Architecting Image Recognition App as Cloud Native Application

ELL887: Cloud Computing Project

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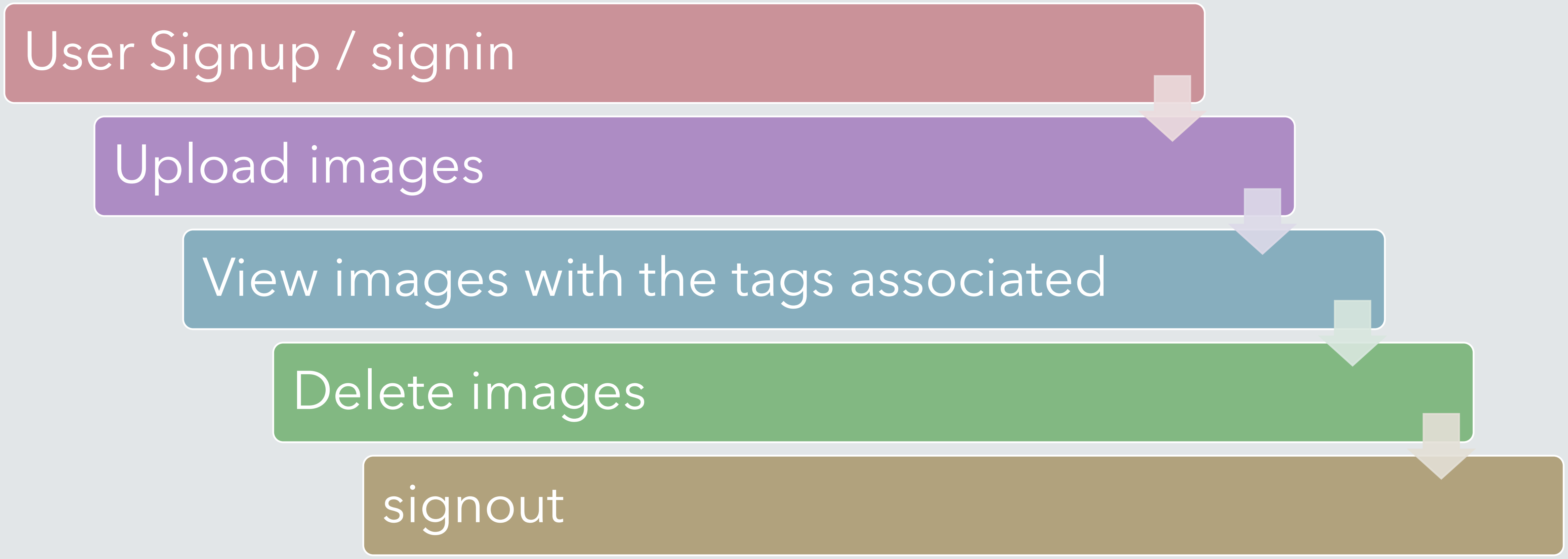
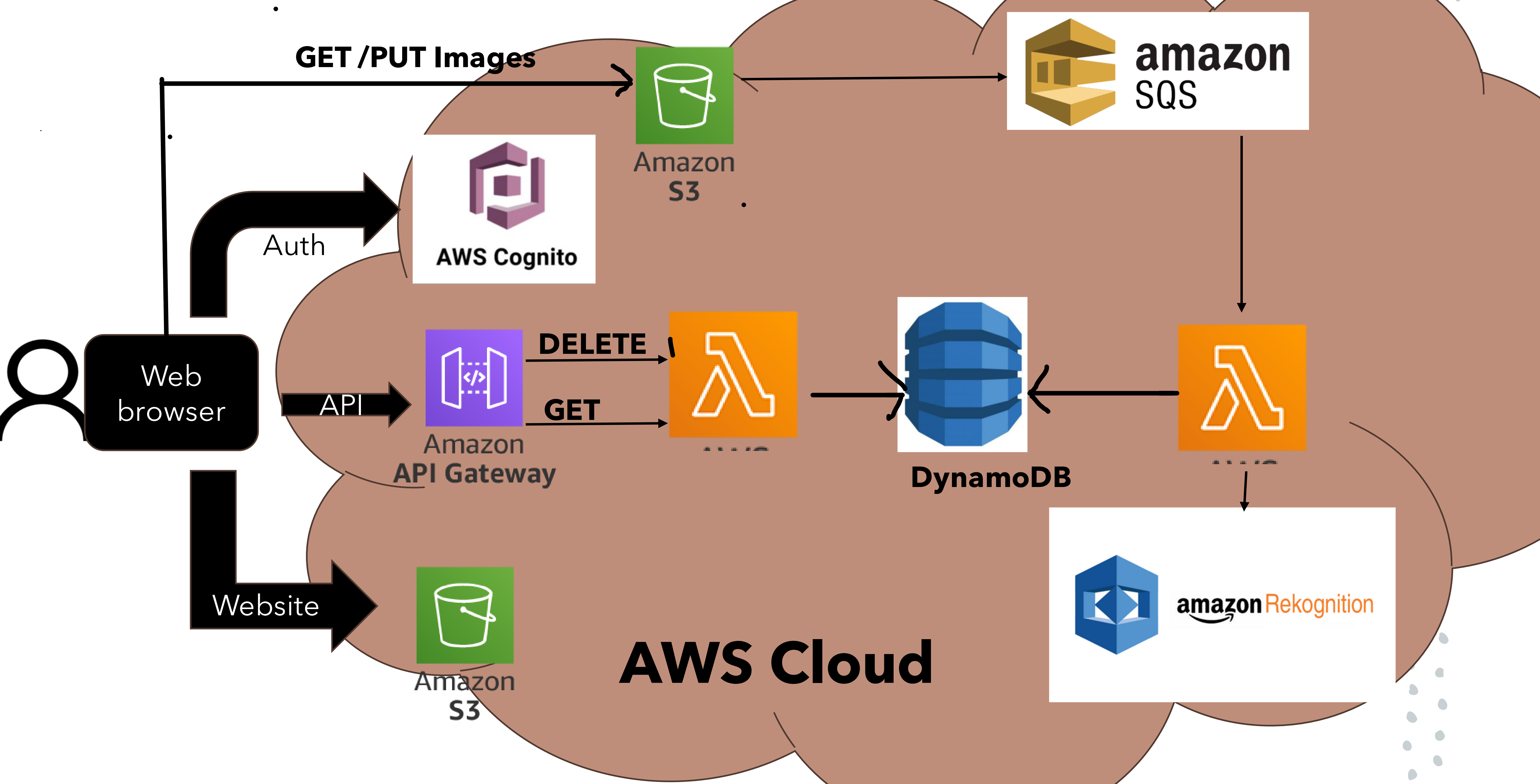
Submitted to: **Prof. Sougata Mukherjee**

