How to build Gen AI models in Python and through AWS

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Agenda

Introduction to Generative AI

Generative AI applications and benefits

Building Gen AI models: Theoretical

Frameworks Building Gen AI models:

Practical Tools

Tips and Tricks for Customized Gen AI models

Introduction to Generative AI

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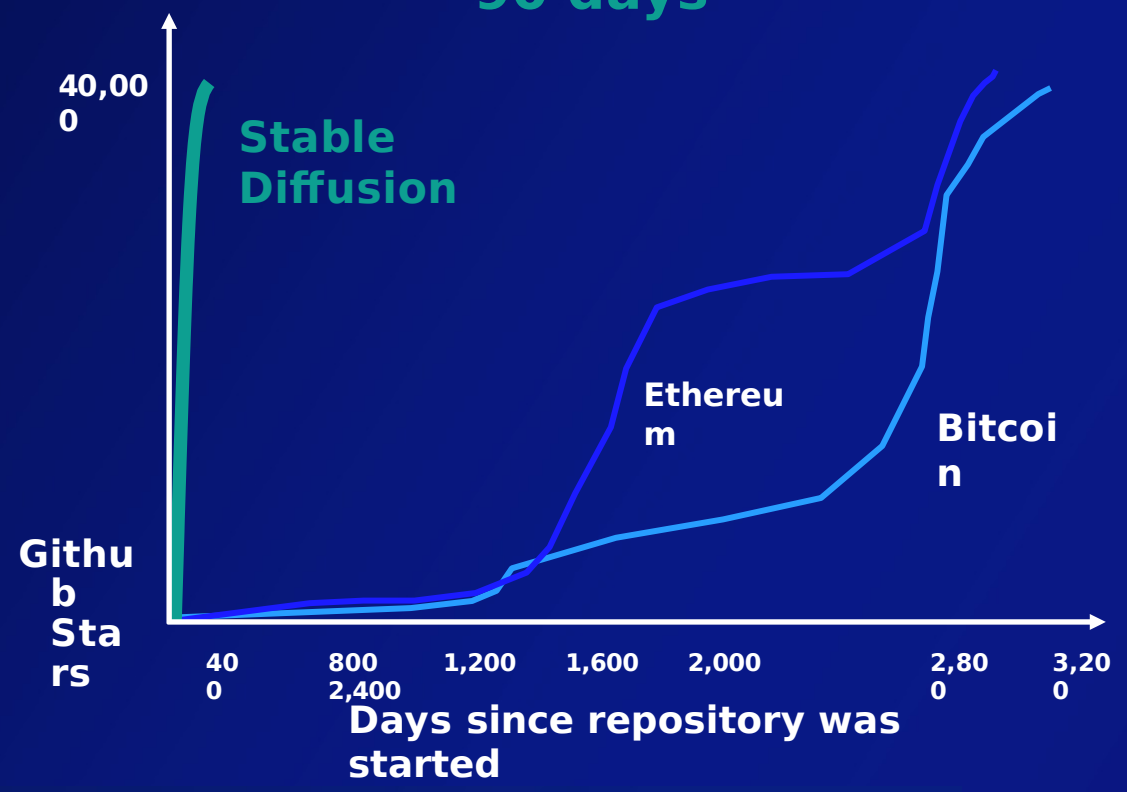
Generative AI is the fastest growing trend in AI

Developer adoption

Stable Diffusion accumulated 40k stars on GitHub in its first 90 days



Consumer adoption

ChatGPT reached the 1 million users mark in just 5 days

What is Generative AI?

AI that can
generate content
close enough to human created content for real-world tasks

Powered by
foundation models
pre-trained on large sets of data with several hundred billion parameters

Applicable to
many use cases
like text summarization, question answering, digital art creation, code generation, etc.

Tasks can be
customized for specific domains
with minimal fine-tuning

New Volvo car concept design by midjourney
Credit: *@sugardesign_1* Instagram

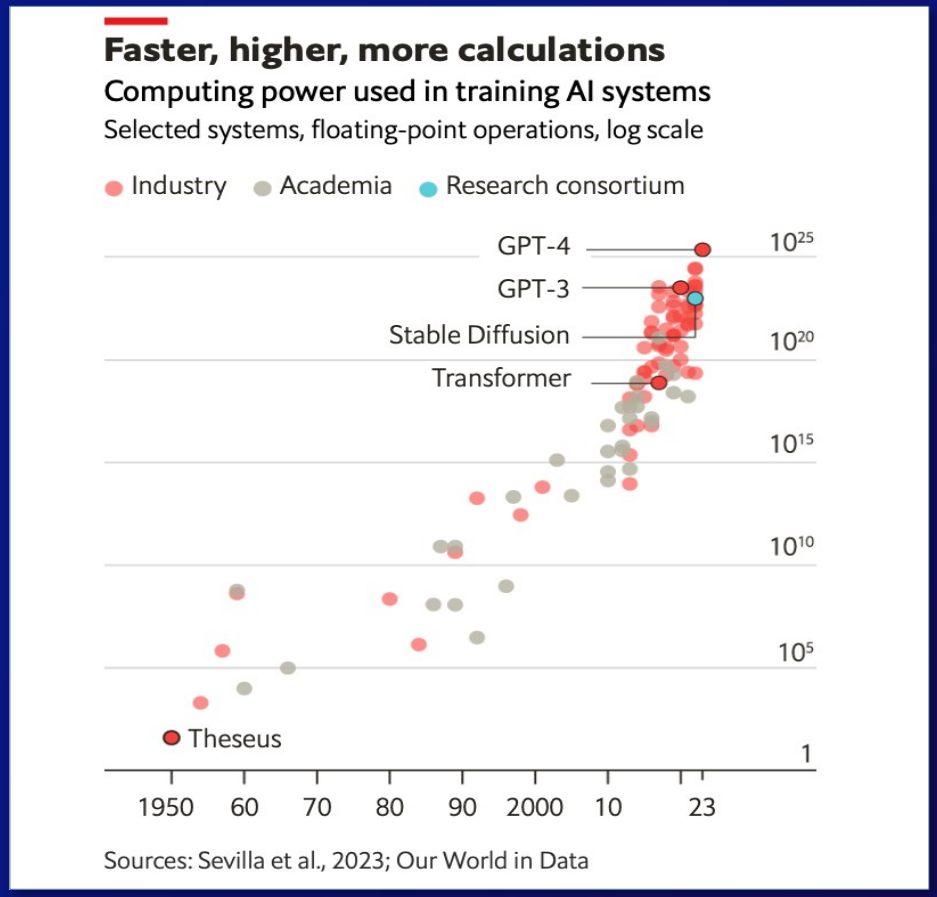
What is Generative AI?

