

Generative AI

For Text & Vision

Sri Vallabha Deevi, Ph.D.

Director, Data Science, Tiger Analytics.
Adjunct Faculty, Data Science & AI, IIT Madras.

Table of contents

1. Introduction
2. Building Blocks
3. Models for Text & Vision
4. Applications

Introduction

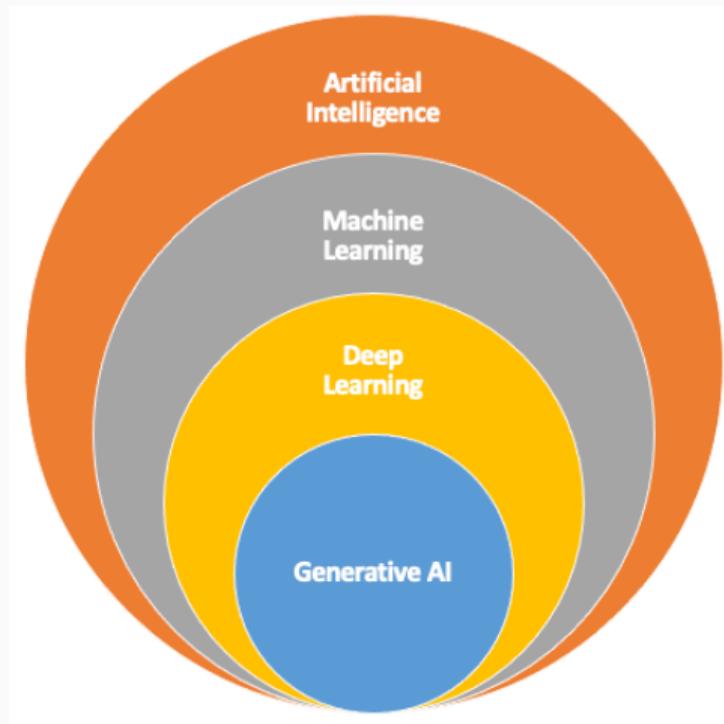
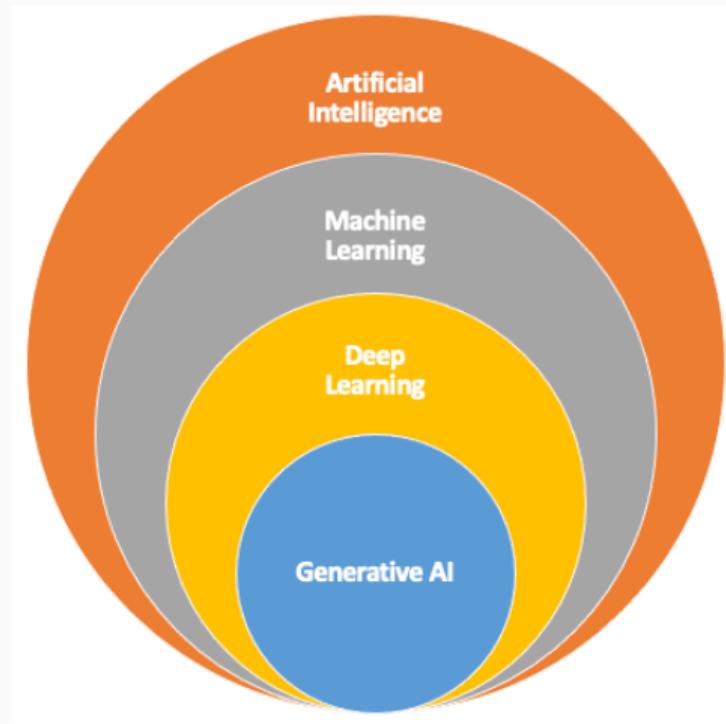
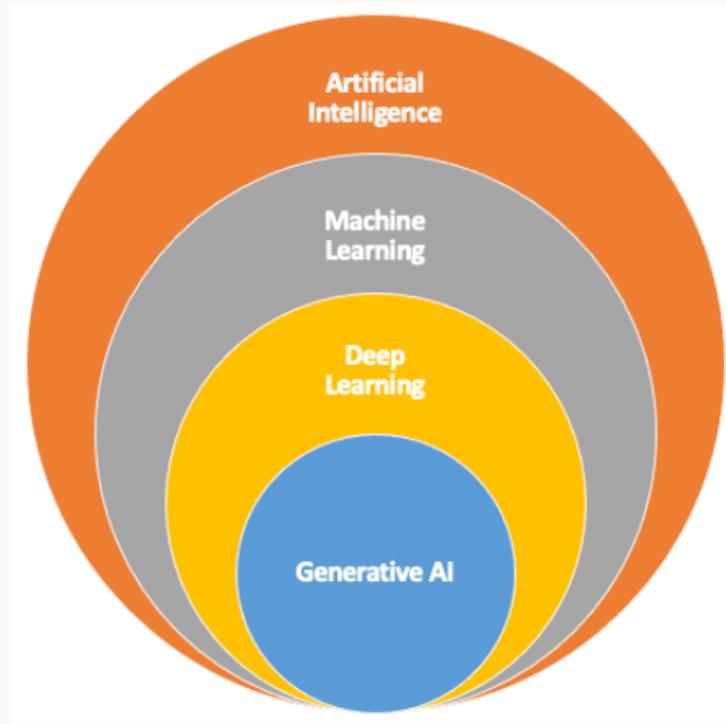


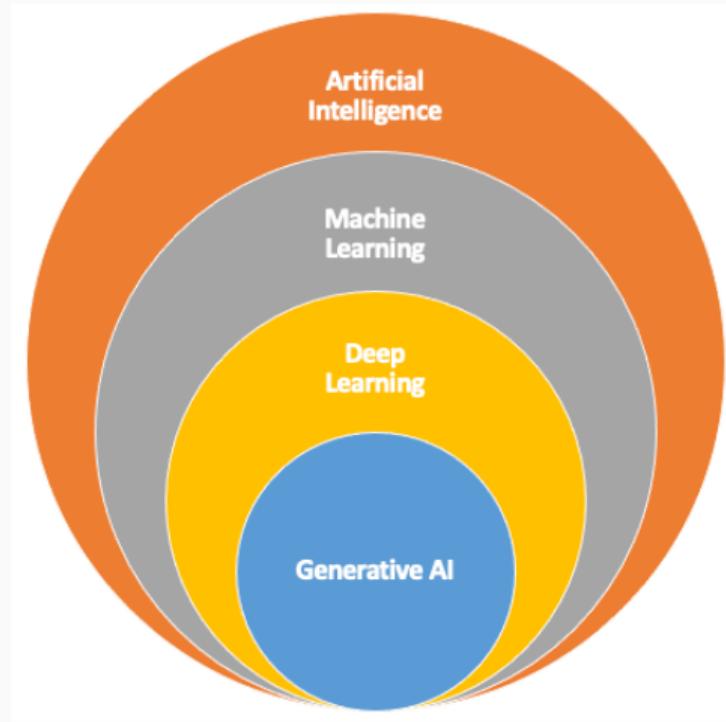
Image: <https://images.app.goo.gl/dHUy8VitcR1AP77S8>



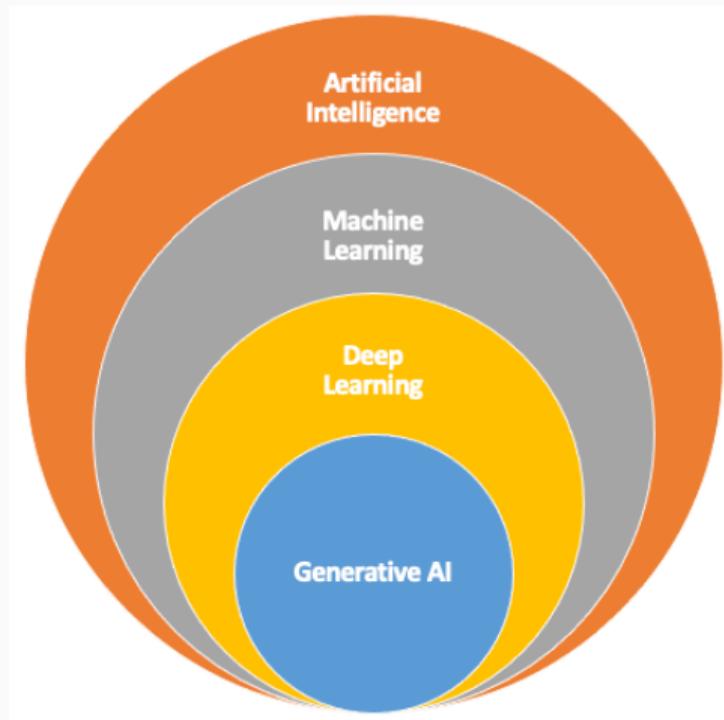
- AI: Sensing, reasoning, acting or adaptation can be based on rules, or a learned function



- AI: Sensing, reasoning, acting or adaptation can be based on rules, or a learned function
- ML: Building models, usually on structured (tabular) data, to aid in decision making



- AI: Sensing, reasoning, acting or adaptation can be based on rules, or a learned function
- ML: Building models, usually on structured (tabular) data, to aid in decision making
- DL: Neural network based models that deal predominantly with unstructured data like images, video, text and speech



- AI: Sensing, reasoning, acting or adaptation can be based on rules, or a learned function
- ML: Building models, usually on structured (tabular) data, to aid in decision making
- DL: Neural network based models that deal predominantly with unstructured data like images, video, text and speech
- Gen AI is a subset of Deep Learning. Uses Neural Networks extensively

Regular AI



User Input: House features (Sq. ft area, # bedrooms, flooring etc.)

Model Output: Price of house

Regular AI



User Input: House features (Sq. ft area, # bedrooms, flooring etc.)

Model Output: Price of house



User Input: Image ($m \times n \times 3$ pixels)
Model Output: Bounding box around cat or dog

Regular AI



User Input: House features (Sq. ft area, # bedrooms, flooring etc.)

Model Output: Price of house



User Input: Image ($m \times n \times 3$ pixels)

Model Output: Bounding box around cat or dog

Many inputs, fewer outputs



User Input: prompt - 'Astronaut Riding a Horse'

Model Output: Above image

Generative AI



User Input: prompt - 'Astronaut Riding a Horse'

Model Output: Above image

A screenshot of a web-based chat interface at https://chat.chatgptdemo.net. The interface has a dark theme. On the left is a sidebar with icons for file operations. The main area shows a conversation between a user and a large language model (indicated by a blue profile icon).

twinkle twinkle

10/14/2023, 9:55:40 AM

Little star,
How I wonder what you are.
Up above the world so high,
Like a diamond in the sky.

Twinkle, twinkle, little star,
How I wonder what you are.

