STABLE DIFFUSION

MARCUS BJÖRKLUND & NIKLAS ANTONČIĆ

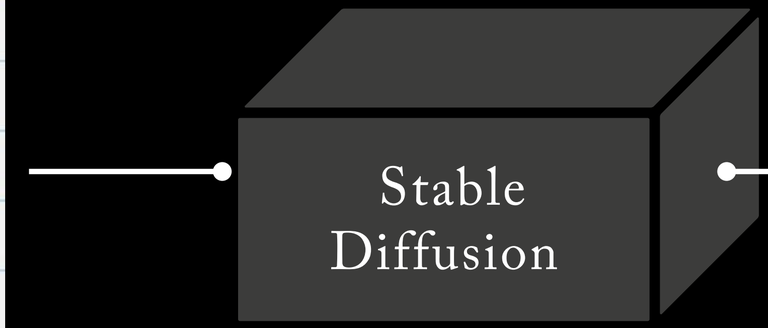
CADEC 2023.01.19 & 2023.01.25 | CALLISTAENTERPRISE.SE

CALLISTA

OVERVIEW

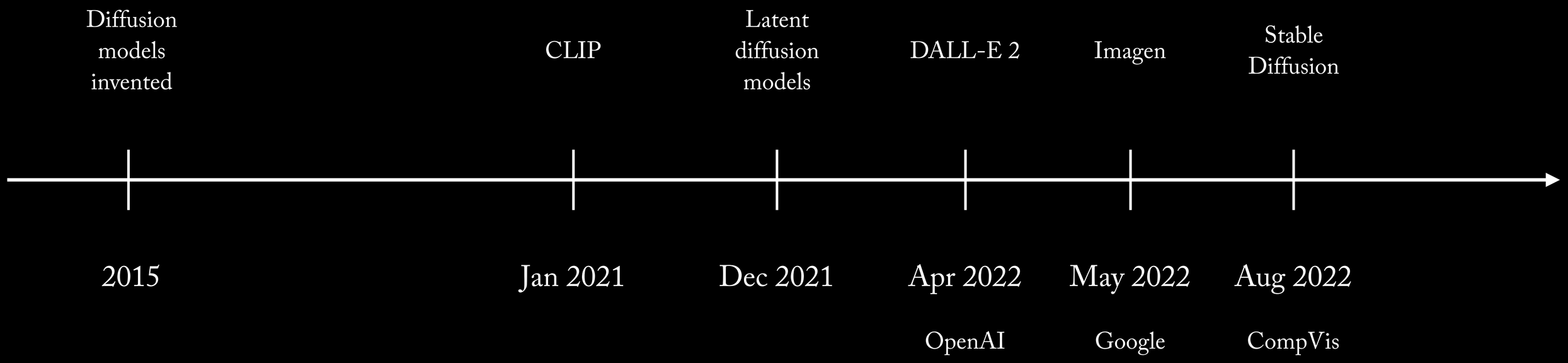
OVERVIEW

“the most beautiful panoramic landscape, oil painting, where a giant dreamy waterfall creates a river, the trees around are starting to bloom, water shining in the river, a ray of light of the sunset by greg rutkowski”



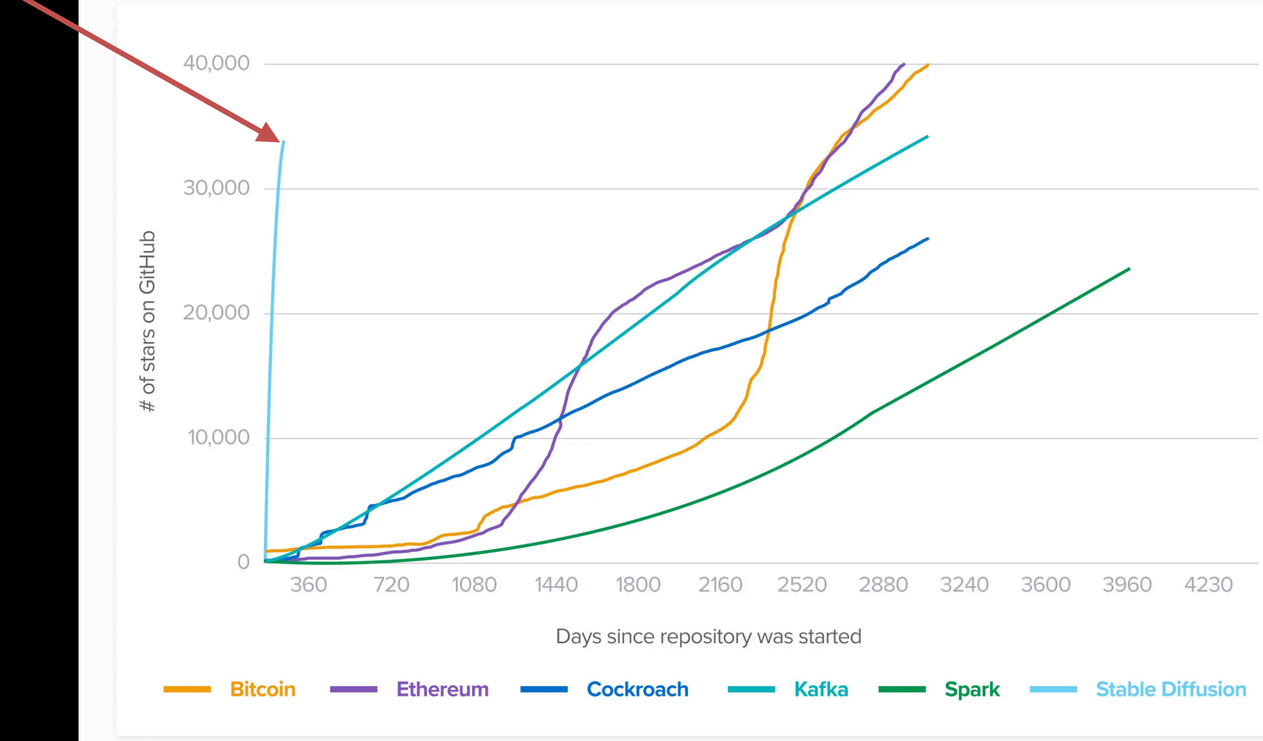
OVERVIEW

- The evolution of latent diffusion models



OVERVIEW

Stable Diffusion Developer Adoption



Stars on GitHub for major open source infrastructure technologies. Stable Diffusion accumulated 33,600 stars in its first 90 days, a benchmark other projects achieve in years or decades.

Source: GitHub

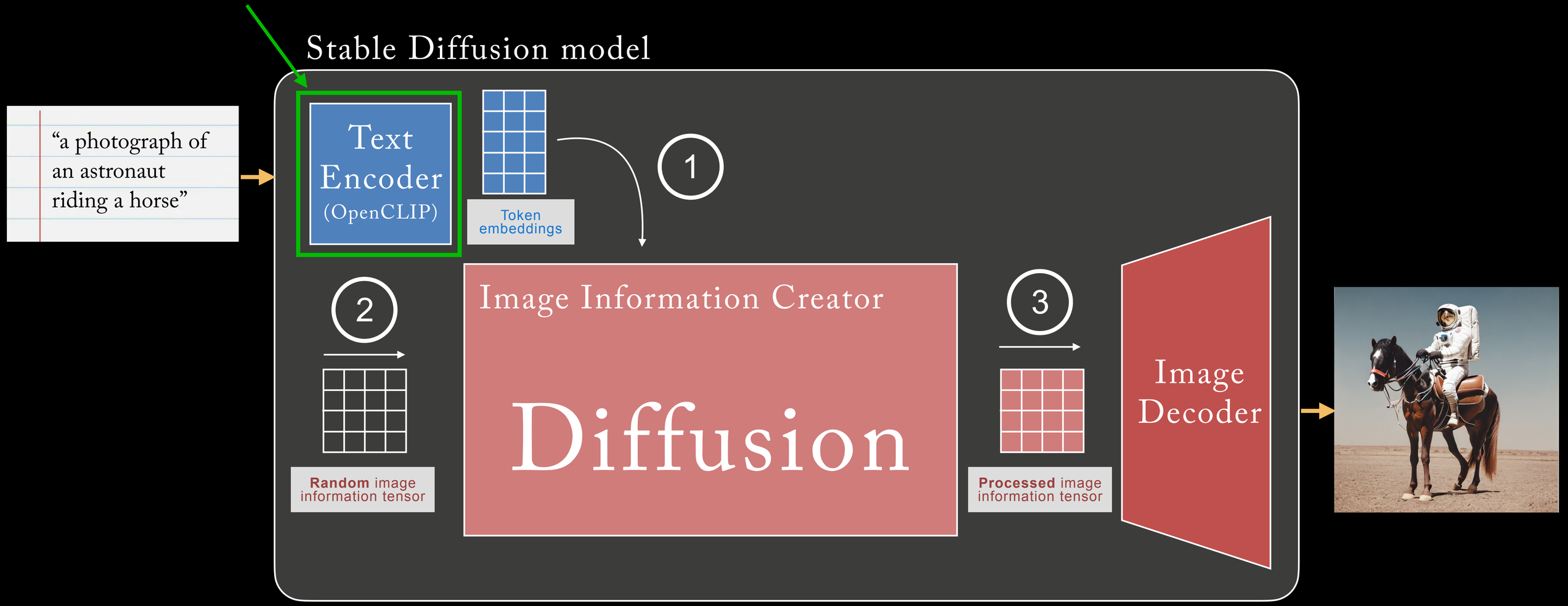
a16z Enterprise

AGENDA

- Overview
- Stable Diffusion
  - OpenCLIP
  - Diffusion models
- Live demo
- Legal aspects
- Summary

