Getting Started with Knowledge Graphs

1. 1. Getting Started with Knowledge Graphs Smart Data Conference January 30, 2017, San Francisco Bay Peter Haase
2. [2.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-2-638.jpg?cb=1487102558)2 Peter Haase • Interest and experience in ontologies, semantic technologies and Linked Data • PhD in KR and semantic technologies • 15 years in academic research and software development • Contributor to OWL 2 standard metaphacts Company Facts • Founded in Q4 2014 • Headquartered in Walldorf, Germany • Currently ~10 people • Platform for knowledge graph interaction & application development About the Speaker
3. [3.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-3-638.jpg?cb=1487102558)3 Introduction: What are Knowledge Graphs? Examples and Applications • Wikidata • Cultural Heritage • Industrial Applications Standards and Principles metaphactory Knowledge Graph Platform Hands-on Exercises Agenda
4. [4.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-4-638.jpg?cb=1487102558)Introduction What are Knowledge Graphs?
5. [5.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-5-638.jpg?cb=1487102558)5 The Rise of Knowledge Graphs
6. [6.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-6-638.jpg?cb=1487102558)6 • We need a structured and formal representation of knowledge • We are surrounded by entities, which are connected by relations • Graphs are a natural way to represent entities and their relationships • Graphs can be managed efficiently Why (Knowledge) Graphs?
7. [7.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-7-638.jpg?cb=1487102558)7 A (very small) Knowledge Graph http://www.w3.org/TR/2014/NOTE-rdf11-primer-20140225/example-graph.jpg
8. [8.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-8-638.jpg?cb=1487102558)8 • Semantic descriptions of entities and their relationships • Uses a knowledge representation formalism (Focus here: RDF, RDF-Schema, OWL) • Entities: real world objects (things, places, people) and abstract concepts (genres, religions, professions) • Relationships: graph-based data model where relationships are first-class • Semantic descriptions: types and properties with a well- defined meaning (e.g. through an ontology) • Possibly axiomatic knowledge (e.g. rules) to support automated reasoning What are Knowledge Graphs?
9. [9.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-9-638.jpg?cb=1487102558)9 Knowledge Graphs Enabling Intelligent Applications Knowledge Graph Algorithms Applications Data Transformation, Integration Natural Language Processing Data Sources • Inferencing • Machine Learning • Entity Recognition • Disambiguation • Text Understanding • Recommendations • Semantic Search • Question Answering • Knowledge Sharing • Knowledge Management • Analytics • Entities • Relationships • Semantic Descriptions • Dashboards
10. [10.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-10-638.jpg?cb=1487102558)Examples and Applications
11. [11.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-11-638.jpg?cb=1487102558)11 Google Knowledge Graph
12. [12.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-12-638.jpg?cb=1487102558)12 Entity Search and Summarizations Google Knowledge Graph
13. [13.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-13-638.jpg?cb=1487102558)13 Discovering Related Entities Google Knowledge Graph
14. [14.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-14-638.jpg?cb=1487102558)14 Google Knowledge Graph Factual Answers
15. [15.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-15-638.jpg?cb=1487102558)15 Knowledge Graph Search API https://developers.google.com/knowledge-graph/
16. [16.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-16-638.jpg?cb=1487102558)16 LinkedIn Economic Graph 16
17. [17.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-17-638.jpg?cb=1487102558)Examples and Applications Wikidata
18. [18.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-18-638.jpg?cb=1487102558)18 Open Knowledge Graphs
19. [19.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-19-638.jpg?cb=1487102558)19 Wikipedia page A query against Wikipedia Query the Knowledge of Wikipedia like a Database 19
20. [20.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-20-638.jpg?cb=1487102558)20 • Collecting structured data. Unlike the Wikipedias, which produce encyclopedic articles, Wikidata collects data, in a structured form. • Collaborative. The data in Wikidata is entered and maintained by Wikidata editors, who decide on the rules of content creation and management in Wikidata supporting the notion of verifiability. • Free. The data in Wikidata is published under the Creative Commons • Large. • 25 million entities • 130 million statements • 130 million labels • 350 languages • >1500 million triples Wikidata
21. [21.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-21-638.jpg?cb=1487102558)22 • Build your applications using Wikidata • Free corpus of structured knowledge • Easily accessible and standards-based • See http://query.wikidata.org/ • Contextualize your enterprise data • Wikidata provides stable identifiers into the open data world • Seamless integration of private data with open data • Enrich Wikidata with your data • Contribute your data to Wikidata • Link to your own data, make it visible • Examples: • Open biomedical databases – Wikidata as a central hub • Cultural heritage Use Cases for the Wikidata Knowledge Graph
22. [22.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-22-638.jpg?cb=1487102558)24 Histropedia