User Input: prompt - 'Twinkle Twinkle'

Model Output: Above poem completion

Generative AI



User Input: prompt - 'Astronaut Riding a Horse'

Model Output: Above image

A screenshot of a web-based chat interface. The URL in the address bar is https://chat.chatgptdemo.net. The conversation log shows a user message "twinkle twinkle" followed by a timestamp "10/14/2023, 9:55:38 AM". The AI response, also timestamped "10/14/2023, 9:55:40 AM", is a poem:

Little star,
How I wonder what you are.
Up above the world so high,
Like a diamond in the sky.

Twinkle, twinkle, little star,
How I wonder what you are.

User Input: prompt - 'Twinkle Twinkle'

Model Output: Above poem completion

Few inputs, many outputs

Building Blocks

Generative Methods

Three fundamental generative approaches. Models are usually variants of these methods.

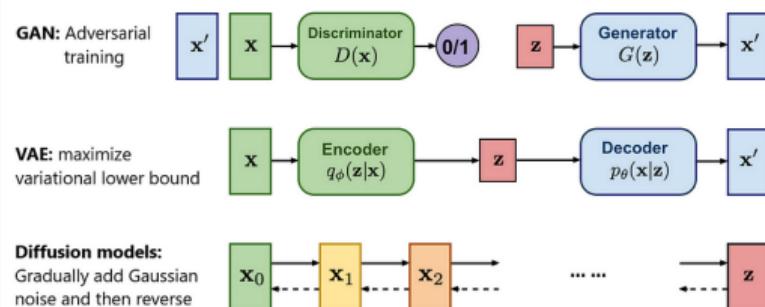
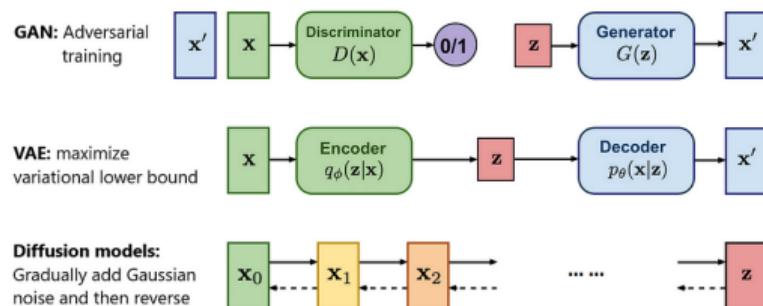


Image: <https://towardsai.net/p/machine-learning/diffusion-models-vs-gans-vs-vaes-comparison-of-deep-generative-models>

Generative Methods

Three fundamental generative approaches. Models are usually variants of these methods.



- Generative Adversarial Networks
- Variational Auto Encoders
- Diffusion Models

Image: <https://towardsai.net/p/machine-learning/diffusion-models-vs-gans-vs-vaes-comparison-of-deep-generative-models>

Generative Adversarial Networks

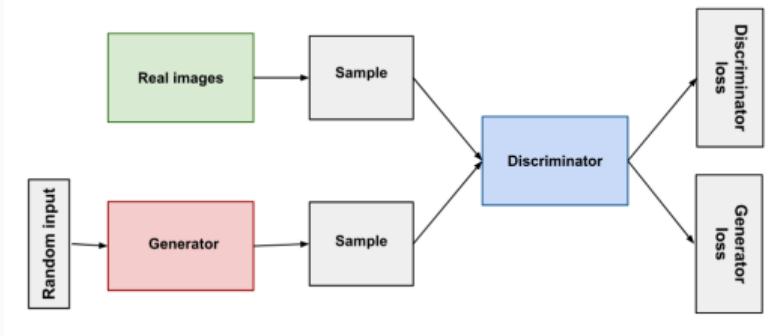


Image: https://developers.google.com/machine-learning/gan/gan_structure

Generative Adversarial Networks

- Contains a Generator and a Discriminator

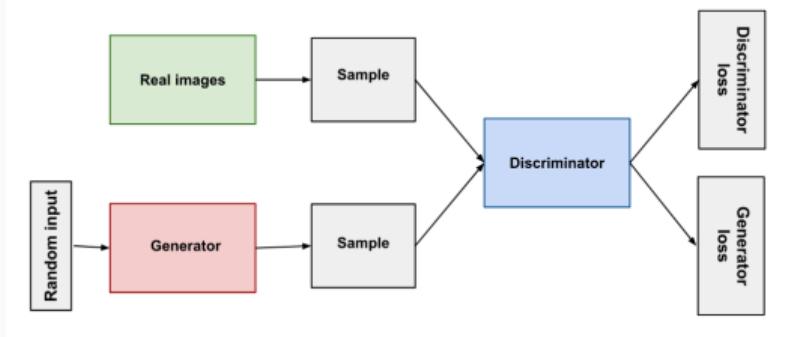
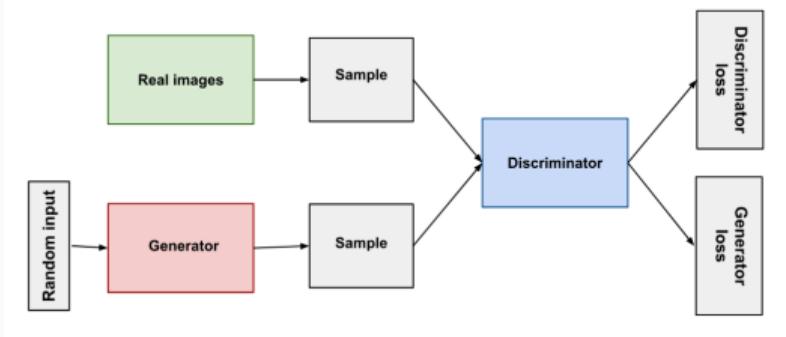


Image: https://developers.google.com/machine-learning/gan/gan_structure

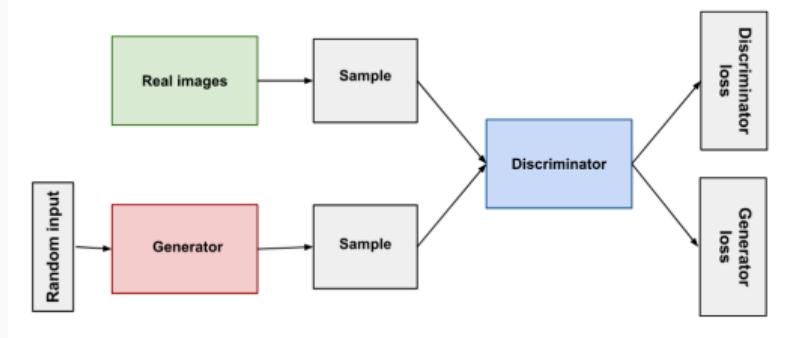
Generative Adversarial Networks



- Contains a Generator and a Discriminator
- Generator learns to generate plausible data

Image: https://developers.google.com/machine-learning/gan/gan_structure

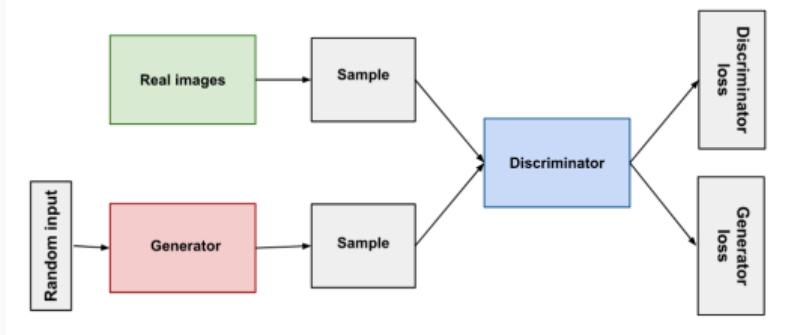
Generative Adversarial Networks



- Contains a Generator and a Discriminator
- Generator learns to generate plausible data
- Generated instances are negative training examples for Discriminator

Image: https://developers.google.com/machine-learning/gan/gan_structure

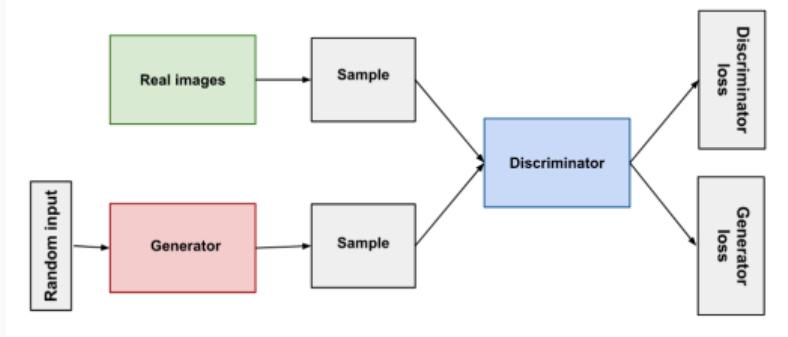
Generative Adversarial Networks



- Contains a Generator and a Discriminator
- Generator learns to generate plausible data
- Generated instances are negative training examples for Discriminator
- Discriminator learns to differentiate Generator's fake data from real data

Image: https://developers.google.com/machine-learning/gan/gan_structure

Generative Adversarial Networks



- Contains a Generator and a Discriminator
- Generator learns to generate plausible data
- Generated instances are negative training examples for Discriminator
- Discriminator learns to differentiate Generator's fake data from real data
- Discriminator penalizes Generator for producing implausible results

Image: https://developers.google.com/machine-learning/gan/gan_structure

Variational Auto Encoders

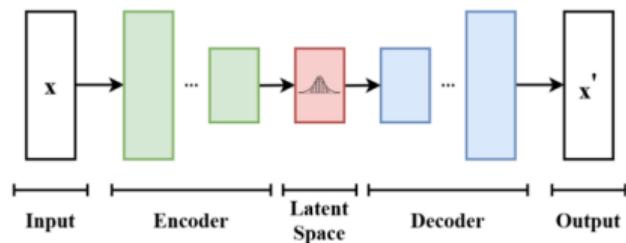


Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

Variational Auto Encoders

- Consists of an Encoder and a Decoder

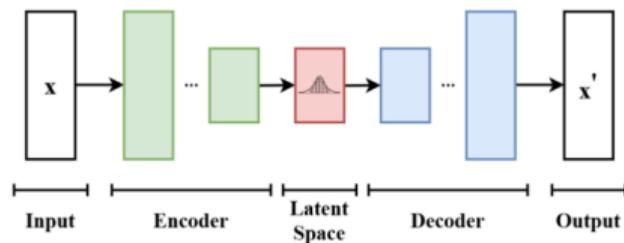


Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

Variational Auto Encoders

- Consists of an Encoder and a Decoder
- Encoder compresses input into a low dimensional space

