Report writing – Prague part

Trajectory inference – Tviblindi

Ring

A ring is a type of algebraic structure that defines a field. A ring consists of two main operations: addition and multiplication. These operations must satisfy certain properties, such as being closed (meaning that the result of the operation is always within the set), associative (meaning that the order of the operation doesn't change the result), and having an identity element (a special element that doesn't change the result when combined with another element). In our approach we use work on two different types of rings: “Z” as a ring of integers and “R” as a ring of real numbers. Each ring will define a set of coefficients of a chain complex

Chain complex

A chain complex is a sequence of abelian groups that are related to each other by homomorphisms called boundary operators, it provides a way to measure the "holes" in a topological space by calculating the homology or cohomology groups.. The elements of the chain complex are called chains and are usually denoted by Cn.

Chain:

In algebraic topology, a chain is a formal linear combination of simplices in a simplicial complex, where each simplex is assigned a coefficient in a group. Formally, a k-chain is a map from the set of k-simplices to a abelian group, that assigns a group element to each k-simplex.

Boundary operator:

A boundary operator, also known as a boundary homomorphism, is a function that maps the elements of one group in a chain complex (n) to the elements of the next group in the sequence (n-1). It is denoted by the symbol ∂n and maps a chain from a group Cn to the next group Cn-1. The boundary operator is a linear map and it satisfies the property ∂n-1 ∂n = 0, this means that the boundary of a boundary is always zero. This property is called the boundary condition, and is a fundamental property of chain complexes. The boundaries in a dimension n are the image of the boundary operator applied on a chain of dimension n+1:

Cycle:

A cycle is a chain in a chain complex whose boundary is equal to zero. It is an element of the chain group Cn that is mapped to zero by the boundary operator, ∂n. In other words, a cycle is a chain that "closes" and does not have any boundaries, hence, it is a chain complex that sends the boundary operator into resulting 0 such as:

Homology:

Homology provides a way to measure the "holes" in a topological space by counting the number of cycles in different dimensions, modulo the boundaries:

Graph

A graph consists of a set of vertices (or nodes) and a set of edges, which connect the vertices. The edges can be directed or undirected, and they can be weighted or unweighted. Formally, a graph G = (V, E) is defined as a set of vertices V and a set of edges E, where each edge is a pair of vertices (u, v) such that u, v ∈ V.

Degree matrix

A degree matrix of a graph is a square matrix that describes the degree of each vertex in the graph. Formally, let G = (V, E) be a graph where V is the set of vertices and E is the set of edges. The degree of a vertex v in G is the number of edges incident to v. The degree matrix D of G is a square matrix of size |V| x |V|, where the element D[i,i] is the degree of vertex i, and all other elements are 0.

Adjacency Matrix

An adjacency matrix is a square matrix that describes the connection between vertices in a graph. Formally, let G = (V, E) be a graph where V is the set of vertices and E is the set of edges. The adjacency matrix A of G is a square matrix of size |V| x |V|, where the element A[i,j] = 1 if there is an edge between vertices i and j, and 0 otherwise. If the graph is directed the element A[i,j] = 1 represents that there is an edge from vertex i to vertex j, and if the graph is undirected, the element A[i,j] = 1 represents that there is an edge between vertices i and j.

Transition Matrix

A transition matrix is a square matrix that represents the probabilities of moving from one state to another in a system with a finite number of states. Each element in the matrix shows the probability of transitioning from one state to another, and the rows of the matrix add up to 1, meaning that the system will move to one of the states.

RNA velocity workflow

Pseudotime

Laplacian

The Laplacian matrix of a graph can be calculated from the adjacency matrix and the degree matrix using the following formula:

L = D - A

Where L is the Laplacian matrix, D is the degree matrix, and A is the adjacency matrix.

Hodge decomposition

The Hodge decomposition provides a way to decompose a differential form into its "harmonic", "exact" and "co-exact" parts.

Vector space

KNN

Derham map

The weighted graph are weights on the edges, it is reversely proportional to the size of the edges.

Transition probability is a 1-form because it assigns a value to an edge.

A pseudo time is a zero form because assigns a value to each cell.