**Determinants**

1. The determinant of an NxN matrix can be computed using the co-factor expansion across any row or down any column
2. If A is a triangular matrix then det(A) is the product of the entries of the diagonal of A
   1. R1 = R1 + cR2 then det(A) = det(A)
   2. R1 switched with R2 then det(A) = -det(A)
   3. R1 = cR1 then det(A) = c\*det(A)
3. Invertible if an only if det(A) != 0
4. det(At)­=det(A)
5. det(AB) = det(A) \* det(B)

**Vector Spaces**

1. The sum of u and v, denoted by u + v is in V
2. u+v = v+u
3. (u+v) +w=u+(v+w)
4. There is a zero vector in V such that u+0=u
5. For each u in V there is a vector –u in V such that u+(-u)=0
6. The scalar multiple of u by c, denoted by cu is in V
7. c(u+v) = cu + cv
8. (c+d)u = cu + du
9. c(du) = (cd)u
10. 1u = u
11. If v1 ….. vp are in a vector space V, then span {v1 ….. vp} is a subspace of V
12. The nullspace of an MxN matrix A is a subspace of Rn, the set of all solutions to a system Ax=0 of m homogeneous linear equations in n unknowns is a subspace of Rn
13. The column space of an MxN matrix a is a subspace of Rm
14. An indexed set {v1 ….. vp} of two of more vectors, with v1 != 0, is linearly dependent if and only if some vj (with j > 1) is a linear combination of the preceding vectors v1 …. vj
15. Let S = {v1 …. vp} be a set in V and let H = span {v1 ….. vp}
    1. If one of the vectors in S, say vk is a linear combination of the remaining vectors in S, then the set formed from S by removing vk still spans H
    2. If H != {0} some subset of S is a basis for H
16. The pivot columns of matrix A form a basis for Col A
17. Let B = {b1 …. bn} be a basic for vector space V. then for each x in V, there exists a unique set of scalars c1 …… cn such that x=c1b1+….+cnbn
18. Let B = {b1 …… bn} be a basic for a vector space V. Then the coordinate mapping x -> [x]b is a one-to-one linear transformation from V onto Rn
19. If a vector space V has a basis B={b1 …. bn} then any set in V containing more than n vectors must be linearly dependent
20. If a vector space V has a basis of n vectors, then every basis of V must consist of exactly n vectors.
21. Let H be a subspace of a finite-dimensional vector space V. Any linearly independent set in H can be expanded, if necessary, to a basis for H. Also, H is finite-dimensional and dim(H) <= dim(V)
22. The basis theorem: Let V be a p-dimensional vector space, p >= 1. Any linearly independent set of exactly p elements in V is automatically a basis for V. Any set of exactly p elements that spans V is automatically a basis for V

**Eigen values and vectors**

1. The eigenvalues of a triangular matrix are the entries on the diagonal
2. If v1 …. vr eigenvectors that correspond to distinct eigenvalues l1 …. lr on an NxN matrix A, then the set {v1 ….. vr} is linearly Independent

Let A be an NxN matrix then A is invertible if and only if

The number 0 is not an eiganvalue of A

The determinant of A is not zero

1. Let A and B be NxN matrices
   1. A is invertible if and only if det(A) != 0
   2. det(AB) = det(A)\*det(B)
   3. det(At) = det(A)
   4. If A is triangular then det(A) is the product of the entries on the main diagonal
   5. A row replacement operation on A does not change the determinant. A row interchange changes the sign. A row scaling also scales the determinant by the same scalar factor.
2. If NxN matrices A and B are similar, then they have the same characteristic polynomial and hence the same eiganvalues (with the same multiplicities)