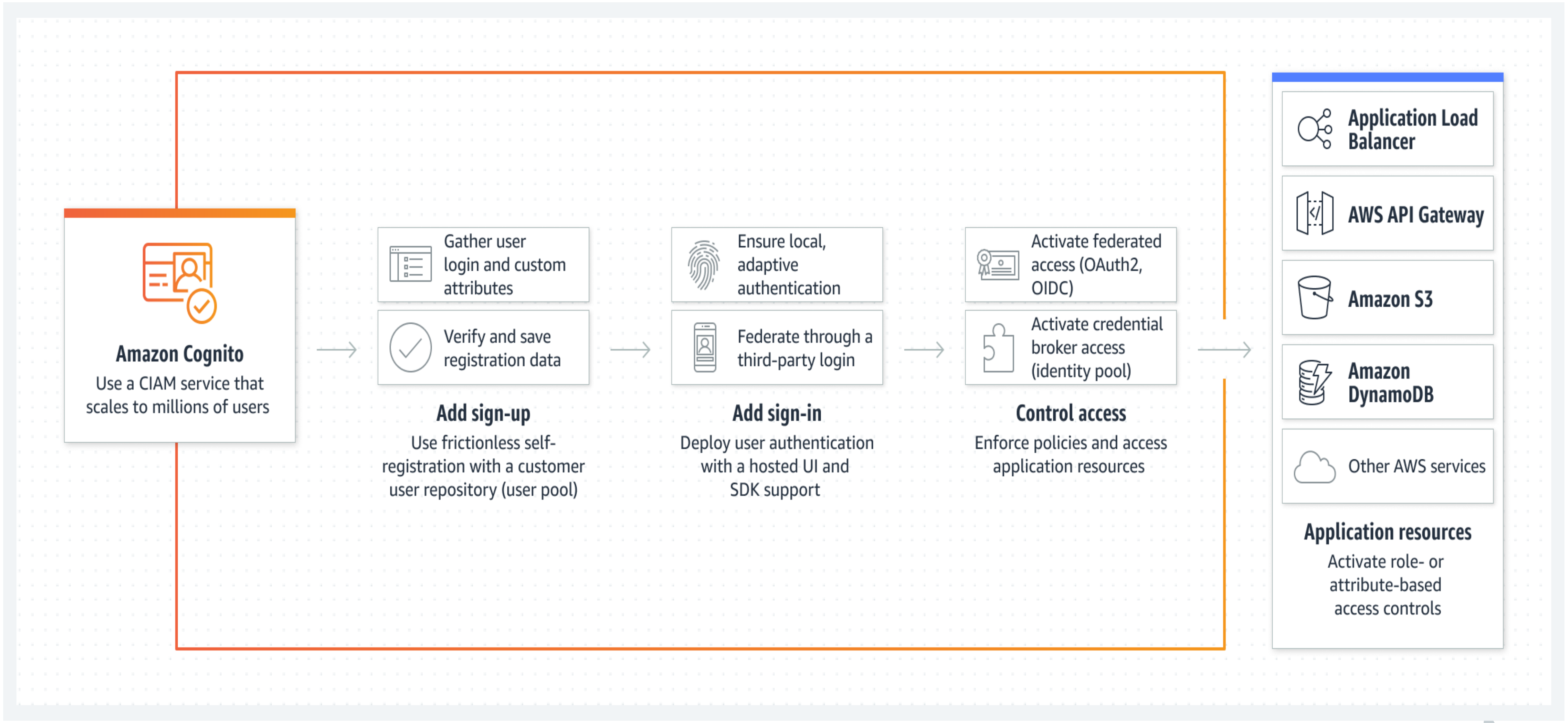
Application flow



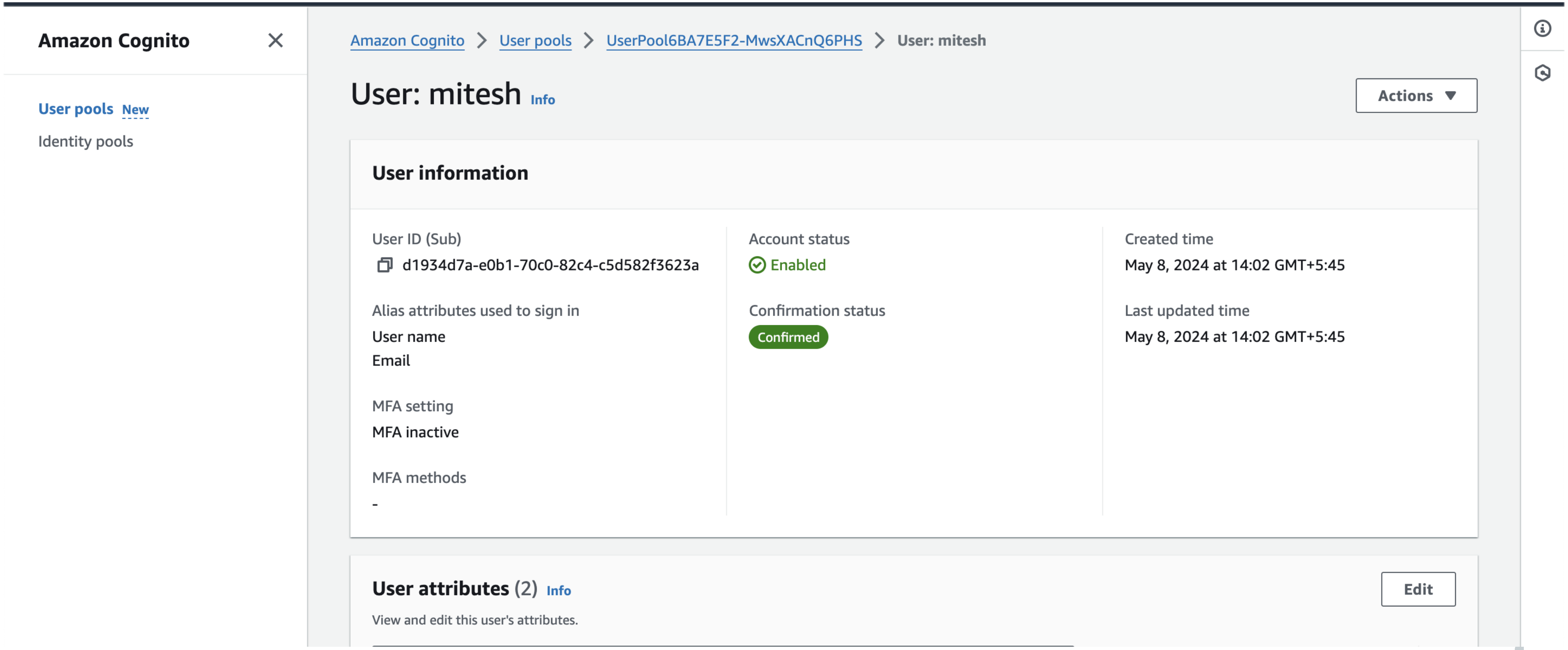
Architecture



Amazon Cognito


Amazon Cognito
Use a CIAM service that scales to millions of users
Gather user login and custom attributes
Verify and save registration data
Add sign-up
Use frictionless self-registration with a customer user repository (user pool)
Ensure local, adaptive authentication
Federate through a third-party login
Add sign-in
Deploy user authentication with a hosted UI and SDK support
Activate federated access (OAuth2, OIDC)
Activate credential broker access (identity pool)
Control access
Enforce policies and access application resources
Application Load Balancer
AWS API Gateway
Amazon S3
Amazon DynamoDB
Other AWS services
Application resources
Activate role- or attribute-based access controls

Amazon Cognito(from console)



Amazon Cognito
User pools New
Identity pools
Amazon Cognito > User pools > UserPool6BA7E5F2-MwsXACnQ6PHS > User: mitesh
Actions
Edit

User: mitesh Info

User information

User ID (Sub)	Account status	Created time
d1934d7a-e0b1-70c0-82c4-c5d582f3623a	Enabled	May 8, 2024 at 14:02 GMT+5:45
Alias attributes used to sign in	Confirmation status	Last updated time
User name Email	Confirmed	May 8, 2024 at 14:02 GMT+5:45
MFA setting		
MFA inactive		
MFA methods		
-		

User attributes (2) Info

View and edit this user's attributes.

Amazon S3 bucket

An object storage service offering industry-leading scalability, data availability, security, and performance