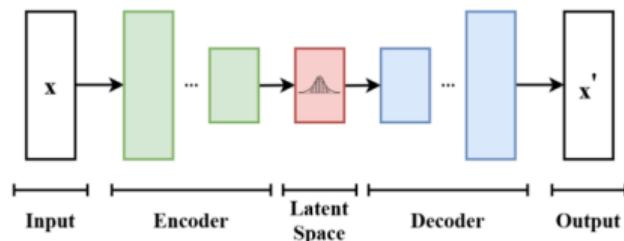


Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

Variational Auto Encoders

- Consists of an Encoder and a Decoder
- Encoder compresses input into a low dimensional space
- Decoder reconstructs the low dimensional input into the original space

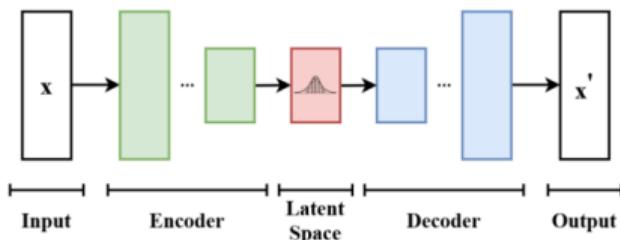


Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

Variational Auto Encoders

- Consists of an Encoder and a Decoder
- Encoder compresses input into a low dimensional space
- Decoder reconstructs the low dimensional input into the original space
- Regular auto encoders minimize the reconstruction error

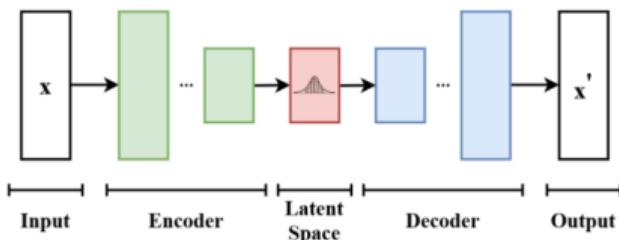
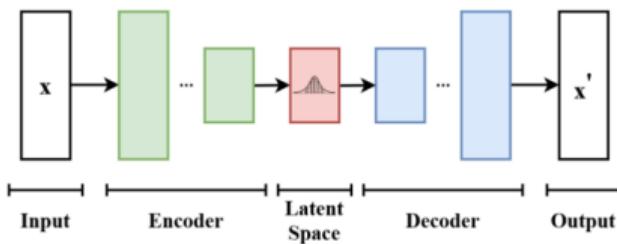


Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

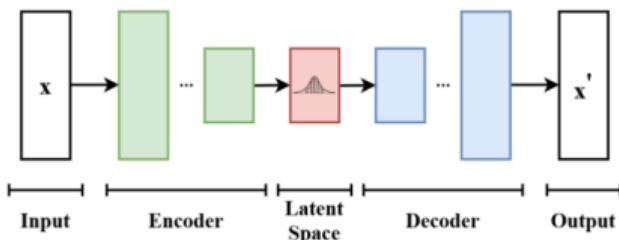
Variational Auto Encoders



- Consists of an Encoder and a Decoder
- Encoder compresses input into a low dimensional space
- Decoder reconstructs the low dimensional input into the original space
- Regular auto encoders minimize the reconstruction error
- VAE uses regularization during training, to avoid overfitting

Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

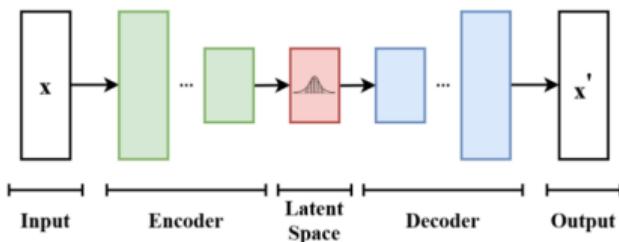
Variational Auto Encoders



- Consists of an Encoder and a Decoder
- Encoder compresses input into a low dimensional space
- Decoder reconstructs the low dimensional input into the original space
- Regular auto encoders minimize the reconstruction error
- VAE uses regularization during training, to avoid overfitting
- Encodes input as a distribution over latent space

Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

Variational Auto Encoders



- Consists of an Encoder and a Decoder
- Encoder compresses input into a low dimensional space
- Decoder reconstructs the low dimensional input into the original space
- Regular auto encoders minimize the reconstruction error
- VAE uses regularization during training, to avoid overfitting
- Encodes input as a distribution over latent space
- Ensures latent space has good properties to enable generative process

Image: https://commons.wikimedia.org/wiki/File:VAE_Basic.png

Variational Auto Encoders



Image: <https://towardsdatascience.com/understanding-variational-autoencoders-vaes-f70510919f73>

Diffusion Models

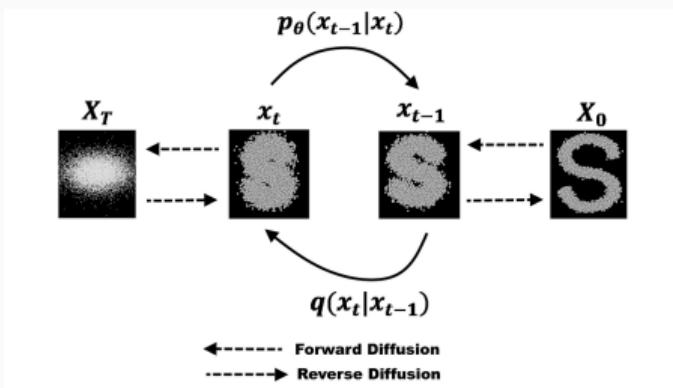


Image: <https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da>

Diffusion Models

- Diffusion models are inspired by concepts of Physics

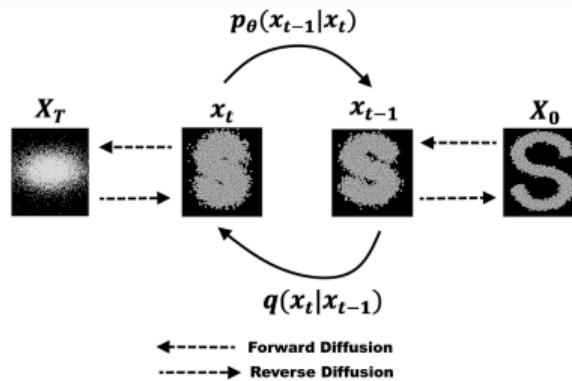
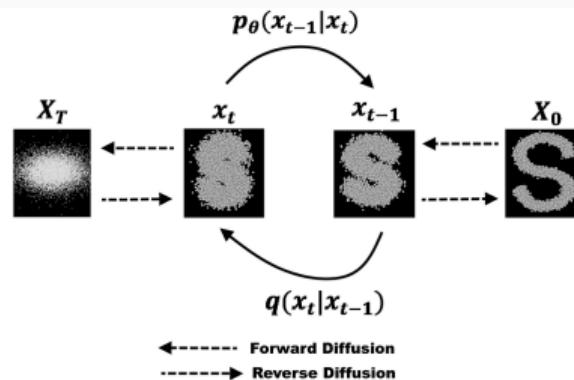


Image: <https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da>

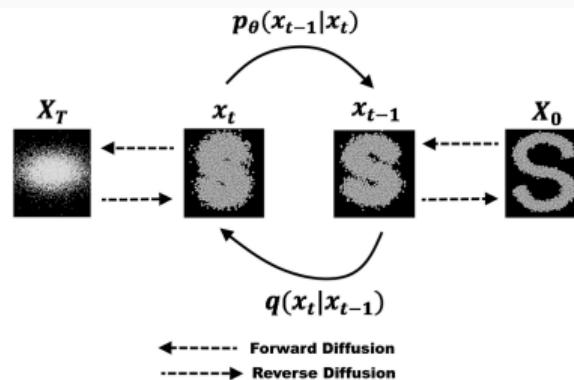
Diffusion Models



- Diffusion models are inspired by concepts of Physics
- Adds Gaussian noise to an image in a series of steps

Image: <https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da>

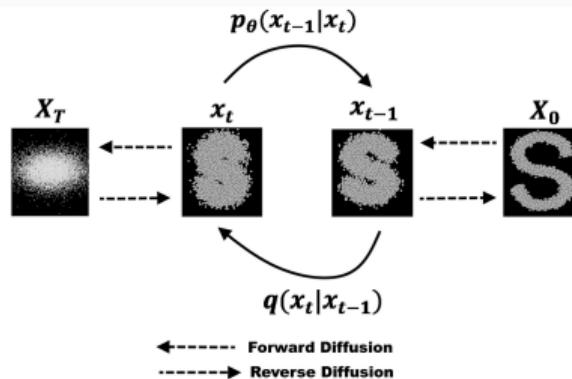
Diffusion Models



- Diffusion models are inspired by concepts of Physics
- Adds Gaussian noise to an image in a series of steps
- A Neural Network is then trained to recover original image by reversing the noising process

Image: <https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da>

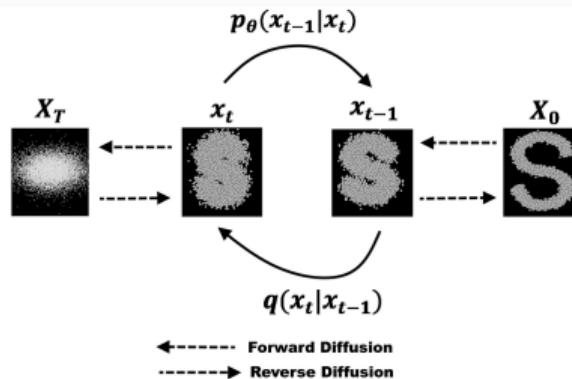
Diffusion Models



- Diffusion models are inspired by concepts of Physics
- Adds Gaussian noise to an image in a series of steps
- A Neural Network is then trained to recover original image by reversing the noising process
- Trained NN can generate new images starting from noise

Image: <https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da>

Diffusion Models



- Diffusion models are inspired by concepts of Physics
- Adds Gaussian noise to an image in a series of steps
- A Neural Network is then trained to recover original image by reversing the noising process
- Trained NN can generate new images starting from noise
- This is sampling process of the generative model

