UNIVERSITÄT BONN

SMART DATA ANALYTICS
FROM DATA TO KNOWLEDGE

MA-INF 4223 - Lab Distributed Big Data Analytics

SANSA: Scalable Semantic Analytics Stack

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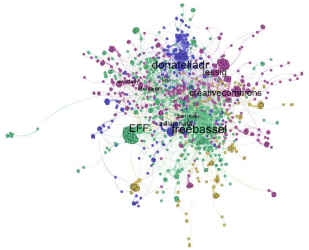
Lesson objectives

- After completing this lesson, you should be able to:
  - Understand the usage of SANSA
  - List and understand the libraries offered by SANSA

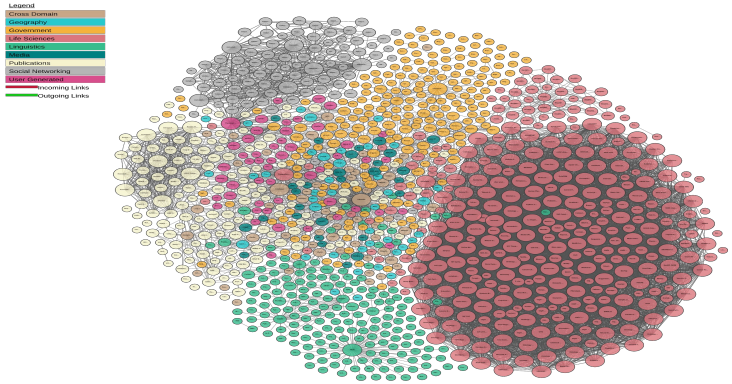
SANSA: Motivation

- Abundant machine readable structured information is available (e.g. in RDF)
  - Across SCs, e.g. Life Science Data
  - General: DBpedia, Google knowledge graph
  - Social graphs: Facebook, Twitter
- Need for scalable querying, inference and machine learning
  - Link prediction
  - Knowledge base completion
  - Predictive analytics



SANSA: Motivation

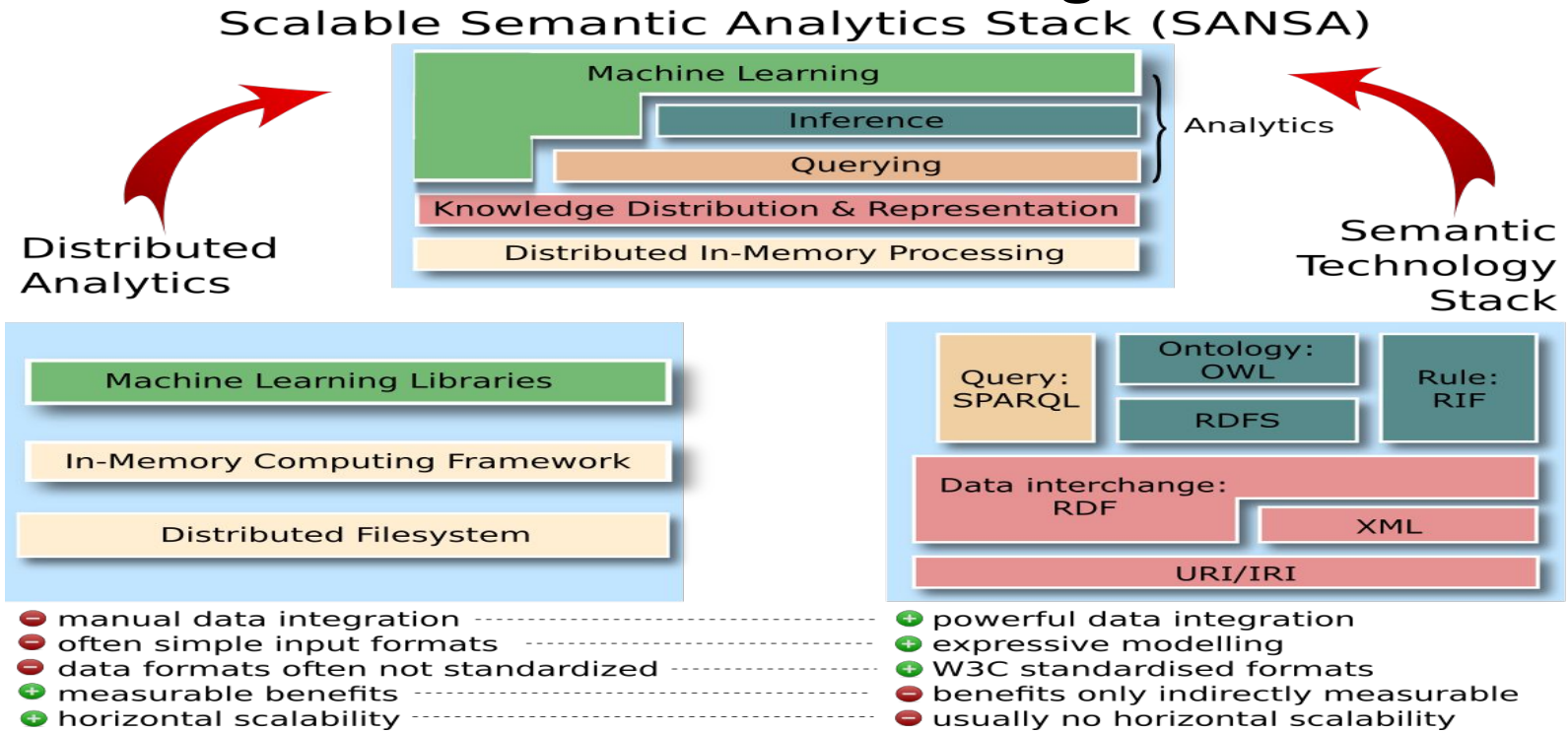
- Over the last years, the size of the Semantic Web has increased and several large-scale datasets were published



