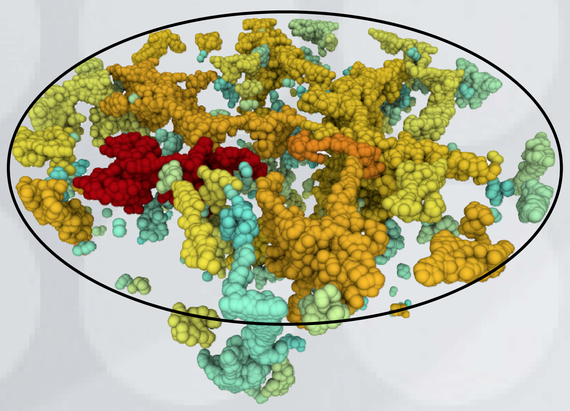
Interactive Topological Exploration of Particle Ensembles

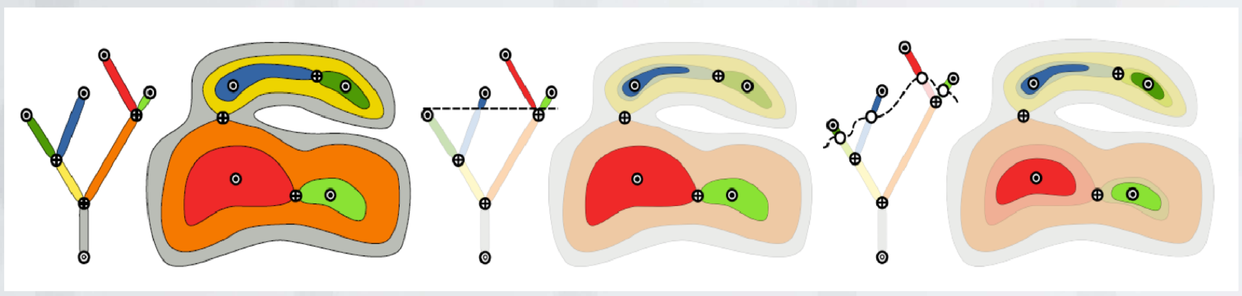
Harsh Bhatia[1], Pavol Klacansky[2], Shusen Liu[2], Wathsala Widanagamaachchi[2], Attila Gyulassy[2], Valerio Pascucci[2], Peer-Timo Bremer[1].
[1]Lawrence Livermore National Laboratory; [2]Scientific Computing & Imaging Institute, University of Utah.

Extraction of viscous fingers through topological exploration of time-varying particular simulation