Two instances of S3 bucket are used in our application

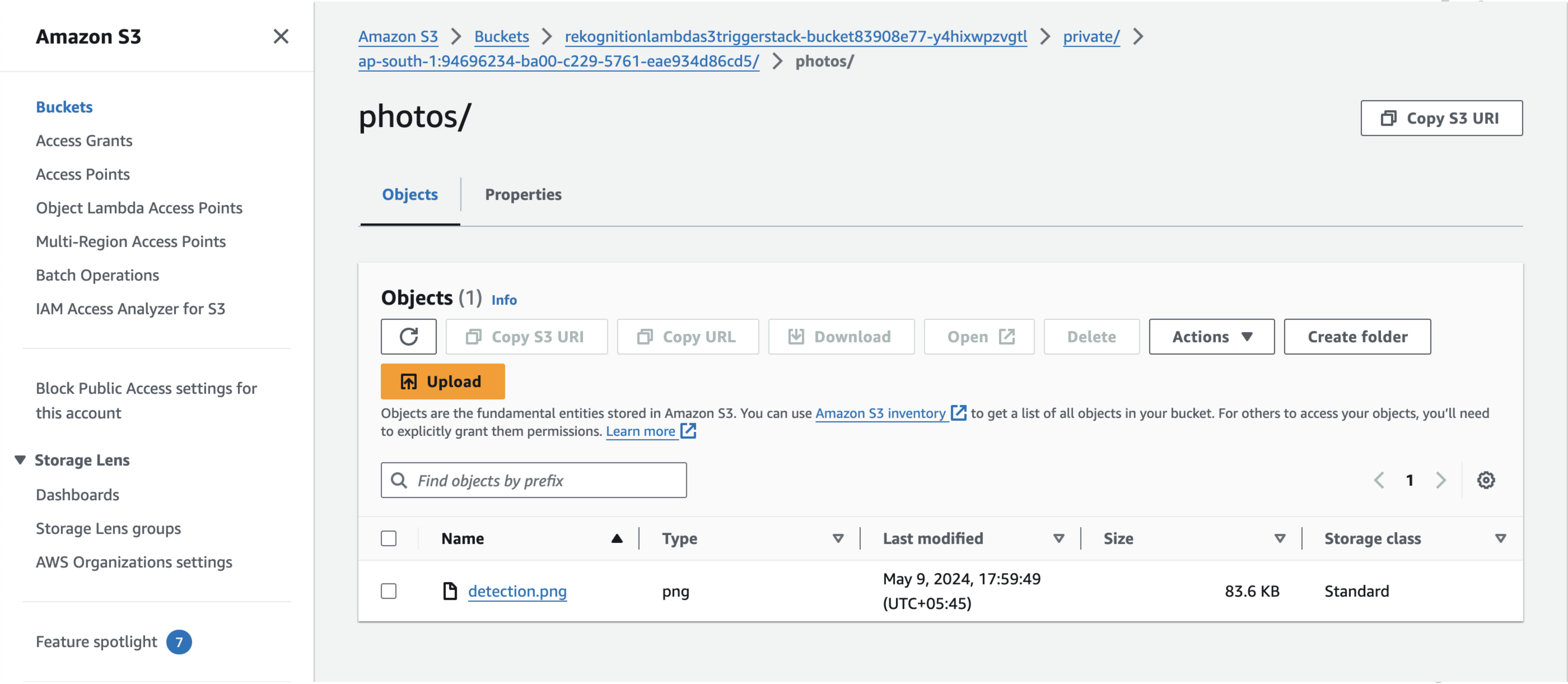
Hosting of static frontend

Amazon S3

For storing photos

Amazon S3

Amazon S3 bucket(Screenshot from console)



Amazon S3
Buckets
Access Grants
Access Points
Object Lambda Access Points
Multi-Region Access Points
Batch Operations
IAM Access Analyzer for S3
Block Public Access settings for this account
Storage Lens
Dashboards
Storage Lens groups
AWS Organizations settings
Feature spotlight 7

Amazon S3 > Buckets > rekognitionlambdas3triggerstack-bucket83908e77-y4hixwpzvgtl > private/ > ap-south-1:94696234-ba00-c229-5761-eae934d86cd5/ > photos/

photos/

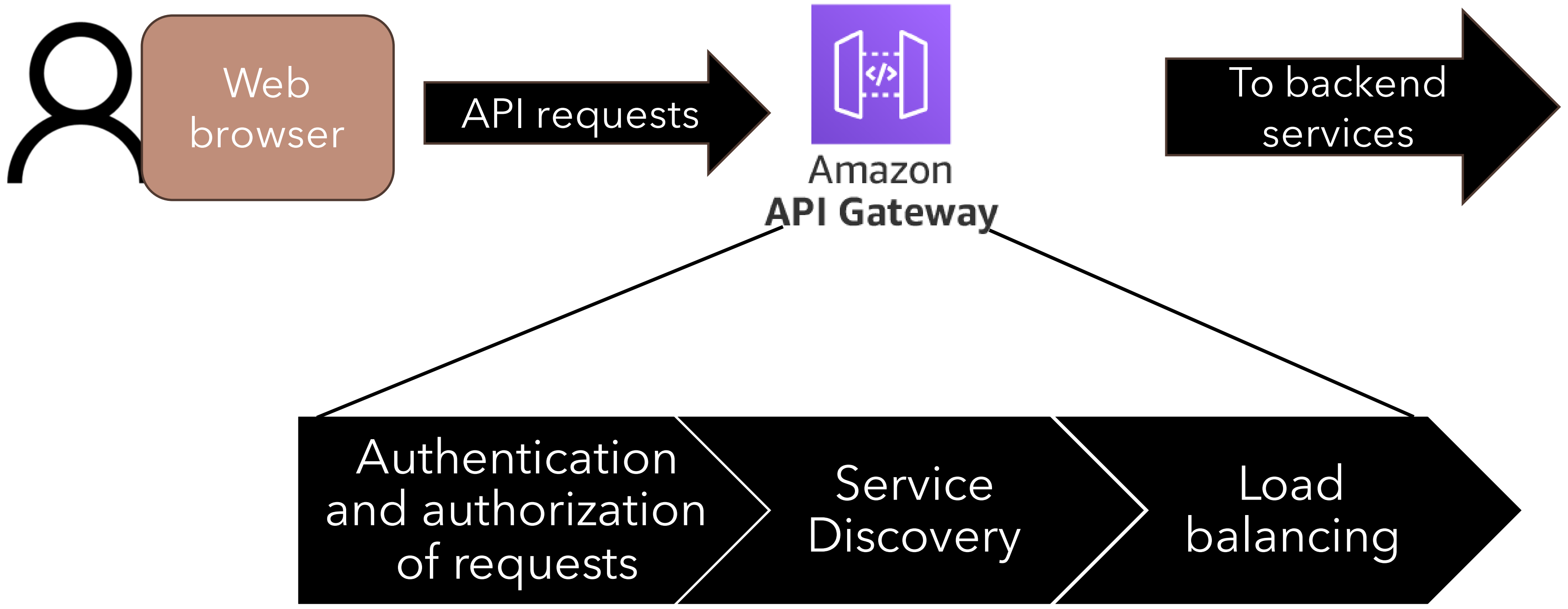
Objects (1) Info

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

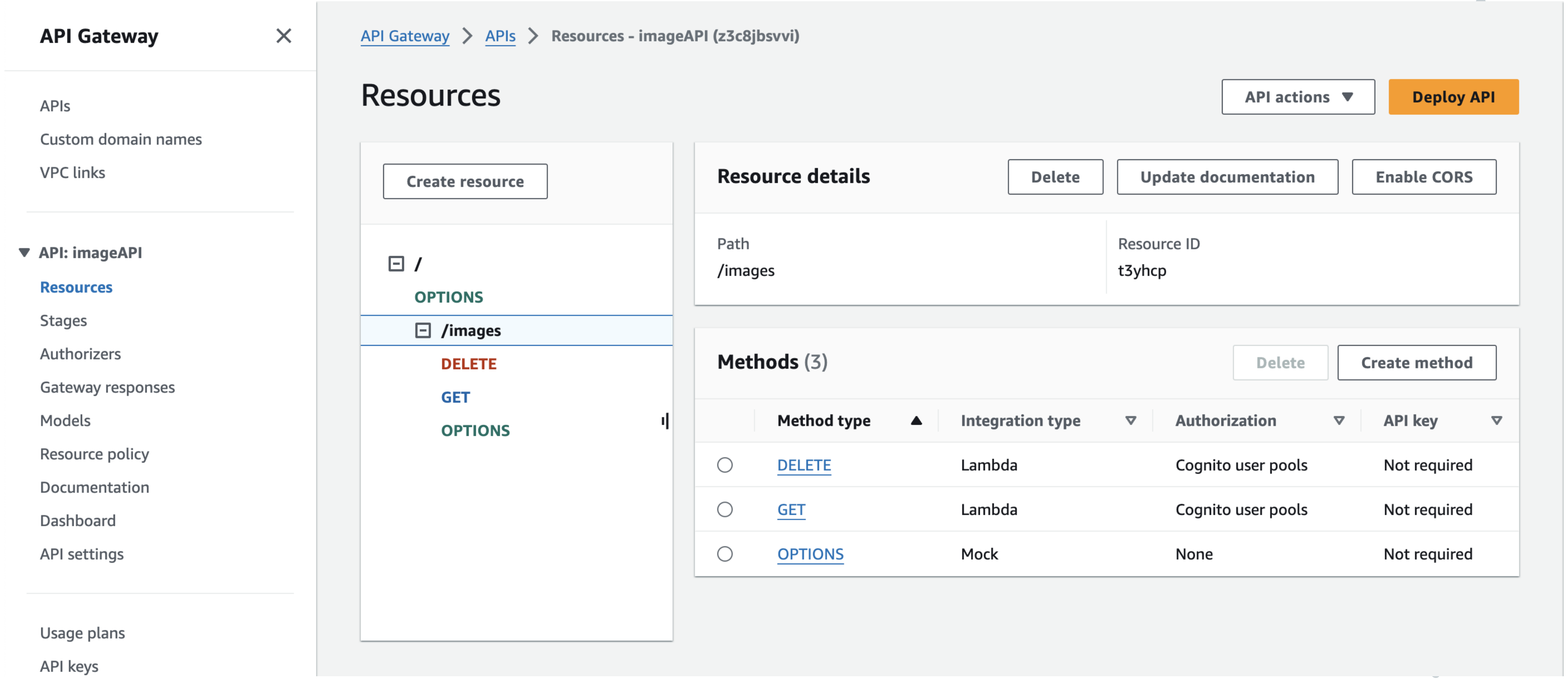
Name	Type	Last modified	Size	Storage class
detection.png	png	May 9, 2024, 17:59:49 (UTC+05:45)	83.6 KB	Standard

