Understanding GANs

Analytics Vidhya

What we will be covering in this module?

- Introduction to Image Generation
- What are Generative Models?
- Understanding Generative Adversarial Networks
- Project on Texture Generation using GANs
  - Simple Implementation
  - Better GAN Architectures
- What's Next?

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Understanding GANs with an example

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Understanding GANs with an example

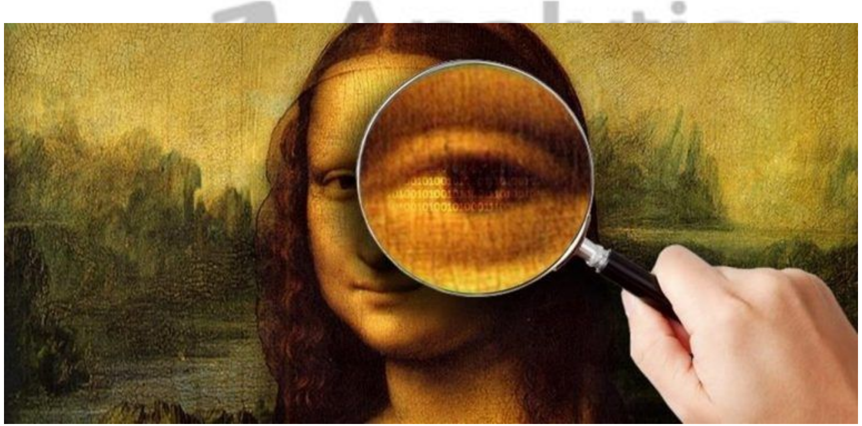
Forger

Create fraudulent imitations of original paintings

Understanding GANs with an example

Art Investigator

Identify the Real and Fake paintings



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How do GANs work?

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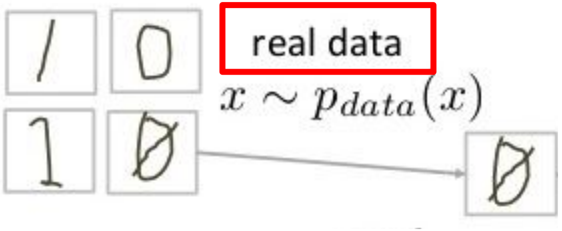

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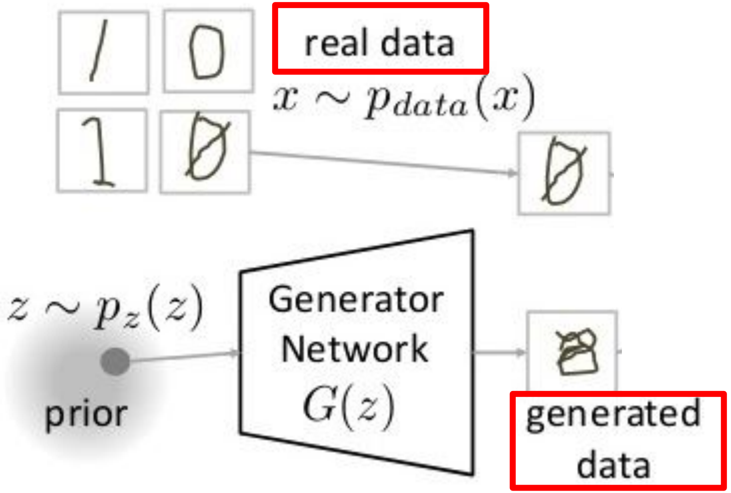

