

Machine Learning

Securing Cloudera Machine Learning

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The Cloudera logo is displayed in a bold, orange, sans-serif font. The word "CLOUDERA" is written in all caps, with the letter "E" stylized as a horizontal bar with a small triangle on its left side.

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Configuring External Authentication with LDAP and SAML



Important: Cloudera recommends you leverage Single Sign-On for users via the CDP Management Console. For instructions on how to configure this, see [Configuring User Access to CML](#). If you cannot do this, we recommend contacting Cloudera Support before attempting to use the LDAP or SAML instructions provided in this section.

Cloudera Machine Learning supports user authentication against its internal local database, and against external services such as Active Directory, OpenLDAP-compatible directory services, and SAML 2.0 Identity Providers. By default, Cloudera Machine Learning performs user authentication against its internal local database. This topic describes the signup process for the first user, how to configure authentication using LDAP, Active Directory or SAML 2.0, and an optional workaround that allows site administrators to bypass external authentication by logging in using the local database in case of misconfiguration.

Configuring LDAP/Active Directory Authentication

This topic describes how to set up LDAP authentication for a workspace.



Important: This is not the recommended method to set up LDAP authentication. Cloudera recommends you use the CDP management console to set this up: [Configuring User Access to CML](#).

Cloudera Machine Learning supports both search bind and direct bind operations to authenticate against an LDAP or Active Directory directory service. The search bind authentication mechanism performs an ldapsearch against the directory service, and binds using the found [Distinguished Name \(DN\)](#) and password provided. The direct bind authentication mechanism binds to the LDAP server using a username and password provided at login.

You can configure Cloudera Machine Learning to use external authentication methods by clicking the Admin link on the left sidebar and selecting the Security tab. Select LDAP from the list to start configuring LDAP properties.

LDAP General Settings

Lists the general settings required to configure LDAP authentication.

- **LDAP Server URI:** Required. The URI of the LDAP/Active Directory server against which Cloudera Machine Learning should authenticate. For example, `ldaps://ldap.company.com:636`.
- **Use Direct Bind:** If checked, the username and password provided at login are used with the LDAP Username Pattern for binding to the LDAP server. If unchecked, Cloudera Machine Learning uses the search bind mechanism and two configurations, LDAP Bind DN and LDAP Bind Password, are required to perform the ldapsearch against the LDAP server.
- **LDAP Bind DN:** Required when using search bind. The DN to bind to for performing ldapsearch. For example, `cn=admin,dc=company,dc=com`.
- **LDAP Bind Password:** Required when using search bind. This is the password for the LDAP Bind DN.
- **LDAP Search Base:** Required. The base DN from which to search for the provided LDAP credentials. For example, `ou=Engineering,dc=company,dc=com`.
- **LDAP User Filter:** Required. The [LDAP filter](#) for searching for users. For example, `(&(sAMAccountName={0})(objectclass=person))`. The `{0}` placeholder will be replaced with the username provided at login.

- **LDAP User Username Attribute:** Required. The case-sensitive username attribute of the LDAP directory service. This is used by Cloudera Machine Learning to perform the bind operation and extract the username from the response. Common values are uid, sAMAccountName, or userPrincipalName.

General Settings

LDAP Server URI *

ldaps://ldap.company.com

☐ **Use Direct Bind**

By default, Cloudera Data Science Workbench searches for the users by binding to the provided **LDAP Bind DN** and **LDAP Bind Password**. When checked, Cloudera Data Science Workbench will attempt to search for the user by binding to the user-provided username and password. In such case, please make sure the users have permissions to search for themselves in the LDAP server.

LDAP Bind DN *

CN=Test1 Person,OU=People,DC=company,DC=com

[Update LDAP Bind Password](#)

LDAP User Search Base *

OU=People,DC=company,DC=com

LDAP User Search Filter

objectClass=person

LDAP User Username Attribute *

sAMAccountName

When you select Use Direct Bind, Cloudera Machine Learning performs a direct bind to the LDAP server using the LDAP Username Pattern with the credentials provided on login (not LDAP Bind DN and LDAP Bind Password).

