ADL x MLDS 2017 Fall
HW4 - Generative Adversarial Networks

adlxmlds@gmail.com

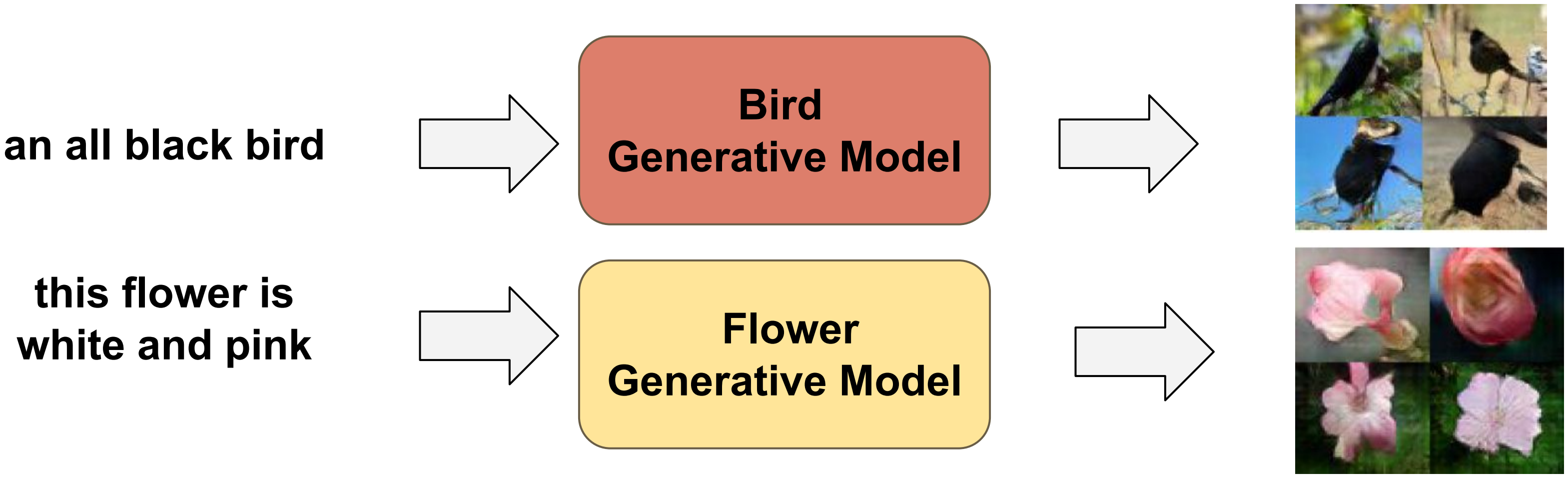
Updates

1. (12/11 17:43): p24, Toolkit version and script usage.
2. (12/14 15:39): p16, About Batch Normalization or not.
3. (12/14 15:49): p20, Ls and Lc mean “Log-likelihood”.
4. (12/16 14:46): p26, Deadline should be at **12/31/2017(Sun.)**
5. (12/17 18:30): p23, Testing Text Content

Outline

- Task Introduction
    - Text2image generation
    - Dataset collection
- Model
    - Conditional GAN
    - Tips for training
        - Discriminator loss function
        - Objective function
- Submission and grading

