Semantic Solutions for Financial Industry Systemic Risk Analysis

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Mission

• Who we are:
  – Non-profit collaborative industry standards development team
  – From financial institutions, standards and trade groups, technology vendors

• Goal:
  – Create semantic financial data standards and operational solutions that will eliminate data quality gaps and will promote progress towards achieving data maturity and health in the financial system

• Our proposal/solution is:
  – A community-based, free and open source financial industry standard
  – Non-proprietary nor dependent on any individual vendor solutions

• Our collective challenge and journey:
  – We seek an open dialogue and the contribution of diverse perspectives to advance the potential of semantics and semantic processing
Poor Data Quality Impacted Early Identification of Risks During the 2008 Global Financial Crisis

While the global financial crisis had multiple causes a major gap was poor quality of financial data that led to:

– opaqueness, lack of transparency and thus inadequate awareness by regulators (and financial institutions) of mounting concentrations of financial risk. Examples:

– overleveraging in over-the-counter (OTC) derivatives (complex financial instruments used for hedging) were relatively opaque to regulators e.g. credit default swaps, resulting in insufficient liquid capital to cover drops in asset prices (ex. AIG, Lehman)

– inability to identify the risks inherent in mortgage backed securities

– impacted sensitivity of analytic risk models
Financial Contagion Influenced Regulators to Recommend Global Financial Data Standards

Regulators and financial institutions also were unable to gain visibility to complex financial interdependencies between counterparties to trades
  – where default risks became magnified
  – resulting in massive financial impacts across institutions and borders

Regulators have thus called for global financial data standards
  – to ensure there is high data consistency, data linkage and data integration
  – as a prerequisite for effective macroprudential risk analysis and reporting
  – data standards are also desired by financial institutions for equal reasons
Regulatory Requirements for Financial Data Standards and Transparency

- Financial data standards have been requested for:
  - identification of legal entities and their subsidiaries, ownership hierarchies
  - identification of financial instruments e.g. derivatives
  - precise and comparable language of financial contracts

So that regulators (and financial institutions) can
- classify undifferentiated swaps into asset classes and risk categories
- analyze linkages between counterparties to trades and identify aggregate positions and exposures across asset classes and ownership hierarchies
- understand exposures at institutional, national and cross-border levels
- aggregate the data and exchange information with other regulatory authorities
- also institutions can more easily filter out prospective trades that are classified outside of risk tolerances
Semantic Technology Can be a Foundation for Financial Data Standards and Transparency

• The Enterprise Data Management Council and the Object Management Group believe that semantic technology
  – is the optimum way forward to define financial data standards in support of the objectives of the financial regulators and the financial industry
  – can supplement and map to existing financial data standards

Semantic technology uses machine intelligence to provide highly advanced data schemas (ontologies) and tools
  – that can help organizations better define, link, integrate and classify their data
  – and do this faster, cheaper, smarter
The View From Mike’s Place

Some banks
The View From Mike’s Place

Some banks

Some IT Firms
Conceptual Model for Data

- Conceptual Model (Semantics)
- Logical Model (Design)
- Physical Model (Implementation specific)

Realise

Implement
Conceptual Model for Data

- Conceptual Model (Semantics)
- Logical Model (Design)
- Physical Model (Implementation specific)

The Language Interface

Business

Technology
Conceptual Model for Data

The Language Interface

Conceptual Model (Semantics)

Logical Model (Design)

Physical Model (Implementation specific)

FIBO bridges the “Language gap” between business and technology
FIBO Bridges the Language Gap...

- Technology governance
  - Not “business”
  - Not “Technology”
  - The business of technology development
- Mature process = predictable results
  - Change management
  - Transparency
  - Reuse of data
- Opportunity costs:
  - Cost over-runs
  - Poor delivery
  - Long and unmanageable discussions for every new change
How does Semantics Help?

- A single version of the truth
- Framed in formal logic
  - Complete and accurate
  - Extensible
- Implementable by technical staff
  - Does NOT require the technologists to understand everything in order to deliver it
  - BUT
  - Cultural shift: does not require the technologists to understand everything...
- New material is additive
  - Provided that the model is truly semantic
Towards Meaning

• The stated benefits for semantics only really apply if the model is actually meaningful
  – Full abstraction of concepts
  – What sort of “Thing” is this?
  – What distinguishes it from other things?
• For each concept, frame this in terms of a simpler, meaningful concept
• If you just implement the same old “data models” in a new syntax, there is no semantics and therefore no benefits from using semantics
• Syntax is not semantics!
What we want

• Business meanings

• In business language

• For business people
What we want

• Business meanings
  – Not data dictionary
• In business language
  – Not a design
• For business people
  – No funny symbols and things
  – No language to learn
  – Just the facts
  – Boxes and lines – something like this...
Types of Entity

- **Thing**
  - **Independent Thing**
    - Anything which can act on its own part.
  - **Autonomous Entity**
    - Any collection, the members of which are themselves autonomous entities (people, firms etc.)
    - EXAMPLES: John Smith, Microsoft Inc., England and Wales Cricket Board, The Bullingdon Club

- **Human Being**
  - Any entity which may incur legal obligation or be sued at law.
  - EXAMPLE: John Smith

- **Legal Person**
  - EXAMPLE: John Smith, Microsoft Inc.

