Topology

- Topology Spines: A Structure-Preserving Visual Representation of Scalar Fields

  Carlos D. Correa, Peter Lindstrom, Peer-Timo Bremer

- Joint Contour Nets: Computation and Properties

  Hamish Carr, David Duke

Michael Prater, 0300450

Überblick

- Contour Tree
- Reeb-graphs
- Morse-Smale (MS) complexes
- Neue visuelle Darstellung: Topological Spines

Related Work

- Topological Analysis gut für scalar und vector valued data
- Anfängliche Forschung fokussiert sich primär auf topological structures

- Fokus hat sich geändert →
  Problem der visuellen Komplexität angehen
  Sorgfältig ausgewählte subsets anzeigen

Extremum Graphs

- Warum Extremum Graphs → beschreibt Konnektivität der spine in topological spine.
- Ziel: Balance finden zwischen Morse-Smale complex und cancellation tree

Extremum Graphs

- Morse-Smale Complex →
- Cancellation Trees →
- Extremum Graphs

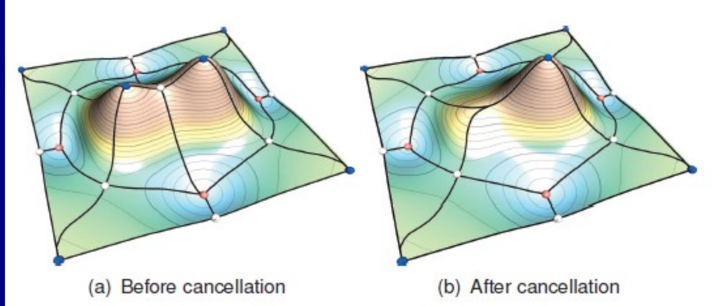


Fig. 4. Cancellation of a saddle-extremum pair. Note how the two arcs orthogonal to the cancellation are removed, while the other two remain in the simplified complex.

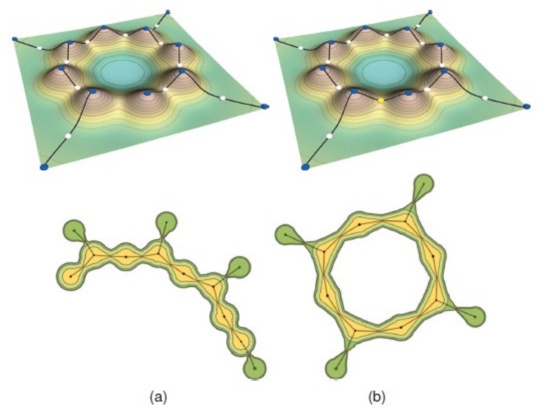


Fig. 5. (a) Cancellation tree of maxima for a cycle of hills (top) and its topological spine (bottom). Since a cycle cannot be canceled, the front most saddle is part of the minima cancellation tree, and the spine provides a misleading structure. (b) The maximum-graph of the same terrain. Since the front most saddle (yellow) is closer in function value to the maxima than to the center minimum, the maximum-graph closes the cycle and creates a more appropriate topological spine (bottom).

Topological Spines

- Canonical Topological Links
- Properties
- Rendering

Ergebnisse

- Geometric Structure from Scalar Fields

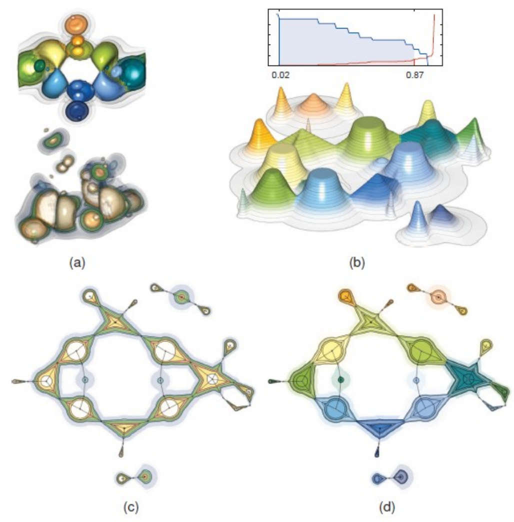


Fig. 9. Neghip data set (a) volume rendering, where color denotes each descending manifold (top) or scalar value (bottom). (b) Persistence plot and topological spine as a landscape (c–d) topological spines depicting scalar value (c) or topological segments (d). Our topological spine preserves the symmetry and cyclic structure of the molecule.

