

# AI Image Generation



# What is an Image?

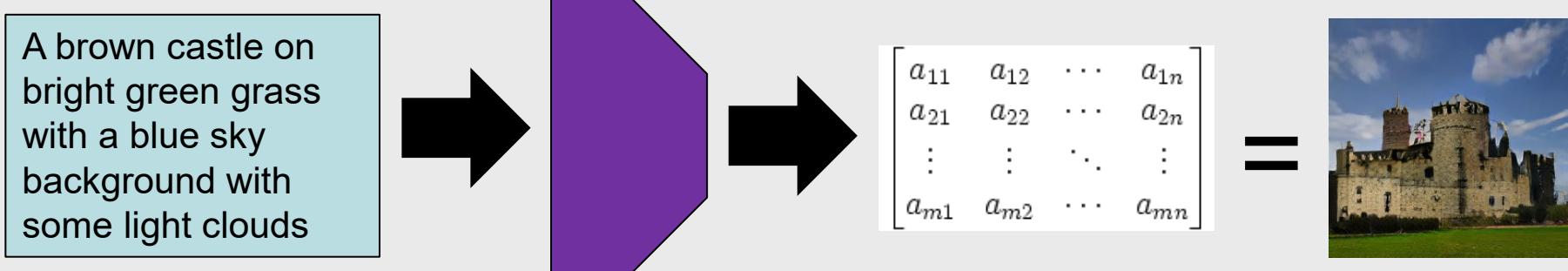
- An image can be represented as a big matrix (1024 x 1024 pixels)
  - Really 3 big matrices for Red, Blue, and Green colors
- Each pixel is a matrix element, its value gives brightness or color
- Pixels have some structure
  - Neighboring pixels are usually the same color
  - Pixels change color at an edge
  - Enclosed regions have the same color



$$= \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

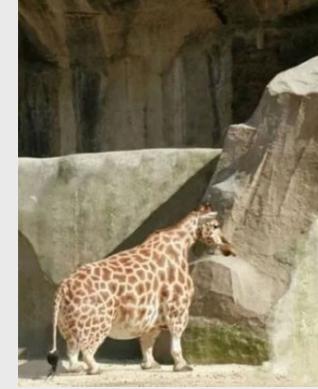
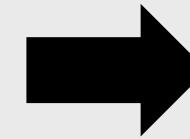
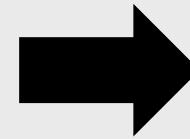
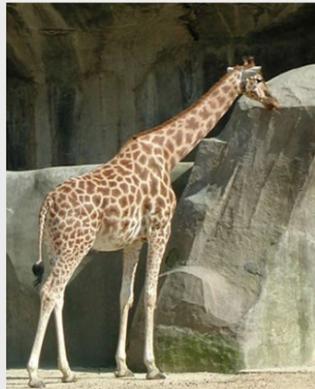
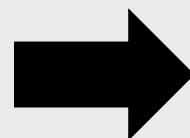
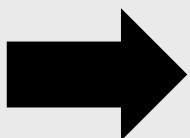
# Image Generation

- Generating an image means generating a matrix of numbers
- The numbers must be arranged in a way to represent real objects
- We would like to control how the pixels are arranged with text descriptions



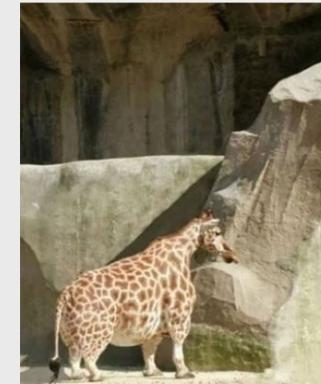
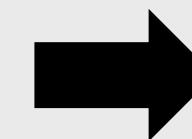
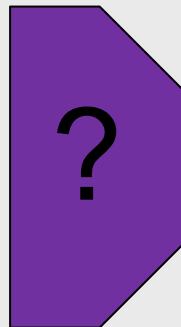
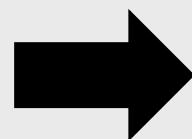
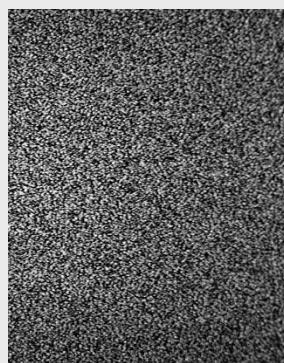
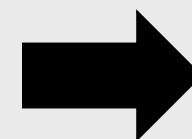
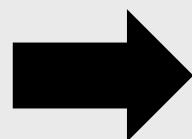
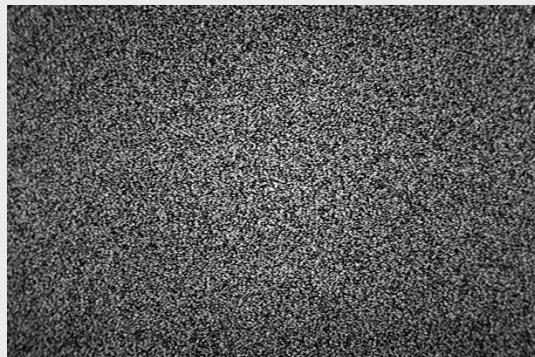
# Modifying an Image

