Description of Baum-Welch Algorithm Implementation

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1 E-Step

In the E-Step, posterior probabilities for the latent states are computed. Specifically:

1. The forward-backward procedure is used to compute the *alpha* and *beta* values, taking into consideration scaling factors for numerical stability.
2. Using *alpha* and *beta*, $\gamma(z_n)$, the marginal posterior distribution, and $\xi(z_{n-1}, z_n)$, the joint posterior distribution of two successive latent states, are computed.

2 M-Step

In the M-Step, the algorithm updates the HMM parameters to maximize the expected complete-data log-likelihood:

1. π is updated as the expected state distribution at the first time step.
2. A is updated using the expected number of transitions between states.
3. The Gaussian parameters μ and σ are updated based on the weighted means and variances of the observed data points.

3 Convergence

The Baum-Welch algorithm is iteratively applied, where the E-step and M-step are repeated until the changes in the Gaussian emission parameters (both μ and σ) between consecutive iterations fall below a predefined threshold.