Image: <https://towardsdatascience.com/diffusion-models-made-easy-8414298ce4da>

Generating text output - RNNs

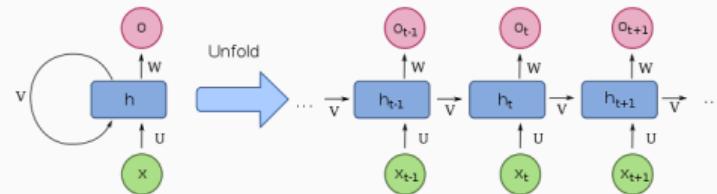


Image: <https://images.app.goo.gl/sA256Vtw2iEPJ8kFA>

Generating text output - RNNs

- Recurrent Neural Networks (RNNs) are one class of DL models

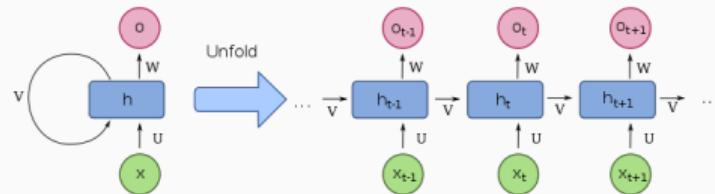


Image: <https://images.app.goo.gl/sA256Vtw2iEPJ8kFA>

Generating text output - RNNs

- Recurrent Neural Networks (RNNs) are one class of DL models
- Can generate a sequence of tokens from a single hidden state

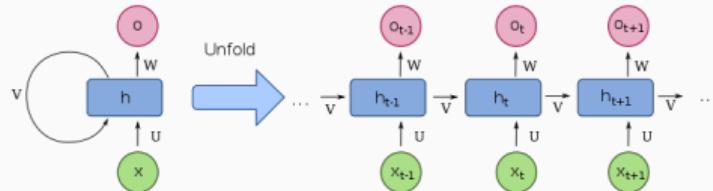
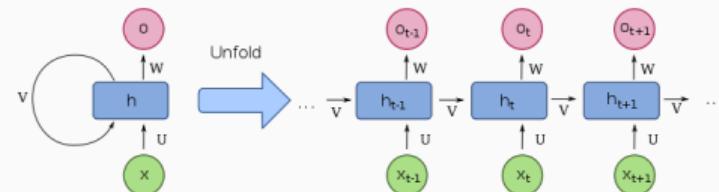


Image: <https://images.app.goo.gl/sA256Vtw2iEPJ8kFA>

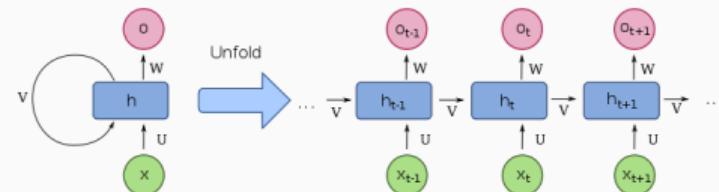
Generating text output - RNNs



- Recurrent Neural Networks (RNNs) are one class of DL models
- Can generate a sequence of tokens from a single hidden state
- Length of sequence can vary based on input state

Image: <https://images.app.goo.gl/sA256Vtw2iEPJ8kFA>

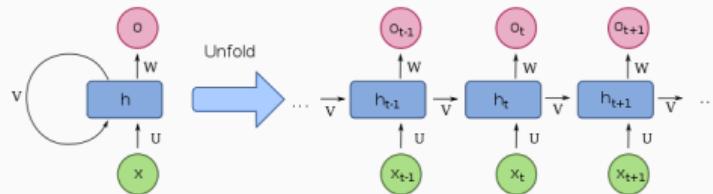
Generating text output - RNNs



- Recurrent Neural Networks (RNNs) are one class of DL models
- Can generate a sequence of tokens from a single hidden state
- Length of sequence can vary based on input state
- Earliest models of Generative AI

Image: <https://images.app.goo.gl/sA256Vtw2iEPJ8kFA>

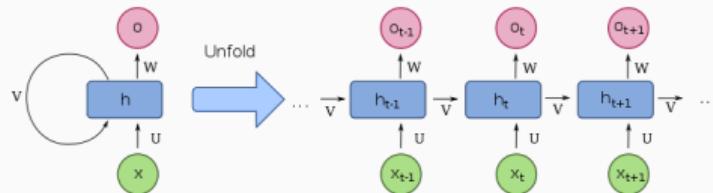
Generating text output - RNNs



- Recurrent Neural Networks (RNNs) are one class of DL models
- Can generate a sequence of tokens from a single hidden state
- Length of sequence can vary based on input state
- Earliest models of Generative AI
- However, required long training times, had poor performance on long sequences

Image: <https://images.app.goo.gl/sA256Vtw2iEPJ8kFA>

Generating text output - RNNs



- Recurrent Neural Networks (RNNs) are one class of DL models
- Can generate a sequence of tokens from a single hidden state
- Length of sequence can vary based on input state
- Earliest models of Generative AI
- However, required long training times, had poor performance on long sequences
- LSTMs, GRUs etc. followed.

Image: <https://images.app.goo.gl/sA256Vtw2iEPJ8kFA>

Generating text output - Transformers

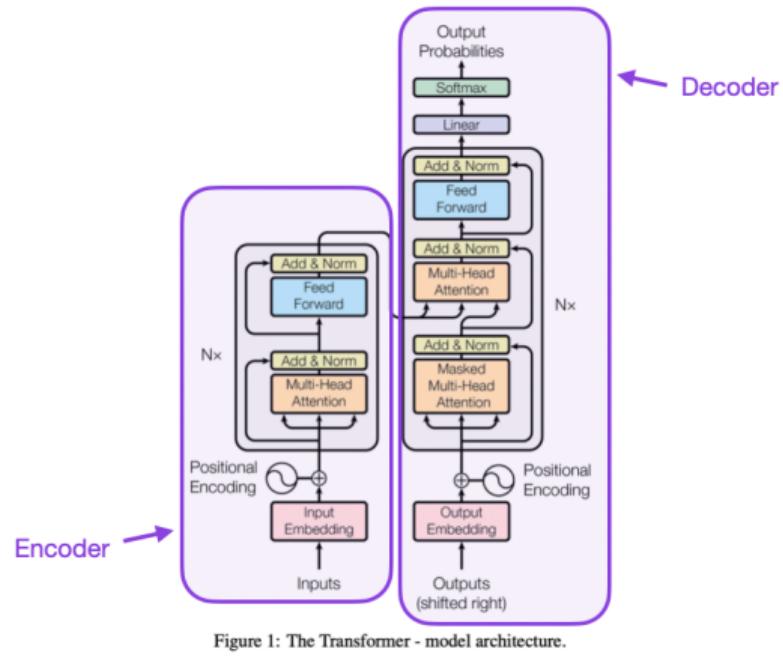
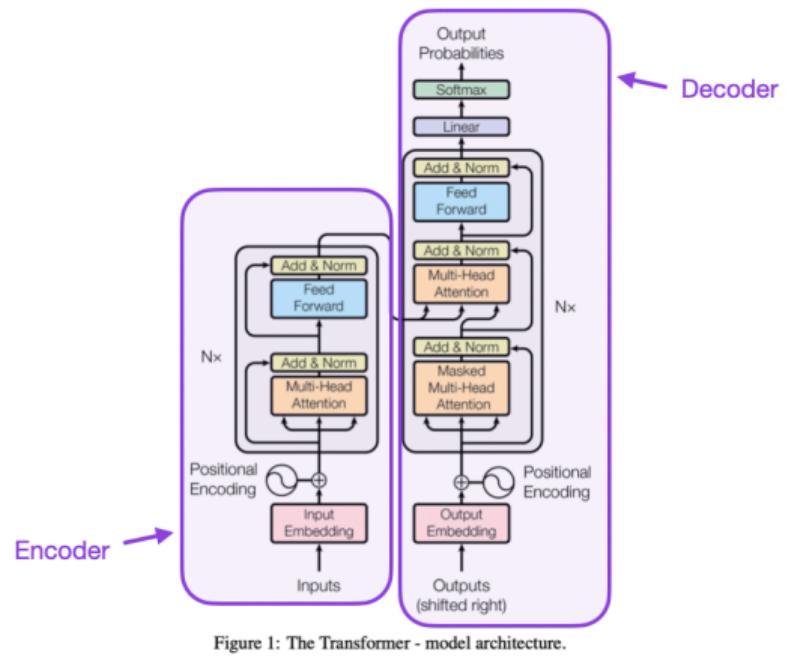


Figure 1: The Transformer - model architecture.

Image: <https://jinglescode.github.io/2020/05/27/illustrated-guide-transformer/>

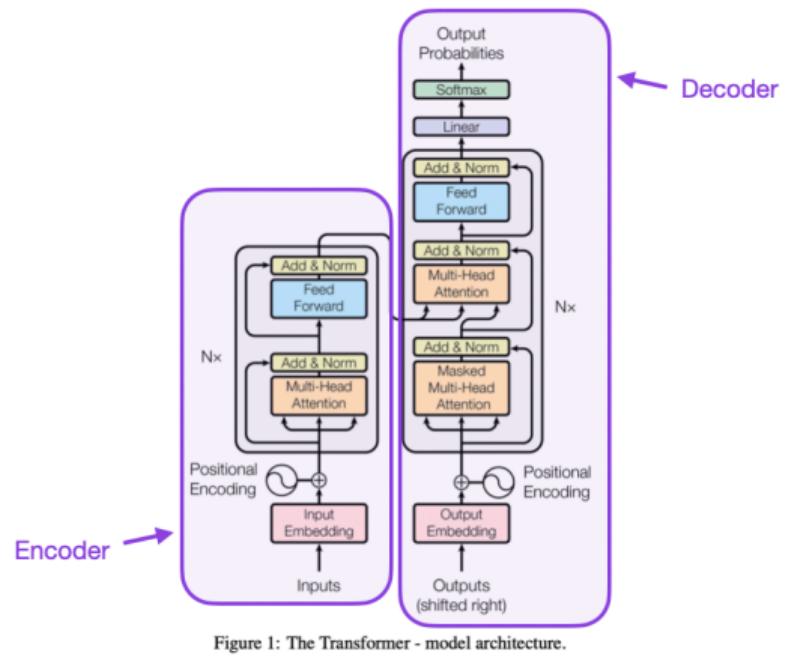
Generating text output - Transformers



- Transformers are a newer variant

Image: <https://jinglescode.github.io/2020/05/27/illustrated-guide-transformer/>

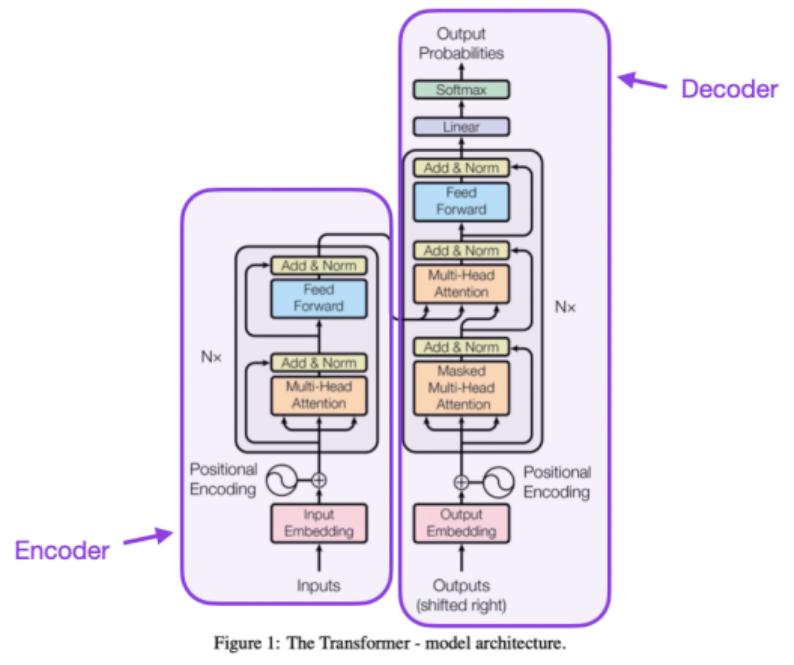
Generating text output - Transformers



- Transformers are a newer variant
- Perform parallel computations instead of sequential computations

