

Lab Module 5b: GitHub: Application Deployment to Kubernetes



Estimated Duration: 120 minutes

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Exercise: Configure GitHub

Use this configuration to prepare GitHub for either one of the following exercises.

Use the same ACR, Azure Key Vault and AKS cluster you created for **Lab 4**.

Task 1 - Create a GitHub account

1. If you don't already have access to a GitHub account, navigate to: <https://github.com>
2. Click on sign up.
3. Use an email of your choice to create an account.
4. Login to your new account.

Task 2 - Create a ssh key

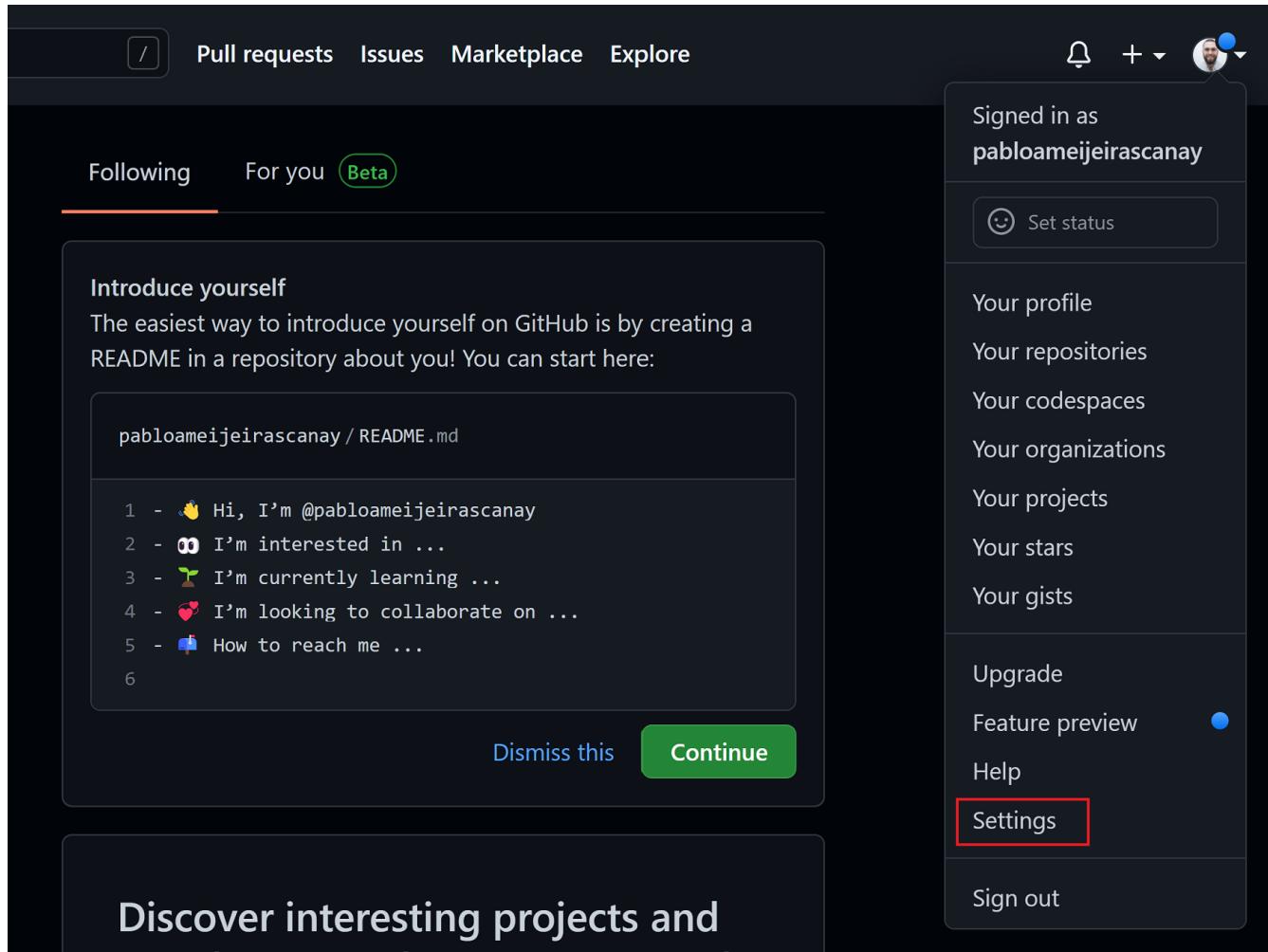
1. Generate a SSH key (use your email) and **DO NOT ENTER A PASSPHRASE**.

```
ssh-keygen -C "myemail@mycompany.com"
```

```
Windows PowerShell + - PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web> ssh-keygen -C "pabloam@microsoft.com"
Generating public/private rsa key pair.
Enter file in which to save the key (C:\Users\pabloam/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in C:\Users\pabloam/.ssh/id_rsa.
Your public key has been saved in C:\Users\pabloam/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:BaiR2NurQZm1YbX01An3znNjoM7v+YkLr6+E8aRS0Rg pabloam@microsoft.com
The key's randomart image is:
+---[RSA 3072]---+
| o . o+ oo.. |
| . + =. = .o. |
| X E. o .. |
| * o o.. .o. |
| . oS= o +o. |
| . . . X .o. |
| o . o * |
| . . . + o . |
| o=ooo |
+---[SHA256]---+
PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web>
```

Task 3 - Configure your GitHub SSH Key

1. If you haven't already done so, login to your GitHub account.
2. Select your avatar in the upper right of the user interface and then click on **Settings** in the menu that appears.



The screenshot shows the GitHub user interface with a dark theme. At the top, there's a navigation bar with links for Pull requests, Issues, Marketplace, and Explore. On the right side, there's a user profile icon and a dropdown menu. The dropdown menu is titled "Signed in as pabloameijeirascany" and includes options like Set status, Your profile, Your repositories, Your codespaces, Your organizations, Your projects, Your stars, Your gists, Upgrade, Feature preview (with a blue dot indicating it's active), Help, Settings (which is highlighted with a red box), and Sign out.

Introduce yourself
The easiest way to introduce yourself on GitHub is by creating a README in a repository about you! You can start here:

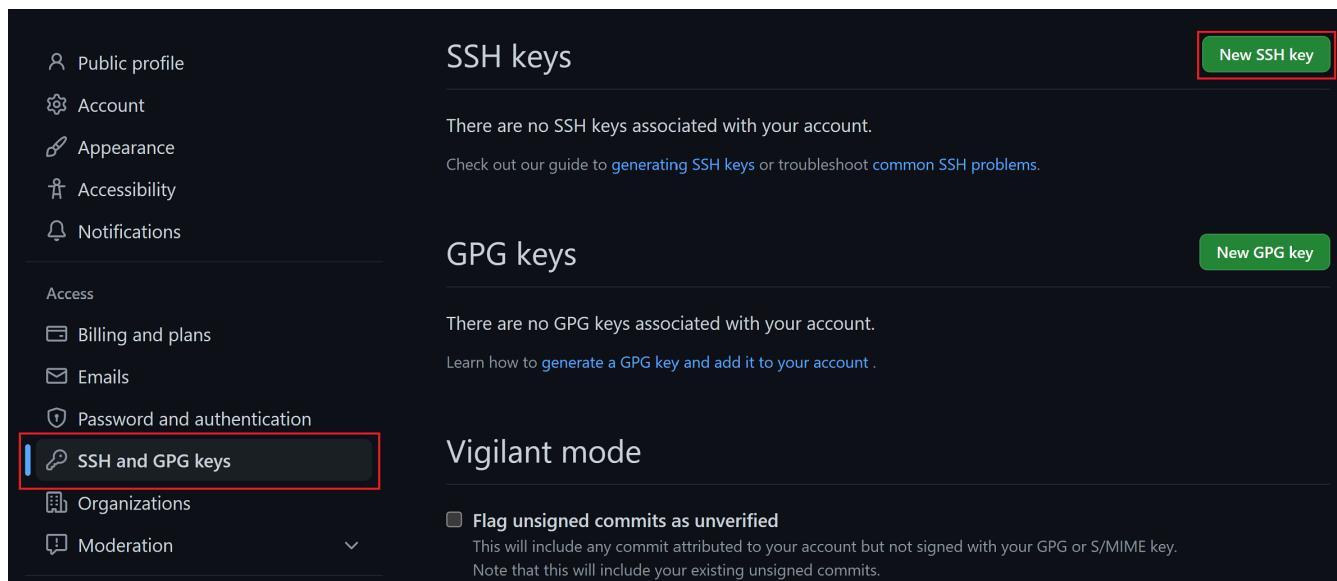
pabloameijeirascany / README.md

```
1 - 🌟 Hi, I'm @pabloameijeirascany
2 - 💬 I'm interested in ...
3 - 🌱 I'm currently learning ...
4 - ❤️ I'm looking to collaborate on ...
5 - 📩 How to reach me ...
6
```

Dismiss this Continue

Discover interesting projects and

3. Click on **SSH and GPG keys** and **New SSH key**.



The screenshot shows the GitHub account settings page. On the left, there's a sidebar with various settings categories: Public profile, Account, Appearance, Accessibility, Notifications, Access, Billing and plans, Emails, Password and authentication, **SSH and GPG keys** (which is highlighted with a red box), Organizations, and Moderation. The main content area has three sections: **SSH keys**, **GPG keys**, and **Vigilant mode**. The **SSH keys** section says "There are no SSH keys associated with your account." and has a "New SSH key" button. The **GPG keys** section says "There are no GPG keys associated with your account." and has a "New GPG key" button. The **Vigilant mode** section has a checkbox for "Flag unsigned commits as unverified" which is unchecked. A note below it says: "This will include any commit attributed to your account but not signed with your GPG or S/MIME key. Note that this will include your existing unsigned commits."

4. Copy the content of the public key (for example, id_rsa.pub) that you generated in your local.

```
cat C:\Users\pabloam\.ssh\id_rsa.pub
```

```
PS C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web> cat C:\Users\pabloam\.ssh\id_rsa.pub
ssh-rsa AAAAB3NzaC1yc2EAAAQABAAQgQDQ4ouamx0REsnPlV6mnxyROEH43q4CmzNCxkNtJlg08P32r2pPCDkRiyW8t2JJ0+QPGS68N4
= pabloam@microsoft.com
PS C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web>
```

5. Name it as ssh key in the **Title section** and paste the content in the **Key** section. Finally, click on **Add SSH key**.

The screenshot shows the GitHub interface for adding a new SSH key. The 'Title' field is filled with 'ssh key'. The 'Key' field contains the copied SSH public key, which is a long string of characters starting with 'ssh-rsa' and ending with a comment line. Below the key field is a green 'Add SSH key' button, which is highlighted with a red border.

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Exercise: Create a GitHub Repository

Task 1 - Create a local git repo for the MT3Chained-Web folder

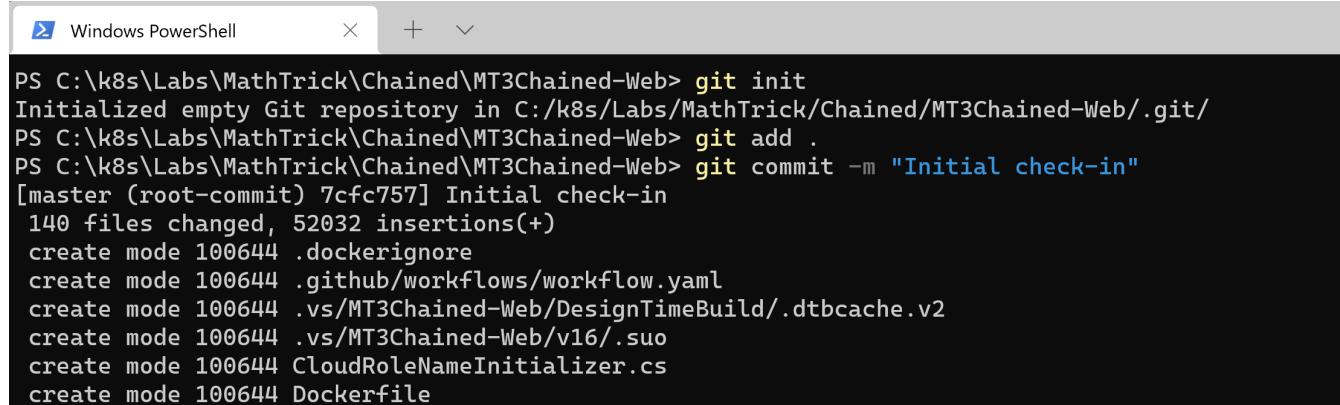
1. Open the Windows Terminal and change into the **C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web** folder.

```
cd C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web
```

