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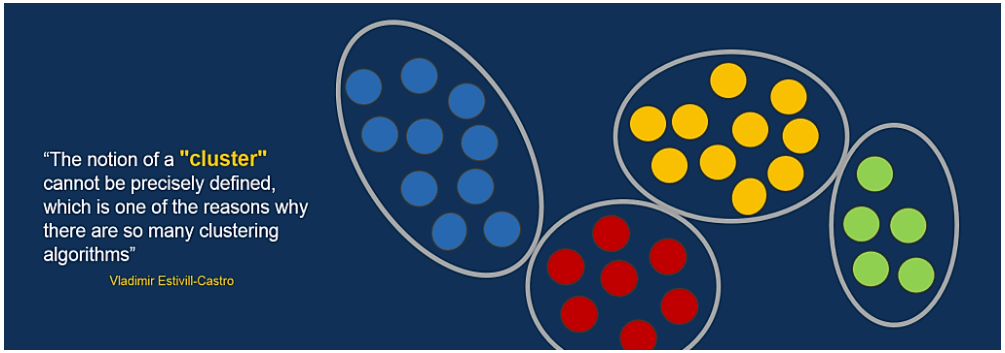
Pruning Dynamic Event Trees Using Density Peaks with Dynamic Time Warping



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Org. 6231

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U.S. DEPARTMENT OF ENERGY | National Nuclear Security Administration | LDRD Laboratory Directed Research & Development

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Outline

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1. Pruning Dynamic Event Trees
2. Density Peaks Clustering Algorithm
3. Preliminary Results and Clustering for Regression
4. Discussion
5. Future Work

Static event trees can oversimplify severe accidents

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Initiating Event: Fire

Static

Assumes the firetruck will arrive in 30 minutes.

Dynamic

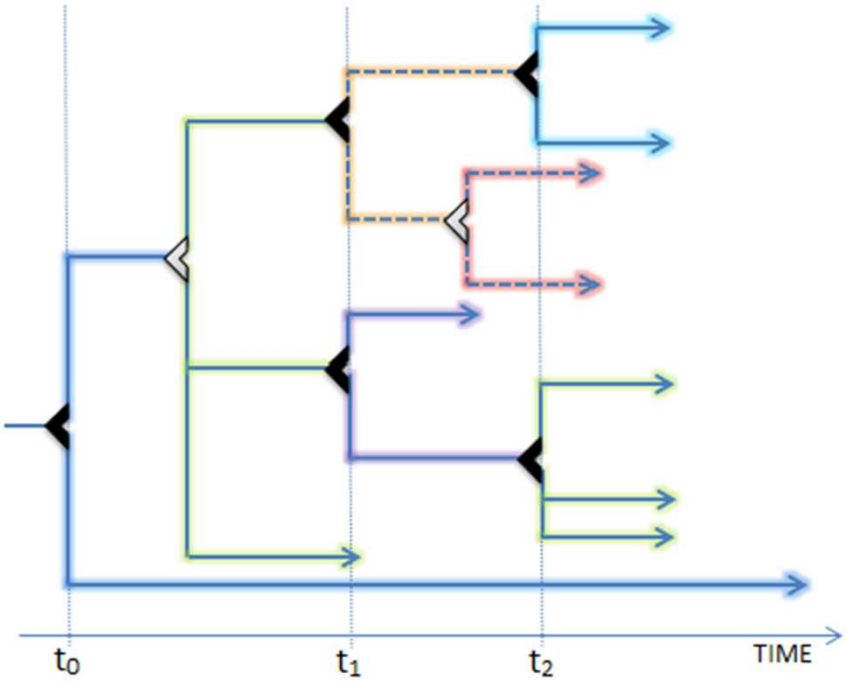
Models the firetruck driving to the house.

Accounts for possible traffic jams, car accidents, etc. that may effect arrival time.

When and Where to Prune?

The key choice that must be made is **when to stop the growth of a branch**.

Pruning can be performed at any branch point in a dynamic event tree. We propose a pruning algorithm that uses density peaks clustering with DTW.