Source: LOD-Cloud (http://lod-cloud.net/)

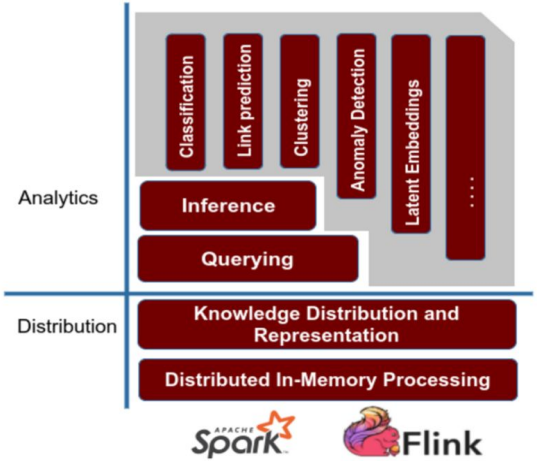
- Now days hadoop ecosystem has become a standard for BigData applications
- We use this infrastructure for Semantic Web as well

A New Vision Combining Semantic Technologies and Distributed Machine Learning



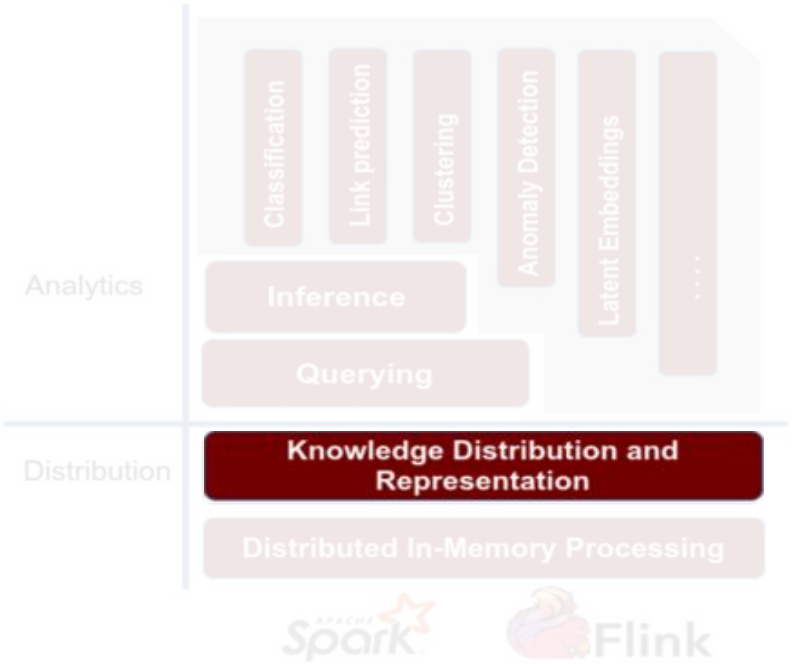
SANSA Stack

- It's core is a **processing data flow** engine that provides data distribution, and fault tolerance for distributed computations over RDF large-scale datasets
- SANSA includes **several libraries** for creating applications:
  - Read / Write RDF / OWL library
  - Querying library
  - Inference library
  - ML- Machine Learning core library



http://sansa-stack.net/

SANSA: Read Write Layer



SANSA: Read Write Layer

- Ingest RDF and OWL data in different formats using Jena / OWL API style interfaces