2. Initialize git and check in the source code.

```
git init  
git add .  
git commit -m "Initial check-in"
```

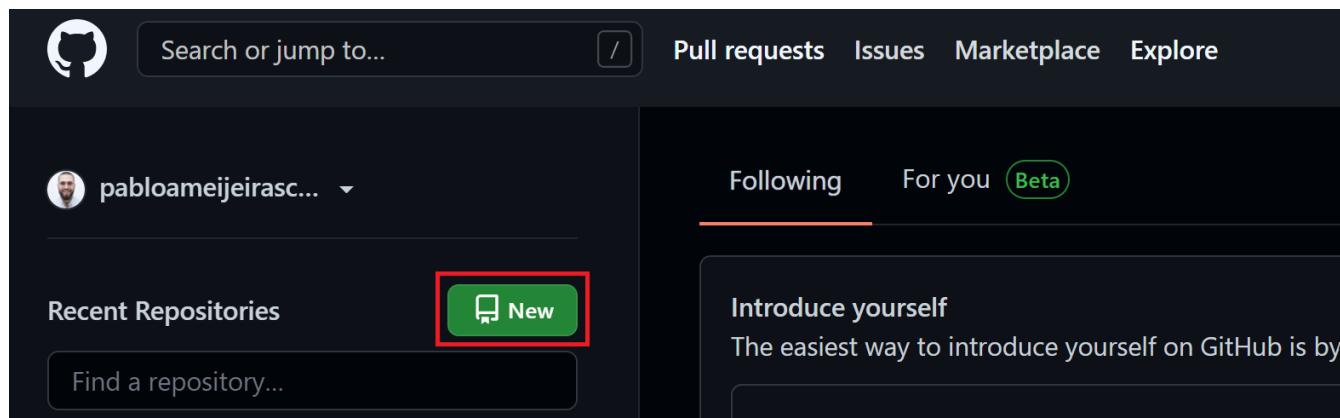
The shell should look like this:



```
PS C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web> git init  
Initialized empty Git repository in C:/k8s/Labs/MathTrick/Chained/MT3Chained-Web/.git/  
PS C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web> git add .  
PS C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web> git commit -m "Initial check-in"  
[master (root-commit) 7fcf757] Initial check-in  
 140 files changed, 52032 insertions(+)  
 create mode 100644 .dockerignore  
 create mode 100644 .github/workflows/workflow.yaml  
 create mode 100644 .vs/MT3Chained-Web/DesignTimeBuild/.dtbcache.v2  
 create mode 100644 .vs/MT3Chained-Web/v16/.suo  
 create mode 100644 CloudRoleNameInitializer.cs  
 create mode 100644 Dockerfile
```

Task 2 - Create the GitHub repo for the local MT3Chained-Web repo

1. Go to the GitHub principal page and Select **New** from the left side.



2. Create a new repository called "MT3Chained-Web". **CHECK "Private"** and click on **Create Repository** button.
3. In the next window copy the following commands.

The screenshot shows the GitHub repository setup interface. At the top, there are navigation links: Code, Issues, Pull requests, Actions, Projects, Security, Insights, and Settings. Below these, a section titled "Quick setup — if you've done this kind of thing before" provides options to "Set up in Desktop" (disabled), "HTTPS", "SSH", and "git@github.com:pabloameijeirascanay/MT3Chained-Web.git". It also encourages users to "Get started by creating a new file or uploading an existing file. We recommend every repository include a README, LICENSE, and .gitignore." A "Copy" button is located at the top right of this section.

Below this, a section titled "...or create a new repository on the command line" contains the following command:

```
echo "# MT3Chained-Web" >> README.md  
git init  
git add README.md  
git commit -m "first commit"  
git branch -M main  
git remote add origin git@github.com:pabloameijeirascanay/MT3Chained-Web.git  
git push -u origin main
```

At the bottom of the page, another section titled "...or push an existing repository from the command line" contains the following command:

```
git remote add origin git@github.com:pabloameijeirascanay/MT3Chained-Web.git  
git branch -M main  
git push -u origin main
```

A red box highlights the command line section, and a red arrow points to the "Copy" button at the top right of the highlighted area.

4. Go back to your Windows Terminal and paste those contents and enter yes.

```
PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web> git remote add origin git@github.com:pabloameijeirascanay/MT3Chained-Web.git  
PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web> git branch -M main  
PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web> git push -u origin main  
The authenticity of host 'github.com (140.82.121.4)' can't be established.  
ED25519 key fingerprint is SHA256:+DiY3wvvV6TuJJhbPZisF/zLDA0zPMsvHdkr4UvCOqU.  
This key is not known by any other names  
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes  
Warning: Permanently added 'github.com' (ED25519) to the list of known hosts.  
Enumerating objects: 97, done.  
Counting objects: 100% (97/97), done.  
Delta compression using up to 8 threads  
Compressing objects: 100% (92/92), done.  
Writing objects: 100% (97/97), 937.45 KiB | 1.86 MiB/s, done.  
Total 97 (delta 15), reused 0 (delta 0), pack-reused 0  
remote: Resolving deltas: 100% (15/15), done.  
To github.com:pabloameijeirascanay/MT3Chained-Web.git  
 * [new branch]      main -> main  
Branch 'main' set up to track remote branch 'main' from 'origin'.  
PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web>
```

5. Refresh the GitHub page, you should see your local files.

The screenshot shows a GitHub repository page for 'pabloameijeirascanay / MT3Chained-Web'. The 'Code' tab is selected. At the top, there are links for Issues, Pull requests, Actions, Projects, Security, Insights, and Settings. Below the header, it shows 'main' branch, 1 branch, 0 tags, and buttons for Go to file, Add file, and Code. The main content area displays a commit history for 'Initial check-in' by 'pabloameijeirascanay' (bbdad36) 7 minutes ago, which includes 1 commit. The commit details show files like .github/workflows, Models, Pages, Properties, Services, wwwroot, .dockerignore, CloudRoleNameInitializer.cs, Dockerfile, MT3Chained-Web.csproj, and MT3Chained-Web.csproj.user all checked in 7 minutes ago.

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Exercise: Create the Secrets for the GitHub repo

Task 1 - Create a service principal and grant it access to the AKS resource group

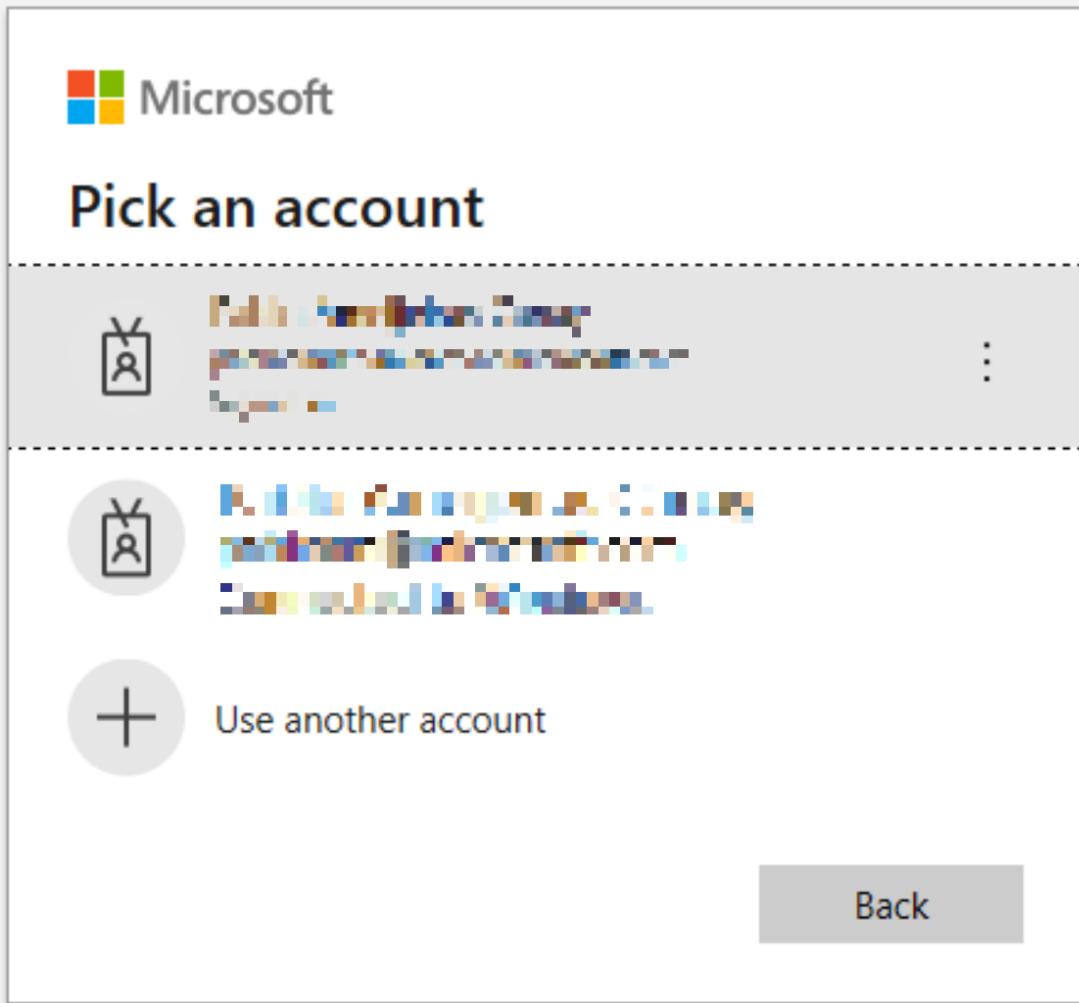
We will create the secrets with Service Principal values, so first we must create a Service Principal.

1. Login to Azure with PowerShell.

```
Connect-AzAccount
```

2. Use your user email and password.

Microsoft Azure



3. Create a Service Principal and assign it the Contributor role in your resource group (AKS Resource Group). You just have to copy the following Azure PowerShell code and paste it in the Windows Terminal.

```
$resourceGroupId = (Get-AzResourceGroup -Name $RESOURCE_GROUP).ResourceId  
  
$SP_NAME="sp-aks-$($YOUR_INITIALS)$SUFFIX"  
  
Write-Host "Service Principal Name:" $SP_NAME  
  
$azurerc = Get-AzContext
```

```

$servicePrincipal = New-AzADServicePrincipal `

-DisplayName $SP_NAME `

-Role Contributor `

-Scope $resourceGroupId

$output = @{
    clientId = $($servicePrincipal.ApplicationId)
    clientSecret = $([System.Net.NetworkCredential]::new('', $servicePrincipal.Secret).Password)
    subscriptionId = $($azurercContext.Subscription.Id)
    tenantId = $($azurercContext.Tenant.Id)
}

$output | ConvertTo-Json

```

4. The script output should look like this:

```

PS C:\k8s\labs\MathTrick\Chained\MT3Chained-Web> $output | ConvertTo-Json
{
    "subscriptionId": "00000000-0000-0000-0000-000000000000",
    "tenantId": "00000000-0000-0000-0000-000000000000",
    "clientId": "00000000-0000-0000-0000-000000000000",
    "clientSecret": "00000000-0000-0000-0000-000000000000"
}
PS C:\k8s\labs\MathTrick\Chained\MT3Chained-Web>

```

5. Copy the script output in a .txt file, since it will be used in the next steps.

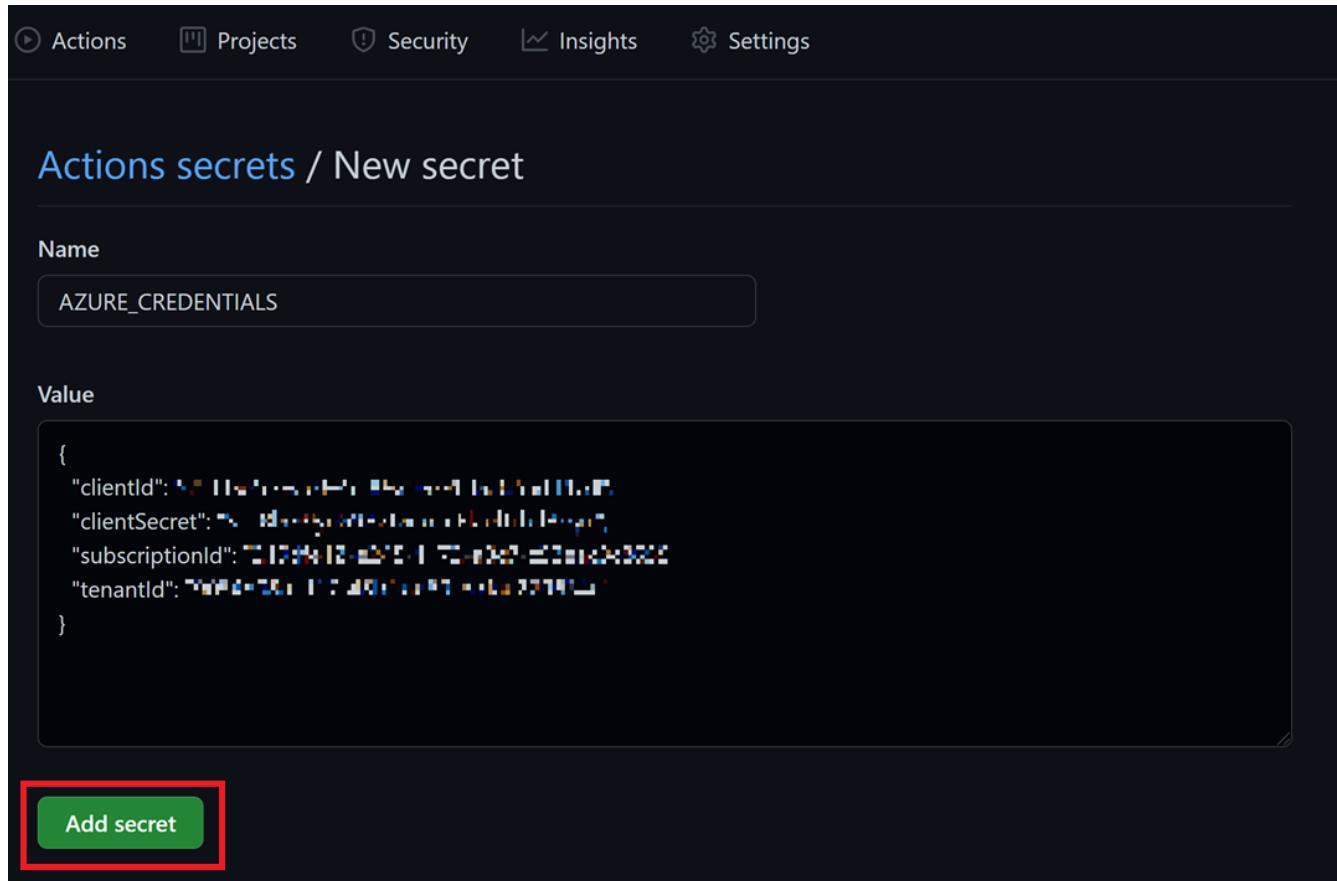
You've created the service principal. Next, create secrets in the GitHub Repository.