Task Introduction - text2image generation



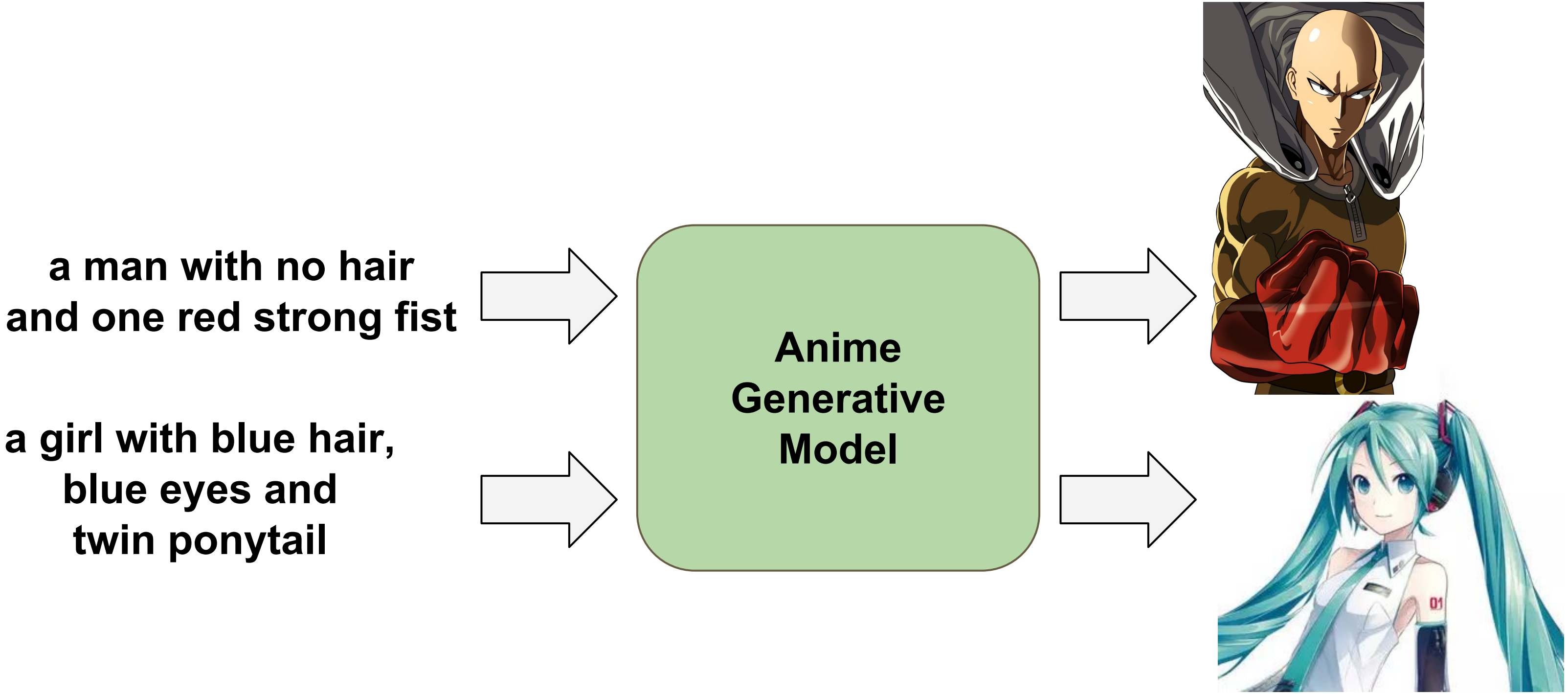
an all black bird

Bird Generative Model

this flower is white and pink

Flower Generative Model

Task Introduction - text2image generation

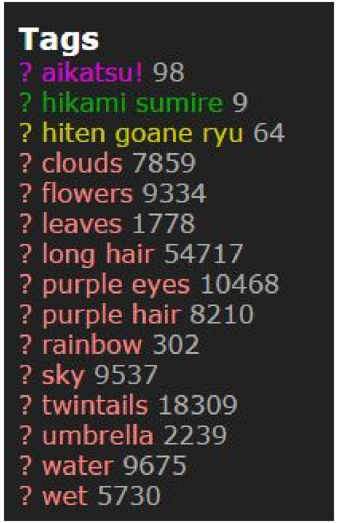


a man with no hair
and one red strong fist

a girl with blue hair,
blue eyes and
twin ponytail

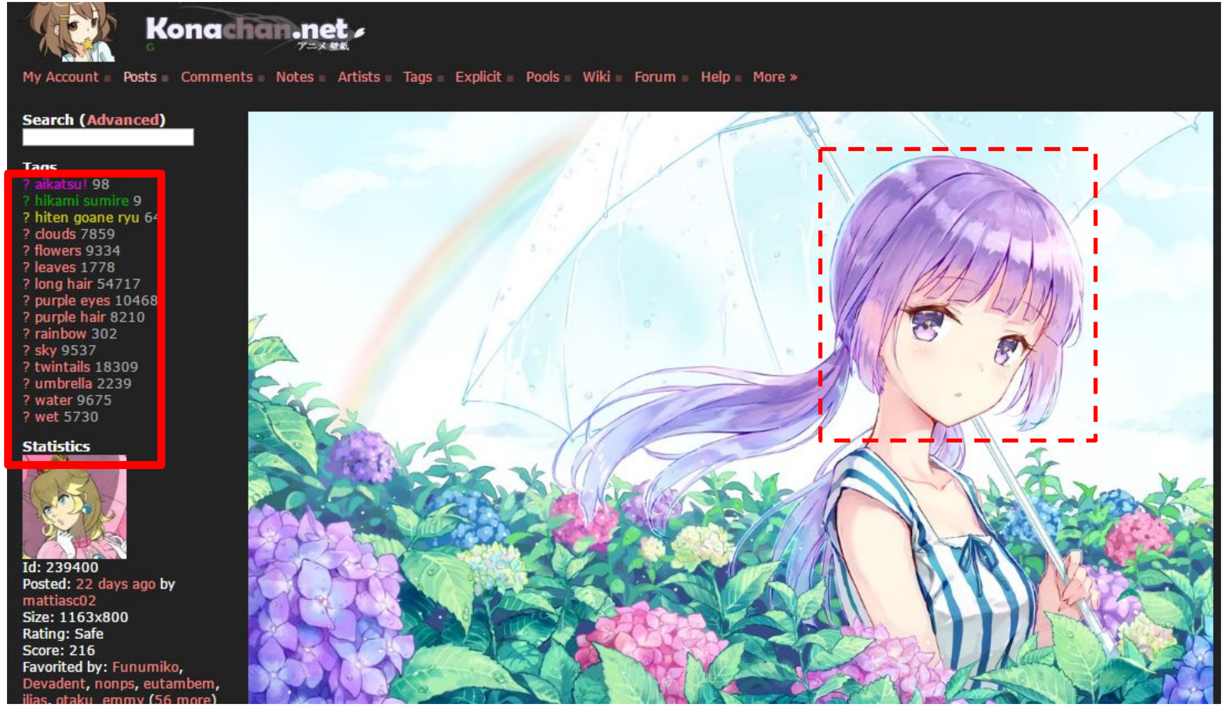
Anime Generative Model

Data Collection



Tags
? aikatsu! 98
? hikami sumire 9
? hiten goane ryu 64
? clouds 7859
? flowers 9334
? leaves 1778
? long hair 54717
? purple eyes 10468
? purple hair 8210
? rainbow 302
? sky 9537