Image: <https://jinglescode.github.io/2020/05/27/illustrated-guide-transformer/>

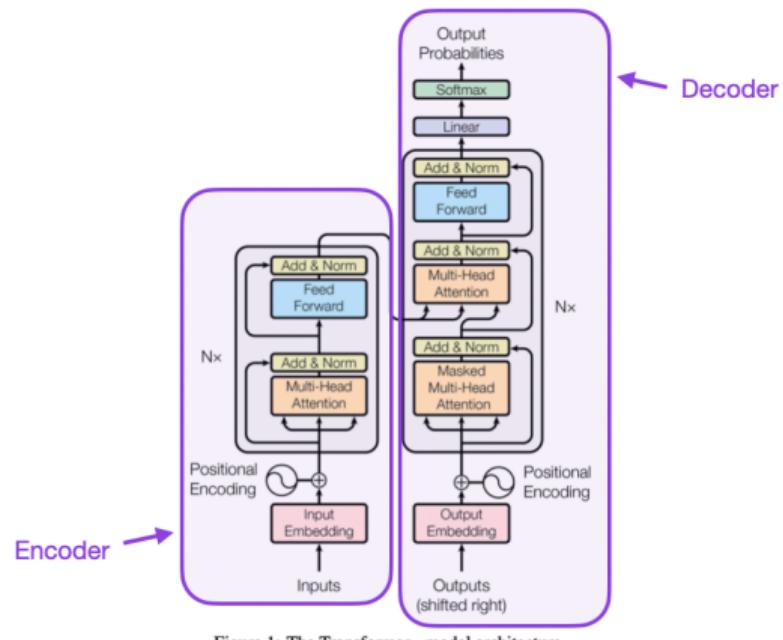
Generating text output - Transformers



- Transformers are a newer variant
- Perform parallel computations instead of sequential computations
- Faster training and good performance over long sequences

Image: <https://jinglescode.github.io/2020/05/27/illustrated-guide-transformer/>

Generating text output - Transformers



- Transformers are a newer variant
- Perform parallel computations instead of sequential computations
- Faster training and good performance over long sequences
- Maximum token size for responses is fixed during training

Image: <https://jinglescode.github.io/2020/05/27/illustrated-guide-transformer/>

Generating text output - Transformers

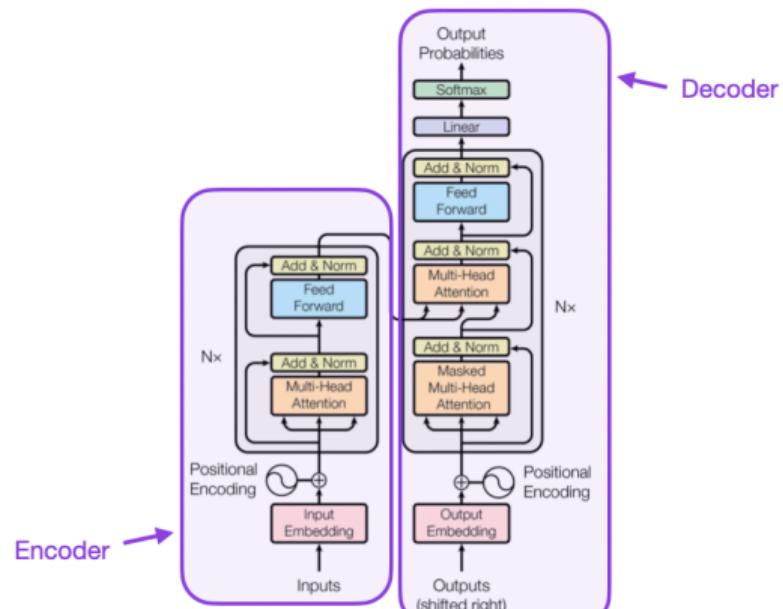


Figure 1: The Transformer - model architecture.

- Transformers are a newer variant
- Perform parallel computations instead of sequential computations
- Faster training and good performance over long sequences
- Maximum token size for responses is fixed during training
- Backbone of all Large Language Models that we see today

Image: <https://jinglescode.github.io/2020/05/27/illustrated-guide-transformer/>

RNN vs. Transformers

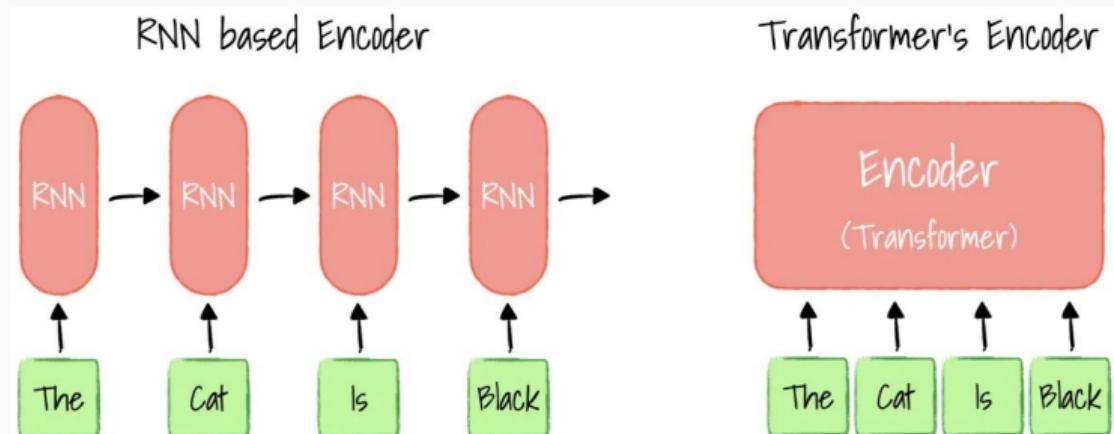


Image: <https://jinglescode.github.io/2020/05/27/illustrated-guide-transformer/>

Vision Transformers

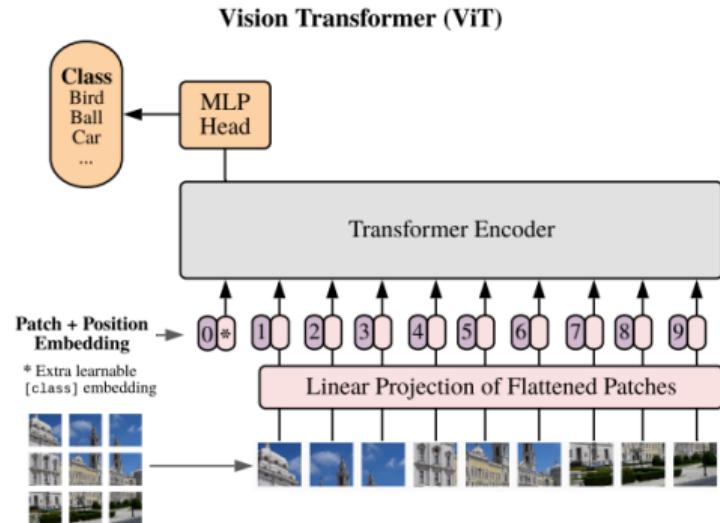
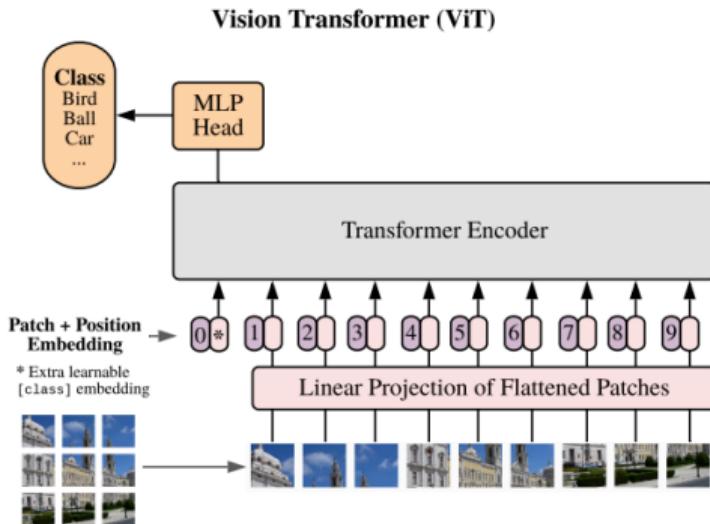


