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## Create, run, and delete Azure Machine Learning resources using REST

Article • 02/02/2024 • 19 contributors

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There are several ways to manage your Azure Machine Learning resources. You can use the [portal](#), [command-line interface](#), or [Python SDK](#). Or, you can choose the REST API. The REST API uses HTTP verbs in a standard way to create, retrieve, update, and delete resources. The REST API works with any language or tool that can make HTTP requests. REST's straightforward structure often makes it a good choice in scripting environments and for MLOps automation.

In this article, you learn how to:

- ✓ Retrieve an authorization token
- ✓ Create a properly-formatted REST request using service principal authentication
- ✓ Use GET requests to retrieve information about Azure Machine Learning's hierarchical resources
- ✓ Use PUT and POST requests to create and modify resources
- ✓ Use PUT requests to create Azure Machine Learning workspaces

- ✓ Use DELETE requests to clean up resources

## Prerequisites

- An **Azure subscription** for which you have administrative rights. If you don't have such a subscription, try the [free or paid personal subscription](#) [↗](#)
- An **Azure Machine Learning workspace**.
- **Administrative REST requests use service principal authentication.** Follow the steps in [Set up authentication for Azure Machine Learning resources and workflows](#) to create a service principal in your workspace
- The **curl** utility. The **curl** program is available in the [Windows Subsystem for Linux](#) or any UNIX distribution. In PowerShell, **curl** is an alias for **Invoke-WebRequest** and `curl -d "key=val" -X POST uri` becomes `Invoke-WebRequest -Body "key=val" -Method POST -Uri uri`.

## Retrieve a service principal authentication token

Administrative REST requests are authenticated with an OAuth2 implicit flow. This authentication flow uses a token provided by your subscription's service principal. To retrieve this token, you'll need:

- Your tenant ID (identifying the organization to which your subscription belongs)
- Your client ID (which will be associated with the created token)
- Your client secret (which you should safeguard)

You should have these values from the response to the creation of your service principal. Getting these values is discussed in [Set up authentication for Azure Machine Learning resources and workflows](#). If you're using your company subscription, you might not have permission to create a service principal. In that case, you should use either a [free or paid personal subscription](#) [↗](#).

To retrieve a token:

1. Open a terminal window
  2. Enter the following code at the command line
  3. Substitute your own values for `<YOUR-TENANT-ID>`, `<YOUR-CLIENT-ID>`, and `<YOUR-CLIENT-SECRET>`. Throughout this article, strings surrounded by angle brackets are variables you'll have to replace with your own appropriate values.
  4. Run the command
-

Bash

 Copy

```
curl -X POST https://login.microsoftonline.com/<YOUR-TENANT-ID>/oauth2/token \  
-d "grant_type=client_credentials&resource=https%3A%2F%2Fmanagement.azure.com%2F&clie
```

The response should provide an access token good for one hour:

JSON

 Copy

```
{  
  "token_type": "Bearer",  
  "expires_in": "3599",  
  "ext_expires_in": "3599",  
  "expires_on": "1578523094",  
  "not_before": "1578519194",  
  "resource": "https://management.azure.com/",  
  "access_token": "YOUR-ACCESS-TOKEN"  
}
```

Make note of the token, as you'll use it to authenticate all administrative requests. You'll do so by setting an Authorization header in all requests:

Bash

 Copy

```
curl -h "Authorization:Bearer <YOUR-ACCESS-TOKEN>" ...more args...
```

### ⓘ Note

The value starts with the string "Bearer " including a single space before you add the token.

## Get a list of resource groups associated with your subscription

To retrieve the list of resource groups associated with your subscription, run:

Bash

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```
curl https://management.azure.com/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups
```

Across Azure, many REST APIs are published. Each service provider updates their API on their own cadence, but does so without breaking existing programs. The service provider uses the `api-version` argument to ensure compatibility.

### ❗ Important

The `api-version` argument varies from service to service. For the Machine Learning Service, for instance, the current API version is `2023-10-01`. To find the latest API version for other Azure services, see the [Azure REST API reference](#) for the specific service.

All REST calls should set the `api-version` argument to the expected value. You can rely on the syntax and semantics of the specified version even as the API continues to evolve. If you send a request to a provider without the `api-version` argument, the response will contain a human-readable list of supported values.

The above call will result in a compacted JSON response of the form:

