Probability Distributions Cheat Sheet

This document summarizes the use of three main types of functions associated with probability distributions.

- The **d_____** functions (`dbinom()`, `dpois()`, etc.) are used for discrete distributions to find probabilities of the form $P(X = x)$.

- The **p_____** functions (`phyper()`, `pnorm()`, etc.) are used for both discrete and continuous distributions to find probabilities of the form $P(X \leq x)$.

- The **q_____** functions (`qnorm()`, `qexp()`, etc.) are used for continuous random variables to find x_0 such that $P(X \leq x_0) = p$, where p is a probability.

Please note that this is not a completely comprehensive list of the distributions in R; these are just some of the more common ones!

Discrete Distributions

Bernoulli/Binomial

For $\boldsymbol{X}$ following a binomial distribution with n trials and probability of success p.

To find $\boldsymbol{P(X = a)}$:

```
dbinom(a, size = n, prob = p)
```

To find $\boldsymbol{P(X \leq a)}$:

```
pbinom(a, size = n, prob = p)
```

To find $\boldsymbol{P(a \leq X \leq b)}$:

```
pbinom(b, size = n, prob = p) - pbinom(a-1, size = n, prob = p)
sum(dbinom(a:b, size = n, prob = p))
```

Geometric

For $\boldsymbol{X}$ following a geometric distribution with probability of success p.

To find $\boldsymbol{P(X = a)}$:

```
dgeom(a-1, prob = p)
```

To find $\boldsymbol{P(X \leq a)}$:

```
pgeom(a-1, prob = p)
sum(dgeom(0:a-1, prob = p))
```

To find $\boldsymbol{P(a \leq X \leq b)}$:

```
sum(dgeom(a-1:b-1, m, n, k))
```

Hypergeometric

For $\boldsymbol{X}$ following a hypergeometric distribution with m successes in the population, n failures in the population, and a sample of k observations from the population.

To find $P(X = a)$:

```
dhyper(a, m, n, k)
```

To find $P(X \leq a)$:

```
phyper(a, m, n, k)
```

To find $P(a \leq X \leq b)$:

```
phyper(b, m, n, k) - phyper(a-1, m, n, k)
sum(dhyper(a:b, m, n, k))
```

Negative Binomial

For $\boldsymbol{X}$ following a negative binomial distribution with r successes we are interested in observing and probability of success p.

To find $P(X = a)$:

```
dnbinom(a-r, size = r, prob = p)
```

To find $P(X \leq a)$:

```
pnbinom(a-r, prob = p)
sum(dnbinom(0:a-r, prob = p))
```

Poisson

For $\boldsymbol{X}$ following a Poisson distribution with a rate parameter λ.

To find $P(X = a)$:

```
dpois(a, lambda = lambda)
```

To find $P(X \leq a)$:

```
ppois(a, lambda = lambda)
```

To find $P(a \leq X \leq b)$:

```
ppois(b, lambda = lambda) - ppois(a-1, lambda = lambda)
sum(dpois(a:b, lambda = lambda))
```

Continuous Distributions

Beta

For $\boldsymbol{X}$ following a beta distribution with parameters α and β.

To find $\boldsymbol{P(X \leq a)}$:

```
pbeta(a, shape1 = alpha, shape2 = beta)
```

To find $\boldsymbol{P(a \leq X \leq b)}$:

```
pbeta(b, shape1 = alpha, shape2 = beta) - pbeta(a, shape1 = alpha, shape2 = beta)
```

To find $\boldsymbol{x_0}$ such that $\boldsymbol{P(X \leq x_0) = p}$:

```
qbeta(p, shape1 = alpha, shape2 = beta)
```

Chi-Square

For $\boldsymbol{X}$ following a chi-square distribution with degrees of freedom d.

To find $\boldsymbol{P(X \leq a)}$:

```
pchisq(a, df = d)
```

To find $\boldsymbol{P(a \leq X \leq b)}$:

```
pchisq(b, df = d) - pbeta(a, df = d)
```

To find $\boldsymbol{x_0}$ such that $\boldsymbol{P(X \leq x_0) = p}$:

```
qchisq(p, df = d)
```

Exponential

For $\boldsymbol{X}$ following an exponential distribution with parameter β.

To find $\boldsymbol{P(X \leq a)}$:

```
pexp(a, rate = 1/beta)
```

To find $\boldsymbol{P(a \leq X \leq b)}$:

```
pexp(b, rate = 1/beta) - pexp(a, rate = 1/beta)
```

To find $\boldsymbol{x_0}$ such that $\boldsymbol{P(X \leq x_0) = p}$:

```
qexp(p, rate = 1/beta)
```

Gamma

For $\boldsymbol{X}$ following a gamma distribution with parameters α and β.

To find $\boldsymbol{P(X \le a)}$:

```
pgamma(a, shape = alpha, scale = 1/beta)
```

To find $\boldsymbol{P(a \le X \le b)}$:

```
pgamma(b, shape = alpha, scale = 1/beta) - pgamma(a, shape = alpha, scale = 1/beta)
```

To find $\boldsymbol{x_0}$ such that $\boldsymbol{P(X \le x_0) = p}$:

```
qgamma(p, shape = alpha, scale = 1/beta)
```

Normal

For $\boldsymbol{X}$ following a normal distribution with mean μ and standard deviation σ.

To find $\boldsymbol{P(X \le a)}$:

```
pnorm(a, mean = mu, sd = sigma)
```

To find $\boldsymbol{P(a \le X \le b)}$:

```
pnorm(b, mean = mu, sd = sigma) - pnorm(a, mean = mu, sd = sigma)
```

To find $\boldsymbol{x_0}$ such that $\boldsymbol{P(X \le x_0) = p}$:

```
qnorm(p, mean = mu, sd = sigma)
```

Student’s t

For $\boldsymbol{X}$ following a Student’s t distribution with degrees of freedom d.

To find $\boldsymbol{P(X \le a)}$:

```
pt(a, df = d)
```

To find $\boldsymbol{P(a \le X \le b)}$:

```
pt(b, df = d) - pt(a, df = d)
```

To find $\boldsymbol{x_0}$ such that $\boldsymbol{P(X \le x_0) = p}$:

```
qt(p, , df = d)
```

Uniform

For $\boldsymbol{X}$ following a uniform distribution with a minimum value min and a maximum value max.

To find $\boldsymbol{P(X \le a)}$:

```
punif(a, min = min, max = max)
```

To find $\boldsymbol{P(a \le X \le b)}$:

```
punif(b, min = min, max = max) - punif(a, min = min, max = max)
```

To find $\boldsymbol{x_0}$ such that $\boldsymbol{P(X \le x_0) = p}$:

```
qunif(p, min = min, max = max)
```