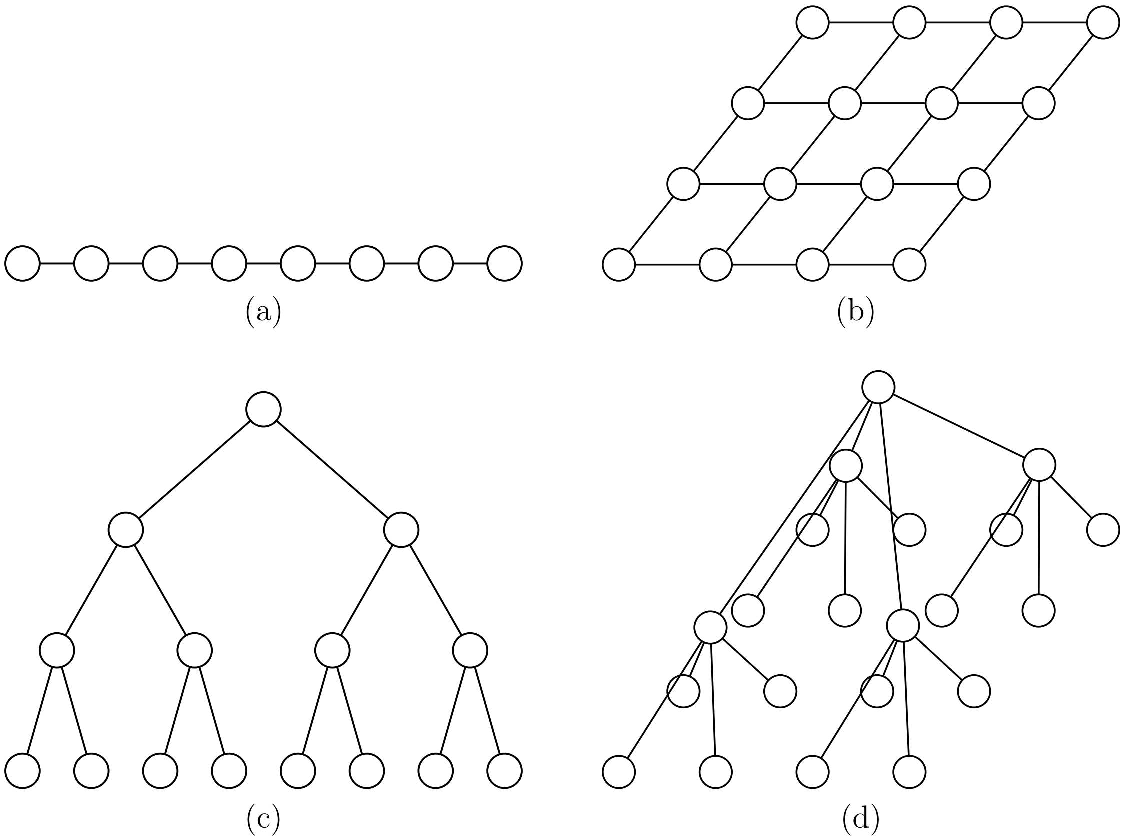

Figure 1-1: Sample graphical model structures. Each node represents a random variable. (a) Markov chain (state space model). (b) Markov random field (2-D nearest neighbor grid). (c) Multiscale autoregressive time series model. (d) Multiscale autoregressive random field model.

cases, many different graphical structures may provide reasonable approximations of the desired dependencies. The challenge, then, is to find graphs which accurately capture important statistical features, but still lead to efficient inference algorithms. For the modeling of one–dimensional time series, linear state space models, which graphically correspond to the Markov chain of Figure 1-1(a), are a common choice. Computationally, they are attractive because efficient and exact inference is possible using the Kalman filter [44]. In addition, their representation of each successive random variable as a noisy function of its immediate predecessors is a good match for many real stochastic processes.

Markov random fields defined on 2-D nearest neighbor grids, as shown in Figure 1-1(b), are a natural generalization of Markov chains for the modeling of spatial processes. The statistical structure they provide, in which each random variable