Amazon API Gateway

Create, publish, maintain, monitor, and secure APIs at any scale



Amazon API Gateway(from AWS console)



Resources

/
OPTIONS
/images
DELETE
GET
OPTIONS

Resource details

Path: /images

Resource ID: t3yhcp

Methods (3)

Method type	Integration type	Authorization	API key
DELETE	Lambda	Cognito user pools	Not required
GET	Lambda	Cognito user pools	Not required
OPTIONS	Mock	None	Not required

AWS Lambda

Runs code in response to events into a modern, production ready, scalable environment supporting serverless applications

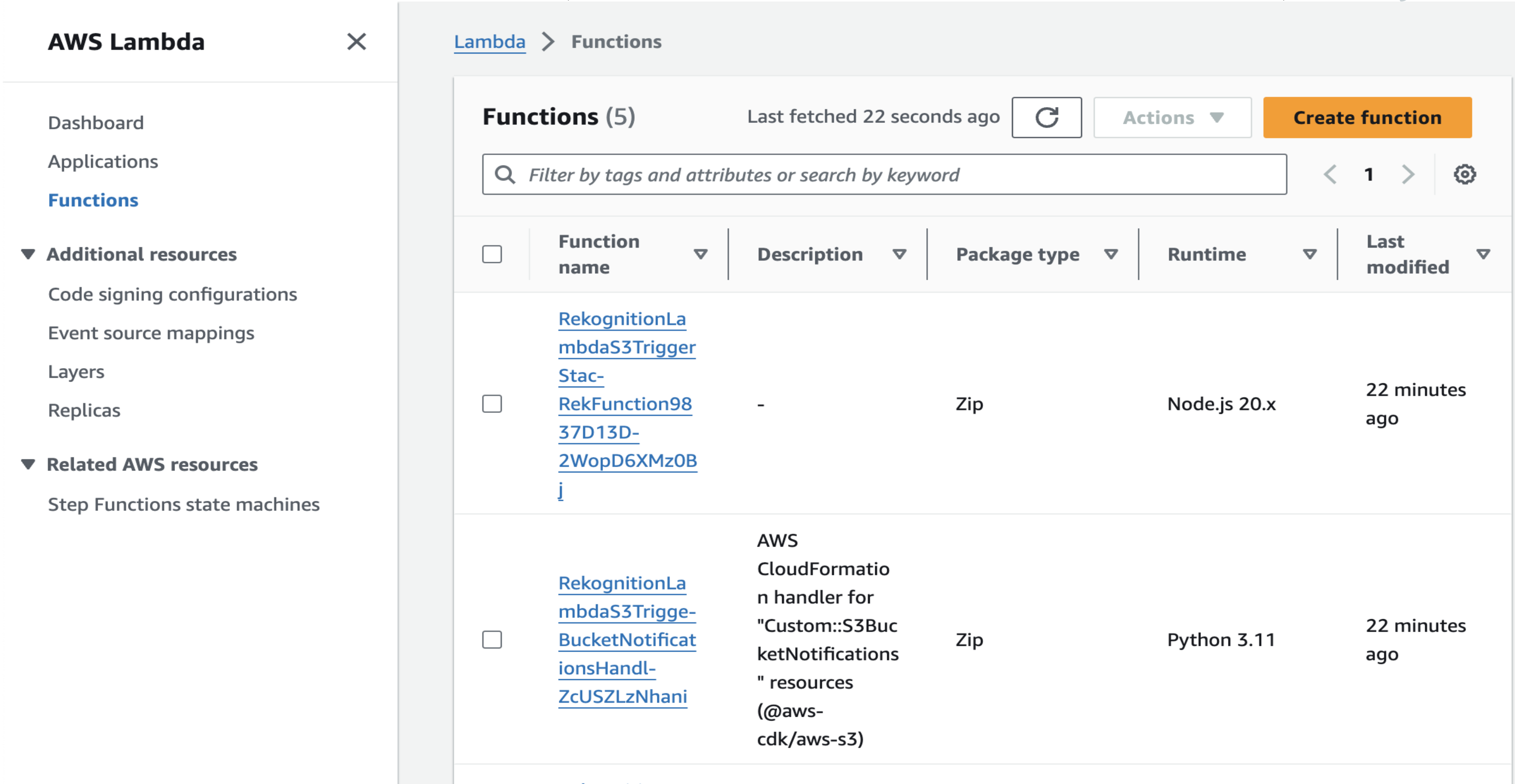
Triggered for GET/DELETE requests from browser

For fetching or deleting images from Amazon Dynamo DB

Trigger by Simple Queue service after image upload

For running the image recognition function (Amazon Recognition)

AWS Lambda(Screenshot from console)



AWS Lambda

- Dashboard
- Applications
- Functions

▼ Additional resources

- Code signing configurations
- Event source mappings
- Layers
- Replicas

▼ Related AWS resources

- Step Functions state machines

Lambda > Functions

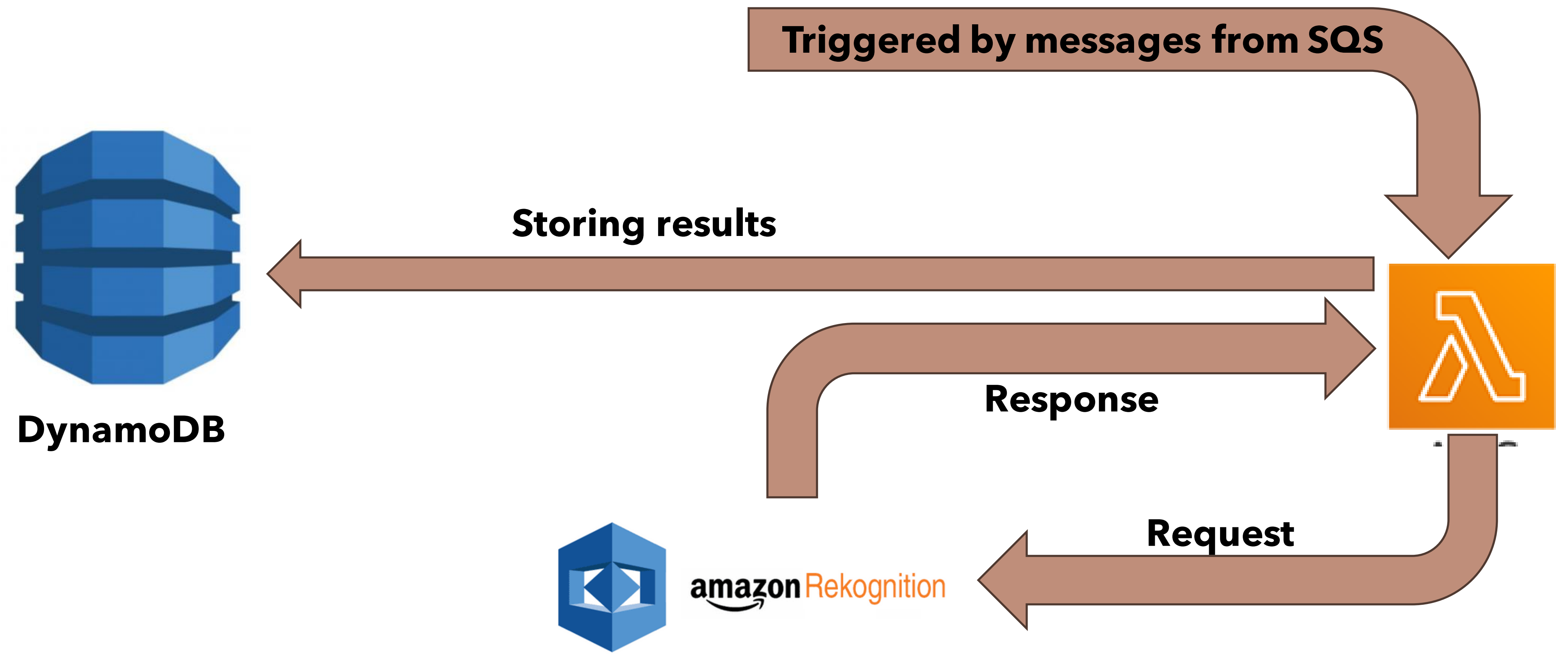
Functions (5)   Last fetched 22 seconds ago   Actions ▼   Create function

