notes1202

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1 Homework

1.1 MCMC

```
for (iter in 1(niter+burnin)){
if (use GPU )
   Z = rtruncnormGPU(  ) CUDA/kernel
else
   Z = rtruncnormCPU(  ) regular R or Pythong
beta = rmvnorm (   )
```

1.2 Probit MCMC

$\mathrm{Y}_i \mid \mathrm{Z}_i = \mathrm{I}_{\{}\{Z_i > 0\}$ $\mathrm{Z}_i \mid \beta \sim \mathrm{N}(\mathrm{x}_i{}^T\ \beta,\ 1)$ $\beta \sim \mathrm{N}(\beta_0,\ \Sigma_0)$
$\mathrm{P}(\beta \mid \mathrm{Z},\ \mathrm{y}) \sim$ Normal $\mathrm{P}(\mathrm{Z}_i \mid \beta,\ \mathrm{y}_i) \sim$ Truncatednormal

1.3 C/C++

- C is a very fast compiled language
- Data types need to be explicitly defined.
- Vectors/matrics are typically implemented using pointers
- Pointers point to memory locations, from which can look up values at the memory locations.

1.4 HW Kernel

- Use the template in the github repo.
- void says the function doesn't return anything. You want the kernels to be void. put the return values into one of the arguments.
- See notes, they are on pearson example

2 Truncated Normal Sampling

If $X \sim N(\mu, \sigma^2) I_{\{X \in (0,\theta)\}}$ then $X \sim Truncated - Normal(\mu, \sigma^2, a, b)$

```
accepted = False
while(!accepted and numtries < maxtries) {
    numtries = numtries + 1
    x = rnorm(mu,sigma)
    if (x > a and x <=b) {
        accepted = True
    }
}
return(x)
```

2.1 Rejection Sampling

To sample form a distribution with pdf $f(x)$ if we can find another distribution with pdf $g(x)$ such that

$$f(x) \leq Mg(x) \qquad forallx \tag{1}$$

then we can use g to sample from f as follows

1. Sample a value x_* from $g(x)$
2. Sample $U \sim U[0,1]$
3. If $U \leq \frac{f(x_*)}{Mg(x_*)}$ then accept x_*, otherwise, return to 1.

Ideally $f(x)$ and $g(x)$ should be close.

2.1.1 From Robert(2009)

To sample from $X \sim N(0,1,\mu^-,\infty)$

1. Generate $Z = \mu^- + Expo(\alpha)$
2. Compute

$$\psi(z) = \begin{cases} \exp(-\frac{(\alpha-z)^2}{2} & if \mu^- < \alpha \\ \exp(-\frac{(\mu^- - \alpha)^2}{2}) \exp(\frac{(\alpha-z)^2}{2}) & if \mu^- \geq \alpha \end{cases} \tag{2}$$

If $U[0,1] < \psi(z)$ accept. Else, try again

2.1.2 Optimal α

$$\alpha = \frac{\mu^- + \sqrt{(\mu^-)^2 + 4}}{2} \tag{3}$$

We need $X \sim N(\mu, \sigma^2; a, \infty)$ Let $Z \sim N(0,1;\mu,\infty)$ What is the distribution of $Y = cZ + k$?

$$Y \sim N(k, c^2, k + c\mu^-, \infty) \tag{4}$$