KCD Sofia 2025

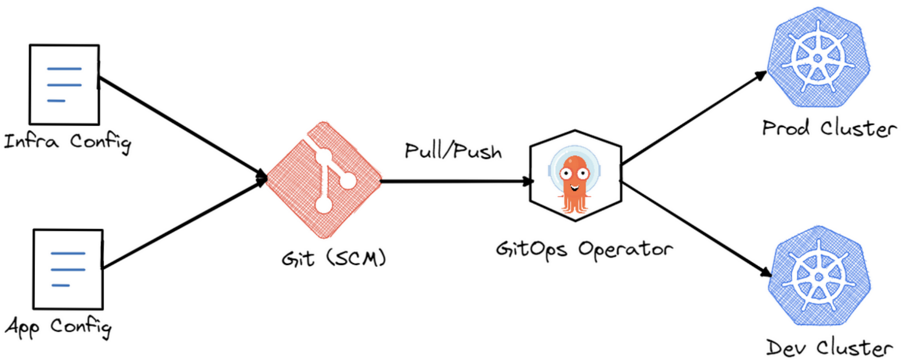
GitOps made simple: Best Practices using ArgoCD & Kubernetes

Overview

GitOps is a powerful approach for using Git as a single source of truth for managing both application and infrastructure configurations. It is a specialized methodology within the broader DevOps cultural and technical philosophy, and brings several key benefits:

- `Repeatability`: Every deployment or configuration is versioned in Git, making environments easy to reproduce or redeploy.
- `Traceability`: Every change is tracked and documented as a commit, enabling audits and clear visibility into who made what change and when.
- `Audit and Rollback`: Since changes are version-controlled, rolling back to a stable state is as simple as reverting a Git commit, making rollbacks secure and fast.

Through Git-driven workflows, GitOps provides automation and reliability, especially for modern cloud environments. Unlike traditional administration approaches—where configuration changes are applied directly to the Kubernetes environment — in GitOps every intended change is made via commits to Git, and only then is it reflected in the cluster.



GitOps Architecture

ArgoCD implements GitOps practices by continuously monitoring Git repositories through a combination of periodic polling and webhooks. It automatically detects changes and syncs those changes to the Kubernetes infrastructure. When a configuration or application update is pushed to Git, ArgoCD ensures the live cluster matches what's described in Git, without requiring manual intervention, thus enabling consistent, secure, and auditable operations.

Throughout this workshop, we'll see in practice how to build a simple infrastructure based on Git, Kubernetes, and ArgoCD, and how to implement these principles hands-on.

Prerequisites

The list of prerequisites to complete the workshop are:

> [!Note] No matter whether you are using Linux, Mac OS, or Windows, they all come with a built-in SSH client in the terminal!

- Personal laptop
- Web browser
- SSH client - built-in like openSSH or third-party like SecureCRT, MobaXterm, Putty, etc.
- Internet connectivity to the cloud infrastructure

In case you are following the instructions after the event, you can recreate the lab environment by creating a dedicated virtual machine based on Ubuntu 24.04 linux using your prefered hypervisor (like KVM, ProxMox VE, VirtualBox, VMware Workstation/Fusion, etc.).

The recommended minimal system requriements are:

- 2 cores
- 4 GB ram
- 15 GB disk size

Get familiar with our hands-on environment

The remote lab (hands-on) environment is a virtual machine deployed in the cloud and is based on Ubuntu Linux 24.04 LTS. It is only accessible over SSH.

The SSH session authentication will be based on the username: `ubuntu` and an `SSH key` that will be shared with you at the beginning of the event.

> [!Note] Please don't change the default credentials!

> [!Warning] The handson machines are short-lived and will be destroyed immediately after the end of the event. Please don't store any important or sensitive data on them!

> [!Warning] Please don't reboot your hands-on VM as this might change its IP address.

The hands-on machine credentials are:

- username: `ubuntu`
- password: `ubuntu`

The built-in user `ubuntu` has regular user privileges. It is a member of the `sudoers` group, and in case you need to elevate your privileges, you can use the `sudo` command.

Connect to the Hands-On Environment

Due to security concerns, SSH requires the private key file permissions to be set to `400` (read-only for the owner). Let's do that first:

```
user@workstation:~$ chmod 400 key.pem
```

> [!Note] If you don't change the key permissions, the OpenSSH client might refuse it with a warning:

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@    WARNING: UNPROTECTED PRIVATE KEY FILE!             @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
```

Throughout the hands-on we might have to create multiple ssh sessions to our target hands-on machine. To make it easier to reference its IP address, let's store it in a text file. In the following examples, please substitute the references to `public.hands.on.ip` with the public IP address of your hands-on machine provided by your instructur.

On Linux or Mac os:

```
echo public.hands.on.ip > ./ip.txt
```

or if you are using the OpenSSH client in Windows PowerShell:

```
"public.hands.on.ip" | Set-Content ip.txt
```

Next, let's log in to our dedicated hands-on machine by first initializing an environment varialbe with the IP address:

```
#Windows:
$HANDSONIP = Get-Content ip.txt

#Mac/Linux:
HANDSONIP=$(cat ./ip.txt)
```

```
user@workstation:~$ ssh -i key.pem ubuntu@$HANDSONIP
~$
```

Task 1. Configure the hands-on infrastructure

In this task, we'll do the initial environment setup:

- Install Docker and Kubernetes
- Verify both services are running
- Install the git server - Gogs

Task 1.1. Installing Docker and Kubernetes

To complete the workshop exercises, we'll need a working Docker CE and a Kubernetes cluster.

Docker CE is an open-source platform that allows us to develop, ship, and run applications in containers — lightweight, portable units that encapsulate everything an application needs to run. It will enable us to create a consistent environment for running our git server - Gogs separate from our Kubernetes cluster.

To automate the installation of Docker and Kubernetes, which are not our main focus in this hands-on, we'll use a shell script.

> [!Warning] Using shell scripts from third parties might be dangerous! Please take a moment to review the script content before executing it!