Filter by tags and attributes or search by keyword   < 1 >

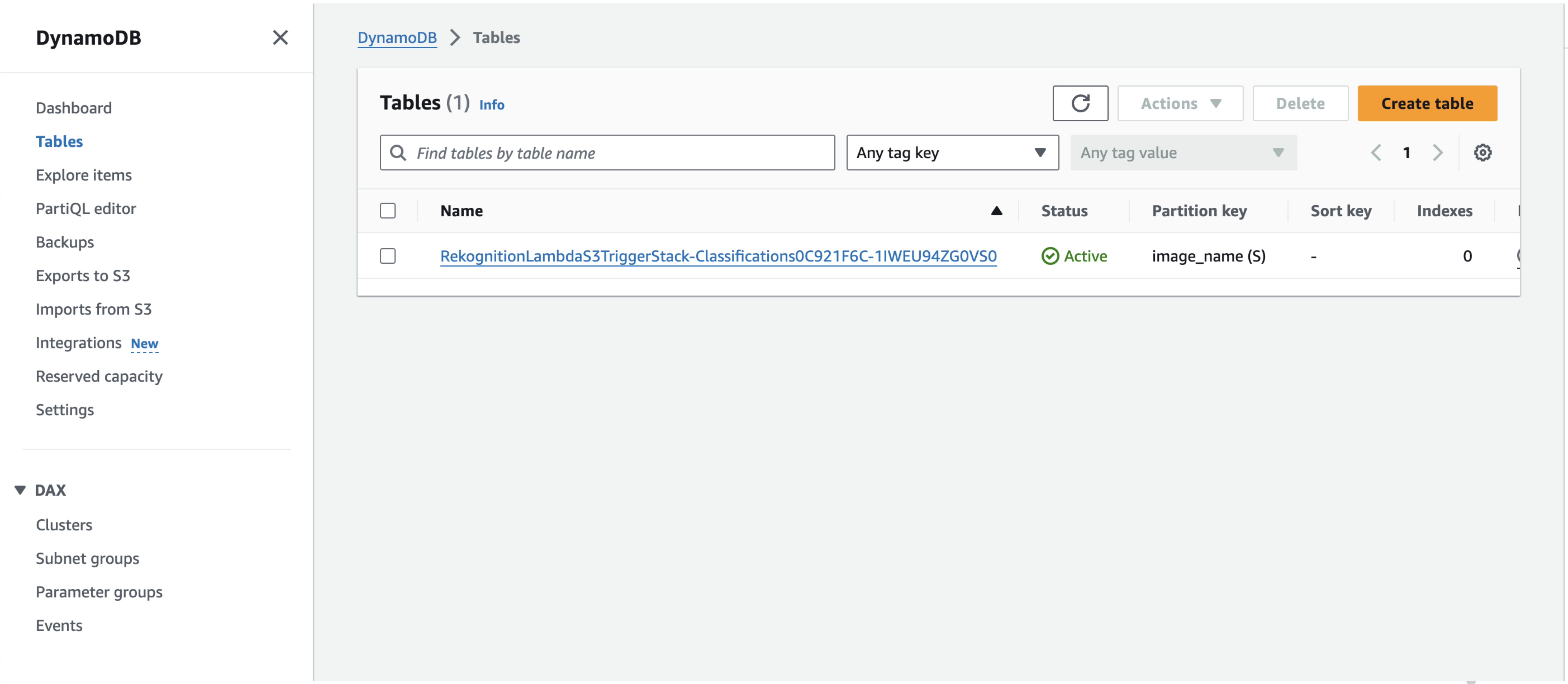
	Function name	Description	Package type	Runtime	Last modified
☐	RekognitionLambdaS3TriggerStac-RekFunction9837D13D-2WopD6XMz0Bj	-	Zip	Node.js 20.x	22 minutes ago
☐	RekognitionLambdaS3Trigge-BucketNotificationsHandl-ZcUSZLzNhani	AWS CloudFormation handler for "Custom::S3BucketNotifications" resources (@aws-cdk/aws-s3)	Zip	Python 3.11	22 minutes ago

AWS DynamoDB

Serverless, NoSQL, fully managed database with single-digit millisecond performance at any scale



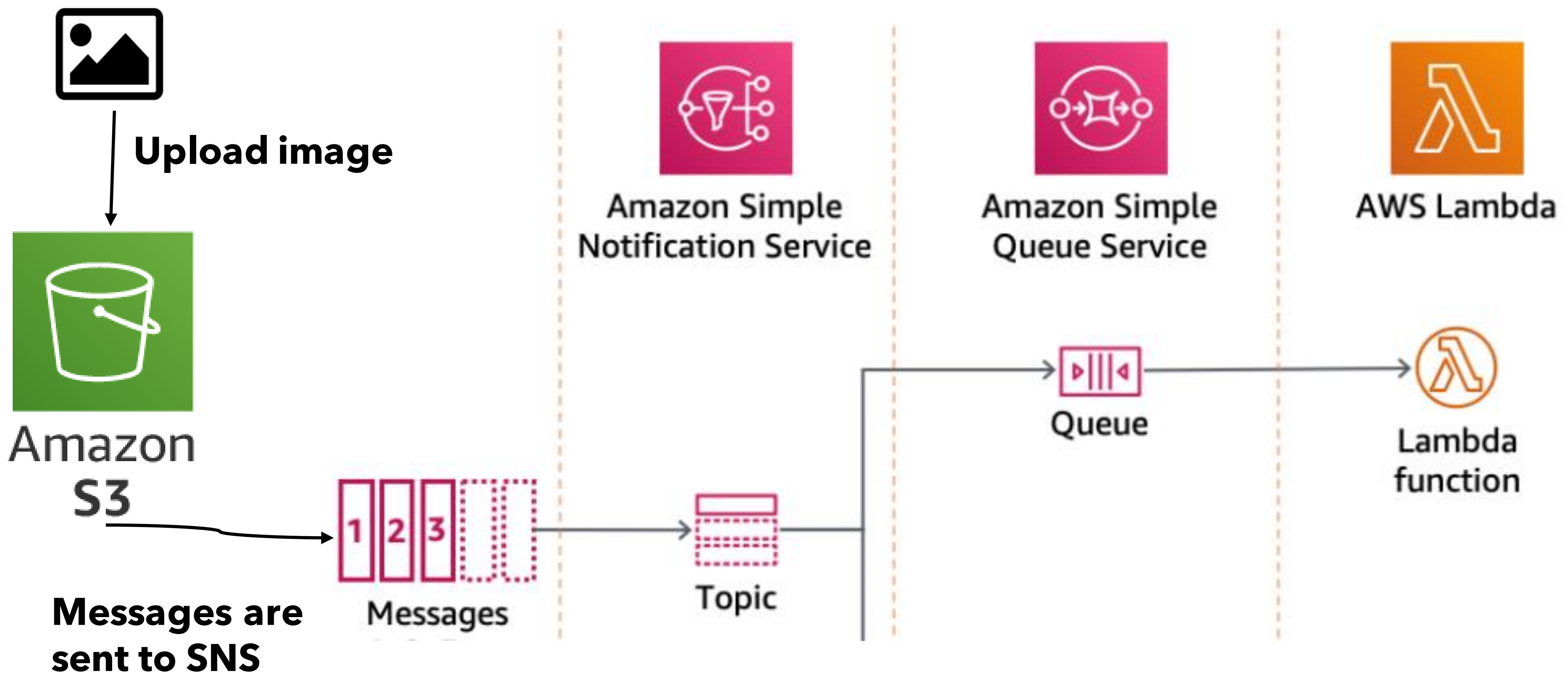
AWS DynamoDB(screenshot from console)



