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KNIME® Spark Executor

Installation Guide
Version 1.6.0

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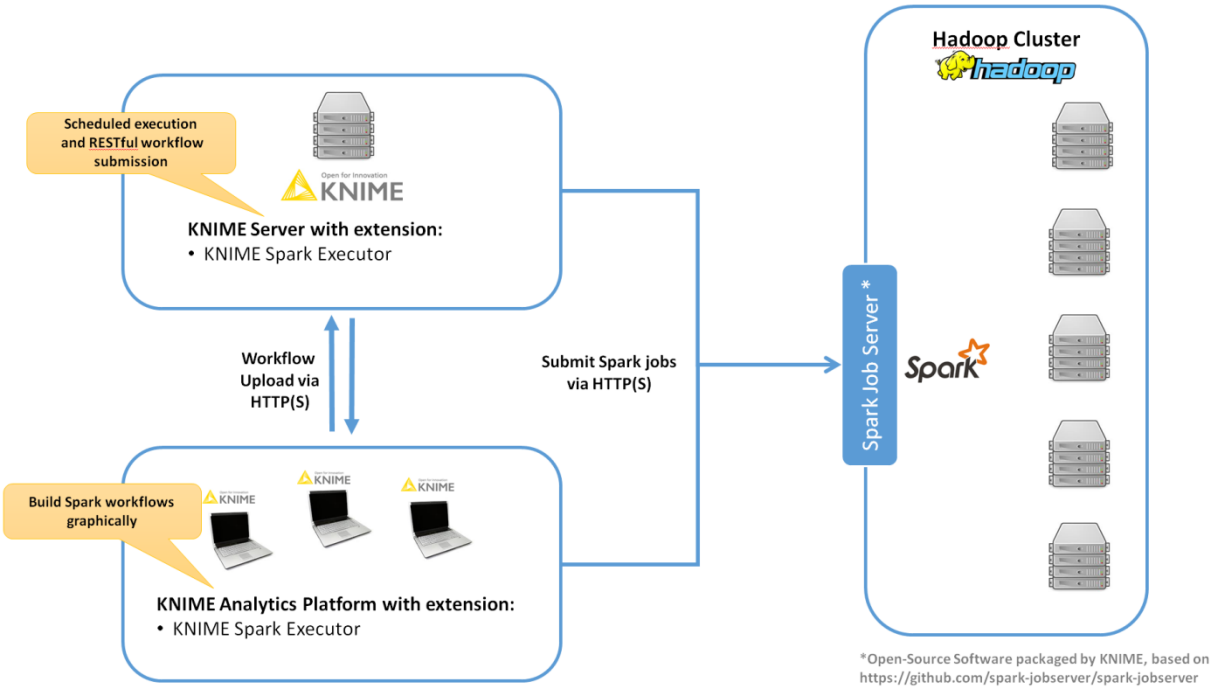
INTRODUCTION

This document describes the installation procedure of the KNIME® Spark Executor to be used with KNIME® Analytics Platform 3.2 and KNIME® Server 4.3.

As depicted below, KNIME Spark Executor consists of:

- an *extension* for KNIME Analytics Platform/KNIME Server
- a service called *Spark Jobserver*, that needs to installed on an edge node of your Hadoop cluster.



SUPPORTED HADOOP DISTRIBUTIONS

- **Supported <u>without</u> Kerberos security:**
  - Hortonworks HDP 2.2 with Spark 1.2
  - Hortonworks HDP 2.3.0 with Spark 1.3
  - Hortonworks HDP 2.3.4 with Spark 1.5
  - Hortonworks HDP 2.4.x with Spark 1.6
  - Cloudera CDH 5.3 with Spark 1.2
  - Cloudera CDH 5.4 with Spark 1.3
  - Cloudera CDH 5.5 with Spark 1.5
  - Cloudera CDH 5.6 with Spark 1.5
  - Cloudera CDH 5.7 with Spark 1.6

- **Supported <u>with</u> Kerberos security:**
  - Hortonworks HDP 2.4.2 with Spark 1.6
  - Cloudera CDH 5.7 with Spark 1.6

SUPPORTED KNIME SOFTWARE VERSIONS

KNIME Analytics Platform 3.2

KNIME Server 4.3

SPARK JOBSERVER SETUP

This section describes how to install the Spark Jobserver on a Linux machine. The KNIME Spark Executor requires the Spark Jobserver to execute and manage Spark jobs.

