



# CODE Presents:

## Advances and Challenges in Generative AI for Image Generation

October 4th, 2023  
Online

**Otto Dobretsberger, PhD**

Sr. Software Dev at CODE Consulting

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"Helping People Build  
Better Software"



# About Otto Dobretsberger

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- Sr. Software Dev @ CODE (15+ years)
  - Degrees in Biomedical Science and Computer Science
  - Professor @ University of Houston (10+ years)
  - Author, Speaker and Presenter
- 
- 2x World Record holder in Bench Press
- 
- [Email: ottod@codemag.com](mailto:ottod@codemag.com)





# About CODE Consulting



- Custom Software Development
- Artificial Intelligence
- Web, Cloud, Mobile, Desktop, Serverless, Databases,...
- Copilot Development, AI, GPT & Azure OpenAI
- Application Security Testing
- User Interface and Interaction Design
- Project Rescue, App Modernization (VB, VFP, Access, etc.)
- Support & Maintenance for existing applications



# AI Consulting Services



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### Executive Briefing (AI)

Are you wondering how AI can help your business? Do you worry about privacy or regulatory issues stopping you from using AI to its fullest? We have the answers! Our Executive Briefings provide guidance and concrete advice that help decision makers move forward in this rapidly changing Age of Artificial Intelligence and Copilots!

**We will send an expert to your office to meet with you. You will receive:**

1. An overview presentation of the current state of Artificial Intelligence.
2. How to use AI in your business while ensuring privacy of your and your clients' information.
3. A sample application built on your own HR documents - allowing your employees to query those documents in English and cutting down the number of questions that you and your HR group have to answer.
4. A roadmap for future use of AI tailored to what you do.

### A Briefing Combined with Solid Deliverables!

**We will send an expert to your office to meet with you. You will receive:**

1. An overview presentation of the current state of Artificial Intelligence.
2. How to use AI in your business while ensuring the privacy of your data.
3. A sample application built on your own HR documents - allowing your employees to query those documents in English and cutting down the number of questions that you and your HR group have to answer.
4. A roadmap for future use of AI tailored to what you do.

Executive Briefings are set up specifically for you and usually take several hours and up to a day. It is up to you whether you want to include only C-level Executives or your entire company. The cost is **\$5,000** (which is a discounted special rate, compared to the normal price of \$7,500) plus expenses if we have to travel to your location, or stay over night. This includes the concrete deliverable of a first implementation of AI for your business (see #3 above, although we may also agree that something slightly different is more appropriate for your organization).

[Contact us today to set up your individual Executive Briefing!](#)

### Setting Directions for the Future of Your Organization

We are experiencing a time of extreme change in technology. While one might argue that this has always been true, it is clear that current developments have a drastic impact on all organizations at a scale that is orders of magnitude beyond what we have experienced in years past.

**This represents a time of extreme opportunity, as well as a time of considerable risks!**

Artificial Intelligence (AI) continues to revolutionize industries across the globe, offering immense potential for organizations to enhance operational efficiency, drive innovation, and achieve competitive advantage. Conversely, ignoring these technological trends means that even very recent technology is quickly turning into "legacy" and your competitors now have the opportunity to leapfrog you. Especially the advent of "The Age of Copilots" (powered largely by the onset of Large Language Models - LLMs) promises a productivity improvement of upwards of 50% in some areas year after year, and that isn't the only trend to pay attention to.

**What does all of this mean specifically for your organization?**

- Check out our new **Executive Briefing** Offer!
- We can help with your AI needs
- What does AI mean for you?
- "Skunk Works" Projects



- [www.codemag.com/AI](http://www.codemag.com/AI)
- [www.codemag.com/ExecutiveBriefing](http://www.codemag.com/ExecutiveBriefing)

# CODE Staffing



- Disrupting the world of staffing!
- Giving our customers the ability to have staff on par with Silicon Valley companies...
- ...and our employees a work environment in a bleeding-edge tech company with the **industry leading benefits!**
- [www.codestaffing.com](http://www.codestaffing.com)



# We Need You!

- We are currently “hiring on all cylinders” across the entire CODE Group Organization!
- Check out [www.codestaffing.com/careers](http://www.codestaffing.com/careers)



# Upcoming Events



- State of .NET Online - .NET 8 – November 15<sup>th</sup> 2023
- <https://www.codemag.com/StateOfDotNet>



- CODE Presents – October 25<sup>th</sup> 2023:  
Harnessing Large Language Models Locally
- <https://www.codemag.com/CODEPresents>





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- Subscribers get CODE Focus issues free of charge!
- Please share this free subscription link:

