Generation of Spatial Weather Fields with Generative Adversarial Networks

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A generative adversarial network (GAN) is a neural network architecture for training a network to produce random samples from arbitrarily complex distributions based on a low-dimensional latent vector. The generator network is optimized by pairing it with a discriminator network that learns representations of the true data by comparing real and synthetic examples. The discriminator network then teaches the generator network its representations, and the networks optimize against each other until they reach an equilibrium. GANs have generated realistic images of faces and animals, and have emulated components of high-energy physics models. In my research, I have found that GANs can also generate a variety of synthetic weather fields and appear to maintain the spatial relationships among related weather variables. However, the fidelity of the synthetic data depends heavily on the components of the neural networks and the optimization procedure. In this presentation, I will identify key procedures for producing realistic weather fields with GANs and demonstrate different metrics for comparing GAN architecture settings. These metrics will be used to assess the generation of both Gaussian random fields and storms paired with their surrounding environments. The utility of using the latent vector to compare and group different samples will also be discussed.