- With some skill and effort and Photoshop, people could edit an existing image



# Generating an Image

- Creating an image from nothing was thought to be very challenging



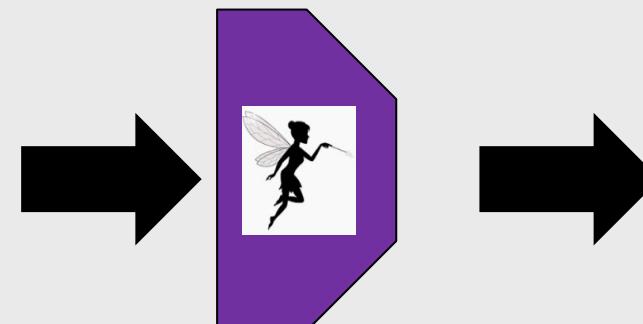
# Generating a Specific Image

- Creating an image from a text description was thought to be a fairy tale

An astronaut holding a bag of weed on a space shuttle

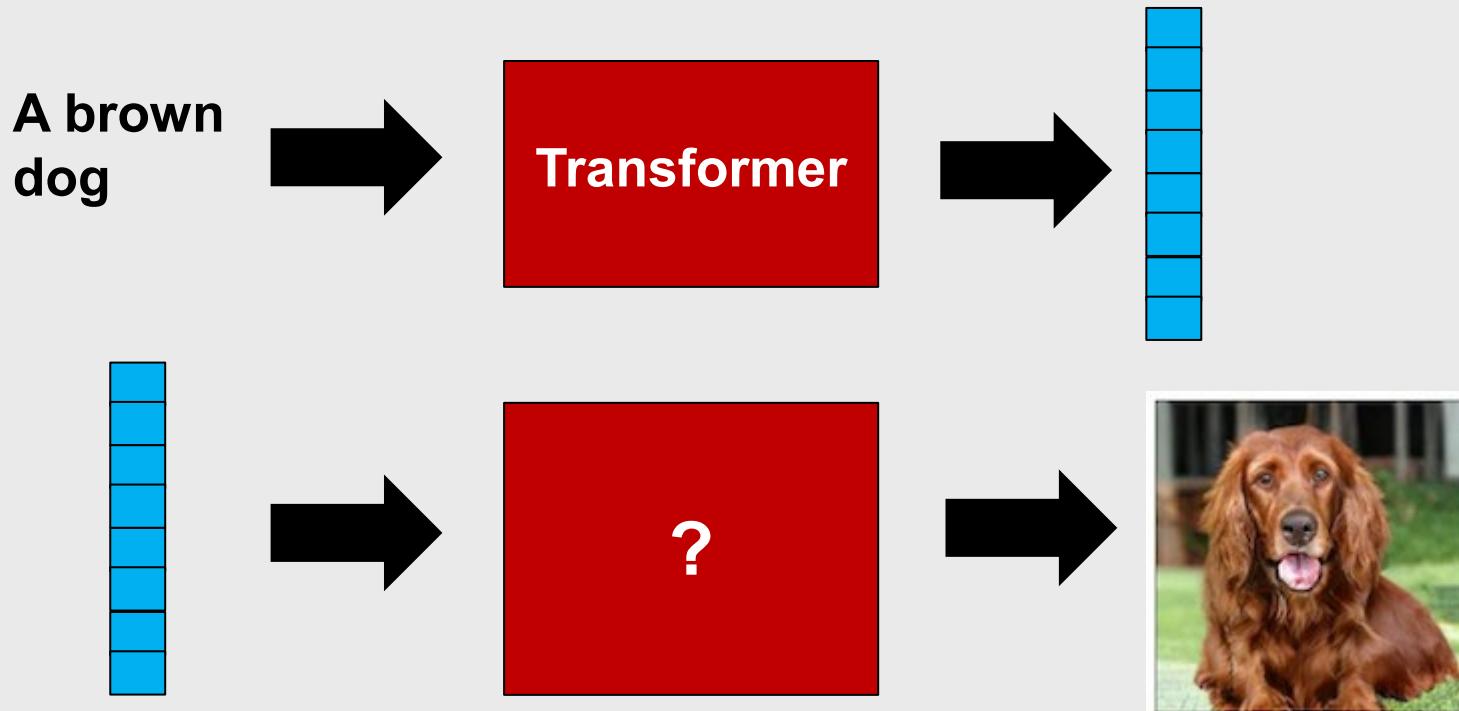


A very short and stout giraffe facing to the right



# Generating Images From Text

- We have a way to map text to a vector (transformer)
- How do we map the vector to an image?



# Diffusion Models

- Diffusion is the random motion of particles
- Diffusion models create images by letting vectors “diffuse” backwards in time



# Diffusion Paper (2015)

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## Deep Unsupervised Learning using Nonequilibrium Thermodynamics