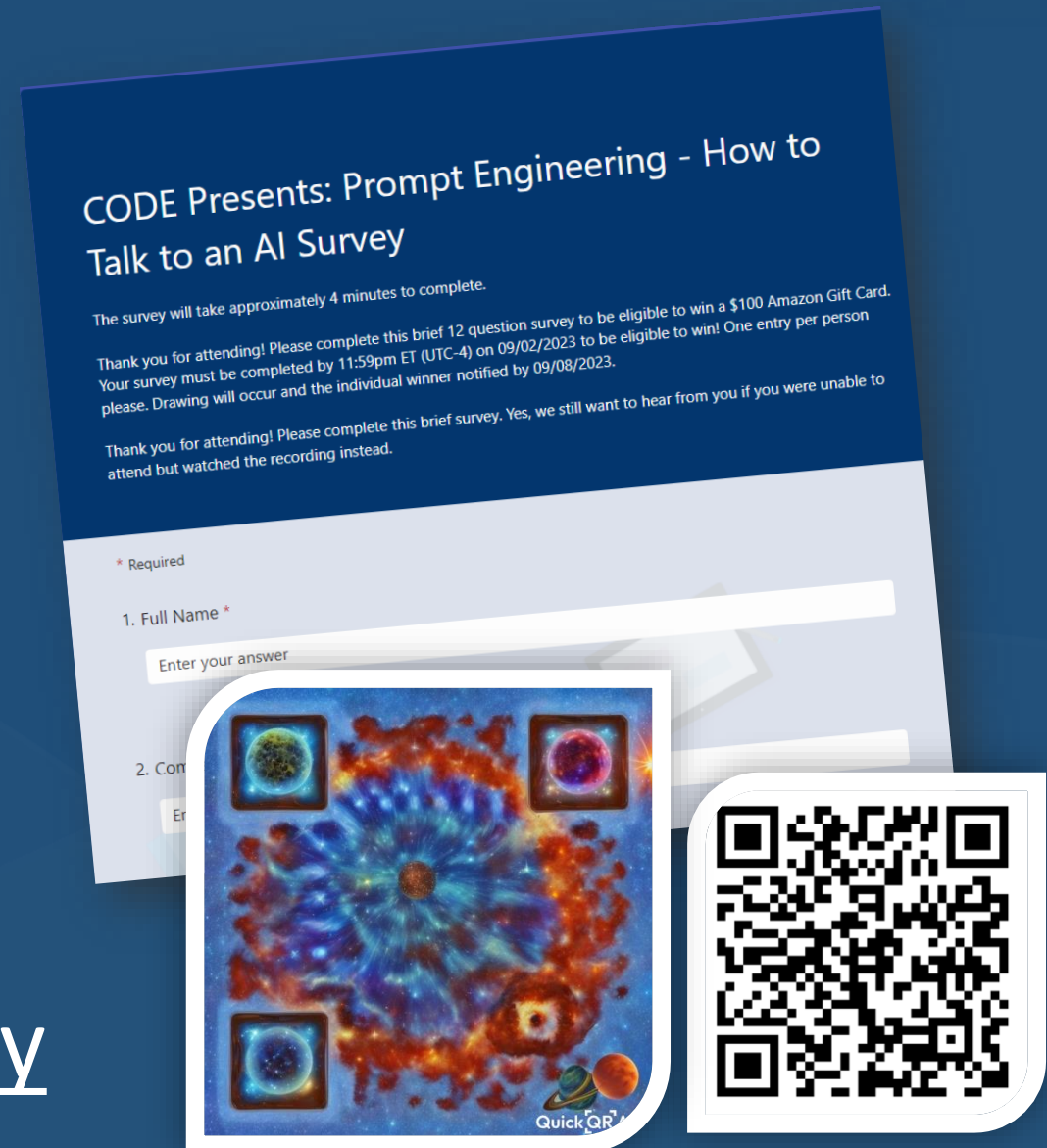


<https://www.codemag.com/subscribe/cp10423>

# Event Survey – Win \$100!

- Complete this very short 12 question survey for a chance at a \$100 Amazon Gift Card!
- Survey must be completed by 11:59pm ET on Friday 10/6/2023 to be eligible!
- THIS SLIDE WILL BE REPEATED AT THE END AND SURVEY LINK REPEATED IN THE CHAT WINDOW!

<https://bit.ly/CP10423Survey>



# Thank you for attending!



- Welcome new attendees!
- Welcome repeat attendees!
  - We now have quite a number of people who attended 50+ events
- Our AI presentations are the most popular we have ever done
  - ...and we have been at this for 30 years!
- Based on the attendee list, I am guessing we have a mix of developers, decision makers, and users

# Agenda

## 1. Introduction

- Brief introduction to Generative AI and its importance
- Contextualizing Image Generation within Generative AI
- Goal of the presentation

## 2. Historical Evolution of Generative Models

- Brief history of generative models (with emphasis on image generation)
- Transition from early models to advanced architectures

## 3. Understanding Key Generative Models

- Introduction to Generative Adversarial Networks (GANs)
- Introduction to Variational Autoencoders (VAEs)

## 4. Running a Simple Generative Model

- Preparing the environment and data
- Training a simple model for image generation
- Discussing the parameters influencing the model's outcomes

## 5. Demonstration: Generating Images

- Demonstration of generating images using a pre-trained model
- Exploring the parameter settings and observing the outcomes

## 6. Discussion: Capabilities and Limitations

- Discussing the strengths and weaknesses of current generative models
- Future trends in generative AI for image generation

# Introduction

- Importance of Generative AI for Image Generation
- Contextualizing Image Generation
- Goal of the presentation

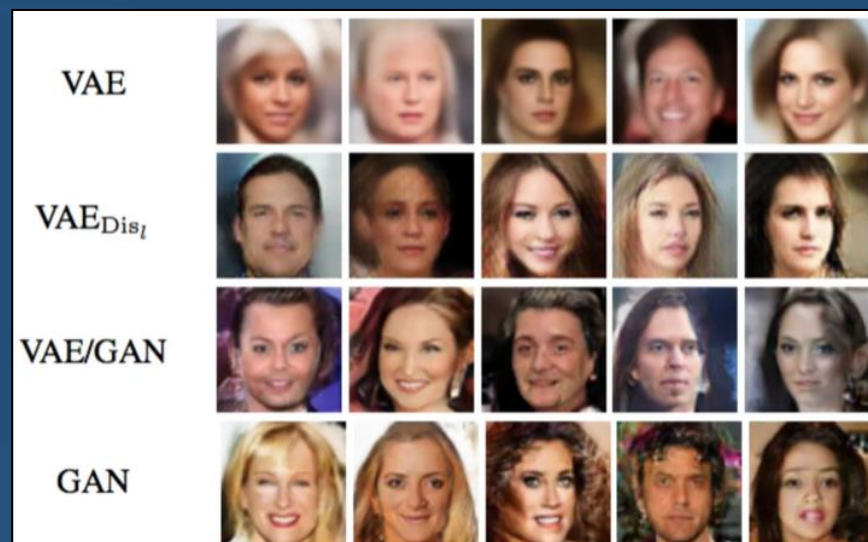


# Historical Evolution

- Early Efforts: RBM (Restricted Boltzmann Machines)
- Introduction of Generative Adversarial Networks (GANs)
- Variational Autoencoders (VAEs)
- Improvement of GANs
- Flow based models
- Performance Benchmarks and App Driven Development
- Ethical Considerations
- Recent Advancements
- Open Source



# GAN vs. VAE



Sik-Ho Tsang

# Generative Adversarial Networks (GANs)

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# Generative Adversarial Networks (GANs)

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- Generator – artist who tries to create a convincingly fake painting
- Discriminator – art critic who tries to tell if the painting is real or fake

For How Long?





