

Udemy Course on Amazon Bedrock & Generative AI Beginner to Advanced

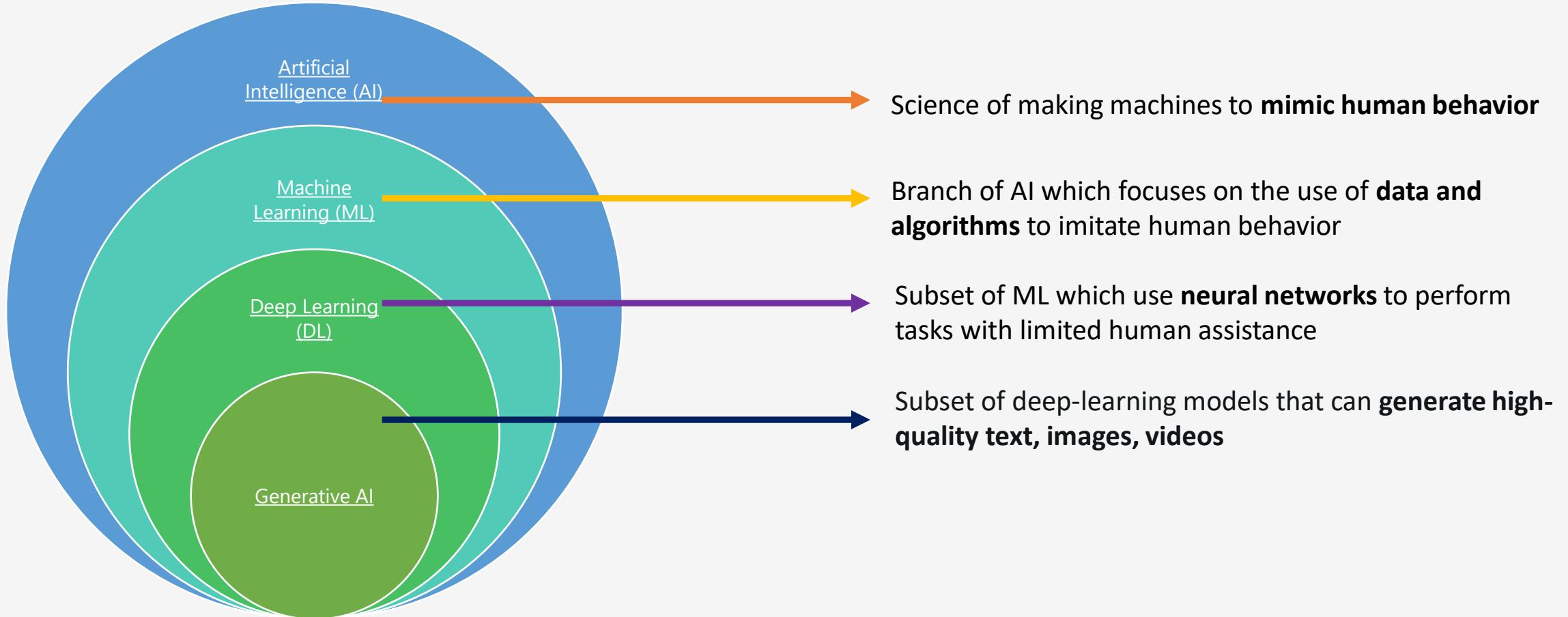


Image Generated using the use case built in this course

*Section on :
Evolution of Generative AI*



What is Generative Artificial Intelligence – Context ?



Artificial Intelligence - Overview



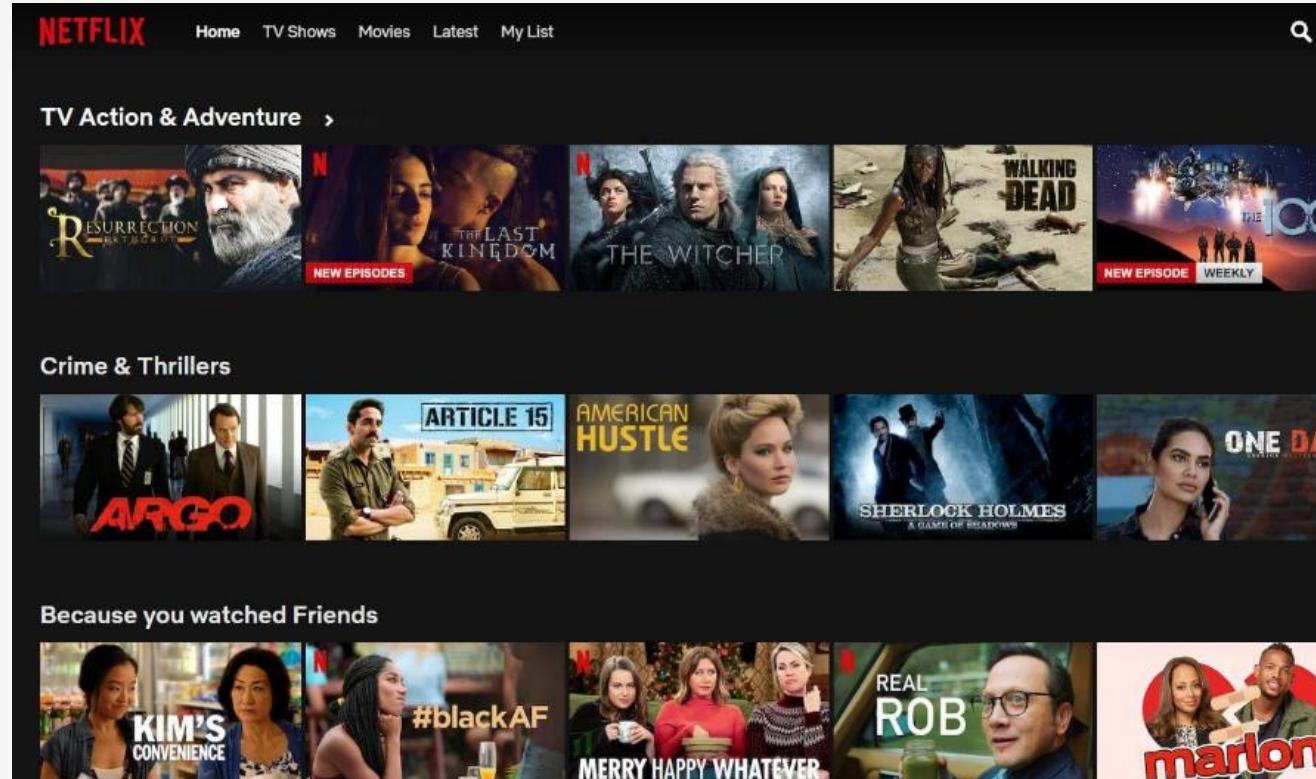
Artificial Intelligence is the science and engineering of **making** intelligent machines, especially **intelligent computer programs** that **simulate human intelligence and decision making.**

Artificial Intelligence - Examples



Self-driving cars use artificial intelligence to make real-time decisions based on sensor data.

Artificial Intelligence - Examples

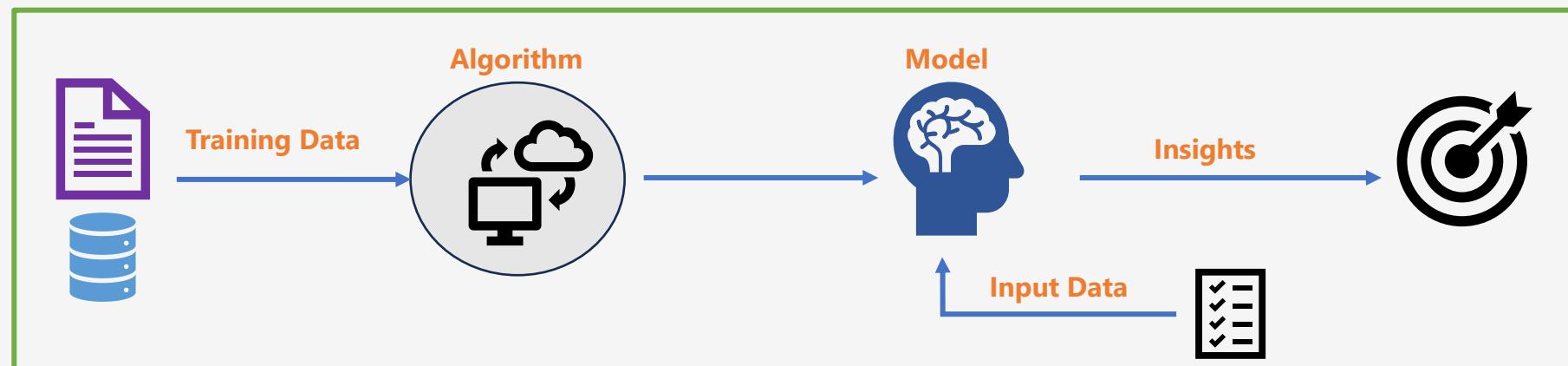


Recommendation engines such as ones from **Netflix and Amazon** use AI to provide custom insights

Machine Learning - Overview



- Machine Learning is a **subset of AI**
- In ML the **algorithm is trained using the historical data** to make **predictions on new data.**

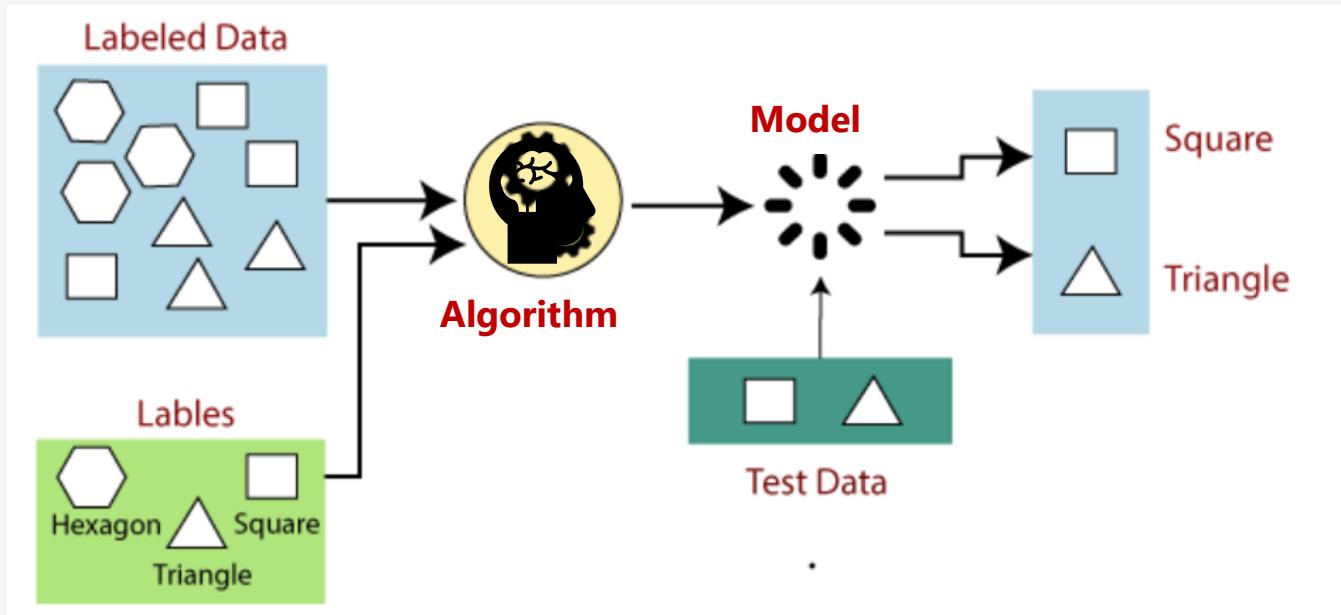


Machine Learning – Broad Categorization



Machine Learning – Supervised Learning

- In supervised learning, **algorithms are trained using labelled dataset.**
- Once the **training is completed**, the **model is tested using test data** and then it predicts the output.



Common Algorithms - Classification and Regression

Use Case (Classification) – Gmail Spam Filter

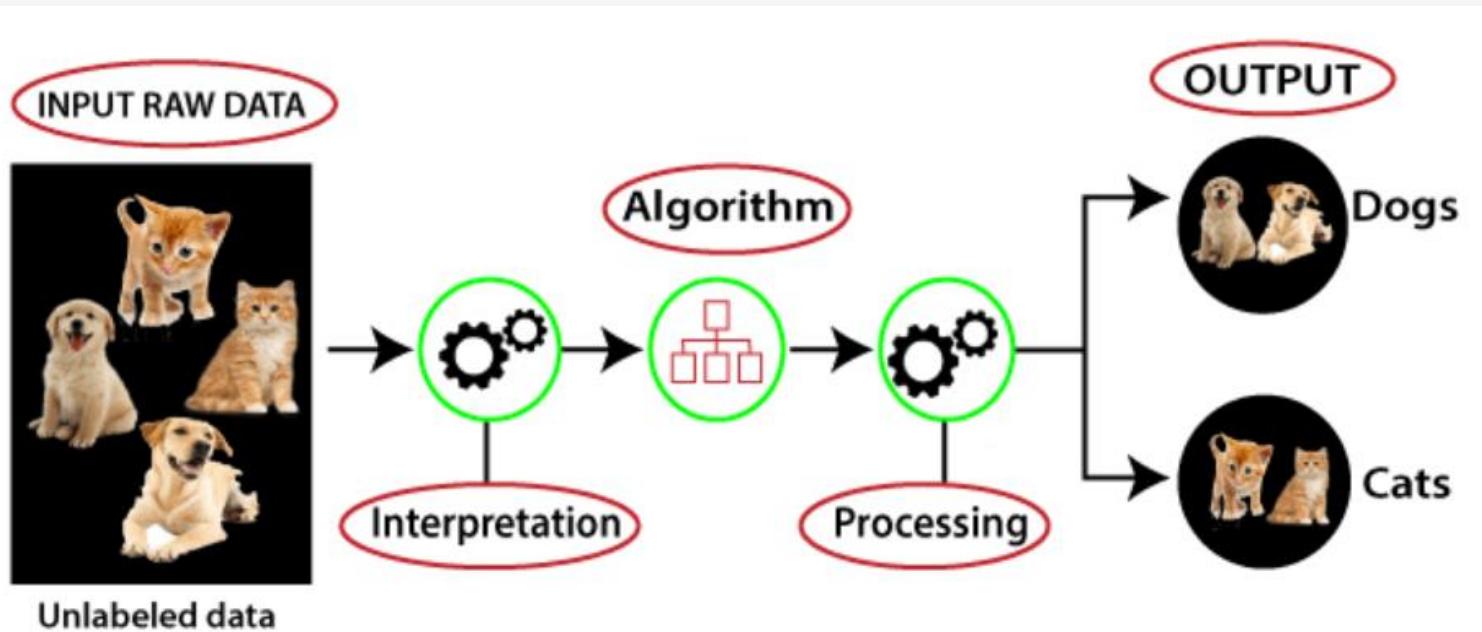


Advertisement	Sales
\$90	\$1000
\$120	\$1300
\$150	\$1800
\$100	\$1200
\$130	\$1380
\$200	??

Use Case (Regression) – Forecasting

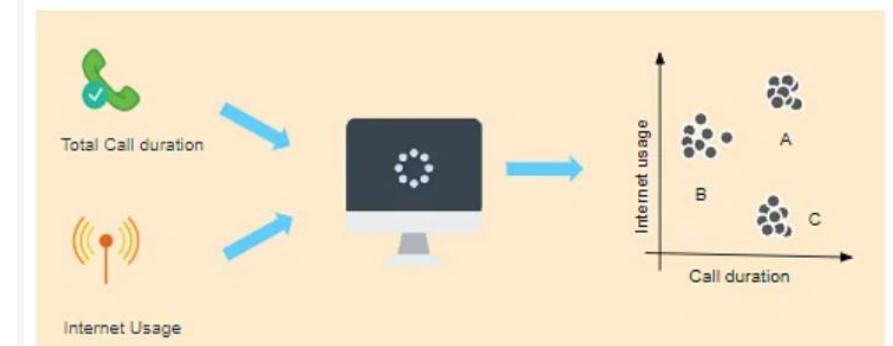
Machine Learning – Unsupervised Learning

- Unsupervised learning is a type of machine learning in which **algorithm are trained using unlabeled dataset**
- Based on the dataset, model finds **hidden patterns and insights** based on the **similarities of the data**



Common Algorithms - Clustering and Association

Use Case (Clustering) – Reduce Churn Rate



Use Case (Association) – Market Basket Analysis



Machine Learning – Reinforced Learning



- Reinforcement learning (RL) is a ML technique that focuses on **training an algorithm following the trial and error approach**.
- No pre-defined dataset
- The **algorithm (agent)** evaluates a current situation (state), **takes an action**, and receives feedback (reward and feedback) from the environment after each act.

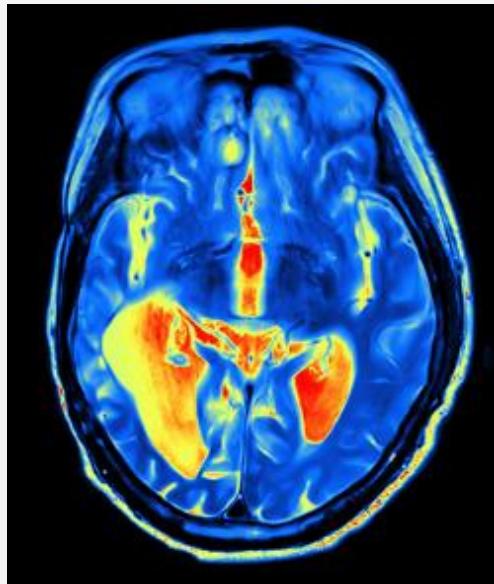


Real World Use Case

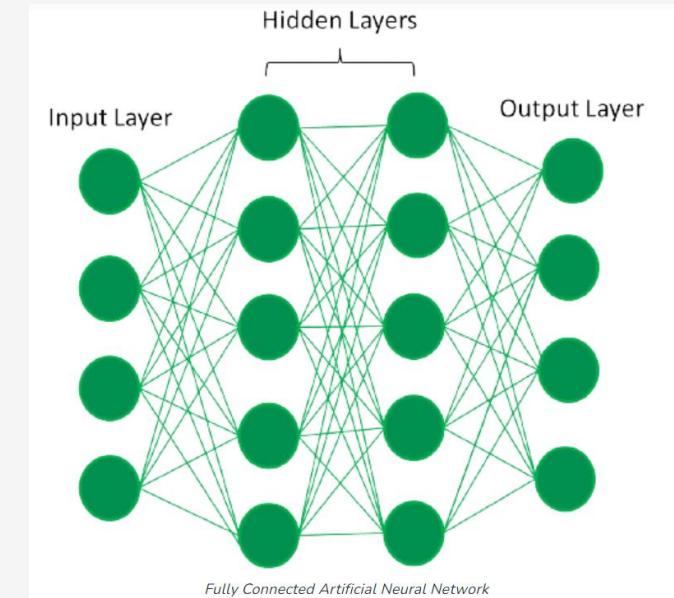
- **Training Industrial Robots**
- **Training Self Driving Cars**

Machine Learning – Deep Learning and Artificial Neural Networks

Neural Pathways in Human Brain

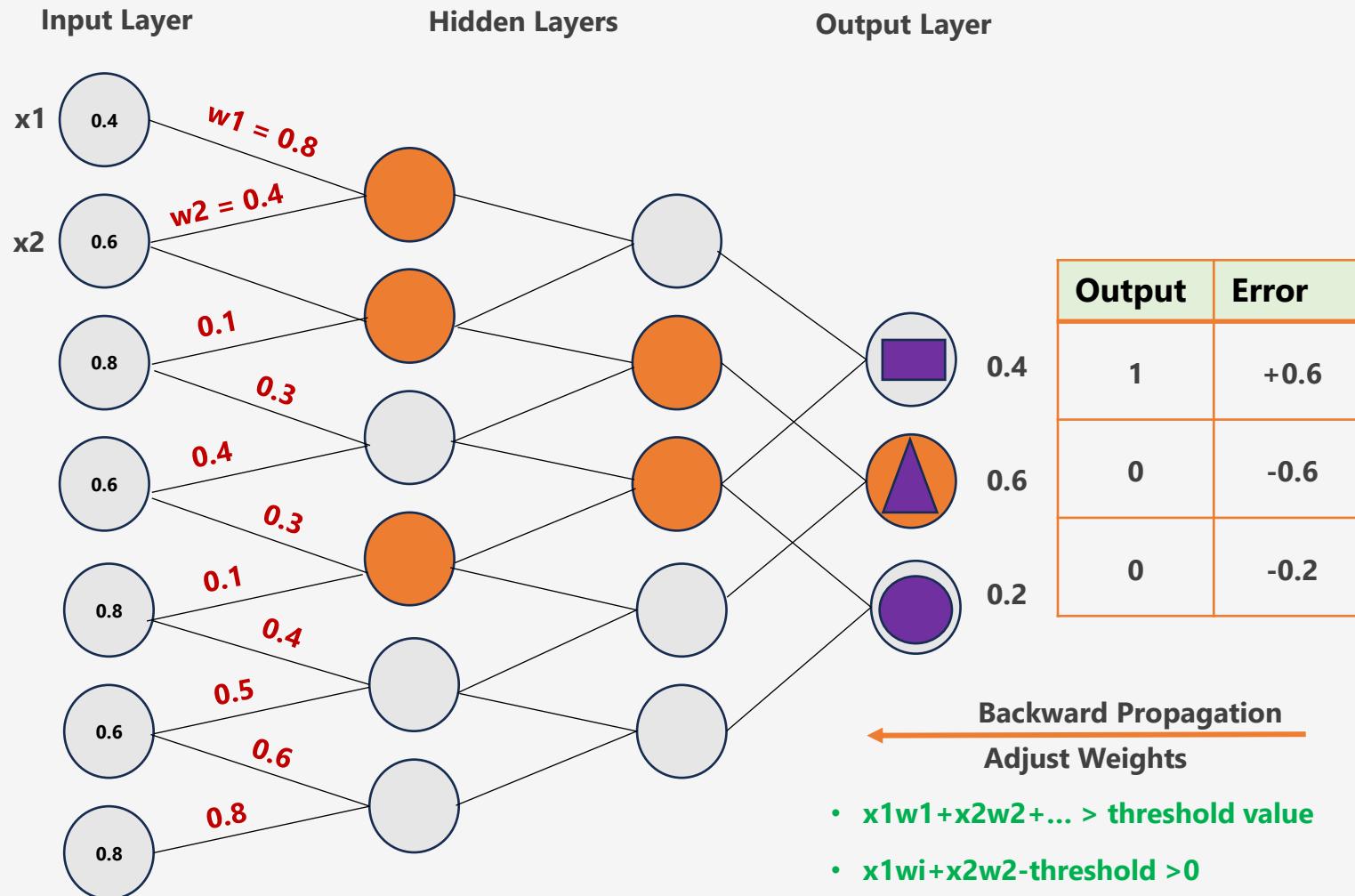
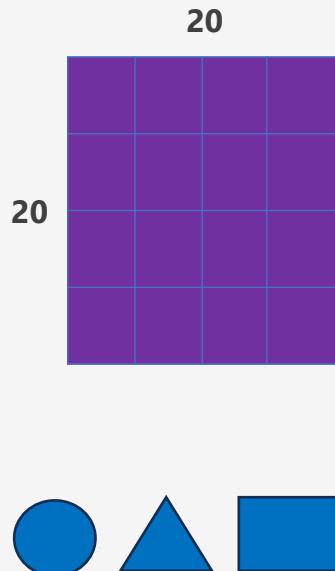


Artificial Neural Network



- **Artificial Neural networks** are designed to **mimic the structure of the human brain**
- Deep Learning is a subset of Machine Learning that **focuses on building artificial neural networks** that **can learn from data**.
- Neural network with **multiple hidden layers** and **multiple nodes** in each hidden layer is known as a **deep learning (>3)**

Machine Learning – Deep Learning with Artificial Neural Networks



Generative Artificial Intelligence(AI)



Generative AI

- Generative AI is a **subset of Deep Learning** which focuses on **creating models capable of generating new content :**
 - Chat and Text
 - Images and Videos
 - Code Generation

Section on :
Generative AI Fundamentals



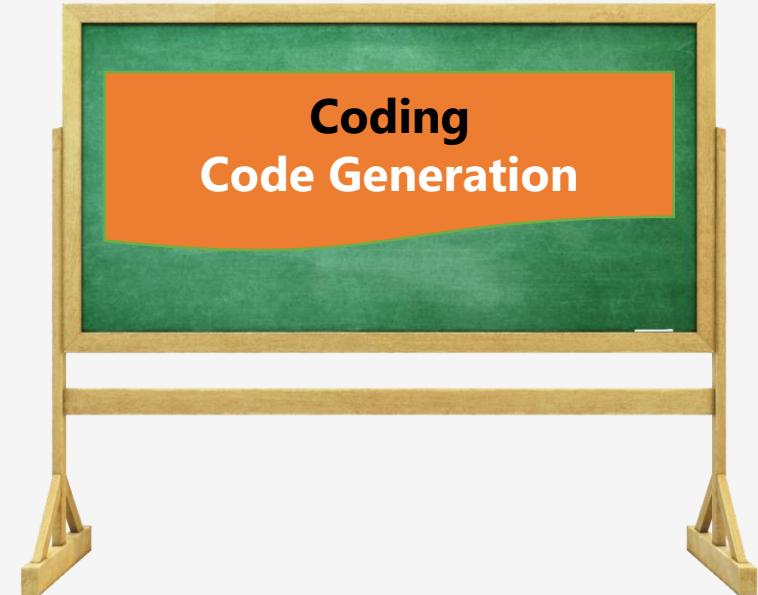
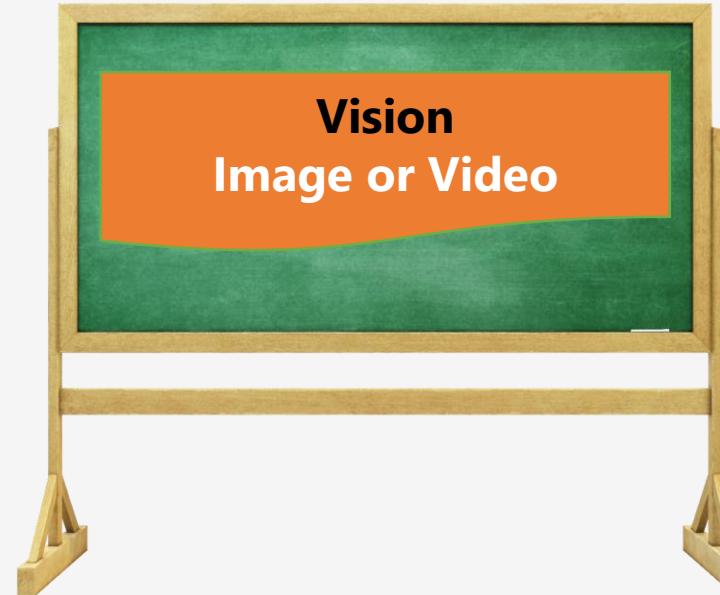
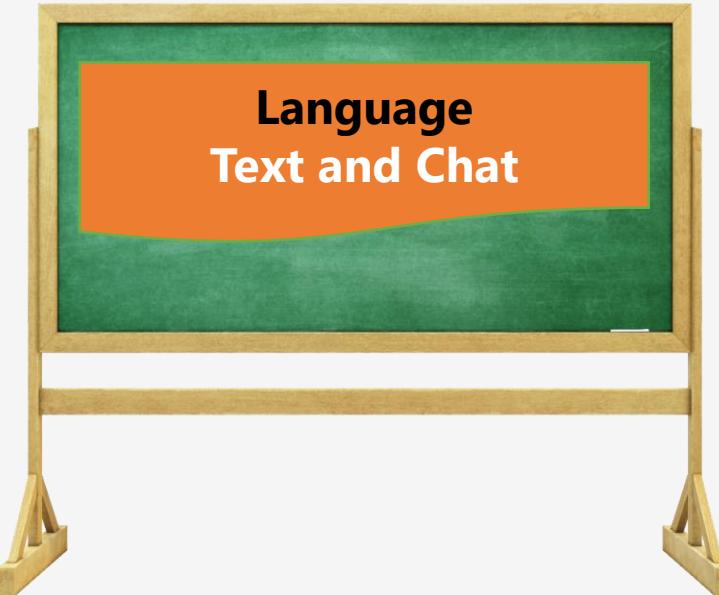
What is Generative AI ?

The screenshot shows the AI21 Labs interface. At the top, there are navigation links for various AWS services: DynamoDB, CodeCommit, Elastic Container Service, ElastiCache, Route 53, RDS, EC2, Cloud9, VPC, and Cognito. Below the header, the AI21 Labs logo is on the left, followed by dropdown menus for "AI21 Labs" and "Jurassic-2 Mid". A "Start new chat" button is on the right. The main area shows a conversation where the user asks "what is generative AI". The AI responds with a detailed explanation: "Generative AI is a branch of artificial intelligence (AI) that focuses on creating models or algorithms that can simulate or generate new data based on existing data. The purpose of generative AI is to mimic the process of natural generation, such as the way living organisms produce offspring with traits similar to their parents." It also notes that generative models can be trained on various data types and have applications in fields like image generation, natural language processing, drug discovery, and robotics.

Generative AI refers to

- Branch of AI that use deep-learning **models**
- Generate high-quality text, images, code based on the data they were trained on
- Popular examples of generative AI include
 - ChatGPT
 - Bard

Generative AI – Use Cases



- ✓ **Text Summarization - Healthcare**
- ✓ **Content Generation – HR & Legal**
- ✓ **Chatbot/ Q&A – Customer Service**
- ✓ **Models : Jurrasic – 2 form AI21 Labs**

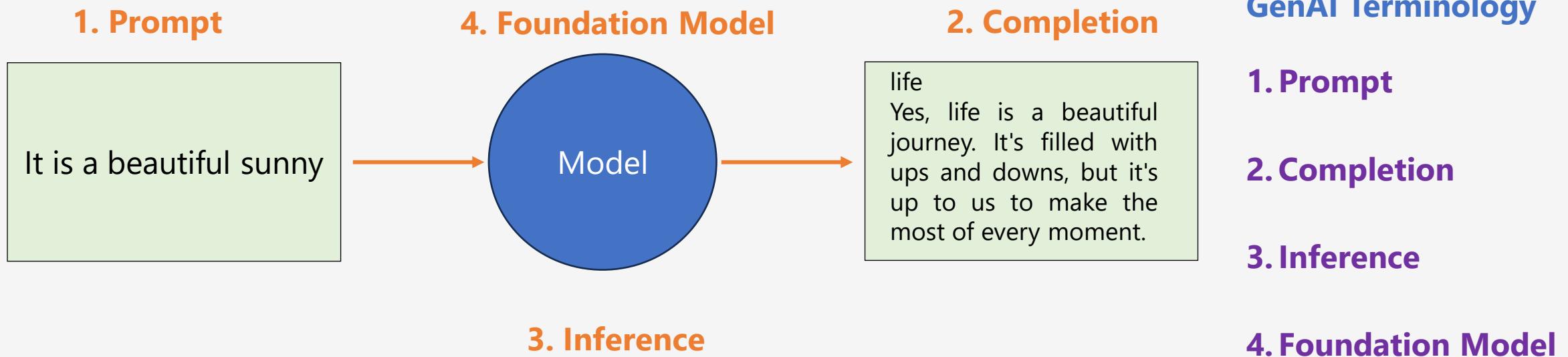
- ✓ **Image Generation - 3D-Design for construction industry**
- ✓ **Video Generation - Content for marketing campaigning**
- ✓ **Models : Stable Diffusion from Stability AI**

- ✓ **Code Generation**
- ✓ **15+ Program Lang**
- ✓ **Multiple IDE's**
- ✓ **AWS Code Whisperer**

Console Walkthrough Amazon Bedrock

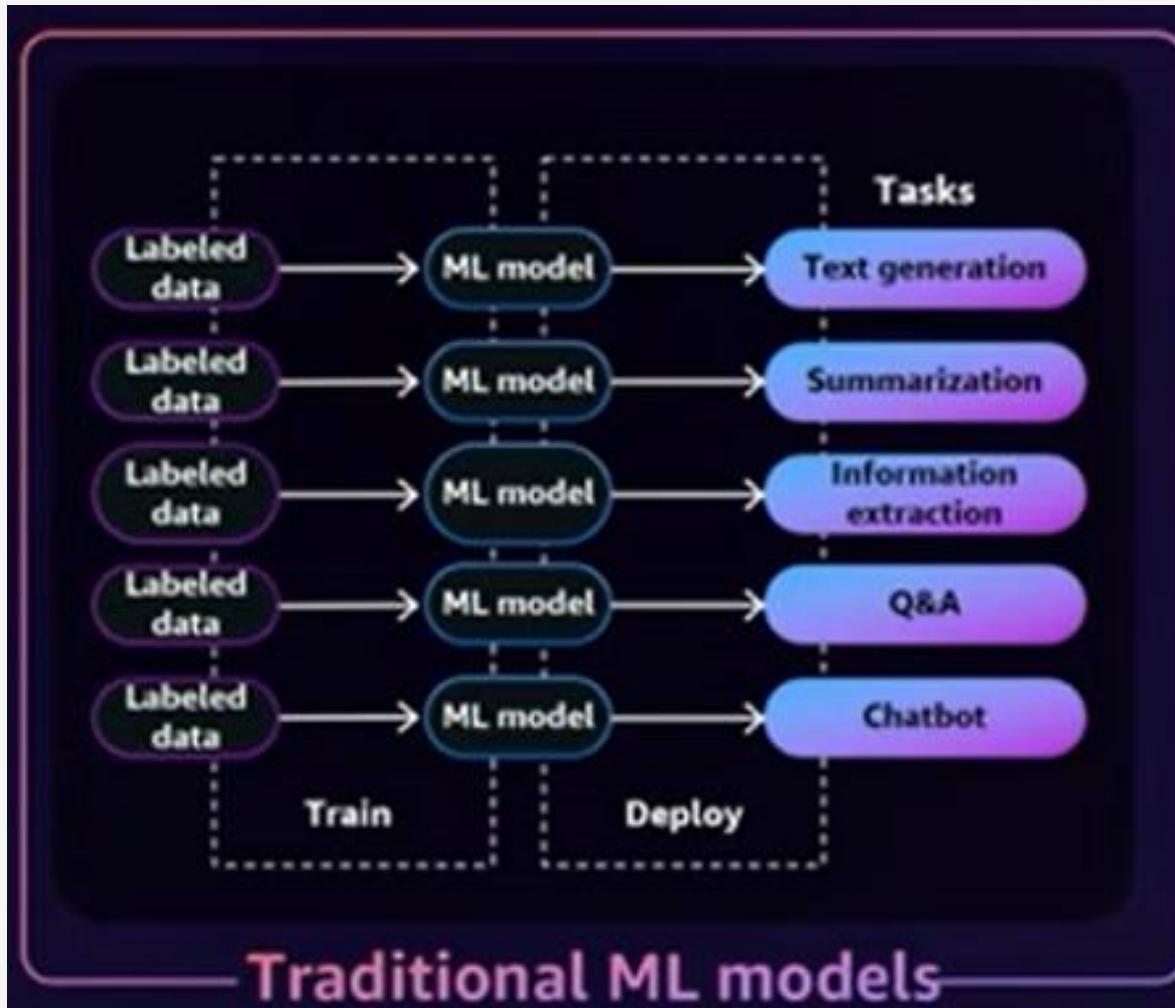
- Bedrock offers a choice of foundation models from leading AI companies.
- Provides access to variety of FMs from **Amazon, AI21 Labs, Anthropic, Cohere, Meta, and Stability AI**

How Generative AI works - Basic Concepts and Terminology - 1



1. Prompt – Input provided to Model
2. Completion – Output of Model
3. Inference : Act of using model to generate text is called Inference

