KTH Stockholm
EECS :: CST
Visualization, Autumn 2018, DD2257
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Homework assignment No. 06

Due October 11, 2018

Before beginning the assignment, use `git pull` to get the latest version of our Inviwo repository. Run CMake and compile once more. The files `topology.h/cpp` and `integrator.h/cpp` contain additional comments and instructions.

Task 6.1: Topology of 2D Vector Fields — 15 P

Load a 2D vector field and visualize its topological skeleton, i.e., its critical points and separatrices. You can use the workspace `topology.inv`. The assignment comes with several data sets for testing. See Figure 1 for examples. In particular, implement the following features:

(a) Extraction of the critical points. This means to find the location of all critical points in the data set. Show them as thick points.
Hint: The VolumeRAM *contains the data points. To find critical points, you can use the* domain decomposition & change-of-sign test *from the lecture.* (10 P)

(b) Classification of the critical points. This means to determine the type of each critical point. The colors are given in the *ColorsCP* array, you can access them by the corresponding *TypeCP* enum value.
Hint: The Interpolator *class has a function* sampleJacobian() *to compute the Jacobian at a given location. In* util/gradient.h *you find the function* eigenAnalysis() *to compute eigenvalues and eigenvectors.* (3 P)

(c) Compute the separatrices. This means to integrate four stream lines from each saddle into the direction of the eigenvectors. Show them as lines in Inviwo. (2 P)

Task 6.2: Analytical Fields — 5 P

Load the `topology_analytical.inv` workspace. You can fill in a formula that is then sampled on a grid/volume.

(a) Create a vector field formula that has a center at position $(5, -3)$. (1 P)

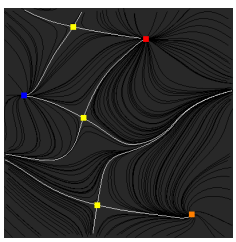
(b) Make up a vector field formula that has a saddle at position $(-2, 7)$. (1 P)

(c) Make up a vector field formula that has both the center from a) and the saddle from b). (1 P)

(d) Visualize the scalar field topology of the field $sin(x) + cos(y)$ in the range $[-10, 10] \times [-10, 10]$. (2 P)

Task 6.3: (Extra Task) Additional structures — 3 Extra Points

Another structure of vector field topology that was discussed in the lecture are *boundary switch points*. Find boundary switch points as seeds, integrate their separatrices and add them to the image.



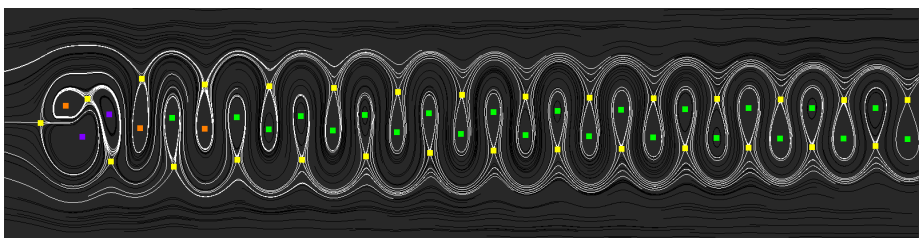


Figure 1: Topological skeletons of different data sets. The noise data set is a good reference. The distinction between foci and centers is dependent on a threshold, so your implementation might create slightly different classifications for the cylinder data sets.