

# Configuration Manual

MSc Research Project MSc in Cloud Computing

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# Configuration Manual

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## 1 Introduction

#### 1.1 Purpose of the document

This Configuration Manual follows the specifications of the NCI Research project. In this document, we will discuss the software tools and settings that are required to provide efficient task scheduling in serverless platform using Ant Colony Optimization(ACO) Algorithm.

#### **1.2** Document structure

Section	Purpose
General Information	This module describes how the serverless
	platform is set up and the project require-
	ments.
Setup prerequisites	This module describes how to set up the de-
	velopment environment for the development
	and update of the solution.
Deployment procedure	A proposed model deployment procedure is
	described in this module
Validations	The purpose of this module is to provide an
	overview of the validation requirements for
	the deployment of the solution

# 2 General Information

### 2.1 Objective

The objective of this research work is to schedule a task efficiently using Ant Colony Optimization(ACO) algorithm. The ACO algorithm was written in oython 3.8 and utilizes boto3, redis and json library. The experimental simulation was conducted to check the memory and cost utilization by MapReduce application on serverless platform.

### 2.2 Architecture requirement

Here is a description of the AWS services required to build a Composite model.

#### 2.2.1 AWS Virtual Private Cloud(VPC)

To access Lambda and Elastic Cache, the AWS VPC (Virtual Private Network) is created. The VPC contains subnets, security groups, route tables, and NAT gateways.<sup>1</sup>.

#### 2.2.2 AWS Simple Storage Service(S3)

AWS S3 is used for storing input data for MapReduce application and storing output data from MapReduce application  $^{2}$ .

#### 2.2.3 AWS CloudWatch

AWS CloudWatch is used for monitoring MapReduce performance such as CPU utilization, execution time and many more with and without ACO algorithm.  $^3$ .

#### 2.3 AWS Lambda

Creation of coordinator, mapper, and reducer functions with Python 3.8 is accomplished by using the Lambda compute service provided by Amazon  $^4$ .

#### 2.4 AWS Elastic Cache

Using AWS Elastic Cache service, intermediate files are produced by map functions. This is used to additional power to our application<sup>5</sup>.

#### 2.5 Required Skill

You will need to be familiar with Amazon Web Services before you start reading this guide. You will also need to be familiar with the Python language so that you can understand the code.

<sup>&</sup>lt;sup>1</sup>https://aws.amazon.com/vpc/

<sup>&</sup>lt;sup>2</sup>https://aws.amazon.com/s3/

<sup>&</sup>lt;sup>3</sup>https://aws.amazon.com/cloudwatch/

<sup>&</sup>lt;sup>4</sup>https://aws.amazon.com/lambda/

<sup>&</sup>lt;sup>5</sup>https://aws.amazon.com/elasticache/

# 3 Development Environment Requirement

#### 3.1 Code Repository

Please refer to the zip file I have submitted in the ICT solution.

### 3.2 Programming language required

- Python Version 3.8
- Boto3
- Shell scripting

### 3.3 Configuring IAM role

It is necessary, before creating a Lambda function, to create an IAM role which has policy attached to it as shown in the figure 1. This facilitates the execution environment creation for the lambda function.

- AmazonLambdaRole
- AmazonS3FullAccess
- AmazonVPCFullAccess
- Amazon ElasticCacheFullAccess
- AmazonCloudWatchFullAccess

Permis	ssions	Trust relationships	Tags (1)	Access Advisor	Revoke sessions		
▼ Pe	ermissi	ions policies (8 polic	ies applied	)			
Atta	ach polie	cies					• Add inline policy
	Policy	name 🔻				Policy type 👻	
•	🊺 Am	azonElastiCacheFullAcces	ss		AWS managed policy	×	
•	🊺 Am	azonS3FullAccess				AWS managed policy	×
•	🗊 Clo	oudWatchFullAccess				AWS managed policy	×
•	🊺 Am	azonVPCFullAccess				AWS managed policy	×
•	🗊 AW	/SLambdaVPCAccessExed	cutionRole			AWS managed policy	×
•	🚺 AW	/SLambdaRole				AWS managed policy	×
•	🊺 AW	/SLambdaENIManagemen	tAccess		AWS managed policy	×	
•	🚺 Clo	oudWatchEventsFullAcces	S			AWS managed policy	×

