice**: 1400 **Verb**: for **QuoteSize**: 18

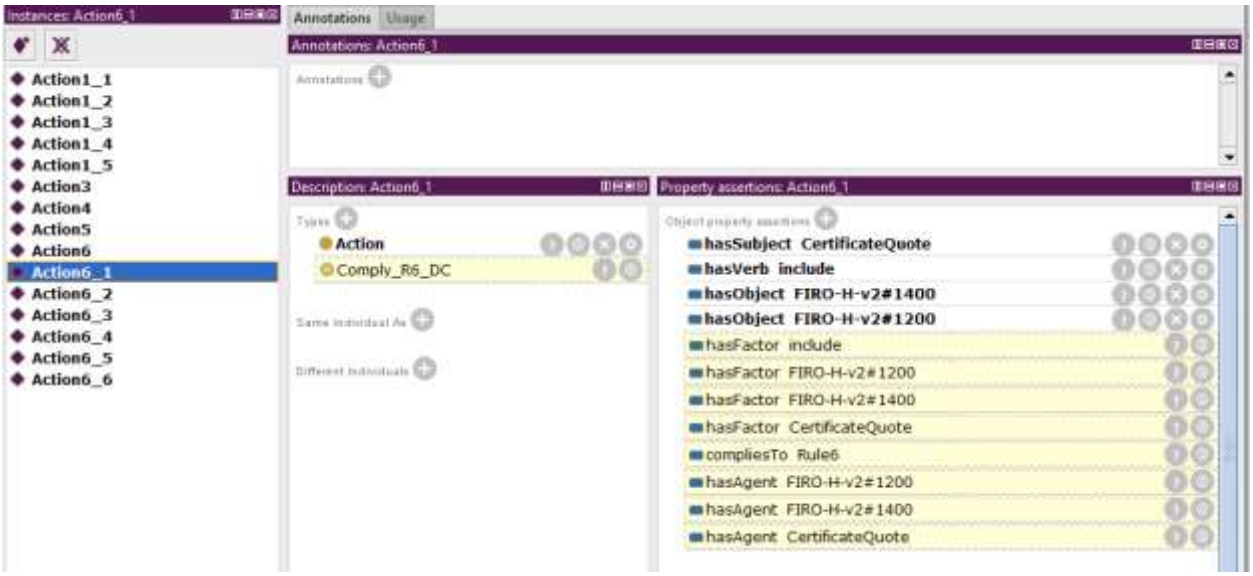
Action 6_3: **QuoteSize**: 18 **Verb**: lt **StandardMarketSize**: 20

Action 6_4: **Certificate**: InvestingCertificates **Verb**: has **Quote**: CertificateQuote

Action 6_5: **Certificate**: InvestingCertificates **Verb**: tradeOn **TradingVenue**: LondonStockExchange

Action 6_6: **Certificate**: InvestingCertificates **Verb**: has **StandardMarketSize**: 20

Results: Above information complies with Rule 6.

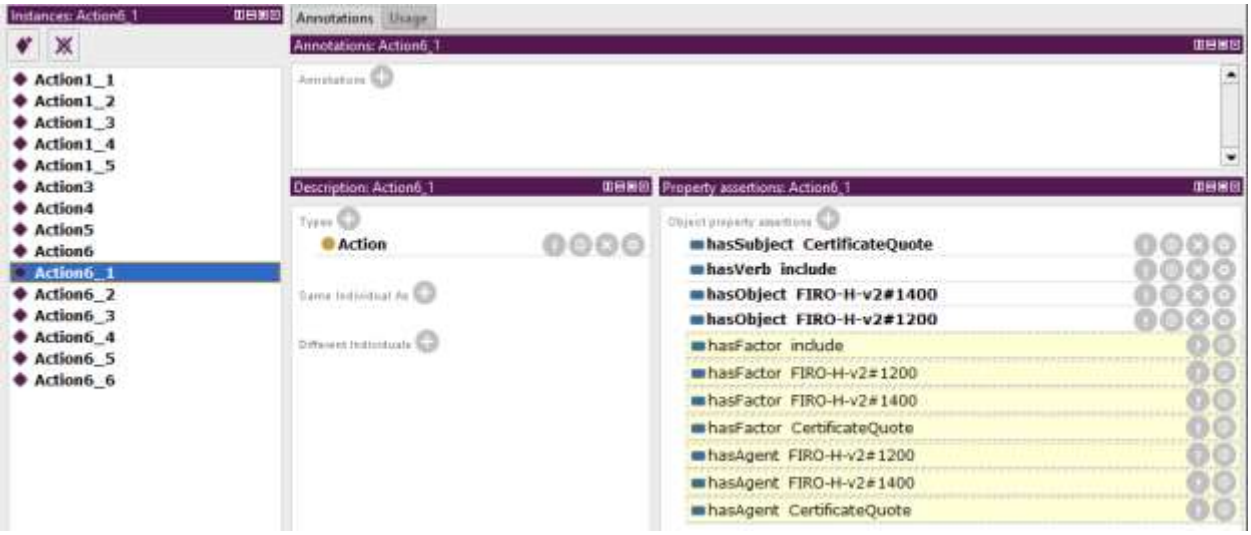


This shows that above data complies with the regulatory statement defined in Rule 6.

Test Case 02:

All the data as in Test Case 01 and Trading venue is empty in Action 6_5.

Result: Above data will not comply with Rule6



The regulatory statement, Rule 6 needs each financial instrument to trade on a trading venue. The data set in Test case 2 does not have a trading venue. Hence this data set cannot be complied with Rule 6.

References:

1. Transparency for systematic internalizes and investment firms trading OTC, Article 14, AIB Bank.
2. J. Breuker, R. Hoekstra, A. Boer and K. den Berg. OWL Ontology of Basic Legal Concepts (LKIF-Core) 1.4.ESTRELLA – European project for standardized transparent representations in order to extend legal accessibility. Jan 2007.
3. Semantics of Business Vocabulary and Rules (SBVT™) , http://www.omg.org/spec/SBVR/.