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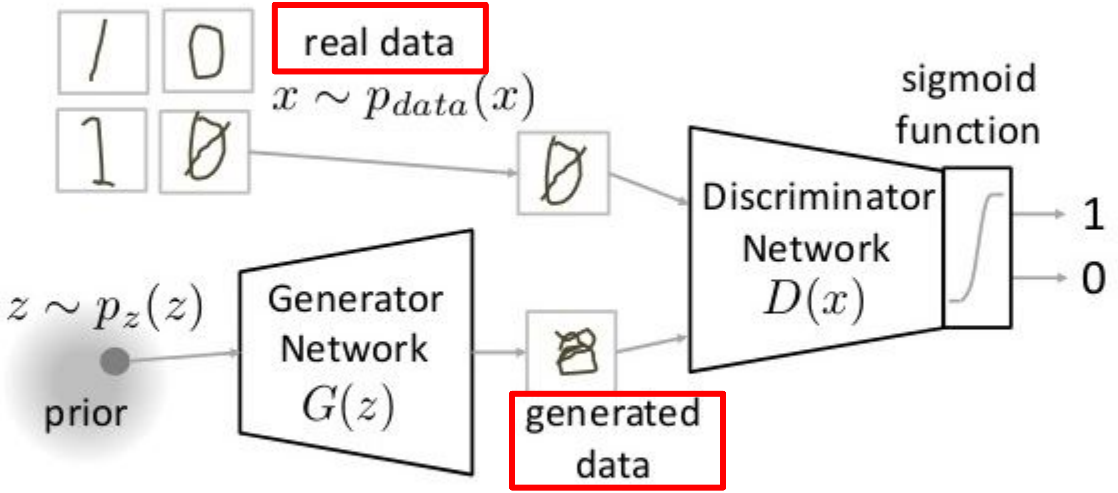

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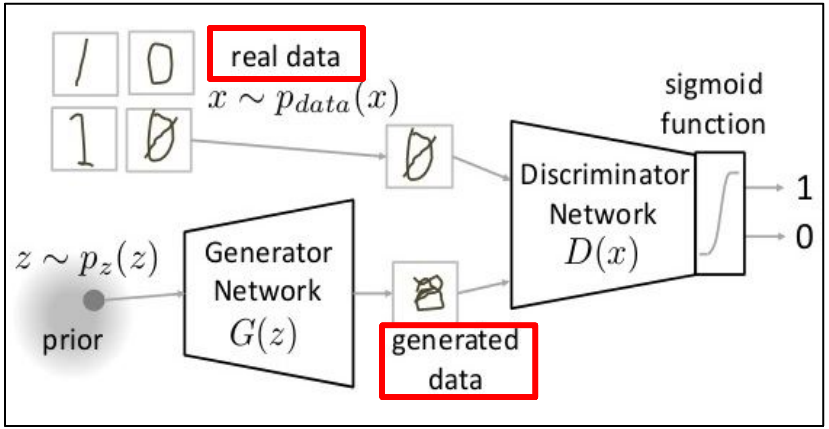
Image Generation is the task of generating completely new realistic images which does not belong to the training dataset, but resembles them

$$\min_G \max_D V(D, G)$$

$$V(D, G) = \mathbb{E}_{x \sim p_{data}(x)}[\log D(x)] + \mathbb{E}_{z \sim p_z(z)}[\log(1 - D(G(z)))]$$



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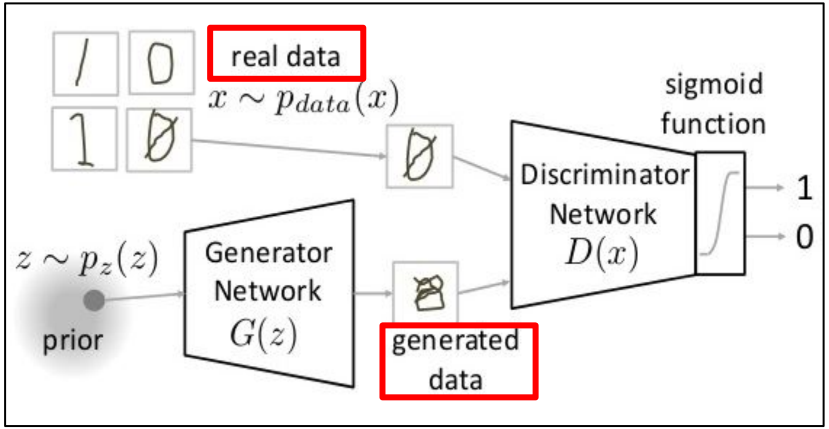

