

SkyGAN

This repo provides base code for anyone looking to create continuous conditional-GAN generated 2D density fields in place of 2LPT or GADGET-III/GADGET-IV simulations of the universe.

This version provides basic functionality required to do this with a conditional generative adversarial network. I will upload my more advanced version at a later date with more functionality and conditionalisation methods as well as a non-conditional GAN version. I also have versions that utilise a Wasserstein loss. Contact me if you want access to these before I have had a chance to upload them.

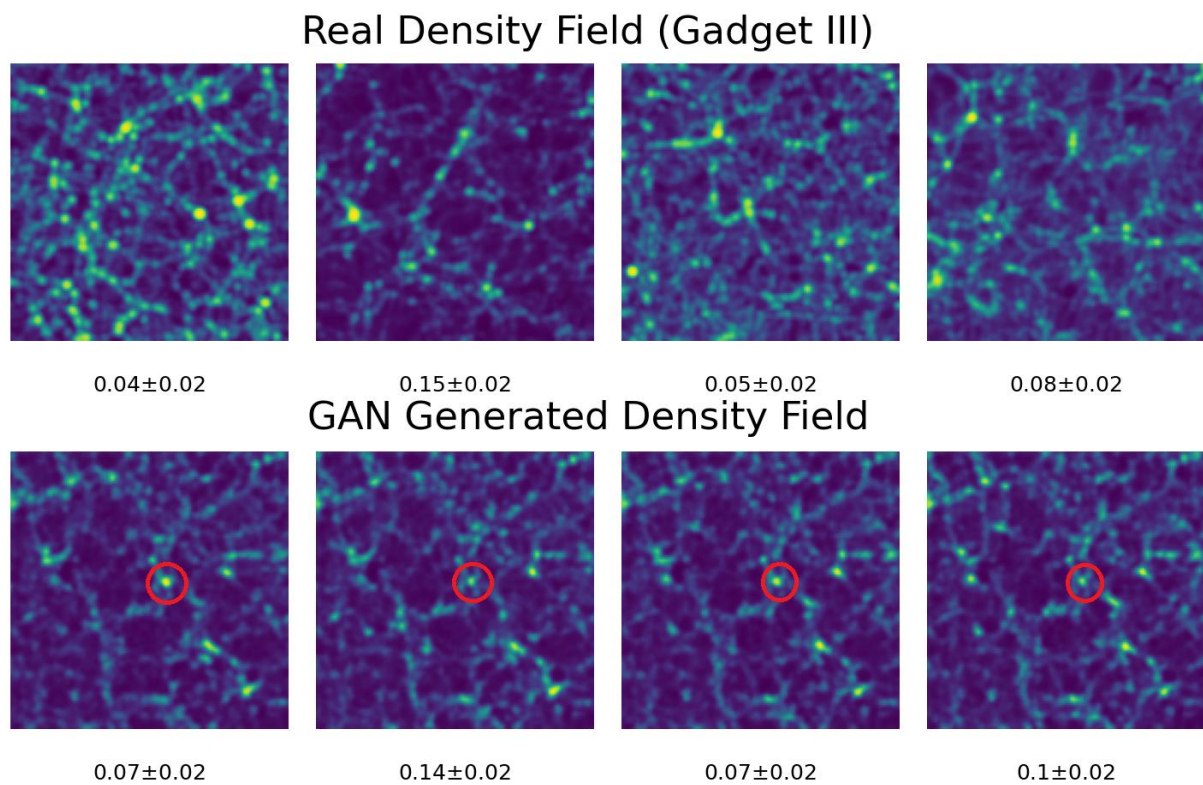
The generator and discriminator have the following structures.