Challenges in Traditional Machine Learning Models

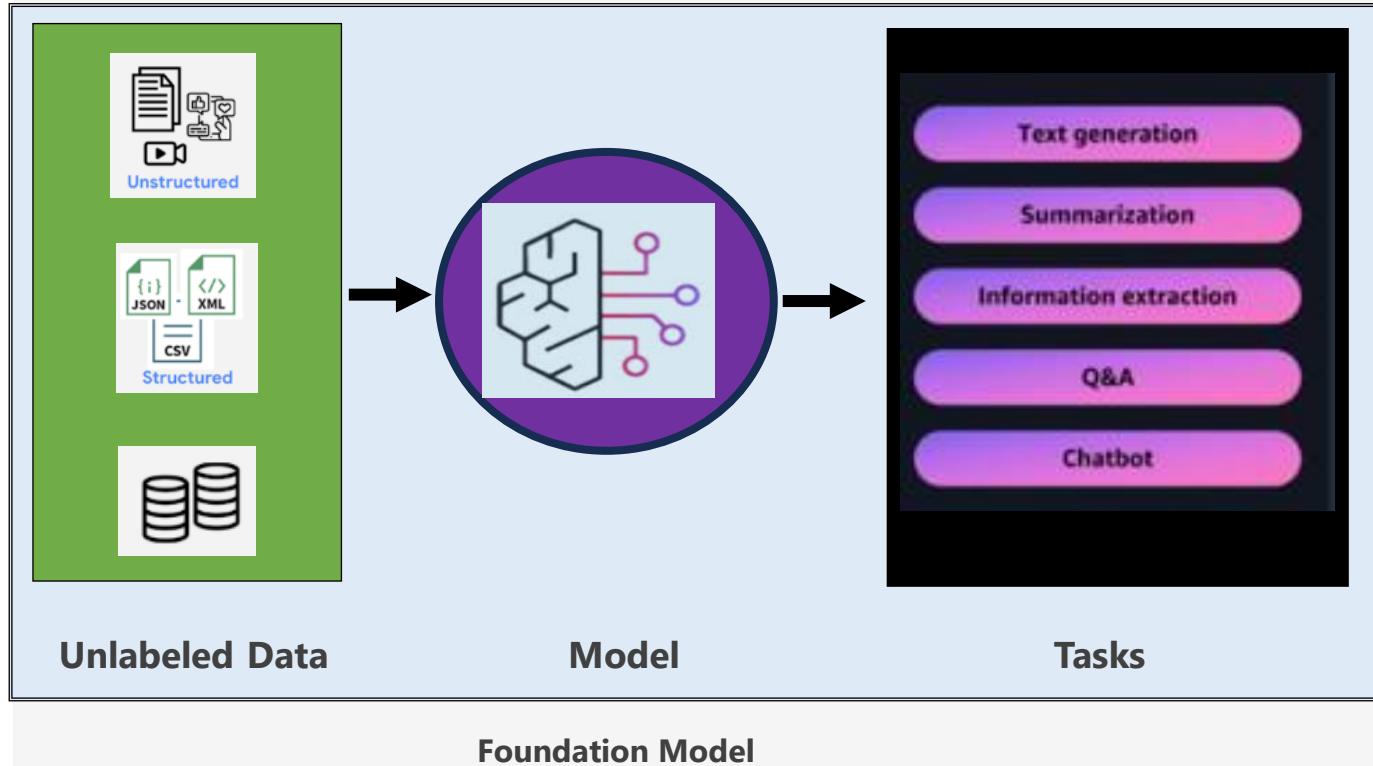


Source : AWS

Challenges in Traditional ML Models

- Each Model focused on specific Task such as
 - Text Generation
 - Summarization
 - Q&A
- Needs labeled data which requires human intervention and can be cost prohibitive

Key Characteristics of Foundational Models

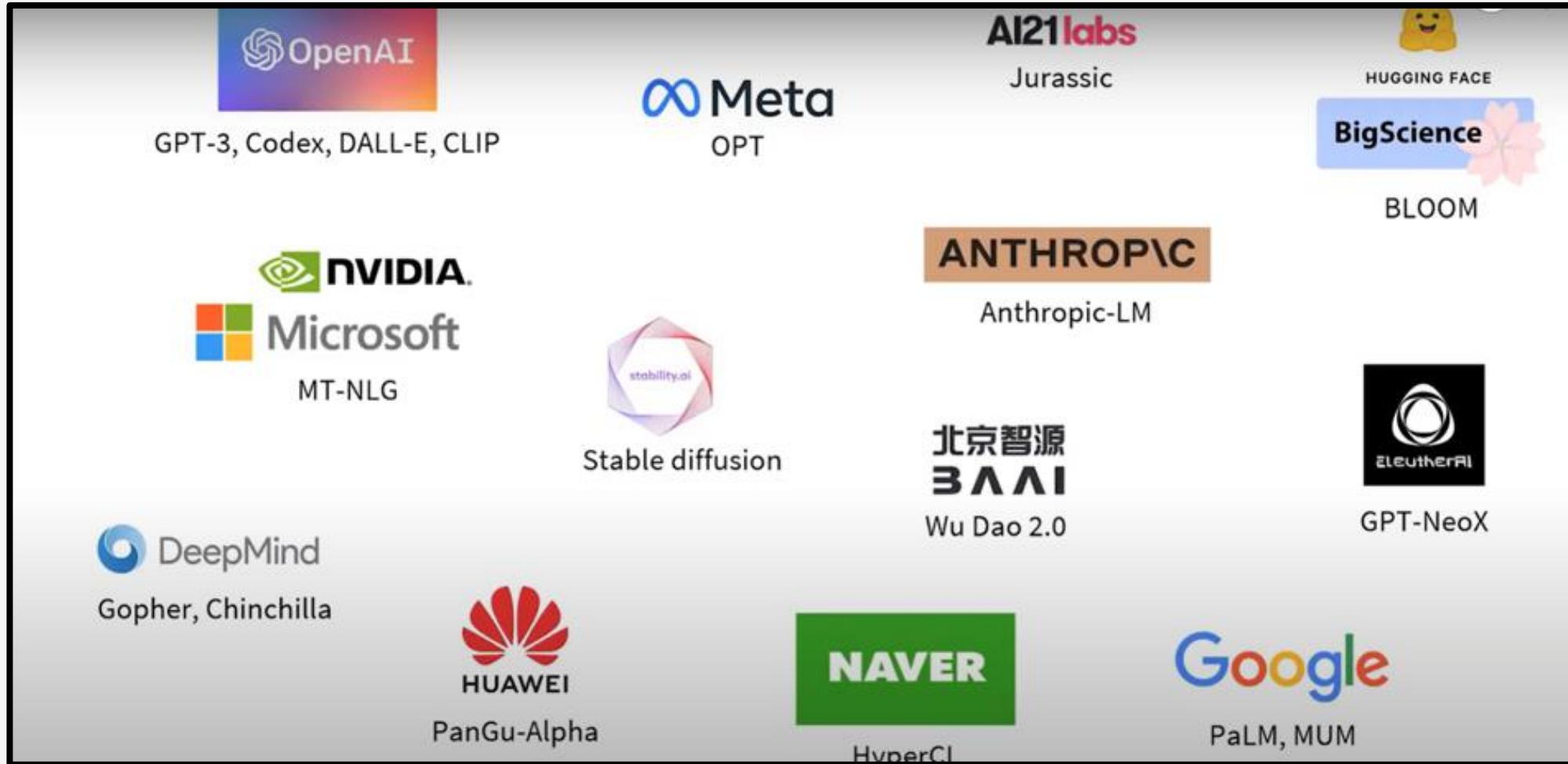


Organization's can utilize **existing FM's as the base for building** task-specific models and **Adapt** them

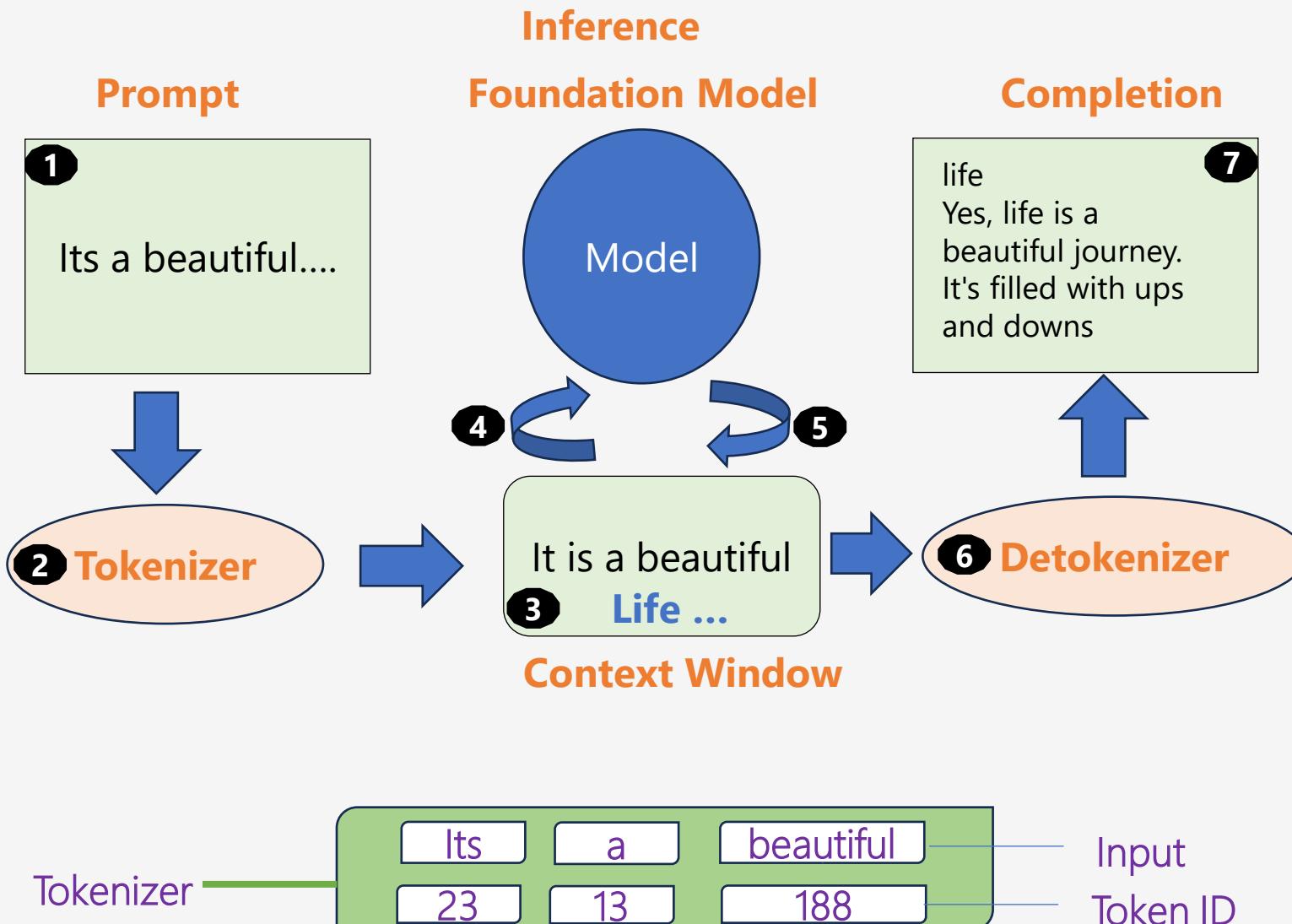
Key Characteristics

- **Deep neural networks** techniques
- **Unlabeled data** - Trained on unlabeled data and Self-supervised learning such as internet data - Wikipedia
- **Generalized** – One FM for multiple tasks
- **Pre-trained** – FM's are pre-trained models
- **Large** – Exposed to vast amounts of data, enabling it to learn patterns & features from data.
- **Expensive** - Developing FM's is an **expensive process** that involves **large amounts of computational resources** and **expertise**.

Popular Foundation Models



How Generative AI works - Basic Concepts and Terminology - 2



GenAI Terminology

- **Prompt**
- **Tokenizer**
- **Context Window**
- **Foundation Model**
- **Max Token/Stop Sequence**
- **Completion**
- **Inference**
- **Context Window** - number of tokens the model can take as input at once

Foundation Model – Tokens, Parameters and Temperature



Tokens

Model	Context length	Number of English pages (1 page = 500 words)
GPT 3.5	4,096	6
GPT 4	8,192	12
	2,048	3
Llama 2	4,096	6



Parameters



Temperature

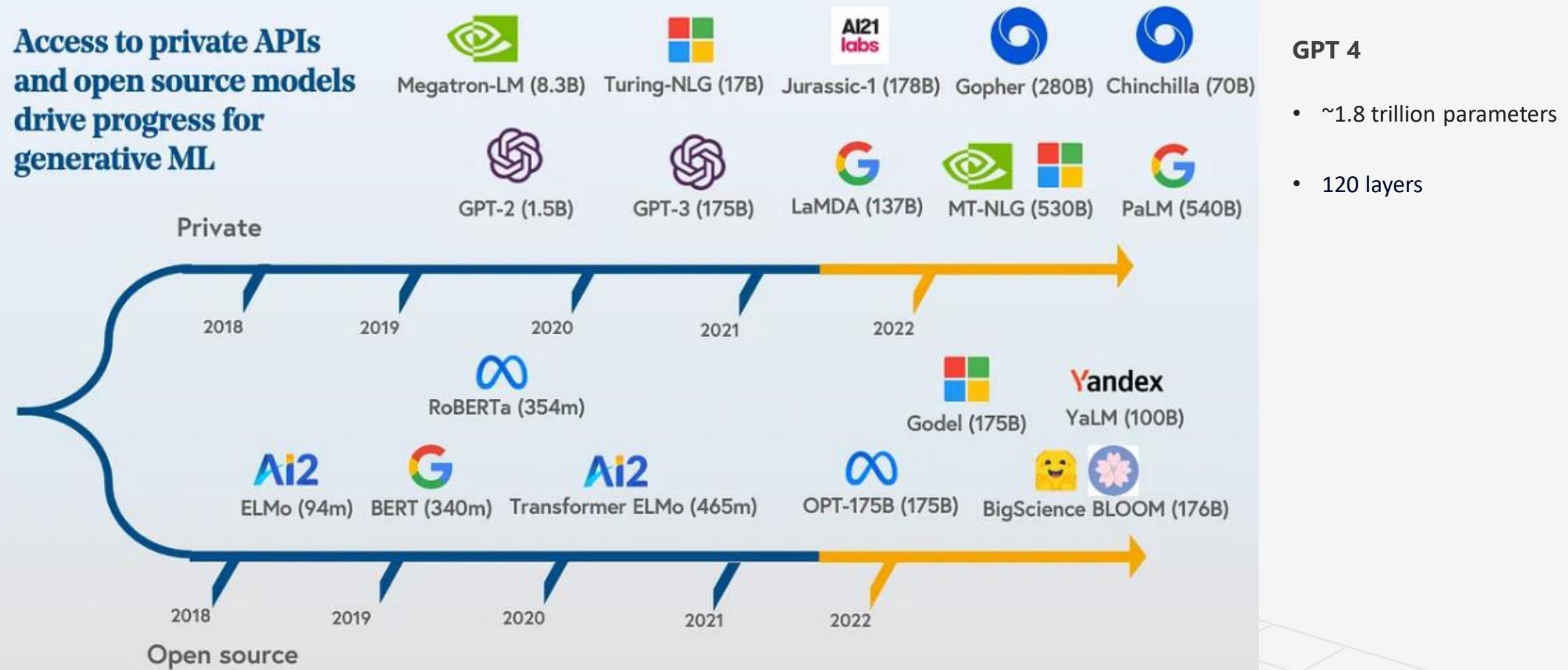
Tokens - **One token** generally corresponds to **~4 characters of text** for common English text

Parameters - can be considered count of **connections & weights** between nodes in a neural network.

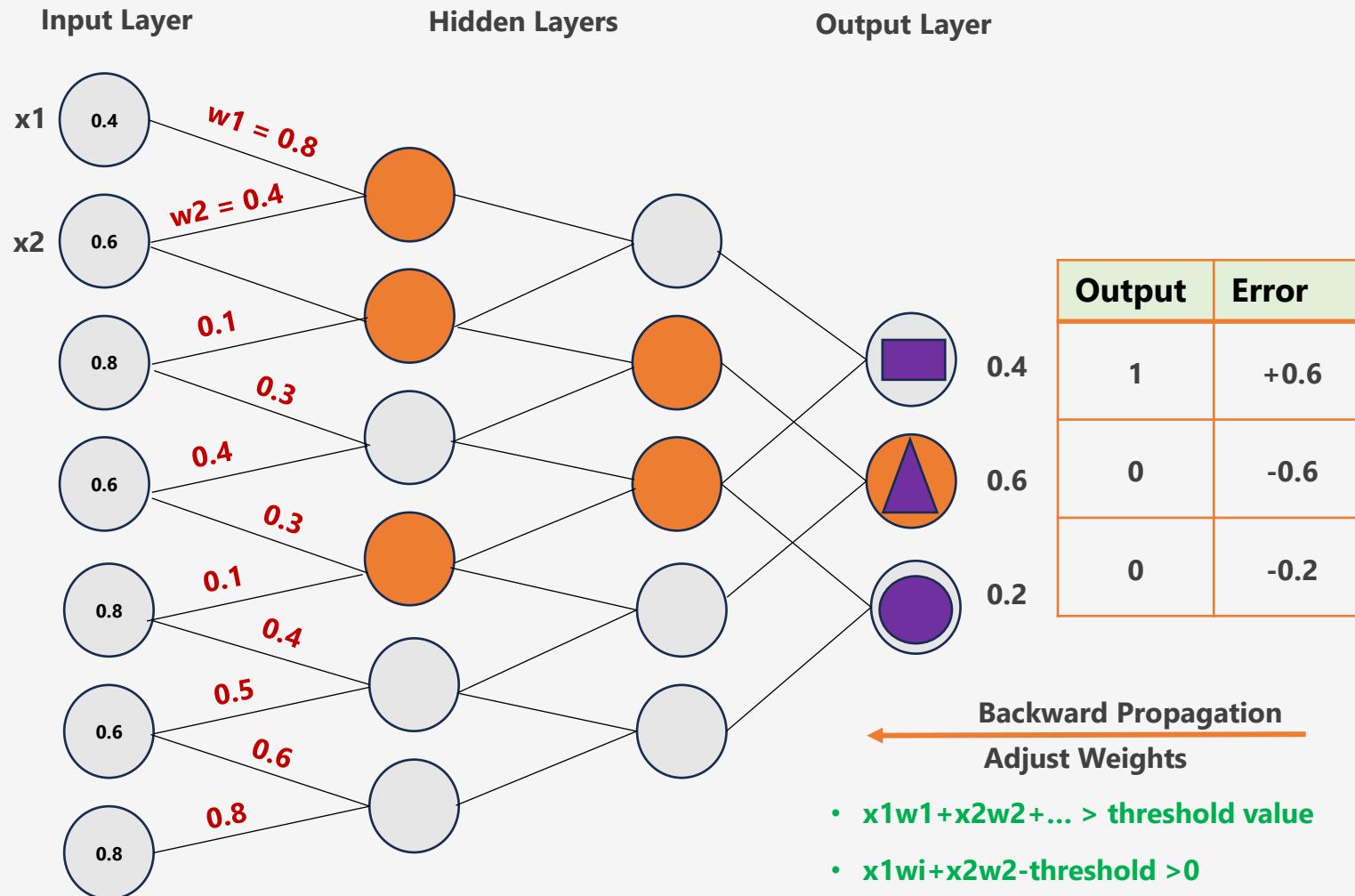
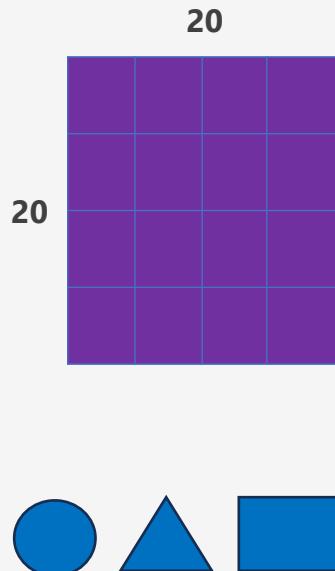
Temperature - This parameter controls the **creative ability** of your model.

Popular Foundation Models (Parameters perspective)

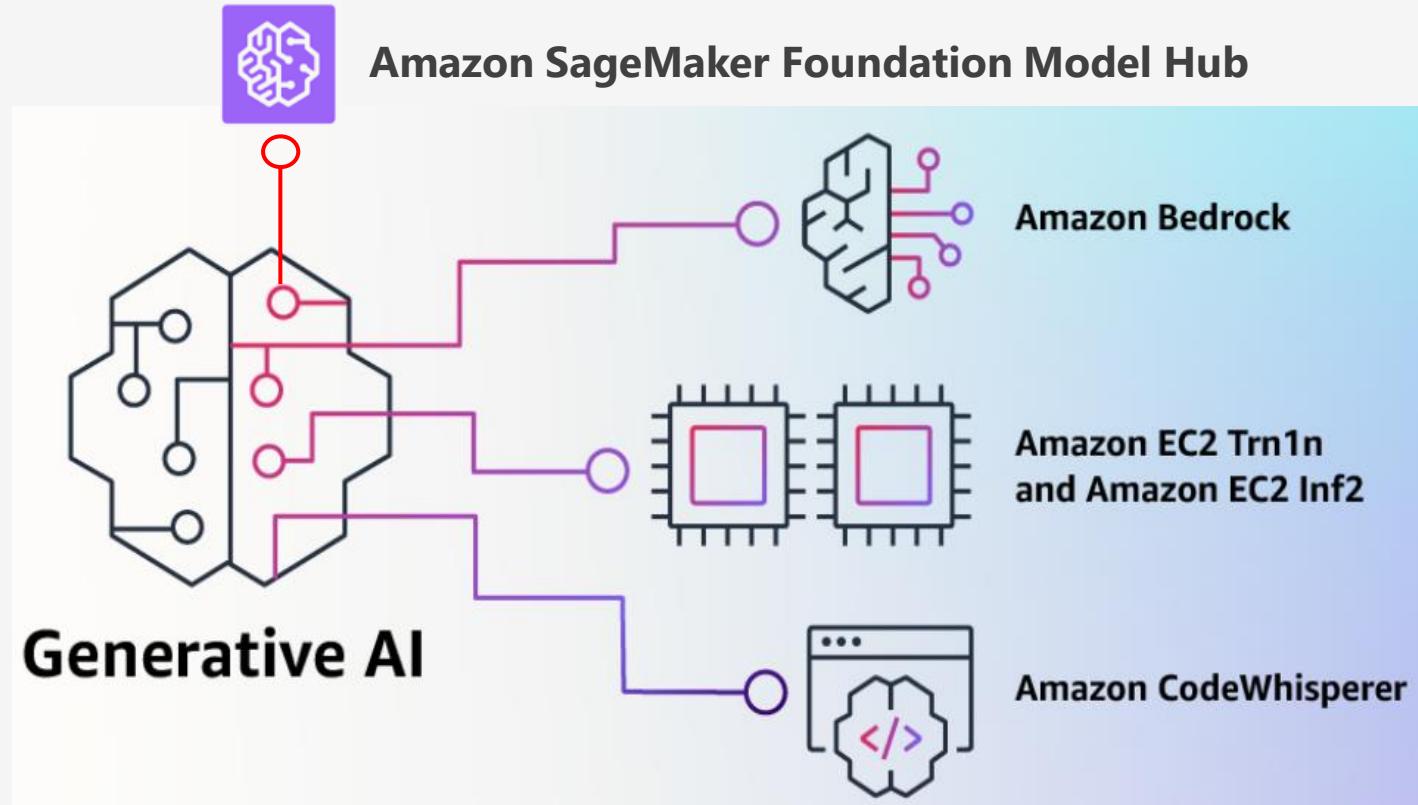
**Access to private APIs
and open source models
drive progress for
generative ML**



Machine Learning – Deep Learning with Artificial Neural Networks



Service Offerings in Generative AI from AWS



4. **Amazon Code Whisperer**

- An AI coding companion in 15+ prog. languages for code generation

1. **Amazon EC2 Trn1n and EC2 Inf2**

- IaaS (self managed) for ML experts to build, train and deploy your own models

2. **Amazon SageMaker JumpStart**

- Provides pretrained, open-source models
- Deploy open source FMs with custom configuration

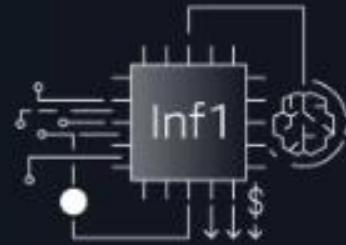
3. **Amazon Bedrock**

- Fully managed serverless service that offers a choice of high-performing FMs from leading AI companies.

Train and Deploy own Models on Amazon EC2 Trn1n and EC2 Inf2



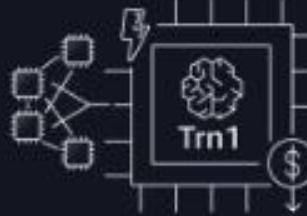
AWS Inferentia



Lowest cost per inference
in the cloud for running
deep learning (DL) models

Up to 70% lower
cost per inference
than comparable
Amazon EC2 instances

AWS Trainium



The most cost-efficient, high-
performance training of
LLMs and diffusion models

Up to 50% savings
on training costs
over comparable
Amazon EC2 instances

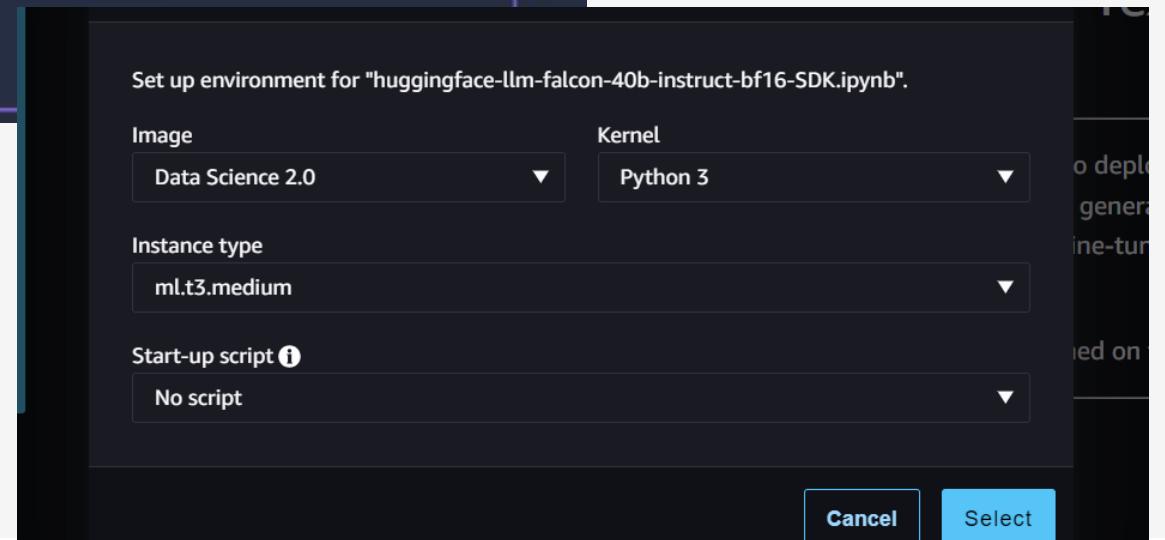
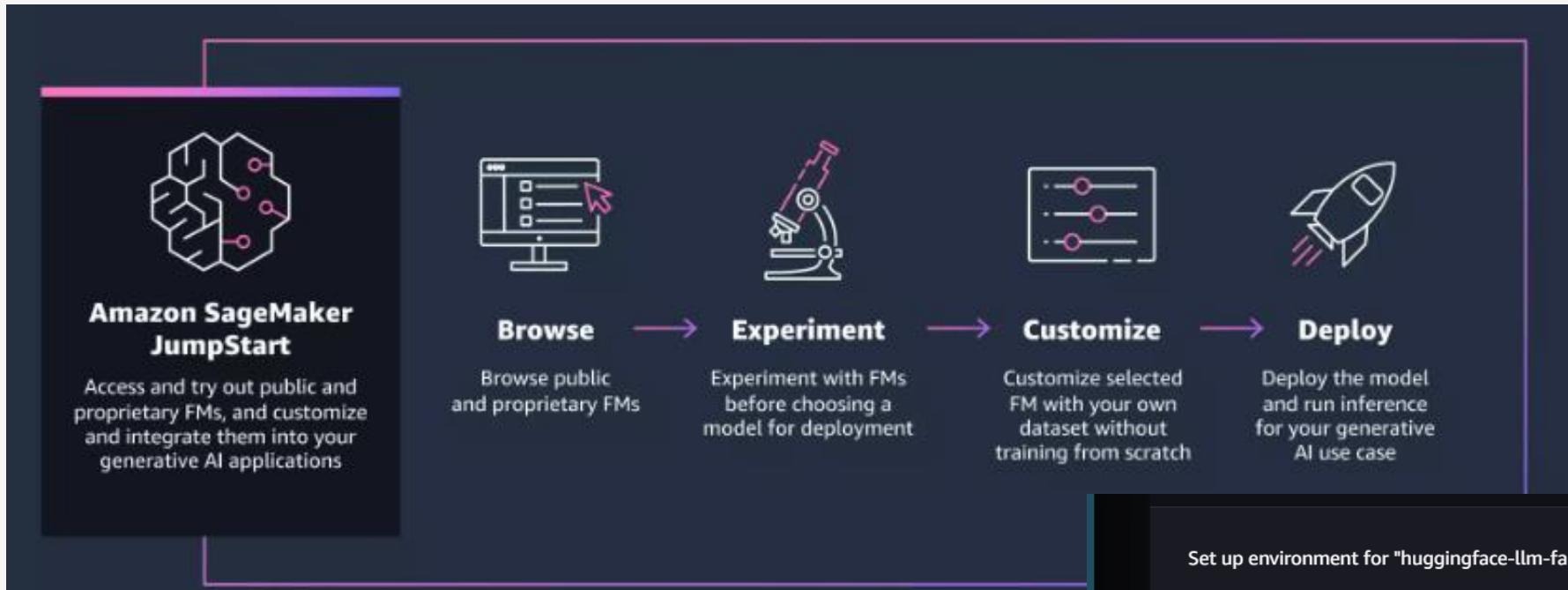
AWS Inferentia2



High performance at the
lowest cost per inference for
LLMs and diffusion models

Up to 40% better
price performance
than comparable
Amazon EC2 instances

AWS Service Offerings in Generative AI



Foundational Models available on SageMaker JumpStart



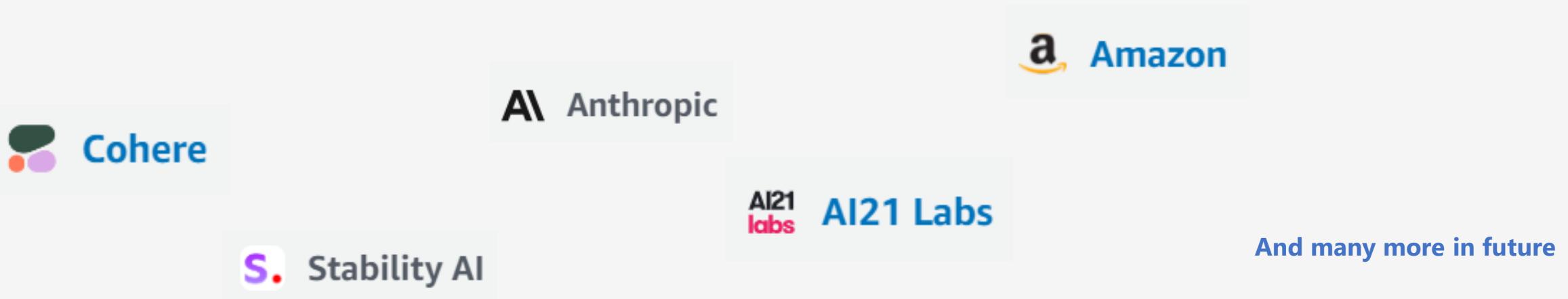
Publicly available			Proprietary models		
stability.ai	alexa		co:here	Light*on	AI21labs
Models Text2Image Upscaling	Models AlexaTM 20B	Models Flan T-5 models (8 variants) DistilGPT2, GPT2 Tasks Machine translation Question answering Summarization Annotation Data generation	Models Cohere generate-med	Models Lyra-Fr 10B	Models Jurassic-1 Grande 17B
Tasks Generate photo-realistic images from text input Improve quality of generated images	Tasks Machine translation Question answering Summarization Annotation Data generation	Tasks Machine translation Question answering Summarization Annotation Data generation	Tasks Text generation Information extraction Question answering Summarization	Tasks Text generation Keyword extraction Information extraction Question answering Summarization Sentiment analysis Classification	Tasks Text generation Long-form generation Summarization Paraphrasing Chat Information extraction Question answering Classification

Section on :
Amazon Bedrock – Deep Dive

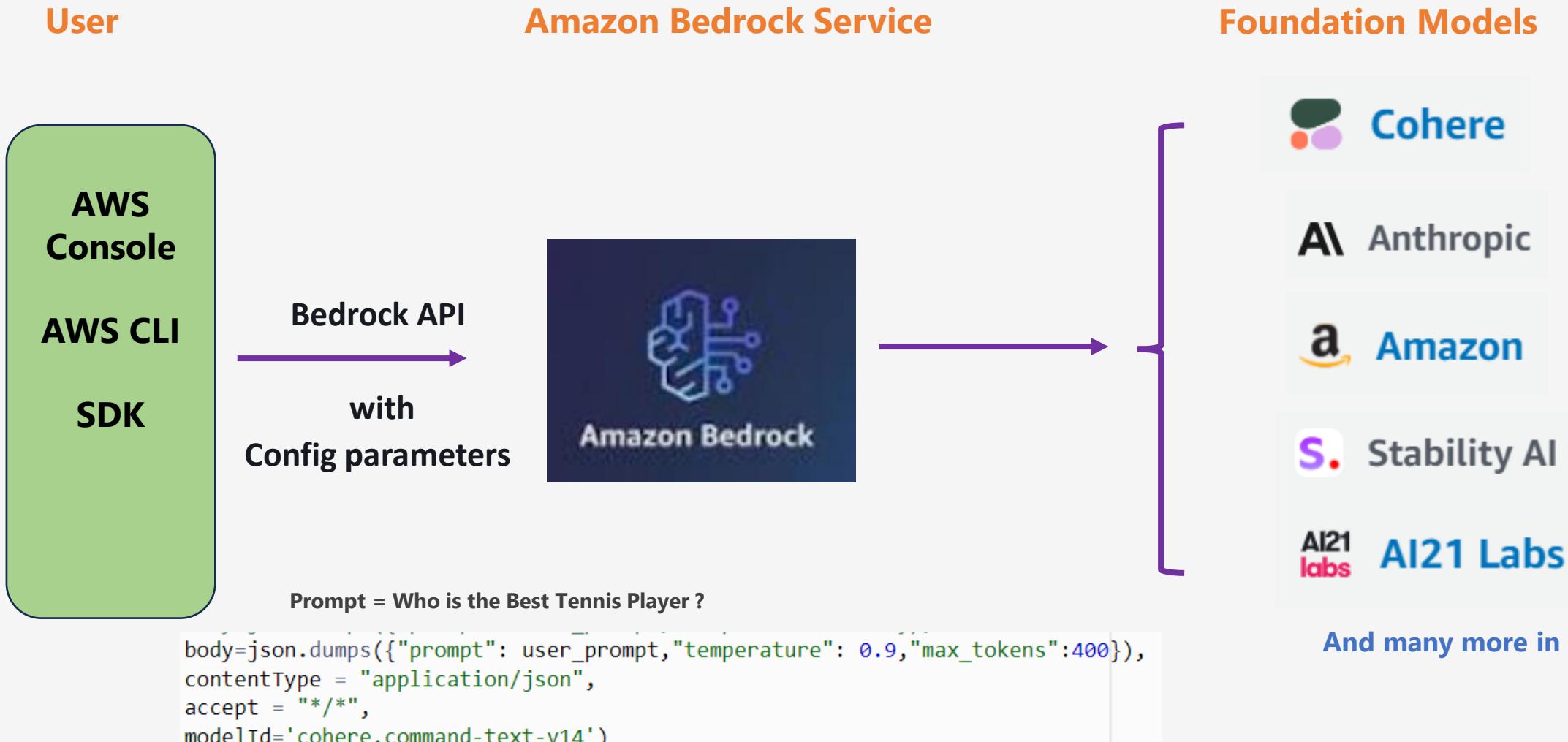


What is Amazon Bedrock ?

- Amazon Bedrock is a **fully managed, serverless service from AWS**
- Makes **base Foundation Models from Amazon and third-party model providers** accessible through **an API**.



How does Amazon Bedrock work – High Level ?



Key features of Foundation Models Amazon Bedrock supports



Amazon Titan

Amazon Titan FMs are a family of models built by Amazon that are pretrained on large datasets, which makes them powerful, general-purpose models



Jurassic-2

Multilingual LLMs for text generation in Spanish, French, German, Portuguese, Italian, and Dutch



Claude

LLM for conversations, question answering, and workflow automation based on research into training honest and responsible AI systems



Stable Diffusion

Generation of unique, realistic, high-quality images, art, logos, and designs

Source : AWS

Amazon Bedrock – Console Walkthrough

The screenshot shows the AWS Amazon Bedrock console. The top navigation bar includes the AWS logo, a services dropdown, a search bar with the placeholder 'Search' and a keyboard shortcut '[Alt+S]', and account information for 'N. Virginia' and user 'rahul'. Below the navigation is a horizontal row of service icons: API Gateway, S3, DynamoDB, CodeCommit, Elastic Container Service, ElastiCache, Route 53, RDS, EC2, Cloud9, VPC, Cognito, and Lambda.

