Volume Analysis Using Multimodal Surface Similarity

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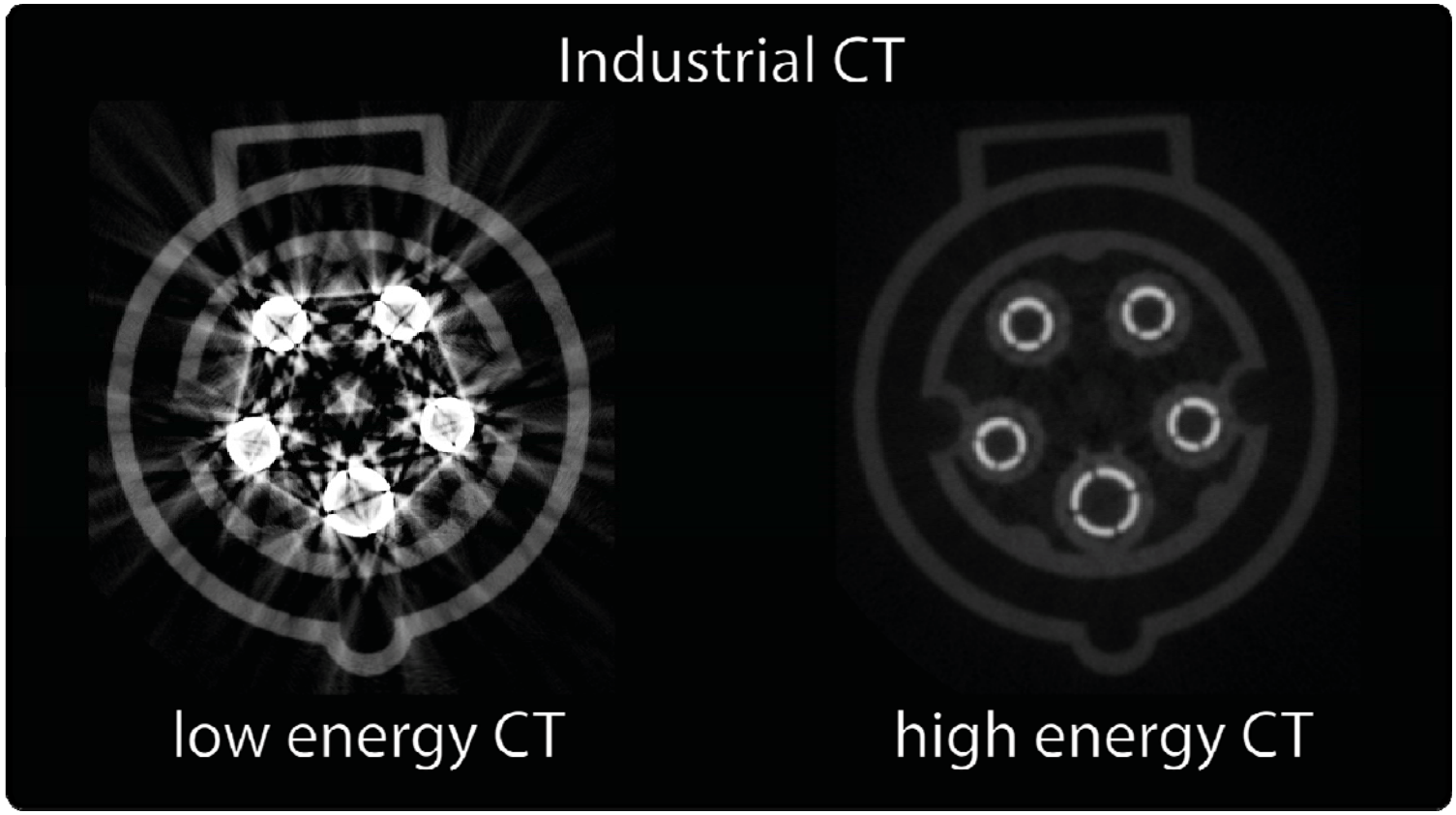
Motivation

- Multimodal data:
  - Same object, different acquisition techniques
  - One modality evens out drawback of the other



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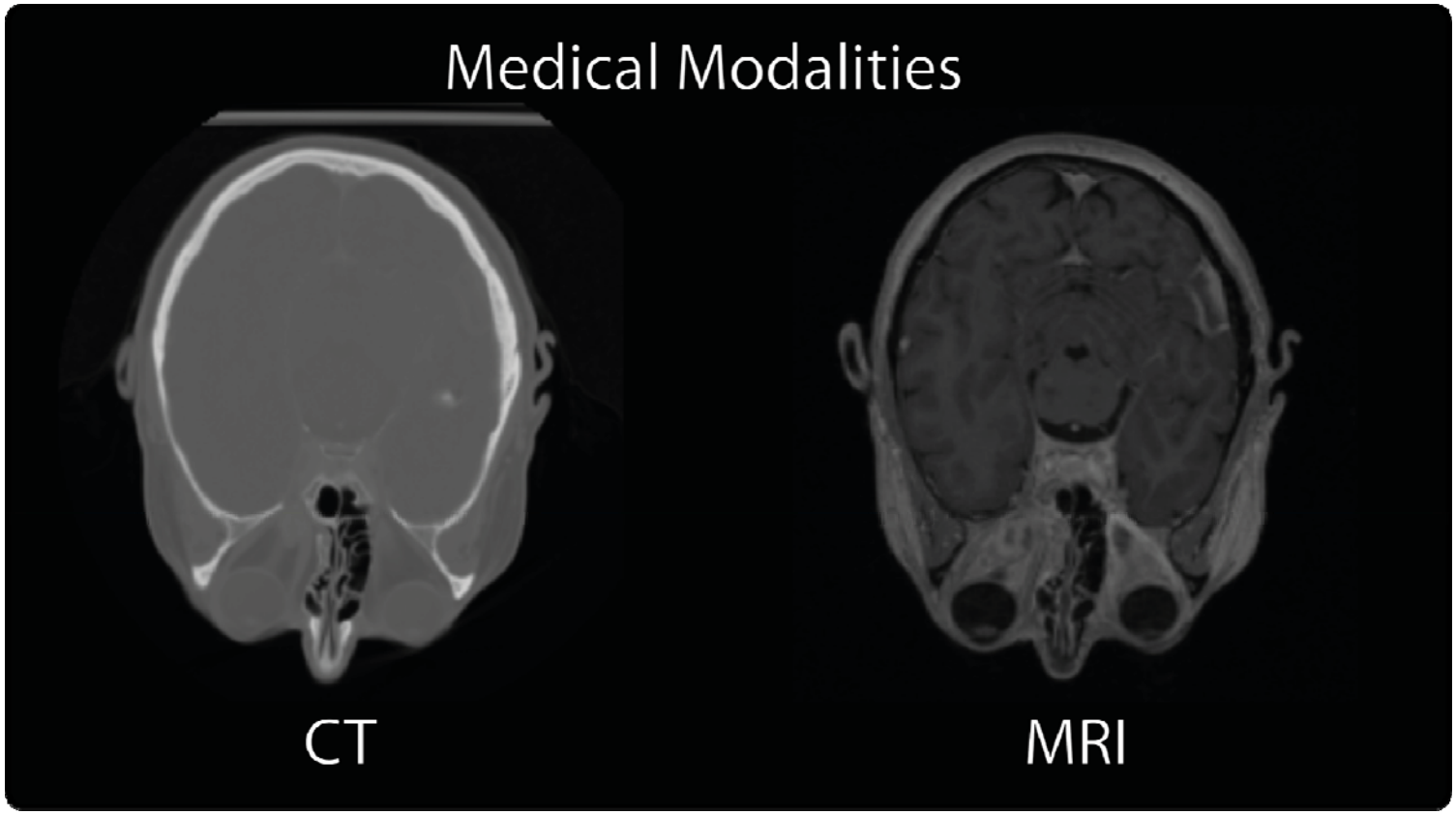
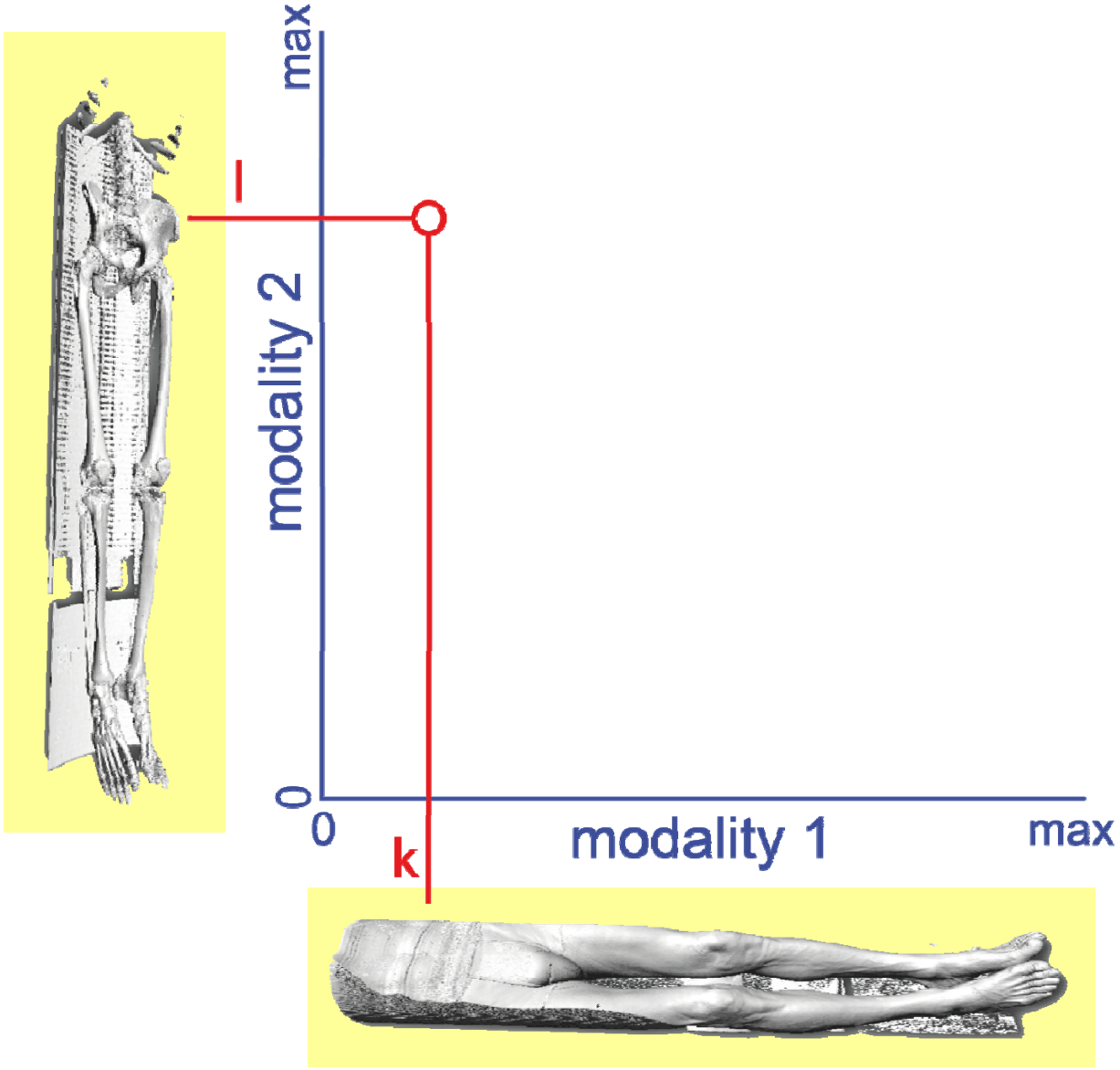


