

An Introduction to Stable Diffusion and Google Colab for Capricon 2023

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What is this workshop about?

This workshop is a tutorial on how to use Google Colab to run a Python program that uses the Stable Diffusion libraries to create AI-Generated art – with a brief introductory excursion into using the openAI GPT-3 and DALL-E libraries.

Coding knowledge is not needed but it will help.

The requirements to complete the workshop are:

- 1 A Google Gmail account (<https://www.google.com/gmail/about/>)
- 2 A HuggingFace account (<https://huggingface.co/join>)
- 3 Optionally, an openAI account for GPT-3 (<https://beta.openai.com/signup>)

Workshop Files (PDF and IPYNB code files) URL:

<https://www.artsnova.com/capricon-science-fiction-2023/>

Presentation URL:

<https://www.artsnova.com/capricon-science-fiction-2023/stable-diffusion-colab-workshop.pdf>

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 for 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 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

Workshop Outline

- A Quick Summary on AI-Generated Art
- Overview of Platform Options
- Overview of Hardware Requirements
- Overview of AI Generation Options
- Introduction to Google Colab
- Introduction to Using Google Colab for openAI GPT-3 and DALL-E
- Introduction to Using Google Colab for Stable Diffusion
- Another Introduction to Using Google Colab for Stable Diffusion
- Prompt Engineering
- Question and Answer

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?

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,
Large Language Models,
Pipeline,
Prompt engineering,
Tensor,
Text Encoder,
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 in 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 software execution platform options?

→ **Online:**

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

→ **Local Install:**

You install and run the software on your desktop or laptop

→ **Cloud-Based Virtual Machine**

You install and run the software on a “computer” that is actually 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 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..

Thelio Major



modify configuration

QUANTITY: 1

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

* Similarly configured Velocity Micro Raptor Z55 costs \$4,434

* Similarly configured Dell Alienware Aurora R15 costs \$4,029.99

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

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 Choice: Use Google Colab**

Pros: Cost, simplicity, and Google Drive connectivity

The lowest prices
for on-demand GPU

	Lambda	FluidStack	CoreWeave	vast.ai Best Price
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. 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 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.

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) ?

Colab notebooks (*.ipynb):

- Colab notebooks are stored in your Google Drive
- Notebooks can be uploaded from and downloaded your local computer
- Notebooks can be loaded from GitHub.
- You can share your Colab notebook (click the Share button)^{#1}

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

#1: 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:

- 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

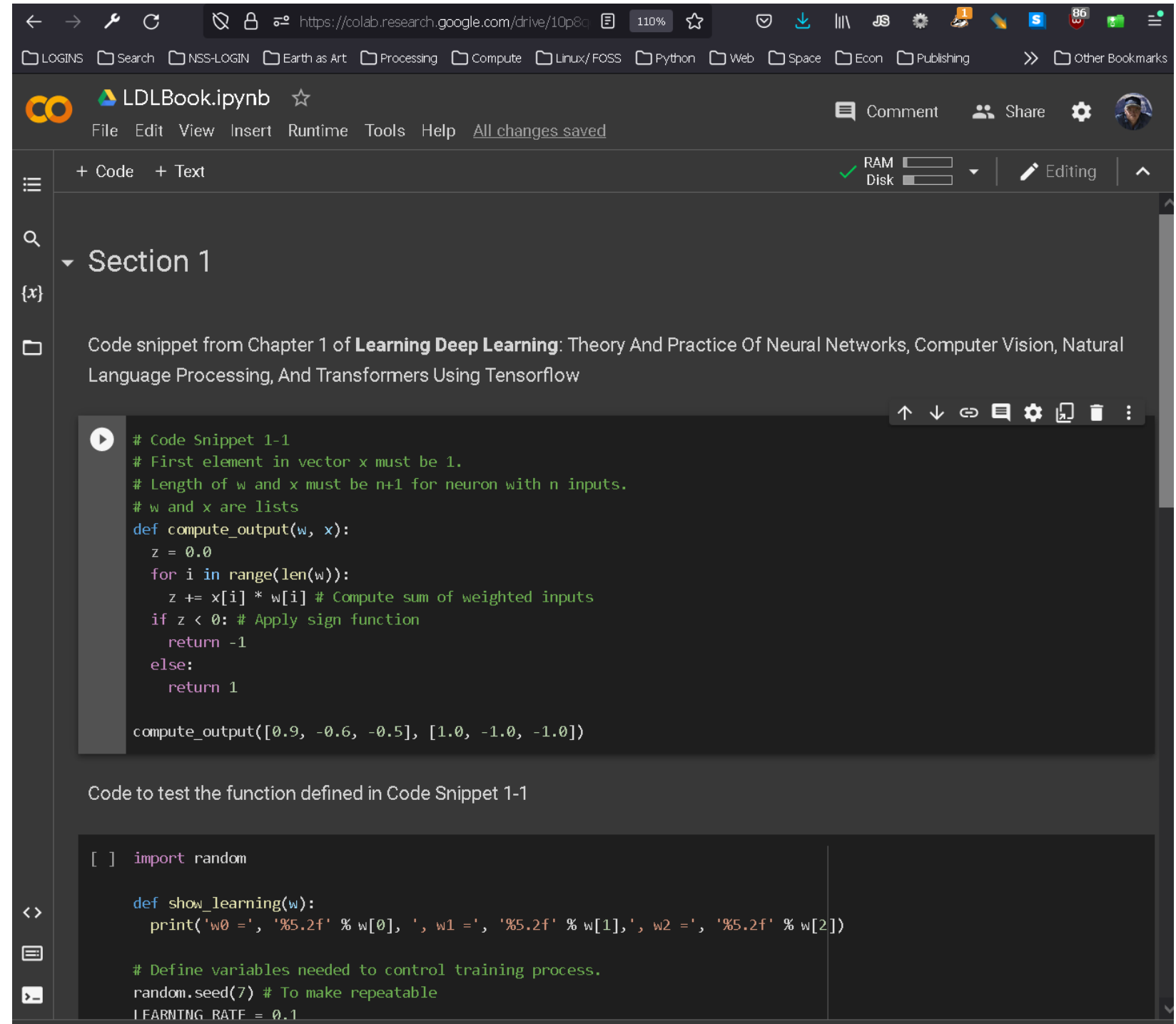
Start a Google Colab session demonstration

