In the name of God

Department of Physics
Shahid Beheshti University

OPTIMIZATION METHODS IN PHYSICS

Exercise Set 6

(Due Date: 1400/09/12)

1. Fitting formula: Using file which is called *fitinput.txt* and consider $y_{theory} = ax^H$ compute a, H and their errors using MCMC method. Now, according to the analytical solution for minimizing χ^2 with respect to model parameters, determine the best value of a and b and compare your results with that of determined by MCMC. The error for data has been set to unity.

2. In order to compare observed data set of SNIa with that of provided by theory for distance modulus (Noble Prize 2011 in physics), we have:

$$d_L = \frac{(1+z)}{\sqrt{|\Omega_K|}} sinn\left[\sqrt{|\Omega_K|}\int_0^z \frac{dz'}{H(z';\Omega_m,\Omega_\lambda,\omega,H_0)/H_0}\right]$$

here $\{\Theta\} \equiv \{\Omega_m, \Omega_\lambda, \omega, H_0\}$, $\Omega_K = 1 - \Omega_m - \Omega_\lambda$ and $\{D\} \equiv \{(z_i, \mu_i)\}$ with $i = 1, 2, 3, .., N$ and

$$\mu = 5\log_{10} d_L + 5\log_{10}\frac{3\times 10^5}{H_0} + 25$$

for $\Omega_K = 0$ $sinn \equiv 1$, $\Omega_K => 0$ $sinn \equiv \sinh$ and $\Omega_K < 0$ $sinn \equiv \sin$, ,

The prior for model free parameters are: $p(\Omega_m) \sim \exp\left(-\frac{(\Omega_m-0.3)^2}{2\sigma_m^2}\right)$ with $\sigma_m = 0.1$, $p(\Omega_\lambda) \sim \exp\left(-\frac{(\Omega_\lambda-0.7)^2}{2\sigma_\lambda^2}\right)$ with $\sigma_\lambda = 0.1$, $p(\omega) \sim \exp\left(-\frac{(\omega+1)^2}{2\sigma_\omega^2}\right)$ with $\sigma_\omega = 1$. Here $H^2(z;\Omega_m,\Omega_\lambda,\omega,H_0) = H_0^2[\Omega_m(1+z)^3 + \Omega_\lambda(1+z)^{3(\omega+1)} - \Omega_K(1+z)^2]^2$. Now by using data set and a MCMC algorithm find the best fit values for free parameters

$$\{\Theta\} \equiv \{\Omega_m, \Omega_\lambda, \omega, H_0\}$$

compare your when all priors set to constant. Plot the marginalized posterior for each free parameter. In SINA.zip folder, there are two txt files. The COV.txt is the covariance matrix of μ_i and the union_data.txt contains (z_i, μ_i) and $i = 1, ..., 580$

Good luck, Movahed