Introduction to Scientific Computing Languages
Practice questions

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Variations of challenge #3

Var. 1

Input: as in Challenge #3.
Output:
The matrix B of size $n \times n$, with $b_{ij} = f_i(a_{ij})$.

Var. 2

Input: as in Challenge #3.
Output:
The matrix B of size $n \times n$, with $b_{ij} = f_j(a_{ji})$.

Write programs to compute B.

Misc

1) Write a function that takes 5 reals $\{a, b, c\}, \{x_0, y_0\}$, computes the first 10.000 elements of the sequence

$$\begin{cases} x_{n+1} \leftarrow y_n - sign(x_n)\sqrt{|bx_n - c|} \\ y_{n+1} \leftarrow a - x_n \end{cases},$$

and plots them in the plane. Test the function with $\{\{.4, 1., 1.\}, \{0.0, 0.0\}\}$, $\{\{.4, 1., 1.\}, \{.2, .4\}\}$, and $\{\{1.4, 1.1, 2.2\}, \{.2, .99\}\}$.

2) Write a one liner that returns a 10-row $\times$ 3-column table that shows the frequency of digit i in the first 10^j digits of π, with $i = 0, \ldots, 9$ and $j = 3, \ldots, 5$.

Sequence

Definition
Let $\mathcal{S}_n$ be an integer, and $\#_k^{(n)}$ $(0 \leq k \leq 9)$ the number of occurrences of the digit k in $\mathcal{S}_n$. The sequence $\mathcal{S}$ is defined by the rule
$\mathcal{S}_{n+1} := \lll \#_0^{(n)}, 0, \#_1^{(n)}, 1, \ldots, \#_9^{(n)}, 9 \ggg$, for all the $\#_k^{(n)} > 0$.
$\lll$ ... $\ggg$ indicates the concatenation of the digits.

Examples
If $\mathcal{S}_n = 42$, then $\mathcal{S}_{n+1} := 1214$, and $\mathcal{S}_{n+2} := 211214$.
If $\mathcal{S}_n = 420000000000$, then $\mathcal{S}_{n+1} := 1001214$, $\mathcal{S}_{n+2} := 20311214$.

Computation
$\mathcal{S}$ might converge or form a loop (this is not important).
To study its evolution, we use the following piece of code, in which the function `iterRule[S_]` is user-defined:

```
FromDigits /@
   FixedPointList[iterRule, IntegerDigits@Sn, 50]
```

Goal
Define the function `iterRule[S_]`.