Motivation

- Multimodal visualization:
  - Side-by-side view
    - Difficult for comparison of both modalities
  - Volumetric fusion
    - Differences and/or similarities between modalities vanish through fusion
- Using similarity information to analyze and visualize multimodal data
  - Similarity of isosurfaces for combinations of isovalues

Multimodal Similarity Map (MSM)



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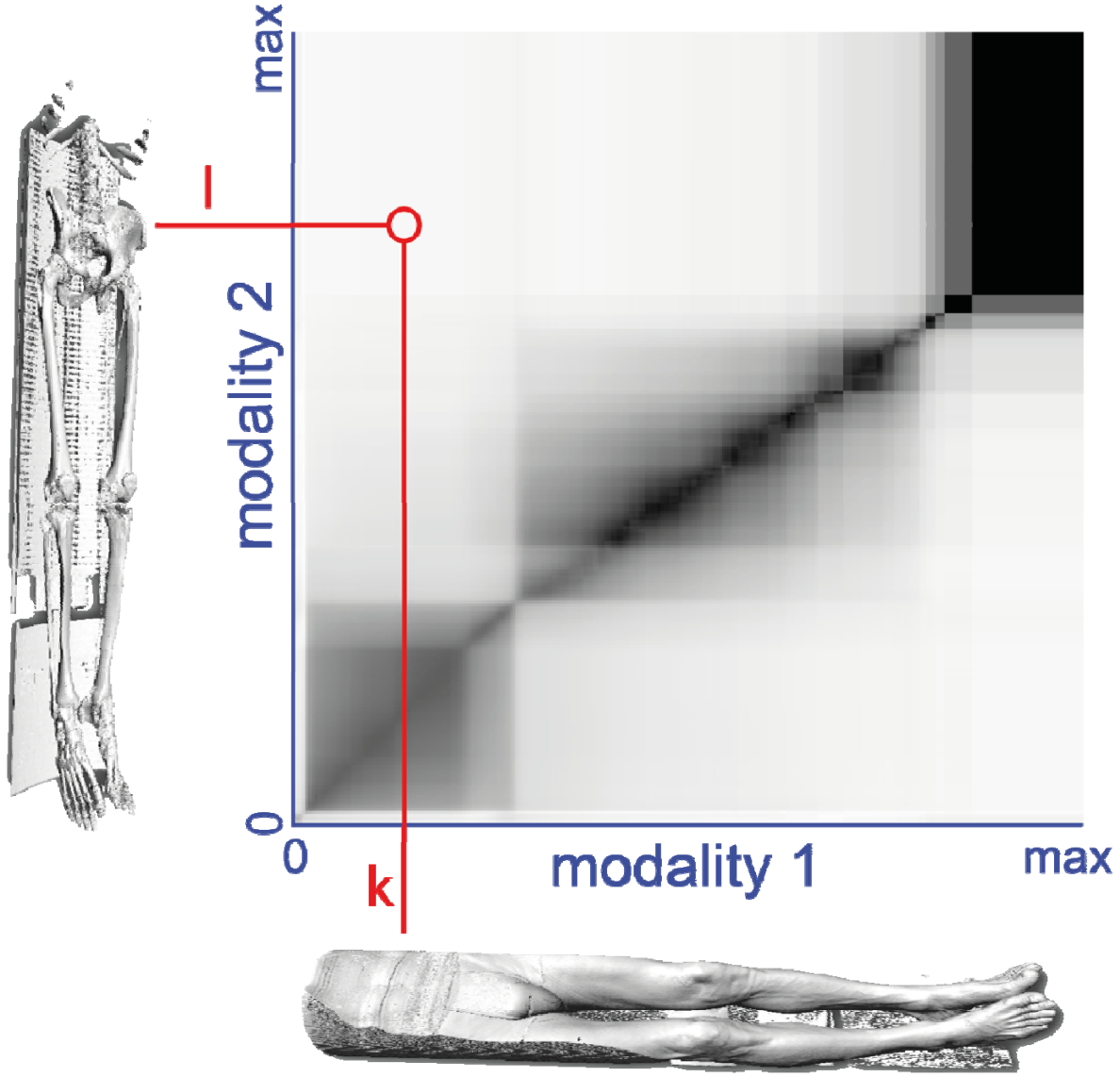
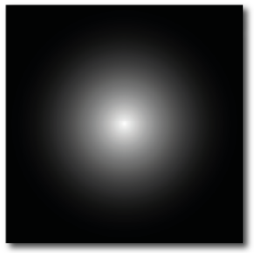
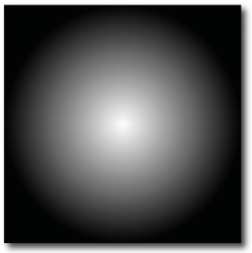


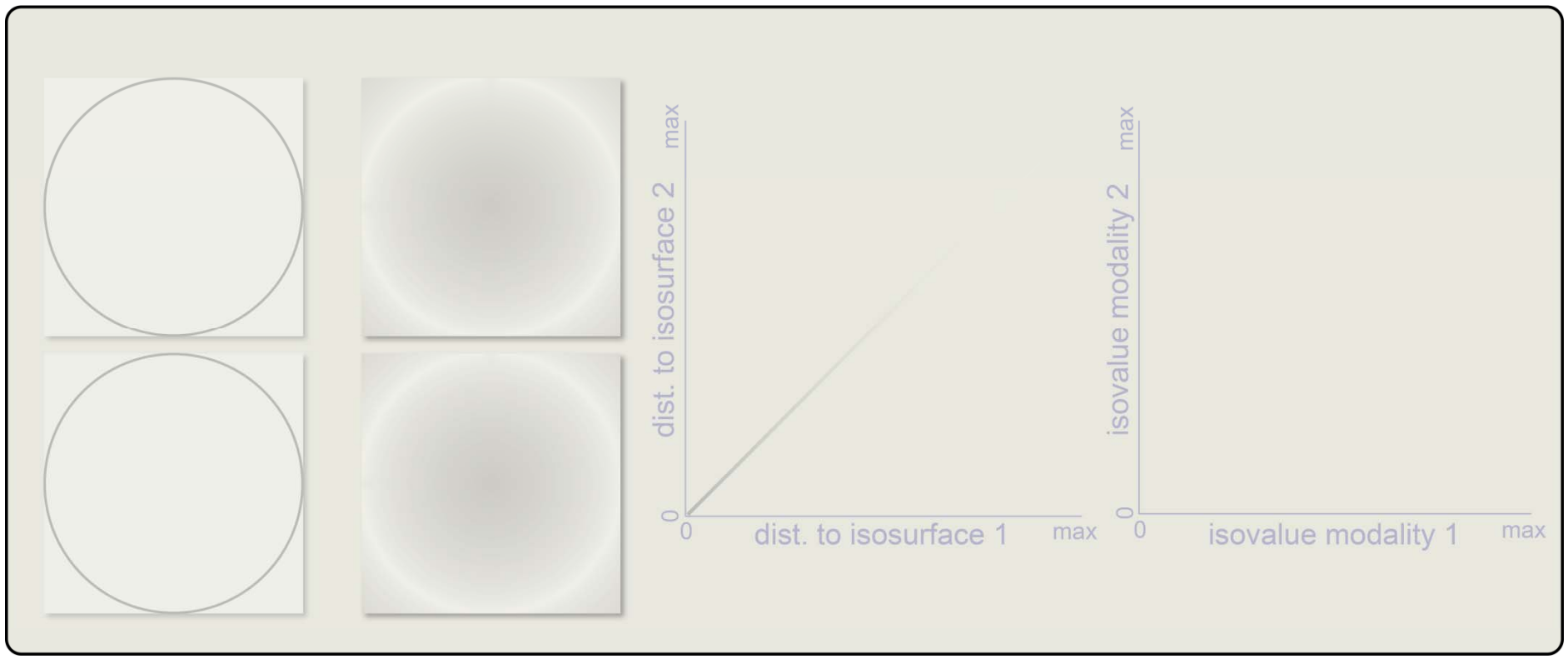
MSM Calculation

modality 1





modality 2



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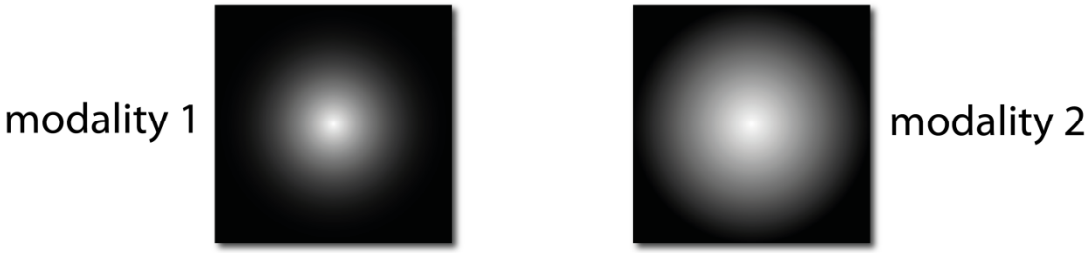