# Generative Adversarial Networks (GANs)

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- Learning Process: Cat and mouse game
  - Generator improves fakes
  - Discriminator improves at spotting fakes
- Training improves both sides
  - Feedback Loop
  - Convergence
  - Objective Measurement
  - Human Intervention (optional)





# Variational Autoencoders (VAEs)

- More orderly and structured
- More like a skilled artist who studies and learns from real images to create new ones
- Study of images and their attributes (style, patterns, features, brushes, color palette)
- Create blueprint & recipe
- New Image Generation (batch)
- Evaluation





# It's never just one!

- All modern image generation services make use of both.
- Different emphasis and focus
- These concepts are **NOT** new!

## AI Models and Timelines

Model	Notable AI products	Research Paper	Details
VAE	Amazon Alexa, Google Photos, Spotify	Dec 2013	Kingma & Welling "Auto-Encoding Variational Bayes"
GAN	AlphaGo, DALL-E, NVIDIA StyleGAN	Jun 2014	Goodfellow & Bengio et al. "Generative Adversarial Networks"
Flow models	Google Pixel 4, GPT-3, NVIDIA StyleGAN	May 2016	Dinh & Bengio et al. "Density estimation using Real NVP"
Transformer	BERT, Google Translate, OpenAI's GPT models	Jun 2017	Vaswani & Polosukhin et al. "Attention is All You Need"
Diffusion	DALL-E 2, Midjourney, Stable Diffusion	Jun 2018	Gregor & Weber et al. "Temporal Difference Variational Auto-Encoder"

 col\_jung  Medium Col Jung

# Running a simple generative model

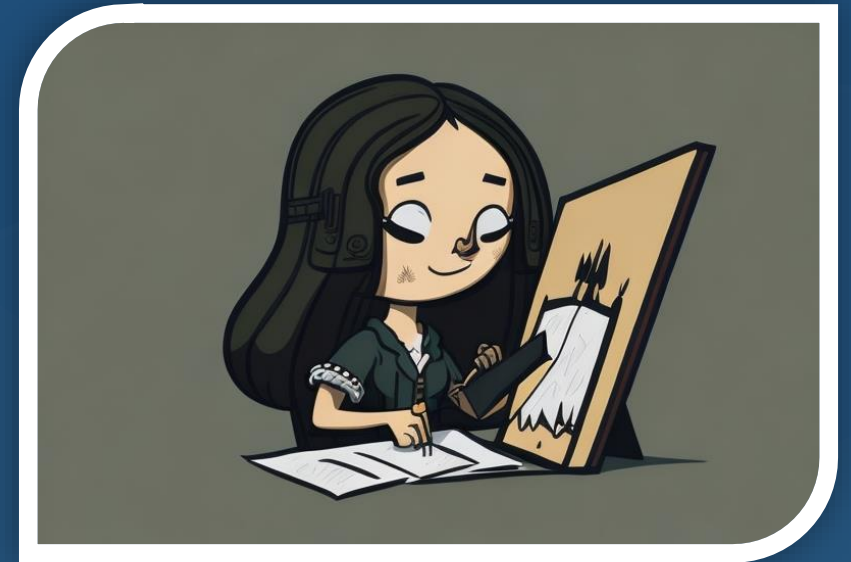
- Preparing the environment and data
  - Environment setup
  - Data collection
  - Data pre-processing
- Training a simple model for image generation
  - Model architecture
  - Training procedure
  - Evaluation during training



AI vs AI

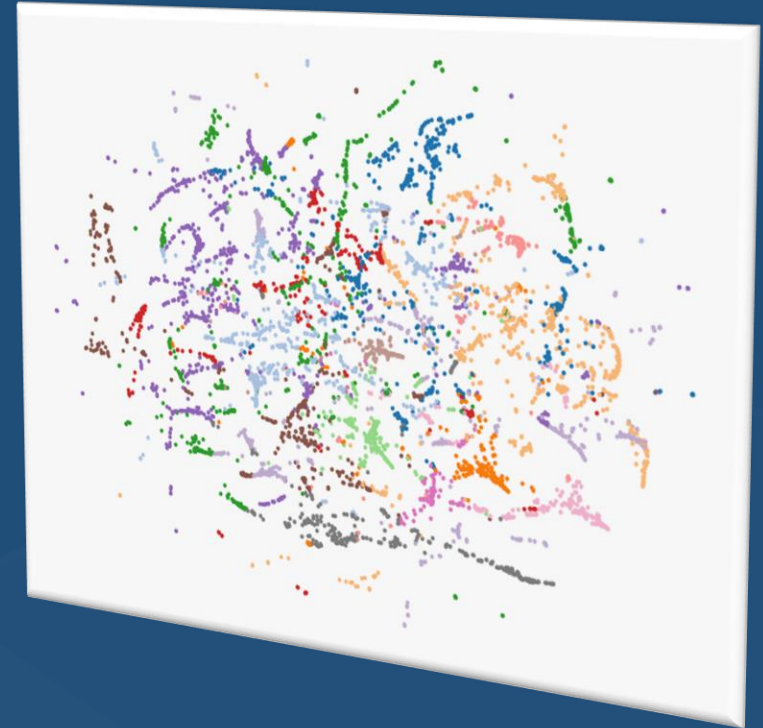
# Parameters influencing the model's outcomes

- Hyper-Parameters
- Regularization
- Loss Functions
- Optimization Algorithms & Algorithm Optimization
- Exploration of Latent Space



# Generating images

- Pretrained Text Embeddings – Text To Vector
- Example: Rhino
  - Gray
  - 4 thick legs
  - 1 or 2 horns
  - Short tail
  - Skin texture
  - Postures
  - Etc.