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**Jascha Sohl-Dickstein**

JASCHA@STANFORD.EDU

Stanford University

**Eric A. Weiss**

EAWEISS@BERKELEY.EDU

University of California, Berkeley

**Niru Maheswaranathan**

NIRUM@STANFORD.EDU

Stanford University

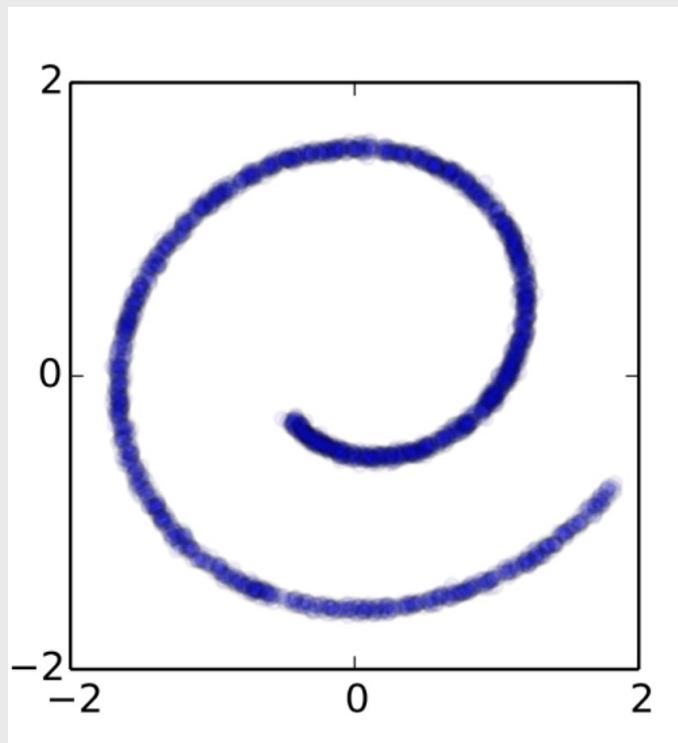
**Surya Ganguli**

SGANGULI@STANFORD.EDU

Stanford University

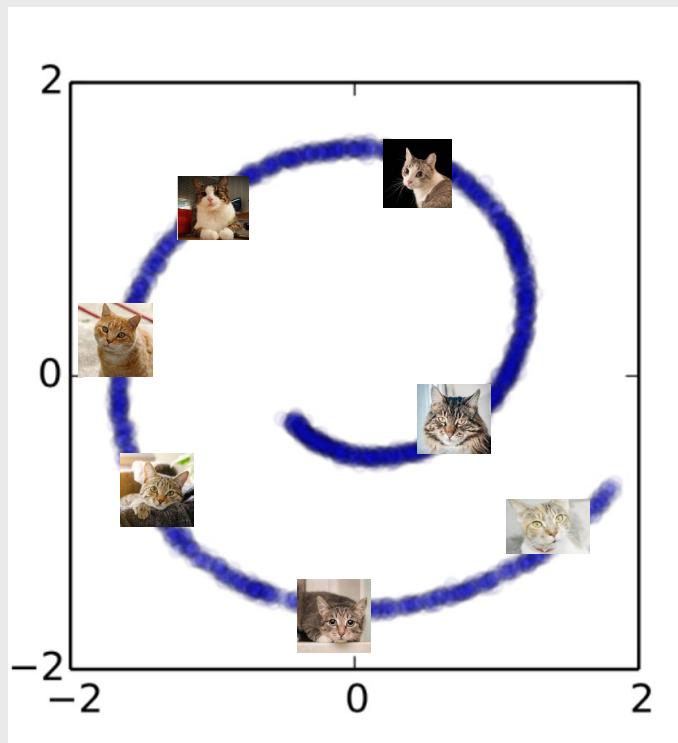
# Diffusion Example

- Imagine our data points start off in a specific shape



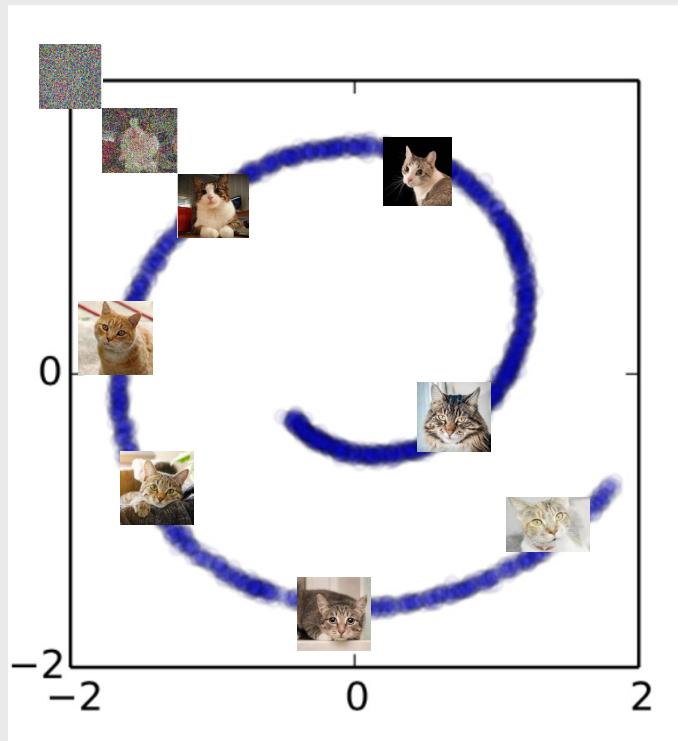
# Diffusion Example

- Imagine our data points start off in a specific shape



# Diffusion Example

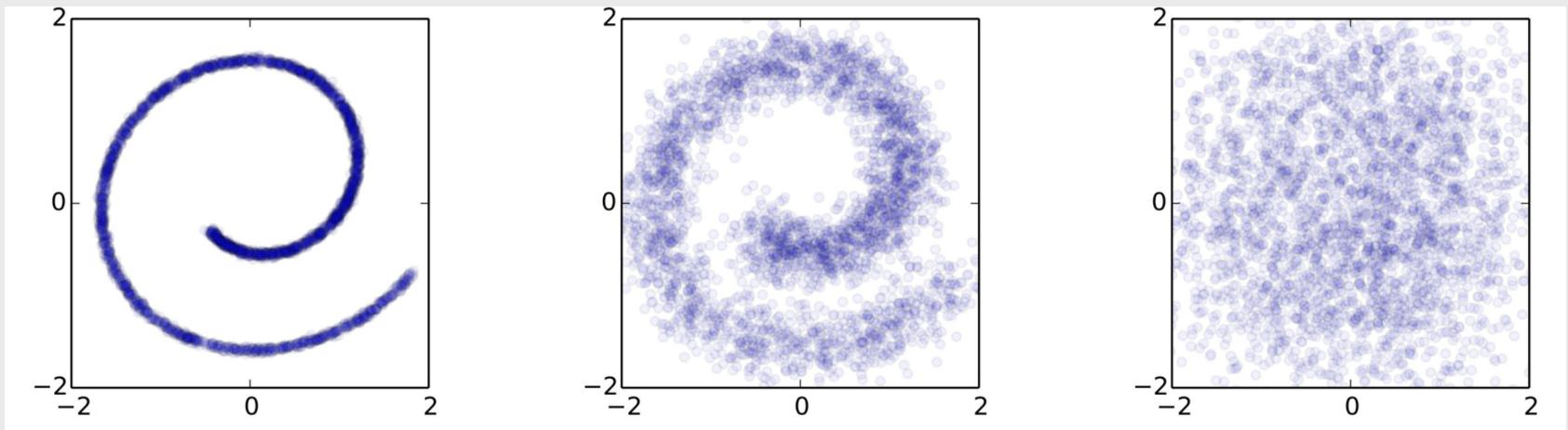
- Imagine our data points start off in a specific shape



# Forward Diffusion

- In the forward direction, the drift velocity is zero always
- We end up with a uniform cloud of points

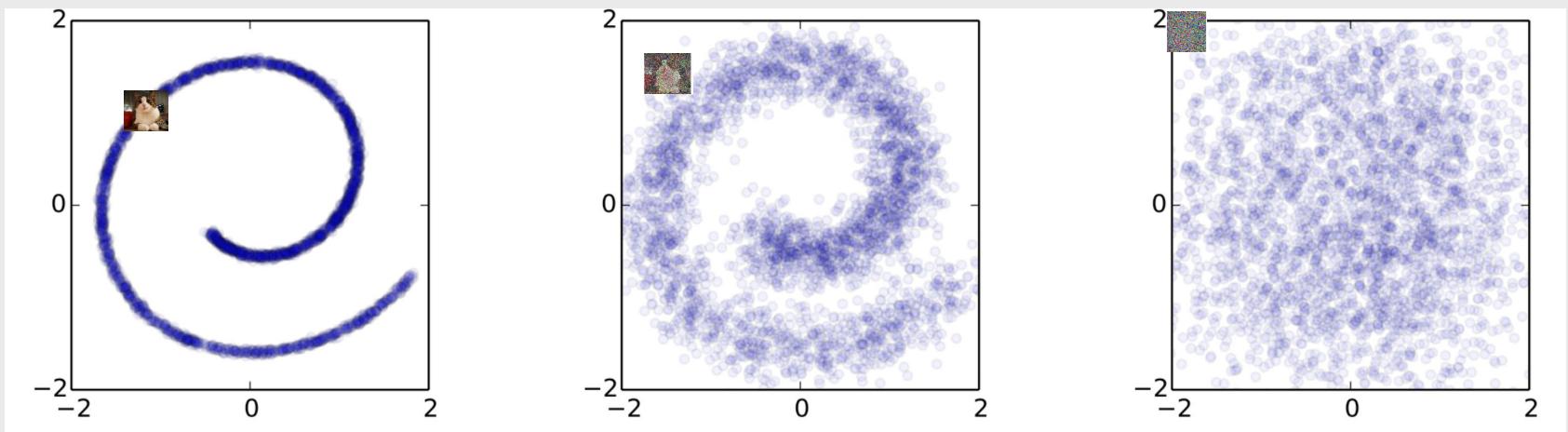
Forward in time



# Forward Diffusion

- In the forward direction, the drift velocity is zero always
- We end up with a uniform cloud of points

