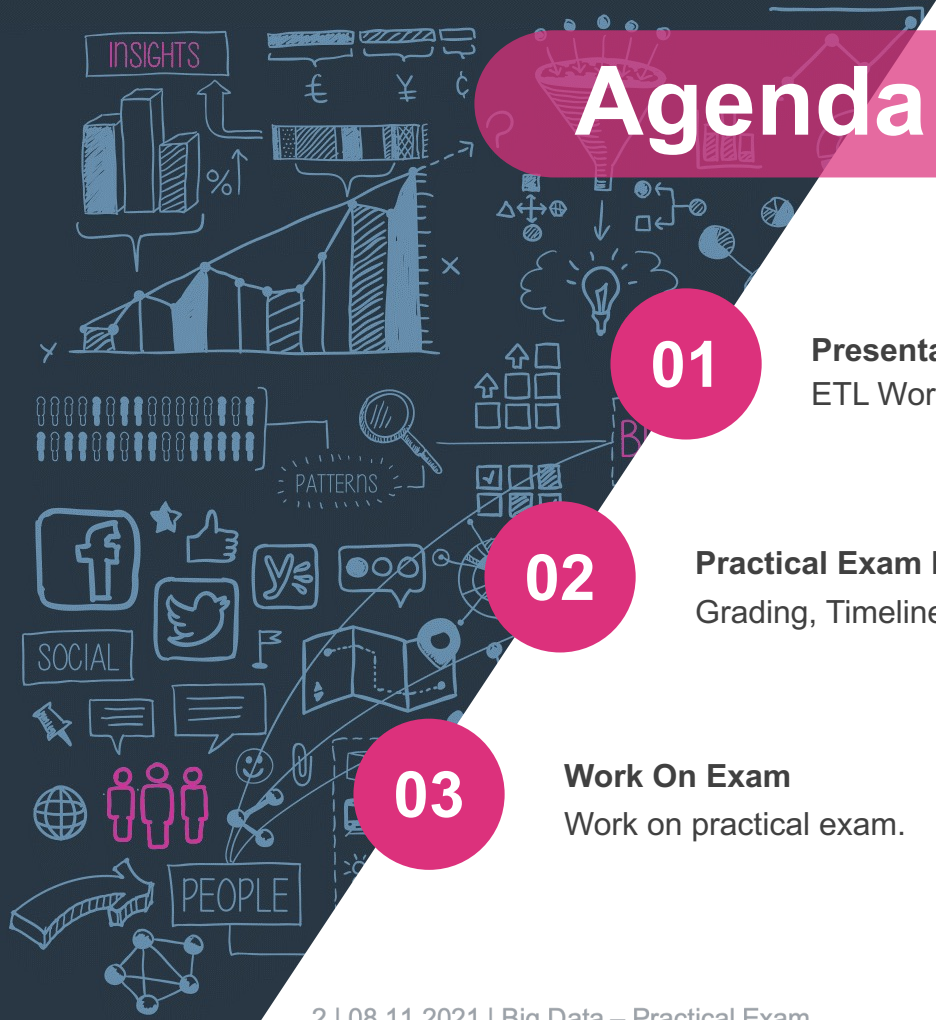

# Big Data – Practical Exam

*Winter Semester 2021/2022,*
*Cooperative State University Baden-Wuerttemberg*

www.marcel-mittelstaedt.com




# Agenda – 08.11.2021

01

**Presentation and Discussion: Exercise Of Last Lecture**
ETL Workflow: Airflow

02

**Practical Exam Discussion**
Grading, Timeline, Deliverables, Presentation Procedure, Exam Topics

03

**Work On Exam**
Work on practical exam.

# Schedule

| | Lecture Topic | HandsOn |
|---|---|---|
| 27.09.2021 13:15-15:45 Ro. N/A | About This Lecture, Introduction to Big Data | Setup Google Cloud, Create Own Hadoop Cluster and Run MapReduce |
| 04.10.2021 13:15-15:45 Ro. N/A | (Non-)Functional Requirements Of Distributed Data-Systems, Data Models and Access | Hive and HiveQL |
| 11.10.2021 13:15-15:45 Ro. N/A | Challenges Of Distributed Data Systems: Partitioning | HiveQL via JDBC, Data Partitioning (with HDFS and Hive) |
| 18.10.2021 13:15-15:45 Ro. N/A | Challenges Of Distributed Data Systems: Replication | Spark, Scala, PySpark and Jupyter Notebooks |
| 25.10.2021 13:15-15:45 Ro. N/A | Batch&Stream Processing, ETL Workflow and Automation | Airflow |
| **08.11.2021 13:15-15:45 Ro. N/A** | **Practical Exam** | **Work On Practical Exam** |
| 15.11.2021 13:15-15:45 Ro. N/A | Practical Exam | Work On Practical Exam |
| 22.11.2021 13:15-15:45 Ro. N/A | Practical Exam | Work On Practical Exam |
| **29.11.2021 13:15-15:45 Ro. N/A** | **Practical Exam Presentation** | |
| **06.12.2021 13:15-15:45 Ro. N/A** | **Practical Exam Presentation** | |

# Practical Exam

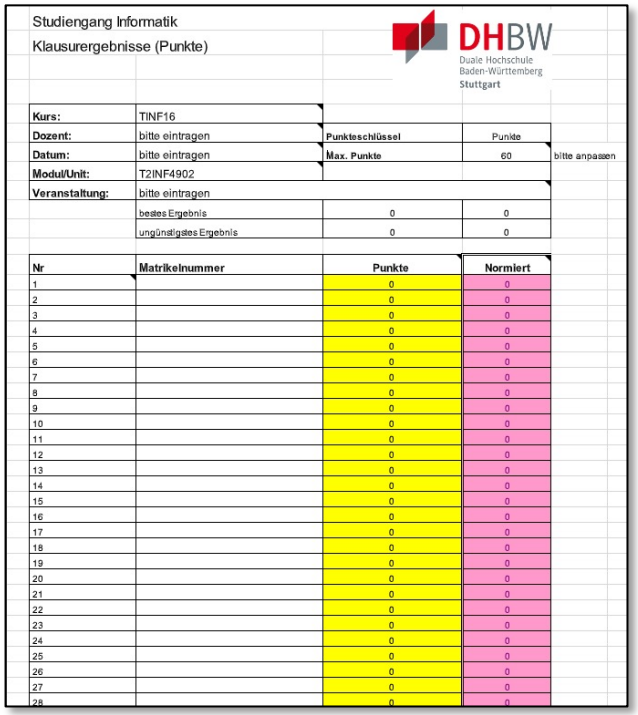
Topics, Deliverables, Presentation…

# Practical Exam - Grading

**Grade/Percentage:**

- grade will be mixed with grade of another lecture
- therefore, the rating won‘t be a grade (1-6) but a percentage:

| Percentage | Grade |
|---|---|
| 100% | 1.0 |
| … | … |
| 50% | 4.0 |
| … | … |



Studiengang Informatik

Klausurergebnisse (Punkte)

DHBW
Duale Hochschule
Baden-Württemberg
Stuttgart

| | | | |
|---|---|---|---|
| Kurs: | TINF16 | | |
| Dozent: | bitte eintragen | Punkteschlüssel | Punkte |
| Datum: | bitte eintragen | Max. Punkte | 60 |
| Modul/Unit: | T2INF4902 | | |
| Veranstaltung: | bitte eintragen | | |
| | bestes Ergebnis | 0 | 0 |
| | ungünstigstes Ergebnis | 0 | 0 |

| Nr | Matrikelnummer | Punkte | Normiert |
|---|---|---|---|
| 1 | | 0 | 0 |
| 2 | | 0 | 0 |
| 3 | | 0 | 0 |
| 4 | | 0 | 0 |
| 5 | | 0 | 0 |
| 6 | | 0 | 0 |
| 7 | | 0 | 0 |
| 8 | | 0 | 0 |
| 9 | | 0 | 0 |
| 10 | | 0 | 0 |
| 11 | | 0 | 0 |
| 12 | | 0 | 0 |
| 13 | | 0 | 0 |
| 14 | | 0 | 0 |
| 15 | | 0 | 0 |
| 16 | | 0 | 0 |
| 17 | | 0 | 0 |
| 18 | | 0 | 0 |
| 19 | | 0 | 0 |
| 20 | | 0 | 0 |
| 21 | | 0 | 0 |
| 22 | | 0 | 0 |
| 23 | | 0 | 0 |
| 24 | | 0 | 0 |
| 25 | | 0 | 0 |
| 26 | | 0 | 0 |
| 27 | | 0 | 0 |
| 28 | | 0 | 0 |

bitte anpassen

**Timeline:**

26.11.2021 23:59 All deliverables (next slide) will be delivered to following email address (DropBox, Google-Drive…):

contact@marcel-mittelstaedt.com

29.11./06.12.2021 13:15-15:45 Presentation of Practical Exam

# Practical Exam - **Deliverables**

**Deliverables:**

- A simple Documentation:
  - Explanation of whole ETL Workflow
  - List of Jobs/Transformations in Case of PDI or DAGs and Steps in Case of Airflow
  - Short description of the purpose of each job/transformation or task and applied business rules
  - all PDI Jobs, Transformations and related files (ktr, kjb, kettle.properties, shared.xml… files)
  - All Airflow DAGs and tasks
- All Scripts (e.g. Download) or other external applications called within PDI
- All Airflow DAGs, Python Files etc.
- All DDLs (`CREATE Table…`):
  - One file for each table
  - Table name = File Name, e.g.:


- Depending on Exam Type:
  - Code of Frontend Application and related Database (DDLs) or
  - Calculated KPIs

# Practical Exam - **Presentation**

**Procedure:**

1. Start ETL Workflow

2. During execution:
    - Quickly explain data source
        - API
        - Data Structure
        - Approach for gathering data
    - Quickly Explain whole ETL Workflow
        - Explain Idea and purpose of each Job/Transformation
        - External ressources/scripts (e.g. download)
        - Explain Data Model (Raw Layer, Final Layer, simple Frontend)

3. After execution:
    - Depending on Exam:
        - Demo of simple Frontend application or
        - Explanation of calculated KPIs

# Work On Practical Exam

Time to work on practical exam

# Use Spotify Audio Features To Categorize Music

Practical Exam

# Goal

Spotify provides an API for basic track information:

- **`ID`**, e.g. *2lEcSduKEXEK5KJ9hJzlCz*
- **`name`**, e.g. *Gloana Bauer (Teenage Dirtbag)*
- **`artist`**, e.g. *D‘ Hundskrippln*
- *…*

as well as related audio features:

- **`energy`**, e.g. *0.454*
  *Energy is a measure from 0.0 to 1.0 and represents a perceptual measure of intensity and activity.* Typically, energetic tracks feel fast, loud, and noisy. For example, death metal has high energy, while a Bach prelude scores low on the scale.
- **`speechiness`**, e.g. *0.0388*
  *Speechiness detects the presence of spoken words in a track. The more exclu sively speech-like the recording (e.g. talk show, audio book, poetry), the closer to 1.0 the attribute value.*
- **`loudness`**, e.g. *-8.758*
  *The overall loudness of a track in decibels (dB). Loudness values are averaged.*
- **`tempo`**, e.g. *97.532*
  *The overall estimated tempo of a track in beats per minute (BPM)*
- **`acousticness`**, *e.g. 0.268*
  *A confidence measure from 0.0 to 1.0 of whether the track is acoustic.*
- *…*

*https://developer.spotify.com/documentation/web-api/reference/#/operations/get-audio-features*



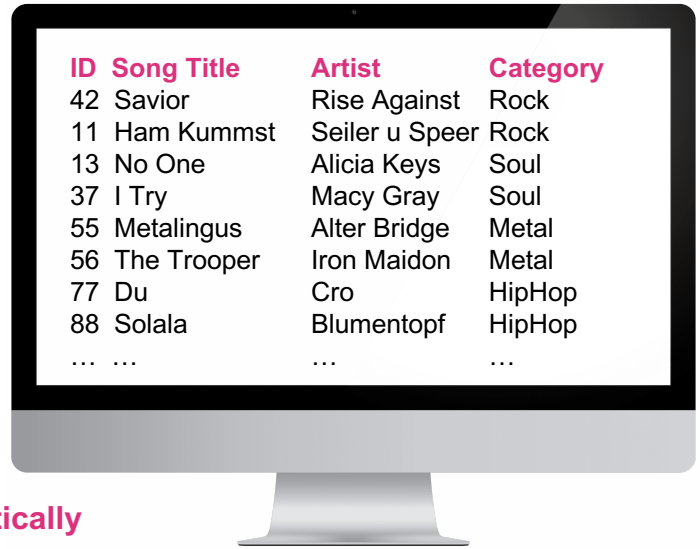
# Goal

We want to make use of those audio features to automatically assign each track to a certain category:

| | | | |
|---|---|---|---|
| ***Metal*** | ***Classic*** | ***Rock*** | ***Vocal*** |
| ***Electro*** | ***Podcast*** | ***Soul*** | ***HipHop*** |

Workflow:

- **Query data** from Spotify API
- **Save raw data** (*JSON* files) to HDFS
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Calculate categories** (*Metal, Classic, Rock, …*)
- **Join track information** and **audio festures** and **save** everything **to end-user database** (e.g. MySQL, MongoDB…)
- Provide a simple HTML Frontend which reads from end-user database and displays result
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. Pentaho Data Integration or Airflow) and **run automatically**

