# Examples of Discrete and Continuous Probabilities Calculations by Using R

**Calculating the expected value of a discrete RV X with the corresponding probabilities p:**

**crossprod(x,p)**

**Calculating the standard deviation of a discrete RV X in R:**

**sqrt(crossprod(x^2,p)-(crossprod(x,p))^2)**

**For both discrete and continuous distributions, the following four functions are available:**

1. **d…():** Calculates the probability mass function (discrete) or the probability density function (continuous). **Example: dbinom()**
2. **p…():** Calculates the cumulative probabilities for both discrete and continuous distributions. **Example: ppois()**
3. **q…():** Given a cumulative probability, calculates the value of the random variable (for both discrete and continuous distributions). **Example: qnorm()**
4. **r…():** Generates a specified number of the random variable according to the specified distribution(for both discrete and continuous distributions). **Example: rbeta()**

**Example:** The popularity rate of the president is 42%. A random sample of 5 citizens is selected.

(a) What is the probability that no one in this sample is in favor of the president?

Success: the citizen is in favor

P = 0.42

n=5

P(X=0)?

```
> dbinom(0,5,0.42)
[1] 0.0656356768
```

Interpretation: In 6.6% of all possible samples of 5 citizens, there will be no one in the sample in favor of the president.

(b) What is the probability that at most 3 in the sample are in favor?
P(X<=3)

```
> pbinom(3,5,0.42)
[1] 0.8966916928
```

**Example:** On the average, Stefan Curry makes 7 three-pointers per game that he plays.

(a) What is the probability that in the game tonight he will succeed in 8 of his three-pointer attempts?

Poisson

Mean $\mu = 7$

P(X=8)=?

```
> dpois(8,7)
[1] 0.1303774322
```

In about 13% of his games, he succeeds in exactly 8 three-pointer attempts.

(b) What is the probability that he succeeds in more than 5 attempts?
P(X>5)=?
=1-P(X<=5)

```
> 1-ppois(5,7)
[1] 0.6992917238
```

Interpretation: In almost 70% of the games, he succeeds in his 3-pointer attempts more than 5 times.

**Example:** What is the probability that after having 9 boys, a couple will have a girl on the $10^{th}$ trial?

Geometric
p=0.5
x=10

```
> dgeom(10,0.5)
[1] 0.00048828125
```

This happens in almost 5 in 10000 cases.

**Example:** **Hypergeometric Distribution:**

(i) The population is of a finite size N.

(ii) There are K successes in the population (e.g., they carry a common genetic trait, or they may be infected with a certain virus).

(iii) Consequently, there are N-K Failures in the population.

(iv) A random sample of size n is selected from the population.

(v) The Hypergeometric RV X is the number of successes in the sample.

**dhyper(x,K,N-K,n)**

(in Excel: **=hypgeom.dist(x, n, K, N,0)**)

**Example:** A jar contains 50 marbles of which 20 are blue. 10 marbles are randomly removed from the jar. What is the probability that there are 3 blue marbles in this sample?

N=50

K=20

N-k = 50 -20 = 30

n=10

P(X=3)=?

```
> dhyper(3,20,30,10)
[1] 0.2259296294
```

**Example:** **The Continuous Uniform Distribution between two values a and b:**

**P(X<x) = P(X<=x) = punif(x,a,b)**

**Mean = (a+b)/2**

If a and b are not indicated as inputs, then the standard uniform formulas are obtained (a=0 and b=1)

**Example:** The Daily revenue at a convenient store is modeled according to the uniform distribution between \$1500 and \$2500.

(a) What is the probability that the revenue will be less than \$2000 tomorrow?

**P(X<2000)=**

```
> punif(2000,1500,2500)
[1] 0.5
```

(b) What is the probability that the revenue will be more than \$1800 tomorrow?

**P(X>1800)=**

```
> 1-punif(1800,1500,2500)
[1] 0.7
```

(c) What is the probability that the revenue will be between $1700 and $2200 tomorrow?

**P(1700<X<2200)=**

```
> punif(2200,1500,2500) - punif(1700,1500,2500)
[1] 0.5
```

**Example: The Normal Distribution**

**Probability density function: dnorm(x,μ, σ)**

**Probability cumulative function P(X<=x) = pnorm(x,μ, σ)**

**Inverse Problems: x = qnorm(prob,μ,σ)**

**Generates N random numbers: rnorm(N,μ, σ)**

Note: If μ and σ are not indicated as inputs, then the standard normal formulas are obtained (μ =0 and σ =1)

**Example:** The distribution of the weights of newborn is normal with a mean of 6.2 lbs and a standard deviation of 1.2 lbs.

(a) What percentage of the newborns are less than 6 lbs?

**P(X<6) =**

```
> pnorm(6,6.2,1.2)
1] 0.4338161674
```

=43%

(b) What percentage are heavier than 10 lbs?

**P(X>10) =**

```
> 1-pnorm(10,6.2,1.2)
[1] 0.0007709847845
```

= 0.08%

(c) What percentage are between 7 lbs and 9 lbs?

**P(7<X<9) =**

```
> pnorm(9,6.2,1.2)-pnorm(7,6.2,1.2)
[1] 0.2426772089
```

= 24%

(d) Find the 90th percentile of the weights distribution.

```
> qnorm(0.9,6.2,1.2)
[1] 7.737861879
```

= 7.7 lbs