? twintails 18309
? umbrella 2239
? water 9675
? wet 5730

Not all tags are useful



Tags
? aikatsu! 98
? hikami sumire 9
? hiten goane ryu 6
? clouds 7859
? flowers 9334
? leaves 1778
? long hair 54717
? purple eyes 10468
? purple hair 8210
? rainbow 302
? sky 9537
? twintails 18309
? umbrella 2239
? water 9675
? wet 5730

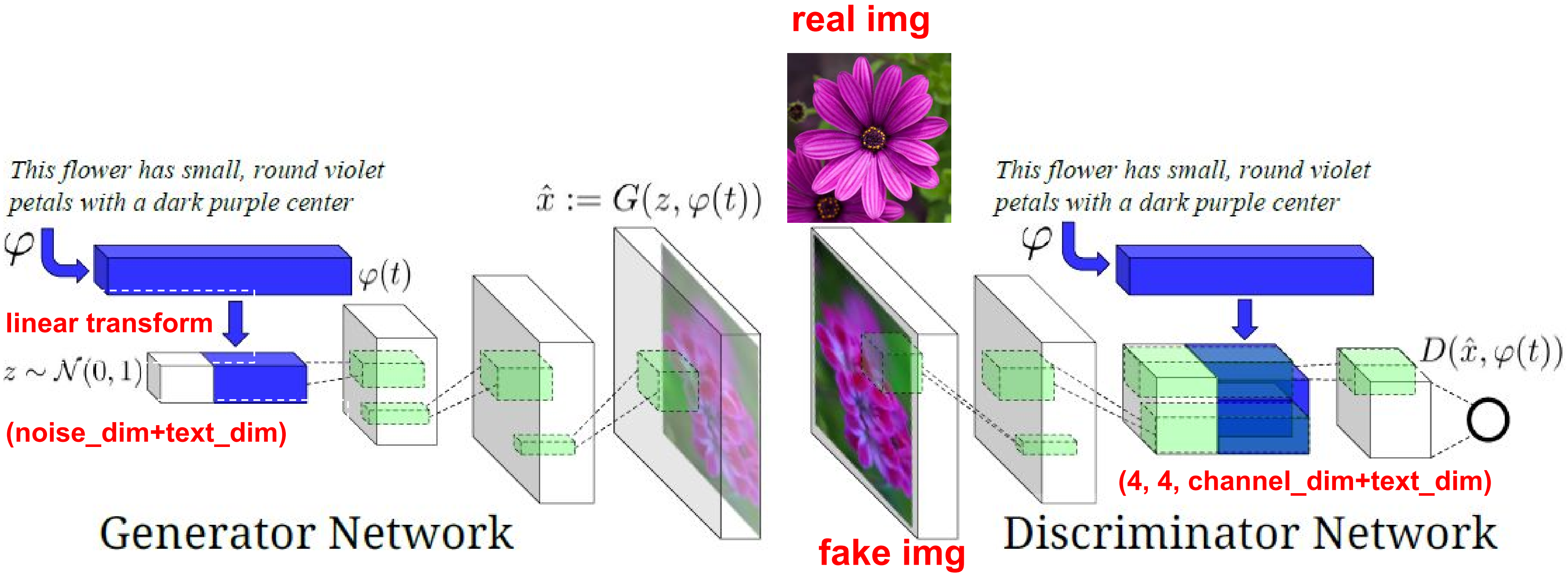
Statistics
Id: 239400
Posted: 22 days ago by mattiasc02
Size: 1163x800
Rating: Safe
Score: 216
Favorited by: Funumiko, Devadent, nonps, eutambem, ilias, otaku_emmy (56 more)

http://konachan.net/post/show/239400/aikatsu-clouds-flowers-hikami_sumire-hiten_goane_r

