Applied Probability and Statistics [CSE-416]

Assignment No 1

1. Explain the Newton-Raphson method with an example. What is the applicability of the Newton-Raphson method?
2. Find the solution of the linear equations 4x+3y=15, and 6x+3y=18 using LU decomposition.
3. Explain quasi-Newton methods with suitable example.
4. Find the solution of the linear equations 7x-5y=12, and -5x+7y=-12 using Cholesky decompositions
5. Differentiate Fisher scoring with Newton's method.
6. What is preconditioning in conjugate gradient method?
7. Find the solution using Cholesky decompositions of the 4x+3y=1, and 3x+4y=-1.
8. What do you mean by EM? Discuss its various derivatives.
9. Find the solution of the linear equations 3x+1y=2, and -6x-4y=-2 using LU decomposition.
10. Explain the conjugate gradient method with an example.
11. Find the solution of the linear equations 5x-2y=7, and 3x-8y=11 using LU decomposition.
12. Explain univariate and multivariate Fisher scoring along with algorithm.

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Assignment No 2

1. What is convex function? Define duality and list KKT conditions.
2. Write the algorithm for Least Angle Regression and explain with example.
3. Explain support vector machines and its applications.
4. What is interior point method and how it works?
5. Explain projected gradients method in detail.
6. Explain the LASSO regression and how it is different from Ridge regression
7. What is isotonic regression method and how it works?
8. Illustrate kriging regression method with example.
9. Explain the augmented Lagrangian methods.

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Assignment No 3

1. Where is Hidden Markov models is used and what is Hidden Markov process?
2. Explain Kalman filter and its applications.
3. Explain Markov random fields.
4. Describe Forward–backward algorithm for hidden Markov models
5. Discus the intuition behind the forward–backward algorithm in hidden Markov model.
6. Explain the utilities of Hidden Markov models.
7. Explain Hidden Markov model taking hot and cold as two hidden states and happy and sad as two observable states. Take any matrix for state transition probabilities and emission probabilities and starting state probability as [0.8,0.2]
8. There are different types of Markov models that are used situationally. List them and explain one in brief.
9. What is Kalman filter used for and how does it work?

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Assignment No 4

1. What is the core idea of quasi-Monte Carlo methods? Explain.
2. Explain the applications of Gaussian quadrature.
3. Discuss the areas in which the Quasi-Monte Carlo method is popular and why.
4. Explain the Gaussian quadrature algorithm with example.
5. Explain the quasi-Monte Carlo method with its applications.
6. Find the solution of $\int_1^2 x^2\,dx$ using two-point Gaussian quadrature algorithm.
7. Find the solution of $\int_1^2 (2x + \frac{3}{x})^2\,dx$ using two-point Gaussian quadrature algorithm.
8. Find the solution of $\int_{-1}^3 (x^2 + 2x + 1)\,dx$ using three-point Gaussian quadrature algorithm.

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Assignment No 5

1. Generate random variables $\theta_1 \dots \theta_n \sim \mathcal{N}(x, 1)$ and calculate $\hat{\delta}_m^{\pi}(x)$ for $x = 0,1,4$ Use the Central Limit Theorem to construct a measure of accuracy of your calculation.
2. Explain Markov chain Monte Carlo in brief.
3. Explain Metropolis–Hastings's algorithm.
4. What is weighted or importance sampling?
5. Explain Hamiltonian Monte Carlo and discuss its pros and cons.
6. Explain any variance reduction methods in detail.
7. What is Rejection sampling and Gibbs sampling? Describe in detail.
8. Explain Markov properties.
9. What are the implementation issues in MCMC.
10. How does stratified sampling can be used as variance reduction methods?
11. Discus any two Markov Chain Monte Carlo (MCMC) methods for sampling from a probability distribution.
12. What is Burn-In in Markov chain Monte Carlo. Is it a necessary part of Markov chain Monte Carlo?
13. Design a rejection sampling algorithm for generating samples from a distribution with the following pdf: $\pi(x) = \frac{3}{2}x^3 + \frac{11}{8}x^2 + \frac{1}{6}x + \frac{1}{12}, 0 \leq x \leq 1$
14. Design a rejection sampling algorithm for generating samples from a distribution with the following pdf: $f(x) = e^{-\frac{x^2}{2}}(\sin^2(6 + x) + 3\cos^2 x \sin^2(4x) + 1)$
15. Use the acceptance-rejection technique to construct a complete algorithm for generating samples from $f(x) = 6x(1 - x), 0 < x < 1$, by first generating samples from the distribution with density $h(x) = 2(1 - x)$.