Crunching and visualizing Big Data

on a Computer Cluster

Joana Simões

April 10, 2015

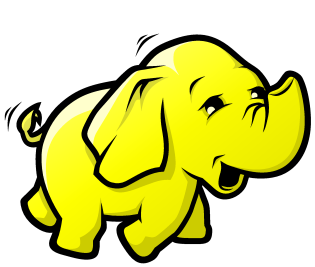




Table of Contents

Motivation

- Problem: the increasing volume of information, by explosion of traditional sources + new sources
- Target: fast query responses, which require a scalable architecture
- Possible solution: support clusters on a cost-effective architecture, such as commodity clusters or cloud environments

Cloud Services

Groups

A thought...

First the use case, then the tools.

Use Case

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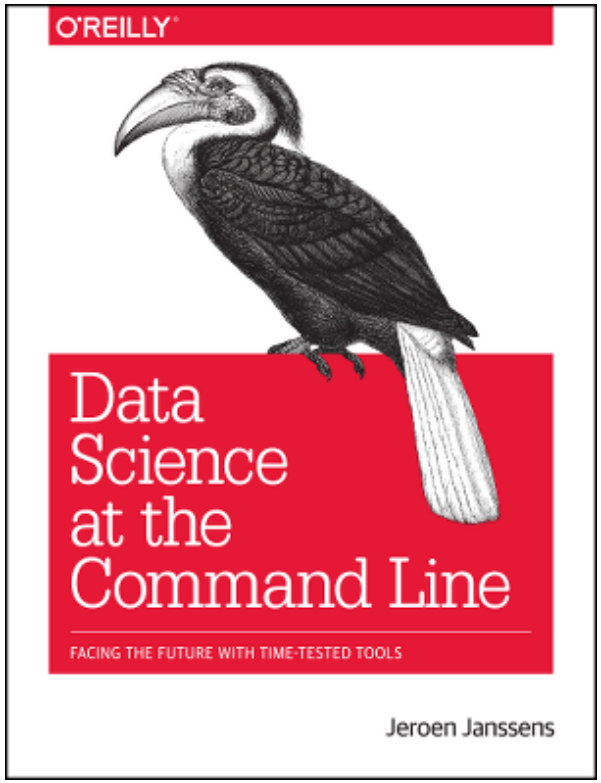
- ETL: process responsible for pulling data out of the source systems and placing it into a data warehouse
  - **Extract** data from different source systems and convert it into one consolidated data warehouse format which is ready for transformation processing
  - **Transform**: cleaning, filtering, splitting a column, joining data, apply validation, apply rules, etc
  - **Load**: into the data warehouse, repository or reporting applications

Another thought...

There are no free lunches.

Scalable ML Platforms

- ML platforms may provide high-level data import tools:



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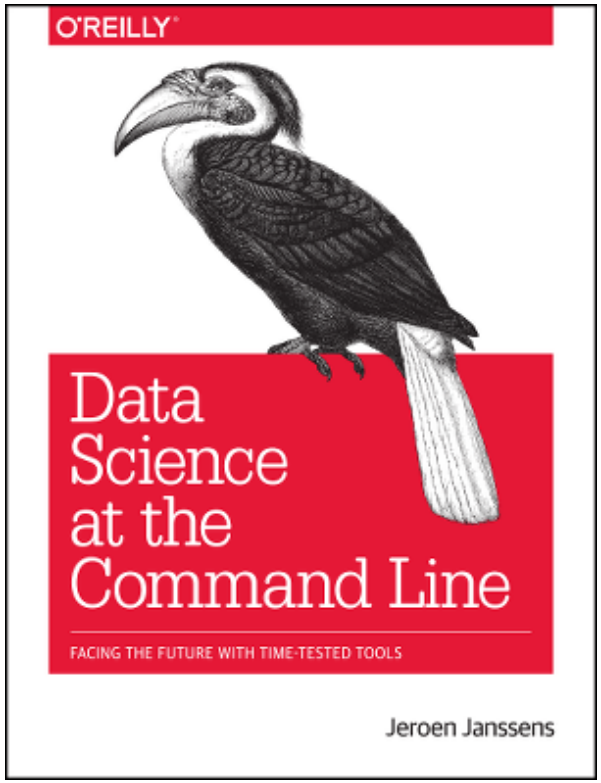

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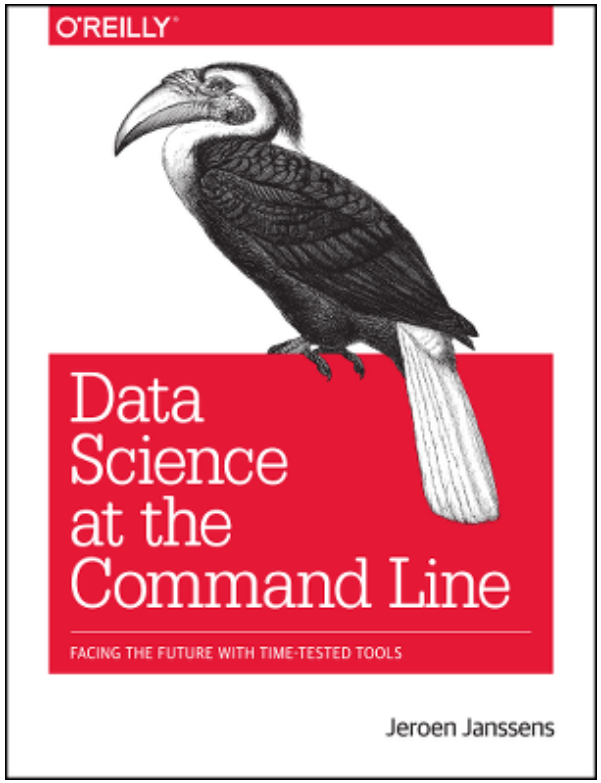

