Working examples

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1 Simulating random samples using Hamiltonian Monte Carlo

The function HMC generates a random sample from a specified distribution. It takes as arguments: total.samples, the number of samples to be simulated after burnin; q.density, the density the samples should be drawn from; M, the mass matrix; q, the starting values for the simulation; epsilon, the stepsize to be used in the leapfrog; L, the number of leapfrog steps to be made; diff.density, the derivative of the density to be drawn from; burnin the number of samples at the beginning of the simulation to be discarded.
The following code will give a random sample of size 1,000 from a univariate standard normal distribution using a step-size (ϵ) of 0.05 and 20 leapfrog iterations, L.

```
HMC(total.samples = 1000,
    q.density = function(x) dnorm(x,0,1),
    M=1,
    q = 0,
    epsilon = 0.05,
    L = 20,
    diff.density = function(x) x,
    burnin = 100)
```

This can be extended to the bivariate Gaussian by specifying a bivariate density function. The following will simulate a bivariate Gaussian distribution with highly-correlated covariates.

```
bivariate.density <- function(l) {
  dmvnorm(l, c(0, 0),matrix(c(1, 0.95, 0.95, 1), 2, 2))
}
bivariate.diff <- function(x) {
  solve(matrix(c(1, 0.95, 0.95, 1), 2, 2))%*%as.matrix(x)
}
HMC(total.samples = 1000,
    q.density = bivariate.density,
    q = c(-2,-2),
    M = diag(2),
    epsilon = 0.18,
    L = 20,
    diff.density = bivariate.diff,
```

```
    burnin = 0)
```

Sampling from higher higher dimensions can be done in a similar manner. The following will simulate 500 samples from a 150-dimensional distribution with independent covariates.

```
multi.density <- function(l) {
  dmvnorm(l,rep(0,150),diag(seq(from=0.02,to=1,
                    length=150)^2))
}
multi.diff <- function(x) {
  solve(diag(seq(from=0.02,to=1,length=150)^2))%*%as.matrix(x)
}
out.multidimension <- HMC(total.samples = 500,
                          q.density = multi.density,
                          q = rep(0,150),
                          M=diag(150),
                          epsilon = 0.014,
                          L = 100,
                          diff.density = multi.diff,
                          burnin = 0)
```

2 Plotting function - WordPrint

The function *WordPrint* is used to plot a random sample from a distribution whose probability density resembles a chosen word. It takes two arguments, word: the word you would like plotted, given as a character string; and samples: the number of simulated points to be used in the plot.

```
WordPrint(word = "abcHMC", samples = 2500)
```