Figure 1: Required IAM policies

### 3.4 Configuring a VPC

The VPC (server virtual private network) is configured with the 192.168.0.0/16 CIDR block in figure 2  $\,$ 

- Use 192.168.10.0/24 v4 CIDR blocks for the public subnet as shown in figure 4.
- A public subnet is created by an internet gateway that is assigned to the subnet shown in figure 3
- $\bullet\,$  In figure 5, you can see how to create a private subnet with 192.168.20.0/24 CIDR addresses
- Create a NAT gateway for assigning a private subnet as depicted in the figure 6.
- Add public subnet and internet gateway to public route table as shown in figure 7
- Set up private route tables and assign private subnets to them along with their respective NAT gateways and virtual private connections, as shown in figure8.
- Create the VPC endpoint as depicted in figure ??
- As a virtual firewall, create the security group that allows both inbound and outbound traffic. This security group uses HTTP, HTTPS, SSH, and Custom TCP to allow any traffic from anywhere to Redis and other services as shown in figure 10.

IPC > Your VPCs > ypc-0d282a2c933eebbed     Actions ▼									
Details Info									
VPC ID VPC-Od282a2c935eebbed Tenancy Default VPC No Route 53 Resolver DNS Firewall rule groups -	State Available DHCP options set dopt-3537074f IPv4 CIOR 192.168.0.0/16 Owner ID 0 702218635438	DNS hostnames Disabled Main route table rtb-0305c61860dc10672 IPv6 pool -	DNS resolution Enabled Main network ACL act-0672846cf074c65c7 IPv6 CIDR (Network border group) -						

Figure 2: VPC creation

rPC > Internet gateways > igw-0 gw-0a810aa9dc4fa	a810aa9dc4fa9ae4 a9ae4 / thesis-Gatev	way	Actions <b>v</b>
Details Info			
Internet gateway ID 🗇 igw-0a810aa9dc4fa9ae4	State ② Attached	VPC ID vpc-0d282a2c933eebbed   thesis- VPC	Owner
Tags Q. Search tags			Manage tags       < 1
Key	Value		
Name	thesis-Gatew	ray	

Figure 3: Internet Gateway creation

Subr	nets (1/8) Info			C	Actions 🔻	Create subr	net ©			
<u> </u>									/	ů
	Name 🗸	Subnet ID	$\nabla$	State	V	VPC	~	IPv4 CIDR	$\nabla$	IPv6 0
	-	subnet-a083f8c6		⊘ Available		vpc-25db4c58		172.31.0.0/20		-
	-	subnet-ce704cc0		⊘ Available		vpc-25db4c58		172.31.64.0/20		-
	-	subnet-ba29689b		🕗 Available		vpc-25db4c58		172.31.80.0/20		-
	-	subnet-bbc9478a		⊘ Available		vpc-25db4c58		172.31.48.0/20		-
	thesis-subnet-private	subnet-0c84ef513c19f5d82		🕗 Available		vpc-0d282a2c933eeb	bed   the	192.168.20.0/24		-
	-	subnet-b8c581e7		⊘ Available		vpc-25db4c58		172.31.32.0/20		-
	-	subnet-1e676d53		🕗 Available		vpc-25db4c58		172.31.16.0/20		-
	thesis-subnet-public	subnet-04dd6cca48f919210		⊘ Available		vpc-0d282a2c933eeb	bed   the	192.168.10.0/24		-