Image: <https://images.app.goo.gl/W5fJQaspiuE4aYcp9>

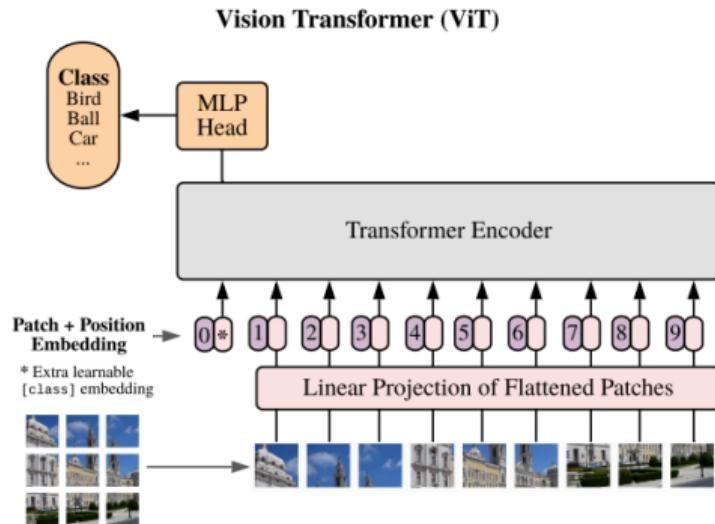
Vision Transformers



- Vision Transformers are used for image captioning and labeling

Image: <https://images.app.goo.gl/W5fJQasp1uE4aYcp9>

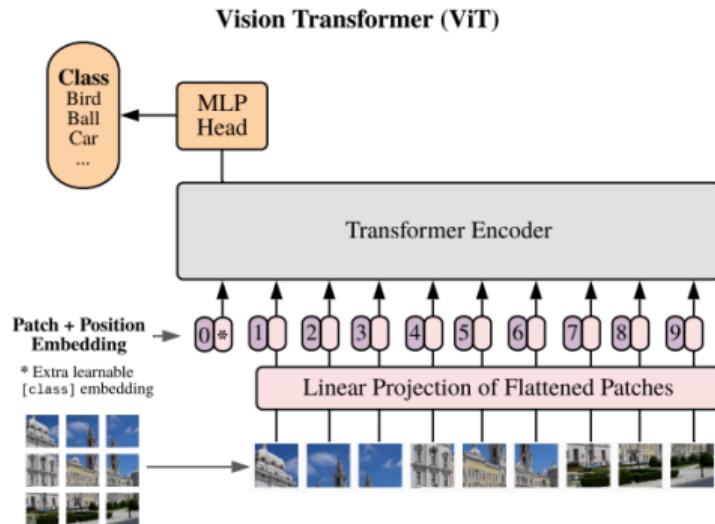
Vision Transformers



- Vision Transformers are used for image captioning and labeling
- Image broken into patches and fed to Transformers with positional embeddings

Image: <https://images.app.goo.gl/W5fJQasp1uE4aYcp9>

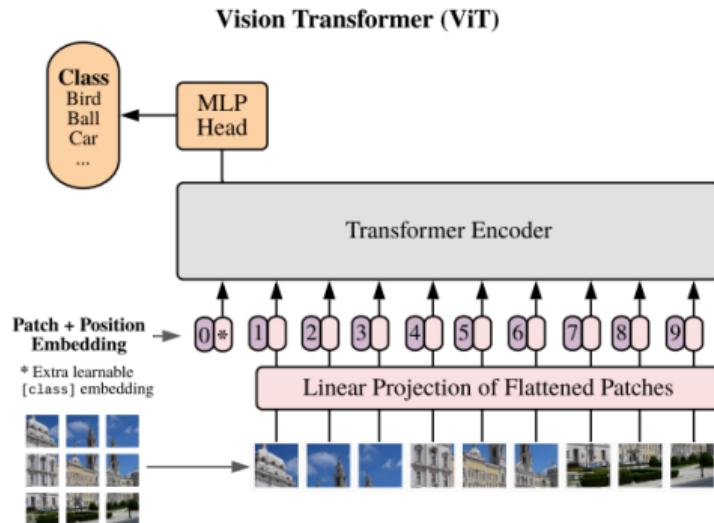
Vision Transformers



- Vision Transformers are used for image captioning and labeling
- Image broken into patches and fed to Transformers with positional embeddings
- Target is the image caption

Image: <https://images.app.goo.gl/W5fJQasp1uE4aYcp9>

Vision Transformers



- Vision Transformers are used for image captioning and labeling
- Image broken into patches and fed to Transformers with positional embeddings
- Target is the image caption
- Shown to be faster than regular CNNs

Image: <https://images.app.goo.gl/W5fJQasp1uE4aYcp9>

Generating image output - Stable Diffusion

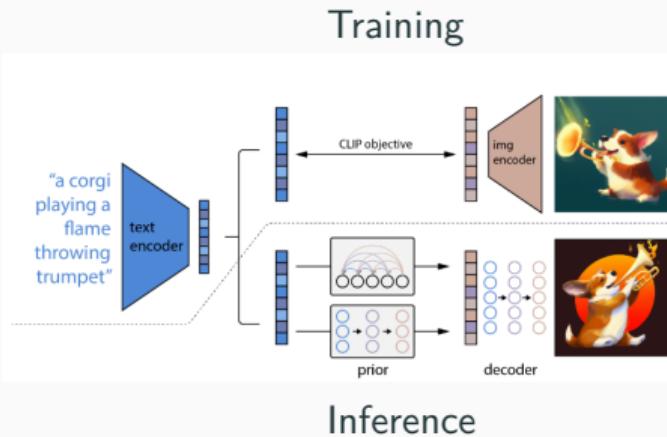


Image: <https://arxiv.org/abs/2204.06125>

Generating image output - Stable Diffusion

- Trained on large image + caption database

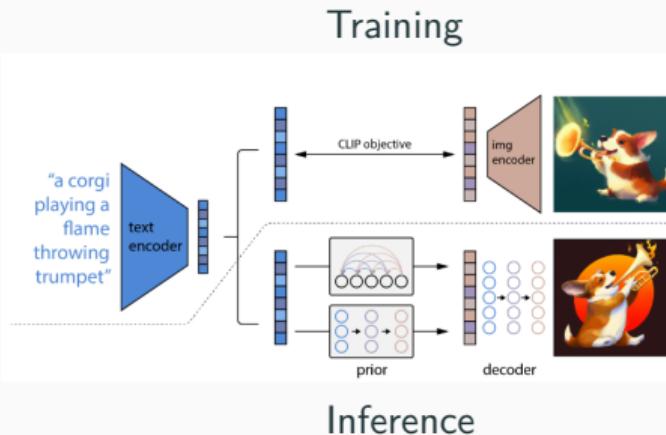


Image: <https://arxiv.org/abs/2204.06125>

Generating image output - Stable Diffusion

- Trained on large image + caption database
- Generates embeddings for images and captions separately

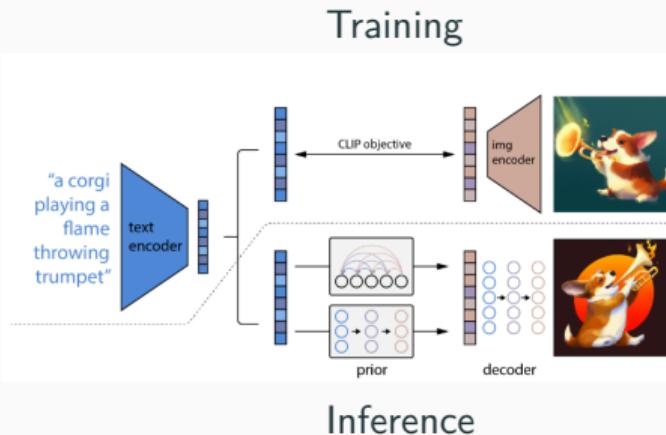
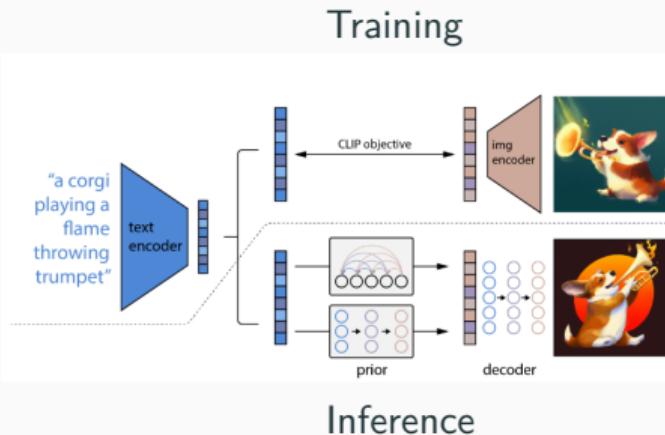


Image: <https://arxiv.org/abs/2204.06125>

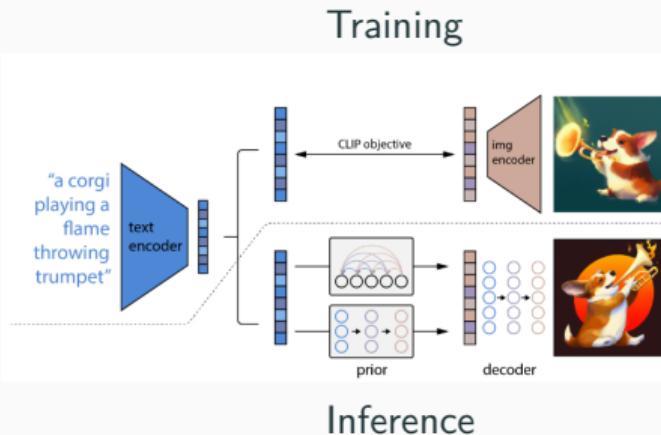
Generating image output - Stable Diffusion



- Trained on large image + caption database
- Generates embeddings for images and captions separately
- Uses Contrastive Language Image Pre-training (CLIP)

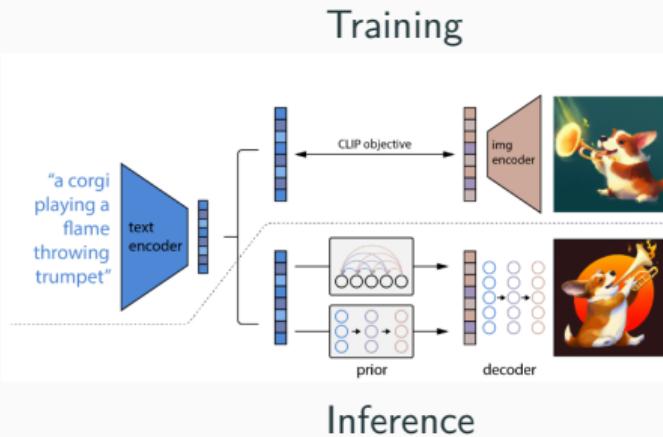
Image: <https://arxiv.org/abs/2204.06125>

Generating image output - Stable Diffusion



- Trained on large image + caption database
- Generates embeddings for images and captions separately
- Uses Contrastive Language Image Pre-training (CLIP)
- To maximize Cosine similarity between correct image & caption pairs

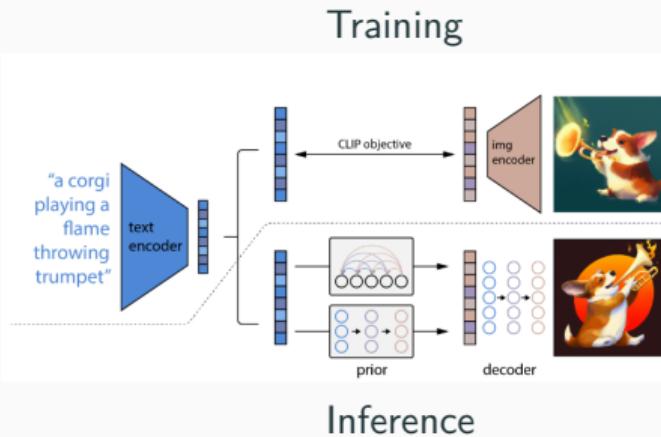
Generating image output - Stable Diffusion