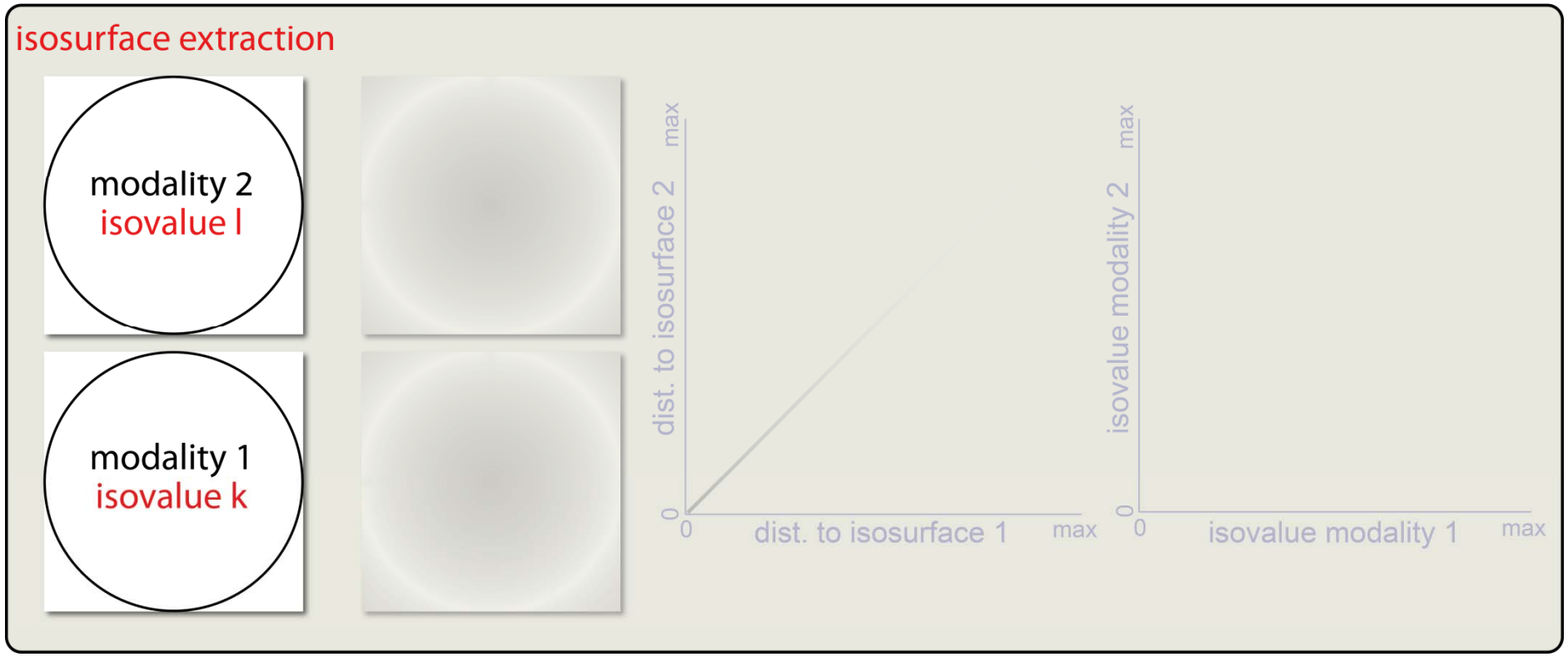

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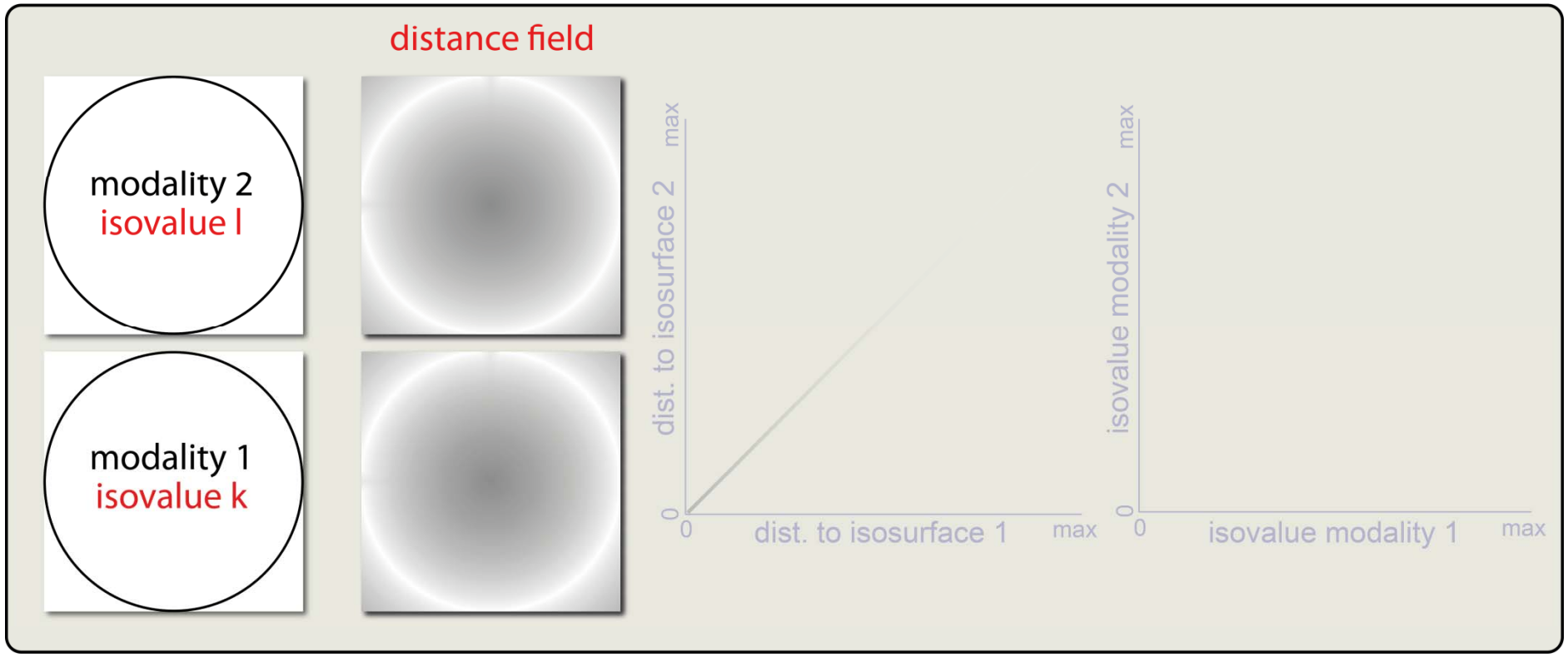

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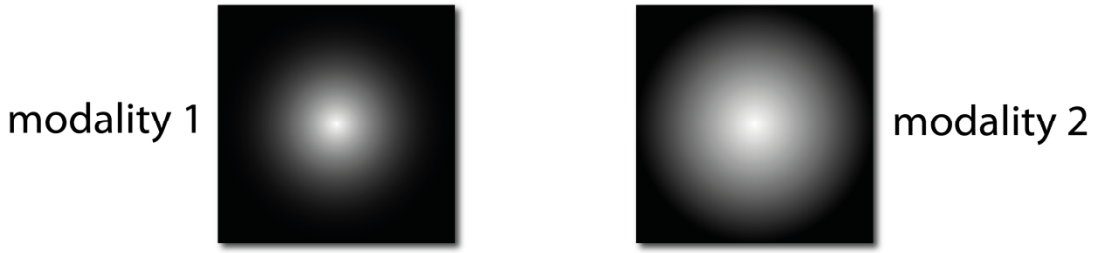

