



## Denodo HDFS Custom Wrapper

Revision 20151118

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## 1 INTRODUCTION

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The hdfs-customwrapper distribution contains five Virtual DataPort custom wrappers capable of reading several file formats stored in **Hadoop Distributed File System** (HDFS).

Supported formats are:

- Delimited text files (both directly from HDFS and also via HDFS over HTTP)
- Sequence files
- Map files
- Avro files

## 2 HDFS

---

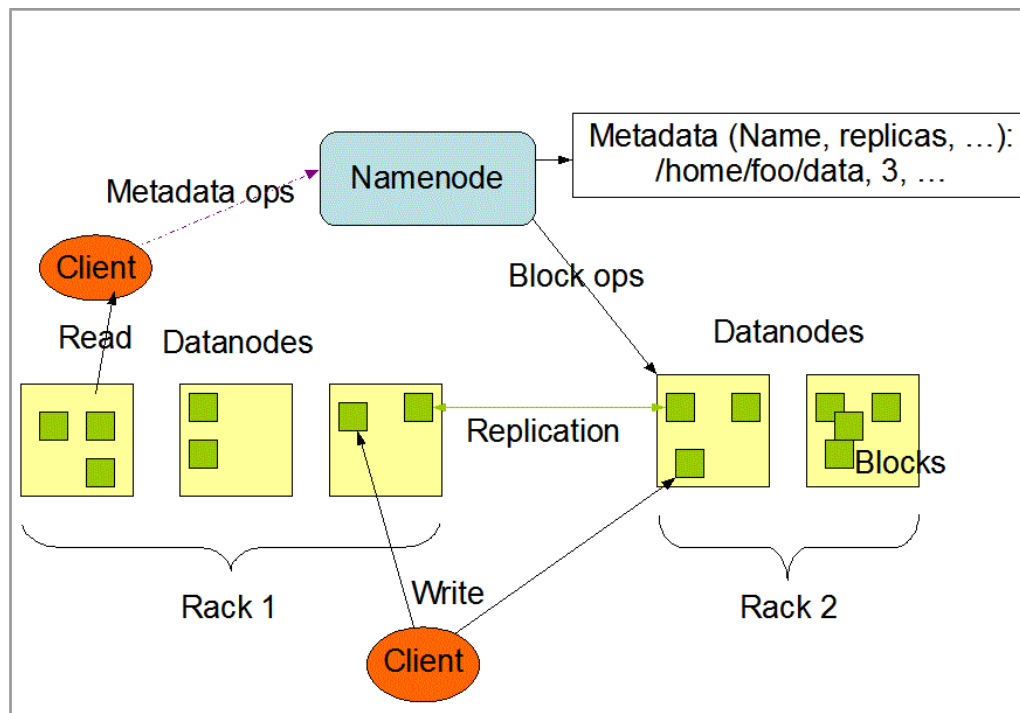
The Hadoop Distributed File System is a distributed, scalable, and portable file system used by the Hadoop platform.

In HDFS, data is divided into blocks and copies of these blocks are stored on other servers in the Hadoop cluster. That is, an individual file is actually stored as smaller blocks that are replicated across multiple servers in the entire cluster. This redundancy offers multiple benefits for Big Data processing:

- Higher availability.
- Better scalability: map and reduce functions can be executed on smaller subsets of large data sets.
- Data locality: move the computation closer to the data to reduce latency.

HDFS has a master/slave architecture in which the **NameNode**, the master, manages the file system namespace and regulates clients access to files. And the **DataNodes**, the slaves, manage storage attached to the nodes that they run on.

The NameNode executes file system namespace operations like opening, closing, and renaming files and directories. It also determines the mapping of blocks to DataNodes. The DataNodes are responsible for serving read and write requests from the file system's clients. The DataNodes also perform block creation, deletion, and replication upon instruction from the NameNode.



