

KNIME Big Data Extensions User Guide

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Overview

KNIME Big Data Extensions integrate Apache Spark and the Apache Hadoop ecosystem with KNIME Analytics Platform.

This guide is aimed at users of KNIME Analytics Platform who want to build workflows that need to access, process and analyze large amounts of data in a big data environment.

Note that additional installation and configuration steps may be necessary in your big data environment. Please consult the Big Data Extensions Admin Guide for details.

Installation

Navigate to File \rightarrow Install KNIME Extensions and open the KNIME Big Data Extensions category. Check the boxes of those extensions that you wish to install.

🛕 Install
Available Software
Check the items that you wish to install.
type filter text
Name
> III IIII KNIME & Extensions
✓ ■ IOD KNIME Big Data Extensions
🖂 🖗 KNIME Big Data Connectors
🗌 🖗 KNIME Column Storage (based on Apache Parquet)
🗹 🖗 KNIME Extension for Apache Spark
🔽 🖗 KNIME Extension for Big Data File Formats
🔽 🖗 KNIME Extension for Local Big Data Environments
🔽 🕼 KNIME Extension for MOJO nodes on Spark
🔽 🖗 KNIME H2O Sparkling Water Integration
V 🖗 KNIME Workflow Executor for Apache Spark (Preview)

KNIME Big Data Extensions are a set of several extensions that build on each other:

- *KNIME Big Data Connectors* provide connector nodes to read/write files in HDFS and query Hive and Impala with SQL.
- KNIME Extension for Big Data File Formats allows to read/write popular file formats such as Parquet in HDFS, Amazon S3 and Azure Blob Store.
- *KNIME Extension for Apache Spark* provides over 60 nodes for data access and wrangling, as well as predictive analytics in Spark. The following extensions add even more functionality around Spark:

- KNIME Extension for Local Big Data Environments provides a node to create a completely local big data environment with Spark and Hive, without any additional configuration or software installation.
- *KNIME H2O Sparkling Water Integration* integrates the the KNIME H2O nodes with Spark to learn H2O models on data in Spark.
- KNIME Extension for MOJO nodes on Spark provides to nodes to do prediction with H2O MOJOs in Spark.
- KNIME Workflow Executor for Apache Spark allows to execute non-Spark KNIME nodes on Apache.

Once you have installed the extension(s), restart KNIME Analytics Platform.



If you don't have direct internet access you can also install the extensions from a zipped update site. Follow the steps outlined in Adding Local Update Sites.

Hive and Impala

The KNIME Big Data Connectors extension provides nodes to connect to Hive and Impala.



Hive Connector

Flow Variables	Job	Mana	ger Selection		Memory P	olicy
Input Type M	lapping		Out	put Type	Mapping	
Connection Sett	ings		JDBC Parame	ters	Adva	nced
Configuration —						
Database Dialect:	Hive					~
Driver Name:	Hive					~
Location						
Hostname					Port	
localhost				~	10,0	00
Database name						
				~	1	
Authentication						
○ Username						
O Username & pass	sword					
○ Kerberos						

Figure 1. Hive Connector configuration dialog

The *Hive Connector* node creates a connection to Hive via JDBC. You need to provide the following information:

- the hostname (or IP address) of the server
- the port
- a database name.
- An authentication method (as required by Hive):
 - Credentials where username and password are be supplied via credentials flow variable (see Credentials Input node).
 - Username where the username is supplied in the dialog.
 - Username & Password where username and password are supplied in the dialog.

• Kerberos where authentication is performed via Kerberos.

When using Kerberos authentication: Additional parameters need to be provided in the JDBC Parameters tab. The exact parameters depend on the JDBC driver selected in the *Driver Name* setting.

The built-in driver with name "Hive" requires the following parameters for Kerberos:

- kerberosAuthType=fromSubject
- principal=hive/<hostqdn>@<REALM>, where
 - <hostqdn> is the fully qualified hostname of the Hive service
 - $\circ~<\!\!\text{REALM}\!\!>$ is the Kerberos realm of the Hive service

Proprietary Hive drivers (e.g. provided by Cloudera) require the following parameters:

- AuthMech=1
- KrbServiceName=hive
- KrbHostFQDN=<hostqdn>, where <hostqdn> is the fully qualified hostname of the Hive service
- KrbRealm=<REALM>, where <REALM> is the Kerberos realm of the Hive service

Please note the proprietary drivers need to registered first as described in Register your own JDBC drivers (KNIME Database Extension Guide).