BACKGROUND

The Spark Jobserver provides a RESTful interface for submitting and managing Apache Spark jobs, jars, and job contexts.

MORE INFORMATION

The Spark Jobserver was originally developed at Ooyala, but the main development repository is now on GitHub. For more information please consult the GitHub repository at https://github.com/spark-jobserver/spark-jobserver/, including licensing conditions, contributors, mailing lists and additional documentation.

In particular, the readme of the Jobserver contains dedicated sections about *HTTPS / SSL Configuration* and *Authentication*. The GitHub repository also contains a general Troubleshooting and Tips as well as YARN Tips section. All Spark Jobserver documentation is available in the doc folder of the GitHub repository.

KNIME packages the official Spark Jobserver and - if necessary – adapts it for the Hadoop distributions supported by KNIME Spark Executor. These packages can be downloaded on the KNIME Spark Executor product website.

VERSION

The packaged versions of the Spark Jobserver provided by KNIME and described in this document are based on the Spark Jobserver release 0.6.2 from April 28th 2016. They have been tested with the supported Hortonworks and Cloudera versions on CentOS 6 Linux.

WHERE TO INSTALL

The Spark Jobserver runs the so-called Spark driver program and executes Spark jobs submitted via REST. Therefore, it must be installed on a Linux machine that

- has full network connectivity to all of your Hadoop cluster nodes,
- and can be connected to via HTTP (default port TCP/8090) from KNIME Analytics Platform or KNIME Server,
- and has Spark as well as Hadoop and Hive libraries installed and properly configured for your cluster.

This can for example be the Hadoop master node or a cluster edge node.

HOW TO INSTALL

1. Locate the Spark Jobserver package that matches your Hadoop distribution on the KNIME Spark Executor product website under **Installation Steps > KNIME Analytics Platform X.Y > Supplementary download links for the Spark Jobserver.**

2. Download the file on the machine where you want to install Spark Jobserver.

3. The recommend installation procedure is to log in as root on that machine and install the Jobserver as follows (replace xxx with the version of your download):

```
root@host$ useradd -d /opt/spark-job-server/ -M -r -s /bin/false
spark-job-server
root@host$ su -l -c "hdfs dfs -mkdir -p /user/spark-job-server ; hdfs
dfs -chown -R spark-job-server /user/spark-job-server" hdfs
root@host$ cp /path/to/spark-job-server-xxx.tar.gz /opt
root@host$ cd /opt
root@host$ tar xzf spark-job-server-xxx.tar.gz
root@host$ ln -s spark-job-server-xxx spark-job-server
root@host$ chown -R spark-job-server:spark-job-server /opt/spark-job-
server spark-job-server-xxx/
```

4. If you are installing on RedHat Enterprise Linux (RHEL), a boot script is provided and can be installed as follows:

```
root@host$ ln -s /opt/spark-job-server/spark-job-server-init.d \
/etc/init.d/spark-job-server
root@host$ chkconfig --levels 2345 spark-job-server on
```

   If you are installing on RHEL 7 or above, you must update the systemd manager configuration with:

```
root@host$ systemctl daemon-reload
root@host$ systemctl enable spark-job-server
```

   The boot script will run the jobserver as the `spark-job-server` system user. If you have installed the Jobserver to a different location, or wish to run the server with a different user, you will have to change the JSDIR and USER variables in the boot script.

5. If you are not using the above boot script, you will have to configure the *logging directory* and *filesystem permissions* by hand:

```
root@host$ chown -R spark-job-server /opt/spark-job-server/
root@host$ mkdir -p /var/log/spark-job-server
root@host$ chown -R spark-job-server /var/log/spark-job-server
```

6. Edit `/opt/spark-job-server/environment.conf` as appropriate. The most important settings are:

- **master**: Set..
  - `master = yarn-client` for running Spark in YARN-client mode
  - `master = spark://localhost:7077` for stand-alone mode
  - `master = local[4]` for local debugging.

  Note: yarn-cluster mode is currently not supported by Spark Jobserver.
- **Settings for predefined contexts.** Under `context-settings`, you can predefine Spark settings for the default Spark context. Please note that these settings can be overwritten by the configuration of the KNIME extension. Under `contexts` you can predefine Spark settings for non-default Spark contexts.