*HDFS Architecture*

## 2.1 DELIMITED TEXT FILES

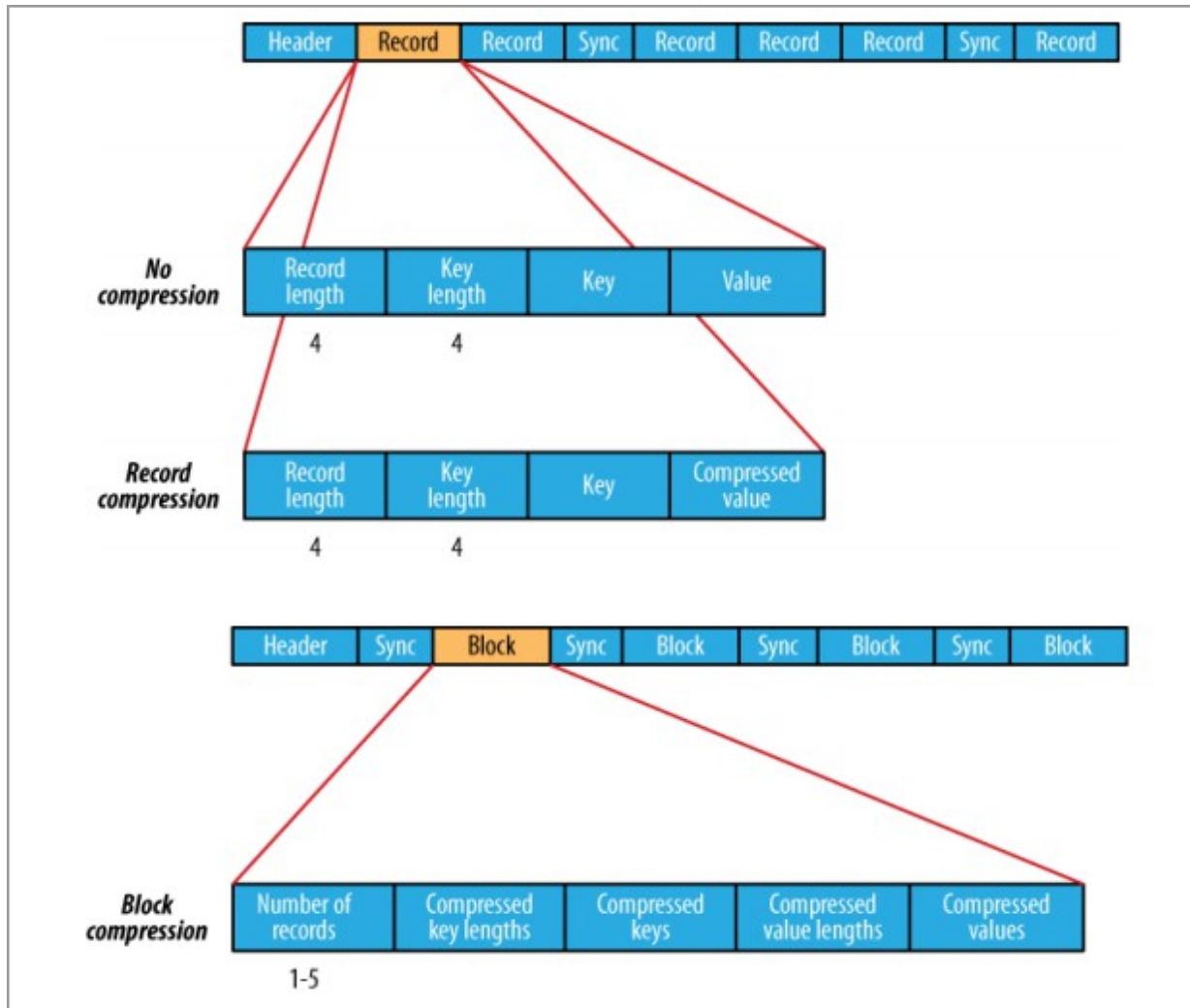
Delimited text files store plain text key/value pairs. The key/value pairs are delimited by a separator such as tab, space, comma, etc.

## 2.2 SEQUENCEFILES

Sequence files are binary record-oriented files, where each record has a serialized key and a serialized value.

