

“A Macro to Generate the Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Their 95% CI's ”

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Screening refers to the application of a test to people who are as yet asymptotic for the purpose of classifying them with respect to their likelihood of having a particular disease. The screening procedure itself does not diagnose illness. Those who test positive are sent on for further evaluation by a subsequent diagnostic test or procedure to determine whether they do in fact have the disease.

The validity of a screening test is measured by its ability to do what it is supposed to do, that is, correctly categorize persons who have preclinical disease as test-positive and those without preclinical disease as test-negative. Assume:

a = The number of individuals for whom the screening test is positive and the individual actually has the disease (true positive).

b = The number for whom the screening test is positive but the individual does not have the disease (false positive).

c = The number for whom the screening test is negative but the individual does have the disease (false negative).

d = The number for whom the screening test is negative and the individual does not have the disease (true negative)

	Disease	
	Yes	No
Test Positive	a	b
Test Negative	c	d

Sensitivity and specificity are two measures of the validity of a screening test. Sensitivity is identified as the probability of testing positive if the disease is truly present and is calculated by $\frac{a}{a+c}$. As the sensitivity of a test increases, the number of persons with the disease who are missed by being incorrectly classified as test-negative (false negative) will decrease. Specificity is defined as the probability of screening negative if the disease is truly absent and is calculated by $\frac{d}{b+d}$. A high specific test will result in lower

proportion of persons without disease who are incorrectly classified as test-positive (false positive).

Other measure that is commonly considered is the predictive of the screening test. Predictive value measures whether or not an individual actually has the disease, given the results of the screening test. Predictive value positive (PV⁺) is the probability that a person actually has the disease given that he or she tests positive and is calculated as :

$$PV^+ = \text{Probability}(D_x + | T+) = \frac{a}{a + b}$$

Analogously, predictive value negative is the probability that an individual is truly disease-free given a negative screening test and is calculated as follows:

$$PV^- = \text{probability}(D_x - | T -) = \frac{d}{c + d}$$

Getting sensitivity, specificity, predictive value positive and negative comes to calculating the statistic $\hat{p}$, which is the observed frequency of success in n Bernoulli trials. Consistent estimator for the standard deviation of $\hat{p}$ is the midpoint of confidence interval. This is not true in general. Clopper and Pearson directed the confidence interval based on F distribution.

The macro first writes a small macro to calculate the estimate of p and its 95% confidence interval based on Clopper and Pearson's method. Then based on the definition of sensitivity, specificity, predictive value positive and negative as explained above, call the small macro to get the estimate and 95% confidence interval of sensitivity, specificity, predictive value positive and negative. Variable 'disease' is dichotomized. When this variable equals variable disnum, the patient has disease, otherwise the patient has no disease. Value '1' is the default number of disnum. The screening test result is valued by variable testvar, based on the limit and sign, screen positive and negative are defined.

Reference:

Clopper, C. J. and Pearson, E. S. (1934). The use of confidence or fiducial limits illustrated in the case of the binomial. *Biometrika* 26, 404-13.

Hollander Wolfe. *Nonparametric Statistical Models*. 22-24.

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*****
*
* Client:          All Clients of Applied Logic Associates, Inc.
*
* Protocol:        All Protocols
*
* Program:         GETSEN.SAS
*
* Output:          GETSEN.LST
*
* Data Files:
*
* Case Report Form: N/A
*
* Programmer:      QZHANG
*
* Date:            May, 1997
*
* Description:     This program get sensitivity, specificity, positive predictive
*                  value, negative predictive value and their 95% CI's
*
* Revision:
*
* Validation:
*
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* DESCRIPTION OF MACRO PARAMETERS SENT FROM YOUR PROGRAM:
* INDSN -- DATA SET WHICH CONTAINS THE INFORMATION OF DISEASE AND TEST RESULT
* DISEASE -- DICHOTOMIZED VARIABLE FOR DISEASE SITUATION
* DISNUM -- NUMERIC VALUE FOR DISEASE, 1 IS THE DEFAULT VALUE
* TESTVAR -- VARIABLE FOR TEST
* SIGN -- SIGN FOR TEST POSITIVE RESULT, LIKE %STR(>=), %STR(<), ETC.
* LIMIT -- LIMIT FOR CUT POINT OF TEST
* OTDSN -- OUTPUT OF THE DATA SET WHICH CONTAINS SENSITIVITY, SPECIFICITY,
*         POSITIVE PREDICTIVE VALUE, NEGATIVE PREDICTIVE VALUE AND THEIR
*         95% CI'S
* _DATDEL-- SPECIFY YES/NO TO INDICATE WHETHER TEMPORARY WORK DATASETS CREATED
*           WITHIN A MACRO SHOULD BE DELETED AFTER THE MACRO COMPLETES EXECUTION
*           THE DEFAULT IS YES
*****

