Non-conjugate Models:

Assume,

$y_i | \mu \overset{iid}{\sim} N(\mu, 1)$ [unknown μ and known σ^2]

$\mu \sim t(0, 1, 1)$

Posterior $(\mu | y_1, \ldots y_n) \propto$ likelihood * prior(μ)

$$\propto \prod_{i=1}^{n} \left[\frac{1}{\sqrt{2\pi}} \exp\left(\frac{-1}{2} (y_i - \mu)^2 \right) \right] * \frac{1}{\pi (1 + \mu^2)}$$

[Density of Normal] [Density of T].

$$\propto \exp\left[\frac{-1}{2} \sum_{i=1}^{n} (y_i - \mu)^2 \right] * \frac{1}{(1+\mu^2)}$$

$$\propto \exp\left\{ \frac{-1}{2} \left[\sum_{i=1}^{n} y_i^2 - 2\mu \sum_{i=1}^{n} y_i + n\mu^2 \right] \right\} * \frac{1}{1+u^2}$$

$$\propto \exp\left[\frac{n(\bar{y}\mu - \mu^2/2)}{1 + \mu^2} \right]$$

Conclusion: looks like Normal but the denominator. so no known posterior distribution

let $g(\mu) =$ Posterior $(\mu | y_1, \ldots y_n)$

Taking log on both sides,

$$\log(g(u)) = n(\bar{y}\mu - \mu^2/2) - \log(1 + \mu^2)$$