- Represent data in multiple formats
  - (e.g. RDD, Data Frames, GraphX, Tensors)
- Allow transformation among these formats
- Compute dataset statistics and apply functions to URIs, literals, subjects, objects → Distributed LODStats

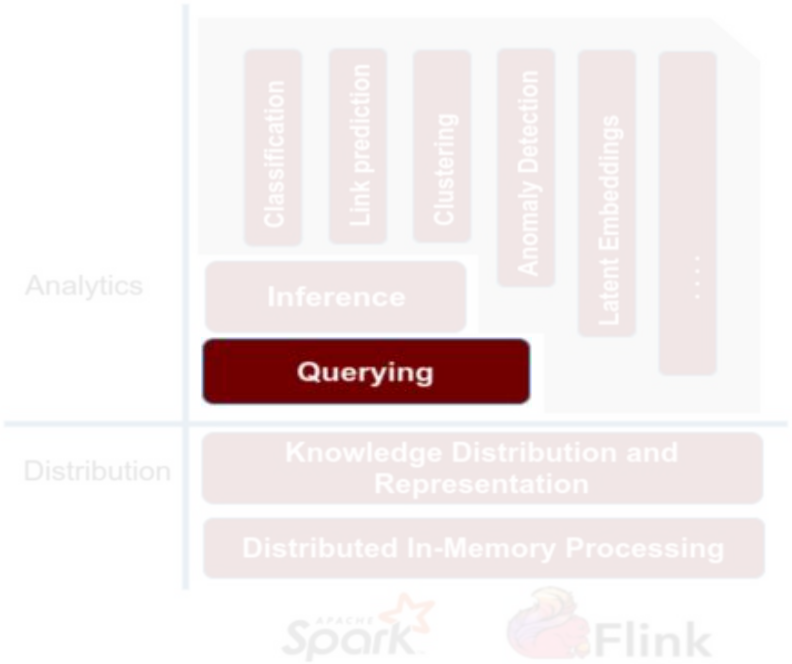
```
val graph: TripleRDD = NTripleReader.load(spark, uri)
graph.find(ANY, URI("http://dbpedia.org/ontology/influenced"), ANY)
val rdf_stats_prop_dist = PropertyUsage(graph, spark).PostProc()
```

SANSA: OWL Support

- Distributed processing of OWL axioms
- Support for Manchester OWL & functional syntax
- Derived distributed data structures:
  - E.g. matrix representation of subclass-of axioms to compute its closure via matrix operations

```
val rdd = ManchesterSyntaxOWLAxiomsRDDBuilder.build(spark, "file.owl")
// get all subclass-of axioms
val sco = rdd.filter(_.isInstanceOf[OWLSubClassOfAxiom])
```

