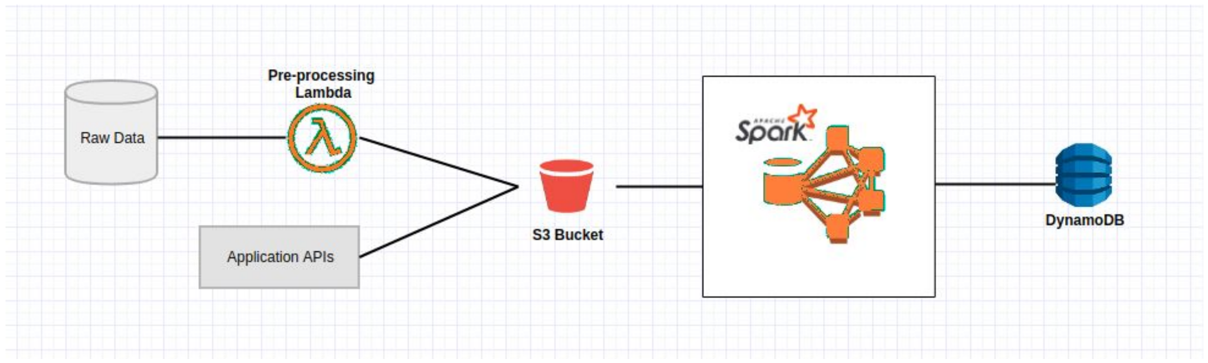
CHECKPOINT 2
DATA CENTER SCALE COMPUTING

PROBLEM DESCRIPTION

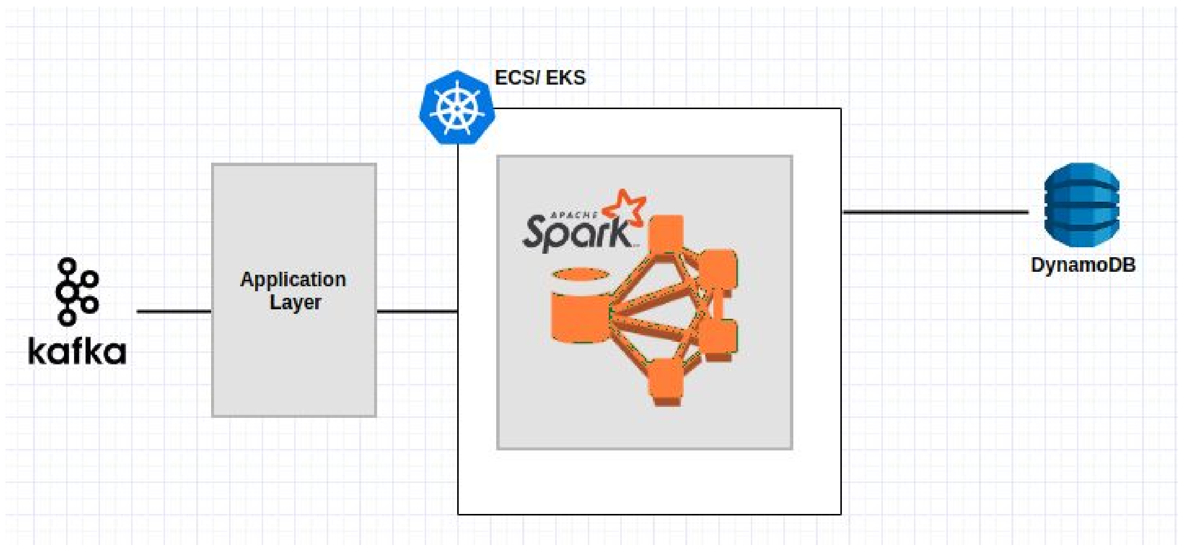
- Through this project, we aim to focus on scalability. In an application like Uber or any taxi service app, it is pertinent that the user requests of a cab are met in an acceptable amount of time. If the application delays a user's response a lot or fails to return a response, this could lead to a reduced popularity for the application.
- The application should be able to handle a large number of requests at the same time, to promote user satisfaction and also for monetary purposes.
- We plan to explore Kubernetes/Docker services (EKS/ECS) to handle multiple requests parallely. We also plan to split independent requirements of a request and delegate them to different microservices so that they are computed parallelly and independently.

HIGH-LEVEL ARCHITECTURE



Pre-Processing data and storing the structured data in DynamoDB database

- Raw data would be put into some kind of database (Maybe S3)
- Pre-processing lambda function takes data from this database, preprocesses it and stores it in S3.
- Spark then takes care of creating tables and columns in DynamoDB.



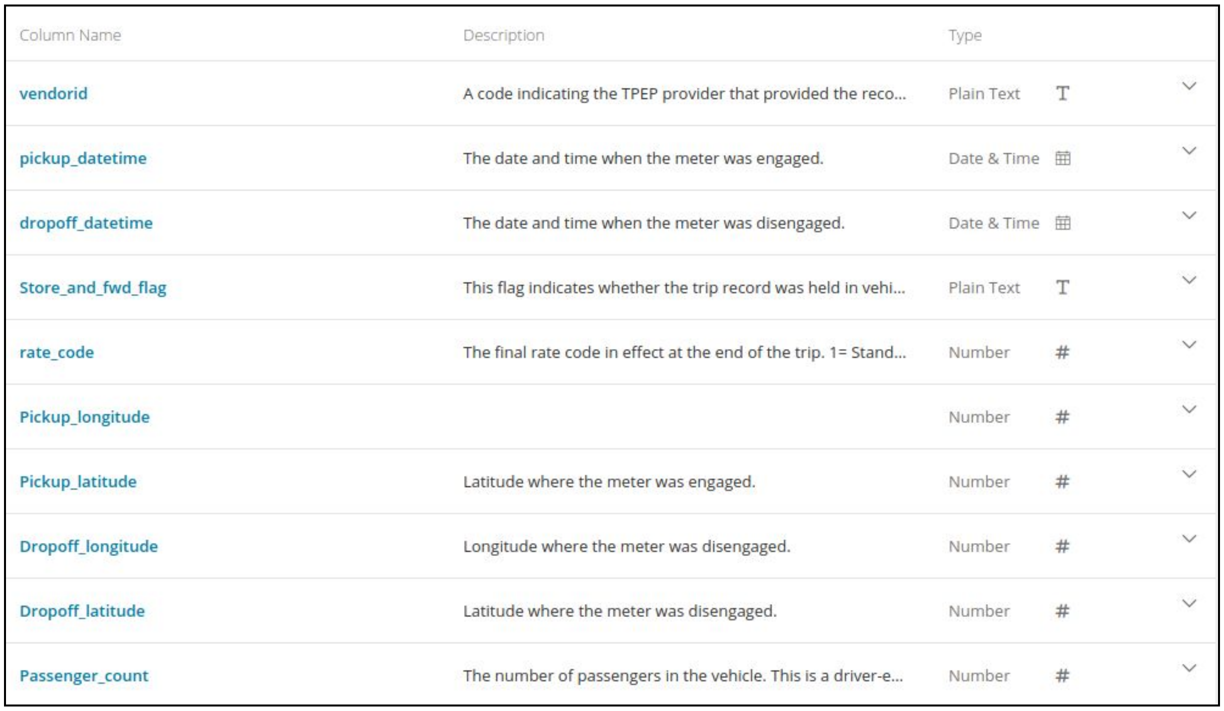
Kafka to process "real time" requests

- Kafka would contain user requests. For example, a request to search for a cab at a particular location.
- This request would then go to the application layer which would structure the user query, maybe add additional context and send it to a node with Spark capabilities in EKS/ECS (Elastic Kubernetes Service or Elastic Container Service).
- EKS is Elastic Kubernetes Service which provides an option to configure a Kubernetes cluster. ECS is Elastic Container Service which provides an option of creating multiple dockers.
- We then configure some nodes in EKS/ECS to have Spark functionalities.
- When a request reaches the EKS/ECS a new node might be created on the fly or use an existing node with spark functionalities.
- Spark takes care of interacting with the DynamoDb and querying for results which it sends back to the application layer.
- Extended Goal: Show some kind of visualization of the result.

DATASET

- We will be using NYC taxi trip data from Yellow Taxi, Green Taxi and Uber from 2014 - database
- Description:
  - Format: .csv
  - The data requires minimal preprocessing. (Removal of unnecessary metadata)
  - The dataset is static.

- The data can be exported as a CSV. There is no need of a developer account.
- The data will be stored in S3 buckets.
- Sample dataset - (Next Page)



Column Name	Description	Type
vendorid	A code indicating the TPEP provider that provided the reco...	Plain Text T
pickup_datetime	The date and time when the meter was engaged.	Date & Time
dropoff_datetime	The date and time when the meter was disengaged.	Date & Time
Store_and_fwd_flag	This flag indicates whether the trip record was held in vehi...	Plain Text T
rate_code	The final rate code in effect at the end of the trip. 1= Stand...	Number #
Pickup_longitude		Number #
Pickup_latitude	Latitude where the meter was engaged.	Number #
Dropoff_longitude	Longitude where the meter was disengaged.	Number #
Dropoff_latitude	Latitude where the meter was disengaged.	Number #
Passenger_count	The number of passengers in the vehicle. This is a driver-e...	Number #

Some Columns that are present in the database

CHALLENGES

- One of the challenges is to process the incoming requests fast and gain a major boost in the processing time through our architecture.
- Our architecture consists of multiple technologies like Kafka, EKS/ECS, ElasticSearch alongwith Microservices. The biggest challenge would be to integrate all the components and run the queries.
- There are technologies like Kubernetes, ECS, EKS, Kafka which our group is not familiar with. It would be a challenge to gain holistic conceptual understanding and recognize appropriate implementation strategies.
- Our metrics of measuring performance of our project would be to calculate the average running times of 100 different requests which requires a considerable processing power and time and compare the running times with and without using ECS/EKS etc.