Artificial Intelligence (AI)

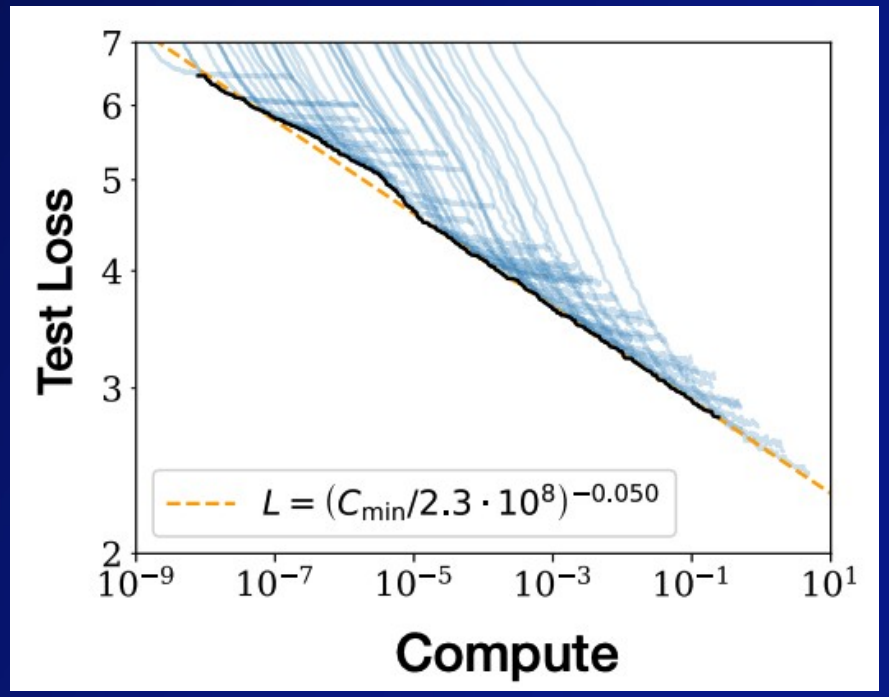
Machine Learning (ML)

Deep Learning (DL)

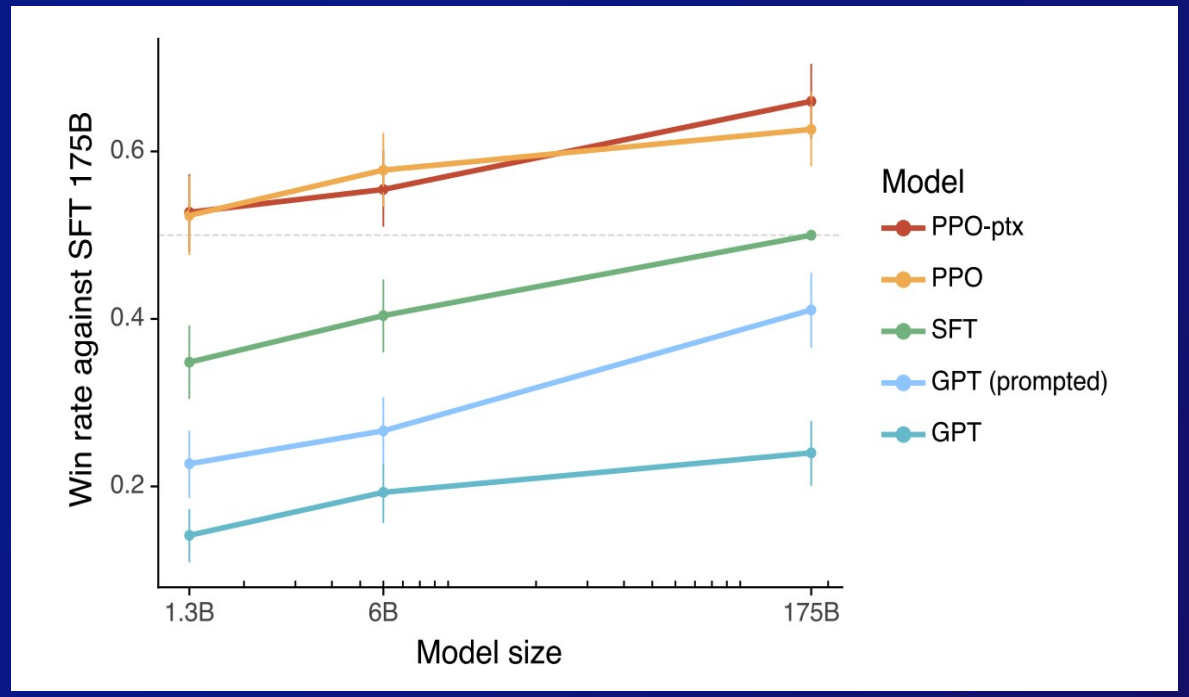
Generative AI



Accuracy revolution



Scaling Laws for Neural Language Models
Kaplan et al, 2020



Training language models to follow instructions with human feedback (InstructGPT)

GPT-3 showed you can 3x accuracy with 10x model size increase

Accuracy revolution

"a picture of a very clean living room"

StackGAN,
Zhang et al.

2016

Stable
Diffusion,
Rombach et al.

2022

Gen AI applications and benefits

Generative AI is emerging across a range of domains …

Productivity
Text generation

Chat
Virtual assistant

Summarization
Text extraction

Search

Code generation

Image generation

Image classification

Create music

Generate videos

Many ML tasks can now be re-cast as generative

Text: I am not into this house; it's way too expensive and too far from the train line!

Model → Sentiment: negative

Traditional classification

Text: I am not into this house; it's way too expensive and too far from the train line!

Classify this sentence into positive or negative sentiment:

Agent: Negative sentiment

Using generation to classify text

Generative AI creates significant business value

CREATIVITY

Create new content and ideas, including conversations, stories, images, videos, and music

PRODUCTIVITY

Radically improve productivity across all lines of business, for example 57% faster task completion with Amazon CodeWhisperer

ECONOMIC GROWTH

$7T increase in global GDP over the next 10 years

Let’s say I asked you to learn everything on the internet. How would you do it?

Structure

Storage

Time

5.74 B pages x 52 seconds = ~82 M hours

=> 40,000 human

A foundation model can do this in a few minutes.