Task 2 - Create the GitHub Action Secret to manage the AKS cluster and the Azure Key Vault

1. In your browser, navigate to your GitHub repository (**MT3Chained-Web**).
2. Select Settings > Secrets > Actions.
3. Select New repository secret.

The screenshot shows the GitHub repository settings interface. The top navigation bar includes links for Code, Issues, Pull requests, Actions, Projects, Security, Insights, and Settings. The Settings link is highlighted with a red box. The left sidebar has sections for General, Access, Collaborators, Code and automation (Branches, Tags, Actions, Webhooks, Pages), Security (Code security and analysis, Deploy keys, Secrets, Actions), Codespaces, and Dependabot. The 'Secrets' section is also highlighted with a red box. The main content area is titled 'Actions secrets' and displays a message: 'There are no secrets for this repository.' It also states that 'Encrypted secrets allow you to store sensitive information, such as access tokens, in your repository.' A 'New repository secret' button is located in the top right corner of this area.

4. Name the secret as **AZURE_CREDENTIALS**.
5. In the **Value** field, paste the JSON object that you copied in the .txt file in the previous section.
6. Click **Add secret**.



The screenshot shows the GitHub Actions secrets creation interface. At the top, there are navigation links: Actions, Projects, Security, Insights, and Settings. Below the header, the title "Actions secrets / New secret" is displayed. The "Name" field contains "AZURE_CREDENTIALS". The "Value" field contains a JSON object:

```
{  
  "clientId": "00000000-0000-0000-0000-000000000000",  
  "clientSecret": "00000000-0000-0000-0000-000000000000",  
  "subscriptionId": "00000000-0000-0000-0000-000000000000",  
  "tenantId": "00000000-0000-0000-0000-000000000000"  
}
```

A green button labeled "Add secret" is visible at the bottom left, with a red box highlighting it.

Task 3 - Create the GitHub Actions Secrets for the Azure Container Registry Authentication

1. Select New repository secret.
2. Name the secret as **ACR_CLIENT_ID**.
3. In the **Value** field, paste the **"clientId"** value of the JSON object that you copied in the previous section in the .txt file.
4. Select **Add secret**.

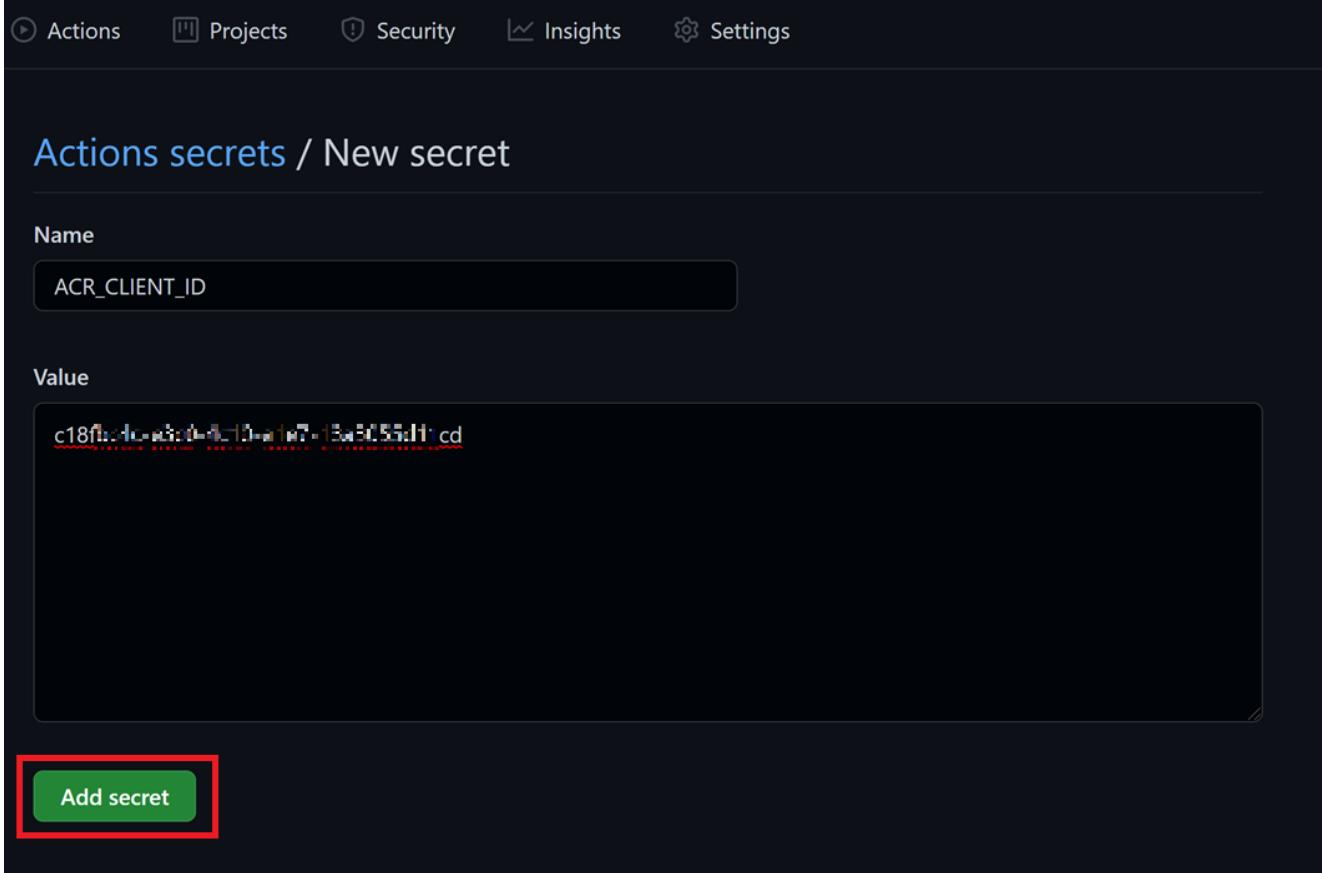
Actions Projects Security Insights Settings

Actions secrets / New secret

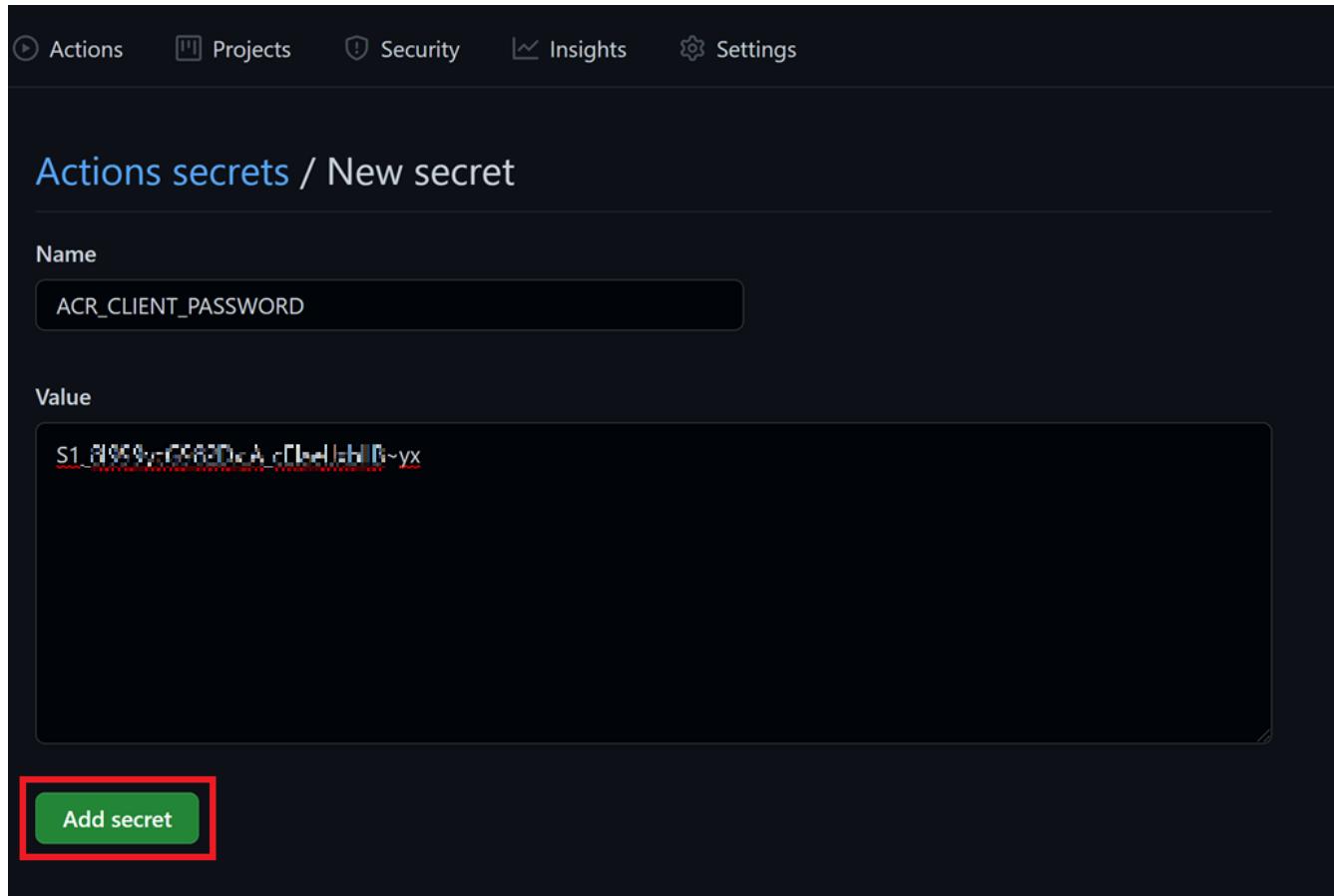
Name
ACR_CLIENT_ID

Value
c18f1e4d-e530-424d-9ea1-6e5055d11cd

Add secret



5. Select New repository secret.
6. Name the secret as **ACR_CLIENT_PASSWORD**.
7. In the **Value** field, paste the **"clientSecret"** value of the JSON object that you copied in the previous section in the .txt file.
8. Click **Add secret**.