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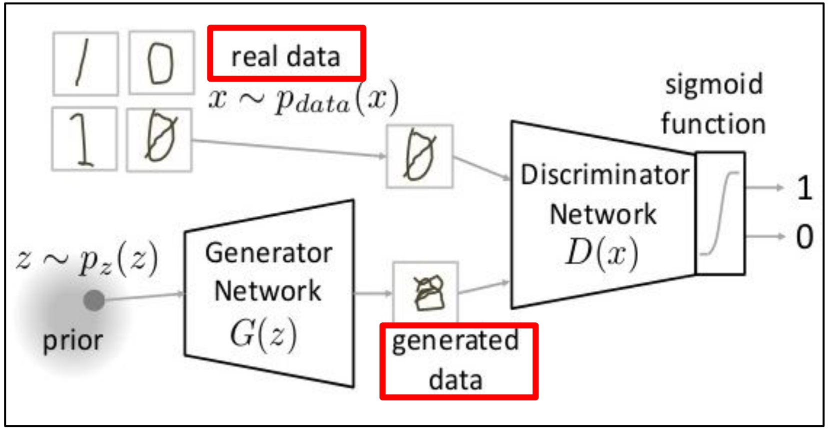

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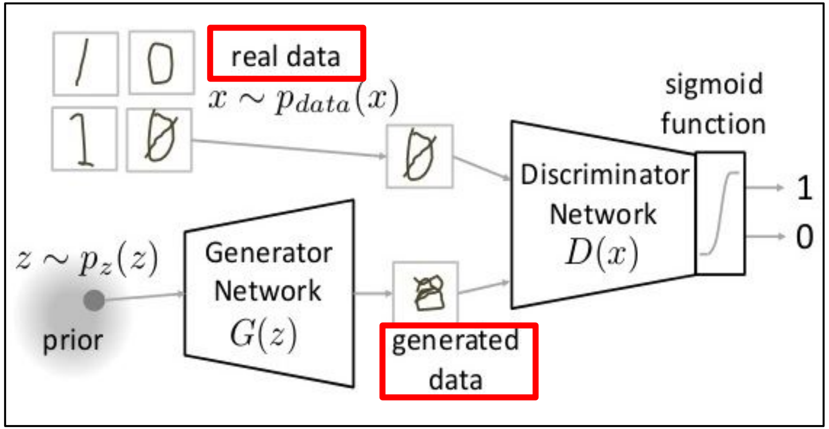
  - pdata(x) -> the distribution of real data
  - x -> sample from pdata(x)



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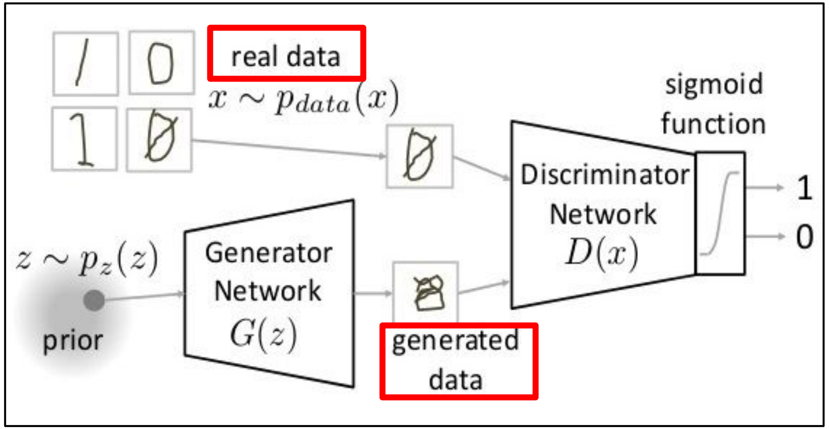