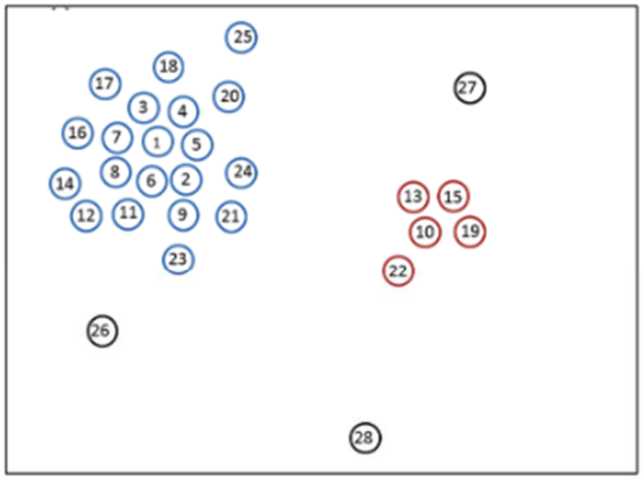


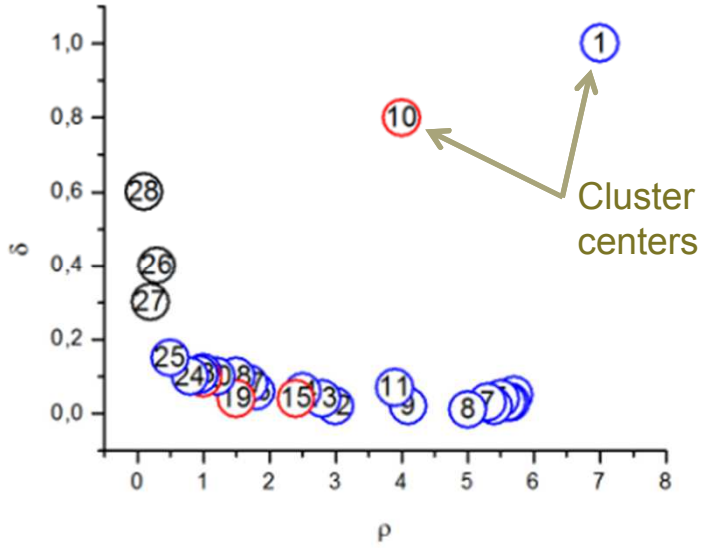
- Cluster centers will be determined at each branch point.
- Branches from clusters will be pruned.
- The number of branches pruned will be related to user-defined acceptable amount of fidelity reduction in the final tree.

Density Peaks Clustering Algorithm

Steps:

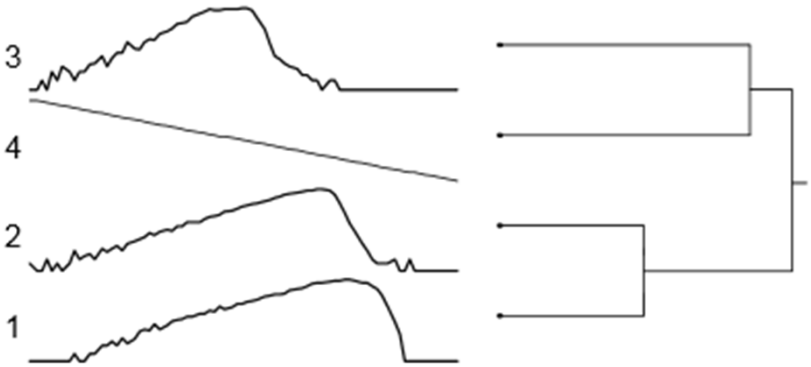
1) Create a pairwise distance matrix for two time series.
2) For each point in the matrix, calculate **the number of data points within a user-determined distance**, ρ_i.
3) Then, for each point, calculate **the distance of the closest data point of higher density**, δ_i .
4) Cluster centers are defined as those points that have the highest values of ρ_i x δ_i .



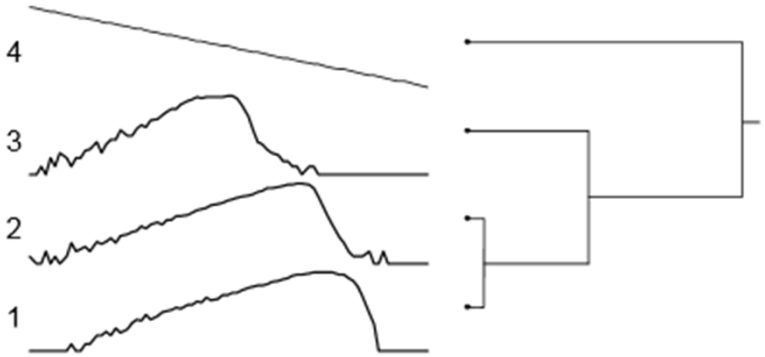


How to Create a Distance Matrix?

- Dynamic Time Warping (DTW) calculates the pairwise distance between all points in two time series.
- DTW is superior to the Euclidean distance as it can identify similarities in two time series even if there is a time lag.

