



***Using AI Tools to Generate Art and Text***

***Stable Diffusion, DALL-E, and GPT-3***

***Using Google CoLaboratory***

***Workshop***

***By Jim Plaxco,***

***ARTSNOVA.COM***



# Using AI Tools to Generate Art and Text With Stable Diffusion, DALL-E, and GPT-3 Using Google CoLaboratory

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## What is this workshop about?

This workshop is a tutorial on how to use Google Colaboratory (aka Colab) to run Python programs that use the OpenAI libraries GPT-3 to generate text responses to prompts and DALL-E to generate art, and the Stable Diffusion libraries to create AI-Generated art.

As an introductory workshop, the Colab platform and the programs provided gives students the knowledge they need to begin to explore the world of AI-Generated content in an entirely free manner. Additional capabilities are available to those who purchase licenses for the products covered in the workshop.

While coding knowledge is not needed, it will be useful for those seeking to expand on the sample programs offered in the workshop.

**This presentation and the three Python programs can be downloaded from  
<https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/>**

# Workshop Outline

- Account Requirements to Run the Software
- Files for the Workshop
- Student Background Review
- A Quick Summary on AI-Generated Art
- Terminology
- Overview of Platform Options
- Overview of Hardware Requirements
- Overview of AI Generation Options
- Introduction to Google Colab
- A Few Words About Coding
- A Few Words About Prompt Engineering
- Introduction to Using Google Colab for openAI GPT-3 and DALL-E
- Introduction to Using Google Colab for Stable Diffusion
- Introduction to Using Google Colab for Stable Diffusion Continued
- Question and Answer

# The requirements to complete the workshop are:

## I. Create a Google Account

In order to access Google Colaboratory (aka Colab), you will need to have a Google account

1. Go to <https://colab.research.google.com/>
2. If you have a Google account, you will need to sign in to your account before being able to access Colab.
3. If you do not have a google account, click the blue sign in button and then on the sign in page, click on the Create account link to create your Google account. Once you have created your account and signed in, you can return to <https://colab.research.google.com/> where you will be launched into your Colab session.

## II. Create an OpenAI Account

In order to access the OpenAI API, you will need to have an account with OpenAI and have created an OpenAI API Key.

1. Go to <https://chat.openai.com/auth/login>
2. Click the green "Sign up" button
3. Follow the steps to create your account
4. To create your OpenAI API Key, go to <https://platform.openai.com/account/api-keys> and click the "Create new secret key" button, then follow the instructions.

To avoid having to sign in to your OpenAI account every time you need to use your API key, make a local copy of it. For additional information about the API keys, see <https://platform.openai.com/docs/api-reference/authentication>

# The requirements to complete the workshop are:

## III Create A HuggingFace account

In order to access Stable Diffusion, you will create an account with HuggingFace.

1. Go to <https://huggingface.co/join> and fill out the Join form.
2. Once you have created an account and signed in, click on the Settings link in the menu.
3. From the main Settings page, click on the Access Tokens link.
4. Create your new token

To avoid having to sign in to your HuggingFace account every time you need to use your token, make a local copy of it.

For additional information about your token, see <https://huggingface.co/docs/hub/security-tokens>

# Workshop Files (PDF and IPYNB code files) URL

All files needed to complete the workshop are located at:

<https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/>

The files you will download to your computer are:

The workshop presentation PDF:

<https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/dalle-gpt3-stable-diffusion-ai-tools-workshop-presentation.pdf>

The Colab Python notebook for the GPT-3 and DALL-E demonstration:

<https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/1-OpenAI-GPT-3-DALL-E.ipynb>

The Colab Python notebook for part 1 of the Stable Diffusion demonstration:

<https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/2-AI-Generated-Art-Using-Stable-Diffusion.ipynb>

The Colab Python notebook for part 2 of the Stable Diffusion demonstration:

<https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/3-AI-Generated-Art-Using-Stable-Diffusion.ipynb>

# What's your background? It doesn't rally matter!

Are you a Creative Coder, Digital Artist, Programmer, Traditional Artist, Enthusiast, Author, or simply curious?

The purpose of this question is to determine the level of relevant experience of those attending this live workshop.

Have you experimented with any of the AI online tools? (chatGPT, MuseNet, Dall-E, Midjourney, etc.)

Your background doesn't really matter. If you're here, you can handle it.

This approach of using Google Colaboratory to access and use various AI libraries is easiest for people who know some Python, some Linux commands, and have used Google Drive. In some cases, knowledge of Git could be helpful.

Remember: you don't need to know how a computer works in order to use a computer.