STABLE DIFFUSION

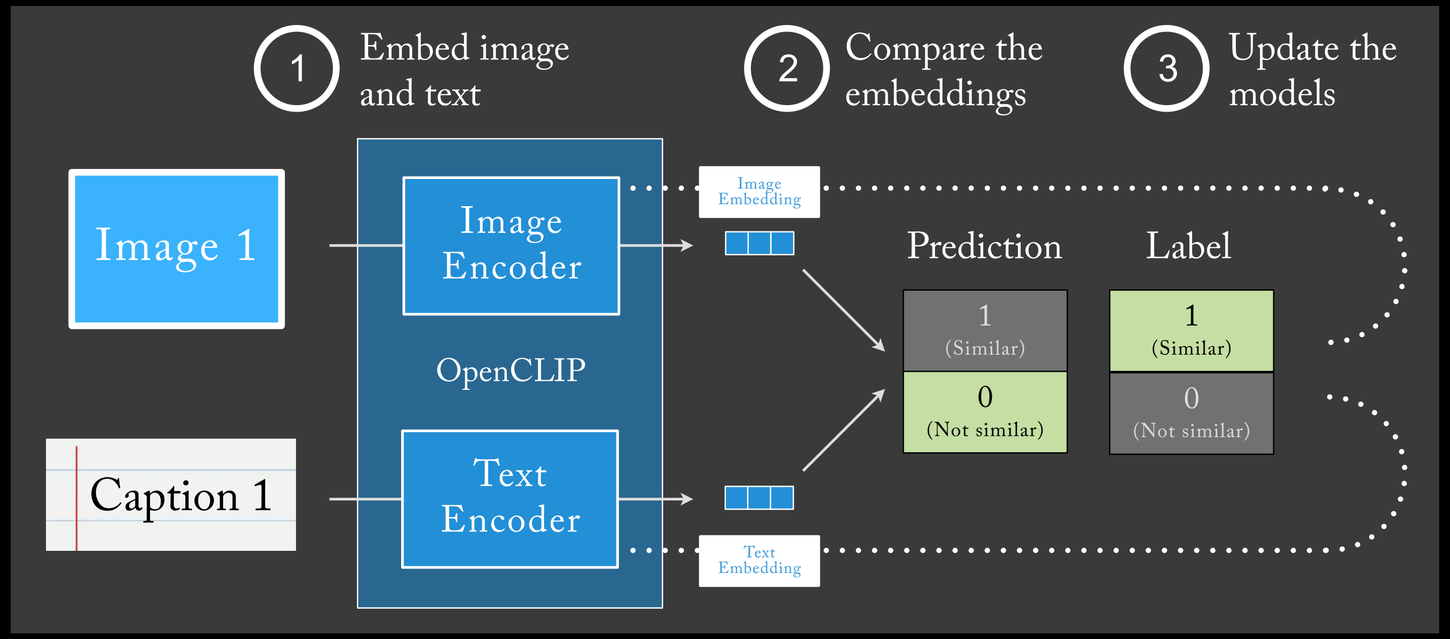
STABLE DIFFUSION



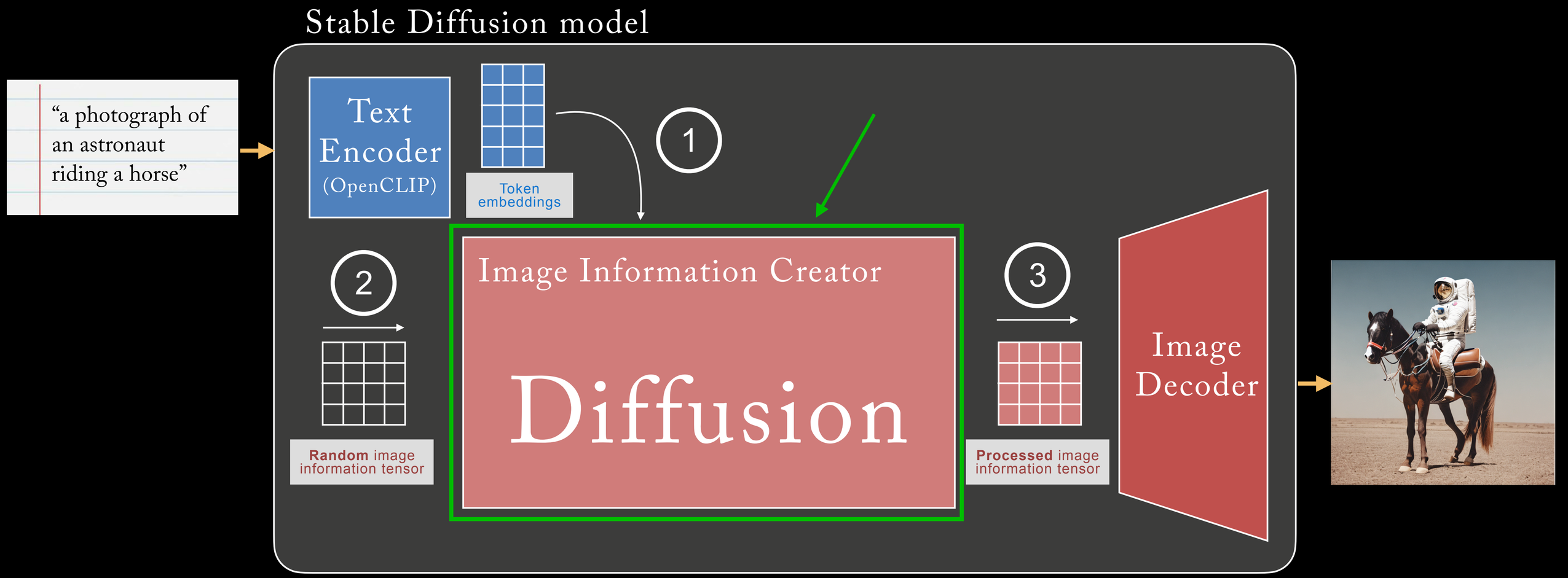
OPENCLIP

OPENCLIP

- Was trained on LAION-2B (2.3 billion pictures fetched from Internet)
- OpenCLIP is a combination of an image encoder and a text encoder
- During training, images and captions are encoded into two numerical embeddings and the model is continuously updated until the two embeddings are similar



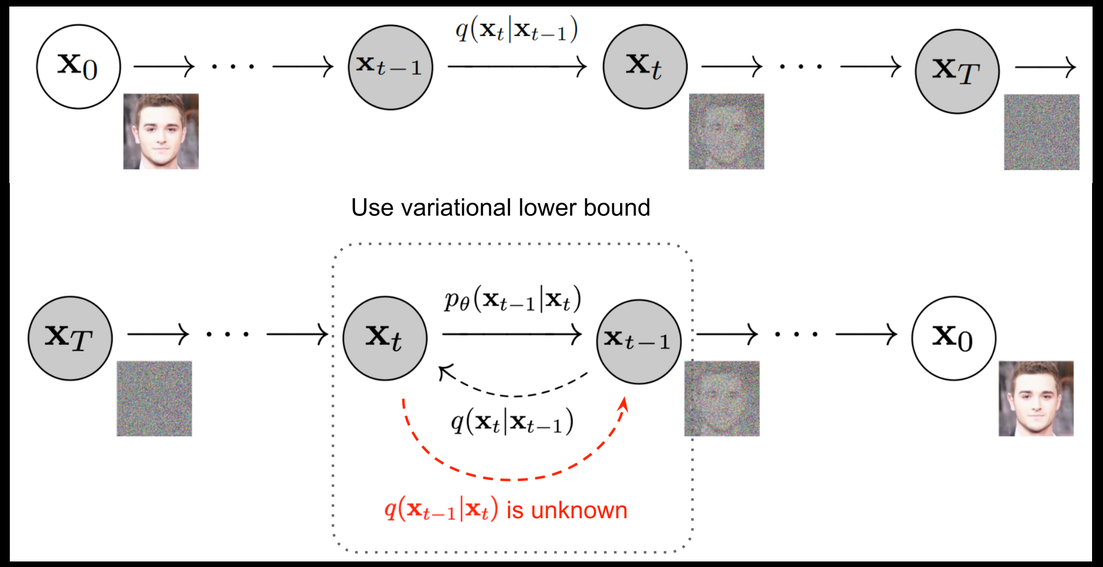
STABLE DIFFUSION



DIFFUSION MODELS - PROCESS

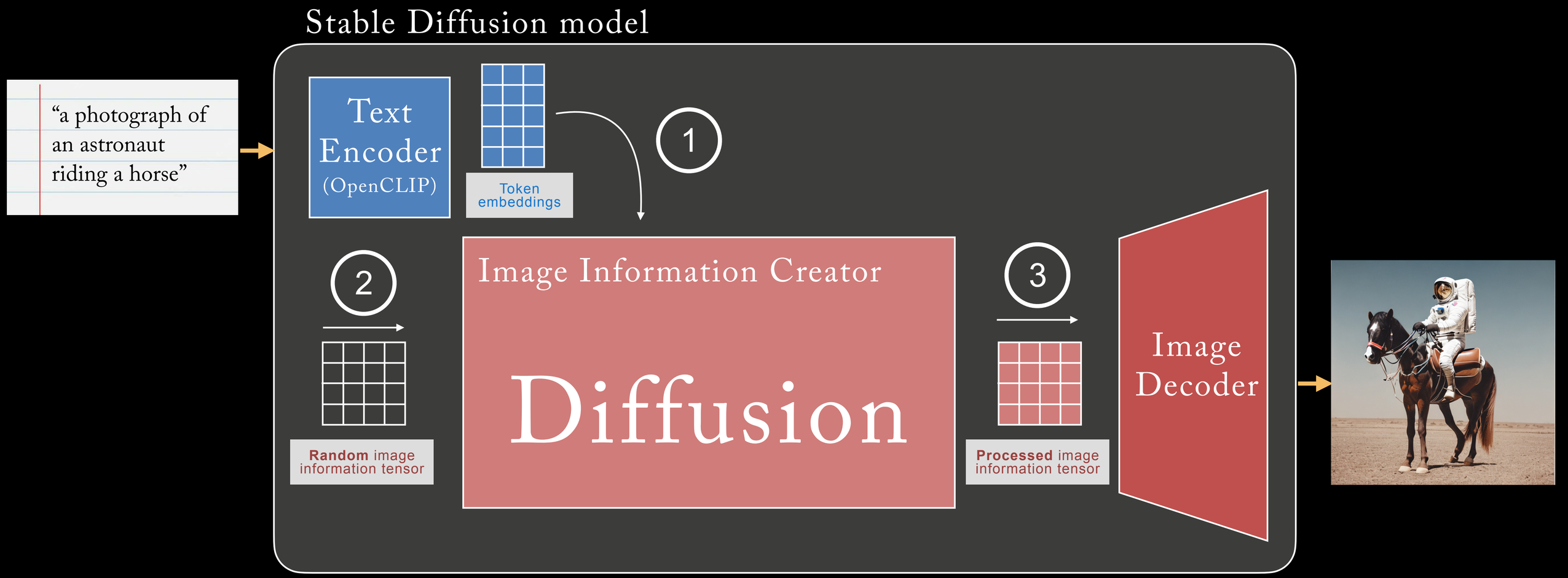
DIFFUSION MODELS - PROCESS

- A Markov chain of diffusion steps
- Forward diffusion:
  - add Gaussian noise to image through a series of T steps
- Reverse diffusion:
  - trained to recover original image by removing noise