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Exercise: Create a Basic CI/CD Pipeline with GitHub Actions

Task 1 - Create the GitHub Action

1. To create a GitHub Action, you need to have a `workflow.yaml` in the `C:\k8s\Jobs\MathTrick\Chained\MT3Chained-Web\.github\workflows` directory. Now there is a file `workflow-web1.yaml` in the `C:\k8s\Jobs\Module5\workflows` directory with the following content:

NOTE: This workflow build, tag, and push the web image to your Azure Container Registry.

```
name: Math Trick 3 - Chained-Web-CI

on:
  push:
    branches:
      - main

env:
  APP_NAME: <appName>
  LOGIN_SERVER: <acrServerName>
```

```

jobs:

  build:
    runs-on: ubuntu-latest
    steps:
      - name: Check Out Repo
        uses: actions/checkout@v2

      # Connect to Azure Container Registry (ACR)
      - name: ACR login
        uses: azure/docker-login@v1
        with:
          login-server: ${{ env.LOGIN_SERVER }}
          username: ${{ secrets.ACRL_CLIENT_ID }}
          password: ${{ secrets.ACRL_CLIENT_PASSWORD }}

      # Container build and push to a Azure Container Registry (ACR)
      - name: Build, tag, and push image to ACR
        uses: docker/build-push-action@v2
        with:
          context: ./
          file: Dockerfile
          push: true
          tags: |
            ${{ env.LOGIN_SERVER }}/{{ env.APP_NAME }}:${{ github.run_number }}
            ## <latestTag> ##
```

NOTE: Take in to account that all the workflow.yaml created in this lab will run whenever you push a change in the main branch of the GitHub repository.

```

on:
  push:
    branches:
      - main
```

2. Obtain the Azure Container Registry Server Name.

```
$ACR_SERVER_NAME=(az acr show -n $ACR_NAME --query loginServer -o tsv)
```

3. Create the **.github\workflows** folder in the path **C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web**.

```
New-Item -Path "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web\.github\workflows" -ItemType Directory
```

4. Replace the **workflow-web1.yaml** file with the correct values and create the right file **workflow.yaml** in the right path.

```

$Path1="C:\k8s\Labs\Module5\workflows"
$Path2="C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web\.github\workflows"
$original_file = (Join-Path $Path1 workflow-web1.yaml)
```

```
$destination_file = (Join-Path $Path2 workflow.yaml)
(Get-Content $original_file) | Foreach-Object {
    $_ -replace "<appName>", "mt3chained-web" ` 
    -replace "<acrServerName>", $ACR_SERVER_NAME
} | Set-Content $destination_file
```

5. Push the changes to your GitHub Repository.

```
git add .
git commit -m "Create the workflow.yaml"
git push
```

6. Now you can see your GitHub Action in the Actions tab of your Repository.

The screenshot shows the GitHub repository 'pabloameijeirascayan / MT3Chained-Web' with the 'Actions' tab selected. Under the 'All workflows' section, there is one workflow run for 'Create the workflow.yaml'. The run was triggered by a commit pushed by 'pabloameijeirascayan' on the 'main' branch, 1 minute ago. The run completed successfully ('1m 9s'). A red box highlights the workflow name 'Create the workflow.yaml'.

7. Click on **Create the workflow.yaml** and then click on build, you can see all the steps of your job.

The screenshot shows the same GitHub repository and actions page as above, but now focusing on the 'Create the workflow.yaml' job. The 'build' step is expanded, showing its sub-steps: 'Set up job', 'Check Out Repo', 'acr login', 'Run docker build -t mt3chained-web .', 'Post Check Out Repo', and 'Complete job'. Each step is marked as successful with a green checkmark and a duration.

NOTE: This GitHub Action build an image with a Dockerfile and push that image to your Azure Container Registry, the name of the image is specified in the Environment variable **APP_NAME**: **mt3chained-web**, and the image tag is the **github.run_number**.

8. Go to the Azure Portal and check your Azure Container Registry Repositories.

The screenshot shows the Azure Container Registry interface. At the top, it displays the namespace "acrpacbyuipswt | Repositories" and indicates it is a "Container registry". Below this is a search bar labeled "Search (Ctrl+ /)" and a refresh button. A sidebar on the left contains icons for Identity, Networking, Security, and Locks, followed by a "Services" section with "Repositories" highlighted by a red box. Other services listed are Webhooks, Replications, and Tasks. To the right of the sidebar, there is a search bar for filtering repositories and a list of repositories starting with "Repositories ↑↓" and "mt3chained-web".

9. Click on the **mt3chained-web** Repository and you can see your tag.

mt3chained-web

...

Repository



Refresh



Delete repository

^ Essentials

Repository

: mt3chained-web

Last updated date : 11/9/2021, 1:30 PM GMT+1



Search to filter tags ...

Tags ↑↓

1

Task 2 - Add in the workflow.yaml the latest image tag

1. Open the Windows Terminal and run the following command to add the lastest tag.

```
(Get-Content (Join-Path $Path2 workflow.yaml)).replace("## <latestTag> ##", ' ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:latest') | Set-Content (Join-Path $Path2 workflow.yaml)
```

NOTE: This script replaces the string `## <latestTag> ##` in the `workflow.yaml` with the right code to add the latest image tag.

2. Push the changes to your GitHub Repository.

```
git add .  
git commit -m "Update the image tags in the workflow.yaml"  
git push
```

3. Now you can see your new workflow run in the Actions tab of your GitHub Repository.

Screenshot of the GitHub Actions page for the repository `pabloameijeirascany / MT3Chained-Web`. The Actions tab is selected, showing two workflow runs:

- Update the image tags in the workflow.yaml**: Triggered by Math Trick 3 - Chained-Web-CI #2: Commit a42b434 pushed by pabloameijeirascanyay. Status: main. Run time: 5 minutes ago (1m 14s ago).
- Create the workflow.yaml**: Triggered by Math Trick 3 - Chained-Web-CI #1: Commit 571acb8 pushed by pabloameijeirascanyay. Status: main. Run time: 43 minutes ago (1m 5s ago).

4. Go to the Azure Portal and check your Azure Container Registry Repositories.

Screenshot of the Azure Container Registry interface for the repository `acrpacbyuipswt | Repositories`. The left sidebar shows services: Identity, Networking, Security, Locks, Services, and Repositories (which is highlighted with a red box). The main area shows a search bar, a refresh button, and a list of repositories. The repository `mt3chained-web` is listed.

5. Click on the **mt3chained-web** Repository and you can see the two new tags (the tag **2** appears because you run the workflow.yaml again, so it creates a new `github.run_number`).

mt3chained-web

...

Repository



Refresh



Delete repository

▲ Essentials

Repository

mt3chained-web

Last updated date

11/19/2021, 1:30 PM GMT+1



Search to filter tags ...

Tags ↑↓

latest

2

1

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Exercise: Add a Kubernetes Deploy Step to the Workflow YAML

Task 1 - Deploy the new workflow.yaml

- To create a new GitHub Action, you need to upgrade the **workflow.yaml** content in the **C:\k8s\Jobs\MathTrick\Chained\MT3Chained-Web\.github\workflows** directory. Now there is a file **workflow-web2.yaml** in the **C:\k8s\Jobs\Module5\workflows** directory with the following content:

NOTE: This workflow does the same as the last one, but with one more step to deploy the app in the AKS cluster.

```
name: Math Trick 3 - Chained-Web-CI

on:
  push:
    branches:
      - main

env:
  APP_NAME: <appName>
  LOGIN_SERVER: <acrServerName>
  CLUSTER_NAME: <clusterName>
  CLUSTER_RESOURCE_GROUP: <clusterResourceGroup>
  NAMESPACE: <namespaceName>

jobs:
  build-and-deploy:
    runs-on: ubuntu-latest
    steps:
      - name: Check Out Repo
        uses: actions/checkout@v2

      # Connect to Azure Container Registry (ACR)
      - name: ACR login
        uses: azure/docker-login@v1
        with:
          login-server: ${{ env.LOGIN_SERVER }}
          username: ${{ secrets.ACRL_CLIENT_ID }}
          password: ${{ secrets.ACRL_CLIENT_PASSWORD }}

      # Container build and push to a Azure Container Registry (ACR)
      - name: Build, tag, and push image to ACR
        uses: docker/build-push-action@v2
        with:
          context: ../
          file: Dockerfile
          push: true
          tags: |
            ${{ env.LOGIN_SERVER }}/{{ env.APP_NAME }}:${{ github.run_number }}

      # Set the target Azure Kubernetes Service (AKS) cluster.
      - uses: azure/aks-set-context@v1
        with:
          creds: '${{ secrets.AZURE_CREDENTIALS }}'
          cluster-name: ${{ env.CLUSTER_NAME }}
```

```

resource-group: ${{ env.CLUSTER_RESOURCE_GROUP }}

# Create namespace if doesn't exist
- run: |
    kubectl create namespace ${{ env.NAMESPACE }} --dry-run -o json | kubectl apply -f -
# Deploy app to AKS
- uses: azure/k8s-deploy@v1
  with:
    manifests: |
      k8s-deployment.yaml
      k8s-service.yaml
    images: |
      ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:${{ github.run_number }}
  namespace: ${{ env.NAMESPACE }}

```

2. Copy the next script in the terminal to replace the **workflow-web2.yaml** file with the right values and copy the content to the right file called (**workflow.yaml**) in the right path (**C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web\.github\workflows**).

```

$Path1="C:\k8s\Lab\Module5\workflows"
$Path2="C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web\.github\workflows"
$original_file = (Join-Path $Path1 workflow-web2.yaml)
$destination_file = (Join-Path $Path2 workflow.yaml)

(Get-Content $original_file) | ForEach-Object {
    $_ -replace "<appName>", "mt3chained-web" ` 
    -replace "<acrServerName>", $ACR_SERVER_NAME ` 
    -replace "<clusterName>", $AKS_NAME ` 
    -replace "<clusterResourceGroup>", $RESOURCE_GROUP ` 
    -replace "<namespaceName>", "default"
} | Set-Content $destination_file

```

3. Now replace in the manifest **k8s-deployment.yaml** the server name of your ACR.

```

tier: mt3chained-web
spec:
  containers:
  - name: mt3chained-web
    image: somecontainerrepo/mt3chained-web:latest
  ports:
  - containerPort: 80
  env:
  - name: FAILURE_RATE

```

Copy the next script in your Windows Terminal.

```
$Path="C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web"
(Get-Content (Join-Path $Path k8s-deployment.yaml)).replace("somecontainerrepo", $ACR_SERVER_NAME)
| Set-Content (Join-Path $Path k8s-deployment.yaml)
```

4. Push the changes to your GitHub Repository.

```
git add .
git commit -m "Update the workflow.yaml and k8s-deployment.yaml"
git push
```

5. Now you can see your new workflow run in the Actions tab of your GitHub Repository.

The screenshot shows the GitHub Actions tab for the repository 'pabloameijeirascanay / MT3Chained-Web'. The 'All workflows' section is selected. There are three workflow runs listed:

- Update the workflow.yaml and k8s-deployment.yaml**:
Status: main
Event: 1 minute ago
Duration: 1m 24s
Actor: pabloameijeirascanay
Commit: Math Trick 3 - Chained-Web-Cl #3: Commit ba3c1b8 pushed by pabloameijeirascanay
- Update the image tags in the workflow.yaml**:
Status: main
Event: 5 minutes ago
Duration: 1m 1s
Actor: pabloameijeirascanay
Commit: Math Trick 3 - Chained-Web-Cl #2: Commit da8058f pushed by pabloameijeirascanay
- Create the workflow.yaml**:
Status: main
Event: 7 minutes ago
Duration: 1m 0s
Actor: pabloameijeirascanay
Commit: Math Trick 3 - Chained-Web-Cl #1: Commit c8826fb pushed by pabloameijeirascanay

6. Copy the next command in the terminal to check your cluster for the expected resources:

```
kubectl get all
```

7. The output should look like this:

```

PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web> kubectl get all
NAME                                         READY   STATUS    RESTARTS   AGE
pod/mt3chained-web-6c7c494988-wcq4d        1/1     Running   0          2m57s

NAME           TYPE      CLUSTER-IP   EXTERNAL-IP   PORT(S)   AGE
service/kubernetes   ClusterIP  10.0.0.1    <none>       443/TCP   16m
service/mt3chained-web   LoadBalancer  10.0.37.23  51.105.235.0  80:31791/TCP  2m56s

NAME             READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/mt3chained-web   1/1      1           1          2m57s

NAME           DESIRED  CURRENT   READY   AGE
replicaset.apps/mt3chained-web-6c7c494988  1         1         1          2m57s
PS C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web>

```

8. Once the EXTERNAL-IP for the "service/mt3chained-web" has been assigned a value (you may have to wait a few minutes), open a browser and enter that IP address in your address bar:

Always Ends with 3 Math Trick



You pick a number and then perform the calculation steps below. After all the calculations have completed, your final result will always be 3, regardless of the number you picked.

Process:

Start by picking a number between 1 and 10.

Calculation Steps:

- Double the number.
- Add 9 to result.
- Subtract 3 from the result.
- Divide the result by 2.
- Subtract the original number from result.

Final result will always be **3**.

Try it Yourself:

Pick a number:
Final Result: **x**

Perform Calculations: **Start**
Failure Rate: **5%**

Calculation Actions Performed:

Platform	Step	Calculation	Result

9. Verify that the correct image was deployed

```
kubectl get pods -o jsonpath=".items[*].spec.containers[*].image"
```

You should see the full name of the image:

```
acr-pacyowrfzcd.azurecr.io/mt3chained-web:3
```

10. Return to the Windows Terminal in the MT3Chained-Web folder.
 11. Create a simple file just to trigger a change in the main branch.

```
echo "Hello" > text.txt
```

12. Commit and push your changes.

```
git add .
git commit -m "Add a test file"
git push
```

13. Wait a few minutes and verify the deployed container in AKS has automatically updated. Verify what image was deployed

```
kubectl get pods -o jsonpath=".items[*].spec.containers[*].image"
```

You should see the full name of the image:

```
acrparityowrfzcd.azurecr.io/mt3chained-web:4
```

CONGRATULATIONS!!! You just built a full CI/CD pipeline from code to Kubernetes.