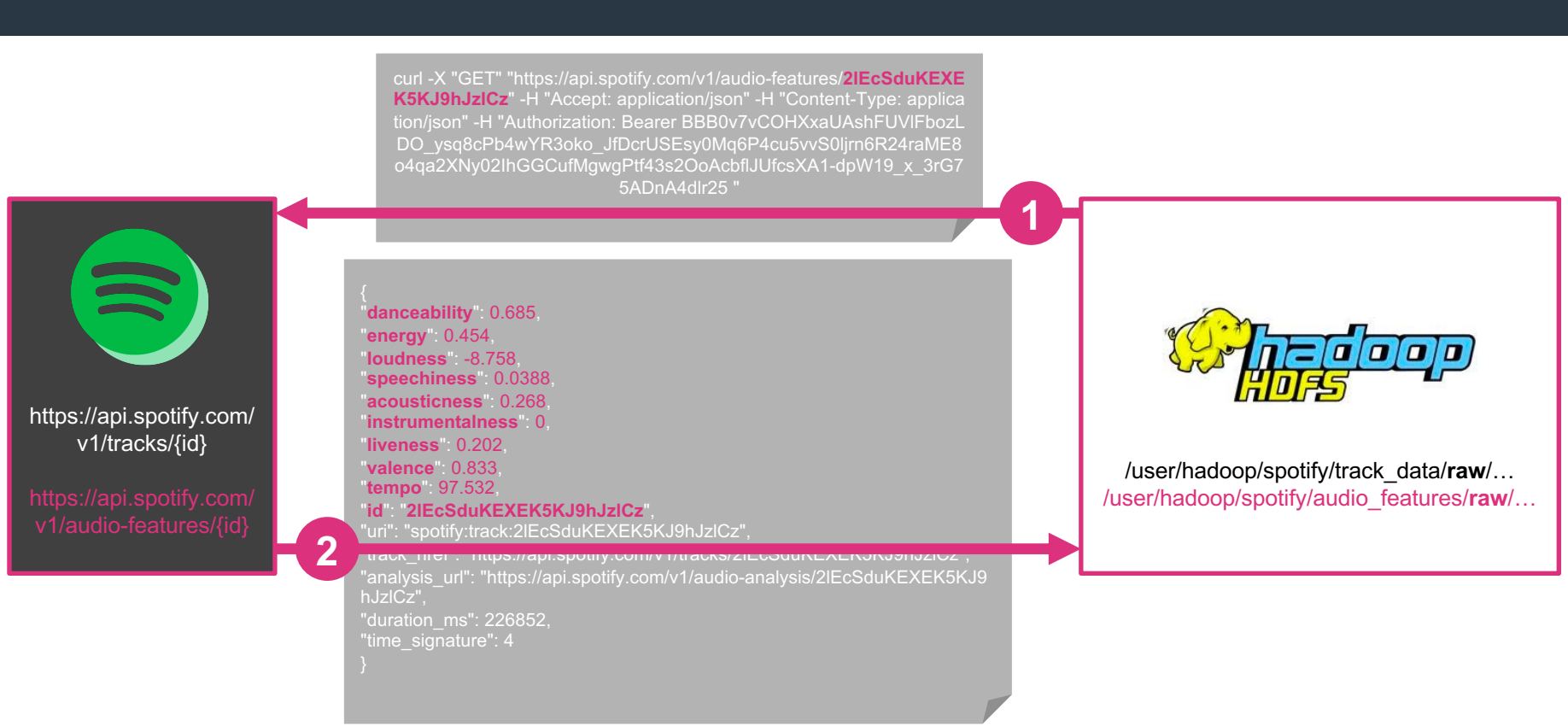


| ID | Song Title | Artist | Category |
|---|---|---|---|
| 42 | Savior | Rise Against | Rock |
| 11 | Ham Kummst | Seiler u Speer | Rock |
| 13 | No One | Alicia Keys | Soul |
| 37 | I Try | Macy Gray | Soul |
| 55 | Metalingus | Alter Bridge | Metal |
| 56 | The Trooper | Iron Maidon | Metal |
| 77 | Du | Cro | HipHop |
| 88 | Solala | Blumentopf | HipHop |
| … | … | … | … |

# Dataflow: 1. Get Track Information

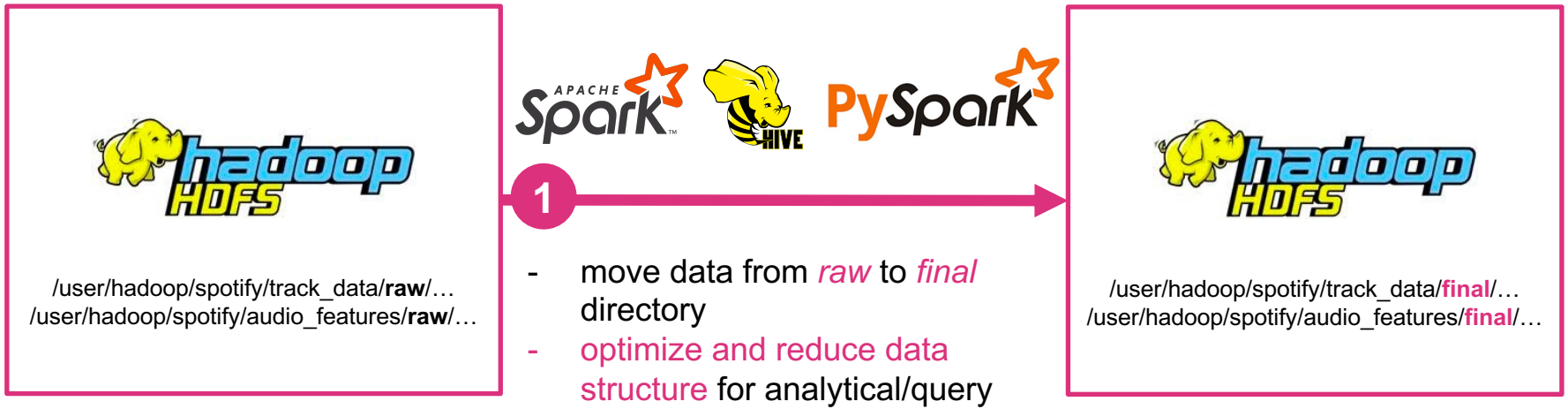

*https://developer.spotify.com/documentation/web-api/reference/#/operations/get-track*

# Dataflow: 2. Get Track Audio Features



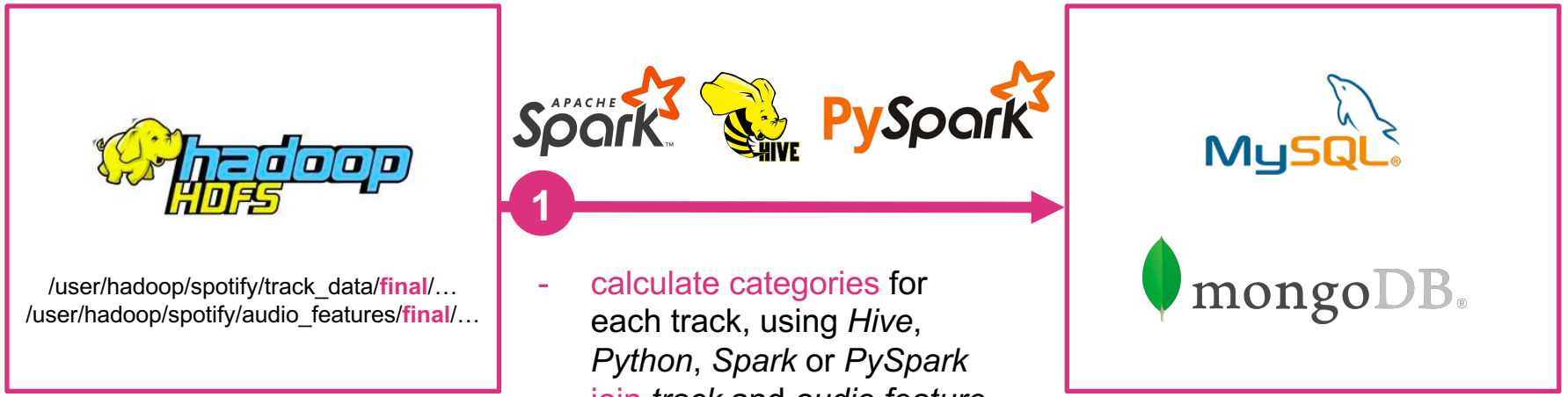

*https://developer.spotify.com/documentation/web-api/reference/#/operations/get-audio-features*

# Dataflow: 3. Raw To Final Transfer




- move data from *raw* to *final* directory
- optimize and reduce data structure for analytical/query purposes (JSON to tabular, only needed attributes etc.)
- remove duplicates if necessary

# Dataflow: 4. Run Analysis and Save Results

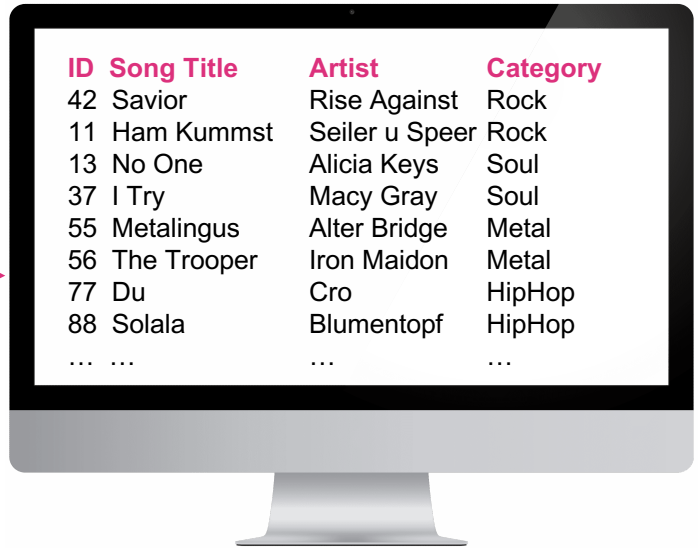



- calculate categories for each track, using *Hive*, *Python*, *Spark* or *PySpark*
- join *track* and *audio feature* data
- save everything to a end-user database (e.g. *MySQL*, *MongoDB*)

# Dataflow: **5. Provide Simple Web Interface**


1

- Create a simple Website which reads and displays data from end-user database



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| 56 | The Trooper | Iron Maidon | Metal |
| 77 | Du | Cro | HipHop |
| 88 | Solala | Blumentopf | HipHop |
| … | … | … | … |

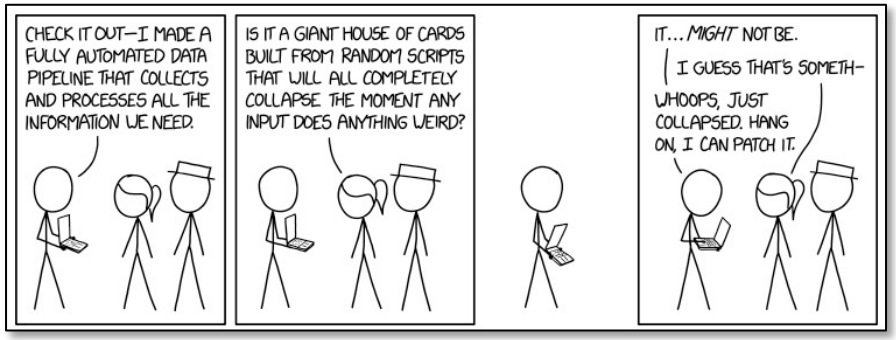
# Use XKCD API To Build A Searchable Database of XKCD Comics

Practical Exam

# Goal

XKCD provides regularly comics:

- https://xkcd.com/
- JSON API: https://xkcd.com/2054/info.0.json




*https://xkcd.com/2054/*


```
{
        "month": "10",
        "num": 2054,
        "link": "",
        "year": "2018",
        "news": "",
        "safe_title": "Data Pipeline",
        "transcript": "",
        "alt": "\"Is the pipeline literally running from your laptop?\" \"Don't b
        e silly, my laptop disconnects far too often to host a service we rel
        y on. It's running on my phone.\"", "img": "https://imgs.xkcd.com/comi
        cs/data_pipeline.png",
        "title": "Data Pipeline",
        "day": "3"
}
```

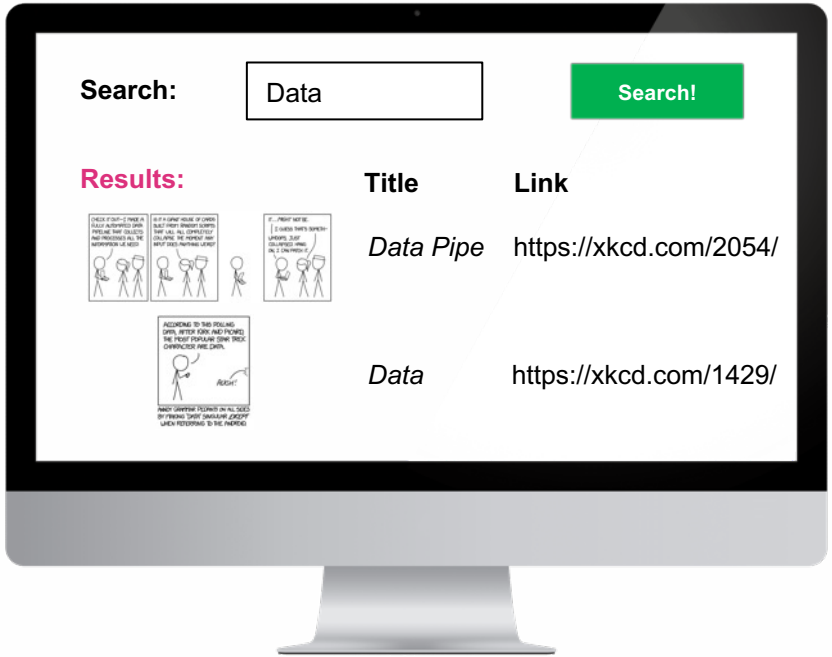

*2054.json*

# Goal

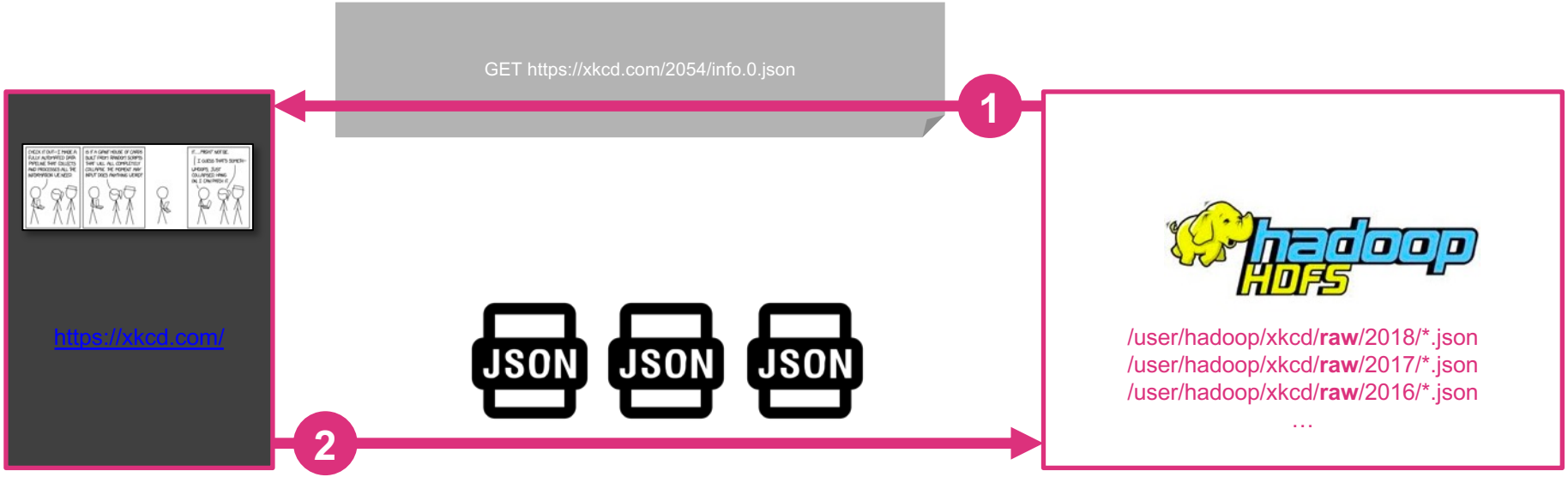
We want to make use of this data to build a searchable database for XKCD comics.