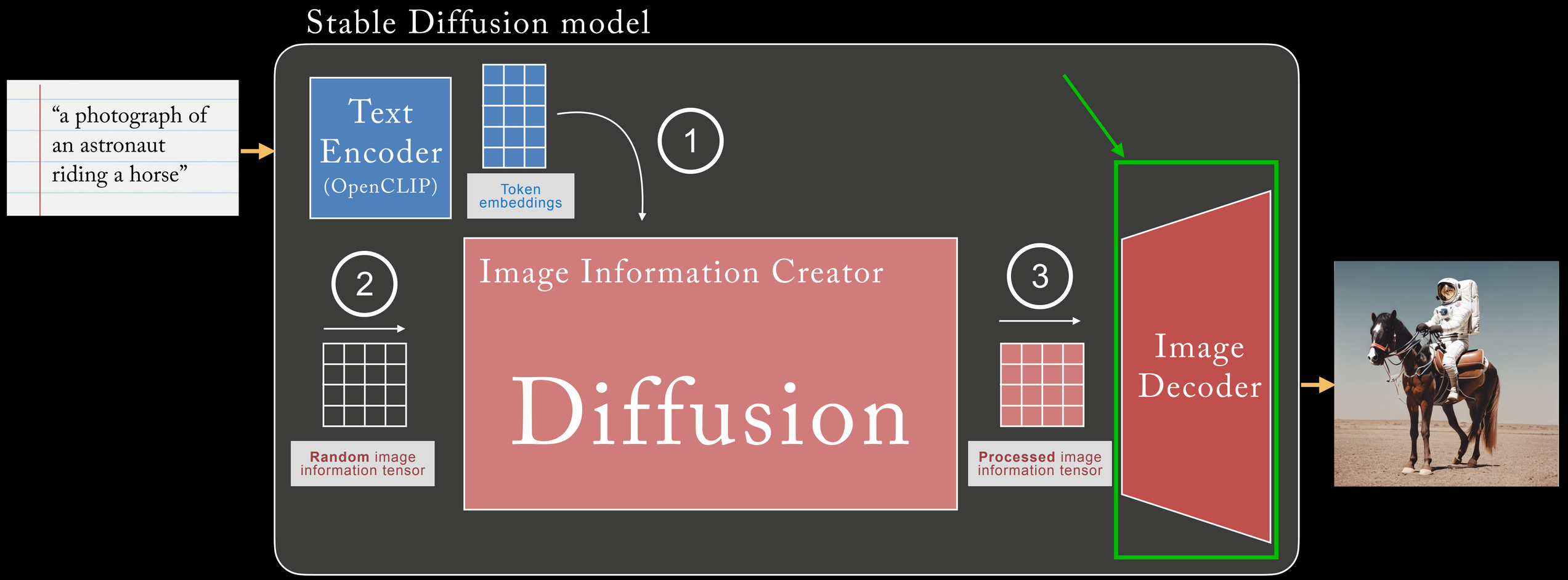


The Markov chain of forward (reverse) diffusion process of generating a sample by slowly adding (removing) noise.
Image source: *Ho et al. 2020*

