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%jacobian2by2.m
%Code 8.1 of Random Eigenvalues by Alan Edelman

%Experiment:    Compute the Jacobian of a 2x2 matrix function
%Comment:       Symbolic tools are not perfect.  The author
%               exercised care in choosing  the variables.

syms p q r s a b c d t e1 e2
X=[p q ; r s]; A=[a b;c d];

%% Compute Jacobians

Y=X^2;              J=jacobian(Y(:),X(:)), JAC_square  =factor(det(J))
Y=X^3;              J=jacobian(Y(:),X(:)), JAC_cube    =factor(det(J))
Y=inv(X);           J=jacobian(Y(:),X(:)), JAC_inv     =factor(det(J))
Y=A*X;              J=jacobian(Y(:),X(:)), JAC_linear  =factor(det(J))
Y=[p q;r/p det(X)/p]; J=jacobian(Y(:),X(:)), JAC_lu      =factor(det(J))

x=[p s r];y=[sqrt(p) sqrt(s) r/(sqrt(p)*sqrt(s))];
                J=jacobian(y,x),      JAC_DMD     =factor(det(J))

x=[p s]; y=[ atan(p/s) sqrt(p^2+s^2)];
                J=jacobian(y,x),      JAC_notrace =factor(det(J))

Q=[cos(t) -sin(t); sin(t) cos(t)];
D=[e1 0;0 e2];Y=Q*D*Q.';
y=[Y(1,1) Y(2,2) Y(1,2)]; x=[t e1 e2];
                J=jacobian(y,x),      JAC_symeig  =simplify(det(J))
X=[p s;s r]; Y=A.'*X*A;
y=[Y(1,1) Y(2,2) Y(1,2)]; x=[p r s];
                J=jacobian(y,x),      JAC_symcong =factor(det(J))
```