Scalable ML Platforms

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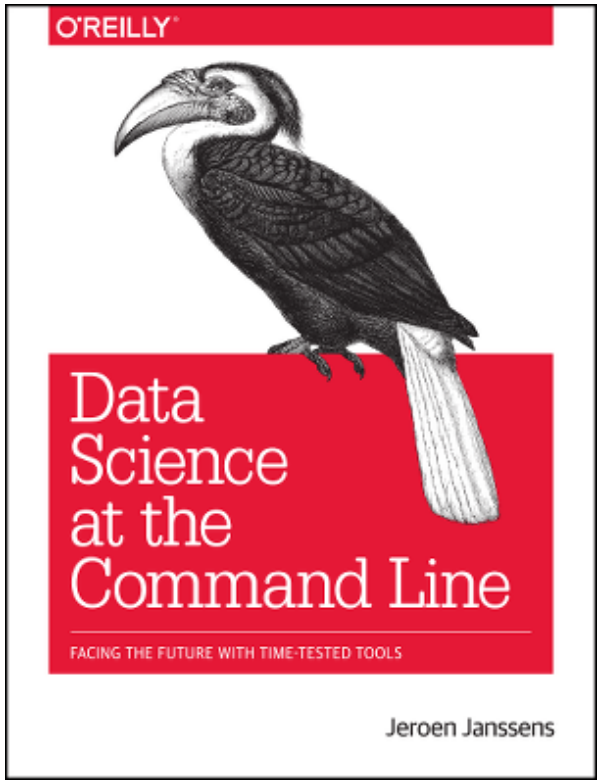
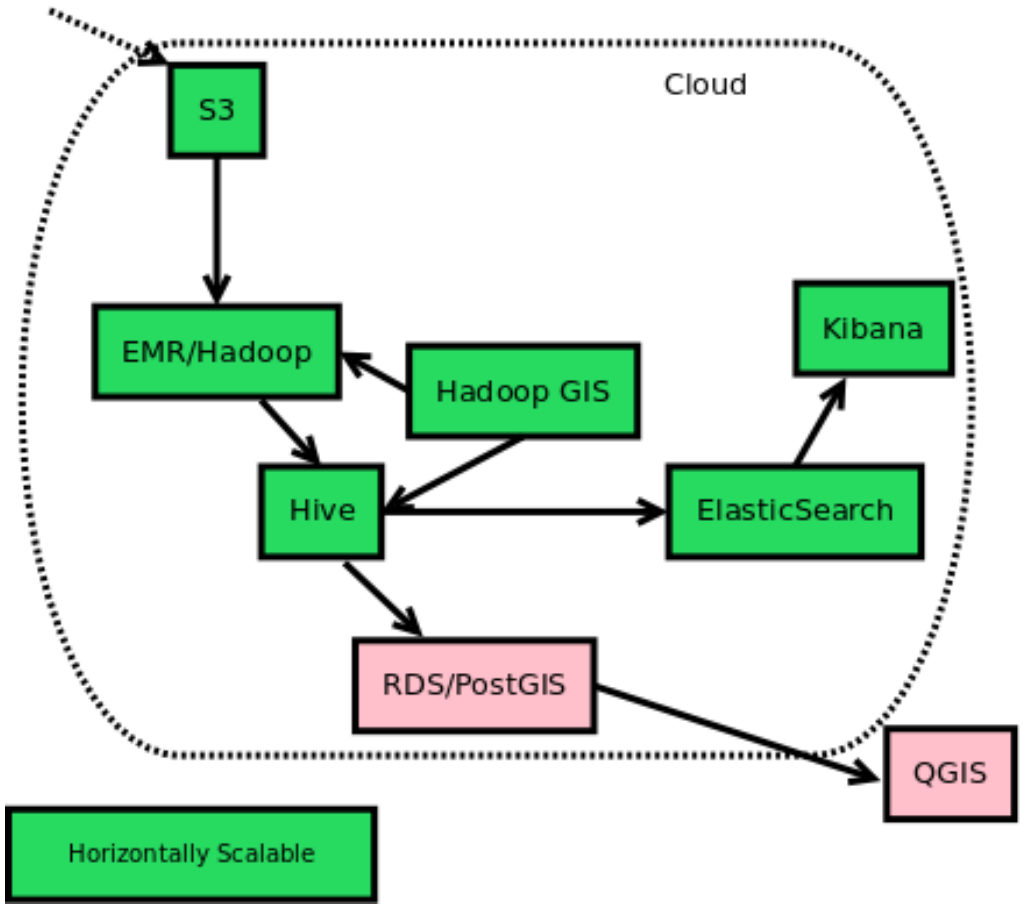
- To ensure maximum flexibility, we should be able to link together many tools, often using the command line.

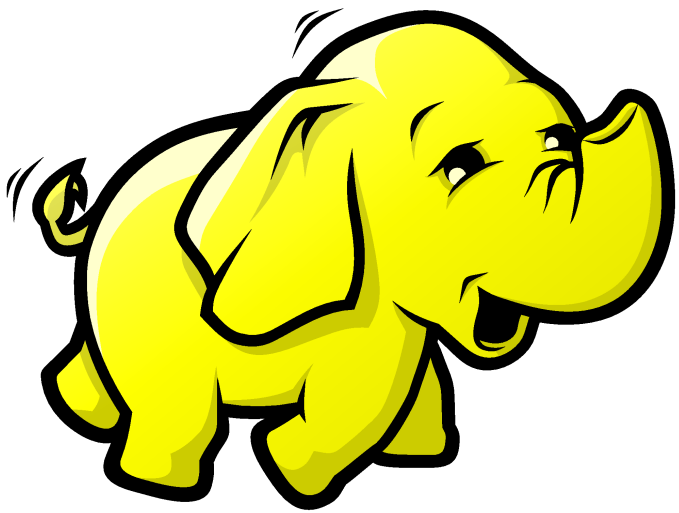


Stack


Cloud
S3
EMR/Hadoop
Hadoop GIS
Kibana
Hive
ElasticSearch
RDS/PostGIS
QGIS
Horizontally Scalable