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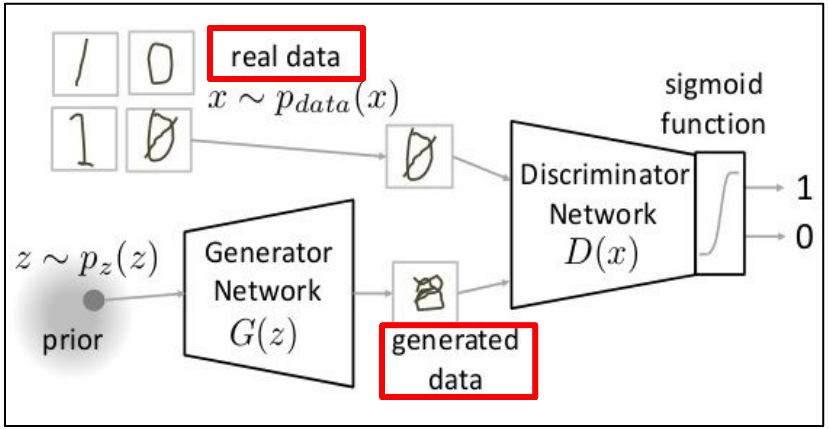
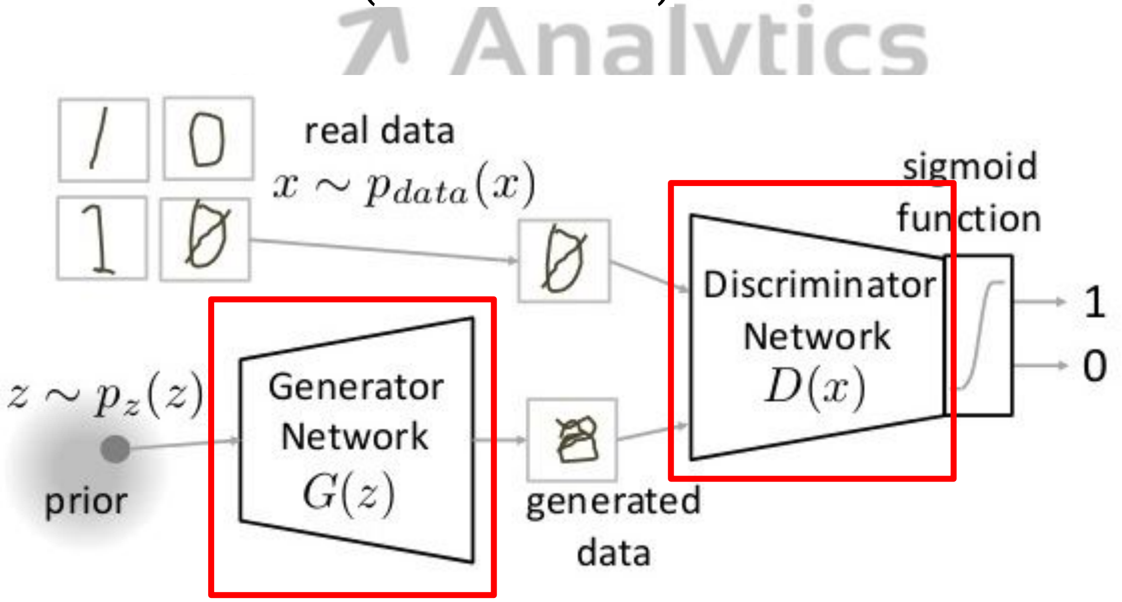
  - G(z) -> Generator Network
  - D(x) -> Discriminator Network



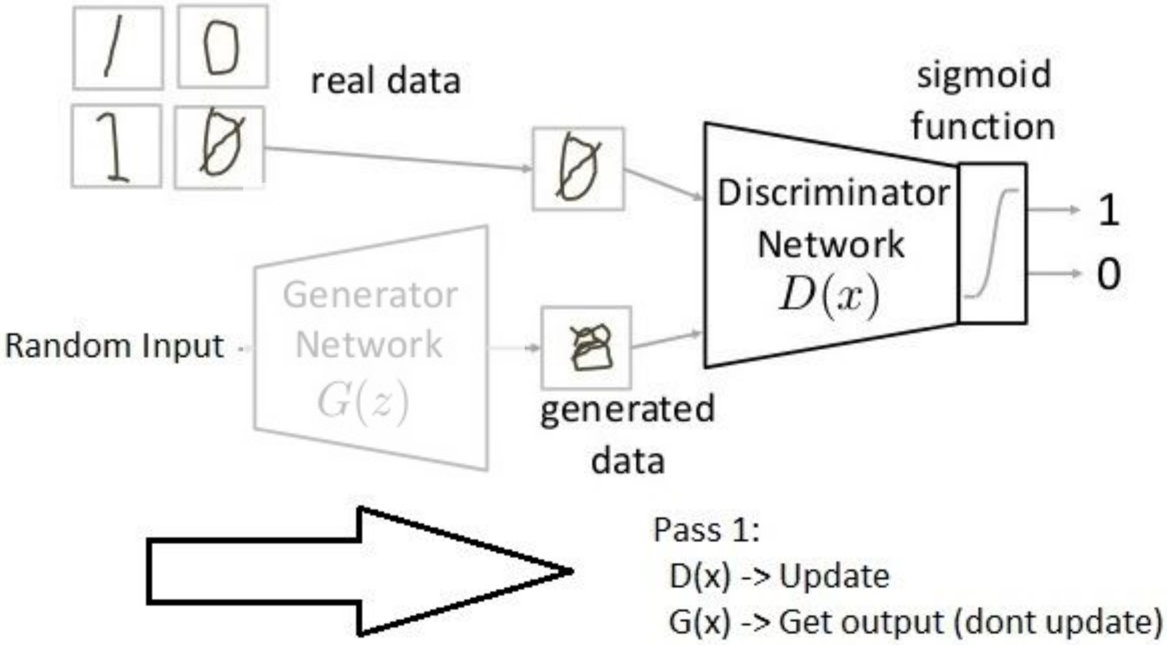
Deep Learning Architecture of simple GANs