GENERAL TASKS AND TIMELINE

Given that we are to present two checkpoints for the given project, we have divided our timeline accordingly.

Weeks	Tasks planned
Oct 23 - Oct 30	Project Proposal ● Teaming up to discuss architecture and write proposal
Nov 1 - Nov 13	● Finalise project Design ● Start setting up EKS/ECS ● Preprocessing, data cleaning and structuring ● Setting up Kafka ● Designing the Application Layer
Nov 14- Nov 29	Project Implementation
	● Integrating Spark with EKS/ECS ● Structuring the queries from Spark on DynamoDB ● Kafka processing ● Kafka-Application Layer integration ● Application Layer ● Application Layer-EKS/ECS Integration ● Writing Unit test cases
Nov 30 - Dec 10	● Project Completion ● Documentation ● Integration testing ● Performance Measure

TASK DIVISION AND TIMELINE

S. No.	Name	Tasks	Timeline
1	Akriti Kapur	● Defining Architecture ● Overlooking preprocessing, data cleaning and structuring ● Kafka processing ● Structure the queries ● Creating test cases to produce “real-time” data	● Week 0 ● Week 1 ● Week 2 ● Week 2 ● Week 3
2	Amith Gopal	● Identifying Challenges ● Containerization using EKS/ECS ● Integration of Spark with EKS/ECS ● Integration of Application Layer with EKS/ECS ● Simple queries to test Spark-dynamoDB	● Week 0 ● Week 1 ● Week 2 ● Week 3 ● Week 3
3	Sowmya	● Identifying the AWS services ● Containerization using EKS/ECS ● Integration of Spark with EKS/ECS ● Integration of Application Layer with EKS/ECS ● Documentation	● Week 0 ● Week 1 ● Week 2 ● Week 3 ● Week 3
4	Tarunianand	● Finding datasets ● Working with Akriti on Kafka processing ● Developing application layer (Django etc.) ● Creating test cases to produce “real-time” data ● Documentation and Demonstration prep	● Week 0 ● Week 1 ● Week 2 ● Week 3 ● Week 3

CONCERN

○ Since our project is heavily dependent on the AWS services, we are concerned about the potential cost incurred by the time we complete the project.

CHECKPOINT 1

Changes to the existing proposal

1. Instead of using Dynamodb as the database, we would be using MongoDB database.

New Timeline

Work done so far:

Summary of the work done

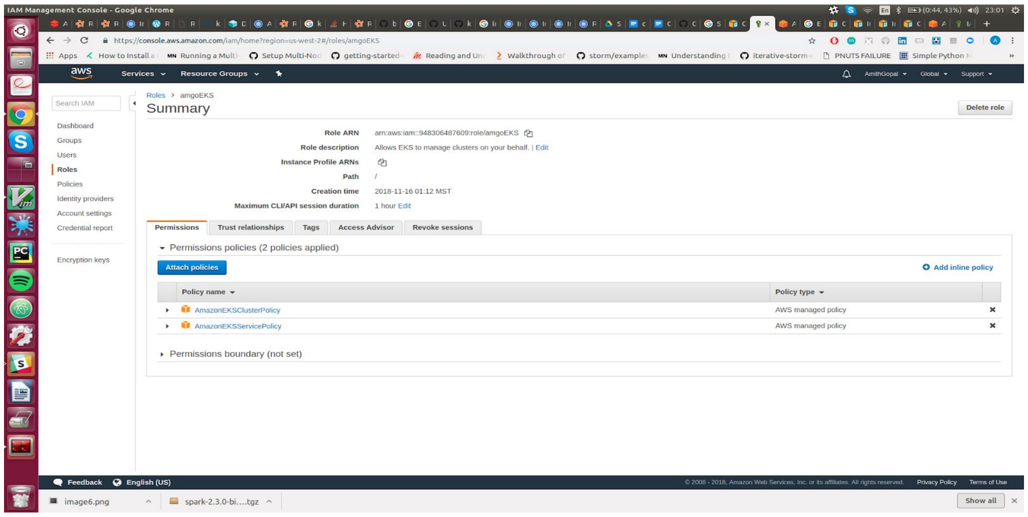
1. **Cleaning and Preprocessing of data**
2. **Storing the cleaned data in a database (MongoDB)**
3. **Setting up Kubernetes Cluster**
4. **Running a sample Spark job on the Kubernetes Cluster to verify the EKS setup**
5. **Setting up Minikube**
6. **Setting up a basic Django App**

Akriti Kapur:

- Preprocessing architecture implemented
    - Lambda function to get rid of certain rows
    - Spark to operate on the sanitized data, create dataframe from the csv
    - Store the spark dataframe to a mongodb database
- Project Structured
    - Project settings, dependencies, environment variables added.

Amith Gopal

- I went through the tutorials, did research on prerequisites required before setting up EKS. After this, I installed kubectl, awscli and aws-iam-authenticator before proceeding to create EKS.
- I created the IAM roles, VPCs required for the creation of the EKS cluster.

- 

IAM Management Console - Google Chrome

https://console.aws.amazon.com/iam/home?region=us-west-2#/roles/amgoEKS

Roles > amgoEKS

Summary

Role ARN: arn:aws:iam::948306487609:role/amgoEKS

Role description: Allows EKS to manage clusters on your behalf. | Edit

Instance Profile ARNs:

Path: /

Creation time: 2018-11-16 01:12 MST

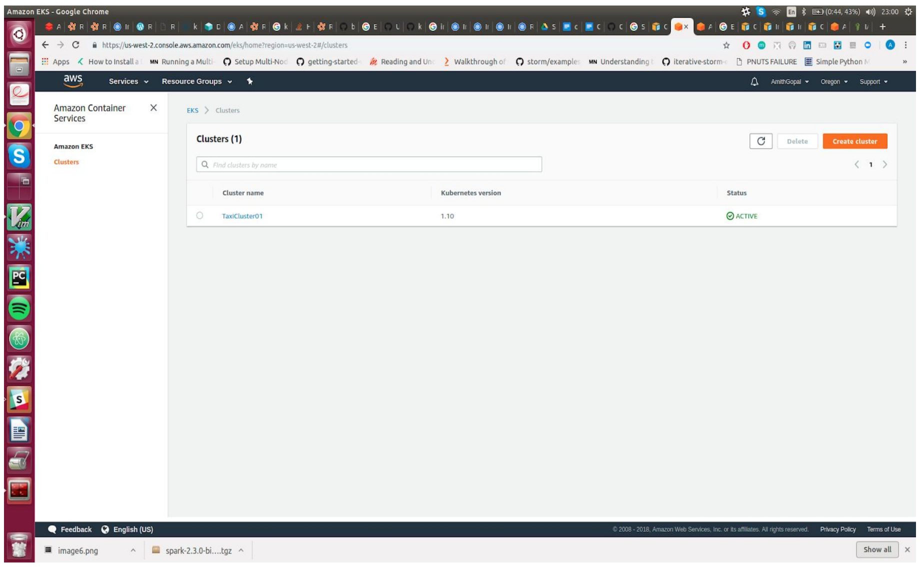
Maximum CLI/API session duration: 1 hour Edit

Permissions policies (2 policies applied)

Policy name	Policy type
AmazonEKSClusterPolicy	AWS managed policy
AmazonEKSServicePolicy	AWS managed policy

Permissions boundary (not set)

- I set up the EKS cluster which is the EKS control plane after the prequisites.



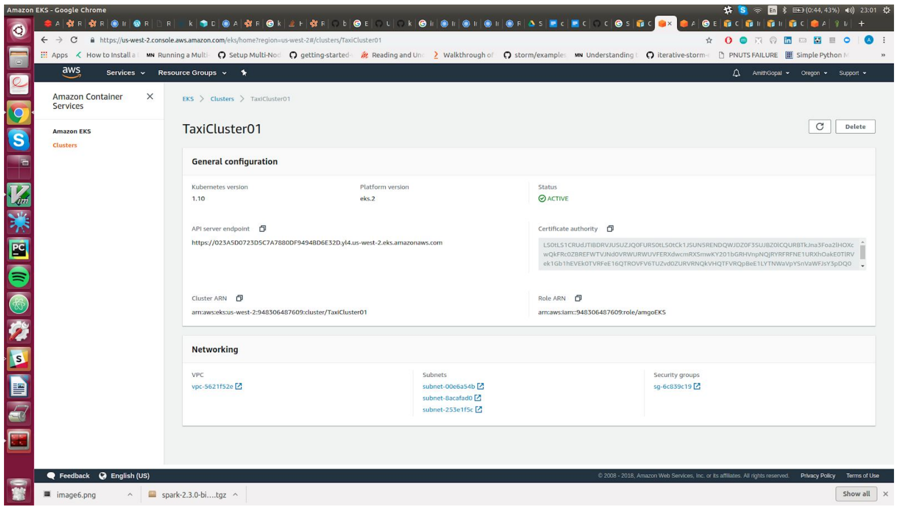
Amazon EKS - Google Chrome

https://us-west-2.console.aws.amazon.com/eks/home?region=us-west-2#/clusters

EKS > Clusters

Clusters (1)