Apache Hadoop

- framework for distributed storage and processing of (Big) Data on computer Clusters



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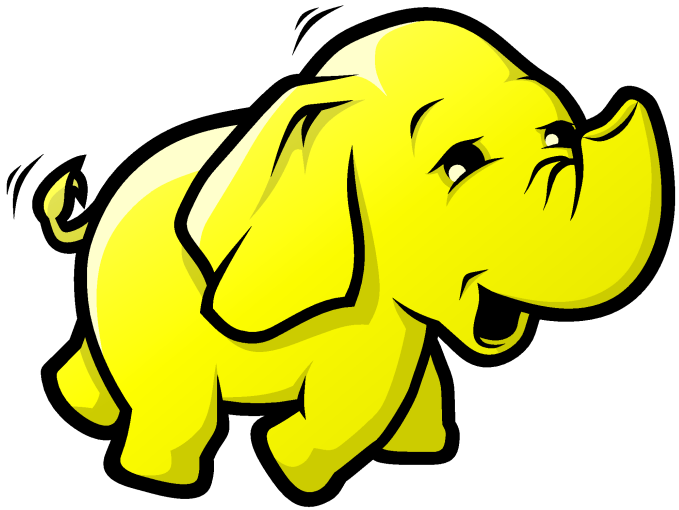

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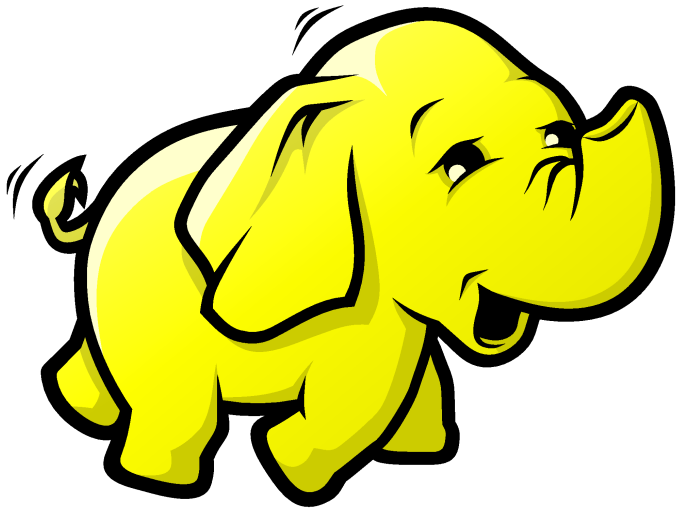

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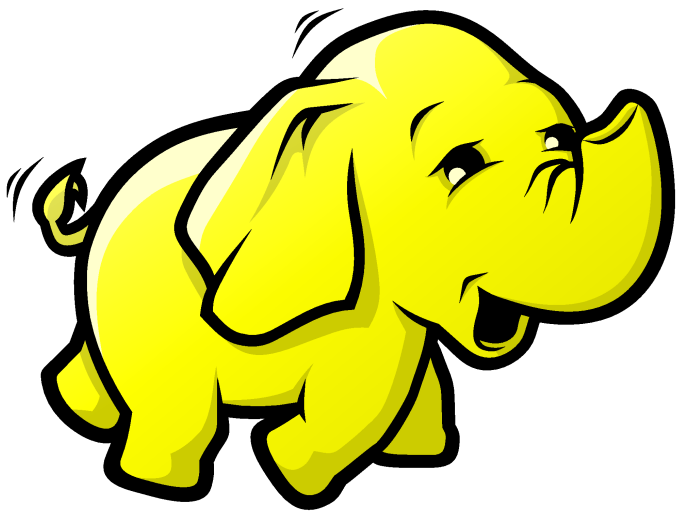

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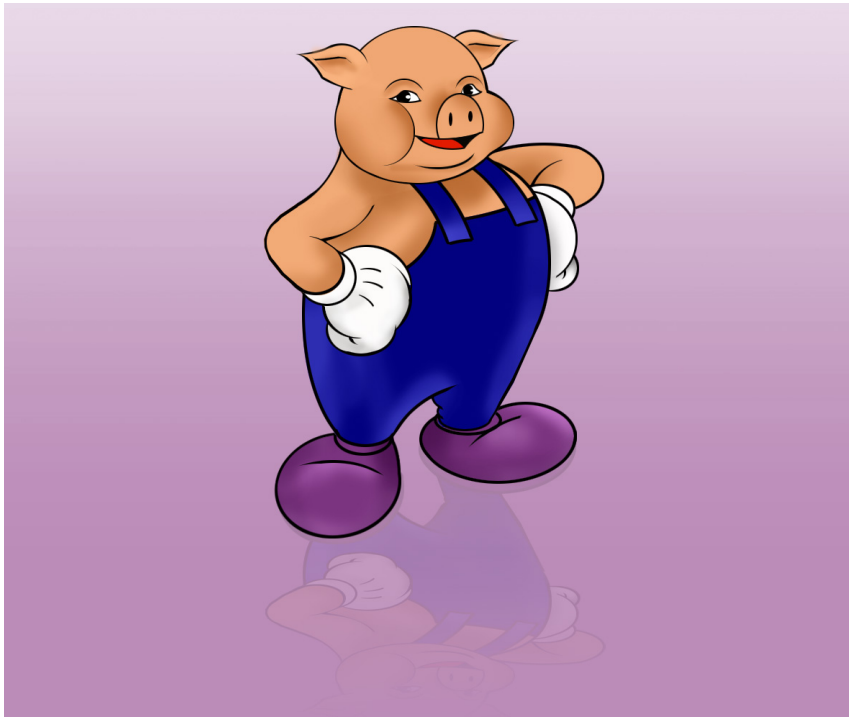