The Hadoop framework supports compressing and decompressing sequence files transparently. Therefore, sequence files have three available formats:

- No compression.
- Record compression: only values are compressed.
- Block compression: both keys and values are collected in 'blocks' separately and compressed.



Sequence file formats

The three formats share a header that contains information which allows the reader to recognize their format:

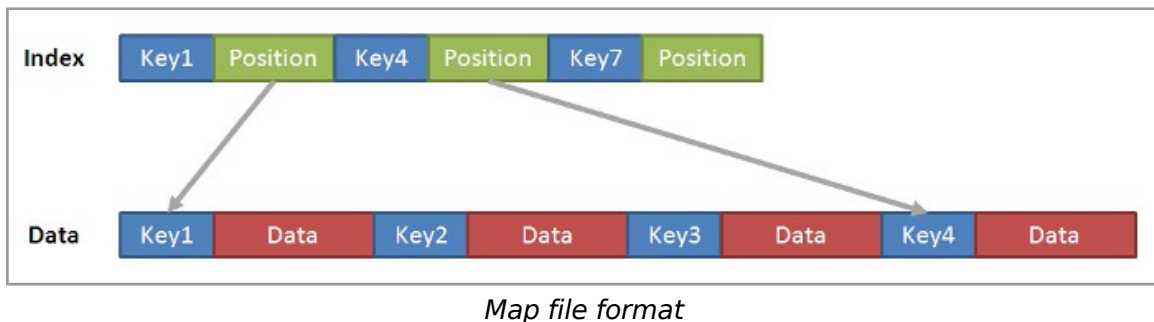
- Version: 3 bytes of magic header SEQ, followed by 1 byte of actual version number.
- Key class name.
- Value class name.
- Compression: specifies if compression is turned on for keys/values.
- Block compression: specifies if block-compression is turned on for keys/values.
- Compression codec: CompressionCodec class which is used for compression of keys and/or values (if compression is enabled).
- Metadata.

- Sync: a sync marker to denote end of the header.

## 2.3 MAPFILES

A map is a directory containing two sequence files. The data file (/data) is identical to the sequence file and contains the data stored as binary key/value pairs. The index file (/index), which contains a key/value map with seek positions inside the data file to quickly access the data.

The index file is populated with the key and a LongWritable that contains the starting byte position of the record. Index does not contains all the keys but just a fraction of the keys. The index is read entirely into memory.



## 2.4 AVRO FILES

**Avro** is a data serialization format.

Avro data files are self-describing, containing the full schema for the data in the file. An Avro schema is defined using JSON. The schema allows you to define two types of data:

- primitive data types: string, integer, long, float, double, byte, null and boolean.
- complex type definitions: a record, an array, an enum, a map, a union or a fixed type.

```
{ "namespace": "example.avro",  
  "type": "record",  
  "name": "User",  
  "fields":  
  [  
    { "name": "name", "type": "string" },  
    { "name": "favorite_number", "type": [ "int", "null" ] },  
    { "name": "favorite_color", "type": [ "string", "null" ] }  
  ]  
}
```

*Avro schema*

Avro relies on schemas. When Avro data is read, the schema used when writing it is always present. This allows each datum to be written with no per-value overheads, making serialization both fast and small. This also facilitates use with dynamic, scripting languages, since data, together with its schema, is fully self-describing.



## 3 HDFS CUSTOM WRAPPER

---

hdfs-customwrapper library includes five custom wrappers:

- `com.denodo.connect.hadoop.hdfs.wrapper.HDFSDelimitedTextFileWrapper`
- `com.denodo.connect.hadoop.hdfs.wrapper.HDFSSequenceFileWrapper`
- `com.denodo.connect.hadoop.hdfs.wrapper.HDFSMapFileWrapper`
- `com.denodo.connect.hadoop.hdfs.wrapper.HFSAvroFileWrapper`
- `com.denodo.connect.hadoop.hdfs.wrapper.WebHDFSFileWrapper`

### 3.1 HDFSDELIMITEDTEXTFILEWRAPPER

Custom wrapper for reading key/value delimited text files stored in HDFS.