Impala Connector

i

🔪 Dialog - 0:1 - Impa Ie	la Connector		—		×
Output Type Mapping Connection Settings	Flow Variables Jo JDBC Parameters	b Manager Se Advanced	lection Inpu	Memory It Type Map	Policy oping
Configuration]
Database Dialect:	Impala				\sim
Driver Name:	Hive				~
Location					
Hostname				Port	
localhost			~	21,050	¢
Database name					
			~		
Authentication					
O Credentials					
⊖ Username					
O Username & passv	vord				
⊖ Kerberos					
ОК	Apply	Cancel		0	
	11.7				

Figure 2. Impala Connector configuration dialog

The *Impala Connector* node creates a connection to Impala via JDBC. You need to provide the following information:

- the hostname (or IP address) of the Impala service
- the port
- a database name.
- An authentication method (as required by Impala):
 - Credentials where username and password are be supplied via credentials flow variable (see Credentials Input node).
 - Username where the username is supplied in the dialog.
 - Username & Password where username and password are supplied in the dialog.
 - Kerberos where authentication is performed via Kerberos.

When using Kerberos authentication: Additional parameters need to be provided in the JDBC Parameters tab. The exact parameters depend on the JDBC driver selected in the *Driver Name* setting.

The built-in driver with name "Hive" requires the following parameters for Kerberos:

- kerberosAuthType=fromSubject
- principal=impala/<hostqdn>@<REALM>, where
 - $\circ~\mbox{stqdn}\mbox{sthe fully qualified hostname of the Hive service}$
 - $\circ~\mbox{\scriptsize REALM}\mbox{\scriptsize is the Kerberos realm of the Hive service}$

Proprietary Hive drivers (e.g. provided by Cloudera) require the following parameters:

- AuthMech=1
- KrbServiceName=impala
- KrbHostFQDN=<hostqdn>, where <hostqdn> is the fully qualified hostname of the Hive service
- KrbRealm=<REALM>, where <REALM> is the Kerberos realm of the Hive service

Bulk data loading

The *DB Loader* node supports bulk loading of data from KNIME Analytics Platform into a Hive or Impala table. Note that the database table needs to exist prior to executing the *DB Loader* node. The example below uses the *DB Table Creator* node to create the table prior to loading the data into the table, but this is not necessary if the table does already exist.

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Figure 3. Workflow that creates a Hive table and then loads data into it.

HDFS

🟠 Node Repository	<u>R</u>
V 🛃 10	
> 🕒 Read	
> 🕂 Write	
> 🛅 Other	
🗸 🚞 File Hand	ling
> 📰 Binary	/ Objects
🗸 🇊 Remo	te
🗸 🗒 Co	onnections
6	Amazon S3 Connection
A	FTP Connection
A	HDFS Connection
B.	HTTP Connection
A HTP	, HTTPS Connection
HER	HttpFS Connection
E KANPE	KNIME Server Connection
8	SSH Connection
	Secured HttpFS Connection
e Hore	Secured WebHDFS Connection
HOP I	WebHDFS Connection

The KNIME Big Data Connectors extension provides several nodes to connect to HDFS:

- HDFS Connection directly communicates with HDFS during data transfer, i.e. the NameNode and all DataNodes. This node requires direct network connectivity (no proxies, no firewall) between KNIME Analytics Platform/KNIME Server and the Hadoop cluster, which is often not the case. Restricted network connectivity typically results in timout errors during data transfer.
- WebHDFS Connection uses HTTP to directly connect to HDFS, i.e. the NameNode and all DataNodes. It is possible to connect through a HTTP proxy, but still all cluster nodes need to be reachable through the proxy.
- Secured WebHDFS Connection uses HTTPS (SSL encrypted) to directly connect to HDFS.
- httpFS Connection (recommended) uses HTTP to connect to a httpFS service on a cluster frontend/edge node. The httpFS service serves as an intermediary between the internal cluster network and KNIME Analytics Platform/KNIME Server.
- httpFS Connection (recommended) uses HTTPS (SSL encrypted) to connect to a httpFS service on a cluster frontend/edge node.

The above connector nodes can be used together with the *KNIME File Handling Nodes* extension to upload, download or list files and perform other file operations.