[Module 5b Table of Contents](#)

[List of Modules](#)

Exercise: A Complex Microservices CI/CD Pipelines Using Helm and Azure Key Vault

Background

Before creating the Git repos for the calculation step microservices, it's important to understand how the code projects of these microservices are structured. Most of the .Net microservices access a common library called **MathTrickCore**. This is a separate solution, but is referenced by .Net "step" projects (except the NodeJS and Python microservices).

The file structure contains the following hierarchy:

```
..\MathTrick
  \Chained
    \MT3Chained-Step1
      \MT3Chained-Step1.csproj
    \MT3Chained-Step2
      \MT3Chained-Step2.csproj
    ...
  \Gateway
    \MT3Gateway-Step1
      \MT3Gateway-Step1.csproj
    \MT3Gateway-Step2
      \MT3Gateway-Step2.csproj
    ...
  \MathTrickCore
    \MathTrickCore.csproj
```

Notice how the **MathTrickCore** is located 2 levels higher than any of the microservices projects. This is an important consideration when working with the **Dockerfile**. Docker files cannot access folder higher up in a hierarchy than the current folder (ie. Dockerfiles do not support references like `..\\file`). That means for build process to work, the Dockerfile has to be run at the parent level (`\MathTrick`) so it can use that parent folder as its *context*:

```
# Executed in the parent folder: ..\Labs\MathTrick>

docker build -t "myacr.azurecr.io/mt3chained-step1:latest" --file "./Chained/MT3Chained-Step1/Dockerfile" .
```

To facilitate this type of build, the **Dockerfile** is setup to copy all of its files from the parent folder:

```
...
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /src
COPY ["./Chained/MT3Chained-Step1/MT3Chained-Step1.csproj", "./Chained/MT3Chained-Step1/"]
COPY ["./MathTrickCore/MathTrickCore.csproj", "./MathTrickCore/"]
RUN dotnet restore "./Chained/MT3Chained-Step1/MT3Chained-Step1.csproj"
COPY . .

FROM build AS publish
WORKDIR "/src/."
RUN dotnet publish "./Chained/MT3Chained-Step1/MT3Chained-Step1.csproj" -c Release -o /app/publish
...
```

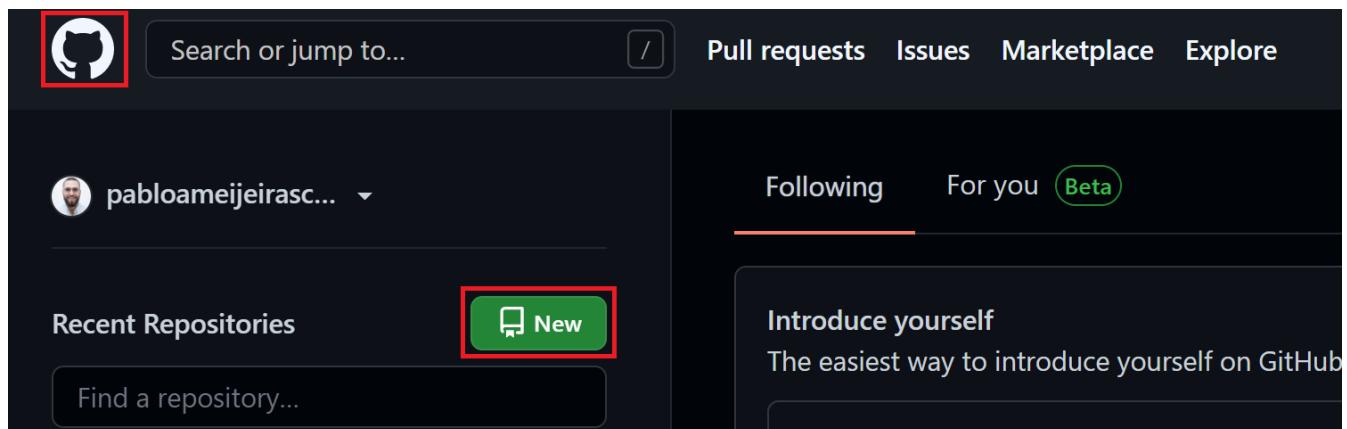
When you add all of these microservices to your GitHub Account, the services will be in different repos, but most will reference the shared project. You'll have to keep this file structure in mind when you check out multiple repos when building the Docker images.

NOTE: This structure does not apply to the Web UI project and the non-.Net microservices. Those projects are self-contained.

Task 1 - Create repos for the remaining microservices

In the previous exercise, you created a repository for the Web microservice. In this exercise, you'll create repositories for each of the remaining services.

1. Open GitHub and click on the GitHub avatar to go home, then click on **New**.



2. Create a new repository called "MT3Chained-Step1". **CHECK "Private"** and click the **Create Repository** button.

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? [Import a repository.](#)

Owner *



pabloameijeirascanay ▾

Repository name *

MT3Chained-Step1



Great repository names are short and memorable. Need inspiration? How about [fantastic-enigma](#)?

Description (optional)

 **Public**

Anyone on the internet can see this repository. You choose who can commit.

 **Private**

You choose who can see and commit to this repository.

Initialize this repository with:

Skip this step if you're importing an existing repository.

Add a README file

This is where you can write a long description for your project. [Learn more.](#)

Add .gitignore

Choose which files not to track from a list of templates. [Learn more.](#)

Choose a license

A license tells others what they can and can't do with your code. [Learn more.](#)

Create repository

4. Repeat the process for the other services, including the Node JS service, but excluding the *Helm* folder (for now).

- └─ Helm
- └─ MT3Chained-Step1
- └─ MT3Chained-Step2
- └─ MT3Chained-Step2-NodeJS
- └─ MT3Chained-Step3
- └─ MT3Chained-Step4
- └─ MT3Chained-Step5
- └─ MT3Chained-Web

5. When you're done, your list should look like this:



[pabloameijeirascanay/MT3Chained-Step2-NodeJS](#)



[pabloameijeirascanay/MT3Chained-Step5](#)



[pabloameijeirascanay/MT3Chained-Step4](#)



[pabloameijeirascanay/MT3Chained-Step3](#)



[pabloameijeirascanay/MT3Chained-Step2](#)



[pabloameijeirascanay/MT3Chained-Step1](#)



[pabloameijeirascanay/MT3Chained-Web](#)

Task 2 - Initialize git, check in the source code and push it to GitHub (For all the repos, excluding the NodeJS step and web repo).

1. Initialize git, check in the source code and push it to GitHub for all step repos. **IMPORTANT: REPLACE THE \$GITHUB_ALIAS VARIABLE WITH YOUR GITHUB ALIAS.**

```
$GITHUB_ALIAS="ENTER YOUR GITHUB ALIAS"

ForEach ($i in 1..5) {
    cd "C:\k8s\Jobs\MathTrick\Chained\MT3Chained-Step$i"
    Write-Host "=====MT3Chained-Step$i=====" -ForegroundColor Green
    git init
    git add .
    git commit -m "Initial check-in"
    git remote add origin "git@github.com:$GITHUB_ALIAS/MT3Chained-Step$i.git"
    git branch -M main
    git push -u origin main
}
```

2. Return back to the GitHub. Select for example the **MT3Chained-Step1** repo, you should see all your files (the same for all the step repos).

pabloameijeirascanay / MT3Chained-Step1 Private Unwatch 1 Star 0 Issues

Code Issues Pull requests Actions Projects Security Insights

main Go to file Add file Code About

File	Description	Time Ago
.vs/MT3Chained-S...	Initial check-in	5 minutes ago
Controllers	Initial check-in	5 minutes ago
Properties	Initial check-in	5 minutes ago
Services	Initial check-in	5 minutes ago
obj	Initial check-in	5 minutes ago
.dockerignore	Initial check-in	5 minutes ago
Dockerfile	Initial check-in	5 minutes ago
Dockerfile.original	Initial check-in	5 minutes ago
MT3Chained-Step...	Initial check-in	5 minutes ago
MT3Chained-Step...	Initial check-in	5 minutes ago
Program.cs	Initial check-in	5 minutes ago
Startup.cs	Initial check-in	5 minutes ago
appsettings.Devel...	Initial check-in	5 minutes ago
appsettings.json	Initial check-in	5 minutes ago

3. Create two new repos called "**Math Trick 3 - Chained**" and "**MathTrickCore**" following the same steps for the others that you created. Use the "**Math Trick 3 - Chained**" repo to store the contents of the "**Helm**" folder and use the "**MathTrickCore**" repo to store the contents of the "**MathTrickCore**" folder.
4. Initialize git, check in the source code and push it to GitHub for the **Math-Trick-3---Chained** repo.

```
cd "C:\k8s\Labs\MathTrick\Chained\Helm"  
git init  
git add .  
git commit -m "Initial check-in"
```

```
git remote add origin git@github.com:$GITHUB_ALIAS/Math-Trick-3---Chained.git
git branch -M main
git push -u origin main
```

5. Initialize git, check in the source code and push it to GitHub for the **MathTrickCore** repo.

```
cd "C:\k8s\Labs\MathTrick\MathTrickCore"
git init
git add .
git commit -m "Initial check-in"
git remote add origin git@github.com:$GITHUB_ALIAS/MathTrickCore.git
git branch -M main
git push -u origin main
```

6. Now, for example you should see all the Helm files in the Math-Trick-3---Chained repo (the same for the MathTrickCore repo)

The screenshot shows a GitHub repository page for 'Math-Trick-3---Chained'. The repository is private. The 'Code' tab is selected. The 'main' branch is selected. The directory structure shows several files:

- steps (Initial check-in)
- chained-ns.yaml (Initial check-in)
- mt3chained-cm.yaml (Initial check-in)
- mt3chained-web-dep.yaml (Initial check-in)
- mt3chained-web-ing.yaml (Initial check-in)
- mt3chained-web-svc.yaml (Initial check-in)

Task 3 - Add the same secrets you added in the [Exercise: Create GitHub secrets](#)

- For the *step* and *Step2-NodeJS* repos create the **ACR_CLIENT_ID** and **ACR_CLIENT_PASSWORD** secrets for the ACR authentication and **AZURE_CREDENTIALS** secret for the Azure Key Vault Authentication (Then we will assign the access policies to the Service Principal created). You can use the following links if you don't remember how to create the secrets:

[Task 2 - Create GitHub secret to manage the AKS cluster and the Azure Key Vault](#)

[Task 3 - Create GitHub secrets for the Azure Container Registry Authentication](#)

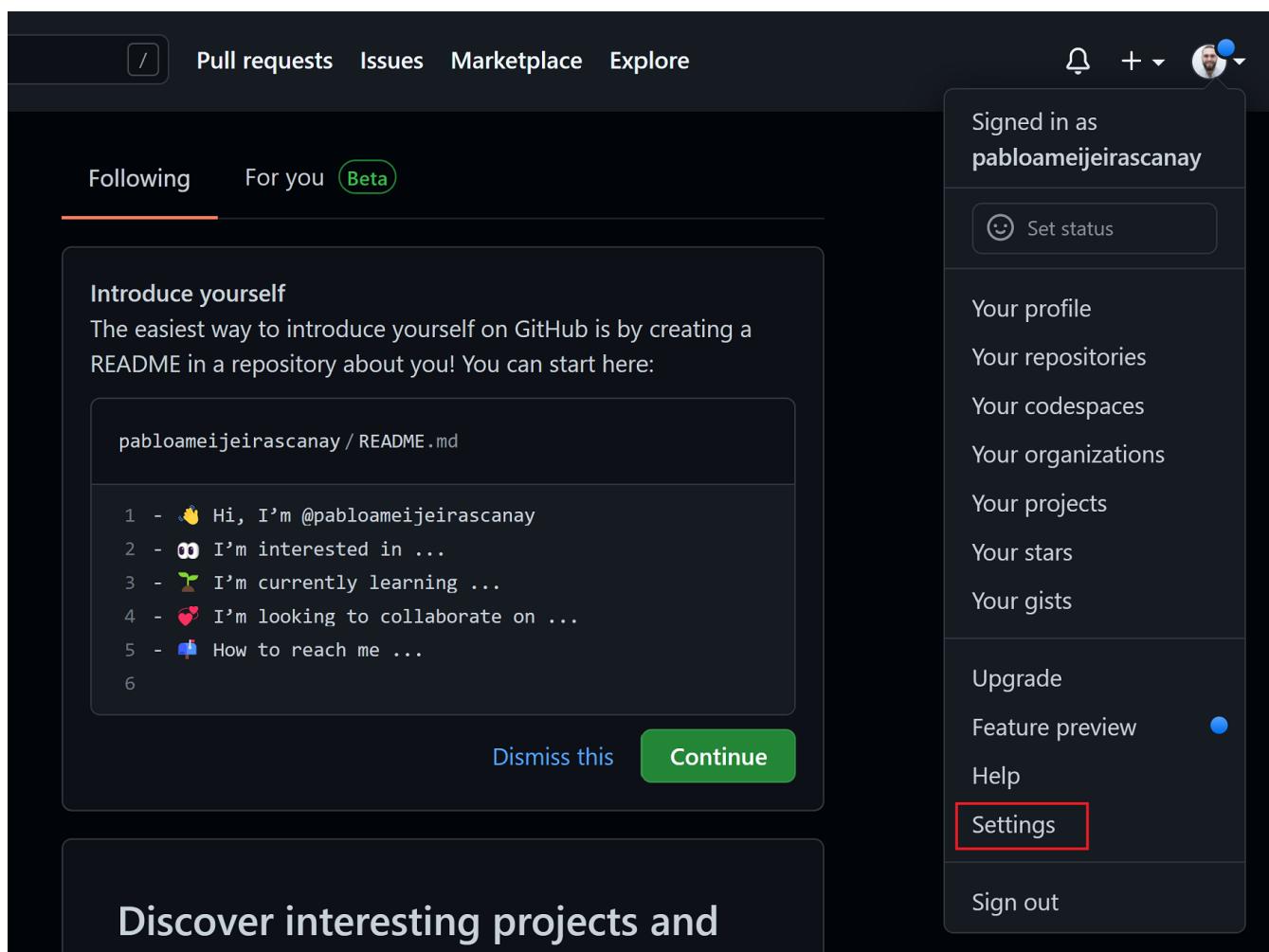
- For the *Math-Trick-3---Chained* repo create the **AZURE_CREDENTIALS** secret for the Azure Key Vault and AKS Authentication. You can use the following link if you don't remember how to create the secret:

[Task 2 - Create GitHub secret to manage the AKS cluster and the Azure Key Vault](#)

Task 4 - Create a GitHub Token

Create a github token to use in the workflow.yaml of each step repos to access the *MathTrickCore* repo; and also for step, NodeJS and web repos to trigger the workflow of the *Math-Trick-3---Chained* when there is a change (it will be used in the last steps of the lab)

- In the upper-right corner of any page, click on your profile photo, then click Settings.