The base views created from the `HDFSDelimitedTextFileWrapper` need the following **mandatory** parameters:

- **File system URI:** A URI whose scheme and authority identify the file system. The scheme determines the file system implementation. The authority is used to determine the host, port, etc.
  - For HDFS the URI has the form `hdfs://<ip>:<port>`.
  - For Amazon S3 the URI has the form `s3n://<id>:<secret>@<bucket>` (Note that since the secret access key can contain slashes, each slash / should be replaced with the string `%2F`).
- **Path:** input path for the delimited file or the directory containing the files.
- **Delete after reading:** Requests that the file or directory denoted by the path be deleted when the wrapper terminates.
- **Separator:** delimiter between the keys and values.

File system URI	<input type="text" value="hdfs://192.168.132.130:8020"/>
Path	<input type="text" value="/user/guest/text"/>
Delete after reading	<input type="checkbox"/>
Separator	<input type="text" value=" "/>
Kerberos enabled	<input type="checkbox"/>
Kerberos principal name	<input type="text"/>
Kerberos keytab file	<input type="text" value="None"/> <input type="button" value="Configure"/>
Kerberos password	<input type="text"/>
Kerberos Distribution Center	<input type="text"/>

*HDFSDeimitedTextFileWrapper base view edition*

df_ds_file	
key	text
value	text

*View schema*

The execution of the wrapper returns the key/value pairs contained in the file or group of files, if the Path input parameter denotes a directory.

Total rows received: 5 (shown 5)	
key	value
1	One, two, buckle my shoe
2	Three, four, shut the door
3	Five, six, pick up sticks
4	Seven, eight, lay them straight
5	Nine, ten, a big fat hen

*View results*

### 3.2 HDFSSEQUENCEFILEWRAPPER

Custom wrapper for reading sequence files stored in HDFS.

The base views created from the HDFSSequenceFileWrapper need the following **mandatory** parameters:

- File system URI: A URI whose scheme and authority identify the file system. The scheme determines the file system implementation. The authority is used to determine the host, port, etc.
  - For HDFS the URI has the form `hdfs://<ip>:<port>`.
  - For Amazon S3 the URI has the form `s3n://<id>:<secret>@<bucket>` (Note that since the secret access key can contain slashes, each slash / should be replaced with the string %2F).
- Path: input path for the sequence file or the directory containing the files.
- Delete after reading: Requests that the file or directory denoted by the path be deleted when the wrapper terminates.
- Key class: key class name implementing `org.apache.hadoop.io.Writable` interface.
- Value class: value class name implementing `org.apache.hadoop.io.Writable` interface.

File system URI	<code>s3n://AKIAJXVIEYD2Q74CGMTA:SALdz9RIETUxC</code>		
Path	<code>/sequencefile/sequence.seq</code>		
Delete after reading	<input type="checkbox"/>		
Key class	<code>org.apache.hadoop.io.IntWritable</code>		
Value class	<code>org.apache.hadoop.io.Text</code>		
Kerberos enabled	<input type="checkbox"/>		
Kerberos principal name	<input type="text"/>		
Kerberos keytab file	<code>None</code>	<input type="button" value="v"/>	<input type="button" value="Configure"/>
Kerberos password	<input type="text"/>		
Kerberos Distribution Center	<input type="text"/>		

*HDFSSequenceFileWrapper base view edition*

sequence_ds_file	
key	int
value	text

*View schema*

The execution of the wrapper returns the key/value pairs contained in the file or group of files, if the Path input parameter denotes a directory.