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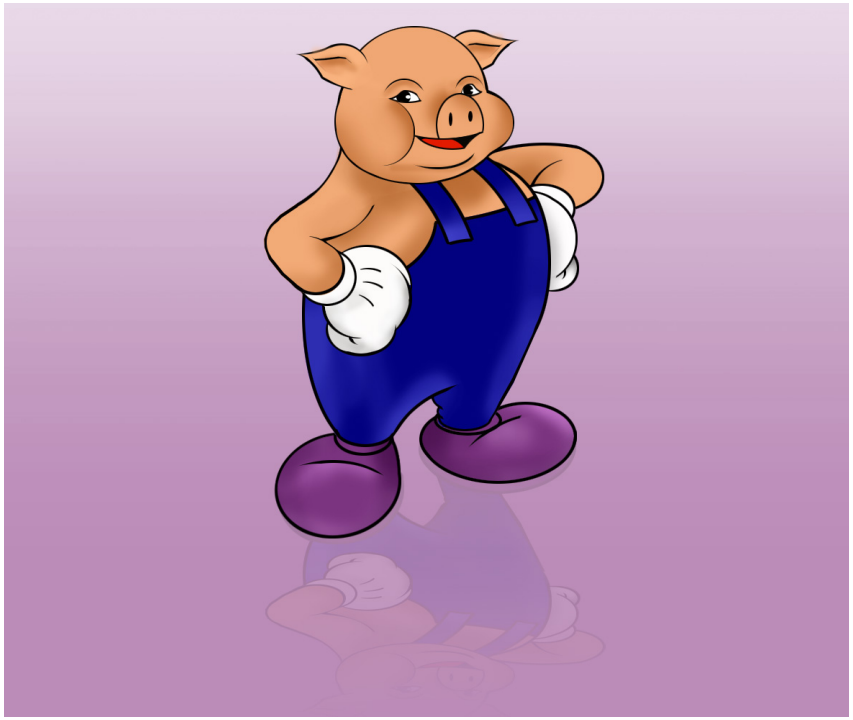

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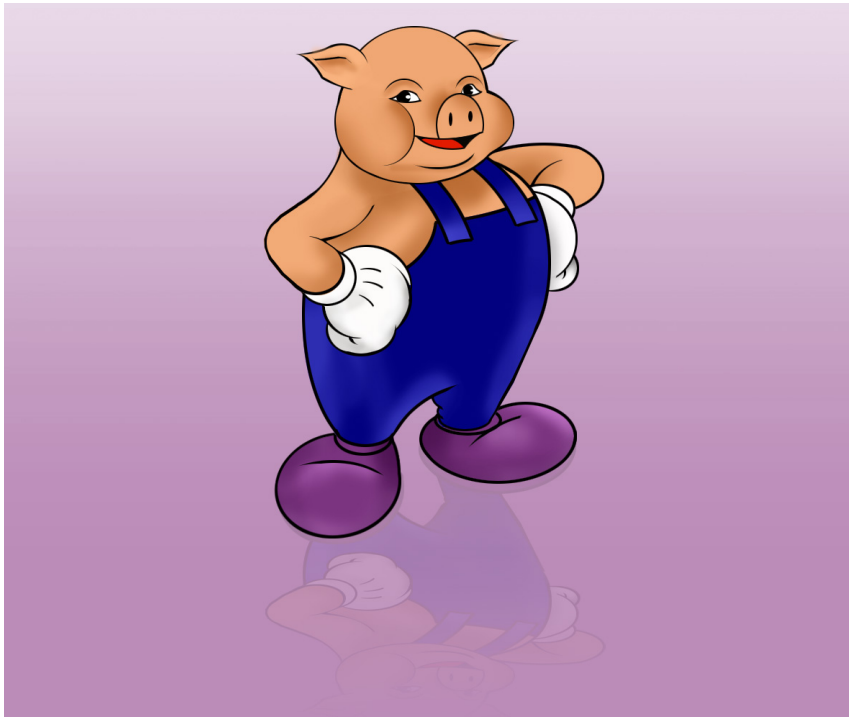

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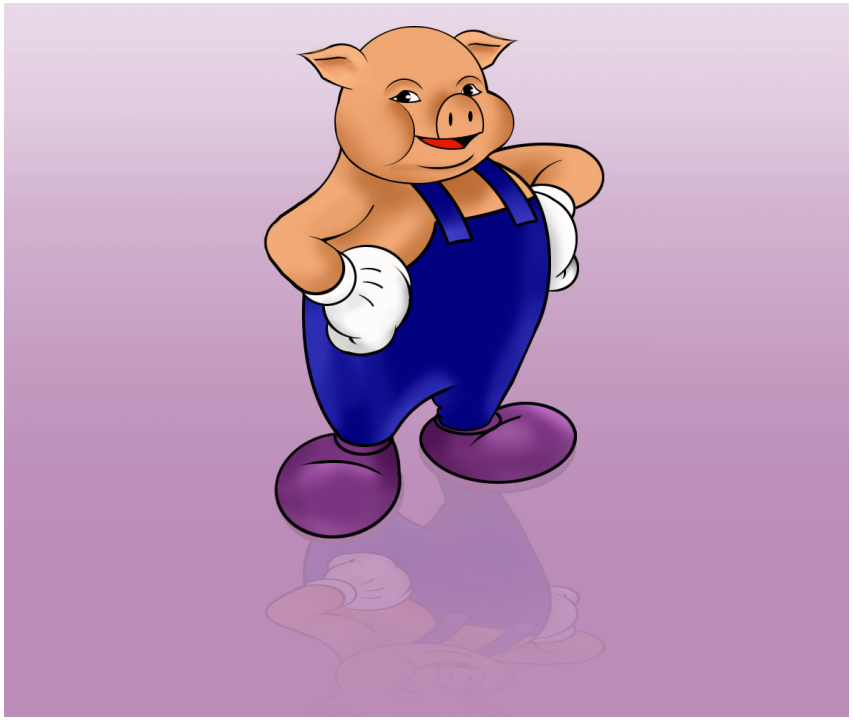