23. [23.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-23-638.jpg?cb=1487102558)Examples and Applications Cultural Heritage
24. [24.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-24-638.jpg?cb=1487102558)26 • Challenge: • Very context-rich data • Multi-disciplinary data, e.g. archaeologists, historians, librarians • Multi-institutional data • Complex domain, relationships, e.g. temporal, spatial, historical, political • Benefits of Knowledge Graphs • Integration and interchange of heterogeneous cultural heritage information • Rich ontologies for knowledge representation • Deep semantics for true conceptual merging • Multi-lingual knowledge representation • Knowledge access across museums and organizations • Enabling knowledge sharing and collaboration Benefits of Knowledge Graphs for Cultural Heritage
25. [25.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-25-638.jpg?cb=1487102558)27 • Collaboration environment for researchers in Cultural Heritage • Expert users: researchers, curators • Based on CIDOC-CRM: very rich, expressive ontology • Large, cross-museum data sets • E.g. British Museum: 100s millions of triples • Advanced search capabilities • Supporting query construction • Sharing of searches, results, visualizations • Knowledge sharing • Discussions around cultural heritage annotations • Argumentation support: Representation of conflicting views and opionions ResearchSpace: Knowledge Graphs for Cultural Heritage http://researchspace.org/
26. [26.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-26-638.jpg?cb=1487102558)28 Demo ResearchSpace Platform
27. [27.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-27-638.jpg?cb=1487102558)Examples and Applications Life Sciences
28. [28.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-28-638.jpg?cb=1487102558)30 Challenge: • Much of the relevant knowledge in external databases • Many disparate databases / data silos • Many different data formats • Complex domain, complex relationships e.g. compounds, targets, pathways, diseases and tissues Benefits of Knowledge Graphs in the Life Sciences
29. [29.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-29-638.jpg?cb=1487102558)31 • Integrated knowledge representation • Common format • Stable, global identifiers • Federated queries • Integrated knowledge access: One-stop portals • Rich semantic search on a conceptual level • Entry points to further data, in-house and external • Crossing boundaries between private and open data Benefits of Knowledge Graphs in the Life Sciences
30. [30.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-30-638.jpg?cb=1487102558)Standards and Principles
31. [31.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-31-638.jpg?cb=1487102558)34 Semantics on the Web Semantic Web Stack Berners-Lee (2006) Syntactic basis Basic data model Simple vocabulary (schema) language Expressive vocabulary (ontology) language Query language Application specific declarative-knowledge Digital signatures, recommendations Proof generation, exchange, validation
32. [32.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-32-638.jpg?cb=1487102558)35 Knowledge Graphs Built on the Semantic Web Layer Cake Unicode URIs RDF (Resource Description Framework) RDF-Schema OWLSKOS SPARQL Query language Entities Relationships Vocabularies Ontologies Expressive Ontology Language Thesauri, classification schemes Graph data model Simple vocabulary language
33. [33.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-33-638.jpg?cb=1487102558)36 Linked Data • Set of standards, principles for publishing, sharing and interrelating structured knowledge • From data silos to interconnected knowledge graphs Linked Data Principles • Use URIs as names for things. • Use HTTP URIs so that people can look up those names. • When someone looks up a URI, provide useful information, using the standards: RDF, SPARQL. • Include links to other URIs, so that they can discover more things. Knowledge Graphs Built on Linked Data Principles
34. [34.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-34-638.jpg?cb=1487102558)37 Our Knowledge Graph again (a bit more technical)
35. [35.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-35-638.jpg?cb=1487102558)38 Graph consists of: • Resources (identified via URIs) • Literals: data values with data type (URI) or language (multilinguality integrated) • Attributes of resources are also URI- identified (from vocabularies) Our Knowledge Graph again (a bit more technical) • Various data sources and vocabularies can be arbitrarily mixed and meshed • URIs can be shortened with namespace prefixes; e.g. schema: → http://schema.org/
36. [36.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-36-638.jpg?cb=1487102558)39 Allows one to talk about anything Uniform Resource Identifier (URI) can be used to identify entities http://dbpedia.org/resource/Leonardo\_da\_Vinci is a name for Leonardo da Vinci http://www.wikidata.org/entity/Q12418 is a name for the Mona Lisa painting Resource Description Framework (RDF) dbpedia: Leonardo\_da\_Vinci wd:Q12418
37. [37.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-37-638.jpg?cb=1487102558)40 Allows one to express statements An RDF statement consists of: • Subject: resource identified by a URI • Predicate: resource identified by a URI • Object: resource or literal Variety of RDF syntaxes, e.g. Turtle (Terse RDF Triple Language): Resource Description Framework (RDF) dbpedia: Leonardo\_da\_Vinci wd:Q12418 dcterms:creator wd:Q12418 dcterms:creator dbpedia:Leonardo\_da\_Vinci .
