Topic 2-1: Likelihood Construction & Estimation

Univariate Models

EXST 7160
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Content

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Statistical Models

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- After a statistical model for the observed data has been formulated, the likelihood function of the data is the natural starting point for the inference in many statistical problems.
- The likelihood function typically leads to essentially automatic methods of inference, including point estimation, interval estimation, and hypothesis testing.
- In this topic, we will focus on constructing the likelihood functions from various types of data, including discrete, continuous, mixture of discrete and continuous, and censored data.

Statistical Models

- The likelihood is the joint density of the observed data to be analyzed.

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- Let the random variables $Y_1, \cdots, Y_n$ have a joint density function $f(\mathbf{Y} = (Y_1, \cdots, Y_n)^T; \boldsymbol{\theta})$ with unknown b density parameters $\boldsymbol{\theta} = (\theta_1, \cdots, \theta_b)$. Then, given observed data $\mathbf{Y} = \mathbf{y}$, where $\mathbf{y} \equiv (y_1, \cdots, y_n)^T$, the function of $\boldsymbol{\theta}$

$$L(\boldsymbol{\theta}; \mathbf{y}) = f(\mathbf{Y} = \mathbf{y}; \boldsymbol{\theta})$$

is the likelihood function.

Likeliihod for iid data

- If the random variables $Y_1, \cdots, Y_n$ are indenpendent, then the likelihood function becomes

$$L(\boldsymbol{\theta}; \mathbf{y}) = \prod_{i=1}^{n} f_i(Y_i = y_i; \boldsymbol{\theta}),$$

where $f_i(Y_i; \boldsymbol{\theta})$ is the density of Y_i.

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  where $f_i(Y_i; \boldsymbol{\theta})$ is the density of Y_i.
- If the random variables $Y_1, \cdots, Y_n$ are indenpendent and indentically distributed (denoted by iid), then the likelihood function becomes

$$L(\boldsymbol{\theta}; \mathbf{y}) = \prod_{i=1}^{n} f(Y_i = y_i; \boldsymbol{\theta}),$$

  where f is the distribution that all $Y_1, \cdots, Y_n$ follow.

Solving the Likelihood

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Discrete IID Random Variables

Discrete IID Random Variables

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Discrete IID Random Variables

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Continuous IID Variables

Continuous IID Variables

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Continuous IID Variables

- References: More examples for constructing the product likelihood likelihood associated with iid data can be found in Section 7.2.2 of Casella and Berger (2002).

Multinomial

Multinomial

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Multinomial

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- References: Examples for

Multivariate Normal

Multivariate Normal

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Multivariate Normal

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Mixture of discrete and continuous

Mixture of discrete and continuous

Mixture of discrete and continuous

Multinomial

Multinomial

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Multinomial

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- References: Examples for

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Proportional Likelihood

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Proportional Likelihood

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Empirical Likelihood

Empirical Likelihood

Empirical Likelihood

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Likelihood With Censored data

Likelihood With Censored data

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A general working defintion of the likelihood

A general working defintion of the likelihood

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A general working defintion of the likelihood

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Empirical Likelihood

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