By default, Cloudera Machine Learning performs an LDAP search using the bind DN and credentials specified for the LDAP Bind DN and LDAP Bind Password configurations. It searches the subtree, starting from the base DN specified for the LDAP Search Base field, for an entry whose attribute specified in LDAP User Username Attribute, has the same value as the username provided on login. Cloudera Machine Learning then validates the user-provided password against the DN found as a result of the search.

LDAP Group Settings

In addition to the general LDAP settings, you can use group settings to restrict the access to Cloudera Machine Learning to certain groups in LDAP.

- **LDAP Group Search Base:** The base distinguished name (DN) where Cloudera Machine Learning will search for groups.
- **LDAP Group Search Filter:** The LDAP filter that Cloudera Machine Learning will use to determine whether a user is affiliated to a group.

A group object in LDAP or Active Directory typically has one or more member attributes that stores the DNs of users in the group. If LDAP Group Search Filter is set to member={0}, Cloudera Machine Learning will automatically substitute the {0} placeholder for the DN of the authenticated user.

- **LDAP User Groups:** A list of LDAP groups whose users have access to Cloudera Machine Learning. When this property is set, only users that successfully authenticate themselves AND are affiliated to at least one of the groups listed here, will be able to access Cloudera Machine Learning.

If this property is left empty, all users that can successfully authenticate themselves to LDAP will be able to access Cloudera Machine Learning.

- **LDAP Full Administrator Groups:** A list of LDAP groups whose users are automatically granted the site administrator role on Cloudera Machine Learning.

The groups listed under LDAP Full Administrator Groups do not need to be listed again under the LDAP User Groups property.

Figure 1: Example

If you want to restrict access to Cloudera Machine Learning to members of a group whose DN is:

```
CN=CMLUsers,OU=Groups,DC=company,DC=com
```

And automatically grant site administrator privileges to members of a group whose DN is:

```
CN=CMLAdmins,OU=Groups,DC=company,DC=com
```

Add the CNs of both groups to the following settings in Cloudera Machine Learning:

- LDAP User Groups: CMLUsers
- LDAP Full Administrator Groups: CMLAdmins

Test LDAP Configuration

Use the Test LDAP Configuration form to test your settings.

You can test your LDAP/Active Directory configuration by entering your username and password in the Test LDAP Configuration section. This form simulates the user login process and allows you to verify the validity of your LDAP/Active Directory configuration without opening a new window.

Before using this form, make sure you click Update to save the LDAP configuration you want to test.

Configuring SAML Authentication

This topic describes how to set up SAML for Single Sign-on authentication for a workspace.



Important: This is not the recommended method to set up SSO. Cloudera recommends you use the CDP management console to set this up: [Configuring User Access to CML](#).

Cloudera Machine Learning supports the [Security Assertion Markup Language \(SAML\)](#) for [Single Sign-on \(SSO\)](#) authentication; in particular, between an identity provider (IDP) and a service provider (SP). The SAML specification defines three roles: the principal (typically a user), the IDP, and the SP. In the use case addressed by SAML, the principal (user agent) requests a service from the service provider. The service provider requests and obtains an identity assertion from the IDP. On the basis of this assertion, the SP can make an access control decision—in other words it can decide whether to perform some service for the connected principal.

The primary SAML use case is called web browser single sign-on (SSO). A user with a user agent (usually a web browser) requests a web resource protected by a SAML SP. The SP, wanting to know the identity of the requesting user, issues an authentication request to a SAML IDP through the user agent. In the context of this terminology, Cloudera Machine Learning operates as a SP.

Cloudera Machine Learning supports both SP- and IDP-initiated SAML 2.0-based SSO. Its [Assertion Consumer Service \(ACS\)](#) API endpoint is for consuming assertions received from the Identity Provider. If your Cloudera Machine Learning domain root were `cdsw.company.com`, then this endpoint would be available at `http://cdsw.company.com/api/v1/saml/acs`. SAML 2.0 metadata is available at `http://cdsw.company.com/api/v1/saml/metadata` for IDP-initiated SSO. Cloudera Machine Learning uses [HTTP Redirect Binding](#) for authentication requests and expects to receive responses from [HTTP POST Binding](#).