38. [38.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-38-638.jpg?cb=1487102558)41 • Language for two tasks w.r.t. the RDF data model: • Definition of vocabulary – nominate: • the ‘types’, i.e., classes, of things we might make assertions about, and • the properties we might apply, as predicates in these assertions, to capture their relationships. • Inference – given a set of assertions, using these classes and properties, specify what should be inferred about assertions that are implicitly made. RDF-S – RDF Schema
39. [39.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-39-638.jpg?cb=1487102558)42 • rdfs:Class – Example: foaf:Person – Represents the class of persons • rdf:Property – Class of RDF properties. Example: foaf:knows – Represents that a person “knows” another • rdfs:domain – States that any resource that has a given property is an instance of one or more classes foaf:knows rdfs:domain foaf:Person • rdfs:range – States that the values of a property are instances of one or more classes foaf:knows rdfs:range foaf:Person RDF-S – RDF Schema
40. [40.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-40-638.jpg?cb=1487102558)43 RDF-S – RDF Schema foaf:knows rdfs:range foaf:Person . <http://example.org/bob#me> foaf:knows <http://example.org/alice#me>. <http://example.org/alice#me> rdf:type foaf:Person. Schema Existing fact Inferred fact We expect to use this vocabulary to make assertions about persons. Having made such an assertion... Inferences can be drawn that we did not explicitly make
41. [41.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-41-638.jpg?cb=1487102558)44 • RDFS provides a simplified ontological language for defining vocabularies about specific domains. • OWL provides more ontological constructs for knowledge representation. • Semantics grounded in Description Logics. • OWL 2 is divided into sub-languages denominated profiles: • OWL 2 EL: Limited to basic classification, but with polynomial-time reasoning • OWL 2 QL: Designed to be translatable to relational database querying • OWL 2 RL: Designed to be efficiently implementable in rule-based systems • Most graph databases concentrate on the use of RDFS with a subset of OWL features. OWL – Web Ontology Language More restrictive than OWL DL
42. [42.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-42-638.jpg?cb=1487102558)45 OWL is made up of terms which provide for: • Class construction: forming new classes from membership of existing ones (e.g., unionOf, intersectionOf, etc.). • Property construction: distinction between OWL ObjectProperties (resources as values) and OWL DatatypeProperties (literals as values). • Class axioms: sub-class, equivalence and disjointness relationships. • Property axioms: sub-property relationship, equivalence and disjointness, and relationships between properties. • Individual axioms: statements about individuals (sameIndividual, differentIndividuals). OWL – Web Ontology Language
43. [43.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-43-638.jpg?cb=1487102558)46 Example: CIDOC-CRM Ontology Class: Person SubClassOf: Actor SubClassOf: Biological Object SubClassOf: was\_born exactly 1 SubClassOf: has\_parent min 2 Class: Physical Thing SubClassOf: Legal Object SubClassOf: Spacetime Volume DisjointWith: Conceptual Object SubClassOf: consists\_of some Material
44. [44.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-44-638.jpg?cb=1487102558)47 • Data model for knowledge organization systems (thesauri, classification scheme, taxonomies) • Conceptual resources (concepts) can be • identified with URIs, • labeled with lexical strings in natural language, • documented with various types of note, • semantically related to each other in informal hierarchies and association networks and • aggregated into concept schemes. SKOS - Simple Knowledge Organization System http://www.w3.org/TR/skos-reference/
45. [45.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-45-638.jpg?cb=1487102558)48 Example: Concept Definition for Paper
46. [46.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-46-638.jpg?cb=1487102558)49 • Query language for RDF-based knowledge graphs. • Designed to use a syntax similar to SQL for retrieving data from relational databases. • Different query forms: • SELECT returns variables and their bindings directly. • CONSTRUCT returns a single RDF graph specified by a graph template. • ASK test whether or not a query pattern has a solution. Returns yes/no. • DESCRIBE returns a single RDF graph containing RDF data about resources. SPARQL – \* Protocol and RDF Query Language