Workflow:

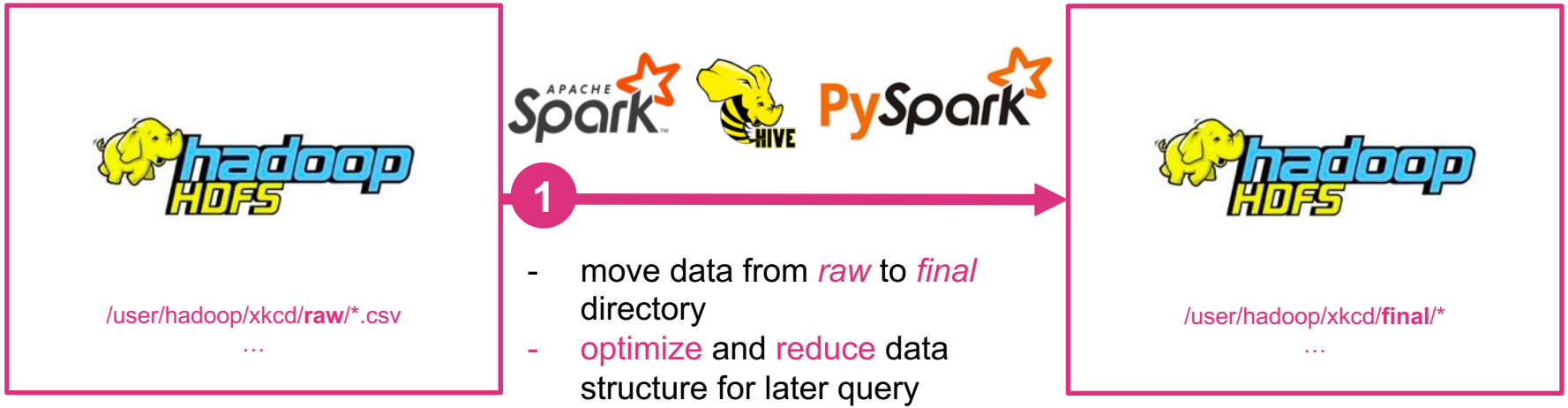
- **Gather data** from xkcd.com
- **Save raw data** (*JSON files*) to HDFS (partitioned by year, e.g. *2018*, *2017*, *2016*…)
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Export** xkcd data **to end-user database** (e.g. MySQL, MongoDB…)
- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (search phrase…)
  - checks against xkcd data in end-user database
  - Display result (comics containing search phrase)
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. Pentaho Data Integration or Airflow) and **run automatically**



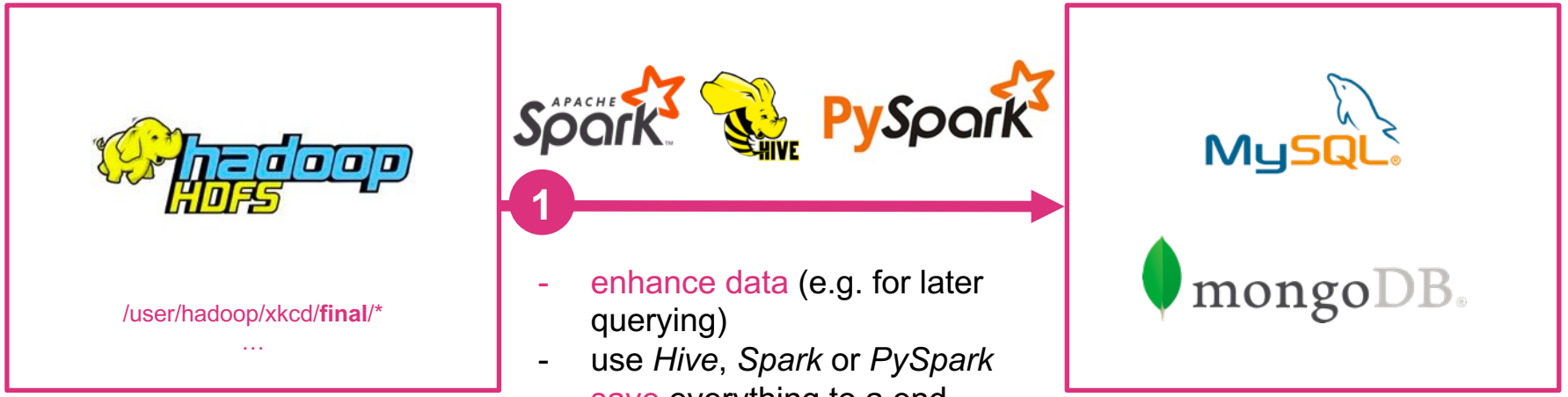
# Dataflow: 1. Get XKCD Data



# Dataflow: 2. Raw To Final Transfer

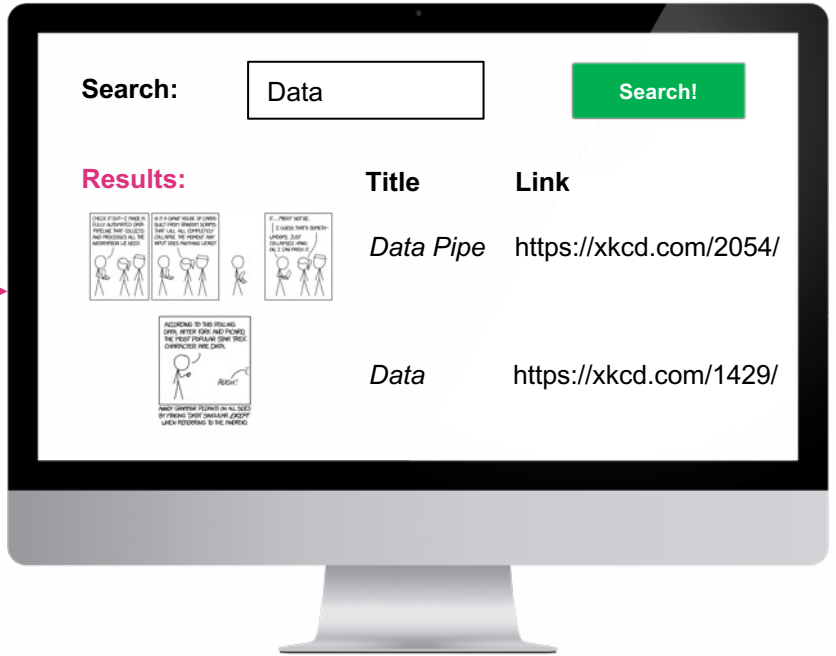


# Dataflow: 3. Enhance Data And Save Results



# Dataflow: 4. Provide Simple Web Interface


1




- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (search phrase…)
  - checks against xkcd data in end-user database
  - Display result (comics containing search phrase)

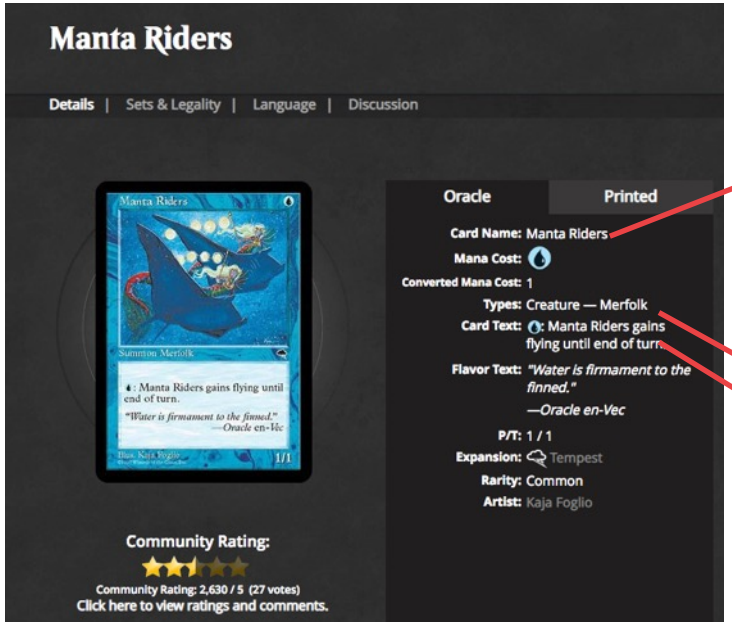
# Create MTG Trading Card Database By Crawler

Practical Exam

# Goal

magicthegathering.io provides up-to-date information regarding all MTG trading cards available:

- https://gatherer.wizards.com/Pages/




```
<div class="smallGreyMono" style="margin-top: 5px;">
  <b class="ft"><b></b></b>
  <div id="ctl00_ctl00_ctl00_MainContent_SubContent_SubContent_nameRow" class="row">
    <div class="label">
      Card Name:</div>
    <div class="value">
      Manta Riders</div>
  </div>
  <div id="ctl00_ctl00_ctl00_MainContent_SubContent_SubContent_manaRow" class="row manaRow">
    <div class="label" style="line-height: 25px;">
      Mana Cost:</div>
    <div class="value">
      <img src="/Handlers/Image.ashx?size=medium&amp;name=U&amp;type=symbol" alt="Blue" align="absbottom" /></div>
  </div>
  <div id="ctl00_ctl00_ctl00_MainContent_SubContent_SubContent_cmcRow" class="row">
    <div class="label" style="font-size: .7em;">
      Converted Mana Cost:</div>
    <div class="value">
      1</div>
  </div>
  <div id="ctl00_ctl00_ctl00_MainContent_SubContent_SubContent_typeRow" class="row">
    <div class="label">
      Types:</div>
    <div class="value">
      Creature  — Merfolk</div>
  </div>
  <div id="ctl00_ctl00_ctl00_MainContent_SubContent_SubContent_textRow" class="row">
    <div class="label">
      Card Text:</div>
    <div class="value">
      <div class="cardtextbox" style="padding-left:10px;"><img src="/Handlers/Image.ashx?size=small&amp;name=U&amp;type=symbol" alt="Blue" align="absbottom" />: Manta Riders gains flying until end of turn.</div></div>
  </div>
```

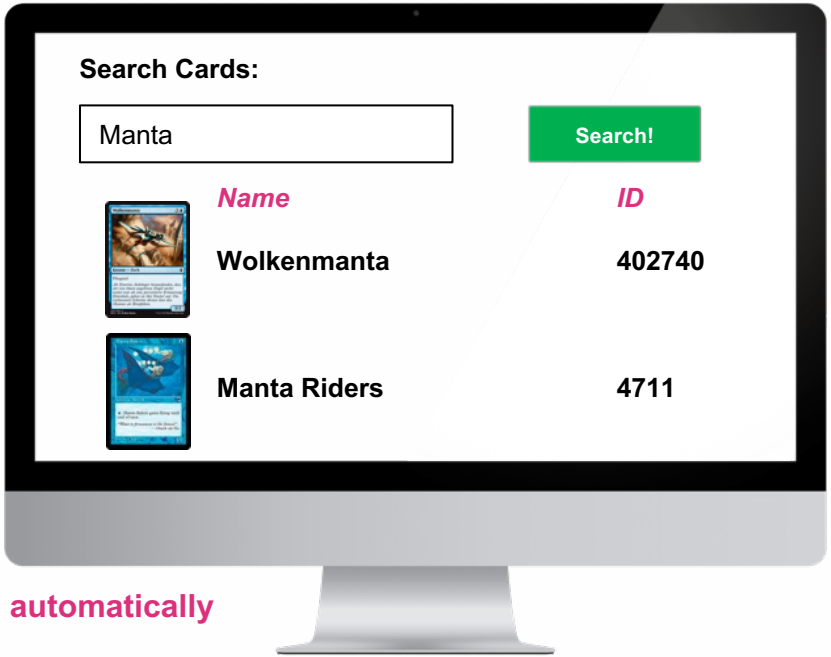
*http://gatherer.wizards.com/Pages/Card/Details.aspx?multiverseid=4711*

# Goal

We want to make use of this data to build a searchable database of all MTG trading cards.

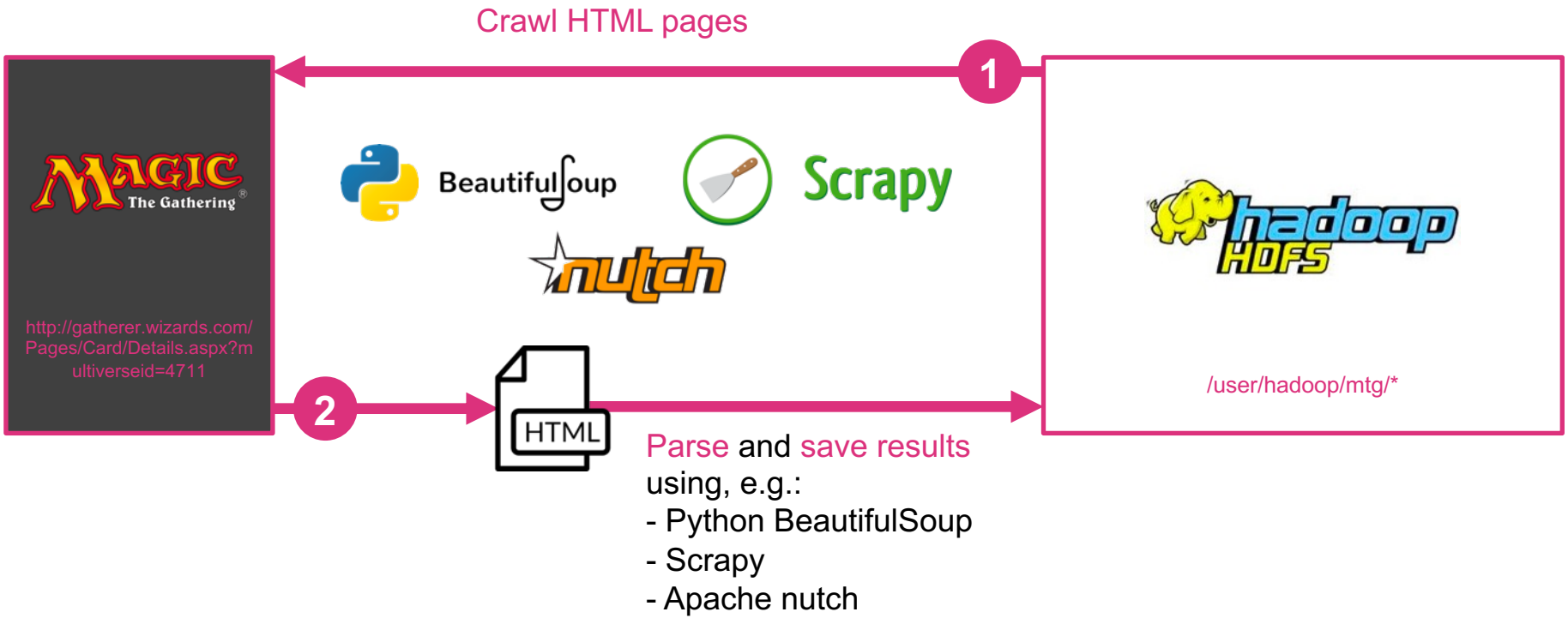
Workflow:

- **Crawl data** from gatherer.wizards.com
- **Parse** required **information** and save them to **HDFS** (queryable through Hive)
- **Export** MTG data **to end-user database** (e.g. MySQL, MongoDB…)
- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (card name, text or artist)
  - **display search results**




- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. Pentaho Data Integration or Airflow) and **run automatically**

# Dataflow: 1. Get MTG Data

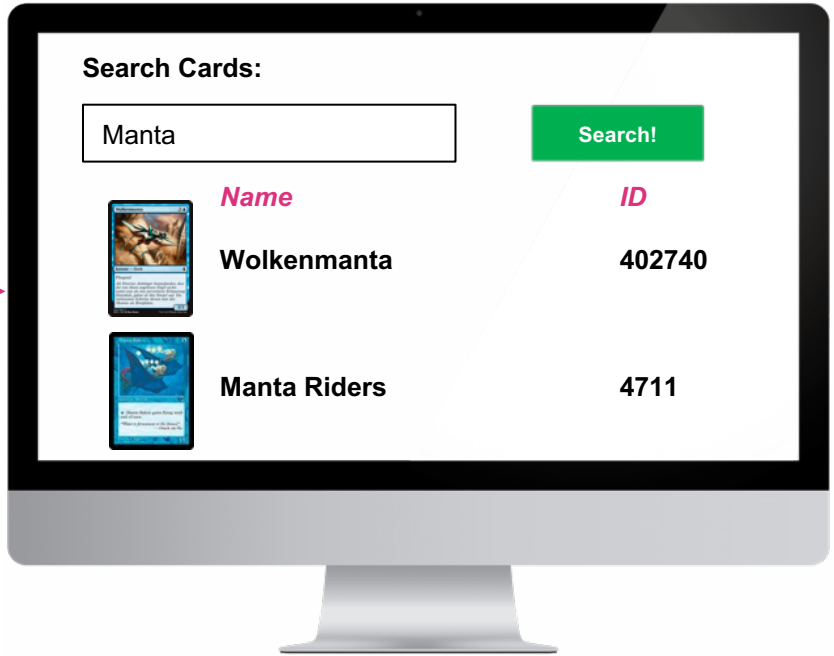


# Dataflow: 3. Enhance Data And Save Results


- enhance data (e.g. for later querying)
- use *Hive*, *Python*, *Spark* or *PySpark*
- save everything to a end-user database (e.g. *MySQL*, *MongoDB*)

# Dataflow: 4. Provide Simple Web Interface


1




- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (card name, text or artist)
  - **display search results**

# Use GeoLite2 To Create A Searchable IP and GeoLocation Database

Practical Exam

# Goal

Maxmind.com provides regulary exports of worldwide IP and Geolocation data:

- https://dev.maxmind.com/geoip/geolite2-free-geolocation-data

```
curl -s http://ifconfig.me
88.130.59.75
```

1

```
network,geoname_id,registered_country_geoname_id,represented_country_geoname_id,is_anonymous_proxy,is_satellite_provider,postal_code,latitude,longitude,accuracy_radius
88.130.59.0/24,2939623,2921044,,0,0,85221,48.2600,11.4340,50
[…]
```

*GeoLite2-City-Blocks-IPv4.csv*

2

```
geoname_id,locale_code,continent_code,continent_name,country_iso_code,country_name,subdivision_1_iso_code,subdivision_1_name,subdivision_2_iso_code,subdivision_2_name,city_name,metro_code,time_zone,is_in_european_union
3207535,de,EU,Europa,DE,Deutschland,BY,Bayern,,,Höhenkirchen-Siegertsbrunn,,Europe/Berlin,1
2939623,de,EU,Europa,DE,Deutschland,BY,Bayern,,,Dachau,,Europe/Berlin,1
3207410,de,EU,Europa,DE,Deutschland,BY,Bayern,,,Rödental,,Europe/Berlin,1
3207412,de,EU,Europa,DE,Deutschland,BY,Bayern,,,Röslau,,Europe/Berlin,1
3208324,de,EU,Europa,DE,Deutschland,BY,Bayern,,,Asbach-Bäumenheim,,Europe/Berlin,1
[…]
```

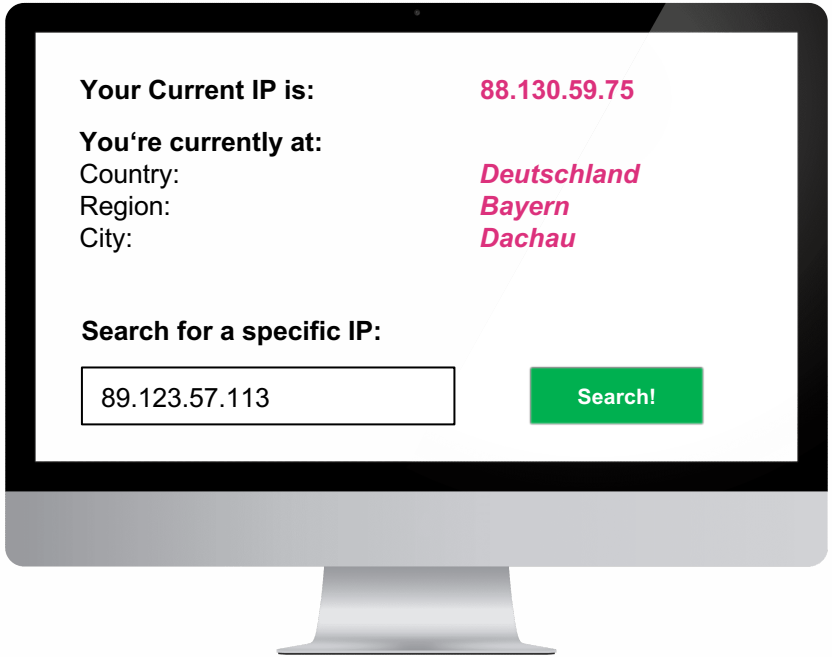
*GeoLite2-City-Locations-[XX].csv*

# Goal

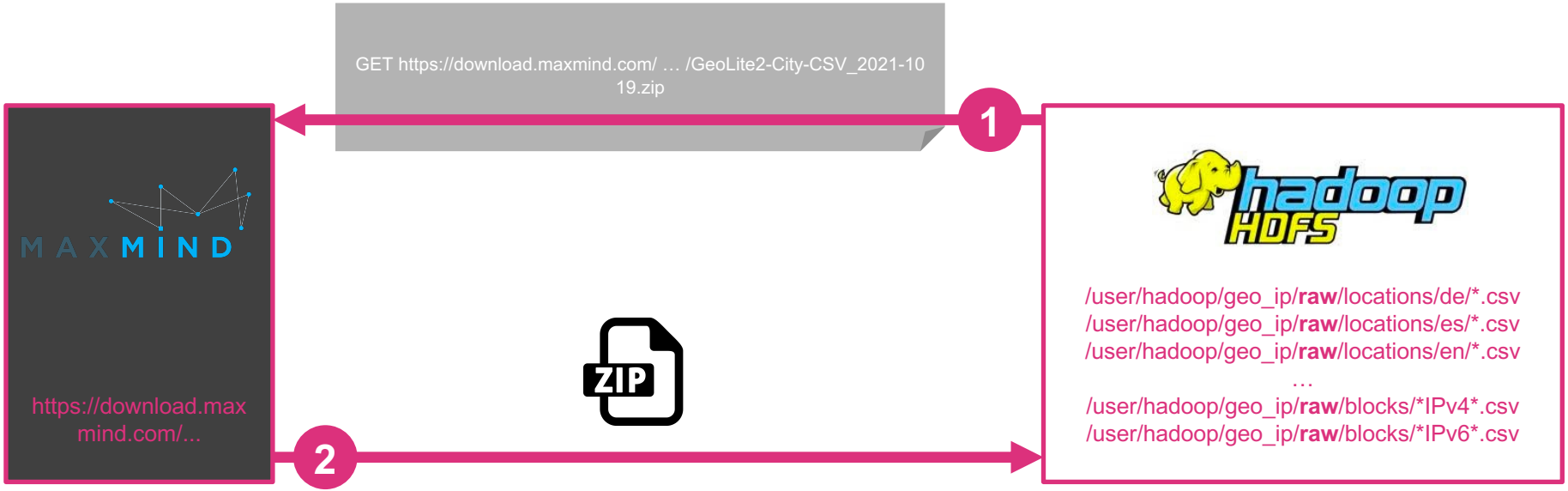
We want to make use of this data to build a real time IP-Geolocation resolution as well as a searchable database for Ips and related Geolocations.

Workflow:

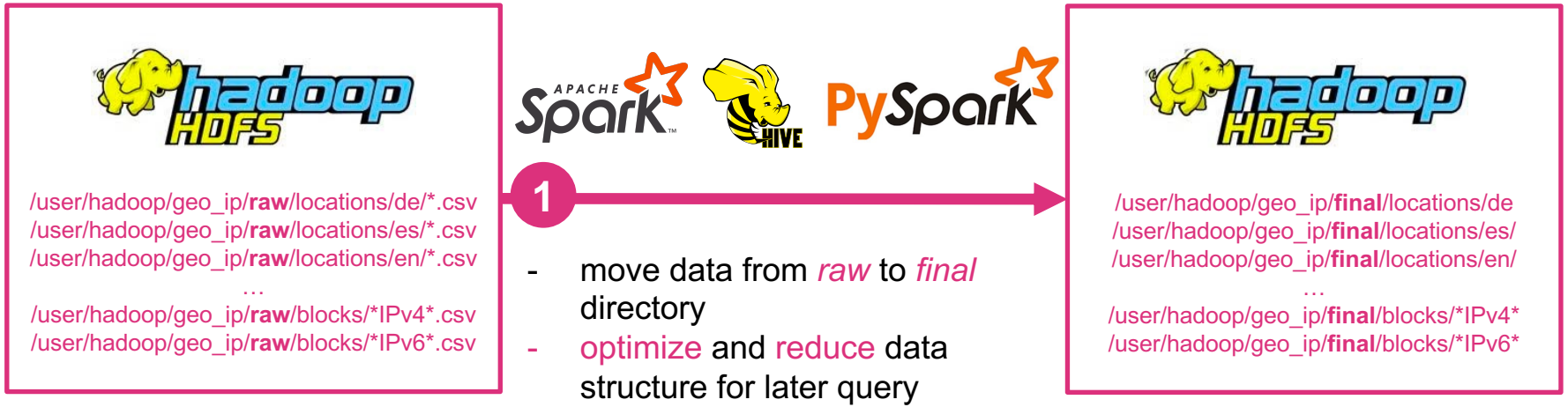
- **Gather data** from maxmind.com
- **Save raw data** (*CSV files*) to HDFS (partitioned by country code, e.g. *de*, *es*, *en*…)
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Export** Geolite2 data **to end-user database** (e.g. MySQL, MongoDB…)
- Provide a simple **HTML Frontend** which is able to:
  - **determine** a user's IP address, **lookup** and **show Geolocation**
  - process user input (IP…) and check against end-user database
  - Display result Geolocation
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. Pentaho Data Integration or Airflow) and **run automatically**



# Dataflow: 1. Get Geolite2 Data

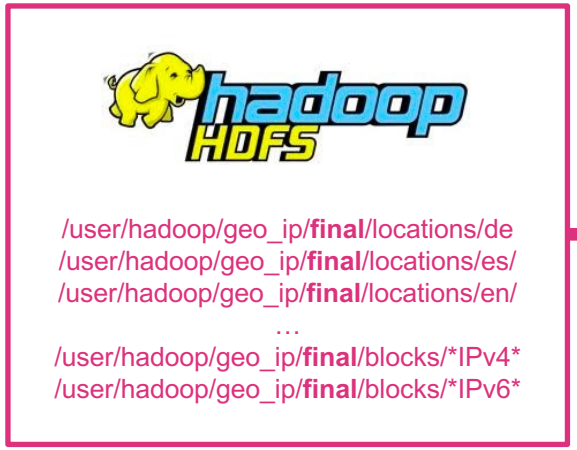


# Dataflow: 2. Raw To Final Transfer




- move data from *raw* to *final* directory
- optimize and reduce data structure for later query purposes if necessary
- remove duplicates if necessary
- …

# Dataflow: 3. Enhance Data And Save Results

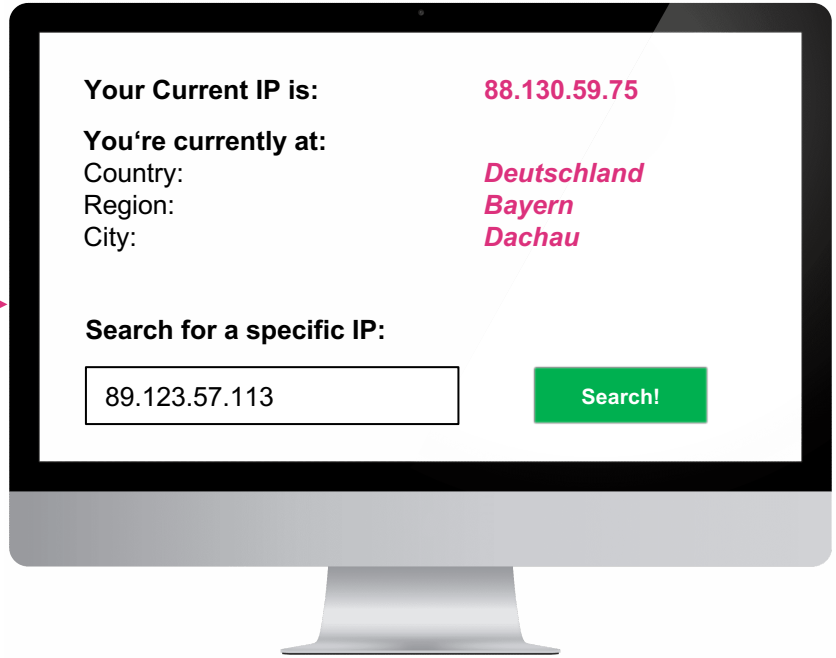




- enhance data (e.g. for later querying)
- use *Hive*, *Python*, *Spark* or *PySpark*
- save everything to a end-user database (e.g. *MySQL*, *MongoDB*)

# Dataflow: 4. Provide Simple Web Interface


1




- Provide a simple **HTML Frontend** which is able to:
  - **determine** a user's IP address, **lookup** and **show** Geolocation
  - process user input (IP…) and check against end-user database
  - Display result Geolocation

# Create MTG Trading Card Database By API

Practical Exam

# Goal

magicthegathering.io provides up-to-date information regarding all MTG trading cards available:

- https://docs.magicthegathering.io/
- E.g. https://api.magicthegathering.io/v1/cards/4711



```
{
  "card":{
    "name":"Manta Riders",
    "manaCost":"{U}",
    "cmc":1,
    "colors":[
      "Blue"
    ],
    "colorIdentity":[
      "U"
    ],
    "type":"Creature — Merfolk",
    "types":[
      "Creature"
    ],
    "subtypes":[
      "Merfolk"
    ],
    "rarity":"Common",
    "set":"TMP",
    "setName":"Tempest",
    "text":"{U}: Manta Riders gains flying until end of turn.",
    "flavor":"\"Water is firmament to the finned.\"\n—Oracle en-Vec",
    "artist":"Kaja Foglio",
    "power":"1",
    "toughness":"1",
    "layout":"normal",
    "multiverseid":4711,
    "imageUrl":"http://gatherer.wizards.com/Handlers/Image.ashx?multiverseid=4711&type=
card",
    […]
```

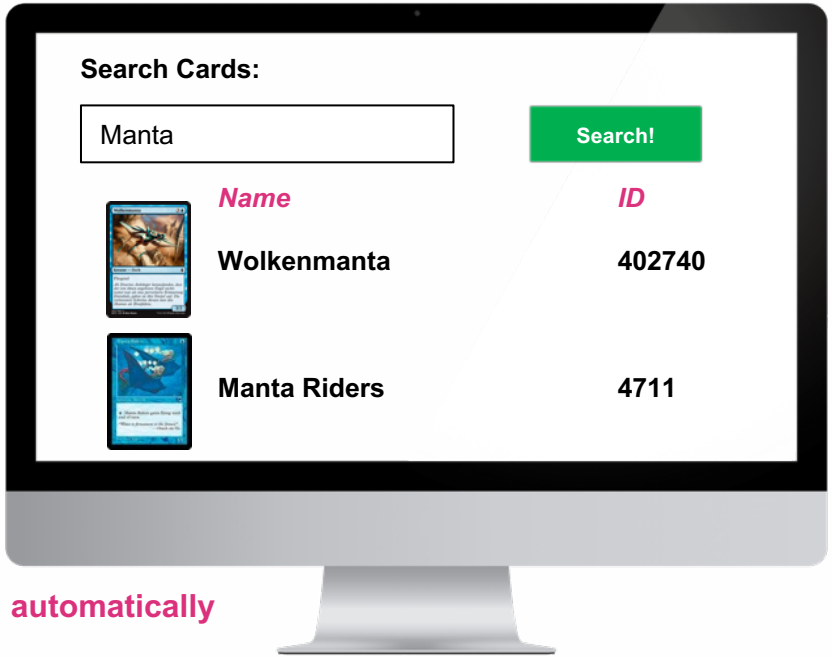
# Goal

We want to make use of this data to build a searchable database of all MTG trading cards.

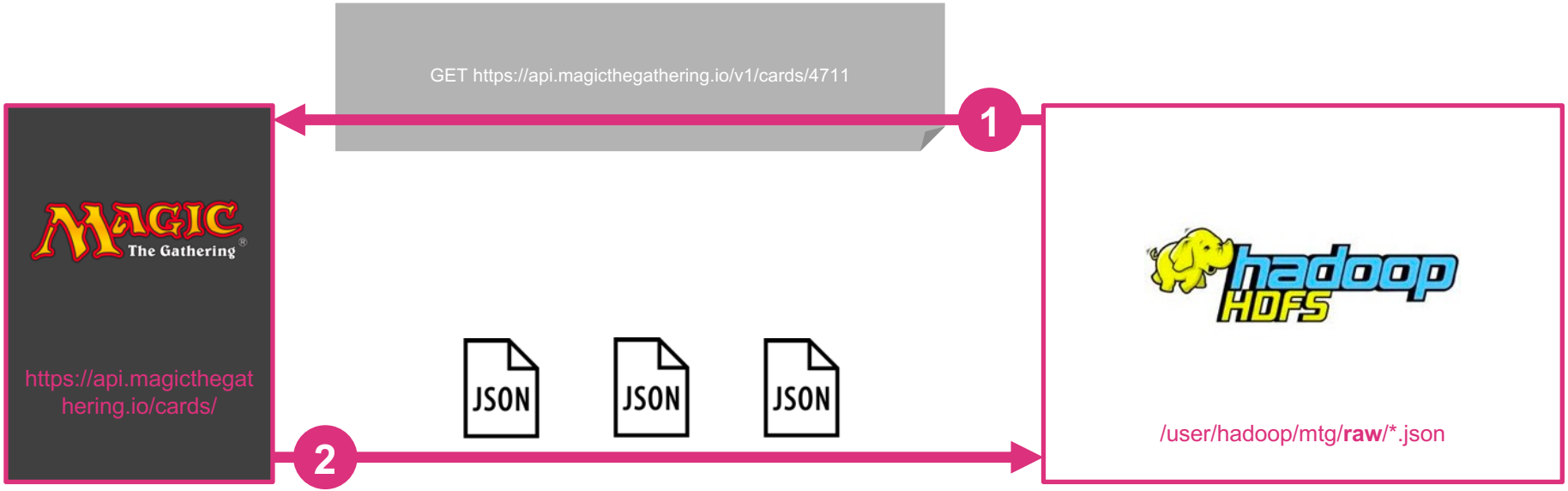
Workflow:

- **Gather data** from api.magicthegathering.io
- **Save raw data** (*JSON files*) to HDFS
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Export** MTG data **to end-user database** (e.g. MySQL, MongoDB…)
- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (card name, text or artist)
  - **display search results**

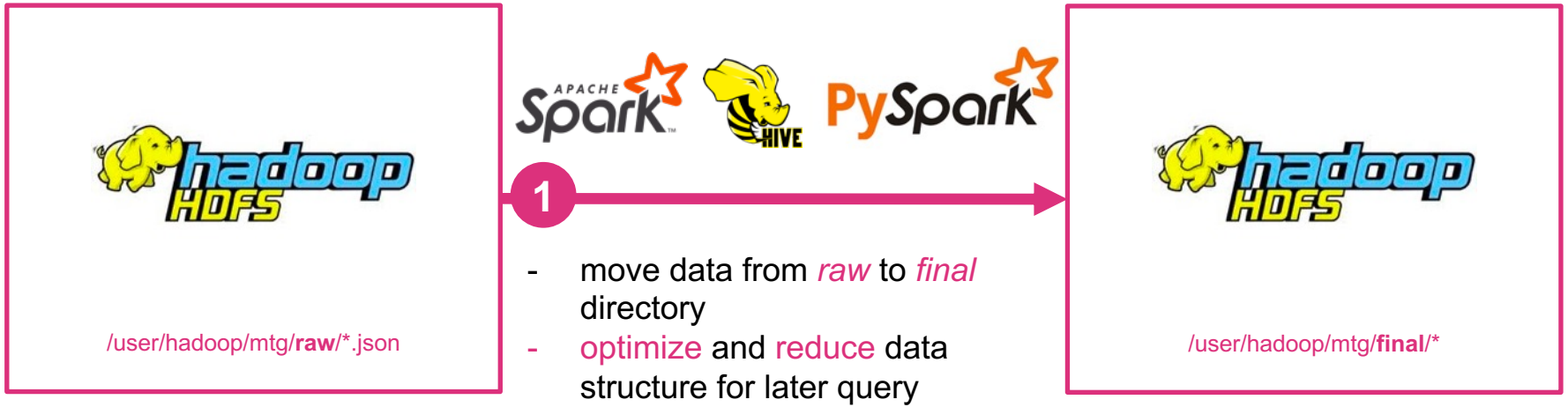
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. Pentaho Data Integration or Airflow) and **run automatically**



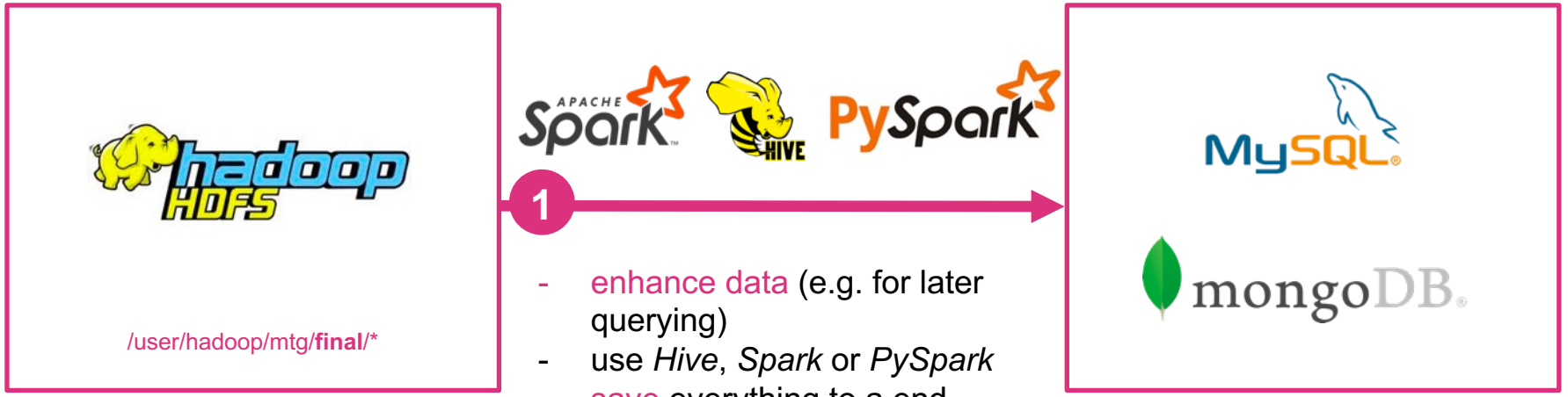
# Dataflow: 1. Get MTG Data



# Dataflow: 2. Raw To Final Transfer



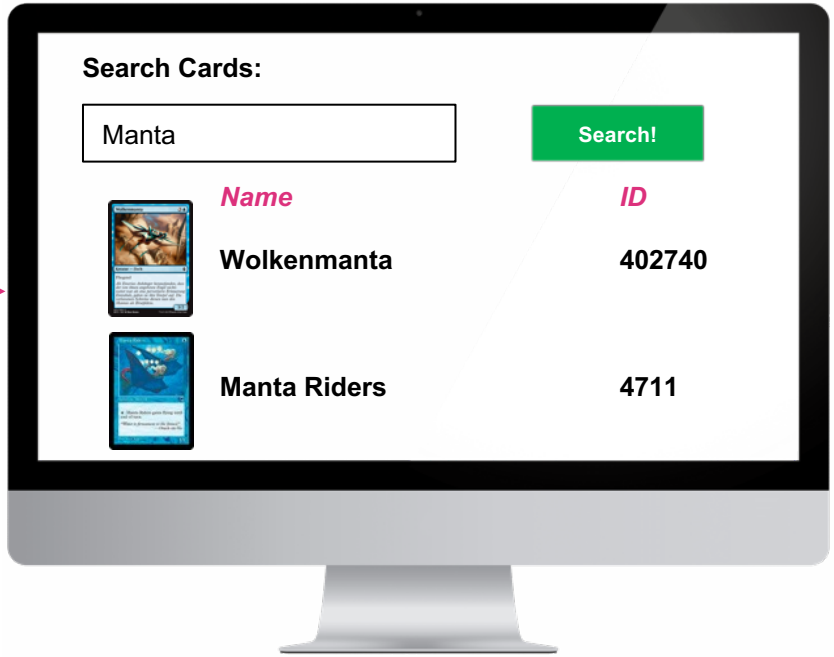
# Dataflow: 3. Enhance Data And Save Results




- enhance data (e.g. for later querying)
- use *Hive*, *Spark* or *PySpark*
- save everything to a end-user database (e.g. *MySQL*, *MongoDB*)

# Dataflow: 4. Provide Simple Web Interface


1




- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (card name, text or artist)
  - **display search results**

# Use OpenAdresses Data To Validate Adresses

Practical Exam

# Goal

OpenAddresses.io provides regulary exports of worldwide adresses (we will focus on US south/west/midwest/northeast for now):

- https://batch.openaddresses.io/data



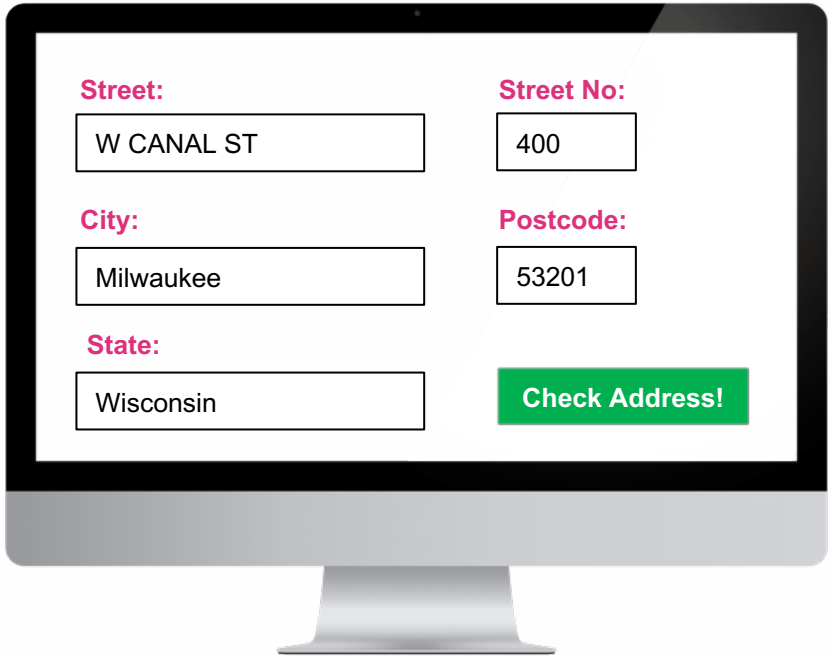
```
{"type":"Feature","properties":{"hash":"394d6a8e3e6cecbf","number":"7705","street":"W LINCOLN AVE","unit":"1","city":"West Allis","district":"","region":"","postcode":"53219","id":""},"geometry":{"type":"Point","coordinates":[-88.0088621,43.0025845]}}
{"type":"Feature","properties":{"hash":"6101cecbe71c7bbe","number":"7705","street":"W LINCOLN AVE","unit":"2","city":"West Allis","district":"","region":"","postcode":"53219","id":""},"geometry":{"type":"Point","coordinates":[-88.0088621,43.0025845]}}
{"type":"Feature","properties":{"hash":"81e3634e904916db","number":"1060","street":"N 115TH ST","unit":"106","city":"Wauwatosa","district":"","region":"","postcode":"53226","id":""},"geometry":{"type":"Point","coordinates":[-88.0551894,43.0441061]}}
{"type":"Feature","properties":{"hash":"fbf0248cdd1623ad","number":"12137","street":"W BURLEIGH ST","unit":"2","city":"Wauwatosa","district":"","region":"","postcode":"53222","id":""},"geometry":{"type":"Point","coordinates":[-88.0649444,43.0741544]}}
{"type":"Feature","properties":{"hash":"6c5867d0d98b7e9a","number":"11515","street":"W CLEVELAND AVE","unit":"B231","city":"West Allis","district":"","region":"","postcode":"53227","id":""},"geometry":{"type":"Point","coordinates":[-88.0560418,42.9946529]}}

[...]
```