感謝樊恩宇助教蒐集data

Model and training tips

Conditional GAN for text2image generation

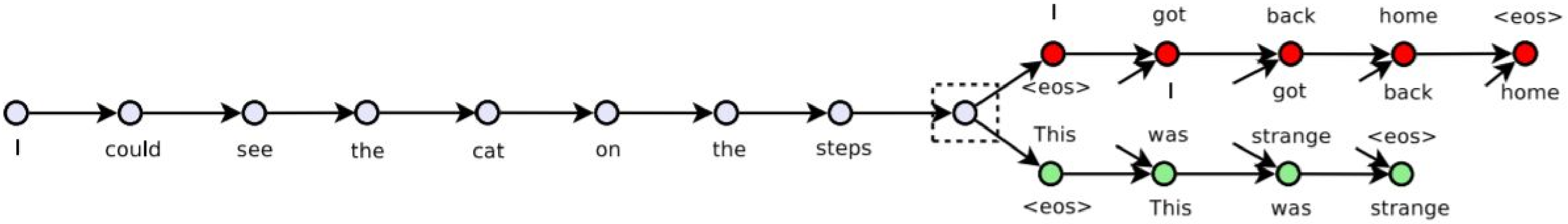

real img
This flower has small, round violet petals with a dark purple center
φ
$\varphi(t)$
linear transform
$z \sim \mathcal{N}(0,1)$
(noise_dim+text_dim)
$\hat{x} := G(z, \varphi(t))$
Generator Network
fake img
This flower has small, round violet petals with a dark purple center
φ
$D(\hat{x}, \varphi(t))$
(4, 4, channel_dim+text_dim)
Discriminator Network

Paper: https://arxiv.org/pdf/1605.05396.pdf

Details for training

- Updates between Generator and Discriminator
    - 1 : 1 or 2 : 1
- ADAM with lr = 0.0002, momentum = 0.5
- gaussian or uniform noise dim = 100
- batch size = 64
- epoch = 300

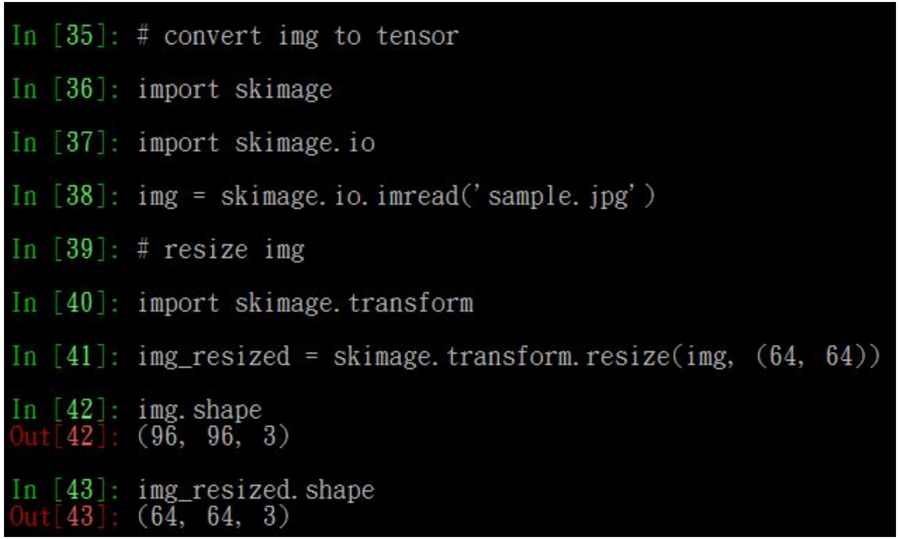
Text feature process tool - Skip-thought vector



