Automating Kubernetes Deployments with Helm and ArgoCD

🔷 Understanding Helm, Kubernetes, and ArgoCD

1.What is Helm?

Helm is a **package manager for Kubernetes**. It helps deploy applications using **Helm Charts**, which are **templates** for Kubernetes resources like Deployments, Services, and ConfigMaps.

🔷 **Think of Helm as a package manager like apt (Ubuntu) or npm (Node.js), but for Kubernetes.**
🔷 Instead of manually writing Kubernetes YAML files, Helm lets you reuse and configure **Helm Charts**.

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2. What is a Helm Chart?

A **Helm Chart** is a **collection of files** that define a Kubernetes application.

Basic Helm Chart Folder Structure:

```
my-app-chart/
├── charts/              # Dependency charts (if any)
├── templates/           # Kubernetes YAML templates
│   ├── deployment.yaml  # Deployment definition
│   ├── service.yaml     # Service definition
│   ├── _helpers.tpl     # Common reusable templates
├── values.yaml          # Configuration values (image tag, replicas, etc.)
├── Chart.yaml           # Metadata about the chart (name, version, etc.)
```

- `values.yaml` → Stores **configurable** values (like image tag, replicas, etc.).
- `templates/` → Contains **Kubernetes manifests** as templates.

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3. What is ArgoCD?

ArgoCD is a **GitOps tool** that **automates Kubernetes deployments**.

🔷 **How does GitOps work?**

- Instead of manually running `kubectl apply`, we **store all Kubernetes configurations (Helm Charts) in Git**.

- ArgoCD **monitors the Git repository** and automatically **deploys changes** to Kubernetes.

🔷 Deployment Flow from Code to Kubernetes Using GitOps

This is how the full **CI/CD pipeline works with Helm and ArgoCD**:

🔵 Step 1: Developer Pushes Code to GitHub/GitLab

- The developer writes application code and **pushes changes** to GitHub/GitLab.
- Example:
- `git add .`
- `git commit -m "Updated app logic"`
- `git push origin main`

🔵 Step 2: CI/CD Builds a Docker Image & Pushes to Registry

- A **CI/CD pipeline (GitHub Actions, Jenkins, GitLab CI/CD)** runs:
  1. **Builds the Docker image**
  2. `docker build -t my-registry/my-app:1.0.0 .`
  3. **Pushes the image to a container registry (Docker Hub, AWS ECR, etc.)**
  4. `docker push my-registry/my-app:1.0.0`

🔵 Step 3: Update Helm Chart to Use New Docker Image

Since Helm Charts store the **image tag** in `values.yaml`, we must update it with the new tag.

Option 1: Update `values.yaml` in Git (Manual or CI/CD)

```
image:
  repository: my-registry/my-app
  tag: "1.0.0"  # <- Update this with the new image tag
```

- This can be done manually **OR** automated with a CI/CD pipeline.

Option 2: Use ArgoCD Image Updater (Fully Automated)

Instead of updating `values.yaml`, **ArgoCD Image Updater** can monitor the container registry and auto-update deployments.

Example `argocd-image-updater-config.yaml`:

```
images:
  - name: my-registry/my-app
    update-strategy: latest
    version: semver:~1.0
```

🔵 Step 4: ArgoCD Detects Changes & Deploys to Kubernetes

- ArgoCD **continuously watches Git** for changes.
- When `values.yaml` (or Helm Chart) is updated, ArgoCD:
    1. Pulls the latest Helm Chart from Git.
    2. Deploys the application to the Kubernetes cluster.

✅ **Now the application is running in Kubernetes with the updated Docker image!** 🚀

🔷 Best Practices for Helm + ArgoCD Deployment

1.**Use `values.yaml` for Configurability**

- Avoid hardcoding values in templates, keep image tags configurable.

2. **Follow Semantic Versioning**

- Update `Chart.yaml` with proper versioning (`1.0.0`, `1.1.0`, etc.).

3. **Use `_helpers.tpl` for Reusability**

- Define common labels and annotations in `_helpers.tpl`.

4. **Leverage Helm Linting**

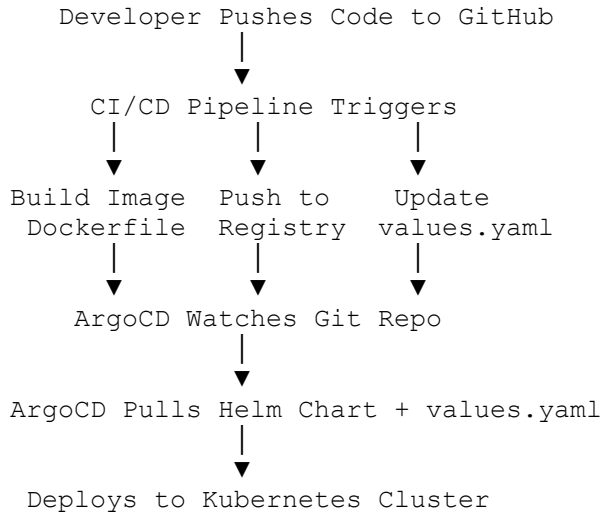
- Run `helm lint` before deploying to check for syntax errors.

5. **Automate with GitOps (ArgoCD)**

- Store Helm Charts in Git and deploy using ArgoCD.

🔷 Diagram: CI/CD Flow with Helm & ArgoCD

Here's a diagram illustrating the entire GitOps flow:



This guide covers **everything from scratch** – from Helm, ArgoCD, and GitOps.