47. [47.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-47-638.jpg?cb=1487102558)50 Main idea: Pattern matching • Queries describe sub-graphs of the queried graph • Graph patterns are RDF graphs specified in Turtle syntax, which contain variables (prefixed by either “?” or “$”) • Sub-graphs that match the graph patterns yield a result • The syntax of a SELECT query is as follows: • SELECT nominates which components of the matches made against the data should be returned. • FROM (optional) indicates the sources for the data against which to find matches. • WHERE defines patterns to match against the data. • ORDER BY defines a means to order the selected matches. SPARQL – \* Protocol and RDF Query Language dbpedia: Leonardo\_da\_Vinci ?var dcterms:creator
48. [48.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-48-638.jpg?cb=1487102558)51 Example: Select the creator of the things that Bob is interested in. SPARQL – \* Protocol and RDF Query Language PREFIX foaf: <http://xmlns.com/foaf/0.1/> PREFIX dcterms: <http://purl.org/dc/terms/> SELECT ?creator WHERE { <http://example.org/bob#me> foaf:topic\_interest ?interest . ?interest dcterms:creator ?creator } dbpedia:Leonardo\_da\_VinciResults:
49. [49.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-49-638.jpg?cb=1487102558)metaphactory Knowledge Graph Platform
50. [50.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-50-638.jpg?cb=1487102558)53 metaphacts – Our Mission The metaphacts team offers an unmatched experience and know-how around enterprise knowledge graphs for our clients in areas such as business, finance, life science, and cultural heritage. The metaphactory is our end-to-end platform to create and utilize enterprise knowledge graphs - from semantic graph data management to data-driven application development. Built entirely on open standards and technologies, our platform covers the entire lifecycle of dealing with knowledge graphs. As a main benefit our platform enables knowledge workers to create and gain meaningful insight into their data with one comprehensive software solution.
51. [51.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-51-638.jpg?cb=1487102558)54 metaphactory Features KNOWLEDGE GRAPH BACKEND • Scalable data processing • Easy-to-use interface • High-performance querying and analytics • Built-in inferencing and custom services • Standard connectors for a variety of data formats • Single server, embedded mode, high availability, and scale out KNOWLEDGE GRAPH CREATION • Semi-automatic creation of knowledge graphs • Curation and interlinking of data from heterogeneous sources • Collaborative management and authoring • Custom query and templates catalogs • Data annotation • Capturing of provenance information KNOWLEDGE GRAPH APPLICATIONS • Rapid development of end-user oriented applications • Web components for end- user friendly presentation and interaction • Interactive visualization • Rich semantic search with visual query construction and faceting • Customizable semantic clipboard
52. [52.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-52-638.jpg?cb=1487102558)55 metaphactory as an Open Platform BUILT IN OPEN SOURCE ü Dual licensing (LGPL & commercial license) ü Open Platform API and SDK ü Integration of external tools and application via APIs ü Easy development of own web components and services ü Full HTML5 compliance ü Re-usable, declaratively configurable Web Components = Easy modification, customization, and extensibility BUILT ON OPEN STANDARDS ü W3C Web Components ü W3C Open Annotation Data Model ü W3C Linked Data Platform Containers ü Data processing based on W3C standards such as RDF, SPARQL ü Expressive ontologies for schema modeling based on OWL 2, SKOS ü Rules, constraints, and query specification based on SPIN and RDF Data Shapes = Sustainable Solution
53. [53.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-53-638.jpg?cb=1487102558)56 metaphactory Platform Architecture Data Services Applications Graph Database Graph Analytics Provenance Catalog Services Exploration VisualizationConfiguration Search Access Control Knowledge Graph Management App Factory End UsersExpert/domain Users Smart Apps Developers InferencingSPARQL Endpoint