Prompt: winter time snow tree  
Inference Steps: 52  
Guidance scale: 6.2

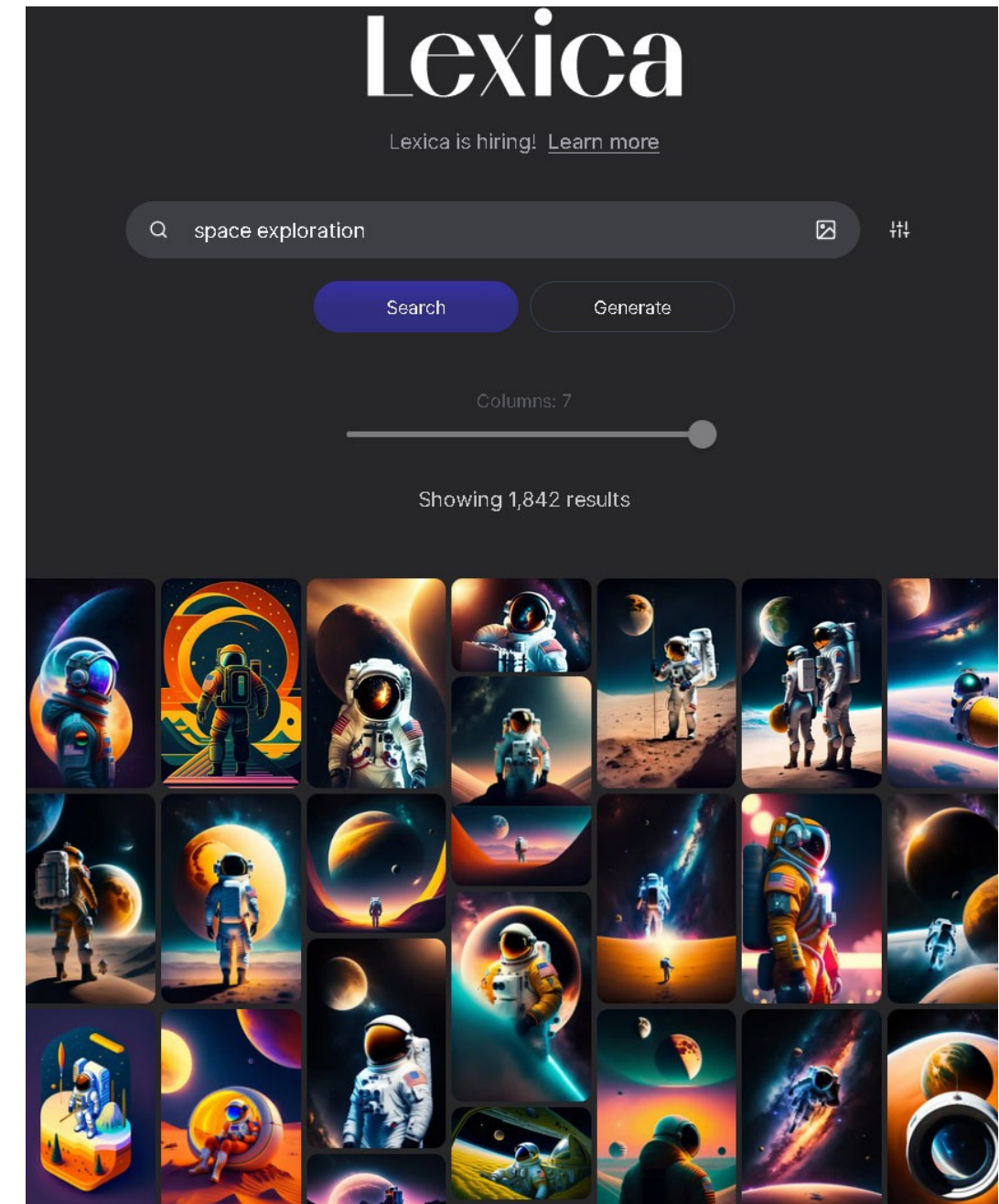


# What is AI-Generated Art?

## According to openAI's chatGPT:

*“AI-generated art refers to artwork that is created by an artificial intelligence system. This can include images, videos, music, and other forms of creative expression. The AI system can use various techniques such as machine learning, neural networks, and generative algorithms to produce the artwork. The artwork can be created completely by the AI system or it can be generated in collaboration with a human artist.”*

**Question: Who made good money in the California Gold Rush: those panning for gold or those selling goods and services to those panning for gold?**