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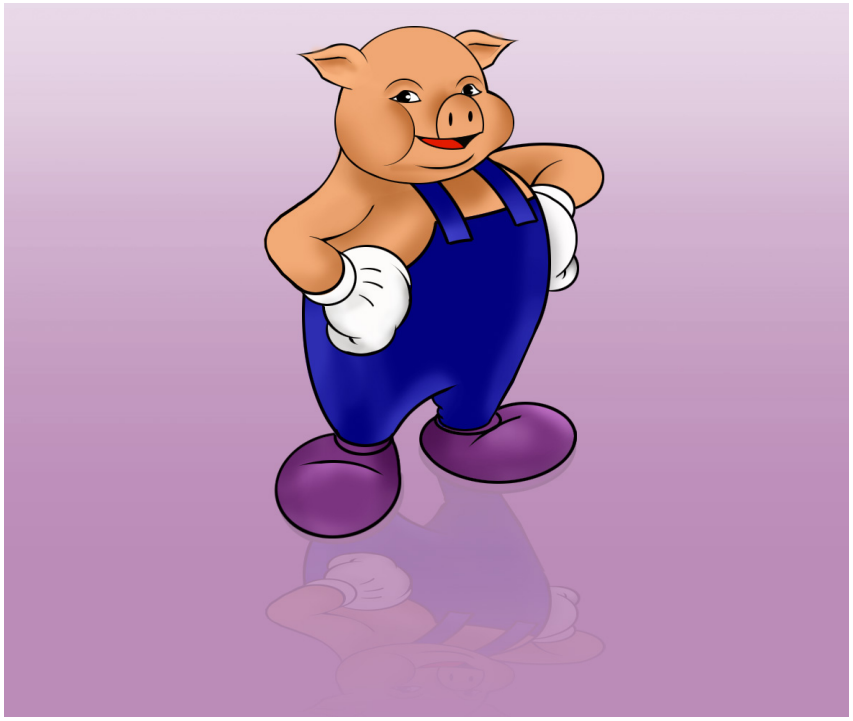

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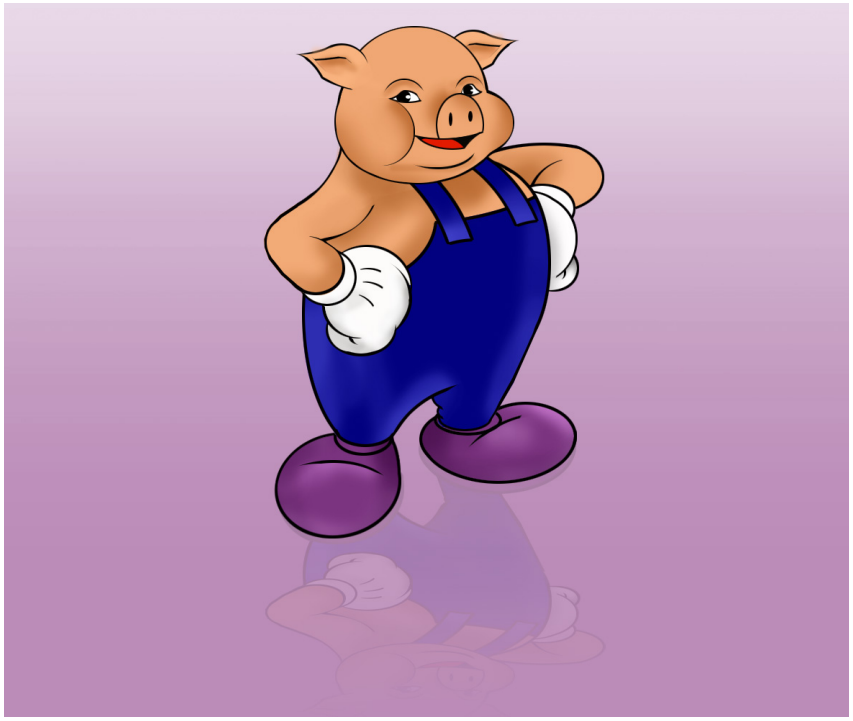

Spatial Support

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- It consists in three libraries:
  - Esri Geometry API for Java.
  - Geoprocessing Tools for Hadoop.
  - **Spatial Framework for Hadoop (SFH):** extends Hive to to enable spatial queries and geometry types.

Pigeon

- Wrapper around the geometry API from ESRI.
- Adds spatial support to Pig Latin.

Systems: Pigeon

FOSS4G KOREA 2014

- **Pigeon : Spatial Support in Pig**
  - **University of Minnesota (Prof. Mohamed Mokbel)**
  - **Pig Query(Non Spatial)**

```
points = LOAD 'points' AS (id:long, lon:double, lat:double);

results = FILTER points BY
          lon < -93.158 AND lon > -93.175 AND
          lat > 45.0077 AND lat < 45.0164;

STORE results INTO 'results';
```

  - **Pigeon Query(Spatial)**

```
IMPORT 'pigeon_import.pig';

points = LOAD 'points-pigeon' AS (id:long, location);
results = FILTER points BY
          ST_Contains(ST_MakeBox(-93.175, 45.0077, -93.158, 45.0164), location);

STORE results INTO 'results-pigeon';
```

Spatial Data Processing on Hadoop 39

PostGIS

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- Famous users: Foursquare, Instagram, CartoDB.