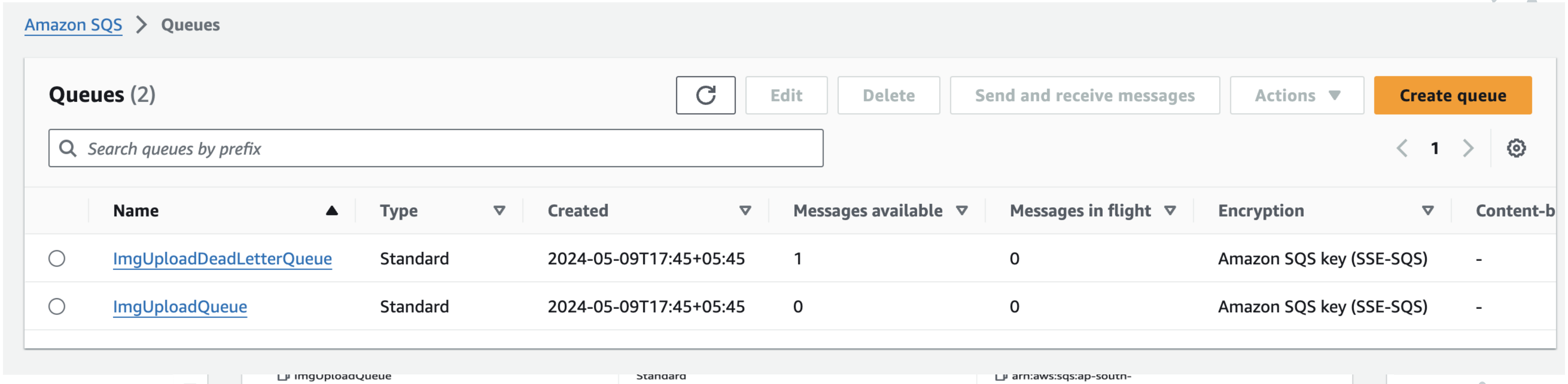
Name	Status	Partition key	Sort key	Indexes
RekognitionLambdaS3TriggerStack-Classifications0C921F6C-1IWEU94ZG0VS0	Active	image_name (S)	-	0

Amazon SQS

Used to deliver Application-to-application(A2A) notifications/messages to integrate and decouple distributed applications



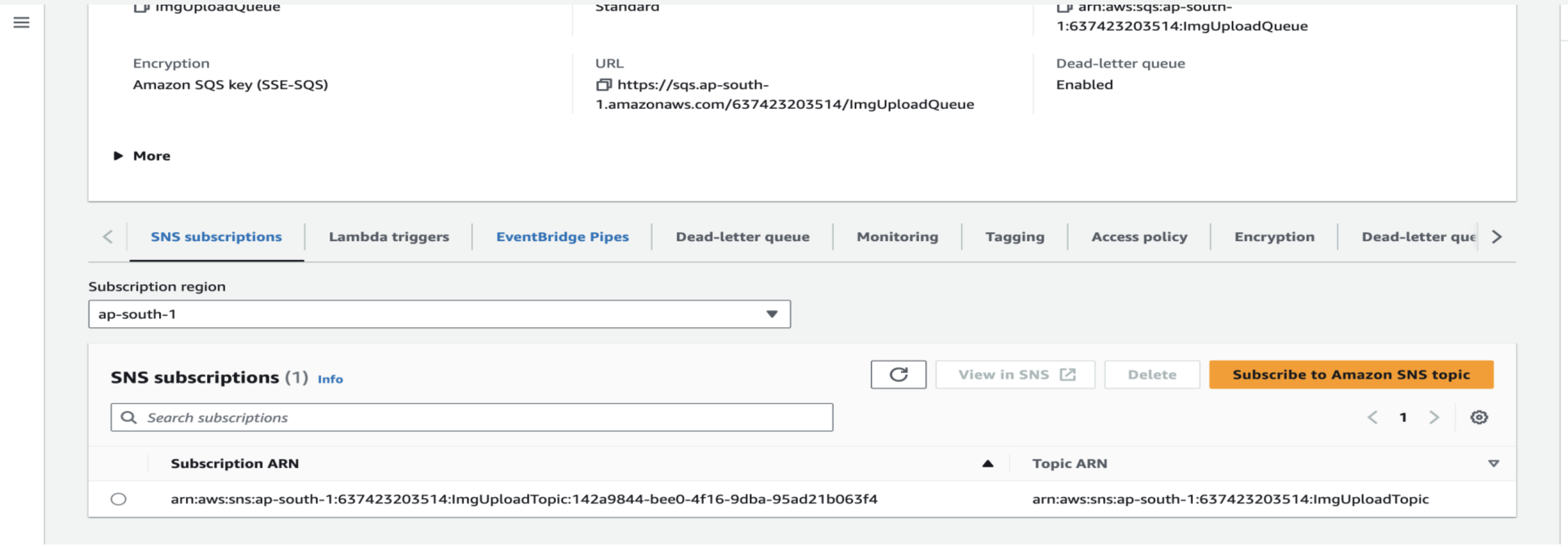
Amazon SNS(screenshot from console)



Amazon SQS > Queues

Queues (2)

	Name	Type	Created	Messages available	Messages in flight	Encryption	Content-b
○	ImgUploadDeadLetterQueue	Standard	2024-05-09T17:45+05:45	1	0	Amazon SQS key (SSE-SQS)	-
○	ImgUploadQueue	Standard	2024-05-09T17:45+05:45	0	0	Amazon SQS key (SSE-SQS)	-



ImgUploadQueue　Standard　arn:aws:sqs:ap-south-1:637423203514:ImgUploadQueue

Encryption Amazon SQS key (SSE-SQS)	URL https://sqs.ap-south-1.amazonaws.com/637423203514/ImgUploadQueue	Dead-letter queue Enabled

▶ More

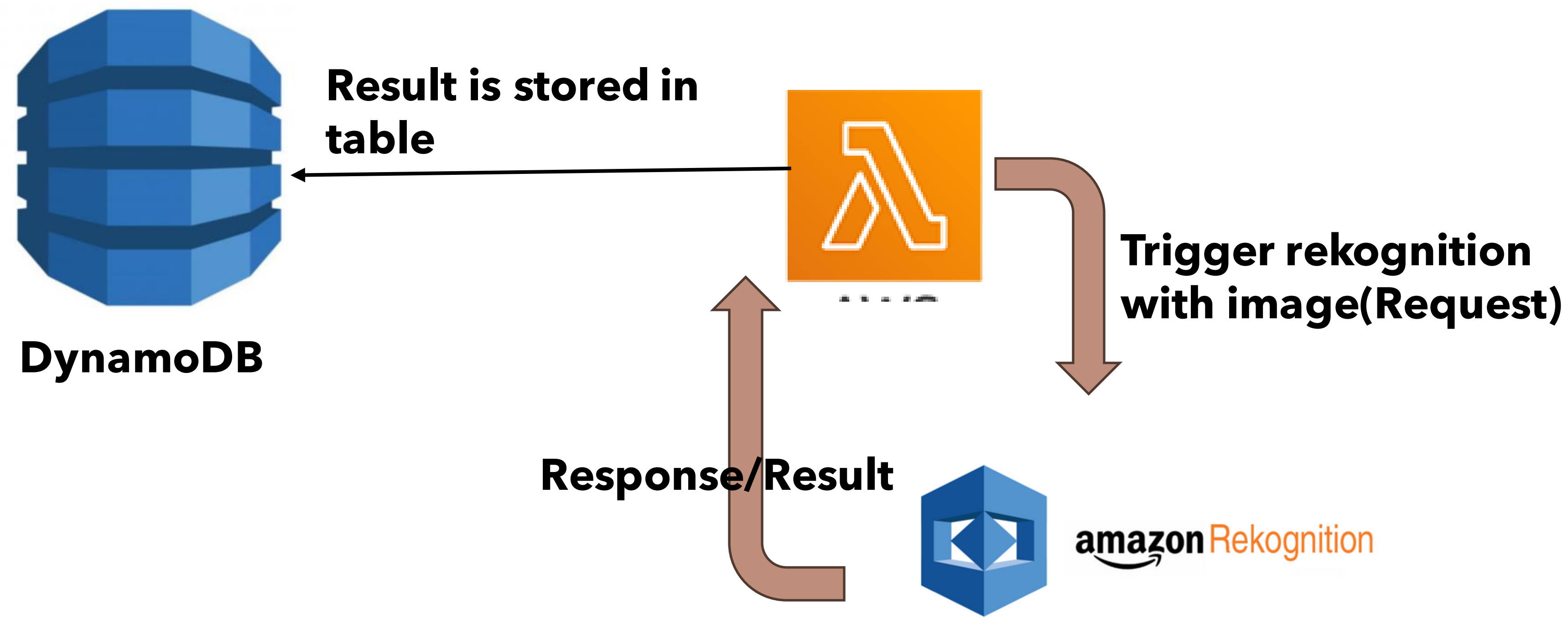
Subscription region
ap-south-1

SNS subscriptions (1) Info

	Subscription ARN	Topic ARN
○	arn:aws:sns:ap-south-1:637423203514:ImgUploadTopic:142a9844-bee0-4f16-9dba-95ad21b063f4	arn:aws:sns:ap-south-1:637423203514:ImgUploadTopic