Source: <https://lexica.art/?q=space+exploration>



## Terms you may hear used:

Attention,  
CLIP model (Contrastive Language-Image Pre-training),  
Convolutional Neural Networks (CNN),  
CUDA (Compute Unified Device Architecture),  
Deep Learning,  
Diffusers,  
Enhanced Real-ESRGAN,  
GPU (Graphics Processing Unit),  
Gradient descent,  
LLM (Large Language Model),  
Pipeline,  
Prompt engineering,  
Tensor,  
Text Encoder,  
TPU (Tensor Processing Unit),  
Transformers,  
Tokenization,  
VRAM (Video Random Access Memory)

# A Few of the Online Web Page-based AI Art Generators

This is the most common and easiest option (SaaS – Software as a Service)

- DreamStudio <https://beta.dreamstudio.ai/> (the online version of Stable Diffusion)
- NightCafe Creator: <https://creator.nightcafe.studio/>
- DALL-E 2 <https://openai.com/dall-e-2/> (OpenAI)
- Deep Dream Generator <https://deepdreamgenerator.com/> (Aifnet)
- DeviantArt DreamUp <https://www.dreamup.com>
- Crayion <https://www.crayion.com>
- Stablecog <https://stablecog.com/> (uses Stable Diffusion)
- Runway ML <https://runwayml.com/>

# Locally Installable AI Art Generators

**Note:** If the install consists of Python programs and libraries, then it can be run either locally or in the Cloud.  
(Recall the California Gold Rush)

**Note:** AI Art generation features are being added to existing image processing products, like Photoshop.

**Studio Artist 5.5** - (Windows or Mac) <https://synthetik.com/>

**DALL-E** - Manual Install that uses Python

- DALL-E (API doc: <https://beta.openai.com/docs/guides/images> )
- <https://beta.openai.com/docs/guides/images/language-specific-tips>

**Stable Diffusion** - Manual Install that uses Python



# What are the AI software access/execution platform options?

## → **Online:**

You access the AI application/service via a web page in your browser

## → **Locally Installed:**

You install and run the software on your desktop or laptop or as an App on a mobile device

## → **Cloud-Based Virtual Machine**

You install and run the software on a “computer” that is a cloud-based system.

## → **Cloud-Based Session Accessed via Your Browser**

You install and run the software in a session that is executes on a cloud-based system which you access via your browser.

# What are the hardware requirements?

**GPU:** NVIDIA RTX 30xx or better GPU with at least 12 gigabytes of GDDR6 VRAM (Video Random Access Memory)

## And the rest:

**RAM:** minimum 16 gigabytes of DDR4 or DDR5

**Disk:** minimum of 10 gigabytes free storage

**CPU:** Look for articles about the best CPU-GPU combinations and match CPU to your GPU

**Motherboard:** Look for articles about the best CPU-Motherboard combinations and match the motherboard to your CPU..

Hardware pricing from Feb 2023:

- \* System 76 Thelio Major desktop costs \$3,981.00
- \* Similarly configured Velocity Micro Raptor Z55 costs \$4,434.00
- \* Similarly configured Dell Alienware Aurora R15 costs \$4,029.99

Thelio Major



modify configuration

QUANTITY:

[REMOVE FROM CART](#)

Base Price	\$1,045.00
Walnut - Classical style in a rich brown finish	
Pop!_OS 22.04 LTS with full disk-encryption	
5.4 GHz 13th Gen Intel i7-13700K (Up to 5.4GHz - 16 Cores - 24 Threads 8P+8E)	\$575.00
32 GB Dual Channel DDR5 up to 4800 MHz (2x 16GB)	\$189.00
1 TB PCIe Gen4 Up to Seq Read: 7000 MB/s, Write: 5000 MB/s	\$175.00
No Additional Storage	
4 TB HDD 5400 RPM Drive	\$179.00
1x 16 GB GeForce RTX 4080 with 9728 CUDA Cores	\$1,530.00
1000 W Power Supply	\$288.00
Built-in Intel® WiFi 6E + Bluetooth 5	
1 Year Limited Parts and Labor Warranty	
Normal Assembly - Ships within 10 business days from assembly	

Product total: **\$3,981.00**

# What is CUDA?

CUDA stands for **Compute Unified Device Architecture**. The term CUDA is most often associated with the CUDA software. The CUDA software stack consists of:

- CUDA hardware driver
- CUDA API and its runtime: The CUDA API is an extension of the C programming language that adds the ability to specify thread-level parallelism in C and also to specify GPU device specific operations (like moving data between the CPU and the GPU).
- Mathematical libraries that have been optimized to run using CUDA.

The CUDA software comes with the software driver, the CUDA toolkit (compiler, debugger, profiler), and the CUDA SDK (CUDA code samples).

