

20.1: Generative Models

Say you are walking down the street and a friend of yours walks right by but doesn't say hello. You would probably try to decide why this happened – Did they not see you? Are they mad at you? Are you suddenly cloaked in a magic invisibility shield? One of the basic ideas behind Bayesian statistics is that we want to infer the details of how the data are being generated, based on the data themselves. In this case, you want to use the data (i.e. the fact that your friend did not say hello) to infer the process that generated the data (e.g. whether or not they actually saw you, how they feel about you, etc).

The idea behind a generative model is that a *latent* (unseen) process generates the data we observe, usually with some amount of randomness in the process. When we take a sample of data from a population and estimate a parameter from the sample, what we are doing in essence is trying to learn the value of a latent variable (the population mean) that gives rise through sampling to the observed data (the sample mean). Figure 20.1 shows a schematic of this idea.

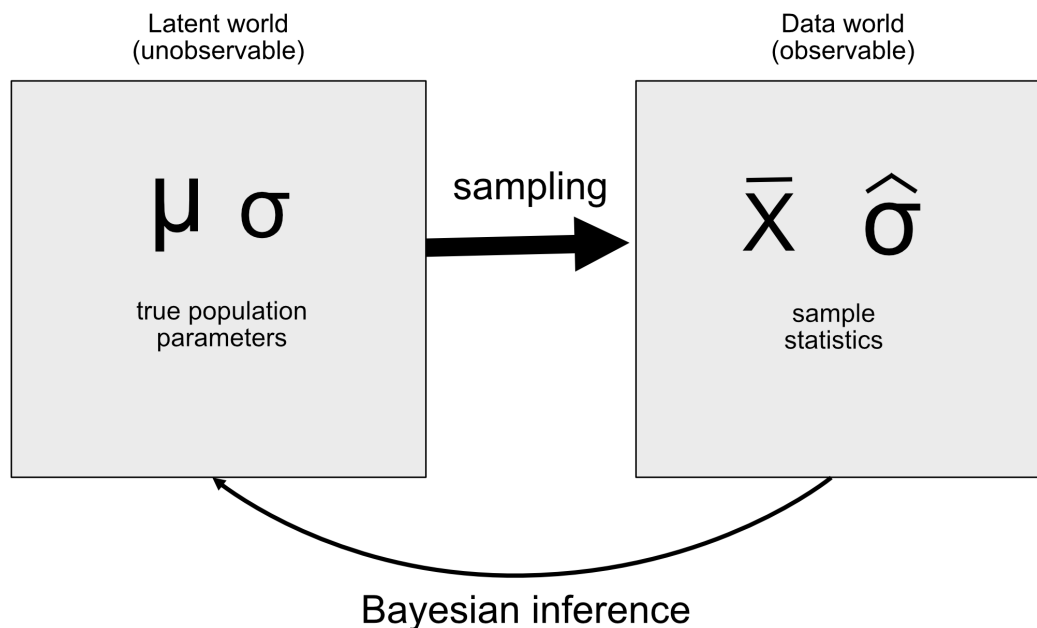


Figure 20.1: A schematic of the idea of a generative model.

If we know the value of the latent variable, then it's easy to reconstruct what the observed data should look like. For example, let's say that we are flipping a coin that we know to be fair, such that we would expect it to land on heads 50% of the time. We can describe the coin by a binomial distribution with a value of $P_{heads} = 0.5$, and then we could generate random samples from such a distribution in order to see what the observed data should look like. However, in general we are in the opposite situation: We don't know the value of the latent variable of interest, but we have some data that we would like to use to estimate it.

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