Questions Related to the Visualization Lectures, Part II

Questions related to Information Visualization I, II, III

In SPLOMs you reduce the feature space to just two variables in each of the displayed scatterplots. Furthermore usually no aggregations take place (except in case of overlapping points maybe). Then why are SPLOMs complete and not partial visualization techniques?

Answer: One scatterplot shows just two variables. A scatterplot matrix shows one scatterplot for each pair of variables. Thus, it is complete. However, it doesn't scale to hundreds of variables leading to many thousands of scatterplots.

Can you give us an example for partial visualization techniques? Are projections to a lower dimensional feature space (e.g. with PCA, Self Organizing Maps, etc.) maybe partial visualizations?

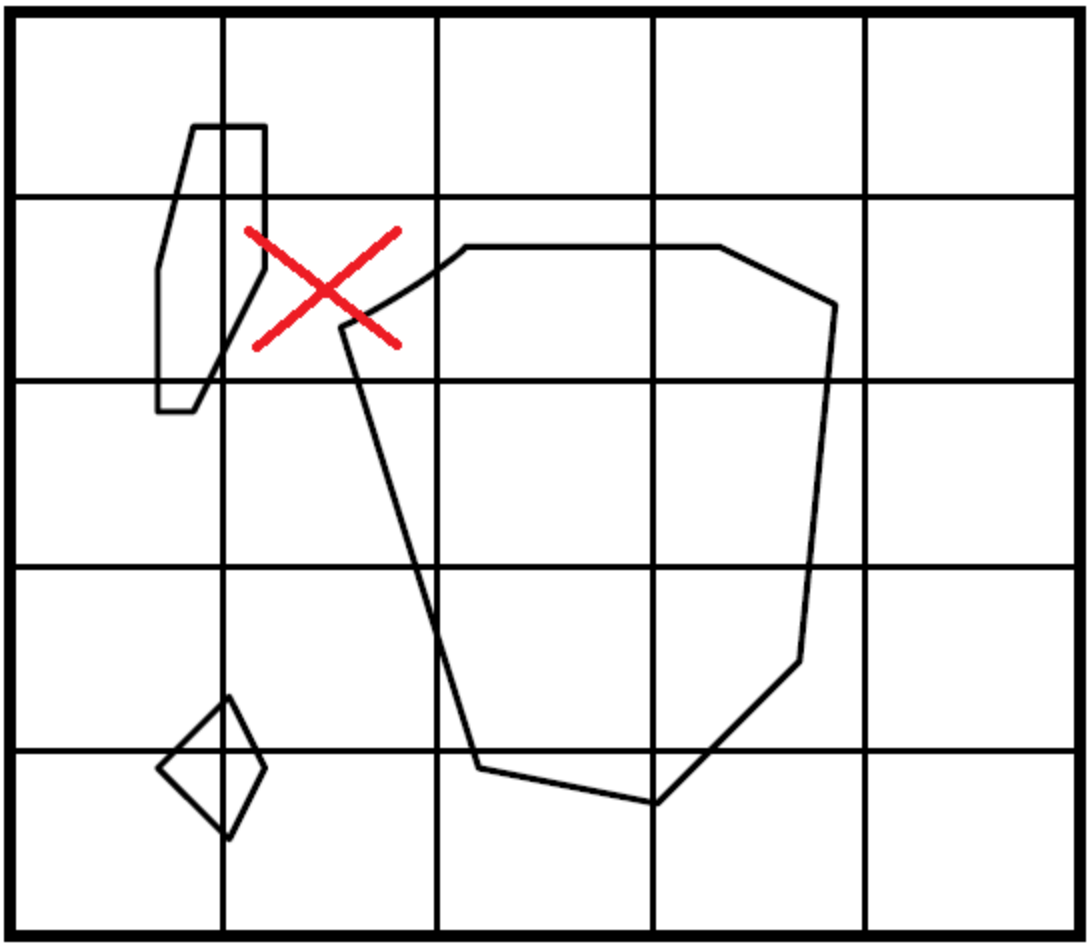
Answer: Exactly.

Is it possible to combine complete and partial visualizations?

Answer: Yes. Show a partial visualization first and complete visualizations on demand.

Questions related to Surface Visualization

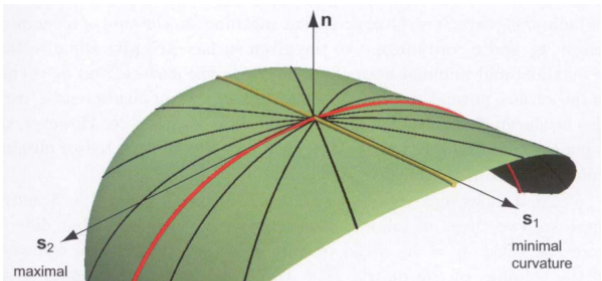
Question 1: Connected Component Analysis



Assume we initialize the CCA algorithm in the marked cell (all other cells unmarked). Since both surfaces go through the cell (and the cell therefore contributes to the surface) wouldn't CCA consider them as one connected component even though they are actually separate? How would the algorithm proceed in such ambiguous cases?

