**HW # 3 solution @Applications of Binomial and Poisson Distribution**

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An experiment is designed to test the potency of a drug on 20 rats. Previous animal studies have shown that a 10-mg dose of the drug is lethal 5% of the time within the first 4 hours; of the animals alive at 4 hours, 10% will die in the next 4 hours.

(4.42) What is the probability that 3 or more rats will die in the first 4 hours?

Here n=20, p=0.05

P(X>=3)=1-P(x<=2)= 0.0755

p42=**1**-cdf("binomial",**2**,**0.05**,**20**)

(4.43) Suppose 2 rats die in the first 4 hours. What is the probability that 2 or fewer rates will die in the next 4 hours?

Here n=18, p=0.10; X~B(n=18,p=0.10)

P(x<=2)=F(2)= 0.7338

p43=cdf("binomial",**2**,**0.1**,**18**)

(4.44) What is the probability that 0 rats will die in the 8-hour period?

Note that in 8-hour period consideration, some rats die in the first 4-hour and those alive will die in the next 4-hour. So, this probability should be computed using the total law of probability.

P(rats will die in 8-hour period)=P(rats will die in the first 4-hour period)+P(rats will die in the next 4-hour period| rats are alive in the first 4-hour period)\*P(rates are alive in the first 4-hour period)=0.05+0.10\*0.95=0.145.

Therefore, in 8-hour period consideration, n=20, p=0.145; **X~B(n=20, p=0.145)**

P(X=0)=p(0)=F(0)= 0.0436. To verify compute:

p44=cdf("binomial",**0**,**0.145**,**20**);

p44=pdf("binomial",**0**,**0.145**,**20**);

(4.45) What is the probability that 1 rat will die in the 8-hour period?

Now, in 8-hour period consideration, n=20, p=0.145.

P(X=1)=p(1)= 0.1478

p45=pdf("binomial",**1**,**0.145**,**20**);

(4.46) What is the probability that 2 rats will die in the 8-hour period?

P(X=2)=p(2)= 0.2382

p46=pdf("binomial",**2**,**0.145**,**20**);

(4.47) Can you write a general formula for the probability that x rats will die in the 8-hour period?

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Assume that the number of episodes per year of otitis media, a common disease of the middle ear in early childhood, follows a Poisson distribution with parameter episodes per year i.e.,

* 1. Find the probability of getting 3 or more episodes of otitis media in the first 2 year of life.

Ans:

p24=**1**-cdf("poisson",**2**,**3.2**);

* 1. Find the probability of not getting any episode of otitis media in the first year of life.

Ans:

p25=pdf("poisson",**0**,**1.6**);

**An interesting question in pediatrics is whether the tendency for children to have many episodes of otitis media is inherited in a family.**

* 1. What is the probability that 2 siblings will both have 3 or more episodes of otitis media in the first 2 year of life?

Note that the number of siblings to have 3 or more episodes of otitis media in the first 2 year of life, , and as per this question, .

Then, p(2)= . The result also follows by independence and by (4.24): .

p26=p24\*p24;

* 1. What is the probability that exactly 1 sibling (in 2-siblings family) will have 3 or more episodes of otitis media in the first 2 year of life.

Ans: , by binomial distribution (n=2, p=0.62).

p27=pdf("binomial",**1**,p24,**2**);

* 1. What is the probability that neither sibling will have 3 or more episodes of otitis media in the first 2 year of life.

Ans: by independence and by 4.24.

Also,

p28=(**1**-p24)\*(**1**-p24);/\*by independence\*/

p28alt=pdf("binomial",**0**,p24,**2**);

* 1. What is the expected number of siblings in a 2-sibling family who will have 3 or more episodes of otitis media in the first 2 year of life ((with , by 4.24). Ans: [(mean of binomial(n=2,p=0.62)];

p29=**2**\*p24;

**data** hw3Chapt4BinoPoisSol;

p24=**1**-cdf("poisson",**2**,**3.2**);

p25=pdf("poisson",**0**,**1.6**);

p26=p24\*p24;

p27=pdf("binomial",**1**,p24,**2**);

p28=(**1**-p24)\*(**1**-p24);/\*by independence\*/

p28alt=pdf("binomial",**0**,p24,**2**);

p29=**2**\*p24;

p42=**1**-cdf("binomial",**2**,**0.05**,**20**);

p43=cdf("binomial",**2**,**0.1**,**18**);

p44=pdf("binomial",**0**,**0.145**,**20**);

p45=pdf("binomial",**1**,**0.145**,**20**);

p46=pdf("binomial",**2**,**0.145**,**20**);

**proc** **print** data= hw3Chapt4BinoPoisSol;

**run**;

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| The SAS System |

| **p24** | **p25** | **p26** | **p27** | **p28** | **p28alt** | **p29** | **p42** | **p43** | **p44** | **p45** | **p46** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.62010 | 0.20190 | 0.38452 | 0.47115 | 0.14433 | 0.14433 | 1.24019 | 0.075484 | 0.73380 | 0.043584 | 0.14783 | 0.23817 |