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 in a browser. The address bar shows 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 status bar at the top right shows "RAM" and "Disk" usage, and "Editing" mode. The main content area is titled "Section 1" and contains a 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 is followed by a call to `compute_output([0.9, -0.6, -0.5], [1.0, -1.0, -1.0])`. Below the code snippet, there is a section titled "Code to test the function defined in Code Snippet 1-1" which contains a function `show_learning(w)` and some initialization code for `random` and `LEARNING_RATE`.

Prompt Engineering

A massive amount of videos and text has been written on “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 most important to know exactly what AI art generator you want to write prompts for.

I suggest using a search engine using the following terms:

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

A Brief Foray into openAI GPT-3 and Dall-E Using Colab

(openAI is the maker of chatGPT)

Requirement: An openAI account and an API Key

Reference Links

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

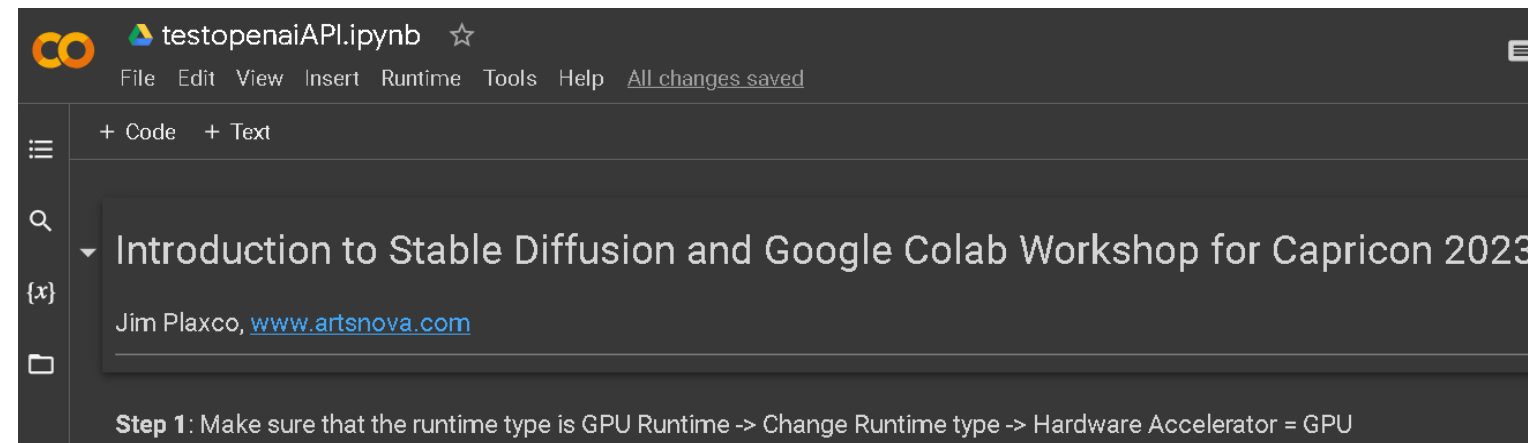
Getting Started with DALL·E <https://help.openai.com/en/collections/3557252-dall-e-2#getting-started-with-dall-e>

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/capricon-science-fiction-2023/CapriconOpenaiAPI.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/>

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

Now for Stable Diffusion

Source Code URL: <https://www.artsnova.com/capricon-science-fiction-2023/CapriconStableDiffusionExample.ipynb>

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"

Stable Diffusion One More Time

Source Code URL: <https://www.artsnova.com/capricon-science-fiction-2023/CapriconStableDiffusion.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>

Questions?

My Capricon 2023 Schedule

AI Generated Art with Stable Diffusion and Google Colab
Superior • Fri 11:30 AM

The Next Big Thing in Energy

Superior • Fri 2:30 PM

Fusion reactors, space solar power satellites, hydrogen: what technologies will drive the next revolution in environmentally friendly power generation? Our panel will explore the possibilities.

The Impact of AI-Generated Art

Colorado • Fri 4:00 PM

AI generated art has really taken off. What are the ramifications? For example, pay my nickel, get an AI generated artwork and then sell it. Will authors turn to AI to get their book covers? AI art is generated based on databases of images made by human artists—did they consent to this, and how should they be compensated? Our panelists will explore these questions and more.

Bankrupt in Space

Missouri • Sat 10:00 AM

Our panelists discuss the logistics of space colonization. Who will pay for it? What happens when the money runs out? What kind of profit motive do you need to make a colony viable?

Will NewSpace Go Bust in 2023?

Superior • Sat 2:30 PM

With the explosion in the number of newSpace companies and the lack of proven markets, will 2023 and the prospects for a global recession see mass bankruptcies and the collapse of the private space industry?

The Artemis Project—Will It Work?

Colorado • Sat 7:00 PM

Artemis is the NASA program that will return astronauts to the Moon. Now that they've achieved the first uncrewed lunar mission, what are the prospects for program success?