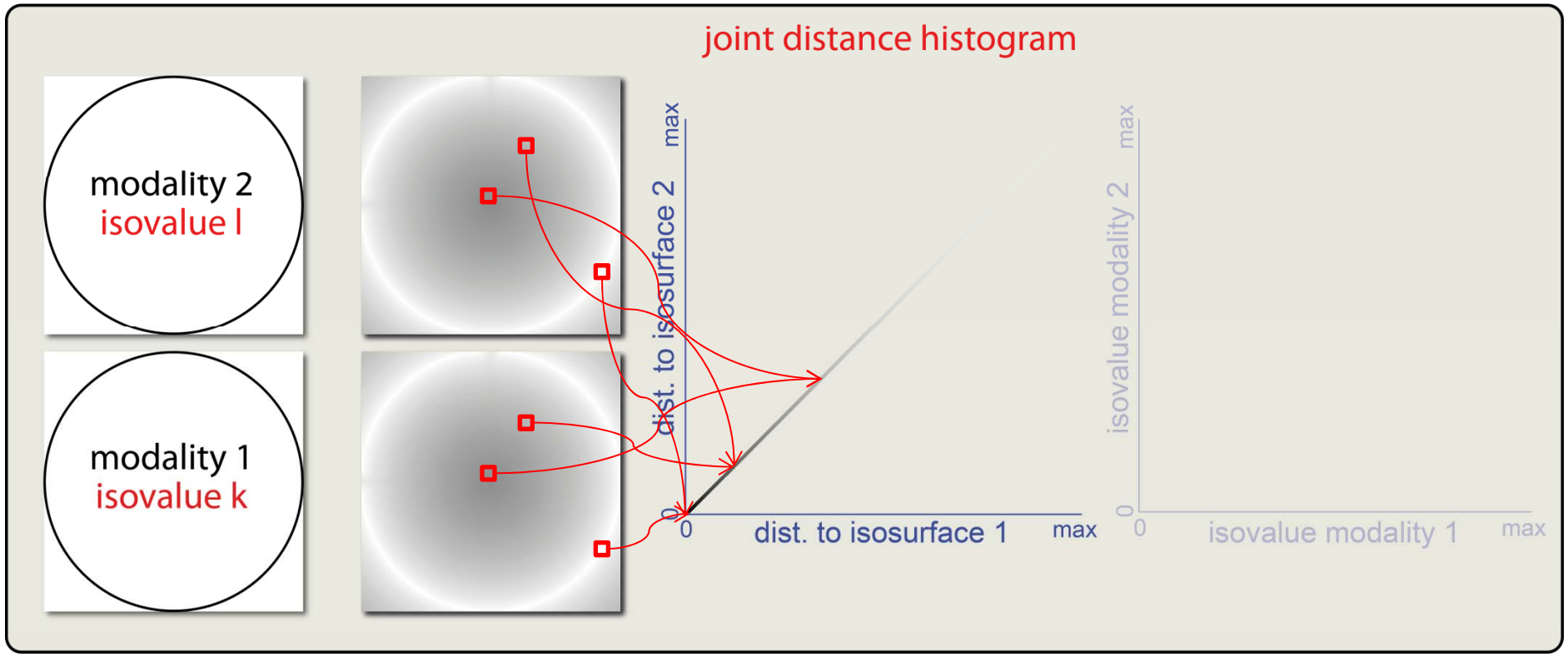

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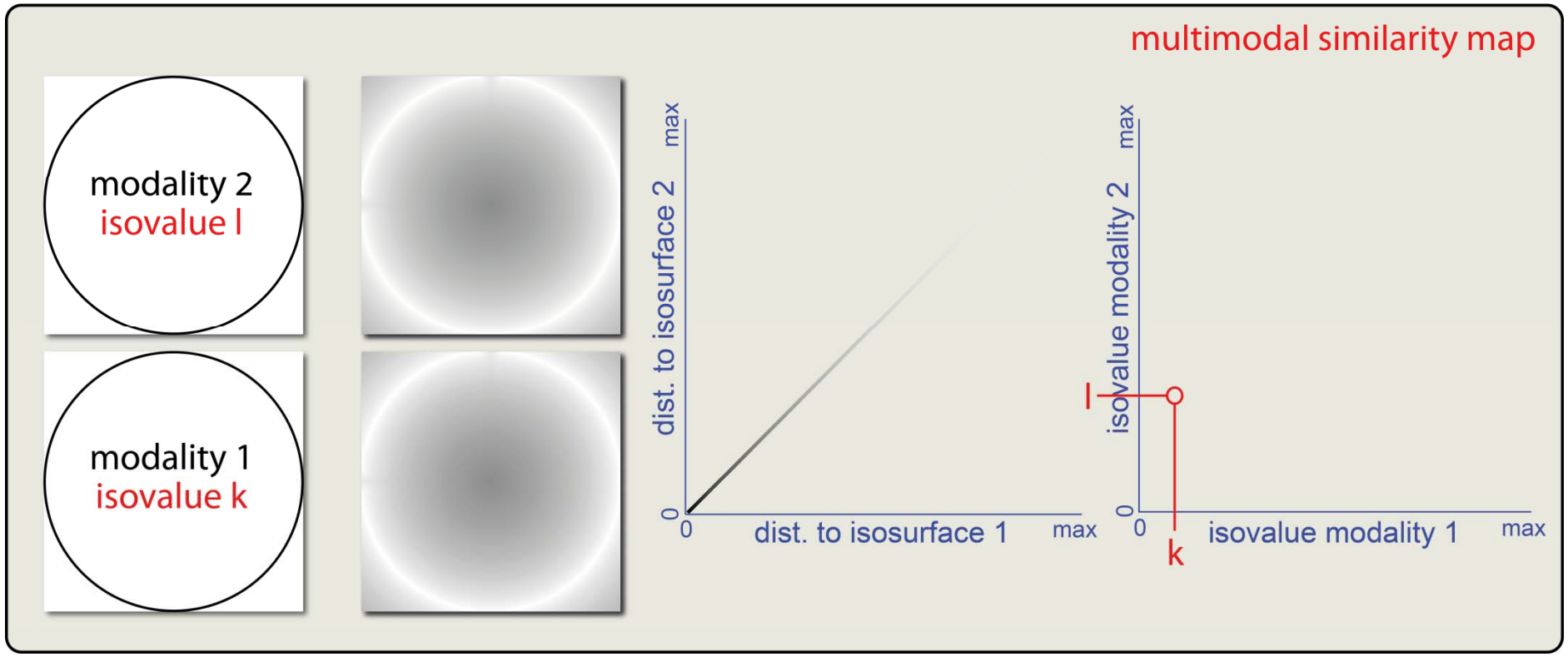
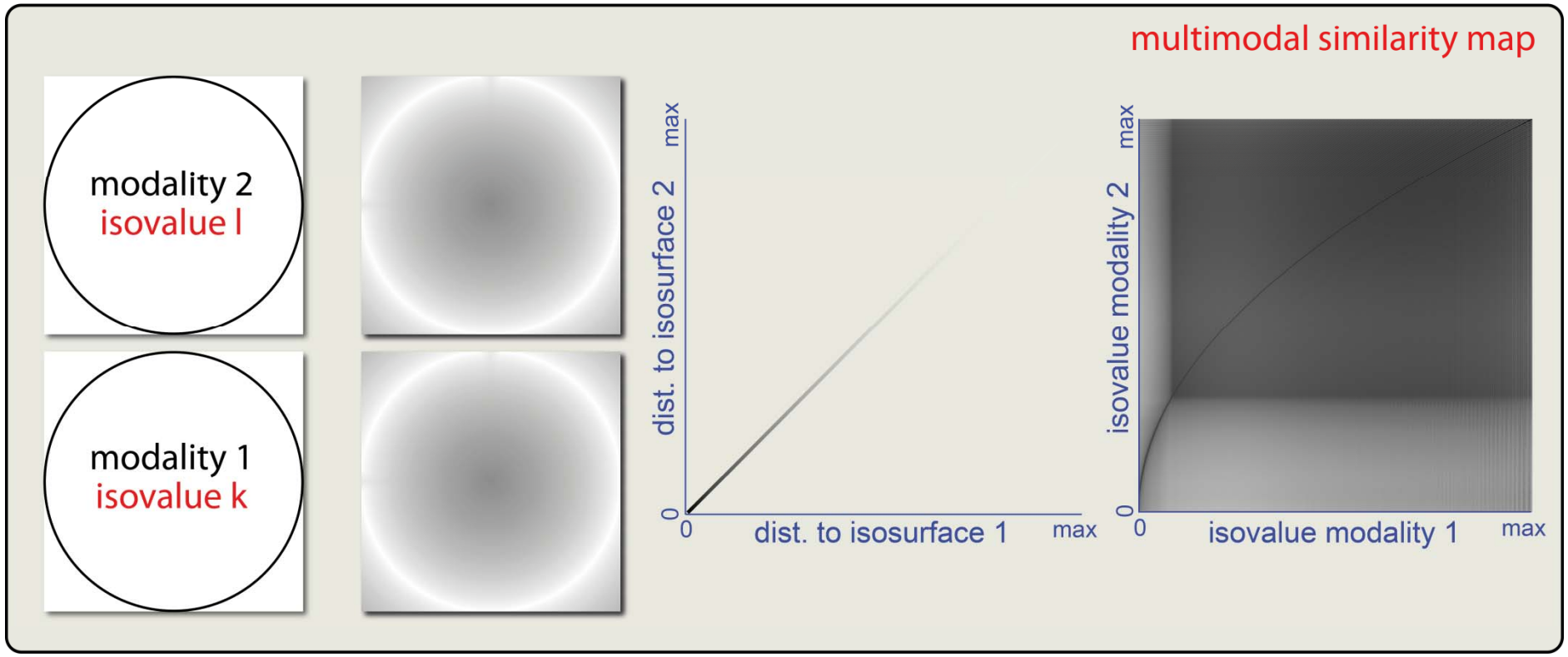
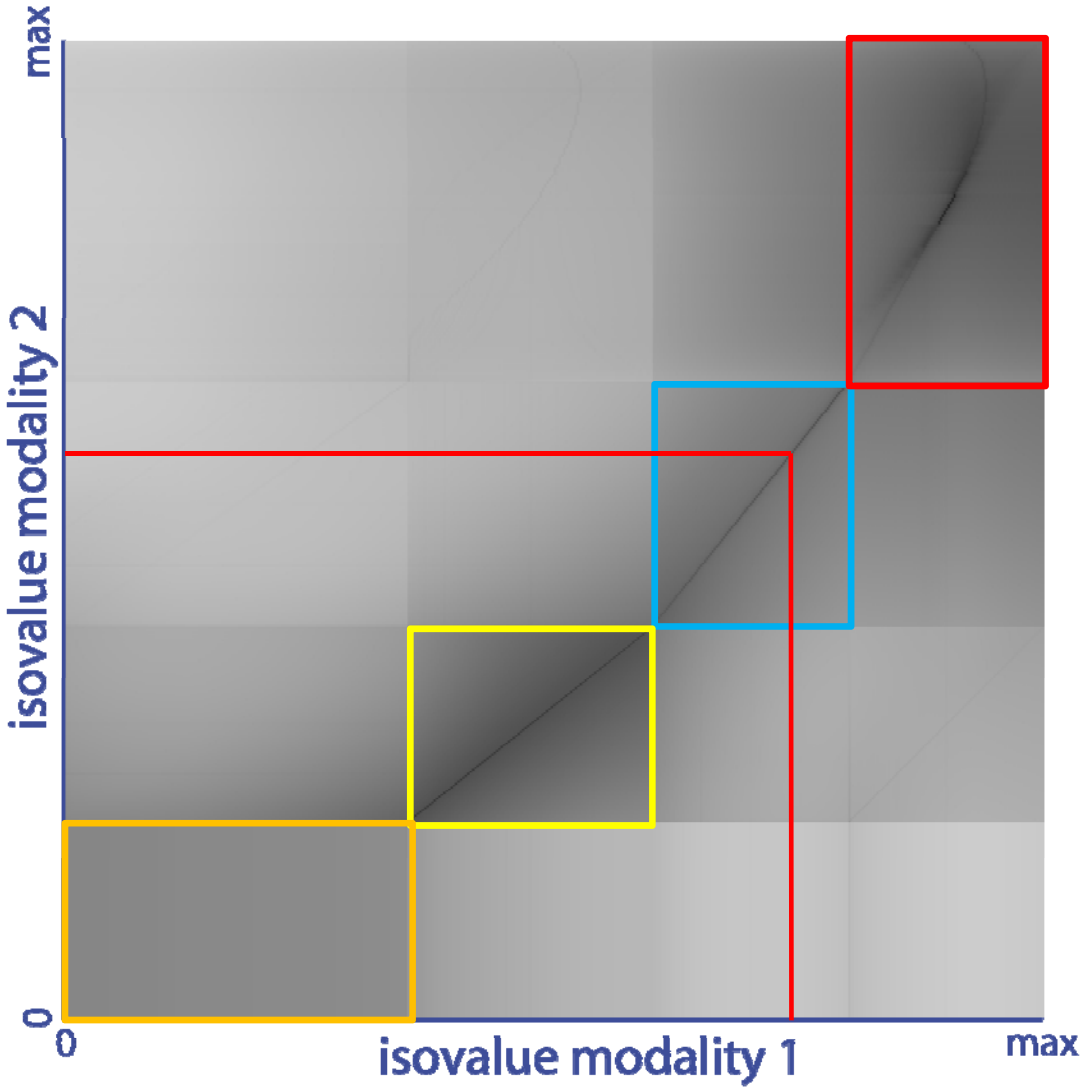
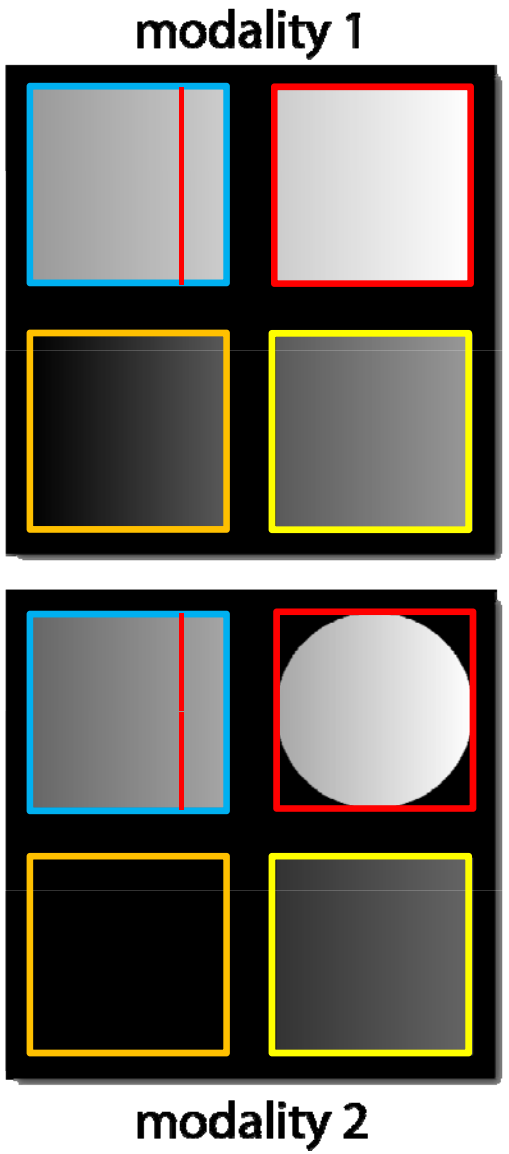