Building Gen AI : Theoretical Frameworks

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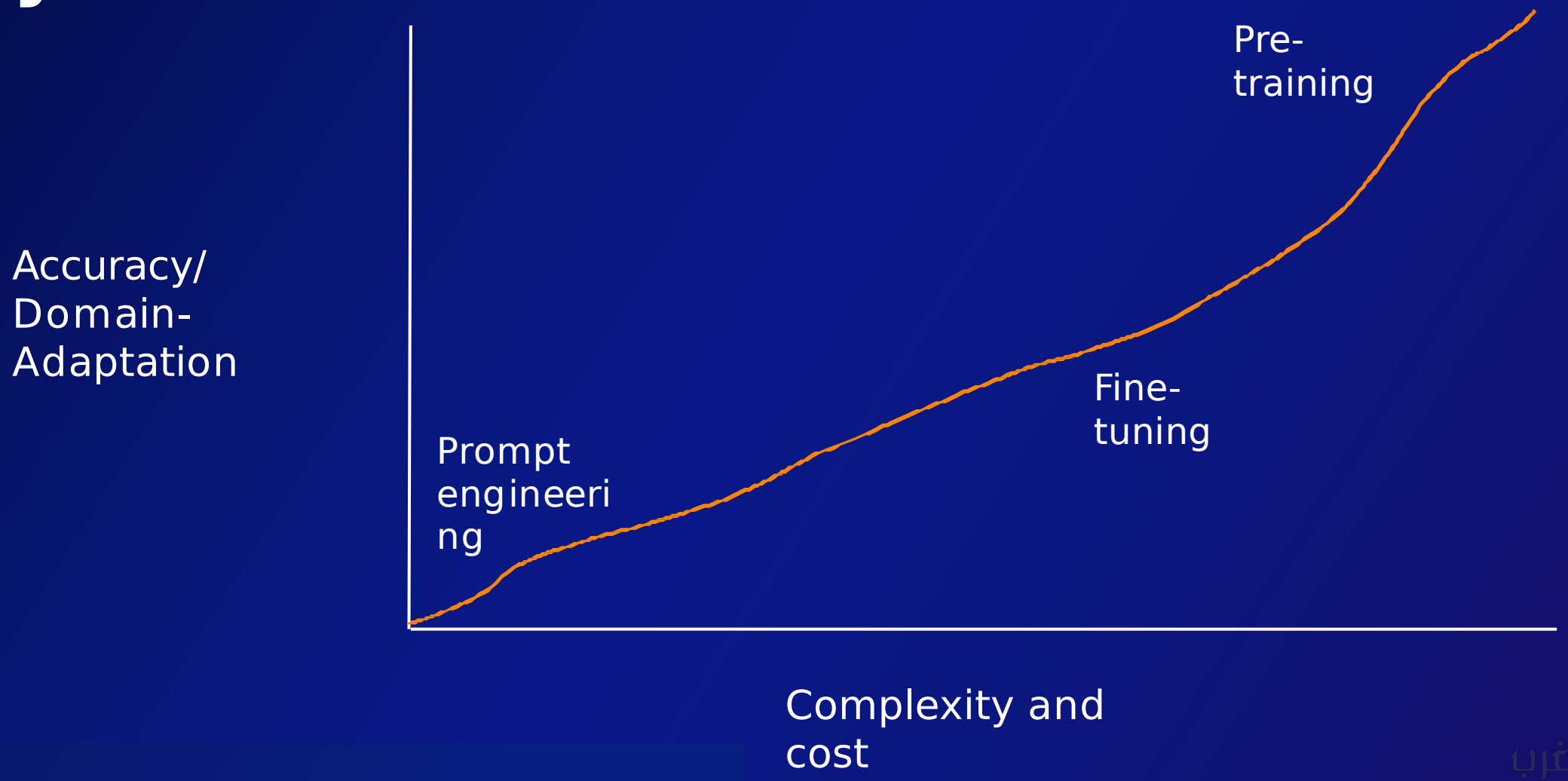
Building Gen AI models:

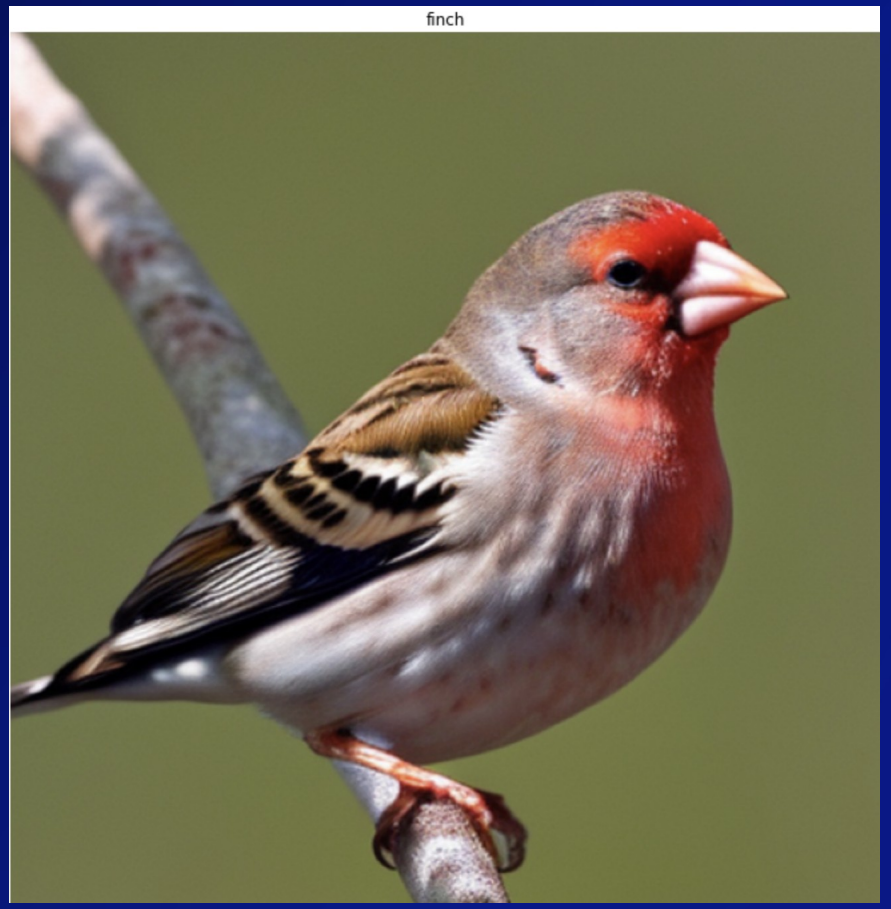
	Prompt engineering on existing models	Fine tuning	Pretraining
Training duration (and cost)	Not required	Minutes to hours	Days to weeks to months
Customization	• No customization on model • Customizing the prompt	**Some** • Specific task tuning • Added domain-specific training data	**FULL** • NN architecture and size • Vocabulary size • Context length • Training data
Expertize needed	Low	Medium	High

Customizing a foundation model to your domain

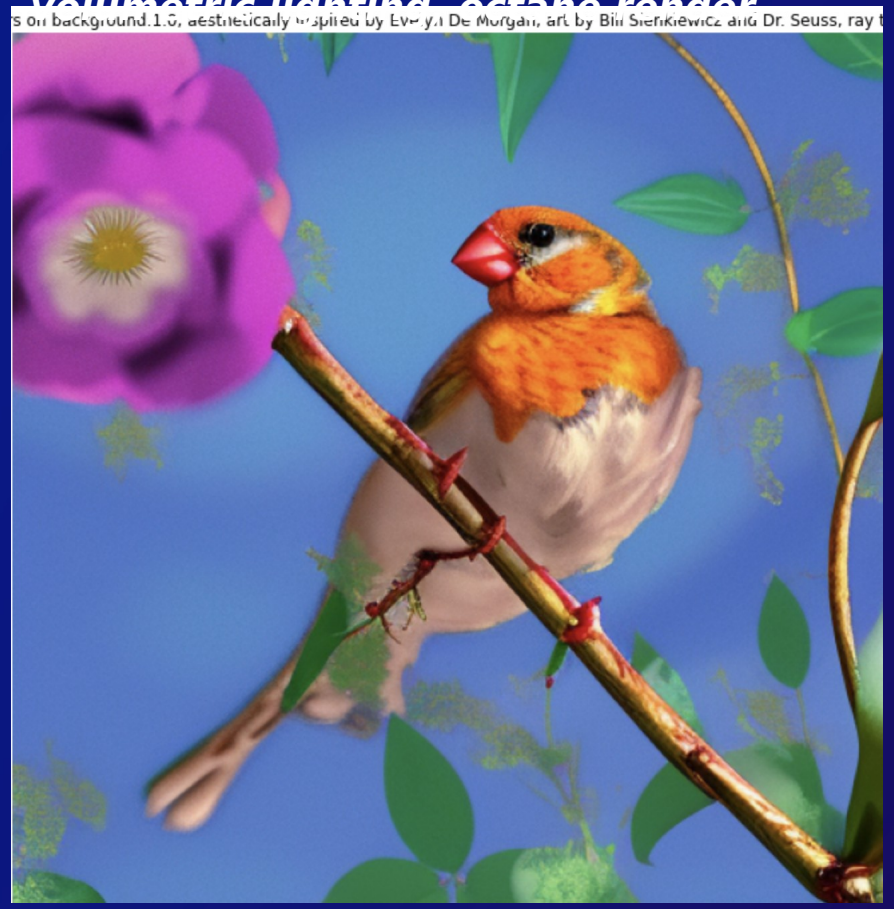


One-Shot prompting:

Finch



A tiny finch on a branch with spring flowers, aesthetically inspired by Evelyn De Morgan, art by Bill Sienkiewicz and Dr. Seuss, ray tracing, volumetric lighting, octane render



Few-shot prompting:

```
Review:
I like the film, but the actor James was not performing as usual
What are the entities and their associated sentiments? Film : positive, Actor James: Negative




Review:
I loved the food in the restaurant but the place was not clean
What are the entities and their associated sentiments? Food : positive, Place: negative




Review:
I enjoyed the hotel room but the reception guy was unpleasant
What are the entities and their associated sentiments? Hotel room: positive, Reception guy: negative




Review:
I liked the boat trip, but the weather was not good
What are the entities and their associated sentiments?
```

The reasoning result is: '['negative, Boat trip: positive, Weather: negative']'

Building Gen AI models: Practical Tools

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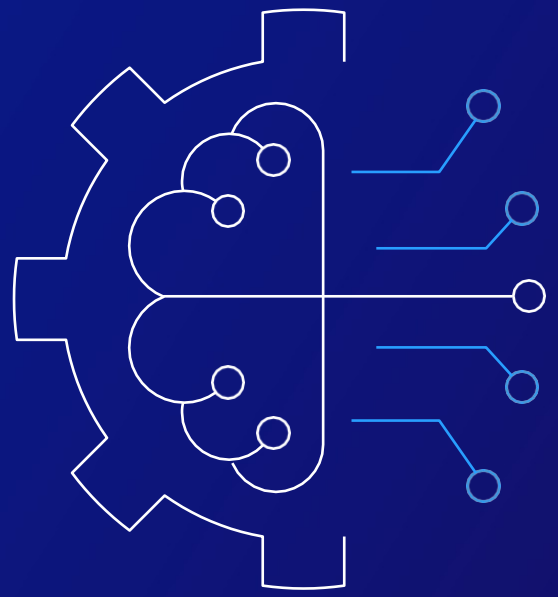
NEW

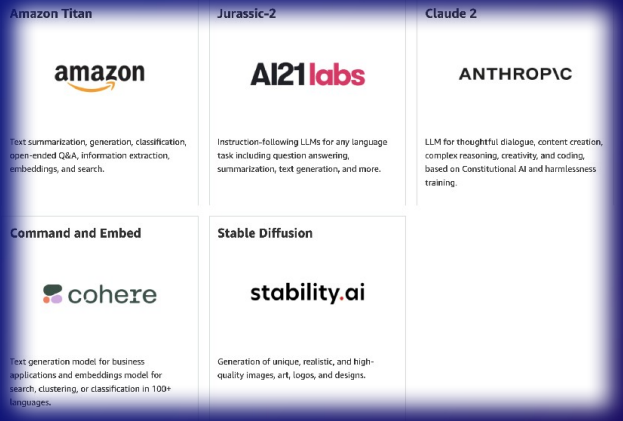
Amazon Bedrock

The easiest way to build and scale generative AI applications with FMs



How it works

- Finding the right model from a list of FMs from leading AI startups and Amazon
- Privately Customizing FMs with specific data
- Integration and deployment into applications using AWS



aws

Amazon Bedrock key benefits

Accelerate development of generative AI applications using FMs through an API, without managing infrastructure

Choose FMs from AI21 Labs, Anthropic, Stability AI, and Amazon to find the right FM for your use case

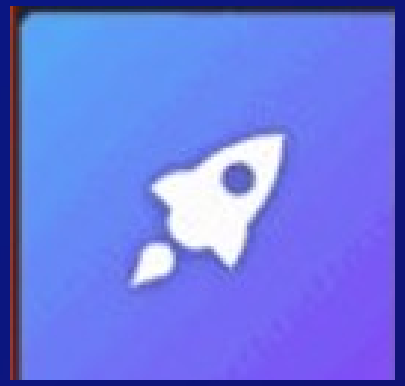
Privately customize FMs using your organization's data

Enhance your data protection using comprehensive AWS security capabilities

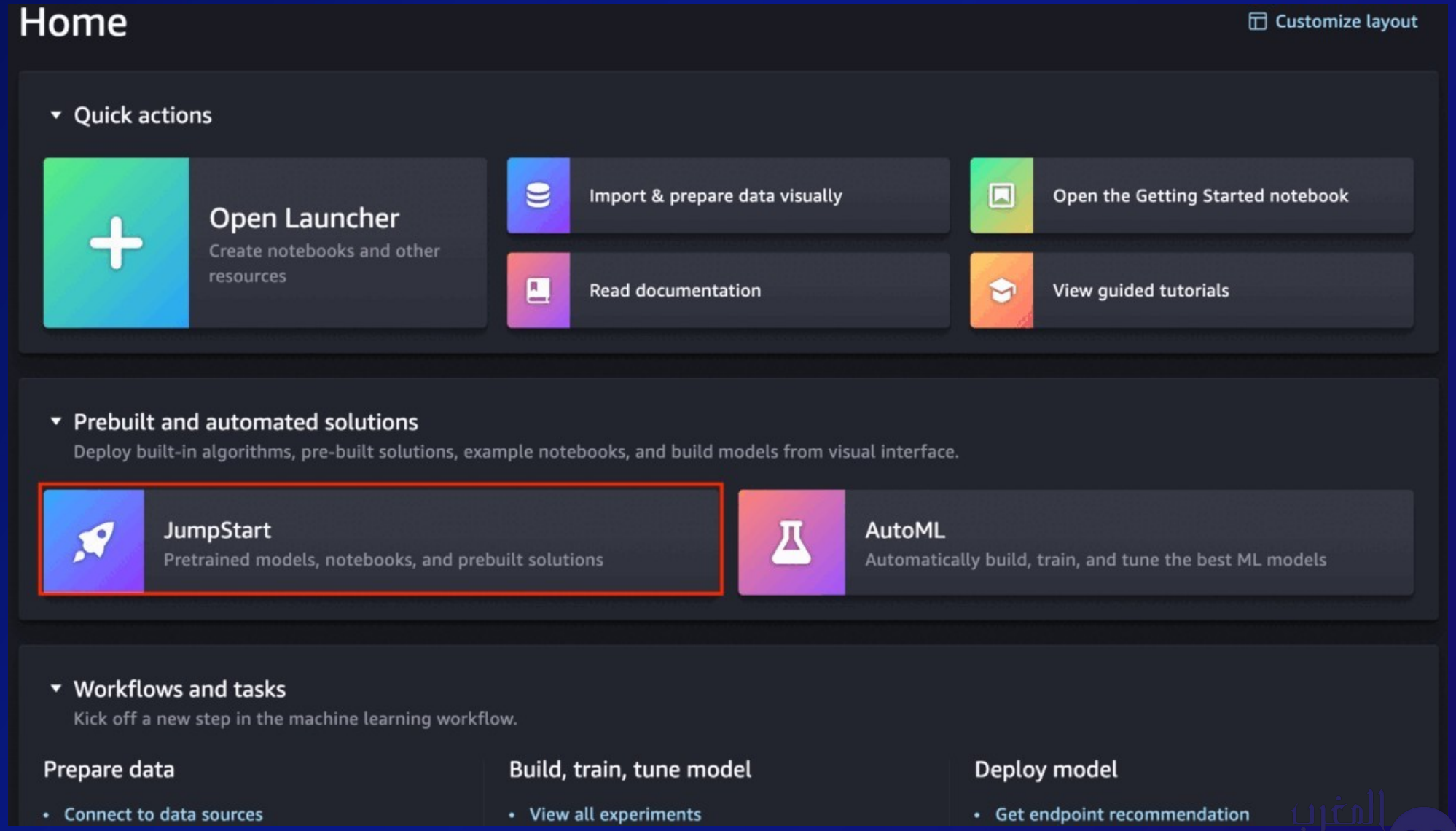
Use AWS tools and capabilities that you are familiar with to deploy scalable, reliable, and secure generative AI applications