# Generating Images

Steps: 5



Steps: 10



Steps: 20



Steps: 40



Steps: 80



Steps: 150



# Running Stable Diffusion Local

txt2img.py X

C:\Users\ottod> Desktop > StableDiff > stablediff2 > stable-diffusion > scripts > txt2img.py > main

```
93 if has_nsfw_concept[1]:
94     x_checked_image[i] = load_replacement(x_checked_image[i])
95 return x_checked_image, has_nsfw_concept
96
97
98 def main():
99     parser = argparse.ArgumentParser()
100
101     parser.add_argument(
102         "--prompt",
103         type=str,
104         nargs="?",
105         default="a painting of a",
106         help="the prompt to render"
107     )
108
109     parser.add_argument(
110         "--outdir",
111         type=str,
112         nargs="?",
113         help="dir to write results to",
114         default="outputs/txt2img-samples"
115     )
116
117     parser.add_argument(
118         "--skip_grid",
119         action='store_true',
120         help="do not save a grid, on"
121     )
122
123     parser.add_argument(
124         "--skip_save",
125         action='store_true',
126         help="do not save individual"
127     )
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132         default=5,
133         help="number of ddim sampling"
134     )
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139         help="use plms sampling",
140     )
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```



# Example results

Blue car on moon



Red flower on ship

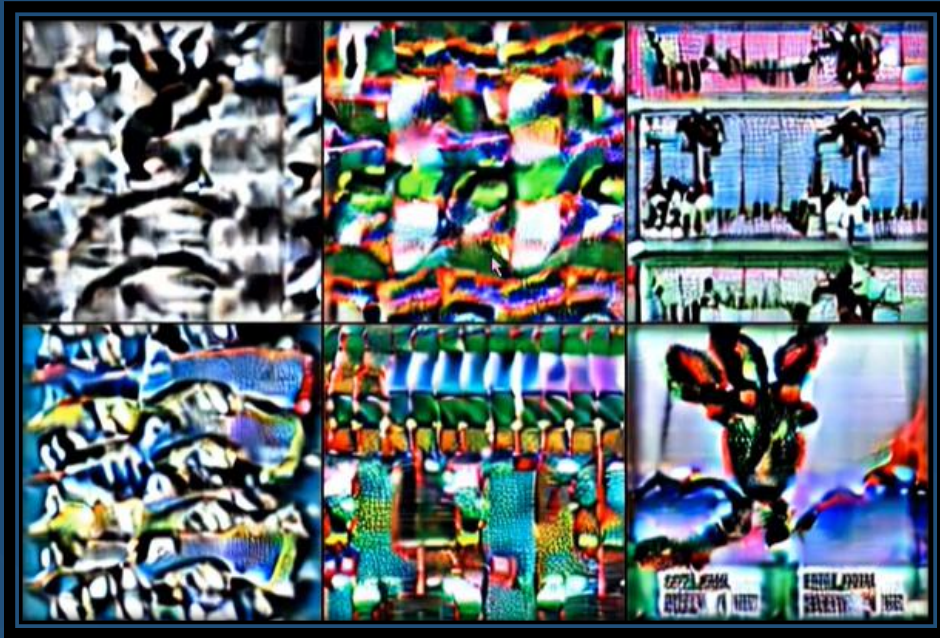


Kangaroo on mountain



6 images, each with 50 steps

# Step Reduction



5 steps

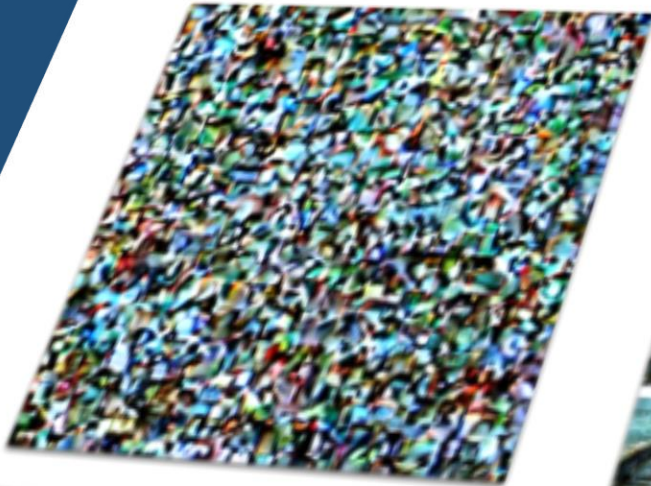


50 steps

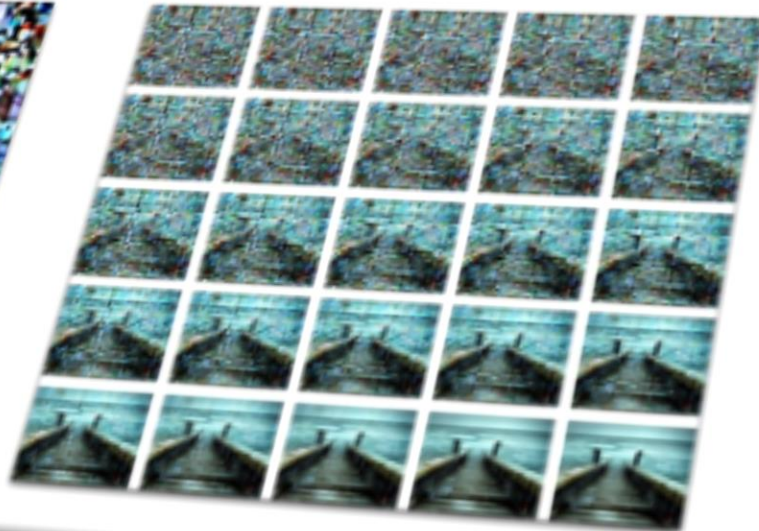


# From noise to image

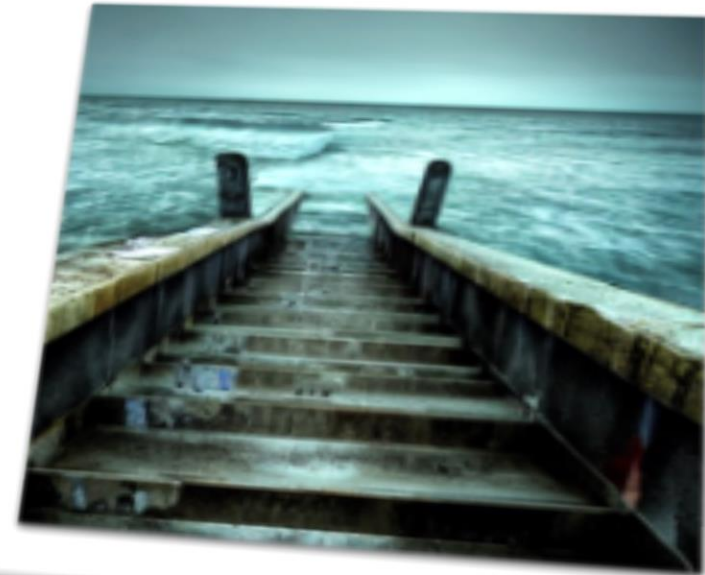
Initial Random Noise



"Remove all noise"



Generated Image





# Prompt engineering

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"astronaut cat, playing piano in space, black hole in the background, high quality, 4k render, dramatic light, photoreal, detailed, pov shot, volumetric lighting, golden hour"