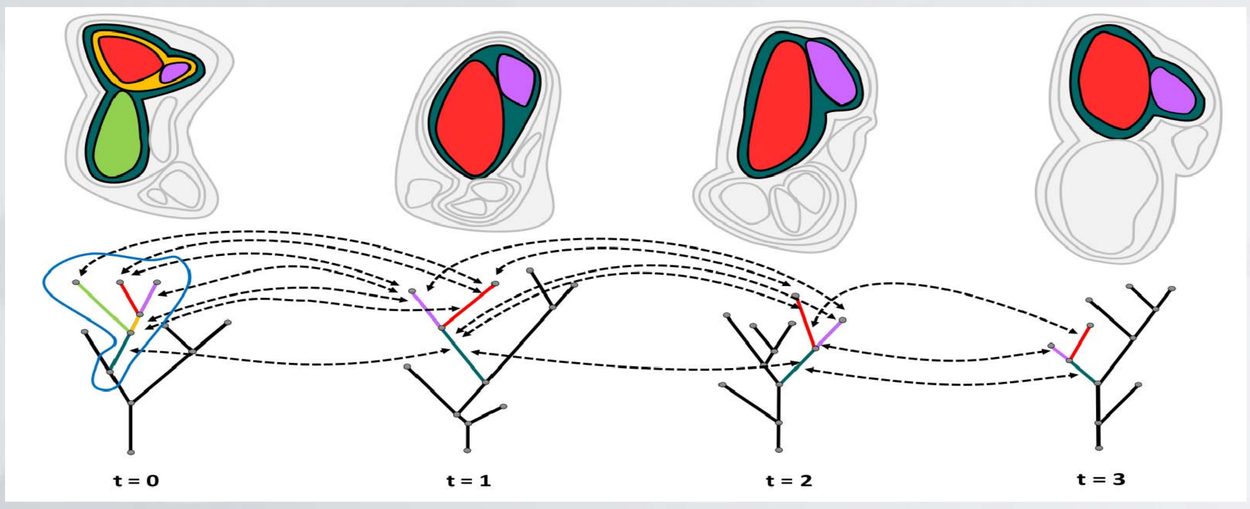


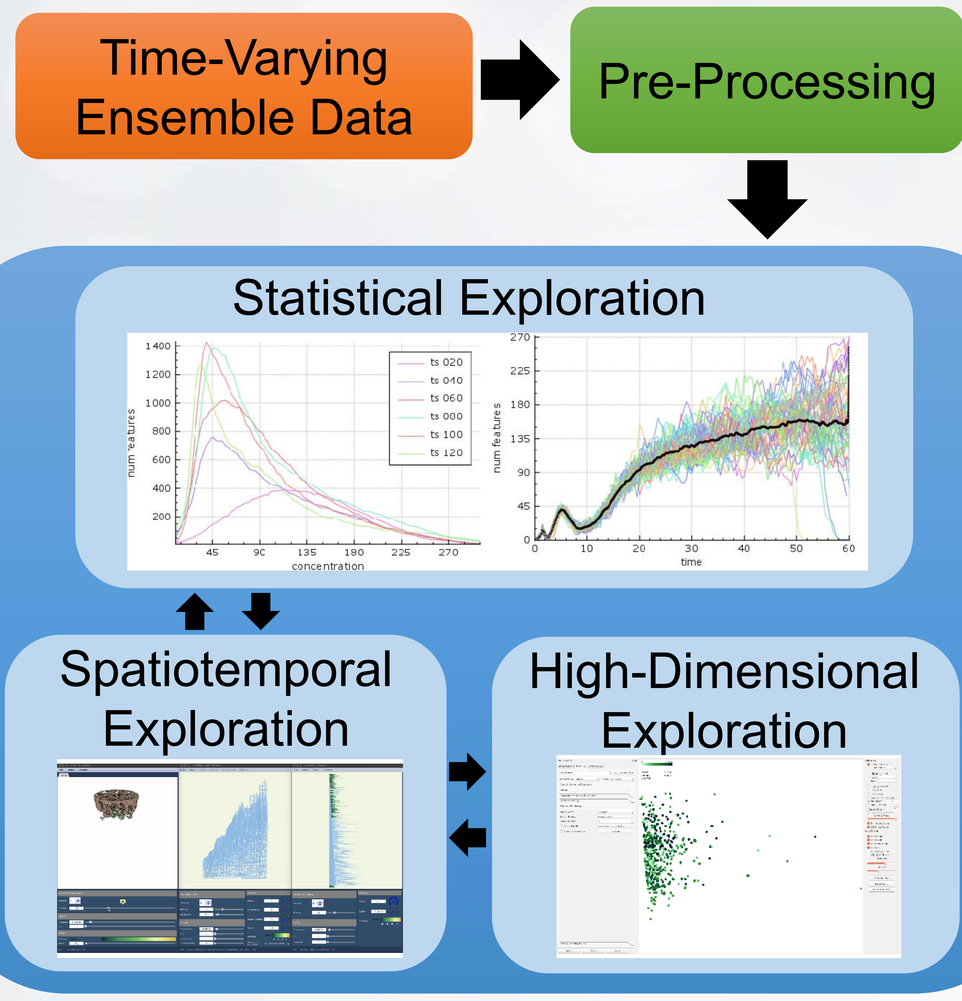
We present an integrated system of tools for exploring ensembles of time-varying particular simulations of salt diffusion. In particular, we allow scientists to interactively explore the nature and temporal evolution of viscous fingers – the primary feature of interest. Using a topological analysis of the salt concentration, our framework provides multiple inter-linked visualization and analysis tools, enabling interactive exploration of feature evolution in both space-time and parameter space. Our pipeline connects spatial visualization of fingers with the visualization and analysis of multi-dimensional statistics, and allows the scientist to interactively perform a detailed exploration of the entire ensemble.