- **Organization**
  - EXAMPLES: Microsoft Inc., England and Wales Cricket Board, The Bullingdon Club
Types of Entity

- Formal representation of the legal “facts of the matter”
  - What is a Legal Person?
  - What is an Organization
  - What kinds of entity may be both?

- This may be very different from any given data model
  - Forms a common key for a range of data models
  - Example: a model of data for loan borrowers will focus on Legal Person, since loan borrowers incur debt
  - Example: an identifier for participants in OTC Contracts is also limited to Legal Persons
  - Some identifiers need to identify Trusts – these are NOT legal persons

- Use as a common key to identify the things referred to in application data models
Legal Persons Fundamentals

A “Legal Person” is distinguished by the fact is able to incur liability.

An “Artificial Person” is a Legal Person with some formal instrument by which it is incorporated.
A “Formal Organization” is distinguished from other (informal) organizations by having some formal covering agreement among the principals. Includes Trusts, Partnerships; also limited companies.
Business Entities Taxonomy
Financial Industry Business Ontology (FIBO)

Requirement #1: Define Uniform and Expressive Financial Data Standards

- FpML
- MISMO
- FIX
- ISO
- MDDL
- XBRL

Semantic Web

Industry Standards

Financial Industry Business Ontology (FIBO)

- Securities
- Business Entities
- Derivatives
- Metadata
- Loans
- Corporate Actions

Unambiguous Shared Meaning
Financial Industry Business Ontology (FIBO)

- **Business Entities**
  - Legal entities, ownership hierarchies, LEI,
- **Securities**
  - Tradable securities - equity, debt securities, reference data terms
- **Loans**
  - Retail lending, corporate, credit facilities
- **Derivatives**
  - Exchange traded and over the counter derivative trades, contracts and terms
- **Market Data**
  - Date and time dependent pricing, analytics
- **Corporate Actions**
  - Corporate event and action types, process
- **Annotation metadata**
  - Provenance, mapping, rulemaking
Some of the benefits of FIBO

- Open semantic standards for financial data that is exchangeable across financial institutions and regulatory authorities
- Provides data consistency and transparency
- Intended to support federal regulatory reporting rules
- Enables business validation and understanding
- Enables reuse and understanding of core industry data elements and concepts
- Reflects collaborative effort across institutions
- *Objective is to release modular ontologies that support business needs and priorities of the regulatory and financial community, e.g. Business Entities, IR Swaps*
Business Conceptual Ontologies

Requirement #1: Define Uniform and Expressive Financial Data Standards

Business Ontology (AKA “conceptual model”)

- Defines contract types
- Defines leg roles
- Defines contract terms

- Something.owl ≠ “an ontology”

Model from Sparx Systems Enterprise Architect
Government Agencies Potentially Interested in FIBO per Dodd-Frank Requirements

The following regulatory agencies have expressed potential interest in semantic financial data standards via FIBO to enable greater data consistency, transparency and risk oversight to fulfill Dodd-Frank mandates:

- OFR
- CFTC
- SEC
- FRB
- OCC
- FDIC
- FINRA
- ECB
- FSA
- FSB
- ECB
Financial Institutions and Industry Organizations who have Expressed Interest in FIBO

![Logos of financial institutions and industry organizations](image-url)
FIBO Business Conceptual and Operational Ontologies are Two Sides of the Same Coin

- **FIBO Business Ontologies**
  - Human facing
  - Standard terms and definitions for business concepts
  - Common reference for regulatory definitions, terms
  - A resource for banks internally (integration, model driven development)

- **FIBO Operational Ontologies**
  - Machine facing
  - Derived from FIBO Business Ontologies
  - Classification, inferencing, and semantic querying
  - Deliver executable functionality to regulators and firms to enable data linkage, transparency and risk analytics

Unambiguous Shared Meaning
Contributors to FIBO OTC Derivatives
Operational Ontologies

Enterprise Data Management Council
Wells Fargo
OMG
Thematix
Adaptive
Semantic Arts
Revelytix
Citi
UBS
Bank of America
Chase
MITRE
Cambridge Semantics
Open Finance

Unambiguous Shared Meaning
FIBO Modular Operational Ontologies for Interest Rate Swaps

Requirement #1: Define Uniform and Expressive Financial Data Standards

SKOS
Organization
Dublin Core
Standards
Ontology Metadata
Requirements
Derivatives Contracts
Financial Common
Derivatives Assets
ISDA Swaps
IR Swap Contracts
Business Entity
IR Swap Individuals
FIBO Interest Rate Swaps Ontology
IR Swap Rules