"astronaut cat, playing piano in space, black hole in the background"



Leonardo.Ai with Alchemy

# Service comparison

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*A dynamic action scene of a knight battling a dragon on a cliffside, with roaring waves below, inspired by the Romanticism movement, reminiscent of the works of Eugène Delacroix.*



Midjourney



Nightcafe



Adobe Firefly



Leonardo

No settings changed, default parameters

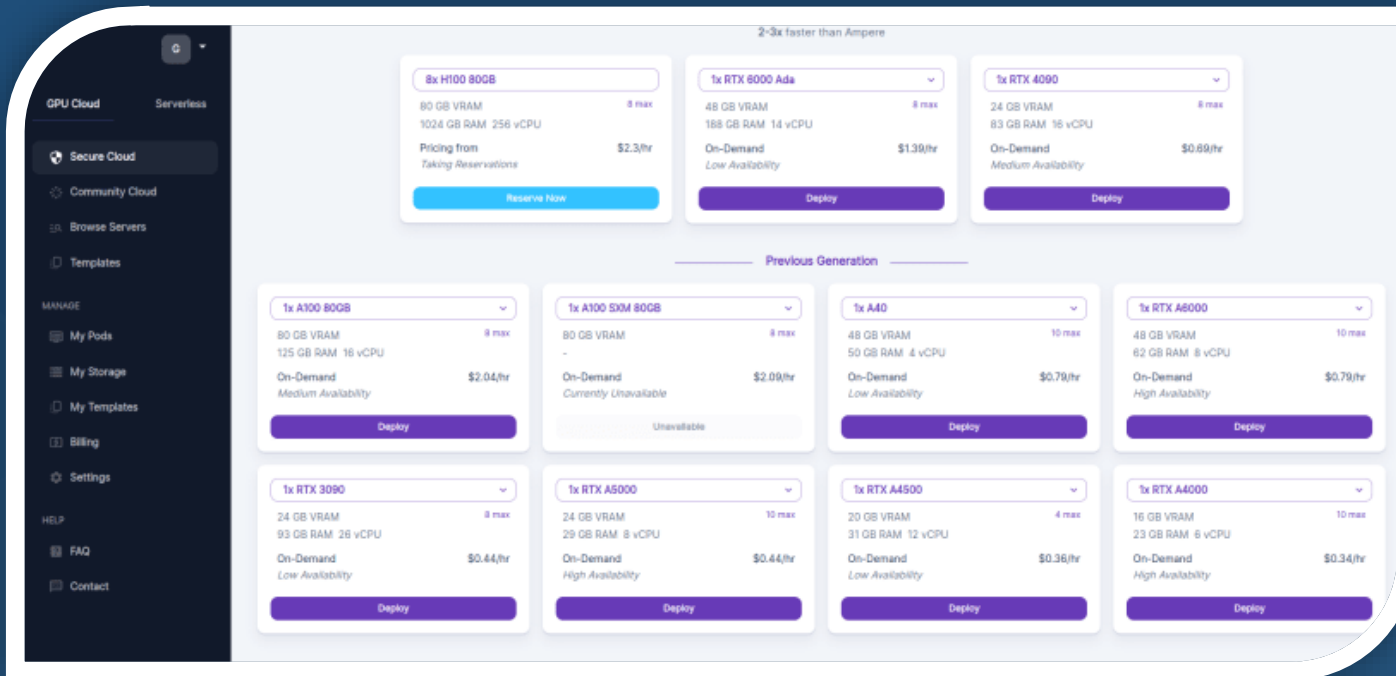
Dreamshaper 8  
(local)





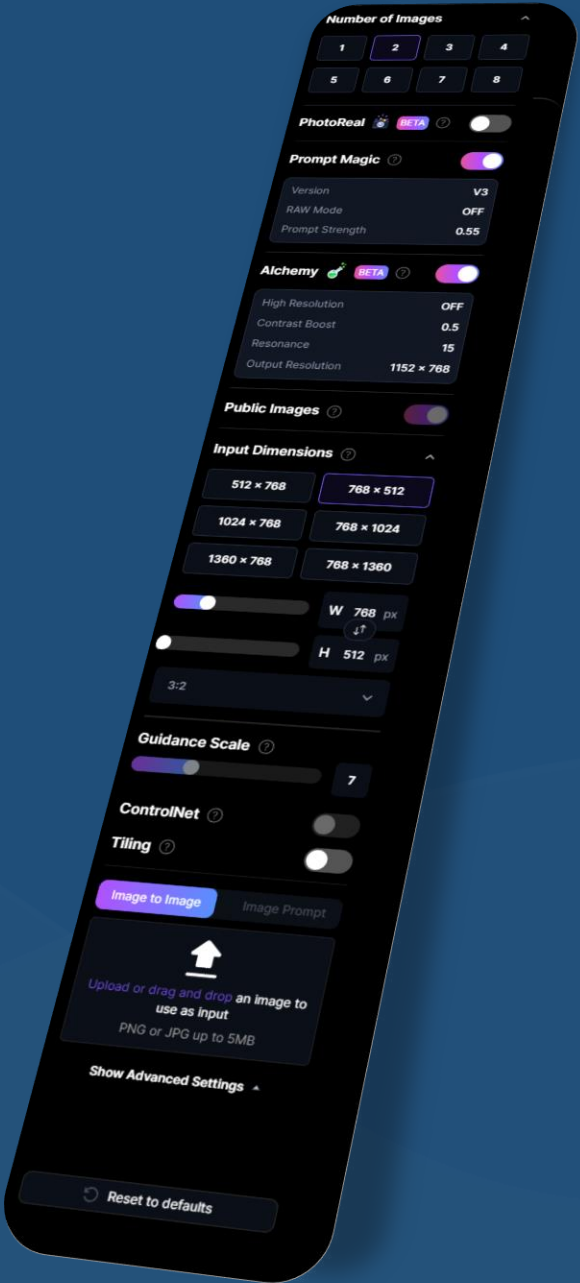
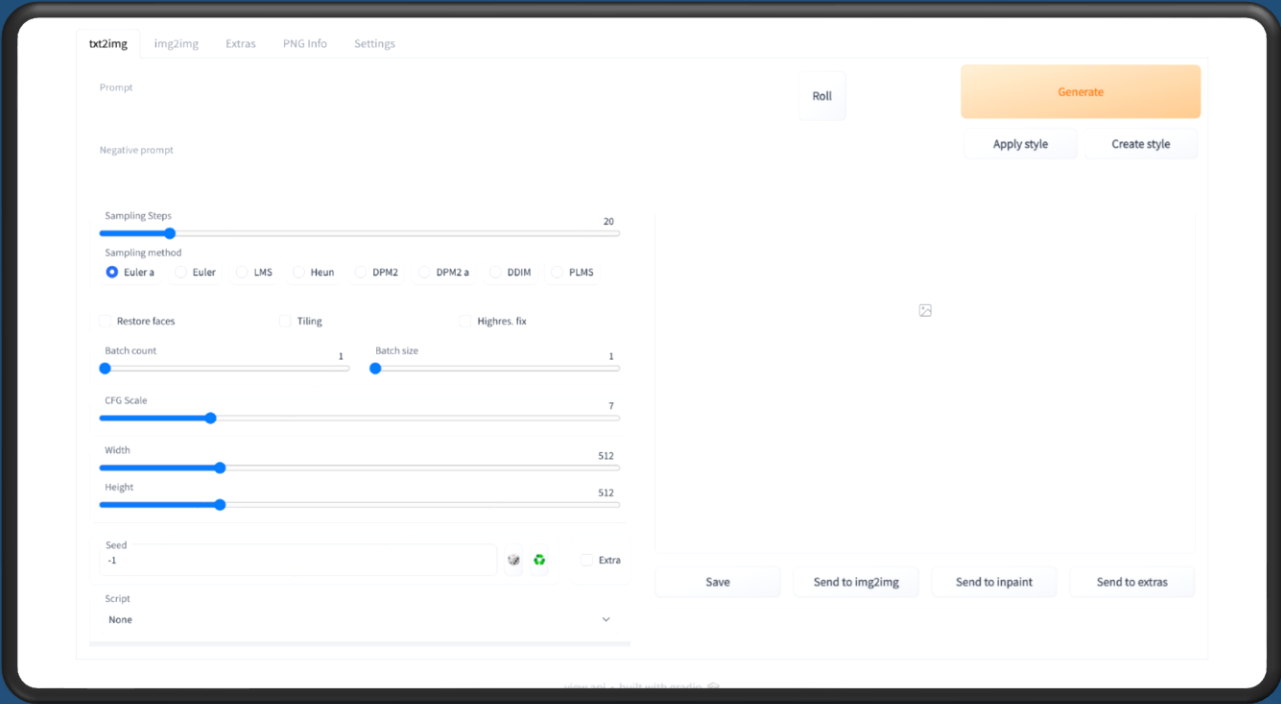
# Local & personal cloud setup with Stable Diffusion

- For instance, on RunPod




Secure Cloud		1x GPU \$/hr	8x GPU \$/hr
A100 80GB 80 GB VRAM 125 GB RAM, 8 vCPU	Spot	-	-
	On-Demand	1.99	15.92
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-
A100 SXM 80GB 80 GB VRAM 125 GB RAM, 16 vCPU	Spot	-	-
	On-Demand	2.19	17.52
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-
H100 80GB SXM5 80 GB VRAM GB RAM, vCPU	Spot	-	-
	On-Demand	4.49	35.92
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-
H100 80GB PCIe 80 GB VRAM 125 GB RAM, 16 vCPU	Spot	-	-
	On-Demand	4.29	34.32
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-
A40 48 GB VRAM 50 GB RAM, 4 vCPU	Spot	-	-
	On-Demand	0.79	6.32
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-
L40 48 GB VRAM 250 GB RAM, 16 vCPU	Spot	0.89	5.52
	On-Demand	1.14	9.12
	1 Month	1.08	8.64
	3 Month	1.02	8.16
	6 Month	0.97	7.76
RTX 6000 Ada 48 GB VRAM 61 GB RAM, 8 vCPU	Spot	-	-
	On-Demand	1.14	9.12
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-
RTX A6000 48 GB VRAM 50 GB RAM, 4 vCPU	Spot	0.49	3.92
	On-Demand	0.79	6.32
	1 Month	0.75	6
	3 Month	0.71	5.68
	6 Month	0.67	5.36
RTX 3090 24 GB VRAM 30 GB RAM, 4 vCPU	Spot	-	-
	On-Demand	0.44	3.52
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-
RTX 4090 24 GB VRAM 29 GB RAM, 4 vCPU	Spot	0.49	3.92
	On-Demand	0.74	5.92
	1 Month	-	-
	3 Month	-	-
	6 Month	-	-


# Web UIs



# Hugging Face

 **Hugging Face**

[Models](#) [Datasets](#) [Spaces](#) [Docs](#) [Solutions](#) [Pricing](#) [Log In](#) [Sign Up](#)