```
wget https://raw.githubusercontent.com/DojoBits/Toolbox/main/k8s-up.sh
```

Inspect the script:

```
less k8s-up.sh
```

Then, if everything looks good, let's execute it:

```
chmod +x k8s-up.sh
sudo ./k8s-up.sh
```

> [!Note] The script execution might take a few minutes, depending on the machine and internet connection speed.

When execution is finished, you'll see:

```
...
[INFO] Removing the control-plane NoSchedule taint...
node/db-lab-110 untainted
[INFO] All done! 🎉

~$
```

Now we have a fully functional single-node Kubernetes cluster!

Task 1.2. Verify the services

Let's quickly validate that the kubernetes (k8s) cluster is up and running.

> [!Note] It may take a few seconds for the cluster status to become `Ready`:

```
kubectl get node
```

```
NAME          STATUS   ROLES           AGE   VERSION
db-lab-110    Ready    control-plane   34m   v1.34.1
~$
```

After the installation script has completed, we should have a working Docker engine. Let's check it out:

```
sudo docker --version
```

If everything works, we should see the Docker version information.

```
Docker version 28.4.0, build d8eb465
```

Now, let's check for any running containers:

```
docker ps
```

```
permission denied while trying to connect to the Docker daemon socket at
unix:///var/run/docker.sock: Get
"http://%2Fvar%2Frun%2Fdocker.sock/v1.47/containers/json": dial unix
/var/run/docker.sock: connect: permission denied
~$
```

We've got a permission error because we use the Docker CLI client as a regular, unprivileged user.

To fix that, we could either run the Docker CLI client with `sudo` every time, or add our linux user to the docker user group:

```
sudo usermod -aG docker $(whoami)
```

To apply this configuration change, we have to log out and log back in into our shell session, but we can use a small trick to work around that.

We will change our primary group to the docker group and then change it back to our initial group.

> [!Note] This is not a permanent change, and it affects only our current session.

```
newgrp docker
groups
```

Output:

```
docker adm cdrom sudo dip plugdev lxd ubuntu
~$
```

Let's test again:

```
docker ps
```

```
CONTAINER ID   IMAGE     COMMAND   CREATED   STATUS    PORTS     NAMES
~$
```

If that workaround doesn't work for you, please try to log out and back in to apply the group change.

Task 1.3. Install Gogs git server

To demonstrate the git principles, we'll need a git server. To avoid third-party dependencies, we'll quickly install our own open source server: Gogs.

"Gogs is a lightweight, self-hosted Git server written in Go, designed for painless installation and minimal resource usage. It lets individuals and teams run their own Git repositories with features like user dashboards, access control, and webhooks, all on their own hardware or private cloud."

To automate the installation of Gogs, which is again not our main focus in this hands-on, we'll use another shell script.

> [!Warning] Using shell scripts from third parties might be dangerous! Please take a moment to review the script content before executing it!

```
wget https://raw.githubusercontent.com/DojoBits/Toolbox/main/gogs-up.sh
```

Inspect the script:

```
less gogs-up.sh
```

If everything looks good, execute the script to deploy our git server:

```
chmod +x gogs-up.sh
./gogs-up.sh
```

> [!Note] The script execution might take a few minutes, depending on the machine and internet connection speed.

> [!Note] The password is dynamically generated during setup. Please write it down so you don't lose it.

```
[+] Running 1/1
 ✔ Container gogs  Started
0.5s
⏳ Waiting for Gogs to start (up to 10s)…
Gogs is up! ✅
   Gogs is ready! 🎉
   URL      : http://localhost:3000/
   admin    : dojo
   password : hTenr4rPpTTF
   (you can change the password later via the UI)
~$
```

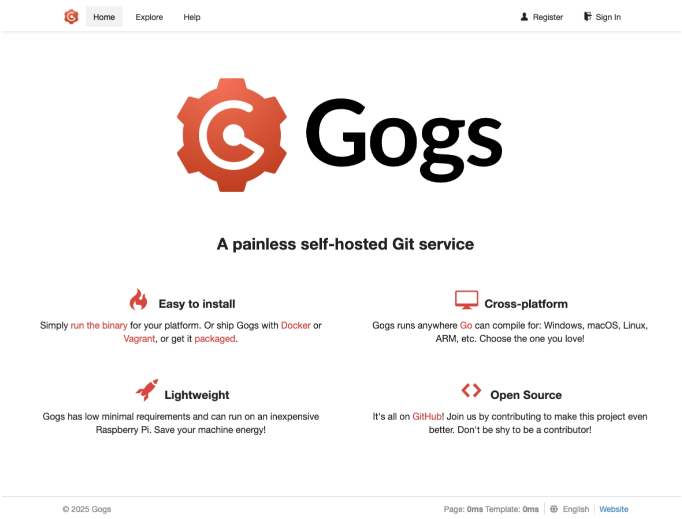
Done! Gogs has a built-in web UI which we can reach by just opening an SSH tunnel to our hands-on machine using its `public ip` address:

```
#Windows:
$HANDSONIP = Get-Content ip.txt

#Mac/Linux:
HANDSONIP=$(cat ./ip.txt)
```

```
ssh -i key.pem -L 2222:localhost:2222 -L 3000:localhost:3000
ubuntu@$HANDSONIP
```

and then using the url: http://localhost:3000/ in a web browser:



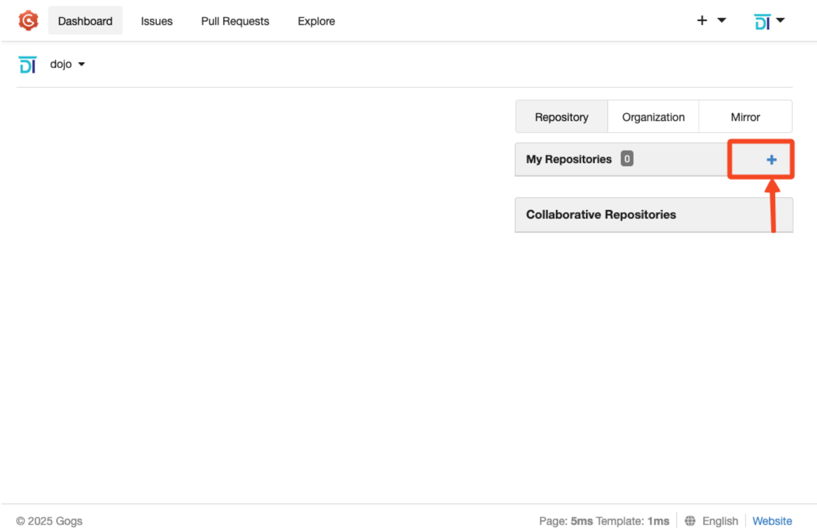
Task 1.4. Create a git repository

We'll need a git repository where we'll store our infrastructure and configurations as code. With Gogs, this is quite easy!

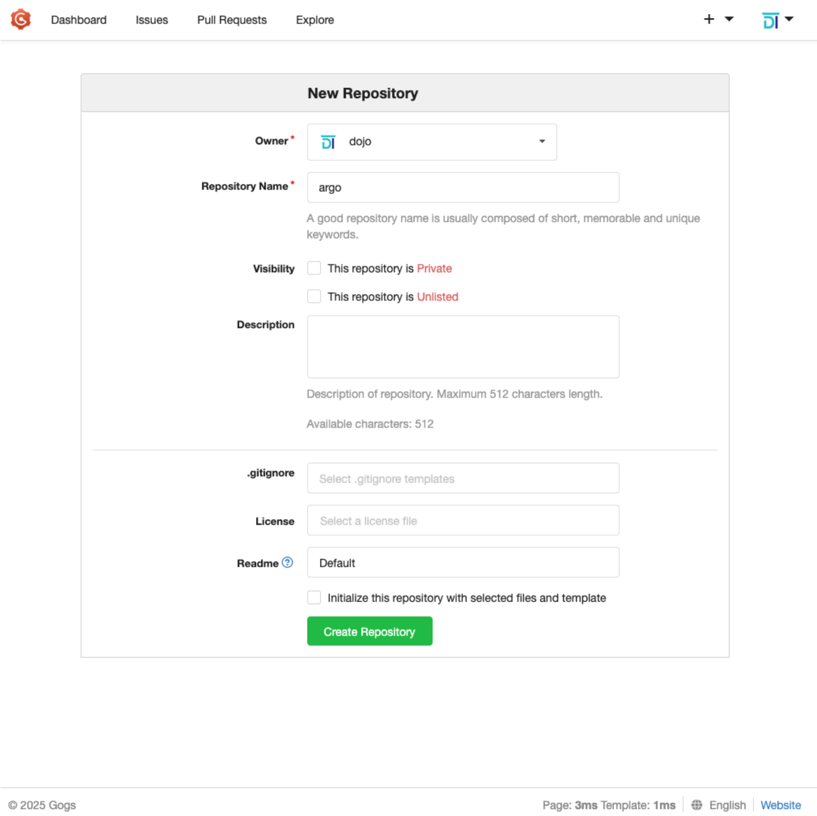
In the Gogs Web ui, click on the `Sign in` link in the upper right-hand side corner and log-in with the credentials from the previous step.

- username: `dojo`
- password: `from the install script output`

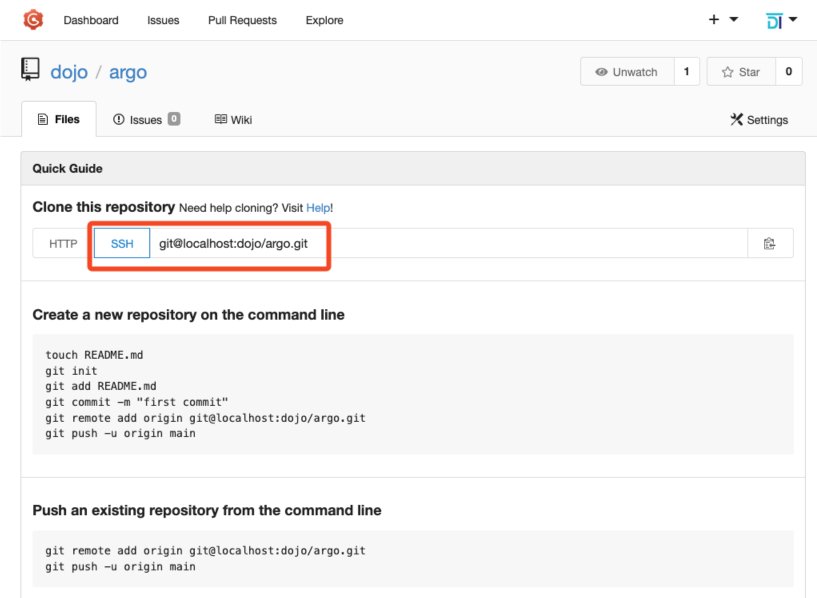
Click on the `+` icon, next to "My Repositories" field on the main screen:



A new screen, `New Repository`, will appear where we can configure our new repository. Let's use the name: `argo` and leave the rest of the settings as default. Click on the `Create Repository` button on the bottom of the screen.



Our repository is now ready! Write down the repository url for later: `git@localhost:dojo/argo.git`



Task 1.5. Configure SSH key-based authentication

To authenticate against our git repository using an SSH key from the console, we need to create an SSH key and add it to our Gogs profile.

Generate a new SSH key and add it to the agent:

```
ssh-keygen -t ed25519 -C "operations@dojobits.io" -N "" -f ~/.ssh/dojo.key
cat <<EOF >> ~/.ssh/config
Host localhost
  HostName localhost
```

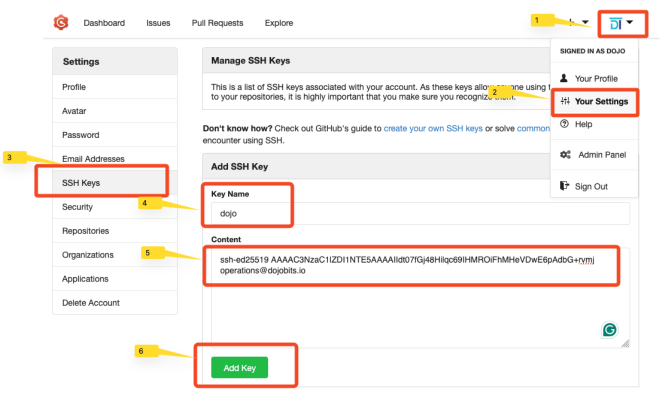
```
  User dojo
  Port 2222
  IdentityFile ~/.ssh/dojo.key
  IdentitiesOnly yes
EOF
```

Copy the content of the public key from the command output:

```
cat ~/.ssh/dojo.key.pub
```

Then register the Key in your Gogs profile:

- Log in to the Gogs web UI.
- Click on the User Profile Image in the upper right-hand side corner → `Your Settings` → "SSH Keys".
- Click `Add Key`, give it a label: `dojo`, paste the contents of your public key.
- Click `Add Key` to save the key.
- Done!



Task 2. ArgoCD Installation & Configuration

With the Git server and Kubernetes cluster up and running, we are almost ready. Next we'll install ArgoCD in our Kubernetes cluster using a Helm chart.

Let's add the ArgoCD Helm repository:

```
helm repo add argo https://argoproj.github.io/argo-helm
helm repo update
```

```
"argo" has been added to your repositories
Hang tight while we grab the latest from your chart repositories...
...Successfully got an update from the "argo" chart repository
Update Complete. ⎈Happy Helming!⎈
```

We'll use a separate Kubernetes namespace for managing the ArgoCD resources: (optionally, the NS could be created by helm as well, using --create-namespace for a quick test):

```
kubectl create namespace argocd
```

Install with sensible defaults

```
helm install argo-cd argo/argo-cd \
  --namespace argocd \
  --set server.service.type=ClusterIP
```

```
NAME: argo-cd
LAST DEPLOYED: Mon Sep 15 13:38:17 2025
NAMESPACE: argocd
STATUS: deployed
REVISION: 1
TEST SUITE: None
NOTES:
In order to access the server UI you have the following options:

1. kubectl port-forward service/argo-cd-argocd-server -n argocd 8080:8080

    and then open the browser on http://localhost:8080 and accept the
certificate

2. enable ingress in the values file `server.ingress.enabled` and either
      - Add the annotation for ssl passthrough: https://argo-
cd.readthedocs.io/en/stable/operator-manual/ingress/#option-1-ssl-
passthrough
      - Set the `configs.params."server.insecure"` in the values file and
terminate SSL at your ingress: https://argo-
cd.readthedocs.io/en/stable/operator-manual/ingress/#option-2-multiple-
ingress-objects-and-hosts


After reaching the UI for the first time, you can log in with username:
`admin` and the random password generated during the installation. You can
find the password by running:

kubectl -n argocd get secret argocd-initial-admin-secret -o jsonpath="
{.data.password}" | base64 -d

(You should delete the initial secret afterwards as suggested by the
Getting Started Guide: https://argo-
cd.readthedocs.io/en/stable/getting_started/#4-login-using-the-cli)
~$
```

With Helm, we've installed all the core ArgoCD components:

```
kubectl -n argocd get po
```

```
NAME                                                        READY   STATUS
RESTARTS   AGE
argo-cd-argocd-application-controller-0                     1/1
Running    0          4m29s
argo-cd-argocd-applicationset-controller-5b74557886-knhg9   1/1
Running    0          4m29s
argo-cd-argocd-dex-server-78b756d64f-z6zsv                  1/1
Running    0          4m29s
argo-cd-argocd-notifications-controller-646d87948-cf6fq     1/1
Running    0          4m29s
argo-cd-argocd-redis-b6c9999c7-z7g28                        1/1
Running    0          4m29s
argo-cd-argocd-repo-server-5f9b4c6f65-825vm                 1/1
Running    0          4m29s
argo-cd-argocd-server-588cd6894b-222dt                      1/1
Running    0          4m29s
```

All pods should be in a `Running` state. If some of them are still initializing, we can use the time to review their function:

- argo-cd-argocd-`application-controller` - Core application reconciliation engine—monitors app states
- argo-cd-argocd-`applicationset-controller` - Automates creation/updating of ArgoCD Applications via ApplicationSet CRDs
- argo-cd-argocd-`dex-server`- SSO/OAuth provider backend
- argo-cd-argocd-`notifications-controller` - Sends notifications/triggers (Slack, email, etc) on sync events
- argo-cd-argocd-`redis` - Internal Redis used for caching and pub/sub
- argo-cd-argocd-`redis-secret-init` - Init job for generating Redis secrets (runs once, then completes)
- argo-cd-argocd-`repo-server` - Manages access to Git repositories and renders manifests
- argo-cd-argocd-`server` - The API & Web UI server

> [!Note] We intentionally avoid using Load balancers and ingress to keep the setup simple.

Next, let's try to connect to the ArgoCD Web UI. To reach the UI running on our remote hands-on machine, we are going to open an SSH tunnel using the familiar approach and use `kubectl port-forward` to make the service reachable from the hands-on machine shell:

In a new terminal tab/window, run the following command to open a new SSH session with the hands-on machine and establish a tunnel:

```
#Windows:
$HANDSONIP = Get-Content ip.txt

#Mac/Linux:
HANDSONIP=$(cat ./ip.txt)
```

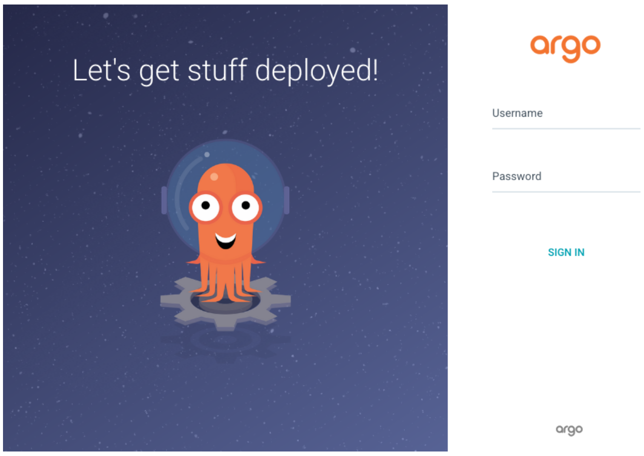
```
ssh -i ./key.pem -L 8080:localhost:8080 ubuntu@$HANDSONIP
```

Then, inside the console, make the kubernetes service for the ArgoCD Web UI reachable using port forwarding:

```
kubectl -n argocd port-forward svc/argo-cd-argocd-server 8080:80
```

If everything goes according to plan, you should be able to open the ArgoCD web UI inside your web browser using the following url: http://localhost:8080:

> [!Note] you'll see a warning `Warning: Potential Security Risk Ahead` or `Your connection is not private` by your browser as we are using insecure connection. Acknowledge the warning and proceed to the web page.



Task 2.1 Log in to ArgoCD Web UI

To log in to the ArgoCD Web UI, we'll need credentials to authenticate. During the installation process, a secret called `argocd-initial-admin-secret` is created automatically. It holds a randomly generated initial password for the built-in `admin` user.

Let's get the password and log in to the Argo CD web ui.

We can go with our familiar kubernetes approach:

```
kubectl -n argocd get secret argocd-initial-admin-secret -o jsonpath="
{.data.password}" | base64 -d && echo
```

> [!Note] Once we install the argocd cli client as seen in the next task, we could use it as well:

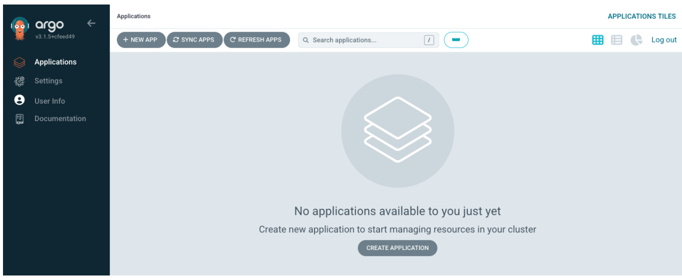
```
argocd admin initial-password -n argocd
```

> [!Note] Your output will be different!