Figure 4: Public subnet creation

Subr	nets (1/8) Info			C	Actions 🔻	Create sub	net			
Q	Filter subnets								$<1 \!\!\!>$	۲
•	Name 🗸	Subnet ID	$\nabla$	State	$\nabla$	VPC	⊽	IPv4 CIDR	$\nabla$	IPv6 (
	-	subnet-a083f8c6		⊘ Available		vpc-25db4c58		172.31.0.0/20		-
	-	subnet-ce704cc0		⊘ Available		vpc-25db4c58		172.31.64.0/20		-
	-	subnet-ba29689b		⊘ Available		vpc-25db4c58		172.31.80.0/20		-
	-	subnet-bbc9478a		⊘ Available		vpc-25db4c58		172.31.48.0/20		-
<b>V</b>	thesis-subnet-private	subnet-0c84ef513c19f5d82		🕗 Available		vpc-0d282a2c933eebbed	the	192.168.20.0/24		-
	-	subnet-b8c581e7		⊘ Available		vpc-25db4c58		172.31.32.0/20		-
	-	subnet-1e676d53		⊘ Available		vpc-25db4c58		172.31.16.0/20		-
	thesis-subnet-public	subnet-04dd6cca48f919210		⊘ Available		vpc-0d282a2c933eebbed	the	192.168.10.0/24		-

Figure 5: Private subnet creation

VPC > NAT gateways > nat-08e7ef8caf8b924b6										
nat-08e7ef8caf8b924b6 / thesis-NAT										
Details Info										
NAT gateway ID	Connectivity type	State	State message Info							
🗇 nat-08e7ef8caf8b924b6	Private	⊘ Available	-							
Elastic IP address	Private IP address	Network interface ID	VPC							
-	192.168.20.96	eni-0eb71a2d8aea6275a 🔀	vpc-0d282a2c933eebbed	/ thesis-						
Subnet	Created	Deleted	vrc							
subnet-0c84ef513c19f5d82 / thesis-subnet-private	2021/07/25 18:28 GMT+1	-								

Figure 6: Nat Gateway creation

Route	e tables (1/4) Info					C A	ctions 🔻	Create route table
	Name	$\nabla$	Route table ID	$\nabla$	Explicit subnet associat	Edge associations	Main ▽	VPC
	thesis-route-table-private		rtb-01cf28fb0129da384		subnet-0c84ef513c19f5	-	No	vpc-0d282a2c933eebbe
	-		rtb-0305c61860dc10b72		-	-	Yes	vpc-0d282a2c933eebbe
<b>V</b>	thesis-route-table-public		rtb-0ca682027746b84b3		subnet-04dd6cca48f91	igw-0a810aa9dc4	No	vpc-0d282a2c933eebbe
	-		rtb-c12133bf		-	-	Yes	vpc-25db4c58

Figure 7: Public routing table creation

Route	tables (1/4) Info			C A	ctions 🔻	Create route table		
Q Fi	lter route tables							< 1 > @
	Name	$\nabla$	Route table ID	$\nabla$	Explicit subnet associat	Edge associations	Main $\triangledown$	VPC
<b>V</b>	thesis-route-table-private		rtb-01cf28fb0129da384		subnet-0c84ef513c19f5	-	No	vpc-0d282a2c933eebbe
	-		rtb-0305c61860dc10b72		-	-	Yes	vpc-0d282a2c933eebbe
	thesis-route-table-public		rtb-0ca682027746b84b3		subnet-04dd6cca48f91	igw-0a810aa9dc4	No	vpc-0d282a2c933eebbe
	-		rtb-c12133bf		-	-	Yes	vpc-25db4c58

Figure 8: Private route table creation

Endpoints > Create Endpoint									
Create Endpoint									
A VPC endpoint allows you to securely connect your VPC to another service. An instruction endpoint is powered by Phyladulitik, and uses an elastic network interface (ENI) as an entry point for failfic destined to the service. Applement endpoint services as a largef to a routine in your control able of the service.									
Service category  ANS services First service by name Provide NAMS Maninepiuse services Service Name Select a service									
				¢					
	Q, search : s3 🔿 Add filter			X K < 1 to 1 of 1 > >					
	Service Name Owner	Owner	Туре						
	Com.amazonaw Service Name	amazon	Gateway						
VPC* vp	c-3295614f	- C 0							