 **Spaces**

Discover amazing ML apps made by the community!

[Create new Space](#) or [learn more about Spaces](#)

[new Full-text search](#) [Sort: Trending](#)

[☆ Spaces of the week 🔥](#)

Running on ZERO

LoRA Roulette

multimodalart

1 day ago

91

Blind Chat

mithril-security

about 4 hours ago

73

Running on T4

Upside-Down-Diffusion

AP123

about 14 hours ago

104

Running on A10G

DeciDiffusion-v1-0

Deci

16 days ago

66

Running on T4

Nougat Transformers

hf-vision

3 days ago

50

Running on CPU UPGRADE

Stable Diffusion 2-1

stabilityai

14 days ago

9.11k

Explore Clinical & Biomedical Language Models

hf4h

15 days ago

77

Running on CPU UPGRADE

Lilac

lilacai

2 days ago

24

[# All running apps, trending first](#)

Running on A10G

IllusionDiffusion

AP123

about 12 hours ago

1.23k

Running on CPU UPGRADE

AI Comic Factory

jbilcke-hf

about 6 hours ago

1.83k

Running on A100

Shopify Image Background Replacement

Shopify

about 2 hours ago

132

Open LLM Leaderboard

HuggingFaceH4

1 day ago

5.45k

# Other Announcements



# AI Consulting Services



**CODE CONSULTING** Home Magazine Consulting Staffing Training Framework VFP Conversion [Login](#)

### Executive Briefing (AI)

Are you wondering how AI can help your business? Do you worry about privacy or regulatory issues stopping you from using AI to its fullest? We have the answers! Our Executive Briefings provide guidance and concrete advice that help decision makers move forward in this rapidly changing Age of Artificial Intelligence and Copilots!

**We will send an expert to your office to meet with you. You will receive:**

1. An overview presentation of the current state of Artificial Intelligence.
2. How to use AI in your business while ensuring privacy of your and your clients' information.
3. A sample application built on your own HR documents - allowing your employees to query those documents in English and cutting down the number of questions that you and your HR group have to answer.
4. A roadmap for future use of AI tailored to what you do.