The main content area has a left sidebar with a tree view:

- Getting started (selected)
- Overview (selected)
- Examples
- Foundation models
 - Base models
 - Custom models
- Providers
- Playgrounds
 - Chat
 - Text
 - Image
- Deployment
- Provisioned Throughput

The main panel displays the 'Overview' section for Amazon Bedrock. It features a large heading 'Overview' and two main sections: 'Foundation models' and 'Use cases example'.

Foundation models: Text states "Amazon Bedrock supports foundation models from industry-leading providers. Choose the model that is best suited to achieving your unique goals." A link "Explore models" is provided. Below the text are logos for AI21 labs, Amazon, Cohere, and Stability AI.

Use cases example: Text states "Amazon Bedrock supports many generative AI use cases such as summarization, chatbots and image generation." A link "Browse all examples" is provided.

Amazon Bedrock – Request Access to Models

The screenshot illustrates the process of requesting access to models in Amazon Bedrock. It shows the navigation menu on the left and the main 'Model access' page with three numbered callouts (1, 2, 3) indicating specific steps.

Navigation Menu:

- Base models
- Custom models
- Providers
- Playgrounds
 - Chat
 - Text
 - Image
- Deployment
- Provisioned Throughput

Model access (Callout 1): This is the selected tab in the navigation bar.

Main Page Content:

Model access

To use Bedrock, you must request access to Bedrock's FMs. To do so, you will need to have the correct IAM Permissions. For certain models, you may first need to submit use case details before you are able to request access. More information about these models is available on the Providers page.

Base models (9)

Models	Access status	Modality	EULA
AI21 Labs	Access granted	Text	EULA
Jurassic-2 Ultra	Access granted	Text	EULA
Jurassic-2 Mid	Access granted	Text	EULA
Amazon	Access granted	Embedding	EULA
Titan Embeddings G1 - Text	Access granted	Text	EULA
Titan Text G1 - Lite Preview	Unavailable	Text	EULA
Anthropic	Use case details submitted		
Claude	Access granted	Text	EULA
Claude Instant	Access granted	Text	EULA
Cohere			
Command	Access granted	Text	EULA
Stability AI			
Stable Diffusion XL Preview	Access granted	Image	EULA

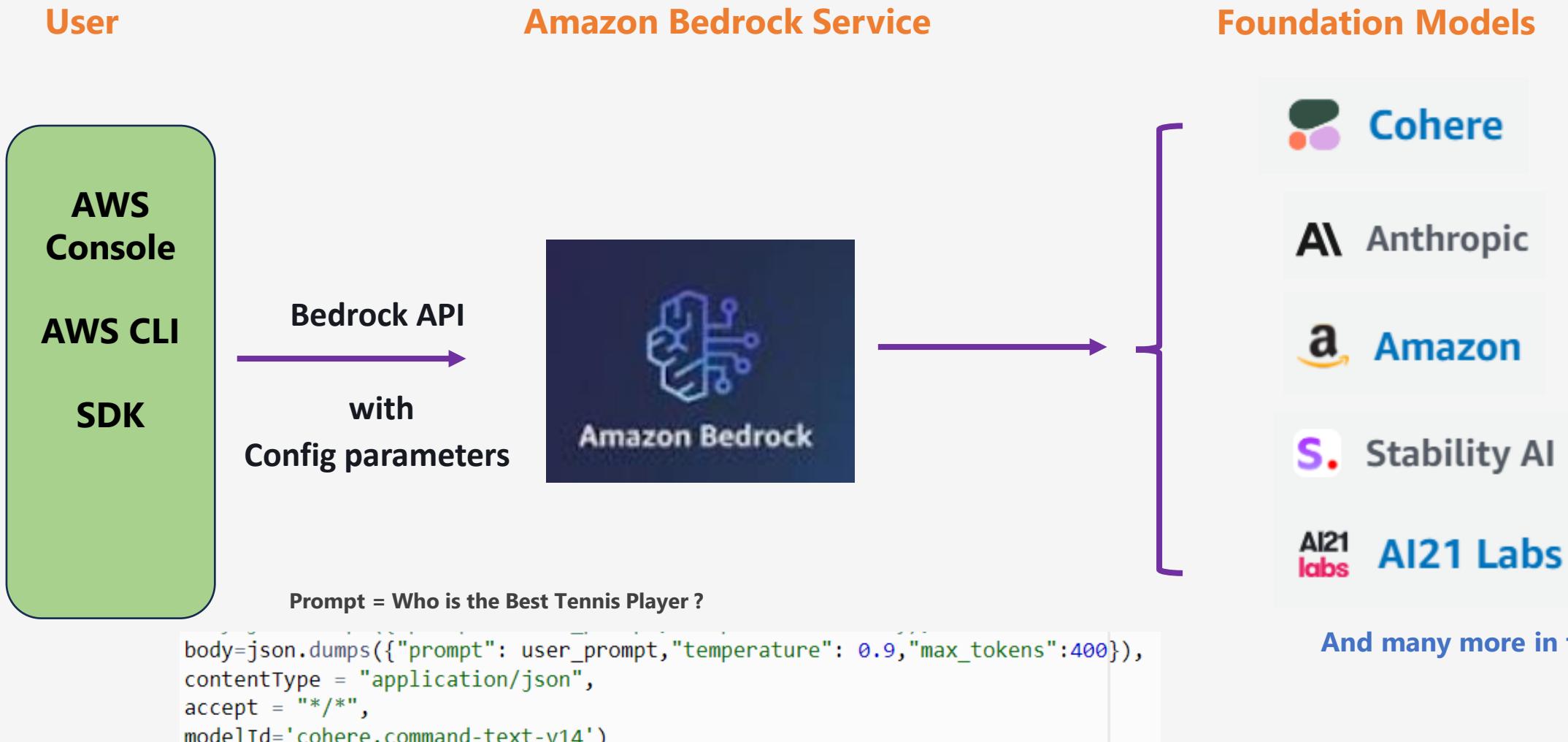
Buttons and Callouts:

- Manage model access** (Callout 2): A button highlighted with a blue box and a green number 2.
- Save changes** (Callout 3): A button at the bottom right highlighted with a blue box and a green number 3.

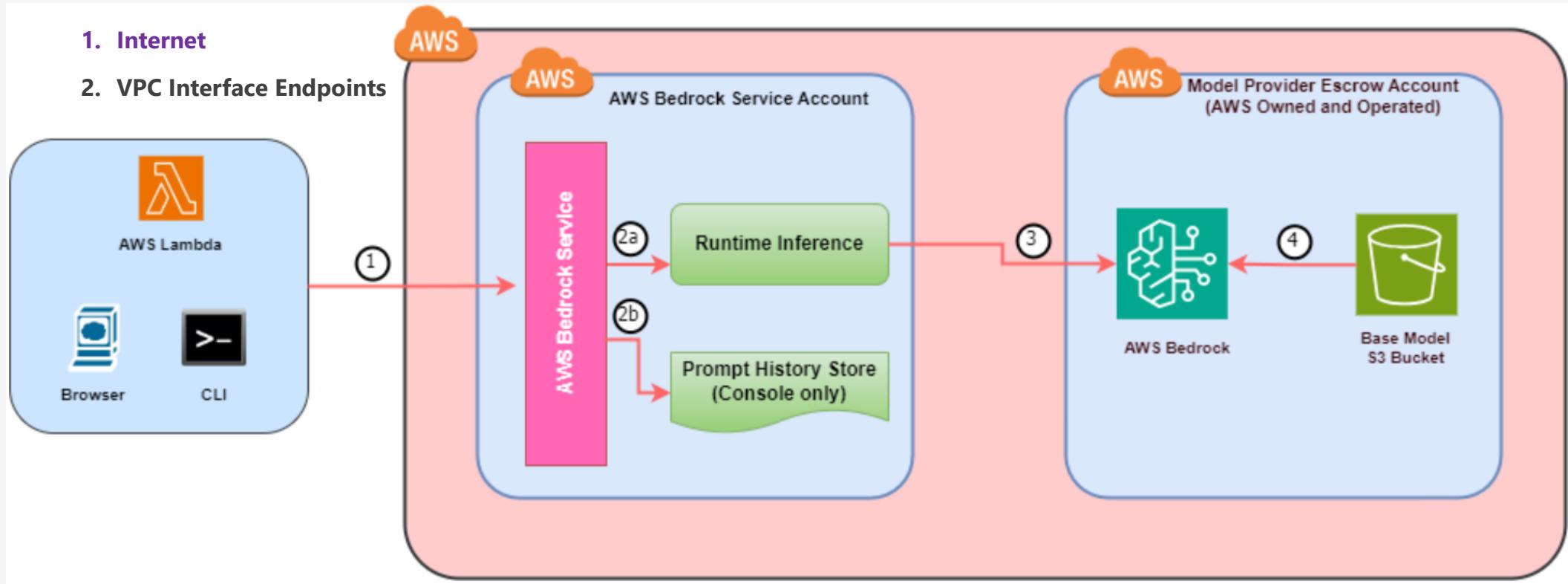
Page Footer:

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How does Amazon Bedrock work – High Level ?



Amazon Bedrock – Architecture – Part 1



- Runtime Inference : Used to redirect to right model endpoint based on the API request
- Base Model : Baseline model provided to every AWS account

Services (2)	
Search	
Clear filters	
Service Name	Type
com.amazonaws.us-east-1.bedrock	Interface
com.amazonaws.us-east-1.bedrock-runtime	Interface

Foundation Models and Impact of Inference Parameters

Inference parameters influence the response generated by the model.

Inference Parameters

1. Randomness and diversity

Temperature

Top K

Top P

2. Length

Response Length

Length Penalty

Stop Sequence

3.Repetition

Repetition penalty

Inference Parameter – 1. Randomness and Diversity

Prompt : I hear the hoof beats of

Parameter	Possible Values	Description	Example
Temperature*	Foundation Models use : Probability to construct the words in a sequence		<ul style="list-style-type: none">• Horse --- > 0.4• Wind ----- > 0.2• Unicorns -- - > 0.1• Change in distance --- > 0.05
	Low value (closer to zero)	Model tends to select the higher-probability words.	<ul style="list-style-type: none">• Horse
	High value (closer to 1 or 5)	Temperature further away from zero, the model may select a lower-probability word	<ul style="list-style-type: none">• Change in distance
Top K	1-500	Cutoff where the model no longer selects the words.	if K=50, the model selects from 50 of the most probable words
Top P	0.01-0.99	Caps choices based on the sum of their probabilities.	If Top P=0.5, Horse and Wind selected

Inference Parameter – 2. Length

Prompt : Write an essay on horse

Parameter	Possible Values	Description
Length : Controls the length of the generated response. Helps control cost .		
Max Length	1- 4096 tokens	Specify the maximum number of tokens to use in the generated response.
Stop Sequence	Any keyword	<ul style="list-style-type: none">Configure up to four sequences that the model recognizes.After a stop sequence, the model stops generating further tokens.The returned text doesn't contain the stop sequence.



Inference Parameter – 3. Repetition

Parameter	Possible Values	Description
Repetition : Help control repetition in the generated response.		
Presence penalty	0-5	Use a higher value to lower the probability of generating new tokens that already appear at least once in the prompt or in the completion.
Count penalty	0-1	Use a higher value to lower the probability of generating new tokens that already appear at least once in the prompt or in the completion. Proportional to the number of appearances.
Frequency penalty	0-500	Use a high value to lower the probability of generating new tokens that already appear at least once in the prompt or in the completion. The value is proportional to the frequency of the token appearances (normalized to text length)
Penalize special tokens		Reduce the probability of repetition of special characters – Whitespace, Punctuations...

Amazon Bedrock - Pricing

Two Modes - On-Demand and Provisioned Throughput

On-Demand Mode

- Pay for what you use, with no time-based term commitments
- Text generation models
 - Charged for every input token processed and every output token generated
- Image generation models
 - Charged for every image generated.
- Embeddings models
 - Charged for every input token processed

AWS Bedrock - Pricing

Provisioned Throughput

- Primarily designed for large consistent inference workloads that need guaranteed throughput.
- Can purchase model units for a specific base or custom model with time commitment (1-6 months)
- Custom models can only be accessed using Provisioned Throughput.
 - Console Custom Models
 - Pricing

Pricing Examples

- A121 Labs
- Anthropic

AWS Bedrock - Pricing

Token Limits - Tokens shared between prompt and completion.

<https://help.openai.com/en/articles/4936856-what-are-tokens-and-how-to-count-them>

Media and Entertainment Industry Use Case :

Generate Movie Poster Design

Use Case Implementation Pre-Requisites 1 : Request Access to Models

Base models
Custom models
Providers
Playgrounds
Chat
Text
Image
Deployment
Provisioned Throughput

1 Model access

Settings
User guide
Bedrock Service Terms

Model access

To use Bedrock, you must request access to Bedrock's FMs. To do so, you will need to have the correct IAM Permissions . For certain models, you may first need to submit use case details before you are able to request access. More information about these models is available on the Providers page.

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Titan Embeddings G1 - Text	Access granted	Text	EULA
Titan Text G1 - Lite	Unavailable	Text	EULA

2 Manage model access

Models	Access status	Modality	EULA
Anthropic	Use case details submitted		
Claude	Access granted	Text	EULA
Claude Instant	Access granted	Text	EULA
Cohere			
Command	Access granted	Text	EULA
Stability AI			
Stable Diffusion XL	Access granted	Image	EULA

3 Save changes

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Use Case Implementation Pre-Requisites 2 : Upgrade boto3 version

1. Create a AWS Lambda Function – bedrock-boto3Upgrade and add import boto3
2. Check the boto3 version. Should be > 1.28.63
3. Use following command to check version - `print(boto3.__version__)`
4. Upgrade the boto3 version for AWS Lambda Function using Lambda Layer -
<https://repost.aws/knowledge-center/lambda-python-runtime-errors>
 - Add Layer Version ARN
 - Check the boto3 version. Should be > 1.28.63
5. Code for Bedrock invocation from AWS Lambda Function
 - Link - <https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/bedrock-runtime.html>

Manually create a Lambda layer that uses the latest Boto3 version

1. Create a lib folder:

```
LIB_DIR=boto3-udemy03/python
```

```
mkdir -p $LIB_DIR
```

2. Install the library to LIB_DIR:

```
pip3 install boto3 -t $LIB_DIR
```

3. Zip all the dependencies to /tmp/boto3-mylayer.zip:

```
cd boto3-udemy03
```

```
zip -r /tmp/boto3-udemy03.zip .
```

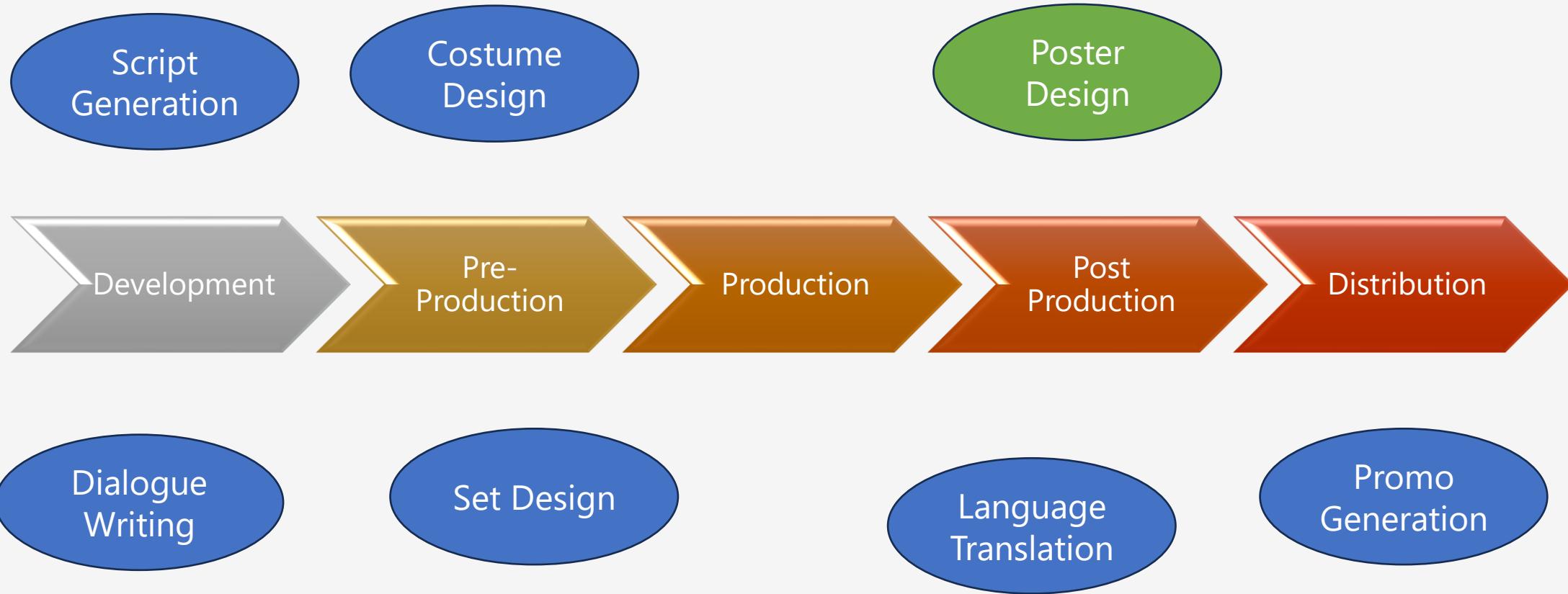
4. Publish the layer:

```
aws lambda publish-layer-version --layer-name boto3-udemy03 --zip-file fileb://tmp/boto3-udemy03.zip
```

Media and Entertainment Industry Use Case :

Generate Movie Poster Design

Generative AI – Media and Entertainment Industry(Film Making)



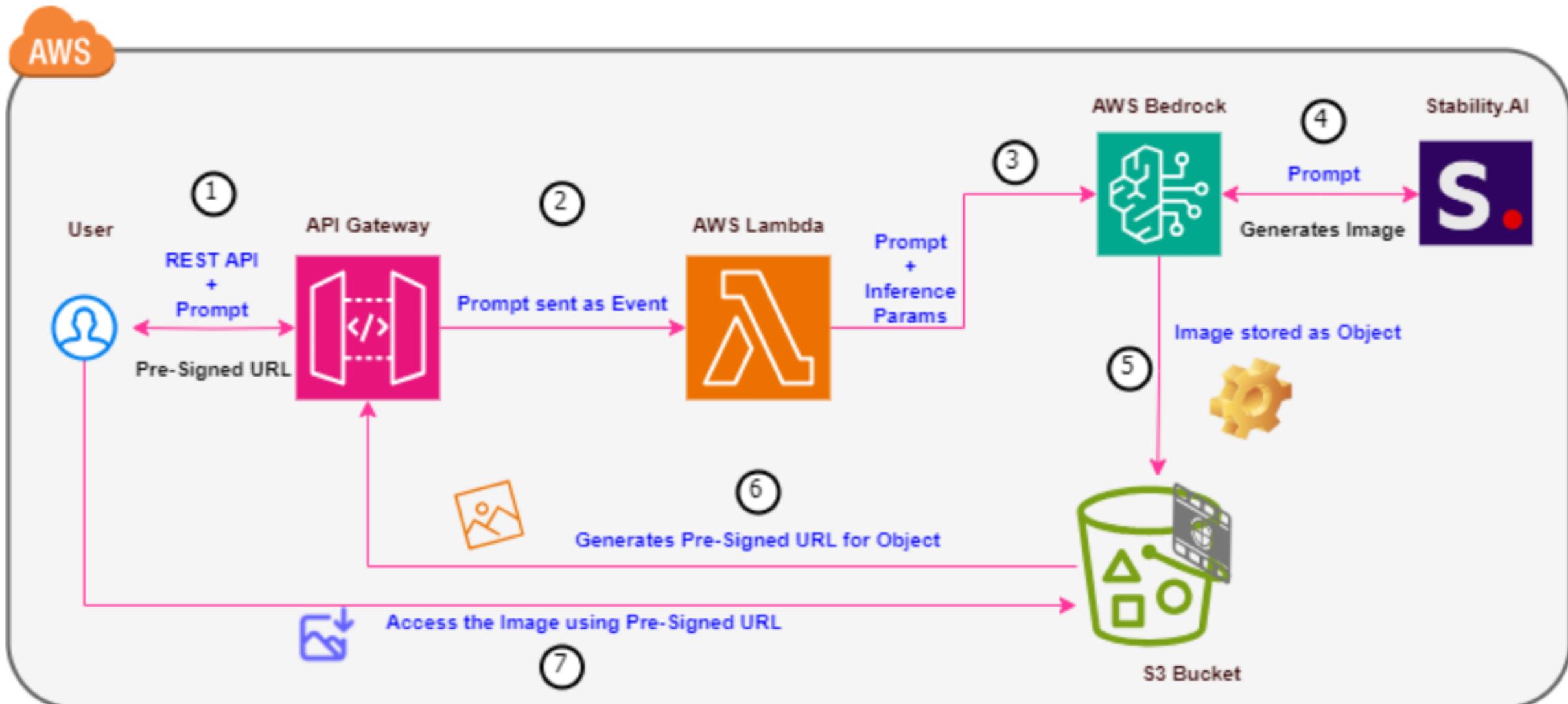
Stages in Movie making and potential role of Generative AI

Generative AI Use Case – Generate Movie Poster Design

Prompt : Generate movie poster photograph with hero shooting the villain with lots of guns in a scenic location with leaves and bullets flying



Movie Poster Design – Generative AI Architecture to Build



Movie Poster Design - Broad Implementation Steps

1. Create an **S3 Bucket** – movieposterdesign01
2. Create a **AWS Lambda Function** - moviePosterDesignFunction
 - Connect to AWS Bedrock – Stability Diffusion Model and Generate an Image based on Prompt
 - Store the Image as an Object in the S3 Bucket
 - Generate a **Pre-Signed URL** for image generated
 - Send the **URL** as a **response** to AWS API Gateway
3. Create a REST API using the AWS API Gateway to allow user to pass the ‘prompt’ and view image using Pre-Signed URL - movePosterDesignAPI
4. Test using Postman API Tool

Generative AI with Bedrock – Lambda Function Pre-requisites

1. Create a AWS Lambda Function
2. Check the boto3 version. Should be > 1.28.63
3. Use following command to check version - `print(boto3.__version__)`
4. Upgrade the boto3 version for AWS Lambda Function using Lambda Layer -

<https://repost.aws/knowledge-center/lambda-python-runtime-errors>

- Add Layer Version ARN
 - Check the boto3 version. Should be > 1.28.63
5. Code for Bedrock invocation from AWS Lambda Function
 - Link - <https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/bedrock-runtime.html>

Movie Poster Design - Implementing Lambda Function Steps

1. Create an IAM Role and Increase timeout limit

- Full Access to Bedrock – Policy Name - [AmazonBedrockFullAccess](#)
- Full Access to S3 – Policy Name- [AmazonS3FullAccess](#)

2. Code for Bedrock invocation from AWS Lambda Function

3. Configure Test Event

```
{ "prompt": "generate an image of a dog with sunset"}
```

Movie Poster Design : Lambda Coding Steps

Broad Steps for writing Lambda Function

#1. import boto3

#2. Create client connection with Bedrock and S3 Services – [Link](#)

#3. Store the input data (prompt) in a variable

#4. Create a Request Syntax - Details from console and documentation(JSON object) - [Link](#)

#5. 5a. Retrieve from Dictionary, 5b. Convert Streaming Body to Byte using json load 5c. Print

#6. 6a. Retrieve data with artifact key, 6b. Import Base 64, 6c. Decode from Base64 - [Link](#)

Movie Poster Design : Lambda Coding Steps

Broad Steps for writing Lambda Function

#7. 7a. Upload the File to S3 using Put Object Method – [Link](#) 7b. Import datetime 7c.

Generate the image name to be stored in S3 - [Link](#)

#8. Generate Pre-Signed URL - [Link](#)

Movie Poster – API Gateway creation and Lambda Integration

4. Create an REST API from API Gateway

- Resource - movePosterDesignAPI
- Method - GET

5. API Gateway - Method Request

- URL query string parameters – Add input parameter
- Enable - Request Validation

Movie Poster– API Gateway creation and Lambda Integration

6. API Gateway - Integration Request

- application/json

```
{
```

```
"prompt" : "$input.params('prompt')"
```

```
}
```

7. Deploy the API to a Stage'(Stage=Dev or any other)

8. Test using API Gateway Console and Postman

Stable Diffusion Inference Parameters

Parameter	JSON object format	Description	Minimum	Maximum	Default
Prompt strength	cfg_scale	<ul style="list-style-type: none">Determines how much the final image portrays the prompt.Lower number to increase randomness in the generation.	0	30	10
Generation step	steps	<ul style="list-style-type: none">Determines how many times the image is sampled.More steps result in a more accurate result.	10	150	30
`Seed	seed	<ul style="list-style-type: none">Set as a random number and not neededUse the same seed and the same settings as a previous run to allow inference to create a similar image.	0	4294967295	0

<https://docs.aws.amazon.com/bedrock/latest/userguide/model-parameters-diffusion.html>

Prompt Design for Stable Diffusion - 1

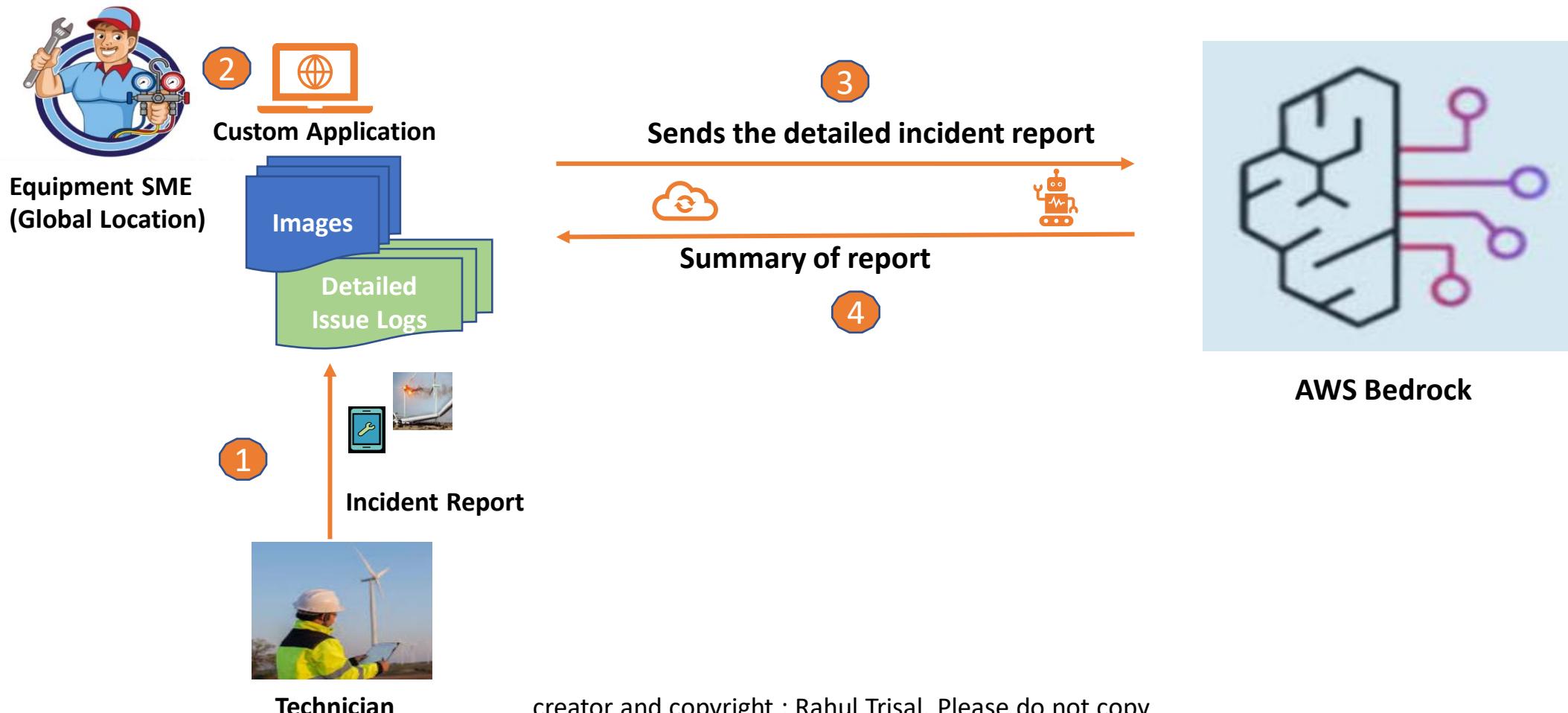
An image of a spy agent fighting in a rival country with guns and helicopters with backdrop of a shopping complex with heavy snow and old Greek architecture building late in the evening with sunsetting behind mountains. The image should be a photograph with Aaron Jasinski style

*Use Case – Text Summarization
for Manufacturing Industry*

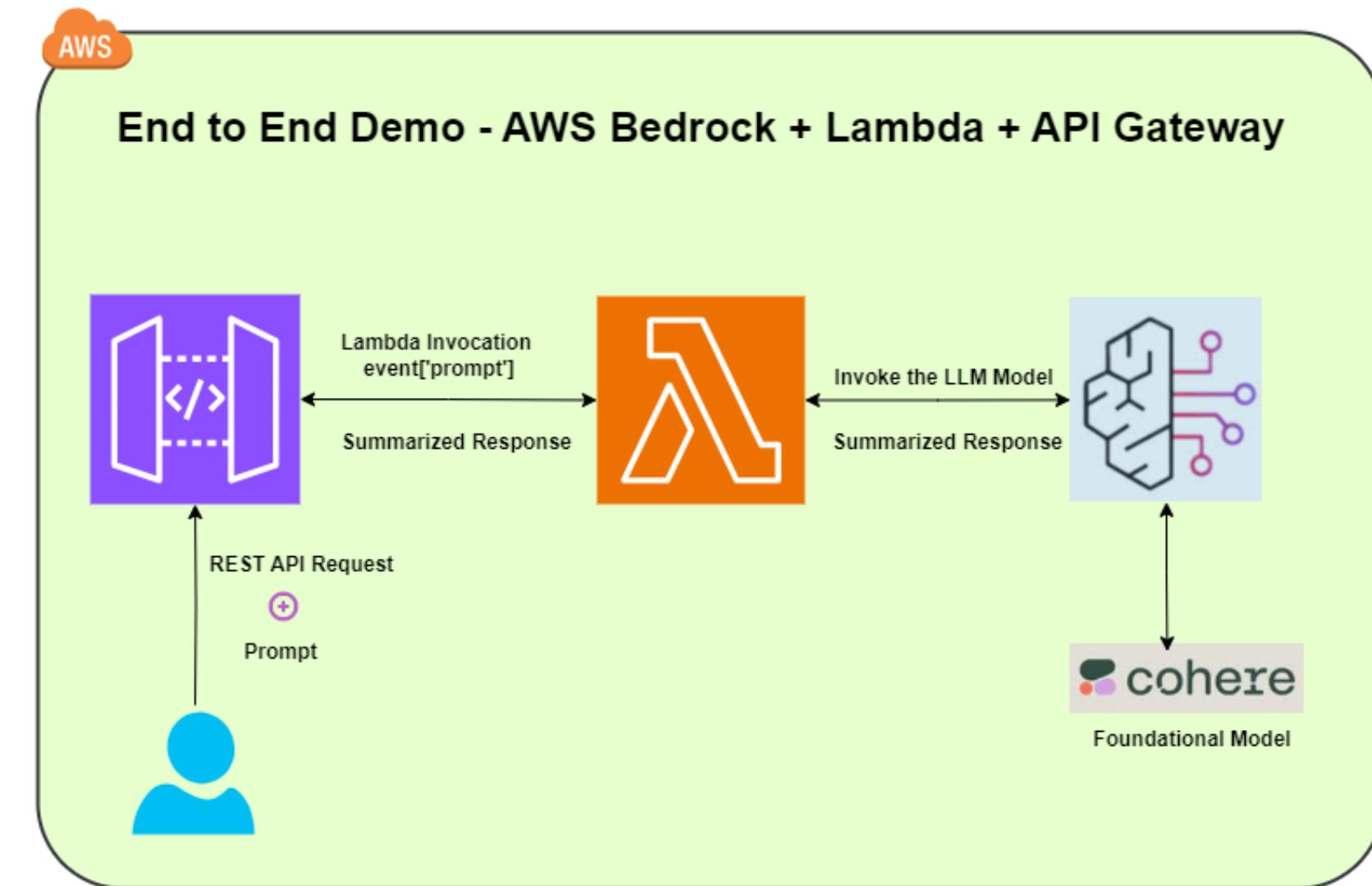
Generative AI – Manufacturing Industry Use Case

Use Case :

Text Summarization using AWS Bedrock for faster issue resolution to improve productivity of technicians.



Generative AI – Use Case Architecture



Generative AI with Bedrock : Step by Step – Pre-Requisites

1. Create a AWS Lambda Function - demoManufacturing
2. Check the boto3 version. Should be $\geq 1.28.63$
3. Use following command to check version - `print(boto3.__version__)`
4. Upgrade the boto3 version for AWS Lambda Function using Lambda Layer -

<https://repost.aws/knowledge-center/lambda-python-runtime-errors>

- Add Layer Version ARN
- Check the boto3 version. Should be $> 1.28.63$

Generative AI with Bedrock : Step by Step Guide

1. Create an IAM Role and Increase timeout limit

2. Code for Bedrock invocation from AWS Lambda Function

- Link - <https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/bedrock-runtime.html>

3. Configure Test Event

```
{ "prompt": "How is weather in Bengaluru"}
```

Generative AI with Bedrock : Step by Step Guide

Broad Steps for writing Lambda Function

#1 Import boto3 and create **client connection** with bedrock

#2 a. Store the input in a variable, b. print the event

#3. Create Request Syntax - Get details from console & body should be json object - use json.dumps for body

#4. Convert Streaming Body to Byte(.read method) and then Byte to String using json.loads#

5 a. Print the event and type , b. Store the input in a variable

#6. Update the 'return' by changing the 'body'

Generative AI with Bedrock : Step by Step Guide

4. Create an REST API from API Gateway

- Resource – demoManufacturing
- Method - POST

5. API Gateway - Method Request

- URL query string parameters – Add input parameter

Generative AI with Bedrock : Step by Step Guide

6. API Gateway - Integration Request

- application/json

```
{ "prompt": "$input.params('prompt')" }
```

7. Deploy the API to a Stage

8. Test using API Gateway Console

9. Sample Text - [Link](#)

Prompt for Summarization Task

This is a on-site log report of turbine breakdown.

Issue Log Date – 25-12-2023, Model Number – TB-CL-7882, **Issue** - Cracks appeared in the part MR 7882-9571 next to the rotor hub. The nut connecting the rotor blade to the rotor hub seems to be damaged. The Anemometer readings seem to be within range. The electric braking seems to be unused. No indication of damage to any other component of the turbine except normal wear and tear.

Potential Root Cause – Seems due to reduced tensile strength of the nut connecting the blade to the rotor.

Last Maintenance Date – 12-12-2023, **Last Maintenance Issues Recorded** - No known issues recorded and all the parameters were within range.

Summarize the text in 2 lines.

Possible and Actual – Completion from the Model

Possible Response:

Model No-TB-CL-7882, Issue - The nut connecting the rotor blade to the rotor hub seems to be damaged,

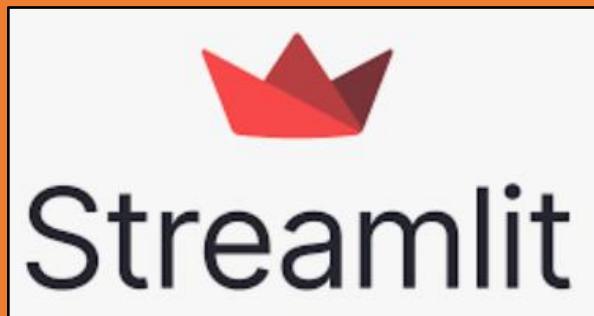
Potential Root Cause – Seems due to reduced tensile strength of the nut connecting the blade to the rotor.

No known issues recorded in last maintenance.

Actual Response :

The turbine experienced cracks in a part and possible damage to the nut connecting the rotor blade, but the anemometer readings were within range. It is unclear what has caused the issue, but it is assumed to be due to reduced tensile strength.

Use Case – Building a Chatbot



Building a Chatbot using Amazon Bedrock : Architecture

Chatbot using Amazon Bedrock – What we will build as part of Use Case

Hi, This is Chatbot Anisha 😎



Hi



Hi, my name is AI. How can I assist you today? How can I help you?



Where is Bengaluru ?



Bengaluru is the capital of Karnataka, a state in South West India.