Amazon Jumpstart

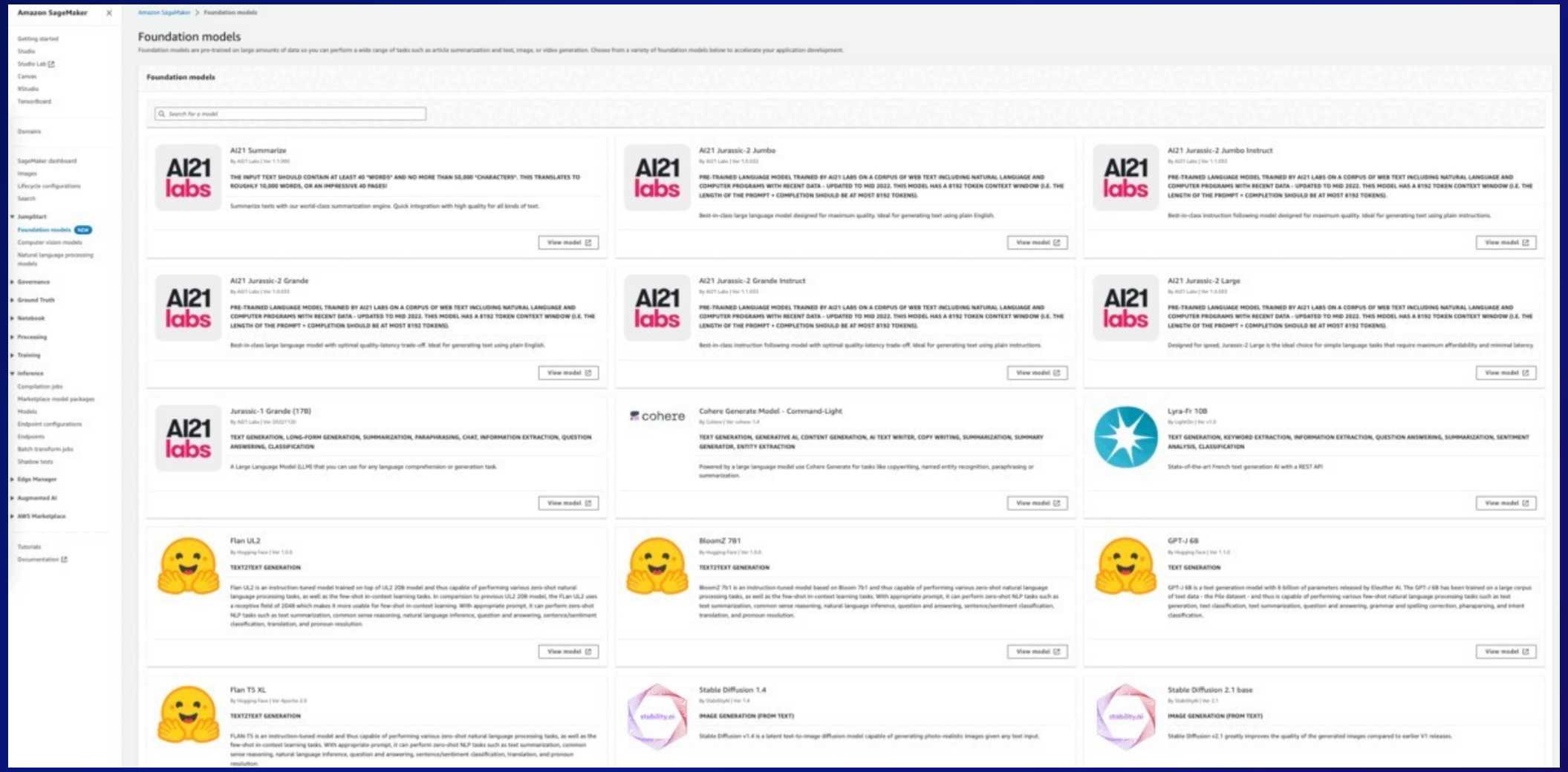
- Provides pretrained open-source models for direct deployement or Notebook experimentations



Jumpstart Foundation Models



Playground experience



Foundation models available on SageMaker JumpStart for self-managed access

Publicly available

stability.ai

Models

Stable Diffusion Upscaling

Tasks

Generate photo-realistic images from text input

Improve quality of generated images

Features

Fine-tuning on SD 2.1 model

alexa

Models

AlexaTM 20B

Tasks

Machine translation

Question answering

Summarization

Annotation

Data generation

🤗

Models

More than 100 models! Including: FLAN-T5 FLAN-UL2 GPT2, GPTJ, GPT-Neo, BLOOM Openjourney

Tasks

Machine translation

Question answering

Summarization

Annotation

Data generation

Proprietary models

co:here

Models

Cohere generate-med

Tasks

Text generation

Information extraction

Question answering

Summarization

Lighton

Models

Lyra-Fr 10B

Tasks

Text generation

Keyword extraction

Information extraction

Question answering

Summarization

Sentiment

AI21 labs

Models

Jurassic-2 (multiple variants)

Tasks

Text generation

Long-form generation

Summarization

Paraphrasing

Chat

Information extraction

Question answering

A strong collaboration to make NLP easy and accessible for all

Hugging Face
AWS

Hugging Face is the most popular open source company providing state-of-the-art NLP technology

Amazon SageMaker offers high performance resources to train and use NLP models

Development in a Jupyter Notebook or Direct Deployment

Terminal 2 | model-txt2img-stabilityai-s | Home | Demo.ipynb | model-txt2img-stabilityai-s

Code | Cluster | Data Science 2.0 | Python 3 | 2 vCPU + 4 GiB | Share

Introduction to JumpStart - Text to Image

Welcome to Amazon SageMaker JumpStart! You can use JumpStart to solve many Machine Learning tasks through one-click in SageMaker Studio, or through SageMaker JumpStart API. In this demo notebook, we demonstrate how to use the JumpStart API to generate images from text using state-of-the-art Stable Diffusion models. Furthermore, we show how to fine-tune the model to your dataset.

Stable Diffusion is a text-to-image model that enables you to create photorealistic images from just a text prompt. A diffusion model trains by learning to remove noise that was added to a real image. This de-noising process generates a realistic image. These models can also generate images from text alone by conditioning the generation process on the text. For instance, Stable Diffusion is a latent diffusion where the model learns to recognize shapes in a pure noise image and gradually brings these shapes into focus if the shapes match the words in the input text.

