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Statistics M11 **Instructor: Nicolas Christou**
Introduction to Statistical Methods for Business and Economics **Winter 2001**

Using Stata to calculate binomial probabilities

In this lab you will use Stata to calculate binomial probabilities.

Let's say that a student is taking a multiple choice exam. There are 10 questions and each question has 4 possible answers. The student does not know the answer to any of the questions and so he will guess. Let X be the number of correct answers among the 10 questions that he answers. Then X follows the binomial distribution with parameters n=10 (number of trials), and p=0.25 (probability of success at each trial).

Questions:

- ***a. What is the probability that the student answers at least 3 questions correct?***
- ***b. What is the probability that the student answers at most 3 questions correct?***
- ***c. What is the probability that the student answers more than 5 questions correct?***
- ***d. What is the probability that the student answers less than 8 questions correct?***
- ***e. What is the probability that the student answers exactly 4 questions correct?***

To answer these questions you can use the binomial probability distribution formula or much faster you can use Stata. You can also use the table of binomial probabilities, but the table does not have entries for all different values of n and p (for example if X follows the binomial distribution with n=13 and p=0.13 you cannot use the table).

There are few ways in Stata to get binomial probabilities. Here is one using the `bitesti` ***command.***

`. bitesti 10 3 0.25` ***(n=10, x=3 successes, and p=0.25)***

```
       N   Observed k   Expected k   Assumed p   Observed p
------------------------------------------------------------
      10          3          2.5       0.25000      0.30000

  Pr(k >= 3)           = 0.474407  (one-sided test)
  Pr(k <= 3)           = 0.775875  (one-sided test)
  Pr(k <= 1 or k >= 3) = 0.718432  (two-sided test)
```

What we need from this Stata output is:

`Pr(k >= 3)            = 0.474407` ***This is the answer to question (a) above.***

`Pr(k <= 3)            = 0.775875` ***This is the answer to question (b) above.***

Do this: ***Using the*** `. bitesti` ***command answer questions c-e.***

Another way to find binomial probabilities in Stata is the following:

```
. for num 0/10: display Binomial(10,X,0.25)
```
(0/10 means that X takes values from 0 to 10)

```
->  display Binomial(10,0,0.25)
1
```
This is P(X>=0)

```
->  display Binomial(10,1,0.25)
.94368649
```
This is P(X>=1)

```
->  display Binomial(10,2,0.25)
.75597477
```
This is P(X>=2)

```
->  display Binomial(10,3,0.25)
.4744072
```
This is P(X>=3)

```
->  display Binomial(10,4,0.25)
.22412491
```
This is P(X>=4)

```
->  display Binomial(10,5,0.25)
.07812691
```
This is P(X>=5)

```
->  display Binomial(10,6,0.25)
.01972771
```
This is P(X>=6)

```
->  display Binomial(10,7,0.25)
.00350571
```
This is P(X>=7)

```
->  display Binomial(10,8,0.25)
.0004158
```
This is P(X>=8)

```
->  display Binomial(10,9,0.25)
.00002956
```
This is P(X>=9)

```
->  display Binomial(10,10,0.25)
9.537e-07
```
This is P(X>=10) = P(X=10)

To answer question (a) you simply take the value from above:
(a). P(X>=3) = 0.4744072.

To answer question (b) you will have to do the following:
(b). P(X<=3) = 1 – P(X>=4) = 1 - 0.22412491 = 0.775875

To answer question (e) you will have to do this:
(e). P(X=4) = P(X>=4) – P(X>=5) = 0.22412491 – 0.07812691 = 0.145998.

Do this:** **Answer questions c-d using the above Stata output.

Note:** **After you answered all the questions using both ways in Stata go on Table C at the back of your textbook and check your answers. They must be the same!

An interesting experiment:

Let X have binomial distribution with n=3, and p=1/6. This is the problem we did in class which was: Roll a die 5 times. Success is observing the number {4}. So X can take the values 0, 1, 2, or 3. Using the binomial distribution formula we constructed the probability distribution of X:

X	***P(X)***
0	***0.5787***
1	***0.3472***
2	***0.0694***
3	***0.0046***

These probabilities are the long run probabilities (or theoretical probabilities). We can run this experiment (roll a die 3 times) many many times and find the proportion of these runs we obtained 0 successes, 1 success, 2 successes, and 3 successes, and compare these "empirical" probabilities with the theoretical (long run) probabilities.

Here is what you must do:
Each one of you, roll a die using the program `dice2` ***(you used it last week!). If you type*** `. dice2` ***you will see what*** `dice2` ***does.***

```
. dice2
Here is how to use dice2
dice2 rolls [numdice numside, save]
  rolls  = number of rolls of the dice
  numdice= the number of dice rolled, default=2
  numside= the number of sides on the dice, default=6
  The save option saves the resulting data, and
    clears out the data currently in memory.
```

We want to roll the die 3 times. This is what you type:

`. dice2 3 1 6, save` ***3 is the number of rolls, 1 is the number of dice, 6 is the number of sides.***

The program will save the 3 numbers (the result of these 3 rolls) and also will construct a histogram of these 3 values. Now you must get the results of these 3 rolls by typing `. list` ***or by typing*** `. edit` ***. In your notebook write how many successes you obtained (0, 1,2, or 3) in these 3 rolls. Remember that you have a success if the number {4} is rolled. So if you rolled one {4} in these 3 rolls then at the end of he experiment you record 1 success, etc. Below are the results of one run of the experiment.***

```
. dice2 3 1 6, save
. list

       trials    sumdice
  1.        1          5
  2.        2          1
  3.        3          4
```

In these particular 3 rolls the results were:
1st roll: 5 => failure
2nd roll: 1 => failure
3rd roll: 4 => success

Repeat the experiment (roll the die 3 times) 20 times. At the end you must give your results to your TA which must look like this:

Out of 20 runs of the experiment I obtained:
This many times 0 successes
This many times 1 successes
This many times 2 successes
This many times 3 successes.

We will discuss the results in class.

Do the experiments!

Good luck!