

# AVA: Towards Autonomous Visualization Agents With Visual-Perception-Driven Decision Making Supplementary Material

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## 1. Evaluation Experiment Setup

### 1.1. Scatter plot

In scatter plot experiments, each task will be performed in 10 experiments, and the final results are aggregated as a percentage number (success rate). In each experiment, 500 points are generated randomly following a pre-defined pattern (e.g., number of clusters).

- **Clustering Count:** For the clustering task, we randomly generate 2 to 10 clusters for each task.  
*Prompts:* "You are a scatter plot visualization expert. Is there any cluster in this visualization? Can you tell me how many clusters are in this visualization?"
- **Outlier Count:** Different from the cluster recognition task, the scatter plot for the outlier detection will sample 1-5 outlier points without overlap in the visualization.  
*Prompts:* "You are a scatter plot visualization expert. Is there any outlier in this visualization? Can you tell me how many outliers are in this visualization?"
- **Correlation Detection** For the correlation detection task, we randomly generated two scatter plot visualizations with different correlation efficient scores ranging from 0.1 to 1.0. It is worth noticing in the experiences that if the correlation in both images is very low (e.g., 0.1, 0.2) and LLM can not distinguish which one has a higher correlation but indicates both scatter plots have a low correlation, we will count this prediction correct.  
*Prompts:* "You are a scatter plot visualization expert. which images have a high correlation?"

### 1.2. Parallel Coordinate

In parallel coordinate experiments, each task will be performed in 10 experiments, and the final results are aggregated as a percentage number (success rate) In each experiment, 500 points are generated randomly following a pre-defined pattern (e.g., number of clusters).

- **Clustering Count:** For the clustering task, we generate 1 to 10 clusters for each task.  
*Prompts:* "You are a parallel coordinate visualization expert. Is there any cluster in this visualization? Can you tell me how many clusters are in this visualization?"
- **Outlier Count:** Different from the cluster recognition task, the

outlier detection will sample 1-5 outlier points without overlap in the visualization.

*Prompts:* "You are a parallel coordinate visualization expert. Is there any outlier in this visualization? Can you tell me how many outliers are in this visualization?"

- **Correlation Detection**

Compared with the scatter plot visualization, in the correlation task, we randomly select two attributions to be correlated and these two attributions are nearby in the parallel coordinate visualization.

*Prompts:* "You are a parallel coordinate visualization expert. Is there any correlation between these variables?"

### 1.3. Graph

It is worth noticing that we use the model to understand the result of an image without interaction operation. Therefore, we only use graph visualization which is visually interpretable (e.g., not edge or node clutter). We use a graph with 10 nodes and the overall sparsity is 20%. The final visualization is displayed by force-directed graph layout. Similarly, each experiment will be performed 10 times and each time the graph and connection are randomly generated.

Prompts used for the graph in LLM evaluation:

- **node count:** *Prompts:* "You are a graph visualization expert. How many nodes are in this visualization?"
- **find node:** *Prompts:* "You are a graph visualization expert. Is there a node named XXX in this visualization?"
- **connection:** *Prompts:* "You are a graph visualization expert. Is there a path from node XXX to node XXX?"
- **neighbor:** *Prompts:* "You are a graph visualization expert. What is the neighbor node of node XXX?"

### 1.4. Volume Rendering

Prompts used to evaluate the structure of interest recognition in the volume rendering:

- **Boston Teapot** "You are provided with several screenshots showing a volume rendering of the same CT data, for each image assess whether you can recognize the structure of interest, a teapot. Only assess for the structure of interest and not any other

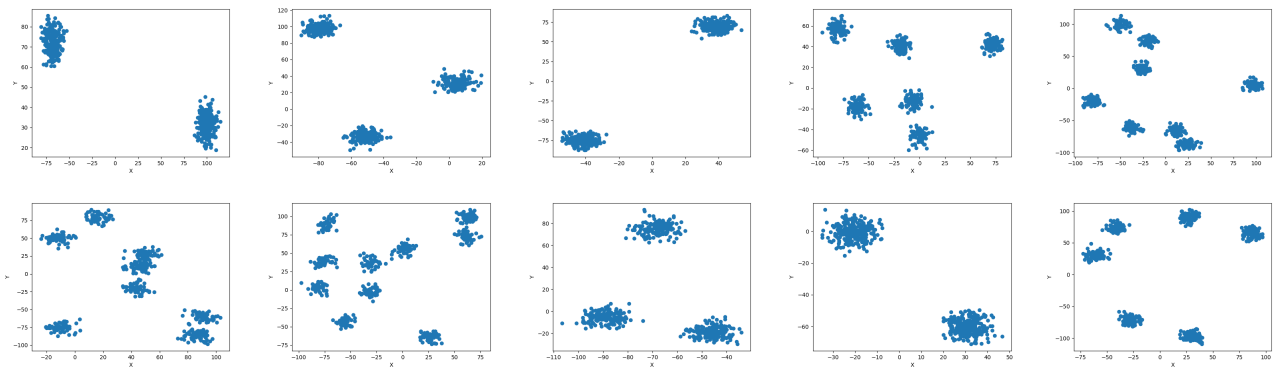


Figure 1: The randomly generated scatter plot with different numbers of clusters for LLM evaluation.

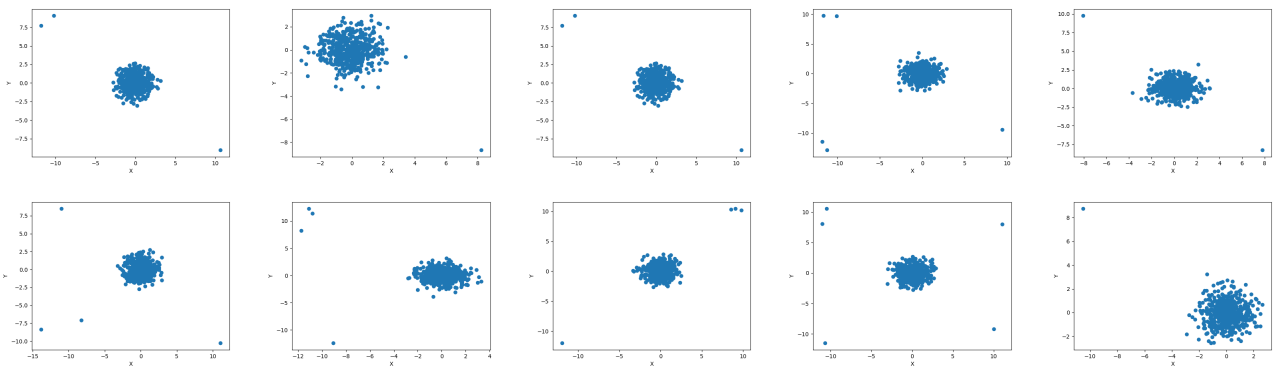


Figure 2: The randomly generated scatter plot with different numbers of outliers for LLM evaluation.

structures you can recognize in the screenshot. Use only one of these options for assessment: 'Not recognizable', and 'Recognizable'. 'Not recognizable' means that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot.?

- **Visible Male** "You are provided with several screenshots showing a volume rendering of the same CT data, for each image assess whether you can recognize the structure of interest, a human face. Only assess for the structure of interest and not any other structures you can recognize in the screenshot. Use only one of these options for assessment: 'Not recognizable', and 'Recognizable'. 'Not recognizable' means that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot."

## 2. User Interface

The user interface is illustrated in Figure 10. The chat window view and the visualization view are separated and potentially run on different processes (e.g., volume rendering example).

## 3. Case Studies

In this section, we provide the responses for the AVAs described in the Case Studies section of the paper.

### 3.1. Head

#### 3.1.1. Action Plan as Code

With this prompt, the agent relies on the user to adjust the opacity transfer function and only provides assessments based on the following input:

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not. Reach the goal by using the input provided and comply with the constraints listed below.

Structure of Interest: the circle of willis

Goal: Provide the user with your assessment

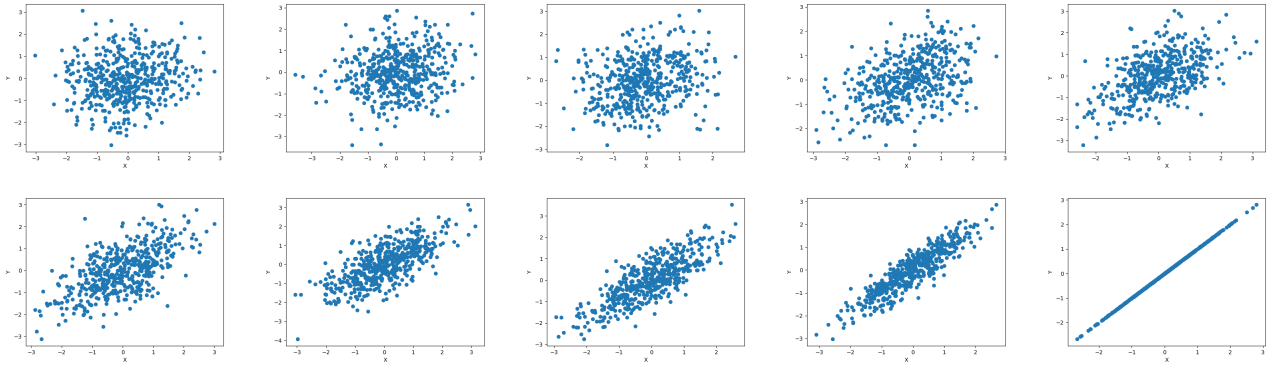


Figure 3: The randomly generated scatter plot with different correlation coefficients.