# Goal

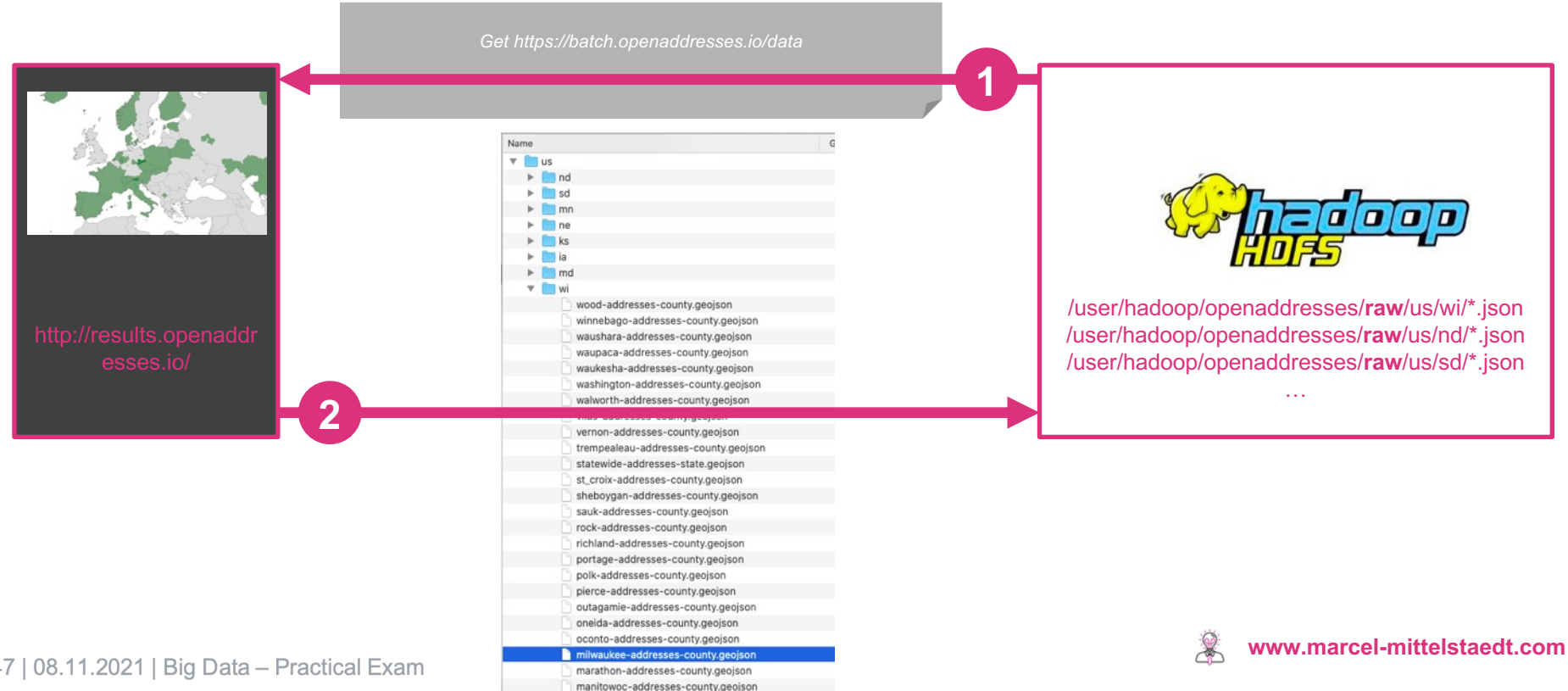
We want to make use of this data to validate adresses entered on a website, to check whether they are real or not.

Workflow:

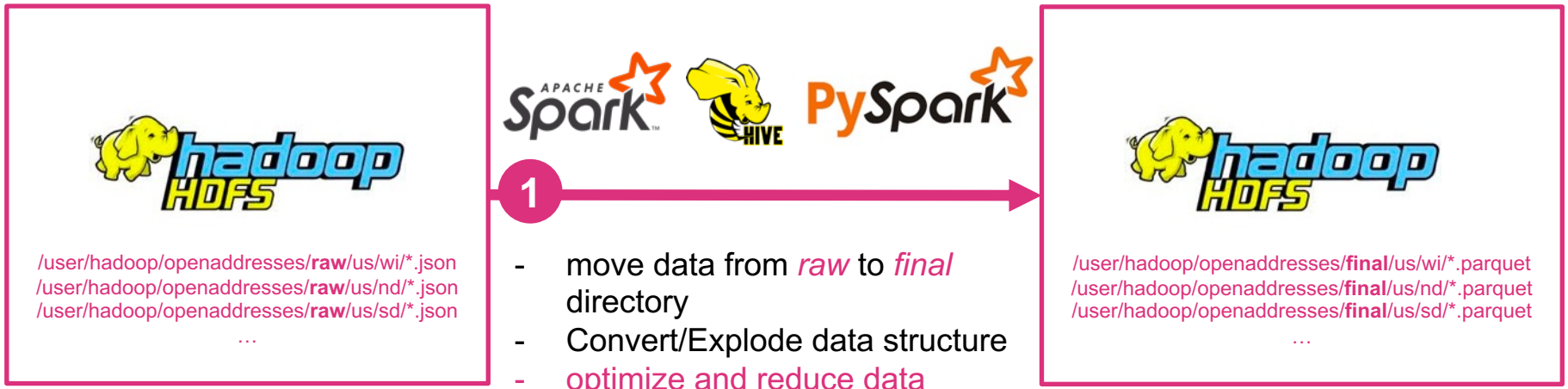
- **Gather data** from OpenAddresses.io
- **Save raw data** (*JSON files*) to HDFS (partitioned by state
- shortcut, e.g. *wi, nd, sd*…)
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Export** address data **to end-user database** (e.g. MySQL, MongoDB…)
- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (Street, City, Postcode…)
  - validate user input against OpenAddress data in end-user database
  - Display result (real or non real address)
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. **Pentaho Data Integration** or **Airflow**) and **run automatically**



# Dataflow: 1. Get Address Data

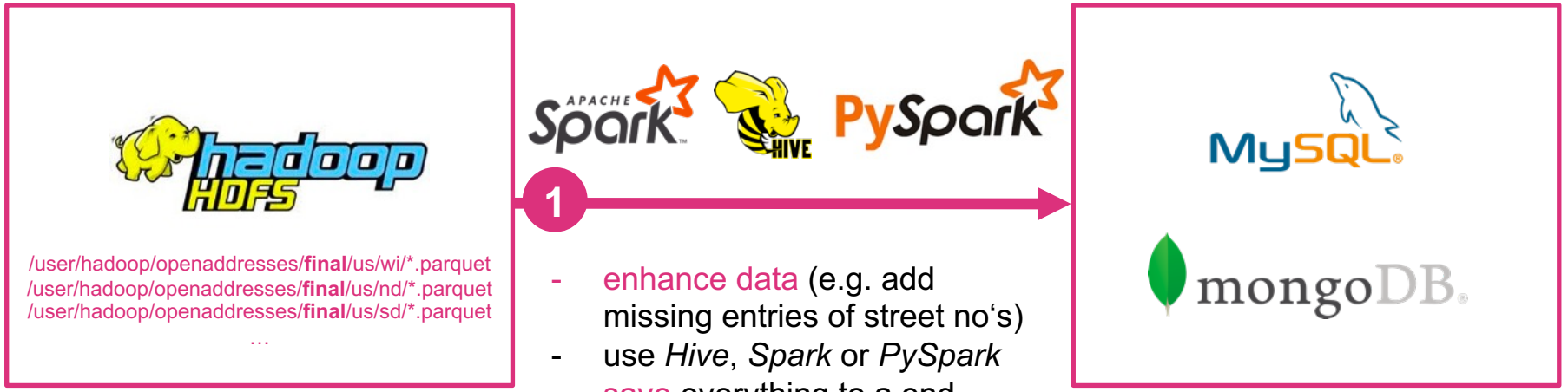


# Dataflow: 2. Raw To Final Transfer



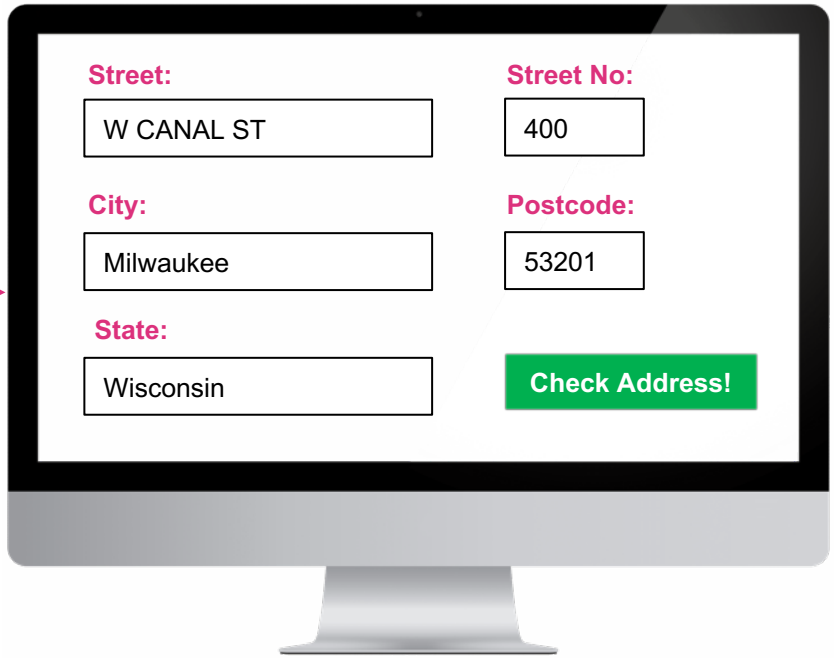

- move data from *raw* to *final* directory
- Convert/Explode data structure
- optimize and reduce data structure for later query purposes if necessary
- remove duplicates if necessary
- …

# Dataflow: 3. Enhance Data And Save Results



# Dataflow: 4. Provide Simple Web Interface


1




- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (Street, City, Postcode…)
  - validate user input against OpenAddress data in end-user database
  - Display result (real or non real address)

# Use OpenCellID Data To Estimate GSM/UMTS/LTE Coverage

Practical Exam

# Goal

OpenCellID.com provides regulary exports of worldwide cell data:

- https://www.opencellid.org
- Latest Full Dump and Diffs: https://www.opencellid.org/downloads.php

**Full Database**

- cell_towers.csv.gz
  *Updated: 2021-03-21 (982MB)*

**Differential**

- OCID-diff-cell-export-2021-03-21-T000000.csv.gz (829KB)
- OCID-diff-cell-export-2021-03-20-T000000.csv.gz (1526KB)
- OCID-diff-cell-export-2021-03-19-T000000.csv.gz (1534KB)
- OCID-diff-cell-export-2021-03-18-T000000.csv.gz (1550KB)
- OCID-diff-cell-export-2021-03-17-T000000.csv.gz (1540KB)
- OCID-diff-cell-export-2021-03-16-T000000.csv.gz (1434KB)
- OCID-diff-cell-export-2021-03-15-T000000.csv.gz (545KB)

```
radio,mcc,net,area,cell,unit,lon,lat,range,samples,changeable,created,updated,averageSignal
UMTS,262,2,801,86355,0,13.285512,52.522202,1000,7,1,1282569574,1300155341,0
GSM,262,2,801,1795,0,13.276907,52.525714,5716,9,1,1282569574,1300155341,0
GSM,262,2,801,1794,0,13.285064,52.524,6280,13,1,1282569574,1300796207,0
UMTS,262,2,801,211250,0,13.285446,52.521744,1000,3,1,1282569574,1299466955,0
UMTS,262,2,801,86353,0,13.293457,52.521515,1000,2,1,1282569574,1291380444,0
UMTS,262,2,801,86357,0,13.289106,52.53273,2400,3,1,1282569574,1298860769,0
UMTS,262,3,1107,83603,0,13.349675,52.497575,3102,222,1,1282672189,1300710809,0
GSM,262,2,776,867,0,13.349711,52.497367,1000,214,1,1282672189,1301575206,0
GSM,262,3,1107,13971,0,13.349743,52.497437,1000,212,1,1282672189,1300710809,0
GSM,262,3,1107,355,0,13.34963,52.497378,1000,198,1,1282672189,1300710809,0
UMTS,262,3,1107,329299,0,13.349223,52.497519,3041,186,1,1282672189,1299860879,0
```