Forward in time →

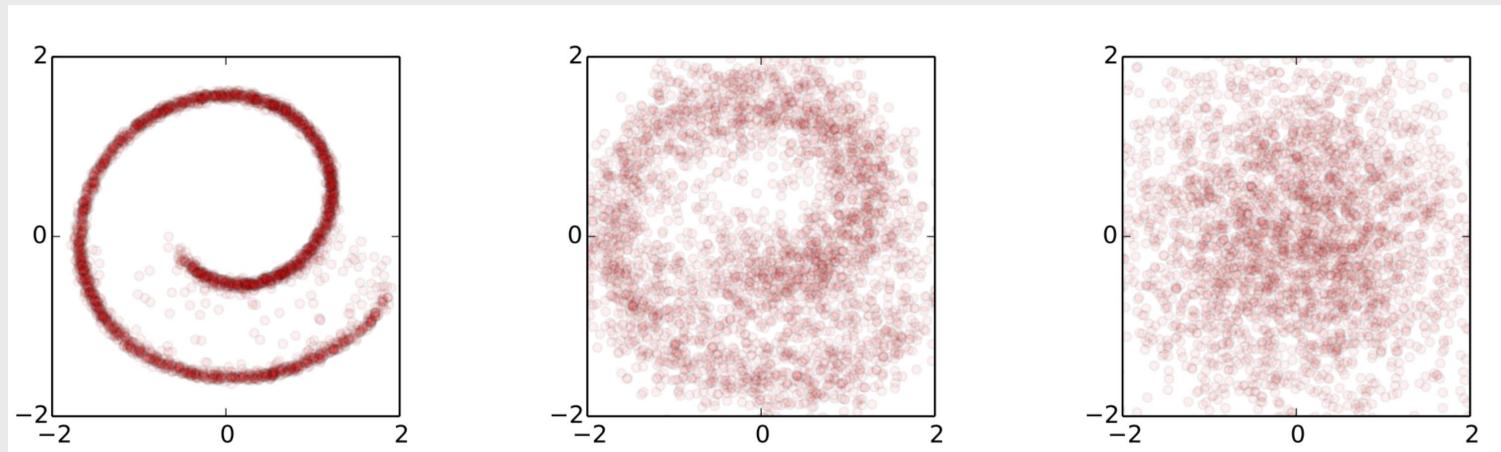




# Backward Diffusion

- In the backward direction, the **drift velocity** is depends on the **time** and **location** of the data point
- We end up with the original data point configuration

