



Super Resolution of Chromatin Structure

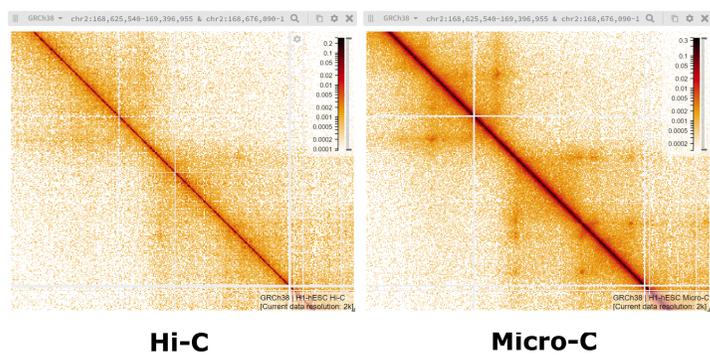
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Introduction

Chromatin conformation capture technologies (Hi-C) allow us to study the structure of the genome via 2D contacts maps. Recent experimental protocols such as Micro-C have increased the resolution to capture DNA contacts to the nucleosome level.

However, Micro-C is expensive and only available for a few human cell-lines. In this work we trained a super-resolution generative adversarial neural network (GAN) architecture to enhance low-resolution Hi-C maps to Micro-C resolution.

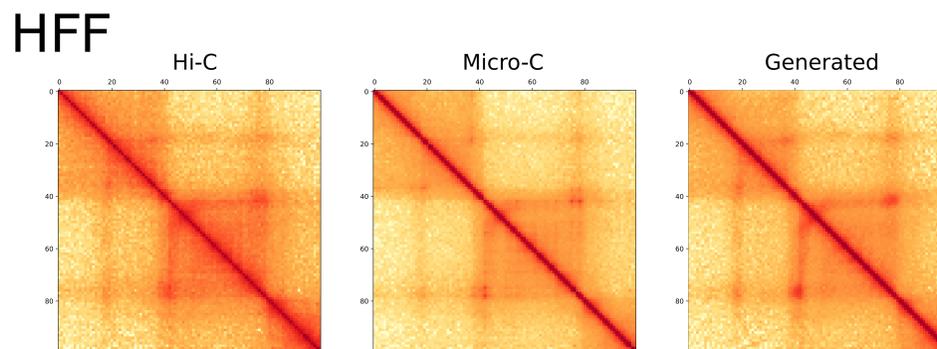
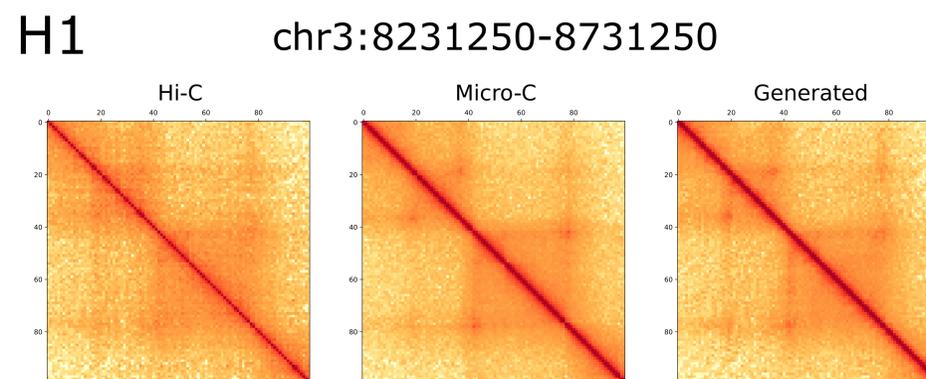
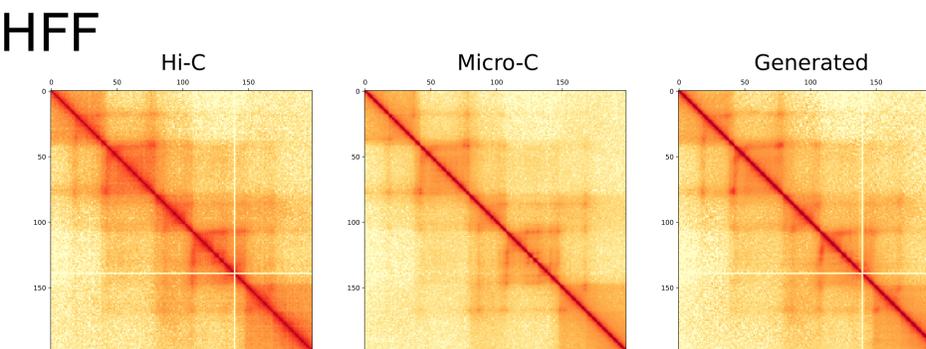
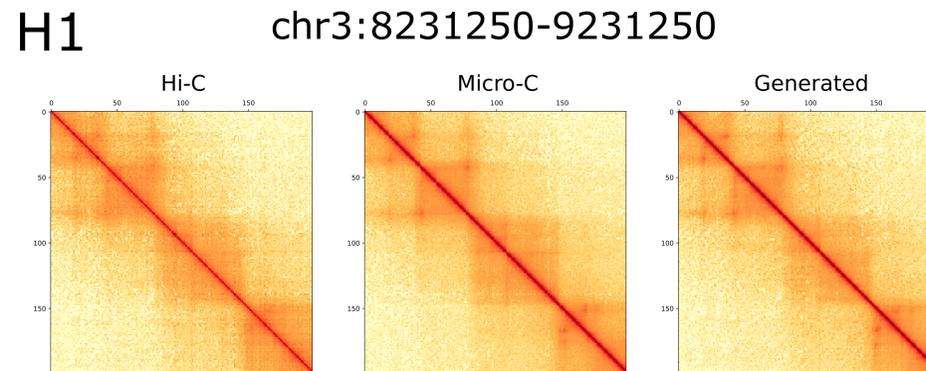