*cell_towers.csv*

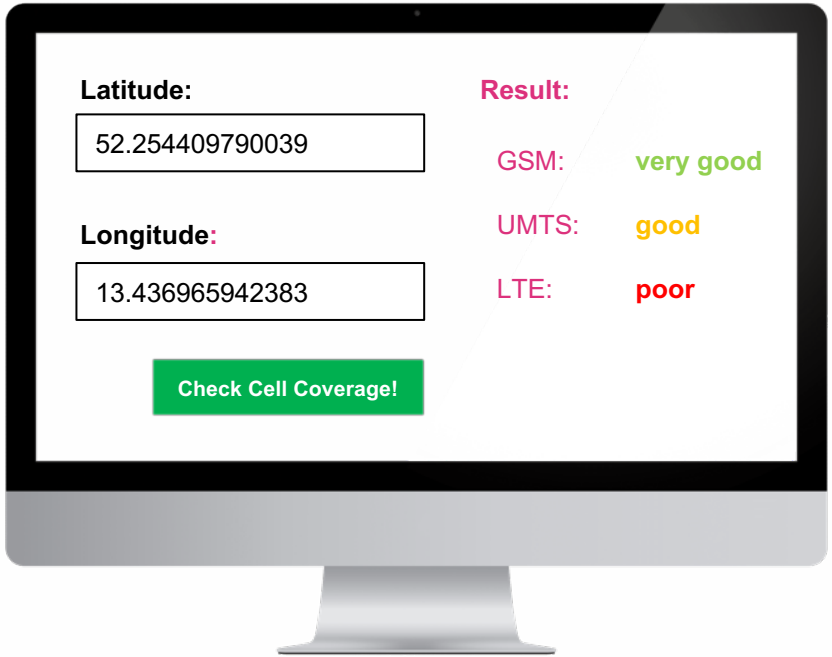


# Goal

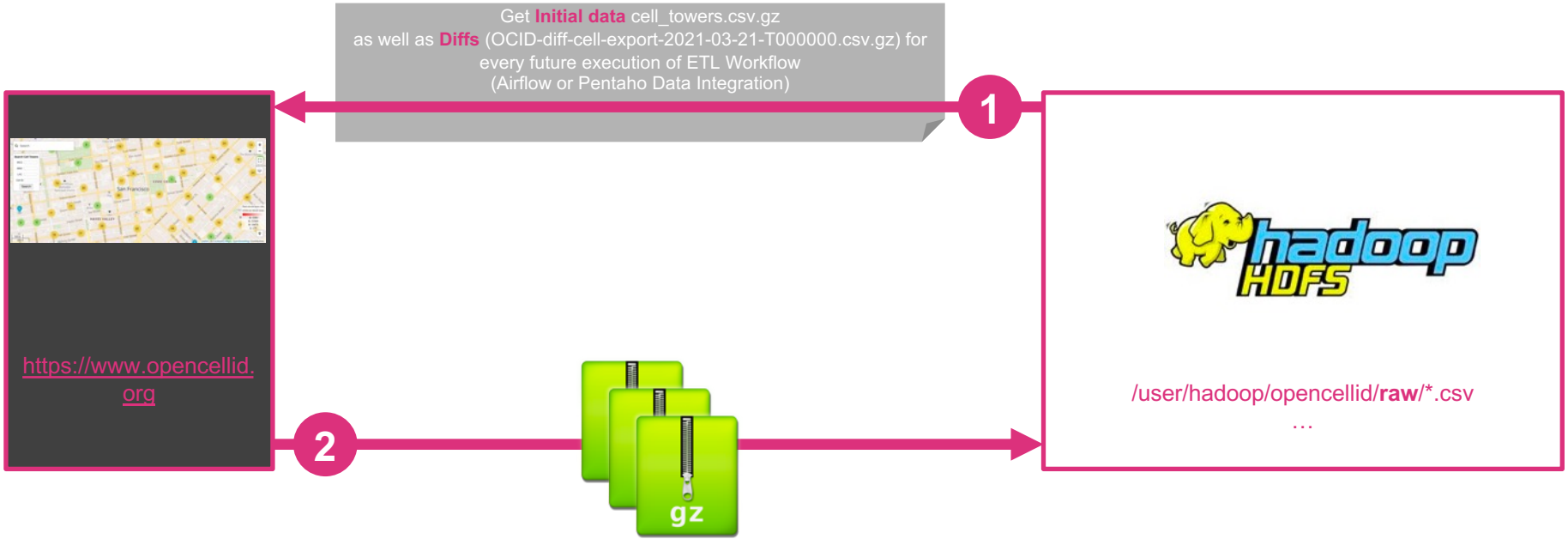
We want to make use of this data to estimate the coverage of GSM, UMTS and LTE for a certain place ( *latitude, longitude*).

Workflow:

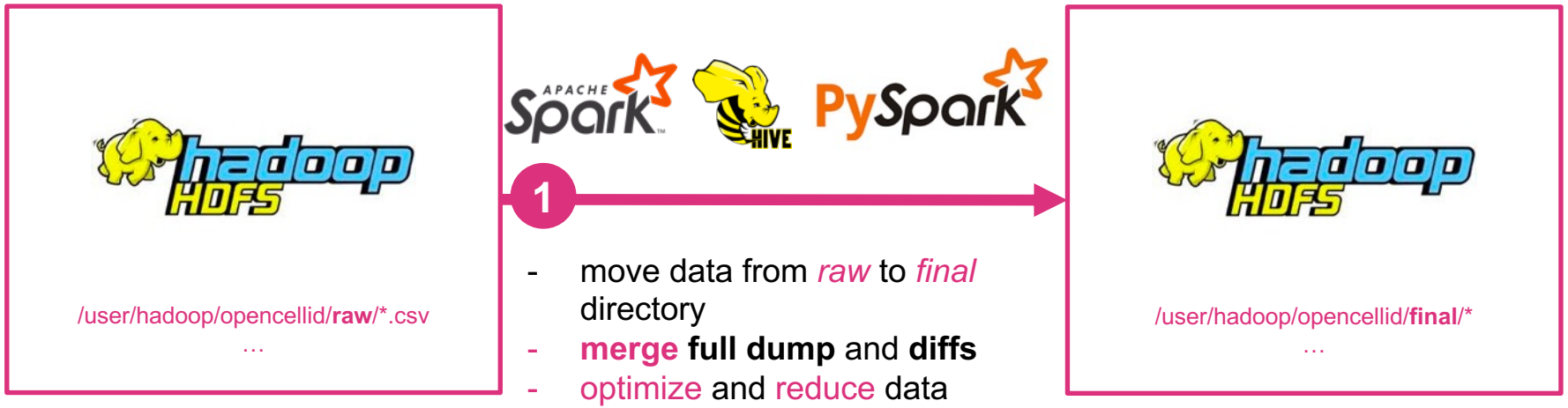
- **Gather data** from OpenCellID.com
- **Save raw data** (*CSV files*) to HDFS (partitioned by radio, e.g. *GSM*, *UMTS*, *LTE*…)
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Export** address data **to end-user database** (e.g. MySQL, MongoDB…)
- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (Latitude, Longitude…)
  - checks against OpenCellID data in end-user database
  - Display result (GSM, LTE and UMTS coverage)
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. **Pentaho Data Integration** or **Airflow**) and **run automatically**



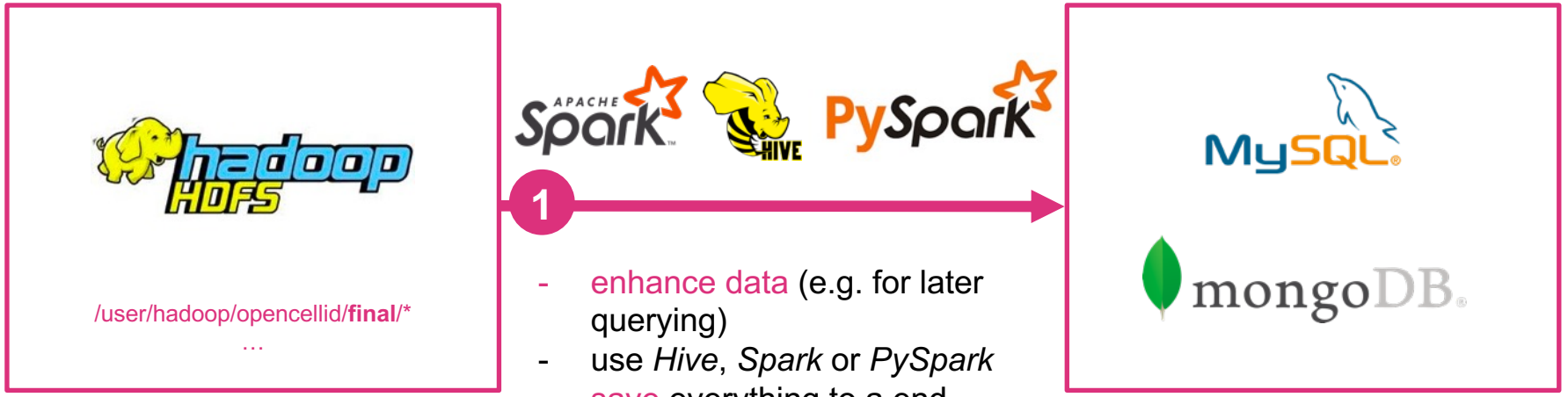
# Dataflow: 1. Get Cell Data



# Dataflow: 2. Raw To Final Transfer

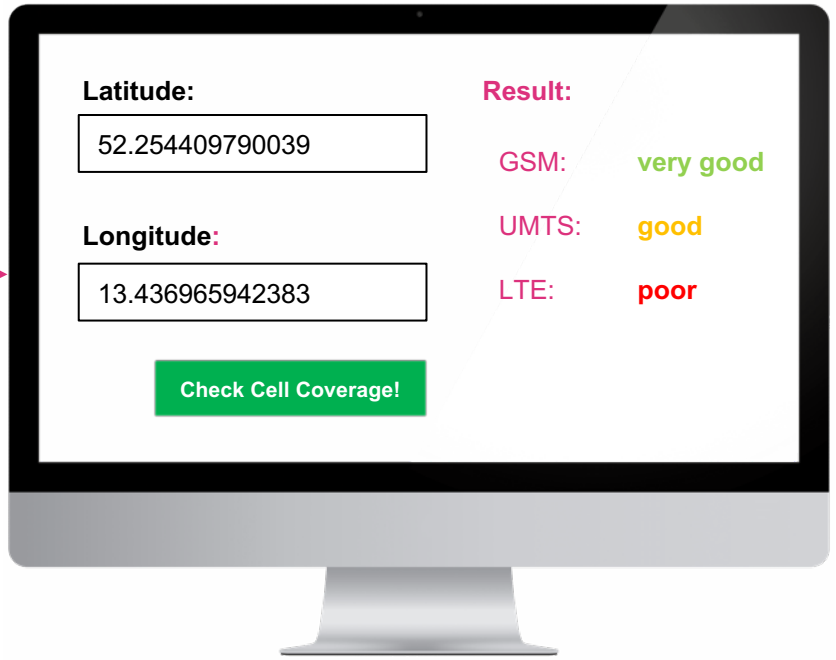


# Dataflow: 3. Enhance Data And Save Results



# Dataflow: 4. Provide Simple Web Interface


1




- Provide a simple **HTML Frontend** which is able to:
  - read from end-user database
  - process user input (Latitude, Longitude…)
  - checks against OpenCellID data in end-user database
  - Display result (GSM, LTE and UMTS coverage)

# Use NYC Taxi Trip Record Data To Calculate Performance KPIs

Practical Exam

# Goal

NYC.gov provides monthly exports of NYC yellow taxi trip records:

- https://www1.nyc.gov/site/tlc/about/tlc-trip-record-data.page
- Latest Full Dumps:
  - *https://nyc-tlc.s3.amazonaws.com/trip+data/yellow_tripdata_2020-12.csv*
  - *https://nyc-tlc.s3.amazonaws.com/trip+data/yellow_tripdata_2020-11.csv*
  - *https://nyc-tlc.s3.amazonaws.com/trip+data/yellow_tripdata_2020-10.csv*
  - *…*

```
VendorID,tpep_pickup_datetime,tpep_dropoff_datetime,passenger_count,trip_distance,RatecodeID,store_and_fwd_flag,PULocationID,DOLocationID,payment_type,fare_amount,extra,mta_tax,tip_amount,tolls_amount,improvement_surcharge,total_amount,congestion_surcharge
1,2020-12-01 00:07:13,2020-12-01 00:18:12,1,7.60,1,N,138,263,1,21.5,3,0.5,2.5,6.12,0.3,33.92,2.5
1,2020-12-01 00:41:19,2020-12-01 00:49:45,1,1.60,1,N,140,263,1,8,3,0.5,2.95,0,0.3,14.75,2.5
2,2020-12-01 00:33:40,2020-12-01 01:00:35,1,16.74,2,N,132,164,1,52,0,0.5,2.5,6.12,0.3,63.92,2.5
2,2020-12-01 00:02:15,2020-12-01 00:13:09,1,4.16,1,N,238,48,1,14,0.5,0.5,1,0,0.3,18.8,2.5
2,2020-12-01 00:37:42,2020-12-01 00:45:11,1,2.22,1,N,238,41,2,8.5,0.5,0.5,0,0,0.3,9.8,0
1,2020-12-01 00:27:47,2020-12-01 00:45:40,0,8.40,1,N,138,137,1,25,3,0.5,6,6.12,0.3,40.92,2.5
2,2020-12-01 00:40:47,2020-12-01 00:57:03,1,6.44,1,N,132,191,1,19.5,0.5,0.5,4.16,0,0.3,24.96,0
2,2020-12-01 00:01:42,2020-12-01 00:06:06,1,.99,1,N,234,137,1,5.5,0.5,0.5,1.86,0,0.3,11.16,2.5
2,2020-12-01 00:58:24,2020-12-01 01:36:14,2,11.81,1,N,261,7,1,36.5,0.5,0.5,1,0,0.3,41.3,2.5
1,2020-12-01 00:08:15,2020-12-01 00:16:04,2,2.70,1,N,237,107,1,9.5,3,0.5,2.65,0,0.3,15.95,2.5
2,2020-12-01 00:04:21,2020-12-01 00:29:00,1,6.28,1,N,41,68,2,23,0.5,0.5,0,0,0.3,26.8,2.5
[…]
```

*yellow_tripdata_2020-12.csv*

# Goal

We want to make use of this data to calculate some KPIs

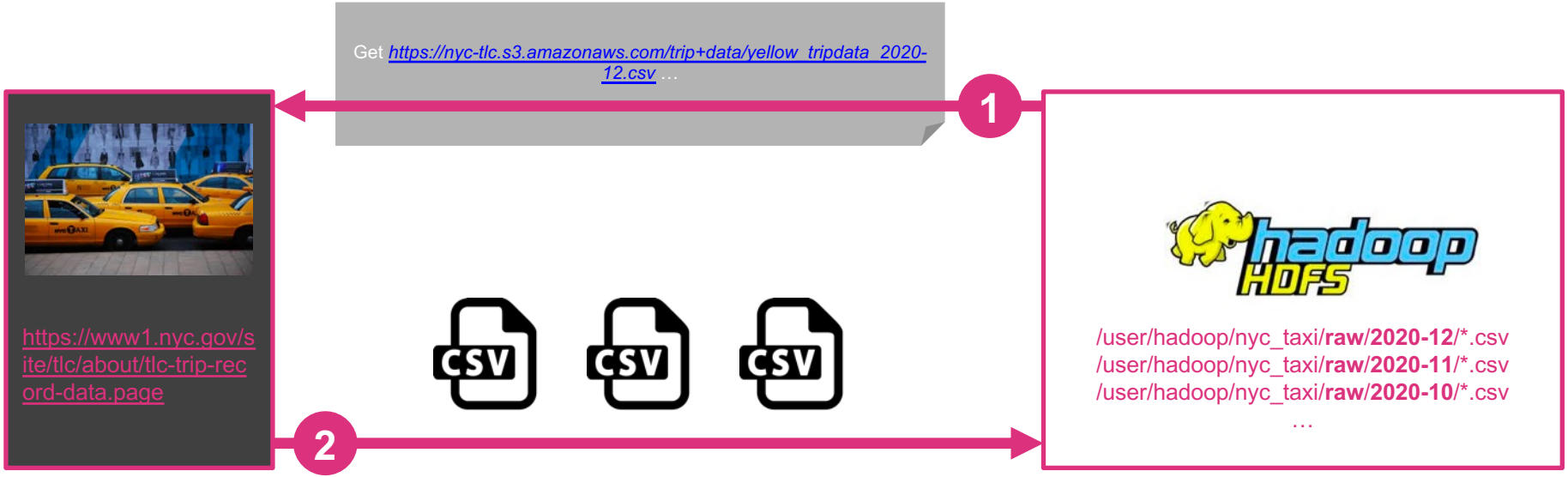
Workflow:

- **Gather data** from https://www1.nyc.gov/site/tlc/about/tlc-trip-record-data.page
- **Save raw data** (*CSV files*) to HDFS (partitioned by *YYYY-MM*)
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Calculate KPIs** and **Export** them to an **Excel File**