- In the left sidebar, click Developer settings.

Archives

 Security log

 Sponsorship log

 Developer settings

3. In the left sidebar, click Personal access tokens.

Settings / Developer settings

GitHub Apps

OAuth Apps

Personal access tokens

4. Click Generate new token.

Personal access tokens

[Generate new token](#)

[Revoke all](#)

Tokens you have generated that can be used to access the GitHub API.

5. Give your token a descriptive name.

New personal access token

Personal access tokens function like ordinary OAuth access tokens. They can be used instead of a password for Git over HTTPS, or can be used to [authenticate to the API over Basic Authentication](#).

Note

My personal access token

What's this token for?

6. To give your token an expiration, select the Expiration drop-down menu, then click a default or use the calendar picker.

Expiration *

30 days



The token will expire on Fri, Dec 31 2021

7. Select the scopes, or permissions, you'd like to grant this token. To use your token to access other repositories, select repo.

Select scopes

Scopes define the access for personal tokens. [Read more about OAuth scopes](#).

<input checked="" type="checkbox"/> repo	Full control of private repositories
<input checked="" type="checkbox"/> repo:status	Access commit status
<input checked="" type="checkbox"/> repo_deployment	Access deployment status
<input checked="" type="checkbox"/> public_repo	Access public repositories
<input checked="" type="checkbox"/> repo:invite	Access repository invitations
<input checked="" type="checkbox"/> security_events	Read and write security events

8. Click Generate token.

Generate token

Cancel

9. Copy the token in a .txt file, it will be used to create a secret.

10. Create a Action Secret for all the **step** repos (including the **NodeJS step** and the **web** repo). Not all of them require the secret at this point, but they will in later Tasks. **Do not create the secret for MathTrickCore and the Math-Trick-3---Chained repos, as those projects don't need it.**
11. For example how to create the **PAT_GITHUB** secret for the *MT3Chained-Step1* repo, just copy the token which was created before and paste it in the Value section.

Actions secrets / New secret

Name
PAT_GITHUB

Value
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

Add secret

IMPORTANT: Repeat this secret creation for all the **step** repos (including the **NodeJS step** and the **web** repo).

Task 5 - Create a new GitHub Action for the step repos

Create the **workflow.yaml** in the the directory of all the step repos `*.github\workflows*` from the **workflow-steps1.yaml** file, in the directory **C:\k8s\Labs\Module5\workflows**, with the following content:

NOTE: This workflow does the same as the first one for the web repo, but with one more step to access the MathTrickCore repo.

```
name: <githubRepoName>

on:
  push:
    branches:
      - main

env:
  APP_NAME: <appName>
  LOGIN_SERVER: <acrServerName>

jobs:
```

```

build:
  runs-on: ubuntu-latest
  steps:

    - name: Check-out Repo
      uses: actions/checkout@v2
      with:
        path: Chained/<githubRepoName>

    - name: Check-out MathTrickCore
      uses: actions/checkout@v2
      with:
        repository: <githubAlias>/MathTrickCore
        path: MathTrickCore
        token: ${{ secrets.PAT_GITHUB }}

    # Connect to Azure Container Registry (ACR)
    - name: ACR login
      uses: azure/docker-login@v1
      with:
        login-server: ${{ env.LOGIN_SERVER }}
        username: ${{ secrets.ACR_CLIENT_ID }}
        password: ${{ secrets.ACR_CLIENT_PASSWORD }}

    # Container build and push to a Azure Container Registry (ACR)
    - name: Build, tag, and push image to ACR
      uses: docker/build-push-action@v2
      with:
        context: ./
        file: Chained/<githubRepoName>/Dockerfile
        push: true
        tags: |
          ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:${{ github.run_number }}
          ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:latest

```

1. Create the **.github\workflows** folder in the step repos.

```

ForEach ($i in 1..5) {
  New-Item -Path "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step$i\.github\workflows" -ItemType
  Directory
}

```

2. Copy the following Azure PowerShell code in the Windows Terminal to replace the **workflow-steps1.yaml** file in the path **C:\k8s\Labs\Module5\workflows** with the correct values and give it the correct file name (**workflow.yaml**) copying it in ***\github\workflows*** folder of each step repo (excluding the NodeJS step and web repo).

```

ForEach ($i in 1..5) {
  $PathTemplate="C:\k8s\Labs\Module5\workflows"
  $PathWorkflow="C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step$i\.github\workflows"
  $original_file = (Join-Path $PathTemplate workflow-steps1.yaml)
  $destination_file = (Join-Path $PathWorkflow workflow.yaml)

```

```

(Get-Content $original_file) | Foreach-Object {
    $_ -replace "<appName>", "mt3chained-step$i"
    -replace "<githubRepoName>", "MT3Chained-Step$i"
    -replace "<acrServerName>", $ACR_SERVER_NAME
    -replace "<githubAlias>", $GITHUB_ALIAS
} | Set-Content $destination_file

# Commit and push workflow
cd "C:\k8s\Jobs\MathTrick\Chained\MT3Chained-Step$i\" 
Write-Host "=====MT3Chained-Step$i=====" -ForegroundColor Green
git add .
git commit -m "Add workflow.yaml"
git push
}

```

2. After all the builds have completed, verify all the images have been created in the ACR.

The screenshot shows the Azure Container Registry (ACR) interface for the namespace `acrpacbyuipswt`. The left sidebar contains navigation links for Identity, Networking, Security, Locks, Services (selected), Repositories (selected), Webhooks, Replications, Tasks, and Connected registries (Preview). The main area displays a list of repositories: `mt3chained-step1`, `mt3chained-step2`, `mt3chained-step3`, `mt3chained-step4`, `mt3chained-step5`, and `mt3chained-web`. There are search bars at the top and bottom, and a refresh button.

Task 6 - Configure the service principal to access the Key Vault created in Lab 4, Exercise 1, Task 2 to be used by your workflows

You created an Azure Key Vault in the previous module and set its name in the `$KV_NAME` variable.

- Create an Access Policy to allow the service principal to read and write secrets to the Key Vault, so the GitHub Action workflows can access to the Key Vault through the **AZURE_CREDENTIALS** secret.

```
$OBJ_ID=$(az ad sp show --id $servicePrincipal.ApplicationId --query objectId -o tsv)
az keyvault set-policy --name $KV_NAME ` 
    --resource-group $RESOURCE_GROUP ` 
    --object-id $OBJ_ID ` 
    --secret-permissions delete get list set
```

- Open the Azure Portal, go to the Key Vault and click on **Access policies** to verify the access policy was created

Name	Email	Key Permissions	Secret Permissions	Certificate Permissions	Action
sp-aks-pacbyuipswt		0 selected	4 selected	0 selected	<button>Delete</button>

- Create the default image tags secrets for all the images. Set the default tags to *latest* so you can use them until they're replaced with the build numbers in the pipelines

```
az keyvault secret set --vault-name $KV_NAME --name "mt3chained-step1-tag" --value "latest"
az keyvault secret set --vault-name $KV_NAME --name "mt3chained-step2-tag" --value "latest"
az keyvault secret set --vault-name $KV_NAME --name "mt3chained-step2-nodejs-tag" --value "latest"
az keyvault secret set --vault-name $KV_NAME --name "mt3chained-step3-tag" --value "latest"
az keyvault secret set --vault-name $KV_NAME --name "mt3chained-step4-tag" --value "latest"
az keyvault secret set --vault-name $KV_NAME --name "mt3chained-step5-tag" --value "latest"
az keyvault secret set --vault-name $KV_NAME --name "mt3chained-web-tag" --value "latest"
```

- On the Key Vault in the Azure Portal, click on **Secrets** to verify they were all created (you may need to click *Refresh*)

Name	Type	Status
mt3chained-step1-tag		✓ Enabled
mt3chained-step2-nodejs-tag		✓ Enabled
mt3chained-step2-tag		✓ Enabled
mt3chained-step3-tag		✓ Enabled
mt3chained-step4-tag		✓ Enabled
mt3chained-step5-tag		✓ Enabled
mt3chained-web-tag		✓ Enabled

Task 7 - Update the Build Pipelines to store image tags in Azure Key Vault

1. Edit the build workflow.yaml create in Task 5.

2. Add 2 env variables.

```
KV_NAME: <keyVaultName>
SECRET_NAME: <appName>-tag
```

NOTE: Notice the secretTagName will match the secret name created in the previous task.

3. Add another task to the end of your workflow. The workflow will execute the same **az keyvault secret set** command that you executed above, except the *value* will be set to the current build tag (**github.run_number**).

```
- name: Azure login
  uses: azure/login@v1
  with:
    creds: ${{ secrets.AZURE_CREDENTIALS }}
- run:
  - az keyvault secret set --vault-name ${{ env.KV_NAME }} --name ${{ env.SECRET_NAME }} --value ${{ github.run_number }}
```

4. Create the new **workflow.yaml** in the the directory of all the step repos **\.github\workflows** from the **workflow-steps2.yaml** file, in the directory **C:\k8s\Labs\Module5\workflows**, with the following content:

```
name: <githubRepoName>

on:
  push:
    branches:
      - main

env:
  APP_NAME: <appName>
  LOGIN_SERVER: <acrServerName>
  KV_NAME: <keyVaultName>
  SECRET_NAME: <appName>-tag

jobs:
  build:
    runs-on: ubuntu-latest
    steps:
      - name: Check-out Repo
        uses: actions/checkout@v2
        with:
          path: Chained/<githubRepoName>
      - name: Check-out MathTrickCore
        uses: actions/checkout@v2
        with:
          repository: <githubAlias>/MathTrickCore
```

```

path: MathTrickCore
token: ${{ secrets.PAT_GITHUB }}

# Connect to Azure Container Registry (ACR)
- name: ACR login
  uses: azure/docker-login@v1
  with:
    login-server: ${{ env.LOGIN_SERVER }}
    username: ${{ secrets.ACR_CLIENT_ID }}
    password: ${{ secrets.ACR_CLIENT_PASSWORD }}
# Container build and push to a Azure Container Registry (ACR)
- name: Build, tag, and push image to ACR
  uses: docker/build-push-action@v2
  with:
    context: ./
    file: Chained/<githubRepoName>/Dockerfile
    push: true
    tags: |
      ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:${{ github.run_number }}
      ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:latest
- name: Azure login
  uses: azure/login@v1
  with:
    creds: ${{ secrets.AZURE_CREDENTIALS }}
- run: |
    az keyvault secret set --vault-name ${{ env.KV_NAME }} --name ${{ env.SECRET_NAME }} --value ${{ github.run_number }}

```

5. Copy the following Azure PowerShell code in the Windows Terminal to replace the **workflow-steps2.yaml** file in the path **C:\k8s\Lab\Module5\workflows** with the correct values and replace the file (**workflow.yaml**) in ***.github\workflows*** folder of each step repo (excluding the NodeJS step and web repo).

```

ForEach ($i in 1..5) {
$PathTemplate="C:\k8s\Lab\Module5\workflows"
$PathWorkflow="C:\k8s\Lab\MathTrick\Chained\MT3Chained-Step$i\.github\workflows"
$original_file = (Join-Path $PathTemplate workflow-steps2.yaml)
$destination_file = (Join-Path $PathWorkflow workflow.yaml)

(Get-Content $original_file) | ForEach-Object {
$_ -replace "<appName>", "mt3chained-step$i" ` 
-replace "<githubRepoName>", "MT3Chained-Step$i" ` 
-replace "<acrServerName>", $ACR_SERVER_NAME ` 
-replace "<keyVaultName>", $KV_NAME ` 
-replace "<githubAlias>", $GITHUB_ALIAS
} | Set-Content $destination_file

# Commit and push workflow
cd "C:\k8s\Lab\MathTrick\Chained\MT3Chained-Step$i\
Write-Host "=====MT3Chained-Step$i=====" -ForegroundColor Green
git add .