Training and deploying large models and running inference on models such as Stable Diffusion is often challenging and include issues such as cuda out of memory, payload size limit exceeded and so on. JumpStart simplifies this process by providing ready-to-use scripts that have been robustly tested. Furthermore, it provides guidance on each step of the process including the recommended instance types, how to select parameters to guide image generation process, prompt engineering etc. Moreover, you can deploy and run inference on any of the 80+ Diffusion models from JumpStart without having to write any piece of your own code.

In the first part of this notebook, you will learn how to use JumpStart to generate highly realistic and artistic images of any subject, object, environment orscene. This may be as simple as an image of a cute dog or as detailed as a hyper-realistic image of a beautifully decoraded cozy kitchen by pixer in the style of Greg Rutkowski with dramatic sunset lighting and long shadows with cinematic atmosphere. This can be used to design products and build catalogs for ecommerce business needs or to generate realistic art pieces or stock images.

In the second part of this notebook, you will learn how to use JumpStart to fine-tune the Stable Diffusion model to your dataset. This can be useful when creating art, logos, custom designs, NFTs, and so on, or fun stuff such as generating custom AI images of your pets or avatars of yourself.

Model license: By using this model, you agree to the CreativeML Open RAIL-M++ license.

[43]:
```
from ipywidgets import Dropdown
from sagemaker.jumpstart.notebook_utils import list_jumpstart_models

# Retrieves all Text-to-Image generation models.
filter_value = "task == txt2img"
txt2img_models = list_jumpstart_models(filter=filter_value)

# display the model-ids in a dropdown to select a model for inference.
model_dropdown = Dropdown(
    options=txt2img_models,
    value="model-txt2img-stabilityai-stable-diffusion-v2-1-base",
    description="Select a model",
    style={"description_width": "initial"},
    layout={"width": "max-content"},
)
display(model_dropdown)
```

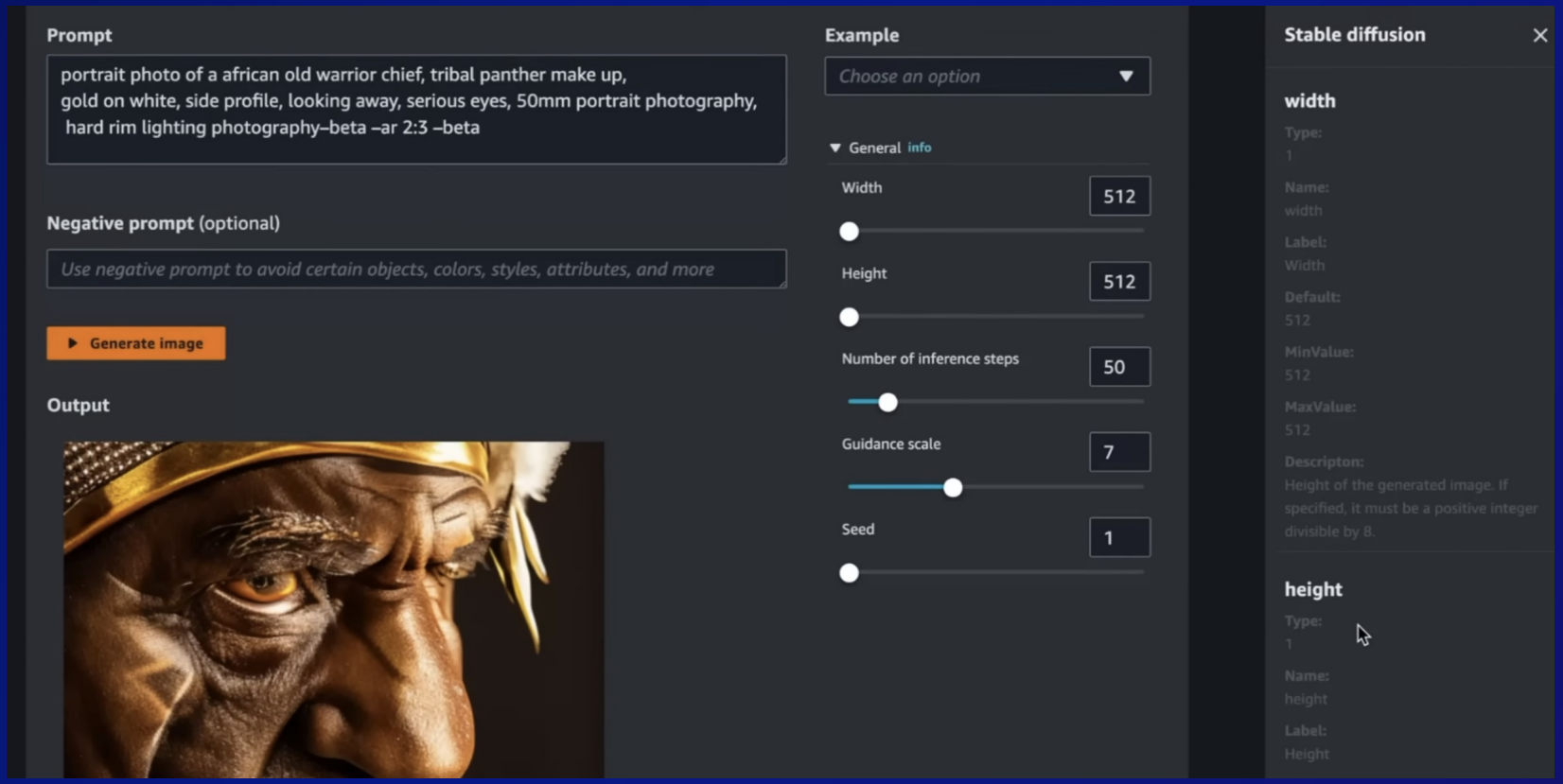
Select a model | model-txt2img-stabilityai-stable-diffusion-v2-1-base

[44]:
```
# model_version="*" fetches the latest version of the model
model_id, model_version = model_dropdown.value, "*"
```

[34]:
```
text = "cottage in impressionist style"
query_response = query(model_predictor, text)
img, prmpt = parse_response(query_response)
display_img_and_prompt(img, prmpt)
```

cottage in impressionist style

Development in a Jupyter Notebook or Direct Deployment



Jupyter Notebook

Using Python Jupyter Notebook to retrieve weights of a pre-trained model and prompt/fine-tune it

Pretrained Model Retrieval

```
model_checkpoint='google/flan-t5-base'
```

```
from transformers import AutoTokenizer

tokenizer = AutoTokenizer.from_pretrained(model_checkpoint, use_fast=True)
```

```
from transformers import AutoModelForSeq2SeqLM

model = AutoModelForSeq2SeqLM.from_pretrained(model_checkpoint)
```

```
inputs = tokenizer(few_shot_prompt, return_tensors='pt')
output = tokenizer.decode(
    model.generate(
        inputs["input_ids"],
        max_new_tokens=50,
    )[0],
    skip_special_tokens=True
)
print(f'FEW SHOT RESPONSE: {output}')
summary = dataset['test'][example_indices[0]]['summary']
print(f'EXPECTED RESPONSE: {summary}')
```

```
FEW SHOT RESPONSE: Tom is late for the train. He has to catch it at 9:30.
```