```
JSON Copy

{
  "value": [
    {
      "id": "/subscriptions/12345abc-abbc-1b2b-1234-57ab575a5a5a/resourceGroups",
      "name": "RG1",
      "type": "Microsoft.Resources/resourceGroups",
      "location": "westus2",
      "properties": {
        "provisioningState": "Succeeded"
      }
    },
    {
      "id": "/subscriptions/12345abc-abbc-1b2b-1234-57ab575a5a5a/resourceGroups",
      "name": "RG2",
      "type": "Microsoft.Resources/resourceGroups",
      "location": "eastus",
      "properties": {
        "provisioningState": "Succeeded"
      }
    }
  ]
}
```

## Drill down into workspaces and their resources

To retrieve the set of **workspaces in a resource group**, run the following, replacing `<YOUR-SUBSCRIPTION-ID>`, `<YOUR-RESOURCE-GROUP>`, and `<YOUR-ACCESS-TOKEN>`:

 Copy

```
curl https://management.azure.com/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups
-H "Authorization:Bearer <YOUR-ACCESS-TOKEN>"
```

Again you'll receive a JSON list, this time containing a list, each item of which details a workspace:

JSON

 Copy

```
{
  "id": "/subscriptions/12345abc-abb-1b2b-1234-57ab575a5a5a/resourceGroups/DeepLea
  "name": "my-workspace",
  "type": "Microsoft.MachineLearningServices/workspaces",
  "location": "centralus",
  "tags": {},
  "etag": null,
  "properties": {
    "friendlyName": "",
    "description": "",
    "creationTime": "2023-01-03T19:56:09.7588299+00:00",
    "storageAccount": "/subscriptions/12345abc-abb-1b2b-1234-57ab575a5a5a/resour
    "containerRegistry": null,
    "keyVault": "/subscriptions/12345abc-abb-1b2b-1234-57ab575a5a5a/resourcegrou
    "applicationInsights": "/subscriptions/12345abc-abb-1b2b-1234-57ab575a5a/r
    "hbiWorkspace": false,
    "workspaceId": "cba12345-abab-abab-abab-ababab123456",
    "subscriptionState": null,
    "subscriptionStatusChangeTimeStampUtc": null,
    "discoveryUrl": "https://centralus.experiments.azureml.net/discovery"
  },
  "identity": {
    "type": "SystemAssigned",
    "principalId": "abcdef1-abab-1234-1234-abababab123456",
    "tenantId": "1fedcba-abab-1234-1234-abababab123456"
  },
  "sku": {
    "name": "Basic",
    "tier": "Basic"
  }
}
```

To work with resources within a workspace, you'll switch from the general `management.azure.com` server to a **REST API server specific to the location of the workspace.**

Note the value of the `discoveryUrl` key in the above JSON response. If you GET that URL, you'll receive a response something like:

JSON Copy

```
{
  "api": "https://centralus.api.azureml.ms",
  "catalog": "https://catalog.cortanaanalytics.com",
  "experimentation": "https://centralus.experiments.azureml.net",
  "gallery": "https://gallery.cortanaintelligence.com/project",
  "history": "https://centralus.experiments.azureml.net",
  "hyperdrive": "https://centralus.experiments.azureml.net",
  "labeling": "https://centralus.experiments.azureml.net",
  "modelmanagement": "https://centralus.modelmanagement.azureml.net",
  "pipelines": "https://centralus.aether.ms",
  "studiocoreservices": "https://centralus.studioservice.azureml.com"
}
```

The value of the `api` response is the URL of the server that you'll use for more requests. To list experiments, for instance, send the following command. Replace `REGIONAL-API-SERVER` with the value of the `api` response (for instance, `centralus.api.azureml.ms`). Also replace `YOUR-SUBSCRIPTION-ID`, `YOUR-RESOURCE-GROUP`, `YOUR-WORKSPACE-NAME`, and `YOUR-ACCESS-TOKEN` as usual:

Bash Copy

```
curl https://<REGIONAL-API-SERVER>/history/v1.0/subscriptions/<YOUR-SUBSCRIPTION-ID>/
providers/Microsoft.MachineLearningServices/workspaces/<YOUR-WORKSPACE-NAME>/experime
-H "Authorization:Bearer <YOUR-ACCESS-TOKEN>"
```

Similarly, to retrieve registered models in your workspace, send:

Bash Copy