Hi-C

Micro-C

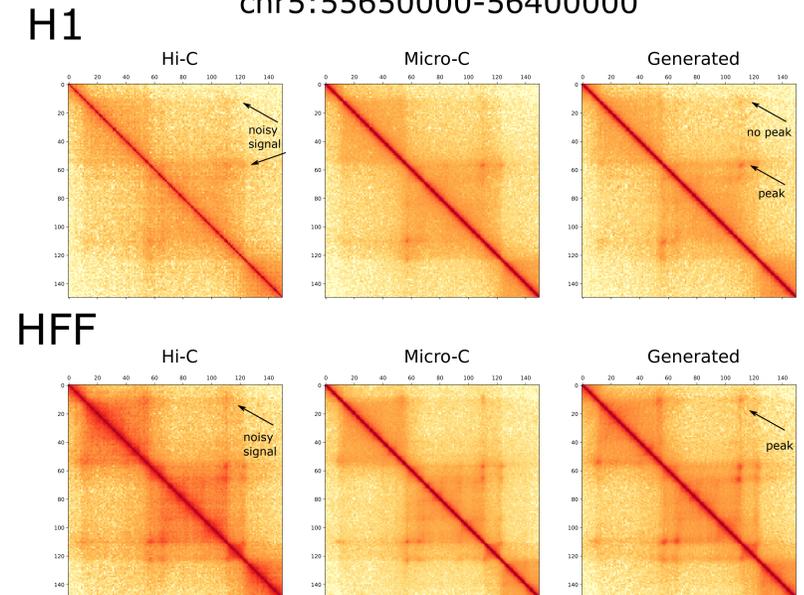
Results

The model produces denoised contact maps, and reveals peaks.



Analysis of Results

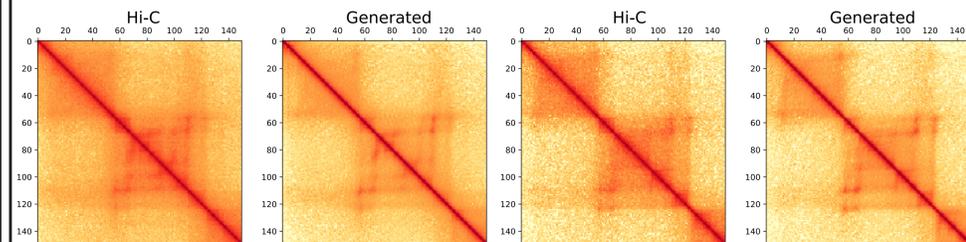
Corners do not always become peaks.
chr5:55650000-56400000



Model can be extended to other cell-types.

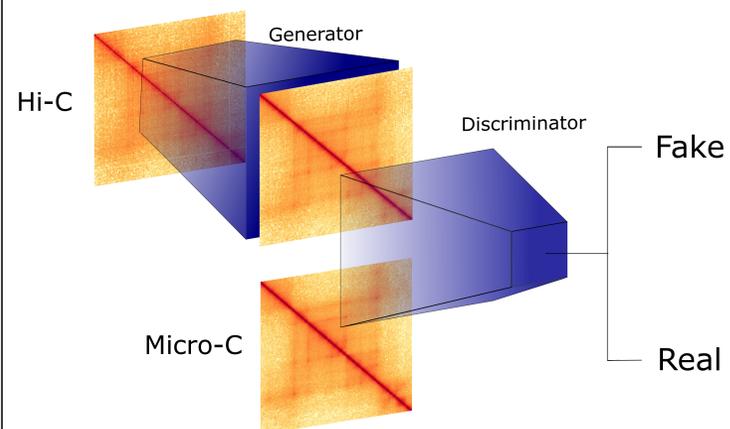
GM12878

IMR90



Methods

The model used was from DeepHiC [1]. This trains a GAN by making use of mean square error loss, perceptual loss[2], total variation (TV) loss [3] and adversarial loss [4]. Our model was trained with Hi-C as input to generate Micro-C. Training with contact maps from the H1 cell-line and testing with the HFF cell-line.



Conclusion

To this day, this is the first model that turns Hi-C maps into Micro-C maps. There are many potential applications to this model, such as enhancing and denoising older datasets. This could potentially reveal structures relevant to gene regulation that were previously hidden by biological and experimental noise.

References

1. Hong, H. et al. DeepHiC: A generative adversarial network for enhancing Hi-C data resolution. PLoS Comput. Biol. 16, e1007287 (2020).
2. Johnson, J., Alahi, A. & Fei-Fei, L. Perceptual losses for real-time style transfer and super-resolution. arXiv [cs.CV] (2016)
3. Mahendran, A. & Vedaldi, A. Visualizing deep convolutional neural networks using natural pre-images. Int. J. Comput. Vis. 120, 233–255 (2016).
4. Goodfellow, I. J. et al. Generative Adversarial Networks. arXiv [stat.ML] (2014).