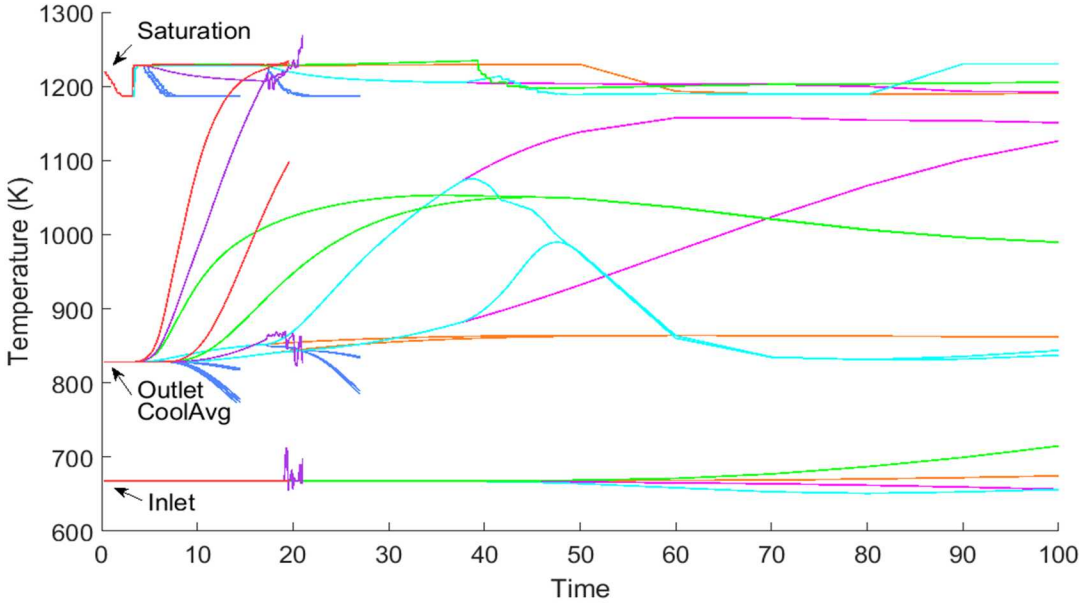


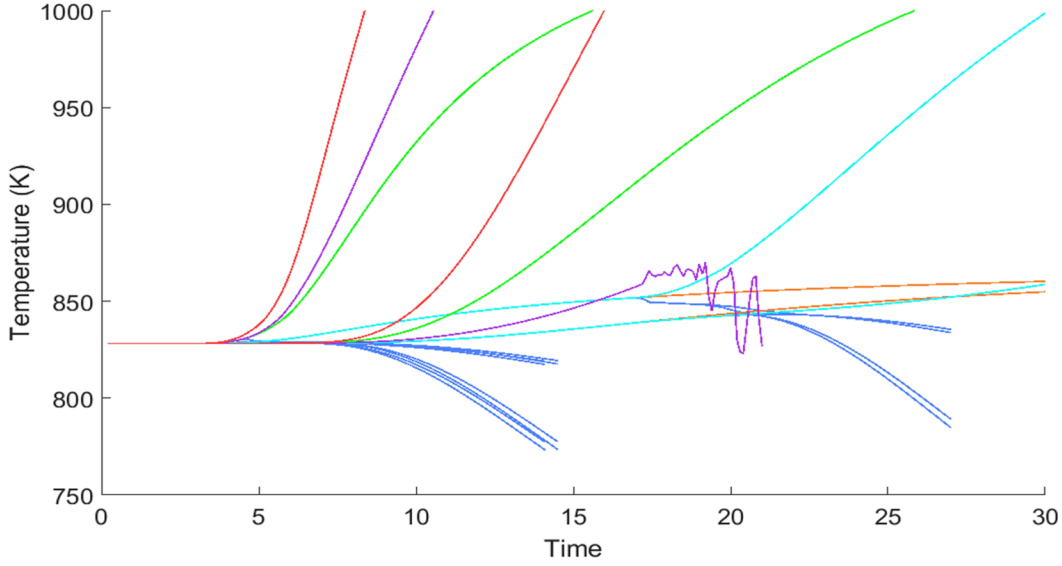
Clustering using Euclidean Distance



Clustering using DTW
More Intuitive Clustering

Preliminary Results of DP with DTW





Discussion

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Benefits of Clustering Algorithm

Arbitrary Clusters	User-Defined Parameters	Multi-Dimensional Data	Noisy Data

Further Work Needed

Time Complexity	Parameter sensitivity	Pruning Metric	Real-Time Algorithm

Conclusion

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- A pruning algorithm could help drastically reduce the computation time needed to run a large severe accident simulation.
- The clustering of time series can also be used as a tool for regression analysis.
- Future work is needed to refine the algorithm and implement it into real-time tree growth.

Personal: Nevin Martin

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- B.S. Finance, University of Arizona
- M.S. Statistics, University of New Mexico (Dec. 2016)
- Student intern since August 2015: Org. 6231 & 436
- Hope to continue work at Sandia after graduation.

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