MSM Calculation



MSM Example


max
isovalue modality 2
0
0
isovalue modality 1
max

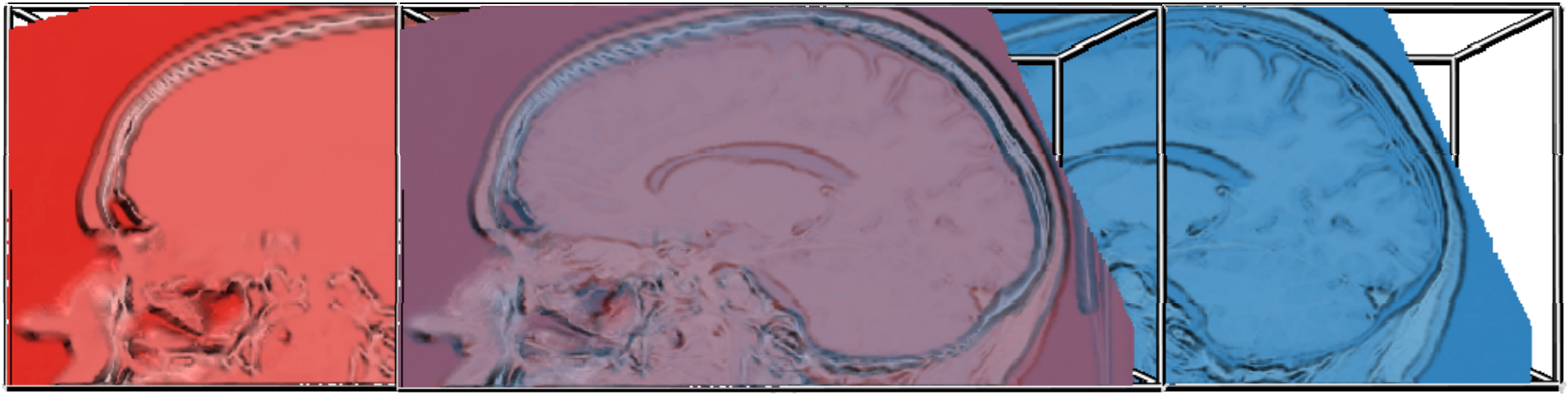

modality 1
modality 2

Using Multimodal Similarity Maps

- Applications for multimodal similarity map:
  - Similarity-based exploration
    - Multimodal similarity map as guidance map
  - Maximum similarity isosurfaces
    - Comparison of isosurfaces from two modalities
  - Similarity-based classification
    - Directly classify multimodal data based on the multimodal similarity map

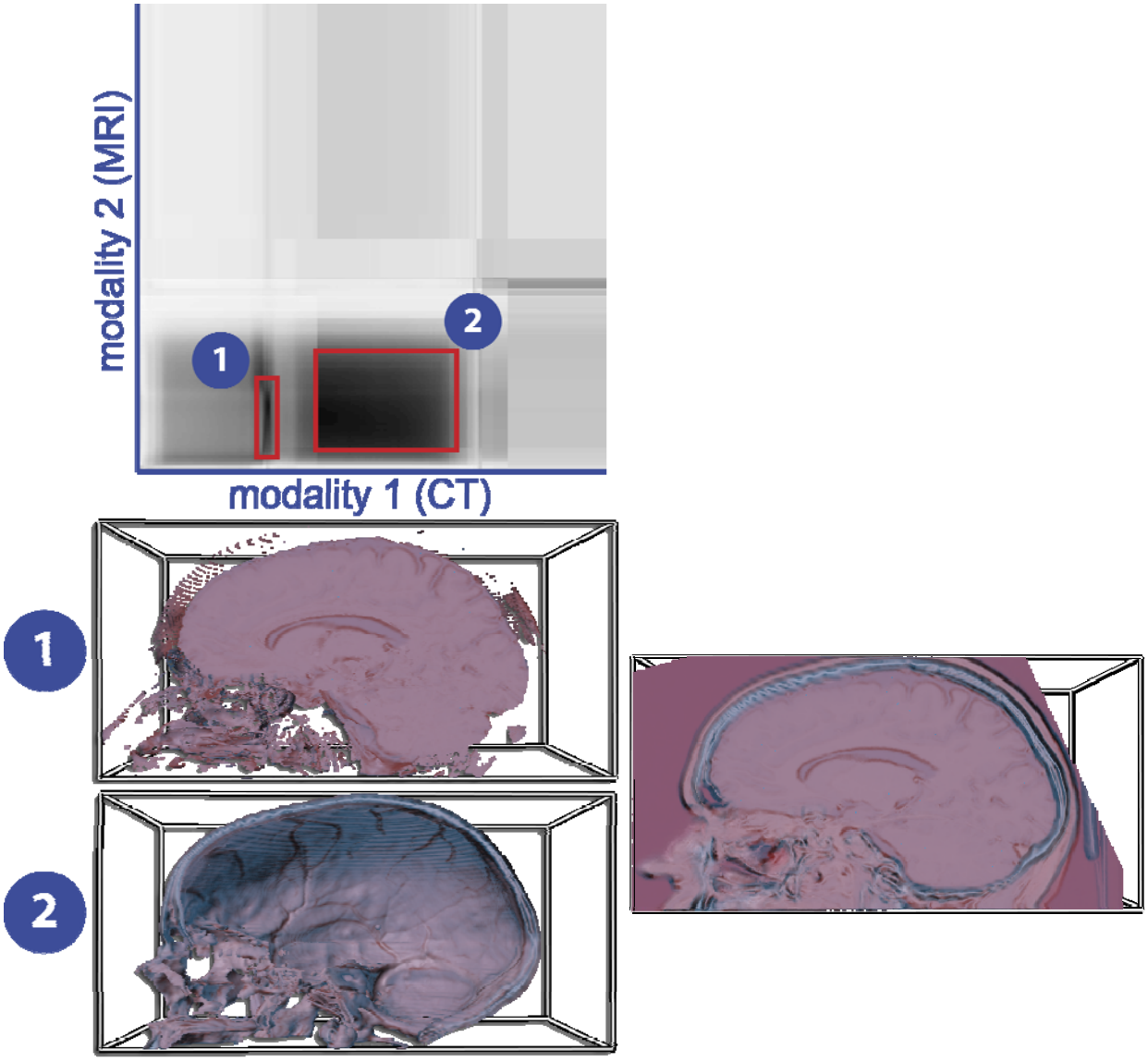
Similarity-Based Exploration

- The multimodal similarity map can be used to detect important structures
  - E.g. regions of high similarity
- Guidance map for the classification