Total rows received: 100 (shown 100)	
key	value
100	One, two, buckle my shoe
99	Three, four, shut the door
98	Five, six, pick up sticks
97	Seven, eight, lay them straight
96	Nine, ten, a big fat hen
95	One, two, buckle my shoe
94	Three, four, shut the door
93	Five, six, pick up sticks
92	Seven, eight, lay them straight
91	Nine, ten, a big fat hen
90	One, two, buckle my shoe
89	Three, four, shut the door
88	Five, six, pick up sticks
87	Seven, eight, lay them straight
86	Nine, ten, a big fat hen
85	One, two, buckle my shoe
84	Three, four, shut the door
83	Five, six, pick up sticks
82	Seven, eight, lay them straight
81	Nine, ten, a big fat hen
80	One, two, buckle my shoe


*View results*

### 3.3 HDFSMAPIFILEWRAPPER

Custom wrapper for reading map files stored in HDFS.

The base views created from the HDFSMapFileWrapper need the following mandatory parameters:

- File system URI: A URI whose scheme and authority identify the file system. The scheme determines the file system implementation. The authority is used to determine the host, port, etc.
  - For HDFS the URI has the form `hdfs://<ip>:<port>`.
  - For Amazon S3 the URI has the form `s3n://<id>:<secret>@<bucket>` (Note that since the secret access key can contain slashes, each slash / should be replaced with the string %2F).
- Path: input path for the directory containing the map file. Also the path to the index or data file could be specified. When using **Amazon S3**, a flat file system where there is no folder concept, the path to the index or data should be used.
- Delete after reading: Requests that the file or directory denoted by the path be deleted when the wrapper terminates.
- Key class: key class name implementing the `org.apache.hadoop.io.WritableComparable` interface. `WritableComparable` is used because records are sorted in **key order**.
- Value class: value class name implementing the `org.apache.hadoop.io.Writable` interface.

File system URI	<input type="text" value="hdfs://192.168.132.130:8020"/>
Path	<input type="text" value="/user/guest/map"/>
Delete after reading	<input type="checkbox"/>
Key class	<input type="text" value="org.apache.hadoop.io.IntWritable"/>
Value class	<input type="text" value="org.apache.hadoop.io.Text"/>
Kerberos enabled	<input type="checkbox"/>
Kerberos principal name	<input type="text"/>
Kerberos keytab file	<input type="text" value="None"/> 
Kerberos password	<input type="text"/>
Kerberos Distribution Center	<input type="text"/>

Configure

*HDFSMapFileWrapper base view edition*

map_ds_file	
key	int
value	text

*View schema*

The execution of the wrapper returns the key/value pairs contained in the file or group of files, if the Path input parameter denotes a directory.

Total rows received: 1024 (shown 150)	
key	value
1	One, two, buckle my shoe
2	Three, four, shut the door
3	Five, six, pick up sticks
4	Seven, eight, lay them straight
5	Nine, ten, a big fat hen
6	One, two, buckle my shoe
7	Three, four, shut the door
8	Five, six, pick up sticks
9	Seven, eight, lay them straight
10	Nine, ten, a big fat hen
11	One, two, buckle my shoe
12	Three, four, shut the door
13	Five, six, pick up sticks
14	Seven, eight, lay them straight
15	Nine, ten, a big fat hen
16	One, two, buckle my shoe
17	Three, four, shut the door
18	Five, six, pick up sticks
19	Seven, eight, lay them straight
20	Nine, ten, a big fat hen
21	One, two, buckle my shoe
22	Three, four, shut the door

*View results*

### 3.4 HDFSAVROFILEWRAPPER


Custom wrapper for reading Avro files stored in HDFS.

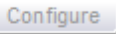
The base views created from the HDFSAvroFileWrapper need the following mandatory parameters:

- File system URI: A URI whose scheme and authority identify the file system. The scheme determines the file system implementation. The authority is used to determine the host, port, etc.
  - For HDFS the URI has the form `hdfs://<ip>:<port>`.
  - For Amazon S3 the URI has the form `s3n://<id>:<secret>@<bucket>` (Note that since the secret access key can contain slashes, each slash / should be replaced with the string %2F).
- Delete after reading: Requests that the file denoted by the path be deleted when the wrapper terminates.

There is also two parameters that are **mutually exclusive**:

- Avro schema path: input path for the Avro schema file.
- Avro schema JSON: JSON of the Avro schema.