%global dataset file;
/*****
**this macro getsen get the sensitivity, specificity, positive predictive**
**value and negative predictive value and their 95% CIs and fisher test**
***** TESTVAR is the number to predict disease, LIMIT is the cut *****
***** point and sign is the direction for <= to be test positive *****
***** or <= to be test positive *****/
%macro getsen(INDSN=,disease=,disnum=1,testvar=,limit=,sign=,OTDSN=,_DATDEL=,_DATDEL=YES);
data _t1 ;
set &INDSN;
/****TPOS: variable for test result, 1 for positive 0 for negative *****/
****DISEA: variable for disease, 1 for disease, 0 for no disease *****/
tpos=(&testvar &sign &limit);
disea=(&disease=&disnum);
run;

proc freq data=_t1 noprint;
table tpos*disea/exact out=_freqdat noprint;
OUTPUT OUT = _FISHER EXACT ;
run;

data _fisher;
set _fisher;
LABEL P_EXACT2 = "FISHER'S EXACT TEST" ;
FORMAT P_EXACT2 6.4 ;
run;

data _freqdat(keep=cnt1-cnt4);
set _freqdat end=lastobs;
retain cnt1-cnt4;
if tpos=1 and disea=1 then cnt1=count; /* test positive, having disease */
if tpos=1 and disea=0 then cnt2=count; /* test positive, no disease */
if tpos=0 and disea=1 then cnt3=count; /* test negative, having disease */

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        if tpos=0 and disea=0 then cnt4=count; /* test negative, no disease */
        if lastobs;
run;

%getci(success=cnt1,nosucc=cnt3,out=_sensiti); /* get sensitivity, p(T+|D) */
%getci(success=cnt4,nosucc=cnt2,out=_specifi); /* get specificity, p(T-|ND) */
%getci(success=cnt1,nosucc=cnt2,out=_ppv); /* get positive predictive value, p(D|T+) */
*/
%getci(success=cnt4,nosucc=cnt3,out=_npv); /* get negative predictive value, p(ND|T-) */
*/

data &OTDSN(KEEP=D_TP ND_TP D_TN ND_TN SEN SEN_CI SPE SPE_CI PPV PPV_CI NPV NPV_CI
P_EXACT2 TEST);
set _freqdat(RENAME=(CNT1=D_TP
CNT2=ND_TP
CNT3=D_TN
CNT4=ND_TN));
set _sensiti(rename=(probt=sen ci=sen_ci));
set _specifi(rename=(probt=spe ci=spe_ci));
set _ppv (rename=(probt=ppv ci=ppv_ci));
set _npv (rename=(probt=npv ci=npv_ci));
set _fisher(keep=p_exact2);
TEST = "&TESTVAR" || "&SIGN" || "&LIMIT";
LABEL D_TP = '# OF TEST POSITIVE, HAVING DISEASE'
ND_TP = '# OF TEST POSITIVE, NO DISEASE'
D_TN = '# OF TEST NEGATIVE, HAVING DISEASE'
ND_TN = '# OF TEST NEGATIVE, NO DISEASE'
SEN = 'SENSITIVITY'
SEN_CI = '95% CI FOR SENSITIVITY'
SPE = 'SPECIFICITY'
SPE_CI = '95% CI FOR SPECIFICITY'
PPV = 'POSITIVE PREDITIVE VALUE'
PPV_CI = '95% CI FOR POSITIVE PREDITIVE VALUE'
NPV = 'NEGATIVE PREDITIVE VALUE'
NPV_CI = '95% CI FOR NEGATIVE PREDITIVE VALUE'
P_EXACT2 = '2-SIDED P-VALUE FOR FISHER EXACT TEST'
TEST = 'DEFINITION OF TEST POSITIVE';

run;