Cluster name	Kubernetes version	Status
TaxiCluster01	1.10	ACTIVE



EKS > Clusters > TaxiCluster01

TaxiCluster01

General configuration

Kubernetes version: 1.10
Platform version: eks.2
Status: ACTIVE

API server endpoint: https://023A5D0723D5C7A7880DF9494BD6E32D.yl4.us-west-2.eks.amazonaws.com

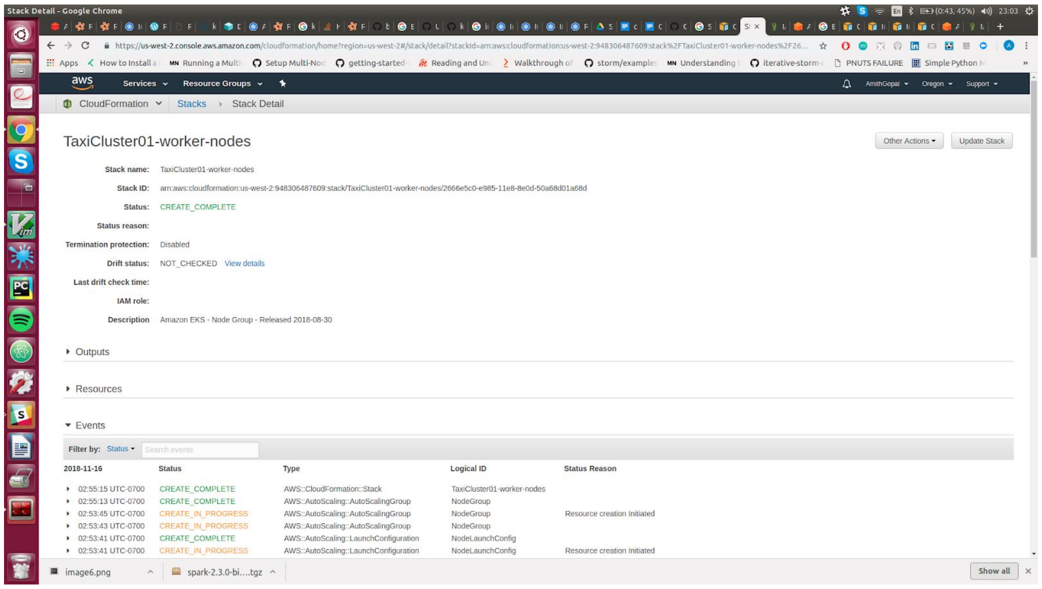
Certificate authority: LS0tLS1CRUdJTiBDRVJUSUZJQ0FURS0tLS0tCk1JSUN5RENDQWJDZ0F3SUJBZ0lCQURBTkJna3Foa2lHOXc wQkFRc0ZBREFWTVJNd0VRWURWUVFERXdwcmRXSmwKY201bGRHVnpNQjRYRFRFNE1URXhOakE0TlRV ek1Gb1hEVEk0TVRFeE16QTROVFV6TUZvd0ZURVRNQkVHQTFVRUF3TUthM1ZpWlhKdVpYUmxjekNDQVNJ...

Cluster ARN: arn:aws:eks:us-west-2:948306487609:cluster/TaxiCluster01
Role ARN: arn:aws:iam::948306487609:role/amgoEKS

Networking

VPC: vpc-5621f52e
Subnets: subnet-00e6a54b, subnet-8acafad0, subnet-253e1f5c
Security groups: sg-6c839c19

- Next, I set up the worker nodes after the cluster was created and later configured kubectl with a .yml file to include the worker nodes.



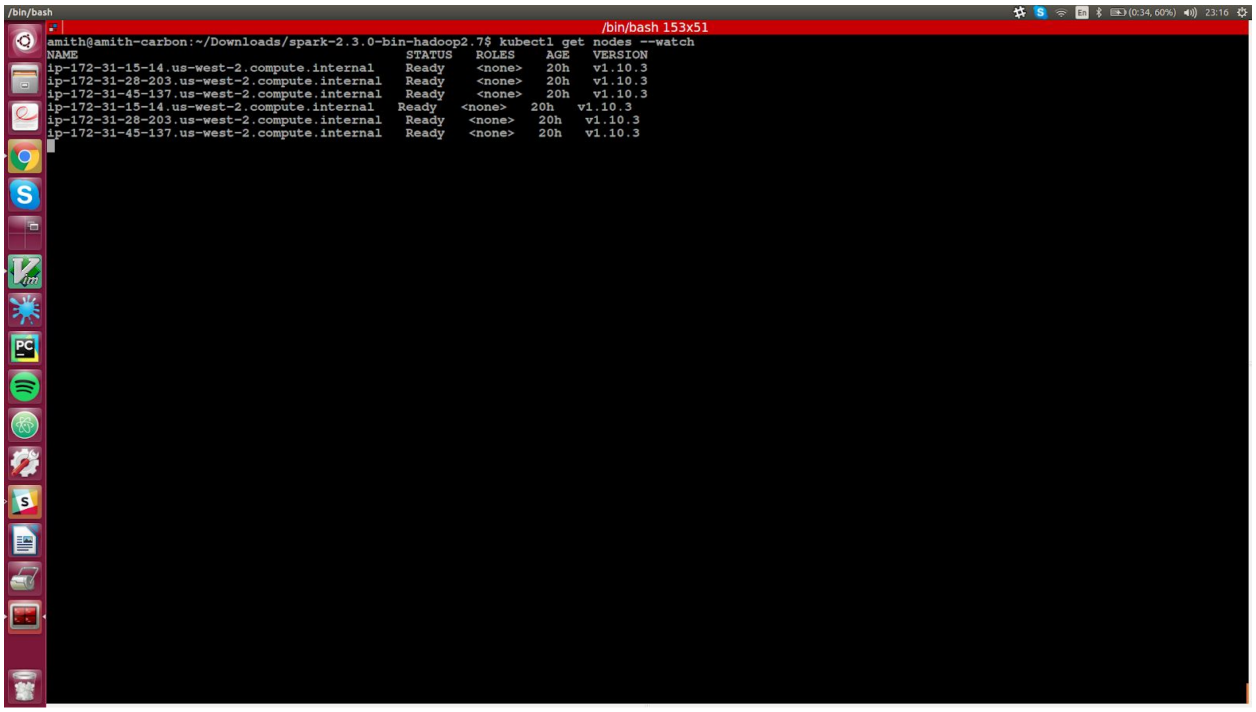
CloudFormation > Stacks > Stack Detail

TaxiCluster01-worker-nodes

Stack name:	TaxiCluster01-worker-nodes
Stack ID:	arn:aws:cloudformation:us-west-2:948306487609:stack/TaxiCluster01-worker-nodes/2666e5c0-e985-11e8-8e0d-50a68d01a68d
Status:	CREATE_COMPLETE
Status reason:	
Termination protection:	Disabled
Drift status:	NOT_CHECKED View details
Last drift check time:	
IAM role:	
Description	Amazon EKS - Node Group - Released 2018-08-30

