Answer 4 questions out of 6.

Q1. This question concerns the connection (i.e., similarities and differences) between loglinear models and other models for categorical data analysis. Loglinear models were popular among sociologists for many years and are still frequently used. Sociologists have made crucial theoretical and empirical contributions in this area. Much substantive work in social stratification is done using loglinear models. Do the following:

1. Describe the data used for loglinear modeling.
2. What other models for categorical data analysis may be used for these data?
3. Discuss the similarities and differences between loglinear modeling and the other approach(es).

Q2. The maximum likelihood is one of the most important methods of estimation for the statistical models social scientists employ. The method is used to estimate logit model, probit model, ordered logit or probit model, multinomial model, Poisson regression model, various event history models, multilevel models, and so on.

The Poisson distribution has probability function

\[ p(X^*?) = \frac{e^{\lambda} \lambda^X}{X!} \]

where \( \lambda \) is the unknown parameter for the mean and the variance. Now we have a sample of \( n \) observations \( X_1, X_2, \ldots, X_n \) (think of this data set as a sample of \( n \) U.S. cities and the outcome variable as the number of riots in 1967). Do the following:

1. Calculate the MLE of \( \lambda \). Show the process.
2. Find its specific numerical value if the sample turns out to be 2, 0, 1, 4, 2, 3, 2, 4, 1, 0, 2.

Q3. Longitudinal data (same cases observed over time) are becoming more common in sociology and the other social sciences. There are a variety of methods available to analyze such data. Do the following:

1. Describe three different statistical models that are used to analyze longitudinal data. Give the major assumptions for each of these models and the type of data that are best handled by each technique.
2. Are there types of longitudinal data that are not well handled by any existing technique? If so, describe their characteristics.

Q4. There has been much concern in recent years about the dangers of sample selection bias in sociological research. Discuss the following points, citing the relevant literature as appropriate:

1. What is the nature of the sample selection problem? Under what circumstances can sample selectivity threaten internal and/or external validity? What kind of sample selection does NOT create validity problems?
2. What method(s) can be used to correct or control sample selection problems in empirical research? How successful are these methods? Are there problems associated with using these methods?
3. How much merit is there in the following (imaginary) charge: "The sample selectivity 'problem' has been greatly overblown. It's another red herring, just like the ratio variables problem or the problem of using significance testing with an entire population. In actual empirical research, it is rare to find convincing instances where selection bias is really an issue. Most of the time, the consequences of sample selection are perfectly negligible." Discuss.

Q5. Structural equations models have become a major tool of sociological research. Answer the following questions about SEM:

1. List and briefly describe the key assumptions made in SEMs.
2. What are the major steps in undertaking structural equation modeling (e.g., model specification is the first step)? Which of these steps is the most difficult?
3. "The null hypothesis, $H_0: \Sigma=\Sigma(?)$, should be eliminated from SEM work." Do you agree or disagree? Justify your answer.

Q6. Quantitative methodology in sociology and the social sciences in general has made great strides over the last several decades. Unresolved issues remain, however. Discuss up to three (at least partially) unresolved methodological issues that you see as the greatest remaining challenges to quantitative methodology. For each issue describe the empirical context where it originates, the nature of the problem, and possible directions (if any) in which a solution might be found.