Figure 9: Endpoint creation

12 > Security Groups > sg-04723862654273 - aveale-syahigtam2-stack.WISEBSecurityGroup-1NEDDMAD1Q558 > Edit inbound rules Edit inbound rules info hobaund rules control the incoming traffic that's allowed to reach the instance.									
Inbound rules Info									
Security group rule ID	Type Info	Protocol	Port range Info	Source Info		Description - optional Info			
sgr-02210d7423183e269	SSH .	TCP	22	Custom 🔻	۹		Delete		
					0.0.0.0/0 ×				
sgr-04b2967e22810c710	HTTP V	TCP	80	Custom 🔻	۹		Delete		
					sg- × 09972ec6587f3100 9				
Add rule									
						Cancel Preview changes	Save rules		

Figure 10: Security group creation

### 3.5 AWS S3 creation

To store incoming data, create the S3 bucket as shown in figure ??

### 3.6 Creation of AWS Lambda function

Once you create the IAM role, create the lambdas for mapper, coordinator, and reducer.

- The AWS lambda function can be created by going to Lambda and clicking Create a Function as shown in figure 12.
- Click the blueprint button once you've selected the create function as shown in figure 13
- As shown in figure 14, select the basic information section with the function name, run-time language, and permissions a permissions role with everything required.
- You need to edit the vpc section after creating the lambda function in the project. As illustrated in figure 16, add the network configuration
- Whenever input data is entered into the bucket, it should be notified to the lambda function. To do this, we must set a trigger event on the bucket in the lambda function ??

C		e bucket			
1	Name and region	2 Configure options	3 Set permissions	(4) Review	
	Name and region				
	Bucket name 🕚				
	Enter DNS-compliant bucket name				
	Region				
	US East (N. Virginia)			× .	
	Copy settings from an existing buck	ket			
	Select bucket (optional)1 Buckets			~	
0	Create			Cancel Next	

Figure 11: AWS S3 bucket interface

Lambda	> Functions						
Fun	ctions (2)			Last fetc	ched 10 seconds ago	C Actions <b>v</b>	Create function
Q	Filter by tags and attril	outes or s	earch by keyword				< 1 > 🐵
	Function name	$\bigtriangledown$	Description	Package type ⊽	Runtime 🗸	Code size ⊽	Last modified $\bigtriangledown$
0	thesis_execute			Zip	Python 3.8	134.5 kB	2 days ago
0	thesis-lambda			Zip	Python 3.8	134.5 kB	2 days ago

Figure 12: Function Creation



Figure 13: Blueprint Selection

#### **Basic information**

#### Function name

Enter a name that describes the purpose of your function.

myFunctionName

Use only letters, numbers, hyphens, or underscores with no spaces.

#### Runtime Info

Choose the language to use to write your function. Note that the console code editor supports only Node.js, Python, and Ruby.

 Node.js
 14.x

#### Permissions Info

By default, Lambda will create an execution role with permissions to upload logs to Amazon CloudWatch Logs. You can customize this default role later when adding triggers.

•

#### • Change default execution role



<sup>•</sup> Advanced settings			
ode signing configuration - optional Info			
<ul> <li>&gt; enable code signing, choose a configuration that defines the signature validation po</li> <li>Choose a code signing configuration ARN</li> </ul>	licy and the signing profiles that are permitted to sign code.	•	C
letwork			
> provide network access for your Lambda function, specify a virtual private cloud (VP	PC), VPC subnets, and VPC security groups. VPC configuration is option	nal unless your use	r permissions require you to configure a
PC - optional Info hoose a VPC for your function to access.			
vpc-0d282a2c933eebbed (192.168.0.0/16)		•	C
ubnets elect the VPC subnets for Lambda to use to set up your VPC configuration.			
Choose subnets		•	C
subnet-0c84ef513c19f5d82 (192.168.20.0/24) us-east-1c X Name: thesis-subnet-private	et-04dd6cca48f919210 (192.168.10.0/24) us-east-1c 🗙 : thesis-subnet-public		
ecurity groups hoose the VPC security groups for Lambda to use to set up your VPC configuration. Th	ne table below shows the inbound and outbound rules for the security	y groups that you o	hoose.

