How can we predict the weather?

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Abstract

People in Vancouver always bring an umbrella with them even if the forecast says that it will not rain. Why isn't there a mutual trust between the weather forecast and the general public? How do we even predict the weather? To answer these questions, we have to examine the mathematical tools that people have used to try to forecast the weather. A simple one is using some Markov chains (the Dynamics essay) and past data to compute the probability of being sunny or rainy tomorrow given it is sunny or rainy today. Even though Markov chains have many more useful applications, it is a very naive model of the weather, as the weather is extremely sensitive to initial conditions. This sensibility is named as the *butterfly effect* (the Chaos essay). A metaphor of the *butterfly effect* on weather is a butterfly flapping its wings in China can cause a hurricane in Texas. The weather is then modeled by a chaotic, continuous dynamical system using Lorenz's equations, keeping account its sensibility. However, there are still many limitations to this model; we cannot predict the weather more than a week. In the absence of perfect knowledge of the initial conditions on the weather due to rounding errors, our ability to predict its future course will always fail,[1] as the Lorenz attractor that is the solution set to the model of the convection processes in the atmosphere forms a fractal-like graph (the Fractal essay).

[1] "Lorenz System." Wikipedia, Wikimedia Foundation, 14 Mar. 2020, https://en.wikipedia.org/wiki/Lorenz_system.