```
curl https://<REGIONAL-API-SERVER>/modelmanagement/v1.0/subscriptions/<YOUR-SUBSCRIPT
providers/Microsoft.MachineLearningServices/workspaces/<YOUR-WORKSPACE-NAME>/models?a
-H "Authorization:Bearer <YOUR-ACCESS-TOKEN>"
```

Notice that to list experiments the path begins with `history/v1.0` while to list models, the path begins with `modelmanagement/v1.0`. The REST API is divided into several operational groups, each with a distinct path.

Area	Path
Artifacts	/rest/api/azureml
Data stores	/azure/machine-learning/how-to-access-data
Hyperparameter tuning	hyperdrive/v1.0/
Models	modelmanagement/v1.0/
Run history	execution/v1.0/ and history/v1.0/

You can explore the REST API using the general pattern of:

[Expand table](#)

URL component	Example
https://	
REGIONAL-API-SERVER/	centralus.api.azureml.ms/
operations-path/	history/v1.0/
subscriptions/YOUR-SUBSCRIPTION-ID/	subscriptions/abcde123-abab-abab-1234-0123456789abc/
resourceGroups/YOUR-RESOURCE-GROUP/	resourceGroups/MyResourceGroup/
providers/operation-provider/	providers/Microsoft.MachineLearningServices/
provider-resource-path/	workspaces/MyWorkspace/experiments/FirstExperiment/runs/1/
operations-endpoint/	artifacts/metadata/

## Create and modify resources using PUT and POST requests

In addition to resource retrieval with the GET verb, the REST API supports the creation of all the resources necessary to train, deploy, and monitor ML solutions.

Training and running ML models require compute resources. You can list the compute resources of a workspace with:

Bash

[Copy](#)

```
curl https://management.azure.com/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups
providers/Microsoft.MachineLearningServices/workspaces/<YOUR-WORKSPACE-NAME>/computes
-H "Authorization:Bearer <YOUR-ACCESS-TOKEN>"
```

To create or overwrite a named compute resource, you'll use a PUT request. In the following, in addition to the now-familiar replacements of `YOUR-SUBSCRIPTION-ID`, `YOUR-RESOURCE-GROUP`, `YOUR-WORKSPACE-NAME`, and `YOUR-ACCESS-TOKEN`, replace `YOUR-COMPUTE-NAME`, and values for `location`, `vmSize`, `vmPriority`, `scaleSettings`, `adminUserName`, and `adminUserPassword`. The following command creates a dedicated, single-node Standard\_D1 (a basic CPU compute resource) that will scale down after 30 minutes:

Bash

 Copy

```
curl -X PUT \
  'https://management.azure.com/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<
  -H 'Authorization:Bearer <YOUR-ACCESS-TOKEN>' \
  -H 'Content-Type: application/json' \
  -d '{
    "location": "eastus",
    "properties": {
      "computeType": "AmlCompute",
      "properties": {
        "vmSize": "Standard_D1",
        "vmPriority": "Dedicated",
        "scaleSettings": {
          "maxNodeCount": 1,
          "minNodeCount": 0,
          "nodeIdleTimeBeforeScaleDown": "PT30M"
        }
      }
    },
    "userAccountCredentials": {
      "adminUserName": "<ADMIN_USERNAME>",
      "adminUserPassword": "<ADMIN_PASSWORD>"
    }
  }'
```

#### ⓘ Note

In Windows terminals you may have to escape the double-quote symbols when sending JSON data. That is, text such as `"location"` becomes `\\"location\\"`.

A successful request will get a `201 Created` response, but note that this response simply means



that the provisioning process has begun. You'll need to poll (or use the portal) to confirm its successful completion.

## Create a workspace using REST

Every Azure Machine Learning workspace has a dependency on four other Azure resources: an Azure Container Registry resource, Azure Key Vault, Azure Application Insights, and an Azure Storage account. You can't create a workspace until these resources exist. Consult the REST API reference for the details of creating each such resource.

To create a workspace, PUT a call similar to the following to `management.azure.com`. While this call requires you to set a large number of variables, it's structurally identical to other calls that this article has discussed.

Bash

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```
curl -X PUT \
  'https://management.azure.com/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<
  /providers/Microsoft.MachineLearningServices/workspaces/<YOUR-NEW-WORKSPACE-NAME>?api
  -H 'Authorization: Bearer <YOUR-ACCESS-TOKEN>' \
  -H 'Content-Type: application/json' \
  -d '{
    "location": "AZURE-LOCATION>",
    "identity" : {
      "type" : "systemAssigned"
    },
    "properties": {
      "friendlyName" : "<YOUR-WORKSPACE-FRIENDLY-NAME>",
      "description" : "<YOUR-WORKSPACE-DESCRIPTION>",
      "containerRegistry" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<
      providers/Microsoft.ContainerRegistry/registries/<YOUR-REGISTRY-NAME>",
      "keyVault" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YOUR-RESOU
      /providers/Microsoft.Keyvault/vaults/<YOUR-KEYVAULT-NAME>",
      "applicationInsights" : "subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/
      providers/Microsoft.insights/components/<YOUR-APPLICATION-INSIGHTS-NAME>",
      "storageAccount" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YOU
      providers/Microsoft.Storage/storageAccounts/<YOUR-STORAGE-ACCOUNT-NAME>"
    }
  }'
```