When Cloudera Machine Learning receives the SAML responses from the Identity Provider, it expects to see at least the following user attributes in the SAML responses:

- The unique identifier or username. Valid attributes are:
 - uid
 - urn:oid:0.9.2342.19200300.100.1.1
- The email address. Valid attributes are:
 - mail
 - email
 - urn:oid:0.9.2342.19200300.100.1.3
- The common name or full name of the user. Valid attributes are:
 - cn
 - urn:oid:2.5.4.3

In the absence of the cn attribute, Cloudera Machine Learning will attempt to use the following user attributes, if they exist, as the full name of the user:

- The first name of the user. Valid attributes are:
 - givenName
 - urn:oid:2.5.4.42
- The last name of the user. Valid attributes are:
 - sn
 - urn:oid:2.5.4.4

Configuration Options

List of properties to configure SAML authentication and authorization in Cloudera Machine Learning.

Cloudera Machine Learning Settings

- Entity ID: Required. A globally unique name for Cloudera Machine Learning as a Service Provider. This is typically the URI.
- NameID Format: Optional. The name identifier format for both Cloudera Machine Learning and Identity Provider to communicate with each other regarding a user. Default: urn:oasis:names:tc:SAML:1.1:nameid-format:emailAddress.
- Authentication Context: Optional. [SAML authentication context](#) classes are URIs that specify authentication methods used in SAML authentication requests and authentication statements. Default: urn:oasis:names:tc:SAML:2.0:ac:classes:PasswordProtectedTransport.

Signing SAML Authentication Requests

- CDSW Private Key for Signing Authentication Requests: Optional. If you upload a private key, you must upload a corresponding certificate as well so that the Identity Provider can use the certificate to verify the authentication requests sent by Cloudera Machine Learning. You can upload the private key used for both signing authentication requests sent to Identity Provider and decrypting assertions received from the Identity Provider.
- CML Certificate for Signature Validation: Required if the Cloudera Machine Learning Private Key is set, otherwise optional. You can upload a certificate in the [PEM format](#) for the Identity Provider to [verify the authenticity](#) of the authentication requests generated by Cloudera Machine Learning. The uploaded certificate is made available at the <http://cdsw.company.com/api/v1/saml/metadata> endpoint.

SAML Assertion Decryption

Cloudera Machine Learning uses the following properties to support SAML assertion encryption & decryption.

- CML Certificate for Encrypting SAML Assertions - Must be configured on the Identity Provider so that Identity Provider can use it for encrypting SAML assertions for Cloudera Machine Learning
- CML Private Key for Decrypting SAML Assertions - Used to decrypt the encrypted SAML assertions.

Identity Provider

- Identity Provider SSO URL: Required. The entry point of the Identity Provider in the form of URI.
- Identity Provider Signing Certificate: Optional. Administrators can upload the [X.509](#) certificate of the Identity Provider for Cloudera Machine Learning to validate the incoming SAML responses.

Cloudera Machine Learning extracts the Identity Provider SSO URL and Identity Provider Signing Certificate information from the uploaded Identity Provider Metadata file. Cloudera Machine Learning also expects all Identity Provider metadata to be defined in a <md:EntityDescriptor> XML element with the namespace "urn:oasis:names:tc:SAML:2.0:metadata", as defined in the [SAMLMeta-xsd schema](#).

For on-premises deployments, you must provide a certificate and private key, generated and signed with your trusted Certificate Authority, for Cloudera Machine Learning to establish secure communication with the Identity Provider.

Authorization

When you're using SAML 2.0 authentication, you can use the following properties to restrict the access to Cloudera Machine Learning to certain groups of users:

- SAML Attribute Identifier for User Role: The Object Identifier (OID) of the user attribute that will be provided by your identity provider for identifying a user's role/affiliation. You can use this field in combination with the following SAML User Groups property to restrict access to Cloudera Machine Learning to only members of certain groups.

For example, if your identity provider returns the `OrganizationalUnitName` user attribute, you would specify the OID of the `OrganizationalUnitName`, which is `urn:oid:2.5.4.11`, as the value for this property.