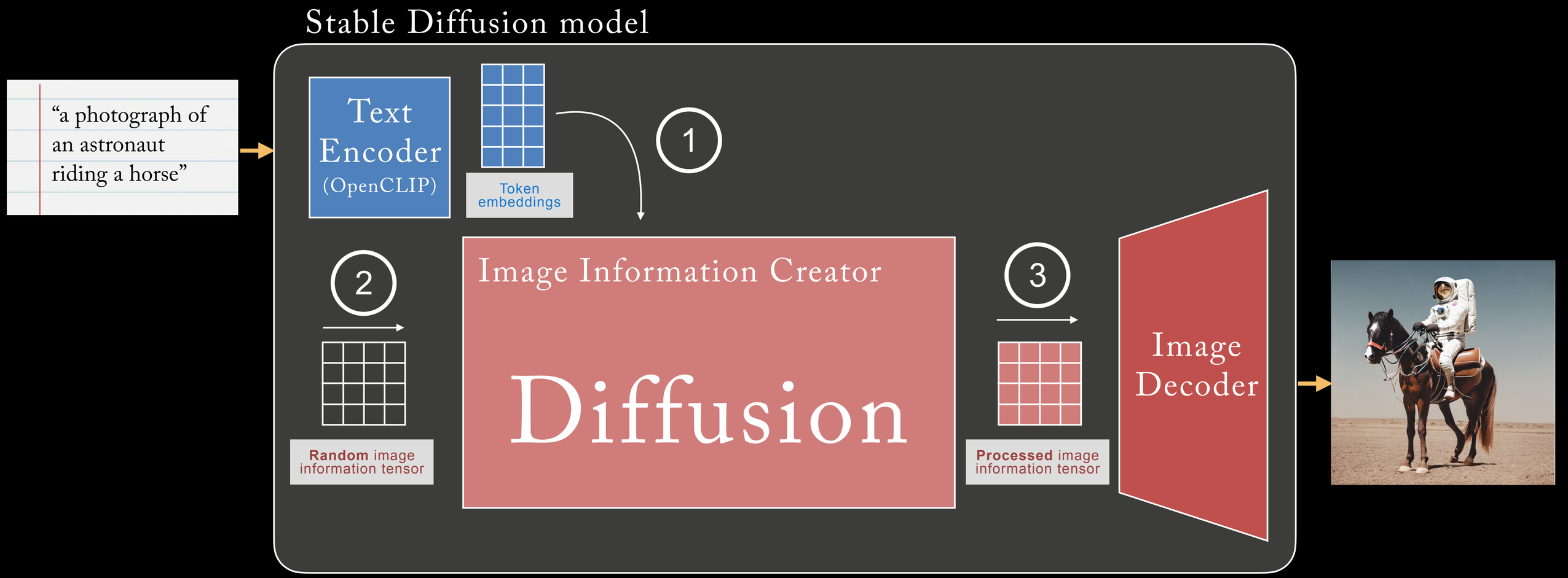
STABLE DIFFUSION



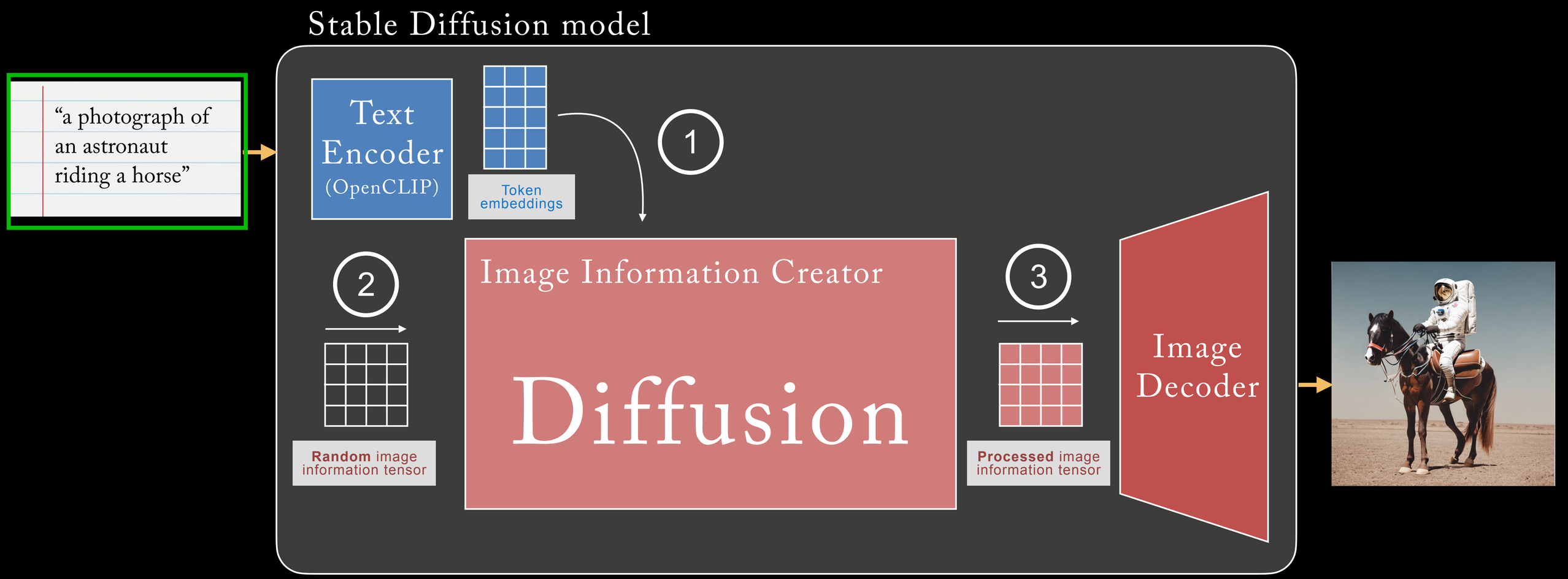
STABLE DIFFUSION



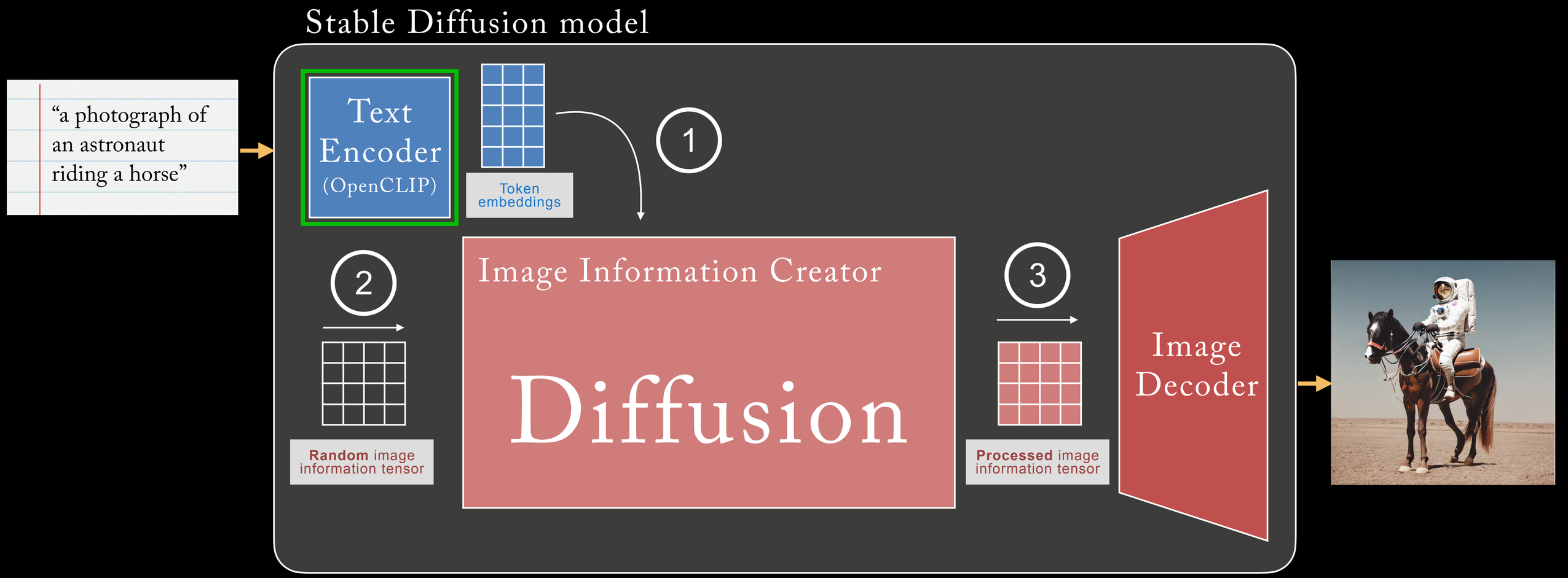
STABLE DIFFUSION



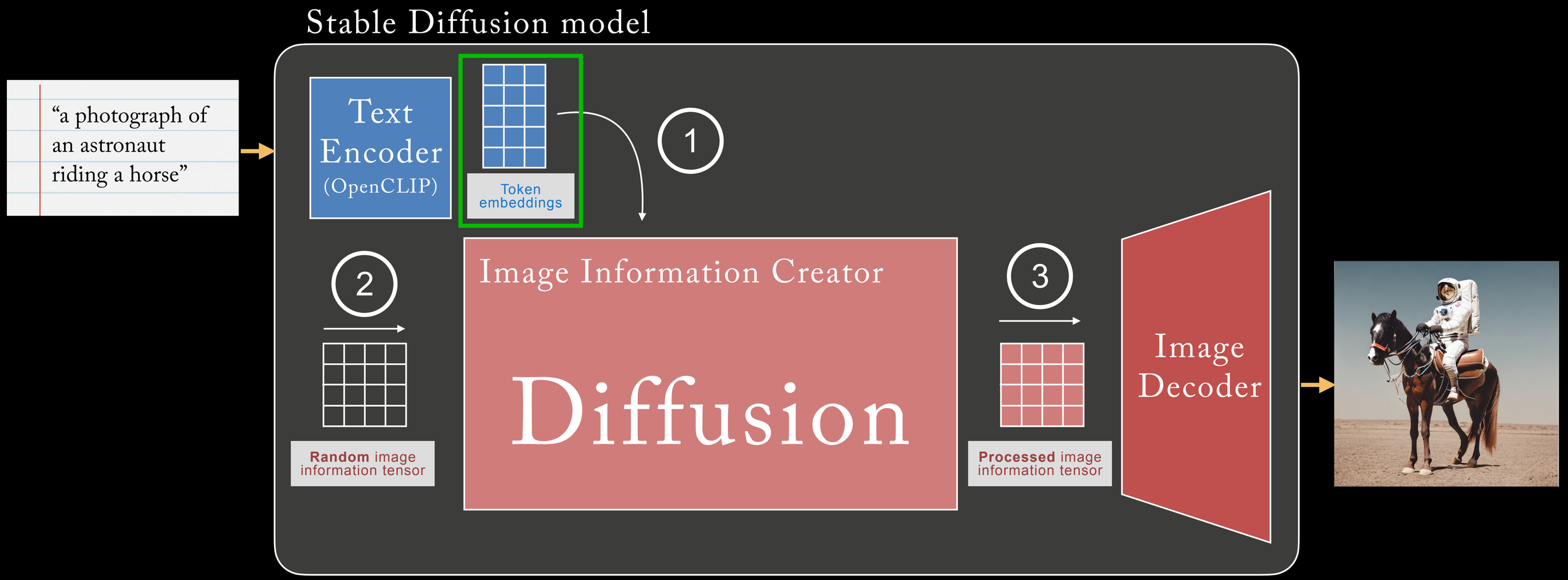
STABLE DIFFUSION



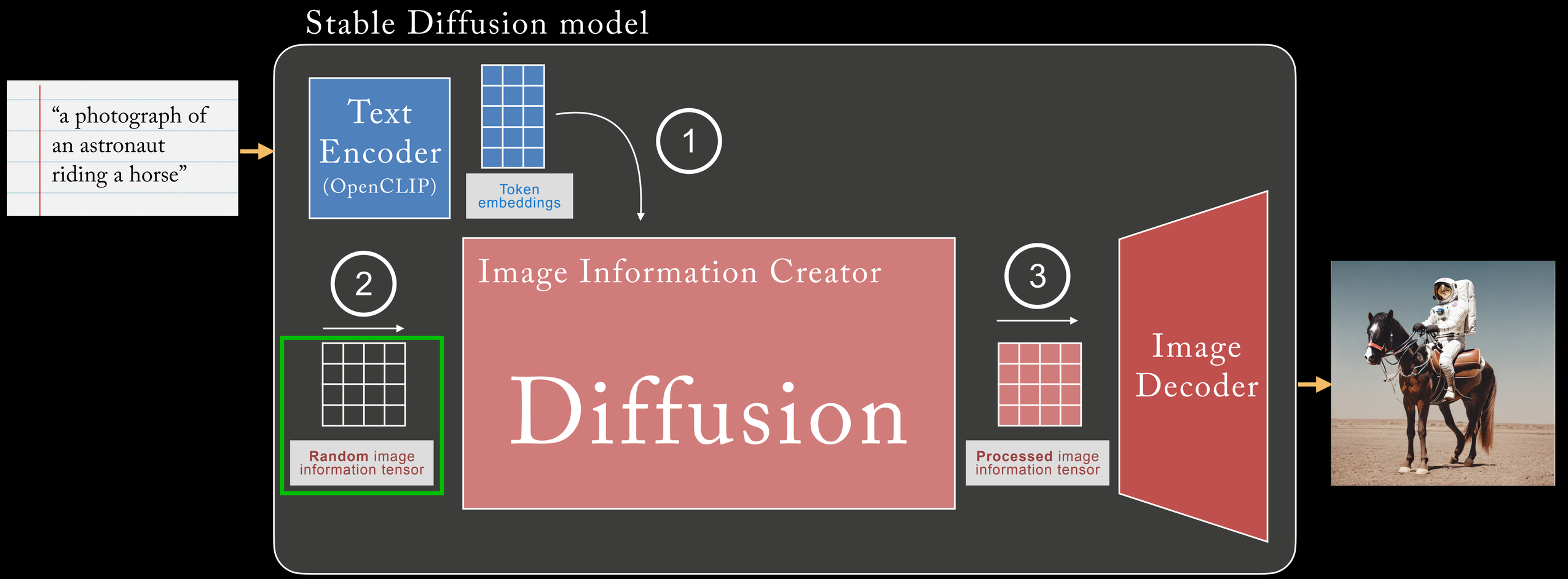
STABLE DIFFUSION



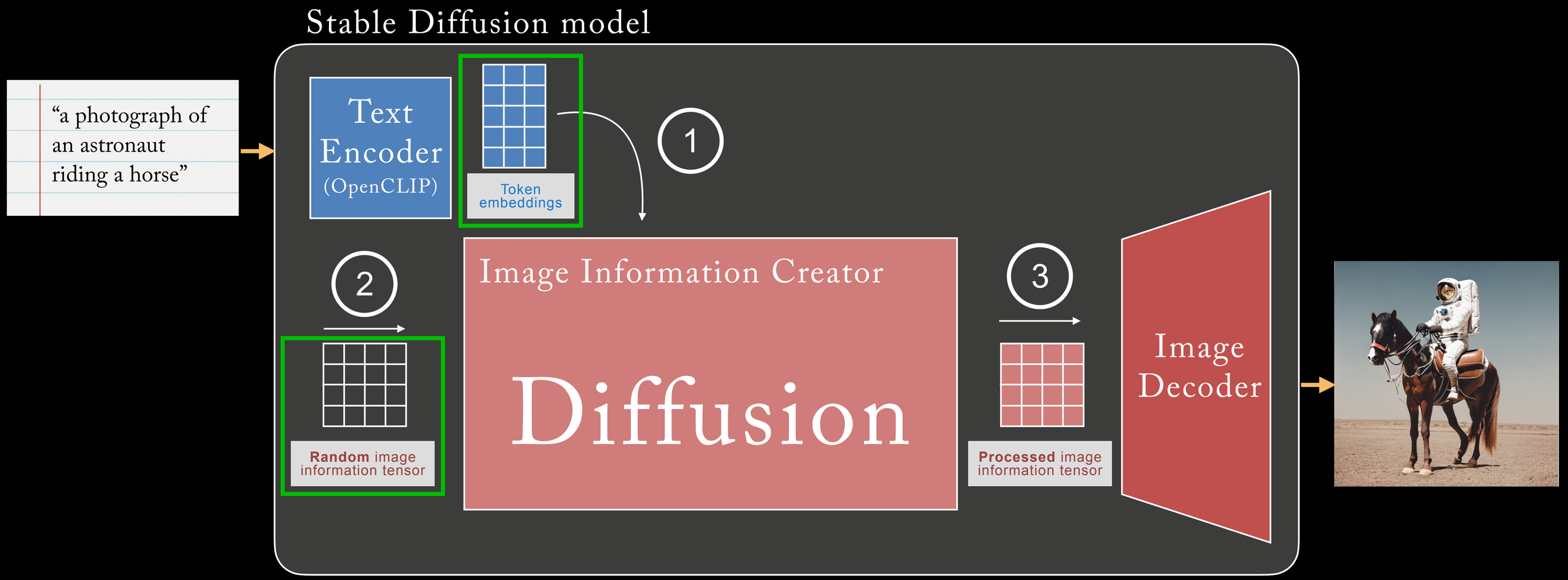
STABLE DIFFUSION



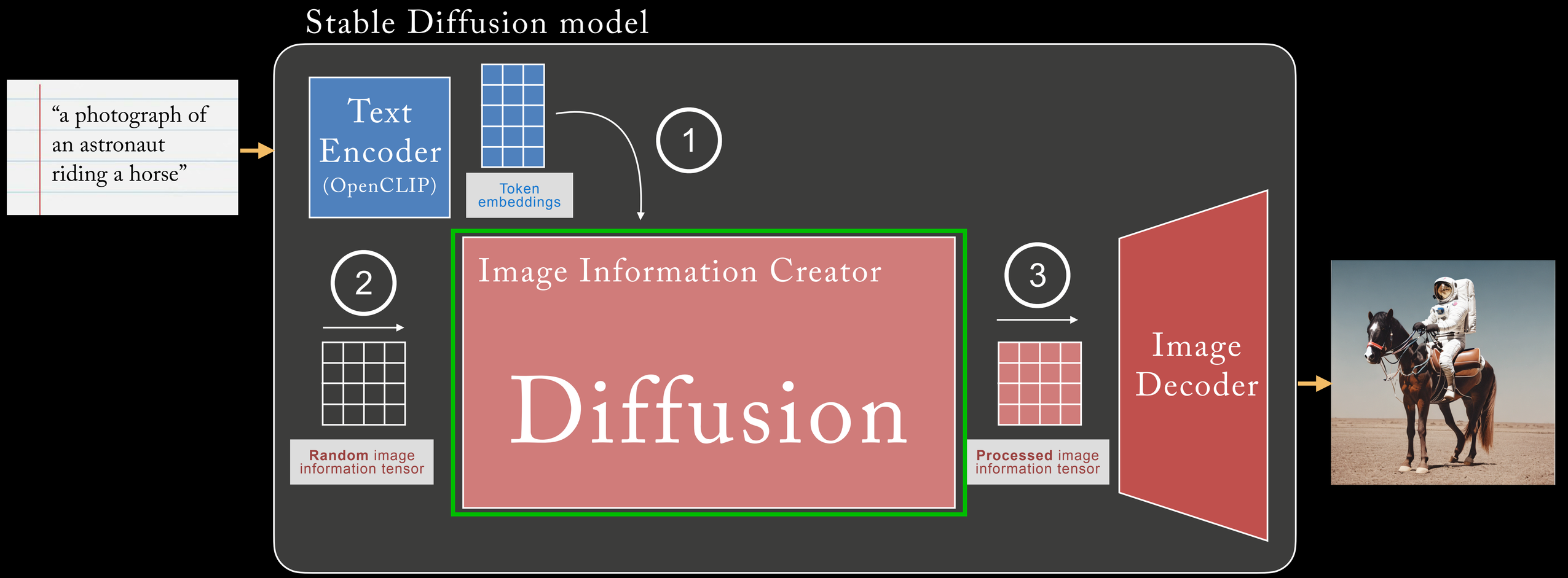
STABLE DIFFUSION



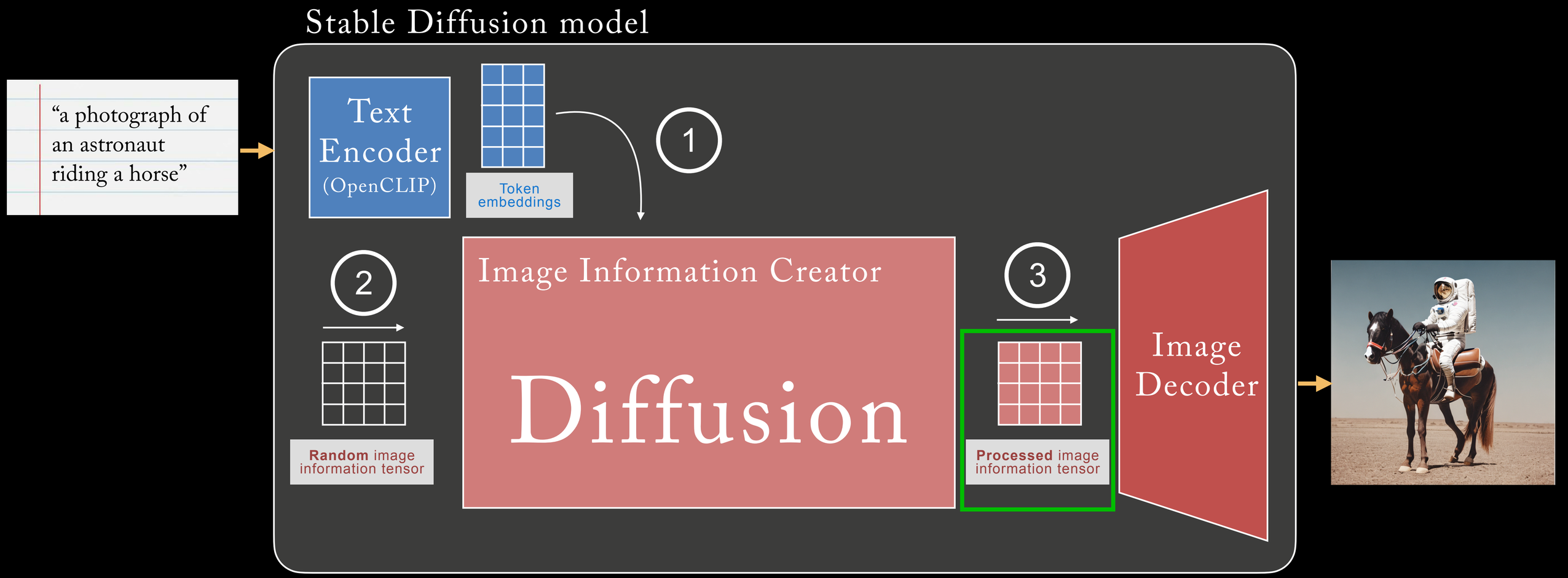
STABLE DIFFUSION



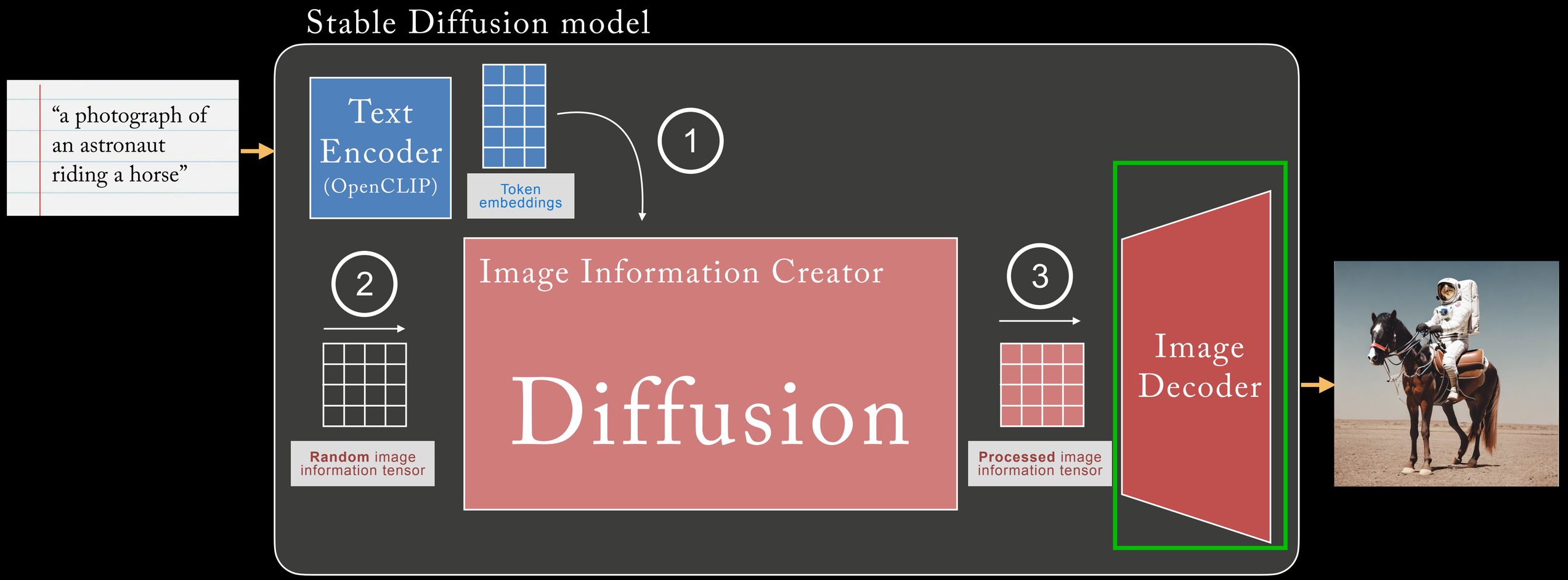
STABLE DIFFUSION



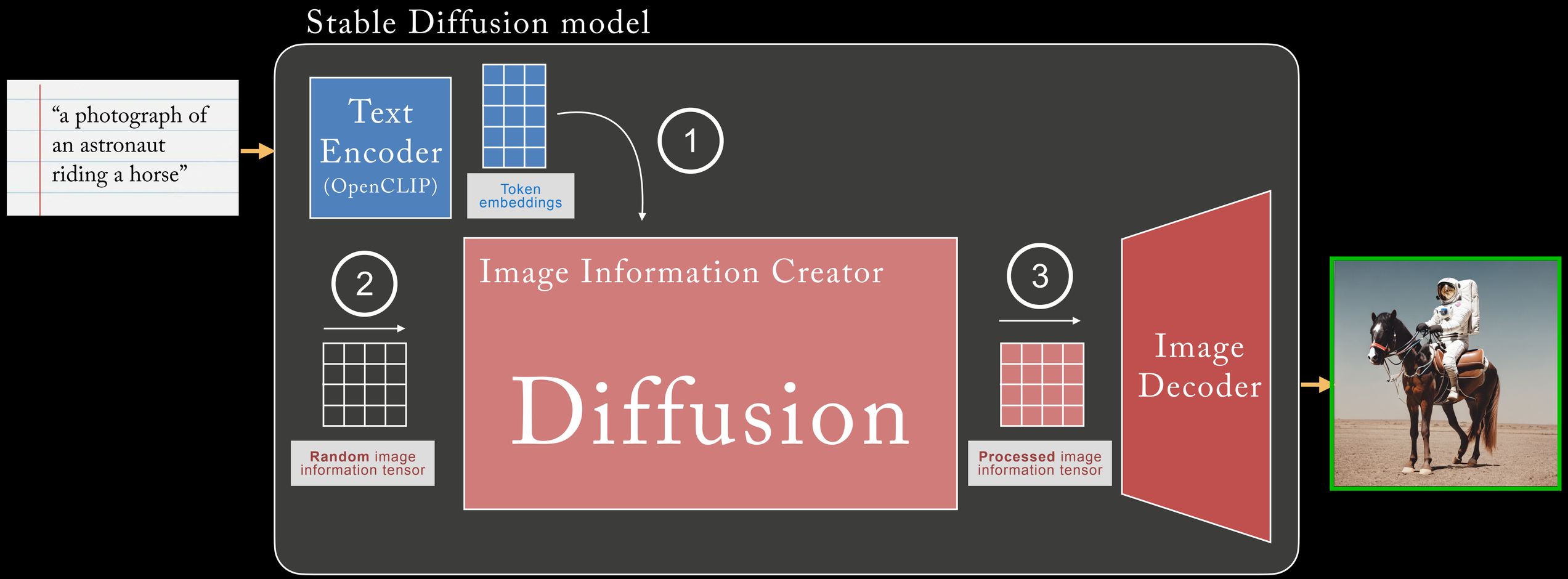
