More SAS Functions

There are many functions in SAS that compute probabilities from known distributions. There are also inverse functions that can compute the value of the random variable associated with a cumulative probability. SAS functions can be included in DATA step operations. Here is a list of some of the functions and their syntax. For a complete list of functions see *SAS Language* manual. (Within SAS Help you can search for SAS functions. See Data Step Information 2 for Help on SAS functions.)

CINV CINV(p, df <,nc>)

p is a numeric probability, with $0 < p < 1$.
df is a numeric degrees of freedom parameter, with $df > 0$.
nc is an optional numeric noncentrality parameter, with $nc \geq 0$.

The CINV function returns the pth quantile from the chi-square distribution with degrees of freedom df and a noncentrality parameter nc. The probability that an observation from a chi-square distribution is less than or equal to the returned quantile is p. The CINV function is the inverse of the PROBCHI function.

Note: Non-centrality parameter is a more advanced concept. In introductory statistical methods classes, the reference tables used have a non-centrality parameter of zero. Non-centrality parameters are non-zero values in the evaluation of the power of a test. Non-centrality parameters can be specified for the chi-square distribution here, and for the t and F distributions below.

PROBCHI PROBCHI(x, df <, nc>)

x is a numeric random variable, with $x \geq 0$.
df is a numeric degrees of freedom parameter, with $df > 0$.
nc is an optional number noncentrality parameter, with $nc \geq 0$.

The PROBCHI function returns the probability that an observation from a chi-square distribution, with degrees of freedom df and noncentrality parameter nc, is less than or equal to x. This function accepts a noninteger value for df. Most commonly, nc = 0. Omitting the comma and value for nc after ddf is the equivalent of nc = 0. The CINV function is the inverse of the PROBCHI function.

FINV FINV(p, ndf, ddf <,nc>)

p is a numeric probability, with $0 < p < 1$.
ndf is a numeric numerator degrees of freedom parameter, with $ndf > 0$.
ddf is a numeric denominator degrees of freedom parameter, with $ddf > 0$.
nc is an optional numeric noncentrality parameter, with $nc \geq 0$.

The FINV function returns the pth quantile from the F distribution with numerator degrees of freedom ndf, denominator degrees of freedom ddf, and noncentrality parameter, nc. The probability that an observation from the F distribution is less than the quantile is p. The FINV function is the inverse of the PROBF function.

PROBF PROBF(x, ndf, ddf <, nc>)

x is a numeric random variable, with $x \geq 0$.
ndf is a numeric numerator degrees of freedom with ndf > 0.
ddf is a numeric denominator degrees of freedom with ddf > 0.
nc is an optional numeric noncentrality parameter, with $nc \geq 0$.

The PROBF function returns the probability that an observation from an F distribution, with numerator degrees of freedom ndf, denominator degrees of freedom ddf, and noncentrality parameter nc, is less than or equal to x. The function accepts noninteger degrees of freedom parameters ndf and ddf. Most commonly, nc = 0. Omitting the comma and value for nc after ddf is the equivalent of nc = 0. The FINV function is the inverse of the PROBF function.

PROBIT PROBIT(p)

p is a numeric probability, with $0 < p < 1$.

The PROBIT function returns the pth quantile from the standard normal distribution. The probability that an observation from the standard normal distribution is less than or equal to the returned quantile is p. The PROBIT function is the inverse of the PROBNORM function.

PROBNORM PROBNORM(x)

x is a number random variable.

The PROBNORM function returns the probability that an observation from the standard normal distribution is less than or equal to x. The PROBIT function is the inverse of PROBNORM.

TINV TINV(p, df <,nc>)

p is a numeric probability, with $0 < p < 1$.
df is numeric degrees of freedom parameter, with df > 0.
nc is an optional numeric noncentrality parameter, with $nc \geq 0$.

The TINV function returns the pth quantile from the Student's t distribution with degrees of freedom df and a noncentrality parameter nc. The probability that an observation from a t

distribution is less than or equal to the returned quantile is p. The TINV function is the inverse of the PROBT function.

PROBT PROBT(x, df <,nc>)

x is a numeric random variable.
df is a numeric degrees of freedom parameter, with df > 0.
nc is an optional numeric noncentrality parameter, with nc $\geq$ 0.

The PROBT function returns the probability that an observation from a Student's t distribution, with degrees of freedom df and noncentrality parameter nc, is less than or equal to x. This function accepts a noninteger degree of freedom parameter df. Omitting the comma and value for nc after ddf is the equivalent of nc = 0. The TINV function is the inverse of the PROBT function.

PROBBNML PROBBNML(p, n, m);

p is a numeric probability of success parameter, with $0 \leq p \leq 1$.
n is an integer number of independent Bernoulli trials, n > 0.
m is an integer number of successes random variable, with $0 \leq m \leq n$.

The returned value is the computed probability of m or fewer successes.

Objective 5: Use the above functions to compute values we can easily verify using statistical tables.

a. Compute the standard normal random variable that has a left hand area of 0.90.
b. Compute the probability of a standard normal random variable above 1.96.
c. Find the value of t when the right hand area is 0.1 and the df = 14.
d. What is the probability a t-statistic larger than 2.086 with 20 df.
e. What is the value of the critical value $\chi^2_{0.04,\ 14}$? (Find the χ^2 value with 14 df that determines a right hand area of 0.04.)
f. Find the p-value (observed significance level) of the χ^2 statistic 17.04 with 6 df for the hypothesis test H_0: $\sigma^2 = 42$ versus H_1: $\sigma^2 \neq 42$.
g. Find the p-value associated with the ANOVA F-statistic of $F_{4,\ 16} = 7.83$.
h. Find the critical F-value determined by $\alpha = 0.03$ for the ANOVA in g.
i. Find the probability of 5 or less successes in 8 trials if the probability of success on a single trial is 0.3.
j. Find the probability of exactly 5 successes in 8 trials if the probability of success on a single trial is 0.3.

```
DATA  one;
a = PROBIT(.90);
b = 1 - PROBNORM(1.96);
c = TINV(0.9, 14);
d = 1 - PROBT(2.086, 20);
e = CINV(0.96, 14);
f = 2*(1 - PROBCHI(17.04, 6) );
g = 1 - PROBF(7.83, 4,16) ;
h = FINV(0.97, 4, 16) ;
i = PROBBNML(.3, 8, 5) ;
j = PROBBNML(.3, 8, 5) - PROBBNML(.3, 8, 4);
PROC PRINT DATA=one;
TITLE 'Objective 5';
RUN;
QUIT;
```

Note: The DATA step of this program does not INPUT any variables. All variables are created using SAS functions. Also, this DATA table has only one observation and 10 variables (a through j). LABELs could still be applied to the variable names if desired. Remember to use the LABEL option on the PRINT procedure if you want those labels to appear in the output listing. Values a, b, c, and d can be confirmed using most reference tables found in an introductory statistical methods books.