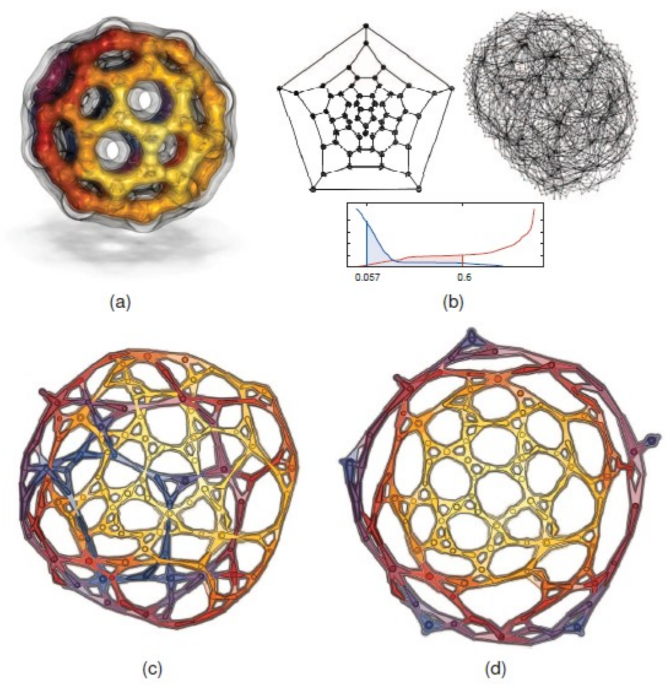


Fig. 12. (a) Bucky ball with color encoding descending manifolds. (b) Planar representation, 2D MS complex layout, and persistence plot. (c) A topological spine that preserves distances appears as a projection. Unlike in the 3D rendering, we now clearly see both the global structure and the local nesting of each bond. (d) By constraining the positions of nodes in one cycle, we can obtain a planar spine representation.

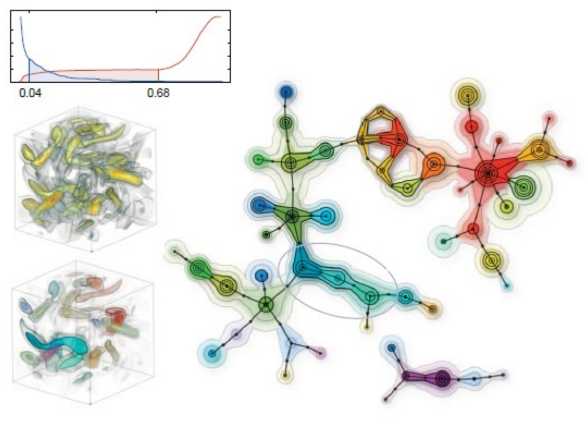


Fig. 10. Vorticity. Color coding each descending manifold allows us to identify and select features with ease. The planarity of the spine eliminates occlusion problems and facilitates feature selection. The circle contours in the topological spine allows us to select a features, highlighted in the 3D rendering in the bottom left corner.

