Based on the uploaded document *"Basics of Linear Algebra for Machine Learning by Jason Brownlee"* and your request, here are **50 multiple-choice questions (MCQs)** of **all difficulty levels** (Easy, Medium, Hard) covering essential topics like vectors, matrices, matrix operations, decomposition, PCA, and applications in machine learning.

✅ Easy Level (1–20)

1. **What is a vector?**
   A) A table of numbers
   B) A single number
   C) An array of numbers arranged in a row or column
   D) A matrix with more than one row
   Ans: C

2. **Which operation is used to compute similarity between two vectors?**
   A) Cross product
   B) Dot product
   C) Scalar addition
   D) Vector subtraction
   Ans: B

3. **What does L1 norm measure?**
   A) Max element
   B) Sum of squared values
   C) Sum of absolute values
   D) Average of all elements
   Ans: C

4. **The dot product of two orthogonal vectors is:**
   A) 1
   B) -1
   C) 0
   D) Undefined
   Ans: C

5. **Which matrix has only diagonal elements non-zero?**
   A) Identity matrix
   B) Diagonal matrix
   C) Sparse matrix
   D) Null matrix
   Ans: B

6. **Which type of matrix has equal rows and columns?**
   A) Row matrix
   B) Column matrix

C) Square matrix
D) Triangular matrix
Ans: C

7. **Matrix multiplication is valid when:**
    A) Dimensions match
    B) Rows of A = columns of B
    C) Columns of A = rows of B
    D) Any two matrices
    Ans: C

8. **Which function is used in NumPy to compute transpose?**
    A) `.swap()`
    B) `.transpose()`
    C) `.inverse()`
    D) `.rank()`
    Ans: B

9. **The identity matrix acts like:**
    A) A scalar
    B) Zero matrix
    C) Neutral element in multiplication
    D) Transpose of any matrix
    Ans: C

10. **Which norm is also known as Euclidean norm?**
    A) L0
    B) L1
    C) L2
    D) Max Norm
    Ans: C

11. **Which matrix operation changes rows into columns?**
    A) Transpose
    B) Inverse
    C) Multiplication
    D) Decomposition
    Ans: A

12. **What is the determinant of an identity matrix?**
    A) 0
    B) -1
    C) 1
    D) Undefined
    Ans: C

13. **Which matrix has a determinant of zero?**
    A) Invertible
    B) Non-singular
    C) Singular
    D) Orthogonal
    Ans: C

14. **Which matrix type is equal to its own transpose?**
    A) Diagonal
    B) Triangular
    C) Symmetric
    D) Orthogonal
    Ans: C

15. **The inverse of an orthogonal matrix is equal to:**
    A) Zero matrix
    B) Diagonal matrix
    C) Its transpose
    D) Its determinant
    Ans: C

16. **What is the rank of a matrix?**
    A) Number of columns
    B) Number of rows
    C) Number of linearly independent rows or columns
    D) Maximum value in matrix
    Ans: C

17. **Principal Component Analysis (PCA) is used for:**
    A) Data normalization
    B) Dimensionality reduction
    C) Data encoding
    D) Classification
    Ans: B

18. **Which of the following is not a matrix decomposition technique?**
    A) LU
    B) QR
    C) FFT
    D) Cholesky
    Ans: C

19. **What is a sparse matrix?**
    A) A matrix with only diagonal elements
    B) A matrix with many zero elements
    C) A matrix with only one row
    D) A matrix with all elements zero

Ans: B

20. **Which value in eigendecomposition indicates the importance of a component?**
    A) Eigenvector
    B) Eigenvalue
    C) Diagonal entry
    D) Trace
    Ans: B

✅ Medium Level (21–40)

21. **If a matrix has full rank, it means:**
    A) It has zero determinant
    B) All rows or columns are linearly independent
    C) It is singular
    D) It is sparse
    Ans: B

22. **Which method is used to solve Ax = b when A is not square?**
    A) SVD
    B) LU
    C) Dot product
    D) Identity matrix
    Ans: A

23. **What is the purpose of the covariance matrix in PCA?**
    A) Normalize data
    B) Measure variance
    C) Capture relationships between variables
    D) None
    Ans: C

24. **Which matrix has 1s on diagonal and 0 elsewhere?**
    A) Symmetric
    B) Identity
    C) Diagonal
    D) Inverse
    Ans: B