Chat with Udemy Course bot here



Langchain

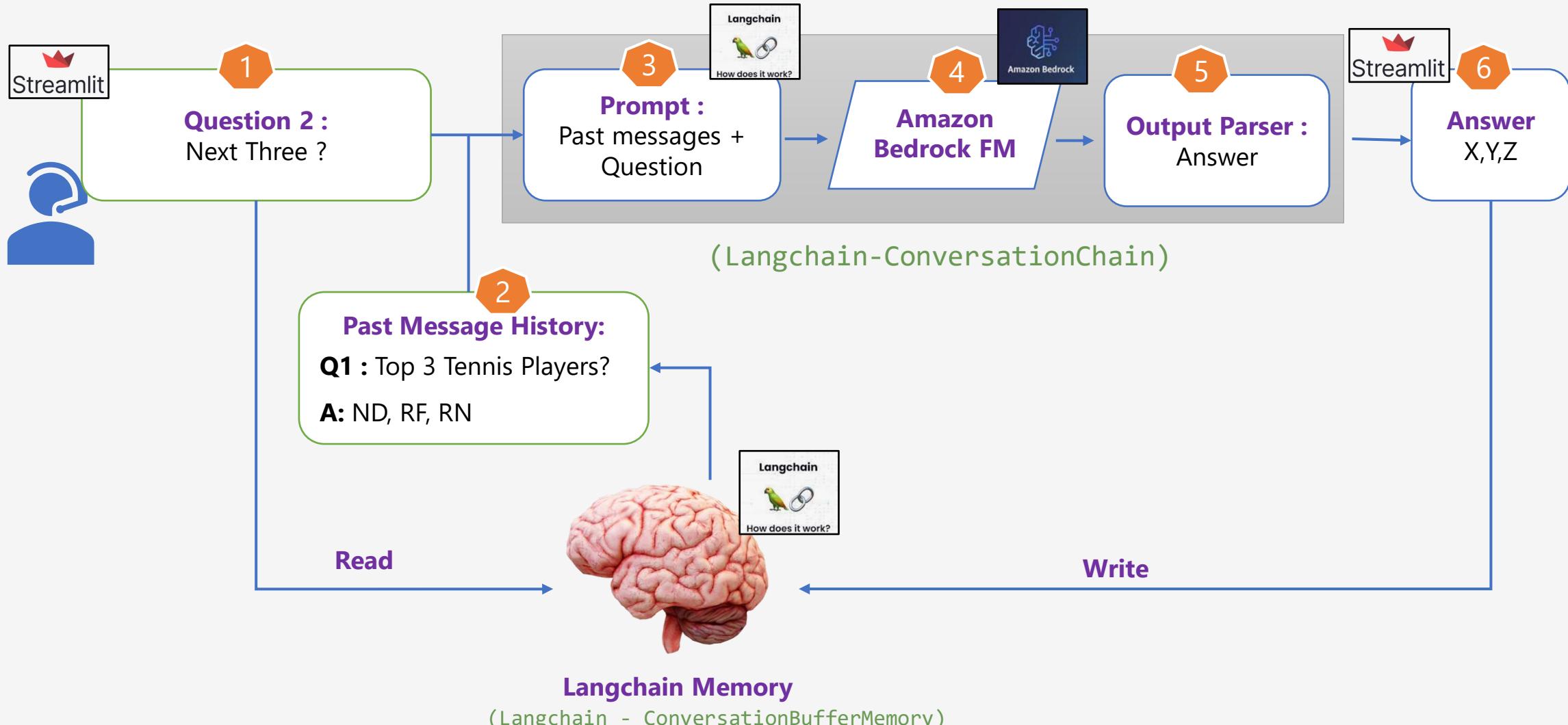


How does it work?



Amazon Bedrock

Chatbot Architecture – Amazon Bedrock + Langchain + Streamlit



Pre-Requisites

Building a Chatbot using Amazon Bedrock

Pre-requisites – List of items to be installed

1. Download VS Code
2. Install Python
3. Install AWS CLI
4. Configure IAM Role for VSCode
5. Anaconda Navigator Download
6. Install Boto3
7. Install Langchain
8. Install Streamlit
9. Bedrock
10. AWS Profile

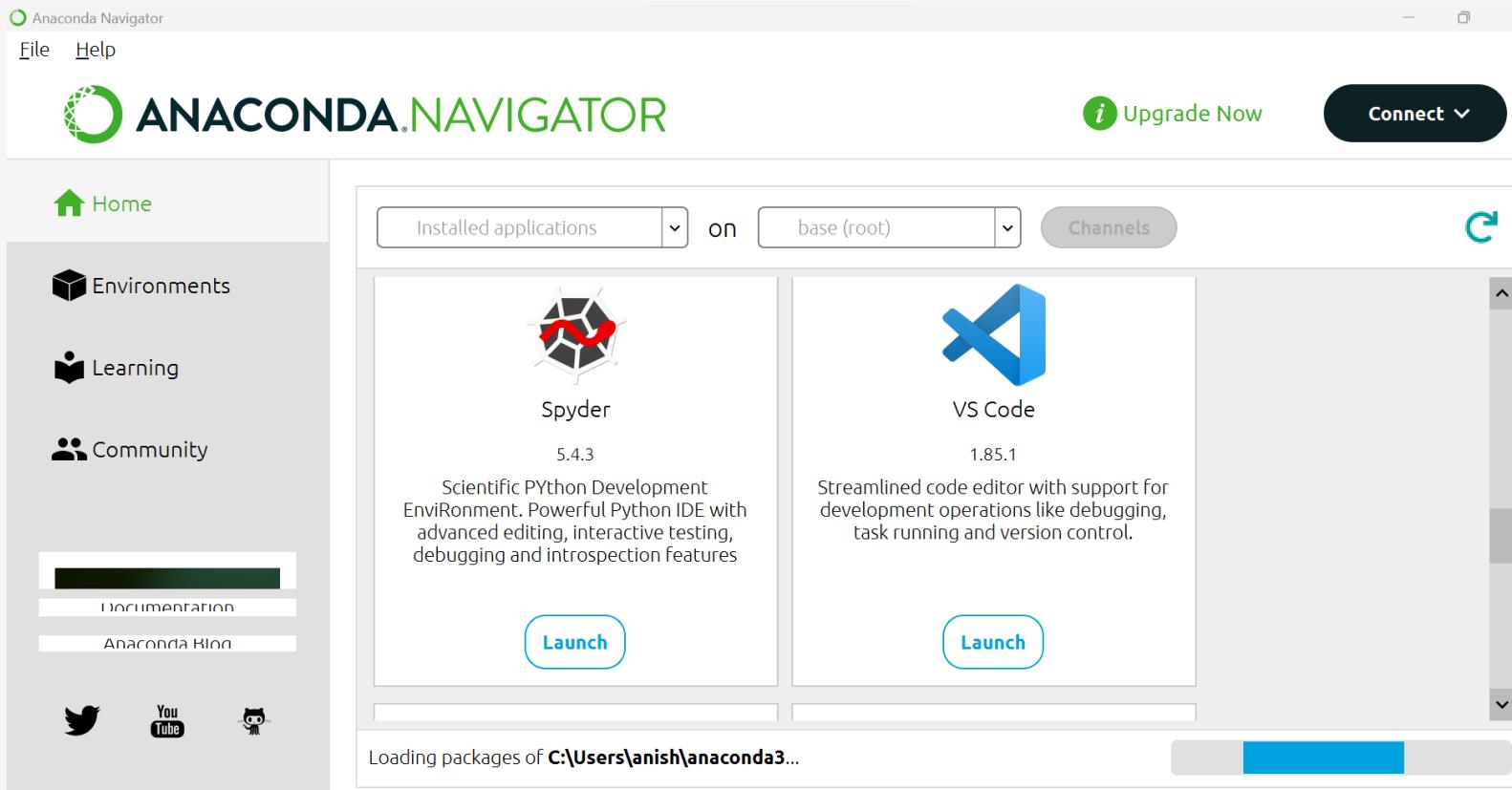
- Download VS Code - <https://code.visualstudio.com/download>
- Install Python
- Install AWS CLI - <https://docs.aws.amazon.com/cli/latest/userguide/getting-started-install.html>
 - `aws -- version`
 - Extensions – AWS Toolkit and AWS Boto3
- Configure IAM Role for VSCode - <https://docs.aws.amazon.com/cli/latest/userguide/cli-configure-files.html>
 - Create IAM Role
 - `aws configure`
 - Provide credentials
 - Set profile - `aws configure set region us-east-1 --profile Udemy_Rahul`
 - Profile Setting Details - <https://docs.aws.amazon.com/cli/latest/userguide/cli-configure-files.html>

- Anaconda Navigator Download - <https://docs.anaconda.com/free/anaconda/install/windows/>
- Open VS Code from Anaconda Navigator – **Very Important**
- Install boto 3 - `pip install boto3`
- Install Langchain – `pip install langchain`
- Install Streamlit – `pip install streamlit`
- Install Bedrock – `pip install bedrock` (If you face issues, restart the VSCode editor and/or your laptop)
- Check profile name - `aws configure list-profiles`

Pre-requisites – Test if everything is working okay

1. Download VS Code
2. Install AWS CLI - `aws -- version`
3. Configure IAM Role for VSCode – `aws s3 ls`
4. Anaconda Navigator Download – Dashboard
5. Install Boto3 – `pip show boto3`
6. Install Langchain – `pip show langchain`
7. Install Streamlit - `streamlit hello`
8. AWS Profile - `aws configure list-profiles`

Anaconda Navigator Dashboard



Coding Steps

Building a Chatbot using Amazon Bedrock

Steps in Building Chatbot – Chatbot Backend Code

- #1 import the OS, Bedrock, ConversationChain, ConversationBufferMemory Langchain Modules
- #2a Write a function for invoking model- client connection with Bedrock with profile, model_id & Inference params-
model_kwargs
- #2b Test out the LLM with Predict method
- #3 Create a Function for ConversationBufferMemory (llm and max token limit)
- #4 Create a Function for Conversation Chain - Input text + Memory
- #5 Chat response using Predict (Prompt template)

#Links :

- #1 <https://python.langchain.com/docs/integrations/llms/bedrock>
- #2b Chains - Combine LLMs and Prompts

Steps in Building Chatbot – Chatbot Frontend Code

- How to Run Chatbot locally
 - `streamlit run <frontend_filename>.py`

Langchain Overview:



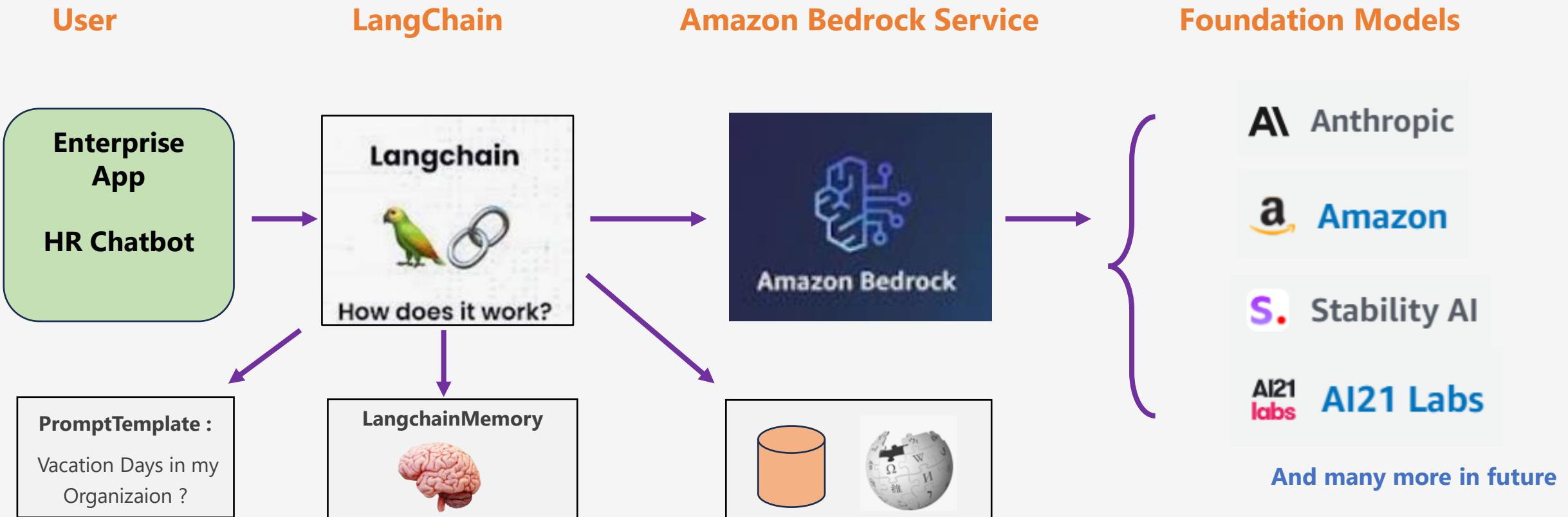
*Challenges in Large Language Models
&
How Langchain helps overcome them*

Challenges in Large Language Models

- **Contextual Memory** - Large Language Models are **Stateless**
- **Contextual Knowledge (Domain Knowledge)** - Enhancing the outcome of LLM's with **organization proprietary data**
- **Hallucination** – Due Lack of knowledge of **recent events (post training date)** or no training data in the specific area.

What is LangChain ?

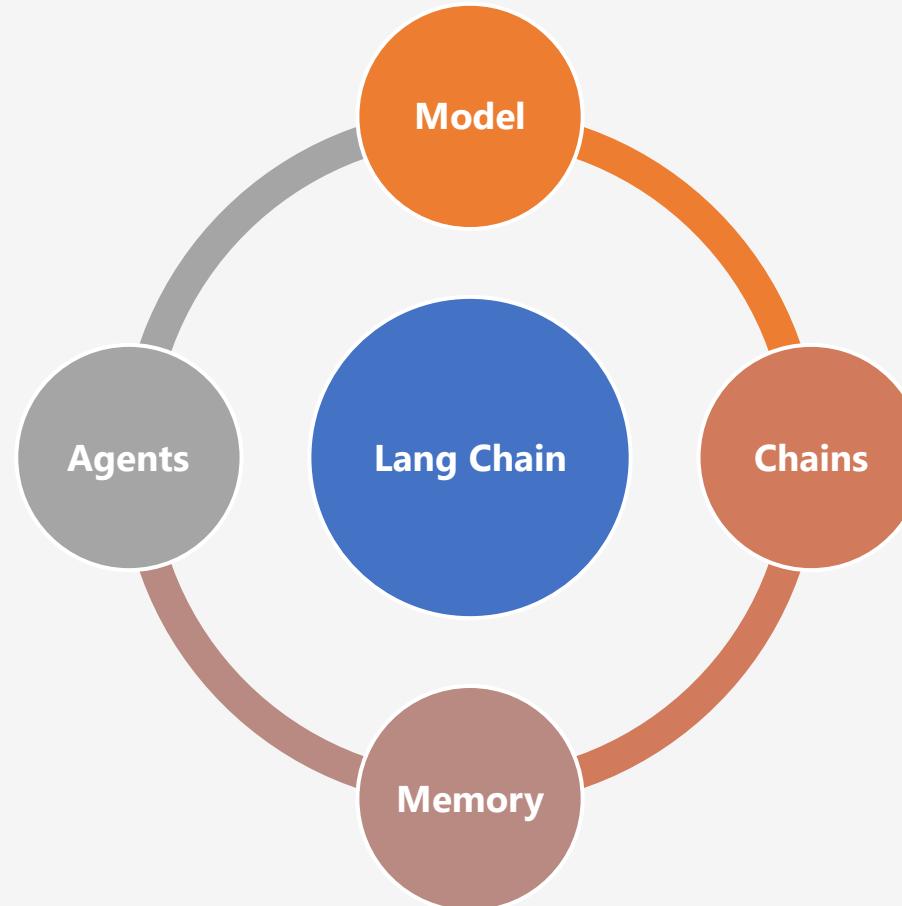
LangChain is a **framework for developing applications** powered by language models.



Lang Chain Components – High Level Overview

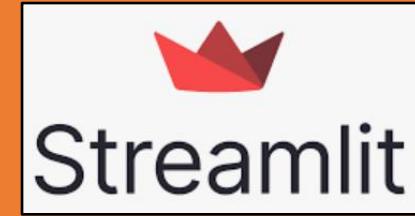
Standard interface to connect different LLMs such as Claude, Titan

In agents, a **LLM** is used as a **reasoning engine** to determine actions & order



Combine **multiple components together** to create a single, coherent application.
Example – Prompt Template + LLMs + External Sources

Provides ability to **store information about past interaction** - Chatbots



Streamlit – Overview

Use Case : Retrieval Augmented Generation (RAG)

Employee HR Q & A Application with RAG

Amazon Bedrock - Claude FM

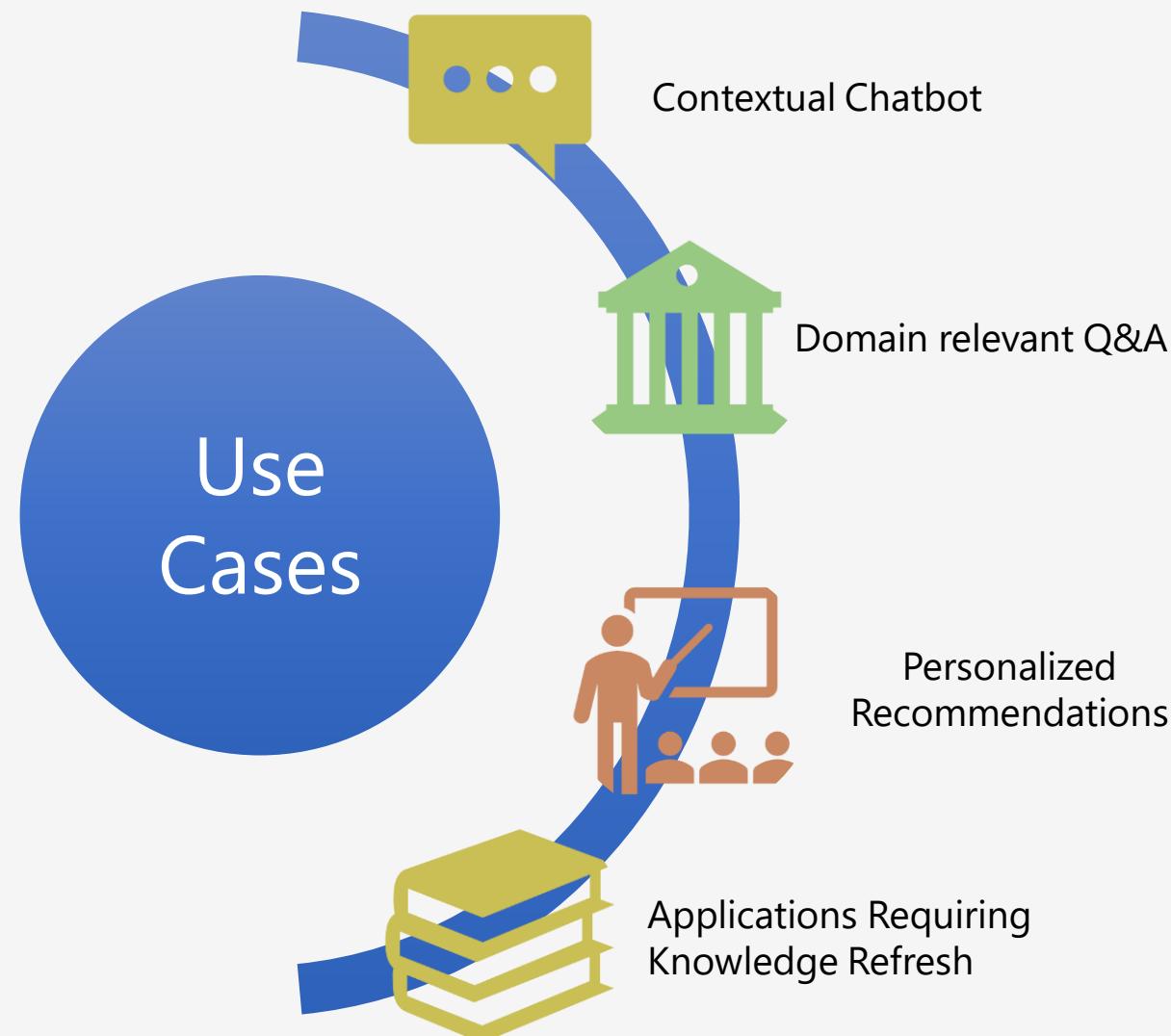
+

Langchain

+

HR Policy Document (PDF)

Key Use Cases for Retrieval Augmented Generation in the Industry



Basic Introduction

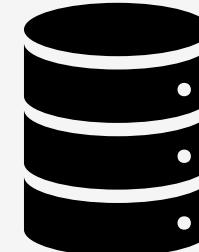
to

Vectors, Embeddings and Vector Search

1. Why do we need Vectors ?



Structured Data



Key Terms

1. **Vectors**
 2. Embedding Models
 3. Data Chunking
 4. Vector Store
 5. Vector Search
 6. Cosine Similarity
 7. K-Nearest Neighbor
- Search



Image Search or Unstructured Data



???

1. What are Vectors ?

Vectors are **mathematical representation of words, sentences** and documents

Vectors are represented by **List of numbers** or sequence of numbers



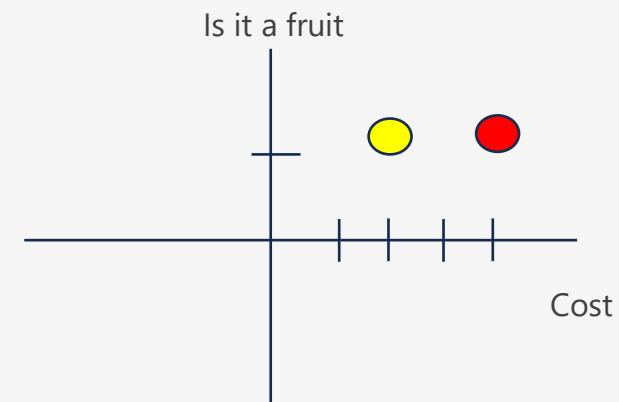
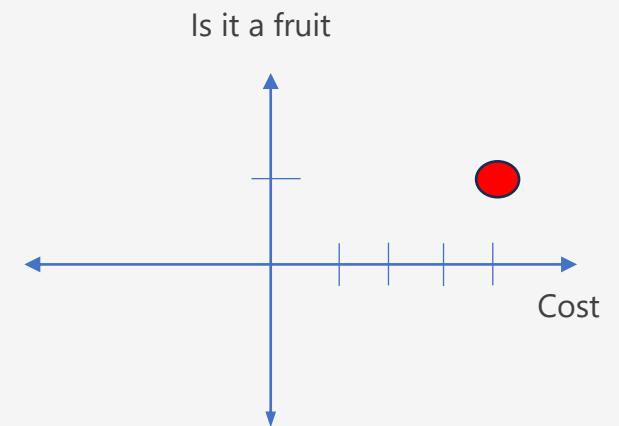
Is it a fruit	Cost
1	\$4

[1 , 4]



Is it a fruit	Cost
1	\$2

[1 , 2]

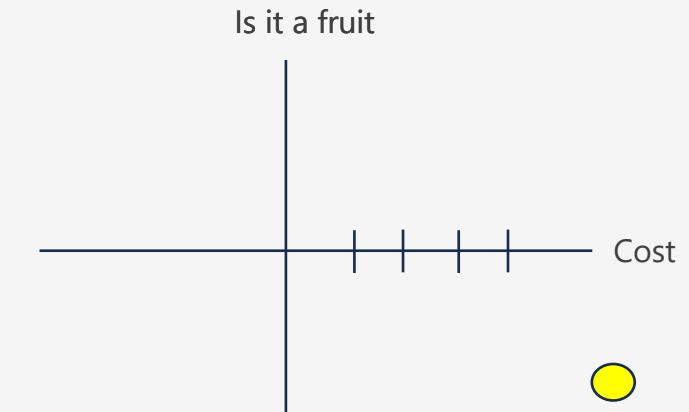


1. What are Vectors ?



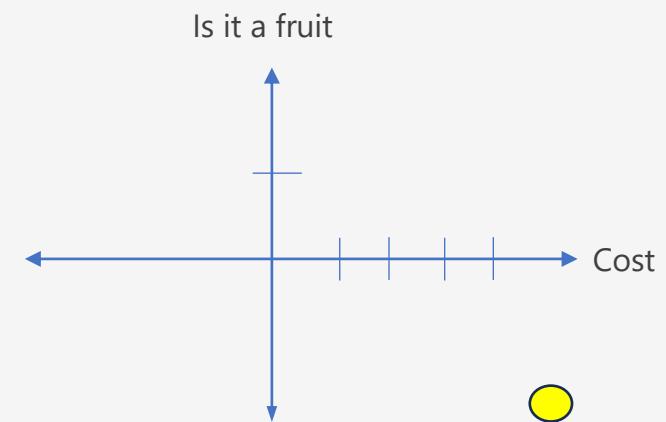
Is it a fruit	Price
-1	\$50

$\begin{bmatrix} -1 \\ 50 \end{bmatrix}$



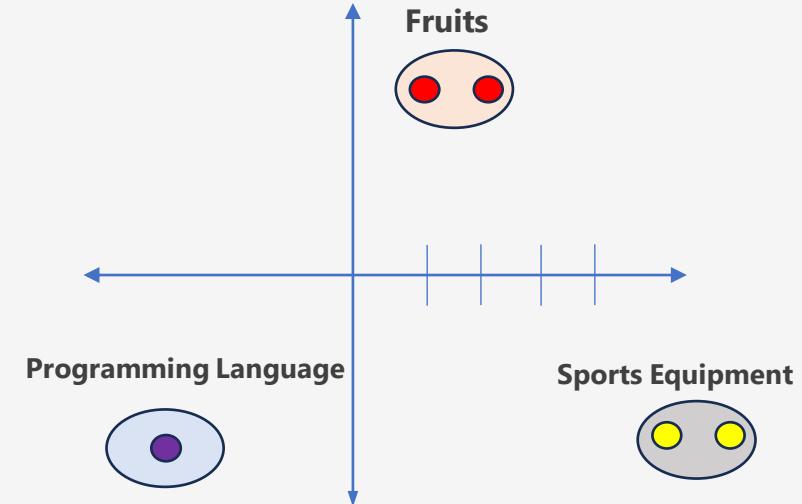
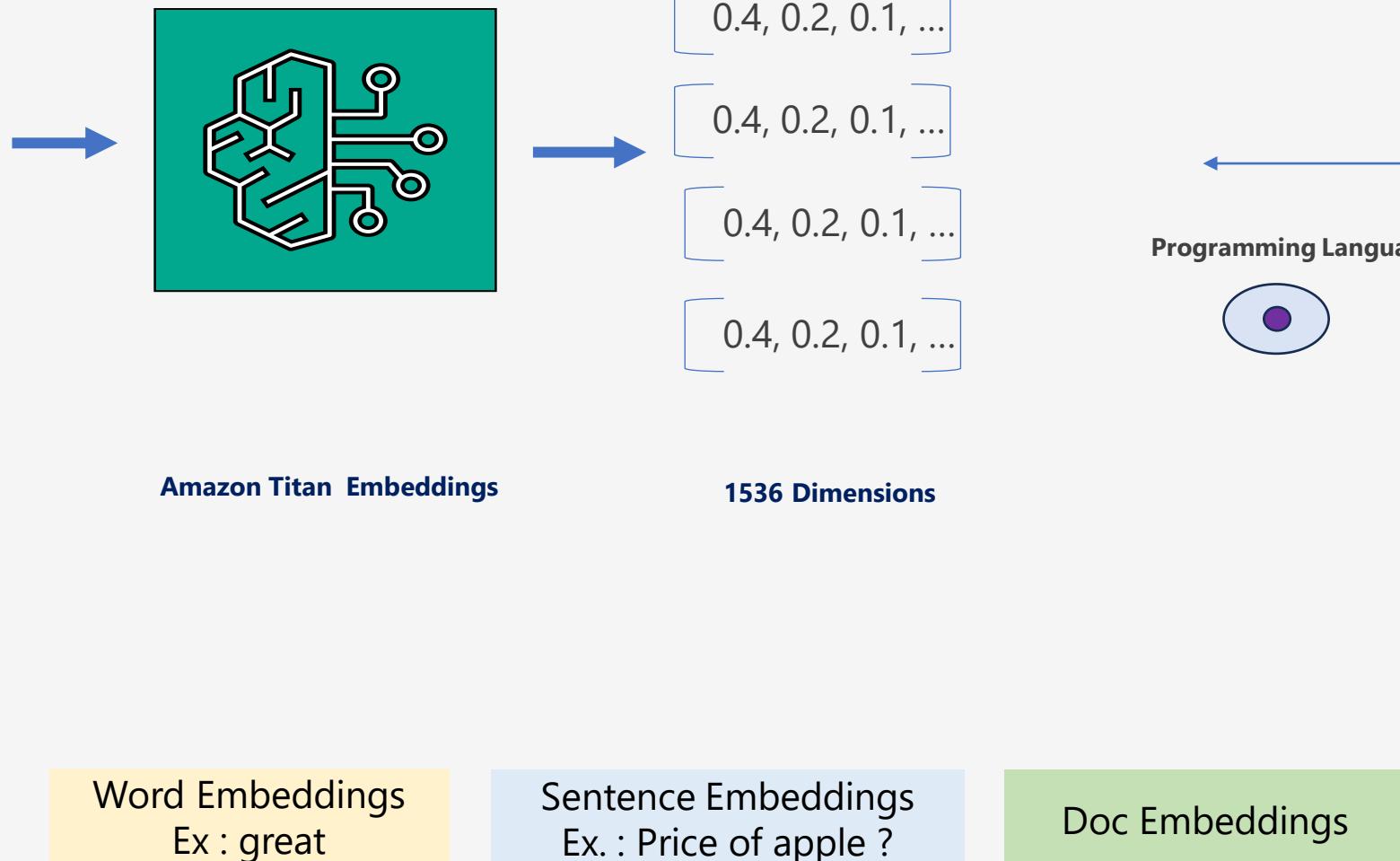
Is it a fruit	Price
-1	\$40

$\begin{bmatrix} -1 \\ 40 \end{bmatrix}$



2. What are Embedding Models ?

- Apple
- Banana
- Grapes
- Football
- Soccer
- GO
- Tennis



Key Terms
1. Vectors
2. Embedding Models
3. Data Chunking
4. Vector Store
5. Vector Search
6. Cosine Similarity
7. KNN

Embedding Models

Output from Embedding Models

Fruit

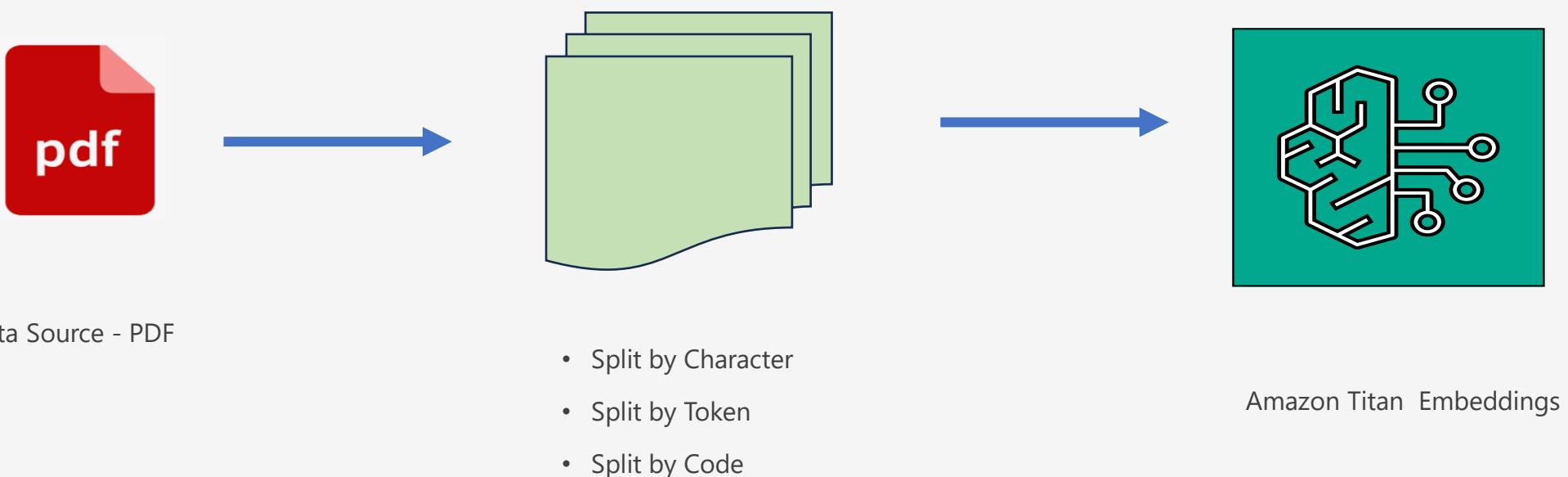


```
[  
  0.022321066, -0.027544279, -0.006137953, 0.0024092742, -0.0003515296,  
  -0.007889225, -0.01853968, -0.037405808, -0.004294867, -0.012602357,  
  0.009385457, 0.02421176, -0.004383281, -0.011901848, -0.020702416,  
  0.00431187, 0.055986296, 0.0040738326, 0.021300908, -0.03713377,  
  -0.004944368, 0.012269106, 0.02614326, -0.019777471, 0.0017206672,  
  0.014867109, 0.004597514, -0.021913003, -0.0042336574, 0.013180447,  
  0.032699477, -0.027245032, -0.0112965545, -0.009358253, -0.004951169,  
  -0.015030335, -0.007501565, -0.018906936, 0.0074675595, -0.0067568496,  
  0.0011952856, 0.0035501514, 0.012316713, 0.016132105, -0.014839904,  
  -0.0044002836, 0.010405616, -0.0066276295, -0.015751246, -0.007141109,  
  0.02729944, -0.00031348618, -0.015669633, -0.015656032, 0.015696838,  
  0.013554505, -0.001635654, 0.006069943, 0.009167824, -0.01917898,  
  -0.006059741, 0.013969369, -0.03006067, 0.007691995, 0.0005028531,  
  -0.005468049, -0.007263528, 0.009970348, -0.016254524, 0.0041248407,  
  0.01964145, 0.037324198, -0.0011340762, -0.0013296065, 0.010392014,  
  -0.01268397, -0.013037625, -0.006811258, -0.0045601083, 0.0028955496,  
  0.027435461, -0.024320576, -0.006161757, 0.014350229, 0.009392259,  
  -0.006328383, -0.025490358, 0.023273215, 0.0083925035, -0.003934411,  
  0.023722084, -0.0072499258, -0.0053626327, 0.017818768, -0.03327077,  
  0.019097365, 0.0022086431, 0.046709653, -0.016825814, -0.032182597,  
  ... 1436 more items  
]
```

Amazon Titan Embeddings

1536 Dimensions

3. Text Splitting or Data Chunking

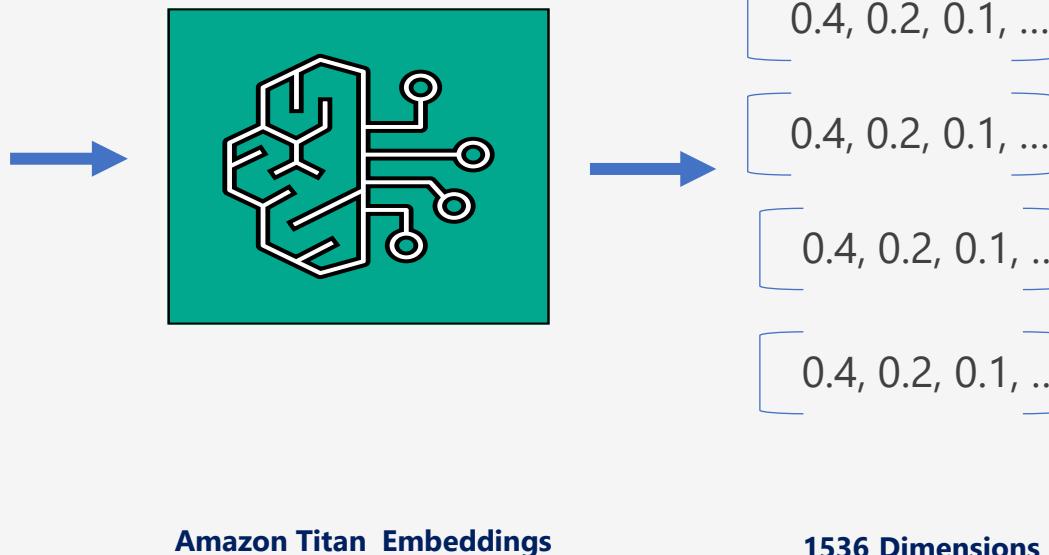


Key Terms

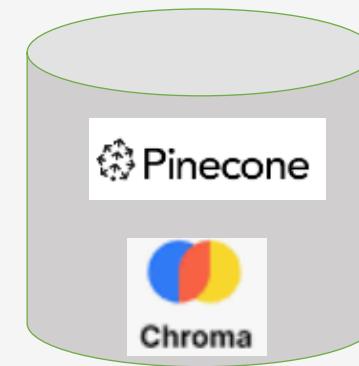
1. Vectors
2. Embedding Models
- 3. Data Chunking**
4. Vector Store
5. Vector Search
6. Cosine Similarity
7. K-Nearest Neighbor Search

4. Vector Store?

- Apple
- Banana
- Grapes
- Football
- Soccer
- GO
- Tennis



Vector Store



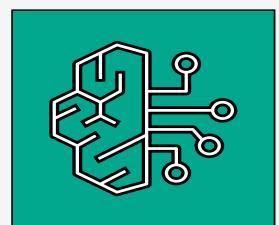
- ✓ FAISS
- ✓ Pinecone
- ✓ Chroma DB

Key Terms

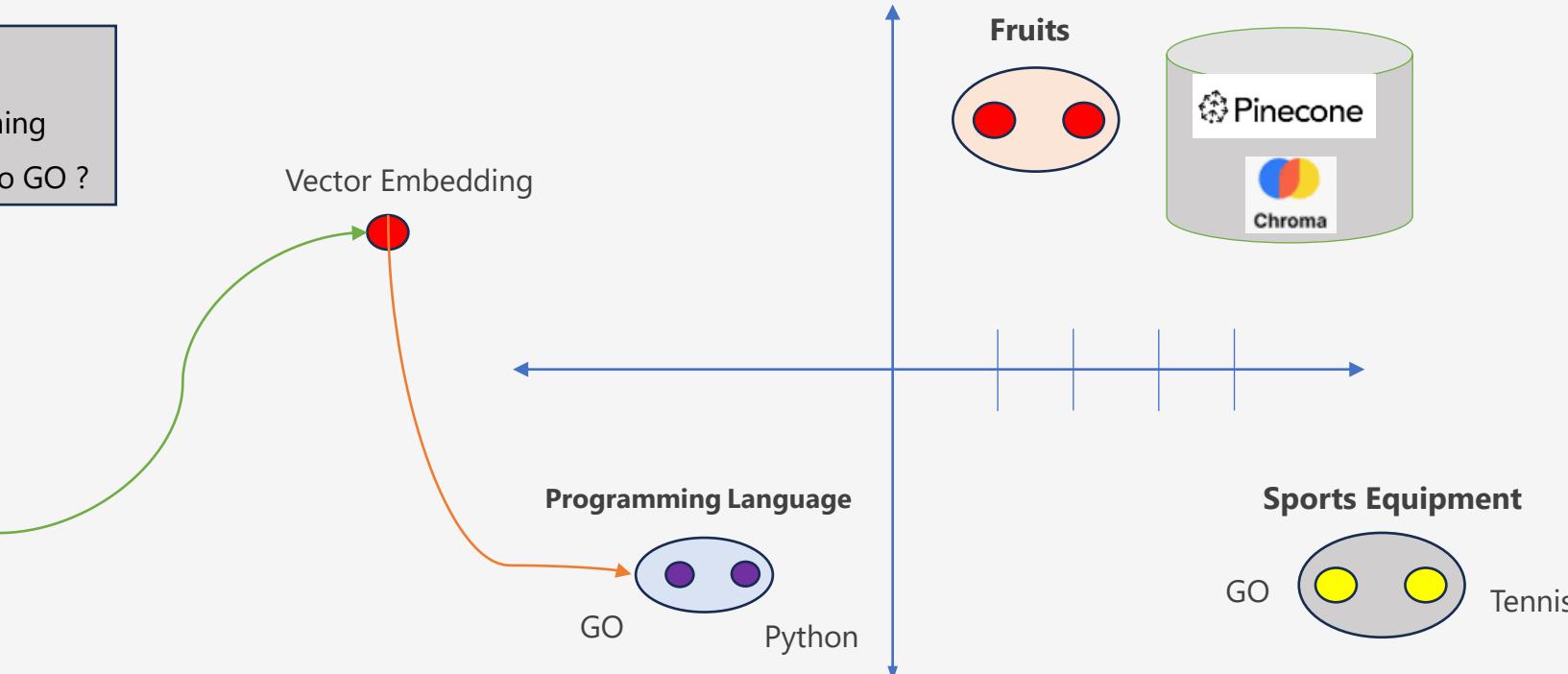
1. Vectors
2. Embedding
- Models
3. Data Chunking
4. **Vector Store**
5. Vector Search
6. Cosine Similarity
7. K-Nearest Neighbor Search

5. Vector Search

Question :
Which programming language is similar to GO ?