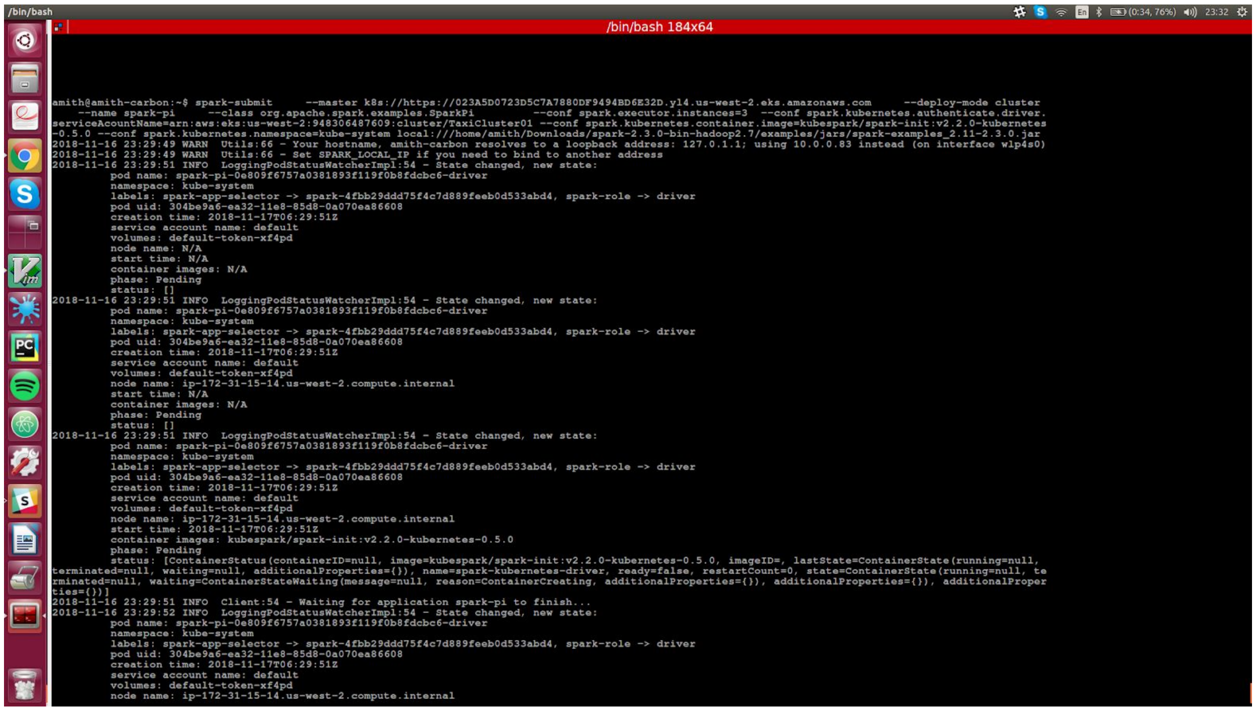
Events

2018-11-16	Status	Type	Logical ID	Status Reason
02:55:15 UTC-0700	CREATE_COMPLETE	AWS::CloudFormation::Stack	TaxiCluster01-worker-nodes	
02:55:13 UTC-0700	CREATE_COMPLETE	AWS::AutoScaling::AutoScalingGroup	NodeGroup	
02:53:45 UTC-0700	CREATE_IN_PROGRESS	AWS::AutoScaling::AutoScalingGroup	NodeGroup	Resource creation Initiated
02:53:43 UTC-0700	CREATE_IN_PROGRESS	AWS::AutoScaling::AutoScalingGroup	NodeGroup	
02:53:41 UTC-0700	CREATE_COMPLETE	AWS::AutoScaling::LaunchConfiguration	NodeLaunchConfig	
02:53:41 UTC-0700	CREATE_IN_PROGRESS	AWS::AutoScaling::LaunchConfiguration	NodeLaunchConfig	Resource creation Initiated

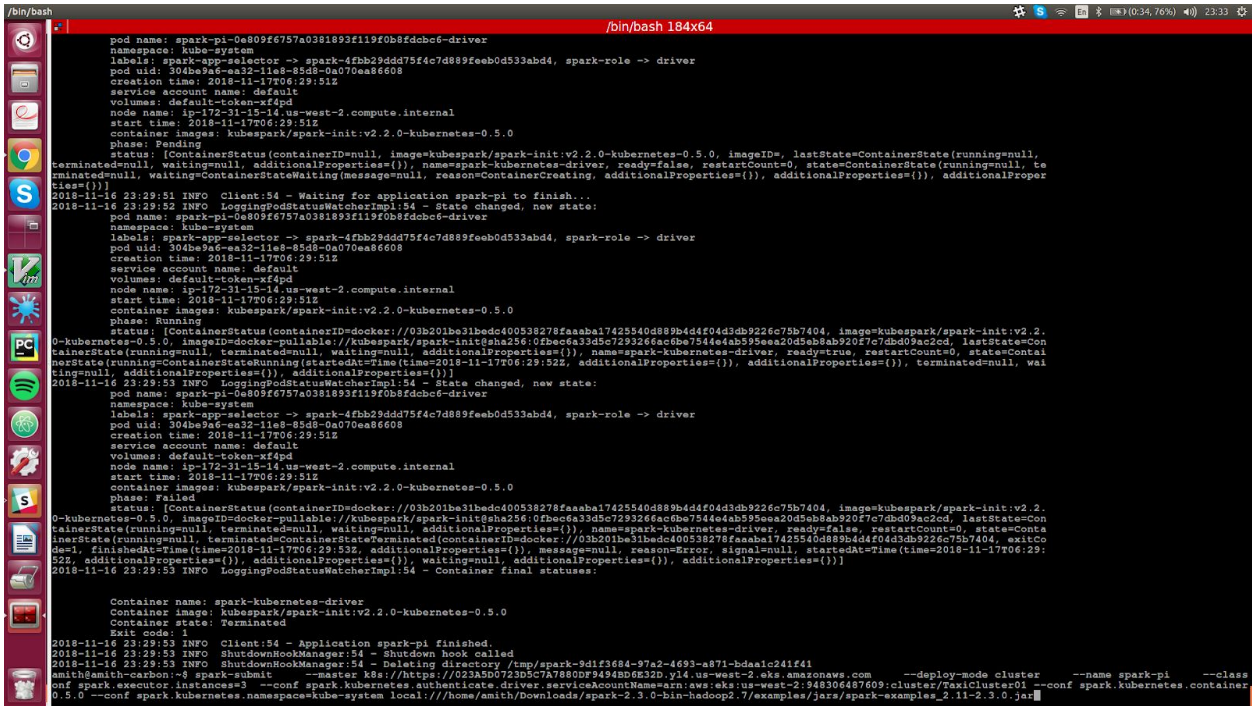


```
amith@amith-carbon:~/Downloads/spark-2.3.0-bin-hadoop2.7$ kubectl get nodes --watch
NAME                                          STATUS    ROLES     AGE     VERSION
ip-172-31-15-14.us-west-2.compute.internal    Ready     <none>    20h     v1.10.3
ip-172-31-28-203.us-west-2.compute.internal   Ready     <none>    20h     v1.10.3
ip-172-31-45-137.us-west-2.compute.internal   Ready     <none>    20h     v1.10.3
ip-172-31-15-14.us-west-2.compute.internal   Ready    <none>   20h    v1.10.3
ip-172-31-28-203.us-west-2.compute.internal   Ready    <none>    20h    v1.10.3
ip-172-31-45-137.us-west-2.compute.internal   Ready    <none>    20h    v1.10.3
```

