17. SYSTEM OF NONLINEAR EQUATIONS

Problem statement: Solution of equations: $f(x,y) = 0$
$g(x,y) = 0$

Symbolic solution: manipulation with expressions
Numeric solution: (i) separation of roots
(ii) iterative approximation of separate roots

COMMANDS

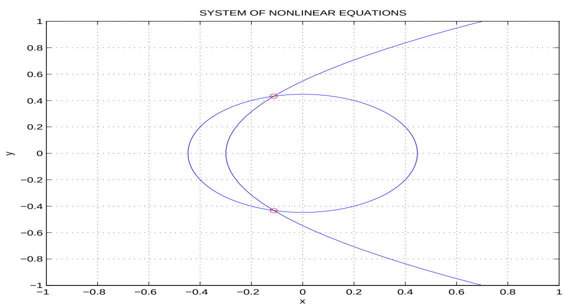
SYMS
SOLVE
DOUBLE
EZPLOT

FUNCTION

17.1 Symbolic Solution

Characteristics:
1. Symbolic solution is not always possible
2. Substitution allows conversion to numerical solution

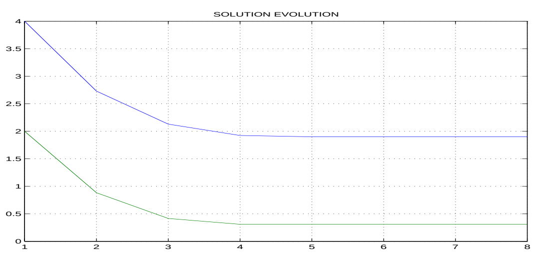
```
% Example 17.1: Symbolic solution of system of nonlinear equations
% Equation1: f(x,y)=x^2-2*x-y+0.5=0
% Equation2: g(x,y)=x^2+4*y^2-4=0
  syms x y
  R1=solve('x^2-2*x-y+0.5=0','x^2+4*y^2-4=0');
  R1.x; R1.y;
  X1=double(R1.x), Y1=double(R1.y)
% Visualization
  ezplot('x^2-2*x-y+0.5=0',[-1 3]); grid on
    hold on; ezplot('x^2+4*y^2-4=0');
      plot(X1([1 4]),Y1([1 4]),'or'); hold off
    title('SYSTEM OF NONLINEAR EQUATIONS')
```



17.2 Numeric Solution

Principle of the Newton method for the system of equations:
1. Expansion of multivariable functions into Taylor series is used
2. Principle is the same as in the one dimensional case

```
%%% Example 17.2: Solution of system of nonlinear equations
%%% Equation1: f(x,y)=x^2-2*x-y+0.5=0
%%% Equation2: g(x,y)=x^2+4*y^2-4=0
%%% for initial approximation P, accuracy eps and for
%%% maximum number of iterations M
    P=[4 2]'; eps=1e-12; M=40; PG=P;
    for k=2:M
      DF=J(P); F=[-f(P); -g(P)];
      DP=inv(DF)*F;
      P=P+DP; PG=[PG P];
      if abs(sum(DP))<eps, break, end
    end
    xk=P(:,end);
    plot(PG'); grid on; title('SOLUTION EVOLUTION')
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
  function z=f(P)          function z=g(P)
  x=P(1); y=P(2);          x=P(1); y=P(2);
  z=x^2-2*x-y+0.5;         z=x^2+4*y^2-4;
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
  function W=J(P)
  x=P(1); y=P(2);
  W=[(2*x-2) (-1);
     (2*x) (8*y)];
```



EXAMPLES 17

17.1 Evaluate symbolic solution of a selected system of nonlinear equations

17.2 Evaluate numeric solution of a selected system of nonlinear equations