1. MBRs and MBSs differ in volume and diagonal, respectively diameter. Calculate volume and length of diagonal of below given MBRs. Assume, the points represent the ends of diagonal.

\[
\begin{align*}
\text{MBR}_1(P_1(12, 46, 34), P_2(44, 50, 46)) \\
\text{MBR}_2(P_1(45, 56, 12), P_2(70, 70, 16)) \\
\text{MBR}_3(P_1(71, 54, 20), P_2(78, 60, 30))
\end{align*}
\]

2. Assume for MBRs, data points are located at the middle of each edge. Consequently, we may construct MBSs with center points that are located at the middle of MBR diagonal. The radius of MBS has to be the distance between the middle of diagonal (of a MBR) and the furthest point from MBR diagonal on an edge (of a MBR). Calculate the center points of MBSs concerning the MBRs from task 1. Further, calculate volume and diameter of the MBSs and compare them with the results from task 1.

3. Considering your results, what may be advantages and disadvantages of MBRs and MBSs? Does an index exists that enables both partitioning strategies? Is it only advantageous to use both?

4. Mostly, tree structures focus on minimization of storage consumption for entries in nodes. How many MBRs or MBSs are you able to store in one node if:

- A node stores up to 512Byte
- MBRs contain 2 points
- Each point has 16 dimensions
- Each dimension is represented by 32Bit-integer values
- MBSs are represented by 1 data point and 1 32Bit-integer value (radius)

Calculate the height of trees for MBRs and MBSs concerning 50,000, 100,000, and 500,000 data points. What may be advantages of each approach?

5. The R*_a-tree was proposed in the lecture. Which a-priori knowledge you need to construct such tree? State the advantages and disadvantages of this approach (with argumentation) and discuss influence factors like tree height on query execution.

Good Luck!