Please consult the example workflows, which are available in KNIME Analytics Platform when connecting to the

e filter text General Help Install/Update KNIME	Hadoop Hadoop Configuration Custom core-site.xml file:	<	> ◄ <> ▼
General A Help Install/Update (NIME	Hadoop Configuration Custom core-site.xml file:		
elp stall/Update NIME	Custom core-site.xml file:		
// Update //E			Browse
			brottsein
n Data	Custom hdfs-site.xml file:		Browse
Hadoon	Use SSL truststore:		
Spark	Hesteanes usefice	Default	
ustomization Profi	Hustname vennen.	Default	
ata Storage	Truststore file:		Browse
atabases	Trustatore recoverdu		
atabases (legacy)	Trusisione passororu:		
	Tuststore type:	jks (default)	
Script Views	Truststore reload interval (ms):	10000	
1E Explorer			
E GUI	Use SSL keystore:		
Workflow Editor	Keystore file:		Browse
rberos	Keystore nacceyord		
ster Key	registore possionar		
eta into Preferenci	Keystore key password:		
erred Kenderers	Keystore type:	jks (default)	
flow Coach			
ung couch			
~			
>		Restore Defaults	Apply

The Hadoop preferences allow to specify typical Hadoop configuration files (core-site.xml and hdfs-site.xml) if necessary.

Furthermore, an SSL trustore can be configured if your HDFS services are using SSL encryption with corporate or self-signed SSL certificates. A keystore can also be defined if required by your Hadoop cluster.

Spark

KNIME Extension for Apache Spark provides a set of over 60 nodes nodes to create and execute Apache Spark applications.



Figure 4. All Spark nodes

The first step in any Spark workflow is to create a Spark context, which represents the connection to a Spark cluster. The Spark context also reserves resources (CPU cores and memory) in your cluster to be exclusively used by your workflow. Hence, a Spark context

should be created at the beginning of a workflow and destroyed at the end, in order to release the resources.

There are several nodes to create a Spark context:

- Create Spark Context (Livy) (recommended)
- Create Spark Context (Jobserver) (deprecated)
- Create Local Big Data Environment (requires KNIME Extension for Local Big Data Environments)

Create Spark Context (Livy)

The Create Spark Context (Livy) node connects to an Apache Livy server to create a new Spark context.



Figure 5. Create Spark Context (Livy) node

Requirements

- **Apache Livy service** Livy needs to be installed as a service in your cluster. Please consult the Apache Livy setup section for more details.
- Network Connectivity: The node initiates a HTTP(S) connection to Livy (default port TCP/8998). Currently, only HTTP(S) proxies that do not require any authentication are supported.
- Authentication: If Livy requires Kerberos authentication, then KNIME Analytics Platform needs to be set up accordingly.
- **Remote file system**: The node requires access to a remote file system to exchange temporary files between KNIME Analytics Platform and the Spark context (running on the cluster). Supported file systems are:
 - HDFS, webHDFS and httpFS. Note that the node must access the remote file system with the same user as the Spark context. When authenticating with Kerberos against both HDFS/webHDFs/httpFS and Livy, then the same user will be used. Otherwise, this must be ensured manually.
 - $\,\circ\,$ Amazon S3 and Azure Blob Store, which is recommended when using Spark on

Amazon EMR/Azure HDInsight. Note that for these file systems a staging area must be specified in the **Advanced** tab of the *Create Spark Context (Livy)* node.

Node dialog

Dialog - 2:1 - Create Spark Context (Livy)	×
General Advanced Flow Variables Job Manager Selection Memory Policy	
Spark version: 2.4 V	
Livy URL: http://livy.mycluster.com:8998/	
Authentication None Kerberos	
Spark executor resources	
✓ Override default Spark executor resources Memory: 16 ÷ GB ∨ Cores: 1 ÷	
O Default allocation Fixed allocation O Dynamic allocation	
Estimated total cluster resources: 146 GB of memory and 9 cores. Estimated per-container resources: • one Spark driver with 2 GB of memory and 1 core(s) • 8 Spark executor(s), each with 18 GB of memory and 1 core(s)	
OK Apply Cancel ?	

Figure 6. Create Spark Context (Livy): General settings tab

The node dialog has two tabs. The first tab provides the most commonly used settings when working with Spark:

- 1. **Spark version:** Please choose the Spark version of the Hadoop cluster you are connecting to.
- 2. Livy URL: The URL of Livy including protocol and port e.g. http://localhost:8998/.
- 3. **Authentication:** How to authenticate against Livy. Supported mechanism are Kerberos and None.
- 4. **Spark Executor resources:** Sets the resources to be request for the Spark executors. If enabled, you can specify the amount of memory and the number of cores for each executor. In addition you can specify the Spark executor allocation strategy.
- 5. **Estimated resources:** An estimation of the resources that are allocated in your cluster by the Spark context. The calculation uses default settings for memory overheads etc. and is thus only an estimate. The exact resources might be different depending on your specific cluster settings.