File system URI	<input type="text" value="hdfs://melkus.denodo.com:8020"/>
Avro schema path	<input type="text" value="/user/test/schema.avsc"/>
Avro schema JSON	<input type="text"/>
Delete after reading	<input type="checkbox"/>
Kerberos principal name	<input type="text"/>
Kerberos keytab file	<input type="text" value="None"/> 
Kerberos password	<input type="text"/>
Kerberos Distribution Center	<input type="text"/>



*HDFSAvroFileWrapper base view edition*

```
{ "type" : "record",
  "name" : "Doc",
  "doc" : "adoc",
  "fields" : [ {
    "name" : "id",
    "type" : "string"
  }, {
    "name" : "user_friends_count",
    "type" : [ "int", "null" ]
  }, {
    "name" : "user_location",
    "type" : [ "string", "null" ]
  }, {
    "name" : "user_description",
    "type" : [ "string", "null" ]
  }, {
    "name" : "user_statuses_count",
    "type" : [ "int", "null" ]
  }, {
    "name" : "user_followers_count",
    "type" : [ "int", "null" ]
  }, {
    "name" : "user_name",
    "type" : [ "string", "null" ]
  }, {
    "name" : "user_screen_name",
    "type" : [ "string", "null" ]
  }, {
    "name" : "created_at",
    "type" : [ "string", "null" ]
  }, {
    "name" : "text",
    "type" : [ "string", "null" ]
  }, {
    "name" : "retweet_count",
    "type" : [ "int", "null" ]
  }, {
    "name" : "retweeted",
    "type" : [ "boolean", "null" ]
  }, {
    "name" : "in_reply_to_user_id",
    "type" : [ "long", "null" ]
  }, {
    "name" : "source",
    "type" : [ "string", "null" ]
  }, {
    "name" : "in_reply_to_status_id",
    "type" : [ "long", "null" ]
  }, {
    "name" : "media_url_https",
    "type" : [ "string", "null" ]
  }, {
    "name" : "expanded_url",
    "type" : [ "string", "null" ]
  } ] }
```

*Avro schema*



avro_ds_file	
avrofilepath	text
doc	avro_ds_file_doc
id	text
user_friends_count	int
user_location	text
user_description	text
user_statuses_count	int
user_followers_count	int
user_name	text
user_screen_name	text
created_at	text
text	text
retweet_count	int
retweeted	boolean
in_reply_to_user_id	long
source	text
in_reply_to_status_id	long
media_url_https	text
expanded_url	text

*View schema*

The execution of the view returns the values contained in the Avro file specified in the WHERE clause of the VQL sentence:

```
SELECT * FROM avro_ds_file WHERE avrofilepath='/user/test/file.avro'
```

avrofilepath	doc
/user/test/file.avro	[Register]...
/user/test/file.avro	[Register]...



RESULT -> doc													
id	user_frien...	user_locati...	user_desc...	user_statu...	user_follo...	user_name	user_scre...	created_at	text	retweet_c...	retweeted	in_reply_to...	sou
1234567890	111	Palo Alto	desc1	11111	111	name1	fake_user1	1985-09-0...	sample tw...	0	false	0	href

*View results*

After applying a flattening operation results are as follows.

avrofilepath	id	user_f...	user_locati...	user_d...	user_statu...	user_follo...	user_name	user_scre...	created_at	text	ret...	retwe...	in_r...	source	in_r...	me...	expa...
/user/testfil...	1234567890	111	Palo Alto	desc1	11111	111	name1	fake_user1	1985-09-0...	sample tw...	0	false	0	href="http://...	0	<null>	<null>
/user/testfil...	2345678901	222	San Franci...	desc2	222222	222	name2	fake_user2	1985-09-0...	sample tw...	0	false	0	href="http://...	0	<null>	<null>

*Flattened results*

### 3.5 WEBHDFSFILEWRAPPER

Custom wrapper for reading key/value delimited text files stored in HDFS using the **WebHDFS**.

#### 3.5.1 About WebHDFS

WebHDFS provides HTTP REST access to HDFS. It supports all HDFS user operations including reading files, writing to files, making directories, changing permissions and renaming.