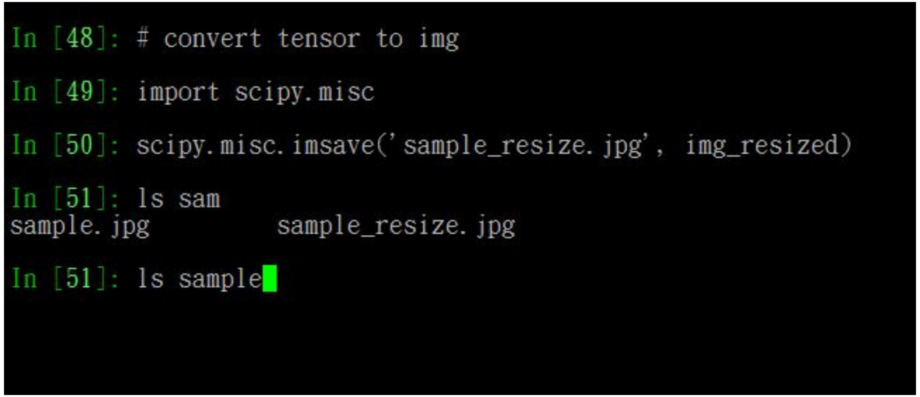
skip-thought source code:
https://github.com/tensorflow/models/tree/master/research/skip_thoughts#download-pretrained-models-optional

No matter which tool you use to process text input, please make sure you include that pre-trained model in your repository to let us run your code successfully.

Image process tool - skimage and scipy.misc



```
In [35]: # convert img to tensor

In [36]: import skimage

In [37]: import skimage. io

In [38]: img = skimage. io. imread(’sample. jpg’)

In [39]: # resize img

In [40]: import skimage. transform

In [41]: img_resized = skimage. transform. resize(img, (64, 64))

In [42]: img. shape
Out[42]: (96, 96, 3)

In [43]: img_resized. shape
Out[43]: (64, 64, 3)
```



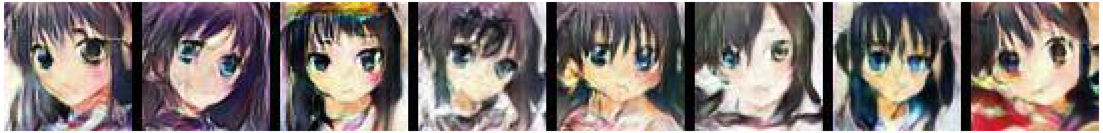
```
In [48]: # convert tensor to img

In [49]: import scipy. misc

In [50]: scipy. misc. imsave(’sample_resize. jpg’, img_resized)

In [51]: ls sam
sample. jpg          sample_resize. jpg

In [51]: ls sample
```

Install:

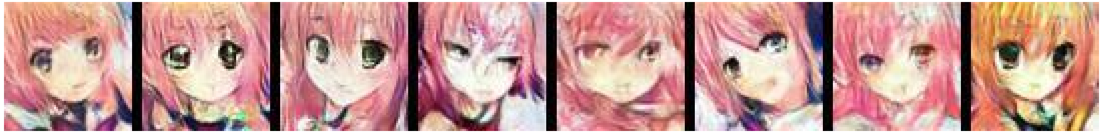
- sudo apt-get install python-skimage
- sudo pip install --user numpy scipy

Little Demo

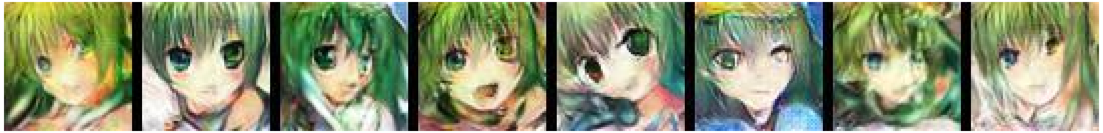
input text: black hair blue eyes



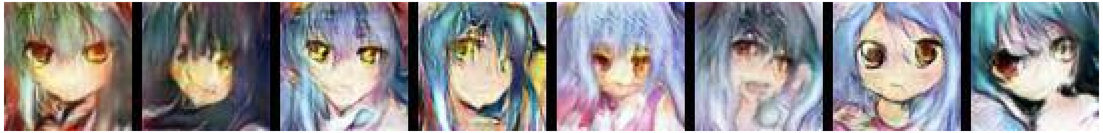
input text: pink hair green eyes



input text: green hair green eyes



input text: blue hair red eyes



Tips for training

- Discriminator output:
  - (real img, right text): 1
  - (fake img, right text): 0
  - (real img, wrong text): 0
  - (wrong img, right text): 0

- Different objective function
  - Wasserstein GAN (WGAN)
  - Improved W-GAN
  - Auxiliary Classifier GAN (ACGAN)

Wasserstein GAN

The output of D is thus not probability anymore.
The D loss turn to be a measure of distance.