- SAML User Groups: A list of groups whose users have access to Cloudera Machine Learning. When this property is set, only users that are successfully authenticated AND are affiliated to at least one of the groups listed here, will be able to access Cloudera Machine Learning.

For example, if your identity provider returns the `OrganizationalUnitName` user attribute, add the value of this attribute to the SAML User Groups list to restrict access to Cloudera Machine Learning to that group.

If this property is left empty, all users that can successfully authenticate themselves will be able to access Cloudera Machine Learning.

- SAML Full Administrator Groups: A list of groups whose users are automatically granted the site administrator role on Cloudera Machine Learning.

The groups listed under SAML Full Administrator Groups do not need to be listed again under the SAML User Groups property.

Configuring HTTP Headers for Cloudera Machine Learning

This topic explains how to customize the HTTP headers that are accepted by Cloudera Machine Learning.

Required Role: Site Administrator

These properties are available under the site administrator panel at Admin Security .



Important: Any changes to the following properties require a full restart of Cloudera Machine Learning. To do so, run `cdsctl restart` on the master host.

Enable Cross-Origin Resource Sharing (CORS)

Most modern browsers implement the [Same-Origin Policy](#), which restricts how a document or a script loaded from one origin can interact with a resource from another origin. When the Enable cross-origin resource sharing property

is enabled on Cloudera Machine Learning, web servers will include the Access-Control-Allow-Origin: * HTTP header in their HTTP responses. This gives web applications on different domains permission to access the Cloudera Machine Learning API through browsers.

This property is disabled by default .

If this property is disabled, web applications from different domains will not be able to programmatically communicate with the Cloudera Machine Learning API through browsers.

Enable HTTP Security Headers

When Enable HTTP security headers is enabled, the following HTTP headers will be included in HTTP responses from servers:

- X-XSS-Protection
- X-DNS-Prefetch-Control
- X-Frame-Options
- X-Download-Options
- X-Content-Type-Options

This property is enabled by default .

Disabling this property could leave your Cloudera Machine Learning deployment vulnerable to clickjacking, cross-site scripting (XSS), or any other injection attacks.

Enable HTTP Strict Transport Security (HSTS)



Note: Without TLS/SSL enabled, configuring this property will have no effect on your browser.

When both TLS/SSL and this property (Enable HTTP Strict Transport Security (HSTS)) are enabled, Cloudera Machine Learning will inform your browser that it should never load the site using HTTP. Additionally, all attempts to access Cloudera Machine Learning using HTTP will automatically be converted to HTTPS.

This property is disabled by default .

If you ever need to downgrade to back to HTTP, use the following sequence of steps: First, deactivate this checkbox to disable HSTS and restart Cloudera Machine Learning. Then, load the Cloudera Machine Learning web application in each browser to clear the respective browser's HSTS setting. Finally, disable TLS/SSL across the cluster. Following this sequence should help avoid a situation where users get locked out of their accounts due to browser caching.

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This property is disabled by default.

If this property is disabled, web applications from different domains will not be able to programmatically communicate with the Cloudera Machine Learning API through browsers.

SSH Keys

This topic describes the different types of SSH keys used by Cloudera Machine Learning, and how you can use those keys to authenticate to an external service such as GitHub.

Personal Key

Cloudera Machine Learning automatically generates an SSH [key pair](#) for your user account. You can rotate the key pair and view your public key on your user settings page. It is not possible for anyone to view your private key.

Every console you run has your account's private key loaded into its [SSH-agent](#). Your consoles can use the private key to authenticate to external services, such as GitHub. For instructions, see [#unique_16](#).

Team Key

Team SSH keys provide a useful way to give an entire team access to external resources such as databases or GitHub repositories (as described in the next section).

Like Cloudera Machine Learning users, each Cloudera Machine Learning team has an associated SSH key. You can access the public key from the team's account settings. Click Account, then select the team from the drop-down menu at the upper right corner of the page.

When you launch a console in a project owned by a team, you can use that team's SSH key from within the console.

