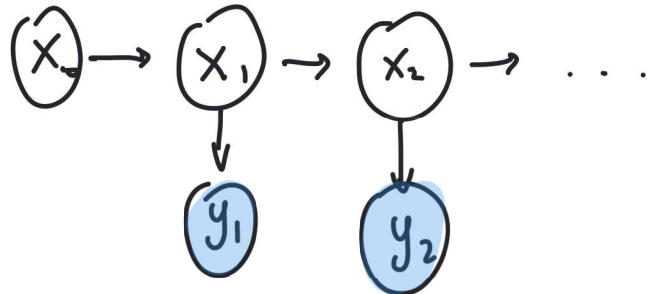# Markov model with observations

Transition probabilities: $p(x_n | x_{n-1})$

initial probabilities: $p(x_0)$

Emission probabilities: $p(y_n | x_n)$

Joint prob. dist. of everything:

$$p(x_{0:n}, y_{1:n}) = p(y_{1:n} | x_{0:n}) \, p(x_{0:n})$$

$$= \left(\prod_{t=1}^{n} p(y_t | x_t) \right) \cdot p(x_0) \cdot \prod_{t=1}^{n} p(x_t | x_{t-1})$$

$$= \underbrace{p(x_0)}_{\text{init.}} \prod_{t=1}^{n} \underbrace{p(x_t | x_{t-1})}_{\text{transition}} \underbrace{p(y_t | x_t)}_{\substack{\text{emission} \\ \text{(measure)}}}$$