%IF &_DATDEL = YES %THEN %DO;
PROC DATASETS;
DELETE _T1 _FISHER _FREQDAT _SENSITI _SPECIFI _PPV _NPV;
RUN;
%END;

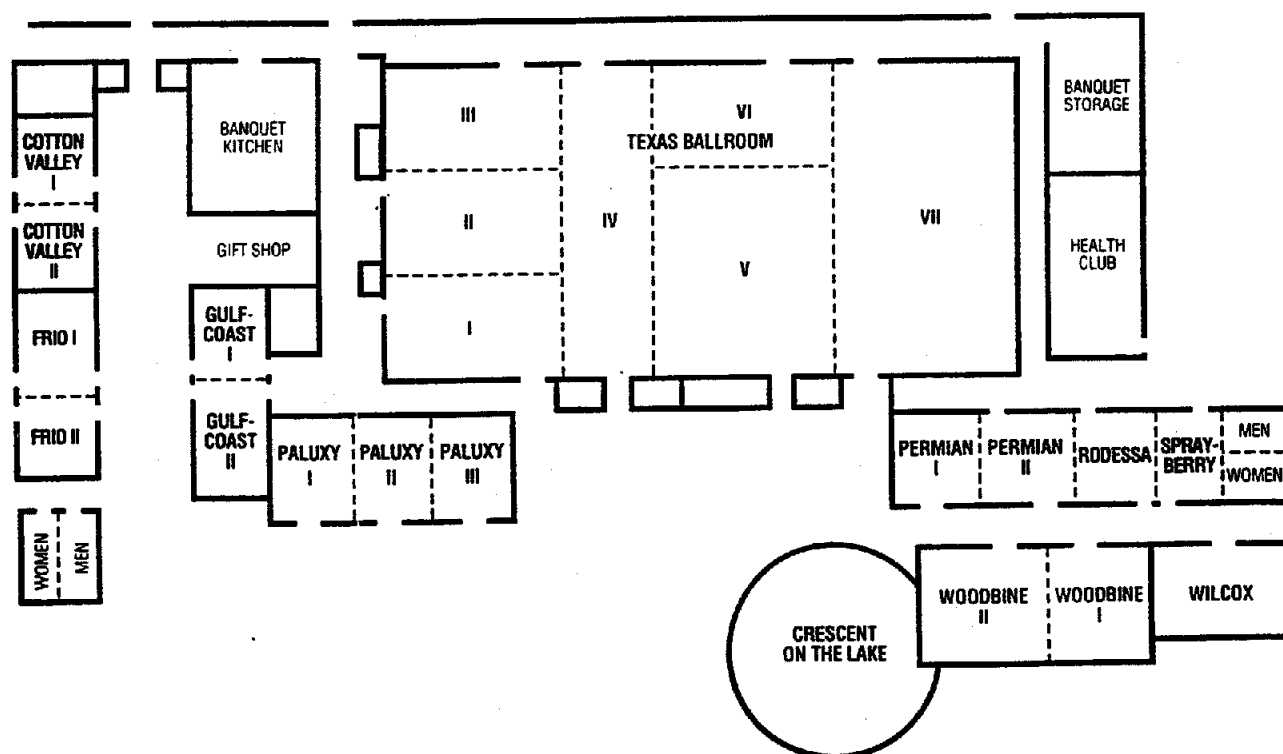
%mend;

/*****
**** macro to get the sensitivity, specificity, positive ****
**** predictive value,negative predictive value and their CIS ****
**** the macro was based on binomial distribution, to ****
**** get the p and CI, see reference for binomial distribution****
**** SUCCESS: variable for number of success, NOSUCC: variable ****
****for number of not success, OUT is the output of data set ****/
%macro getci(success=, nosucc=, out=);
data &out(keep=probt ci);
set _freqdat;
length ci $15;
n=&success+&nosucc;
probt=100*&success/n;
n_df1=2*(n-&success+1);
d_df1=2*&success;
n_df2=2*(&success+1);
d_df2=2*(n-&success);
prob=1-0.05/2;
if n_df1=0 then n_df1=5;
if d_df1=0 then d_df1=5;
if n_df2=0 then n_df2=5;
if d_df2=0 then d_df2=5;
probf1=finv(prob,n_df1,d_df1);
probf2=finv(prob,n_df2,d_df2);
prob_l=100*&success/(&success+(n-&success+1)*probf1);
prob_u=100*(1-&nosucc/(&nosucc*(n-&nosucc+1)*probf2));
ci='(' || put(prob_l,6.3) || ',' || put(prob_u,6.3) || ')';
%mend;