Adding an SSH Key to GitHub

Add your Cloudera Machine Learning SSH public key to your GitHub account if you want to use GitHub repositories to create new projects or collaborate on projects.

Procedure

1. Sign in to Cloudera Machine Learning.
2. Go to the upper right drop-down menu and switch context to the account whose key you want to add.
3. On the left sidebar, click Settings.
4. Go to the SSH Keys tab and copy your public SSH key.
5. Sign in to your GitHub account and add the Cloudera Machine Learning key copied in the previous step to your GitHub account. For instructions, refer the GitHub documentation on [adding SSH keys to GitHub](#).

Creating an SSH Tunnel

You can use your SSH key to connect Cloudera Machine Learning to an external database or cluster by creating an SSH tunnel.

About this task

In some environments, external databases and data sources reside behind restrictive firewalls. A common pattern is to provide access to these services using a bastion host with only the SSH port open. Cloudera Machine Learning provides a convenient way to connect to such resources using an SSH tunnel.

If you create an [SSH tunnel](#) to an external server in one of your projects, then all engines that you run in that project are able to connect securely to a port on that server by connecting to a local port. The encrypted tunnel is completely transparent to the user and code.

Procedure

1. Open the Project Settings page.
2. Open the Tunnels tab.
3. Click New Tunnel.
4. Enter the server IP Address or DNS hostname.
5. Enter your username on the server.
6. Enter the local port that should be proxied, and to which remote port on the server.

What to do next

On the remote server, configure SSH to accept password-less logins using your individual or team SSH key. Often, you can do so by appending the SSH key to the file `/home/username/.ssh/authorized_keys`.

Autoscaling Workloads with Kubernetes

Kubernetes dynamically resizes clusters by using the `Kubernetes Cluster Autoscaler` (on Amazon EKS) or `cluster-autoscaler` (on Azure). The cluster autoscaler changes the desired capacity of an autoscaling group to expand or contract a cluster based on pod resource requests.

Scaling Up

The primary trigger for scaling up (or expanding) an autoscaling group is failure by the Kubernetes pod scheduler to find a node that meets the pod's resource requirements. In Cloudera Machine Learning (CML), if the scheduler

cannot find a node to schedule an engine pod because of insufficient CPU or memory, the engine pod will be in “pending” state. When the autoscaler notices this situation, it will change the desired capacity of the autoscaling group (CPU or GPU) to provision a new node in the cluster. As soon as the new node is ready, the scheduler will place the session or engine pod there. In addition to the engine pod, certain CML daemonset pods will also be scheduled on the new node.

The time taken to schedule an engine pod on a new node depends on the amount of time the autoscaler takes to add a new node into the cluster, plus time taken to pull the engine’s Docker image to the new node.

Scaling Down

A cluster is scaled down by the autoscaler by removing a node, when the resource utilization on the given node is less than a pre-defined threshold, provided the node does not have any non-evictable pods running on it. This threshold is currently set to 20% CPU utilization. That is, a node is removed if the following criteria are met:

- The node does not have non-evictable pods
- The node's CPU utilization is less than 20%
- The number of active nodes in the autoscaling group is more than the configured minimum capacity

It is possible that certain pods might be moved from the evicted node to some other node during the down-scaling process.



Note: By default, on AWS and Azure, autoscaling groups can include a maximum of 30 nodes. If more nodes are needed, contact your Cloudera representative.

Limitations on Azure

On Azure, there are some specific limitations to how autoscaling works.

- CPU nodes cannot scale down to zero. You can only have one or more CPU nodes.
- Autoscaling down is sometimes blocked by Azure services. You can check the cluster autoscaler logs to see if this is occurring.

Autoscale Groups

A Cloudera Machine Learning (CML) workspace or cluster consists of three different autoscaling groups: “infra”, “cpu” and “gpu”. These groups scale independently of one another.

Infra Autoscaling Group

The Infra autoscaling group is created automatically when a user provisions a CML cluster, and is not configurable from the UI. This group is meant to run the core CML services that are critical to the overall functioning of the workspace. This group is loosely analogous to the master node of legacy CDSW, however it can scale up or down if necessary. The instance count for this group ranges from 1 to 3, with the default set to 2. The instance type used for the group is m5.2xlarge on AWS, and Standard DS4 v2 on Azure.