Backward in time

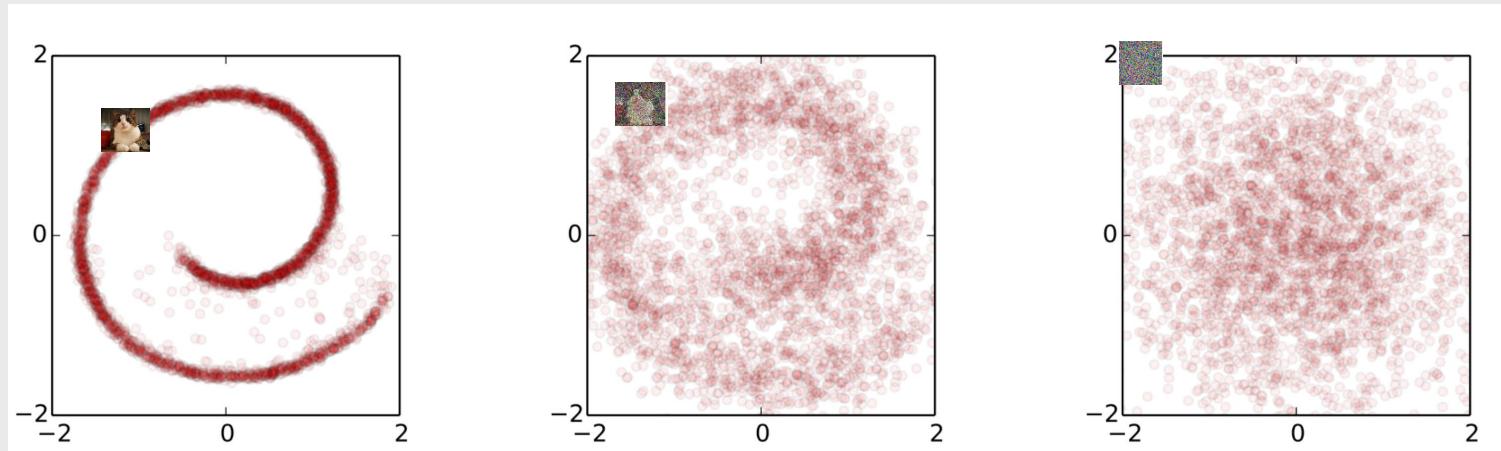




# Backward Diffusion

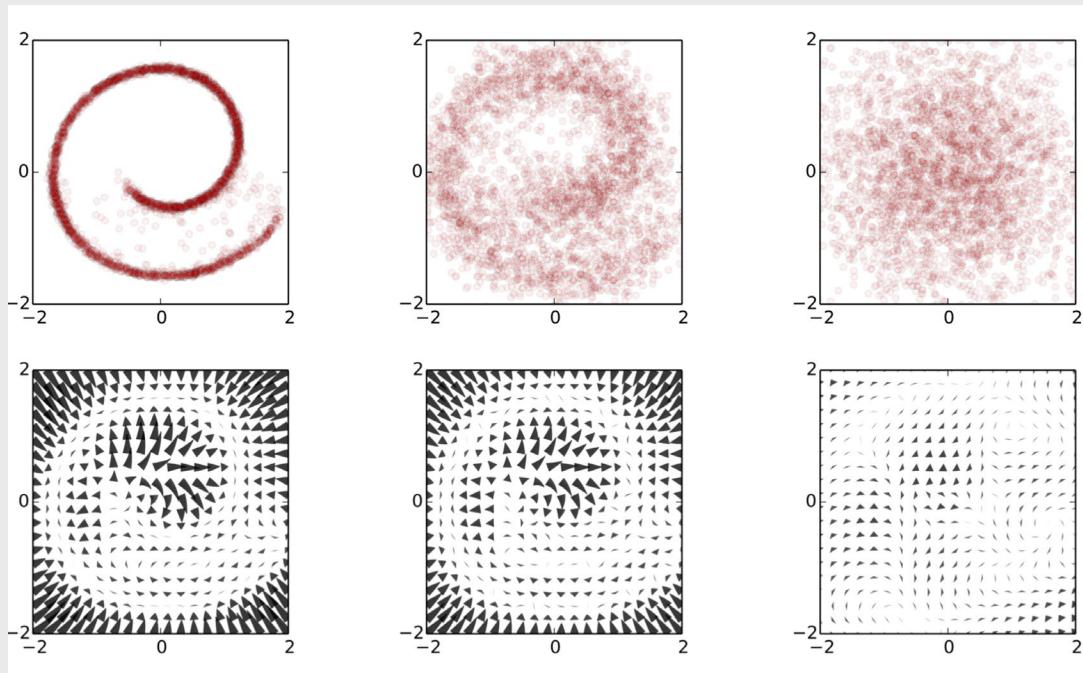
- In the backward direction, the **drift velocity** is depends on the **time** and **location** of the data point
- We end up with the original data point configuration

Backward in time



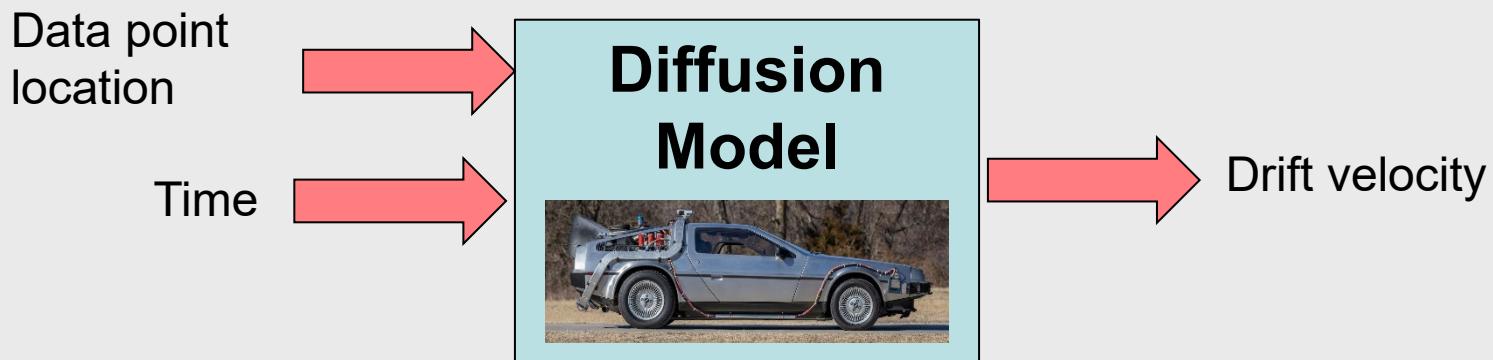
# Backward Drift Velocity

- Initially, backward drift velocity is almost zero – no rush to go anywhere
- Near the end, the velocity can become very strong – no data points in certain regions



# Latent Diffusion Models

- The backward drift velocity is the key to a latent diffusion model
- We can use a **neural network** to model the drift velocity

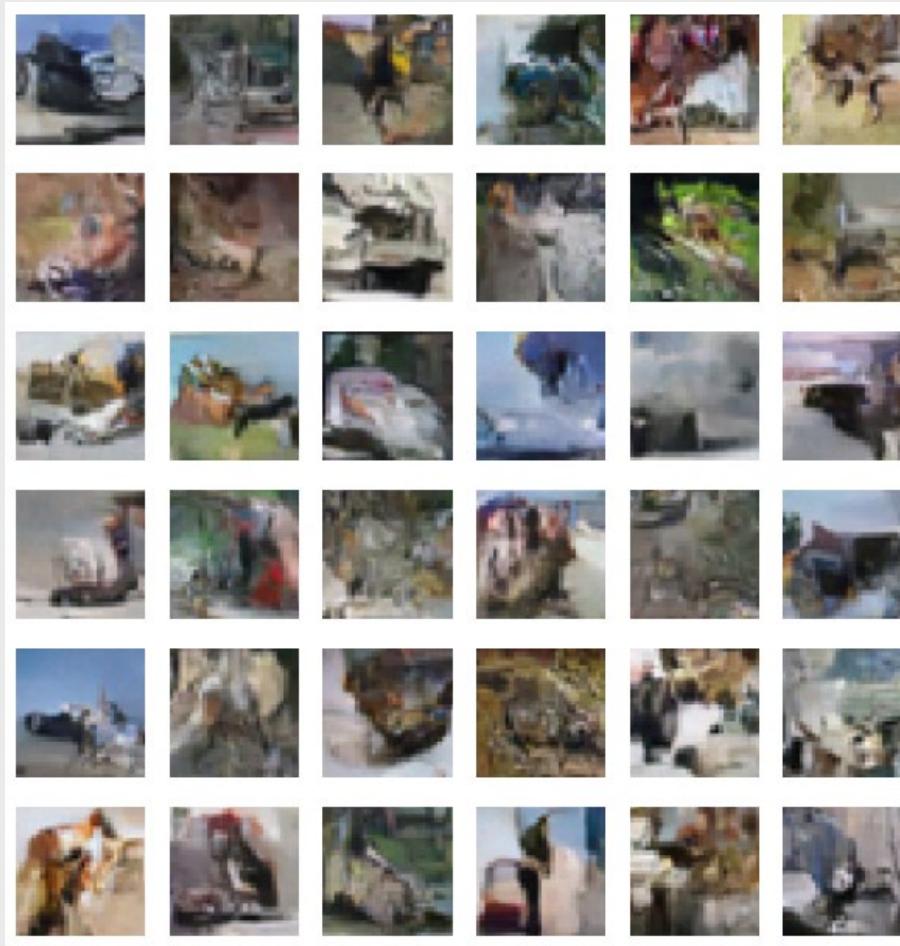


# Diffusion Model Image Generation

- Data points can be images
- The diffusion model will drift pixel colors in noisy image until they look like something from your training data