7. Edit *settings.sh* as appropriate:
   - **SPARK_HOME**, please change if Spark is not installed under the given location.
   - **LOG_DIR,** please change if you want to log to a non-default location.

8. Edit *log4j-server.properties* as appropriate (not necessary unless you wish to change the defaults).

HOW TO INSTALL ON A KERBEROS-SECURED CLUSTER

In a Kerberos secured cluster, jobserver requires a Ticket Granting Ticket (TGT) in order to access Hadoop services and provide user impersonation. To set this up, please first follow the installation steps in the previous section. Then proceed with the following steps:

1. Via kadmin, create a service principal and a keytab file for the `spark-job-server` Linux user. By default this is assumed to be `spark-job-server/host@REALM`, where
   - `host` ist the fully qualified hostname (FQDN) of the machine where you are installing jobserver,
   - `REALM` is the Kerberos realm of your cluster.

2. Upload the keytab file to the machine where jobserver is installed and limit its accessibility to only the `spark-job-server` system user:

   ```
   root@host$ chown spark-job-server:spark-job-server /path/to/keytab
   root@host$ chmod go= /path/to/keytab
   ```

3. Now you have to tell jobserver about the keytab file and, optionally, about the service principal you have created. In `/opt/spark-job-server/settings.sh` uncomment and edit the following lines:

   ```
   export JOBSERVER_KEYTAB=/path/to/keytab
   export JOBSERVER_PRINCIPAL=user/host@REALM
   ```

   Note: You only need to set the principal, if it is different from the assumed default principal `spark-job-server/$(hostname -f)/<default realm from /etc/krb5.conf>`

4. In `/opt/spark-job-server/environment.conf` set the following properties:
```
spark {
  jobserver {
    context-per-jvm = true
  }
}
shiro {
  authentication = on
  config.path = "shiro.ini"
  use-as-proxy-user = on
}
```
The effect of these settings is that jobserver will authenticate all of its users, and each user will have its own Spark context, that can access Hadoop resources in the name of this user.

5. Configure the authentication mechanism of jobserver in `/opt/spark-job-server/shiro.ini`. You can find two example templates in `/opt/spark-job-server/shiro.ini.xxx.template`. Further instructions on configuring authentication can be found in the README file of the Jobserver github page.

6. Add the following properties to the core-site.xml of your Hadoop cluster:
```
hadoop.proxyuser.spark-job-server.hosts = *
hadoop.proxyuser.spark-job-server.groups = *
```
This should be done either via Ambari (on HDP) or Cloudera Manager (on CDH). A restart of the affected Hadoop services (HDFS, YARN) is required.

MAINTENANCE

STARTING THE SPARK JOBSERVER

On RHEL 6, start the server via the boot-script:

```
root@host$ /etc/init.d/spark-job-server start
```

On RHEL 7 and higher start the server via systemd:

```
root@host$ systemctl start spark-job-server
```

Otherwise, you can always start the Spark Jobserver via:

```
root@host$ /opt/spark-job-server/server_start.sh
```

You can verify that the Spark Jobserver has correctly started via the WebUI (see Spark Jobserver Web UI).

STOPPING THE SPARK JOBSERVER

On RHEL 6, stop the server via the boot-script:

```
root@host$ /etc/init.d/spark-job-server stop
```

On RHEL 7 and higher start the server via systemd:

```
root@host$ systemctl stop spark-job-server
```

Otherwise, you can always stop the Spark Jobserver via:

```
root@host$ /opt/spark-job-server/server_stop.sh
```

CLEANUP JOB HISTORY

It is advisable to re-start the Spark Jobserver every once in a while and clean-up its rootdir. Remove either the entire directory or only the jar files under `/tmp/spark-jobserver`, or whichever file system locations you have set in `environment.conf`.

SPARK JOBSERVER WEB UI

Point your browser to *http://<server>:<port>* to check out the status of the Spark Jobserver. The default port is 8090. Three different tabs provide information about active and completed jobs, contexts and jars.

TROUBLESHOOTING

JOBSERVER FAILS TO RESTART

At times, the Spark Jobserver cannot be restarted when large tables were serialized from KNIME to Spark. It fails with a message similar to *java.io.UTFDataFormatException: encoded string too long: 6653559 bytes*. In that case it is advisable to delete `/tmp/spark-jobserver`, or whichever file system locations you have set in `environment.conf`.