### A Briefing Combined with Solid Deliverables!

**We will send an expert to your office to meet with you. You will receive:**

1. An overview presentation of the current state of Artificial Intelligence.
2. How to use AI in your business while ensuring the privacy of your data.
3. A sample application built on your own HR documents - allowing your employees to query those documents in English and cutting down the number of questions that you and your HR group have to answer.
4. A roadmap for future use of AI catered to what you do.

Executive Briefings are set up specifically for you and usually take several hours and up to a day. It is up to you whether you want to include only C-level Executives or your entire company. The cost is **\$5,000** (which is a discounted special rate, compared to the normal price of \$7,500) plus expenses if we have to travel to your location, or stay over night. This includes the concrete deliverable of a first implementation of AI for your business (see #3 above, although we may also agree that something slightly different is more appropriate for your organization).

[Contact us today to set up your individual Executive Briefing!](#)

### Setting Directions for the Future of Your Organization

We are experiencing a time of extreme change in technology. While one might argue that this has always been true, it is clear that current developments have a drastic impact on all organizations at a scale that is orders of magnitude beyond what we have experienced in years past.

**This represents a time of extreme opportunity, as well as a time of considerable risks!**

Artificial Intelligence (AI) continues to revolutionize industries across the globe, offering immense potential for organizations to enhance operational efficiency, drive innovation, and achieve competitive advantage. Conversely, ignoring these technological trends means that even very recent technology is quickly turning into "legacy" and your competitors now have the opportunity to leapfrog you. Especially the advent of "The Age of Copilots" (powered largely by the onset of Large Language Models - LLMs) promises a productivity improvement of upwards of 50% in some areas year after year, and that isn't the only trend to pay attention to.