Amazon Titan Embeddings

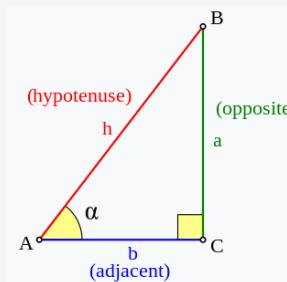


Key Terms

1. Vectors
2. Embedding Models
3. Data Chunking
4. Vector Store
5. **Vector Search**
6. Cosine Similarity
7. K-Nearest Neighbor Search

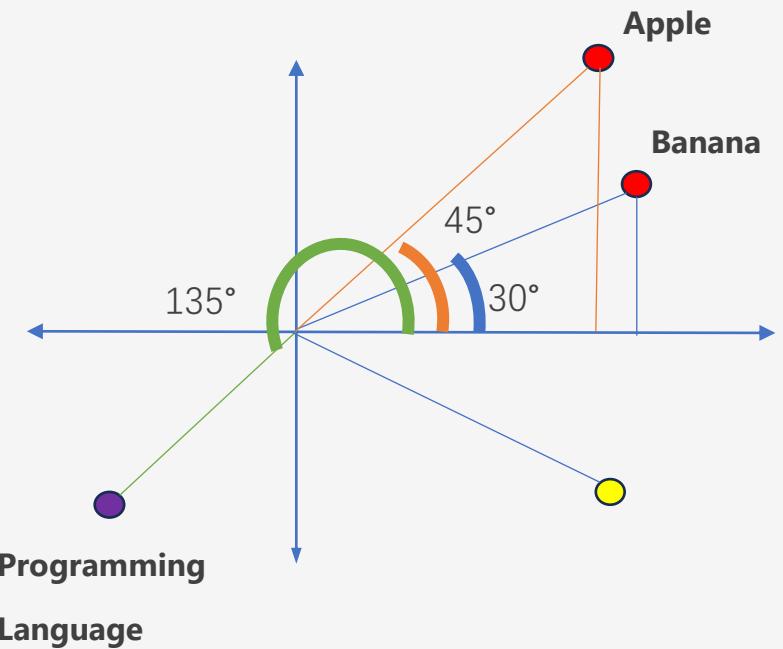
6. Similarity Search – Cosine Similarity

1. Cosine $\theta = \text{adjacent}/\text{hypotenuse}$



2. Similarity Search using Cosine Distance:

- Cosine distance metric is used to find **similarities between different vectors**
- In cosine metric we measure the **degree of angle between two vectors**
- $\cos 0 = 1$, $\cos 90 = 0$ and $\cos 180 = -1$
- **Cosine value 1** is for **vectors pointing in the same direction** --- > Similar
- At Cosine Value 0 ---- > Vectors unrelated (some similarity found).
- Value -1 for vectors pointing in opposite directions(No similarity).



7. Cosine Similarity and K- Nearest Neighbor Algorithm or ANN

KNN is a *supervised machine learning algorithm* used **classification and regression** tasks.

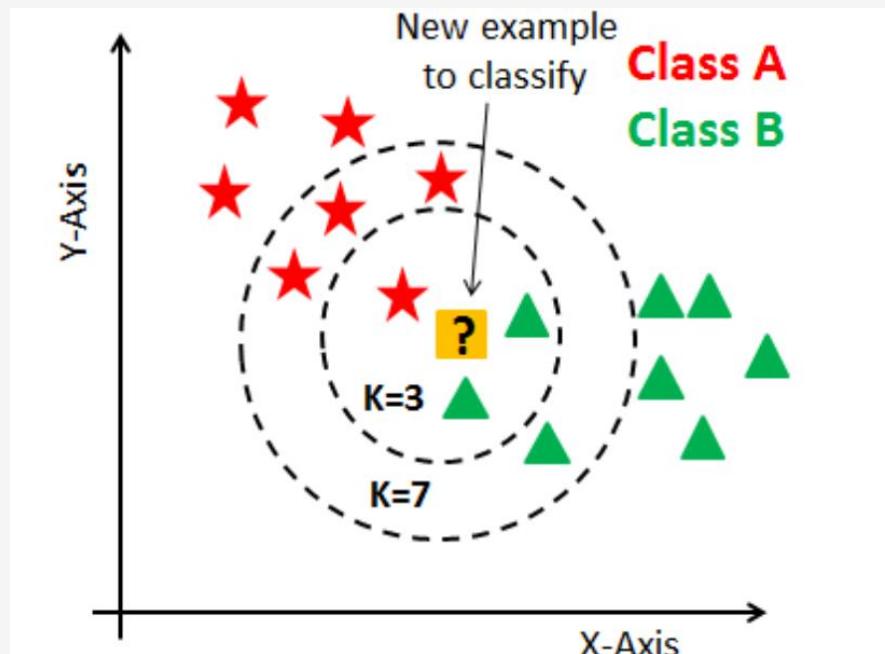


Image Source : Internet

Key Terms

1. Vectors
2. Embedding Models
3. Data Chunking
4. Vector Store
5. Vector Search
6. **Cosine Similarity**
7. **KNN**

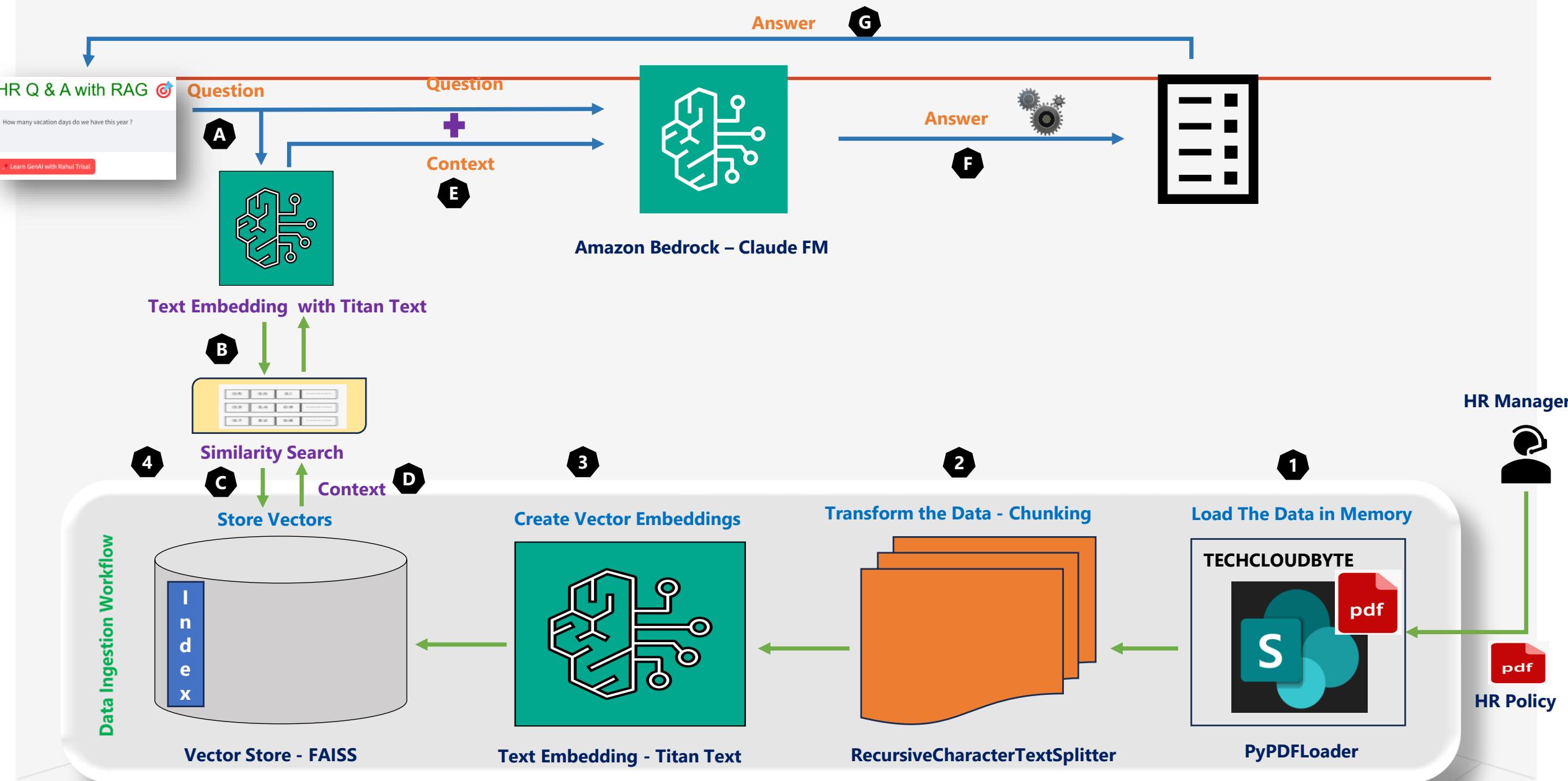
ANN - Approximate Nearest Neighbor

Use Case : Retrieval Augmented Generation (RAG)

Employee HR Q & A Application with RAG

Architecture Overview

HR Question & Answer Application with Retrieval Augmented Generation - Architecture



Use Case : Retrieval Augmented Generation (RAG)

Employee HR Q & A Application with RAG

Pre- Requisites - Installation

Pre-requisites – List of items to be installed

- 1. pip3 install flask-sqlalchemy**
 - 2. pip install pypdf**
 - 3. pip install faiss-gpu** (for CUDA supported GPU)
- or**
- 4. pip install faiss-cpu** (depending on Python version).

Pre-Requisites

For installation of other items for this use case, if not already installed, refer to below Section and Lecture (one shown in video as well). If already installed, skip next few slides.

*Section : Building a Chatbot with Llama 2, Langchain & Streamlit
&*

Lecture : Chatbot - Environment Setup before coding

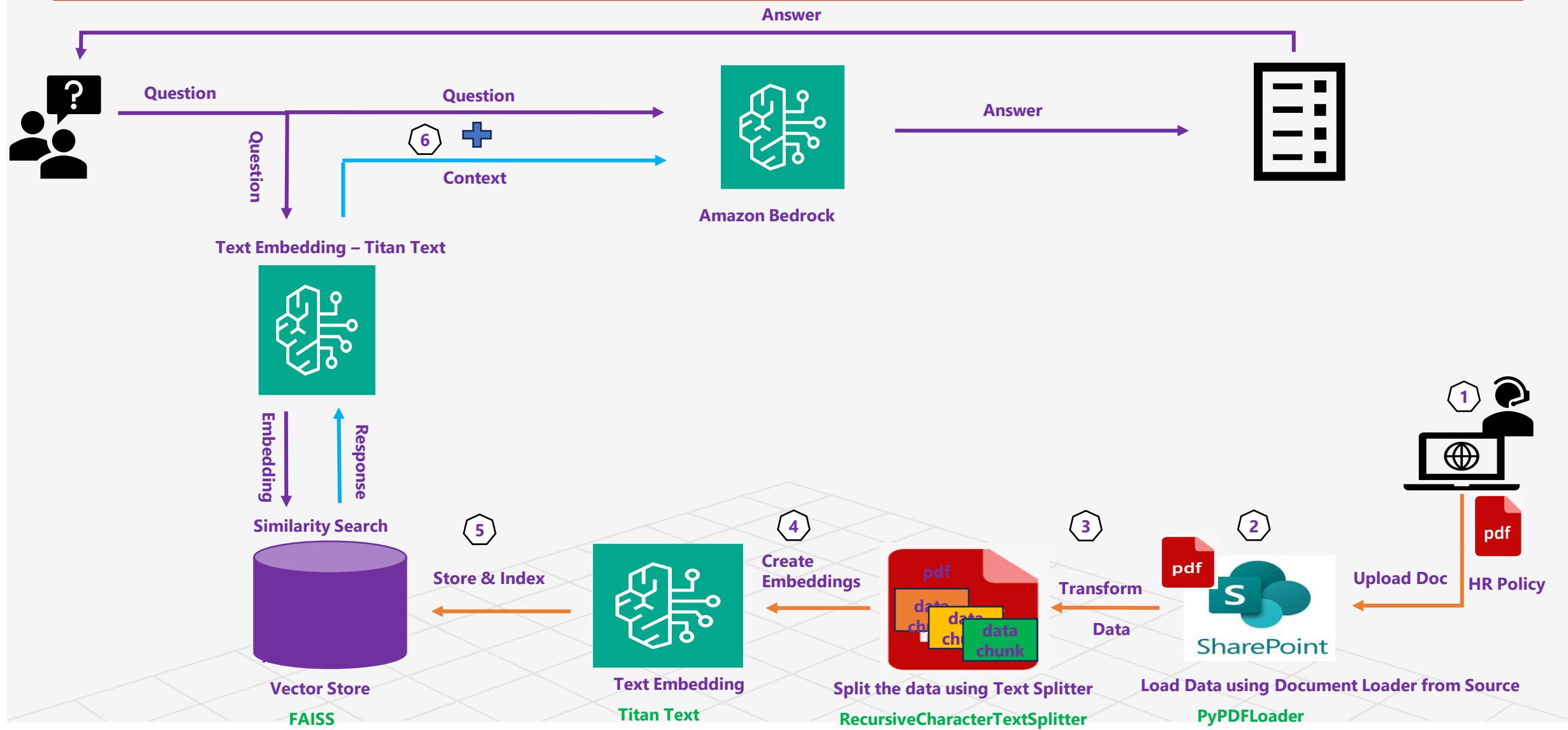
Use Case : Employee HR Q & A App with RAG

Coding Steps

Steps in Building HR Q&A Solution with RAG – Backend Code

- #1. Import OS, Document Loader, Text Splitter, Bedrock Embeddings, Vector DB, VectorStoreIndex, Bedrock-LLM
- #2. Define the data source and load data with PDFLoader(<https://www.upl-ltd.com/images/people/downloads/Leave-Policy-India.pdf>)
- #3. Split the Text based on Character, Tokens etc. - Recursively split by character - ["\n\n", "\n", " ", ""]
- #4. Create Embeddings -- Client connection
- #5a Create Vector DB, Store Embeddings and Index for Search - VectorstoreIndexCreator
- #5b Create index for HR Report
- #5c. Wrap within a function
- #6a. Write a function to connect to Bedrock Foundation Model
- #6b. Write a function which searches the user prompt, searches the best match from Vector DB and sends both to LLM.
- # Index creation --> <https://api.python.langchain.com/en/latest/indexes/langchain.indexes.vectorstore.VectorstoreIndexCreator.html>

HR Question & Answer App with RAG - Solution Architecture



Steps in Building HR Q&A Solution with RAG – Frontend Code

- Modify the Streamlit frontend code where ### highlighted
- Run Chatbot locally
 - `streamlit run <frontend_filename>.py`

Data Source URL

<https://www.upl-ltd.com/images/people/downloads/Leave-Policy-India.pdf>

GenAI Project Lifecycle

Generative AI – Implementation Lifecycle

1

Scope of Program

2

Model Selection

3

Adapt and Align
Foundation Model

4

Deployment &
Integration

- Identify the Use Case
- Define key objectives & outcomes

- FM model selection criteria
- Evaluate and select the Foundation Model
- Prompt Engineering
- RAG
- Fine Tuning

- Deploy the Model
- Integrate with existing application landscape



Generative AI – Implementation Lifecycle

1

Scope of Program

2

Model Selection

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Adapt and Align
Foundation Model

4

Deployment &
Integration

- Identify the Use Case
- Define key objectives & outcomes

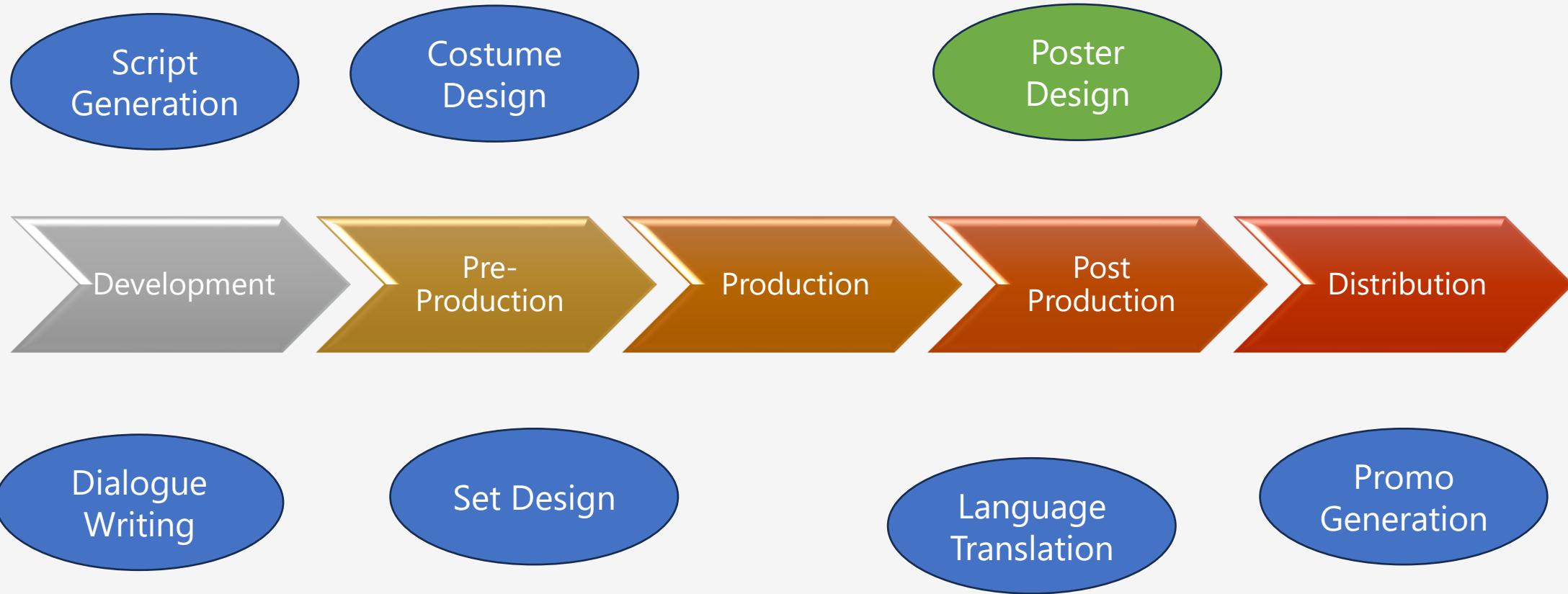
- FM model selection criteria
- Evaluate and select the Foundation Model

- Prompt Engineering
- RAG
- Fine Tuning

- Deploy the Model
- Integrate with existing application landscape



Generative AI – Media and Entertainment Industry(Film Making)

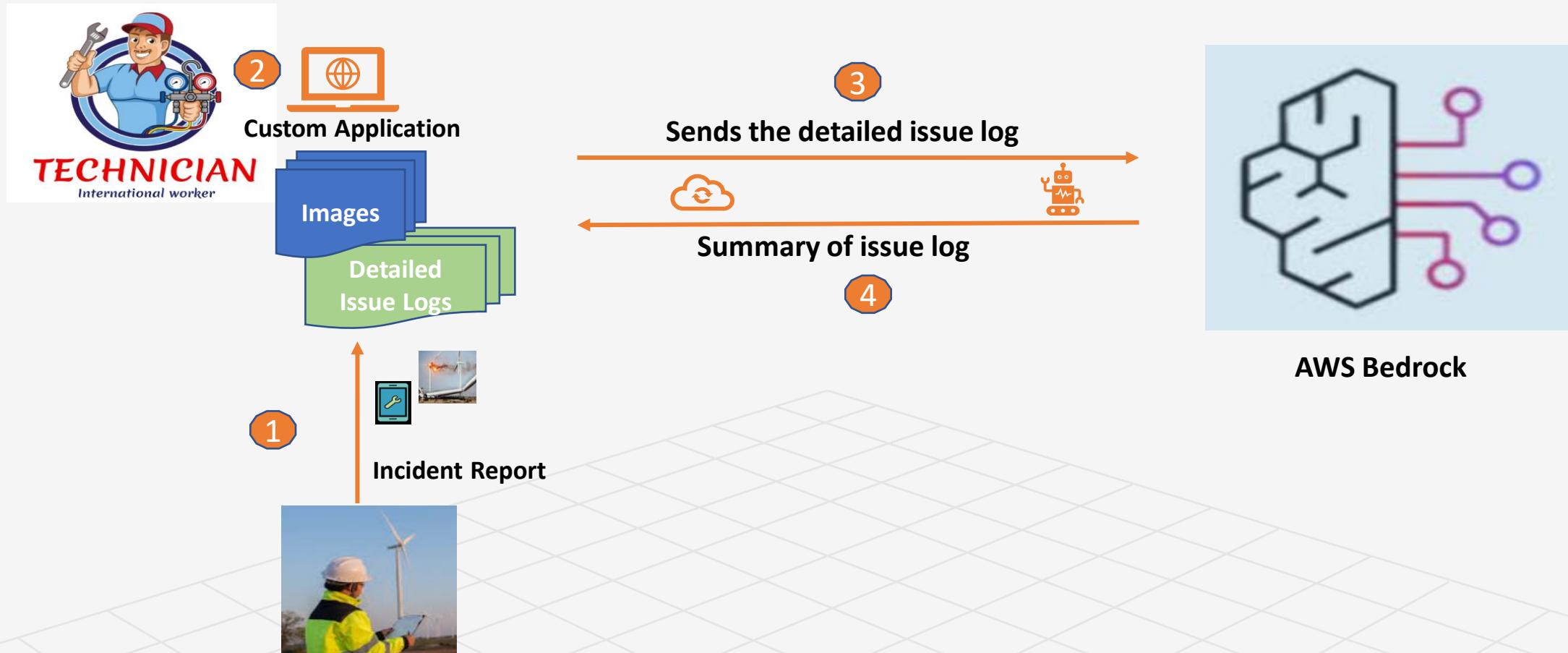


Stages in Movie making and potential role of Generative AI

Generative AI – Manufacturing Industry Use Case

Use Case :

Text Summarization using AWS Bedrock for faster issue resolution to improve productivity of technicians.



Generative AI – Use Cases

Protein folding	Design parts	Risk management	Product review summaries	Video game generation
Drug design	Material design	Fraud detection	Chatbots	Media content improvement
Personalized medicine	Predictive maintenance	Customer segmentation	Optimize pricing and inventory	Face synthesis
Improve medical imaging	Synthetic data	Next best action	Product descriptions	Film preservation
Ambient digital scribes	Chip design	Credit scoring	Fraud detection	Video generation
Healthcare & Life Sciences	Industrial & manufacturing	Financial services	Retail	Media & entertainment

Generative AI – Use Cases

- AWS Generative AI Use Case Based on Industry : [Link](#)
- AWS Generative AI Case Studies – [Link](#)

GenAI Project Lifecycle – Foundation Model Selection

Generative AI Application Lifecycle

1

Scope of Program

2

Model Selection

3

Adapt and Align
Foundation Model

4

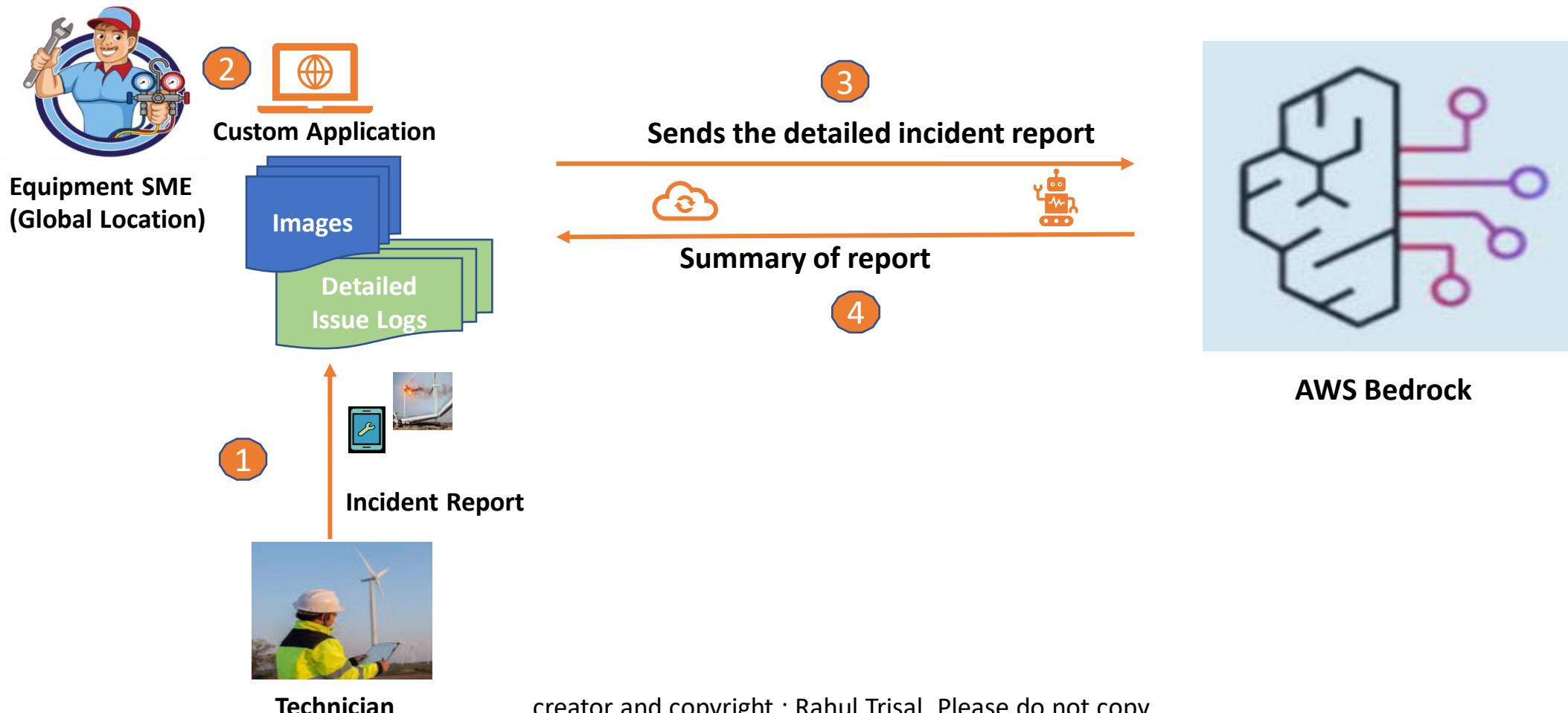
Integration

- Identify the Use Case
- Define key objectives & outcomes
- Define model selection criteria
- Evaluate and select the Foundation Model
- Prompt Engineering
- Fine Tuning
- RAG
- Deploy the Model
- Integrate with existing application landscape

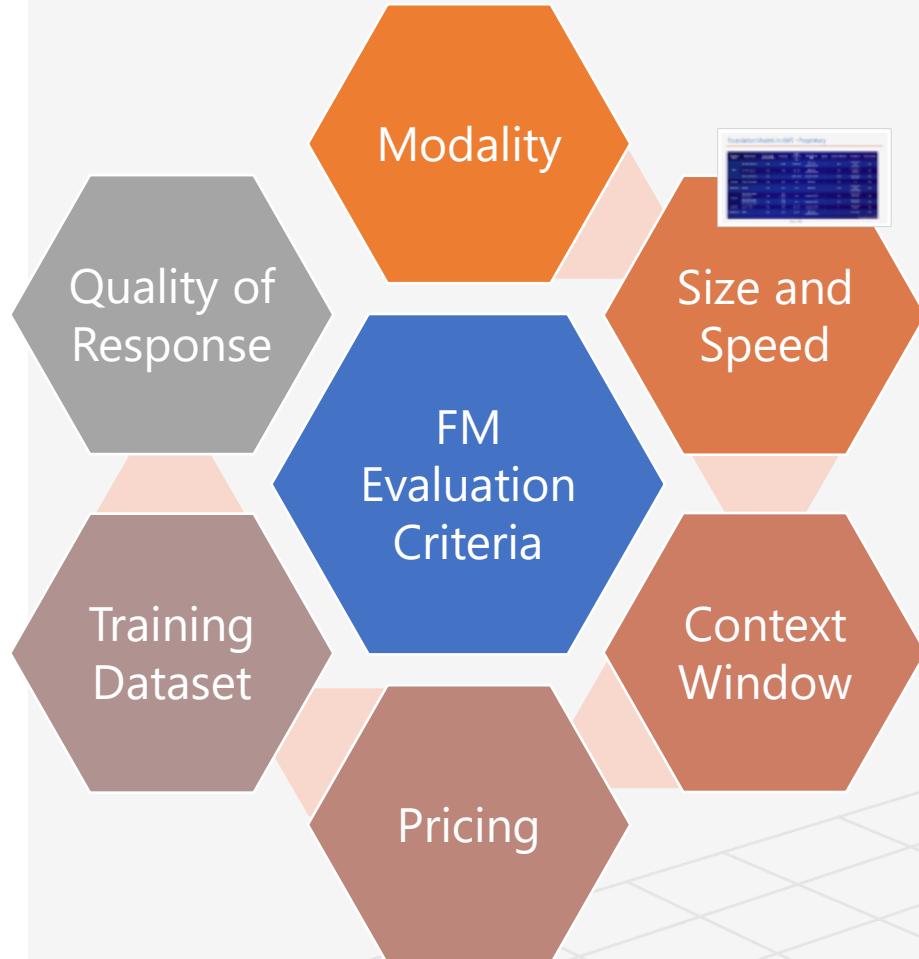
Generative AI – Manufacturing Industry Use Case

Use Case :

Text Summarization using AWS Bedrock for faster issue resolution to improve productivity of technicians.