You should receive a 202 Accepted response and, in the returned headers, a Location URI. You can GET this URI for information on the deployment, including helpful debugging information if there's a problem with one of your dependent resources (for instance, if you forgot to enable admin access on your container registry).

# Create a workspace using a user-assigned managed identity

When creating workspace, you can specify a user-assigned managed identity that will be used to access the associated resources: ACR, KeyVault, Storage, and App Insights. To **create a workspace with user-assigned managed identity**, use the below request body.

Bash

 Copy

```
curl -X PUT \
  'https://management.azure.com/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/</providers/Microsoft.MachineLearningServices/workspaces/<YOUR-NEW-WORKSPACE-NAME>?api
  -H 'Authorization: Bearer <YOUR-ACCESS-TOKEN>' \
  -H 'Content-Type: application/json' \
  -d '{
    "location": "AZURE-LOCATION>",
    "identity": {
      "type": "SystemAssigned,UserAssigned",
      "userAssignedIdentities": {
        "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YOUR-RESOURCE-GROUP>/\
providers/Microsoft.ManagedIdentity/userAssignedIdentities/<YOUR-MANAGED-IDENTITY>":
      }
    },
    "properties": {
      "friendlyName" : "<YOUR-WORKSPACE-FRIENDLY-NAME>",
      "description" : "<YOUR-WORKSPACE-DESCRIPTION>",
      "containerRegistry" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<
providers/Microsoft.ContainerRegistry/registries/<YOUR-REGISTRY-NAME>",
      "keyVault" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YOUR-RESOU
/providers/Microsoft.Keyvault/vaults/<YOUR-KEYVAULT-NAME>",
      "applicationInsights" : "subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/
providers/Microsoft.insights/components/<YOUR-APPLICATION-INSIGHTS-NAME>",
      "storageAccount" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YOU
providers/Microsoft.Storage/storageAccounts/<YOUR-STORAGE-ACCOUNT-NAME>"
    }
  }'
```

# Create a workspace using customer-managed encryption keys

By default, **metadata for the workspace is stored in an Azure Cosmos DB instance** that Microsoft maintains. This data is encrypted using Microsoft-managed keys. **Instead of using the Microsoft-managed key, you can also provide your own key.** Doing so creates an **another set of resources** in your Azure subscription to store your data.

To create a workspace that uses your keys for encryption, you need to meet the following prerequisites:

- The Azure Machine Learning service principal must have contributor access to your Azure subscription.
- You must have an existing Azure Key Vault that contains an encryption key.
- The Azure Key Vault must exist in the same Azure region where you'll create the Azure Machine Learning workspace.
- The Azure Key Vault must have soft delete and purge protection enabled to protect against data loss if there was accidental deletion.
- You must have an access policy in Azure Key Vault that grants get, wrap, and unwrap access to the Azure Cosmos DB application.

To create a workspace that uses a user-assigned managed identity and customer-managed keys for encryption, use the below request body. When using a user-assigned managed identity for the workspace, also set the `userAssignedIdentity` property to the resource ID of the managed identity.

