GANs for Biological Image Synthesis

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Motivation
Generative Adversarial Networks (GANs) [1] to synthesize biological images (fission yeast cells imaged by fluorescence microscopy).

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LIN dataset
LIN dataset [2] contains 170,000 cell images each with two fluorescent tags: red and green.

Red shows Bgs4 protein which shows the area of active growth.

Green shows one of other 41 proteins of interest. There is technology to image up to 3-5 channels at a time, but more than 2 is hard and expensive.

Goal
- Synthesize multi-channel images given 2-channel data
- Capture randomness of the green given the red
- Learn a latent space to interoplate between cells
- Quantitatively measure quality

Approach
- Separable generator instead of conditioning
- WGAN-GP [3] to avoid mode collapse
- Star-shaped multi-channel model trained on two channel data
- Neural network two-sample test (C2ST) [4] to measure quality
- Interpolation between GAN noise vectors

Separable generator
Based on DCGAN [5]
Red and green noise
Red and green towers

Star-shaped model
Adaptation for multiple greens

Fighting mode collapse
Separable GAN
Separable Wasserstein GAN

Interpolating cell growth cycle
Bgs4 Alp14 Arp3 Cki2 Mkh1 Sid2 Tel2

Quantitative evaluation: two-sample test
With a model fixed, one trains a network to classify real vs fake. Test accuracy is taken as a similarity measure.

Correlation of C2ST and quality

Comparing different C2ST

C2ST for real vs real of different classes

C2ST for evaluating different conditional WGAN-GP

References