$$L_D^{WGAN} = E[D(x)] - E[D(G(z))]$$

$$L_G^{WGAN} = E[D(G(z))]$$

$$W_D \leftarrow clip\_by\_value(W_D, -0.01, 0.01)$$

Wasserstein GAN

- In each training iteration:

No sigmoid for the output of D

Learning D

Repeat k times

  - Sample m examples $\{x^1, x^2, \ldots, x^m\}$ from data distribution $P_{data}(x)$
  - Sample m noise samples $\{z^1, z^2, \ldots, z^m\}$ from the prior $P_{prior}(z)$
  - Obtaining generated data $\{\tilde{x}^1, \tilde{x}^2, \ldots, \tilde{x}^m\}$, $\tilde{x}^i = G(z^i)$
  - Update discriminator parameters θ_d to maximize
    - $\tilde{V} = \frac{1}{m}\sum_{i=1}^{m} D(x^i) - \frac{1}{m}\sum_{i=1}^{m} D(\tilde{x}^i)$
    - $\theta_d \leftarrow \theta_d + \eta \nabla \tilde{V}(\theta_d)$ Weight clipping

Learning G

Only Once

  - Sample another m noise samples $\{z^1, z^2, \ldots, z^m\}$ from the prior $P_{prior}(z)$
  - Update generator parameters θ_g to minimize
    - $\tilde{V} = \frac{1}{m}\cancel{\sum_{i=1}^{m} logD(x^i)} - \frac{1}{m}\sum_{i=1}^{m} D\left(G(z^i)\right)$
    - $\theta_g \leftarrow \theta_g - \eta \nabla \tilde{V}(\theta_g)$

Wasserstein GAN

Implementation Notes :

- Do not apply sigmoid at the output of D
- Clip the weight of D
- Use RMSProp instead of Adam
- Train more iteration of D (the paper use 5)
- ~~Do not use batch normalization~~
- Do not apply batch normalization on **Discriminator** only when using **Improved W-GAN loss (WGAN-GP loss)**
  (ref: https://arxiv.org/pdf/1704.00028.pdf, page.4)

ref:https://arxiv.org/pdf/1701.07875.pdf

Improved W-GAN

Do not clip the weight of D but to add a new objective called “Gradient Penalty”.

$$L_D^{WGAN\_GP} = L_D^{WGAN} + \lambda E[(|\nabla D(\alpha x - (1 - \alpha G(z)))| - 1)^2]$$

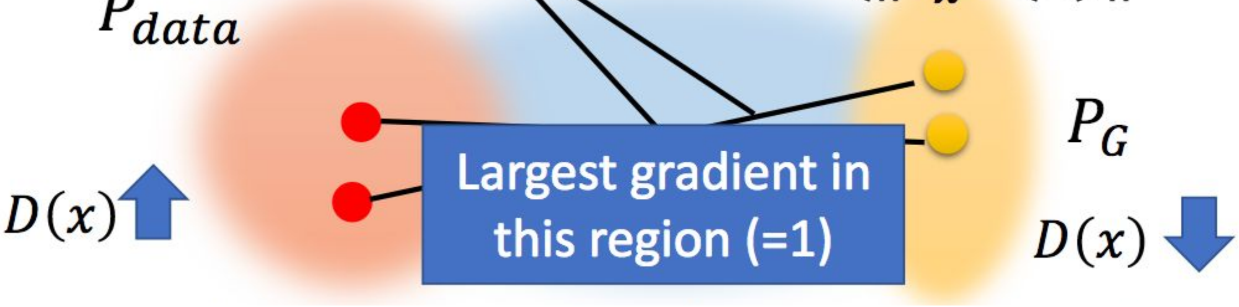
$$L_G^{WGAN\_GP} = L_G^{WGAN}$$

Improved W-GAN

$$W(P_{data}, P_G) \approx \max_D \{E_{x \sim P_{data}}[D(x)] - E_{x \sim P_G}[D(x)]$$

$$-\lambda E_{x \sim P_{penalty}}[\cancel{max(0, \|\nabla_x D(x)\| - 1)}]\}$$

$$(\|\nabla_x D(x)\| - 1)^2$$



Largest gradient in this region (=1)

ref:https://arxiv.org/pdf/1704.00028.pdf

ACGAN

Discriminator should also be able to do a classification task.