```

```
git commit -m "Add workflow.yaml"
git push
}
```

6. When the build completes successfully, go to the Azure Portal and look up the secrets in the key vault, click on the *mt3chained-step1-tag* secret for example.
7. Click on the link below the **CURRENT VERSION** of the secret. Click the **Show Secret Value** button
8. The latest build tag should be in the value of the secret.

The screenshot shows the Azure Key Vault interface for a secret named **bfa84eeb04e9412896459f964dcf3d64**. The top navigation bar includes a lock icon, the secret name, a copy icon, and three dots. Below the name, it says "Secret Version". There are "Save" and "Discard changes" buttons. The main content area has sections for "Properties" and "Settings". Under Properties, Created is 12/6/2021, 9:42:12 PM and Updated is 12/6/2021, 9:42:12 PM. The Secret Identifier is a URL. Under Settings, there are checkboxes for "Set activation date" and "Set expiration date", both of which are unchecked. The "Enabled" setting has a blue "Yes" button highlighted. The "Tags" section shows 1 tag. In the "Secret" section, there is a "Content type (optional)" input field and a "Hide Secret Value" button. The "Secret value" field contains the number **2**, which is highlighted with a red box. A blue "Copy" icon is to the right of the secret value field.

9. Which should match the last *github.run_number* tag in the ACR repository *mt3chained-step1*.

mt3chained-step1

...

Repository

 Refresh  Delete repository

^ Essentials

Repository

mt3chained-step1

Tag count

3

Last updated date

12/6/2021, 9:42 PM GMT+1

Manifest count

2

 Search to filter tags ...

Tags ↑↓

latest

2

1

Task 8 - Build the Pipelines for the Web and NodeJS microservice

1. The process is similar to the one followed in Task 7 above. We will create a workflow for the *MT3Chained-Web* and the *MT3Chained-Step2-NodeJS* repos. This workflow's structure will be simpler than the structure of the **step** repositories, since these are self contained projects and don't require the obtention of dependencies of the *MathTrickCore* repo.
2. To create the new **workflow.yaml** in the the directory *`\github\workflows*` of *MT3Chained-Web* and the *MT3Chained-Step2-NodeJS* repos you will use the **workflow-web3.yaml** file, in the directory `C:\k8s\Labs\Module5\workflows`. It has 3 main steps: checkout, login into Azure, and image build and upload, and finally store the tag as a secret in the Azure Key Vault.

```
name: <githubRepoName>

on:
  push:
    branches:
      - main
```

```

env:
  APP_NAME: <appName>
  LOGIN_SERVER: <acrServerName>
  KV_NAME: <azureKeyVaultName>
  SECRET_NAME: <secretName>
jobs:
  build:
    runs-on: ubuntu-latest
    steps:
      - name: Check-out Repo
        uses: actions/checkout@v2

      # Connect to Azure Container Registry (ACR)
      - name: ACR login
        uses: azure/docker-login@v1
        with:
          login-server: ${{ env.LOGIN_SERVER }}
          username: ${{ secrets.ACR_CLIENT_ID }}
          password: ${{ secrets.ACR_CLIENT_PASSWORD }}
      # Container build and push to a Azure Container Registry (ACR)
      - name: Build, tag, and push image to ACR
        uses: docker/build-push-action@v2
        with:
          push: true
          tags: |
            ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:${{ github.run_number }}
            ${{ env.LOGIN_SERVER }}/${{ env.APP_NAME }}:latest

      - name: Azure login
        uses: azure/login@v1
        with:
          creds: ${{ secrets.AZURE_CREDENTIALS }}
      - run: |
          az keyvault secret set --vault-name ${{ env.KV_NAME }} --name ${{ env.SECRET_NAME }} --value ${{ github.run_number }}


```

3. Copy the following Azure PowerShell code in the Windows Terminal to replace the **workflow-web3.yaml** file in the path **C:\k8s\Lab\Module5\workflows** with the correct values and replace the **(workflow.yaml)** file with the new content in the ***\github\workflows*** folder of web repo.

```

$Path1="C:\k8s\Lab\Module5\workflows"
$Path2="C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web\.github\workflows"
$original_file = (Join-Path $Path1 workflow-web3.yaml)
$destination_file = (Join-Path $Path2 workflow.yaml)
(Get-Content $original_file) | Foreach-Object {
  $_ -replace "<appName>", "mt3chained-web" ` 
  -replace "<githubRepoName>", "MT3Chained-Web" ` 
  -replace "<acrServerName>", $ACR_SERVER_NAME ` 
  -replace "<azureKeyVaultName>", $KV_NAME ` 


```

```

-replace "<secretName>", "mt3chained-step1-web-tag"
} | Set-Content $destination_file

```

4. Commit the changes and push them to the GitHub repository. This will also trigger the workflow execution.

```

cd "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web"
git add .
git commit -m "Update workflow.yaml"
git push

```

5. We'll repeat the same process for the *MT3Chained-Step2-NodeJS* repo. The definition of the workflow is basically the same. But first we need to create the `*.github\workflows*` folder of NodeJS repo.

```

New-Item -Path "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step2-NodeJS\.github\workflows" -ItemType Directory

```

6. Now, run the following script:

```

$Path1="C:\k8s\Labs\Module5\workflows"
$Path2="C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step2-NodeJS\.github\workflows"
$original_file = (Join-Path $Path1 workflow-web3.yaml)
$destination_file = (Join-Path $Path2 workflow.yaml)
(Get-Content $original_file) | ForEach-Object {
    $_ -replace "<appName>", "mt3chained-step2-nodejs" ` 
        -replace "<githubRepoName>", "MT3Chained-Step2-NodeJS" ` 
        -replace "<acrServerName>", $ACR_SERVER_NAME ` 
        -replace "<azureKeyVaultName>", $KV_NAME ` 
        -replace "<secretName>", "mt3chained-step2-nodejs-tag"
} | Set-Content $destination_file

```

7. Init and Commit the changes and push them to the GitHub repository (As you can see we have some steps more as this repo wasn't initialized before). This will also trigger the workflow execution.

```

cd "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step2-NodeJS"
git init
git add .
git commit -m "Initial check-in"
git remote add origin git@github.com:pabloameijeirascanay/MT3Chained-Step2-NodeJS.git
git branch -M main
git push -u origin main

```

8. Once the execution is over, verify the images in your Azure Container Registry and the tags in your Azure Key Vault.

9. When all the workflows have run at least once. You can verify their status by selecting "Actions" tab and checking the execution log.

Task 9 - Build a single Release Pipelines that uses Helm to update the AKS cluster

Now that all of the microservice images are automatically built, pushed and their tags are saved, it's time to create a workflow that is triggered automatically and updates the AKS cluster when **ANY** microservice is modified. This will require a small change in all the

previously added workflows, as well as a workflow that contains a special trigger.

GitHub does not support triggering child workflows from outside of a repository. This means that, we either bundle the entire solution in a single repository, which would be undesirable, or we'll have to find a way to achieve the same behavior. Fortunately, this can be done by using a feature from the GitHub API called [workflow_dispatch](#). Let's see how to add this event to our previous pipelines.

1. The use of the GitHub API requires us to authenticate ourselves to perform the required request. This means we need a personal access token available in the repositories that will trigger a deployment when updated. In Task 4 we have already taken care of this step but make sure that all our **step** repositories (Including NodeJS) and the **web** repository have the PAT_GITHUB secret created. This step is mandatory.
2. Once we have the required secrets in place, we have to add the following step at the end of each of our existing workflows.

```
# Issue workflow dispatch event to trigger Helm chart deployment
- name: Invoke workflow in another repo with inputs
  uses: benc-uk/workflow-dispatch@v1
  with:
    workflow: Math-Trick-3---Chained
    repo: <githubAlias>/Math-Trick-3---Chained
    token: ${{ secrets.PAT_GITHUB }}
```

The code shown above uses an action to perform the API request that will trigger the `workflow_dispatch` event for the required repository and workflow. The `workflow` and `repo` parameters determine where the event will be sent. The `token` parameter should be passed the PAT_GITHUB secret we have defined for our repositories.

3. Copy the following Azure PowerShell code in the Windows Terminal to replace the **workflow-steps3.yaml** file in the path **C:\k8s\Lab\Module5\workflows** with the correct values and replace the **(workflow.yaml)** content in `*.\github\workflows*` folder of all the step repos.

```
ForEach ($i in 1..5) {
  $PathTemplate="C:\k8s\Lab\Module5\workflows"
  $PathWorkflow="C:\k8s\Lab\MathTrick\Chained\MT3Chained-Step$i\.github\workflows"
  $original_file = (Join-Path $PathTemplate workflow-steps3.yaml)
  $destination_file = (Join-Path $PathWorkflow workflow.yaml)

  (Get-Content $original_file) | ForEach-Object {
    $_ -replace "<appName>", "mt3chained-step$i" ` 
      -replace "<githubRepoName>", "MT3Chained-Step$i" ` 
      -replace "<acrServerName>", $ACR_SERVER_NAME ` 
      -replace "<keyVaultName>", $KV_NAME ` 
      -replace "<githubAlias>", $GITHUB_ALIAS
  } | Set-Content $destination_file
}
```

4. Copy the following Azure PowerShell code in the Windows Terminal to replace the **workflow-web4.yaml** file in the path **C:\k8s\Lab\Module5\workflows** with the correct values and replace the **(workflow.yaml)** content in `*.\github\workflows*` folder of web repo.

```
$Path1="C:\k8s\Lab\Module5\workflows"
$Path2="C:\k8s\Lab\MathTrick\Chained\MT3Chained-Web\.github\workflows"
$original_file = (Join-Path $Path1 workflow-web4.yaml)
$destination_file = (Join-Path $Path2 workflow.yaml)
(Get-Content $original_file) | ForEach-Object {
```

```

$_ -replace "<appName>", "mt3chained-web" ` 
-replace "<githubRepoName>", "MT3Chained-Web" ` 
-replace "<acrServerName>", $ACR_SERVER_NAME ` 
-replace "<azureKeyVaultName>", $KV_NAME ` 
-replace "<secretName>", "mt3chained-web-tag" ` 
-replace "<githubAlias>", $GITHUB_ALIAS
} | Set-Content $destination_file

```

5. We'll repeat the same process for the *MT3Chained-Step2-NodeJS* repo as the web repo above. The definition of the workflow is basically the same.

```

$Path1="C:\k8s\Labs\Module5\workflows"
$Path2="C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step2-NodeJS\.github\workflows"
$original_file = (Join-Path $Path1 workflow-web4.yaml)
$destination_file = (Join-Path $Path2 workflow.yaml)
(Get-Content $original_file) | Foreach-Object {
    $_ -replace "<appName>", "mt3chained-step2-nodejs" ` 
        -replace "<githubRepoName>", "MT3Chained-Step2-NodeJS" ` 
        -replace "<acrServerName>", $ACR_SERVER_NAME ` 
        -replace "<azureKeyVaultName>", $KV_NAME ` 
        -replace "<secretName>", "mt3chained-step2-nodejs-tag" ` 
        -replace "<githubAlias>", $GITHUB_ALIAS
} | Set-Content $destination_file

```

DO NOT PUSH THE CHANGES YET, AS WE STILL NEED TO ADD THE WORKFLOW THAT WILL RECEIVE THE EVENTS

6. Once the code repositories are ready, we need to create a workflow that will issue the deployment of our Helm chart. This workflow must be triggered in two circumstances. The first one would be the reception of the `workflow_dispatch` event, which would correspond to a change made to one of the subprojects (subrepos: step repos, NodeJS and web repo) that are part of the chart. The second is when changes to the Helm repository itself are performed. To do this, we have to make a slight modification to the `on` section of our workflow:

```

on:
  workflow_dispatch: ~
  push:
    branches: [main]

```

This new definition will cause the workflow to execute following the rules we have previously explained.