- Trained on large image + caption database
- Generates embeddings for images and captions separately
- Uses Contrastive Language Image Pre-training (CLIP)
 - To maximize Cosine similarity between correct image & caption pairs
 - To minimize Cosine similarity between incorrect pairs

Image: <https://arxiv.org/abs/2204.06125>

Generating image output - Stable Diffusion



- Trained on large image + caption database
- Generates embeddings for images and captions separately
- Uses Contrastive Language Image Pre-training (CLIP)
 - To maximize Cosine similarity between correct image & caption pairs
 - To minimize Cosine similarity between incorrect pairs
- For inferencing, uses Guided Language to Image Diffusion for Generation and Editing (GLIDE)

Image: <https://arxiv.org/abs/2204.06125>

Models for Text & Vision

Large Language Models

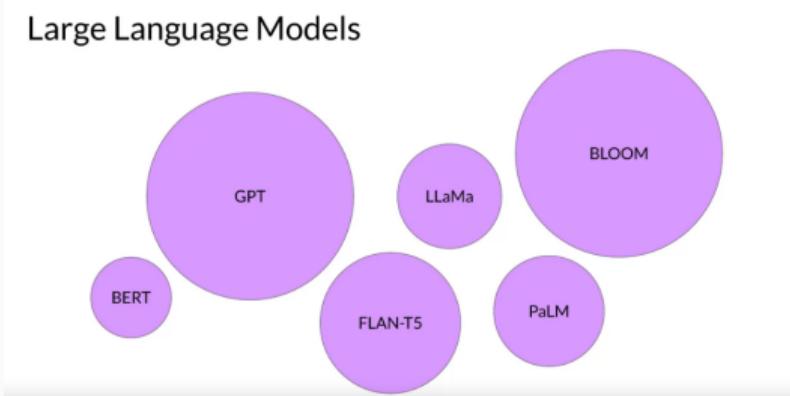


Image: <https://images.app.goo.gl/Em7LWHZFPNEh4tfQ8>

Large Language Models

- Transformer based architecture

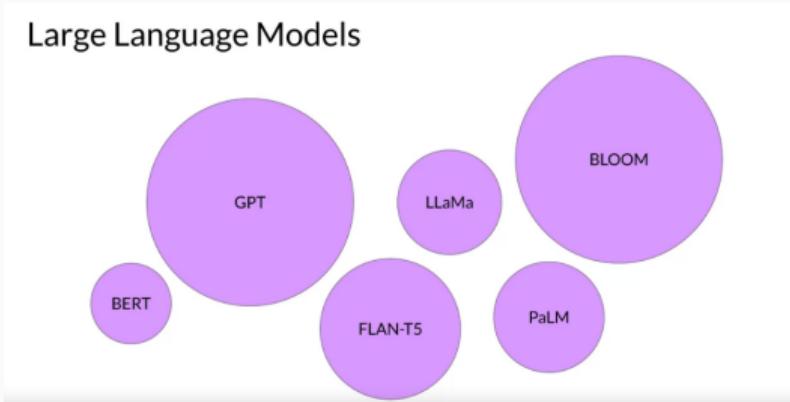
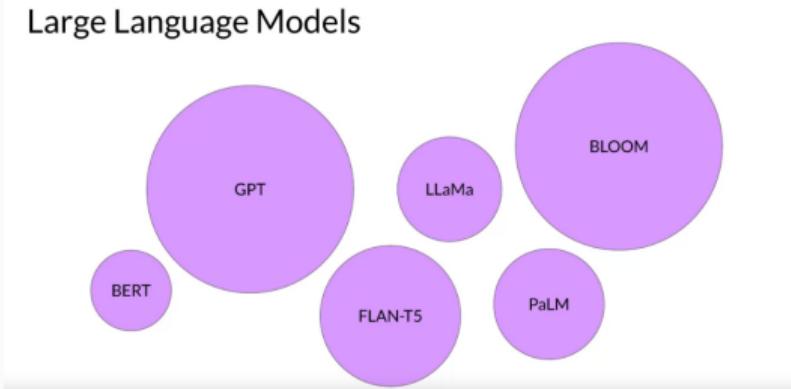


Image: <https://images.app.goo.gl/Em7LWHZFPNEh4tfQ8>

Large Language Models

Large Language Models



- Transformer based architecture
- Nearly achieves general purpose understanding and generation

Image: <https://images.app.goo.gl/Em7LWHZFPNEh4tfQ8>

Large Language Models

Large Language Models



- Transformer based architecture
- Nearly achieves general purpose understanding and generation
- Trained on a huge corpus of text available on internet

Image: <https://images.app.goo.gl/Em7LWHZFPNEh4tfQ8>

Large Language Models

Large Language Models

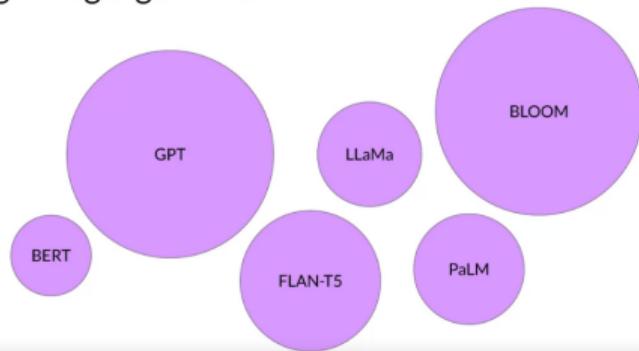


- Transformer based architecture
- Nearly achieves general purpose understanding and generation
- Trained on a huge corpus of text available on internet
- Millions/Billions of parameters, significant compute resources for training

Image: <https://images.app.goo.gl/Em7LWHZFPNEh4tfQ8>

Large Language Models

Large Language Models



- Transformer based architecture
- Nearly achieves general purpose understanding and generation
- Trained on a huge corpus of text available on internet
- Millions/Billions of parameters, significant compute resources for training
- Uses self supervised and semi supervised approaches for training

Image: <https://images.app.goo.gl/Em7LWHZFPNEh4tfQ8>

Text to Image Models - MidJourney



Image: https://www.reddit.com/r/midjourney/comments/11t1avr/midjourney_evolution/

Text to Image Models - Stable Diffusion



Image: <https://huggingface.co/stabilityai/stable-diffusion-xl-base-1.0/blob/main/01.png>

Text to Image Models - Cm3leon



Image: <https://ai.meta.com/blog/generative-ai-text-images-cm3leon/>

Applications

Generative AI applications

Visual

Generative AI applications

Visual

- Image Captioning

Visual

- Image Captioning
- Image Enhancement

Visual

- Image Captioning
- Image Enhancement
- Image Translation

Visual

- Image Captioning
- Image Enhancement
- Image Translation
- Image Generation

Generative AI applications

Visual

Text

- Image Captioning
- Image Enhancement
- Image Translation
- Image Generation

Generative AI applications

Visual

- Image Captioning
- Image Enhancement
- Image Translation
- Image Generation

Text

- Question Answering Bots

Generative AI applications

Visual

- Image Captioning
- Image Enhancement
- Image Translation
- Image Generation

Text

- Question Answering Bots
- Conversational Chatbots

Generative AI applications

Visual

- Image Captioning
- Image Enhancement
- Image Translation
- Image Generation

Text

- Question Answering Bots
- Conversational Chatbots
- Code Generation

Generative AI applications

Visual

- Image Captioning
- Image Enhancement
- Image Translation
- Image Generation

Text

- Question Answering Bots
- Conversational Chatbots
- Code Generation
- Language Translation

Generative AI applications

Visual

- Image Captioning
- Image Enhancement
- Image Translation
- Image Generation

Text

- Question Answering Bots
- Conversational Chatbots
- Code Generation
- Language Translation

Vision Applications



"man in black shirt is playing guitar."



"construction worker in orange safety vest is working on road."

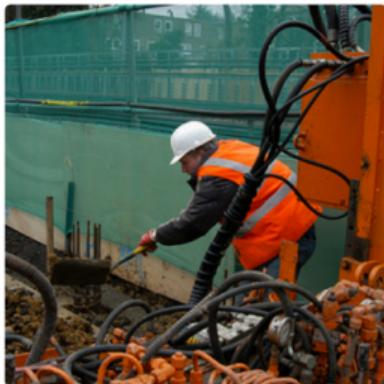
Image Captioning

Image: <https://www.microsoft.com/en-us/research/blog/enhancing-your-photos-through-artificial-intelligence/>

Vision Applications



"man in black shirt is playing guitar."



"construction worker in orange safety vest is working on road."

Image Captioning

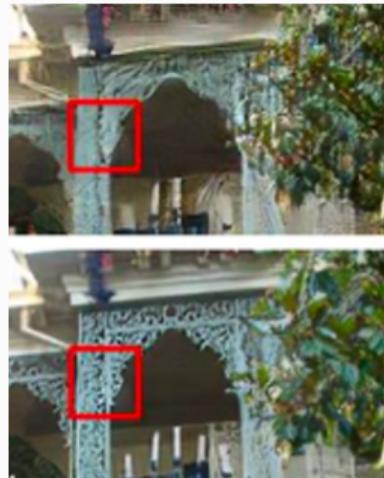


Image Enhancement



Image: <https://www.microsoft.com/en-us/research/blog/enhancing-your-photos-through-artificial-intelligence/>

Vision Applications



horse to zebra

label to image

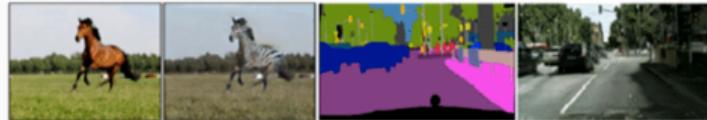


messy to neat

Image Translation

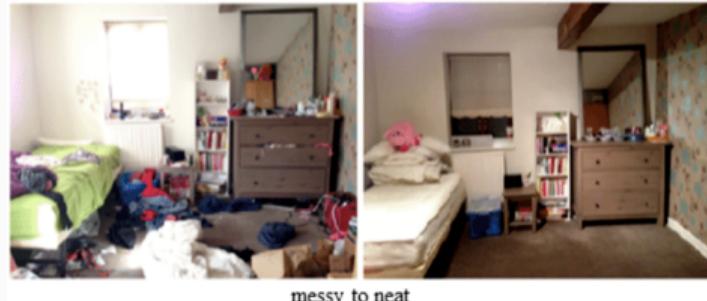
Image: https://www.researchgate.net/figure/Different-cases-of-image-to-image-translation-Top-left-is-the-horse-to-zebra-by_fig1_346682557, <https://creator.nightcafe.studio/creation/z97IWz2kogG9fzGSG7iX>

Vision Applications



horse to zebra

label to image



messy to neat

Image Translation



Image Generation

Image: https://www.researchgate.net/figure/Different-cases-of-image-to-image-translation-Top-left-is-the-horse-to-zebra-by_fig1_346682557, <https://creator.nightcafe.studio/creation/z97IWz2kogG9fzGSG7iX>

Text Applications

Question:

What is the nucleus of a cell and what function does it perform in living organisms?



