Variational Bayes

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1 System Model

In a telecommunication system, we can assume

$$y = H(x_d + x_p) + z$$

where y is the received signal, x_p is the pilot and x_d is data, and $z \in \mathcal{CN}(0, \sigma^2)$.

2 Proposed Method

2.1 Prime Variational Bayes

The target is to find the channel and the symbol to maximize the posterior, i.e.,

$$p(x_d, H; y, \sigma^2, x_p) = \arg\max_{x \in \Omega} p(y|x_d, y|H; \sigma^2, x_p) p(x_d) \tag{1}$$

Here, we use a distribution family q to approximate the distribution above.

$$p(x_d, H; y, \sigma^2, x_p) \propto q(x_d) q(H|\gamma^{-1}) q(\gamma)$$

where $x_d \in \mathcal{CN}(0, 1)$, $H \in \mathcal{CN}(0, \gamma^{-1})$, and $p(\gamma) = gamma(\gamma; a, b)$. Here, we use the Gamma distribution because it is the conjugate prior of the Gaussian distribution.
The algorithm structure is given as below:

1: **for** $t \in 0, \cdots, T-1$ **do**
2: Update q(x_d)
3: Update q(H)
4: Update q(γ)
5: **end for**
6: **return** $q(x)$

2.2 GNN

In the primary Variational Bayes, we assume q follows a Gaussian distribution, we use GNN to simulate the distribution to improve the performance.