STATS 412

Nineth Class Note

In Son Zeng

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My Office Hour:

My office hours are on **16:30 - 18:00 Tuesday** and **13:30 - 15:00 Friday**, at **USB 2165**. You may check the campus map to get to my office. I am prepared for your questions, so please feel free to come to my office hours.

Calculus Review:

• Last week, I uploaded a book for probability to the Piazza. Particularly, I recommend you to read (Type the page number in PDF):

(1) Improper integral: page 203 - 210

(2) Double integral: page 214 - 218

(3) Cumulative distribution function: page 224 - 229

(4) Expectation and Variance: page 235 - 244

(5) Joint Distributions: page 299 - 304

(6) Combination (Ignore the proof): page 38 - 42

(7) Binomial Distribution: page 135 - 146

These are great practices to prepare you with essential integration skills for the subsequent homework and the midterm.

Reminders for Assignment 5

• The concepts "0, otherwise" is always important. You should include this for every probability density/mass function, conditional distribution and marginal distribution.

• In question 7, it is strongly encouraged that you give the reason why the approximation can be applied (see the lecture note 4, page 8).

• Be aware of the difference between Binomial distribution and Poisson distribution: the domain of Binomial distribution is $X = 0, 1, 2, ..., n$, but the domain of Poisson distribution is $X = 0, 1, 2, ...$ In other words, there is an upper limit for the value of X in Binomial distribution, but there is no upper limit for the value of X in Poisson distribution.

• When you encounter a question asking uncertainty, I personally encourage you to express your estimation and uncertainty in the form (estimate) $\pm$ (uncertainty), which is an important expression later in this course.

• In question 5 and question 10, in part b), c), e) and f), I believe that you will try your very best to provide a reasonable interpretation/explanation to your decision. One notable idea may help your understanding and interpretation is what we will go through after the midterm:

p-value: The p-value is defined as the probability, under the null hypothesis (H_0, the hypothesis that we would like to find evidence to reject), of obtaining a result **equal to or more extreme than** what was actually observed.

Key Points during Lecture:

Poisson Distribution: It is clear in the lecture that Poisson distribution is an important and special distribution because its mean and variance are the same. That is, for a Poisson random variable $X \sim Poisson(\lambda)$:

$$\boxed{E(X) = V(X) = \lambda} \tag{1}$$

Test Reminder: When you take a square root of variance to obtain the standard deviation, be sure to include the absolute value. It is because standard deviation is the positive square root of the variance. For example,

$$\boxed{SD(\hat{p}) = SD\Big(\frac{X}{n}\Big) = \Big|\frac{1}{n}\Big| SD(X) = \frac{1}{n}\sqrt{np(1-p)} = \sqrt{\frac{p(1-p)}{n}}} \tag{2}$$

As we do not know p, we use $\hat{p}$ to estimate p with uncertainty $\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$.

Optional Question: When does the uncertainty achieve its maximum?

Ans: When $p = \frac{1}{2}$, the uncertainty achieves its maximum, which is $\sqrt{\frac{1}{4n}} = \frac{1}{2\sqrt{n}}$. This quantity is often mentioned in statistics books as the conservative expression of uncertainty.

Last Comment:

Please inform me to fix the typos and grammatical mistakes if they exist. It is a great practice of writing and I appreciate your help!