Cell Biology

Difficulty Easy

76% Confidence

Answer:

A nucleus is the central core of an atom, containing protons and neutrons, which are held together by the strong nuclear force. An array of holes, or pores, in the nuclear membrane allows for the selective passage of certain molecules (such as proteins and nucleic acids) into and out of the nucleus.

[Report Answer](#)

Long Explanation

A nucleus, as related to [genomics](#), is the membrane-enclosed organelle within a [cell](#) that contains the [chromosomes](#). An array of holes, or pores, in the nuclear membrane allows for the selective passage of certain molecules (such as proteins and nucleic acids) into and out of nucleus.

The nucleus is one of the most obvious parts of the cell when you look at a picture of the cell. It's in the middle of the cell, and the nucleus contains all of the cell's chromosomes, which encode the genetic material. So this is really an important part of the cell to protect. The nucleus has a membrane around it that keeps all the chromosomes inside and makes the distinction between the chromosomes being inside the nucleus and the other organelles and components of the cell staying outside.

Question Answering

Image: <https://towardsdatascience.com/rag-vs-finetuning-which-is-the-best-tool-to-boost-your-lm-application-94654bieaba7>

Text Applications

Question:

What is the nucleus of a cell and what function does it perform in living organisms?



Cell Biology

Difficulty Easy

70% Confidence

Answer:

A nucleus is the central core of an atom, containing protons and neutrons, which are held together by the strong nuclear force. An array of holes, or pores, in the nuclear membrane allows for the selective passage of certain molecules (such as proteins and nucleic acids) into and out of the nucleus.

[Report Answer](#)

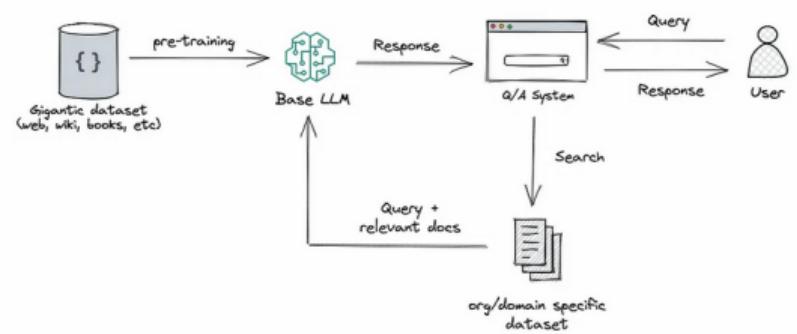
Long Explanation

A nucleus, as related to [genomics](#), is the membrane-enclosed organelle within a [cell](#) that contains the [chromosomes](#). An array of holes, or pores, in the nuclear membrane allows for the selective passage of certain molecules (such as proteins and nucleic acids) into and out of nucleus.

The nucleus is one of the most obvious parts of the cell when you look at a picture of the cell. It's in the middle of the cell, and the nucleus contains all of the cell's chromosomes, which encode the genetic material. So this is really an important part of the cell to protect. The nucleus has a membrane around it that keeps all the chromosomes inside and makes the distinction between the chromosomes being inside the nucleus and the other organelles and components of the cell staying outside.

Question Answering

Image: <https://towardsdatascience.com/rag-vs-finetuning-which-is-the-best-tool-to-boost-your-llm-application-94654bieaba7>



Intelligent Chatbots

Text Applications

K

Generate a Python function that takes a product review and its corresponding sentiment as inputs, and appends these as a new row to a specified CSV file.

B

Sure, I can provide a Python function for that. We will use Python's built-in `csv` library to read and write CSV files. The function will append a new row to the CSV file with the review and its sentiment.

Here's the function:

```
python
Copy code

import csv

def append_review_to_csv(filename, review, sentiment):
    # Open the file in append mode
    with open(filename, 'a', newline='', encoding='utf-8') as csvfile:
        # Create a writer object
        writer = csv.writer(csvfile)
        # Write the review and sentiment as a new row
        writer.writerow([review, sentiment])
```

Code Generation

Image: <https://towardsdatascience.com/rag-vs-finetuning-which-is-the-best-tool-to-boost-your-lm-application-94654bieaba7>

Text Applications

K Generate a Python function that takes a product review and its corresponding sentiment as inputs, and appends these as a new row to a specified CSV file.

 Sure, I can provide a Python function for that. We will use Python's built-in `csv` library to read and write CSV files. The function will append a new row to the CSV file with the review and its sentiment.

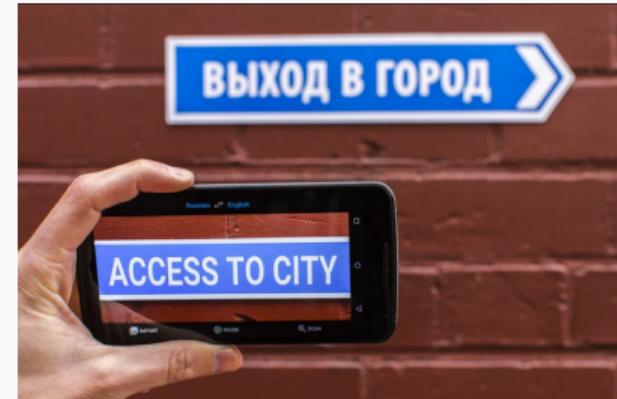
Here's the function:

```
python

import csv

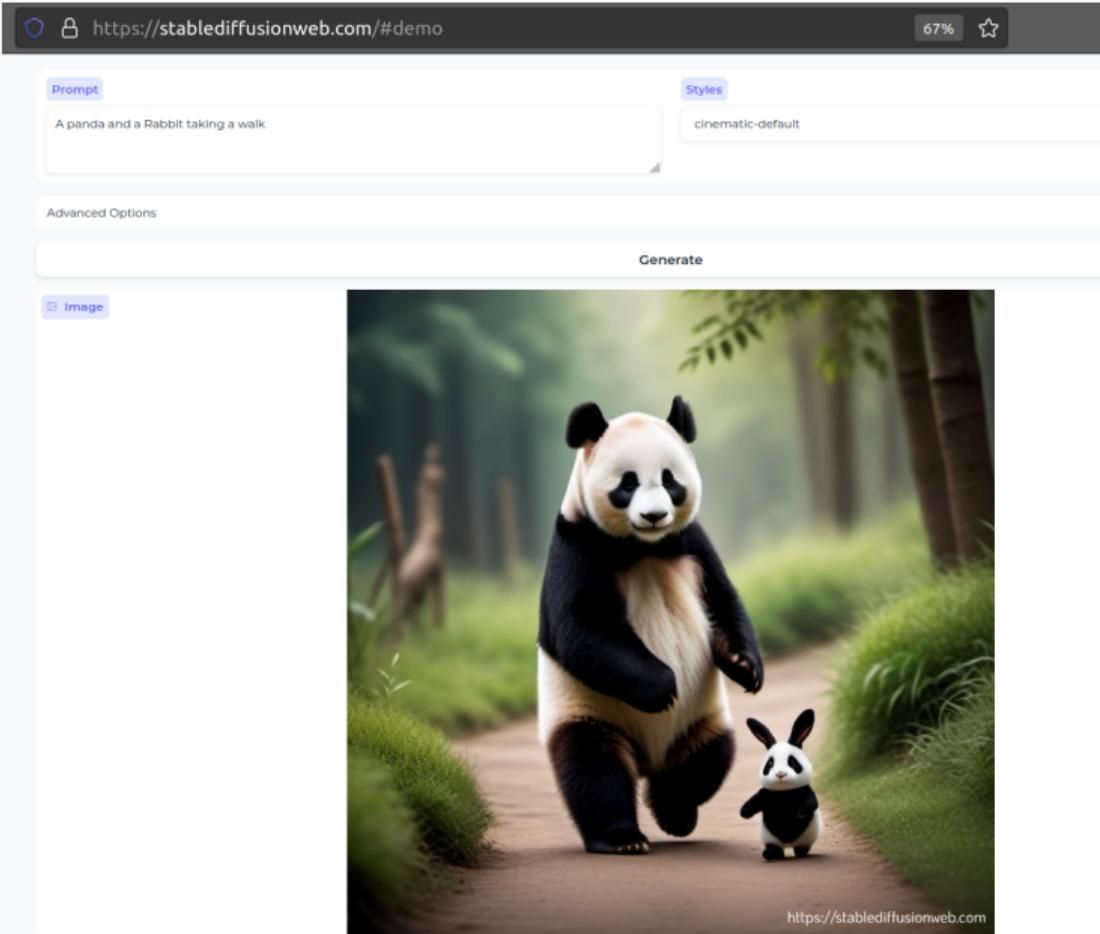
def append_review_to_csv(filename, review, sentiment):
    # Open the file in append mode
    with open(filename, 'a', newline='', encoding='utf-8') as csvfile:
        # Create a writer object
        writer = csv.writer(csvfile)
        # Write the review and sentiment as a new row
        writer.writerow([review, sentiment])
```

Code Generation



Language Translation

Image: <https://towardsdatascience.com/rag-vs-finetuning-which-is-the-best-tool-to-boost-your-llm-application-94654bieaba7>



https://stablediffusionweb.com

Input Prompt



Question: What is on the phone screen? Answer:



Question: What can you see out the window? Answer:



Question: Whom is the person texting? Answer:

Output

A text message from a friend.

A parking lot.

The driver.

GenAI Shortcomings



GenAI Shortcomings



- Accuracy & Hallucinations

GenAI Shortcomings



- Accuracy & Hallucinations
- Bias

GenAI Shortcomings



- Accuracy & Hallucinations
- Bias
- Intellectual Property & Copyright

GenAI Shortcomings



- Accuracy & Hallucinations
- Bias
- Intellectual Property & Copyright
- Lack of transparency

GenAI Shortcomings



- Accuracy & Hallucinations
- Bias
- Intellectual Property & Copyright
- Lack of transparency
- Cybersecurity & Fraud

GenAI Shortcomings



- Accuracy & Hallucinations
- Bias
- Intellectual Property & Copyright
- Lack of transparency
- Cybersecurity & Fraud
- Sustainability

Thank you.