Memory Protocol Medical Visualization 2019 - Oral Exam

In general you should know all of the slides cause each oral exam is very different. You should especially be able to explain basics like the *direct volume rendering pipeline* and *marching cubes*.
They often ask about possible techniques and examples so you can choose what techniques you want to mention. Sometimes they ask a few more specific questions when they want to hear a specific method. Or they want to know how a method works.
The book "Visual computing for medicine : theory, algorithms, and applications" from professor Preim is really helpful if you have problems with certain topics. (You can download it or borrow it for free in the university library.)

This is a brief overview of how my exam went. The answers might not be 100% correct, also it is not always the only correct answer as there are multiple possible techniques and you could often just choose and explain one of it.

My exam started with an **example case**: there are spine metastases and the doctor wants to do a biopsy.

Question: How would you visualize it?
Answer: Use Hybrid Techniques, visualize important structures with surface models and the context with direct volume rendering

Question: What are important structures?
Answer: Tumor and nerves at the spine

Question: What are context structures?
Answer: Skin, ...

Question: How do you render context?
Answer: Opaque or with illustrative visualizaion. If there are structures in front of the focus object use magic lense. It should not distract attention from the focus region.

Question: What views would you provide? One or multiple? Axial, Sagittal, Coronal?
Answer: Multiple views to enhance spacial view. 3D view as explained in the beginning and maybe slices. One possibility could be to choose the slice where your needle tip is currently.

Question: How to visualize safe paths for the biopsy needle.
Answer: One option (from the lecture slides) is to visualize the safe paths as cones. The cones mark the space where no nerve strings are in front of the tumor.

Question: What do you use to generate a surface?
Answer: Marching Cubes

Question: Why is Marching Cubes so fast? What are general dis(advantages) of it?
Answer: Marching Cubes is so fast because of the lookup table and because every cell is

handled individually. General disadvantages: problems like tiling (triangulation), branching and especially correspondence are not really solved. Also you have some artifacts, especially staircase artifacts.

Question: What are other approaches to generate a surface?
Answer: MUP, put points in border voxels.

Questions: How would you generate a Surface from these points?
Answer: Triangulation, e.g. Delaunay

Question: What are the steps of the direct volume rendering pipeline? Explain shortly what is done in the single steps.
Answer:
- Data Traversal: Raycasting, Splatting, Slicing to generate sample points in the data
- Interpolation: Resampling Filter (Box, Tent, Sinc) to get the data at the sampling
- Gradient Computation: compute gradients
- Classification: Transfer Functions, they map data values to color and opacity
- Shading and Illumination: enhances spatial relation, e.g. Depth Cueing
- Compositing: How to decide what value a pixel on the screen should have, e.g. MIP

Question: How can you compute the gradient?
Answer: The gradient is a vector and shows in the direction of greatest change in the data. This means it is appearing at edges, so you could use an edge detection filter.

Question: What is a typical edge detection filter?
Answer: Sobel filter

Another student had the visualisation of blood vessel structures as the example case. They were asked to describe techniques on how to extract the vessel structures, from the imaging methods (DSA, CTA) to the visualisation techniques. They had to explain several techniques (Truncated Cones, Convolution Surfaces, MDU) and then compare them in regards to quality and what they should be best used for (presentation/education vs diagnoses vs surgery planning). Marching Cubes was specifically asked for here as well, though it was enough to just mention them, no explanation necessary. The topic afterwards was CPRs, where the different approaches were handled in detail in regards to what they were, how they were used, why they were used and what the different applications are.
The Direct Volume Rendering Pipeline was the next big topic, though there weren't many details in each step/the follow-up questions strongly depended on the answers that the student gave. Acceleration techniques (specifically how to skip empty space -> answer: octree) and the different kinds of data traversal were two topics that were handled in more detail.

Topics of another student:
- direct volume rendering pipeline (including short explanations of raycasting, splatting, slicing (~3 sentences each, so e.g. the main idea of slicing, the slice alignment ->popping artefacts, and I mentioned the depth of field effect); types of interpolation; why the gradient is computed (-> approximation of normal -> shading and determination of alpha/transparency value (the higher the gradient magnitude, the opaquer the value)...then we drift off the topic, because we never finished the pipeline)
- what is the window function? why is it needed?
- DICOM: what is dicom/the structure of dicom -> separated in data elements with different meta information (about patient and modality,..), data elements have different tags (some are obligatory, some optional)
- I had to tell something about virtual endoscopy, so I started with some pro/cons; the rough pipeline, then I was asked about the different projections
- then he described a case (brain tumor) and I had to describe a possible focus+context visualization. Here I said the tumor would be indirect VR, so you could enable measurements (like diameter of tumor, distances,...). And the surrounding could be DVR. Then he asked for other context visualizations and I just had to name a few illustrative techniques
- In general he just gave a topic and you can say what you want and depending on your answer he will ask a few more detailed questions