54. [54.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-54-638.jpg?cb=1487102558)57 Users and their Benefits EXPERT USERS • Collaboratively construct and manage knowledge graphs • Integrate data from heterogeneous sources • Use standard connectors for a variety of data formats • Benefit from scalable data processing for big graphs • Conduct high- performance querying and analytics DEVELOPERS • Rapidly develop Web and mobile end-user oriented applications • Benefit from various deployment modes: stand- alone, HA, scale-up, scale- out • Interact with an easy-to- use interface • Collaboratively manage, annotate and author data • Use large set of custom query and templates catalogs • Capture of provenance information END USERS • Benefit from user-friendly interaction with data • Gain insights into complex relationships • Enable transparency and extract value • Ask questions and obtain precise results • Reduce effort for data analysis • Reduce noise – obtain targeted, high quality results • Enhance quality of business decisions
55. [55.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-55-638.jpg?cb=1487102558)58 metaphacts Supports the Whole Data Lifecyle Data Extraction & Integration Data Linking & Enrichment Storage & Repositories Querying & Inferencing Search Visualization Authoring end-to-end platform
56. [56.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-56-638.jpg?cb=1487102558)59 Search • Domain independent, fully customizable search widget • Satisfy complex information needs without learning SPARQL • Search functionalities • Graphical query construction • End user friendly search interfaces for building and sharing complex queries • Semantic auto suggestion • Interactive result visualization • Faceted search and exploration of item collections • Ability to invoke external full text search indices such as Solr including the possibility to score, rank and limit the results for responsive autosuggestion • Saving and sharing of queries and search results Search
57. [57.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-57-638.jpg?cb=1487102558)60 Table Transform your queries into durable, interactive tables Many customization possibilities, e.g. pagination, filters and cell templates Graph Visualize and explore connections in a graph view Custom styling of the graph Variety of graph layouts Carousel Animated browsing through a list of result items Chart Visualize trends and relationships between numbers, ratios, or proportions Visuali- zation Tree Table Tree-based visualization, navigation and browsing through sub- tree structures Map Displaying spatial data on a geographic map Visualization
58. [58.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-58-638.jpg?cb=1487102558)61 Autho- ring • Annotations • Based on W3C Open Annotation Data Model • Automated semantic link extraction • Form based authoring • Manually author and update instance data, backed by query templates, data dependencies, and type constraints • Rich editing components for special data types • Customizable flexible forms • Autosuggestion and validation against the knowledge graph • Capturing of provenance information • User group management Authoring
59. [59.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-59-638.jpg?cb=1487102558)62 Install & Go: Out-of-the-Box Functionality Getting Started Tutorial to guide you through your first steps with metaphactory Get started Management of Queries in Catalog for easy reuse and updating Keyword Search Interface with semantic autosuggestion, driven by SPARQL Search Data Overview Pages with Web components for end-user friendly data presentation and interaction Template-based Data Browser used to define generic views which are automatically applied to entire sets of instances Explore
60. [60.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-60-638.jpg?cb=1487102558)63 Example: Simple Semantic Search Keyword search with semantic autosuggestion, driven by SPARQL Set up in ~2 minutes! Declarative Components Developer embeds ‘semantic-simple-search’ into the page <semantic-simple-search data- config='{ "query":" SELECT ?result ?label ?desc ?img WHERE { ?result rdfs:label ?label . ?result rdfs:comment ?desc . ?result foaf:thumbnail ?img . FILTER(CONTAINS(?label, ?token)) }", "searchTermVariable":"token", // user input "template":" <span title="{{result}}"> <img src="{{img}}" height="30"/> {{label}} ({{desc}})</span>" }'/> 1 Rendered component is displayed to the user and can be used right away 2 Autosuggestions are dynamically computed based on query and user input 3
61. [61.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-61-638.jpg?cb=1487102558)64 • Associate a class in the knowledge graph with a template • The template is applied to instances of the class HTML5 Template Pages Bob foaf:Person rdf:type