The advantage of WebHDFS are:

- **Version-independent** REST-based protocol which means that can be read and written to/from Hadoop clusters no matter their version. This addresses the issue of using the Java API (RPC-based) that requires both the client and the Hadoop cluster to share the same version. Upgrading one without the other causes serialization errors meaning the client cannot interact with the cluster.
- Read and write data in HDFS in a cluster behind a firewall. A proxy WebHDFS (for example: HttpFS) could be use, it acts as a gateway and is the only system that is allowed to send and receive data through the firewall.  
The only difference between using or not the proxy will be in the `host:port` pair where the HTTP requests are issued:

- Default port for WebHDFS is 50075.
- Default port for HttpFS is 14000.

### 3.5.2 Custom wrapper

The base views created from the WebHDFSFileWrapper need the following mandatory parameters:

- Host IP: IP or <bucket>.s3.amazonaws.com for Amazon S3.
- Host port: HTTP port. Default port for WebHDFS is 50075. For HttpFS is 14000. For Amazon S3 is 80.
- Path: input path for the delimited file.
- Separator: delimiter between the keys and values.
- Delete after reading: Requests that the file or directory denoted by the path be deleted when the wrapper terminates.

Optional parameter:

- User: The name of the the authenticated user when security is off. If is not set, the server may either set the authenticated user to a default web user, if there is any, or return an error response.

When using **Amazon S3** <id>:<secret> should be indicated.

Host IP	<input type="text" value="melkus.denodo.com"/>
Host port	<input type="text" value="50070"/>
User	<input type="text"/>
Path	<input type="text" value="/user/test/text"/>
Separator	<input type="text" value=" "/>
Delete after reading	<input type="checkbox"/>

*WebHDFSFileWrapper base view edition*

webhdfs_ds_file	
key	text
value	text

*View schema*

The execution of the wrapper returns the key/value pairs contained in the file.

Total rows received: 5 (shown 5)	
key	value
1	One, two, buckle my shoe
2	Three, four, shut the door
3	Five, six, pick up sticks
4	Seven, eight, lay them straight
5	Nine, ten, a big fat hen

*[View results](#)*

## 4 HDFS COMPRESSED FILES

---

Hadoop is intended for storing large data volumes, so compression becomes a mandatory requirement here. There are different compression formats available like DEFLATE, GZip, BZip2, Snappy and LZO.

Hadoop has native implementations of compression libraries for performance reasons and for non-availability of Java implementations:

Compression format	Java implementation	Native implementation
DEFLATE	Yes	Yes
gzip	Yes	Yes
bzip2	Yes	No
LZO	No	Yes
Snappy	No	Yes

### *Compression library implementations*

For reading HDFS compressed files using the `hdfs-customwrapper` library there are two options:

- Use the Java implementation. `hdfs-customwrapper` handles compressed files transparently.
- Use the native implementation (for performance reasons or for non-availability of Java implementation). `hdfs-customwrapper` must have Hadoop native libraries in the `java.library.path`.

Hadoop comes with prebuilt native compression libraries for 32- and 64-bit Linux, which could be found in the `lib/native` directory. For other platforms, the libraries must be compiled, following the instructions on the Hadoop wiki at <http://wiki.apache.org/hadoop/NativeHadoop>.

In the Cloudera QuickStart VM (see [Software requirements](#) section) native libraries could be found at `/opt/cloudera/parcels/CDH-5.0.0-1.cdh5.0.0.p0.47/lib/hadoop/lib/native/`.

## 5 SECURE CLUSTER WITH KERBEROS

---


The configuration required for accessing a Hadoop cluster with Kerberos enabled is the same as the one needed to access HDFS and, additionally, the user must supply the Kerberos credentials.

The Kerberos parameters are:

- `kerberos enabled`: Check it when accessing a Hadoop cluster with Kerberos enabled.
- `kerberos principal name`: Kerberos v5 Principal name to access HDFS, e.g. `primary/instance@realm`
- `kerberos keytab file`: Keytab file containing the key of the Kerberos principal.
- `kerberos password`: Password associated with the principal.
- `kerberos Distribution Center`: Kerberos Key Distribution Center.