More information on CUDA is available at: <http://www.nvidia.com/cuda>

Source: [https://nvidia.custhelp.com/app/answers/detail/a\\_id/2132/~/what-is-cuda%3F](https://nvidia.custhelp.com/app/answers/detail/a_id/2132/~/what-is-cuda%3F)

## Creative Software That Uses CUDA

3ds Max	Adobe Family	ArcGIS Pro	Autodesk AutoCAD
Blender	Blender Cycles	Cinema 4D	Corel Draw

Source: <https://www.nvidia.com/en-us/studio/software/>



# What are the options for execution using the Cloud?

→ **Install in a virtual machine that is running in the Cloud (Desktop as a service (DaaS))**

(Amazon Workspaces, Microsoft Azure Virtual Desktop, VMware Horizon Cloud, Citrix, Google Compute Engine)

See What is a Virtual Machine? at

<https://cloud.google.com/learn/what-is-a-virtual-machine>

→ **Run your code in a browser-accessible session running in the Cloud**

(Google Colab, Kaggle Notebooks, Microsoft Azure Notebooks, IBM Watson Studio Cloud, JetBrains Datalore)

\* Each of the above uses its own custom environment.

→ **My “FREE” Choice: Use Google Colab**

Pros: Cost (free), simplicity, and Google Drive connectivity

Cons: Amount of VRAM available and session connect time

The lowest prices  
**for on-demand GPU**

	Lambda	FluidStack	CoreWeave	<b>vast.ai</b> <span>Best Price</span>
GPU	4x RTX A6000	4x RTX A6000	4x RTX A6000	4x RTX A6000
CPU	Intel® CPU	Intel® CPU	Intel® CPU	Xeon® E5-2683 v4
Virtual Cores	32/64 cpu	32/64 cpu	32/64 cpu	32/64 cpu
System Ram	256 GB	256 GB	256 GB	256 GB
TFLOPS	180.6	180.6	180.6	180.6
On-demand Price	\$9.00/hr 5.5X More	\$7.97/hr 4.5X More	\$6.72/hr 4X More	\$1.61/hr 400-550% Savings!
Interruptible Price	N/A	N/A	N/A	\$0.80/hr

# What is Google Colaboratory?

## **According to chatGPT:**

Google Colab is a free platform for machine learning education and research. A product of Google Research, it provides access to free GPUs and TPUs for running large-scale computations, and it allows users to share and collaborate on Jupyter notebook documents. Colab supports many programming languages, including Python, and can be used for tasks such as data preprocessing, training AI models, and running experiments. It is a great tool for machine learning and data science enthusiasts and can be used to explore and build models on large datasets.

## **According to Google:**

Colaboratory ("Colab" for short) is a data analysis and machine learning tool that allows you to combine executable Python code and rich text along with charts, images, HTML, LaTeX and more into a single document stored in Google Drive. It connects to powerful Google Cloud Platform runtimes and enables you to easily share your work and collaborate with others. More technically, Colab is a hosted Jupyter notebook service that requires no setup to use, while providing access free of charge to computing resources including GPUs.

## **Google Colab References:**

<https://colab.research.google.com/>

<https://research.google.com/colaboratory/faq.html>

<https://colab.research.google.com/notebooks/intro.ipynb>

# Where does Colab keep my code (and data) ?

Your programs are saved as Colab notebooks (\*.ipynb):

- Colab notebooks are stored in your Google Drive
- Notebooks can be uploaded from and downloaded to your local computer
- Notebooks can be loaded from GitHub.
- You can share your Colab notebooks from Google Drive (click the Share button)<sup>#1</sup>

As to data:

- Data files stored on Google Drive are easily accessed – just get the path right
- Data files can be uploaded directly into your session – but they are deleted at the end of your session
- Data files can be accessed via a URL

<sup>#1</sup>: Be careful when running someone else's colab that requires access to your Google Drive.



# What We Won't Be Doing



The first Colab for Stable Diffusion I used.