- Broadly a GAN architecture has two main subparts
  - Generator Network (MLP network)
  - Discriminator Network (MLP network)



Deep Learning Architecture of GANs

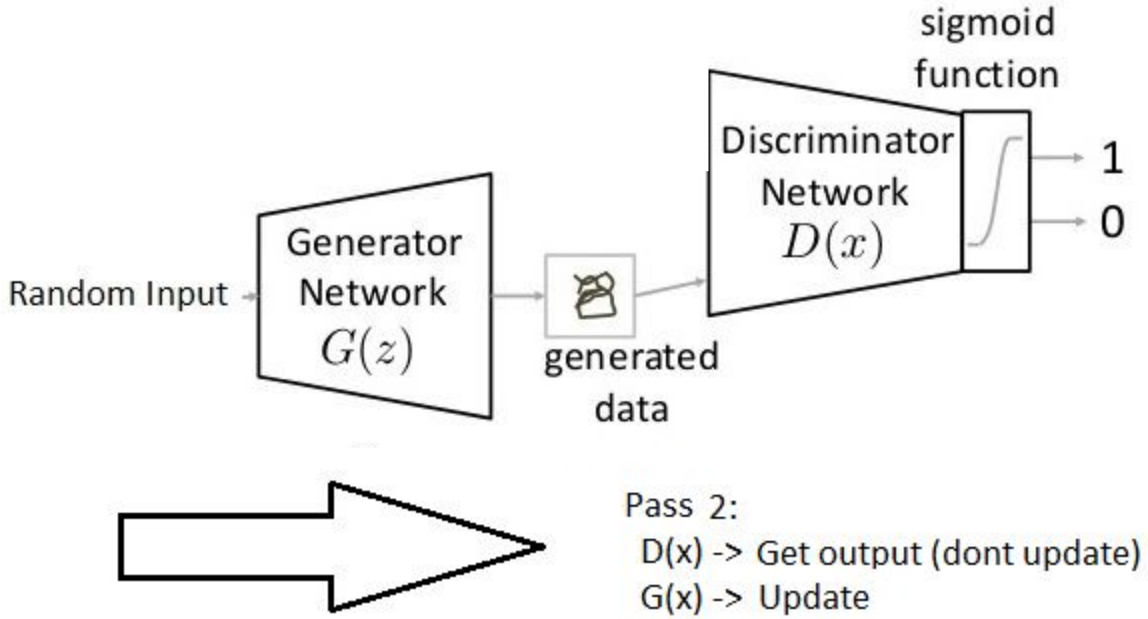
Pass 1: Train discriminator and freeze generator



Pass 1:
D(x) -> Update
G(x) -> Get output (dont update)

