$$p(a) = \int p(a,b)\, db$$

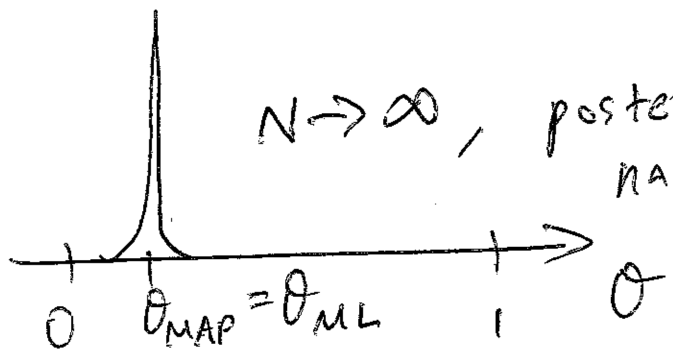
$$p(a|c) = \int p(a,b|c)\, db$$

$$p(a,b) = p(a|b)\, p(b)$$

$$p(a,b|c) = p(a|b,c)\, p(b|c)$$ always true

$$p(a,b|c) \neq p(a|c)\, p(b|c)$$

if a & b are conditionally independent given c



$N \to \infty$, posterior becomes narrower & taller

$$p(y \mid x, \theta) = \frac{p(x, y \mid \theta)}{p(x \mid \theta)} \propto p(x, y \mid \theta)$$

$$\underset{\text{parameter}}{\operatorname{argmax}} \boxed{p(\text{parameter} \mid \text{data})} \leftarrow \text{MAP}$$

$$\underset{\text{parameter}}{\operatorname{argmax}} \, p(\cancel{\text{that}}\ \text{data} \mid \text{parameter}) \leftarrow \text{ML}$$

mode of distribution $p(z) = \underset{z}{\operatorname{argmax}} \, p(z)$

$$\int p(\theta|D)\, d\theta = \int \frac{k(N_0, N_1, a, b)\, \text{Beta}(\theta | N_1 + a, N_0 + b)}{p(D)}\, d\theta$$

$$1 = \frac{k(N_0, N_1, a, b)}{p(D)}$$

$p(x) = \text{pdf}$ if x <u>is continuous</u>

~~$p(x) = \text{pmf}$~~

$p(x) = \text{pmf}$ if x is discrete

$p(\theta | a, b)$

$p(\theta)$

$p(x) > 0$

$\int \underline{p(x)}\, dx = 1$

$X \sim N(0, 1)$

$p(X)$ <u>OR</u> $p(x | \mu = 0, \sigma^2 = 1)$

Baseball

$$\underset{a,b}{\operatorname{argmax}}\ p(\text{data} \mid a, b)$$

Generative

$X \sim N(0, 5)$

We know $p(X)$, so we can sample from $p(X)$

feature X, want to predict Y

We know $p(X, Y)$, so we can sample from $p(X, Y)$

Beta-Binomial

$$p(D) = \int p(D, \theta)\, d\theta$$

$$= \int \underbrace{p(\theta)}_{\text{Beta dist}}\ \underbrace{p(D \mid \theta)}_{\text{Binomial likelihood}}\, d\theta$$

$= \text{function of } a, b, N_0, N_1$

$= p(D \mid a, b)$

$$p(\text{John hits the next ball} \mid \text{history}) = \frac{20+70}{100+70+200} = A$$

$$p(\text{John does not hit the ball} \mid \text{history}) = 1 - A$$

$$= 1 - \frac{20+70}{100+70+200}$$

$$= \frac{80+200}{100+70+200}$$