Answer: Very good question. Nobody asked it in more than 15 years! Indeed in this special case, the algorithm would fail. To generalize: It cannot correctly separate structures at a subvoxel level. There are advanced methods that provide segmentation on subvoxel level but that is far beyond this lecture.

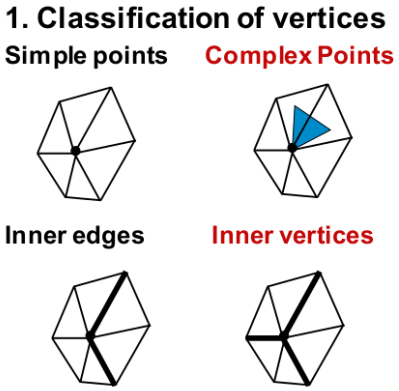
How is the major curvature direction calculated? We start from the normal,



but how do we know in which direction from that normal the maximal curvature direction is?

Answer: I have not explained this exactly and of course do not require you to do this. My point was to explain to you how the curvature values are computed and I used the fitting process of a quadratic function for this. I looked up how to compute the curvature directions (Wikipedia for example). This is based on the Weingarten mapping - but that is beyond this lecture.

Could you reiterate examples to make the difference between simple points, inner edges & inner vertices more clear? they are all based on 3d points, correct?



Answer: Most points are simple points; the topology is correct (unlike the complex points with additional triangles). The classification w.r.t. Inner edges and inner vertices is based on thresholds for the dihedral angle (the difference of the normal direction of two adjacent triangles). If the dihedral angle exceeds the threshold for at least one pair of triangles in the topological neighborhood of a vertex, it is classified as Inner Edge; if this is fulfilled for at least three pairs of triangles, it is an inner vertex. In the mesh decimation process, I would avoid removing inner edges and even more critical is to remove inner vertices. Why? Because the inaccuracy related to this removal is higher. Ideally, you only remove “simple points”. A typical threshold is 20 degrees for the dihedral angle.

Do the two major curvature directions correspond to the eigenvectors and kappa 1 & 2 to the eigenvalues of the Hessian matrix (at the position of the vertex)?

Answer: I have not explained how to compute the curvature directions. I just used an illustration of a saddle surface to give you an intuition. I'm not sure whether these directions can be directly computed from the Hessian (the representation of second order partial derivatives). The Wikipedia pages on curvature direction explain a different approach based on the Weingarten mapping, which I think is correct. What makes me a bit skeptical about using the Hessian is that there are three eigenvectors and three eigenvalues.

Questions related to (Direct) Volume Visualization

Is a voxel referring to a cell (hexahedra) or vertex within a cell in a regular 3D grid?

Further Questions:

1. Will there be pictures shown as a task?(Werden Bilder vorgegeben und wir sollen Algorithmen durch die das Bild entstanden ist erklären?)

Answer: We consider that you cannot draw/sketch anything, but are restricted to verbal descriptions.

2. Could you explain the Pixel-by-Pixel-Contouring-Algorithm again? Or give a hyperlink where to find further information about it? (Können Sie den Pixel-by-Pixel-Algorithmus erklären oder einen Link zu einer erklärenden Webseite weiterleiten?)

Answer: Pixel-by-Pixel contouring is really simple: Every pixel that has the isovalue (or isovalue +/- epsilon) belongs to the contour; all others not. You just iterate over all pixels. That does neither guarantee that the contour is

closed, nor that is has a constant width. When the decision is on a per-pixel level, the context is just missing.

3. Is it possible to see all tasks at once?(Kann man bei der Klausur alle Aufgaben einsehen und sich dann entscheiden welche man zuerst bearbeitet?)

Answer: Probably not. We think of presenting them in random order. That was strongly advised to make it more difficult that students discuss with each other how to solve a certain task.

4. Could you explain the terminology of topology again? (Könnten Sie den Begriff “Topologie” nochmal erklären?)

Answer: Think of a graph with nodes and edges or more concrete to a map with cities and train stations. Topology covers everything that is related to connectedness, e.g., is there a direct connection from A to B; do I have to change to get from A to B, how many stations are between A and B? What is NOT topology? The distance from A to B, the exact direction from A to B. In mesh processing the vertices (nodes) and edges are considered. Methods that do not change connectedness, e.g., most mesh smoothing approaches that just displace vertices are **topology-preserving**. In contrast, methods that remove vertices and reconnect existing ones, such as mesh simplification, alter the topology. If you translate, rotate or scale a dataset - many things change, but the topology is preserved.