- Lastly, I downloaded spark2.3 and and ran a spark job on the kubernetes cluster using the command shown in the "Steps-followed-for-setting-EKS.txt" and verified the working of the kubernetes cluster.



```
amith@amith-carbon:~$ spark-submit     --master k8s://https://023A5D0723D5C7A7880DF9494BD6E32D.yl4.us-west-2.eks.amazonaws.com     --deploy-mode cluster
    --name spark-pi     --class org.apache.spark.examples.SparkPi         --conf spark.executor.instances=3  --conf spark.kubernetes.authenticate.driver.
serviceAcountName=arn:aws:eks:us-west-2:948306487609:cluster/TaxiCluster01 --conf spark.kubernetes.container.image=kubespark/spark-init:v2.2.0-kubernetes
-0.5.0 --conf spark.kubernetes.namespace=kube-system local:///home/amith/Downloads/spark-2.3.0-bin-hadoop2.7/examples/jars/spark-examples_2.11-2.3.0.jar
2018-11-16 23:29:49 WARN  Utils:66 - Your hostname, amith-carbon resolves to a loopback address: 127.0.1.1; using 10.0.0.83 instead (on interface wlp4s0)
2018-11-16 23:29:49 WARN  Utils:66 - Set SPARK_LOCAL_IP if you need to bind to another address
2018-11-16 23:29:51 INFO  LoggingPodStatusWatcherImpl:54 - State changed, new state:
         pod name: spark-pi-0e809f6757a0381893f119f0b8fdcbc6-driver
         namespace: kube-system
         labels: spark-app-selector -> spark-4fbb29ddd75f4c7d889feeb0d533abd4, spark-role -> driver
         pod uid: 304be9a6-ea32-11e8-85d8-0a070ea86608
         creation time: 2018-11-17T06:29:51Z
         service account name: default
         volumes: default-token-xf4pd
         node name: N/A
         start time: N/A
         container images: N/A
         phase: Pending
         status: []
2018-11-16 23:29:51 INFO  LoggingPodStatusWatcherImpl:54 - State changed, new state:
         pod name: spark-pi-0e809f6757a0381893f119f0b8fdcbc6-driver
         namespace: kube-system
         labels: spark-app-selector -> spark-4fbb29ddd75f4c7d889feeb0d533abd4, spark-role -> driver
         pod uid: 304be9a6-ea32-11e8-85d8-0a070ea86608
         creation time: 2018-11-17T06:29:51Z
         service account name: default
         volumes: default-token-xf4pd
         node name: ip-172-31-15-14.us-west-2.compute.internal
         start time: N/A
         container images: N/A
         phase: Pending
         status: []
2018-11-16 23:29:51 INFO  LoggingPodStatusWatcherImpl:54 - State changed, new state:
         pod name: spark-pi-0e809f6757a0381893f119f0b8fdcbc6-driver
         namespace: kube-system
         labels: spark-app-selector -> spark-4fbb29ddd75f4c7d889feeb0d533abd4, spark-role -> driver
         pod uid: 304be9a6-ea32-11e8-85d8-0a070ea86608
         creation time: 2018-11-17T06:29:51Z
         service account name: default
         volumes: default-token-xf4pd
         node name: ip-172-31-15-14.us-west-2.compute.internal
         start time: 2018-11-17T06:29:51Z
         container images: kubespark/spark-init:v2.2.0-kubernetes-0.5.0
         phase: Pending
         status: [ContainerStatus(containerID=null, image=kubespark/spark-init:v2.2.0-kubernetes-0.5.0, imageID=, lastState=ContainerState(running=null,
terminated=null, waiting=null, additionalProperties={}), name=spark-kubernetes-driver, ready=false, restartCount=0, state=ContainerState(running=null, te
rminated=null, waiting=ContainerStateWaiting(message=null, reason=ContainerCreating, additionalProperties={}), additionalProperties={}), additionalProper
ties={})]
2018-11-16 23:29:51 INFO  Client:54 - Waiting for application spark-pi to finish...
2018-11-16 23:29:52 INFO  LoggingPodStatusWatcherImpl:54 - State changed, new state:
         pod name: spark-pi-0e809f6757a0381893f119f0b8fdcbc6-driver
         namespace: kube-system
         labels: spark-app-selector -> spark-4fbb29ddd75f4c7d889feeb0d533abd4, spark-role -> driver
         pod uid: 304be9a6-ea32-11e8-85d8-0a070ea86608
         creation time: 2018-11-17T06:29:51Z
         service account name: default
         volumes: default-token-xf4pd
         node name: ip-172-31-15-14.us-west-2.compute.internal
```



```
        pod name: spark-pi-0e809f6757a0381893f119f0b8fdcbc6-driver
        namespace: kube-system
        labels: spark-app-selector -> spark-4fbb29ddd75f4c7d889feeb0d533abd4, spark-role -> driver
        pod uid: 304be9a6-ea32-11e8-85d8-0a070ea86608
        creation time: 2018-11-17T06:29:51Z
        service account name: default
        volumes: default-token-xf4pd
        node name: ip-172-31-15-14.us-west-2.compute.internal
        start time: 2018-11-17T06:29:51Z
        container images: kubespark/spark-init:v2.2.0-kubernetes-0.5.0
        phase: Pending
        status: [ContainerStatus(containerID=null, image=kubespark/spark-init:v2.2.0-kubernetes-0.5.0, imageID=, lastState=ContainerState(running=null,
terminated=null, waiting=null, additionalProperties={}), name=spark-kubernetes-driver, ready=false, restartCount=0, state=ContainerState(running=null, te
rminated=null, waiting=ContainerStateWaiting(message=null, reason=ContainerCreating, additionalProperties={}), additionalProperties={}), additionalProper
ties={})]
2018-11-16 23:29:51 INFO  Client:54 - Waiting for application spark-pi to finish...
2018-11-16 23:29:52 INFO  LoggingPodStatusWatcherImpl:54 - State changed, new state:
        pod name: spark-pi-0e809f6757a0381893f119f0b8fdcbc6-driver
        namespace: kube-system
        labels: spark-app-selector -> spark-4fbb29ddd75f4c7d889feeb0d533abd4, spark-role -> driver
        pod uid: 304be9a6-ea32-11e8-85d8-0a070ea86608
        creation time: 2018-11-17T06:29:51Z
        service account name: default
        volumes: default-token-xf4pd
        node name: ip-172-31-15-14.us-west-2.compute.internal
        start time: 2018-11-17T06:29:51Z
        container images: kubespark/spark-init:v2.2.0-kubernetes-0.5.0
        phase: Running
        status: [ContainerStatus(containerID=docker://03b201be31bedc400538278faaaba17425540d889b4d4f04d3db9226c75b7404, image=kubespark/spark-init:v2.2.
0-kubernetes-0.5.0, imageID=docker-pullable://kubespark/spark-init@sha256:0fbec6a33d5c7293266ac6be7544e4ab595eea20d5eb8ab920f7c7dbd09ac2cd, lastState=Con
tainerState(running=null, terminated=null, waiting=null, additionalProperties={}), name=spark-kubernetes-driver, ready=true, restartCount=0, state=Contai
nerState(running=ContainerStateRunning(startedAt=Time(time=2018-11-17T06:29:52Z, additionalProperties={}), additionalProperties={}), terminated=null, wai
ting=null, additionalProperties={}), additionalProperties={})]
2018-11-16 23:29:53 INFO  LoggingPodStatusWatcherImpl:54 - State changed, new state:
        pod name: spark-pi-0e809f6757a0381893f119f0b8fdcbc6-driver
        namespace: kube-system
        labels: spark-app-selector -> spark-4fbb29ddd75f4c7d889feeb0d533abd4, spark-role -> driver
        pod uid: 304be9a6-ea32-11e8-85d8-0a070ea86608
        creation time: 2018-11-17T06:29:51Z
        service account name: default
        volumes: default-token-xf4pd
        node name: ip-172-31-15-14.us-west-2.compute.internal
        start time: 2018-11-17T06:29:51Z
        container images: kubespark/spark-init:v2.2.0-kubernetes-0.5.0
        phase: Failed
        status: [ContainerStatus(containerID=docker://03b201be31bedc400538278faaaba17425540d889b4d4f04d3db9226c75b7404, image=kubespark/spark-init:v2.2.
0-kubernetes-0.5.0, imageID=docker-pullable://kubespark/spark-init@sha256:0fbec6a33d5c7293266ac6be7544e4ab595eea20d5eb8ab920f7c7dbd09ac2cd, lastState=Con
tainerState(running=null, terminated=null, waiting=null, additionalProperties={}), name=spark-kubernetes-driver, ready=false, restartCount=0, state=Conta
inerState(running=null, terminated=ContainerStateTerminated(containerID=docker://03b201be31bedc400538278faaaba17425540d889b4d4f04d3db9226c75b7404, exitCo
de=1, finishedAt=Time(time=2018-11-17T06:29:53Z, additionalProperties={}), message=null, reason=Error, signal=null, startedAt=Time(time=2018-11-17T06:29:
52Z, additionalProperties={}), additionalProperties={}), waiting=null, additionalProperties={}), additionalProperties={})]
2018-11-16 23:29:53 INFO  LoggingPodStatusWatcherImpl:54 - Container final statuses:


        Container name: spark-kubernetes-driver
        Container image: kubespark/spark-init:v2.2.0-kubernetes-0.5.0
        Container state: Terminated
        Exit code: 1
2018-11-16 23:29:53 INFO  Client:54 - Application spark-pi finished.
2018-11-16 23:29:53 INFO  ShutdownHookManager:54 - Shutdown hook called
2018-11-16 23:29:53 INFO  ShutdownHookManager:54 - Deleting directory /tmp/spark-9d1f3684-97a2-4693-a871-bdaa1c241f41
amith@amith-carbon:~$ spark-submit     --master k8s://https://023A5D0723D5C7A7880DF9494BD6E32D.yl4.us-west-2.eks.amazonaws.com     --deploy-mode cluster     --name spark-pi     --class
onf spark.executor.instances=3  --conf spark.kubernetes.authenticate.driver.serviceAcountName=arn:aws:eks:us-west-2:948306487609:cluster/TaxiCluster01 --conf spark.kubernetes.container
0.5.0 --conf spark.kubernetes.namespace=kube-system local:///home/amith/Downloads/spark-2.3.0-bin-hadoop2.7/examples/jars/spark-examples_2.11-2.3.0.jar
```

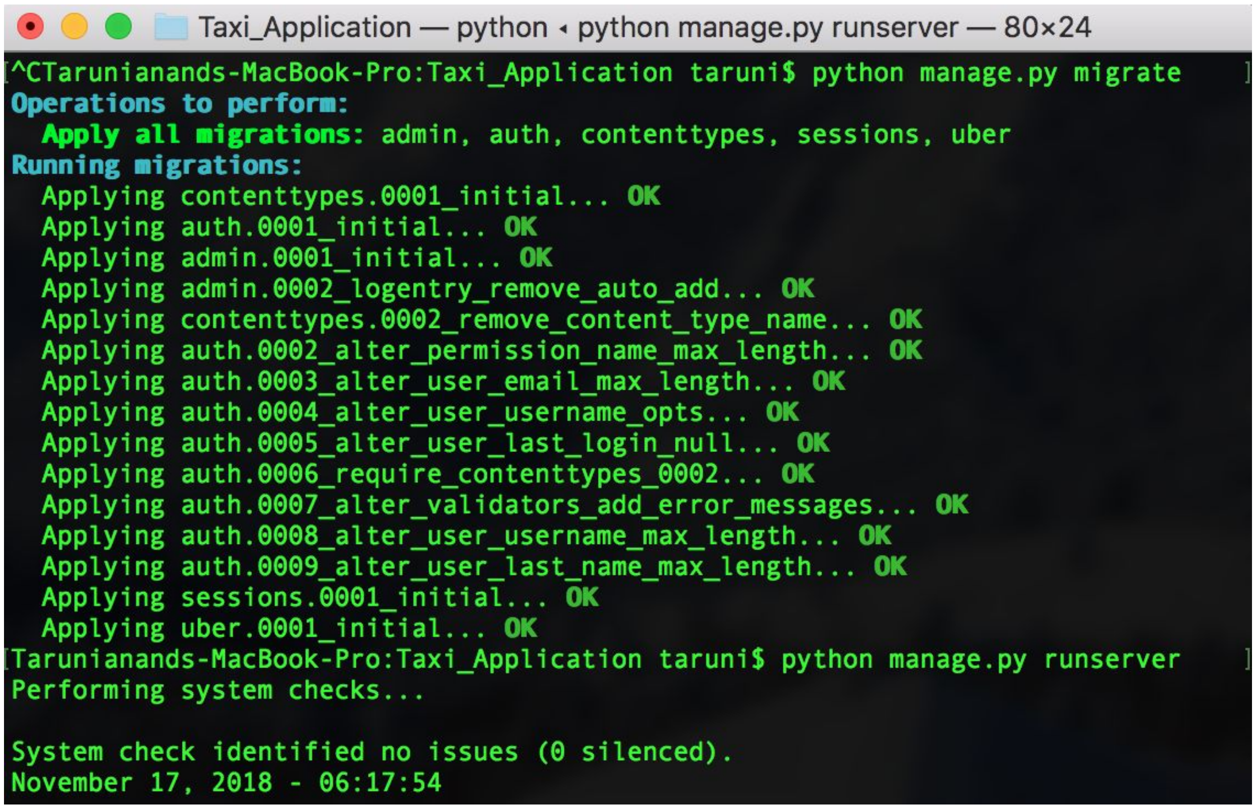
- I learnt more about Spark's integration with EKS and other functionalities and properties of EKS which can be used

Sowmya Ramakrishnan :

- Learnt Kubernetes basics, concepts, commands, creating pods and clusters with labels and selectors, scaling up/ down, zero downtime deployment.(Documentation and tutorials)
- Installed Minikube on local machine.
- Set up a cluster on AWS EKS and went through tutorials to ensure its working.