Practical

Hands-on

From S3 to HDFS

- Micro-task: Understand the dataset structure
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  - Download and view dataset

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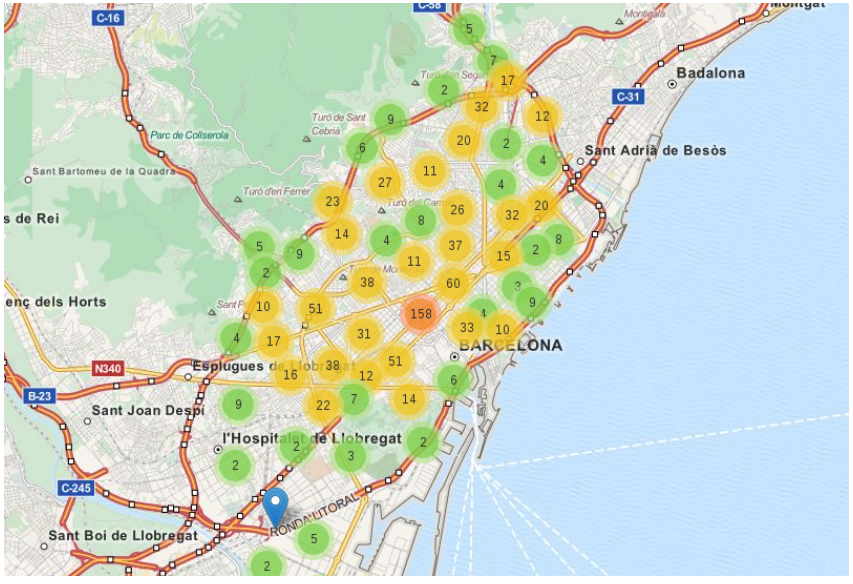
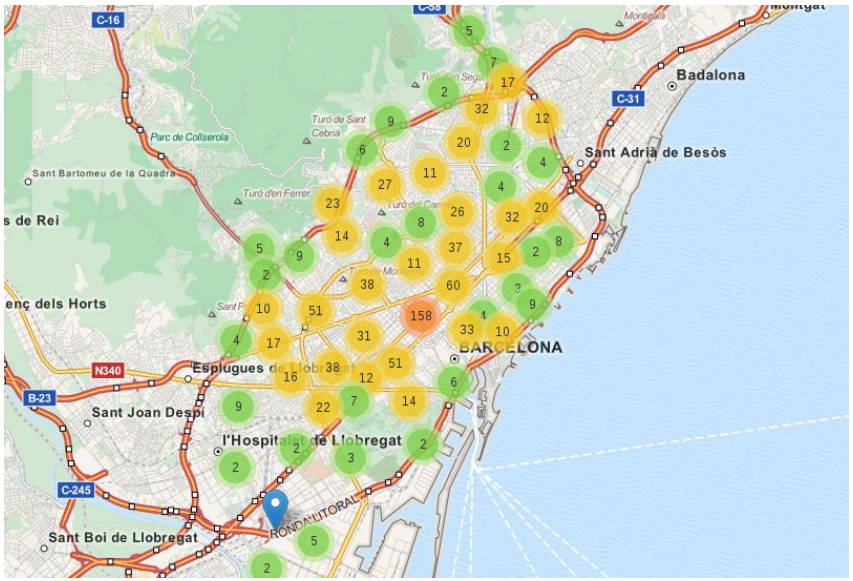
  - View table

What is so "Special" about Spatial



What is so "Special" about Spatial

- Location attributes allow us to detect spatial patterns
- Location also works as a "key", allowing us to connect with other datasets



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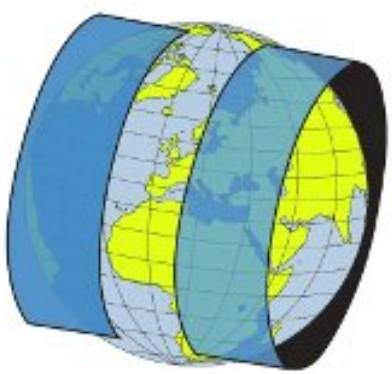
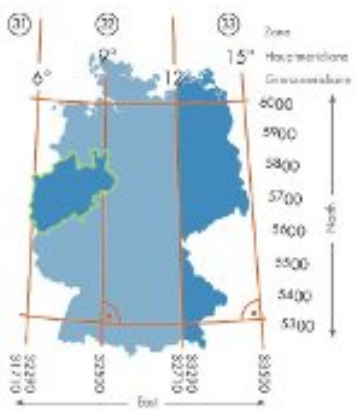
    - $lon = y/1000 + 400000$
    - $lat = y/1000 + 4500000$

CRS

World Geodetic System (WGS84, EPSG:4326): standard for use in cartography, geodesy, and navigation; reference CRS for GPS.