Topological Data Analysis [1]

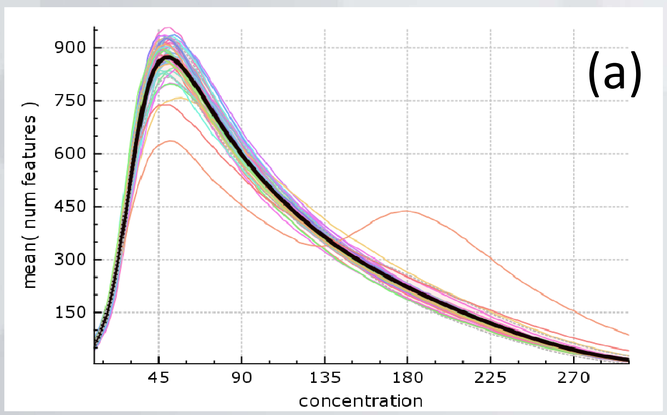


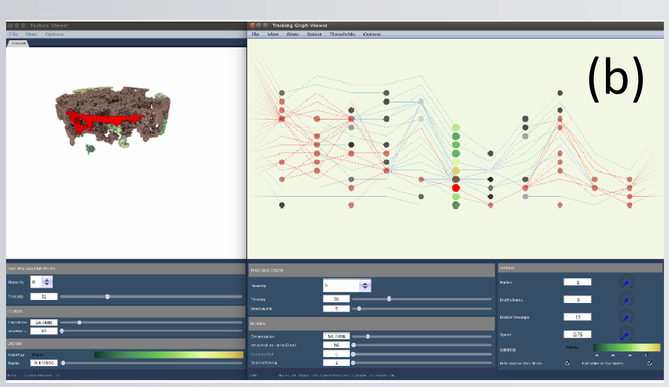
Spatiotemporal Exploration Utilizing Topology-Based Feature Tracking [2]





Exploration of Viscous Fingers in Time-Varying and Ensemble Data



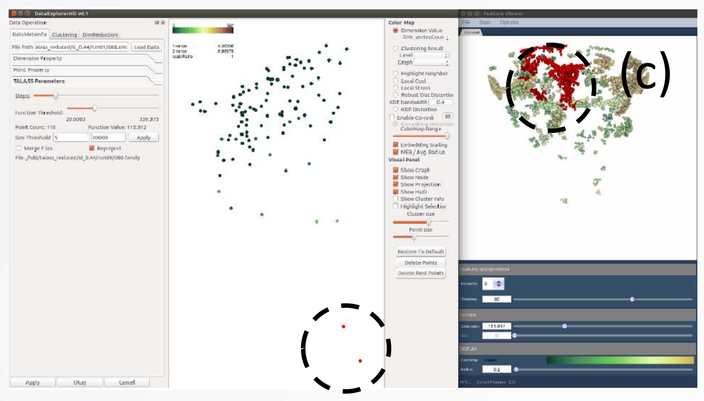


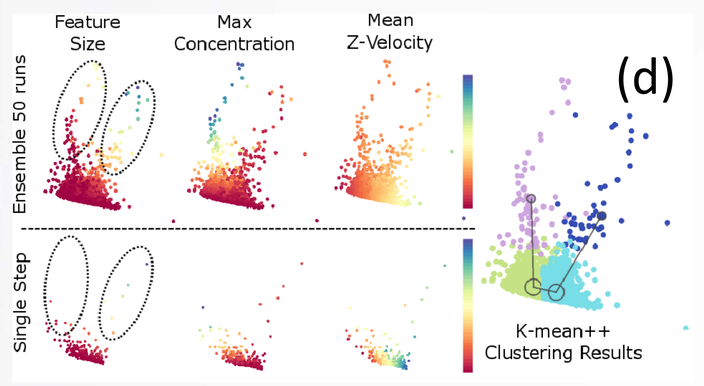
(a) Statistical exploration allows determining the threshold for capturing the finger features in the topological hierarchy, and also shows outlier runs.

(b) Feature tracking over time using **TALASS** [2] allows exploring the evolution of features over time.

(c) High-dimensional exploration using **DataExplorerHD** [3], integrated with TALASS enables the study of the feature properties as an abstract high-dimensional space.

(d) Integrated exploration highlights differences between ensembles and individual runs: the ensemble visualization of the parameters reveals interesting branching behavior.





References

[1] P.-T. Bremer, G. Weber, V. Pascucci, M. Day, and J. Bell. Analyzing and tracking burning structures in lean premixed hydrogen flames. IEEE Transactions on Visualization and Computer Graphics, 16(2):248–260, Mar 2010.
[2] W. Widanagamaachchi, C. Chrisactensen, V. Pascucci, and P.-T. Bremer. Interactive exploration of large-scale time-varying data using dynamic tracking graphs. In IEEE Symposium on Large Data Analysis and Visualization (LDAV), 9–17, Oct. 2012.
[3] S. Liu, B. Wang, J. J. Thiagarajan, P.-T. Bremer, and V. Pascucci. Visual exploration of high-dimensional data through subspace analysis and dynamic projections. In Computer Graphics Forum, volume 34, pages 271–280. Wiley Online Library, 2015.

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