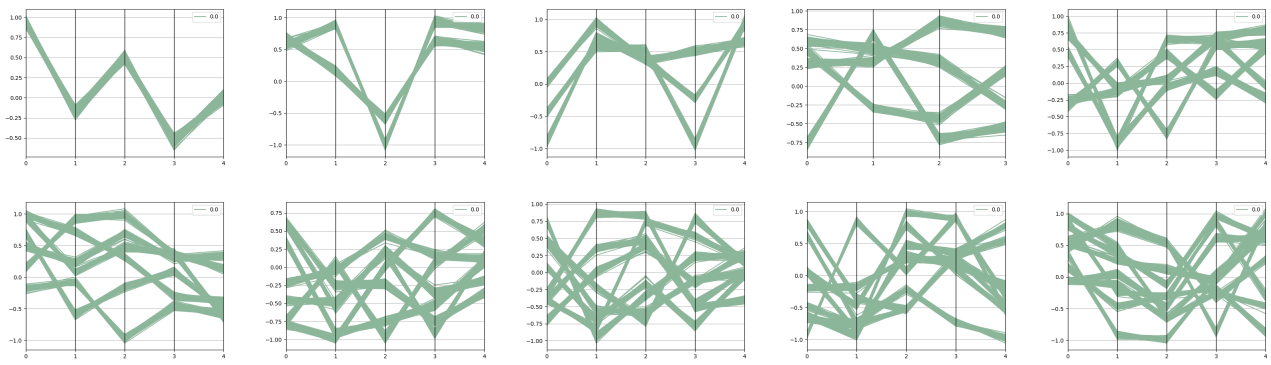


Figure 4: The randomly generated parallel coordinate with five dimensions and different numbers of clusters for LLM evaluation.

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**Algorithm 1** Opacity Transfer Function Adjustment - Used for the Heuristic-centric Action Plan
 

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```

1:  $scalar\_range \leftarrow max\_val - min\_val$ 
2:  $window\_width \leftarrow scalar\_range / bins$ 
3:  $step\_size \leftarrow window\_width \times window\_factor$ 
4:  $start\_point \leftarrow min\_val$ 
5:  $end\_point \leftarrow start\_point + window\_width$ 
6: repeat
7:    $assessment\_result \leftarrow assess\_screenshot()$ 
8:   if  $assessment\_result == "not\ recognizable"$  then
9:      $start\_point \leftarrow start\_point + step\_size$ 
10:     $end\_point \leftarrow end\_point + step\_size$ 
11:   else if  $assessment\_result == "recognizable"$  then
12:      $start\_point \leftarrow start\_point + step\_size \times speed\_reduction$ 
13:      $end\_point \leftarrow end\_point + step\_size \times speed\_reduction$ 
14:   end if
15: until  $assessment\_result == "clear"$ 

```

---

of whether the structure of interest can be recognized in the provided screenshot. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible but no other structures are visible.

## Constraints:

1. The assessments are with respect to the structure of interest, but not for any other structures you recognize in the screenshot.
2. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.
3. Your response can only be in the following JSON format (do not add comments to the JSON response):

```

{
  "thought": "thought",
  "reasoning": "reasoning",

```

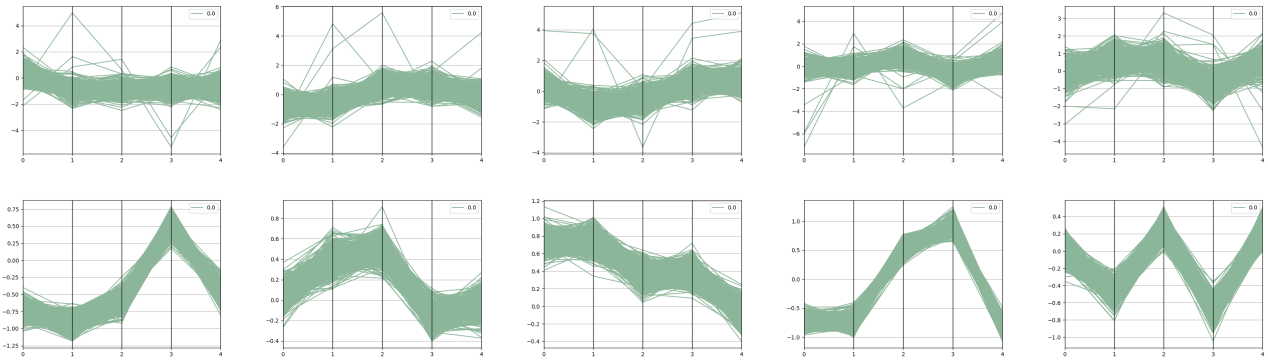


Figure 5: The randomly generated parallel coordinate with five dimensions and different numbers of outliers for LLM evaluation.

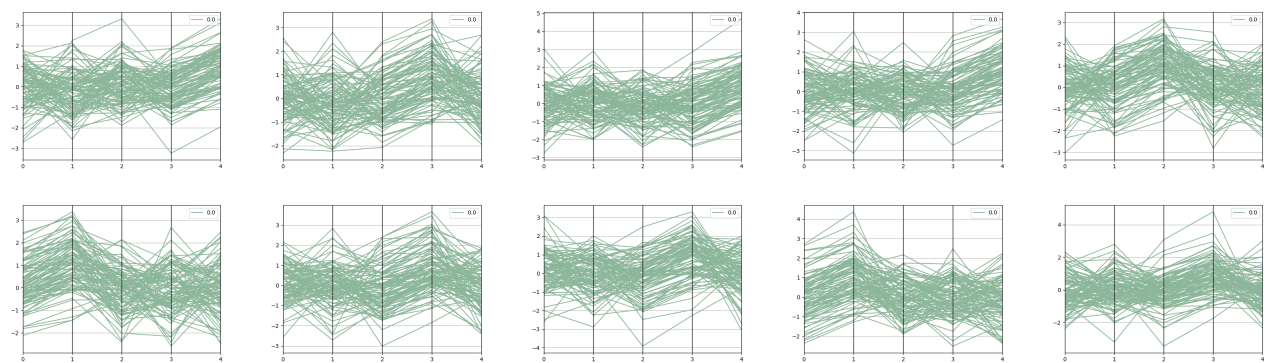


Figure 6: The randomly generated parallel coordinate with five dimensions and two of them have a high correlation.

```
"plan": "long-term plan",
"assessment": "assessment"
}
4. For your assessment select one from the
options. If you weren't provided with the
screenshot, the "assessment" in your response
is 'N/A'.
5. Based on your assessment, the user will move
the window of the opacity function to higher
values and will provide you with a new screenshot
based on the opacity function.
6. Provide assessments, until you can clearly
denote the structure of interest.
```

### 3.1.2. Action Plan as Prompt

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal

by using the input provided and comply with the constraints listed below. Use the algorithm described below to determine the opacity function. Reach the goal by using the input, the described algorithm and comply with the constraints listed below.

Structure of Interest: the circle of willis  
 Minimum Value in the data = 0  
 Maximum Value in the data = 685

Goal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible but no other structures are visible.

Algorithm for Opacity Function Identification:

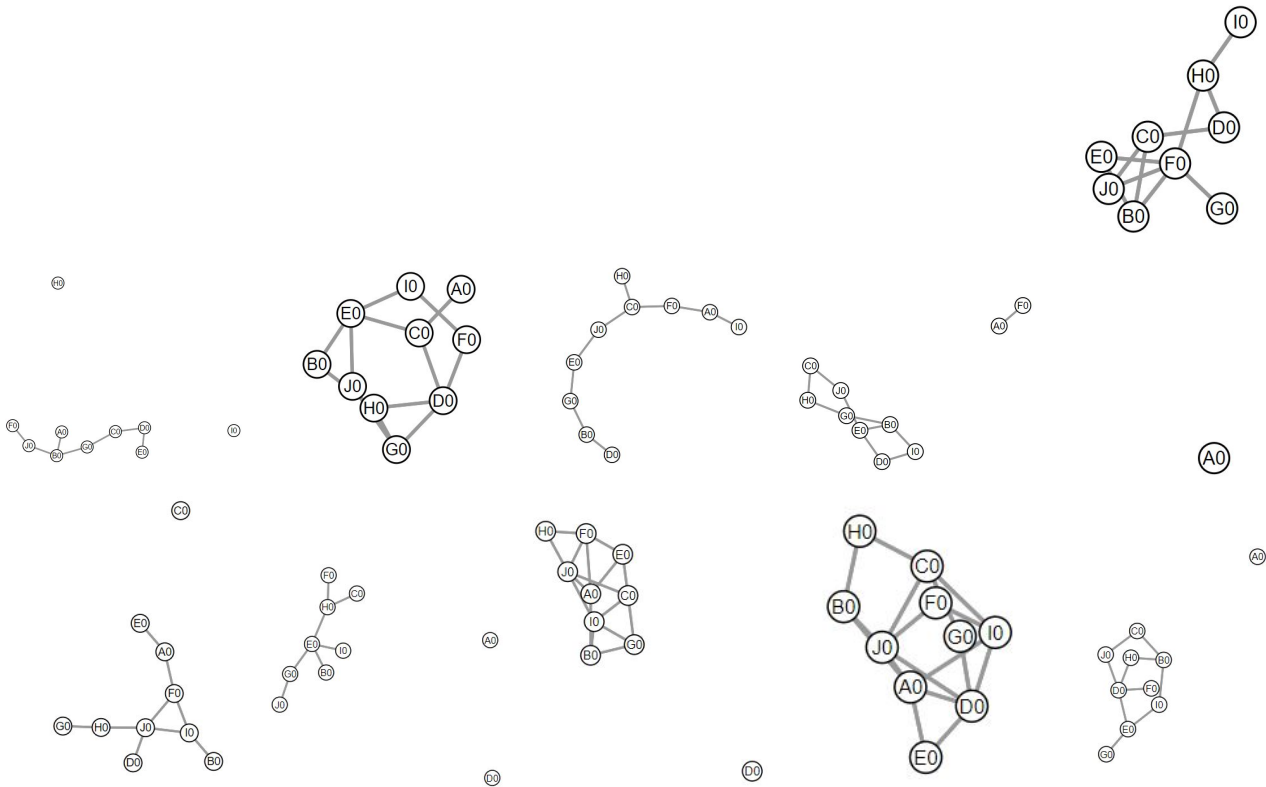


Figure 7: The randomly generated graph for graph exploration tasks

#### 1. Initialization:

- The scalar range is defined by maximum value minus minimum value.
  - Define window width as one-tenth of the scalar range.
  - Define the step size for shifting the window towards higher values. This is determined as 1 times the window width. The step size controls how the range of interest moves through the scalar range to find the best start and end points.
  - Initialize the start point and end point: Set the initial start point of the opacity function as `min_val`. The initial end value is calculated by adding the window width to the start value.
- #### 2. Refinement Loop (Repeat until the assessment is "clear"):
- Assess the provided screenshot of the volume rendering.
  - If the assessment is "not recognizable" shift the window by the predetermined step size.
  - If the assessment is "recognizable" shift the window by half a step size.

#### Constraints:

1. The assessments are with respect to the

structure of interest, but not for any other structures you recognize in the screenshot.

2. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.

3. Your response must be in the following JSON format and do not add comments to the JSON response:

```
{
  "thought": "thought",
  "reasoning": "reasoning",
  "plan": "long-term plan",
  "assessment": "assessment",
  "opacity function": "[start point, end point]"
}
```

4. For your assessment select one from the options. If you weren't provided with the screenshot, the "assessment" in your response is 'N/A'.
5. Based on your assessment, the user will move the window of the opacity function to higher values and will provide you with a new screenshot based on the opacity function.
6. Provide assessments, until you can clearly denote the structure of interest.
7. Start your response with the initial opacity function based on the algorithm.
8. If the structure of interest is not visible in

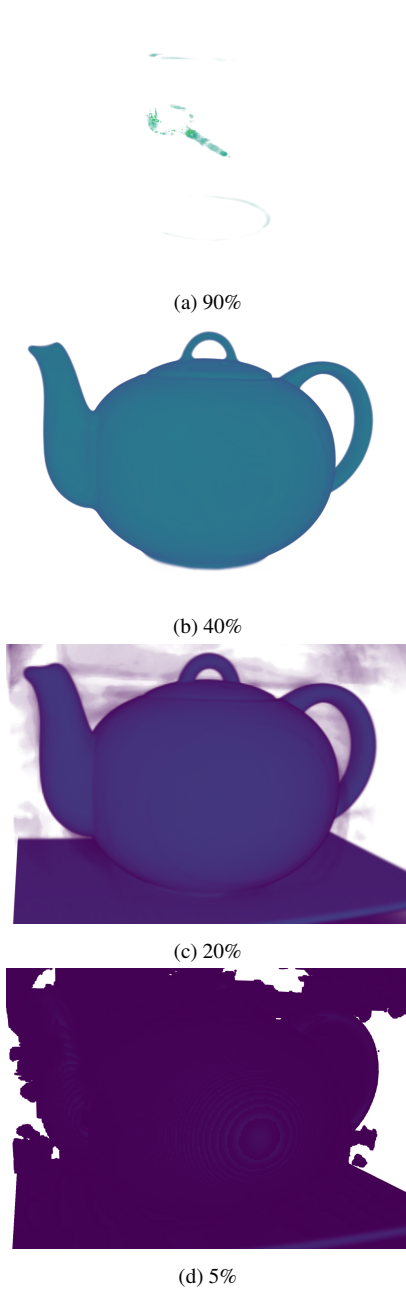


Figure 8: The Boston Teapot dataset volume rendered using the same color map but at varying opacity levels. Structure of interest: the teapot. The response from the LLM model was 8a: 'not recognizable', 8b: 'recognizable', 8c: 'recognizable', and 8d: 'not recognizable'

the image, continue with assessing the images and providing opacity functions.

9. Do not provide any other text, only provide the response in the json format described above.

### 3.1.3. Model Derives Own Action Plan

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal by using the input provided and comply with the constraints listed below. Use your knowledge about transfer function design from the scientific literature. Reach the goal, by considering the histogram of the data, the data acquisition modality and comply with the constraints below.

Structure ofInterest: the circle of willis

Histogram:

Bin edges:

0.0, 6.85, 13.7, 20.549999999999997, 27.4, 34.25, 41.099999999999994, 47.949999999999996, 54.8, 61.65, 68.5, 75.35, 82.19999999999999, 89.05, 95.89999999999999, 102.75, 109.6, 116.44999999999999, 123.3, 130.15, 137.0, 143.85, 150.7, 157.54999999999998, 164.39999999999998, 171.25, 178.1, 184.95, 191.79999999999998, 198.64999999999998, 205.5, 212.35, 219.2, 226.04999999999998, 232.89999999999998, 239.75, 246.6, 253.45, 260.3, 267.15, 274.0, 280.84999999999997, 287.7, 294.55, 301.4, 308.25, 315.09999999999997, 321.95, 328.79999999999995, 335.65, 342.5, 349.34999999999997, 356.2, 363.04999999999995, 369.9, 376.75, 383.59999999999997, 390.45, 397.29999999999995, 404.15, 411.0, 417.84999999999997, 424.7, 431.54999999999995, 438.4, 445.25, 452.09999999999997, 458.95, 465.79999999999995, 472.65, 479.5, 486.34999999999997, 493.2, 500.04999999999995, 506.9, 513.75, 520.6, 527.44999999999999, 534.3, 541.15, 548.0, 554.85, 561.69999999999999, 568.55, 575.4, 582.25, 589.1, 595.94999999999999, 602.8, 609.65, 616.5, 623.35, 630.19999999999999, 637.05, 643.9, 650.75, 657.59999999999999, 664.44999999999999, 671.3, 678.15, 685.0

Histogram counts:

103856, 54165, 1234226, 3879846, 3987313, 2306358, 1153787, 1104229, 1185128, 1346964, 1447848, 1406969, 1241270, 874426, 787375, 563782, 385669, 254363, 163099, 91602, 72303, 48387, 34013, 24748, 18059, 13332, 8558, 7631, 5867, 4614, 3786, 3275, 2882, 2294, 2582, 2465, 2359, 2179, 1980, 1626, 1644, 1573, 1460, 1304,

1199, 1087, 952, 1041, 967, 837, 804, 727, 680, 587, 570, 542, 469, 422, 372, 246, 324, 290, 212, 196, 192, 147, 125, 140, 111, 72, 94, 91, 66, 60, 55, 47, 41, 27, 28, 16, 20, 11, 10, 10, 9, 2, 2, 2, 0, 1, 2, 0, 0, 0, 2, 0, 0, 0, 0, 1

Data Modality: 3T MRT TOF

Goal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible but no other structures are visible.

Constraints:

1. The opacity function is defined by two values, a start point and end point, which define the range of the values that are potentially associated with the structure of interest. For value smaller than the start point the opacity is 0. At the middle point between start and end point, the opacity is 1. For values larger than the end point the opacity is 0. The opacity linearly increases from start point to the middle point and linearly decreases from center to end point. Therefore, the opacity function will always look like a triangle with two sides of the same length.
2. Reflect on past decisions and strategies to try different opacity functions.
3. The assessments are with respect to the structure of interest, but not for any other structures you recognize in the screenshot.
4. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.
5. Your response must be in the following JSON format and do not add comments to the JSON response:
 

```
{
  "thought": "thought",
  "reasoning": "reasoning",
  "plan": "long-term plan",
  "assessment": "assessment",
  "opacity function": "[start point, end point]"
}
```
6. For your assessment select one from the options. If you weren't provided with the screenshot, the "assessment" in your response is 'N/A'.
7. Based on your assessment, the user will move the window of the opacity function to higher

values and will provide you with a new screenshot based on the opacity function.

8. Provide assessments and opacity functions, until your assessment is "clear"
9. Start your response with the initial opacity function based on the algorithm.
10. If the structure of interest is not visible in the image, continue with assessing the images and providing opacity functions.

## 3.2. Boston Teapot

### 3.2.1. Model Derives Own Action Plan

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal by using the input provided and comply with the constraints listed below. Use your knowledge about transfer function design from the scientific literature.

Reach the goal, by considering the histogram of the data, the data acquisition modality and comply with the constraints below.

Structure of Interest: the lobster

Histogram:

Bin edges:

0.0, 2.55, 5.1, 7.6499999999999995, 10.2, 12.75, 15.299999999999999, 17.849999999999998, 20.4, 22.95, 25.5, 28.049999999999997, 30.599999999999998, 33.15, 35.699999999999996, 38.25, 40.8, 43.349999999999994, 45.9, 48.449999999999996, 51.0, 53.55, 56.099999999999994, 58.65, 61.199999999999996, 63.749999999999999, 66.3, 68.85, 71.399999999999999, 73.949999999999999, 76.5, 79.05, 81.6, 84.149999999999999, 86.699999999999999, 89.25, 91.8, 94.35, 96.899999999999999, 99.449999999999999, 102.0, 104.55, 107.1, 109.649999999999999, 112.199999999999999, 114.749999999999999, 117.3, 119.85, 122.399999999999999, 124.949999999999999, 127.499999999999999, 130.049999999999998, 132.6, 135.149999999999998, 137.7, 140.25, 142.799999999999998, 145.35, 147.899999999999998, 150.45, 153.0, 155.549999999999998, 158.1, 160.649999999999998, 163.2, 165.75, 168.299999999999998, 170.85, 173.399999999999998, 175.95, 178.5, 181.049999999999998, 183.6, 186.149999999999998, 188.7, 191.25, 193.799999999999998, 196.35, 198.899999999999998, 201.45, 204.0, 206.549999999999998, 209.1,

211.64999999999998, 214.2, 216.74999999999997,  
 219.29999999999998, 221.85, 224.39999999999998,  
 226.95, 229.49999999999997, 232.04999999999998,  
 234.6, 237.14999999999998, 239.7,  
 242.24999999999997, 244.79999999999998, 247.35,  
 249.89999999999998, 252.45, 255.0

Histogram counts:

9061925, 1083760, 153840, 167256, 56447, 83767,  
 56627, 75533, 33467, 42257, 36195, 24110, 37148,  
 25759, 41426, 29250, 36529, 23860, 39260, 27695,  
 50604, 40950, 11772, 15877, 10448, 15674, 10222,  
 15203, 10242, 15253, 15527, 10584, 15934, 10761,  
 16472, 11214, 17669, 12268, 18568, 13352, 20989,  
 23093, 16317, 26575, 19627, 33870, 19466, 15925,  
 5101, 3052, 1265, 700, 1070, 669, 912, 542, 563,  
 206, 249, 104, 93, 49, 34, 28, 9, 25, 10, 21, 8,  
 9, 13, 4, 10, 6, 5, 4, 6, 2, 9, 7, 4, 4, 5, 4, 1,  
 2, 5, 4, 3, 3, 4, 4, 1, 1, 2, 0, 3, 0, 4, 2

Data Modality: CT Scan

Goal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible but no other structures are visible.

Constraints:

1. The opacity function is defined by two values, a start point and end point, which define the range of the values that are potentially associated with the structure of interest. For value smaller than the start point the opacity is 0. At the middle point between start and end point, the opacity is 1. For values larger than the end point the opacity is 0. The opacity linearly increases from start point to the middle point and linearly decreases from center to end point. Therefore, the opacity function will always look like a triangle with two sides of the same length.
2. Reflect on past decisions and strategies to try different opacity functions.
3. The assessments are with respect to the structure of interest, but not for any other structures you recognize in the screenshot.
4. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.
5. Your response must be in the following JSON format and do not add comments to the JSON response:

```
{
  "thought": "thought",
  "reasoning": "reasoning",
  "plan": "long-term plan",
  "assessment": "assessment",
  "opacity function": "[start point, end point]"
}
```

6. For your assessment select one from the options. If you weren't provided with the screenshot, the "assessment" in your response is 'N/A'.
7. Based on your assessment, the user will move the window of the opacity function to higher values and will provide you with a new screenshot based on the opacity function.
8. Provide assessments and opacity functions, until your assessment is "clear"
9. Start your response with the initial opacity function based on the algorithm.
10. If the structure of interest is not visible in the image, continue with assessing the images and providing opacity functions.

### 3.3. Lobster

#### 3.3.1. Model Derives Own Action Plan

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal by using the input provided and comply with the constraints listed below. Use your knowledge about transfer function design from the scientific literature.

Reach the goal, by considering the histogram of the data, the data acquisition modality and comply with the constraints below.

Structure of Interest: the lobster

Histogram:

Bin edges:

0.0, 2.55, 5.1, 7.649999999999995,  
 10.2, 12.75, 15.299999999999999,  
 17.849999999999998, 20.4, 22.95, 25.5,  
 28.049999999999997, 30.599999999999998,  
 33.15, 35.699999999999996, 38.25, 40.8,  
 43.349999999999994, 45.9, 48.449999999999996,  
 51.0, 53.55, 56.099999999999994, 58.65,  
 61.199999999999996, 63.749999999999999, 66.3,  
 68.85, 71.399999999999999, 73.949999999999999,  
 76.5, 79.05, 81.6, 84.149999999999999,  
 86.699999999999999, 89.25, 91.8, 94.35,  
 96.899999999999999, 99.449999999999999,  
 102.0, 104.55, 107.1, 109.649999999999999,  
 112.199999999999999, 114.749999999999999, 117.3,

119.85, 122.39999999999999, 124.94999999999999,  
 127.49999999999999, 130.04999999999998,  
 132.6, 135.14999999999998, 137.7, 140.25,  
 142.79999999999998, 145.35, 147.89999999999998,  
 150.45, 153.0, 155.54999999999998, 158.1,  
 160.64999999999998, 163.2, 165.75,  
 168.29999999999998, 170.85, 173.39999999999998,  
 175.95, 178.5, 181.04999999999998, 183.6,  
 186.14999999999998, 188.7, 191.25,  
 193.79999999999998, 196.35, 198.89999999999998,  
 201.45, 204.0, 206.54999999999998, 209.1,  
 211.64999999999998, 214.2, 216.74999999999997,  
 219.29999999999998, 221.85, 224.39999999999998,  
 226.95, 229.49999999999997, 232.04999999999998,  
 234.6, 237.14999999999998, 239.7,  
 242.24999999999997, 244.79999999999998, 247.35,  
 249.89999999999998, 252.45, 255.0

Histogram counts:

1724348, 300333, 262257, 497606, 431373, 843120,  
 608967, 396922, 32513, 22649, 18887, 11147,  
 15057, 9490, 13122, 8271, 11508, 7178, 9881,  
 6288, 8982, 8570, 5580, 8111, 5161, 7468, 4768,  
 7063, 4446, 6388, 5986, 3902, 5649, 3586, 5297,  
 3296, 4819, 3088, 4565, 3004, 4441, 4234, 2706,  
 4059, 2680, 3998, 2731, 4049, 2802, 4505, 6317,  
 6351, 10789, 7610, 13756, 9507, 11041, 4563,  
 4832, 1834, 1585, 882, 432, 543, 321, 418, 249,  
 316, 190, 294, 249, 137, 179, 120, 150, 94, 148,  
 94, 123, 61, 101, 97, 67, 111, 58, 78, 62, 80,  
 46, 73, 76, 46, 66, 47, 62, 43, 56, 31, 61, 47

Data Modality: CT Scan

Goal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible without any visual occlusions.

Constraints:

1. The opacity function is defined by two values, a start point and an end point, which define the range of the values that are potentially associated with the structure of interest. For value smaller than the start point the opacity is 0. At the middle point between start and end point, the opacity is 1. For values larger than the end point the opacity is 0. The opacity linearly increases from start point to the middle point and linearly decreases from center to end point. Therefore, the opacity function will always look like a triangle with two sides of the same length.

2. Reflect on past decisions and strategies to try different opacity functions.

3. The assessments are with respect to the structure of interest, but not for any other structures you recognize in the screenshot.

4. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.

5. Your response must be in the following JSON format and do not add comments to the JSON response:

```
{
  "thought": "thought",
  "reasoning": "reasoning",
  "plan": "long-term plan",
  "assessment": "assessment",
  "opacity function": "[start point, end point]"
}
```

6. For your assessment select one from the options. If you weren't provided with the screenshot, the "assessment" in your response is 'N/A'.

7. Based on your assessment, the user will move the window of the opacity function to higher values and will provide you with a new screenshot based on the opacity function.

8. Provide assessments and opacity functions, until your assessment is "clear"

9. Start your response with the initial opacity function based on the algorithm.

10. If the structure of interest is not visible in the image, continue with assessing the images and providing opacity functions.

### 3.4. Additional Datasets used for Stability and Repeatability Tests

In order to evaluate the stability and repeatability of AVA for Volume Rendering, we conducted a feasibility assessment as described in Section 6. We added two additional datasets to demonstrate the versatility of this approach: the *Tooth* dataset [?], and the *Engine* dataset [?]. We deliberately added these two datasets as they contains several objects and we demonstrated in the systematic evaluation that AVA was able to adjust the opacity function to recognize the object in all cases. In more than 40% (Engine) and more than 70% (Tooth) of the optimization loops it was able to set the opacity function to determine a visualization that AVA regarded as "clear", which could be either increased by a higher resolution dataset, or higher number of iterations (currently limited at 10). This evaluation was run automatically (10 optimizations with 10 iterations per structure of interest) and we logged all the details, including agent setup prompts, conversations, timestamps, rendering output, opacity functions, and assessment, which are all included in the Supplementary Materials of this paper.

### 3.5. Tooth Dataset

#### 3.5.1. Model Derives Own Action Plan

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal, by considering the histogram of the data, and the data acquisition modality and comply with the constraints below. Use your knowledge about transfer function design from the scientific literature.

Structure of Interest: tooth

Histogram:

Bin edges:

0.0, 2.55, 5.1, 7.649999999999995,  
10.2, 12.75, 15.299999999999999,  
17.849999999999998, 20.4, 22.95, 25.5,  
28.049999999999997, 30.599999999999998,  
33.15, 35.699999999999996, 38.25, 40.8,  
43.349999999999994, 45.9, 48.449999999999996,  
51.0, 53.55, 56.099999999999994, 58.65,  
61.199999999999996, 63.749999999999999, 66.3,  
68.85, 71.399999999999999, 73.949999999999999,  
76.5, 79.05, 81.6, 84.149999999999999,  
86.699999999999999, 89.25, 91.8, 94.35,  
96.899999999999999, 99.449999999999999,  
102.0, 104.55, 107.1, 109.649999999999999,  
112.199999999999999, 114.749999999999999, 117.3,  
119.85, 122.399999999999999, 124.949999999999999,  
127.499999999999999, 130.049999999999998,  
132.6, 135.149999999999998, 137.7, 140.25,  
142.799999999999998, 145.35, 147.899999999999998,  
150.45, 153.0, 155.549999999999998, 158.1,  
160.649999999999998, 163.2, 165.75,  
168.299999999999998, 170.85, 173.399999999999998,  
175.95, 178.5, 181.049999999999998, 183.6,  
186.149999999999998, 188.7, 191.25,  
193.799999999999998, 196.35, 198.899999999999998,  
201.45, 204.0, 206.549999999999998, 209.1,  
211.649999999999998, 214.2, 216.749999999999997,  
219.299999999999998, 221.85, 224.399999999999998,  
226.95, 229.499999999999997, 232.049999999999998,  
234.6, 237.149999999999998, 239.7,  
242.249999999999997, 244.799999999999998, 247.35,  
249.899999999999998, 252.45, 255.0

Histogram counts:

35, 53, 111, 371, 389, 728, 624, 970, 628, 817,  
657, 371, 496, 314, 417, 259, 399, 257, 425, 293,  
439, 426, 284, 484, 333, 526, 847, 12267, 63000,  
307196, 418904, 156856, 93218, 27527, 18563,  
7611, 8399, 4689, 6205, 3491, 4931, 4602, 3235,  
4268, 2713, 3942, 2622, 4077, 2580, 3927, 4034,  
2888, 4921, 3248, 5496, 4150, 7077, 6011, 9165,  
7362, 14865, 27694, 27302, 52681, 35233, 37245,  
12807, 6670, 2318, 2558, 2192, 1558, 2101, 1366,  
1986, 1256, 2031, 1323, 1997, 1304, 2013, 2245,  
1436, 2298, 1589, 2832, 2007, 3434, 3000, 6850,

13346, 11398, 16243, 8180, 7665, 3456, 2452, 559,  
172, 12

Data Modality: CT Scan

Goal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible without any visual occlusions.

Constraints:

1. The opacity function is defined by two values, a start point and end point, which define the range of the values that are potentially associated with the structure of interest. For value smaller than the start point the opacity is 0. At the middle point between start and end point, the opacity is 1. For values larger than the end point the opacity is 0. The opacity linearly increases from start point to the middle point and linearly decreases from center to end point. Therefore, the opacity function will always look like a triangle with two sides of the same length.
2. Reflect on past decisions and strategies to try different opacity functions.
3. The assessments are with respect to the structure of interest, but not for any other structures you recognize in the screenshot.
4. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.
5. Your response must be in the following format:
  - "assessment": this entry should be either 'not recognizable', 'recognizable', 'clear' according to the definition above.
  - "reasoning": provide reasoning for your assessment
  - "plan": provide a your plan to reach the goal
  - "opacity function": only provide a opacity function in the following format '[start point, end point]'
6. For your assessment select one from the options. If you weren't provided with the screenshot, the "assessment" in your response is 'N/A'.
7. Based on your assessment, the user will move the window of the opacity function to higher values and will provide you with a new screenshot based on the opacity function.

8. Provide assessments and opacity functions, until your assessment is 'clear'  
 9. Start your response with the initial opacity function based on the algorithm.  
 10. If the structure of interest is not visible in the image, continue with assessing the images and providing opacity functions.  
 11. You are always provided with a new screenshots based on the opacity function you suggested. If the screenshot doesn't seem to change from the previous, change your plan entirely.  
 12. If your assessment is 'not recognizable' for more than five times, change your plan entirely.