Unambiguous Shared Meaning
Semantic Financial Metadata Annotations: Setting the Standard for Standards

Requirement #1: Define Uniform and Expressive Financial Data Standards

- In conventional data schemas limited explanatory information or metadata is available, resulting in:
  - the need to access independent metadata tools
  - confusion and data rationalization problems, which incurs errors, delays and cost

- Semantic metadata is directly linked to the elements in the ontology, including specific facts
  - One-stop integrated locus for related knowledge

- Metadata annotations provides:
  - Data Provenance, source and reference information
  - Cross-reference to data elements in related financial data standards, regulatory rules, business requirements and specifications e.g. FpML, CFTC rules, etc

- Metadata can be accessed as Linked Open Data
Semantic Metadata for Interest Rate Swap Contract

Requirement #1: Define Uniform and Expressive Financial Data Standards

Metadata annotations provide rich context to drive precise understanding of an ontology element.

Metadata objects are interlinked and suitable for querying.

*Gruff 3.0 courtesy of Franz, Inc.*
Semantic Reasoning Classifies and Links Data into a Networked Graph Pattern for Powerful Access

Requirement #2: Classify Financial Instruments into Asset Classes

Data in semantic graphs can be traversed, classified and aggregated

Concepts can be inferred using axioms

Float-FLOAT Swap (Axiom)
swap leg minimum 2
floating_rate_leg

Interest Rate Swap

Fixed Float Swap

Acme Inc

LEI5001

name

party

leg

index

notional

currency

10000000

USD

LIBOR

10000000

USD

3.5%

Leg 1

Leg 2

Big Bank

name

party

leg

index

notional

currency

10000000

USD

Lei2222

LEI7777

LEI9999

LEI3333

parent

child

Trader LLC

Securities LLC

Parent LLC

LEI2222

parent

child

Child LLC

Securities LLC

Good Fund

name

party

leg

index

notional

currency

10000000

USD

10000000

USD

3.5%

Leg 1

Leg 2

Cross Currency Swap

Cross Currency Float Float Swap

USD

LIBOR

50000000

EUR

50000000

FedFunds

USD

5/19/2012

Unambiguous Shared Meaning

Concepts can be inferred using axioms.
Semantically Defined Network Graph Structures Provide a Framework for Systemic Risk Analytics

Requirement #3: Link Disparate Information for Risk Analysis

Conventional database technologies have limited ability to represent the complex entities and inter-relationships that span financial networks and that are necessary to traverse in order to perform highly effective risk analysis and simulations.

- Network models based upon semantic financial data standards are flexible and easy to change.
- Semantic network graphs can interconnect ownership entities, transactions, contracts, market data.
- Reflect *transitive exposures* across counterparties, sovereigns.
- Provide diverse aggregations that can rollup from atomic transactions to high level classifications for powerful analytics.
Semantics can Identify Positions of Legal Entities and Their Hierarchies Across Trades and Asset Classes

Requirement #3: Link Disparate Information for Risk Analysis

- Data is queried using graph pattern matching techniques vs. relational joins
- Queries can process inferred data and highly complex and abstract data structures
- Queries can federate across semantic endpoints (using SPARQL 1.1)
- Data can be aggregated and summarized (using SPARQL 1.1)

Query all Transaction Repositories to report on the sum total of aggregate exposure for all counterparties and their parents involved in all swaps associated with an interest rate swap taxonomy.

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Unambiguous Shared Meaning
FIBO Operational Ontologies can Represent Contractual Provisions of Swap Agreements for Risk Analytics

Requirement #4: Electronically Express Contractual Provisions

- ISDA Master Agreement
  - Schedules
  - Credit Support Annex
  - Schedules
- Axioms and Rules
- Identify Key Contractual Events
- Identify Key Contractual Actions
- Classify Contract Type by Cash Flow
- Default Events
- Termination Events
- Increase Collateral
- Transfer Payments
- Infer Counterparty Transitive Exposures
- Infer Capital, Liquidity Risks et al.
- Reduce Value of Collateral
- Downgrade Counterparty Credit
- Classify Counterparties into Risk Categories for Analytics
- OTC Derivative Confirm
- Transaction Repository, et al.
- Credit Rating Agency
- Market Reference Data
- Risk Analyst


**Report on OTC Derivatives Data Reporting and Aggregation Requirements, the International Organization of Securities Commissioners (IOSCO), August 2011

***Joint Study on the Feasibility of Mandating Algorithmic Descriptions for Derivatives, SEC/CFTC, April 2011
Proposed FIBO Architecture for Institutional and Macroprudential Oversight

Semantically defined financial data standards ensures data quality and fidelity between institutions and regulators

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Unambiguous Shared Meaning
FIBO OTC Derivatives Operational Ontology Demonstration

* Protégé Ontology Editor courtesy of Stanford University