📐 Dialog - 2:1 - Create Spark Context (Livy)		_		×
General Advanced Flow Variables Job Manager Selection Mer	mory Policy			
✓ Override default Spark driver resources Memory: 1 → GB ∨ Cores: 1 →				
Set staging area for Spark jobs	Dr	01400	V	
Set custom Spark settings	DI	UWSC		
Key Value]
Add Add All Remove	F	Remove /	All	
Livy connection timeout (seconds): 30				
Livy response timeout (seconds): 60				
Job status polling interval (seconds):				
OK Apply	Cancel	?		

Figure 7. Create Spark Context (Livy): Advanced settings tab

The second tab provides the advanced settings that are sometimes useful when working

with Spark:

- 1. **Override default Spark driver resources:** If enabled, you can specify the amount of memory and number of cores to be allocated for the Spark driver process.
- 2. **Set staging area for Spark jobs:** If enabled, you can specify a directory in the connected remote file system, that will be used to transfer temporary files between KNIME and the Spark context. If no directory is set, then a default directory will be chosen, e.g. the HDFS user home directory. However, if the remote file system is Amazon S3 or Azure Blob Store, then a staging directory must be provided.
- 3. **Set custom Spark settings:** If enabled, you can specify additional Spark settings. A tooltip is provided for the keys if available. For further information about the Spark settings refer to the Spark documentation.

Create Spark Context (Jobserver)

This node connects to Spark Job Server to create a new Spark context.



Its node dialog has two main tabs. The first tab is the Context Settings tab which allows you to specify the following Spark Context settings:

- 1. **Spark version:** Please choose the Spark version of the Hadoop cluster you are connecting to.
- 2. Context name: A unique name for the Spark context.
- 3. **Delete objects on dispose:** KNIME workflows with Spark nodes create objects such as DataFrames/RDDs during execution. This setting specifies whether those objects shall be deleted when closing a workflow.
- Override Spark settings: Custom settings for the Spark context, e.g. the amount of memory to allocate per Spark executor. These settings override those from Job Server's environment.conf.
- 5. **Hide context exists warning:** If not enabled the node will show a warning if a Spark Context with the defined name already exists.

Flow Variables Job I Context Settings		Conne	ction Settings	olic
Spark version:	2.0	~		
Context name:	knimeSparkCo	ontext		
🗹 Delete obje	cts on dispose			
Spark job log l	evel:			
O DEBUG) INFO () W	ARN O ERROR		
Override sp	ark settings			
Custom spark set	ttings:			
memory-per	-node: 10	; 		
spark.exec	utor.inst	ances: 3		
Hide contex	t exists warnin	g		

Figure 8. Create Spark Context: Context Settings tab

The second tab is the **Connection Settings** tab which allows you to specify the following connection settings:

- 1. **Job server URL**: This is the HTTP/HTTPS URL under which the Spark Job Server WebUI can be reached. The default URL is http://localhost:8090/.
- 2. **Credentials:** If you have activated user authentication, you need to enter a username and password here.
- 3. Job timeout in seconds/Job check frequency: These settings specify how long a single Spark job can run before being considered failed, and, respectively, in which intervals the status of a job shall be polled.



Figure 9. Create Spark Context: Connection Settings tab

Adapting default settings for the Create Spark Context node

The default settings of the Create Spark Context node can be specified via a preference page. The default settings are applied whenever the node is added to a KNIME workflow. To change the default settings, open **File > Preferences > KNIME > Big Data > Spark** and adapt them to your environment (see [knime_ext_create_spark_context]).

Destroy Spark Context node

Once you have finished your Spark job, you should destroy the created context to free up the resources your Spark Context has allocated on the cluster. To do so you can use the **Destroy Spark Context** node.



Figure 10. How to use the Destroy Spark Context node

Proxy settings

If your network requires you to connect to Livy or Spark Job Server via a proxy, please open *File > Preferences > Network Connections*. Here you can configure the details of your HTTP/HTTPS/SOCKS proxies. Please consult the official Eclipse documentation on how to configure proxies.

Example workflow



The above example workflow first creates a Spark context (*Create Spark Context (Livy*)) and then reads training data from a Parquet file stored in HDFS (*Parquet to Spark*). It then trains a decision tree model (*Spark Decision Tree Learner*) on that data. Additionally, it reads a Hive table with test data into Spark (*Hive to Spark*), uses the previously learned model to perform predictions (*Spark Predictor*), and determines the accuracy of the model given the test data (*Spark Scorer*).

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For more examples consult the example workflows, which are available in KNIME Analytics Platform in the KNIME Explorer View, when connecting to the EXAMPLES server. Under $01_Big_Data \rightarrow 02_Spark_Executor$ you will find a variety of example workflows that demonstrate how to use the Spark nodes.



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