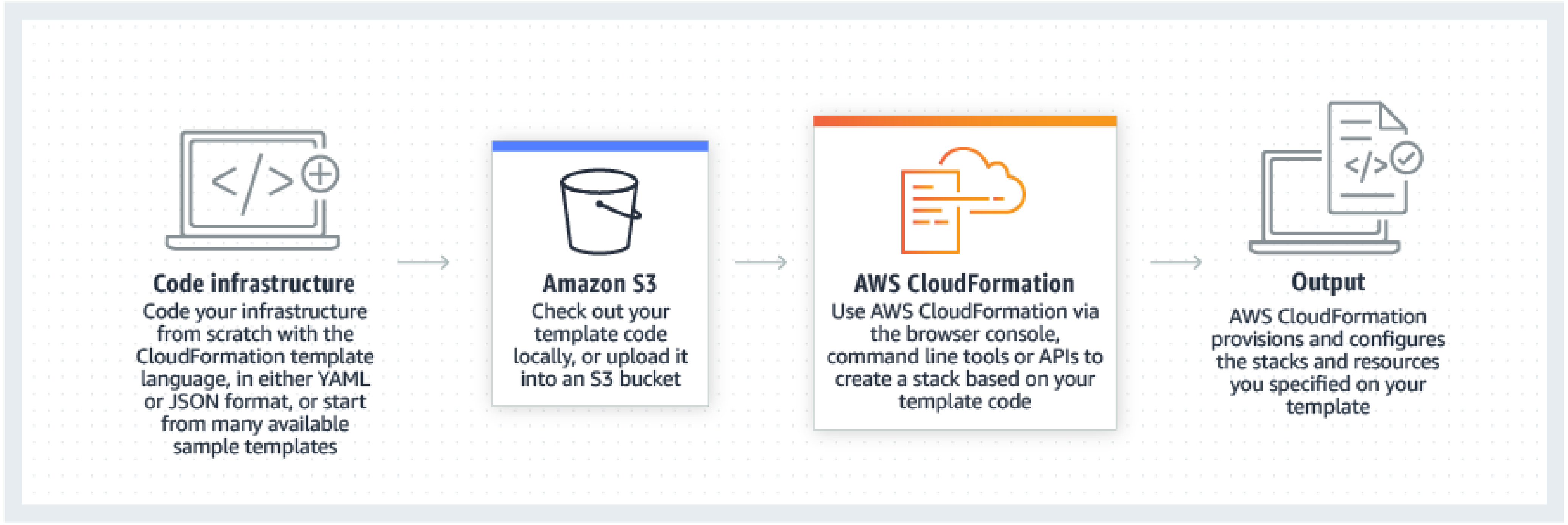
Amazon Rekognition

Amazon Rekognition offers pre-trained and customizable computer vision (CV) capabilities to extract information and insights from your images and videos


Result is stored in table
DynamoDB
Trigger rekognition with image(Request)
Response/Result
amazon Rekognition

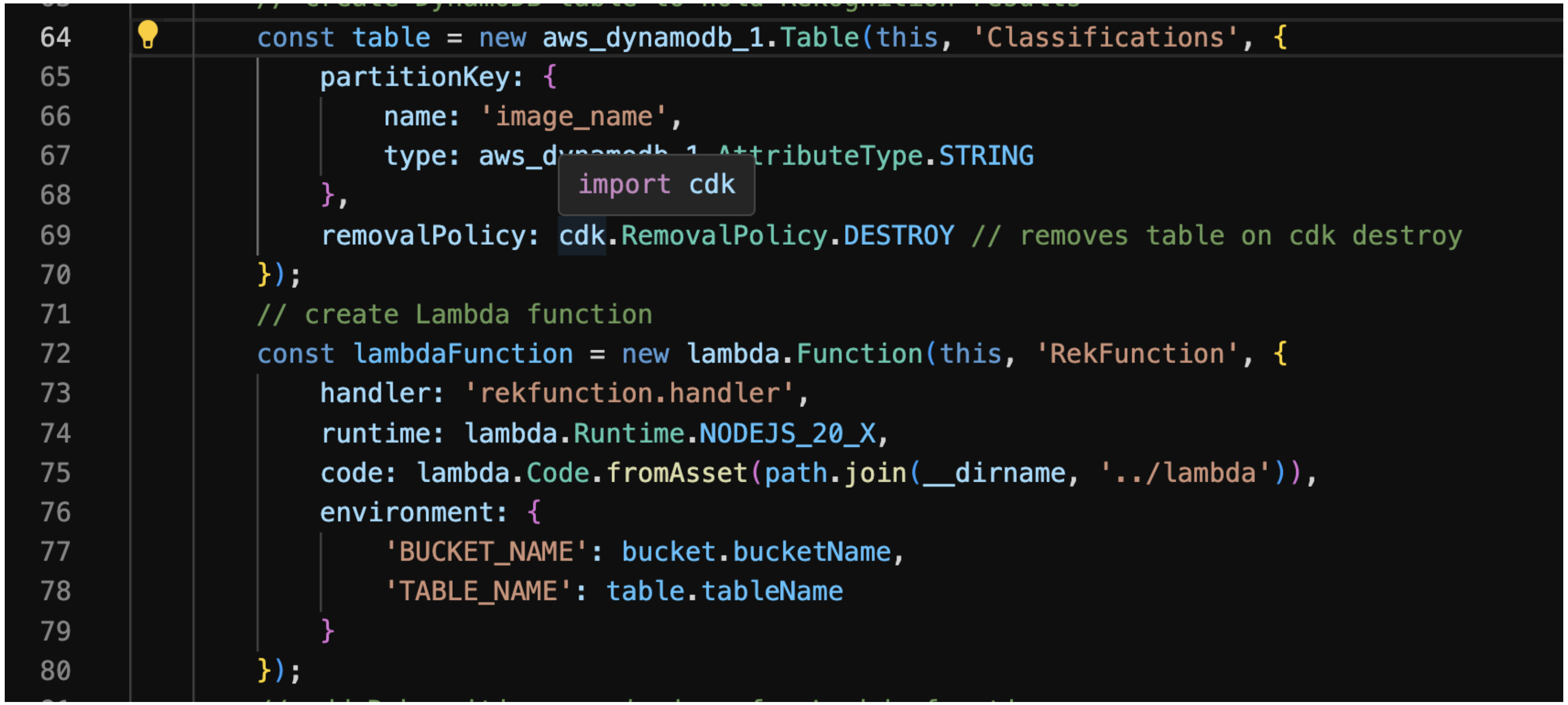
AWS CloudFormation

AWS CloudFormation lets us model, provision, and manage AWS and third-party resources by treating infrastructure as code


Code infrastructure
Code your infrastructure from scratch with the CloudFormation template language, in either YAML or JSON format, or start from many available sample templates
Amazon S3
Check out your template code locally, or upload it into an S3 bucket
AWS CloudFormation
Use AWS CloudFormation via the browser console, command line tools or APIs to create a stack based on your template code
Output
AWS CloudFormation provisions and configures the stacks and resources you specified on your template