**What does all of this mean specifically for your organization?**



- Check out our new **Executive Briefing** Offer!
  - We can help with your AI needs
  - What does AI mean for you?
  - "Skunk Works" Projects
- 
- [www.codemag.com/AI](http://www.codemag.com/AI)
  - [www.codemag.com/ExecutiveBriefing](http://www.codemag.com/ExecutiveBriefing)

# CODE Staffing



- Disrupting the world of staffing!
- Giving our customers the ability to have staff on par with Silicon Valley companies...
- ...and our employees a work environment in a bleeding-edge tech company with the **industry leading benefits!**
- [www.codestaffing.com](http://www.codestaffing.com)



# We Need You!

- We are currently “hiring on all cylinders” across the entire CODE Group Organization!
- Check out [www.codestaffing.com/careers](http://www.codestaffing.com/careers)



# Upcoming CODE Training Classes



- Public AI Training Classes
  - Introduction to Development with Open AI, ChatGPT, Azure Open AI, and more...
  - Building Copilots for your own apps
- Classes are also available as individualized private classes and mentoring sessions



<https://www.codemag.com/training>

# Upcoming Events



- State of .NET Online - .NET 8 – November
- <https://www.codemag.com/StateOfDotNet>



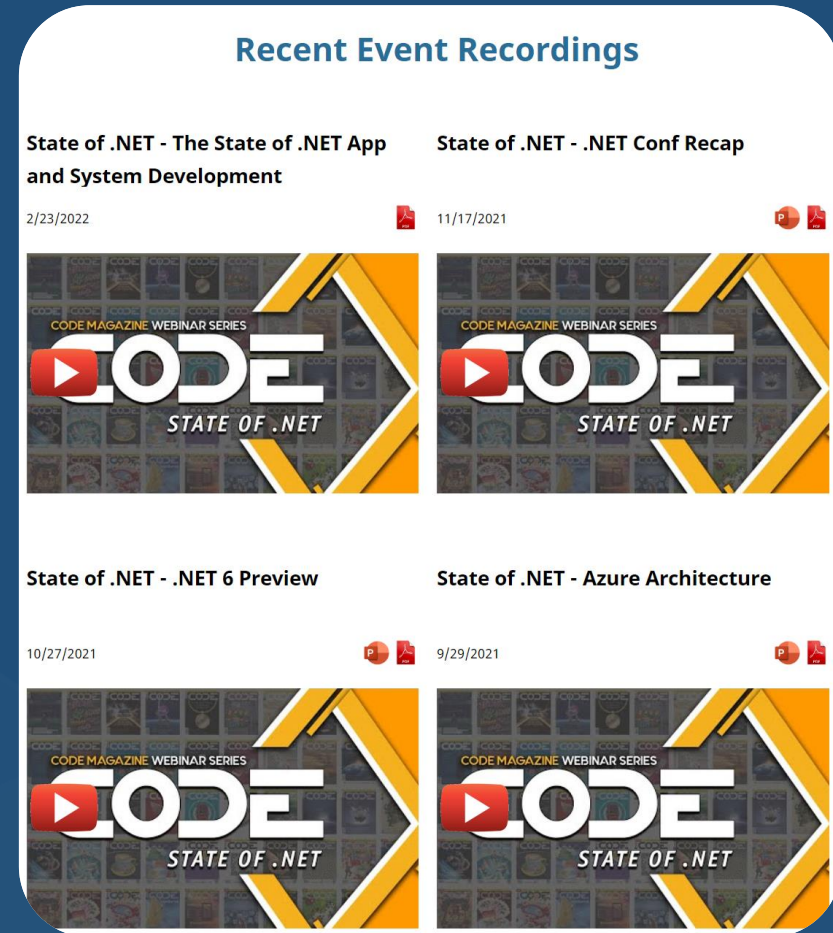
- CODE Presents – Monthly – Mostly AI
- <https://www.codemag.com/CODEPresents>





# Recordings & Slide Decks

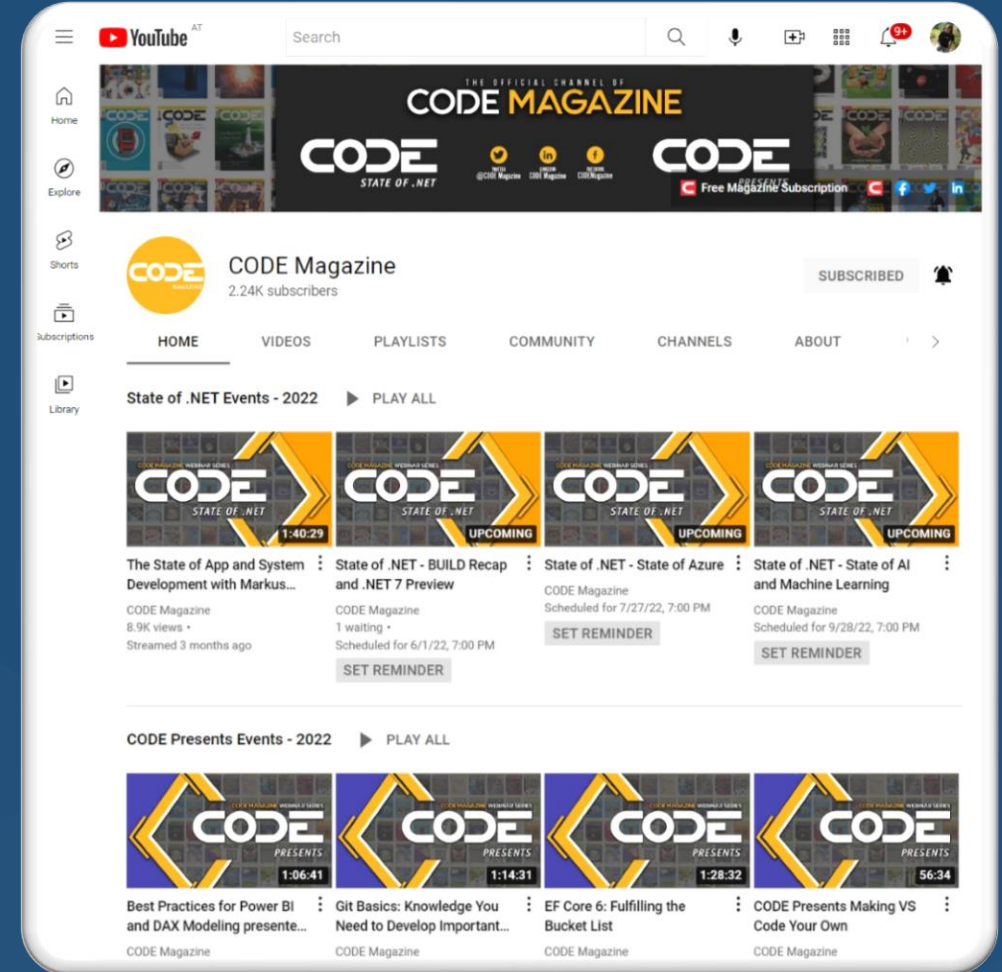
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# Event Survey – Win \$100!

- Complete this very short 12 question survey for a chance at a \$100 Amazon Gift Card!
- Survey must be completed by 11:59pm ET on Friday 9/8/2023 to be eligible!
- THIS SLIDE WILL BE REPEATED AT THE END AND SURVEY LINK REPEATED IN THE CHAT WINDOW!

<https://bit.ly/CP10423Survey>



# Q&A

Contact us with questions!

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