CLOUD COMPUTING SYSTEMS

Lab 10

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GOAL

In the end of this lab you should be able to:

- Understand how to create a docker image
- Know how to launch a container in Azure Containers services

- Understand how to create a (simple) Kubernetes config file
- Understand how to deploy a Kubernetes-based system

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DOCUMENTATION

Dockerfile

https://docs.docker.com/engine/reference/builder/

Azure Container Instances

https://docs.microsoft.com/en-us/azure/container-instances/

https://docs.microsoft.com/en-us/azure/container-instances/container-instances-quickstart

CREATING A DOCKER IMAGE

Create a new directory.

Create a Dockerfile specifying the new image (name must be Dockerfile – Dockerfile.txt, etc. is not good).

DOCKERFILE (EXAMPLE)

```
FROM tomcat:9.0-jdk11-openjdk

WORKDIR /usr/local/tomcat

ADD scc2122-backend-1.0.war webapps

EXPOSE 8080
```

For more info on the commands, check the lecture or the link presented before.

CREATING A DOCKER IMAGE

Create a new directory.

Create a Dockerfile specifying the new image.

Copy all resources to be copied to the image to the new directory.

Run the command:

```
docker build -t tagname directory
```

Example:

```
docker build -t nunopreguica/scc2122-app dir
```

MAKING THE IMAGE AVAILABLE

Alternatives:

1. Use Docker Hub
2. Create Microsoft Repository

MAKING THE IMAGE AVAILABLE

Alternatives:

1. **Use Docker Hub**
2. Create Microsoft Repository

Deploy new image to Docker Hub

Create new account

https://hub.docker.com/signup

Run the command to push the image to Docker Hub registry

```
docker push tag
```

Example:

```
docker push nunopreguica/scc2122-app
```

RUNNING THE IMAGE LOCALLY

To run the image locally you can run:

```
docker run --rm -p 8080:8080 nunopreguica/scc2122-app
```

Your image will be available at URL:

http://localhost:8080/name_of_war_file

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START A (STANDALONE) CONTAINER IN AZURE

Create a resource group, if needed.

```
az group create --name name --location  loc
```

Example:

```
az group create --name scc2122-cluster-4204 --location westeurope
```

START A (STANDALONE) CONTAINER IN AZURE (2)

Start a container.

Example:

```
az container create --resource-group scc2122-cluster-4204 --name scc-app --image
nunopreguica/scc2122-app --ports 8080 --dns-name-label scc-discord-4204
```

`--dns-name-label name` : dns name label for container with public IP

`--port port1 … portn` : list of ports to open

`--environment-variables prop=val …` : list of environment variable (these values can be read in your application using System.getenv(…))

https://docs.microsoft.com/en-us/cli/azure/container?view=azure-cli-latest

START A (STANDALONE) CONTAINER IN AZURE (2)

Start a container.

Example:

```
az container create --resource-group scc2122-cluster-4204 --name scc-app --image
nunopreguica/scc2122-app --ports 8080 --dns-name-label scc-discord-4204
```

Check the output for the ipAddress of the container. The URL for accessing the application should be something like (depending on the war file and DNS label specified):

```
http://scc-discord-4204.westeurope.azurecontainer.io:8080/scc2122-
backend-1.0/ctrl/version
```

Delete a started (standalone) container in Azure (3)

Delete a container given the resource group and name.

Example:

```
az container delete --resource-group scc2122-cluster-4204 --name scc-app
```

TODO

1. Create a Docker image with the code of your application service.
2. Push the image to a registry (suggestion: use Docker Hub)
3. Create a Docker image with artillery and your tests.
   - Use a node.js image as base
   - Install artillery and the other dependencies
   - Copy your tests to the image.
4. Push the image to a registry (suggestion: use Docker Hub)
5. You can now try to start your server in one region and have artillery clients in different regions making calls to your server.

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DOCUMENTATION

Kubernetes

https://kubernetes.io/docs/home/

Kubernetes service at Azure

https://docs.microsoft.com/en-us/azure/aks/

https://docs.microsoft.com/en-us/azure/aks/kubernetes-walkthrough

KUBERNETES KEY CONCEPTS

Pod: encapsulates an application's container (or multiple containers), storage resources, a unique network IP, and options that govern how the container(s) should run.

Service: a Service is an abstraction which defines a logical set of Pods and a policy by which to access them.

Volume: a volume is a directory which is accessible to the Containers in a Pod. A Kubernetes volume has the same lifetime of the Pod that encloses it.

Namespace: Namespaces provide a scope for names. Names of resources need to be unique within a namespace, but not across namespaces.

KUBERNETES KEY CONCEPTS (2)

Deployments: A Deployment provides declarative updates for Pods and ReplicaSets.

ReplicaSet: A ReplicaSet's purpose is to maintain a stable set of replica Pods running at any given time.