SANSA: Query Layer

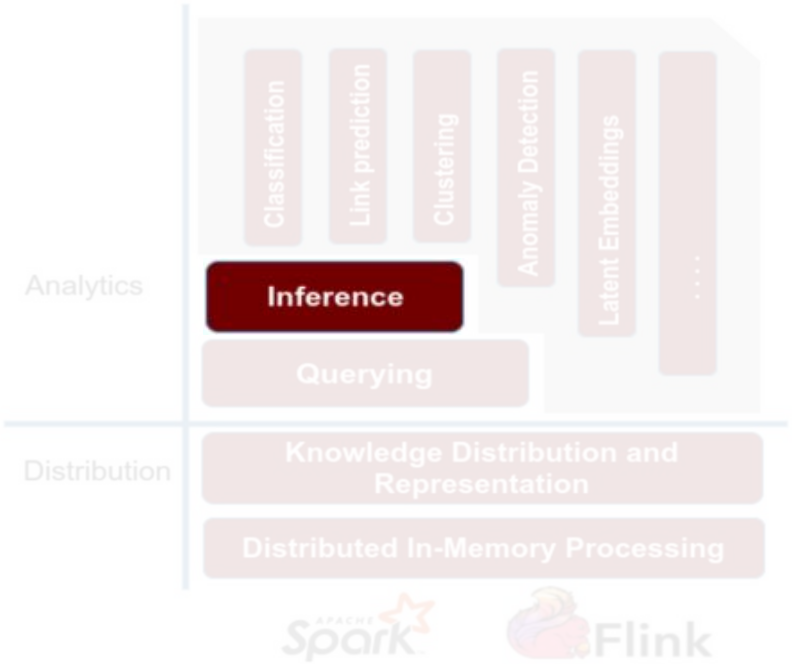


SANSA: Query Layer

- To make generic queries efficient and fast using:
  - Intelligent indexing
  - Splitting strategies
  - Distributed Storage
- SPARQL query engine evaluation
  - (SPARQL-to-SQL approaches, Virtual Views)
- Provision of W3C SPARQL compliant endpoint

```
// providing a SPARQL endpoint
val graphRdd = NTripleReader.load(spark,input)
val partitions = RdfPartitionUtilsSpark.partitionGraph(graphRdd)
val rewriter = SparqlifyUtils.createSparqlSqlRewriter(spark, partitions)
val qef = new QueryExecutionFactorySparqlifySpark(spark, rewriter)
```