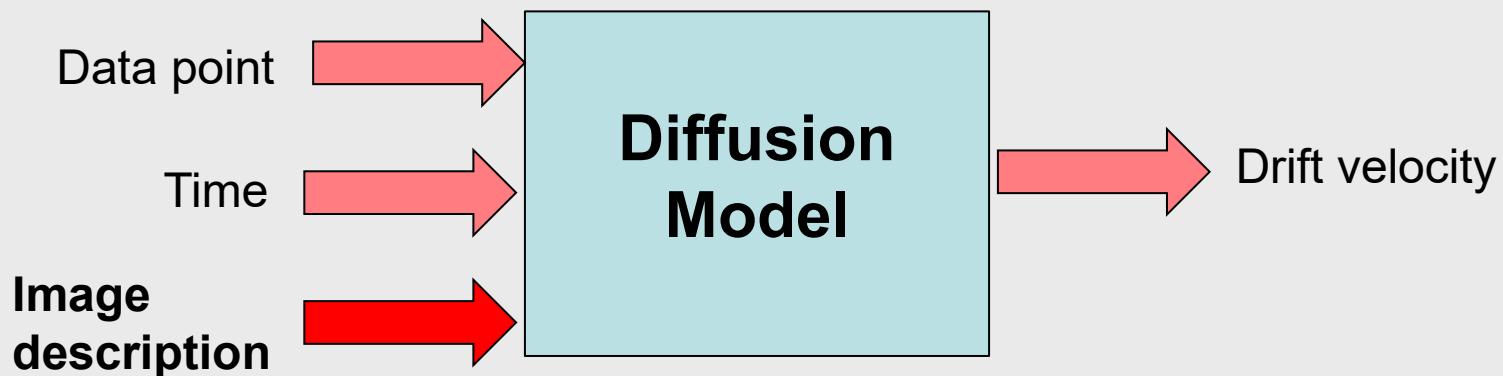


# First Diffusion Model Generated Images (2015)



# Latent Diffusion Models with Text

- Diffusion model gives us drift velocity
- We can use a text image description to guide the diffusion



# DALLE-2 (2022)

- DALLE-2 puts text and image embeddings in the same space

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## Hierarchical Text-Conditional Image Generation with CLIP Latents

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**Aditya Ramesh\***

OpenAI

aramesh@openai.com

**Prafulla Dhariwal\***

OpenAI

prafulla@openai.com

**Alex Nichol\***

OpenAI

alex@openai.com

**Casey Chu\***

OpenAI

casey@openai.com

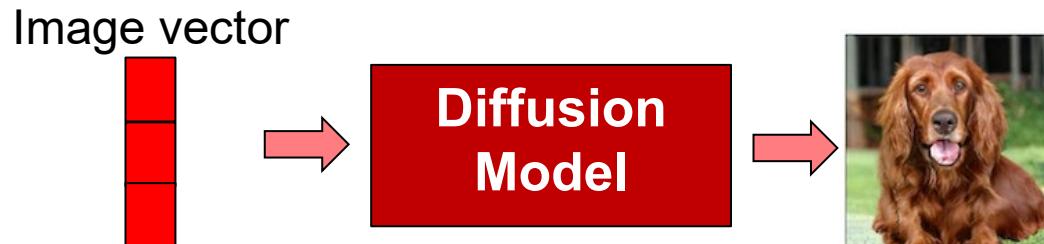
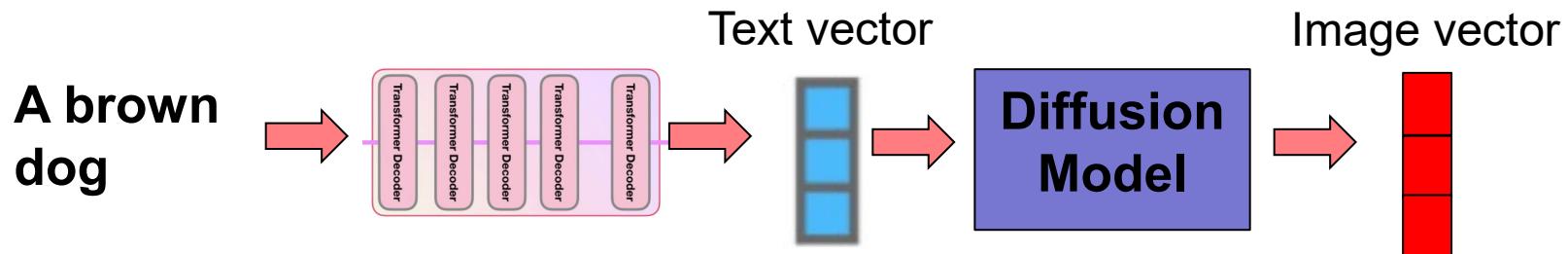
**Mark Chen**

OpenAI

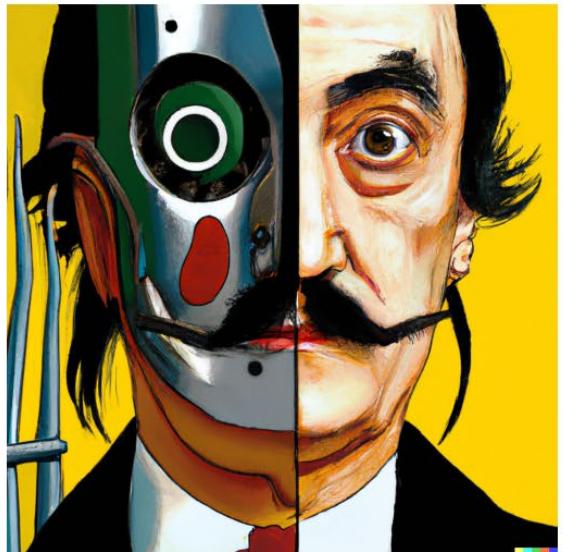
mark@openai.com

# DALL-E 2 Architecture

- DALL-E 2 uses a diffusion model to turn a text vector into an image vector
- It then uses another diffusion model to decode the image vector into an image



# DALLE-2 Examples



vibrant portrait painting of Salvador Dalí with a robotic half face



a shiba inu wearing a beret and black turtleneck



a close up of a handpalm with leaves growing from it

# Diffusion Model Pros and Cons

- **Pros**
  - Text guided image generation
  - High quality images
- **Cons**
  - Slow image generation
  - Can't maintain consistency across images



# AI Image Generators

- Diffusion models + transformers are now used by nearly all AI image generators
- Many AI image generators available today
  - DALLE-3 (ChatGPT) from OpenAI
  - Midjourney from Midjourney
  - Stable Diffusion from Stability AI
  - Firefly from Adobe
  - Imagen (Gemini) from Google
  - And many more<sup>1</sup> ...