Deep Learning Architecture of GANs

Pass 2: Train generator and freeze discriminator



Pass 2:
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G(x) -> Update

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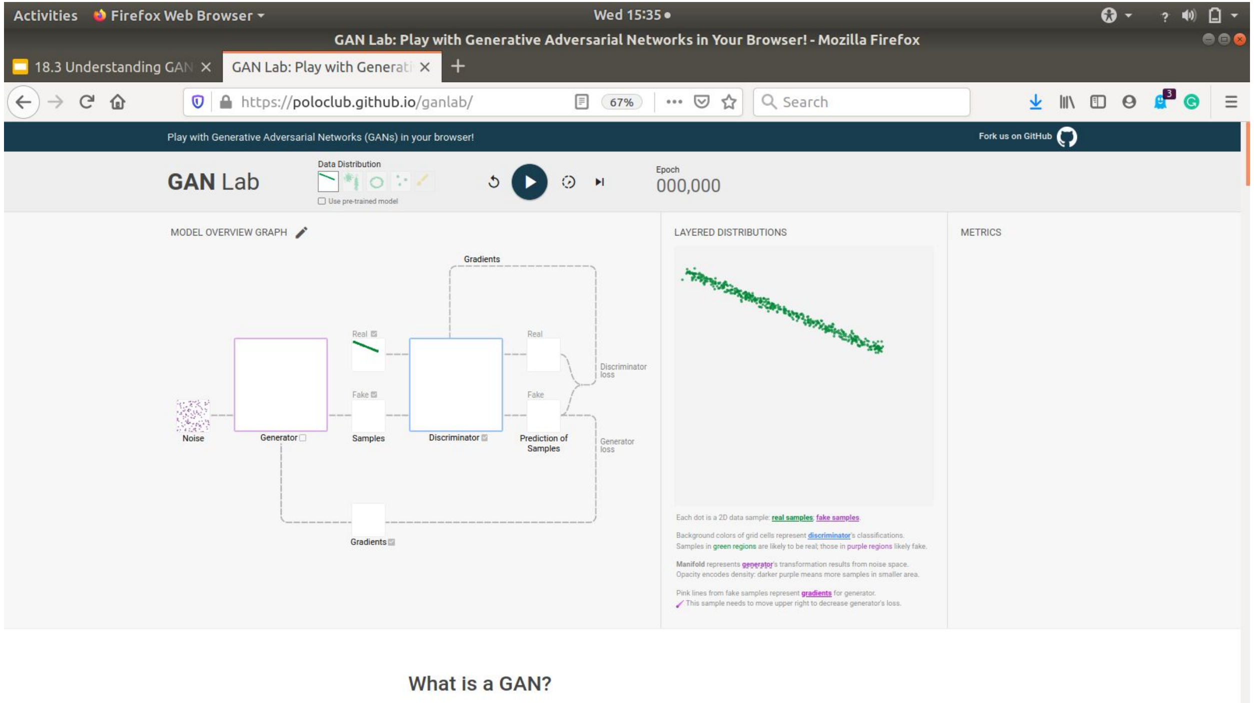
Deep Learning Architecture of GANs



Play with Generative Adversarial Networks (GANs) in your browser!

Each dot is a 2D data sample: real samples; fake samples.