STABLE DIFFUSION



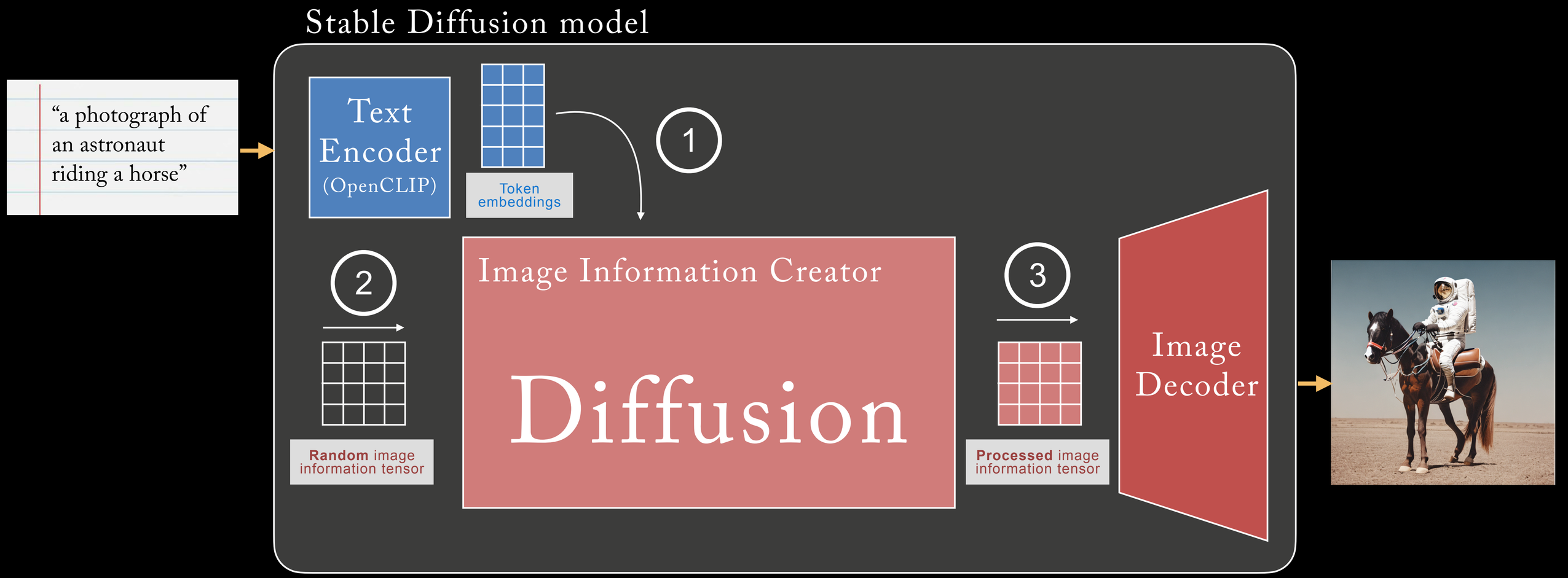
STABLE DIFFUSION



STABLE DIFFUSION



STABLE DIFFUSION



AGENDA

- Overview
- Stable Diffusion
  - OpenCLIP
  - Diffusion models
- Live demo
- Legal aspects
- Summary

AGENDA STABLE DIFFUSION DEMO

- Hardware
- SD Implementations
- Text to Image
- Image to Image
- Finetuning
- Upscaling

HARDWARE - THE BEAST

PC from 2017

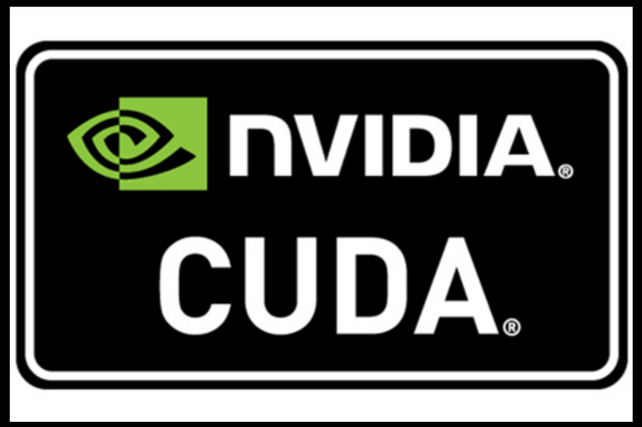
CPU Intel X86

GPU Nvidia 1080ti

HARDWARE - WHY NOT RUN ON MY MAC?

Stable Diffusion uses PyTorch framework for ML

- It can run on both CPU and GPU