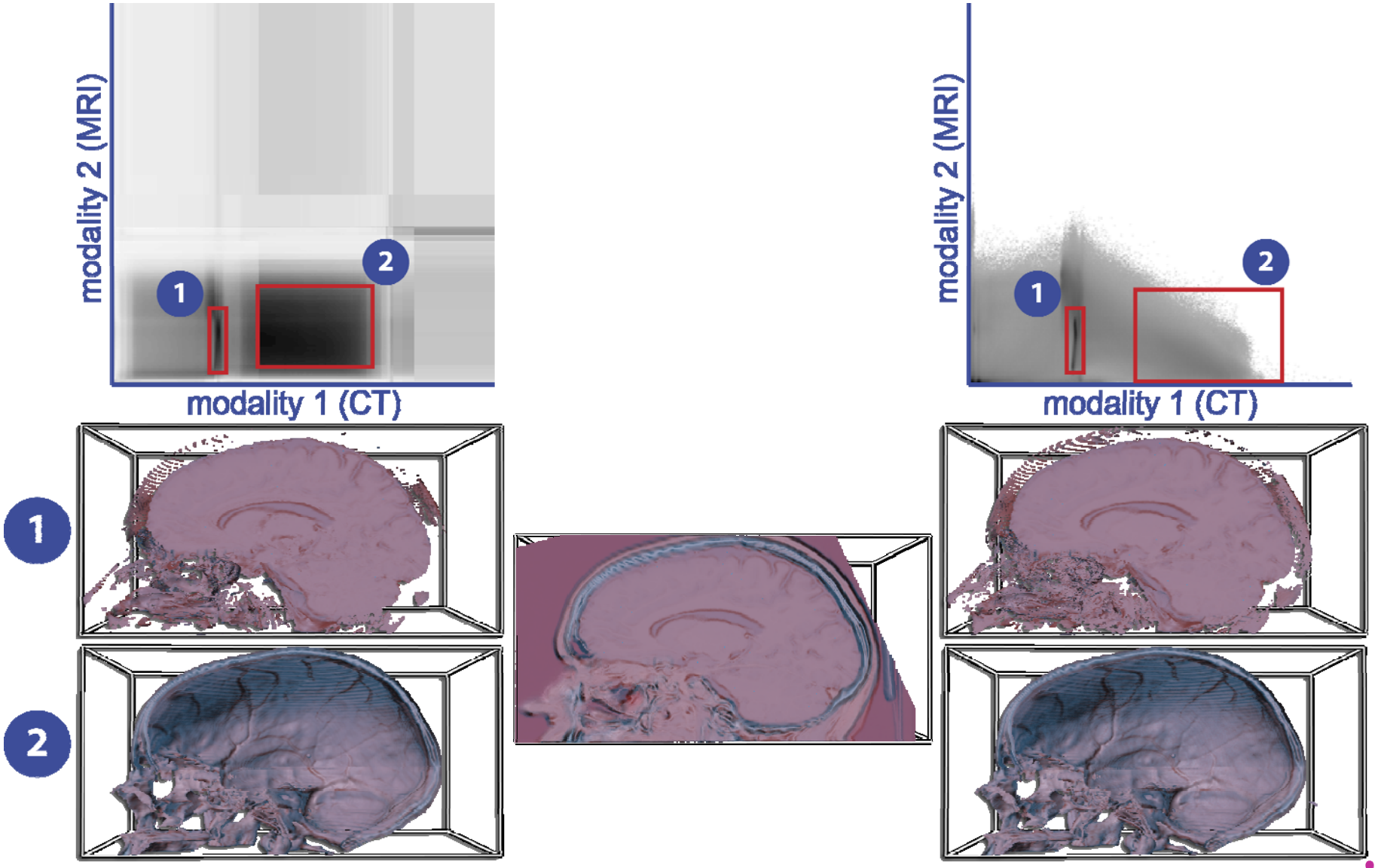


CT MRI

Similarity-Based Exploration

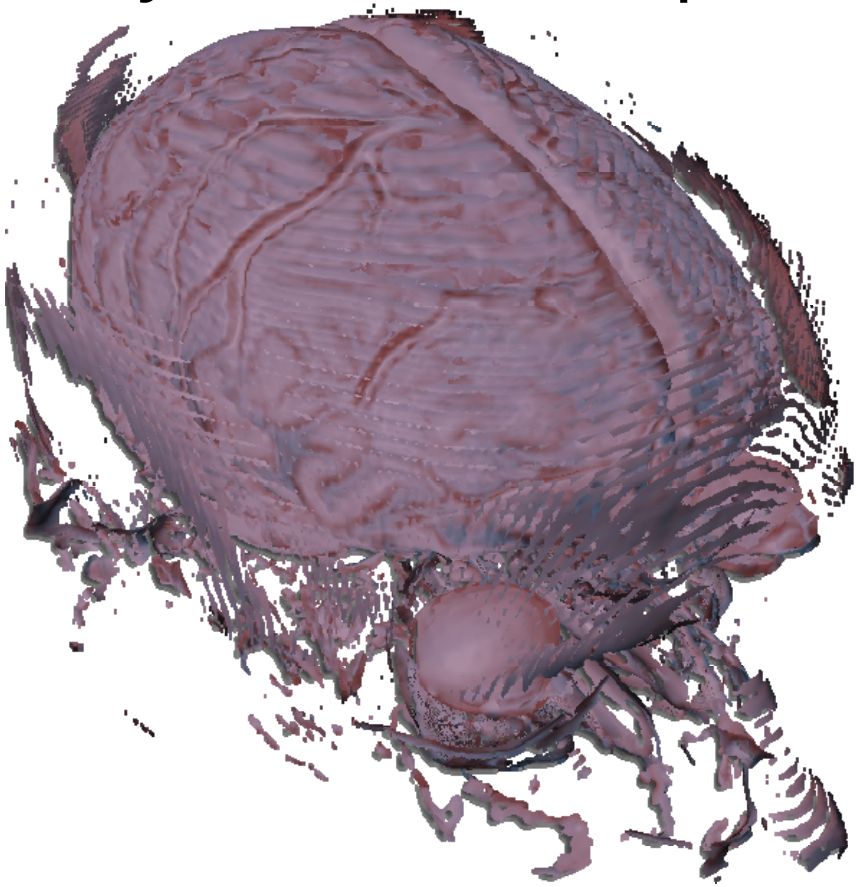


Similarity-Based Exploration



Similarity-Based Exploration

- Similarity-Based Weighting
  - Use similarity value to manipulate opacity



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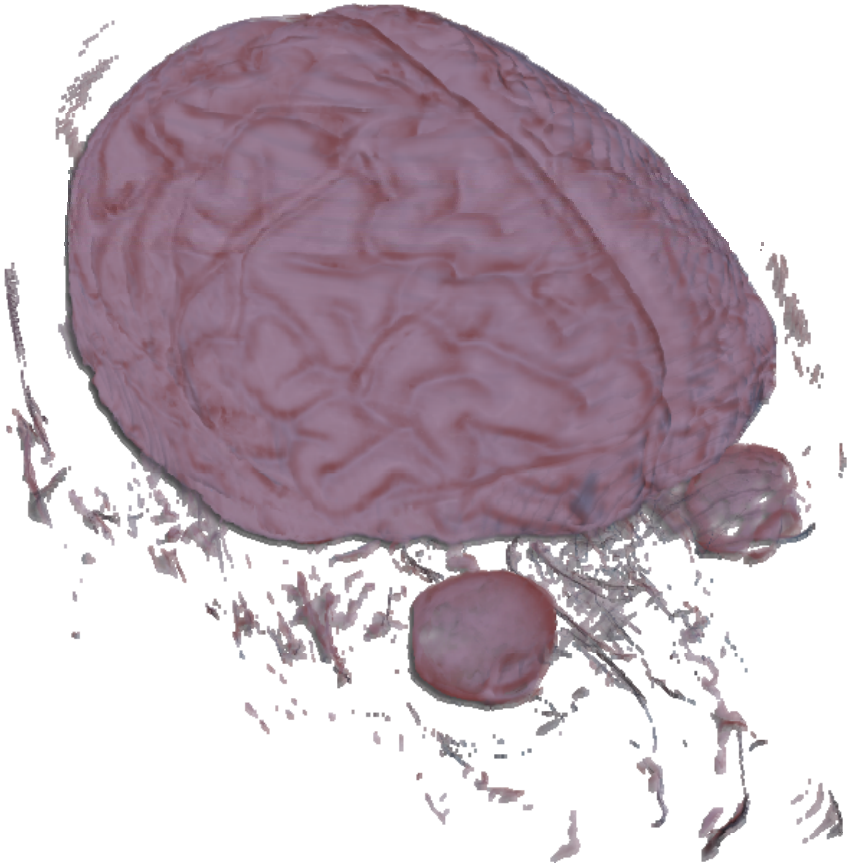
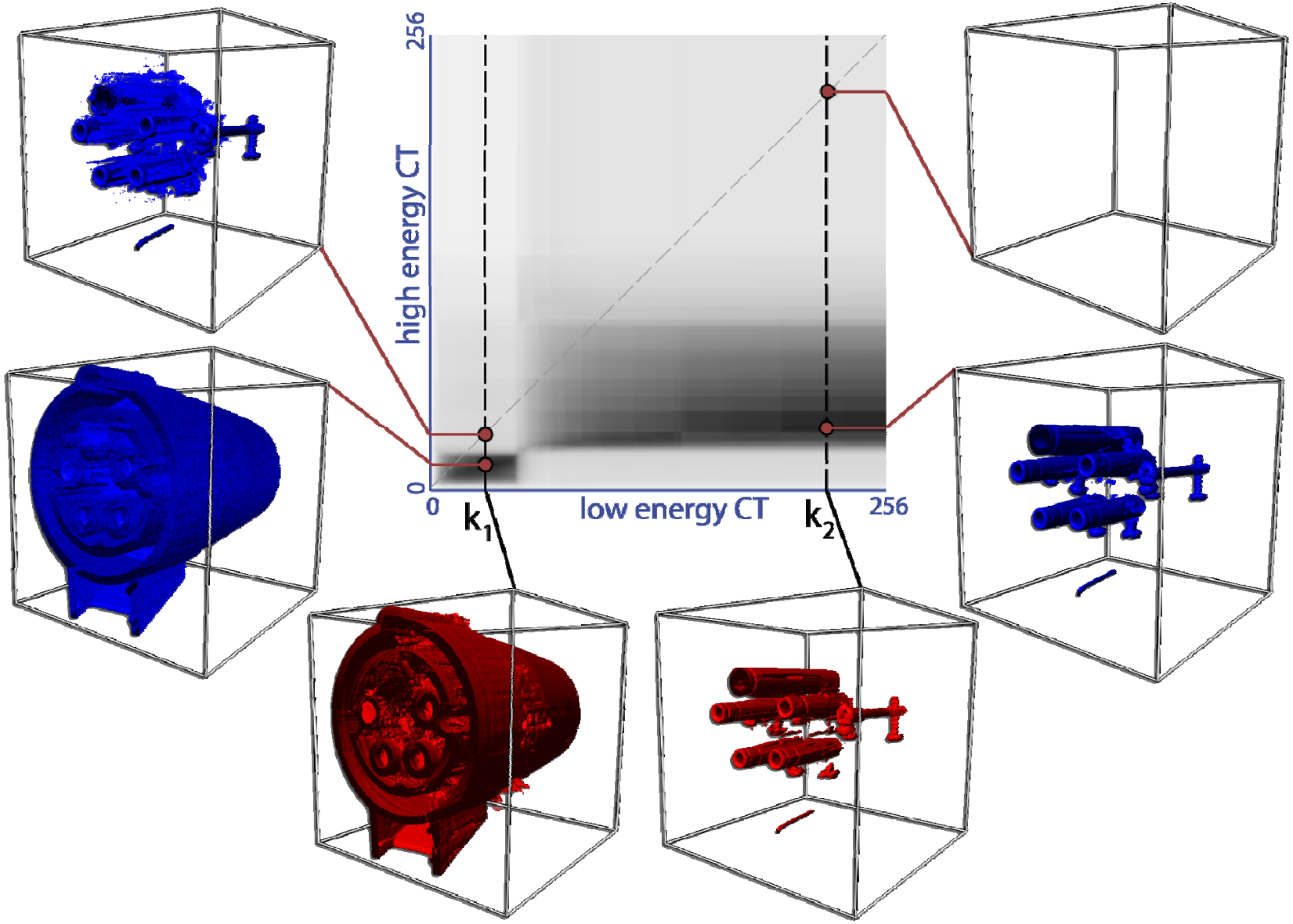