Weaknesses:

- number of external dependencies
- code complexity

- 43.5 8.5x11 pages of code
- 110 library import stmts
- 42 subprocesses pulling in code from Github, etc.
- Required access to my Google Drive

# Some Coding Principals

## When creating a program:

- Understand your development environment (your IDE or in this case Google Colab)
- Start simple and build
- Understand your program's algorithmic hierarchy
- Understand your variables and their values
- Understand the input parameters and the outputs of the functions you use  
In Python: `print(type(outputVariable))`
- Incrementally add functionality
- Test your code following each addition of functionality
- Incorporate documentation

## Understand that

- Debugging difficulty increases with program complexity
- As external dependencies increase, so too does program fragility

## Be mindful of

- Wirth's Law (due to complexity, programs are getting slower faster than hardware is getting faster)
- Zawinski's Law (software functionality bloat due to the continued addition of features)

# Prompt Engineering

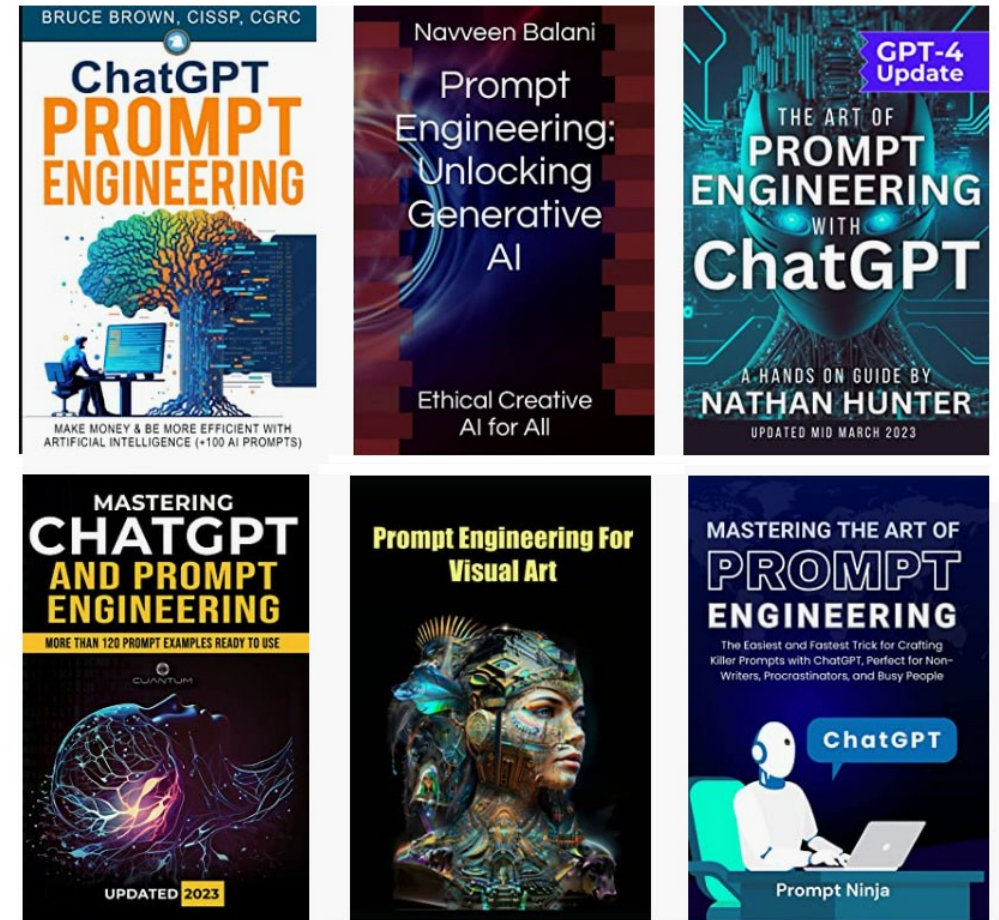
A massive amount of videos and text has been written on prompt engineering or “how to write a prompt”.

Note that different AI art generators and different versions of the same generator have their own prompt characteristics.

It’s important to know what AI art or text generator (and version) you want to write prompts for since they each have their own unique features.

I suggest using a search engine using the following terms:

- stable diffusion prompt engineering
- stable diffusion 2 prompt engineering
- Dall-E prompt engineering
- chatgpt prompt engineering