- CPU 5-10 times slower than GPU
- PyTorch uses CUDA framework for GPU integration with Nvidia GPU
- Recently also support for Apples Metal Performance Shaders for GPU on Apple Silicon



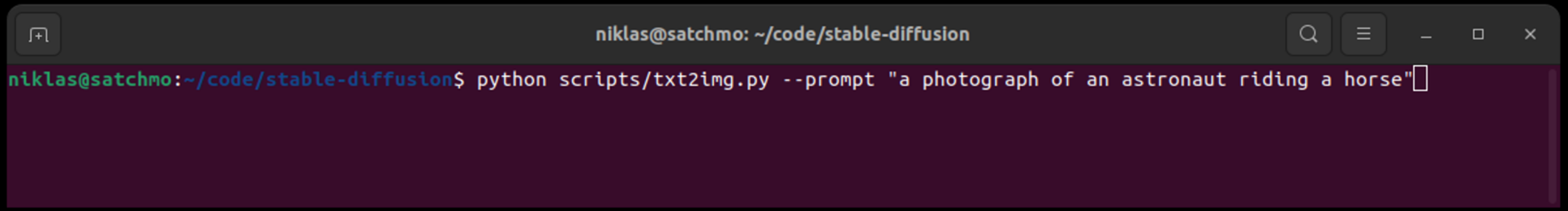
HARDWARE - BENCHMARK

Generating two images with same prompt and seed

- Macbook M1 Pro on CPU 20 min
- Macbook M1 Pro on GPU 5 min
- The Beast on 1080ti 1 min

STABLE DIFFUSION IMPLEMENTATIONS

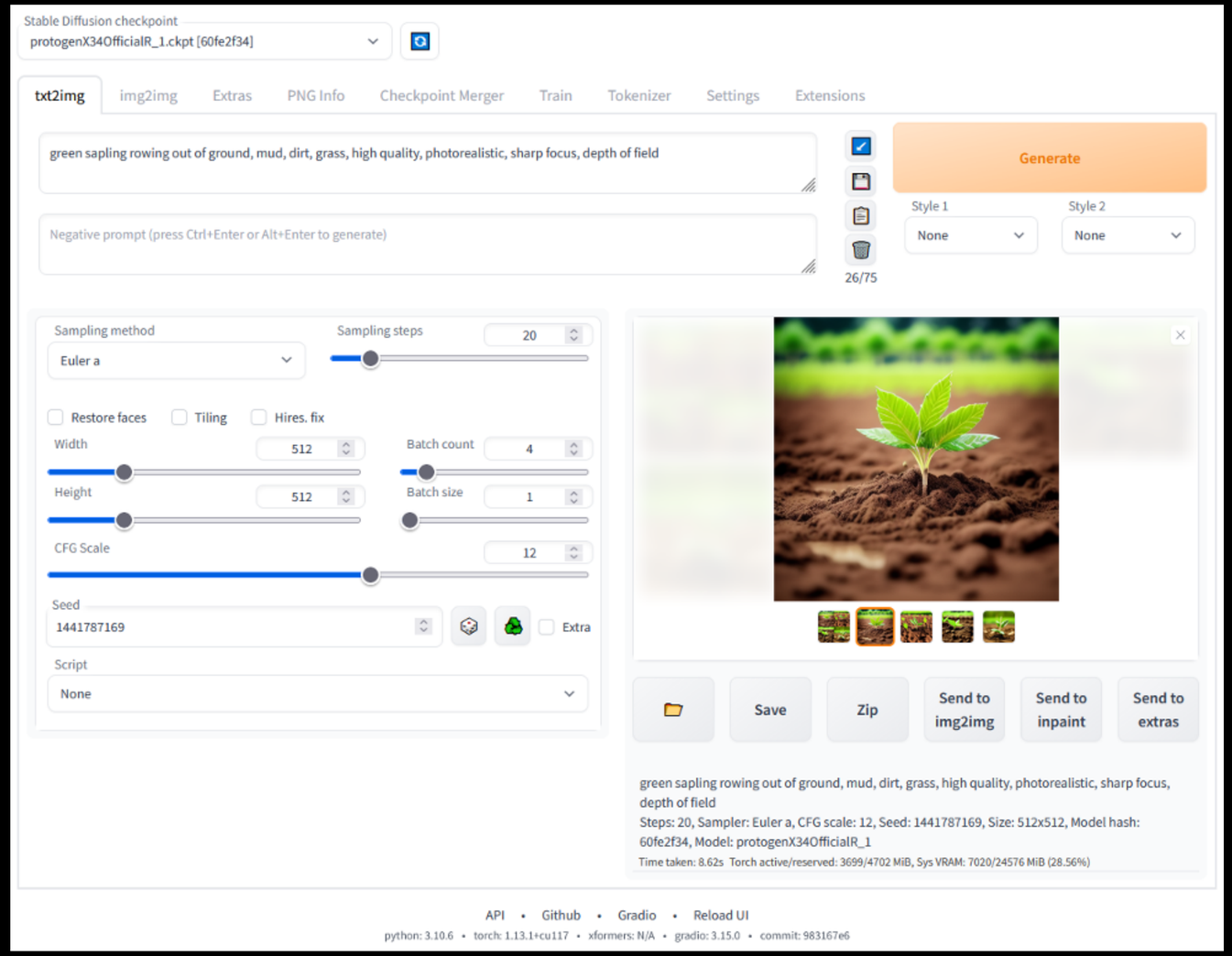
- Original reference implementation by CompVis (1.x)
- Latest reference implementation by Stability AI (2.x)