Maximum Similarity Isosurfaces

- Using multimodal similarity map to find most similar isosurface
  - One isovalue for one modality is given
  - Lookup in the MSM provides isovalue for most similar isosurface in modality 2
- Useful for finding differences in both modalities
  - E.g. artifacts

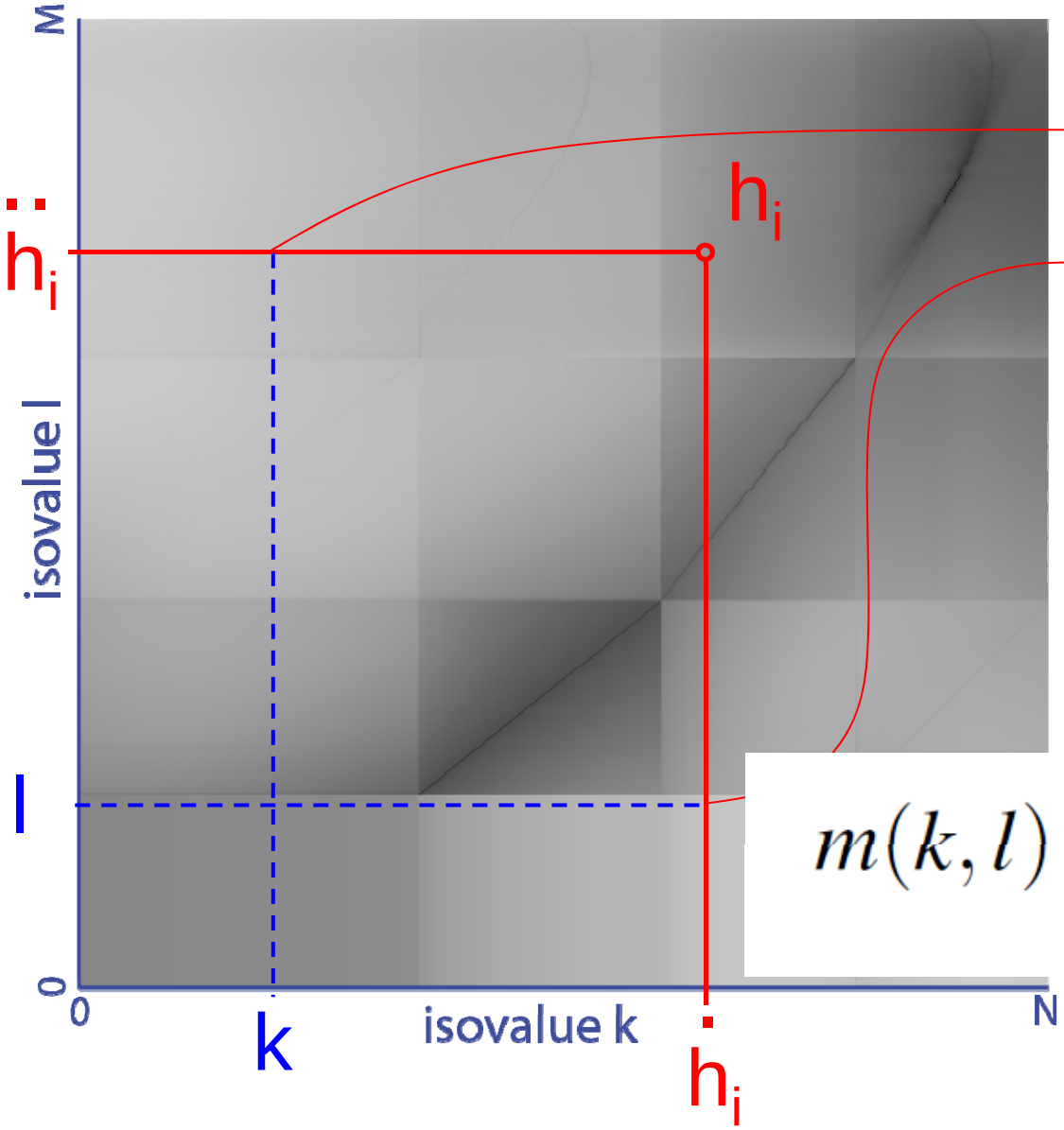
Maximum Similarity Isosurfaces



Similarity-Based Classification

- Classify multimodal data directly in the multimodal similarity map
- Individual transfer functions are not necessary
- User defines set of control points
- Combination of isovalues is classified with control point which is most similar
  - Metric is based on similarity values

Similarity-Based Classification



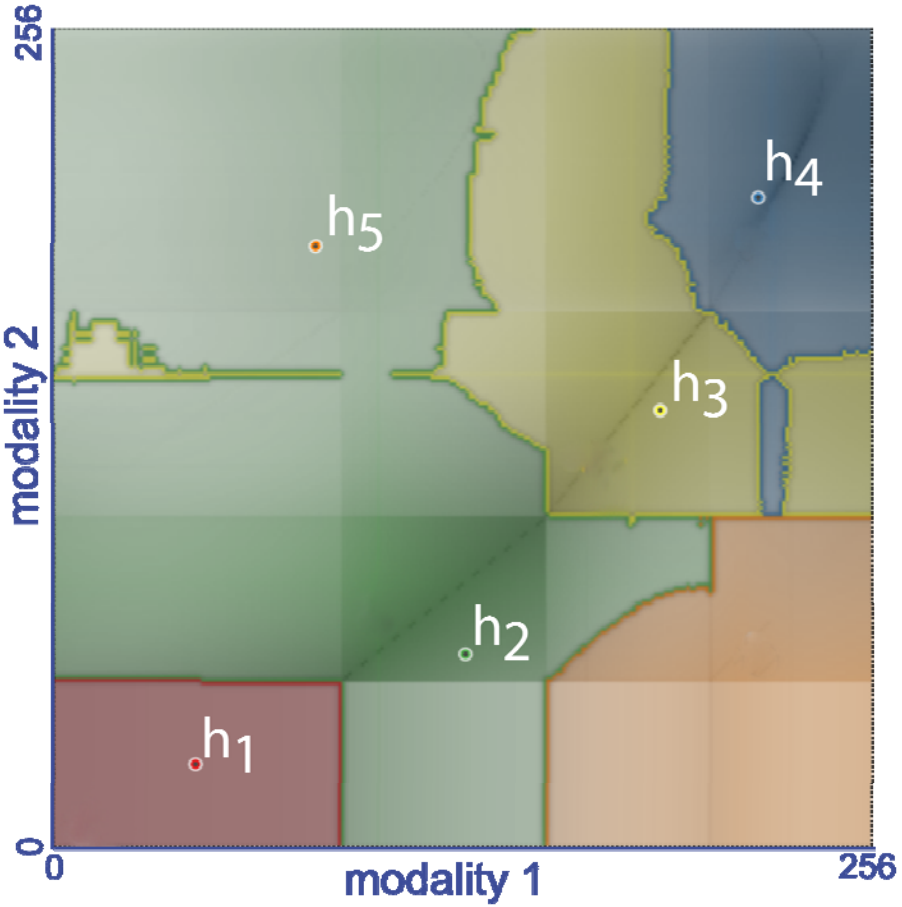
$$\dot{s}_i(k) = \mathrm{MSM}(k, \ddot{h}_i)$$