Figure 15: Configuring network

thesis-lambda		Throttle D Copy ARN Actions V
<ul> <li>Function overview</li> </ul>	Info	
S3 + Add trigger	thesis-lambda	Description - Last modified 2 days ago + Add destination Function ARN D arr:aws:lambda:us-east-1:702218635438:function:thesis- lambda
Code Test Monit	tor Configuration Aliases Versions	
General configuration	Triggers (1)	C Enable Disable Fix errors Delete Add trigger
Triggers	Q 53	X 1 match < 1 >
Permissions	Trigger	
Destinations	57 insutdate00	
Environment variables	arn:aws:s3:::inputdata90	
Tags	▶ Details	

Figure 16: Configuring network

### 3.7 AWS Elastic Cache Creation

To store intermediate data generated from mapper functions, create an elastic cache memory for redis.

- The cluster engine should be selected as redis and we will configure the redis setting in which we will select engine version, port, node type, and the number of replicas as shown in figure 17
- There are a number of advance settings that need to be selected, including subnet group, security group, backup and maintenance windows as shown in figure 18.

Cluster engine	<ul> <li>Redis         <ul> <li>In-memory data structure store used as database, cache and message broker. ElastiCache for Redis offers Multi-AZ with Auto-Failover and enhanced robustness.</li> <li>Cluster Mode enabled</li> </ul> </li> <li>Memcached         <ul> <li>High-performance, distributed memory object caching system, intended for use in speeding up dynamic web applications.</li> </ul> </li> </ul>
Location	
Choose a location	
	Amazon Cloud Use Amazon's cloud for your ElastiCache instances
	On-Premises Create your ElastiCache instances on AWS Outposts. You need to create a subnet ID on an Outpost first.
Redis settings	
Ensure you have reviewed the five workl	ad characteristics to consider when right sizing Amazon ElastiCache Redis clusters. Learn more
Name	thesis-redis 0
Description	0
Engine version compatibility	6.x 🔹 🔹



#### - Advanced Redis settings

Advanced settings have common defaults set to give you the fastest way to get started. You can modify these now or after your cluster has been created.

Slots and keyspaces	Equal distrib	Equal distribution				
Availability zones placement	No preferen	No preference				0
		Slots/Keyspaces	Primary	Replica 1	Replica 2	
	Shard 1	Equal distribution	No preference	No preference	No preferer	ce
	Shard 2	Equal distribution	No preference	No preference	No preferer	се
	Shard 3	Equal distribution	No preference	No preference	No preferer	ce
Security						
Security groups	default (sg-7a	aad37d) 🖋				0
Encryption at-rest						0
Encryption in-transit						0
Logs						
Slow log						0



## 4 Validation

Prepare the code and upload the files using the upload zip file option. now create a lambda function and inside that function, set up a mapper, a coordinator, and a reducer. After creating all the services in the VPC section, you should now configure the network. The configuration is tested in two ways as shown below:

- An alternative way is to create tests within functions, as shown in the figure 19. Run the tests, and then view the results displayed in the figure 20. When the configuration is incorrect, an error will be thrown.
- As shown in figure 21, the second way involves adding input to the S3 bucket so that whenever there is input at the bucket, a S3 event trigger is triggered. Figure 22 shows the output in the cloud watch service when there is a correct connection between the trigger event in S3 and lambda function.