European Terrestrial Reference System 1989 (ETRS89, EPSG:5554): proposed, multipurpose Pan-European mapping standard; based on the ETRS89 Lambert Azimuthal Equal-Area projection coordinate reference system





Objective

- Separate lat, long fields and map them to correct types
- Remove invalid values
- Convert all coordinates into a single CRS (WGS84)

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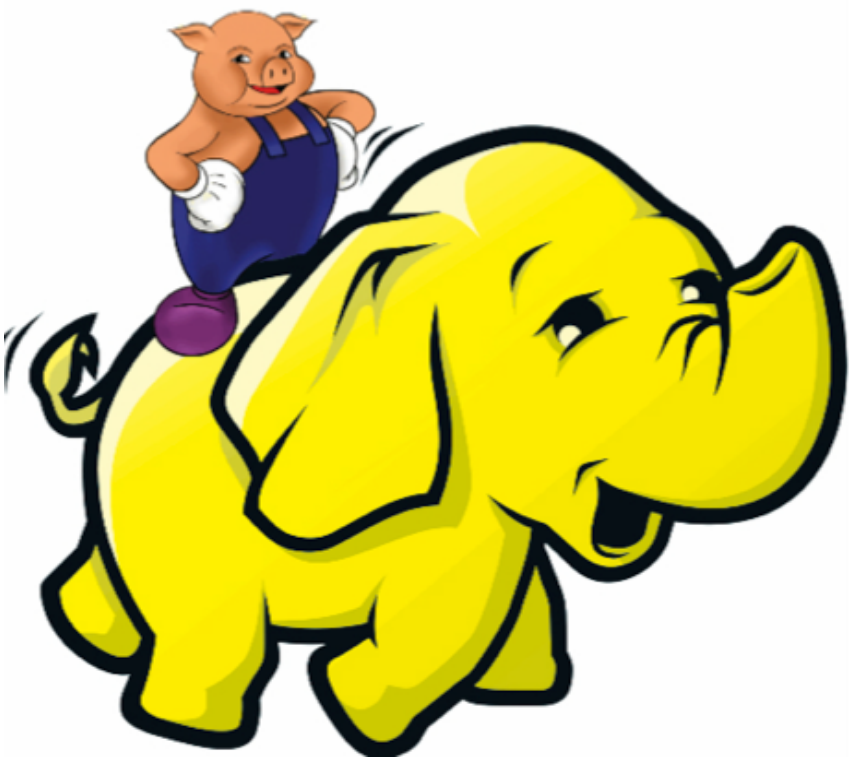
  - Export this table into a tsv
  - Store it in HDFS (if needed)
  - View exported data

Presenting the Pig Script

- Subsets the coordinate list, using filters
- Detects each coordinate "type", using regular expressions
- In the case of grid encoded, it applies a formula to decode back into grid
- Stores the results into separate files, in HDFS



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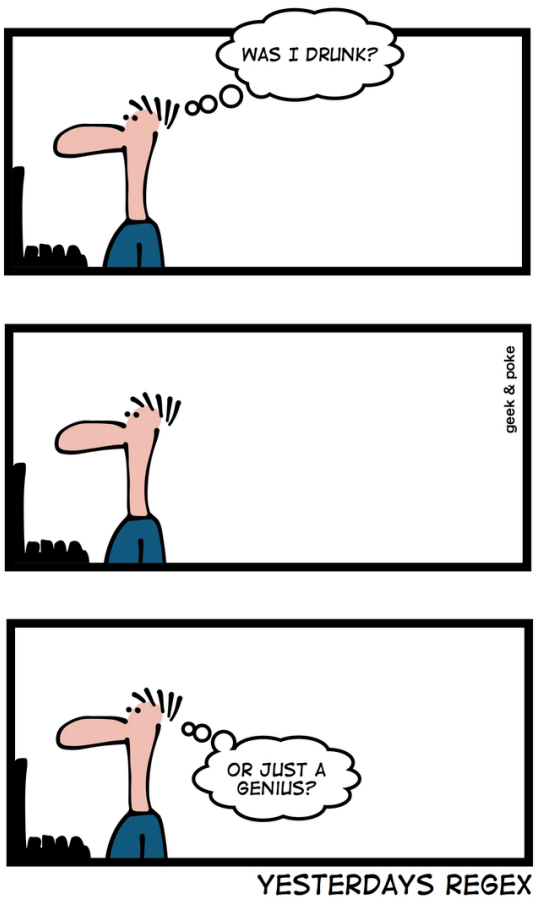
- Sequence of characters that forms a search pattern, mainly for use in pattern matching with strings, or string matching



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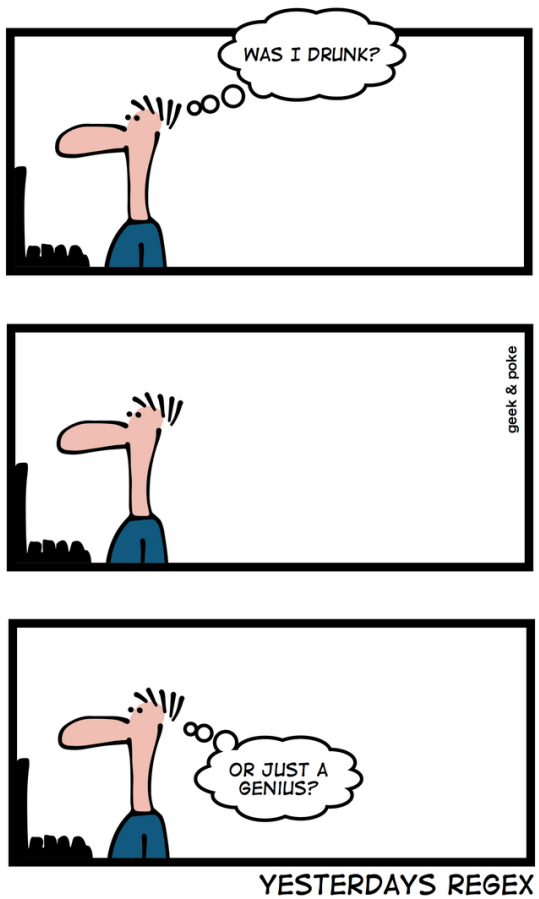