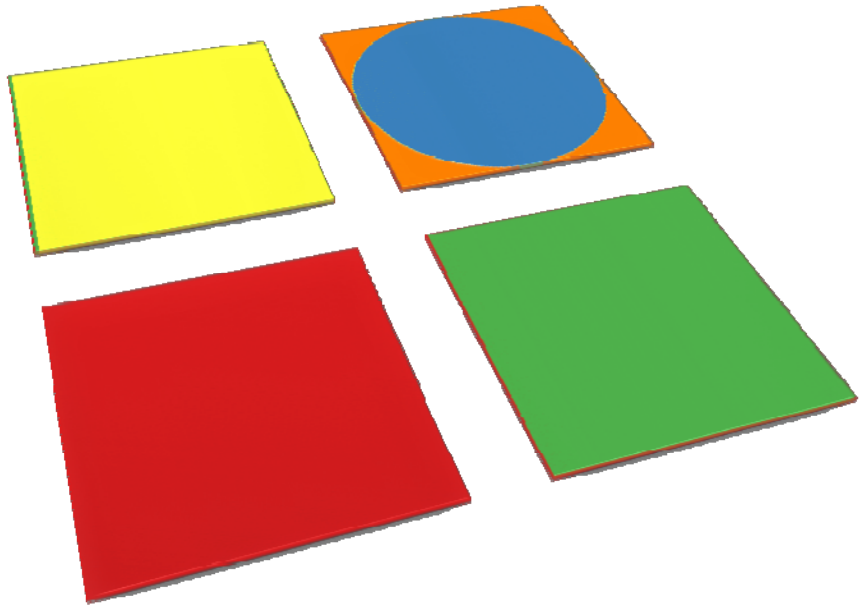
$$\ddot{s}_i(l) = \mathrm{MSM}(\dot{h}_i, l)$$

$$s_i(k,l) = \dot{s}_i(k)\ddot{s}_i(l)$$

$$m(k,l) = \arg\max_i s_i(k,l)w_i$$

Similarity-Based Classification

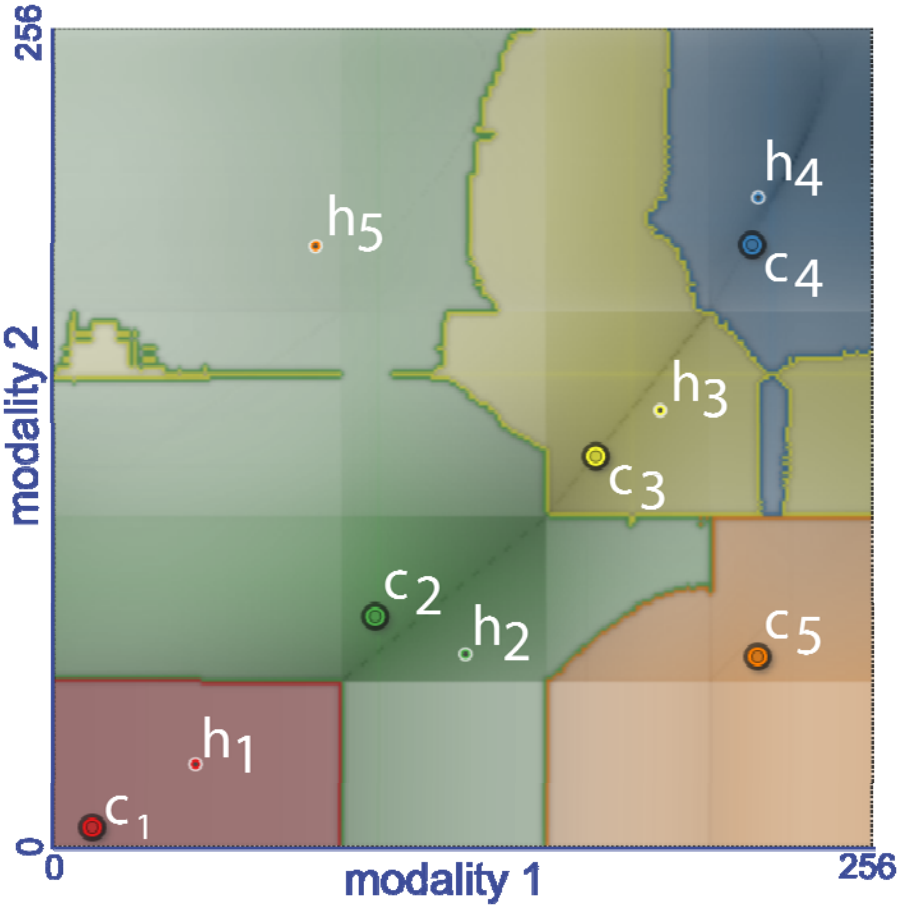


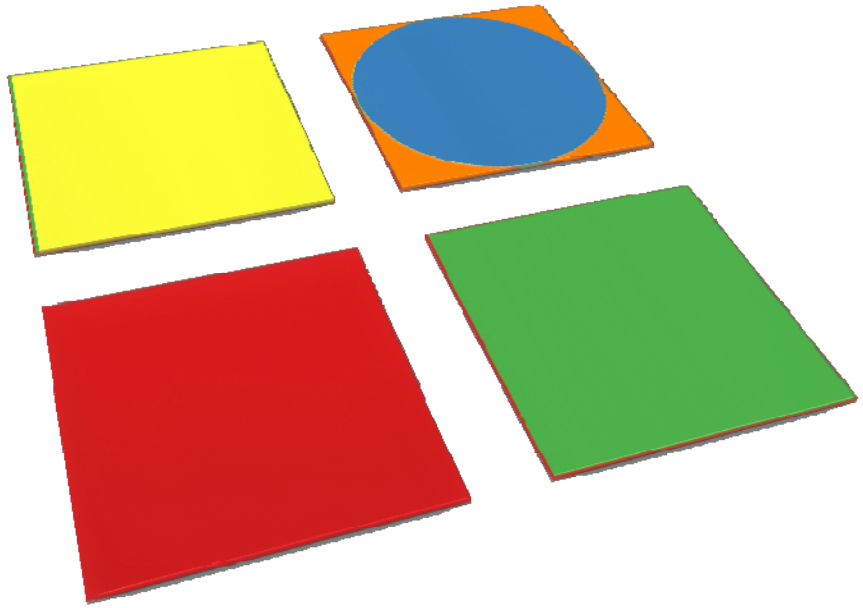


Similarity-Based Classification

- Generate clusters based on user-specified control points c_i
- Calculate the cluster centroids h_i and use these points to finally generate the clusters
- The original control point c_i is the centroid of this cluster
  - More intuitive user interaction

Similarity-Based Classification





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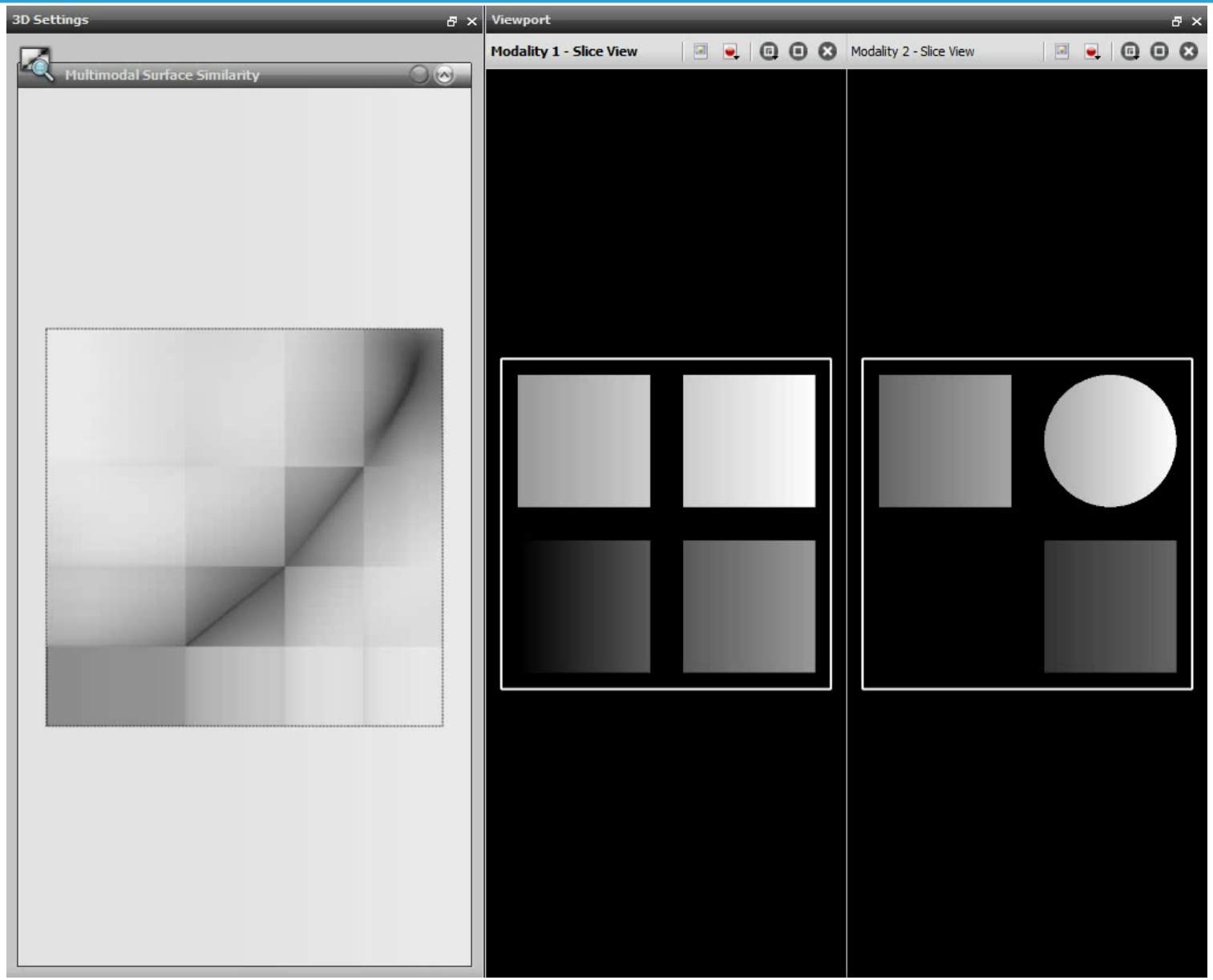

Conclusion

- Multimodal similarity map can be used to analyze multimodal data
  - Detect similarities/differences in two modalities
- A sub-sampled version of the volumes can be used for calculation
  - Reduce calculation time to seconds
- MSM can either be used as guidance map in an existing framework or to classify multimodal data directly

Thank you!

Questions?