```
6YdzXYvGGk6yxqOK
```

Finally, let's log in to the UI:

- URL: http://localhost:8080
- Username: `admin`
- Password: (the output from the previous command)



Task 2.2 Install the Argo CD cli client

To install the ArgoCD cli client, we'll download the official binary from github:

```
VERSION=$(curl -L -s https://raw.githubusercontent.com/argoproj/argo-cd/stable/VERSION)
curl -sSL -o argocd https://github.com/argoproj/argo-cd/releases/download/v$VERSION/argocd-linux-amd64
```

Next, we'll make the binary executable and place it in the system path:

```
sudo install -m 555 argocd /usr/local/bin/argocd
rm argocd
```

Let's verify:

```
argocd version --client
```

```
argocd: v3.1.5+cfeed49
  BuildDate: 2025-09-10T16:01:20Z
  GitCommit: cfeed4910542c359f18537a6668d4671abd3813b
  GitTreeState: clean
  GoVersion: go1.24.6
  Compiler: gc
  Platform: linux/amd64
```

To manage the ArgoCD server using the ArgoCD CLI client, we need to log in and authenticate first. We'll be using the same credentials as in the Web UI:

> [!Note] We need the `--insecure` flag to skip the TLS verification because we're using a self-signed certificate.

```
argocd login localhost:8080 --username admin --password <password> --insecure
```

If everything works, our argocd context (connection profile) should be updated successfully:

```
'admin:login' logged in successfully
Context 'localhost:8080' updated
```

Let's verify:

```
argocd context
```

```
CURRENT  NAME            SERVER
*        localhost:8080  localhost:8080
```

Task 3. First Application Deployment

Now that we have our infrastructure fully configured, it is time to see how we can implement the GitOps principles in practice using ArgoCD. We'll do that by deploying a simple app from our Gogs git server using a declarative manifest. By defining the deployment manifest and application configuration as code and storing them in Git, we treat our setup as code and make Git our `single source of truth`.

We'll start by cloning our Gogs repository:

```
git clone git@localhost:dojo/argo.git
```

```
Cloning into 'argo'...
The authenticity of host '[localhost]:2222 ([::1]:2222)' can't be
established.
ED25519 key fingerprint is
SHA256:pjdbAy6PKLRvWbymFDN2fUru6VpeuREtnMd5cdObLDQ.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '[localhost]:2222' (ED25519) to the list of
known hosts.
warning: You appear to have cloned an empty repository.
~$
```

```
cd argo
```

> [!Note] Placing the yaml manifests in the root of the git repository is NOT a good practice! We do it here for convenience. This is something we'll get back to in the next task!

Then we'll create a standard Kubernetes deployment:

```
nano deploy-demo.yml && cat $_
```

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: deploy-demo
spec:
  replicas: 2
  selector:
    matchLabels:
      app: deploy-demo
  template:
    metadata:
      labels:
        app: deploy-demo
    spec:
      containers:
        - name: deploy-demo
          image: argoproj/rollouts-demo:green
          ports:
            - containerPort: 8080
```

... and a service for our application:

```
nano svc-demo.yml && cat $_
```

```yaml
apiVersion: v1
kind: Service
metadata:
  name: deploy-demo
spec:
  selector:
    app: deploy-demo
  ports:
    - protocol: TCP
      port: 8090
      targetPort: 8080
```

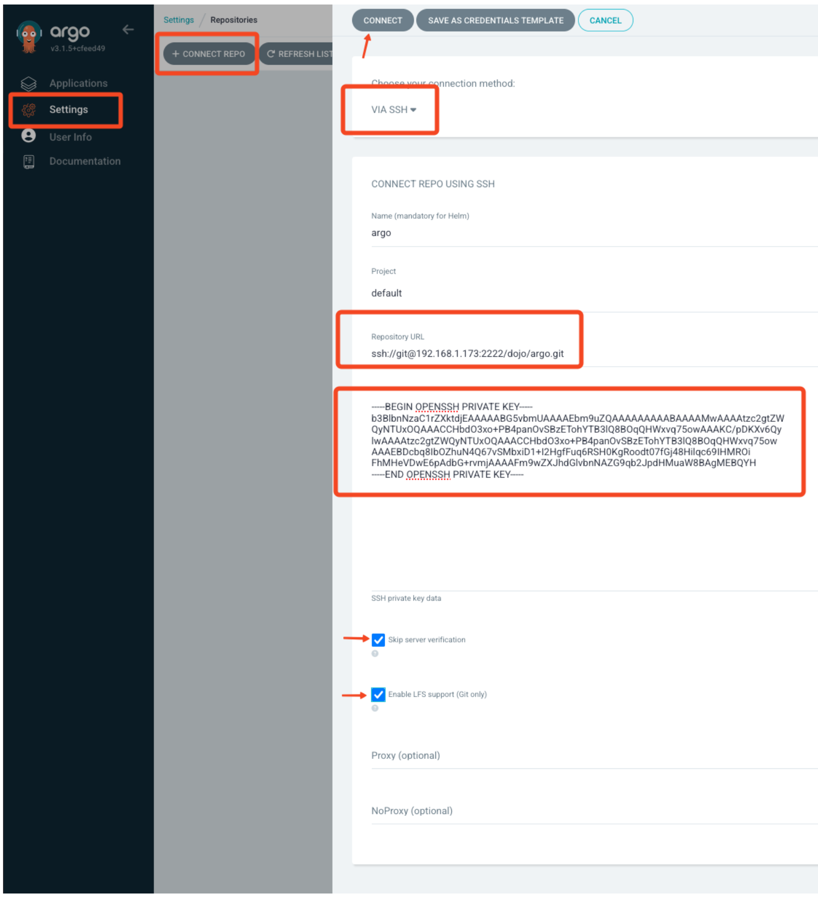
Let's commit and push them to our git repository:

```
git config --global user.email "operations@dojobits.io"
git config --global user.name "dojo"
git checkout -b main
git add .
git commit -av -m "demo app deployment and service"
git push --set-upstream origin main
```

Task 3.1 ArgoCD - Configure connected repository

Before we can deploy our application and create an Argo Application, we have to configure the Git Repository authentication.

