OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
INF FAKULTÄT FÜR INFORMATIK
Lehrstuhl für Visualisierung

09.07.2019

Visualization Exam

Date: 09. 07. 2019
Bearbeitungszeit: 120 Minutes
Allowed Tools: Ruler

Name:			
Student Number:		Degree Course:	

Information:

- Of the **7 topic blocks**, only **6 need to be solved**. Please cross out the deselected block in the list below. If no block is explicitly deselected by you, block G will automatically not be evaluated.
- If you want to conclude the exam with an **ungraded performance (Schein)**, please tick the box below.
- Only the **appended blank pages** shall be used for completing the tasks. If you need more pages, please contact the supervisor.
- Please include your **name** and **student number** on **each sheet**.

From the guidelines for conducting written examinations of the Faculty of Computer Science:

We hereby inform you that, cheating, attempted cheating (e.g. usage of prohibited additional material, copying from other students, etc.) and unruly behavior will result in a "failed" grade for the exam. Any violation of the rules will be recorded.

- The Chair of Visualization wishes you much success! -

Block A:	___ / 5	+	___ / 3	+	___ / 4				=		/ 12 Pts
Block B:	___ / 3	+	___ / 2	+	___ / 2	+	___ / 5		=		/ 12 Pts
Block C:	___ / 4	+	___ / 4	+	___ / 4				=		/ 12 Pts
Block D:	___ / 1	+	___ / 4	+	___ / 3	+	___ / 4		=		/ 12 Pts
Block E:	___ / 5	+	___ / 7						=		/ 12 Pts
Block F:	___ / 4	+	___ / 5	+	___ / 3				=		/ 12 Pts
Block G:	___ / 3	+	___ / 5	+	___ / 4				=		/ 12 Pts

☐ Ungraded performance (Schein) Sum = **/ 72 Pts**

Name: **Student Number:**

Block A: Visual Perception

1. For each correct answer, there is half a point. For each wrong answer, 0.25 points are deducted, but the total number of points cannot be negative. If no answer is given, the corresponding subtask will not be evaluated. *(5 Pts.)*

(a) The human eye perceives light with the following wavelength:
☐ ≈380-780 µm ☐ ≈380-780 nm ☐ ≈380-780 mm

(b) The fovea represents the point with the highest visual resolution in the eye.
☐ True ☐ False

(c) The RGB color space is a perceptually oriented color space.
☐ True ☐ False

(d) Color differences of objects are perceived preattentively.
☐ True ☐ False

(e) The ratio of cones which are sensitive to red (R), green (G) and blue (B) is:
☐ 10R : 10G : 1B ☐ 10R : 1G : 10B ☐ 1R : 10G : 10B

(f) Cones have a faster reaction time than rods.
☐ True ☐ False

(g) Movement is not perceived preattentively.
☐ True ☐ False

(h) Rods are responsible for colour perception.
☐ True ☐ False

(i) Colour is perceived uniformly throughout the field of vision.
☐ True ☐ False

(j) Combinations of less than 3 preattentive properties continue to be perceived preattentively.
☐ True ☐ False

2. Specify the criteria for good mapping of scalar data to color. Give an example of a color scale that meets these criteria well or poorly. *(3 Pts.)*

3. Briefly name and explain (one key point each) the four main visualization goals. *(4 Pts.)*

Block B: Data Structures

1. Name 4 general requirements for data structures and explain one of them in more detail. *(3 Pts.)*

2. Explain the term *topology* using the example of a point cloud obtained by a laser scan. Also, explain why the creation of a topology would be desired in this example. *(2 Pts.)*

3. The following statements refer to the Delaunay triangulation. Indicate whether statements (a) and (b) are correct. Complete statements (c) and (d). There is a half point for each correct answer. For each incorrect answer, 0.25 points are subtracted, and the total number of points cannot become negative. If no answer is given, the corresponding subtask will not be evaluated. *(2 Pts.)*

(a) It is always uniquely defined.
☐ True ☐ False

(b) It maximizes the relationship between the inscribed circle and the circumference of the formed triangles.
☐ True ☐ False

(c) It is the _____ graph of the Voronoi diagram.
☐ inverse ☐ dual ☐ integral ☐ co-dependent

(d) It is constructed by connecting _____ in the Voronoi diagram by edges.
☐ the intersections of all adjacent edges
☐ the centers of all edges of neighboring cells
☐ the points with more than 4 adjacent cells
☐ the points of all adjacent cells

4. Data formats:

(a) Characterize the terms "*structure*" and "*attributes*" in relation to data. Provide two examples for each of them. *(3 Pts.)*

(b) What is *meta-data*? Name two possible examples of meta-data that could be stored together with a structured grid. *(2 Pts.)*