Prompting/ Fine-tuning on Jupyter Notebook

```python
start_prompt = 'Summarize the following conversation.\n'
end_prompt = '\n\nSummary: '
dialogue = dataset['test'][example_indices[1]]['dialogue']
summary = dataset['test'][example_indices[1]]['summary']
prompt = f'{start_prompt}{dialogue}{end_prompt}'

inputs = tokenizer(prompt, return_tensors='pt')
output = tokenizer.decode(
    model.generate(
        inputs["input_ids"],
        max_new_tokens=50,
    )[0],
    skip_special_tokens=True
)
print(f'INPUT PROMPT:\n{prompt}\n')
print(f'MODEL GENERATION:\n{output}\n')
print(f'BASELINE SUMMARY:\n{summary}')
```

```
INPUT PROMPT:
Summarize the following conversation.
#Person1#: May, do you mind helping me prepare for the picnic?
#Person2#: Sure. Have you checked the weather report?
#Person1#: Yes. It says it will be sunny all day. No sign of rain at all. This is your father'
Daniel.
#Person2#: No, thanks Mom. I'd like some toast and chicken wings.
#Person1#: Okay. Please take some fruit salad and crackers for me.
#Person2#: Done. Oh, don't forget to take napkins disposable plates, cups and picnic blanket.
#Person1#: All set. May, can you help me take all these things to the living room?
#Person2#: Yes, madam.
#Person1#: Ask Daniel to give you a hand?
#Person2#: No, mom, I can manage it by myself. His help just causes more trouble.

Summary:

MODEL GENERATION:
The weather report says it will be sunny all day.
```

```python
trainer = Trainer(
    model=model,
    args=training_args,
    train_dataset=sample_tokenized_dataset['train'],
    eval_dataset=sample_tokenized_dataset['validation']
)
```

```python
trainer.train()
```

```
/opt/conda/lib/python3.7/site-packages/transformers/optimization.py:395: FutureWarning: This i
ill be removed in a future version. Use the PyTorch implementation torch.optim.AdamW instead,
sable this warning
  FutureWarning,
```

[33/33 06:54, Epoch 1/1]

Epoch	Training Loss	Validation Loss
1	No log	35.455990

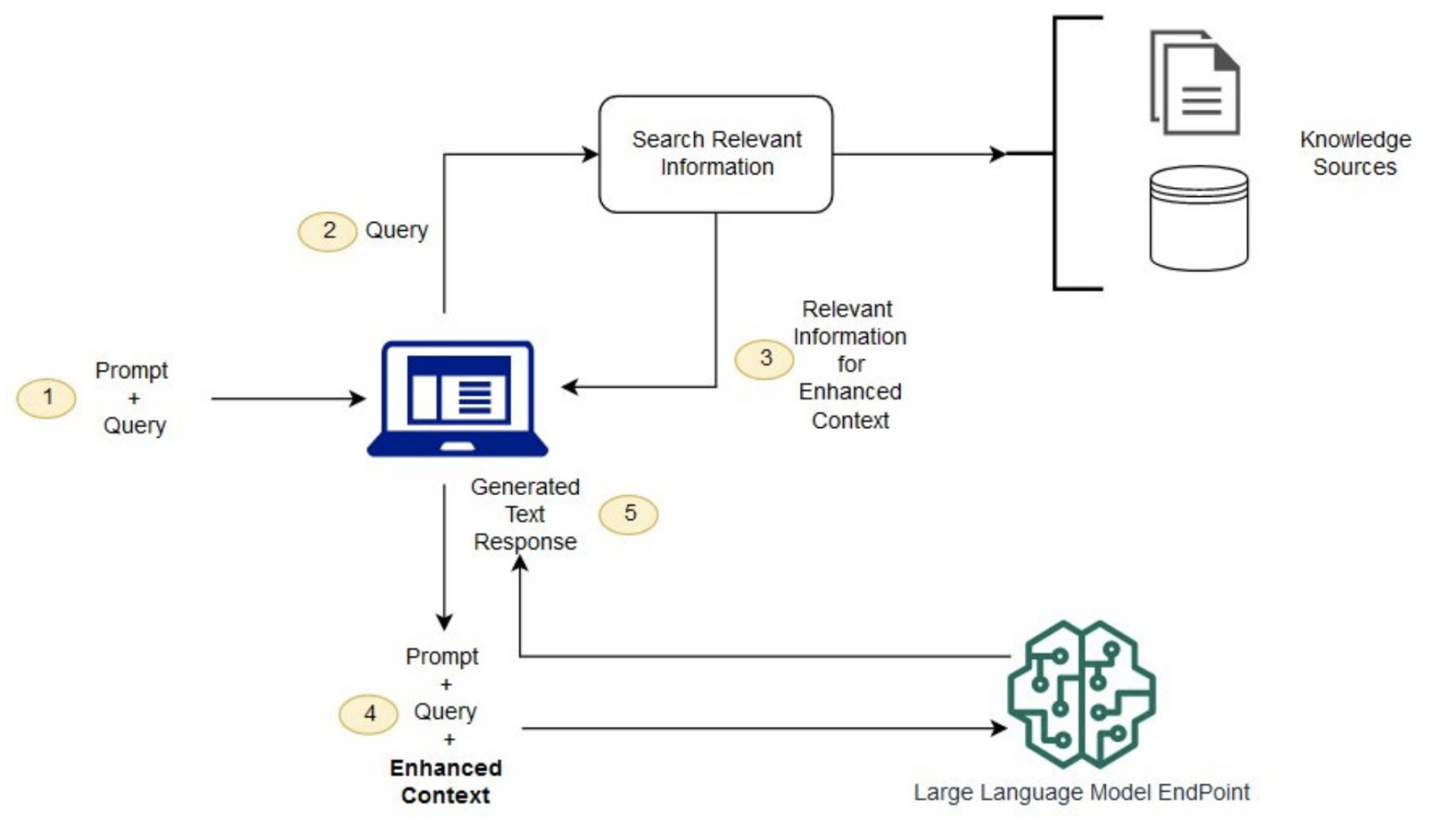
```python
supervised_fine_tuned_model_path = "./flan-dialogue-summary-checkpoint"
# supervised_fine_tuned_model_path = f"./{output_dir}/<put-your-checkpoint-dir-here>"

tuned_model = AutoModelForSeq2SeqLM.from_pretrained(supervised_fine_tuned_model_path)
model = AutoModelForSeq2SeqLM.from_pretrained(model_checkpoint)
```