Foundation Model Selection - Criteria



1. Modality : Text | Image (Vision) | Embedding - [Command](#), [Anthropic](#).....
2. Size : Number of model parameters > [50B](#)
3. Inference Speed or Latency : Response time for completion – [Few Seconds](#)
4. Context Window : 77- 200K token size – [Claude has max context window](#)
5. Pricing : [FM pricing](#) – [Claude most expensive and Titan least](#)
6. Training Dataset – Internet, Code, Human Feedback – [Diverse dataset](#)
7. Proprietary or Open Source – [Prefer Open Source](#)
8. Fine-tunable – [Should be fine-tunable](#)
9. Additional Features – [Multi-Lingual support](#) – [Jurassic](#), [Titan](#)
10. Quality of Response - [Accuracy](#), [Toxicity](#) and [Robustness](#)

Foundation Model – Tokens, Parameters and Temperature

	Model name	Version	Provider	Modality	Max tokens	Description
○	Embed English	v3 <small>New</small>	Cohere	Embedding	512	Embed translates text into numeric
○	Embed Multilingual	v3 <small>New</small>	Cohere	Embedding	512	Embed translates text into numeric
○	Titan Embeddings G1 - ...	v1.2	Amazon	Embedding	8k	The new Titan Embeddings G1 – Te
●	Titan Multimodal Emb...	v1 <small>New</small>	Amazon	Embedding	128 tokens	Titan Multimodal Embeddings Gen
○	SDXL 0.8	v0.8	Stability AI	Image	77	SDXL produces more detailed imag
●	SDXL 1.0	v1.0 <small>New</small>	Stability AI	Image	77	SDXL generates images of high qua
●	Titan Image Generator...	v1 - preview <small>New</small>	Amazon	Image	77 tokens	Titan Image Generator G1 is an ima
○	Jurassic-2 Ultra	v1	AI21 Labs	Text	8191	Jurassic-2 Ultra is AI21's most pow
○	Jurassic-2 Mid	v1	AI21 Labs	Text	8191	Jurassic-2 Mid is less powerful than
○	Claude	v2.1 <small>New</small>	Anthropic	Text	200k	An update to Claude 2 that feature
○	Claude	v2	Anthropic	Text	100k	Anthropic's most powerful base mo
○	Claude	v1.3	Anthropic	Text	100k	An earlier version of Anthropic's ap



Modality



Parameters



Max Tokens

Bedrock Console View

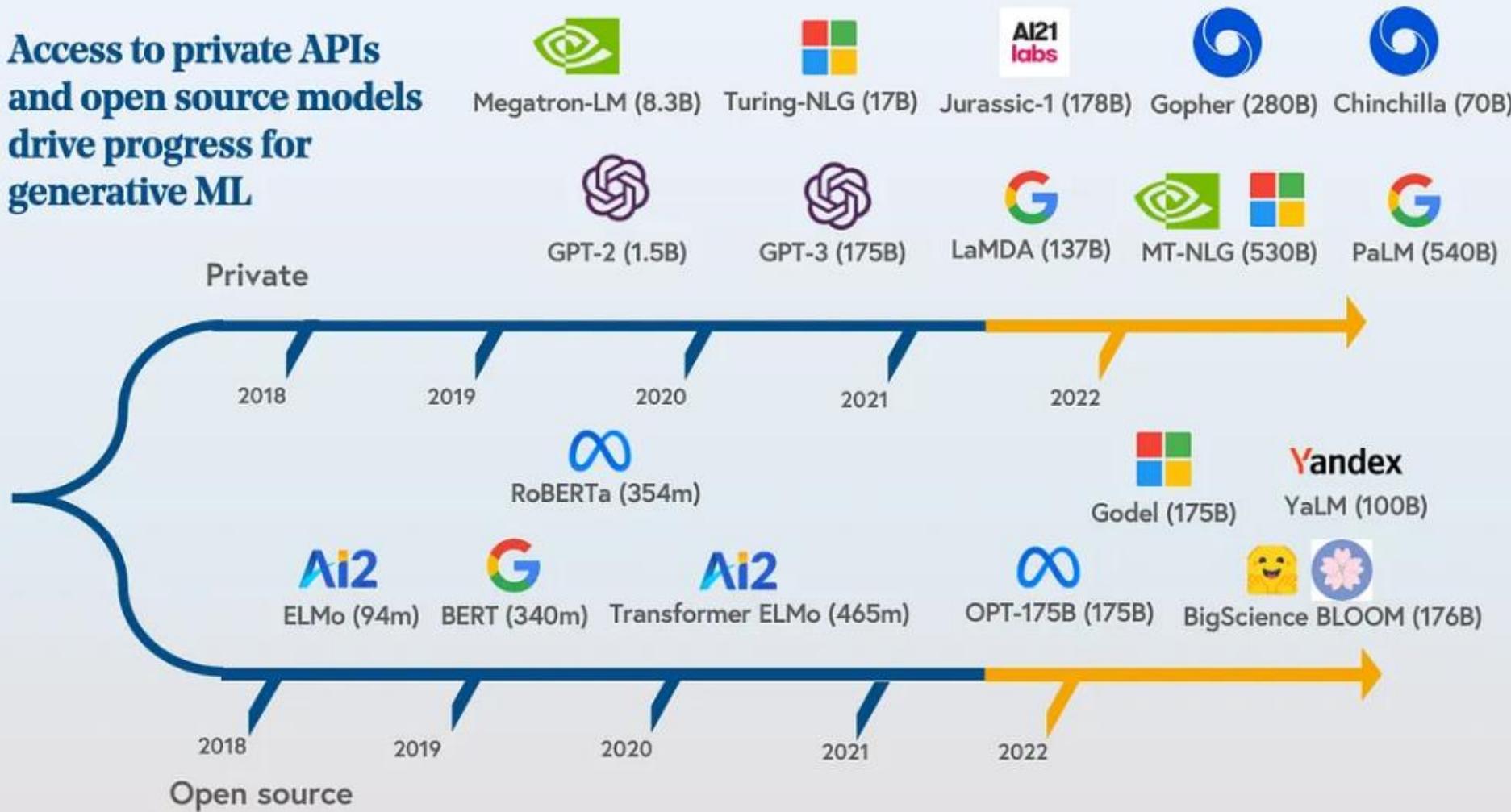
Foundation Models in AWS - Proprietary

Company Name	Model Name	Can be used Commercially	# Params	GPU instance req.	Available on AWS	Speed	Context Window	Trained on	Fine-tunable
AI21	J2 Ultra Instruct	Yes	178 B	p4d.24xl	Bedrock, Jumpstart/SM	-	8 K	Internet Data, Code, Instructions	No
	J2 Mid Instruct	Yes	17 B	g5.12xl	Bedrock, Jumpstart/SM	-	8 K	Internet Data, Code, Instructions	No
	AI21 Summarize	Yes		g4dn.12xl	Jumpstart/SM	-	~13 K	Internet Data, Instructions	No
Amazon	Titan Text Large	Yes	n/a	n/a	Bedrock	-	4 K	n/a	No
Anthropic	Claude	Yes	n/a	n/a	Bedrock	-	12 K	Internet Data, Code, Instructions, Human feedback	No
Cohere	Generate Model Command	Yes	n/a (50 B)	n/a	Jumpstart/SM	-	4 K	Internet Data, Instructions	No
	Generate Model Command-Light	Yes	n/a (6 B)	n/a	Jumpstart/SM	-	4 K	Internet Data, Instructions	No
LightOn	Lyra-Fr 10B	Yes	10 B	g5.12xl	Jumpstart/SM	-	?	Internet Data (French)	No
Stability AI	SDXL	Yes	n/a	g5.xl	Bedrock, Jumpstart/SM	-	-	<Text, Image>	No

*Last update July 2023

Popular Foundation Models (Parameters perspective)

Access to private APIs and open source models drive progress for generative ML



Cohere

- Cohere has **52 billion** parameters

Claude 2 by Anthropic

- **137 billion** parameters

Foundation Models in AWS – Open Source



Company Name	Model Name	Can be used Commercially	# Params	GPU instance req.	Available on AWS	Speed	Context Window	Trained on	Fine-tunable
Google	FLAN-UL2	Yes	20 B	g5.12xl	Jumpstart/SM	-	2 K	Internet Data, Code, Instructions	Yes
	FLAN-T5-XXL	Yes	11 B	g5.xl	Jumpstart/SM	-	512	Internet Data, Code, Instructions	Yes
Eleuther	GPT-J	Yes	6 B	g5.xl	Jumpstart/SM	-	512	Internet Data, Code	Yes
TII	Falcon-40B-Instruct	Yes	40 B	g5.12xl	Jumpstart/SM	-	2 K	Internet Data, Code, Instructions	Yes
	Falcon-7B-Instruct	Yes	7 B	g5.xl	Jumpstart/SM	-	2 K	Internet Data, Code, Instructions	Yes
BigCode	Starcoder	Yes	15 B	g5.12xl	SM	-	8 K	Code	Yes
	Santa Coder	Yes	1.1 B	g5.xl	SM	-	2K	Code	Yes
LMSYS Org	Vicuna-13B	No	13 B	g5.xl	SM	-	2 K	Internet Data, Code, Instructions	Yes
Meta	Llama-65B	No	65 B	g5.48xl	SM	-	2 K	Internet Data, Code	Yes
Stability AI	SD 2.1	Yes	-	g5.xl	Jumpstart/SM	-	-	<Text, Image>	Yes

*Last update July 2023

AWS Bedrock Foundation Model Evaluation Service

AWS Bedrock Model Evaluation Service

1. Automatic

- Task Type ----> Text Generation, Text Summarization, Q&A, Text Classification
- DataSet --- > Built in – Gigaword, XSUM or Bring your own dataset
- Metrics --- > Accuracy, Toxicity and Robustness

2. Human: Bring your own work team

- Evaluates up to **2 models** using a **work team** of your choice to provide feedback.
- Provides **results based** on the parameters that are specified while creating the evaluation.

3. Human: AWS Managed work team

Generative AI Application Lifecycle

1

Scope of Program

2

Model Selection &
Architecture Alignment

3

Adapt and Align
Foundation Model

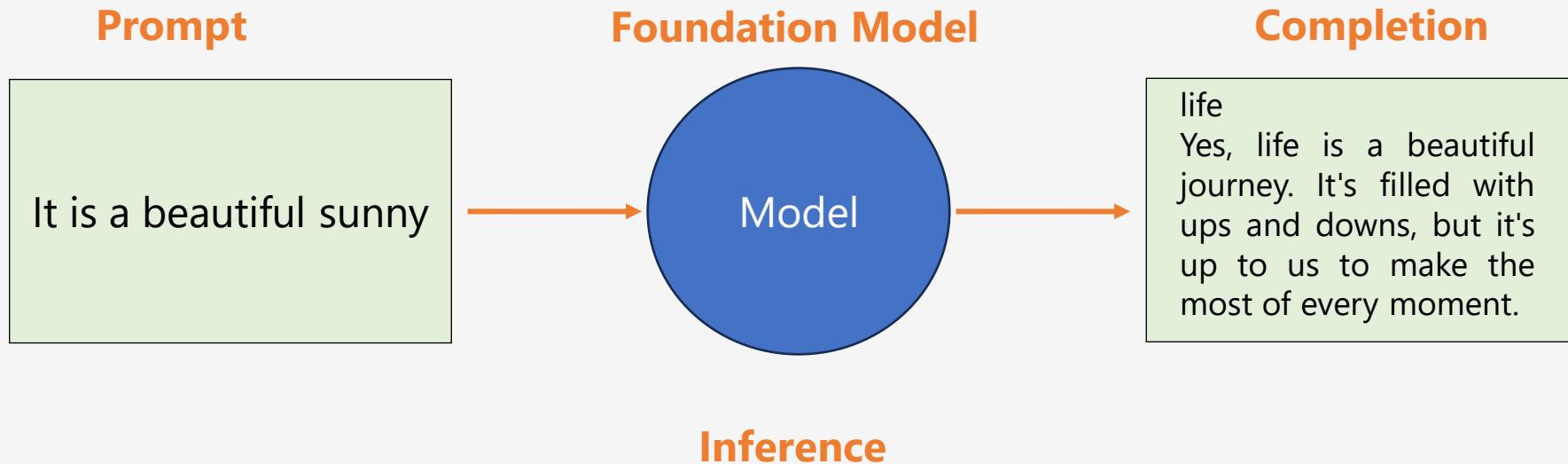
4

Integration

- Identify the Use Case
- Define key objectives & outcomes
- Define model selection criteria
- Evaluate and select the Foundation Model
- **Prompt Engineering**
- Fine Tuning
- RAG
- Deploy the Model
- Integrate with existing application landscape

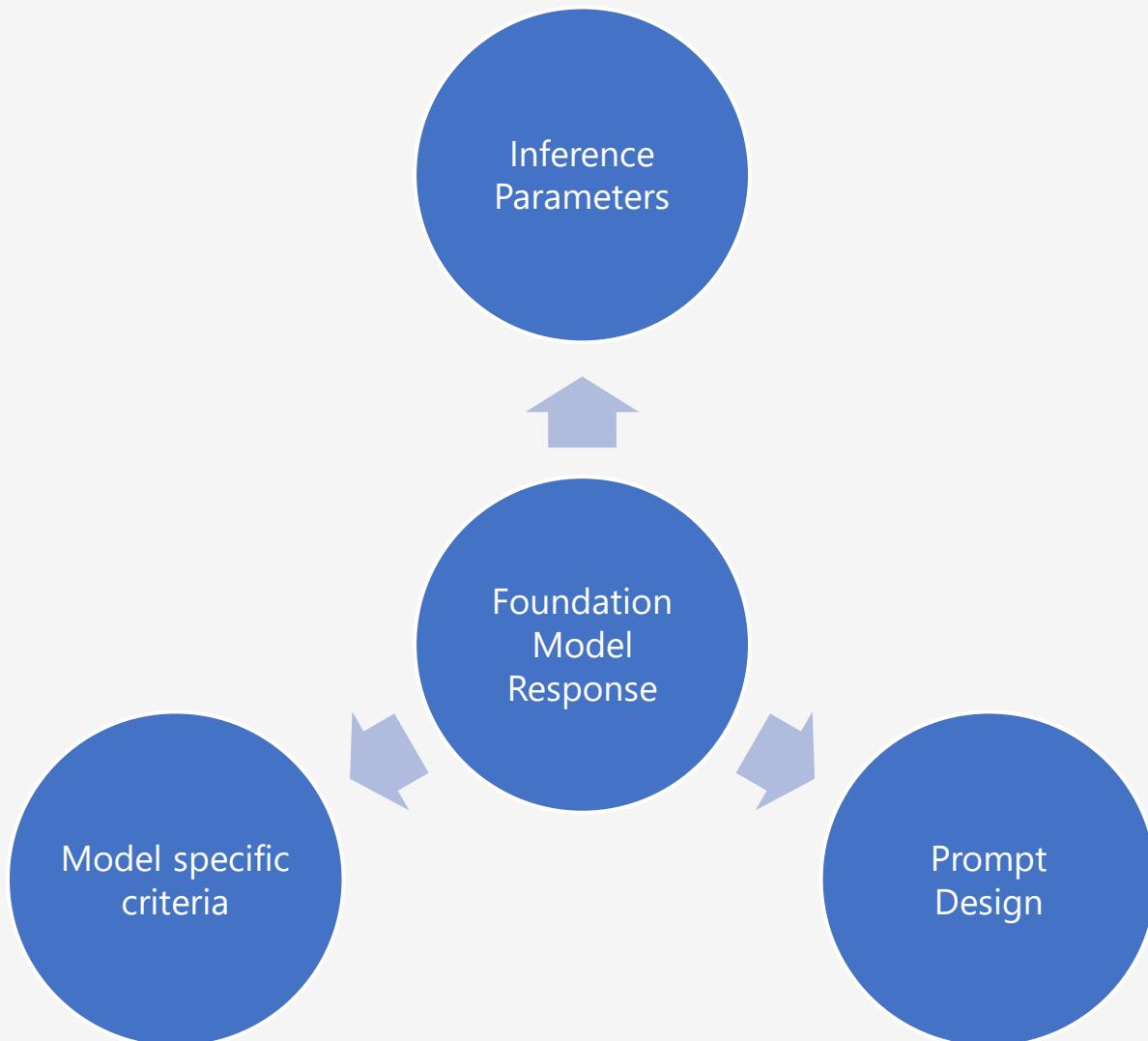
GenAI Project Lifecycle – Prompt Engineering

What is a Prompt ?



- **Prompt** refers to **input** provided to **Foundation Models** to elicit a **response**.
- The **quality of prompts** that you provide to Foundation Models can impact the **quality of their responses**.
- **Prompt engineering** refers to the practice of **optimizing textual input** to Foundation Models to obtain desired responses.

Factors impacting good response/completion from Foundation Models



Factors influencing good Completion from FM's:

1. *Prompt Design*

2. *Inference Parameters*

3. *Knowledge of Foundation Model*

Manufacturing Use Case - Prompt for Summarization Task

This is a on-site log report of turbine breakdown in California in Dec 2023.

Issue Log Date – 25-12-2023, Model Number – TB-CL-7882, **Issue** - Cracks appeared in the part MR 7882-9571 next to the rotor hub. The nut connecting the rotor blade to the rotor hub seems to be damaged. The Anemometer readings seem to be within range. The electric braking seems to be unused. No indication of damage to any other component of the turbine except normal wear and tear.

Potential Root Cause – Seems due to reduced tensile strength of the nut connecting the blade to the rotor.

Last Maintenance Date – 12-12-2023, **Last Maintenance Issues Recorded** - No known issues recorded and all the parameters were within range.

Summarize the text in 2 lines.



2. Elements of a Good Prompt Design

This is a review of football world cup Qatar 2022 :

"Lionel Messi can finally be called a world champion.

Messi scored twice in one of the most epic soccer games anyone has ever watched as Argentina won the 2022 FIFA World Cup Final over France on penalties.

The climactic match in Qatar finished 3-3 after extra time, with La Albiceleste claiming the shootout by a 4-2 margin.

Argentina held a comfortable 2-0 lead until the 80th minute courtesy of a Messi penalty and a sublime team goal finished by Ángel Di María in the first half. However, Kylian Mbappé converted from the spot and finished a sumptuous volley in a span of two minutes to send the game to extra time.

Messi was once again on hand to put Argentina in front in the 108th minute, but Mbappé kept his cool from the penalty spot once more to send the final to a shootout. Messi knocked home the first penalty, then Argentina keeper Emiliano Martínez made a save in the second round from Kingsley Coman's effort. France's Aurélien Tchouaméni sent his spot-kick wide in the third round, leaving Gonzalo Montiel to seal the title in the fourth."

Summarize the above review in 2 lines:

Contextual Information about the task

Input text for Task

1. Clear concise instructions

2. Task to be accomplished at the end

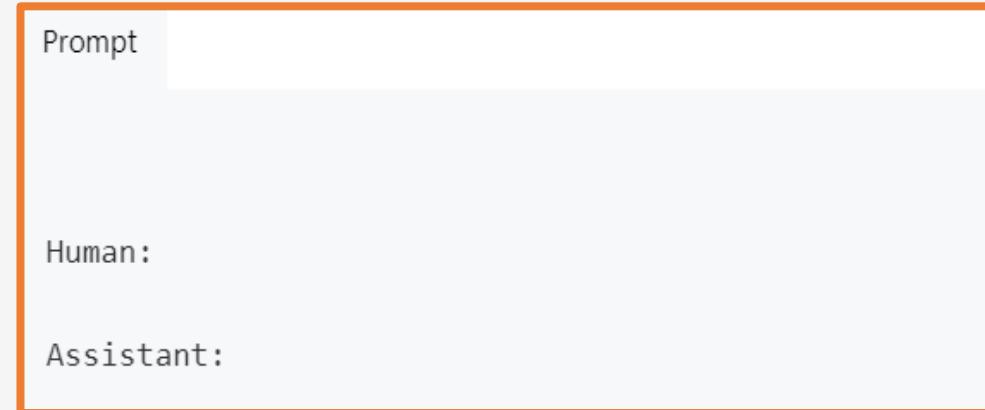
3. Output specification

1. **Task Specification – Summarize**
2. **Output Specification – 2 lines**

Designing Prompts varies based on Foundation Model used - Claude

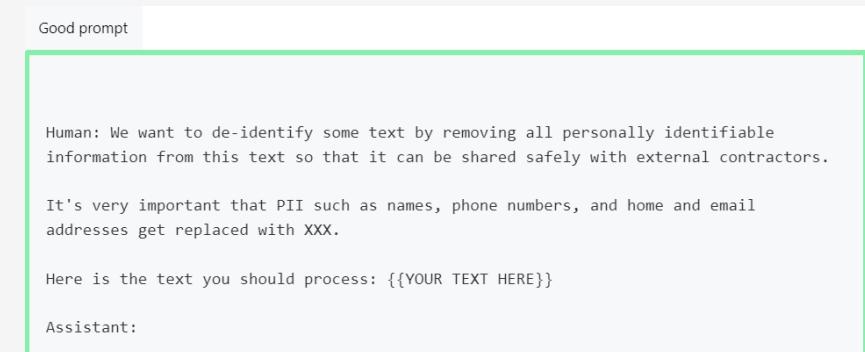
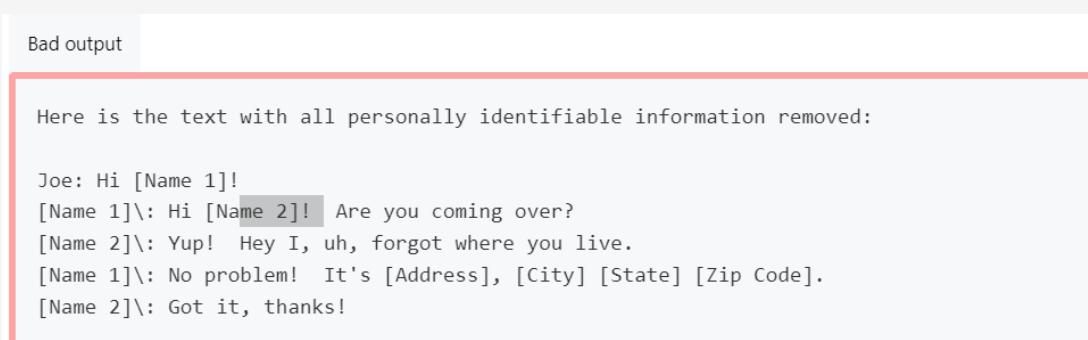
1. Use the correct format

- Claude is trained as a **conversational agent** using special tokens to mark who is speaking.
- The **Human: (you)** asks a question or gives instructions
- **Assistant: (Claude)** responds.



2. Describe the task well

- Good to give Claude as much context and detail as possible



Designing Prompts - Claude

3. Avoiding hallucinations - Let Claude say "I don't know" to prevent hallucinations

Bad prompt

Human: What is the heaviest hippo ever recorded?

Assistant:

Bad output

The heaviest hippo ever recorded was a bull named Hubert, who weighed 5,000 kg or 11,023 lbs. Hubert was measured in Kenya in the early 20th century. Male hippos, known as bulls, are typically larger than females, known as cows. Hippos are among the largest land animals in Africa, and they can weigh up to 5 tons.

Good prompt

Human: Answer the following question only if you know the answer or can make a well-informed guess; otherwise tell me you don't know it.

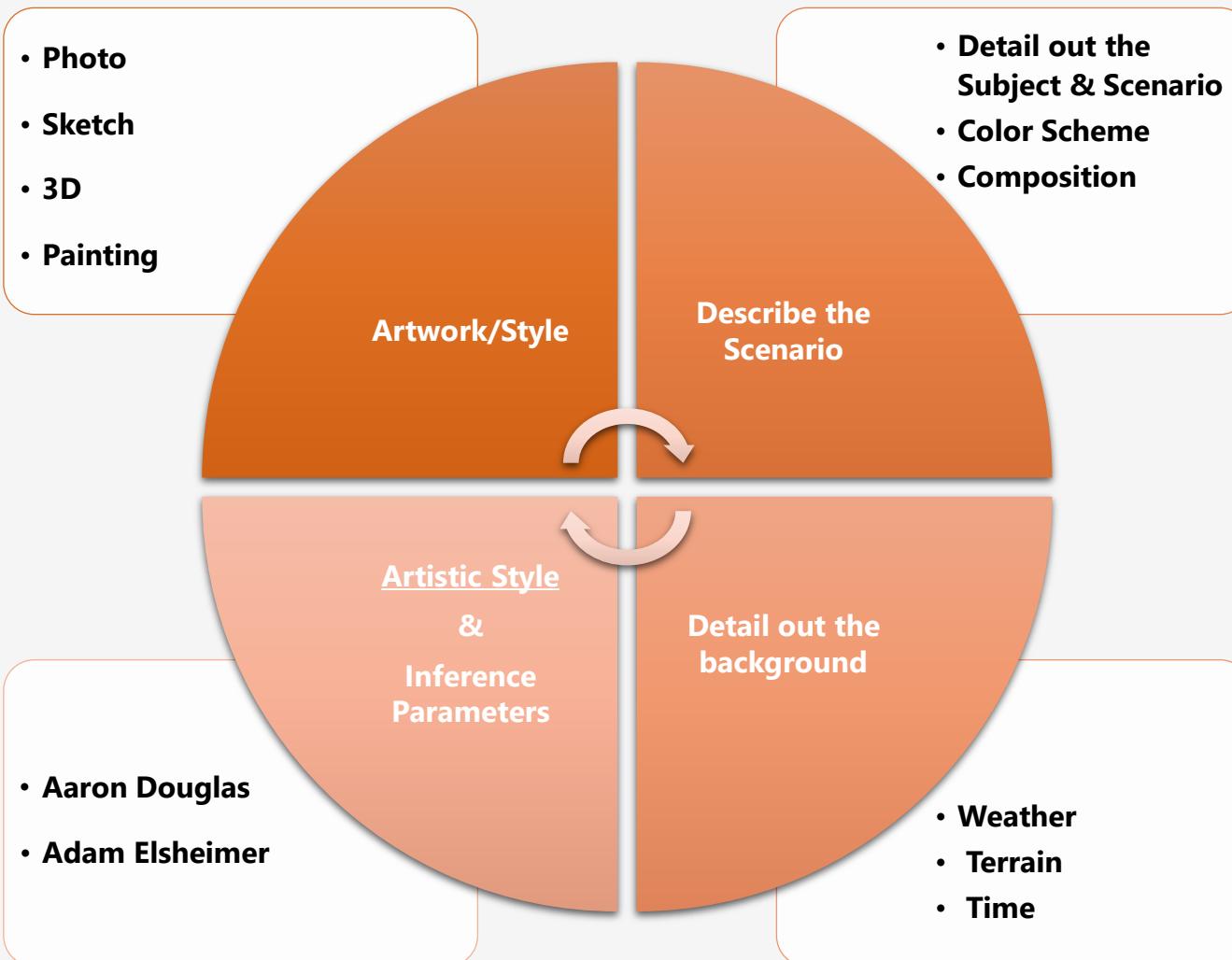
What was the heaviest hippo ever recorded?

Assistant:

Good output

I'm sorry, I don't know the exact weight of the heaviest hippo ever recorded. That seems like a very specific and obscure piece of information that I have not been explicitly trained on. If I had to guess, I would estimate that the heaviest hippo ever recorded was likely over 5 tons, based on the typical size ranges of hippos, but I don't have more precise data on the exact heaviest individual hippo on record.

Prompt Design for Stability AI



Start prompt with :

- “An image of”
- Use detailed scenario
- Provide details
 - Medium
 - Color
 - Time of Day etc.
- Style
- Photo/Sketch etc.
- Inference Parameters

Prompt Design for Stability Diffusion - 1

An **image** of a **spy agent fighting** in a rival country with guns and helicopters with backdrop of a shopping complex with heavy snow and old **Greek architecture** building late in the **evening** with **sun setting behind mountains**. The image should be a **photograph** with Aaron Jasinski style

Prompt Design for Amazon Titan and AI21 – Text generation

Text generation

Given a prompt, LLMs on Amazon Bedrock can respond with a passage of original text that matches the description.

Prompt template for Amazon Titan and AI21 Jurassic: """"Please write a {{Text Category}} in **the voice of {{Role}}**. """"

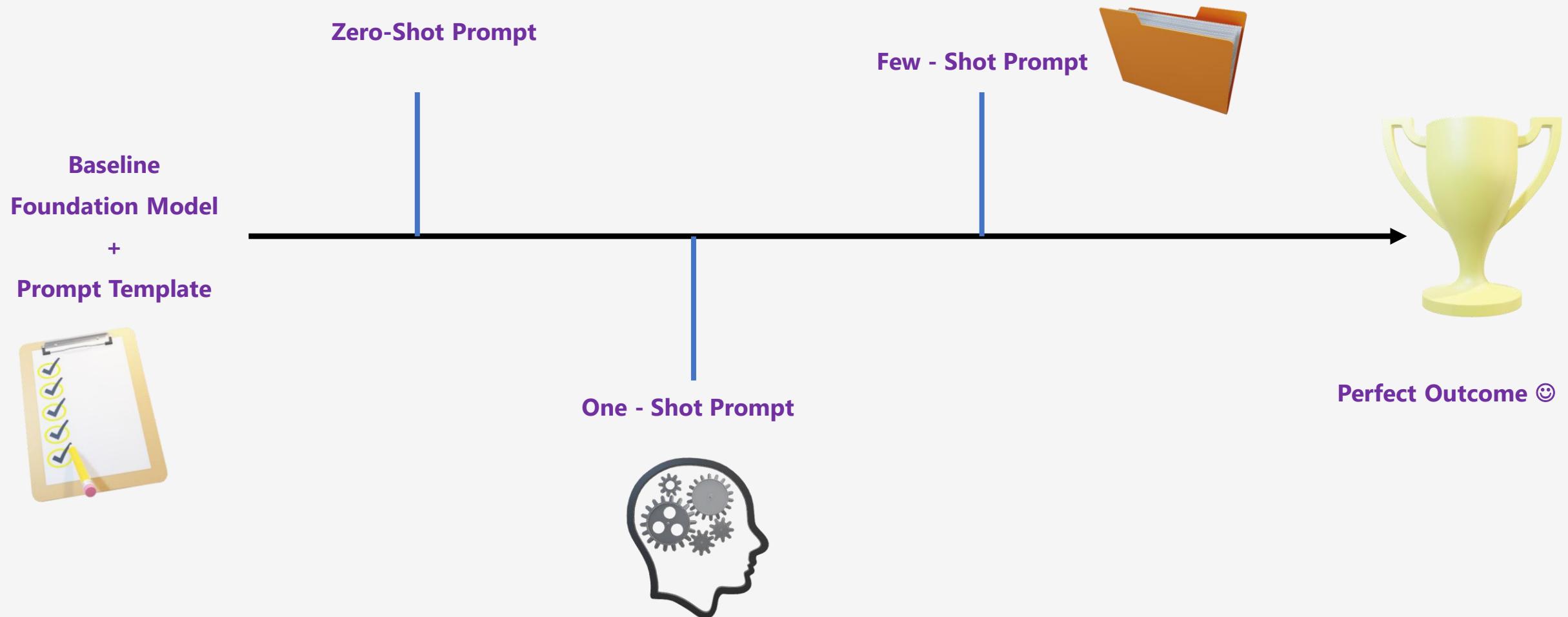
User prompt:

Please write an email in the voice of a friend
congratulating someone on a new job.

Output:

Hey [Name],
I just found out about your new job, and I'm so happy for you! Congratulations! You deserve this opportunity since you worked so hard to get it. I know you'll do great and make a positive impact on your team. I'm here to support you every step of the way.
Wishing you all the best in this exciting new chapter of your life!

Prompt Engineering Techniques



Zero-Shot Prompting

Zero-Shot Prompting

- FM's are capable of **performing some simple tasks "zero-shot."**
- No examples need to be provided to accomplish the task



PROMPT

Write an engaging product description for a T-shirt for a clothing eCommerce site:

COMPLETION

This T-shirt is perfect for any occasion. It's made of high-quality materials and it's comfortable to wear. It's also stylish and versatile, so you can wear it with anything.

One -Shot Prompting

One-Shot Prompting

- One-Shot Prompting provides **examples to the model** to assist the model to comprehend and generate responses



PROMPT

Write an engaging product description for a clothing eCommerce site.

Make sure to include the following features in the description.

Product: Women's Boho Beach Dress Features: - Midi dress - Swing hem - Slimming - Special for summer

Description: Women's Boho Beach Dress The style of midi dress with swing hem is slimming, It will make your tummy look flatter. This dress for women could not only make you feel cool, but also perfectly present the curve of female waist. Even in hot summer, it still keeps your elegant.

Write an engaging product description for a clothing eCommerce site.

Make sure to include the following features in the description.

Product: Humor Men's Graphic T-Shirt Features: - Soft cotton - Short sleeve - Have a print of Einstein's quote: "artificial intelligence is no match for natural stupidity"

Description:

COMPLETION

This soft cotton t-shirt is perfect for fans of the classic scientist, Albert Einstein. The quote "artificial intelligence is no match for natural stupidity" is a reminder that sometimes the most intelligent people are the most foolish. So whether you're a science nerd or just a fan of witty quotes, this t-shirt is for you.

Few - Shot Prompting

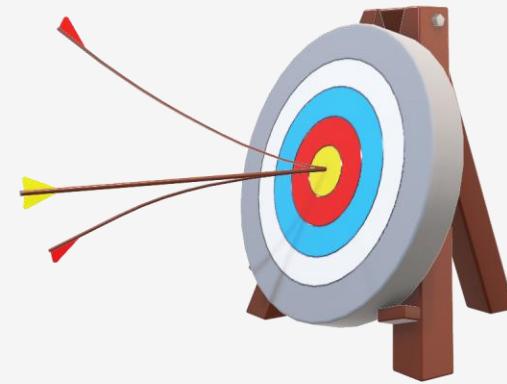
Few-Shot Prompting

- Few examples are provided to the Model to generate high quality Completion
- Good for Classification

PROMPT
Write an engaging product description for a clothing eCommerce site. Make sure to include the following:
Product: Camp Director Crossbody Bag
Features:
- Canvas purse
- Rainbow space print
- Leather trim
- Two securely-zipped compartments
Description:
This Camp Director Crossbody Bag is the perfect accessory for carrying your essentials in style. The can

Write an engaging product description for a clothing eCommerce site. Make sure to include the following:
Product: Women's Boho Beach Dress
Features:
- Midi dress
- Swing hem
- Slimming
- Special for summer
Description:
Women's Boho Beach Dress The style of midi dress with swing hem is slimming, It will make your tum

Write an engaging product description for a clothing eCommerce site. Make sure to include the following:
Product: Humor Men's Graphic T-Shirt
Features:
- Soft cotton
- Short sleeve
- Have a print of Einstein's quote: "artificial intelligence is no match for natural stupidity"
Description:



COMPLETION

This Humor Men's Graphic T-Shirt is perfect for anyone who wants to make a statement.

The soft cotton and short sleeve make it comfortable to wear, and the print of Einstein's quote is sure to get a chuckle.

Whether you're a fan of science or just looking for a funny shirt, this shirt is a great choice.