Bash

 Copy

```
curl -X PUT \  
  'https://management.azure.com/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<  
/providers/Microsoft.MachineLearningServices/workspaces/<YOUR-NEW-WORKSPACE-NAME>?api  
-H 'Authorization: Bearer <YOUR-ACCESS-TOKEN>' \  
-H 'Content-Type: application/json' \  
-d '{  
  "location": "eastus2euap",  
  "identity": {  
    "type": "SystemAssigned"  
  },  
  "properties": {  
    "friendlyName": "<YOUR-WORKSPACE-FRIENDLY-NAME>",  
    "description": "<YOUR-WORKSPACE-DESCRIPTION>",  
    "containerRegistry" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YO  
providers/Microsoft.ContainerRegistry/registries/<YOUR-REGISTRY-NAME>",  
    "keyVault" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YOUR-RESOUR  
/providers/Microsoft.Keyvault/vaults/<YOUR-KEYVAULT-NAME>",  
    "applicationInsights" : "subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<Y  
providers/Microsoft.insights/components/<YOUR-APPLICATION-INSIGHTS-NAME>",  
    "storageAccount" : "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YOUR-  
providers/Microsoft.Storage/storageAccounts/<YOUR-STORAGE-ACCOUNT-NAME>",  
    "encryption": {  
      "status": "Enabled",  
      "identity": {  
        "userAssignedIdentity": null  
      },  
    },  
    "keyVaultProperties": {  
      "keyVaultArmId": "/subscriptions/<YOUR-SUBSCRIPTION-ID>/resourceGroups/<YO
```

```
providers/Microsoft.KeyVault/vaults/<YOUR-VAULT>","
    "keyIdentifier": "https://<YOUR-VAULT>.vault.azure.net/keys/<YOUR-KEY>/<YO
    "identityClientId": ""
  }
},
"hubWorkspace": false
}
}'
```

## Delete resources you no longer need

Some, but not all, resources support the DELETE verb. Check the [API Reference](#) before committing to the REST API for deletion use-cases. To delete a model, for instance, you can use:

```
Bash                                                                    Copy

curl
-X DELETE \
'https://<REGIONAL-API-SERVER>/modelmanagement/v1.0/subscriptions/<YOUR-SUBSCRIPTION-
-H 'Authorization:Bearer <YOUR-ACCESS-TOKEN>'
```

## Troubleshooting

### Resource provider errors

When creating an Azure Machine Learning workspace, or a resource used by the workspace, you may receive an error similar to the following messages:

- No registered resource provider found for location {location}
- The subscription is not registered to use namespace {resource-provider-namespace}

Most resource providers are automatically registered, but not all. If you receive this message, you need to register the provider mentioned.

The following table contains a list of the resource providers required by Azure Machine Learning:

[Expand table](#)

Resource provider	Why it's needed
Microsoft.MachineLearningServices	Creating the Azure Machine Learning workspace.
Microsoft.Storage	Azure Storage Account is used as the default storage for the workspace.
Microsoft.ContainerRegistry	Azure Container Registry is used by the workspace to build Docker images.
Microsoft.KeyVault	Azure Key Vault is used by the workspace to store secrets.
Microsoft.Notebooks	Integrated notebooks on Azure Machine Learning compute instance.
Microsoft.ContainerService	If you plan on deploying trained models to Azure Kubernetes Services.

If you plan on using a customer-managed key with Azure Machine Learning, then the following service providers must be registered:

 Expand table

Resource provider	Why it's needed
Microsoft.DocumentDB	Azure CosmosDB instance that logs metadata for the workspace.
Microsoft.Search	Azure Search provides indexing capabilities for the workspace.

If you plan on using a managed virtual network with Azure Machine Learning, then the Microsoft.Network resource provider must be registered. This resource provider is used by the workspace when creating private endpoints for the managed virtual network.

For information on registering resource providers, see [Resolve errors for resource provider registration](#).

## Moving the workspace

### Warning

Moving your Azure Machine Learning workspace to a different subscription, or moving the owning subscription to a new tenant, is not supported. Doing so may cause errors.

# Deleting the Azure Container Registry

The Azure Machine Learning workspace uses Azure Container Registry (ACR) for some operations. It will automatically create an ACR instance when it first needs one.

## Warning

Once an Azure Container Registry has been created for a workspace, do not delete it. Doing so will break your Azure Machine Learning workspace.

## Next steps

- Explore the complete [Azure Machine Learning REST API reference](#).
- Explore [Azure Machine Learning with Jupyter notebooks](#).

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## Additional resources

### Documentation

#### [Azure Machine Learning REST APIs](#)

The Machine Learning REST APIs allow you to develop clients that use REST calls to work with the service.

#### [Deploy models using online endpoints with REST APIs - Azure Machine Learning](#)

Learn how to deploy models using online endpoints with REST APIs.

## [Register and work with models - Azure Machine Learning](#)

Learn how to register and work with different model types in Azure Machine Learning (such as custom, MLflow, and Triton).

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
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