Name: **Student Number:**

Block C: Basic Visualization Techniques

1. Isolines:

(a) Name two properties of isolines. *(1 Pts.)*

(b) What is the advantage of subdividing isolines into "*primary*" and "*secondary*" lines? *(1 Pts.)*

(c) What problem occurs when isolines are generated on noisy data? How can this problem be solved? *(2 Pts.)*

2. Scatterplot diagrams:

(a) Describe the basic structure of Scatterplot diagrams. Name a problem that may occur when displaying scatterplot diagrams that is not already mentioned in Task 2b. *(2 Pts.)*

(b) Briefly name and explain a way to display data with more than 3 dimensions using scatter plots. *(2 Pts.)*

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.)*

Block D: Basic Visualization Algorithms

1. Name 2 methods for extracting 2D isolines. *(1 Pts.)*

2. At the end of the tasks, you will find a regular 2D grid with data values at the respective grid points. For these values, isolines with an iso value of 5 are to be drawn. The grid points have a horizontal and vertical distance of 4 cm to each other (not to scale). The origin (0, 0) of the grid is located in the lower left corner.

(a) First calculate the intersection point at the edge marked with (a). Enter the distances to the two data points in cm. Enter the results in the table below the grid. Draw the intersection points at the remaining grid edges as estimated and connect them to isolines. *(2 Pts.)*

(b) Clear the ambiguities in the cells marked with (b) and (c) mathematically. Draw the isolines that were decided to be correct and dashed the rejected ones. *(2 Pts.)*

3. Explain the structure of pie charts. Also, discuss the limits of their applicability and any perception problems that may occur. *(3 Pts.)*

4. Explain the difference between "*data quality*" and "*uncertainty*". Identify two sources of uncertainty in data and give one example each. *(4 Pts.)*

Name: **Student Number:**

Block E: Volume Visualization

1. Iso Surfaces:

(a) Below are the processing steps of the Marching Cubes algorithm for volume data records. Put steps A-H in the correct order and sort out the **two wrong steps**. *(3 Pts.)*

A: *For each Triangle D*

B: *Calculate intersection point on the intersection edges by linear interpolation*

C: *Calculate intersection of Triangle **D** with the cell edges*

D: *Check for each Voxel if Data Value ≥ Iso Value*

E: *For each Layer k*

F: *Connect intersection points to form Triangles*

G: *Check each cube (Cell) consisting of 4 Voxels in Layer **k** and 4 Voxels in Layer **k+1***

H: *Find intersection edges based on Indices*

(b) What characterizes a "complex point" in terms of decimating meshes? Can the Marching Cubes algorithm generate such a point? If so, sketch an example where this would occur. If not, justify your decision. *(2 Pts.)*

2. The generation of iso-surfaces often requires post-processing.

(a) Explain the difference between smoothing and decimating a triangle mesh. Does it make sense to apply both methods to a triangle mesh generated by the Marching Cubes algorithm? Justify your decision. *(2 Pts.)*

(b) Name and explain the 3 steps of the mesh decimation algorithm. *(3 Pts.)*

(c) What is the difference between Laplace smoothing with correction (Laplace+HC) and the original Laplace process? What is the advantage of Laplace+HC? *(2 Pts.)*

Block F: Information- and Multiparameter Visualization (1)

1. Parallel Coordinates:

(a) Describe the basic concept of parallel coordinates. *(2 Pts.)*

(b) Name and describe at least two variants of parallel coordinates. *(2 Pts.)*

2. Scalability of visualizations:

(a) Name and explain three general limiting factors that influence the scalability of visualizations. *(3 Pts.)*

(b) How can the scalability of a visualization be improved through interaction? What are the limits? *(2 Pts.)*

3. Explain the difference between "Symbols" and "Glyphs" in relation to icon-based visualizations. Give an example for each. *(3 Pts.)*

Name: **Student Number:**

Block G: Information- and Multiparameter Visualization (2)

1. Describe the concept of focus and context visualizations. What general interaction possibilities do these visualizations offer? *(3 Pts.)*

2. In the context of a study on air pollution, measuring stations are installed at various locations in a city, which measure the temperature, wind direction and pollution of the air at regular intervals and transmit them by radio to a central receiving station.