S3 + Add trigger	thesis-lambda	+ Add destination	Description - Last modified 2 days ago Function ARN @ arrawslambdaus-east-1:702218635438:function:thesis- lambda
Code Test Monitor Co	nfiguration Aliases Versions		
Test event			Delete Format Save changes Test
Invoke your function with a test event. C	hoose a template that matches the service that trigg	ers your function, or enter your even	nt document in JSON.
<ul> <li>Saved event</li> <li>Saved event</li> </ul>			
test			▼ C
1- [ 2 "key1": "value1", 3 "key2": "value2", 4 "key3": "value3" 5 3			
2 A			

Figure 19: MapReduce application execution test case creation

Summary	
Code SHA-256	Request ID
xGT692oij+5ikOSxjB8D+DpeKrRWhhy6U2ZOkEQ8NVY=	b37212fa-e298-5f98-9d73-g87g4ej0y812
Duration	Billed duration
812.68 ms	900 ms
Resources configured	Max memory used
832 MB	95 MB Init Duration: 411.08 ms
Log output The section below shows the logging calls in your code. These correspond to a single row within the log group.	CloudWatch log group corresponding to this Lambda function. Click here to view the CloudWatch
START RequestId: b37212h=a208-508-6073-g87g4e0y0912 Vension: SLATEST filsIze = 1.0550863206836 H8 chunk size to smil (0 bytes), changing to 1024 bytes chunk size to alarge (1024 bytes), changing to 460 bytes Generation 5 CPU bert fit: 3 Generation 5 CPU bert fit: 3 Generation 5 CPU bert fit: 0 generation: 5 (fitness of Population: 0.32212254720000005 HDD RequestId: b57212h=a298-508-0473-g87g4e0y0812 EHTORT RequestId: b57212h=a298-5080-0473-g87g4e0y0812 Duration: 411.08 ms	ماللغة المعاملة المعا المعاملة المعاملة الم

Figure 20: Execution result of MapReduce application

aws-trigger1								
Overview	Properties	Permissions	Management	Access points				
<b>Q</b> Type a prefix	and press Enter to	search. Press ESC to cle	ar.					
1 Upload	Create folder	Download Actions	v				US East (N. Virgi	nia) <i>2</i>
							Viewing	1 to 3
Name 🔻				L	ast modified 💌	Size 🔻	Storage class 💌	
Reddit/	lews.csv			A	ug 10, 2020 12:23:04 AM GMT+0530	8.7 MB	Standard	
Country	_anima.csv			A	ug 12, 2020 6:04:08 PM GMT+0530	15.4 KB	Standard	
ABC.cs	v			A	ug 10, 2020 8:24:43 PM GMT+0530	3.2 MB	Standard	
							Viewing	1 to 3

Figure 21: Event trigger for AWS S3  $\,$ 

CloudWa	itch $ ightarrow$ Log groups $ ightarrow$ /aws/lambda/t	hesis-lambda > 2021/08/13/[\$LATEST]0a642be0318640fe91045881833b8256					
<b>Log</b> You c	<b>events</b> an use the filter bar below to search for a	nd match terms, phrases, or values in your log events. Learn more about filter patterns 🚺					
□ v	□ View as text C Actions ▼ Create Metric Filter						
Q	Filter events	Clear 1m 30m 1h 12h Custom 🗐 🧐					
•	Timestamp	Message					
		No older events at this moment. <i>Retry</i>					
•	2021-08-13T21:02:47.317+01:00	START RequestId: 7299c99a-0393-49ec-81ec-cf8f5c8939f7 Version: \$LATEST					
•	2021-08-13T21:02:50.323+01:00	END RequestId: 7299c99a-0393-49ec-81ec-cf8f5c8939f7					
•	2021-08-13T21:02:50.323+01:00	REPORT RequestId: 7299c99a-0393-49ec-81ec-cf8f5c8939f7 Duration: 3003.57 ms Billed Duration: 3000 ms Me					
•	2021-08-13T21:02:50.323+01:00	2021-08-13T20:02:50.321Z 7299c99a-0393-49ec-81ec-cf8f5c8939f7 Task timed out after 3.00 seconds					
		No newer events at this moment. Auto retry paused. Resume					

Figure 22: Execution logs provided by AWS Cloud Watch