Open the ArgoCD Web UI: https://localhost:8080/applications. From the left siderbar select: Settings -> Repositories -> `Connect Repo`



Inside the form, we configure how ArgoCD connects and authenticates against the remote git repository.

- Connection method: `VIA SSH`
- Connection Name: `argo`
- Project: `default`
- Repository URL: `ssh://git@<private.host.ip.addr>:2222/dojo/argo.git` The <private.host.ip.addr> is the private ip address of the hands-on machine. You can get it form the terminal. Use the command `ip -4 a` to list all ipv4 addresses and related network interfaces. Look for the first network interface. Alternatively you could filter the interfaces with: `ip -4 -o a | cut -d ":" -f 2 | grep -vE "^ lo|^ br-|^ docker|^ cilium_host"`
- SSH key: This is the SSH key we've generated in the previous step. You can get it from the shell using: `cat ~/.ssh/dojo.key`
- Skip server verification: `checked`
- Enable LFS support (Git only): `checked`

Click: `CONNECT` to save the configuration and test the connection. Upon successful connection, the connection status should change to: `Successful`:

Task 3.2 Register the demo App with ArgoCD

Now that we have connected the git repository, let's deploy our application! In the Applications dashboard, click on `New App`.

Fill in the following information:

General:

- Application Name: `deploy-demo`
- Project Name: `default`

SYNC POLICY:

- Sync Policy: `Automatic`
- ENABLE AUTO-SYNC: `Checked`

SYNC OPTIONS:

- AUTO-CREATE NAMESPACE: `Checked`

SOURCE:

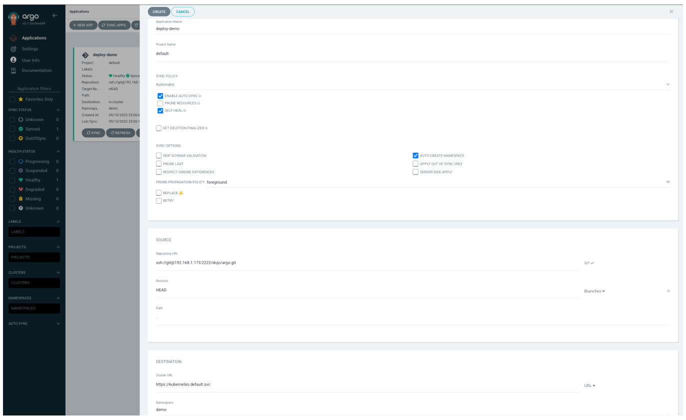
- Repository URL: `Select from the drop-down menu`
- Revision: HEAD
- Path: `.`

DESTINATION:

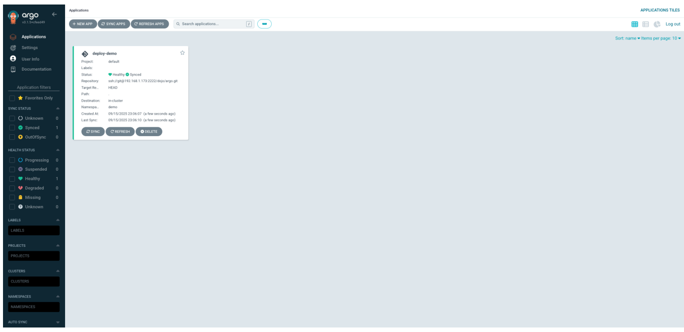
- Cluster URL: `https://kubernetes.default.svc`
- Namespace: `demo`

> [!Note] In our original manifest, we've not specified any namespace, and here we effectively overwrite `default` namespace with a custom one for the deployment.

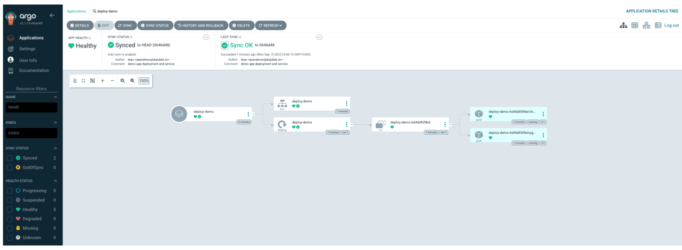
Finally, click `CREATE` to create the application.



Upon successful creation, a new card with the application status will appear on the dashboard. In a few seconds, the state should change to: Healthy and Synced:



Click on the card to reveal details about the newly deployed application in a tree view:



You can also validate that the resources have been properly created using kubectl

```
kubectl -n demo get all
```

```
NAME                                 READY   STATUS    RESTARTS   AGE
pod/deploy-demo-6d4ddfd9bd-m7bg9   1/1     Running   0          13h
pod/deploy-demo-6d4ddfd9bd-t5d5j   1/1     Running   0          13h

NAME                  TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)
AGE
service/deploy-demo   ClusterIP   10.96.146.224   <none>        8090/TCP
39h

NAME                          READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/deploy-demo   2/2     2            2           39h

NAME                                     DESIRED   CURRENT   READY   AGE
replicaset.apps/deploy-demo-5764675dfb   0         0         0       14h
replicaset.apps/deploy-demo-6d4ddfd9bd   2         2         2       39h
~$
```

Challenge 1. Access the demo app web ui

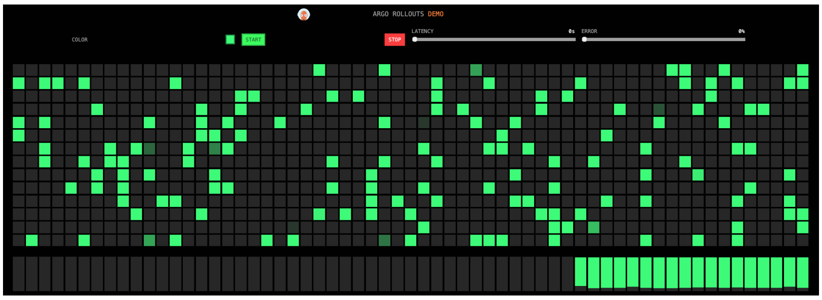
> [!Note] For this challenge task, we are not going to provide instructions on how to solve it. We've already seen the techniques required in the previous tasks.

