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2025 USA-NA-AIO Round 1, Problem 1, Part 9

USAAIO Mar 2025

Part 9 (15 points, coding task)

Define a class called `My_Fib`.

- Attributes:
  - `Q`: This attribute is matrix $\mathbf{Q}$ computed above. It is a numpy array with shape `(2,2)`.
  - `lambdas`: This attribute is a numpy array with shape `(2,)` that includes two eigenvalues computed above.
- Method `__init__`:
  - All atttribute values shall be initialized when an object in this class is constructed.
- Method `compute_fib`:
  - This method computes the sequence values on designated indices.
  - You must use the spectral decomposition result to write this method.
  - **You are not allowed to use any loop.**
  - Inputs:
    - `f0`: The value of F_0
    - `f1`: The value of F_1

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- `indices` : a list/tuple/range object that includes indices with which the sequence values shall be computed.

For instance, if `indices` takes the value `[3, 5, 9]` , we need to compute F_3, F_5, F_9.

In our test cases, you are guaranteed that `len(indices)` is at least 1. You do not need to worry about the size of the test cases or whether the sequence values are too big (that is, on your side, you do not need to worry about those corner cases).

- Outputs:
  - Return a numpy array `fib_values` with shape `(len(indices),)` and datatype `int32` .
  - `fib_values[i]` takes the value of $F_{indices[i]}$.

  For instance, if `indices` takes the value `[3, 5, 9]` , then `fib_values` has shape `(3,)` . The values of `fib_values[0]` , `fib_values[1]` , `fib_values[2]` are F_3, F_5, F_9, respectively.
- Inside this method:
  - Print `fib_values` .

- Method `plot_fib` :
  - This method plots indices vs. sequence values on those indices.
  - Inputs: The same as the method `compute_fib(f0, f1, indices)` .
  - Outputs: None.
  - In your plot,
    - All data points with input indices are with marker `x` .

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- The linestyle is `--`.
- The color is red.
- The x-lable is: n.
- The y-label is: F_n.
- The title is: Fibounacci sequence.

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