`hdfs-customwrapper` provides two ways for accessing a kerberized Hadoop cluster:

1. The client has a valid Kerberos ticket in the ticket cache (obtained, for example, using the `kinit` command in the Kerberos Client).  
In this case only the `kerberos enabled` parameter should be checked. The HDFS wrapper would use the Kerberos ticket to authenticate itself against the Hadoop cluster.
2. The client does not have a valid Kerberos ticket.  
In this scenario all the Kerberos configuration parameters should be provided. `kerberos keytab file` and `kerberos password` are **mutually exclusive**.

File system URI	<input type="text" value="hdfs://melkus.denodo.com:8020"/>
Avro schema path	<input type="text" value="/user/test/schema.avsc"/>
Avro schema JSON	<input type="text"/>
Delete after reading	<input type="checkbox"/>
Kerberos enabled	<input checked="" type="checkbox"/>
Kerberos principal name	<input type="text" value="test@DENODO.COM"/>
Kerberos keytab file	<input type="text" value="None"/> 
Kerberos password	<input type="password" value="•••••"/>
Kerberos Distribution Center	<input type="text" value="melkus.denodo.com"/>

*[View edition](#)*

## 6 SOFTWARE REQUIREMENTS

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hdfs-customwrapper has been tested in Cloudera QuickStart VM 5.0.0 using Hadoop v2.4.0 and Avro v1.7.4.

**Cloudera** provides a virtual machine that gives a working Apache Hadoop environment out-of-the-box. It can be downloaded from:

<http://www.cloudera.com/content/support/en/downloads.html>

hdfs-customwrapper has been tested in Amazon S3 too, using Hadoop v2.4.0 and Avro v1.7.4. For more information see <http://aws.amazon.com/es/s3/>



## 7 TROUBLESHOOTING

---

### Symptom

Error message: "Host Details : local host is: "<your domain/your IP>"; destination host is: "<hadoop IP>:hadoop port>".

### Resolution

It is a version mismatch problem. Hadoop server version is **older** than the version distributed in the custom wrapper artifact denodo-hdfs-customwrapper-5.0-xxx-jar-with-dependencies, which is Hadoop v2.4.0.

To solve the problem you should use the custom wrapper artifact denodo-hdfs-customwrapper-5.0-xxx and copy the Hadoop server libraries to the \$DENODO\_PLATFORM\_HOME/extensions/thirdparty/lib directory.

### Symptom

Error message: "Server IPC version X cannot communicate with client version Y".

### Resolution

It is a version mismatch problem. Hadoop server version is **newer** than the version distributed in the custom wrapper artifact denodo-hdfs-customwrapper-5.0-xxx-jar-with-dependencies, which is Hadoop v2.4.0.

To solve the problem you should use the custom wrapper artifact denodo-hdfs-customwrapper-5.0-xxx and copy the Hadoop server libraries to the \$DENODO\_PLATFORM\_HOME/extensions/thirdparty/lib directory.

### Symptom

Error message: "SIMPLE authentication is not enabled. Available:[TOKEN, KERBEROS]".

## Resolution

You are trying to connect to a Kerberos-enabled Hadoop cluster. You should configure the custom wrapper accordingly. See [Secure cluster with Kerberos section](#) for **configuring Kerberos** on this custom wrapper.

## Symptom

Error message: "Cannot get Kerberos service ticket: KrbException: Server not found in Kerberos database (7) ".

## Resolution

Check that nslookup is returning the fully qualified hostname of the KDC. If not, modify the /etc/hosts of the client machine for the KDC entry to be of the form "IP address fully.qualified.hostname alias".

## Symptom

Error message: "Invalid hostname in URI s3n://<id>:<secret>@<bucket>".

## Resolution

Check your bucket name: underscores are not permitted. Also check your secret key, if it contains forward slashes request a new id and secret from the AWS site until you get one that doesn't have a forward slash.