CPU Autoscaling Group

The CPU autoscaling group forms the main worker nodes of a CML cluster, and is somewhat configurable from the UI. The user can choose from three different instance types, and can also set the autoscaling range from 0 to 30 CPU worker nodes. This group is meant to run general CPU-only workloads.

GPU Autoscaling Group (not available on Azure)

The GPU autoscaling group consists of instances that have GPUs, and are meant for workloads that require GPU processing. Like the CPU group, this group is configurable from the UI. Unlike the CPU group, this group is meant exclusively for sessions that request > 0 GPUs, and are therefore fenced off from CPU-only workloads, in part because GPU instance types are much more expensive than regular instance types.

Critical and Non-critical Pods

The pods running various Cloudera Machine Learning (CML) services and jobs broadly fall into critical and non-critical types.

Critical pods are protected from preemption by autoscaling to avoid interrupting important services. Most of the pods running in the “infra” autoscaling group are critical. Pods that run user sessions, such as engine pods and Spark executor pods, are also considered critical, and are marked as not safe to evict. CML system services that are deployed as daemonsets (they run on all nodes in the cluster) are deemed important, but not critical. These pods are marked as “safe-to-evict” by autoscaling.

Restricting User-Controlled Kubernetes Pods

Cloudera Machine Learning includes three properties that allow you to control the permissions granted to user-controlled Kubernetes pods.

Required Role: Site Administrator

An example of a user-controlled pod is the engine pod, which provides the environment for sessions, jobs, etc. These pods are launched in a per-user Kubernetes namespace. Since the user has the ability to launch arbitrary pods, these settings restrict what those pods can do.

They are available under the site administrator panel at **Admin Security** under the **Control of User-Created Kubernetes Pods** section.

Do not modify these settings unless you need to run pods that require special privileges. Enabling any of these properties puts CML user data at risk.

Allow privileged pod containers

Pod containers that are “privileged” are extraordinarily powerful. Processes within such containers get almost the same privileges that are available to processes outside the container.

If this property is enabled, a privileged container could potentially access all data on the host.

This property is disabled by default .

Allow pod containers to mount unsupported volume types

The volumes that can be mounted inside a container in a Kubernetes pod are already heavily restricted. Access is normally denied to volume types that are unfamiliar, such as GlusterFS, Cinder, Fibre Channel, etc. If this property is enabled, pods will be able to mount all unsupported volume types.

This property is disabled by default .

Hadoop Authentication for ML Workspaces

About this task

CML does not assume that your Kerberos principal is always the same as your login information. Therefore, you will need to make sure CML knows your Kerberos identity when you sign in.

This procedure is required if you want to run Spark workloads in an ML workspace.

Procedure

1. Navigate to your ML workspace.
2. Go to the top-right dropdown menu, click **Account settings Hadoop Authentication**.
3. To authenticate, either enter your password or click **Upload Keytab** to upload the keytab file directly.

Results

Once successfully authenticated, Cloudera Machine Learning uses your stored credentials to ensure you are secure when running workloads.

CML and outbound network access

Cloudera Machine Learning expects access to certain external networks. See the related information *Outbound internet access and proxy* for further information.



Note: The outbound network access destinations listed in *Outbound internet access and proxy* are only the minimal set required for CDP installation and operation. For environments with limited outbound internet access due to using a firewall or proxy, access to Python or R package repositories such as Python Package Index or CRAN may need to be whitelisted if your use cases require installing packages from those repositories. Alternatively, you may consider creating mirrors of those repositories within your environment.

Related Information

[Outbound internet access and proxy](#)

Transparent Proxy and Egress Trusted List

Cloudera Machine Learning, when used on AWS public cloud, supports transparent proxies. Transparent proxy enables CML to proxy web requests without requiring any particular browser setup.

Egress Trusted List

In normal operation, CML requires the ability to reach several external domains. See *Outbound internet access and proxy* for more information.

Related Information

[Outbound internet access and proxy](#)