25. **In SVD, the matrix is decomposed into:**
    A) Q, R
    B) L, U
    C) U, Σ, V^T
    D) X, Y, Z

Ans: C

26. **Which matrix decomposition is used when the matrix is symmetric and positive-definite?**
    A) LU
    B) Cholesky
    C) QR
    D) PCA
    Ans: B

27. **Which Python library is widely used for matrix computation?**
    A) Matplotlib
    B) Pandas
    C) NumPy
    D) Scikit-learn
    Ans: C

28. **Which of the following is not a vector operation?**
    A) Norm
    B) Addition
    C) Dot product
    D) Rank
    Ans: D

29. **Trace of a matrix refers to:**
    A) Sum of elements
    B) Product of diagonals
    C) Sum of diagonal elements
    D) Determinant
    Ans: C

30. **A matrix is invertible if:**
    A) Its determinant is zero
    B) It is symmetric
    C) It has full rank
    D) All entries are non-zero
    Ans: C

31. **Which concept ensures axes in PCA are orthogonal?**
    A) Covariance
    B) Eigenvectors
    C) Transpose
    D) Rank
    Ans: B

32. **NumPy's `dot()` function computes:**
    A) Element-wise multiplication

B) Transpose
C) Dot product
D) Diagonal
Ans: C

33. **Matrix A is of size 3x2. Matrix B is of size 2x3. What will be the shape of AB?**
    A) 2x2
    B) 3x3
    C) 2x3
    D) 3x2
    Ans: B

34. **Which operation cannot be applied to all matrices?**
    A) Transpose
    B) Inverse
    C) Dot product
    D) Addition
    Ans: B

35. **What happens if you multiply a matrix by its inverse?**
    A) Identity matrix
    B) Zero matrix
    C) Transpose
    D) Rank 1 matrix
    Ans: A

36. **Which matrix multiplication rule is correct?**
    A) AB = BA always
    B) AB ≠ BA generally
    C) AB = A+B
    D) AB = B/A
    Ans: B

37. **Which of the following reduces overfitting in linear regression?**
    A) Normal equation
    B) Regularization
    C) Transpose
    D) Covariance
    Ans: B

38. **Which matrix has eigenvalues 1?**
    A) Identity
    B) Diagonal
    C) Singular
    D) Rank deficient
    Ans: A

39. **If eigenvalue is 0, then the matrix is:**
    A) Non-invertible
    B) Invertible
    C) Diagonal
    D) Orthogonal
    Ans: A

40. **Which is not a reason to use PCA?**
    A) Reduce noise
    B) Increase accuracy of raw features
    C) Reduce dimensionality
    D) Speed up training
    Ans: B

✅ Hard Level (41–50)

41. **If a matrix is not square but full rank, which decomposition helps compute a pseudoinverse?**
    A) QR
    B) LU
    C) SVD
    D) Eigen
    Ans: C

42. **Which property defines an orthogonal matrix Q?**
    A) $Q = Q^2$
    B) $Q^T = Q$
    C) $Q^{-1} = Q^T$
    D) $Q = -Q$
    Ans: C

43. **Which of the following does PCA rely on?**
    A) LU decomposition
    B) Singular values
    C) Covariance matrix
    D) Determinant
    Ans: C

44. **What does it mean if all eigenvalues of a matrix are real and positive?**
    A) Matrix is diagonal
    B) Matrix is orthogonal
    C) Matrix is positive definite
    D) Matrix is singular
    Ans: C

45. **Which decomposition is used in gradient descent initialization for linear regression?**
    A) QR
    B) LU
    C) Cholesky
    D) None
    Ans: D

46. **The PCA components are:**
    A) Eigenvectors of input matrix
    B) Eigenvectors of covariance matrix
    C) Diagonal elements
    D) Singular values
    Ans: B

47. **What is the shape of the covariance matrix for m features?**
    A) m x 1
    B) m x m
    C) 1 x m
    D) m x n
    Ans: B

48. **In PCA, what does projecting data onto eigenvectors achieve?**
    A) Noise addition
    B) Data corruption
    C) Data reconstruction
    D) Dimensionality reduction
    Ans: D

49. **What is the eigen decomposition formula for symmetric matrix A?**
    A) $A = U\Sigma V^T$
    B) $A = Q\Lambda Q^T$
    C) $A = LU$
    D) $A = AB$
    Ans: B

50. **In SVD, which matrix contains singular values?**
    A) U
    B) Σ
    C) V
    D) V^T
    Ans: B

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