## **Variational Inference:**

* **The Challenges in Variational Inference**

Assume we have a very simple “Exponential-Normal Model”:

* **What do we know?**

1. The **prior** on :
2. The **likelihood**:
3. The **joint distribution**:

* **What we don’t know?**

1. The **marginal**: (area under the curve)
2. The **posterior** (Bayes Rules): but is impossible/hard to obtain in most cases, because of it is intractable. (!!! Posterior is proportional to the joint, i.e., , which already allows us to maximize a posterior estimate)

A screenshot of a computer

Description automatically generated with low confidence

Figure 1 given an observed dataset ，plot the joint probability of

* Variational Inference (VI) attempts to find a surrogate posterior by maximizing the :

**Problem:** Posterior of a Normal distribution with unknown mean

Assume we have some data that is data points, we seek a posterior: . Here, we propose a surrogate , where are learnable parameters. TO MAXIMIZE ELBO:

Then, approximate Expectation by sampling samples:

1. Sample samples from
2. Evaluate approximate ELBO.
3. are used for the creation of the samples and the evaluation of the log probability.