Ergebnisse

- High-dimensional Data Exploration

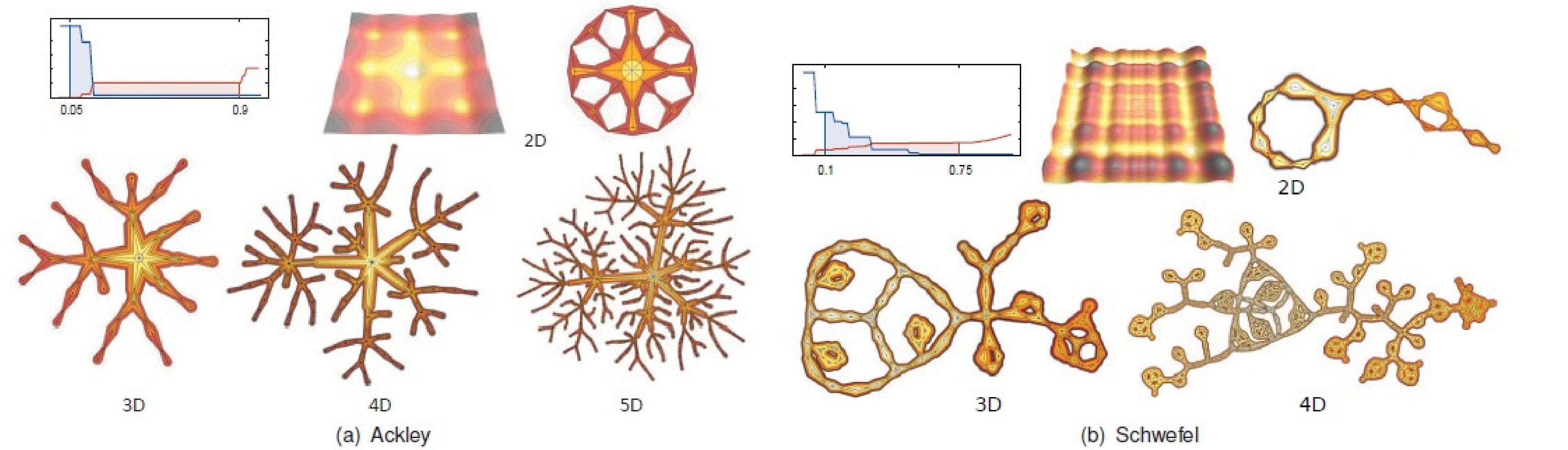


Fig. 13. Topological spines of high dimensional functions. (a) Ackley's path function in 2–5 dimensions, which reveals structural properties, such as the $2d$-fold radial symmetry and the exponential increase in complexity (the number of extrema is 3^d). (b) Schwefel's function in 2D–4D. Note that the fractal structure and the cardinality of the different geometric structures are preserved.

Ergebnisse

- Structure-preserving Topological Landscapes

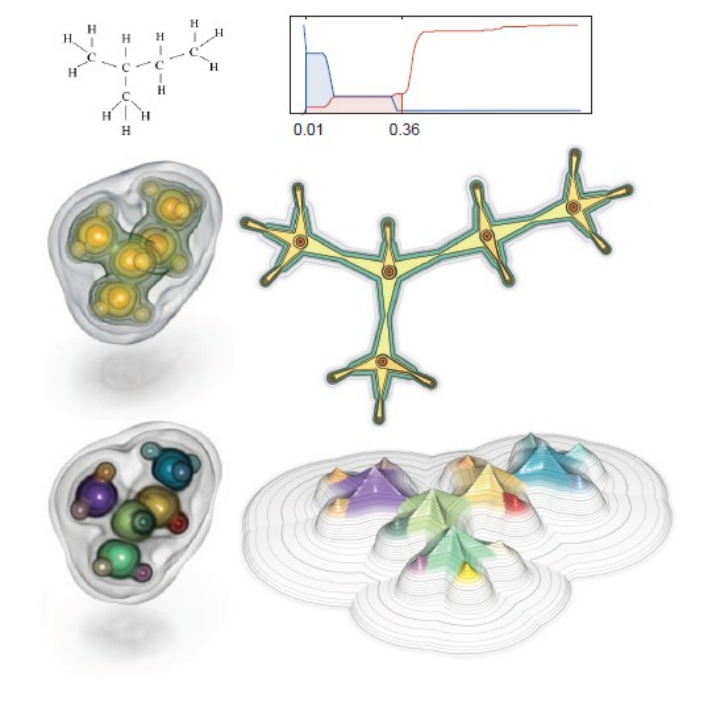
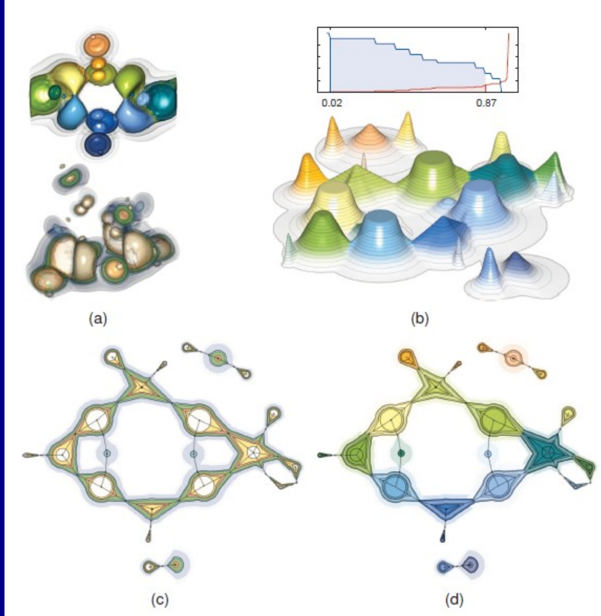


Fig. 11. Electron density of isopentane. Top: schematic and persistence plot. Middle: 3D rendering and corresponding topological spine, which accurately depicts the molecular structure. Bottom: 3D rendering with color encoding each descending manifold, and structure-preserving landscape, obtained by vertically extruding the spine.



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Limitations

- Topological spines designed für structural properties
- Nicht für andere geometric properties wie shape und curvature designed.

Joint Contour Nets

- Contour trees
- Reeb graphs

→ Joint Contour Net

Kritik

- Topological Spines
- Joint Contour Nets

Ende

Danke für eure Aufmerksamkeit