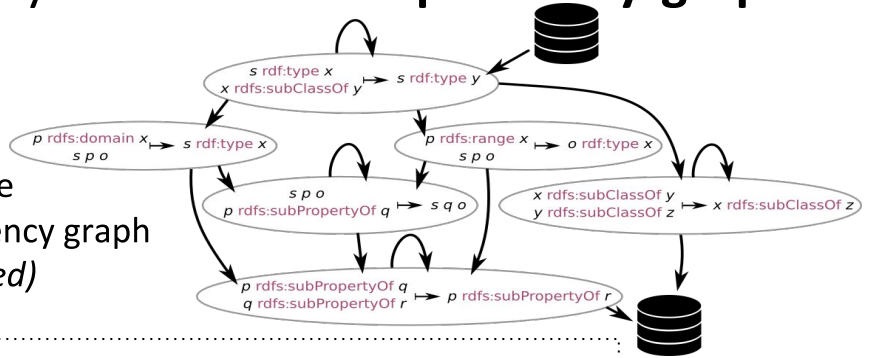
SANSA: Inference Layer



SANSA: Inference Layer

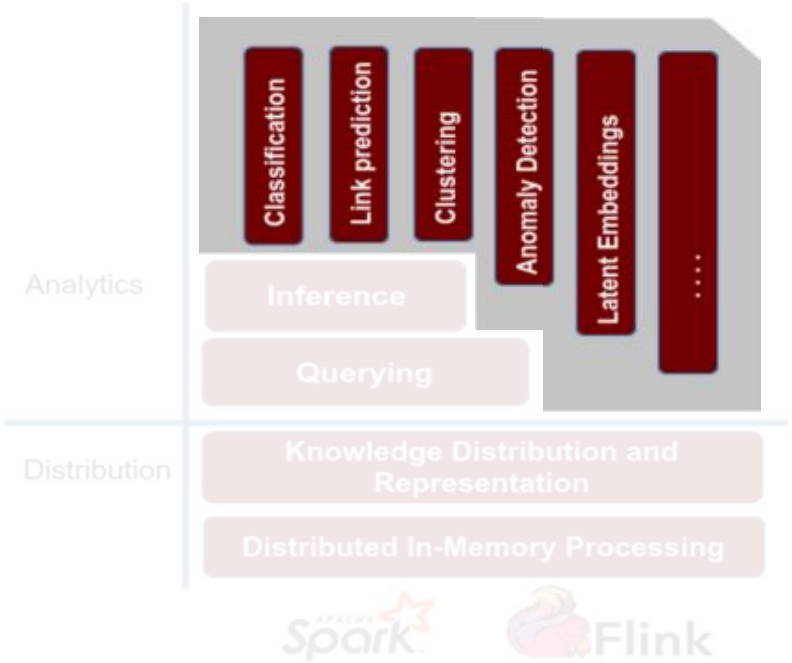
- W3C Standards for Modelling: RDFS and OWL
- Parallel in-memory inference via rule-based forward chaining
- Beyond state of the art: dynamically build a **rule dependency graph** for a rule set
- ⟶ Adjustable performance levels

RDFS rule dependency graph *(simplified)*




```
val graph = RDFGraphLoader.loadFromDisk(spark, uri)
val reasoner = new ForwardRuleReasonerOWLHorst(spark.sparkContext)
val inferredGraph = reasoner.apply(graph)
```

SANSA: ML Layer



SANSA: ML Layer

- Distributed Machine Learning (ML) algorithms that work on RDF data and make use of its structure / semantics
- Algorithms:
  - Knowledge graph embeddings for e.g. KB completion, link prediction
  - Graph Clustering
    - Power Iteration, BorderFlow, Link based
    - Modularity based clustering
  - Association rule mining (AMIE+ = mining horn rules from RDF data using partial completeness assumption and type constraints)
  - Semantic Decision trees (in progress)

Interactive SANSA in your Browser

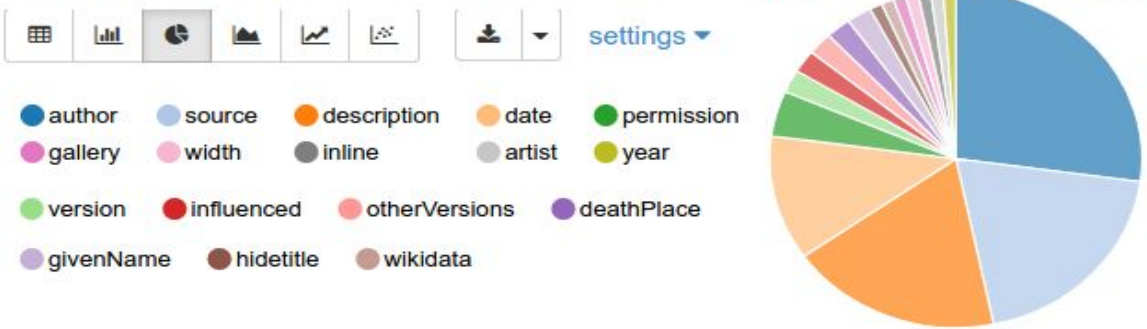
```
val input = "hdfs://namenode:8020/data/rdf.nt"
val triplesRDD = NTripleReader.load(spark, JavaURI.create(input))

val propertyDist = PropertyUsage(triplesRDD, spark).PostProc()
                                .map(f => f._1.getLocalName+ "\t" + f._2)

println("%table Property Distribution\tFrequency\n " + propertyDist.mkString("\n"))
```