"agent\_setup\_message": "You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal, by considering the histogram of the data, the data acquisition modality and comply with the constraints below. Use your knowledge about transfer function design from the scientific literature.\nStructure of Interest: tooth\n\nHistogram: \nBin edges: \n0.0, 2.55, 5.1, 7.649999999999995, 10.2, 12.75, 15.299999999999999, 17.849999999999998, 20.4, 22.95, 25.5, 28.049999999999997, 30.599999999999998, 33.15, 35.699999999999996, 38.25, 40.8, 43.349999999999994, 45.9, 48.449999999999996, 51.0, 53.55, 56.099999999999994, 58.65, 61.199999999999996, 63.749999999999999, 66.3, 68.85, 71.399999999999999, 73.949999999999999, 76.5, 79.05, 81.6, 84.149999999999999, 86.699999999999999, 89.25, 91.8, 94.35, 96.899999999999999, 99.449999999999999, 102.0, 104.55, 107.1, 109.649999999999999, 112.199999999999999, 114.749999999999999, 117.3, 119.85, 122.399999999999999, 124.949999999999999, 127.499999999999999, 130.049999999999998, 132.6, 135.149999999999998, 137.7, 140.25, 142.799999999999998, 145.35, 147.899999999999998, 150.45, 153.0, 155.549999999999998, 158.1, 160.649999999999998, 163.2, 165.75, 168.299999999999998, 170.85, 173.399999999999998, 175.95, 178.5, 181.049999999999998, 183.6, 186.149999999999998, 188.7, 191.25, 193.799999999999998, 196.35, 198.899999999999998, 201.45, 204.0, 206.549999999999998, 209.1, 211.649999999999998, 214.2, 216.749999999999997, 219.299999999999998, 221.85, 224.399999999999998, 226.95, 229.499999999999997, 232.049999999999998, 234.6, 237.149999999999998, 239.7, 242.249999999999997, 244.799999999999998, 247.35, 249.899999999999998, 252.45, 255.0\n\nHistogram counts: \n35, 53, 111, 371, 389, 728, 624, 970,

628, 817, 657, 371, 496, 314, 417, 259, 399, 257, 425, 293, 439, 426, 284, 484, 333, 526, 847, 12267, 63000, 307196, 418904, 156856, 93218, 27527, 18563, 7611, 8399, 4689, 6205, 3491, 4931, 4602, 3235, 4268, 2713, 3942, 2622, 4077, 2580, 3927, 4034, 2888, 4921, 3248, 5496, 4150, 7077, 6011, 9165, 7362, 14865, 27694, 27302, 52681, 35233, 37245, 12807, 6670, 2318, 2558, 2192, 1558, 2101, 1366, 1986, 1256, 2031, 1323, 1997, 1304, 2013, 2245, 1436, 2298, 1589, 2832, 2007, 3434, 3000, 6850, 13346, 11398, 16243, 8180, 7665, 3456, 2452, 559, 172, 12\n\nData Modality: CT Scan\n\nGoal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible without any visual occlusions.\n\nConstraints:\n\n1. The opacity function is defined by two values, a start point and end point, which define the range of the values that are potentially associated with the structure of interest. For value smaller than the start point the opacity is 0. At the middle point between start and end point, the opacity is 1. For values larger than the end point the opacity is 0. The opacity linearly increases from start point to the middle point and linearly decreases from center to end point. Therefore, the opacity function will always look like a triangle with two sides of the same length.\n\n2. Reflect on past decisions and strategies to try different opacity functions.\n\n3. The assessments are with respect to the structure of interest, but not for any other structures you recognize in the screenshot.\n\n4. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.\n\n5. Your response must be in the following format:\n\n\"assessment\": this entry should be either 'not recognizable', 'recognizable', 'clear' according to the definition above. \n\n \"reasoning\": provide reasoning for your assessment\n\n\n \"plan\": provide a your plan to reach the goal\n\n\n \"opacity function\": only provide a opacity function in the following format '[start point, end point]'\n\n6. For your assessment select one from the options. If you weren't provided with the screenshot, the \"assessment\" in your response is 'N/A'. \n\n7. Based on your assessment, the user will move the window of the opacity function to higher values and will provide you with a new screenshot based on the opacity function.\n\n8. Provide assessments and opacity

functions, until your assessment is 'clear'\n9. Start your response with the initial opacity function based on the algorithm. \n10. If the structure of interest is not visible in the image, continue with assessing the images and providing opacity functions.\n 11. You are always provided with a new screenshots based on the opacity function you suggested. If the screenshot doesn't seem to change from the previous, change your plan entirely.\n 12. If your assessment is 'not recognizable' for more than five times, change your plan entirely.\n"

### 3.6. Engine Dataset

#### 3.6.1. Model Derives Own Action Plan

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal, by considering the histogram of the data, the data acquisition modality and comply with the constraints below. Use your knowledge about transfer function design from the scientific literature.

Structure of Interest: two metal components that look like rings

Histogram:

Bin edges:

0.0, 2.55, 5.1, 7.649999999999995,  
10.2, 12.75, 15.299999999999999,  
17.849999999999998, 20.4, 22.95, 25.5,  
28.049999999999997, 30.599999999999998,  
33.15, 35.699999999999996, 38.25, 40.8,  
43.349999999999994, 45.9, 48.449999999999996,  
51.0, 53.55, 56.099999999999994, 58.65,  
61.199999999999996, 63.749999999999999, 66.3,  
68.85, 71.399999999999999, 73.949999999999999,  
76.5, 79.05, 81.6, 84.149999999999999,  
86.699999999999999, 89.25, 91.8, 94.35,  
96.899999999999999, 99.449999999999999,  
102.0, 104.55, 107.1, 109.649999999999999,  
112.199999999999999, 114.749999999999999, 117.3,  
119.85, 122.399999999999999, 124.949999999999999,  
127.499999999999999, 130.049999999999998,  
132.6, 135.149999999999998, 137.7, 140.25,  
142.799999999999998, 145.35, 147.899999999999998,  
150.45, 153.0, 155.549999999999998, 158.1,  
160.649999999999998, 163.2, 165.75,  
168.299999999999998, 170.85, 173.399999999999998,  
175.95, 178.5, 181.049999999999998, 183.6,  
186.149999999999998, 188.7, 191.25,  
193.799999999999998, 196.35, 198.899999999999998,

201.45, 204.0, 206.549999999999998, 209.1,  
211.649999999999998, 214.2, 216.749999999999997,  
219.299999999999998, 221.85, 224.399999999999998,  
226.95, 229.499999999999997, 232.049999999999998,  
234.6, 237.149999999999998, 239.7,  
242.249999999999997, 244.799999999999998, 247.35,  
249.899999999999998, 252.45, 255.0  
Histogram counts:  
4821016, 1247272, 397118, 302500, 96800, 74446,  
28835, 30730, 16420, 21032, 18520, 11507, 15783,  
10169, 14586, 9346, 13063, 8527, 12175, 7747,  
11120, 10914, 7158, 10669, 7103, 10553, 6822,  
9978, 6725, 10301, 10027, 6676, 10176, 6955,  
10784, 7289, 10970, 7375, 12166, 9405, 15974,  
16401, 10525, 14431, 9503, 14863, 10660, 17353,  
13076, 23246, 31876, 30475, 66916, 63046, 124668,  
98667, 148336, 86845, 86605, 31652, 21858, 8123,  
2858, 2623, 1352, 1598, 1074, 1835, 1293, 1885,  
1742, 1125, 1664, 1081, 1830, 1151, 1824, 5321,  
7211, 1991, 2997, 1874, 1277, 3533, 3528, 4258,  
1709, 1742, 913, 1319, 1240, 826, 1256, 866,  
1422, 940, 1677, 1203, 2153, 28560

Data Modality: CT Scan

Goal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible without any visual occlusions.

Constraints:

1. The opacity function is defined by two values, a start point and end point, which define the range of the values that are potentially associated with the structure of interest. For value smaller than the start point the opacity is 0. At the middle point between start and end point, the opacity is 1. For values larger than the end point the opacity is 0. The opacity linearly increases from start point to the middle point and linearly decreases from center to end point. Therefore, the opacity function will always look like a triangle with two sides of the same length.
2. Reflect on past decisions and strategies to try different opacity functions.
3. The assessments are with respect to the structure of interest, but not for any other structures you recognize in the screenshot.
4. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.

5. Your response must be in the following format:  
"assessment": this entry should be either 'not recognizable', 'recognizable', 'clear' according to the definition above.

"reasoning": provide reasoning for your assessment

"plan": provide a your plan to reach the goal  
"opacity function": only provide a opacity function in the following format '[start point, end point]'

6. For your assessment select one from the options. If you weren't provided with the screenshot, the "assessment" in your response is 'N/A'.

7. Based on your assessment, the user will move the window of the opacity function to higher values and will provide you with a new screenshot based on the opacity function.

8. Provide assessments and opacity functions, until your assessment is 'clear'

9. Start your response with the initial opacity function based on the algorithm.

10. If the structure of interest is not visible in the image, continue with assessing the images and providing opacity functions.

11. You are always provided with a new screenshots based on the opacity function you suggested. If the screenshot doesn't seem to change from the previous, change your plan entirely.

12. If your assessment is 'not recognizable' for more than five times, change your plan entirely.

"agent\_setup\_message": "You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity function for volume rendering. You are able to view and analyze images. In each step, you will receive a screenshot of the volume rendering from the user, and your task is to determine whether the structure of interest is visible in that screenshot or not and based on the assessment provide the opacity function. Reach the goal, by considering the histogram of the data, the data acquisition modality and comply with the constraints below. Use your knowledge about transfer function design from the scientific literature.\n\nStructure of Interest: two metal components that look like rings \n\nHistogram: \nBin edges: \n 0.0, 2.55, 5.1, 7.649999999999995, 10.2, 12.75, 15.299999999999999, 17.849999999999998, 20.4, 22.95, 25.5, 28.049999999999997, 30.599999999999998, 33.15, 35.699999999999996, 38.25, 40.8, 43.349999999999994, 45.9, 48.449999999999996, 51.0, 53.55, 56.099999999999994, 58.65, 61.199999999999996, 63.749999999999999, 66.3, 68.85, 71.399999999999999, 73.949999999999999, 76.5, 79.05, 81.6, 84.149999999999999, 86.699999999999999, 89.25, 91.8, 94.35, 96.899999999999999, 99.449999999999999,

102.0, 104.55, 107.1, 109.649999999999999, 112.199999999999999, 114.749999999999999, 117.3, 119.85, 122.399999999999999, 124.949999999999999, 127.499999999999999, 130.049999999999998, 132.6, 135.149999999999998, 137.7, 140.25, 142.799999999999998, 145.35, 147.899999999999998, 150.45, 153.0, 155.549999999999998, 158.1, 160.649999999999998, 163.2, 165.75, 168.299999999999998, 170.85, 173.399999999999998, 175.95, 178.5, 181.049999999999998, 183.6, 186.149999999999998, 188.7, 191.25, 193.799999999999998, 196.35, 198.899999999999998, 201.45, 204.0, 206.549999999999998, 209.1, 211.649999999999998, 214.2, 216.749999999999997, 219.299999999999998, 221.85, 224.399999999999998, 226.95, 229.499999999999997, 232.049999999999998, 234.6, 237.149999999999998, 239.7, 242.249999999999997, 244.799999999999998, 247.35, 249.899999999999998, 252.45, 255.0\n\nHistogram counts: \n4821016, 1247272, 397118, 302500, 96800, 74446, 28835, 30730, 16420, 21032, 18520, 11507, 15783, 10169, 14586, 9346, 13063, 8527, 12175, 7747, 11120, 10914, 7158, 10669, 7103, 10553, 6822, 9978, 6725, 10301, 10027, 6676, 10176, 6955, 10784, 7289, 10970, 7375, 12166, 9405, 15974, 16401, 10525, 14431, 9503, 14863, 10660, 17353, 13076, 23246, 31876, 30475, 66916, 63046, 124668, 98667, 148336, 86845, 86605, 31652, 21858, 8123, 2858, 2623, 1352, 1598, 1074, 1835, 1293, 1885, 1742, 1125, 1664, 1081, 1830, 1151, 1824, 5321, 7211, 1991, 2997, 1874, 1277, 3533, 3528, 4258, 1709, 1742, 913, 1319, 1240, 826, 1256, 866, 1422, 940, 1677, 1203, 2153, 28560\n\nData Modality: industrial x-ray CT Scan\n\nGoal: Provide the user with your assessment of whether the structure of interest can be recognized in the provided screenshot as well as your recommendation for the opacity function. Use only one of these options: 'not recognizable,' 'recognizable,' 'clear.' 'Not recognizable' indicates that the structure of interest cannot be identified in the image, even if another structure is recognizable. 'Recognizable' implies that both the structure of interest and its shape can be discerned in the screenshot. 'Clear' denotes that the structure of interest is distinctly visible without any visual occlusions.\n\nConstraints:\n\n1. The opacity function is defined by two values, a start point and end point, which define the range of the values that are potentially associated with the structure of interest. For value smaller than the start point the opacity is 0. At the middle point between start and end point, the opacity is 1. For values larger than the end point the opacity is 0. The opacity linearly increases from start point to the middle point and linearly decreases from center to end point. Therefore, the opacity function will always look like a triangle with two sides of the same length.\n\n2. Reflect on past decisions and strategies to try different opacity functions.\n\n3. The assessments are with respect to the