Tarunianand Muruganandan:

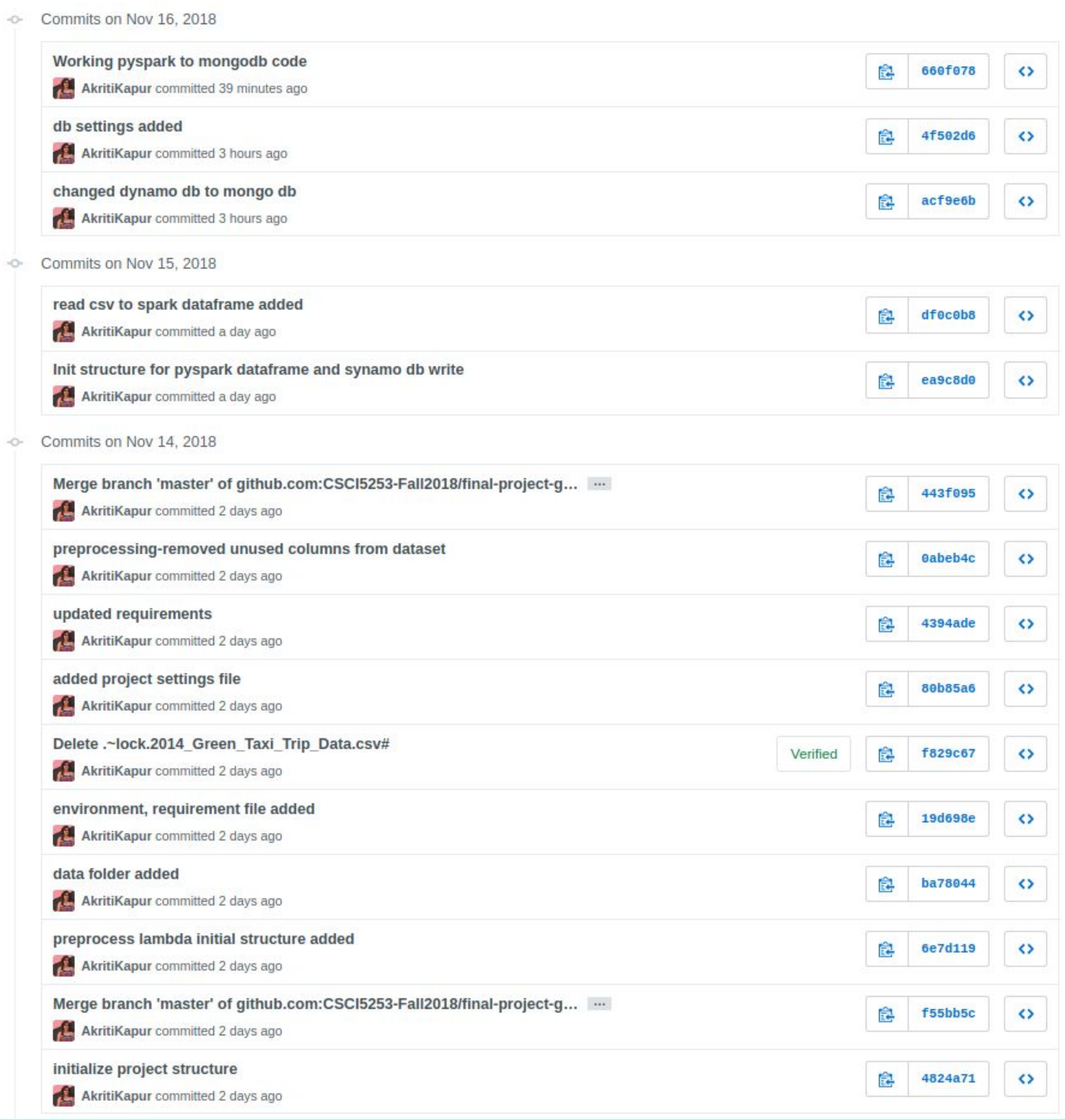
- Began with working on the basic Django framework as a starting point to build an application.
- Have been working locally to understand the backend portion, at a bare bones level.
- Reading up on Spring and other RESTful web APIs that can be used for the project.
- I have been trying to make a presentable application, but still working on setting up the right environment. I have currently managed to run all migration and start the server, with some rendering issues left to be fixed.
- Learnt how submodules work on GitHub if we push a pre-existing repo into another repo.


Taxi_Application — python ◂ python manage.py runserver — 80×24

```
[^CTarunianands-MacBook-Pro:Taxi_Application taruni$ python manage.py migrate    ]
Operations to perform:
  Apply all migrations: admin, auth, contenttypes, sessions, uber
Running migrations:
  Applying contenttypes.0001_initial... OK
  Applying auth.0001_initial... OK
  Applying admin.0001_initial... OK
  Applying admin.0002_logentry_remove_auto_add... OK
  Applying contenttypes.0002_remove_content_type_name... OK
  Applying auth.0002_alter_permission_name_max_length... OK
  Applying auth.0003_alter_user_email_max_length... OK
  Applying auth.0004_alter_user_username_opts... OK
  Applying auth.0005_alter_user_last_login_null... OK
  Applying auth.0006_require_contenttypes_0002... OK
  Applying auth.0007_alter_validators_add_error_messages... OK
  Applying auth.0008_alter_user_username_max_length... OK
  Applying auth.0009_alter_user_last_name_max_length... OK
  Applying sessions.0001_initial... OK
  Applying uber.0001_initial... OK
[Tarunianands-MacBook-Pro:Taxi_Application taruni$ python manage.py runserver    ]
Performing system checks...

System check identified no issues (0 silenced).
November 17, 2018 - 06:17:54
```

Github checkins



Commits on Nov 16, 2018

Working pyspark to mongodb code
AkritiKapur committed 39 minutes ago — 660f078

db settings added
AkritiKapur committed 3 hours ago — 4f502d6

changed dynamo db to mongo db
AkritiKapur committed 3 hours ago — acf9e6b

Commits on Nov 15, 2018

read csv to spark dataframe added
AkritiKapur committed a day ago — df0c0b8

Init structure for pyspark dataframe and synamo db write
AkritiKapur committed a day ago — ea9c8d0

Commits on Nov 14, 2018

Merge branch 'master' of github.com:CSCI5253-Fall2018/final-project-g… …
AkritiKapur committed 2 days ago — 443f095

preprocessing-removed unused columns from dataset
AkritiKapur committed 2 days ago — 0abeb4c

updated requirements
AkritiKapur committed 2 days ago — 4394ade

added project settings file
AkritiKapur committed 2 days ago — 80b85a6

Delete .~lock.2014_Green_Taxi_Trip_Data.csv# — Verified
AkritiKapur committed 2 days ago — f829c67

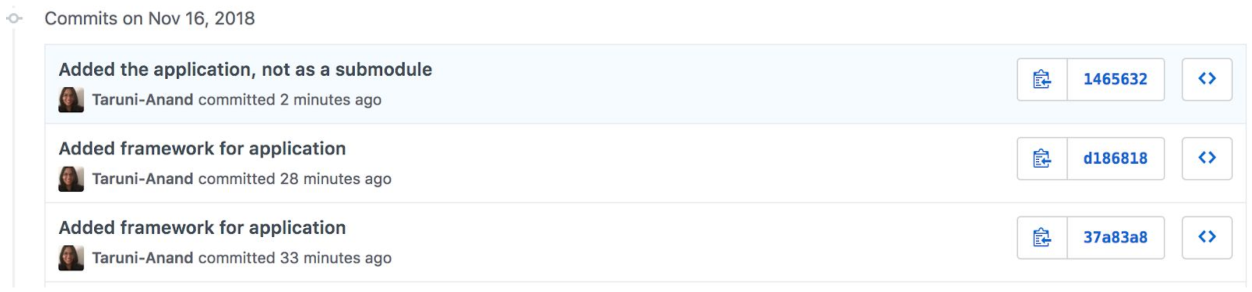
environment, requirement file added
AkritiKapur committed 2 days ago — 19d698e

data folder added
AkritiKapur committed 2 days ago — ba78044

preprocess lambda initial structure added
AkritiKapur committed 2 days ago — 6e7d119