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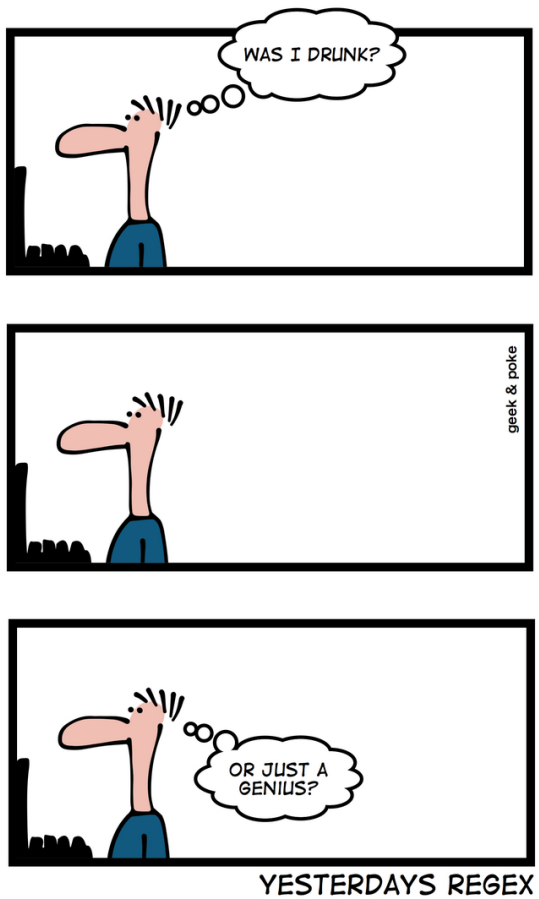

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  - Check output files

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  - Create table with wgs84 data
  - Create table with grid data
  - Create table with police-decoded data

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  - Copy data into table

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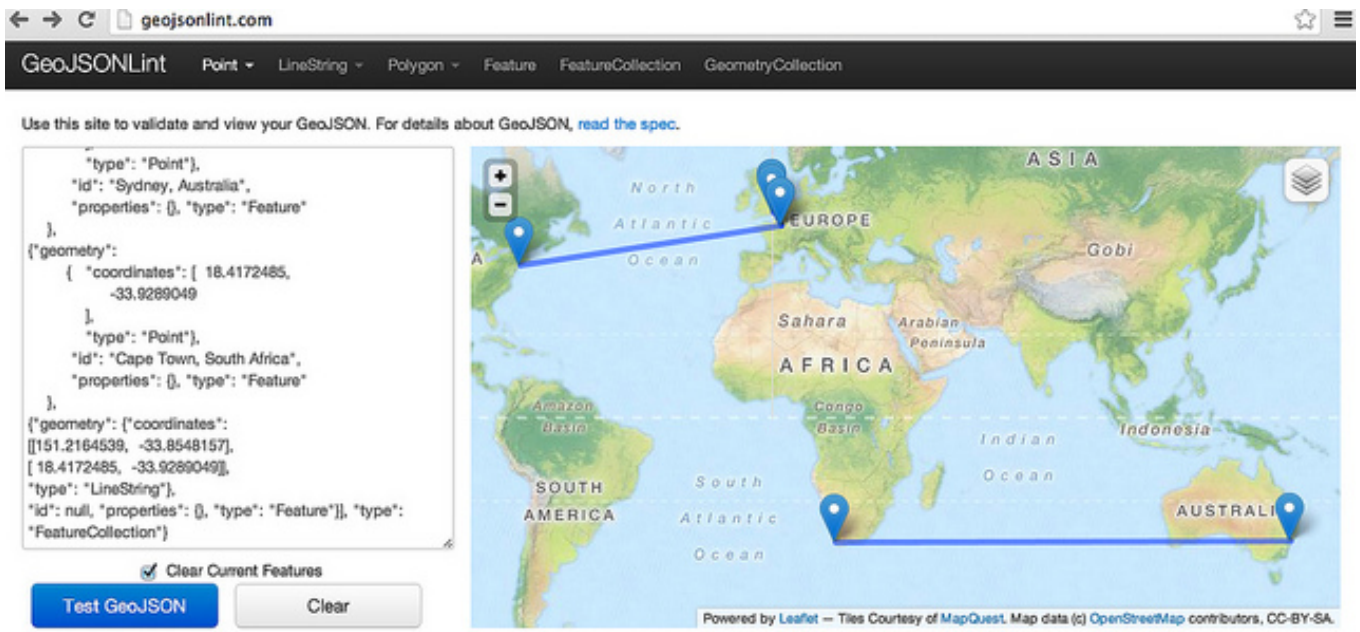
    - Create geometry index
  - Instantiate grid geometry
  - Transform grid geometry into another CRS

CRS Transformation

- Micro-task: Convert all features in European grid to WGS84
  - Create geometry fields to accomodate geometry in the two CRS (Grid, WGS84)
    - Add columns
    - Set SRID
    - Create geometry index
  - Instantiate grid geometry
  - Transform grid geometry into another CRS
  - Export grid geometry in GeoJSON

GeoJSON

GeoJSON: is an open standard format for encoding collections of simple geographical features along with their non-spatial attributes using JavaScript Object Notation.



Importing Data back into Hive

- Micro-task: Import transformed data

Importing Data back into Hive

- Micro-task: Import transformed data
  - Enter Hive

Importing Data back into Hive

- Micro-task: Import transformed data
  - Enter Hive
  - Create table linking to the PostGIS export

Importing Data back into Hive

- Micro-task: Import transformed data
  - Enter Hive
  - Create table linking to the PostGIS export
  - Create new table and instantiate geometry from GeoJSON

Joining Data

- Micro-task: Join imported coordinates with WGS84 coordinates and the rest of the dataset

Joining Data

- Micro-task: Join imported coordinates with WGS84 coordinates and the rest of the dataset
  - Join imported records with original table with all fields

Joining Data

- Micro-task: Join imported coordinates with WGS84 coordinates and the rest of the dataset
  - Join imported records with original table with all fields
  - Merge imported records with WGS84 records, for a single table with unified geometry

Understanding Indexes

Generating Indexes

References

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Thank you for Listening!