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# Prof. Dr. Serkan Dağ
# ME 310 Numerical Methods
# File 4.4
# Newton-Raphson Method for Two Coupled Nonlinear Equations
# Solves the nonlinear system (u(x, y) = 0, v(x, y) = 0)
 # xr0, yr0: Initial guesses
restart :
Digits := 16 :
# Define the equations
u := x - y - x^2 + 0.5;
 v := y - x^2 + 5·x·y;
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$$u := x - y - x^2 + 0.5$$
$$v := -x^2 + 5\,x\,y + y \qquad (1)$$

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# Find the derivatives
ux := diff(u, x);
 uy := diff(u, y);
 vx := diff(v, x);
 vy := diff(v, y);
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$$ux := 1 - 2\,x$$
$$uy := -1$$
$$vx := -2\,x + 5\,y$$
$$vy := 5\,x + 1 \qquad (2)$$

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# Number of significant figures and error criterion
n := 3 :
epss := 0.5·10^(2 - n);
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$$epss := 0.05000000000000000 \qquad (3)$$

```
# Maximum number of iterations
kmax := 20 :
# Initial guesses
xr0 := 1.2 :
 yr0 := 0.3 :
# Initiate the iterations
for k from 1 by 1 to kmax
while true do
if k = 1 then
printf("\n %5.1f %15.10f %15.10f", k - 1, xr0, yr0);
end if:
 x := xr0 :
 y := yr0 :
jdet := ux·vy - uy·vx :
numx := u·vy - v·uy :
numy := v·ux - u·vx :
 xrn := xr0 - numx/jdet :
 yrn := yr0 - numy/jdet :
 if xrn ≠ 0 then
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$epsax := evalf\left(\text{abs}\left(\frac{(xrn - xr0)}{xrn} \right) \cdot 100 \right)$:

end if:

if $yrn \neq 0$ **then**

$epsay := evalf\left(\text{abs}\left(\frac{(yrn - yr0)}{yrn} \right) \cdot 100 \right)$:

end if:

printf("\n %5.1f %15.10f %15.10f %15.10f %15.10f", k, xrn, yrn, epsax, epsay);

$xr0 := xrn$:

$yr0 := yrn$:

if ($epsax < epss$ **and** $epsay < epss$) **then**

break:

end if:

end do:

```
 0.0    1.2000000000    0.3000000000
 1.0    1.2355140187    0.2102803738    2.8744326778   42.6666666667
 2.0    1.2333228871    0.2122423443    0.1776608198    0.9244010334
 3.0    1.2333177930    0.2122450145    0.0004130413    0.0012580744
```

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