SPARK COLLABORATIVE FILTERING NODE FAILS

If your Spark Collaborative Filtering node fails with *a "Job canceled because SparkContext was shutdown"* exception the cause might be missing native libraries on the cluster. If you find the error message *JAVA.LANG.UNSATISFIEDLINKERROR: ORG.JBLAS.NATIVEBLAS.DPOSV* in your Jobserver log the native JBlas library is missing on your cluster. To install the missing lib execute the following command as root on all cluster nodes:

RedHat-based systems: `yum install libgfortran`

Debian-based systems: `apt-get install libgfortran3`

For detailed instructions on how to install the missing libraries go to the JBlas Github page. For information about the MLlib dependencies see the Dependencies section of the MLlib Guide.

The issue is described in https://spark-project.atlassian.net/browse/SPARK-797

REQUEST TO SPARK JOBSERVER FAILED, BECAUSE THE AMOUNT OF UPLOADED DATA WAS TOO LARGE

Spark Jobserver limits how much data can be submitted in a single REST request. For Spark nodes that submit large amounts of data to Spark Jobserver, e.g. a large MLlib model, this can result in a request failure with an error that says Request to "Spark Jobserver failed, because the amount of uploaded data was too large". This problem can be addressed by increasing the maximum content length in Jobserver's webserver. Add and adjust the following section in `environment.conf`:

```
spray.can.server.parsing {
      max-content-length = 200m
}
```

SPARK JOB EXECUTION FAILED BECAUSE NO FREE JOB SLOTS WERE AVAILABLE ON SPARK JOBSERVER

Spark Jobserver limits how much jobs can run at the same time within the same context. This limit can be changed by adjusting the following setting in `environment.conf`:

```
spark {
  jobserver {
    max-jobs-per-context = 100
  }
}
```

EXTENSION SETUP

This section describes how to install the client-side extension of KNIME Spark Executor in KNIME Analytics Platform or KNIME Server. The extension provides all the necessary KNIME nodes to create workflows that execute on Apache Spark.

INSTALLATION

The extension can be installed via the KNIME Update Manager:

1. Go to **File > Install KNIME Extensions ...**
2. Open the category **KNIME.com Big Data Extensions (licenses required)**.
3. Select the **KNIME Spark Executor** extension.
4. Click on Next and follow the subsequent dialog steps to install the extension.

If you don't have direct internet access you can also install the extension from a zipped update site:

1. Download the zipped update site from the KNIME Spark Executor product website under **Installation Steps > X.Y > Extension for KNIME Analytics Platform/KNIME Server.**
2. Then register the update site in the KNIME Analytics Platform via **File > Preferences > Install/Update > Available Software Sites**. Then follow the installation steps for the KNIME Update Manager (see above).

Note that using the client-side extension requires a license, which you can purchase via the KNIME Store.

CONFIGURATION

After installing the client-side extension, you have to configure it to work with your environment e.g. your Spark Jobserver configuration.

To setup the extension within KNIME Analytics Platform, open **File > Preferences > KNIME > Spark** and adapt the following settings to your environment:

1. **Job server URL:** This is the HTTP/HTTPS URL under which the Spark Jobserver 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 is allowed to run before being considered failed, and, respectively, in which intervals the status of a job shall be polled.
4. **Spark version:** Please choose the Spark version of the Hadoop cluster you are connecting to.
5. **Context name:** The name of the Spark context. This should be the same for all users of the same Spark Jobserver. If you want to use multiple contexts you should install a Spark Jobserver for each context.
6. **Delete Spark objects on dispose:** KNIME workflows with Spark nodes create objects such as RDDs during execution. This settings specifies whether those objects shall be deleted when closing a workflow.
7. **Spark job log level:** The Spark jobs triggered by KNIME nodes often create some log messages on the Spark jobserver. Log messages with a log level equal or above the one specified here will also be display inside KNIME Analytics Platform, which can be useful when debugging workflows.
8. **Override Spark settings:** Custom settings for the remote Spark context, e.g. the amount of memory to allocate per Sparkexecutor.Thesesettin gsoverridethosefrom Jobserver's *environment.conf.*

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