E-step – Fix parameters, find expected state assignments

$$m{\gamma_i(t)} = m{p}(S_t = m{i}|m{O}, m{ heta}) = rac{lpha_t^i eta_t^i}{\sum_j lpha_t^j eta_t^j}$$

Forward-Backward algorithm

$$\boldsymbol{\xi_{ij}(t)} = \boldsymbol{p}(S_{t-1} = i, S_t = j | \boldsymbol{O}, \boldsymbol{\theta})$$

$$= \frac{p(S_{t-1} = i | O, \theta) p(S_t = j, O_t, \dots, O_T | S_{t-1} = i, \theta)}{p(O_t, \dots, O_T | S_{t-1} = i, \theta)}$$

$$= \frac{p(O_t, \dots, O_T)}{p(O_t, \dots, O_T)}$$
$$= \frac{\gamma_i(t-1) p_{ij} q_j^{O_t} \beta_t^j}{\beta_{t-1}^i}$$