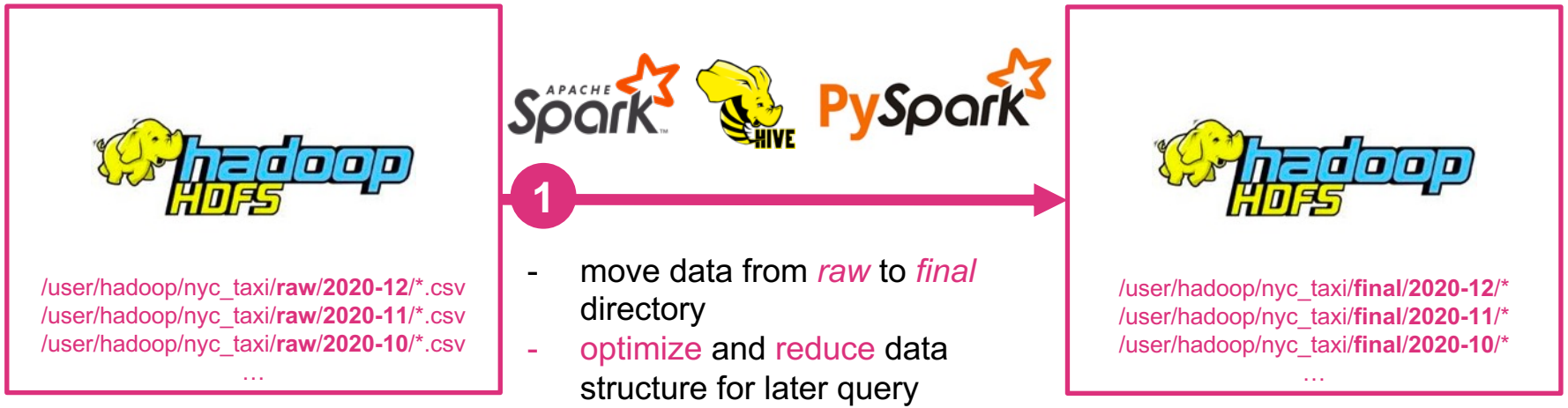
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. Pentaho Data Integration or Airflow) and **run automatically**



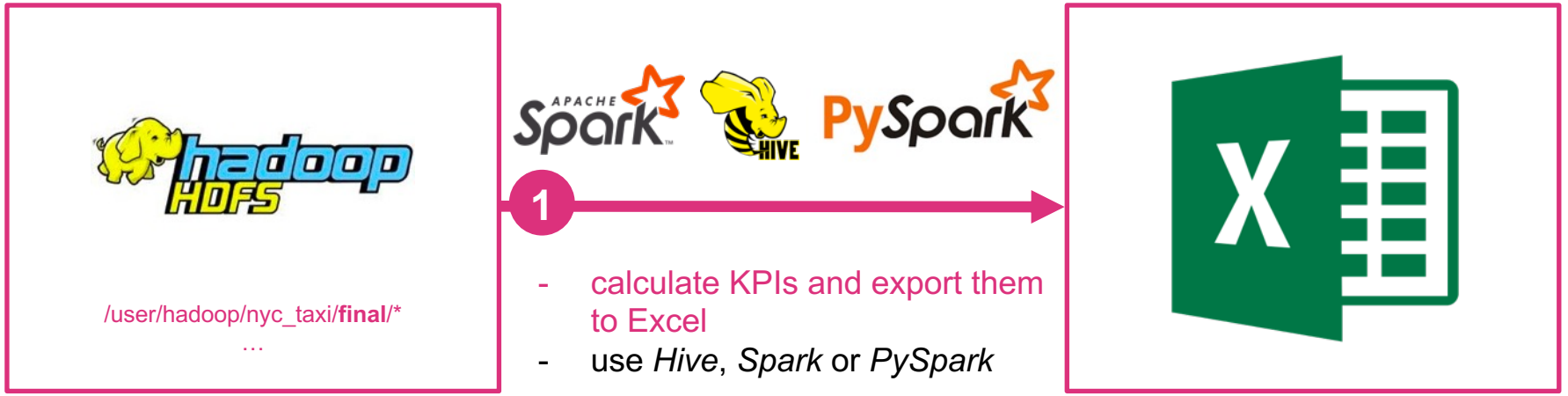
# Dataflow: 1. Get TLC NYC Taxi Data



# Dataflow: 2. Raw To Final Transfer



# Dataflow: 3. Calculate And Export KPIs



# Dataflow: 4. KPIs To Calculate

**Calculate per Month:**

- Average Trip Duration (in minutes)
- Average Trip Distance (in miles)
- Average total amount (in USD)
- Average tip amount (in USD)
- Average passenger count (as Number)
- Usage Share by payment type (credit card, cash… in percent)
- Usage share per timeslot (in percent):
  - 00:00-06:00
  - 06:00-12:00
  - 12:00-18:00
  - 18:00-24:00



# Use *kaggle.com* Hubway Data To Calculate Bike Sharing Usage KPIs

Practical Exam

# Goal

kaggle.com provides monthly exports of Hubway bike sharing trip records:

- https://www.bluebikes.com/
- Latest Full Dumps: https://www.kaggle.com/acmeyer/hubway-data

```
"tripduration","starttime","stoptime","start station id","start station name","start station latitude","start station longitude","end station id","end station name","end station latitude","end station longitude","bikeid","usertype","birth year","gender"
"133","2015-12-01 00:01:52","2015-12-01 00:04:06","9","Agganis Arena - 925 Comm Ave.","42.351246","-71.115639","41","Packard's Corner - Comm. Ave. at Brighton Ave.","42.352261","-71.123831","199","Customer","1995","1"
"1522","2015-12-01 00:05:30","2015-12-01 00:30:53","41","Packard's Corner - Comm. Ave. at Brighton Ave.","42.352261","-71.123831","54","Tremont St / West St","42.354979","-71.063348","876","Customer","1983","1"
"153","2015-12-01 00:07:46","2015-12-01 00:10:20","75","Lafayette Square at Mass Ave / Main St / Columbia St","42.36346469304347","-71.10057324171066","67","MIT at Mass Ave / Amherst St","42.3581","-71.093198","757","Subscriber","1995","1"
"435","2015-12-01 00:07:48","2015-12-01 00:15:04","68","Central Square at Mass Ave / Essex St","42.36507","-71.1031","29","Innovation Lab - 125 Western Ave. at Batten Way","42.363732","-71.124565","853","Subscriber","1988","1"
"1208","2015-12-01 00:12:15","2015-12-01 00:32:23","36","Boston Public Library - 700 Boylston St.","42.349673","-71.077303","110","Harvard University Gund Hall at Quincy St / Kirkland S","42.376369","-71.114025","437","Customer","1982","1"
"1117","2015-12-01 00:16:31","2015-12-01 00:35:09","31","Seaport Hotel","42.348833","-71.041747","67","MIT at Mass Ave / Amherst St","42.3581","-71.093198","1161","Subscriber","1988","1"
"1287","2015-12-01 00:16:50","2015-12-01 00:38:18","10","B.U. Central - 725 Comm. Ave.","42.350406","-71.108279","23","Mayor Martin J Walsh - 28 State St","42.35892","-71.057629","565","Subscriber","1966","1"
```

# Goal

We want to make use of this data to calculate some Usage KPIs.

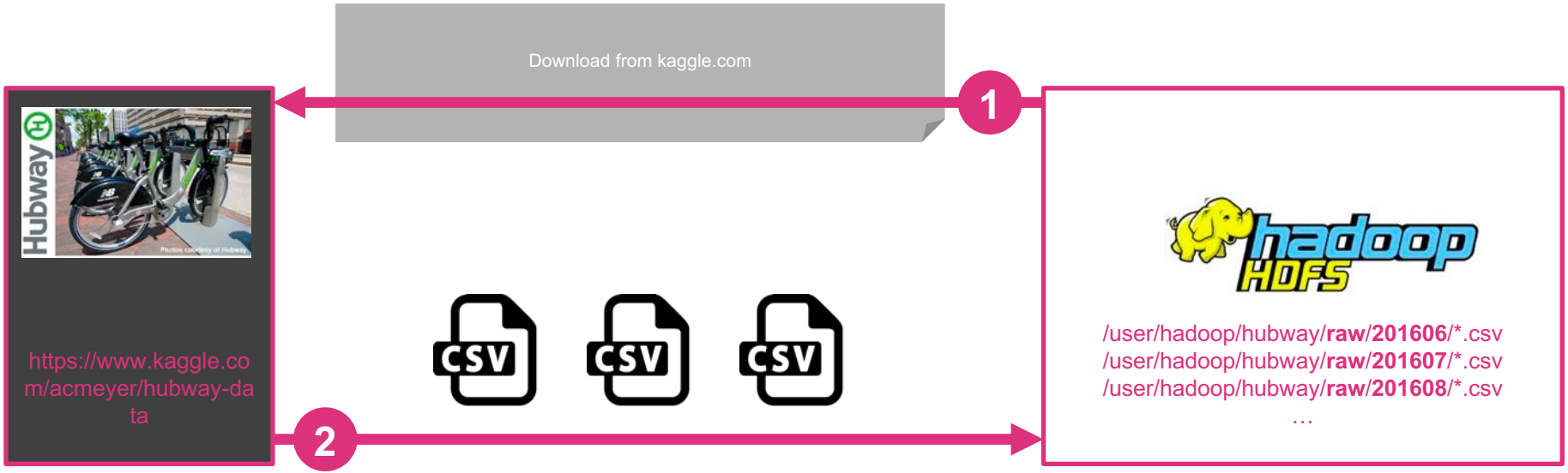
Workflow:

- **Gather data** from https://www.kaggle.com/acmeyer/hubway-data
- **Save raw data** (*CSV files*) to HDFS (partitioned by *YYYYMM*)
- **Optimize**, **reduce** and **clean raw data** and save it to **final** directory on HDFS
- **Calculate KPIs** and **Export** them to an **Excel File**

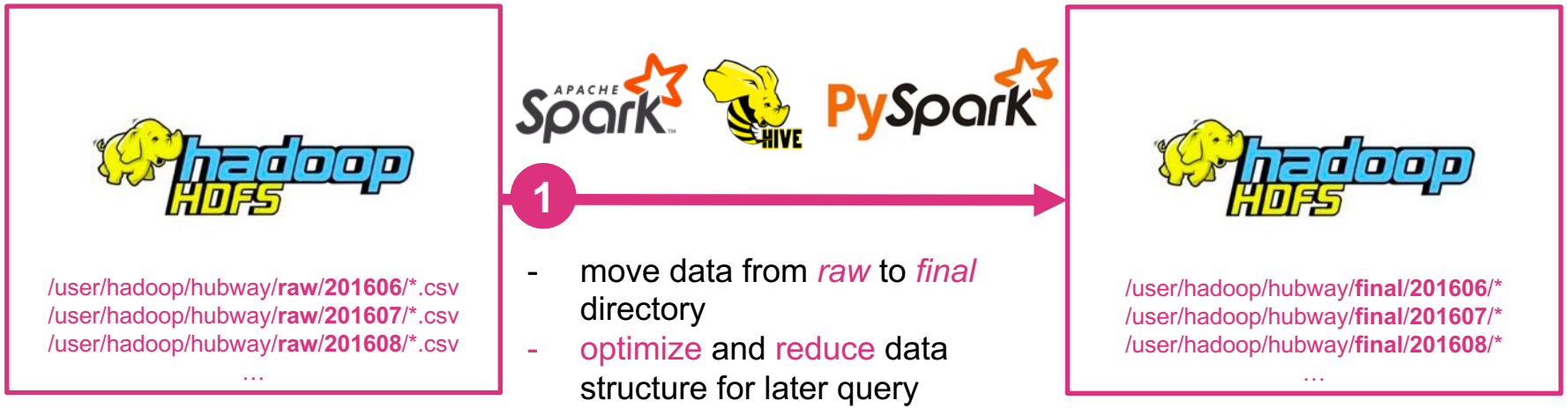
- The whole data workflow **must be implemented** within an ETL **workflow tool** (e.g. Pentaho Data Integration or Airflow) and **run automatically**



# Dataflow: 1. Get Hubway Bike Sharing Data

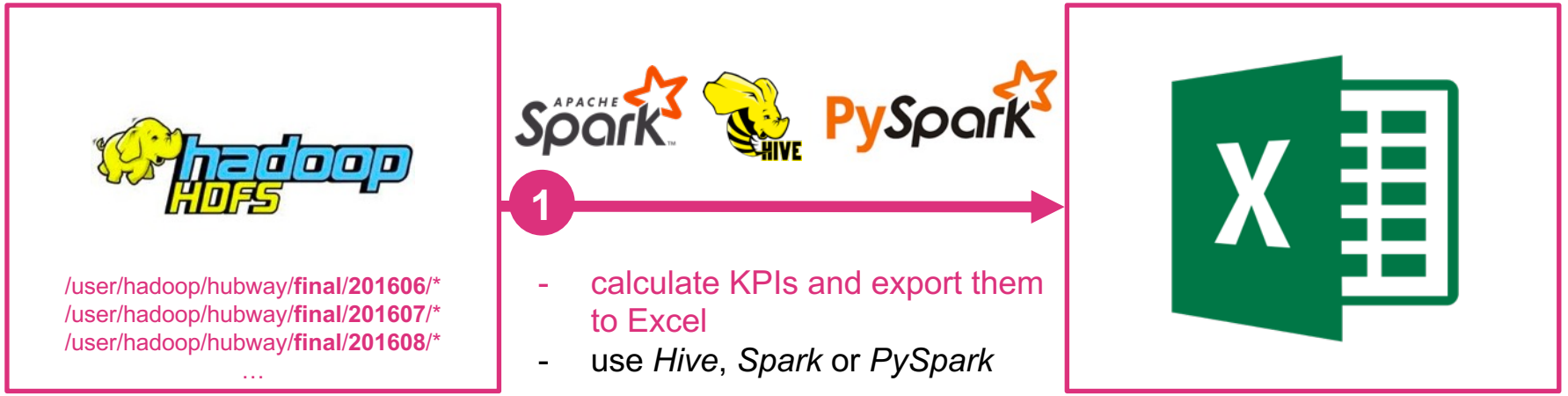


# Dataflow: 2. Raw To Final Transfer




- move data from *raw* to *final* directory
- optimize and reduce data structure for later query purposes if necessary
- remove duplicates if necessary
- …

# Dataflow: 3. Calculate And Export KPIs



# Dataflow: 4. KPIs To Calculate

**Calculate per Month:**

- Average Trip Duration (in minutes)
- Average Trip Distance (in km)
- Usage Share by gender (in percent)
- Usage Share by age (in percent)
- Top 10 most used bikes
- Top 10 most start stations
- Top 10 most end stations
- Usage share per timeslot (in percent):
  - 00:00-06:00
  - 06:00-12:00
  - 12:00-18:00
  - 18:00-24:00



# Good Luck and have fun!

GOOD LUCK
AND
HAVE FUN!

# Stop Your VM Instances

DON'T FORGET TO STOP YOUR VM INSTANCE!

```
gcloud compute instances stop big-data
```