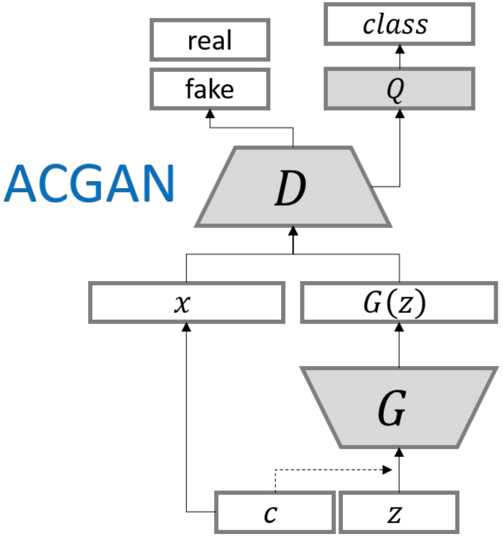
$$L_{D,Q}^{ACGAN} = L_D^{GAN} + E[P(class = c|x)] + E[P(class = c|G(z))]$$

$$L_G^{ACGAN} = L_G^{GAN} + E[P(class = c|G(z))]$$

ACGAN

$$L_S = E[\log P(S = real \mid X_{real})] + E[\log P(S = fake \mid X_{fake})]$$

$$L_C = E[\log P(C = c \mid X_{real})] + E[\log P(C = c \mid X_{fake})]$$



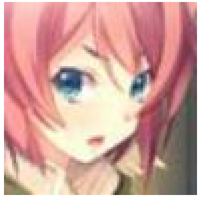
D is trained to maximize **L_s + L_c** while **G** is trained to maximize **L_c - L_s**

ref:https://arxiv.org/pdf/1610.09585.pdf

Submission and Grading

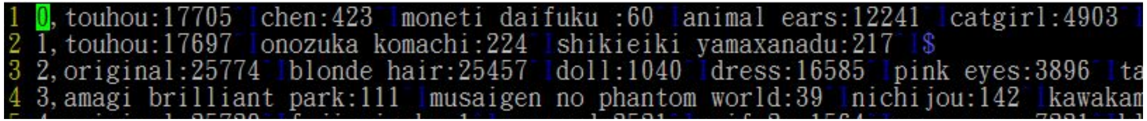
Homework 4 package

- Anime Dataset:
  - training data: 33.4k (image, tags) pair
  - faces/, tags.csv, sample_testing.txt



blue eyes
red hair
short hair

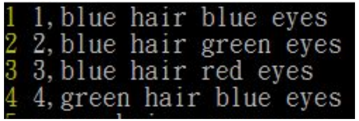
- training tags file format
  - img_id <comma> tag1 <colon> #_post <tab> tag2 <colon> …



```
0, touhou:17705  chen:423  moneti daifuku :60  animal ears:12241  catgirl:4903
1, touhou:17697  onozuka komachi:224  shikieiki yamaxanadu:217  $
2, original:25774  blonde hair:25457  doll:1040  dress:16585  pink eyes:3896  ta
3, amagi brilliant park:111  musaigen no phantom world:39  nichijou:142  kawakam
```

tags.csv

- testing text file format
  - testing_text_id <comma> testing_text



```
1,blue hair blue eyes
2,blue hair green eyes
3,blue hair red eyes
4,green hair blue eyes
```

sample testing_text.txt

- testing text only includes **‘color hair’** and **‘color eyes’**, only alphabetic char involved.
- Data download link:
  - https://drive.google.com/open?id=1bXXeEzARYWsvUwbW3SA0meulCR3nIhDb
  - If you want to do something cool beyond generating faces, mail us. We will give you original images

Testing Text Content

[color hair]:

'orange hair', 'white hair', 'aqua hair', 'gray hair',
'green hair', 'red hair', 'purple hair', 'pink hair',
'blue hair', 'black hair', 'brown hair', 'blonde hair'.

[color eyes]:

'gray eyes', 'black eyes', 'orange eyes',
'pink eyes', 'yellow eyes', 'aqua eyes', 'purple eyes',
'green eyes', 'brown eyes', 'red eyes', 'blue eyes'.

Allowed packages

- Allowed package includes:
    - PyTorch v0.2.0
    - tensorflow r1.3
    - Keras 2.0.7
    - MXNet 0.11.0
    - CNTK 2.2
    - python 2.7/3.5/3.6
        - In .sh file, please call “python2” or “python3.5” or “python3.6”
        - Ex. python2 GAN_train.py

Submission on Github

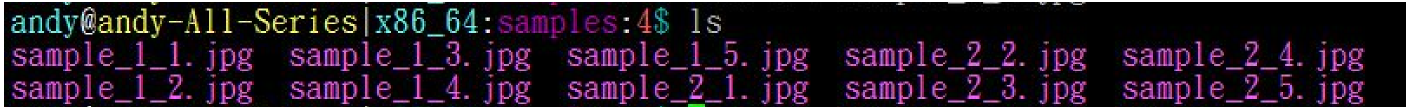
- Only one branch **master** is needed
- **master** stores the model by **using GAN structure**
- Remember to put your **pre-trained models or download scripts** so that we can run your code successfully

Submission

- Deadline: **12/31/2017(Sun.) 23:59:59 (UTC+8)**
- **ADLxMLDS2017/hw4** should contain the following files:
  - **run.sh train.py, (pre-)trained_model, generate.py, samples/, report.pdf**
  - If some files are too big, upload to your cloud and download them when running your run.sh
- TAs will run your run.sh to generate images given a text
  - bash run.sh [testing_text.txt]
  - run.sh must output in **10 minutes**.