1. <https://zapier.com/blog/best-ai-image-generator>

# AI Image Generators

- Prompt: A Yale men's basketball player jumping from the free-throw line for a dunk during the championship game

# AI Image Generators

- Prompt: A Yale men's basketball player jumping from the free-throw line for a dunk during the championship game



Firefly



Stable Diffusion



Midjourney



ChatGPT

# AI Image Generators

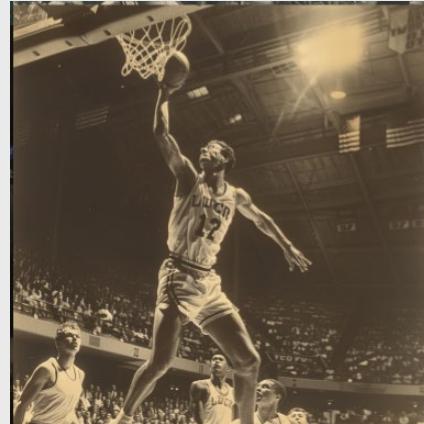
- Prompt: A Yale men's basketball player jumping from the free-throw line for a dunk during the championship game



Firefly



Stable Diffusion



Midjourney



ChatGPT



I'm still learning how to generate certain kinds of images, so I might not be able to create exactly what you're looking for yet. Also, I can't help with photorealistic images of identifiable people, children, or other images that go against my [guidelines](#). If you'd like to ask for something else, just let me know!

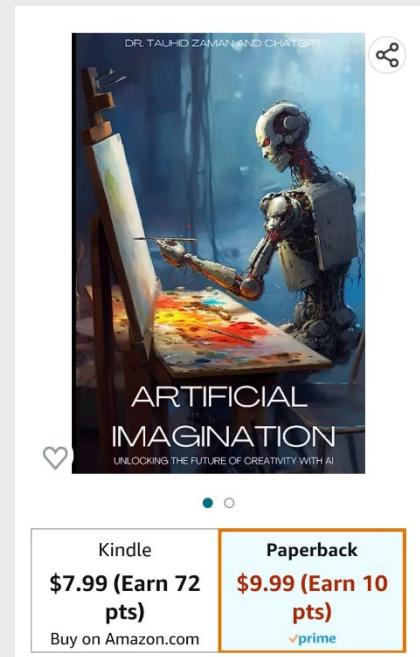
Gemini

# New Generative AI Landscape

- **Text guided image generation opens up a wide array of possibilities**
  - Simple graphic design for any skill level
  - Visualize concepts for artistic projects
  - Create engaging visual content
- **Combined with text generation, we have even more possibilities**

# Writing Books With AI

- One can easily write books by combining text and image generation
- ChatGPT
  - Book title and outline
  - Chapter titles and content
  - Prompts for illustrations
- Midjourney
  - Illustrations



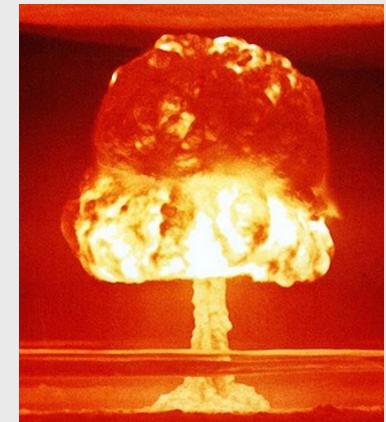
# Dangers of AI Image Generation + Social Media



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# **Fake Tweets and Images**

- Use AI to create fake tweets about a topic
- Use AI to make fake images matching tweets

# Fake Tweets and Images

- Use AI to create fake tweets about a topic
- Use AI to make fake images matching tweets

## Fake tweet

A screenshot of a tweet from the Twitter interface. The tweet is from a user named "PatriotPaul" (verified) with the handle "@MAGAdefender45". The tweet content is:  
Just heard the news that our LEGITIMATE 45th President, Donald J. Trump, has been ARRESTED! 😠 This is nothing but a WITCH HUNT by the Deep State and liberal elites! We will NOT stand for this disgraceful attempt to silence our voices! 🇺🇸💪 #FreeTrump  
#MAGA #FightForFreedom

The tweet was posted at 8:06 PM · Mar 15, 2023. It has 658 Retweets, 125 Quote Tweets, and 1.3K Likes. Below the tweet are standard social media interaction icons: a speech bubble, a retweet symbol, a heart, and an upward arrow.

# Fake Tweets and Images

- Use AI to create fake tweets about a topic
- Use AI to make fake images matching tweets

Fake tweet

A screenshot of a Twitter post from the account @MAGAdefender45. The profile picture is a man with a mustache wearing a red baseball cap. The tweet reads:  
Just heard the news that our LEGITIMATE 45th President, Donald J. Trump, has been ARRESTED! 😠 This is nothing but a WITCH HUNT by the Deep State and liberal elites! We will NOT stand for this disgraceful attempt to silence our voices! 🇺🇸💪 #FreeTrump #MAGA #FightForFreedom  
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Fake image



# Midjourney



# Midjourney

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**"Joe biden tripping in the Oval office in front of a bunch of reporters"**