62. [62.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-62-638.jpg?cb=1487102558)Hands-on Exercises
63. [63.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-63-638.jpg?cb=1487102558)66 Hands-on Exercises DATA LOADING & QUERYING • Loading your data • Querying your data VISUALIZATION • Visualizing results in a table • Visualizing results in a graph SEARCH • Embedding a simple search interface AUTHORING • Creating a template • Inserting and updating data
64. [64.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-64-638.jpg?cb=1487102558)67 • Download metaphactory (or copy from USB stick) http://www.knowledgegraph.info/ • Follow README, start metaphactory start.sh / start.bat • Open start page http://localhost:10214 • Follow “Getting started tutorial” http://localhost:10214/resource/Help:Tutorial • Have fun and ask questions ;-) Hands-on Exercises
65. [65.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-65-638.jpg?cb=1487102558)68 Data Loading & Querying Load data into the store via the data import and export administration page 1 2 Query the data via the SPARQL endpoint. E.g.: issue a query for all statements made about Bob as a subject 3 Visualize results in a table … or as raw data
66. [66.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-66-638.jpg?cb=1487102558)69 Visualizing Results in a Table 3 Visualize results in a table displaying thumbnails as images, the labels of the resources as captions, and links to the individual resource pages 1 Embed ‘semantic-table’ component <semantic-table config='{ "query":"SELECT \* WHERE { <http://example.org/bob#me> ?predicate ?object }“ }'> </semantic-table> to visualize previous query as a table in a page 2 Customize the query to embed thumbnail images in the result visualization SELECT ?uri ?label ?thumbnail WHERE { ?uri rdfs:label ?label; <http://schema.org/thumbnail > ?thumbnail } Use tupleTemplate to define a template for displaying the new table
67. [67.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-67-638.jpg?cb=1487102558)70 Visualizing Results in a Graph 1 Embed ‘semantic-graph’ component <semantic-graph query="CONSTRUCT WHERE { ?s ?p ?o }"> </semantic-graph> 2 Visualize results in a graph
68. [68.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-68-638.jpg?cb=1487102558)71 Embedding a Simple Search Interface Embed ‘semantic-simple- search’ into the page <semantic-simple-search config='{ "query":" SELECT ?uri ?label WHERE { FILTER REGEX(?label, "?token", "i") ?uri rdfs:label ?label } LIMIT 10 ", "searchTermVariable":"token", "resourceSelection":{ "resourceBindingName":"uri", "template":"<span style="color: blue;" title="{{uri.value}}">{{label. value}}</span>" }, "inputPlaceholder":"Search for something e.g. "Bob"" }'> </semantic-simple-search> 1 Rendered component is displayed and can be used right away 2 Autosuggestions are dynamically computed based on query and user input 3
69. [69.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-69-638.jpg?cb=1487102558)72 Creating a Template 1 Use the templating mechanism to create a template for the resource type ‘Person’, to display: • the person's name • an image, if available • his interests • his friendship relationship 2 Visualize the result on Bob’s instance page
70. [70.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-70-638.jpg?cb=1487102558)73 Inserting and Updating Data 1 Use a SPARQL UPDATE operation against the SPARQL endpoint to create and add new instance data • the person's name • an image, if available • his interests • his friendship relationship 2 Visualize the result
71. [71.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-71-638.jpg?cb=1487102558)74 • Knowledge graphs as a flexible model for data integration and knowledge representation • Standards for “semantic” knowledge graphs • RDF as graph-based data model • OWL as expressive ontology language • SKOS for taxonomic knowledge • SPARQL as query language • Application areas • Open knowledge graphs, e.g. Wikidata • Cultural Heritage • Life Sciences • And many more • Get started with the metaphactory Knowledge Graph platform today! Summary
72. [72.](https://image.slidesharecdn.com/smartdatatutorialknowledgegraphs-170214200114/95/getting-started-with-knowledge-graphs-72-638.jpg?cb=1487102558)75 metaphacts GmbH Industriestraße 41 69190 Walldorf Germany p +49 6227 6989965 m +49 157 50152441 e info@metaphacts.com @metaphacts www.metaphacts.com Get in Touch!