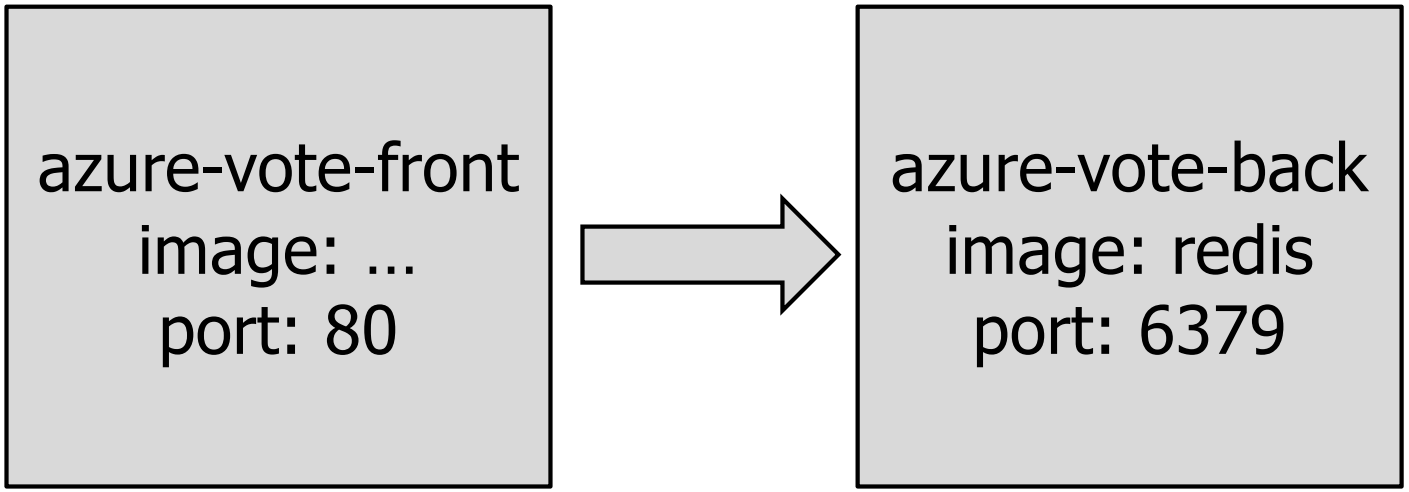
DaemonSet: A *DaemonSet* ensures that all Nodes run a copy of a Pod. As nodes are added/removed to the cluster, Pods are added to/deleted from them.

StatefulSet: StatefulSet is the workload API object used to manage stateful applications.

Job: A Job creates one or more Pods and ensures that a specified number of them successfully terminate

SIMPLE KUBERNETES EXAMPLE

From: https://docs.microsoft.com/en-us/azure/aks/kubernetes-walkthrough



```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: azure-vote-back           # name of deployment
spec:
  replicas: 1                     # number of replica of...
  selector:
    matchLabels:
      app: azure-vote-back        # ... app azure-vote-back

...
```

```
template:
  metadata:                         # pod definition for
    labels:
      app: azure-vote-back          # azure-vote-back
  spec:
    nodeSelector:                   # nodes to run the pod
      "kubernetes.io/os": linux
    containers:                     # containers to start
    - name: azure-vote-back         # name of the container
      image: redis                  # image (from docker hub)
      env:                          # environment variables for redis
      - name: ALLOW_EMPTY_PASSWORD
        value: "yes"
      resources:                    # resources to assign
        requests:
          cpu: 100m                 # 100 mili cpu (10% of cpu time)
          memory: 128Mi             # 128 MB
        limits:
          cpu: 250m
          memory: 256Mi
      ports:
      - containerPort: 6379         # port for accessing the container
        name: redis
```

```
---
apiVersion: v1
kind: Service                       # define a service
metadata:
  name: azure-vote-back             # name to access the service
spec:
  ports:
  - port: 6379                      # port for the outside
  selector:
    app: azure-vote-back            # app associated with the service
---
```

```
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: azure-vote-front
spec:

...                                 # spec omitted

---
apiVersion: v1
kind: Service
metadata:
  name: azure-vote-front
spec:
  type: LoadBalancer                # exposes the service using the
  ports:                            # cloud load balancer
  - port: 80                        # port for the outside
    targetPort: 80                  # port of the app/pods
  selector:
    app: azure-vote-front
```

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Using Azure Kubernetes Service (1)

Create a resource group:

```
$ az group create --name scc2223-cluster-4204 --location westeurope
{
  "id": "/subscriptions/83abecdf-8b40-49a0-bcae-
b5fba4011353/resourceGroups/scc2223-cluster-4204",
  "location": "westeurope",
  "managedBy": null,
  "name": "scc2223-cluster-4204",
  "properties": {
    "provisioningState": "Succeeded"
  },
  "tags": null,
  "type": "Microsoft.Resources/resourceGroups"
}
```

USING AZURE KUBERNETES SERVICE (2)

Create a service principal:

```
$ az ad sp create-for-rbac --name http://scc2223-admin --role
Contributor
{
  "appId": "31c09123-e077-4f72-9fbe-f5b99cafbf12",
  "displayName": "http://scc2223-admin",
  "name": "31c09123-e077-4f72-9fbe-f5b99cafbf12",
  "password": "xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx",
  "tenant": "ae7e50a2-ed26-41f7-bd75-f49683f2433a"
}
```