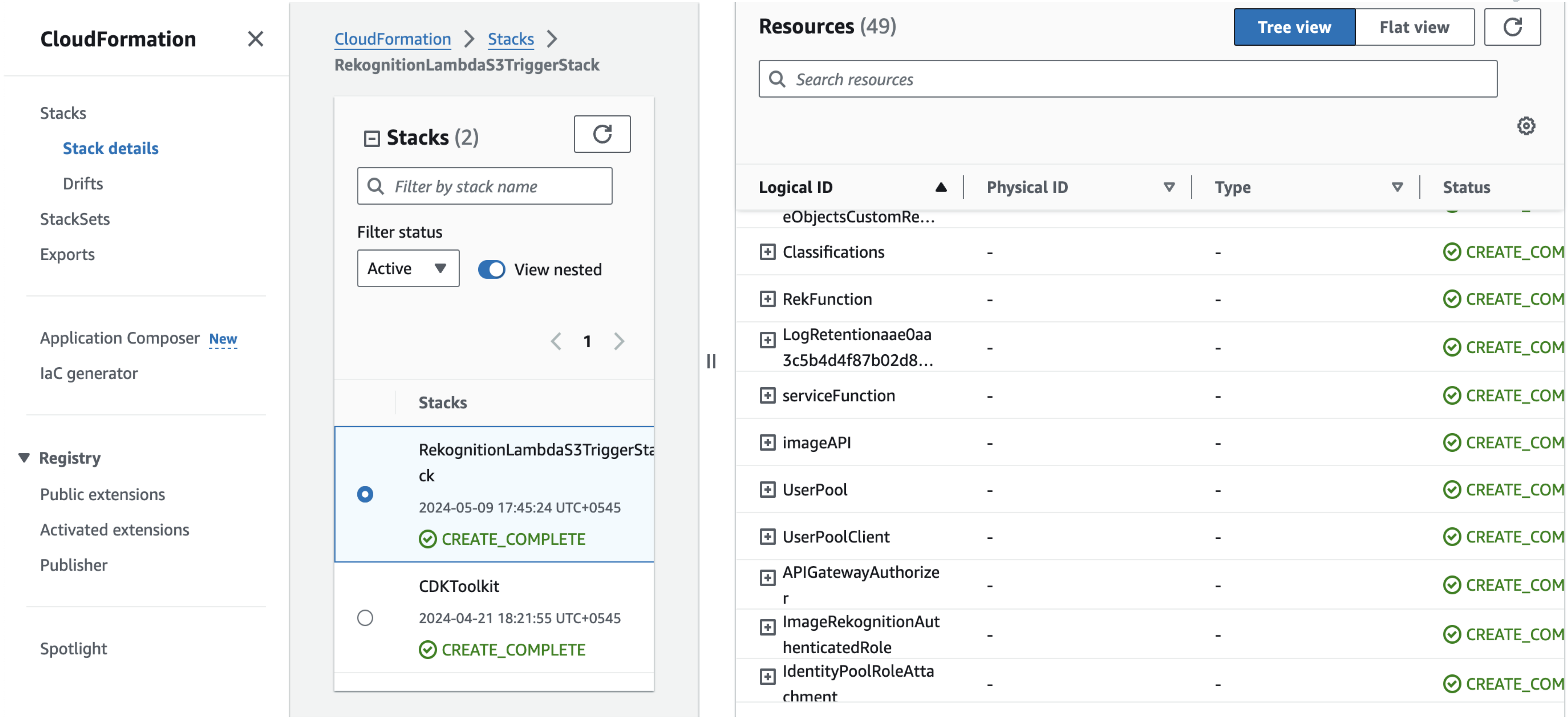
AWS CloudFormation

AWS Cloud Development Kit(CDK) making it very easy to write the cloud formation templates as it provides wrapper over it in different familiar languages of choice .
I used typescript.



```
const table = new aws_dynamodb_1.Table(this, 'Classifications', {
    partitionKey: {
        name: 'image_name',
        type: aws_dynamodb_1.AttributeType.STRING
    },
    removalPolicy: cdk.RemovalPolicy.DESTROY // removes table on cdk destroy
});
// create Lambda function
const lambdaFunction = new lambda.Function(this, 'RekFunction', {
    handler: 'rekfunction.handler',
    runtime: lambda.Runtime.NODEJS_20_X,
    code: lambda.Code.fromAsset(path.join(__dirname, '../lambda')),
    environment: {
        'BUCKET_NAME': bucket.bucketName,
        'TABLE_NAME': table.tableName
    }
});
```

AWS CloudFormation(Screenshot from console)



CloudFormation

Stacks
Stack details
Drifts
StackSets
Exports

Application Composer New
IaC generator

Registry
Public extensions
Activated extensions
Publisher

Spotlight

CloudFormation > Stacks > RekognitionLambdaS3TriggerStack

Stacks (2)

Filter by stack name

Filter status: Active — View nested

	Stacks
●	RekognitionLambdaS3TriggerStack 2024-05-09 17:45:24 UTC+0545 CREATE_COMPLETE
○	CDKToolkit 2024-04-21 18:21:55 UTC+0545 CREATE_COMPLETE

Resources (49) — Tree view | Flat view

Search resources

Logical ID	Physical ID	Type	Status
eObjectsCustomRe...			
Classifications	-	-	CREATE_COM
RekFunction	-	-	CREATE_COM
LogRetentionaae0aa3c5b4d4f87b02d8...	-	-	CREATE_COM
serviceFunction	-	-	CREATE_COM
imageAPI	-	-	CREATE_COM
UserPool	-	-	CREATE_COM
UserPoolClient	-	-	CREATE_COM
APIGatewayAuthorizer	-	-	CREATE_COM
ImageRekognitionAuthenticatedRole	-	-	CREATE_COM
IdentityPoolRoleAttachment	-	-	CREATE_COM

Technologies behind Frontend

React

node

TS TypeScript

Demo

Challenges Faced

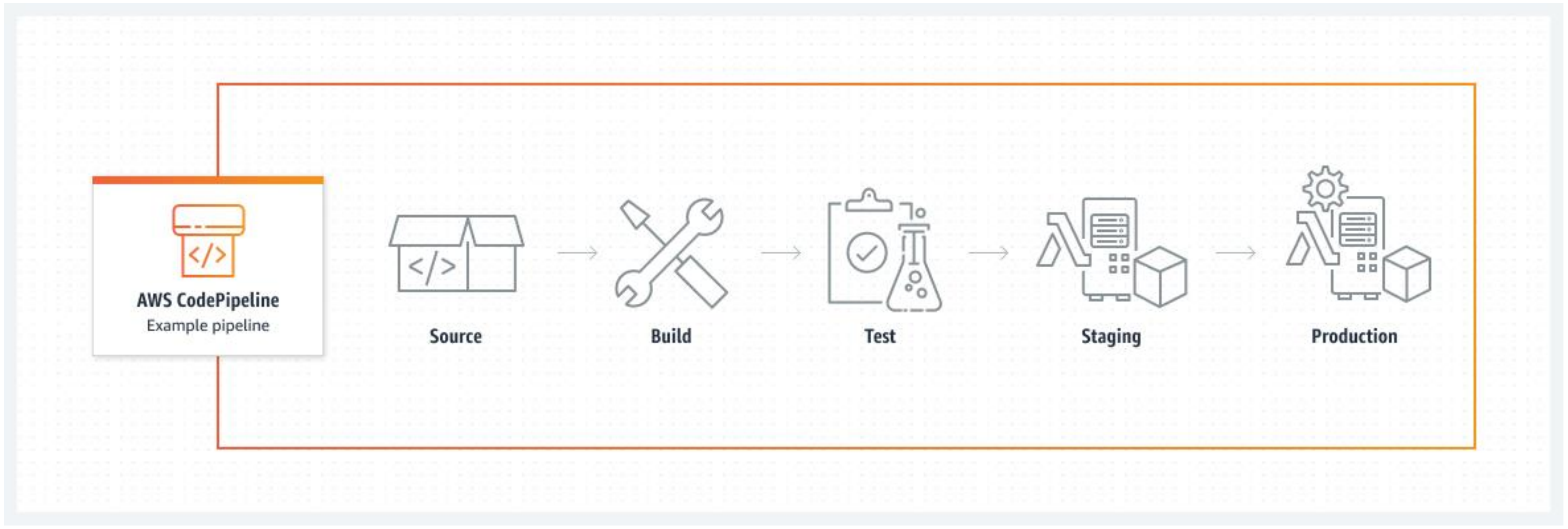
Attempted directly writing cloudformation templates, became painful, so switched to using AWS CDK which allowed writing IaaC in familiar language(typescript)

Adapting to the microservices and cloud native thinking is inherently difficult

Cloudmonitor logs became a important asset to debug problems associated with microservices communitcation

Future Work

Integrating CI/CD into the application using AWS CodePipeline



Thankyou