(a) Characterize the data with regard to the terms "multivariate" and "multidimensional". Justify your decision. *(1 Pts.)*

(b) Describe a possible visualization that displays all the data that is generated, including the time component. *(2 Pts.)*

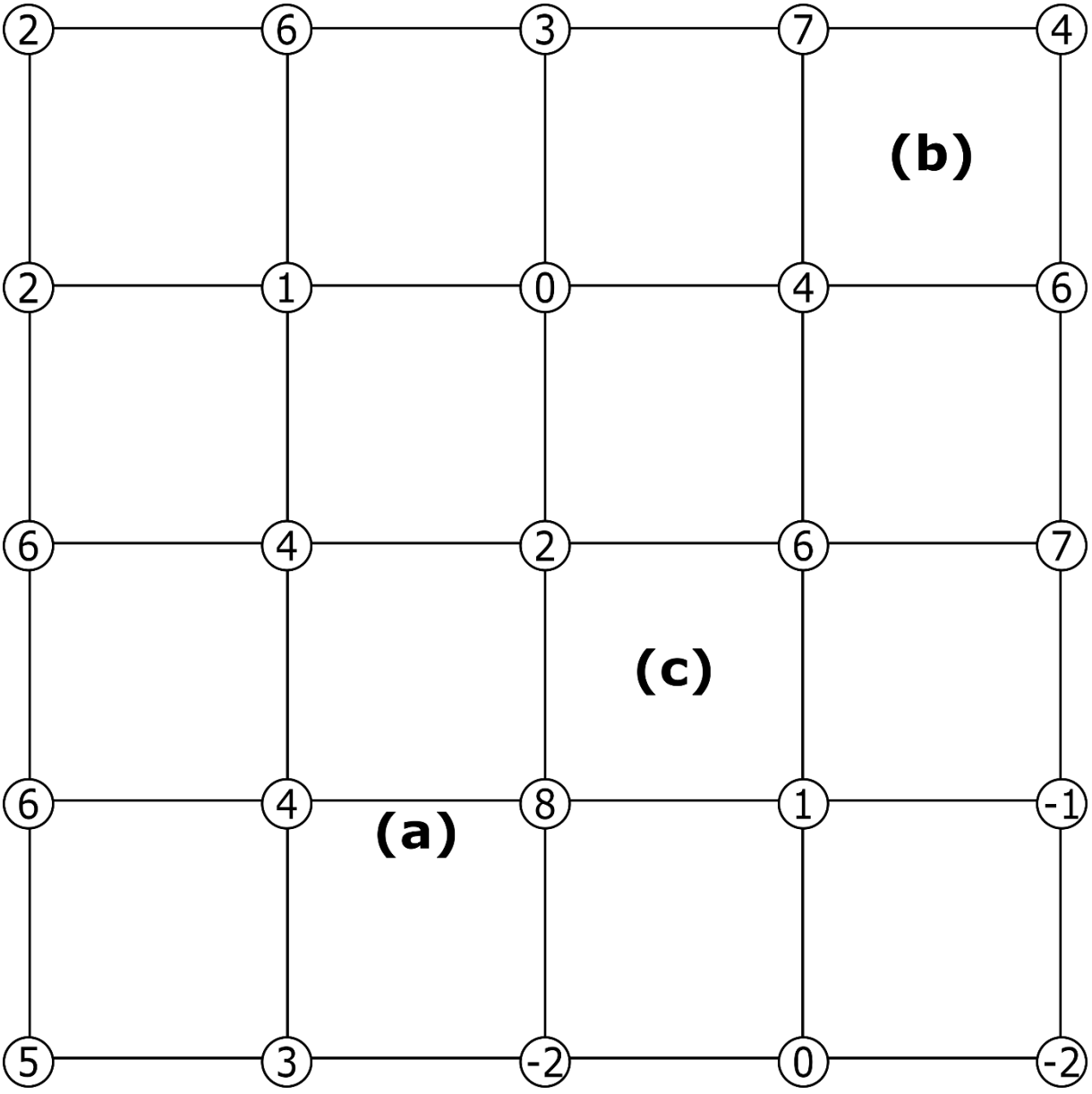
(c) When evaluating the data, you notice that individual measured values of a particular probe show an unrealistically high pollutant load. You then examine the corresponding probe and find no technical defect. Name two possible problems, which could have led to these incorrect measurements. How can you deal with the incorrect values in your visualization? *(2 Pts.)*

3. You work in the research and development department of a major electronics manufacturer and have recently developed a new smartphone. Unfortunately, shortly after the launch, you notice that in some cases the devices overheat and then explode. In order to narrow down the error more precisely, you have examined the exploded devices in the laboratory and additionally collected information from affected buyers with the help of a questionnaire. You now know from each affected device whether it was used and/or charged at the time of the explosion, which operating system version was installed, in which factory it was manufactured and which of the 9 possible combinations of battery and charging electronics were used. Describe a method how this information can be visualized to help you find the cause of overheating. *(4 Pts.)*

2D Grid for Block D

Iso- = 5

horizontaler/vertikaler Abstand der Gitterpunkte = 4cm (nicht maßstabsgetreu)



Distances		
Edge	Direction	Distance (in cm)
(a)	From 4 to intersection	
	From 8 to intersection	