



***Knowledge Graph
Architecture for the
Enterprise***
by Dean Allemang



Module 0. About the Course (7 min)

Module 1. Definitions and Business Case (55 min)

- *History of Knowledge Graphs*
 - Knowledge Graphs on the Web
 - Knowledge Graph of Banking (abridged)
 - Semantic Web Description of Banking: EBF, abnarmo, CTFC, ECFR, Cornell
 - Semantic Web Description of Banking (abridged)
 - Knowledge Graph of Banking Summary
 - Use Case for Knowledge Graphs
 - Berners-Lee Quote
 - Industrial Scale Semantic Web – Finance Part 1 & 2
 - Industrial Scale Semantic Web – Chemistry Part 1 & 2
 - How Can We Share Meaning?
 - Sharing Terminology Part 1 & 2
 - Linking Terminology
 - Describing Terminology
 - Describing Terminology in FIBO Part 1 & 2
 - Ontologies Refer to One Another
 - Semantic Services in an Enterprise Knowledge Graph Part 1 & 2
- *Knowledge Graphs in Various Industries - Finance*
 - Semantic Enterprise Data Integration
 - Role of FIBO in Semantic Data Integration
- *Knowledge Graphs in Various Industries – Media*
 - Steps in Movie Production
- *Knowledge Graphs in Various Industries – Agriculture*
 - Managing Agricultural Publications Using AGROVOC
 - AGROVOC
- *Knowledge Graphs in Various Industries – Pharmaceuticals*
 - CDISC – Clinical Data Interchange Standards Consortium
- *Data Management Challenges in the Enterprise*
 - Data Management Landscape – a Metaphor Part 1 & 2
 - Map of the Enterprise Data Jungle
 - How the WEB was Won

Module 2. Knowledge Graph Supporting Technologies (40 min)

- *Features of Graph Data Systems*
 - What is a Graph? Part 1 & 2
 - Other Words for Graphs
 - Why Graphs?
- *Approaches to Graphs as Data*



DM-06: Knowledge Graph Architecture for the Enterprise

- Graphs as Linked Tables
- Graphs with Attributes
- Linked Identities
- *Property Graph Data Capabilities*
 - What are Graphs Good at?
 - Entity Resolution
 - Entity Resolution Example
 - Entity Resolution with Graphs Part 1-3
 - Fraud Detection
 - Path Analytics Part 1 & 2
- *Graph Data Queries*
 - Complex Data is a Bowl of Spaghetti Part 1-4
 - Various Query Languages
- *Graph Data Visualization*
 - Graph Data Visualization
 - Small, Detailed Displays
 - Small Detailed Graphs
 - Large Uniform Graphs Part 1 & 2
 - Connected Subgraphs
- *Graph Data Systems*
 - Graph Data Systems
 - What Does a Graph Data System Do?
 - Data Applications
 - Multi-Modal Databases
 - Multi-Modal Vendors
 - Graph Data Standards
- *Standardizing Data*
 - Why Standardize Data? Part 1 & 2
 - Graph Data Standards
 - Well-Known Non-Graph Data Standards: Relational Database
 - Well-Known Non-Graph Data Standards: Documents
 - Graph Data Standards: Semantic Web
 - Graph Data Standards: Property Graph

Module 3. Semantic Technology Fundamentals (58 min)

- *Knowledge Graph Stack*
- *RDF Brings Data Together*
 - RDF Basic – Data as “Triples”
 - Distributing Tabular Data
 - Column-by-column?
 - Row-by-row?
 - Cell-by-cell?



DM-06: Knowledge Graph Architecture for the Enterprise

- Triples in RDF
- Tabular Data as a Graph
- Combining Data on a Web Site
- *RDFS Enhance Data with Types & Properties*
 - RDF Schema Language (RDFS)
 - Example Classes/Subclasses, Domains/Ranges Part 1 & 2
- *OWL Provides Precision Logic to Describe Models*
 - OWL Example
- *SPARQL Lets you Ask Questions About the Data*
- *Example Knowledge Graph Capabilities Using Semantic Web Standards*
 - Components of the Sample Knowledge Graph
 - Using FIBO for Semantic Data Integration (simple example)
 - AML/KYC Data
 - Data as RDF
 - Semantic Federated Queries
 - FIBO + RDFS Provides Information About Types
 - Inferences Using FIBO and RDFS
 - Semantic Federated Queries
 - FIBO Contribution
 - Data Including FIBO Metastatement about Inverses
- *Using SKOS for Knowledge Management*
 - SKOS Organizes Terminology
 - SKOS – Simple Knowledge Organization System Part 1
 - The Role of SKOS in Enterprise Data
 - SKOS Organizes Terminology
 - Vocabulary for Use and Defining Data Elements
 - Vocabularies for Enterprise Data Management Part 1 – 3
 - FIBO as Master Vocabulary
 - Who Uses SKOS?
 - SKOS Example: Agrovoc
- *The Meaning of Meaning*
 - How Do We Express Meaning?
 - Sample Data
 - Expressing Meaning in Words: Part 1 – 3
 - Expressing Meaning as Reference
 - Expressing Meaning as Structure
 - Expressing Meaning with a Graph
 - Explaining the Swap Record
 - Expressing Meaning as a Structured Graph Part 1 – 4
 - What Role did the Ontology Play in Meaning?