Using Azure Kubernetes Service (3)

Create a cluster (appId and password should be the values returned from the service principal; for VM sizes and pricing check: https://docs.microsoft.com/en-us/azure/virtual-machines/sizes):

```
$ az aks create --resource-group scc2223-cluster-4204 --name my-scc2223-cluster-4204 --node-vm-size Standard_B2s --generate-ssh-keys --node-count 2 --service-principal appId_REPLACE --client-secret password_REPLACE
{
...
}
```

Using Azure Kubernetes Service (4)

Get credentials to access the Kubernetes cluster:

```
$ az aks get-credentials --resource-group scc2223-cluster-4204 --
name my-scc2223-cluster-4204

Merged "my-scc2223-cluster-4204" as current context in
/Users/nmp/.kube/config
```

After creating the Kubernetes cluster @ Azure, we will use standard Kubernetes commands.

Using Azure Kubernetes Service (5)

Deploy an application:

```
$ kubectl apply -f azure-vote.yaml
deployment.apps/azure-vote-back created
service/azure-vote-back created
deployment.apps/azure-vote-front created
service/azure-vote-front created
```

NOTE: If you don't have kubectl in your computer, you can install it running: az aks install-cli

Using Azure Kubernetes Service (6)

Check the application services:

```
$ kubectl get services
```

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
azure-vote-back	ClusterIP	10.0.224.135	<none>	6379/TCP	18s
azure-vote-front	LoadBalancer	10.0.75.174	51.105.126.35	80:30891/TCP	18s
kubernetes	ClusterIP	10.0.0.1	<none>	443/TCP	4m47s

The application running in the Kubernetes service is accessible using the External IP.
Example: http://51.105.126.35:80

Using Azure Kubernetes Service (7)

Check the application Pods:

```
$ kubectl get pods
NAME                                READY   STATUS    RESTARTS   AGE
azure-vote-back-798985f86b-xzrg8    1/1     Running   0          9m36s
azure-vote-front-84c8bf64fc-29254   1/1     Running   0          9m36s
```

Using Azure Kubernetes Service (8)

Stream the logs from one Pod:

```
$ kubectl logs -f azure-vote-front-84c8bf64fc-29254
... Messages
```

Using Azure Kubernetes Service (9)

Delete all objects (but persistent volumes) on Kubernetes.

```
$ kubectl delete deployments,services,pods --all
deployment.apps "azure-vote-back" deleted
deployment.apps "azure-vote-front" deleted
service "azure-vote-back" deleted
service "azure-vote-front" deleted
service "kubernetes" deleted
pod "azure-vote-back-798985f86b-xzrg8" deleted
pod "azure-vote-front-84c8bf64fc-29254" deleted
```

Using Azure Kubernetes Service (10)

Delete persistent volumes on Kubernetes (if you have created any).

```
$ kubectl delete pv --all
```

Using Azure Kubernetes Service (11)

Delete cluster

```
$ az group delete --resource-group scc2223-cluster-4204
```

If commands fail, do not forget to delete resources on Azure portal!

GUIDELINE: REDIS

When launching a container based on the default “redis” image, you have:

- Default port: 6379
- No password
- Simple HTTP - no TLS

GUIDELINE: MEDIA STORAGE AT PERSISTENT STORAGE

At Kubernetes, volumes have the lifetime of the Pod where they are mounted.

Kubernetes also supports persistent volumes that persist beyond the life of a Pod.

For information about persistent volumes at Azure, please check:

https://docs.microsoft.com/en-us/azure/aks/concepts-storage#persistent-volumes

GUIDELINE: MEDIA STORAGE AT PERSISTENT STORAGE (2)

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: azure-managed-disk
spec:
  accessModes:
  - ReadWriteOnce
  storageClassName: azurefile
  resources:
    requests:
      storage: 1Gi
```

Allow to claim storage from the Kubernetes environment.

Can be mounted by as read-write by a single node.

Standard storage for azure files.

GUIDELINE: MEDIA STORAGE AT PERSISTENT STORAGE (3)

```
spec:
     containers:
     - name: ...
       image: ...
       volumeMounts:
       - mountPath: "/mnt/vol"
         name: mediavolume
       ...
     volumes:
     - name: mediavolume
       persistentVolumeClaim:
         claimName: azure-managed-disk
```

Define mount point and specify the volume name

Define volume and associate it to a persistentVolumeClaim

GUIDELINE: DATABASE

Suggestion:

- Create a service + pod with a **single instance** of the database you want to use.
- Check docker hub for info on how to launch a container with a single instance.
- Suggested database: mongodb, postgres.
- https://hub.docker.com/_/mongo
- https://hub.docker.com/_/postgres

GUIDELINE: AZURE FUNCTIONS

Suggestion:

- Replace Timer-triggered functions by Kubernetes cronjobs.
- https://kubernetes.io/docs/concepts/workloads/controllers/cron-jobs/

- Replace HTTP-triggered functions by a REST resource.