- Text to Image
- Image to Image
- Inpainting
- Upscaling x4
- Depth to Image

STABLE DIFFUSION WEBUI

- Created by AUTOMATIC1111
- Uses reference implementation
- Lots of added functionality
- REST API in Python
- Web UI in Python
- Extensions



STABLE DIFFUSION WEBUI - SETUP

- Graphics card driver
- CUDA Toolkit
- Python
- Clone the project repository
- xFormers
- model weights (20 ish GB)

DEMO - TEXT TO IMAGE

Starwars film poster with Luke Skywalker riding a bike on a sunny day.
Model: v2.1_768, Model hash: ad2a33c361, Sampler: Euler a, Steps: 20, CFG scale: 7, Size: 768x768, Seed: 2782

- Model - actual trained model file
- Prompt - text
- Sampling method - Disc Diff Eq solver algorithm
- Classifier-Free Guidance Scale - Prompt “volume control”
- Dimensions - One side should be as trained
- Seed - random default

DEMO - IMAGE TO IMAGE

- Applying style to an existing image guided by text
- De-noising strength is “volume control” for Img2Img

Creating a superhero out of an IT-consultant

DEMO - FINETUNING WITH DREAMBOOTH

- DreamBooth
- Re-training part of the model with some images to create a new category

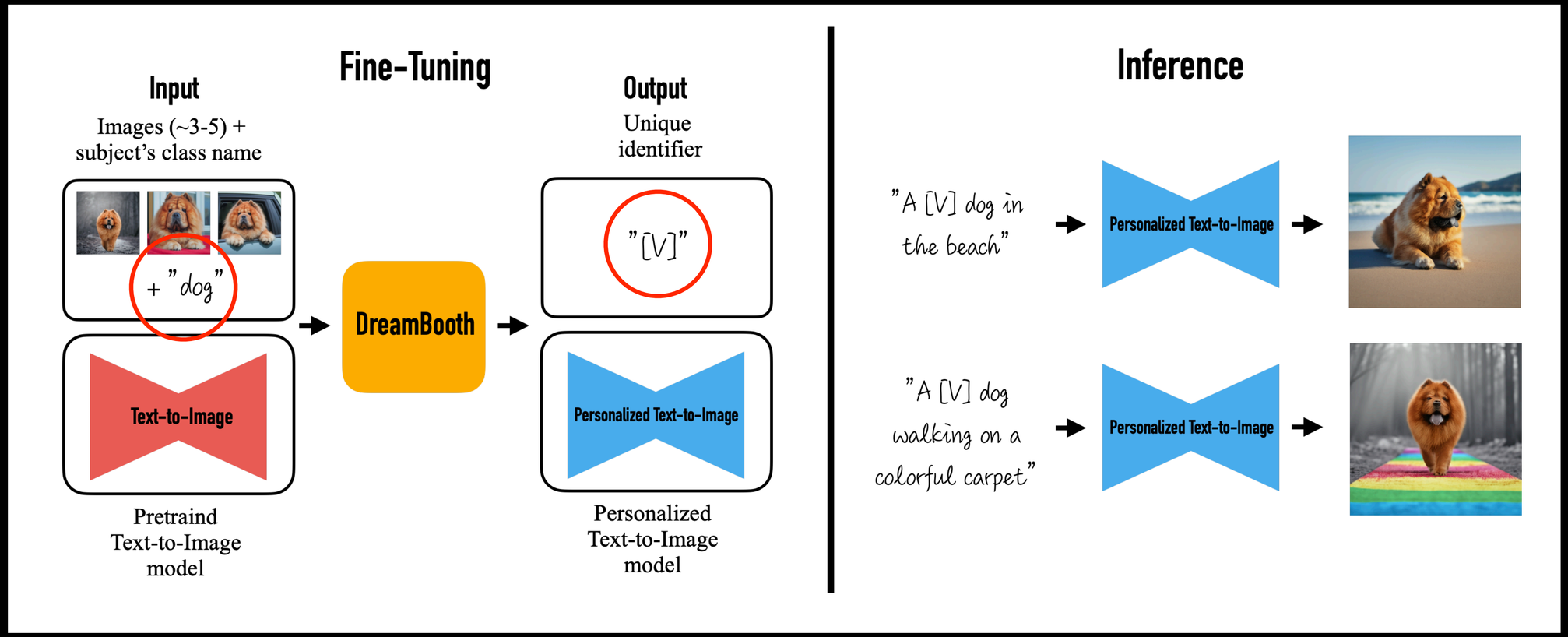
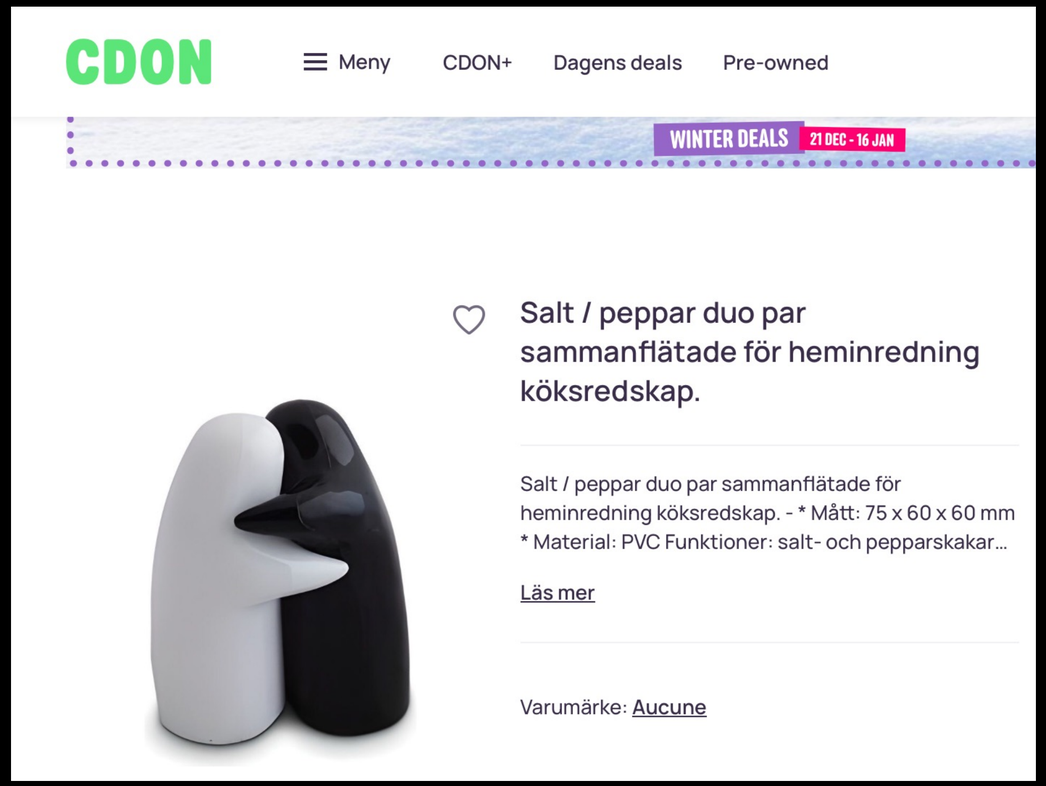