Merge branch 'master' of github.com:CSCI5253-Fall2018/final-project-g… …
AkritiKapur committed 2 days ago — f55bb5c

initialize project structure
AkritiKapur committed 2 days ago — 4824a71

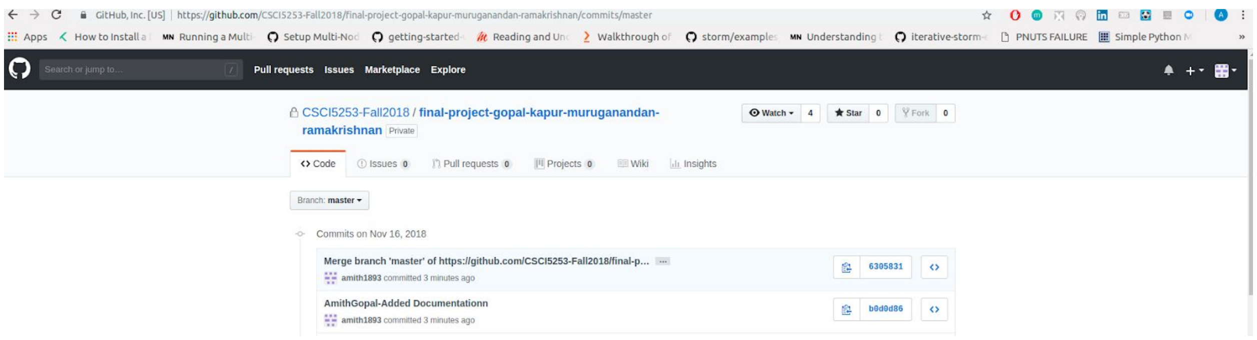


Commits on Nov 16, 2018

Added the application, not as a submodule
Taruni-Anand committed 2 minutes ago — 1465632

Added framework for application
Taruni-Anand committed 28 minutes ago — d186818

Added framework for application
Taruni-Anand committed 33 minutes ago — 37a83a8



https://github.com/CSCI5253-Fall2018/final-project-gopal-kapur-muruganandan-ramakrishnan/commits/master

CSCI5253-Fall2018 / final-project-gopal-kapur-muruganandan-ramakrishnan Private

Branch: master

Commits on Nov 16, 2018

Merge branch 'master' of https://github.com/CSCI5253-Fall2018/final-p... — amith1893 committed 3 minutes ago — 6305831

AmithGopal-Added Documentationn — amith1893 committed 3 minutes ago — b0d0d86

	Name	Tasks	Timeline
1	Akriti Kapur	● Kafka processing ● Structure the queries ● Creating test cases to produce “real-time” data ● Simple queries to test Spark-dynamoDB	● 19th Nov week ● 26th Nov week ● 26th Nov week
2	Amith Gopal	● Running custom application through Spark on EKS ● Running different tests to test Spark on EKS further ● Trying minikube as a fallback if we encounter issues in EKS ● Integration of Application Layer with EKS/ECS	● 19th Nov week ● 19th Nov week ● 26th Nov week ● 26th Nov week
3	Sowmya	● Integration of Spark with Kubernetes ● Integration of Application Layer with EKS/ECS ● Documentation	● 19th Nov week ● 26th Nov week ● 26th Nov week
4	Tarunianand	● Developing application layer, check how the backend would change to accomodate the rest of the project. ● Trying different frameworks for the application (Spring, Flask etc.), finalize framework. ● Integrating application layer with EKS/ECS ● Creating test cases to produce “real-time” data ● Documentation and Demonstration prep	● 19th Nov week ● 19th Nov week ● 26th Nov week ● 26th Nov week ● 26th Nov week

Costs

Costs incurred

Estimated Costs for future use

Database Management

- We did not have to do a lot of cleaning on the database. There were few columns we did not need and hence removed it from the database.
- As our focus in the project is on scalability, we need to perform certain tasks on the kubernetes cluster. We may need additional columns depending on the tasks we need spark to perform on this database. These additional columns if needed, will be added to the database in the pre-processing step while using spark to write the data frame to MongoDB.

Challenges faced:

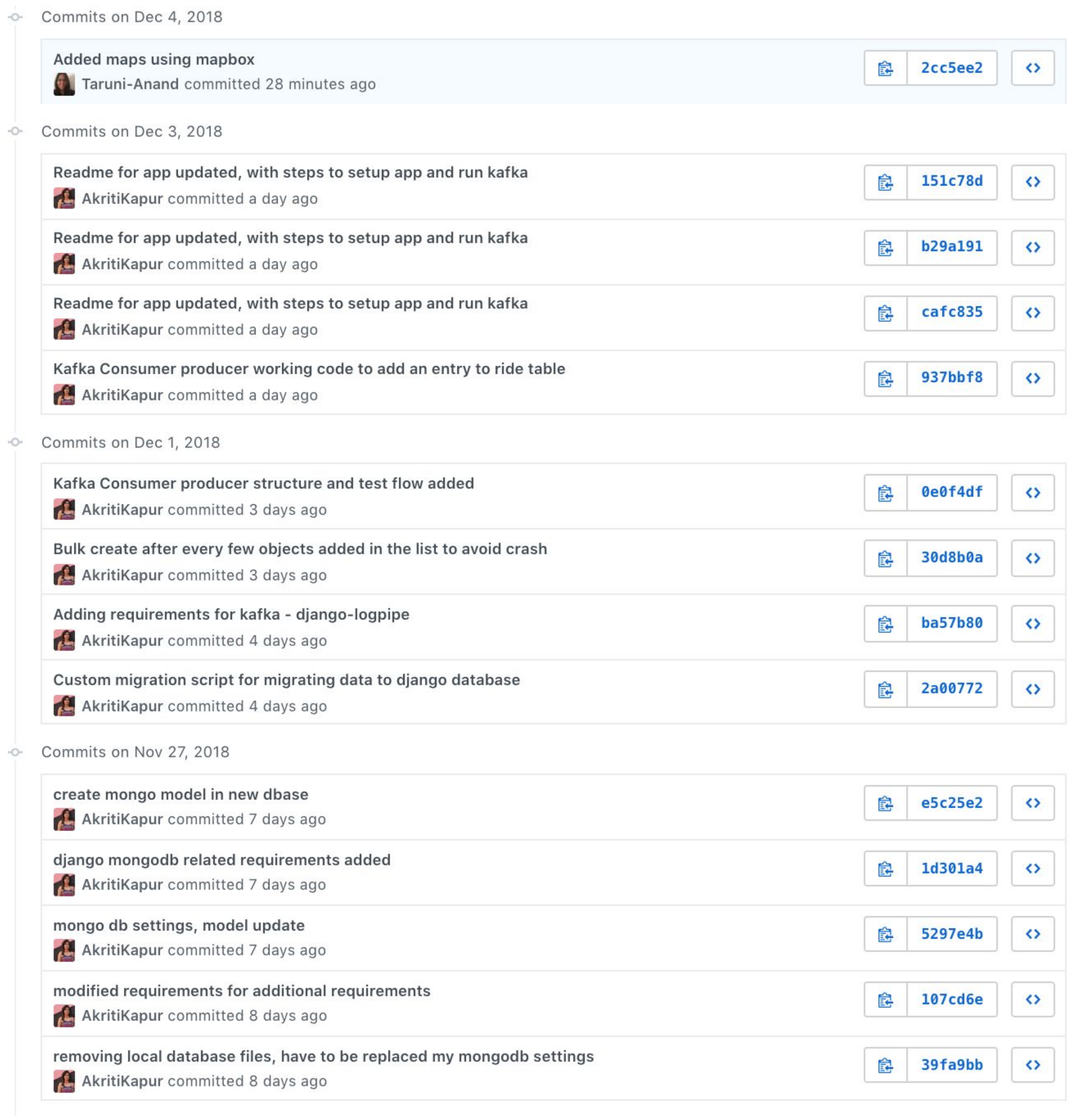
- Setting up EKS cluster was a challenge since there were a lot of steps to be followed and lot of prerequisites to be satisfied.
- Running spark on EKS. Had to figure out the permissions to send spark jobs from a local machine to a remote EKS cluster.
- Storing data from Spark into DynamoDB was difficult since we couldn't find any documentation online for saving pyspark dataframe to DynamoDB which is why we switched to MongoDB where the whole data storage pipeline is successfully constructed.
- We will be testing minikube as a fallback if there are any issues with EKS.

CHECKPOINT 2

Summary of the work done

- Got spark working on kubernetes clusters spun up on Minikube as well as AWS EKS
- Created an application using Django with Kafka integration
- Added map visualizations for taxi rides in New York
- Research on MongoDB integration with Kubernetes

Github Commits



Commits on Dec 4, 2018

Added maps using mapbox
Taruni-Anand committed 28 minutes ago — 2cc5ee2

Commits on Dec 3, 2018

Readme for app updated, with steps to setup app and run kafka
AkritiKapur committed a day ago — 151c78d

Readme for app updated, with steps to setup app and run kafka
AkritiKapur committed a day ago — b29a191

Readme for app updated, with steps to setup app and run kafka
AkritiKapur committed a day ago — cafc835

Kafka Consumer producer working code to add an entry to ride table
AkritiKapur committed a day ago — 937bbf8

Commits on Dec 1, 2018

Kafka Consumer producer structure and test flow added
AkritiKapur committed 3 days ago — 0e0f4df

Bulk create after every few objects added in the list to avoid crash
AkritiKapur committed 3 days ago — 30d8b0a

Adding requirements for kafka - django-logpipe
AkritiKapur committed 4 days ago — ba57b80

Custom migration script for migrating data to django database
AkritiKapur committed 4 days ago — 2a00772

Commits on Nov 27, 2018

create mongo model in new dbase
AkritiKapur committed 7 days ago — e5c25e2

django mongodb related requirements added
AkritiKapur committed 7 days ago — 1d301a4

mongo db settings, model update
AkritiKapur committed 7 days ago — 5297e4b

modified requirements for additional requirements
AkritiKapur committed 8 days ago — 107cd6e

removing local database files, have to be replaced my mongodb settings
AkritiKapur committed 8 days ago — 39fa9bb

	Name	Tasks	Timeline
1	Akriti Kapur	● Connect Django/ Kafka with Kubernetes-Spark ● Work with Taruni on visualization for taxi rides nearby.	Current week till December 12th
2	Amith Gopal	● Currently reading up on how to connect to MongoDB from Kubernetes Cluster. Will be working with Sowmya on this one since it’s an unexplored area and requires a lot of research. ● Will try running spark queries on MongoDB	Current week till December 12th
3	Sowmya	● Will be working with Amith to connect MongoDB from the Kubernetess Cluster. Will be working with Amith on this one since it’s an unexplored area and requires a lot of research. ● Will be working on communication from Kubernetes cluster to the Django Application.	Current week till December 12th
4	Tarunianand	● Finalize the app configurations and make it user friendly, complete visualizations, make required migrations and connections ● Work with Akriti in connecting Django with Kubernetes-Spark	Current week till December 12th

Akriti Kapur

- Integrating MongoDB with Django
- Creating Database models in Django - Django models correspond to database tables
- Migrating data to the model created through Django - A custom migration script to migrate rows from the old (cleaned) database to Django managed database. This was done so that the Django ORM can be used for visualizations later!
- Integrating Kafka with the application - Kafka would be used to put tasks (topics) on the queue like “find rides in the range {start time} and {end time} and in a longitude and latitude range”
- A producer and consumer test code added for Kafka
- Creating a Readme on instructions on how to get the application running with installation instructions.