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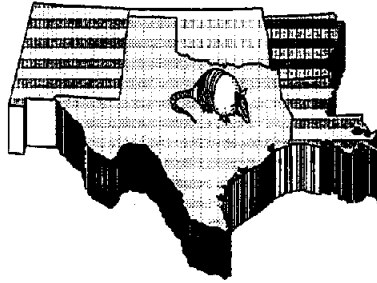
Houston Marriott Westside

Houston, Texas



SCSUG '97 Conference Facility Usage Plan

- Texas Ballroom I - Tutorials, General Interest
- Texas Ballroom II - Statistical Computing, Application Development
- Texas Ballroom III - Hands-On Workshops
- Texas Ballroom IV - Posters (+ passageway to Texas Ballrooms II, III, & VI)
- Texas Ballroom V - (Monday) Year 2000, Tutorials;
(Tuesday) Application Development, Consultants' Workshop
- Texas Ballroom VI - Formal Demonstrations by SAS Institute
- Texas Ballroom VII - (Monday) Opening Session, Tutorials, General Interest;
(Tuesday) Coders' Corner, Data Warehousing, Intelligent Technologies, Closing Session
- Paluxy I, II, & III - SAS Institute Exhibit Area
- Victories & Roustabout - Luncheon & Roundtable Discussions



ANNOUNCEMENT & CALL FOR PAPERS

Eighth Annual
South-Central Regional SAS Users' Group Conference
Omni Richardson Hotel, Richardson, Texas
October 25-27, 1998

This two-day, regional conference for SAS users from Texas, Louisiana, Oklahoma, Arkansas, New Mexico and adjoining states will include presentations of technical papers, poster presentations, roundtable luncheon discussion meetings, demonstrations, workshops, "birds-of-a-feather" sessions, problem-solving sessions, and one-on-one technical exchanges. The conference will feature general sessions for all participants, as well as concurrent sessions covering various areas of specialization.

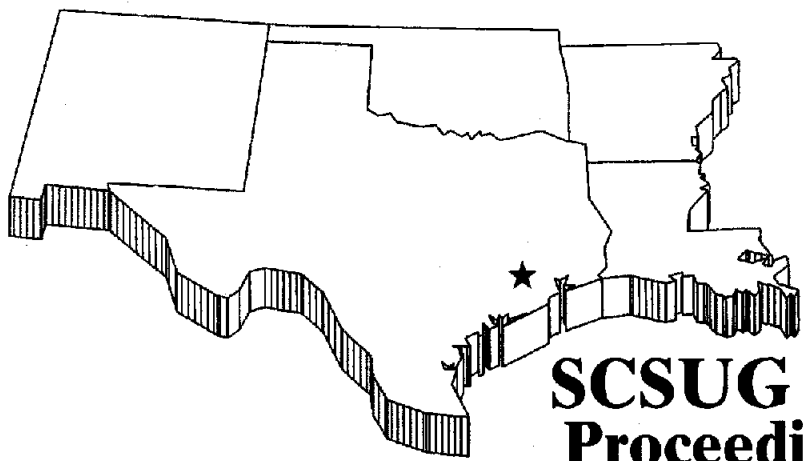
Please consider sharing your methods, experiences and results with other conference attendees. We anticipate that papers will be presented in the following sections: Applications Development, Coders' Corner, Forecasting, Future Products, Statistical Computing, Training, and Tutorials. Papers covering topics in these, and other, areas would be most welcome. There will be a published conference proceedings.

Proposed papers, or abstracts of papers, should be sent to Tom Winn, 10906 Rustic Manor Lane, Austin, TX 78750, by June 1.

Volunteers are needed to help with registration/check-in, and as roundtable discussion leaders, messengers, session coordinators, timekeepers, and other facilitators at the conference.

If you are able to help, please contact Conference Chairperson Clarence Wm. Jackson by telephoning (214) 670-4876, via postal mail at: City of Dallas ECI (Operations and Plans), 1500 Marilla St, 4DS, Dallas, TX 75201, or via the Internet at cljacks@ci,dallas.tx.us or CJac@compuserve.com.

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