Image from Google paper https://arxiv.org/abs/2208.12242

DEMO - FINETUNING WITH DREAMBOOTH

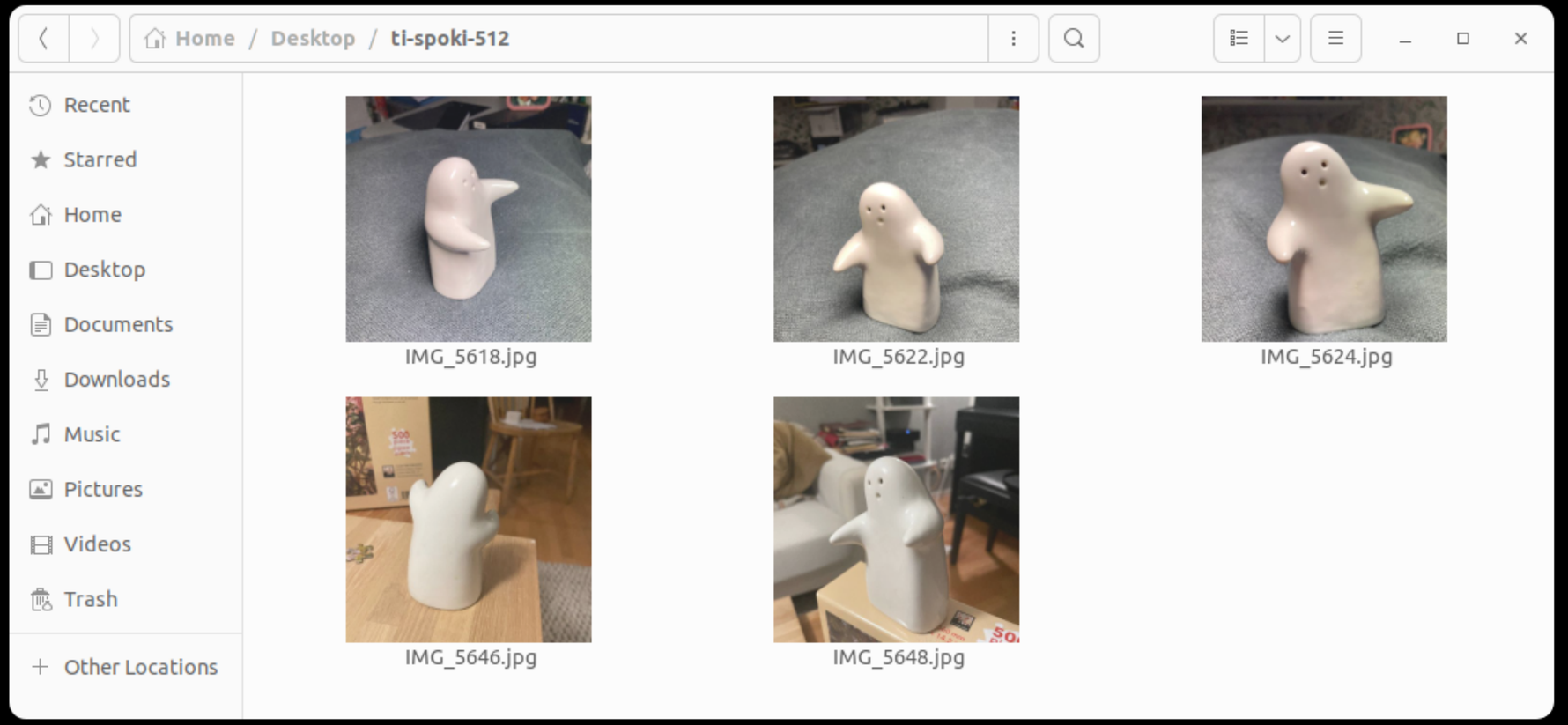


DEMO - FINETUNING WITH DREAMBOOTH

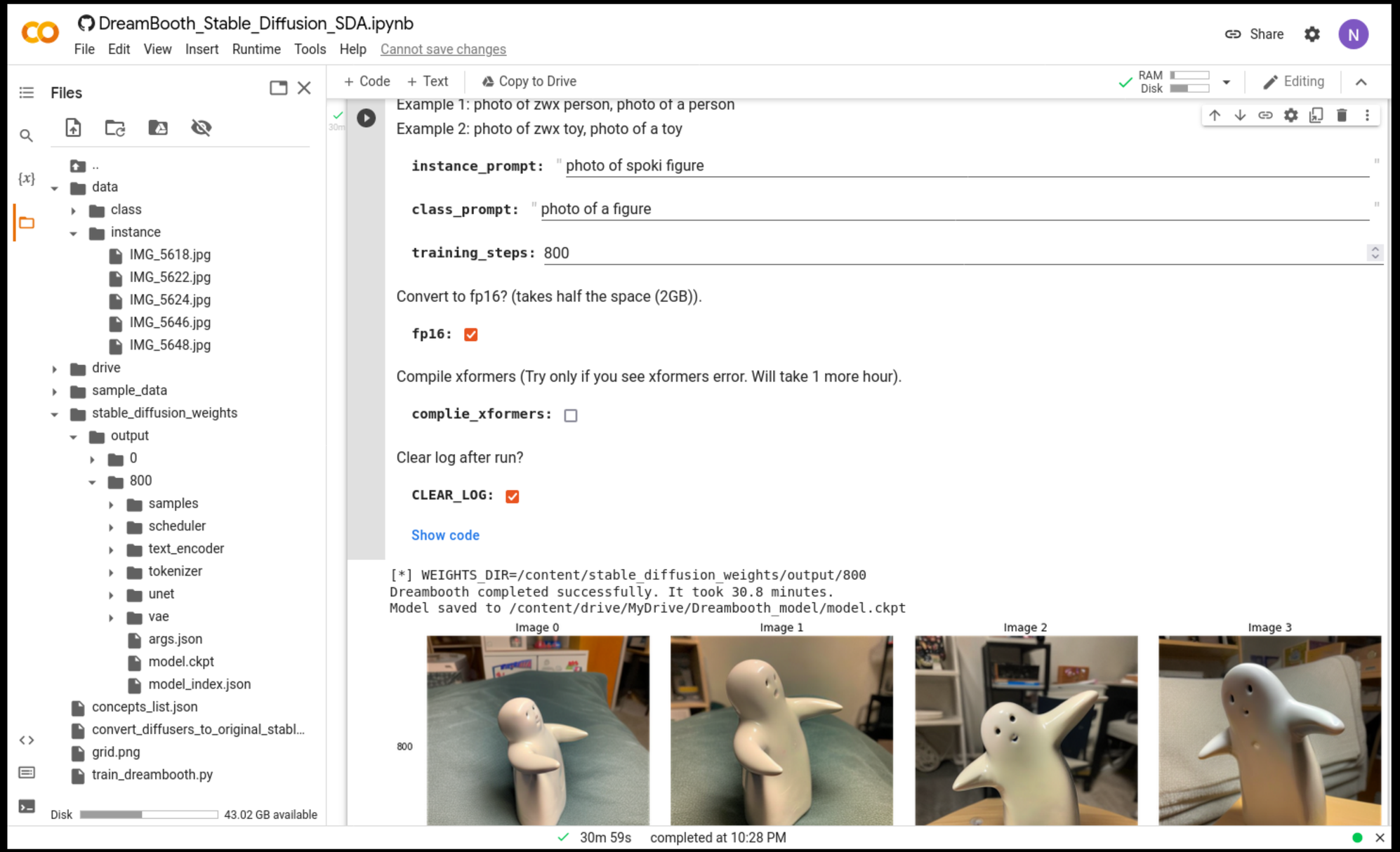
- Spoki

DEMO - FINETUNING WITH DREAMBOOTH

- Class prompt: A photo of a **figure**
- Instance prompt: A photo of a **spoki** figure



DEMO - FINETUNING WITH DREAMBOOTH



CALLISTA

UPSCALING X4

200 x 200

200 x 200

800 x 800

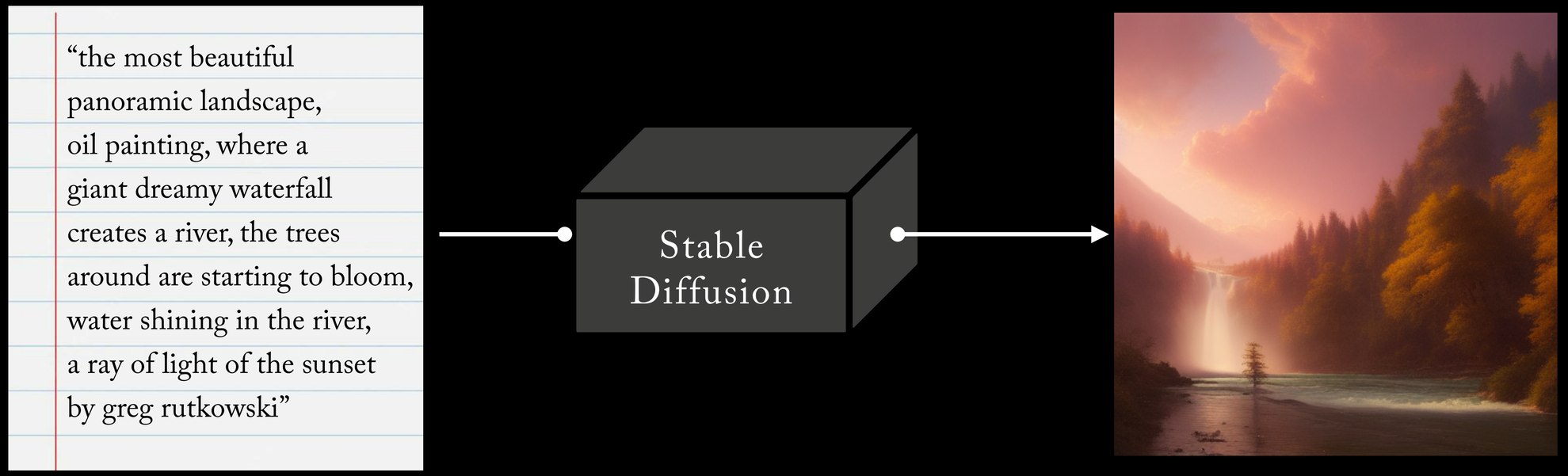
AGENDA

- Overview
- Stable Diffusion
  - OpenCLIP
  - Diffusion models
- Live demo
- Legal aspects
- Summary

LEGAL ASPECTS

LEGAL ASPECTS

- Everything looks better with Greg Rutkowski
- Is this his art, or our art?
- Lastest Stable Diffusion version:
  - » Now it is harder for users to mimic specific artists



AGENDA

- Overview
- Stable Diffusion
  - OpenCLIP
  - Diffusion models
- Live demo
- Legal aspects
- Summary

SUMMARY

SUMMARY

- Stable Diffusion is the state-of-the-art in AI image generation and it has taken the world by storm
- AI image generation points clearly to a shift in how humans create art
- This technology is mainly used in the gaming, film and advertisement industry
- The release of Stable Diffusion is a clear milestone in this development because it made a high-performance model available to the masses
- Regulation will eventually catch up with the technology
- Stable Diffusion itself will not take your job

THANKS! - SOME USEFUL LINKS

- Model weights:
  - Huggingface: https://huggingface.co/models
- Code
  - Stable diffusion v1: https://github.com/CompVis/stable-diffusion
  - Stable diffusion v2: https://github.com/Stability-AI/stablediffusion
  - Stable diffusion webui: https://github.com/AUTOMATIC1111/stable-diffusion-webui
- Prompt Engineering and practical things
  - Stable Diffusions Art: https://stable-diffusion-art.com/
- Papers:
  - Stable Diffusion: https://arxiv.org/abs/2112.10752
  - CLIP: https://arxiv.org/abs/2103.00020
- Another great explanation:
  - https://medium.com/@steinsfu/stable-diffusion-clearly-explained-ed008044e07e

MORE ON AI - GOTHENBURG AI ALLIANCE

https://gaia.fish