# Midjourney



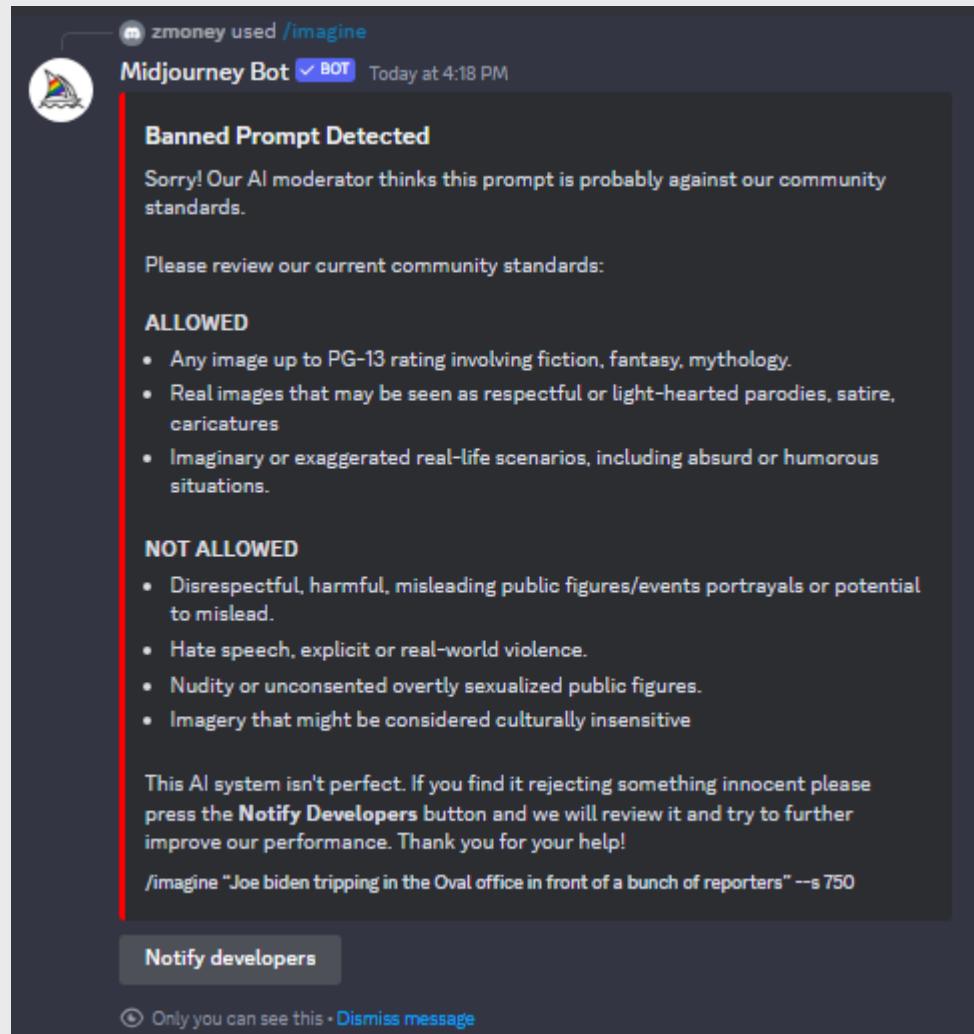
**"Joe biden tripping in the Oval office in front of a bunch of reporters"**

# Midjourney (2 years ago)



"Joe biden tripping in the Oval office in front of a bunch of reporters"

# Midjourney (today)



zmoney used /imagine

Midjourney Bot ✅ BOT Today at 4:18 PM

**Banned Prompt Detected**

Sorry! Our AI moderator thinks this prompt is probably against our community standards.

Please review our current community standards:

**ALLOWED**

- Any image up to PG-13 rating involving fiction, fantasy, mythology.
- Real images that may be seen as respectful or light-hearted parodies, satire, caricatures
- Imaginary or exaggerated real-life scenarios, including absurd or humorous situations.

**NOT ALLOWED**

- Disrespectful, harmful, misleading public figures/events portrayals or potential to mislead.
- Hate speech, explicit or real-world violence.
- Nudity or unconsented overtly sexualized public figures.
- Imagery that might be considered culturally insensitive

This AI system isn't perfect. If you find it rejecting something innocent please press the **Notify Developers** button and we will review it and try to further improve our performance. Thank you for your help!

/imagine "Joe biden tripping in the Oval office in front of a bunch of reporters" --s 750

**Notify developers**

Only you can see this · Dismiss message

"Joe biden tripping in the Oval office in front of a bunch of reporters"

# Deep Fake: Balenciaga Pope

- **Fake image of Pope in Balenciaga jacket**
- **Goes viral on social media**
- **Effective because the fake part is in the realm of reality**



# Inducing Emotion with AI Images

- AI images can make us feel emotion even if we know they are fake
- Prompt: a robot comforting a human after he lost his wife to cancer as a photorealistic image (MidJourney)



# Dangerous Deep Fakes

## Who Is Behind the Spread of Taylor Swift's Deepfake Nudes?

After an examination into the source of the AI-generated images that caused a firestorm online and ignited a political debate, Microsoft responds to a report that its AI image generator tool was used.

BY KEVIN DOLAK  FEBRUARY 1, 2024 11:38AM



Taylor Swift NOAM GALAI/GETTY IMAGES

# Policing AI Generated Content

## YouTube to roll out labels for ‘realistic’ AI-generated content



By Clare Duffy, CNN

⌚ 3 minute read · Published 6:00 AM EST, Tue November 14, 2023

[f](#) [X](#) [✉](#) [🔗](#)

TECH / POLICY / POLITICS

## Meta to require political advertisers disclose AI-generated content

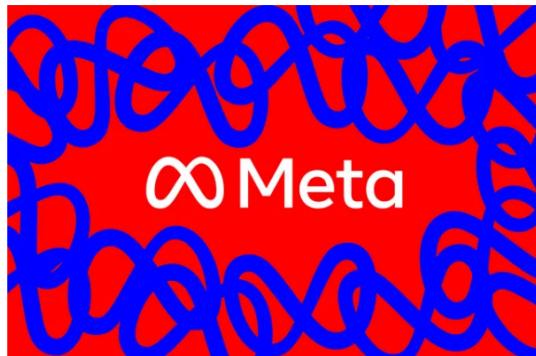


Illustration: Nick Barclay / The Verge

/ The company already banned political advertisers from using its new generative AI ad tools.

By [Makena Kelly](#), a reporter who covers the politics and power influencing the tech industry. Before joining The Verge in 2018, she covered Congress and breaking news.

Nov 8, 2023, 6:00 AM EST



Comments (0 New)

## Twitter tries to crack down on AI images with Community Notes feature

The update comes on the heels of several AI-generated images that gained notoriety — remember Balenciaga pope?

## Meta Will Label AI-Generated Images On Instagram, Facebook—Battling Those Who ‘Want To Deceive’

# **Don't Be Evil**

- As AI improves, fake text, images, audio, (and soon videos) become more realistic and effective
- Danger is amplified when AI enters social media
- Please don't use this for evil

# **Coding Session**

- We will use ChatGPT's API to generate images
- Learn some prompt engineering tricks
- Create content for an AI Instagram account
- Also try out Midjourney