5. Is it possible to switch languages within the exam? (Ist es möglich zwischen den Sprachen innerhalb der Klausur zu wechseln? Manchmal werden Begriffe in den Aufgaben anders übersetzt als man es selbst verstanden hätte oder man kann eine Aufgabe besser in Englisch erklären)

Answer: Yes. If you are able to use both languages, feel free to switch.

6. Is it possible to cross a section out like it was last year? (Kann man wieder einen Block, der einem gar nicht liegt, herausstreichen?)

Answer: We have not decided this yet. With the new kind of tasks it is more difficult since there will be fewer tasks.

7. Could you give examples of transfer tasks in your “Altklausuren”? (Können Sie Beispiele von sogenannten Transferaufgaben aus den Altklausuren nennen?)

Answer: The old exams were based on the assumption that you could not use any information. This time, of course, you can easily use the slides, Wikipedia, the YouTube videos. Thus, the exam has to be completely different. We try to make it not extraordinarily hard, we will be generous when evaluating it and we will pay attention to the overall distribution of the grades - we have some flexibility which number of points is needed for which grade and we will use it if necessary to avoid particularly bad results. It is an experiment for all of us but the only chance to bring you forward in your study in these times.

8. How will the “Klausureneinsicht - questions about the exam afterwards” be? (Wie erfolgt die Klausureneinsicht?)

   Answer: Probably not as a physical meeting. Probably as Zoom meetings, where the screen can be shared.

9. Was versteht man unter Meta-Daten? zwei mögliche Meta-Daten, die zusammen mit einem strukturierten Gitter gespeichert werden könnten?

Answer: The question is about “Meta-Data”. Metadata describe the data; i.e. there is a small amount of meta data that describes typically a large amount of raw data. In case of a structured grid: Meta-data describes at least the resolution in x, y, z-direction; in case of time-depependent data also in the time dimension. In case of an industrial CT dataset, there will be

also the name of the CT device, the (few) parameters of the scanning process, such as the voltage, perhaps also why this data was acquired and who is responsible.

10. Zwei Beispiele für die Begriffe “Struktur” und “Attribute” in Bezug auf Daten?

    3. You have developed an algorithm that generates a triangular surface from image data. For each triangle of this surface, you have calculated the size of the minimum angle.

    (a) Would you save this data as a cell attribute or as a vertex attribute? Justify your decision. *(1 Pts.)*

    (b) You want to visualize this information on the surface with color. Name a color scale with which the data is displayed appropriately and one with which it is displayed inappropriately (in terms of perception). Justify your decision in each case. *(2 Pts.)*

    (c) By your visualization, you recognize that many triangles have a minimum angle under 5°. What information can you extract from this in relation to your algorithm? *(1 Pts.)*

11.
12. Zwei Beispiele für Unsicherheit?

Answer: The question is about uncertainty and in fact the slides contain many examples. Uncertainty is a quality problem in data, it relates to
(1) uncertainty in values (e.g. what will the temperature in Magdeburg in 10 days?, what will be the COVID incidence in Germany in four weeks),
(2) uncertainty in positions (e.g. where will be the center of the hurricane in three days)
(3) uncertainty in directions (e.g. what will be the further course of a weather phenomena)
In all these case you perform simulations and as a consequence you can predict values/positions/directions with limited confidence. Some values are likely, others are possible and some really can be excluded. The goal in visualization is to convey the (locally different) amount of uncertainty.
Also measured data, e.g., data about the past, has uncertainties. Most physical measurement processes, e.g. the use of sensors, involves “measurement noise”.

13. Zwei Varianten von parallele Koordinaten?

Answer: The question is about variants of parallel coordinates. We saw a couple of them: The raw method, where polygons represent datasets and all are shown in the same way (color, transparency, line width). We saw variants where different colours were used, e.g., to discriminate male and female customers or members of different clusters. We saw variants where transparency or grey values are adapted to emphasize some polygons and de-emphasize others, e.g. risk patients are emphasized. We saw edge bundling which reduces crossing lines and is also aesthetically more pleasing. All these advanced variants serve to avoid overplotting.

14. Do we need to calculate something? (Müssen wir Sachen in der Klausur ausrechnen?)

Answer: That is possible, indeed. It is one kind of tasks that makes sense in this remote situation.

15. Werden wir wieder Isolinien berechnen müssen?

Answer: The question is about calculating isolines in the exam. It is too specific; we cannot reasonably tell this in advance.

16. Will the exam with all specified answers be automatically submitted / handed in once the time is up?

Answer: Yes, and you can also hand in the exam manually before the time is up.

17. The current prüfungsplan states there will be video supervision vs. you were saying there will be none, so do we need a webcam?

Answer: We contacted the examination office and there will be no video supervision in the exam.

18. Should we be in the questions zoom call during the whole exam or only when we have Qs (are we allowed to hear Qs of fellow students)?

Answer: You may stay in the zoom call the entire time. We would even recommend doing so, so you do not have to open up the call each time you have a question. If a person in the call has a question, we will move them to a dedicated breakout room where they may privately ask their question.