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Selecting Discrete Sampling Distributions

In quality assurance, five discrete sampling distributions are in common use. Each has a particular type of application, since each one models a particular circumstance. This article provides an overall view of the distributions and applications. Other articles in the Ombu Library describe each of the distributions. The five distributions of interest, in alphabetical order, are Binomial, Geometric, Hypergeometric, Negative Binomial, and Poisson.

The questions and chart below provide guidance on the applications most suitable for each distribution.

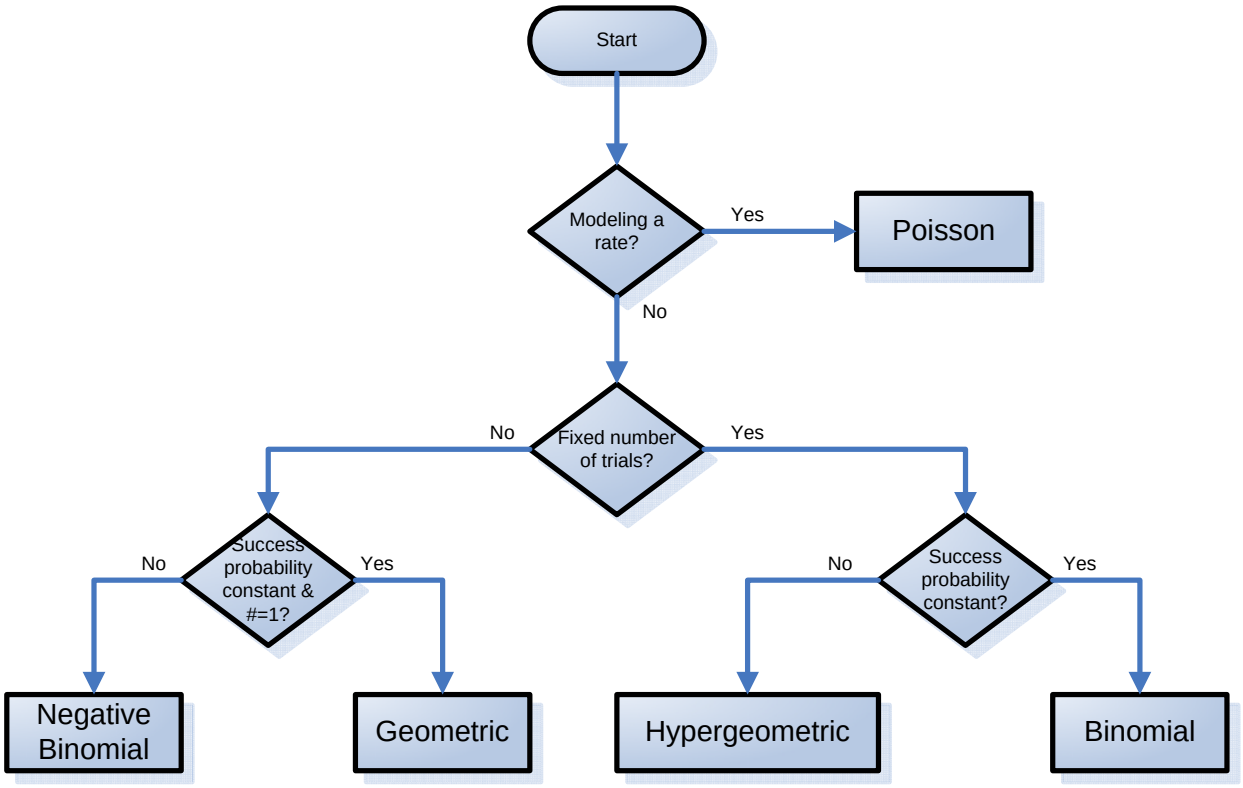
Questions

1. Does this model a rate, a number of events in a certain interval such as time, distance, area, or volume?
    - Yes – Poisson distribution
    - No – Question #2

2. Is the number of trials fixed?
    - Yes – Question #3
    - No – Question #4

3. Is the probability of success the same on all trials?
    - Yes – Binomial distribution
    - No – Hypergeometric distribution

4. Is the probability of success the same on all trials and the number of successes is 1?
    - Yes – Geometric distribution
    - No – Negative binomial distribution



Poisson
The Poisson distribution models the probability of a given number of events in a fixed interval when the events are independent and occur with a constant rate.

Example – A Quality Engineer needs to model the number of repairs arriving at a repair stations each hour.

Binomial
The binomial distribution models the probability of a number of "success" in a sequence of *n* independent experiments where the probability of success is denoted *p* and each experiment has only two possible outcomes: success or failure. Typical applications include sampling with replacement from a finite population or sampling from a potentially infinite population. In both cases the probability of success, *p*, remains constant.

Example – A Quality Engineer needs to model the probability of getting 0 nonconforming items in a sample of size 20 when drawing the sample from an infinite population.

Hypergeometric
The hypergeometric distribution models the probability of a number a number of "success" in a sequence of *n* experiments where the probability of success changes with each experiment. Typical applications include sampling without replacement from a finite population.

Example – A Quality Engineer needs to model the probability of getting 2 nonconforming items from a finite population of 20 when conducting process validation on a pilot project.

Geometric
The geometric distribution models the number of independent experiments to conduct before getting the first success where the probability of success is denoted *p* and each experiment has only two possible outcomes: success or failure.

Example – A Quality Engineer models the output of a potentially infinite process to estimate the number of items to check before the first nonconforming item appears.

Negative Binomial
The negative binomial distribution models the number of independent experiments to conduct before getting the x^{th} success where the probability of success is denoted *p* and each experiment has only two possible outcomes: success or failure.

Example – A Quality Engineer models the output of a potentially infinite process to estimate the number of items to check before the third nonconforming item appears.