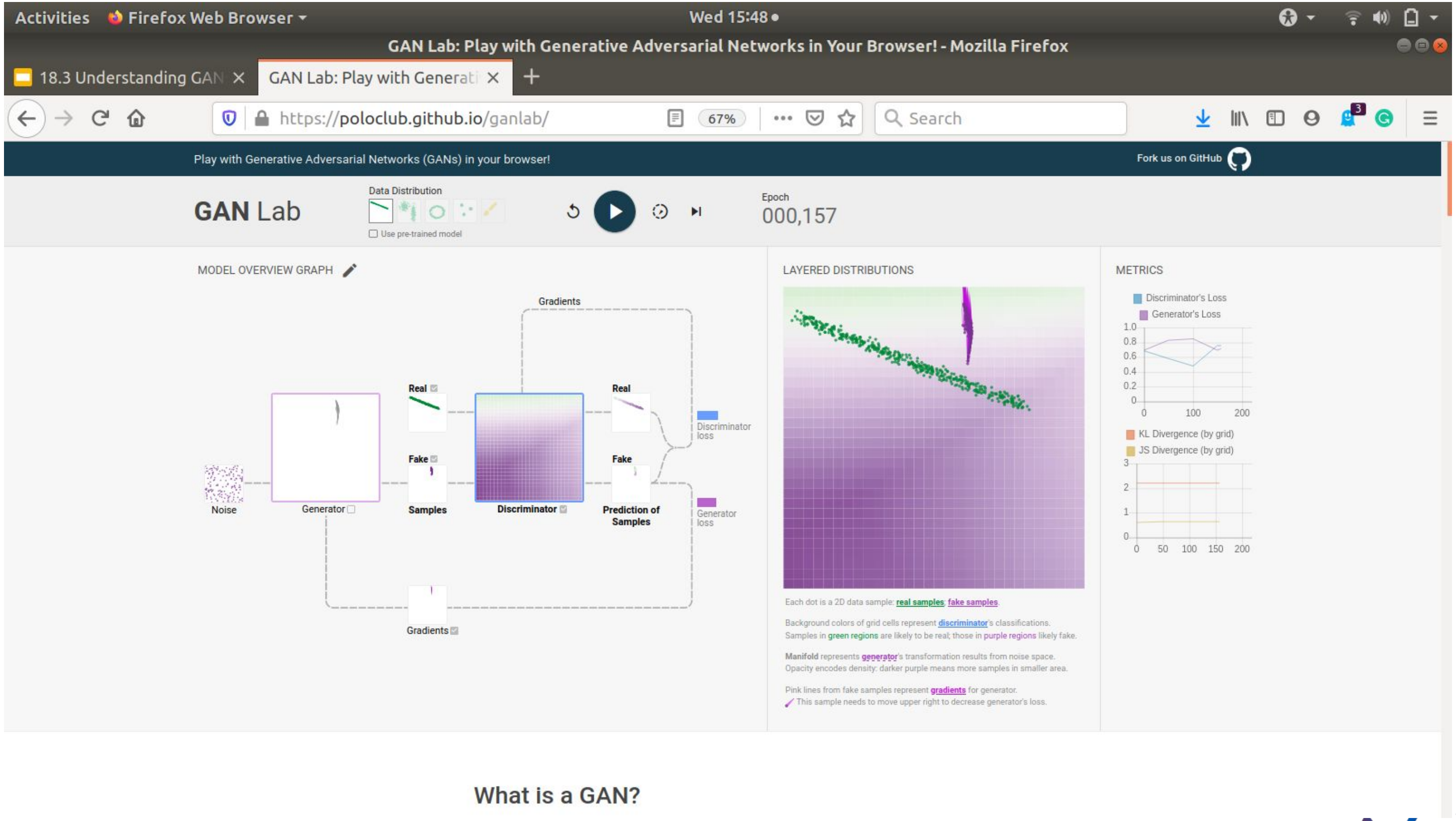
Background colors of grid cells represent discriminator's classifications.
Samples in green regions are likely to be real; those in purple regions likely fake.

Manifold represents generator's transformation results from noise space.
Opacity encodes density: darker purple means more samples in smaller area.

Pink lines from fake samples represent gradients for generator.
This sample needs to move upper right to decrease generator's loss.

What is a GAN?

Deep Learning Architecture of GANs



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Formal Training Methodology of GANs

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- **Step 1:** Define architecture of Discriminator

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- **Step 2:** Define architecture of Generator

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Formal Training Methodology of GANs

- **Step 1:** Define architecture of Discriminator
- **Step 2:** Define architecture of Generator
- **Step 3:** Train Discriminator

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Formal Training Methodology of GANs

- **Step 1:** Define architecture of Discriminator
- **Step 2:** Define architecture of Generator
- **Step 3:** Train Discriminator
    - **Step 3.1:** Take samples from real data

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Formal Training Methodology of GANs

- **Step 1:** Define architecture of Discriminator
- **Step 2:** Define architecture of Generator
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    - **Step 3.2:** Generate fake data from Generator

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    - **Step 3.3:** Update the parameters of Discriminator on the combined batch

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- **Step 1:** Define architecture of Discriminator
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- **Step 3:** Train Discriminator (for one or more iterations)
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- **Step 4:** Train generator

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- **Step 1:** Define architecture of Discriminator
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- **Step 3:** Train Discriminator (for one or more iterations)
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  - **Step 3.3:** Update the parameters of Discriminator on the combined batch
- **Step 4:** Train generator
  - **Step 4.1:** Generate fake data from Generator
  - **Step 4.2:** Update the parameters of Generator on how well the Discriminator is fooled
- **Step 5:** (Optional) Check if the fake data visually if it seems legit. If yes, stop training, else go to Step 3

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Thank you

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