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(1a)
iteration with initial guess at x0=y0=1:
tolerance @ 5e-09

Found solution after 29 iterations.

the approximate root is [0.5      0.8660254]
f(root) = [-4.3136214600281164e-09, -4.714810764028243e-10]

running order of convergence for alpha = 1
[0.22374855 0.22374855]
[0.47528213 0.47528213]
[0.5900429  0.5900429 ]
[0.61478579 0.61478579]
[0.58802571 0.58802571]
[0.54858881 0.54858881]
[0.50906251 0.50906251]
[0.4728112  0.4728112 ]
[0.44479692 0.44479692]
[0.44300887 0.44300887]
[0.50178519 0.50178519]
[0.59368033 0.59368033]
[0.62106123 0.62106123]
[0.59409387 0.59409387]
[0.55422616 0.55422616]
[0.51493429 0.51493429]
[0.47873698 0.47873698]
[0.44891152 0.44891152]
[0.43944687 0.43944687]
[0.48377176 0.48377176]
[0.5774849  0.5774849 ]
[0.62168904 0.62168904]
[0.60153744 0.60153744]
[0.56161959 0.56161959]
[0.5190582  0.5190582 ]
[0.47378119 0.47378119]
[0.41634855 0.41634855]
[0.31459123 0.31459123]

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newton's method with initial guess at x0=y0=1:
tolerance @ 5e-16

Found solution after 5 iterations.
the approximate root is [0.5      0.8660254]
f(root) = [-1.1102230246251565e-16, 2.220446049250313e-16]

running order of convergence for alpha = 1
[[2.23748544e-01 2.23748544e-01]
 [1.21023214e-01 1.21023214e-01]
 [2.93860849e-03 2.93860849e-03]
 [4.77656972e-05 4.77656972e-05]]

running order of convergence for alpha = 2
[[0.43224899 0.43224899]
 [1.04491807 1.04491807]
 [0.20964601 0.20964601]
 [1.15962953 1.15962953]]

running order of convergence for alpha = 3
[[8.35040933e-01 8.35040933e-01]
 [9.02185402e+00 9.02185402e+00]
 [1.49565517e+01 1.49565517e+01]
 [2.81528529e+04 2.81528529e+04]]

```

(3b)
iteration with initial guess at $x_0=y_0=z_0=1$:
tolerance @ $5e-16$

Found solution after 6 iterations.

the approximate root is:

$x = 1.3603283832230446$

$y = 1.3603283832230446$

$z = 1.3603283832230446$

$f(\text{root}) = 0.0$

iterations:

```
[[1.          1.          1.          ]
 [1.10606061  1.42424242  1.42424242]
 [1.09392616  1.36174169  1.36174169]
 [1.09364246  1.36032911  1.36032911]
 [1.09364232  1.36032838  1.36032838]
 [1.09364232  1.36032838  1.36032838]
 [1.09364232  1.36032838  1.36032838]]
```

running order of convergence for $\alpha = 1$

```
[[1.76094847e-01 1.76094847e-01 1.76094847e-01]
 [2.21266952e-02 2.21266952e-02 2.21266952e-02]
 [5.11241374e-04 5.11241374e-04 5.11241374e-04]
 [2.61523416e-07 2.61523416e-07 2.61523416e-07]
 [1.16340316e-03 1.16340316e-03 1.16340316e-03]]
```

running order of convergence for $\alpha = 2$

```
[[3.39876736e-01 3.39876736e-01 3.39876736e-01]
 [2.42518401e-01 2.42518401e-01 2.42518401e-01]
 [2.53243077e-01 2.53243077e-01 2.53243077e-01]
 [2.53393911e-01 2.53393911e-01 2.53393911e-01]
 [4.31027770e+09 4.31027770e+09 4.31027770e+09]]
```

running order of convergence for $\alpha = 3$

```
[[6.55988505e-01 6.55988505e-01 6.55988505e-01]
 [2.65810933e+00 2.65810933e+00 2.65810933e+00]
 [1.25443791e+02 1.25443791e+02 1.25443791e+02]
 [2.45517114e+05 2.45517114e+05 2.45517114e+05]
 [1.59690936e+22 1.59690936e+22 1.59690936e+22]]
```