# Start a Google Colab session demonstration

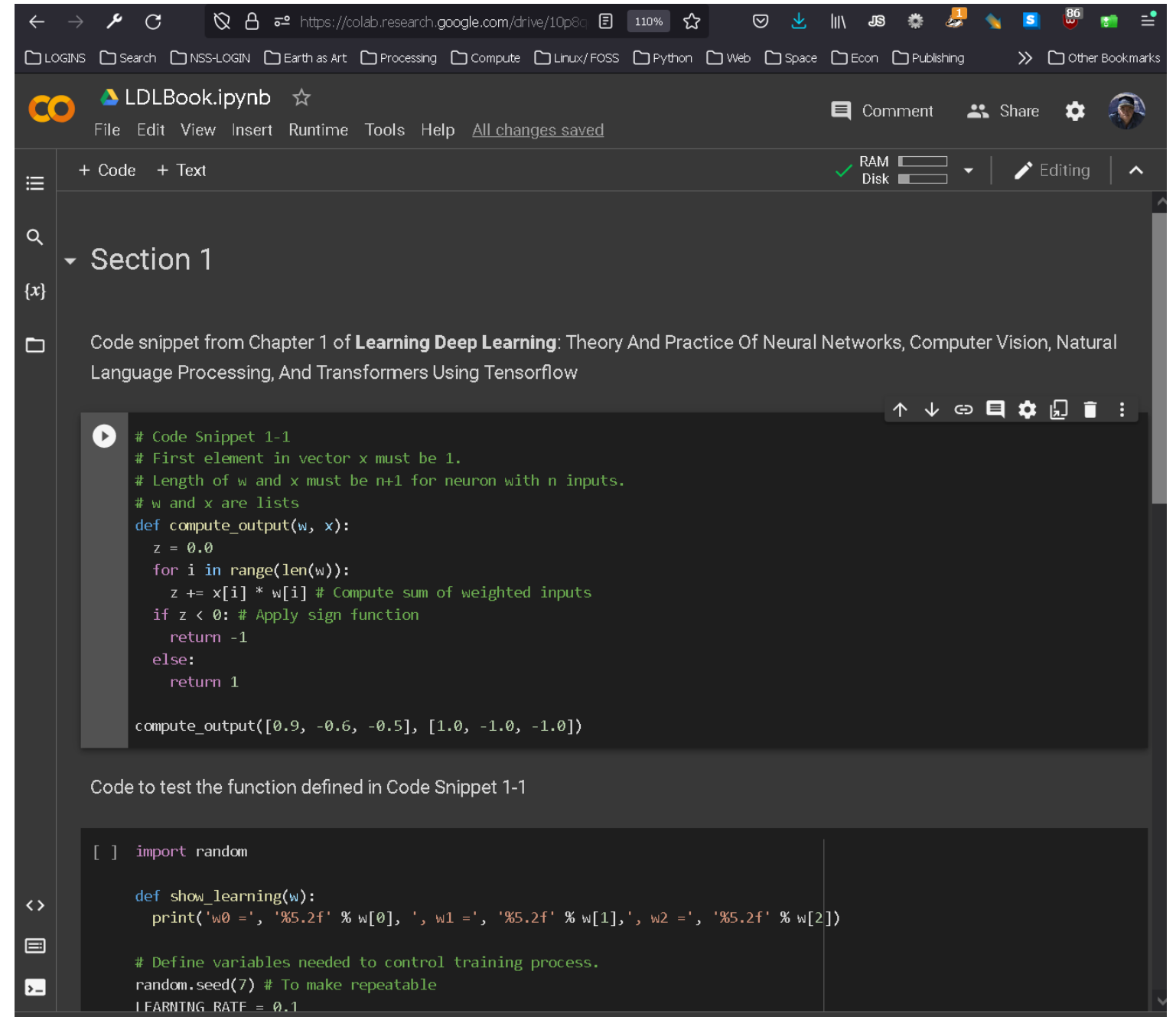
Think of starting a Google Colab session as starting a program on your computer.

You will need to sign into your Google account first.

And since Google fails to provide Colab as an option in the App Launcher you'll need to type in the colab url.

**URL: <https://colab.research.google.com/>**

**Note: If your session is disconnected, you need to start over again from the very beginning.**



The screenshot shows a Google Colab interface. The browser address bar displays the URL `https://colab.research.google.com/drive/10p8c...`. The page title is "LDLBook.ipynb". The interface includes a menu bar with "File", "Edit", "View", "Insert", "Runtime", "Tools", and "Help". A sidebar on the left shows a file explorer with "Section 1" expanded. The main area contains a code snippet titled "Code snippet from Chapter 1 of Learning Deep Learning: Theory And Practice Of Neural Networks, Computer Vision, Natural Language Processing, And Transformers Using Tensorflow". The code defines a function `compute_output(w, x)` and calls it with `compute_output([0.9, -0.6, -0.5], [1.0, -1.0, -1.0])`. Below this, there is a section titled "Code to test the function defined in Code Snippet 1-1" which includes `import random` and a function `show_learning(w)` that prints the first three elements of `w`. The interface also shows RAM and Disk usage indicators and an "Editing" mode button.