7. This repository will connect to our Azure KeyVault and fetch the secrets corresponding to the versions of each of the apps in our solution. These secrets will be used to perform a variable replacement of the entries in the `values.yaml` file in the chart. We need two steps to perform these tasks. The convenience and versatility of GitHub actions and the workflow syntax can be seen again in this brief example. The chosen actions eliminate the need to manually perform the obtention of the secrets and the replacement of the values in the `.yaml` code, providing an easy to use alternative for common tasks.

```

# Get secrets
- name: Get Keyvault secrets
  uses: Azure/get-keyvault-secrets@v1
  with:
    keyvault: ${{ env.KV_NAME }}
    secrets: 'mt3chained-step1-tag,mt3chained-step2-nodejs-tag,mt3chained-step2-

```

```

tag,mt3chained-step3-tag,mt3chained-step4-tag,mt3chained-step5-tag,mt3chained-web-tag'
    id: versiontags

    - name: 'Set version tags'
      uses: microsoft/variable-substitution@v1
      with:
        files: mt3chained/values.yaml
      env:
        tags.mt3chainedweb: ${{ steps.versiontags.outputs.mt3chained-web-tag }}
        tags.mt3chainedstep1: ${{ steps.versiontags.outputs.mt3chained-step1-tag }}
        tags.mt3chainedstep2: ${{ steps.versiontags.outputs.mt3chained-step2-tag }}
        tags.mt3chainedstep2nodejs: ${{ steps.versiontags.outputs.mt3chained-step2-nodejs-tag }}
        tags.mt3chainedstep3: ${{ steps.versiontags.outputs.mt3chained-step3-tag }}
        tags.mt3chainedstep4: ${{ steps.versiontags.outputs.mt3chained-step4-tag }}
        tags.mt3chainedstep5: ${{ steps.versiontags.outputs.mt3chained-step5-tag }}

```

8. Before we attempt to deploy our chart, we need to set the AKS context.

```

- name: Azure Kubernetes set context
  uses: Azure/aks-set-context@v1
  with:
    creds: ${{ secrets.AZURE_CREDENTIALS }}
    resource-group: ${{ env.RESOURCE_GROUP }}
    cluster-name: ${{ env.AKS_NAME }}

```

10. Once our AKS context is set, we must install Helm.

```

- name: Helm tool installer
  uses: Azure/setup-helm@v1

```

11. Finally, we just have to run the Helm command to install/upgrade a release.

```

- name: Deploy
  run: |
    helm upgrade --install chained mt3chained/

```

12. The complete workflow for the Helm repository will look like this:

```

name: Math-Trick-3---Chained

on:
  workflow_dispatch: ~
  push:
    branches: [main]

env:
  KV_NAME: <azureKeyVaultName>
  AKS_NAME: <aksName>
  RESOURCE_GROUP: <aksResourceGroup>

```

```

jobs:

deploy-to-aks:
  runs-on: ubuntu-latest
  steps:

    - name: 'Checkout' # Checkout the repository code.
      uses: 'actions/checkout@v1'

    # Connect to Azure
    - name: Azure login
      uses: azure/login@v1
      with:
        creds: ${{ secrets.AZURE_CREDENTIALS }}

    # Get secrets
    - name: Get Keyvault secrets
      uses: Azure/get-keyvault-secrets@v1
      with:
        keyvault: ${{ env.KV_NAME }}
        secrets: 'mt3chained-step1-tag,mt3chained-step2-nodejs-tag,mt3chained-step2-tag,mt3chained-step3-tag,mt3chained-step4-tag,mt3chained-step5-tag,mt3chained-web-tag'
        id: versiontags

    - name: 'Set version tags'
      uses: microsoft/variable-substitution@v1
      with:
        files: mt3chained/values.yaml
      env:
        tags.mt3chainedweb: ${{ steps.versiontags.outputs.mt3chained-web-tag }}
        tags.mt3chainedstep1: ${{ steps.versiontags.outputs.mt3chained-step1-tag }}
        tags.mt3chainedstep2: ${{ steps.versiontags.outputs.mt3chained-step2-tag }}
        tags.mt3chainedstep2nodejs: ${{ steps.versiontags.outputs.mt3chained-step2-nodejs-tag }}
        tags.mt3chainedstep3: ${{ steps.versiontags.outputs.mt3chained-step3-tag }}
        tags.mt3chainedstep4: ${{ steps.versiontags.outputs.mt3chained-step4-tag }}
        tags.mt3chainedstep5: ${{ steps.versiontags.outputs.mt3chained-step5-tag }}

    - name: Azure Kubernetes set context
      uses: Azure/aks-set-context@v1
      with:
        creds: ${{ secrets.AZURE_CREDENTIALS }}
        resource-group: ${{ env.RESOURCE_GROUP }}
        cluster-name: ${{ env.AKS_NAME }}

    - name: Helm tool installer
      uses: Azure/setup-helm@v1

    - name: Deploy
      run:
        helm upgrade --install chained mt3chained/

```

13. But first we need to create the *\.github\workflows* folder of Helm repo.

```
New-Item -Path "C:\k8s\Labs\MathTrick\Chained\Helm\.github\workflows" -ItemType Directory
```

14. Copy the following Azure PowerShell code in the Windows Terminal to replace the **workflow-helm.yaml** file in the path **C:\k8s\Labs\Module5\workflows** with the correct values and give it the correct file name (**workflow.yaml**) copying it in *\.github\workflows* folder of Helm repo.

```
$Path1="C:\k8s\Labs\Module5\workflows"
$Path2="C:\k8s\Labs\MathTrick\Chained\Helm\.github\workflows"
$original_file = (Join-Path $Path1 workflow-helm.yaml)
$destination_file = (Join-Path $Path2 workflow.yaml)
(Get-Content $original_file) | Foreach-Object {
    $_ -replace "<azureKeyVaultName>", $KV_NAME ` 
    -replace "<aksName>", $AKS_NAME ` 
    -replace "<aksResourceGroup>", $RESOURCE_GROUP
} | Set-Content $destination_file
```

15. Copy the following Azure PowerShell code in the Windows Terminal to replace the **values.yaml** file in the path **C:\k8s\Labs\MathTrick\Chained\Helm\mt3chained** with your correct Azure Container Registry name.

```
$Path="C:\k8s\Labs\MathTrick\Chained\Helm\mt3chained"
(Get-Content (Join-Path $Path values.yaml)).replace("kizacr.azurecr.io", $ACR_SERVER_NAME) | Set-Content (Join-Path $Path values.yaml)
```

Task 10 - Push the changes

1. Once the Helm workflow is ready, we'll commit and push the changes. This will trigger the execution of the workflow.

```
cd "C:\k8s\Labs\MathTrick\Chained\Helm"
git add .
git commit -m "Create the workflow.yaml and update the values.yaml"
git push
```

NOTE: Note that the execution of this workflow requires the docker images for all the projects to be present in the ACR. This means at least one correct execution of the workflow for each of the projects is required.

2. Wait to see the Helm github action finished.

3. Now, we can push the changes for the **step**, **NodeJS** and **web** repos. From this point onwards, any change to these projects will also cause the deployment of the chart. Copy the following script in your Windows Terminal:

```
ForEach ($i in 1..5) {
    cd "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step$i\
    Write-Host "=====MT3Chained-Step$i=====" -ForeGround
Green
    git add .
    git commit -m "Add workflow.yaml"
    git push
    Start-Sleep -s 60
}

cd "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Step2-NodeJS\
git add .
git commit -m "Add workflow.yaml"
git push
Start-Sleep -s 60

cd "C:\k8s\Labs\MathTrick\Chained\MT3Chained-Web\
git add .
git commit -m "Add workflow.yaml"
git push
```

NOTE: The command `Start-Sleep -s 60` is just to avoid the following error:

```

    ▾ ✘ Deploy

  1 ► Run helm upgrade --install chained mt***chained/
18 Error: UPGRADE FAILED: release: already exists
19 Error: Process completed with exit code 1.

```

This happens because each of the above pushes will create a trigger for the workflow in the Math-Trick-3---Chained repo, and without the Start-Sleep -s 60 command there would be 7 helm upgrade --install chained mt3chained/ running at the same time.

4. Assuming the pipeline succeeds, check the cluster to verify everything has been deployed and is running.

```
kubectl get all -n chained
```

```

PS C:\k8s\Lab\MathTrick\Chained\Helm> kubectl get all -n chained
NAME                                         READY   STATUS    RESTARTS   AGE
pod/mt3chained-step1-dep-5c5ccbcf47-f5wv9   1/1     Running   0          2m5s
pod/mt3chained-step2-dep-84f665f4d9-csgkz   1/1     Running   0          2m5s
pod/mt3chained-step3-dep-67f846d9b-h9fzn   1/1     Running   0          2m5s
pod/mt3chained-step4-dep-67f59c6fdb-plfwz   1/1     Running   0          2m5s
pod/mt3chained-step5-dep-cb4fdb848-j2kvl   1/1     Running   0          2m5s
pod/mt3chained-web-dep-77dc995794-s7skh   1/1     Running   0          2m5s

NAME                TYPE        CLUSTER-IP      EXTERNAL-IP      PORT(S)         AGE
service/mt3chained-step1-svc  ClusterIP  10.0.237.19  <none>           5010/TCP       2m5s
service/mt3chained-step2-svc  ClusterIP  10.0.100.2   <none>           5020/TCP       2m5s
service/mt3chained-step3-svc  ClusterIP  10.0.190.221 <none>           5030/TCP       2m5s
service/mt3chained-step4-svc  ClusterIP  10.0.94.127  <none>           5040/TCP       2m5s
service/mt3chained-step5-svc  ClusterIP  10.0.35.172  <none>           5050/TCP       2m5s
service/mt3chained-web-svc   LoadBalancer 10.0.62.1    20.93.209.221  80:30386/TCP  2m5s

NAME                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/mt3chained-step1-dep   1/1     1           1           2m6s
deployment.apps/mt3chained-step2-dep   1/1     1           1           2m6s
deployment.apps/mt3chained-step3-dep   1/1     1           1           2m6s
deployment.apps/mt3chained-step4-dep   1/1     1           1           2m6s
deployment.apps/mt3chained-step5-dep   1/1     1           1           2m6s
deployment.apps/mt3chained-web-dep    1/1     1           1           2m6s

NAME            DESIRED   CURRENT   READY   AGE
replicaset.apps/mt3chained-step1-dep-5c5ccbcf47  1         1         1         2m6s
replicaset.apps/mt3chained-step2-dep-84f665f4d9  1         1         1         2m6s
replicaset.apps/mt3chained-step3-dep-67f846d9b   1         1         1         2m6s
replicaset.apps/mt3chained-step4-dep-67f59c6fdb  1         1         1         2m6s
replicaset.apps/mt3chained-step5-dep-cb4fdb848   1         1         1         2m6s
replicaset.apps/mt3chained-web-dep-77dc995794    1         1         1         2m6s

```

5. Open a browser and enter the EXTERNAL-IP address listed for the Load Balancer service.

6. Click the Start button to ensure all the services are connected.

Always Ends with 3 Math Trick

Chained

[View System Diagram](#)

You pick a number and then perform the calculation steps below. After all the calculations have completed, your final result will always be 3, regardless of the number you picked.

Process:

Start by picking a number between 1 and 10.

Calculation Steps:

1. Double the number.
2. Add 9 to result.
3. Subtract 3 from the result.
4. Divide the result by 2.
5. Subtract the original number from result.

Final result will always be **3**.

Try it Yourself:

Pick a number: Final Result: **3**

Perform Calculations: **Start** Failure Rate: **5%**

Platform	Step	Calculation	Result
.NET Core	1	5×2	10
.NET Core	2	$10 + 9$	19
.NET Core	3	$19 - 3$	16
.NET Core	4	$16 / 2$	8
.NET Core	5	$8 - 5$	3

7. Verify that the Helm pipeline used all the tags from the Key Vault and replaced all the tags successfully, including the ACR.

```
helm get values chained -a
```

```
PS C:\k8s\labs\MathTrick\Chained\MT3Chained-Web> helm get values chained -a
COMPUTED VALUES:
namespace: chained
platform: dotnet
repo: acrpactqkyvnju.azurecr.io
tags:
  mt3chainedstep1: "3"
  mt3chainedstep2: "3"
  mt3chainedstep2nodejs: "2"
  mt3chainedstep3: "3"
  mt3chainedstep4: "3"
  mt3chainedstep5: "3"
  mt3chainedweb: "6"
PS C:\k8s\labs\MathTrick\Chained\MT3Chained-Web>
```

8. Finally, confirm that the entire process is working correctly by adding a test file in any microservice and check it in.

```
# Change into any of the microservice folders.
echo "Test" > pipeline.txt
git add .
```

```
git commit -m "Pipeline test"  
git push
```

9. Wait a few minutes to ensure that **ONLY** that effected Pod was automatically replaced with the new version.

```
kubectl get all -n chained
```

NAME	READY	STATUS	RESTARTS	AGE
pod/mt3chained-step1-dep-896fddd8-wjq42	1/1	Running	0	29s
pod/mt3chained-step2-dep-84f665f4d9-csgkz	1/1	Running	0	31m
pod/mt3chained-step3-dep-67f846d9b-h9fzn	1/1	Running	0	31m
pod/mt3chained-step4-dep-67f59c6fdb-plfwz	1/1	Running	0	31m
pod/mt3chained-step5-dep-cb4fdb848-j2kvl	1/1	Running	0	31m
pod/mt3chained-web-dep-77dc995794-s7skh	1/1	Running	0	31m

CONGRATULATIONS!!! You now have a "practical" pipeline you can use as a template for complex microservices applications.

[List of Modules](#)