Output Format Requirement

- The generated images should be in Directory samples/
    - make sure it’s empty before we run your code
- Each generated image must be resized to 64 x 64 in size
- For each input text, you must generate 5 images
- Generated img should be named as **“sample_(testing_text_id)_(sample_id).jpg”**
- Example:



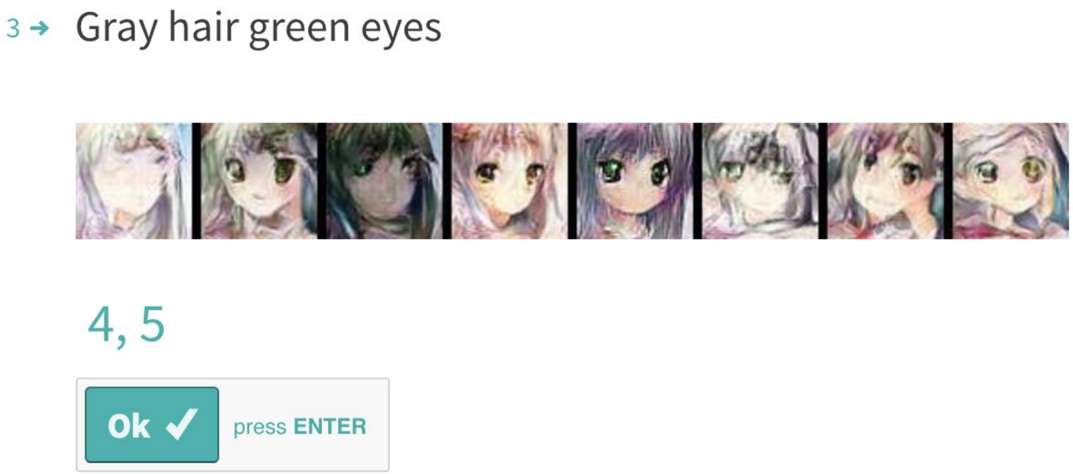
```
andy@andy-All-Series|x86_64:samples:4$ ls
sample_1_1.jpg  sample_1_3.jpg  sample_1_5.jpg  sample_2_2.jpg  sample_2_4.jpg
sample_1_2.jpg  sample_1_4.jpg  sample_2_1.jpg  sample_2_3.jpg  sample_2_5.jpg
```

組別互評

- We will put your generated images in the grading platform
- Link will be sent to your mail after HW deadline
- Answer **2** scores for each image
  - How the image fits the text
  - How the image looks real
- Scores should be integer from 1 to 5
  - 1 to 5 corresspondin to (super bad, bad, average, good, super good)
- You may score your results, so be fair when your are scoring :)

組別互評

- Separate scores with a comma (score for matching text, score for reality)
- Example:



3 → Gray hair green eyes

4, 5

What report should cover?

- Model description(2%)
  - Must include model strucuture, objective function for G and D
- How do you improve your performance (2%)
- Experiment settings and observation (2%)
- No more than 5 pages
- Please written in Chinese (unless you don’t know how to type Chinese)

Grading Policy (18%)

- Wrong output format will not be graded
- Report (6%)
- 限時任務(2%) [To be announced]
- Score others’ generated images(2%)
- Peer feedback(4%)
- Code (4%)
  - You will be scored only if you use GAN and output results in 10 minutes
  - Fix random seed so we can reproduce your results
- Bonus
  - style-transfer (2%)

Special Mission

- Open a folder ADLxMLDS2017/hw4/early/
- The condition is: red hair, green eyes
- Please generate 5 images corresponding to this condition
- Period: 2017/12/18~2017/12/24(23:59)

Other Policy

- Late policy: 25% off per day late afterwards.
  [Delay form will be announced afterwards]
- No plagiarism is allowed.

TA hours

- If you have other questions,
    - please contact TAs via adlxmlds@gmail.com
    - post your questions on facebook group
    - go to TA office hours
        - 季大中 Mon 17:30-19:00 (德田524)
        - 葉政杰 Fri 15:30-17:00 (電二531)
        - 楊靖平 Thu 15:30-17:00 (電二531)