IIIT-Bangalore
SM 402 - Basic Computational Topology:
Implementation Assignments

(Total marks: 20)

Instruction: Document the details of your algorithm, implementation steps and demo-results in a pdf and submit along with the implementation sources. Put all the files in single folder and submit the zipped folder. **And show demo of your implementation.**

P1. Given any input simplicial complex (up to 3-dimensional), compute β_0 using the boundary matrix method.

P2. Given any input simplicial complex (up to 3-dimensional), compute β_1 using the boundary matrix method.

P3. Given any input simplicial complex (up to 3-dimensional), compute β_2 using the boundary matrix method.

P4. Given any input simplicial complex (up to 3-dimensional), compute β_3 using the boundary matrix method.

P5. Given any input simplicial complex (up to 3-dimensional), compute its Betti numbers using the incremental algorithm.

P6. Given any input simplicial complex (up to 3-dimensional), plot the barcode of the evolution of the Betti numbers when the simplices are added incrementally.

P7. Given a volumetric scalar data, compute a sub-level set corresponding to a given scalar value. Integrate with P1 and compute β_0 for an increasing sequence of scalar values.

P8. Given a volumetric scalar data, compute a sub-level set corresponding to a given scalar value. Integrate with P2 and compute β_1 for an increasing sequence of scalar values.

P9. Given a volumetric scalar data, compute a sub-level set corresponding to a given scalar value. Integrate with P3 and compute β_2 for an increasing sequence of scalar values.

P10. Given a volumetric scalar data, compute a sub-level set corresponding to a given scalar value. Integrate with P4 and compute β_3 for an increasing sequence of scalar values.

P11. Given a volumetric scalar data, compute a super-level set corresponding to a given scalar value. Integrate with P1 and compute β_0 for an increasing sequence of scalar values.

P12. Given a volumetric scalar data, compute a super-level set corresponding to a given scalar value. Integrate with P2 and compute β_1 for an increasing sequence of scalar values.

P13. Given a volumetric scalar data, compute a super-level set corresponding to a given scalar value. Integrate with P3 and compute β_2 for an increasing sequence of scalar values.

P14. Given a volumetric scalar data, compute a super-level set corresponding to a given scalar value. Integrate with P4 and compute β_3 for an increasing sequence of scalar values.

P15. Given any input simplicial complex (up to 3-dimensional), corresponding to each 0-hole compute a representative 0-cycle and visualize all the representative 0-cycles. (interact with P1)

P16. Given any input simplicial complex (up to 3-dimensional), corresponding to each 1-hole (tunnel) find a representative 1-cycle and visualize all the representative 1-cycles. (interact with P2)

P17. Given an input simplicial complex (up to 3-dimensional), corresponding each 2-hole (void) find a representative 2-cycle and visualize all the representative 2-cycles in the input simplicial complex. (interact with P3)

P18. Given an input triangulation of a shape or surface, compute the Morse critical points and their types using a chosen height field (Morse function). From that compute the Betti numbers of the surface.