PROBABILITY

Sample: set of observations drawn from a population.
Sample space: set of all possible outcomes that can happen in a chance situation.
Event: a subset of the sample space. A probability is assigned to the event.
Probability: p = # desired outcomes / # possible outcomes.
Probability Rules:

1. The probability of an outcome in the sample space is 1. **P(S)=1**
2. For any event A **0 <= P(A) <=1**
3. Disjoint events **P(A or B) = P(A)+P(B) = 1, P(A and B) = 0**
4. Complement **P(A) = 1- P(Ac)**
5. Non disjoint events **P(A or B) = P(A)+P(B) - P(A and B)**

Independent events: occurrence of one event has no effect on the other. **P(A and B) = P(A)xP(B)**
Joint probability: chance of an outcome of having two events occurring together at the same time.
Marginal probability: the probability of observing an outcome with a single variable, regardless of its other variables.
Conditional probability: the conditional probability of an event A given that the event B occurs. **P(A|B) = P(A and B)/P(B)**
Multiplication rule: P(A and B)= P(A|B)xP(B), P(A and B)= P(B|A)xP(A)
Bayes Rule: P(A|B)=P(B|A)xP(A)/P(B)
Representation: Tree/Probability table

RANDOM VARIABLES

Random variable: describes the probability for an uncertain future numerical outcome of a random process.
Discrete random variable: the set of possible outcomes is finite.
Continue random variable: can take any value within an interval.
Expected value: weighted average, **E(X) = X1*p(X1) + X2*p(X2) + … + Xn*p(Xn)**
Variance: describes the spread is the data from the mean value. **Var(X)= E[(X-m)2]**
Standard deviation: √**Var(X)**
Covariance: measures variance between two random variables. **Cov(X,Y) = (∑(Xi - Xmean)(Yj - Ymean))/n.** + = same direction
Correlation: measures strength of the relationship between variables. **Corr(X,Y) = Cov(X,Y)/(stdx*stdy).** + = variables highly correlated.
Distance matrix: squared matrix that contains the distance between the variables of the set.
I.i.d (Identically independent distributed) random variables: have same distribution and are mutually independent.

MATRICES

A_{mxn} It is a matrix with m rows and n columns.
Square matrix: when m=n
Column vector: is a matrix with only 1 column
Row vector: a matrix with only 1 row
Transpose matrix: interchange rows and columns. Notation: **A'=t(A)**
Diagonal matrix: has 0 values except the main diagonal
Symmetric matrix: square matrix unchanged when it is transposed. **A'=A**
Identity matrix: diagonal matrix with all elements of the diagonal equal to 1. Notation: I
Matrix multiplication: A_{rxm} B_{mxn}= C_{rxn}
Element-wise multiplication: A_{nxm} B_{nxm}= C_{nxm}
Inverse matrix: AA^{-1}=I
Trace: sum of the elements of the diagonal.
Determinant: Notation: **det(A)=|A|**

Eigenvalues and eigenvectors Ax =ƛx
ƛ is a scalar and is called the eigenvalue of A
x is the eigenvector belonging to **ƛ**.
Any nonzero multiple of x will be an eigenvector.
To find **ƛ: |A - ƛI|=0**