

# Math 4610 Exam II Questions - Fall 2022

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1. Explain the difference between concurrent processes and parallel processes in computing.
2. From a mathematical point of view describe the difference between a data fitting problem where the size of the matrix is larger than the number of coefficients being determined or fit and the case where the size of the matrix is the same as the number coefficients to be determined. Hint: Think about determining the order of convergence from computed errors when approximating derivatives or when approximating definite integrals.
3. Explain the differences between direct methods iterative methods for the solution of linear systems of equations  $Ax = b$ . Use examples of direct methods like Gaussian elimination with back substitution or LU factorization on the direct solution side and Jacobi and Gauss-Seidel on the iterative method side.
4. Describe how the residual vector can be used to compute the error in an approximate solution of linear systems of equations. How does this compare to the exact solution and when is the residual preferable to estimating the exact error from the approximation.
5. How are the normal equations used in the determination of the rate of convergence of an algorithm for fitting errors?
6. Describe the pros and cons of using Jacobi iteration and Gauss-Seidel iteration in the solution of linear systems of equations. Your description should include terms like efficiency, accuracy, and robust.
7. Describe the mathematics of the power method. That is, give a brief explanation of the mathematics behind the power method for computing the largest eigenvalue of the matrix.
8. What is the inverse power method for finding the smallest eigenvalue of the smallest eigenvalue of a matrix.
9. What is the Rayleigh quotient and how is it used to approximate eigenvalues of a matrix?
10. Suppose you want to compute an approximate value for the eigenvalue of a matrix that is closest to a given real number, say  $\mu$ . Describe how to do this using a variant of the power method.
11. What is Moore's law for computer performance? Does this still apply and how can parallel computation be used to compensate for the so-called "Power Wall" in the design of hardware?

12. Describe the three ways to interact with OpenMP to achieve parallelization of serial code.