Steps to engineer a good prompt

1



Develop a test case

2



Articulate a Preliminary Prompt

3



Prompts against Test Case

4



Refine a Prompt

5



Final Prompt

GenAI Project Lifecycle – FineTuning Foundation Models

Generative AI Application Lifecycle

1

Scope of Program

2

Model Selection &
Architecture Alignment

3

Model Adaptation

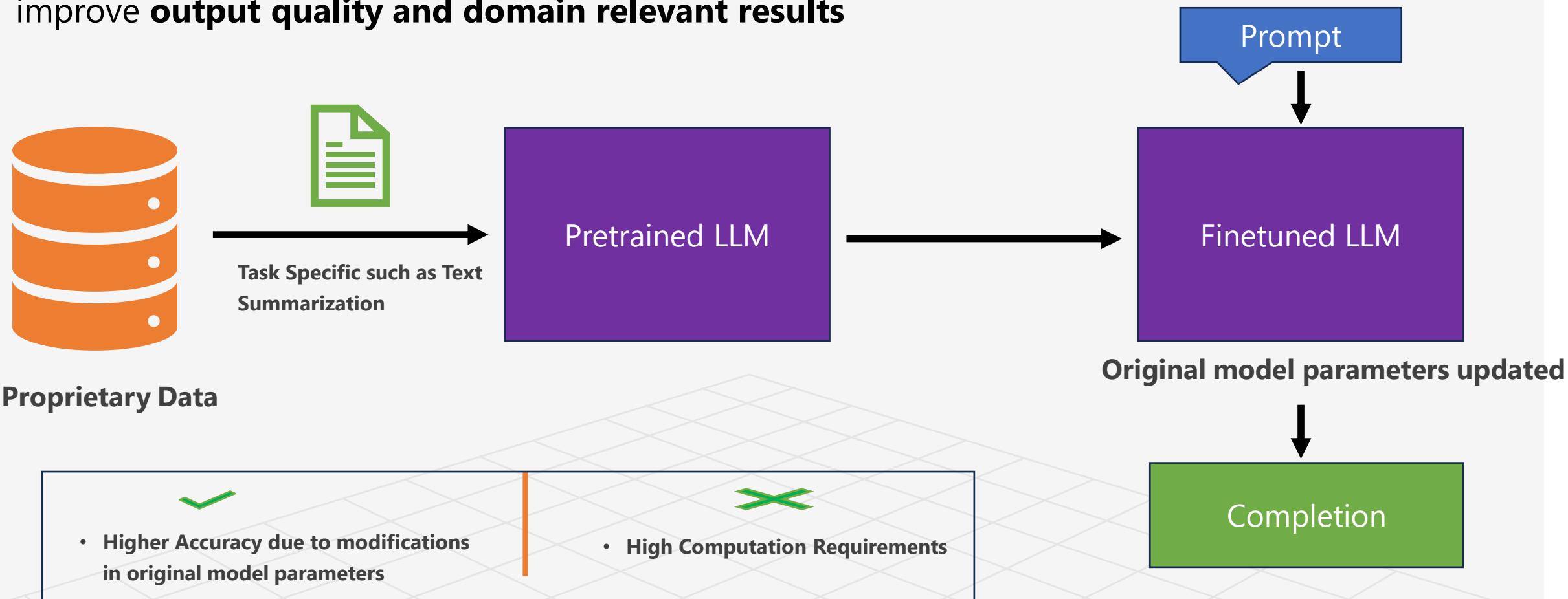
4

Integration

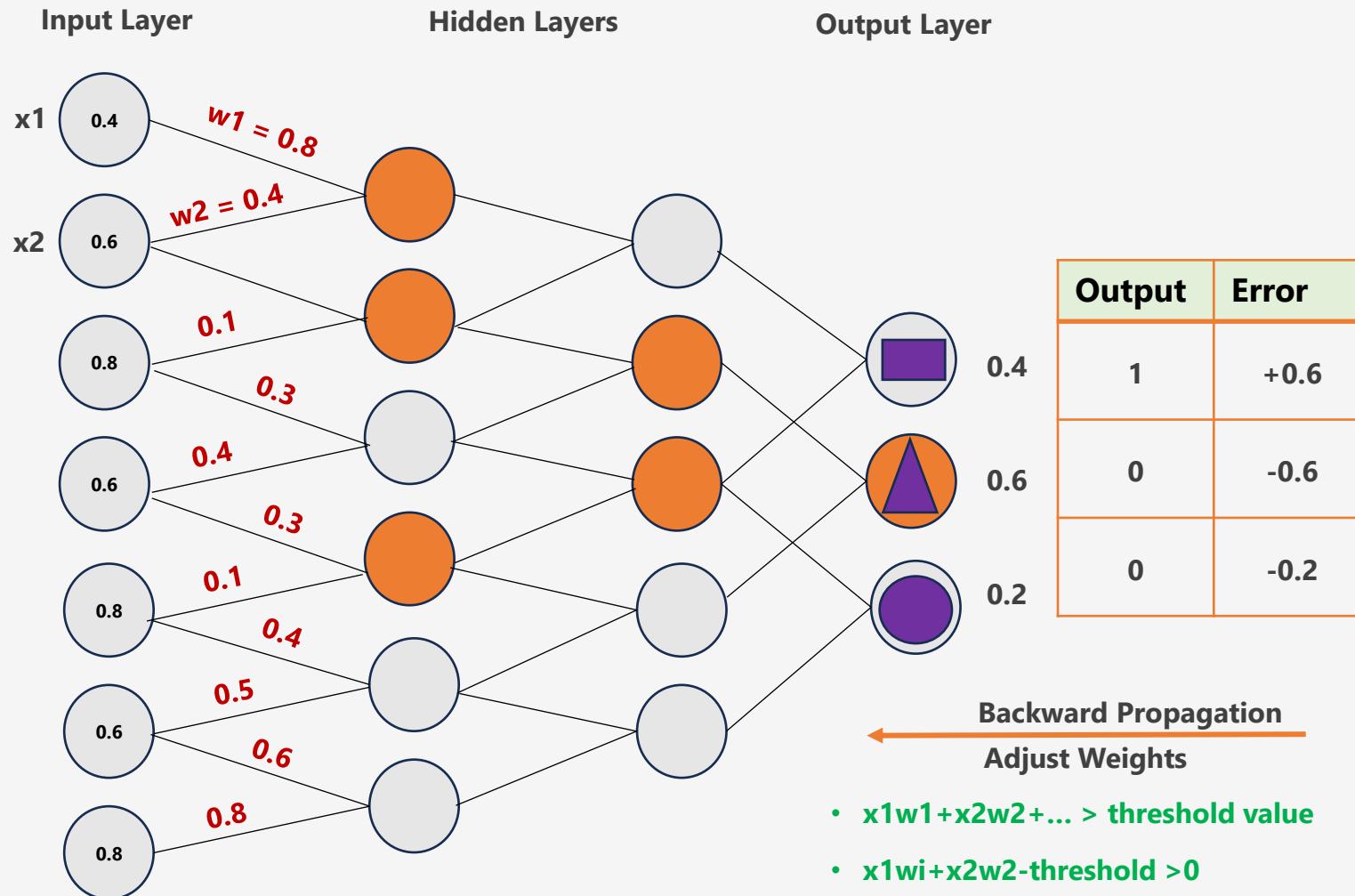
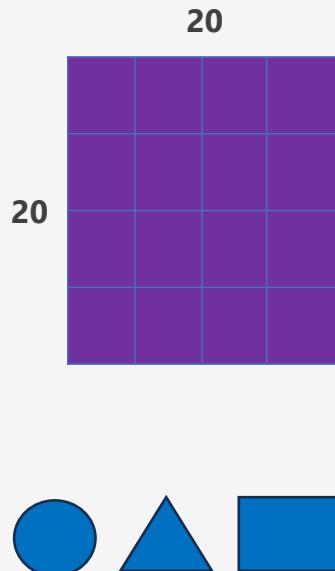
- Identify the Use Case
- Define key objectives & outcomes
- Define model selection criteria
- Evaluate and select the Foundation Model
- Prompt Engineering
- **Fine Tuning**
- RAG
- Deploy the Model
- Integrate with existing application landscape

What is Fine Tuning Large Language Models (or Foundation Models)

Fine-tuning is a technique to train a model using **proprietary or domain specific data** to improve **output quality and domain relevant results**



Machine Learning – Deep Learning with Artificial Neural Networks

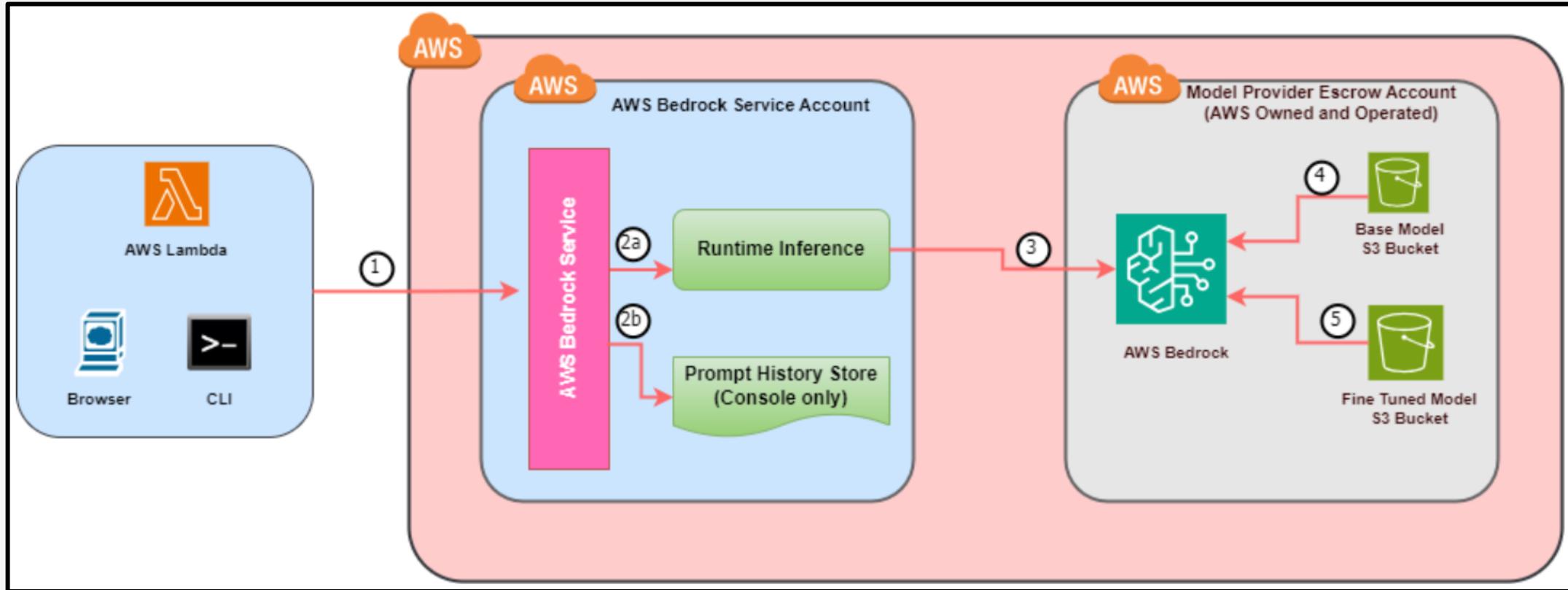


Amazon Bedrock – Key Customer Challenges from Data Security

Key Customer concerns in adopting AWS Bedrock :

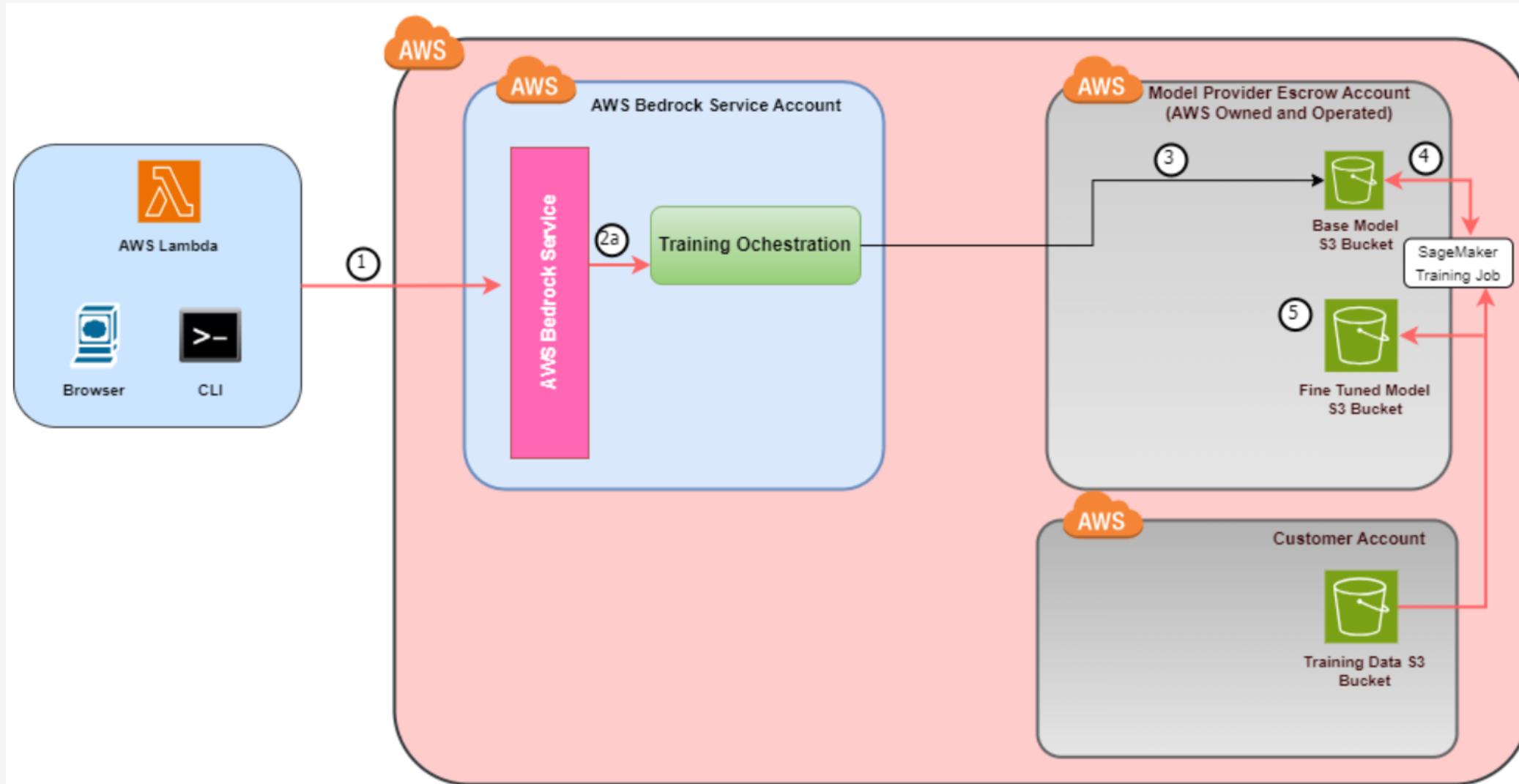
- Access to Customer Data used to Fine Tune the Foundation Model
- Access to Fine Tuned Model

Amazon Bedrock – Architecture – Part 2



- Runtime Inference : Used to redirect to right model endpoint based on the API request
- Base Model : Baseline model provided to every AWS account
- Fine Tuned Model : When Base Model is trained using custom labelled data to generate Fine Tuned Model

Amazon Bedrock – Architecture – Fine Tuning Foundation Models



Fine Tuning Foundation Models - Demo

DEMO



Fine Tuning Foundation Models – Model Parameters and Hyperparameters

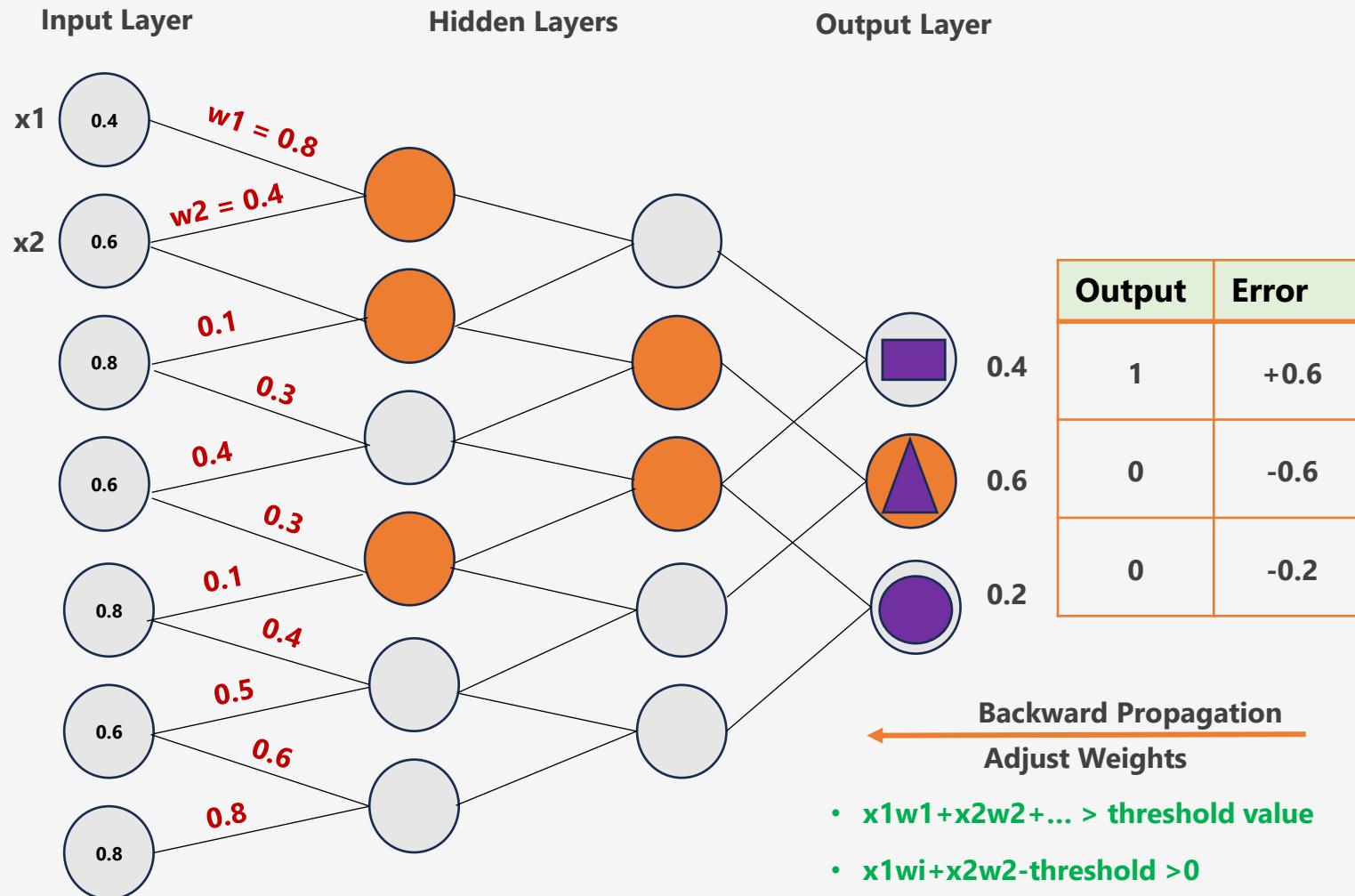
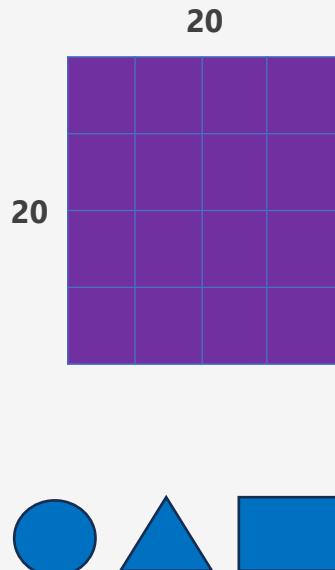
Parameters :

- Internal to Model
- Updated during training process

Hyperparameters :

- External to Model
 - Specified by developers/scientist
- 

Machine Learning – Deep Learning with Artificial Neural Networks



Instruction Fine Tuning – Key Terminology to set Hyperparameters

Terminology	Description	Example
Sample	One row of data	1
Dataset	Total number of training samples	100
Batch Size	Total number of training samples in each mini-batch	20
Iterations	Number of times Batch Size is run for entire dataset	5
Epoch	Epoch elapses when an entire dataset is run	1-Infinity
Learning rate	The rate at which model parameters are updated after each batch of training data.	

Use Case 3:

Code Generation with AWS CodeWhisperer

(From my AWS CDK Udemy Course)

AWS CodeWhisperer (Generative AI Tool powered by LLM)

- Amazon CodeWhisperer is an **AI coding** companion that **helps improve developer productivity** by **generating code recommendations based on their comments in natural language** and code in the (IDE).
- As you write code, **CodeWhisperer automatically generates suggestions** based on your existing code and comments.
- CodeWhisperer is powered by a **Large Language Model (LLM) that is trained on billions of lines of code**, and as a result, has learned how to write code in 15 programming languages.

"Accenture is using Amazon CodeWhisperer to accelerate coding as part of our software engineering best practices initiative in our Velocity platform," says Balakrishnan Viswanathan, Senior Manager, Tech Architecture at Accenture. "The Velocity team was looking for ways to improve developer productivity. After searching for multiple options, we came across Amazon CodeWhisperer to reduce our development efforts by up to 30% and we are now focusing more on improving security, quality, and performance."



Source : <https://aws.amazon.com/blogs/machine-learning/how-accenture-is-using-amazon-codewhisperer-to-improve-developer-productivity/>

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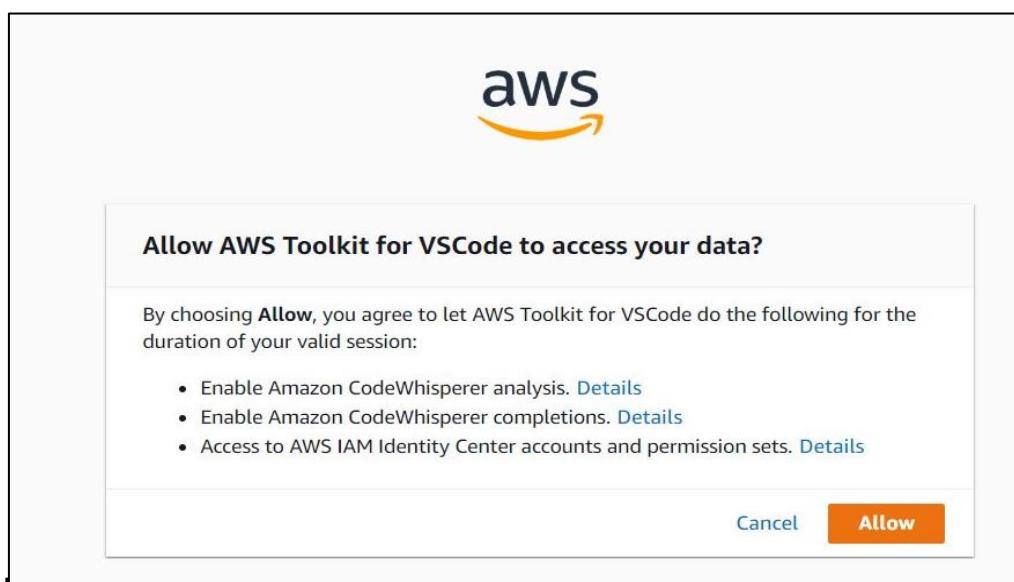
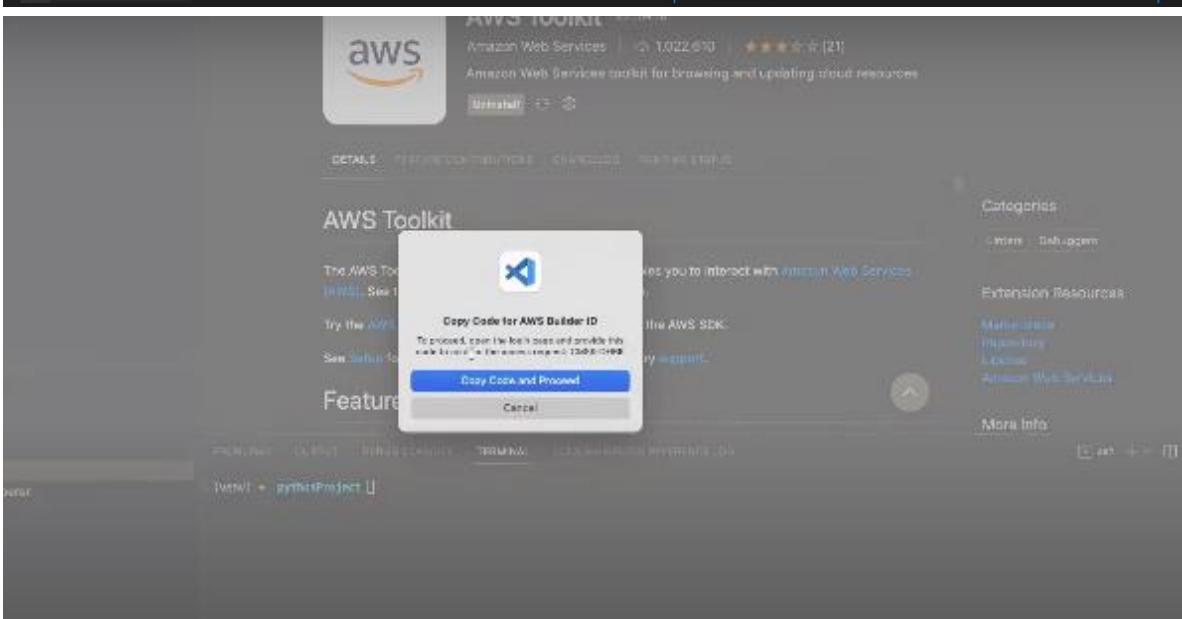
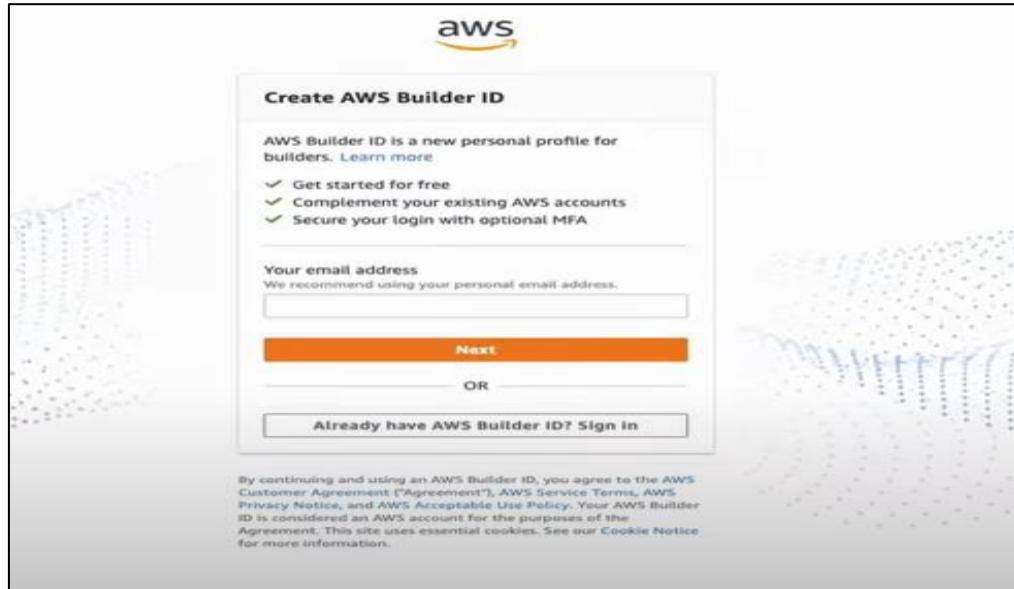
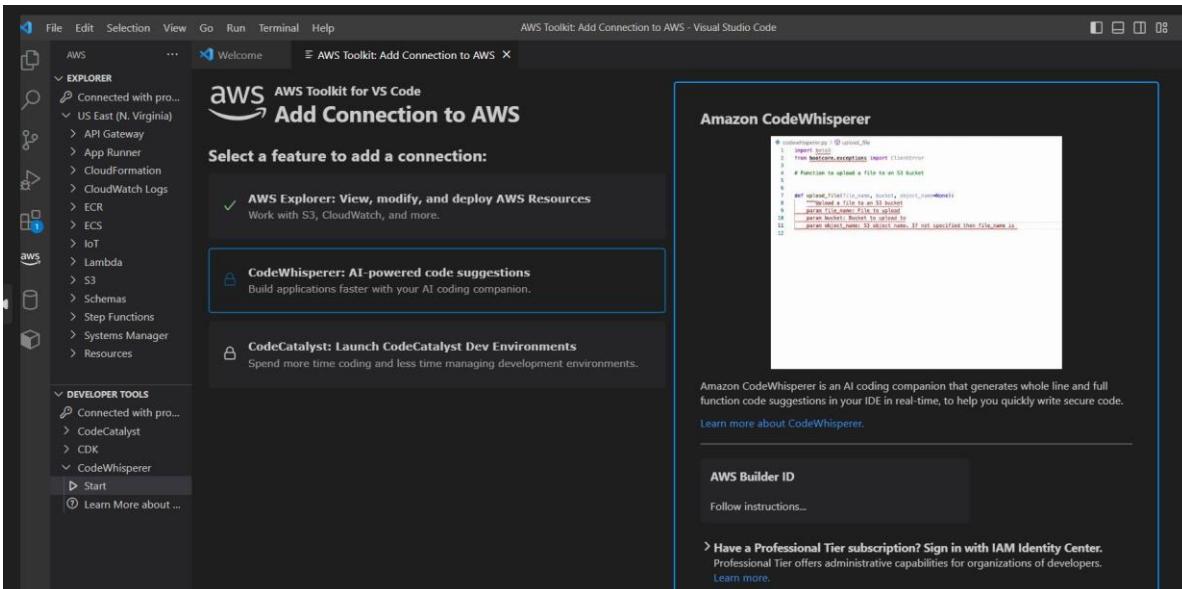
AWS CDK and CodeWhisperer (Generative AI powered by LLM)

Install Code AWS Whisperer on VSCode from below link:

- Use **Individual Tier** which is free to use and requires a simple sign-up to create an **AWS Builder ID**.
- <https://docs.aws.amazon.com/codewhisperer/latest/userguide/whisper-setup-indv-devs.html>
- <https://www.youtube.com/watch?v=rHNMfOK8pWI>



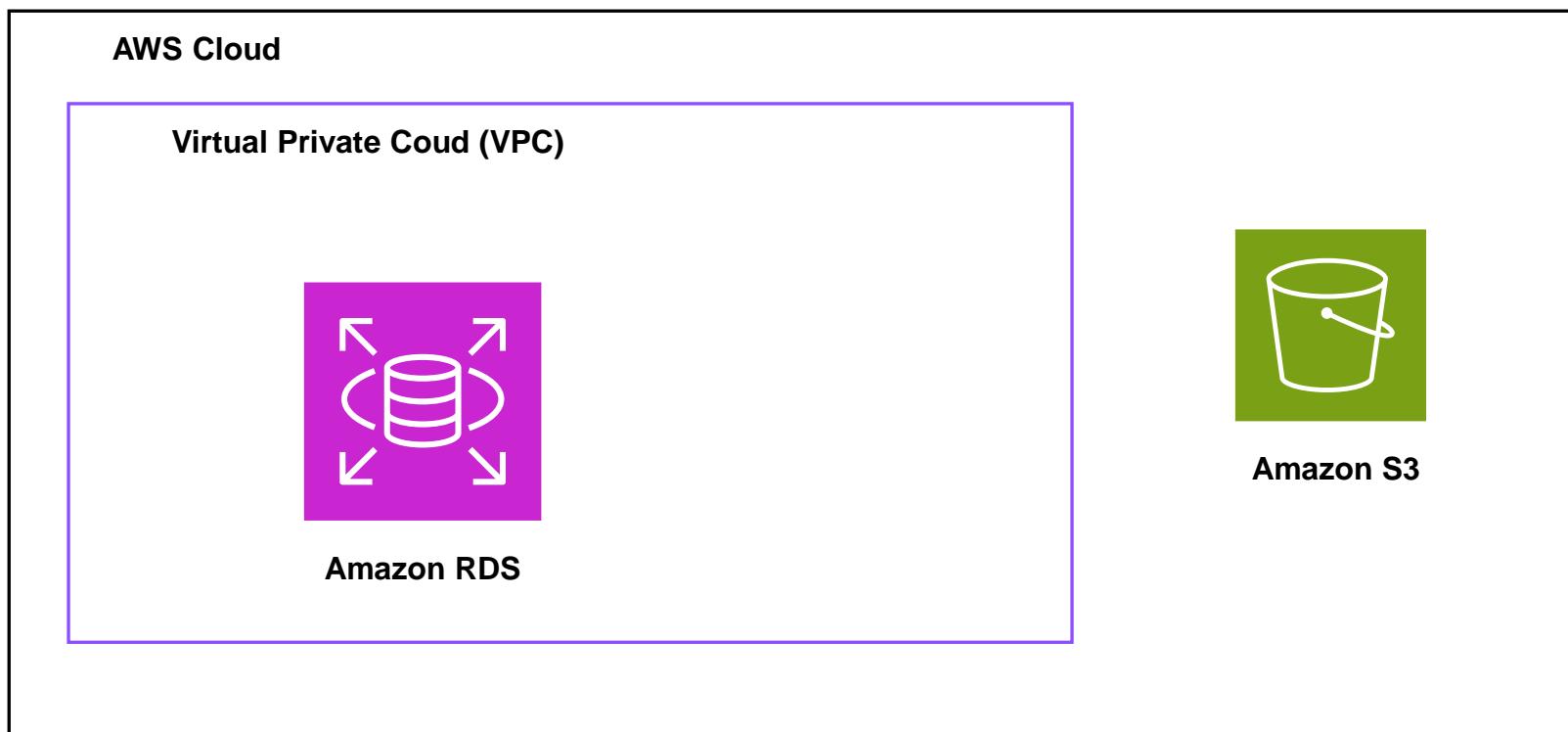
AWS CDK and CodeWhisperer (Generative AI powered by LLM)



Rahul Trisal

AWS CDK and CodeWhisperer (Generative AI powered by LLM)

What will we build using AWS CodeWhisperer and CDK ?



Summary of Steps to create any AWS Resource using CDK v2

Step 1. – Open the new folder in Visual Studio Code Editor and open Terminal

Step 2. – Create the app: Create the Directory - ***mkdir codewhisperer and cd codewhisperer***

Step 3. – Initialize the CDK with ***cdk init app --language typescript***

Step 4. – Import the module for aws service being created - [Link](#)

Step 5. – Define Scope, Logical ID and Props – ***(this, 'logical id', {props})***

Step 6. – Build the app (Optional) with ***npm run build***

Step 7. – Bootstrap (One Time) with ***cdk bootstrap***

Step 8. – Synthesize an AWS CloudFormation template for the app with ***cdk synth***

Step 9. – Deploying the stack with ***cdk deploy***

AWS CDK v2 – CodeWhisperer

Keyboard Shortcut	Action
[TAB]	To accept suggestions from Code Whisperer
[left arrow] and [right arrow]	Navigate between suggestions.
Keep typing (or hit ESC).	To ignore the suggestions from Code Whisperer
MacOS: Option + C	
Windows: Alt + C	Prompt Code Whisperer for Suggestions

AWS CDK v2 – CodeWhisperer – AWS Recommendations

- Write **descriptive comments**. “Function to upload a file to S3” will get better results than “Upload a file”.
- **Specify the libraries** you prefer by using import statements.
- Use **descriptive names for variable and functions**. A function called “upload_file_to_S3” will get better results than a function called “file_upload”.
- Give CodeWhisperer something to work with. The **more code your file contains**, the more context CodeWhisperer has for generating recommendations.

Source : AWS Documentation

Python Refresher

(from my Udemy Course on :

AWS Lambda, Python(Boto3) & Serverless-

Beginner to Advanced)

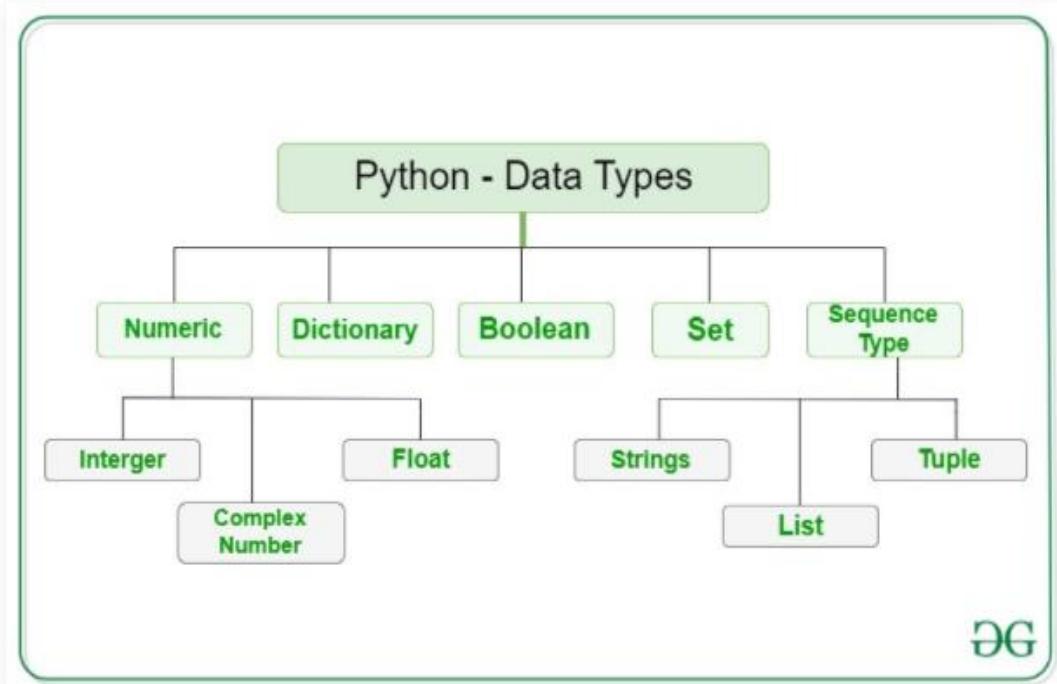
Python Basics—Refresher



1. Print Function – print the message to screen or any interface; Syntax : `print()`

2. Variables - Containers for storing data values string, float or integers and no need to declare; Syntax : `x = 3, greeting = "hello"` etc.

3. Data Type

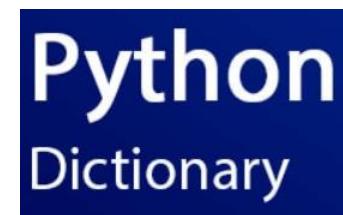


Data Type	Example
Int	<code>x = 20</code>
Float	<code>x = 20.5</code>
Dictionary	<code>x = {"name": "John", "age": 36}</code>
Strings	<code>x = "Hello World"</code>
List	<code>x = ["apple", "banana", "cherry"]</code>

Python Basics—Refresher

3. Data Types – Dictionary

- curly brackets
- key: pair values
- Nested Dictionary



Dict

```
response = {1: 'Rahul', 2: 'John', 3: 'Joy'}
```

Nested Dict

```
response = {1:'Python', 2:{'books': 'arch', 'aws':'Lambda'}}}
```

4. Nested Dictionary

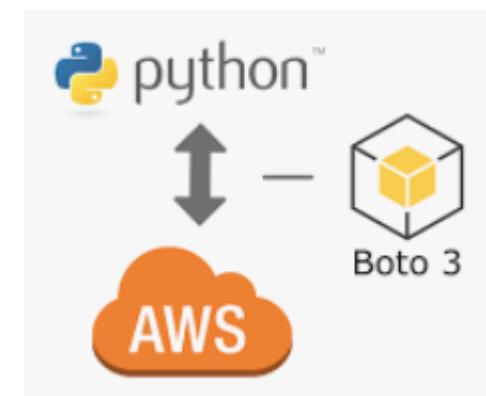


Python Basics—Refresher

5. Sample Example from Boto3

Response Syntax

```
{  
    'Buckets': [  
        {  
            'Name': 'string',  
            'CreationDate': datetime(2015, 1, 1)  
        },  
    ],  
    'Owner': {  
        'DisplayName': 'string',  
        'ID': 'string'  
    }  
}
```



https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/s3/client/list_buckets.html#

Python Basics—Refresher

6. Data Types – List

- Lists in Python can be created by just placing the sequence inside the **square brackets []**
 - A single list may contain Data Types like Integers, Strings, as well as Objects.
 - List in Python are ordered and have a definite count. The elements in a list are indexed with 0 being the first index.
 - **slice(start, stop, step)**
 - Reverse [:: -1]
-

```
list = [1, 4, 'For', 6, 'Anisha']
```

.....