Tarunianand Muruganandan

- Finalized Django as the framework to be used, weighing the pros and cons with other frameworks.
- Researched on some visualization tools and APIs to represent taxi travel on a map with Django.
- Finalized on using MapBox, got a basic map and navigation tool to work as a separate page on the application.
- Most of the progress was made locally, as they were run on local applications, that I built solely to test on. Once the rendering was satisfactory, it made its way to a commit.

Amith Gopal & Sowmya Ramakrishnan

Running Spark on EKS

The same steps as listed in the 'Integrating Spark and EKS' document were followed for successful creation of a Kubernetes cluster on AWS (EKS).
It was ensured that a user can list, edit, create and delete pods using the command
'kubectl auth can-i '*' '*' '

Installing Spark2.3 and running Spark jobs

- The Spark binary files were downloaded.
- The environment variables (JAVA_HOME - /usr/lib/jvm/java-8-openjdk-amd64/jre and SPARK_HOME - /home/kagura/Downloads/spark2.3) were set.
- The Kubernetes Cluster Master URL was obtained by running the command kubectl cluster-info.
- Kube-DNS (required to properly resolve cluster.local names) was ensured to be installed and functioning (running) properly using the command 'kubectl get pod -n kube-system'
- To allow the driver pod to create pods and services (for the local machine to be given access to the Kubernetes cluster), two Cluster Role Bindings were created using the following commands:

```
kubectl create clusterrolebinding cluster-system-anonymous
--clusterrole=cluster-admin --user=system:anonymous

kubectl create clusterrolebinding default-admin --clusterrole cluster-admin
--serviceaccount=default:default
```

- Using the master URL and example jar (uploaded in a public S3 bucket), the spark-submit binary was used to execute the sample spark query (that calculates the value of Pi). The spark image was obtained from a Google cloud container registry.

```
spark-submit --master
k8s://https://962DF1838BF53D6B319A4ABA4913E410.yl4.us-east-1.eks.amazonaws.
com
--deploy-mode cluster \
--name spark-pi \
--class org.apache.spark.examples.SparkPi \
--conf spark.executor.instances=5 \
--conf
spark.kubernetes.container.image=gcr.io/cloud-solutions-images/spark:v2.3.0-gcs
--conf spark.kubernetes.driver.pod.name=spark-pi-driver
http://sparkexamplejar.s3.amazonaws.com/spark-examples_2.11-2.3.0.jar
```

- The job was monitored on the Kubernetes Dashboard and succeeded, with the logs having information and the calculated Pi values.

Running Spark on Minikube

- The following prerequisites were met: The Apache Spark 2.3 binary was downloaded, Docker, VirtualBox, Minikube and kubectl were installed on a Linux machine.
- Minikube was started locally with 8 gigs of memory and 4 cpu cores using the command ‘minikube start --memory 8192 --cpus 4’
- A spark docker image was created locally using docker and the downloaded spark distribution. In the extracted spark folder, the following command was run: ‘./bin/docker-image-tool.sh -m -t spark-docker build’ . Running the command ‘docker image ls’ showed the available docker build.
- This image was then pushed to a public docker hub repository. To enable access to the repo, we first logged onto docker hub using the ‘sudo docker login --username <username>’ command. The following steps were involved in pushing the image to the repo:

```
sudo ./bin/docker-image-tool.sh -r sowmya2910/myrepo -t v2.3.0 build

sudo docker tag sowmya2910/myrepo/spark:v2.3.0 sowmya2910/myrepo-spark:v2.3.0

sudo docker push sowmya2910/myrepo-spark:v2.3.0
```

- To allow the driver pod to create pods and services (for the local machine to be given access to the Kubernetes cluster), two Cluster Role Bindings were created using the following commands:

```
kubectl create clusterrolebinding cluster-system-anonymous
--clusterrole=cluster-admin --user=system:anonymous

kubectl create clusterrolebinding default-admin --clusterrole cluster-admin
--serviceaccount=default:default
```

- The spark job was submitted using the following command:

```
spark-submit \
--master k8s://https://192.168.99.100:8843 \
--deploy-mode cluster \
--name spark-pi \
--class org.apache.spark.examples.SparkPi \
--conf spark.executor.instances=3 \
--conf spark.kubernetes.container.image=sowmya2910/myrepo-spark:v2.3.0
http://sparkexamplejar.s3.amazonaws.com/spark-examples_2.11-2.3.0.jar
```

- The cluster was then deleted using the ‘minikube stop’ and ‘minikube delete’ commands in succession.
- The job was monitored on the Kubernetes Dashboard and succeeded, with the logs having information and the calculated Pi values.

Thus, we were able to run spark on kubernetes using both EKS as well as Minikube. The issues encountered, appropriate/consequent debugging performed and screenshots validating successful run are documented separately and uploaded in the project git repository.

Meetings

We have a channel through which we communicate. This channel is very active. We put down any notes about changes we are considering in our implementations or design here. Any contentions are discussed further. However, physically we have met the following times:

- We had a meeting to outline the tasks and divide our tasks into subtasks after checkpoint 1. All four of the teammates were a part of this meeting. This was a one-hour brainstorming meeting. We mainly discussed the division of tasks into subtasks and how to approach each subtask. For example, if someone was using Kafka what all libraries were he/she going to try, what was the approach, would this be part of Django or a different service etc.
- Amith and Sowmya had a meeting to get Spark working on Kubernetes. Both of us were constantly communicating and discussing about how to overcome the errors we were facing while deploying Spark on the Kubernetes cluster. We met on 4th December for about an hour to resolve some issues that were occuring in my(Amith) setup due to some discrepancies in the configuration. We also discussed about the future steps to be taken which involved how to go about connecting MongoDB from the Kubernetes cluster and how to communicate with the Django application.

Changes to the Proposal

There weren’t any changes to the proposal. However, there are a few things (details) that weren’t anticipated or mentioned as a part of the document. These are as follows:

- Visualizations - This was a stretch goal for us but we decided to include it in our project as this is the best way to showcase that the tasks like finding taxi rides etc are executed.
- Migrations - Django, the web framework works best with a Model-view-controller defined and since we are building a web application we decided this was the route to take and decided to have Django models.
- Using Minikube as an alternative to AWS EKS is being considered. Although we were able to run sample spark queries successfully on kubernetes clusters spun up on both the interfaces, we are leaning more toward Minikube primarily since integration of the MongoDB database with Kubernetes looks simpler with Minikube, and it is also a more rational choice, cost-wise.

Dataset Management

- We did not have any issues with scrubbing or cleaning data. However, it did take a considerable amount of time to perform migrations to Django. This was because a Django model needed to be created and a script needed to be written for copying the data from our original database to the new one. This was needed so that we could perform queries using the inbuilt Django ORM which would make things like visualizations, any data manipulations or get, post, put, delete calls easier.

Challenges

- Running spark on EKS. Had to figure out the permissions to send spark jobs from a local machine to a remote EKS cluster, and had to deal with the many issues that popped up, as outlined in the ‘Work Done’ section

- Running spark on Minikube. There were many intricacies involved and figuring out and debugging issues took quite some time and lots of research. Due to excellent community support (both Spark and Kubernetes) though, we were able to get it up and running.

Costs

Costs incurred

We used AWS EKS to spin up our Kubernetes cluster, and ran sample spark queries on it. The process of setting up Kubernetes using EKS is elaborate and required launch of a cluster VPC and worker nodes (CloudFormation) and the cluster plane (EKS). EKS costs at about $0.20 per hour of use, and the AWS resources that it uses cost too. - t2.medium EC2 instances ($0.05 * 3 per hour) and EBS volumes ($0.10 per GB-month of provisioned storage). Setting up the cluster using EKS involves quite a bit of steps, and we could hence not terminate the cluster and its resources when not using them (that time was considerably less), this costed us about $30 in the couple weeks that we used the resources. The starter account could not be used since it does not allow use of IAM, among everything else.

Estimated Costs for future use

We are trying to make things work with Minikube instead, but if we find that using EKS is simpler and opt for it instead, we might incur some cost. We can try keeping it at a minimum by terminating all resources and bringing them up again from time to time, which is again a tradeoff since it is way more tedious to do so.