**生成式對抗網路 (Generative Adversarial Network, GAN) (2004)**

Generative model

- input a vector from simple distribution (distribution we know the formula, e.g. Gaussian distribution

- output a distribution (for task that require “creativity”)

- police vs fake money

**Step 1: fix generator, train discriminator**

Discriminator: identify the real from the fake

Discriminator: output a score (real give high score, fake give low score

タイムライン

自動的に生成された説明

The objective of Generator is to to look for a value which the divergence: distribution between P true data and P sample sample (from generator) need to be small. 🡪 but it is difficult to find divergence 🡪 but actually it is relating to the discriminator’s objective: Discriminator: binary classifier 🡪 minimize cross entropy. (Maximize its ability to identify the real from fake)

🡪 if divergence is small 🡪 discriminator hard to discriminate 🡪 discriminator’s objective function hard to maximize.

**Step 2: fix discriminator, train generator**

- Aim: Make the discriminator to output a higher score (gradient ascent) by making more authentic pictures

(Generator learns to fool the discriminator, why fix discriminator? Because otherwise will be like a game that being hacked)

Generator update parameter to output picture that can obtain a higher score with given discriminator

(Loop)

What is the problem of JS divergence?

ダイアグラム

自動的に生成された説明

W-GAN

W-distance to measure the divergence between P-data and P-generator 🡪 so that we can update the loss.

グラフ, ヒストグラム

自動的に生成された説明

**Q: How to evaluate your generator’s performance**

Ans: for image generative model, put it into a image classifier model, if the output is concentrated, that mean the image classifier model is very confident of its classification of your generator’s output.

ダイアグラム, テキスト

中程度の精度で自動的に生成された説明

**Problem 1: Mode Collapse**

- a blind point of discriminator 🡪 generator learn to fool it by just keeping generating the same kind of pic.

グラフィカル ユーザー インターフェイス, アプリケーション

自動的に生成された説明

**Problem 2: Mode Dropping**

- diversity is much wider in reality

アプリケーション が含まれている画像

自動的に生成された説明

Solution: Put it into an image classifier

ダイアグラム

中程度の精度で自動的に生成された説明

Sound contradictory but actually not, because quality is talking about one image, while diversity is talking about a group of images (if the average output of the prediction of the class is uniformly average) vs Quality (the prediction is very concentrated on one class

**3. Conditional GAN**

- input a condition as well. e.g., red color hair, black eye

For discriminator, there is **paired label** to train it (

- Application: black and white pic 🡪 color pic (GAN + supervised)

- Application 2: Sound to image 🡪 let the generator to imagine what is happening by inputting a sound

- Application 3: pic can move

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自動的に生成された説明

テキスト

中程度の精度で自動的に生成された説明

Discriminators need to see the input and output of the generator when giving the score.

First, is x good or not.

Second, how is the condition match x

(Negative example also required to train discriminator!

**4. GAN + Unsupervised Learning (Cycle GAN**

- Application example: **Image style Transfer**: 3D people 🡪 Anime people (very expensive to produce the label

Problem of the GAN

Problem: the generator G(x🡪y) may ignore the input

Solution: train another generator G(y🡪x) as well that have to reconstruct back the image back to its original one, (the vector distance as close as possible = minimize reconstruction error). Therefore, this Cycle-GAN can force the picture that produce during the y-domain have some sort of relationship with the original input picture.

A screenshot of a computer screen

Description automatically generated

タイムライン

低い精度で自動的に生成された説明