structure of interest, but not for any other structures you recognize in the screenshot.\n4. The provided screenshots are from volume renderings that differ only in their opacity function usage. They are all rendered with the same color map and the same viewpoint.\n5. Your response must be in the following format:\n\n\"assessment\": this entry should be either 'not recognizable', 'recognizable', 'clear' according to the definition above. \n\n\n\"reasoning\": provide reasoning for your assessment\n\n\n\"plan\": provide a your plan to reach the goal\n\n\n\"opacity function\": only provide a opacity function in the following format '[start point, end point]'\n6. For your assessment select one from the options. If you weren't provided with the screenshot, the \"assessment\" in your response is 'N/A'. \n7. Based on your assessment, the user will move the window of the opacity function to higher values and will provide you with a new screenshot based on the opacity function.\n8. Provide assessments and opacity functions, until your assessment is 'clear'\n9. Start your response with the initial opacity function based on the algorithm. \n10. If the structure of interest is not visible in the image, continue with assessing the images and providing opacity functions.\n11. You are always provided with a new screenshots based on the opacity function you suggested. If the screenshot doesn't seem to change from the previous, change your plan entirely.\n12. If your assessment is 'not recognizable' for more than five times, change your plan entirely."

Structure of Interest: the structure in the scatterplot (e.g., clusters, shape, anything that deviates from a simple uniform distribution)

Constraints:

1. Your response must be in the following format:  
 "assessment": this entry should use several words to indicate which plot is better, use "previous plot" to describe the first plot, and use "current plot" to describe the second plot.  
 "reasoning": provide reasoning for your comparison assessment  
 "comparison": Use 0 to indicate the first plot is better, 1 to indicate otherwise, and put the number in []. Do not provide any words in this entry

### 3.7. MNIST - tSNE

### 3.8. Scatterplot Opacity Optimization

You are AVA, an autonomous visualization agent that assists users in iteratively finding an appropriate opacity value for scatterplots to mitigate the overplotting challenge. You are able to view and analyze images. In each step, you will receive two scatterplots from the user the only difference being their choice of point opacity. And your task is to provide the user with your assessment of which plot is better. A better scatterplot indicates the chosen opacity allows the viewer to obtain a better understanding of the overall distribution of the underlying data and does not have a serious overplotting issue that can obscure the structure of interest. The provided plots are from scatterplots that differ only in their point opacity value. They are all rendered with the same color map and the same viewpoint. The opacity function is defined by one floating value between 0.0 and 1.0. Use your knowledge about scatterplots from information visualization literature.

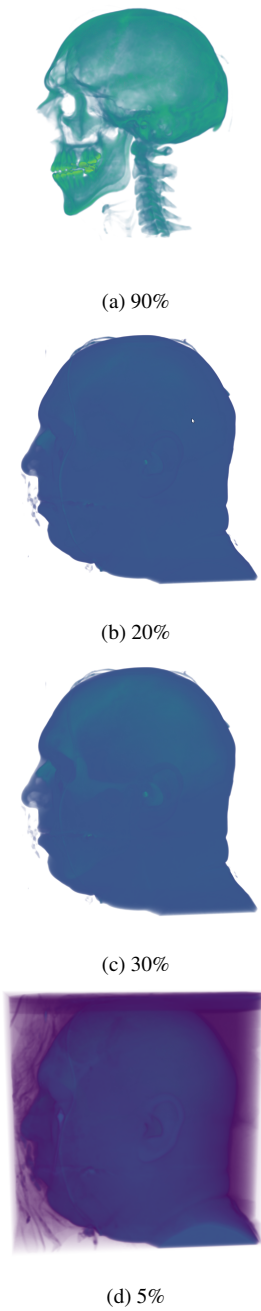


Figure 9: The Human Male dataset. In this figure, we conducted tests on the same set of screenshots, focusing on two distinct structures of interest: the male face and the bones. Notably, all images were accurately identified, except for the instance depicted in Figure 9d, where the presence of background partially occludes the head. The high degree of noise in this scenario appears to have affected the recognition of the skull. The agent’s response for a ‘male face’ as the structure of interest: 9a: ‘not recognizable’, 9b: ‘recognizable’, 9c: ‘recognizable’, and 9d: ‘not recognizable’. The agent’s response for a ‘bones’ structure of interest: 9a: ‘recognizable’, 9b: ‘not recognizable’, 9c: ‘not recognizable’, and 9d: ‘recognizable’.

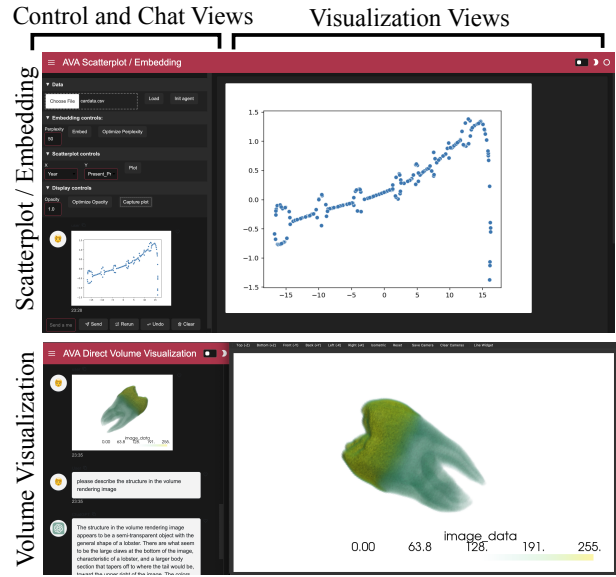


Figure 10: AVA integrated visualization interface. We implement AVA as a configurable system where individual components can be combined/configured for different target applications.

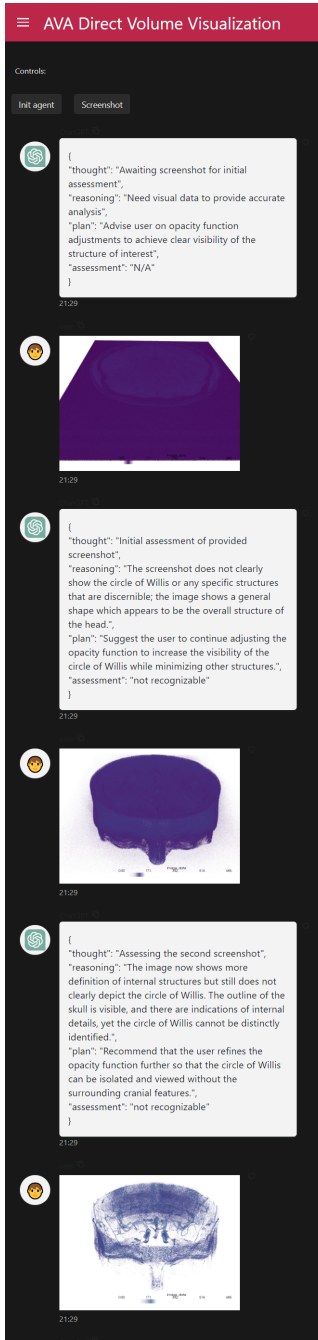


Figure 11: The response from the heuristic-centric agent. It only provided the assessment, but the action plan was hard coded as a linear search that sweeps the values with a triangle function as the opacity transfer function.

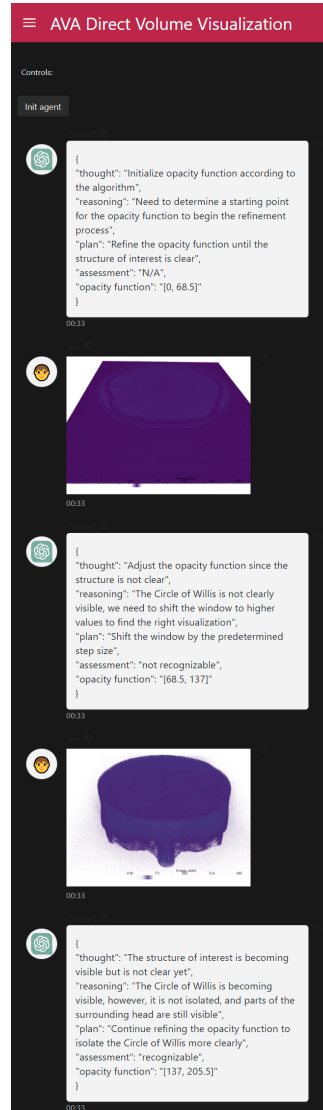
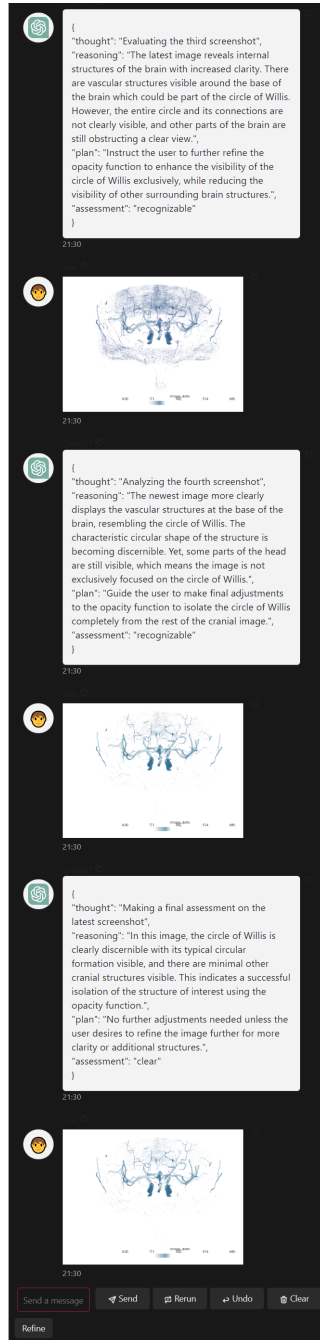
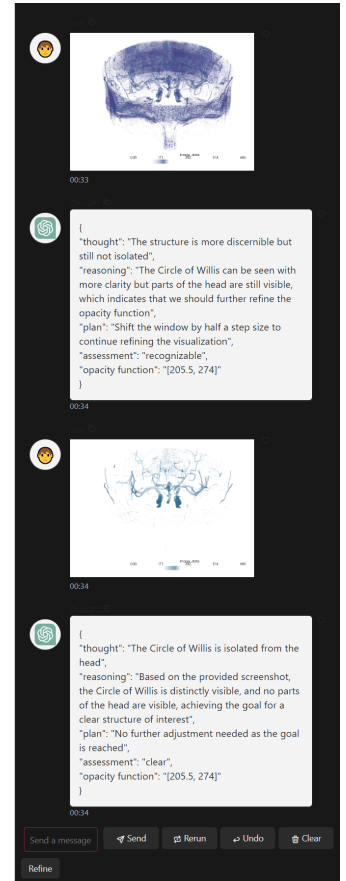


Figure 12: The response from the heuristic-centric agent. It provided the assessment and used the heuristic provided by the user as its action plan. It employs a linear search that sweeps the values with a triangle function as the opacity transfer function.



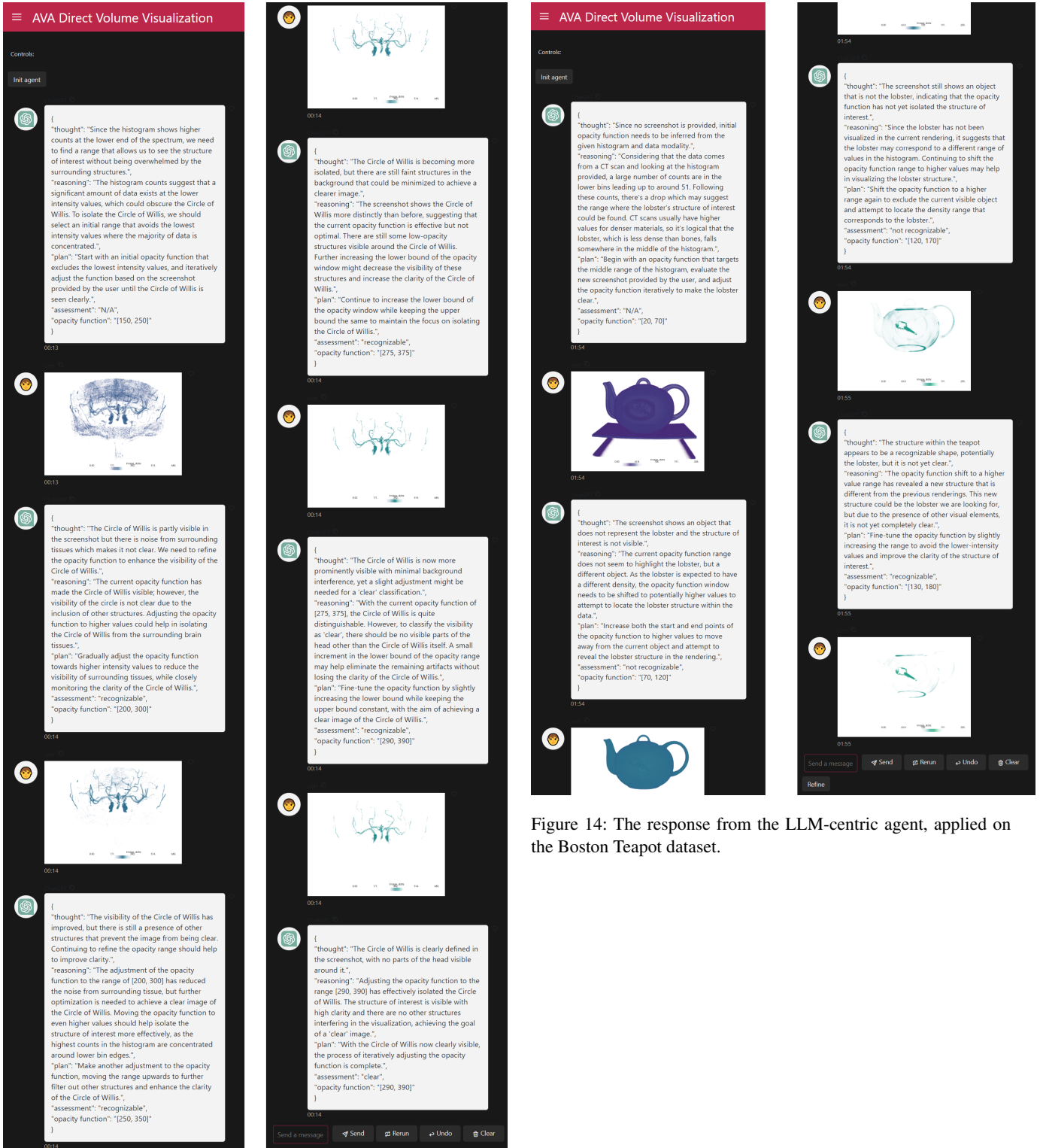


Figure 13: The response from the LLM-centric agent. It uses the prior knowledge of an LLM and devised its own action plan to perform the opacity transfer function optimization.

Figure 14: The response from the LLM-centric agent, applied on the Boston Teapot dataset.



Figure 15: The response from the LLM-centric agent, applied on the Lobster dataset.

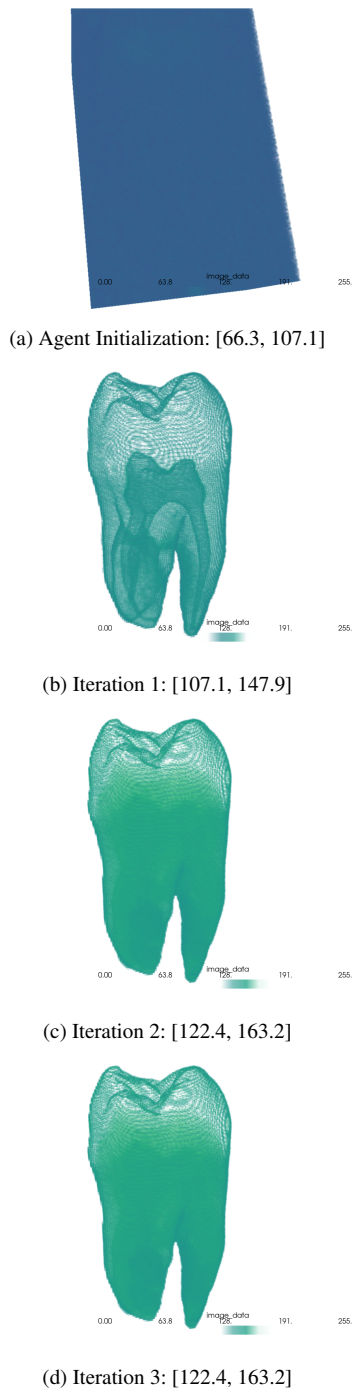


Figure 16: The figures depicts one of the 10 runs we conducted for the Tooth dataset. The dataset was volume rendered using the same color map but at varying opacity functions, suggested by the agent. Structure of interest: the tooth. The response from the LLM model was 16a: 'N/A', 16b: 'recognizable', 16c: 'recognizable', and 16d: 'clear'

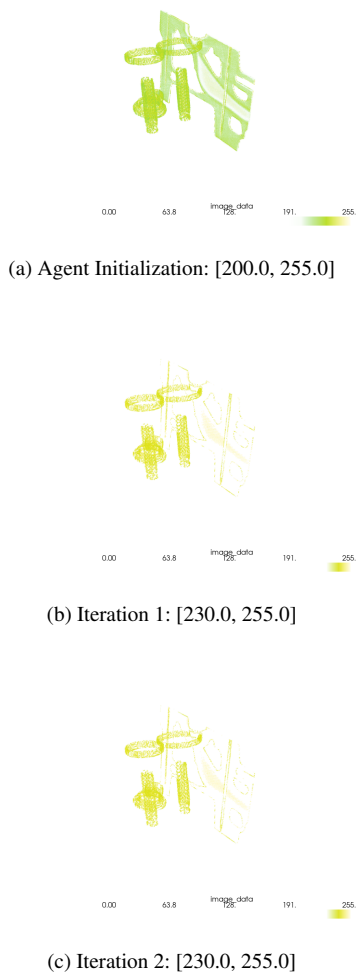


Figure 17: The figures depicts one of the 10 runs we conducted for the Engine dataset. The dataset was volume rendered using the same color map but at varying opacity functions, suggested by the agent. Structure of interest: the two metal components that look like rings. The response from the LLM model was 17a: 'N/A', 17b: 'recognizable', and 17c: 'clear'

AVA Scatterplot / Embedding

Data: Choose File, No file chosen, Load, Init agent

Scatterplot controls: X: col\_1, Y: col\_1, Plot

Display controls: Opacity: 1.0, Optimize Opacity, Capture plot

Chat messages:

- Agent: Understood. Please provide me with the initial embedding generated using the default perplexity value so I can start the assessment. (23:47)
- User: [Image: Scatterplot with perplexity = 15] (23:48)
- Agent: "assessment": The perplexity value is set appropriately. "reasoning": The embedding with perplexity value of 45 shows a good balance between cluster separation and compactness. The clusters are discernible and well-spaced without being too scattered, indicating that the data structure is well-represented at this perplexity level. "suggestion": [45] (23:48)
- User: [Image: Scatterplot with perplexity = 45] (23:48)
- Agent: "assessment": The perplexity value might be slightly low for this dataset. "reasoning": The clusters appear to be forming but the separation between them is not very clear, which is indicative of a perplexity value that might be too low. A higher perplexity might help to better define the clusters and spaces between them. "suggestion": [30] (23:47)
- User: [Image: Scatterplot with perplexity = 30] (23:47)

Figure 18: The response from the LLM-centric agent, applied on the MNIST dataset.

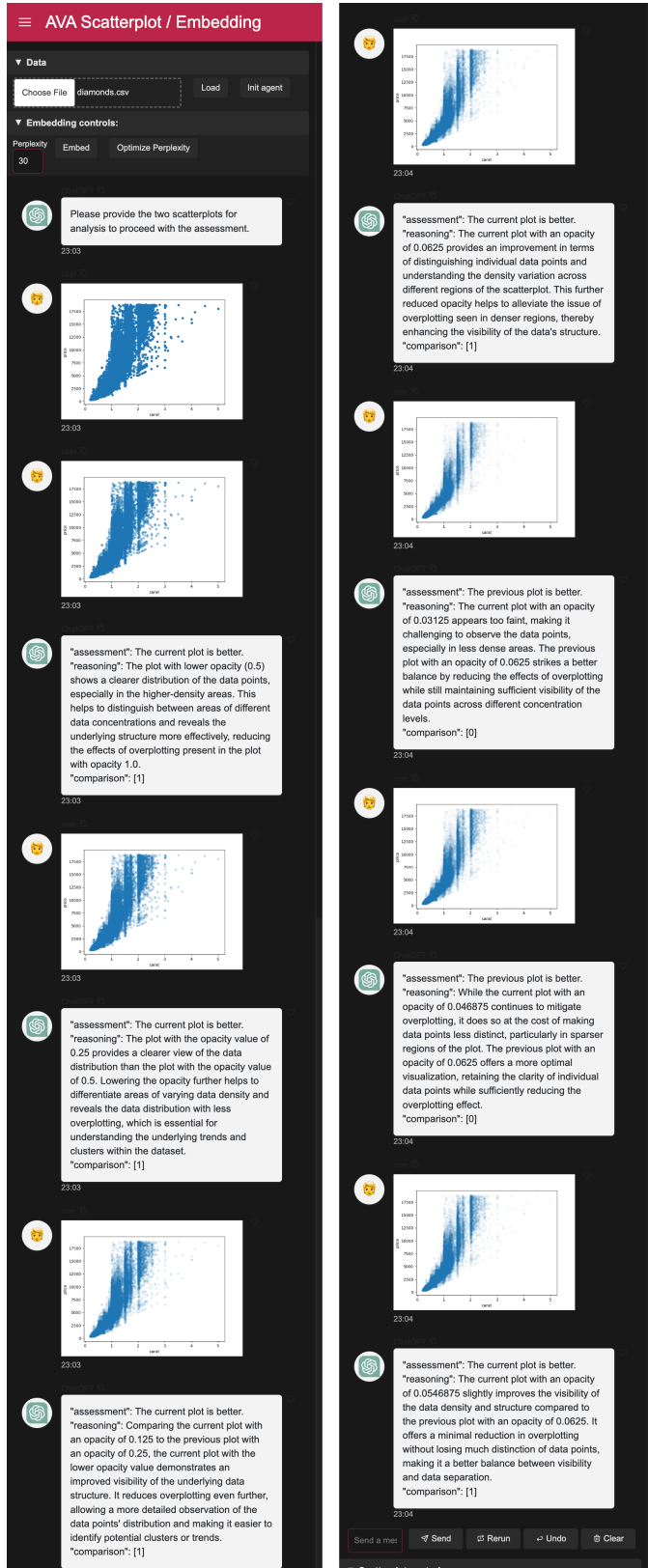


Figure 19: The response from the agent, applied on the Diamond dataset.

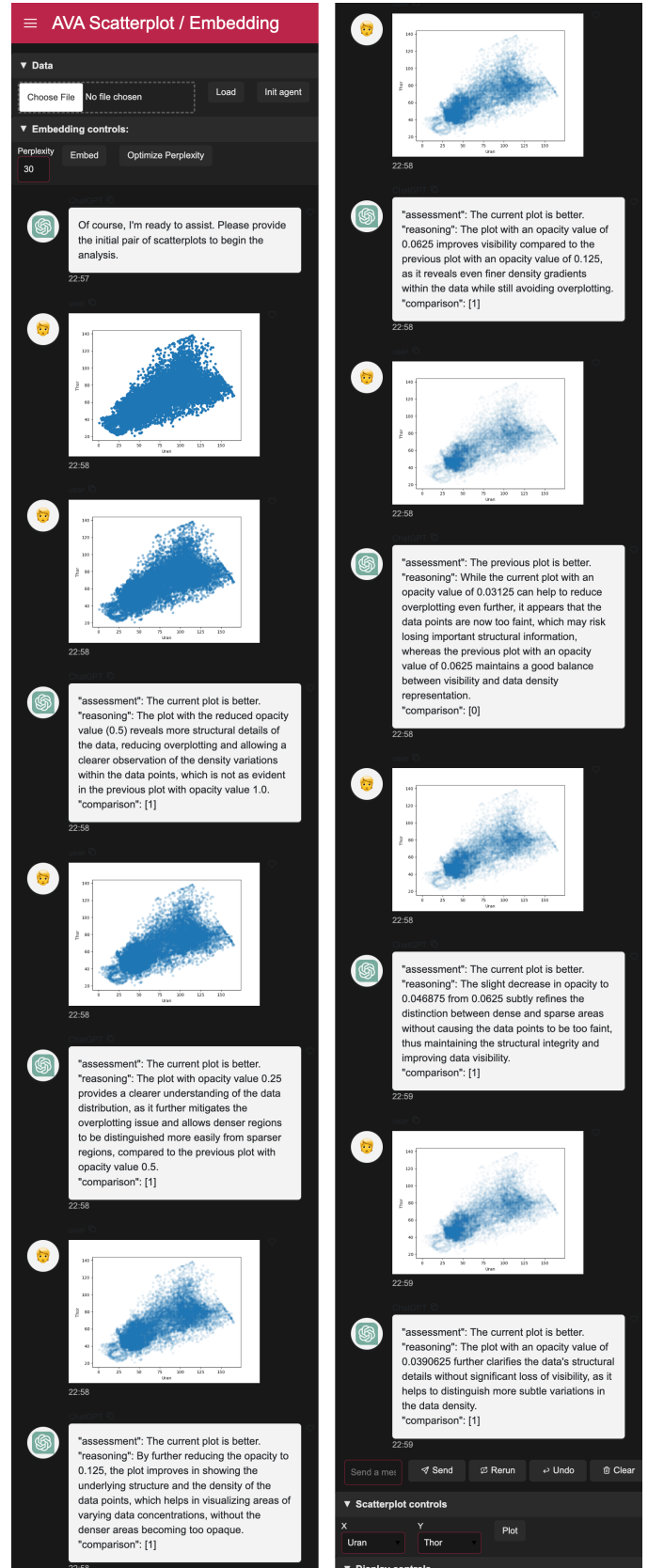


Figure 20: The response from the agent, applied on the Out5D dataset.

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