Module 4. Knowledge Graph Enterprise Framework (35 min)



DM-06: Knowledge Graph Architecture for the Enterprise

- *Application Vs. Enterprise Data*
- *The Enterprise Data Jungle*
- *Sustainable Extensibility*
- *Enterprise Data Community*
- *Prerequisites for Distributed Data*
- *Common Reference*
 - Shared References are Everywhere
 - Linked Open Data Cloud
- *Connecting References*
- *Semantic Alignment*
 - Semantic Alignment by Common Reference
- *Things vs. Strings*
 - Things vs. Strings Part 1 & 2
- *Tools and Components*
 - Graph Databases
 - Property Graphs
 - Property Graphs Part 1 & 2
 - Some Cool Things You Can Do With Property Graphs
 - Graph Matching Example: Recommendation Engine
 - Graph Matching Example: Recommendation Engine Part 1 & 2
 - Triple Stores
 - Input Triples Part 1 & 2
 - Query Triples
 - Update / Delete Triples
 - Persistent Data
 - Connection to Other Data Stores
 - Some Cool Things You Can Do With Semantic Graphs
 - Semantic Middleware
 - Shared Strengths
 - Differentiators
- *Applications of Knowledge Graphs*
 - Knowledge Graph Application Categories
 - Data Catalog
 - Represent Metadata as a Graph
 - Mapping Tables / Columns to Ontologies
 - Smart Data Lake
 - What Makes a Data Lake Smart?
 - Smart Data Lake Examples
 - Future-Proof Data
 - Smart Markup
 - Steps in Movie Production



Module 5. Modeling Methodology and Architecture (33 min)

- *Modeling Methodology and Architecture*
 - Durable Data Part 1 & 2
 - Iterative Modeling & Content Development
 - Recipe for Modeling Failure
 - Recipe for Success
 - Use Cases for Knowledge Graphs
 - Scope of a Model
 - Scope Examples
 - How to Address Scope-Use Cases
 - Anatomy of a Use Case
 - Example: Estimate Cost of Loans
 - Example: Estimate Cost of Television Distribution
 - Using Use Cases for Scoping: TV Show Example
 - Using Use Cases for Scoping: Loan Example
- *Terminology Sources*
- *Guidelines for Terminology*
 - Definition Guidelines (Based on ISO 704)
 - Example of Refined Definitions
 - Conceptual Modeling
 - Basics of Conceptual Modeling Part 1 & 2
 - Steps in Domain Analysis
 - Example of Domain Analysis – Bonds Part 1 & 2
 - Example of Domain Analysis: SKOS
 - Statements in SKOS: Part 1 & 2
 - Modeling Statements in SKOS
 - Combining Modeling Approaches
 - Combining SKOS and OWL
 - Ontology Testing and Evaluation
 - Types of Ontology Testing
 - Logic Errors: Unsatisfiable Class
 - Logic Errors: Unsatisfiable Property
 - Application Testing and Evaluation
 - Competency Questions and Data Mapping
 - Competency Questions and Data Mapping Example
 - Series Data
 - Mapping Data
 - Application Level Testing - Recap
 - Iteration
 - Fixing Issue
 - Mapping Data
 - Adjust and Repeat
 - Methodology Take-Aways



Module 6. Implementation Fundamentals of Knowledge Graph (47 min)

- *Example Implementation*
- *Incremental Development*
- *Knowledge Graph Implementation*
- *Presentation Approach*
- *Select a Use Case*
 - Use Case Selection
 - Refine Use Case
 - Selecting Use Case in the Example: Part 1 & 2
- *Inventory Data Sources*
 - Existing Data Reflect Business Reality
 - Example Inventory
 - Find Legacy Ontologies
 - Ontologies are Everywhere
 - Finding Ontologies in Our Example: Parts 1-4
 - Formalize the Ontologies
 - Ontologies in the Example
- *Draw on Reference Ontologies*
 - Reference Ontologies
 - Reference Ontologies in the Example part 1-3
- *Identify Controlled Vocabulary*
 - Internal vs External Controlled Vocabularies
 - Controlled Vocabularies in the Example: Part 1 & 2
- *Map Metadata to Ontologies*
 - Mapping of Ontology to Metadata
 - Mapping Metadata in the Example Part 1 & 2
 - Metadata Applications
- *Materialize Data as Needed*
 - Materialize Data
 - Complex Structural Materialization
- *Build Queries to Respond to Business Questions*
 - Queries Drive Application
 - Example Query
 - Semantic Middleware
- *Repeat from Step 3 with New Data*
- *How Can This Fail?*
- *Summary: Incremental Development*