Layer	Hyperparameters	Activation	Output Dimension
Generator			
Input			b x 1028
Concatenation			b x 1033
Dense		Relu	b x 256
Dense		Relu	b x 512
Dense		Relu	b x 32,768
Conditional Batch Normalisation	momentum = 0.5		b x 32,768
Reshape		Relu	b x 8 x 8 x 512
Batch Normalisation	momentum = 0.5		b x 8 x 8 x 512
Convolutional Transpose	S = 2, K = 5	Relu	b x 16 x 16 x 256
Batch Normalisation	momentum = 0.5		b x 16 x 16 x 256
Convolutional Transpose	S = 2, K = 5	Relu	b x 32 x 32 x 128
Batch Normalisation	momentum = 0.5		b x 32 x 32 x 128
Convolutional Transpose	S = 2, K = 5	Relu	b x 64 x 64 x 64
Batch Normalisation	momentum = 0.5		b x 64 x 64 x 64
Convolutional Transpose	S = 2, K = 5	tanh	b x 128 x 128 x 1
Discriminator			
Input			b x 128 x 128 x 1
Convolutional	S = 2, K = 5	Leaky Relu	b x 64 x 64 x 64
Batch Normalisation	momentum = 0.5		b x 64 x 64 x 64
Convolutional	S = 2, K = 5	Leaky Relu	b x 32 x 32 x 128
Batch Normalisation	momentum = 0.5		b x 32 x 32 x 128
Convolutional	S = 2, K = 5	Leaky Relu	b x 16 x 16 x 256
Batch Normalisation	momentum = 0.5		b x 16 x 16 x 256
Convolutional	S = 2, K = 5	Leaky Relu	b x 8 x 8 x 512
Batch Normalisation	momentum = 0.5		b x 8 x 8 x 512
Flatten			b x 32,768
Concatenation			b x 32,773
Dense		Leaky Relu	b x 512
Dense		Leaky Relu	b x 256
Dense		Leaky Relu	b x 128
Dense		sigmoid	b x 1

Please reference the code if used in future work. Feel free to email me for more details, I have done many months' worth of research in this area and can help with any inquiries or if you are stuck.

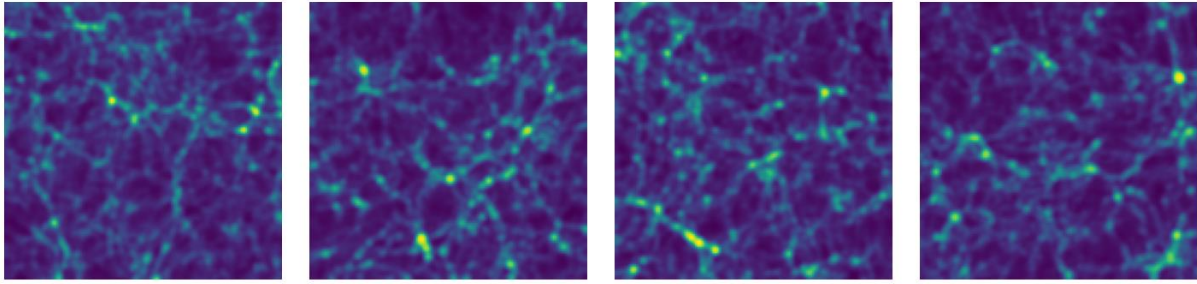
I have more advanced GAN monitoring functions on the way including live summary statistics of the GAN generated density fields as well as WGANs to the same effect.

Some example outputs of this GAN include



The non-conditional version produced outputs that were visually indistinguishable from the dataset:

Real Density Field (Gadget III)



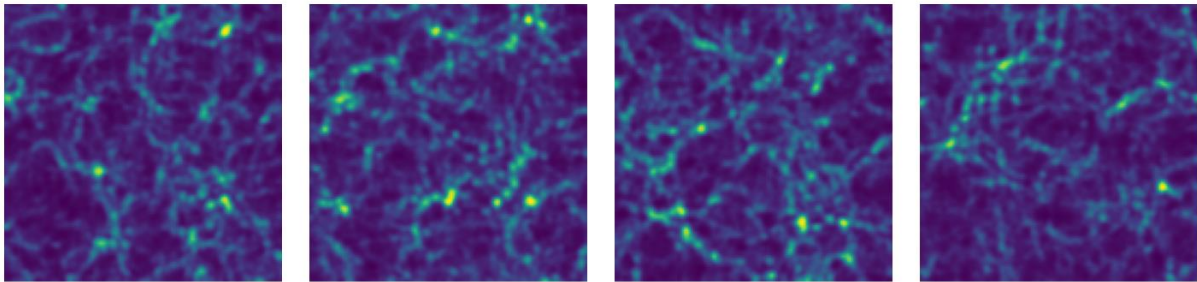
0.18 ± 0.02

0.15 ± 0.02

0.15 ± 0.02

0.15 ± 0.02

GAN Generated Density Field



0.16 ± 0.02

0.15 ± 0.02

0.15 ± 0.02

0.18 ± 0.02

And the statistics of the resulting density fields were outstanding <2% error at the significant k modes.