7. Nested List

Nested List => nestedList = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]

Python Basics—Refresher

8. Data Types – List and Dictionary

Python
Dictionary

9. Data Type Determination

```
response = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]  
print(type(response))
```

Response Syntax

```
{  
    'Buckets': [  
        {  
            'Name': 'string',  
            'CreationDate': datetime(2015, 1, 1)  
        },  
        ],  
    'Owner': {  
        'DisplayName': 'string',  
        'ID': 'string'  
    }  
}
```



https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/s3/client/list_buckets.html#

Python Basics—Refresher

10. Function

Python Function

A function is a block of code which runs when it is called.

Syntax:

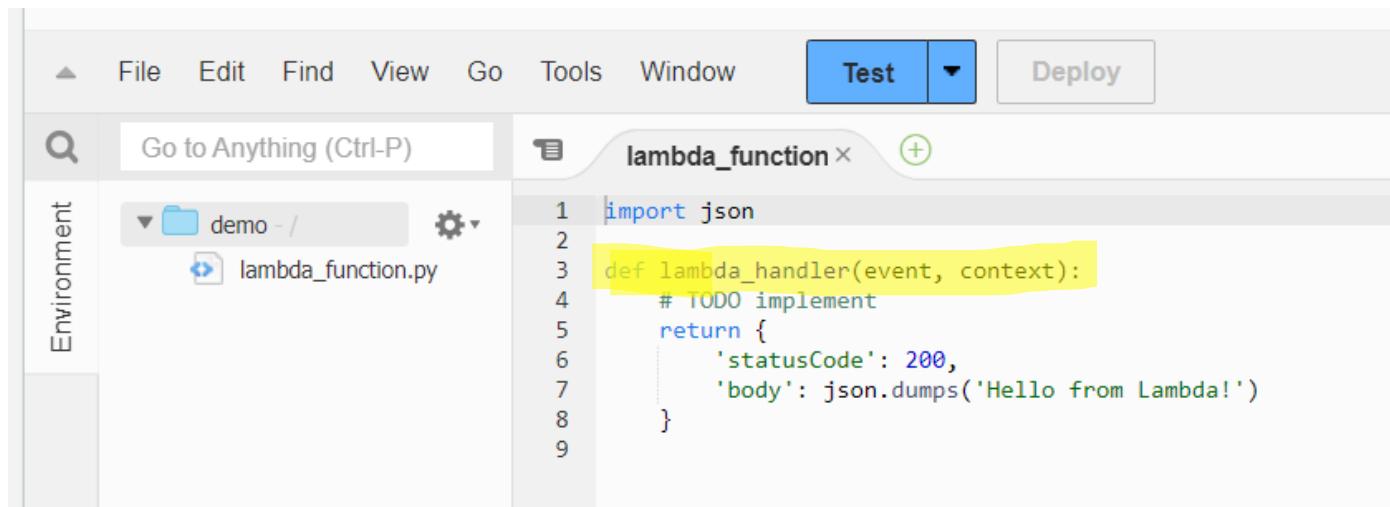
```
def function_name (argument/parameters):
```

```
    return expression or value
```

Example

```
# A simple Python function to check whether x is even or odd
```

```
def evenOdd(x):
    if (x % 2 == 0):
        print("even")
    else:
        print("odd")
# Driver code to call the function
evenOdd(2)
evenOdd(3)
```



The screenshot shows a Python code editor interface. At the top, there's a menu bar with File, Edit, Find, View, Go, Tools, Window, a Test button, and a Deploy button. Below the menu is a search bar labeled "Go to Anything (Ctrl-P)". The main area shows a file named "lambda_function.py" with the following code:

```
1 import json
2
3 def lambda_handler(event, context):
4     # TODO implement
5     return {
6         'statusCode': 200,
7         'body': json.dumps('Hello from Lambda!')
8     }
9
```

The third line, "def lambda_handler(event, context):", is highlighted with a yellow background.

API Gateway Refresher

(from my Udemy Course on :

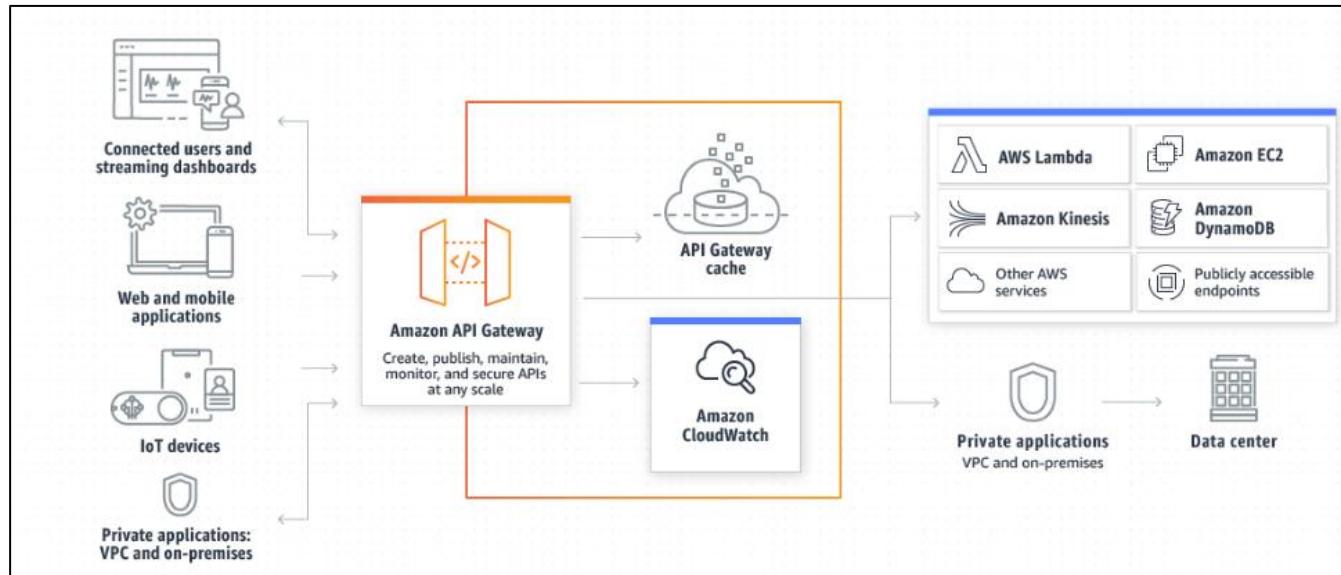
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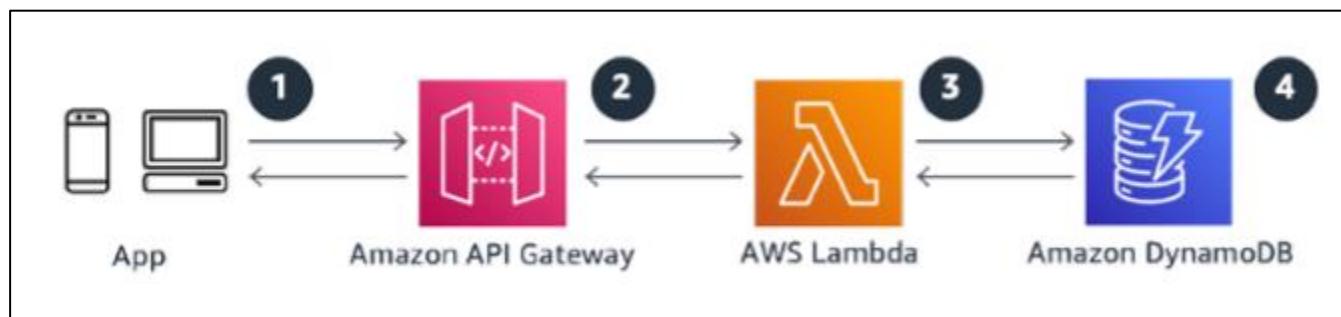
AWS API Gateway - Overview

What is API Gateway

Amazon API Gateway is an AWS service for **creating, publishing, maintaining, monitoring, and securing REST, HTTP, and WebSocket APIs at any scale.**



Sample Architecture - RESTful microservices



AWS API Gateway - Overview

Key Features Of API Gateway

1. API Types

1. HTTP API

Build **low-latency and cost-effective REST APIs** with built-in features such as OIDC and OAuth2, and native CORS support.

2. WebSocket API

Build a WebSocket API using **persistent connections for real-time use cases such as chat applications or dashboards**.

3. REST API



Develop a REST API where you gain complete control over the request and response along with **API management capabilities**.

4. REST API (Private)

Create a REST API that is **only accessible from within a VPC**.

<https://aws.amazon.com/blogs/compute/introducing-amazon-api-gateway-private-endpoints/>

AWS API Gateway - Overview

Key Features of API Gateway

REST API's vs HTTP API's

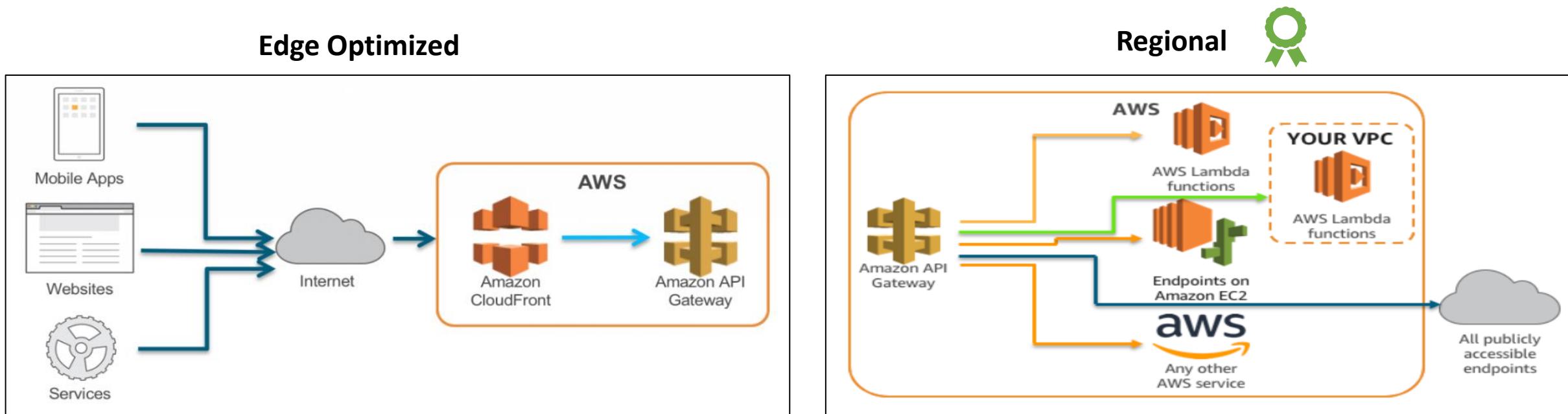
- REST APIs support **more features** than HTTP APIs, while HTTP APIs are designed with **minimal features** and offered at a **lower price**.
 - Choose **REST APIs** if you need features such as **API keys, per-client throttling, request validation, AWS WAF integration, or private API endpoints**.
 - Choose **HTTP APIs** if you don't need the features included with **REST APIs**.
-
- <https://aws.amazon.com/blogs/compute/introducing-amazon-api-gateway-private-endpoints/>

API Gateway - Overview

2. API Endpoint Types

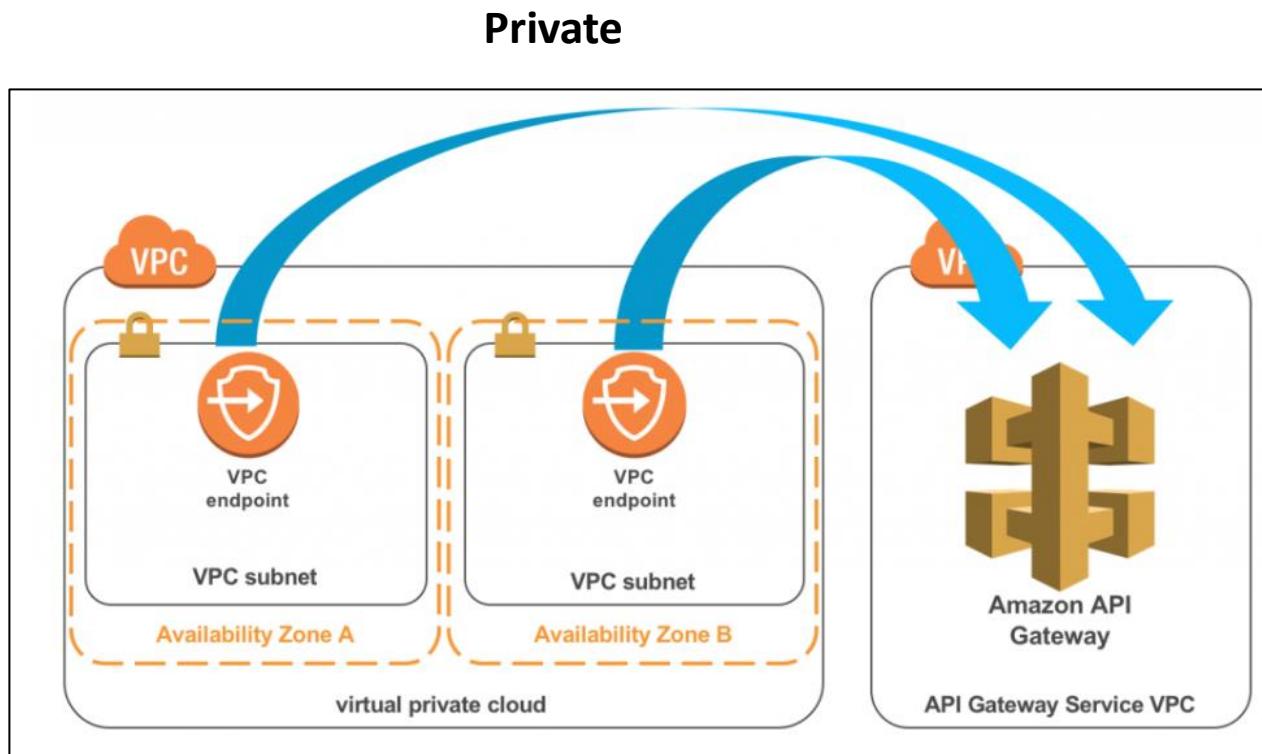
An **API endpoint type** refers to the **hostname of the API**.

The API endpoint type can be ***edge-optimized*, *regional*, or *private***, depending on where the majority of your API traffic originates from.



API Gateway - Overview

2. API Endpoint Types



API Gateway - Overview

3. Resources



REST architecture treats every content as a **resource**.

These resources can be Text Files, Html Pages, Images, Videos or Business Data.

4. Methods



Method	Description
GET	Retrieve information about the REST API resource
POST	Create a REST API resource
PUT	Update a REST API resource
DELETE	Delete a REST API resource or related component

API Gateway - Overview

5. Integration Type

Lambda Function



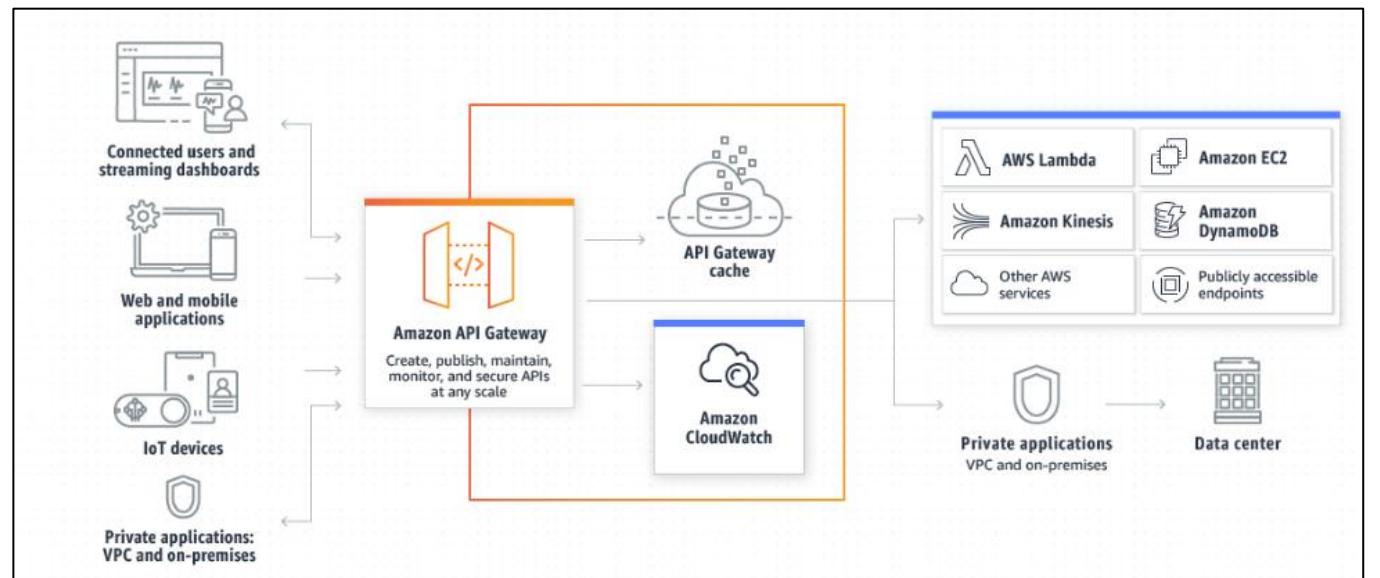
This type of integration lets an API method be integrated with the Lambda function

HTTP

- Allows integration with existing HTTP endpoint
- This type of integration lets an API expose HTTP endpoints in the backend.

Mock

- This type of integration lets API Gateway return a response without sending the request further to the backend.



API Gateway - Overview

5. Integration Type

AWS Service

This type of integration lets an API expose AWS service actions.

VPC Link

A VPC link is a resource in [Amazon API Gateway](#) that allows for connecting API routes to private resources inside a VPC

API Gateway - Overview

5. Deployment



After **creating your API**, you must **deploy it** to make it callable by your users.

To **deploy an API**, you **create an API deployment** and **associate it with a stage**.

Important Tip :

Every time you update an API, you must redeploy the API to an existing stage or to a new stage.

Updating an API includes modifying routes, methods, integrations, authorizers, and anything else other than stage settings.

6. Stages



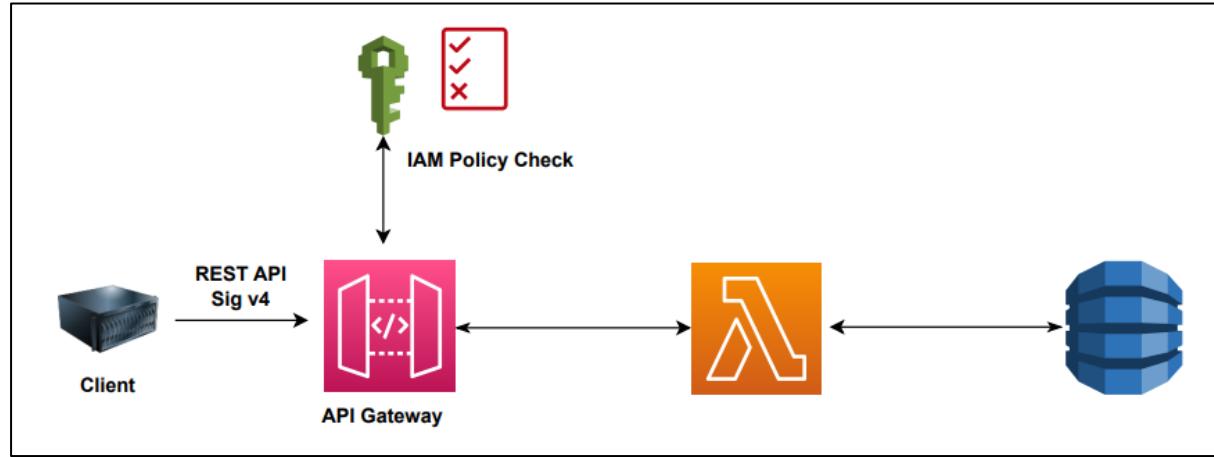
A logical reference to a **lifecycle state of your API** (for example, 'dev', 'prod', 'beta', 'v2').

<https://{{restapi-id}}.execute-api.{{region}}.amazonaws.com/{{stageName}}>

<https://ent94mc14j.execute-api.us-east-1.amazonaws.com/dev/students>

API Gateway - Overview

7. AWS API Gateway - Authentication and Authorization

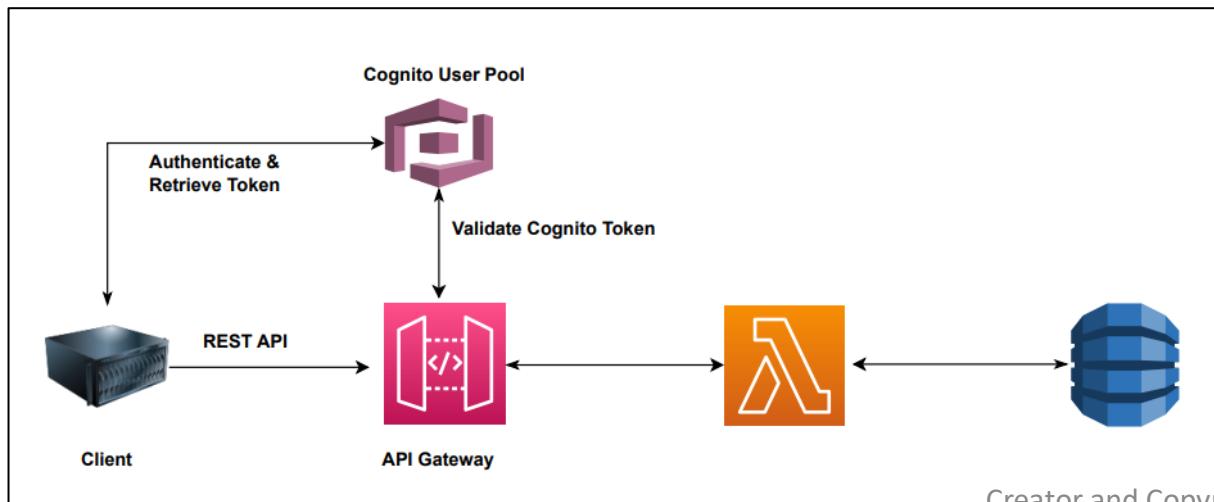


1. API Security – IAM

Authentication – IAM

Authorization – IAM Policy

Use Case : Internal AWS Services, Cross Account Access



2. API Security – Cognito

Authentication – Cognito User Pool

Authorization – API Gateway Methods

Use Case : External Users for Web/Mobile Apps

API Gateway - Overview

7. AWS API Gateway - Authentication and Authorization



3. API Security – Lambda Authorizer

Authentication – External

Authorization – Lambda Function

Use Case : Third Party Identity Provider such as OAuth 2.0

<https://docs.aws.amazon.com/apigateway/latest/developerguide/apigateway-use-lambda-authorizer.html>

API Gateway - Overview

8. Usage Plans



Usage Plans

Use Case : Differentiate between Basic and Premium Customers

Sets the **target request rate - Throttling, Burst and Quota Limit for each API Key**

9. API Keys



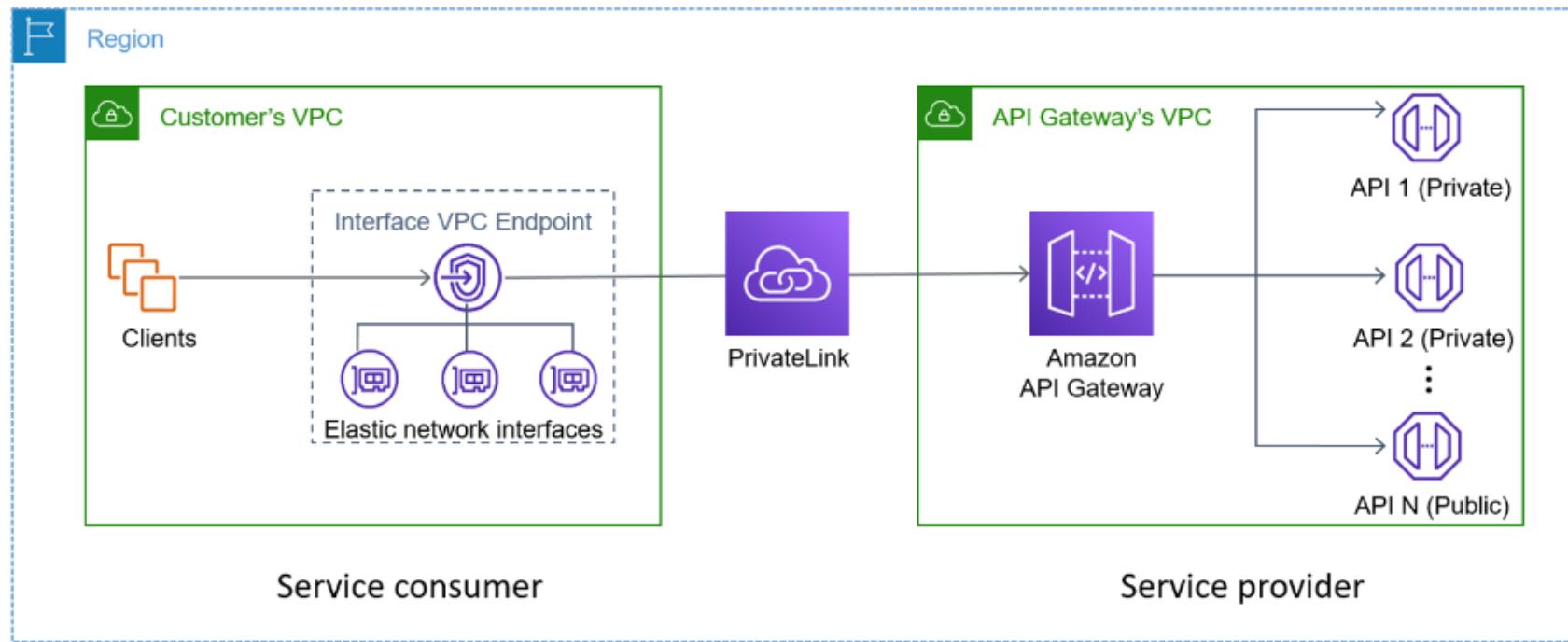
- An **alphanumeric string** that API Gateway uses to identify an app developer who uses your REST or WebSocket API.
- You can use API keys together with [Lambda authorizers](#) or [usage plans](#) to control access to your APIs.

API Gateway - Overview

10. API Integration and Private API's

Private API's

A private API means that the **API endpoint is reachable only through the VPC**. Private APIs are **accessible only from clients within the VPC or from clients that have network connectivity to the VPC**.

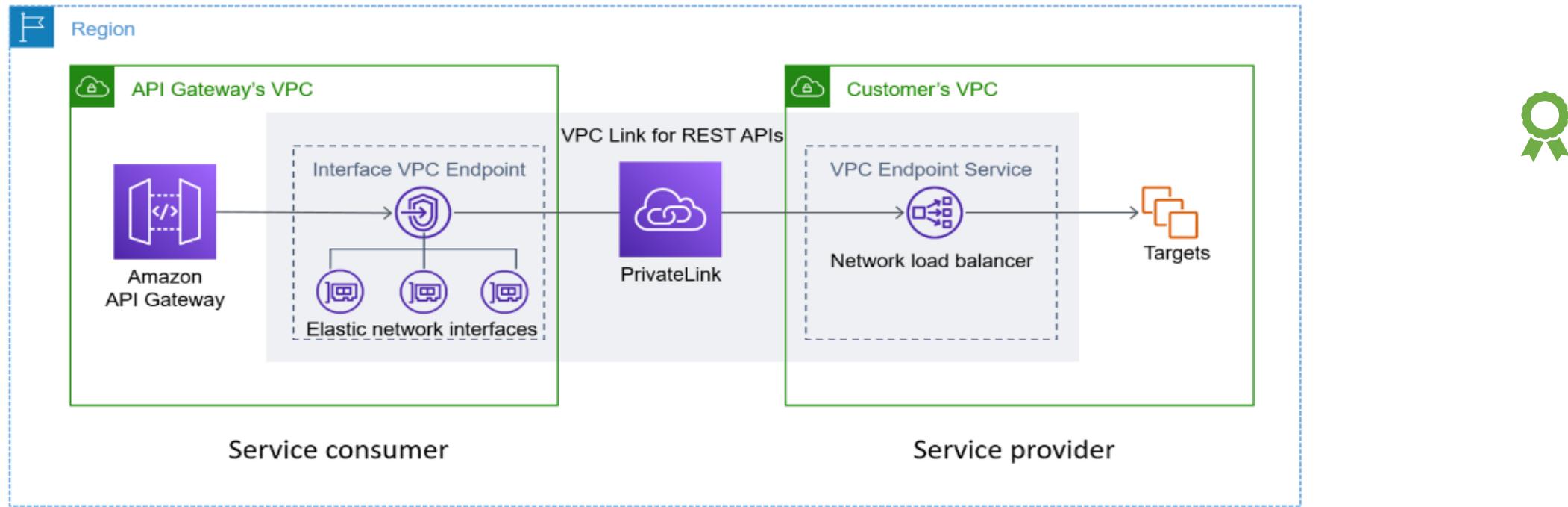


API Gateway - Overview

10. API Integration, Private API's and VPC Link

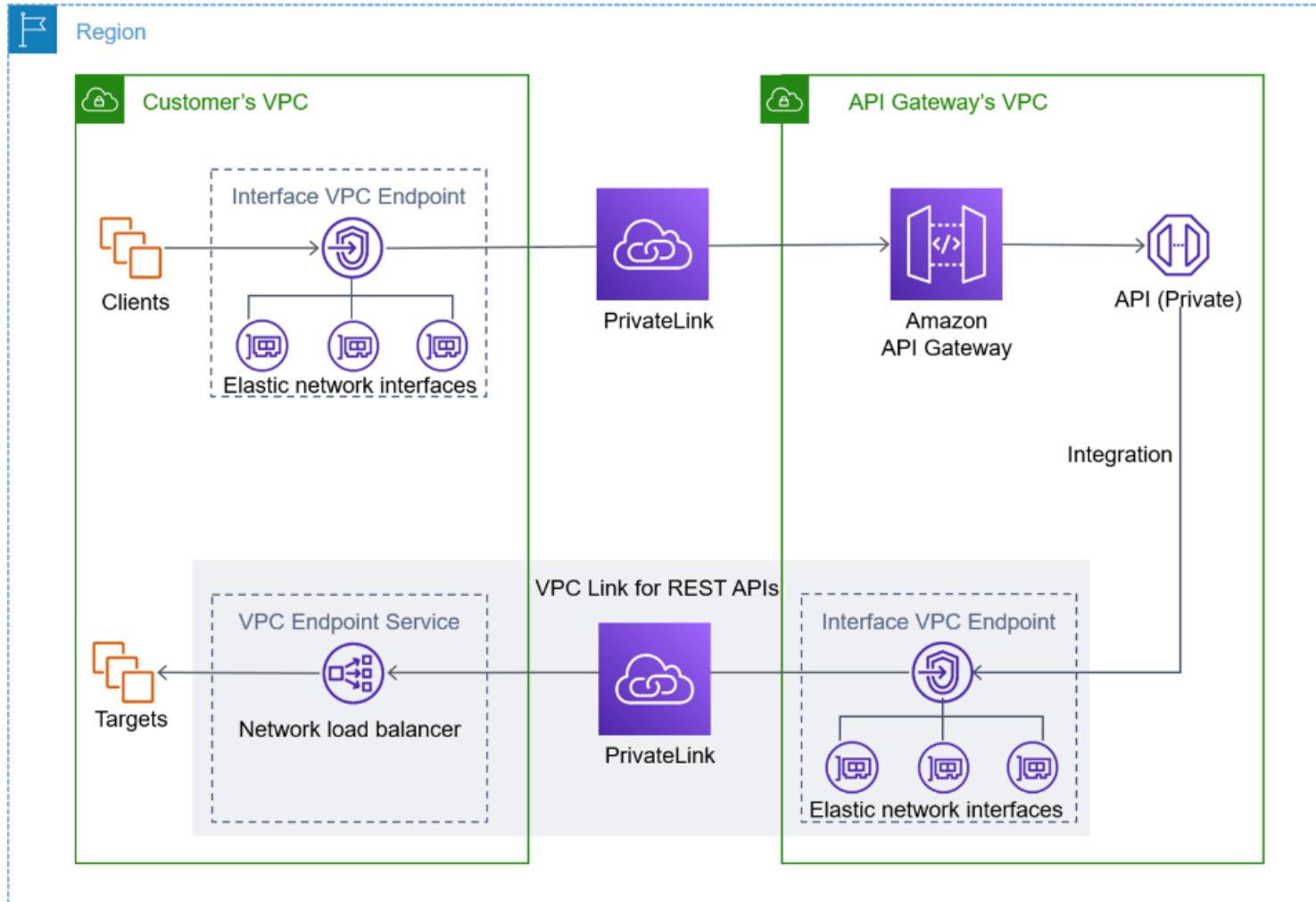
Private Integration

An API Gateway integration type for a client to access resources inside a customer's VPC through a private REST API endpoint without exposing the resources to the public internet.



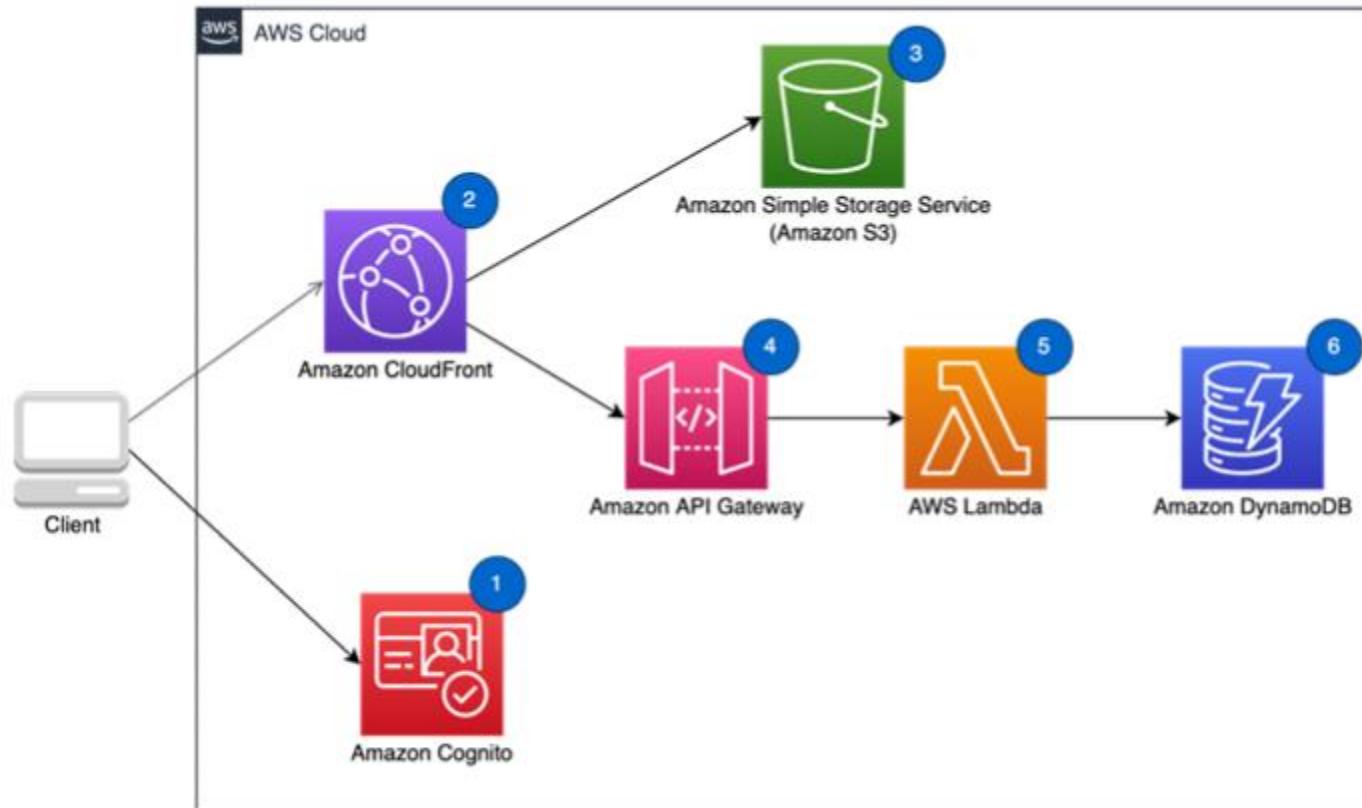
API Gateway - Overview

10. API Integration and Private API's



API Gateway - Overview

Sample Architecture



Thank You