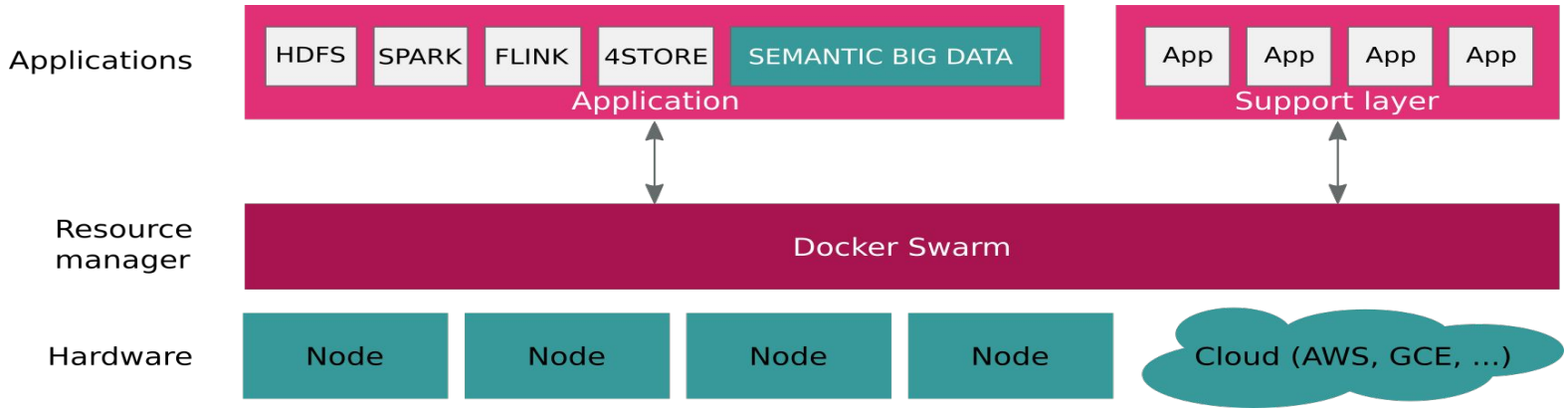
FINISHED

```
input: String = hdfs://namenode:8020/data/rdf.nt
triplesRDD: org.apache.spark.rdd.RDD[org.apache.jena.graph.Triple] = MapPartitionsRDD[27] at map at NTripleReader.scala:39
propertyDist: Array[String] = Array(author    25, source    18, description 17, date  11, permission 4, version  2, influenced  2,
2, deathPlace    2, givenName    2, hidetitle  1, wikidata  1, gallery      1, width  1, inline      1, artist   1, year 1)
```



BDE & General Integration

- SANSA = Scala / Maven Repositories based on Spark / Flink
- Easy to include both in BDE platform and any Spark / Flink environment



SANSA Planning and Pulse

- **SANSA 0.3 in Dec 2017, releases every 6 months**
- Apache Open Source License
- Project activity:
  - Contributors (*at least one commit*): **17**
  - Commits per day: **3.4 -** Commits previous year: **1160**
  - Github stars (all repos): **131**

Conclusions and Next steps

- A generic stack for (big) Linked Data
  - Build on top of a state-of-the-art distributed frameworks (Spark, Flink)
- Out-of-the-box framework for scalable and distributed semantic data analysis combining semantic web and distributed machine learning for (1) querying, (2) inference and (3) analytics of RDF datasets.
- Next steps
  - Refinement of data structures (RDF/OWL Layer)
  - Support for SPARQL 1.1 and other partitioning strategies (Query Layer)
  - Backward chaining and better evaluation (Inference Layer)
  - More algorithms and definition of ML pipelines (ML Layer)

References

[1]. "Linking Open Data cloud diagram 2017, by Andrejs Abele, John P. McCrae, Paul Buitelaar, Anja Jentzsch and Richard Cyganiak. http://lod-cloud.net/".

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THANK YOU !

http://sda.cs.uni-bonn.de/teaching/dbda/

- http://sda.cs.uni-bonn.de/
- https://github.com/SANSA-Stack
- https://github.com/big-data-europe
- https://github.com/SmartDataAnalytics

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