Goals:

- Open a local port-forwarding tunnel from your machine to the hands-on vm using the SSH client

- Configure port forwarding on the hands-on vm so that the `deploy-demo` service from the `demo` namespace is reachable from the hands-on VM.
- Open the demo-app web ui on your local browser.

Upon successful completion, you should be able to see the application in your browser:



Task 3.3 You break it, Argo fixes it

It happens pretty often, even if we don't want to admit it. We are tasked with making an urgent change, and the quickest way to do it is... by applying the change directly in our infrastructure. This happens again and again, and our infrastructure's current state drifts further from our desired state. Sometimes our change might even have unforeseen side effects, but as it wasn't properly documented, it could be harder to troubleshoot. Luckily, ArgoCD can help!

Let's do a quick imperative patch in production (temporary, of course!):

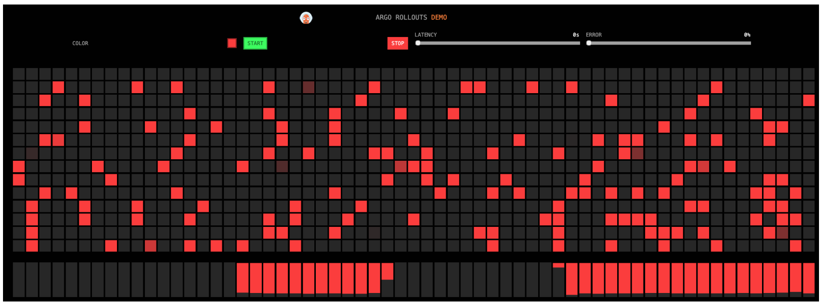
```
kubectl -n demo patch deployment deploy-demo -p '{"spec":{"template":
{"spec":{"containers":[{"name":"deploy-demo","image":"argoproj/rollouts-
demo:red"}]}}}}'
```

Refresh your browser with the app ui a few times.

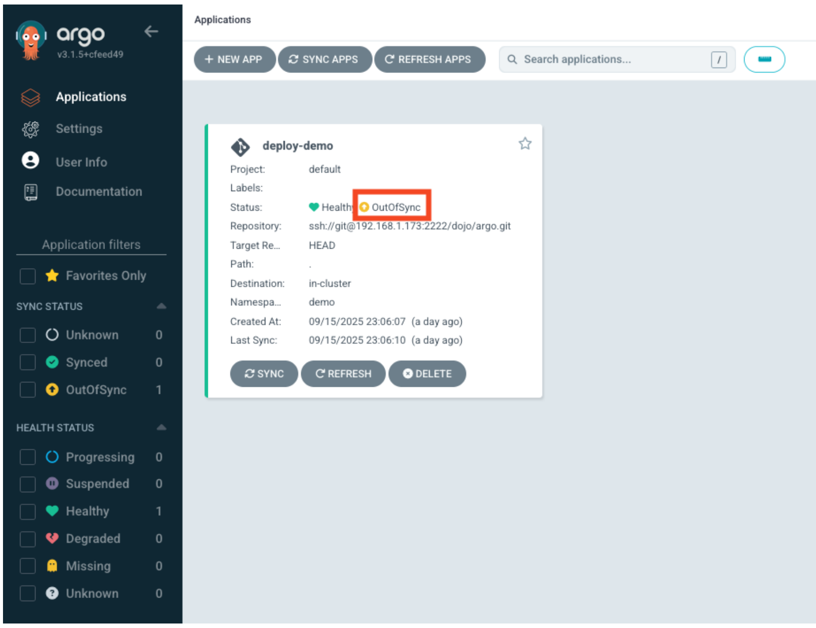
> [!Note] You might have to restart the port forwarding to the app in your terminal session with the SSH tunnel

```
kubectl -n demo port-forward svc/deploy-demo 8090:8090
```

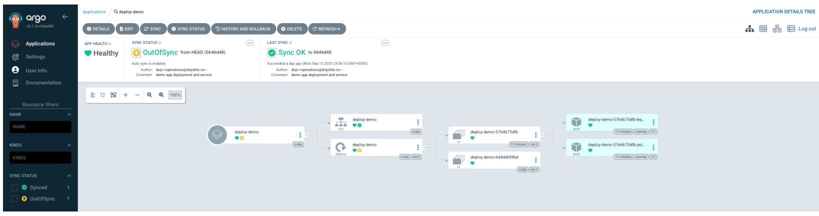
The rogue version of the app is now on the loose:



Let's check what is going on in the ArgoCD web ui. Starting with the App card:



Click on the app card to see application details tree:



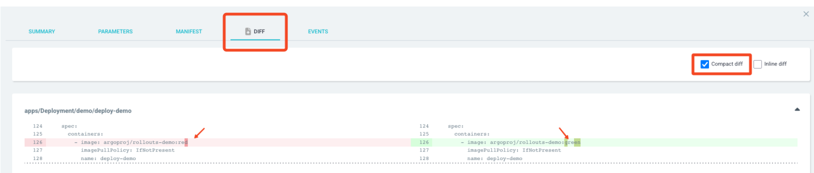
We get a lot of information just from a single look! First, Argo clearly tells us that there is a deviation from the desired state. The Sync Status for the app is "OutOfSync" (we kinda knew that already...), but we also see which objects of the app are out of sync!

- The first object of the three, the app root object, represents the app itself. The state OutOfSync tells us that our app doesn't match the desired state in git. It can also tell us, however, precisely what has changed - we'll see it in a moment.
- Underneath the root object, we see the deploy resource is out of sync, but not the SVC resource. We are on something!

Another interesting observation is that none of the child objects are shown out of sync. After all, they are supposed to be created by their parent objects: pods -> rs -> deployment. In our kubernetes cluster, however, their current live state matches their desired state (from the k8s point of view), so technically they are not out of sync. This also helps us bubble up/isolate the problem faster, focusing on the problem closer to the root cause.

So something is out of sync, but what? Click on the root object in the tree. A pop-up window will appear with summary information about the app. On top of the window, click on the `DIFF` tab:

> [!Note] There is also a convenient `DIFF` button in the toolbar of the app tree view

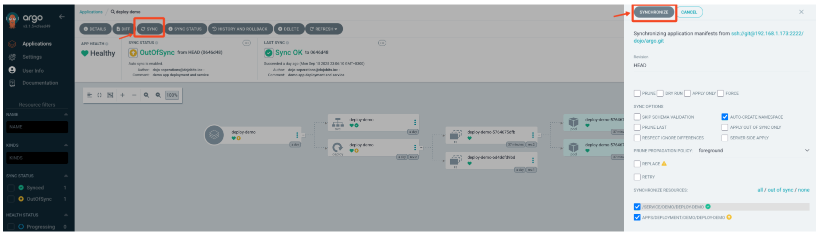


We'll see a diff between the two states of our app - current and desired. You can click on the `Compact diff` checkbox to filter out the parts of the manifests that have not changed. Now it is becoming very clear what exactly is the source of change - the image tag that we've patched.

