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#!/usr/bin/env python3
# -*- coding: utf-8 -*-

## Solving  $x^2 = 4$  by Picard's Method

import numpy as np
import matplotlib.pyplot as plt

# A quadratic polynomial
def f(x):
    return x**2 - 4

# Picard,  $x = g(x)$ 
def g(x):
    return x**2 + x - 4

i_max = 5 # maximum number of iterations (no infinite loops)
x = 1.5 # initial guess
res = abs(f(x)) # residual

i = 0
while (res > 1e-8):

    print(i, x, res)
    x = g(x)
    res = abs(f(x))
    i += 1

## Picards Method doesn't converge for this problem!

if (i >= i_max):
    print(i, x, res)
    print('Iteration did not converge.')
    break

x_plt = np.linspace(-4, 4, 201)

###
plt.figure()
plt.plot([-4, 4], [0,0], 'k--')
plt.plot(x_plt, f(x_plt), 'b-')
plt.plot(x, f(x), 'go', markersize=8)
plt.plot(2, 0, 'ro', markerfacecolor='none', markersize=8)
plt.plot(-2, 0, 'ro', markerfacecolor='none', markersize=8)
plt.xlim([-4, 4])
plt.ylim([-5, 5])
plt.xlabel('x')
plt.ylabel('$f(x)$')
plt.title('A Polynomial Equation')
plt.show()

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