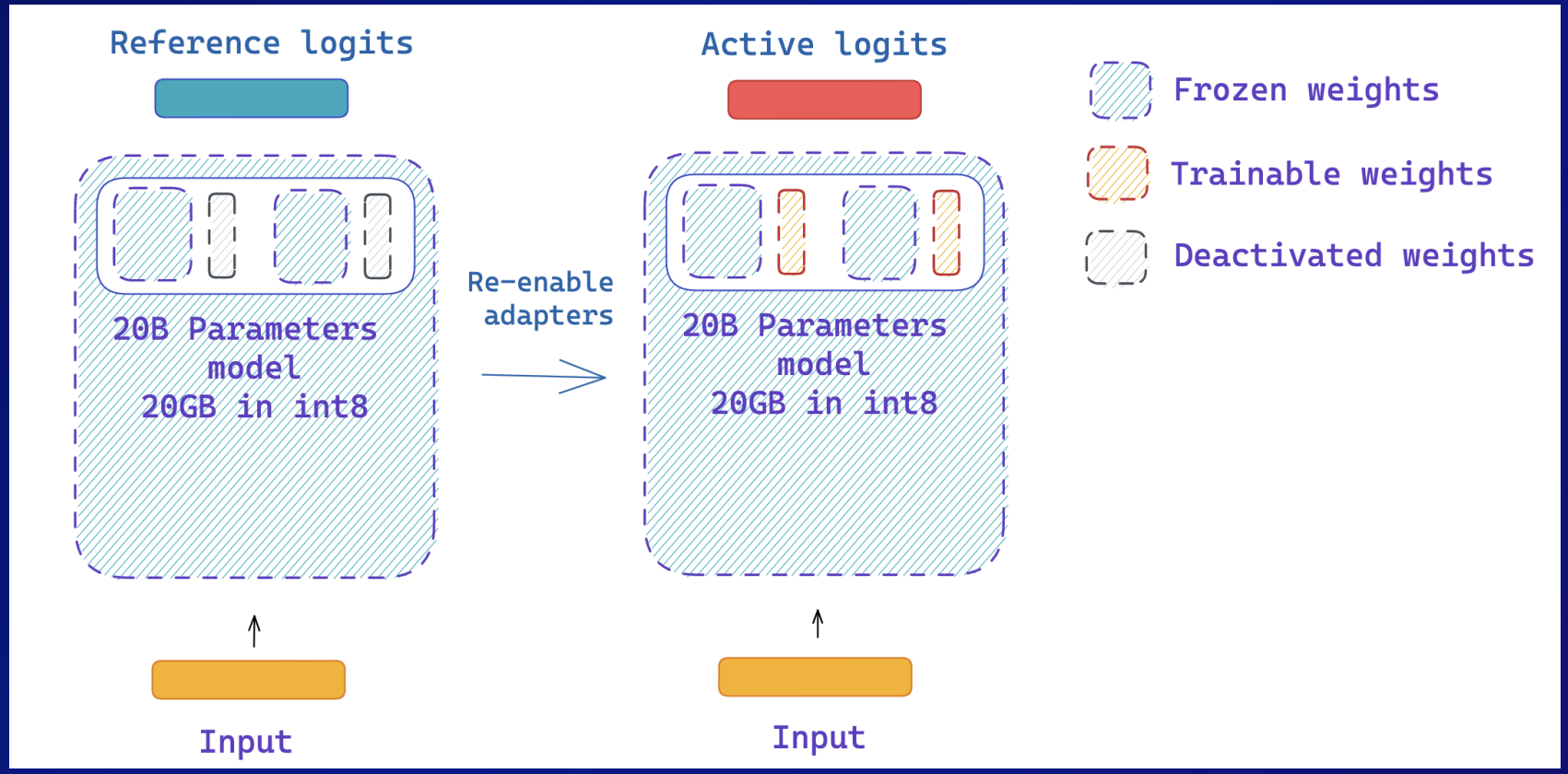
```python
outputs = tuned_model.to('cpu').generate(
    model_input,
    GenerationConfig(max_new_tokens=200, num_beams=1,),
)
text_output = tokenizer.decode(outputs[0], skip_special_tokens=True)
```

Tips and Tricks for Customized Gen AI

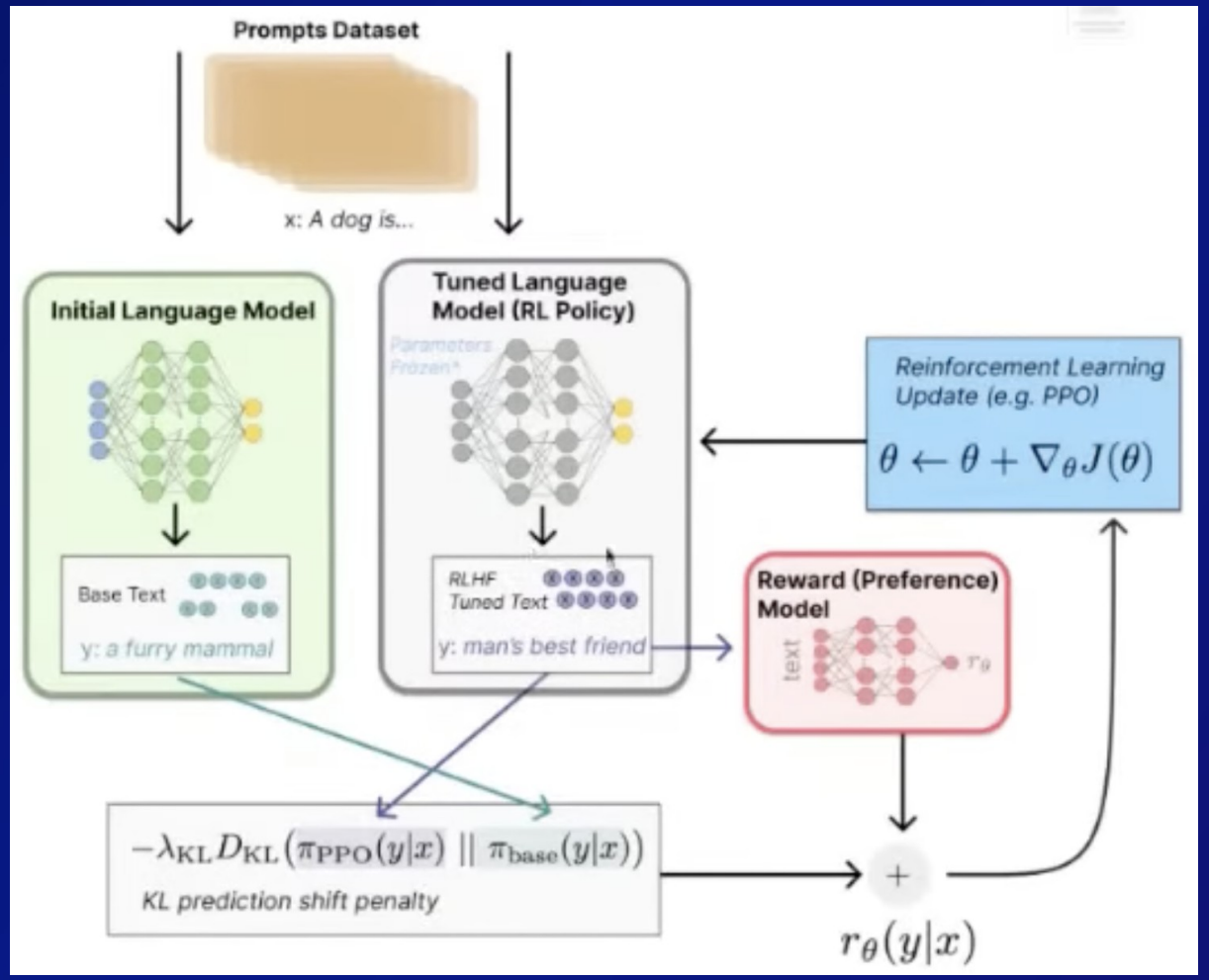
Retrieval Augmented Generation



PEFT - Partiel Efficient Fine Tuning



RHLF – Reinforcement Learning with Human Feedback



Thank you!

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