2a):- Provide a brief summary of the paper. Explain how the likelihood and odds ratio for ordinal regression is different from multi-class classification. How is it different from the regression problems?

1. **Ordinal Regression Likelihood:**
   - Ordinal regression employs the concept of likelihood to play a pivotal role in its analysis. It serves as a measure of the probability that an observation belongs to a specific ordinal category, taking into account various predictor variables.
   - Specifically, models like the proportional odds model or cumulative logit model utilize cumulative probabilities or logits to compute this likelihood.
   - The unique characteristic of ordinal regression models is their consideration of the order or hierarchy among the ordinal categories. They predict not only which category an observation belongs to but also the probability of the observed outcome being above or below each of the category thresholds.
2. **Ordinal Regression Odds Ratio:**
   - In the context of ordinal regression, calculating odds ratios is a valuable tool for understanding the relationship between a predictor variable and the odds of being in a higher ordinal category.
   - Ordinal regression models often assume proportional odds, which means they estimate a common odds ratio for each predictor variable across all category thresholds. This simplifies the interpretation of how changes in the predictor variable relate to changes in the odds of moving up the ordinal scale.
3. **Multi-Class Classification:**
   - Multi-class classification, in contrast to ordinal regression, is concerned with the likelihood of an observation falling into one of several non-ordered, mutually exclusive categories.
   - In this scenario, odds ratios are typically not applicable because there is no inherent concept of odds or order among the categories. The primary objective here is to assign observations to discrete categories based on their characteristics.
   - Multi-class classification is often used in scenarios where the order among the categories is not relevant, such as classifying emails into different folders or species of animals.
4. **Regression Problem:**
   - In a regression problem, likelihood is employed to construct a model that describes the distribution of a continuous outcome variable, typically in relation to predictor variables.
   - Unlike ordinal regression, the concept of odds ratios is not used in regression because the primary aim is to predict a continuous numerical value, not to assess odds or order among categories.
   - Regression is frequently used in scenarios where the outcome variable is continuous and quantitative, such as predicting someone's age based on various explanatory factors or forecasting sales revenue.

In summary, understanding the nuances between ordinal regression, multi-class classification, and regression is crucial, as each approach is tailored to address different types of data and research objectives. McCullagh's paper underscores the importance of choosing the appropriate statistical method based on the nature of the data and the specific research goals.