# Using Google Colab to run openAI GPT-3 and DALL-E

**Requirement: An openAI API Key**

**Reference Links**

**openAI Discord Invite:** <https://discord.com/invite/openai>

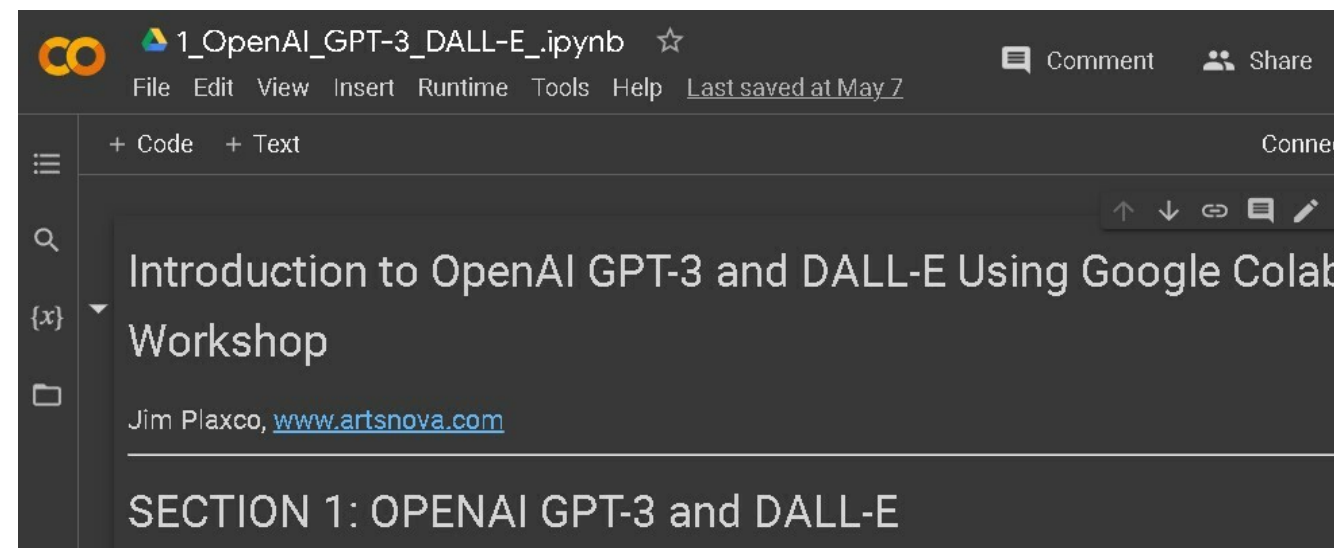
**Getting Started with DALL-E** <https://help.openai.com/en/collections/3557252-dall-e-2#getting-started-with-dall-e>

**DALL-E-2-prompt-book-v1.02** <https://dallery.gallery/wp-content/uploads/2022/07/The-DALL%C2%B7E-2-prompt-book-v1.02.pdf>

**Can I sell images I create with DALL-E? (Yes)** <https://help.openai.com/en/articles/6425277-can-i-sell-images-i-create-with-dall-e>

**DALL-E API FAQ** <https://help.openai.com/en/articles/6704941-dall-e-api-faq>

**DALL-E Developer Guide for Image Generation** <https://beta.openai.com/docs/guides/images>



**Source Code URL:** <https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/1-OpenAI-GPT-3-DALL-E.ipynb>

# Stable Diffusion Terms of Use

**"the specific affirmation you make when using the DreamStudio Beta and the Stable Diffusion services is that of the CC0 1.0 Universal Public Domain Dedication “**

Source: <https://creativecommons.org/publicdomain/zero/1.0/>

**CC0 1.0 Universal (CC0 1.0) Public Domain Dedication** : <https://creativecommons.org/publicdomain/zero/1.0/>

“The person who associated a work with this deed has dedicated the work to the public domain by waiving all of his or her rights to the work worldwide under copyright law, including all related and neighboring rights, to the extent allowed by law....

You can copy, modify, distribute and perform the work, even for commercial purposes, all without asking permission. See Other Information below.”

# Using Google Colab to run Stable Diffusion

To clarify:

- the original images themselves aren't stored in the Stable Diffusion model
- over 100 terabytes of images used to create a 4GB model
- you can use Stable Diffusion as a base for training your own model. which has generated concern because an individual can grab images from a single artist, use that to train a new fine-tuned model.
- there are over 700 models in the Concepts Library on HuggingFace so far: <https://huggingface.co/sd-concepts-library>