So far, so good, but what should we do about it? Well, it depends..

- If this were in fact a valid urgent change inside the infrastructure, we could directly update the git resource definitions and make it the current desired state
- On the other hand, if this were a temporary test that should not persist, we could quickly revert it.

Close the diff pop-up (use the X in the upper right-hand side). On the main app tree view, click on the `SYNC` button in the upper toolbar. A pop-up will appear:



To revert the state, we could click on the `SYNCHRONIZE` button, but we can also make a few observations:

- Both the insync and out-of-sync resources are selected by default (svc and deploy)
- There are several sync options available to choose from.

We are not going to go into details for each of the options in here, but we'll touch on the subject: Which resources should we synchronize?

First, with these current/default settings, syncing a resource that is already in sync will not change it (argo does idempotent re-apply). If you deselect the SVC resource, argo will show you a warning:

```
WARNING: partial synchronization is not recorded in history
```

This is a warning due to the way that ArgoCD only records full application syncs (when all resources are selected) in the sync history and enables rollback based on those points.

When you perform a partial sync — syncing just a subset of resources, such as only the Deployment but not the Service, ArgoCD does not save this operation in the application's history log. As a result:

- You cannot roll back to this partial sync point (rollback is tied to full syncs).
- The change will not appear in the sync history timeline.

Best practices:

- Production deployments: Always use full sync in production to maintain auditability, rollback support, and guarantee everything matches Git.
- Development/debugging: Partial sync can be useful when you want to quickly test changes or fix a single resource without touching the rest of the app.
    - Note: The partial sync can break the app if the rest of the resources depend on the resource synced.

  - For complex apps, the partial sync can slightly speed up the process and reduce the API load
- Use full sync by default and partial sync only in development/debugging when needed.

Click on the `SYNCHRONIZE` button, leaving the default options. In a second, everything will be back to green and in a synced state. If we refresh the browser (and our port forwarding with kubectl), we should be back to the green state.

Challenge 2. Patch the app and persist the change in git

> [!Note] For this challenge task, we are not going to provide instructions on how to solve it. We've already seen the techniques required in the previous tasks.

Similar to the previous task, start by changing the production state:

```
kubectl -n demo patch deployment deploy-demo -p '{"spec":{"template":{"spec":{"containers":[{"name":"deploy-demo","image":"argoproj/rollouts-demo:red"}]}}}}'
```

Goals:

- Remediate the state of the app by updating the yaml manifests and committing the changes in Git.
- After the commit, observe the changes in the Argo App state in the UI.

> [!Note] As we've not configured webhooks, it might take a few seconds for Argo to recognize the changes in git (do a pull). To speed up the state sync, you could use the `REFRESH` button from the top of the app tree view.

Upon successful completion, the sync state of the app should be back to green.

Task 4 Best practices

In the earlier tasks, we've seen some good and some bad practices - like placing all of the manifests in the root of the git repository. Here we'll review some of the best practices regarding:

- Repository organization
- ArgoCD Configuration
- Team collaboration

Task 4.1 GitOps and Argo CD best practices review

In this task, we'll review some of the GitOps and Argo CD best practices and recommendations. Some of those recommendations are actually coming from the official Argo CD [Best Practices] guide:

- Use Git repositories as a single source of truth
  - Store a `declarative representation` of our `desired state` from tools like Helm, Kustomize, etc., inside Git and modify them only through Git commits.
  - `WHY`: This single source of truth prevents configuration drift, making the infrastructure more reliable and reproducible. Besides that, it helps maintain an auditable and versioned history of every deployment.

- Separate Application Configuration from Application Source Code and Infrastructure related resources in different repositories
  - Store application manifests (Deployments, Services, ConfigMaps, Secrets, etc.) in dedicated repositories, separate from repositories holding infrastructure related resources (like Namespaces, RBAC, ClusterRoles, etc.) and Source Code.
  - `WHY`: This separation enforces Permission and Security Boundaries, allowing for more effective management, access control, and operational simplicity.
- Centralize environment-specific configurations from a single repository/branch
- Manage all environment-specific configurations in a centralized location and use methods like Kustomize overlays, Helm Values, and ApplicationSets (Argo) to effectively manage them.
- `WHY`: This allows easier promotion of changes between environments while using git to version control them. Argo CD supports ApplicationSets (automates management of multiple applications from a single source through templating and generators)
- Use templating tools
  - The templating and overlay tools like Helm, Kustomize, or ApplicationSets to define the base application configuration and then apply environment-specific changes.
  - `WHY`: manually managing configuration manifests is error-prone, not scalable and hard to maintain.
- Utilize the Argo CD `Projects` and Role-Based Access Control (`RBAC`) for shared environments
  - In case the environments are shared between multiple teams or tenants through the use of Argo Projects, we can impose fine-grained controls over what gets deployed, where, and by whom. The `RBAC` policies enable to define granular permissions preventing unauthorized access.
  - `WHY`: Enforces the principles of `Least Privilege` and apply logical isolation. This also improves auditability, governance, compliance, scalability and reduces complexity
- Uses of Automated Sync and Sync Waves
  - Through `automatic synchronization` in `non-production` environments (like dev and staging), we can implement continuous/rapid deployment. In `production`, it is safer to implement manual policy requiring human approval, perhaps `4-Eyed` principle. With `auto-pruning` we can reduce configuration drift, making sure the resources not tracked in git are removed. The `Sync Waves` allows us to control the order of resource synchronization - in case there are dependencies. For example, a database should be configured before deploying the application.
  - `WHY`: Ensures predictable and successful deployments through proper dependency management.

We are all done!

Let's get in touch!

- Website: Dojobits
- LinkedIn: Dojobits
- Iliyan Petkov: LinkedIn
- Valentin Hristev: LinkedIn

THANK YOU for joining us!

Thank you for attending today. We hope you leave with a good understanding of the core principles of GitOps and feel empowered to start applying these best practices with Argo CD in your next projects.