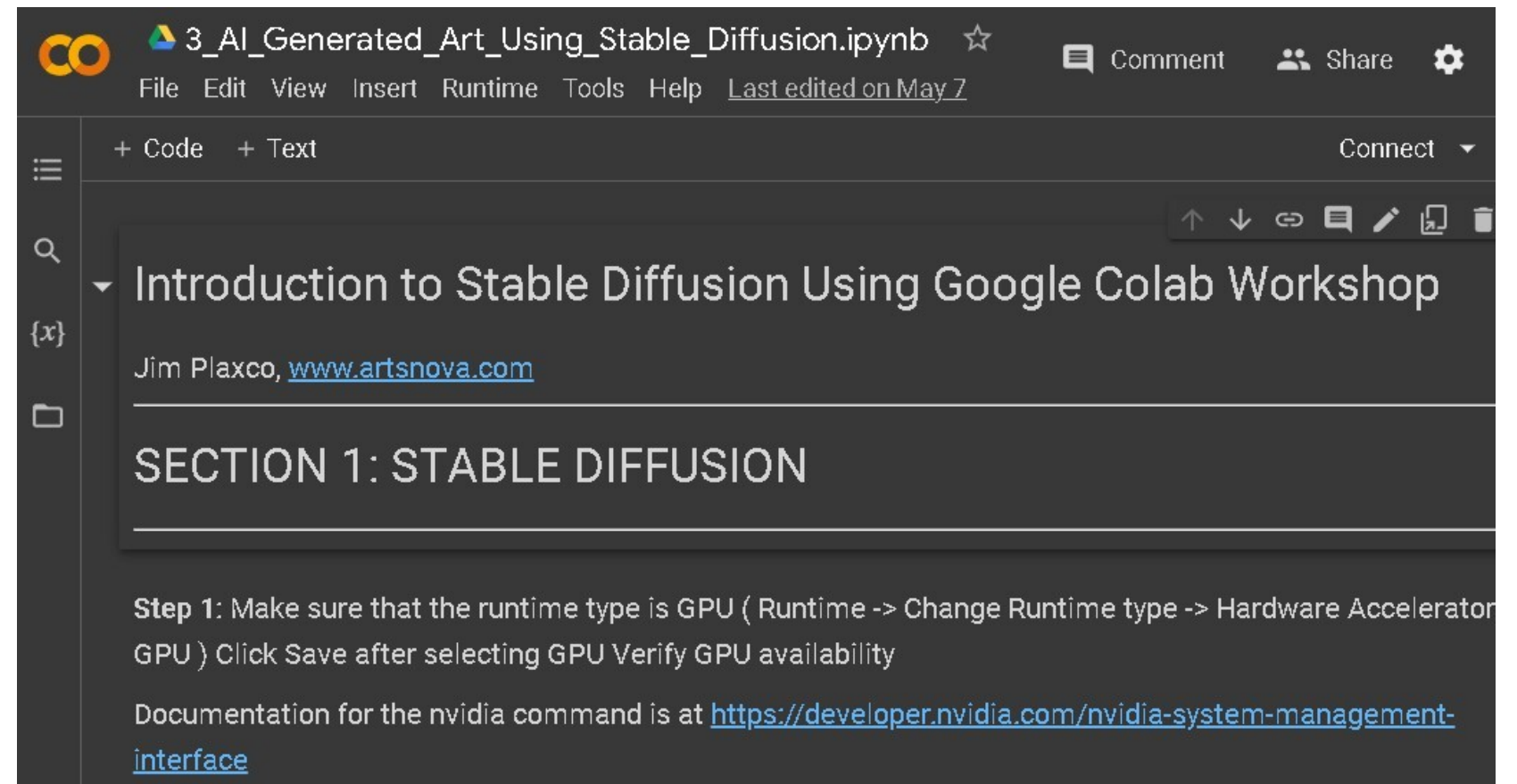
Source: CapriconStableDiffusionExample.ipynb,  
Prompt: "dark concept art of aliens at a science fiction convention lurking in the shadows, sharp details, octane render"

**Source Code URL:** <https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/2-AI-Generated-Art-Using-Stable-Diffusion.ipynb>

# Another Stable Diffusion Notebook

Note that because we are loading a new notebook, we will have to reinitialize our session.

No, Colab does not allow us to have two concurrent sessions running at the same time.



## Source Code URL:

<https://www.artsnova.com/dalle-gpt3-stable-diffusion-ai-tools-workshop/3-AI-Generated-Art-Using-Stable-Diffusion.ipynb>

If time permits, let's test another Colab Notebook (not mine):

<https://colab.research.google.com/github/pcuenca/diffusers-examples/blob/main/notebooks/stable-diffusion-seeds.ipynb#scrollTo=HGcM2nF53WxR>



# Discussion and Questions

## TOPICS

- Google Colaboratory (COLAB)
- OpenAI DALL-E
- OpenAI GPT-3
- Stable Diffusion
- Python