Systems Biology – Exercises

Week 2: Paradigm of Nature and Bio-inspired computing

Introduction-1

- At the root of all biological life, there is evolution by natural selection. The scientific theory dates back to Charles Darwin and Alfred Russel Wallace, who came to similar conclusions on the mechanisms in the 1850s.
- Changes and evolution are not inherently superior to prior traits but present adaptations that are beneficial to a specific environment. In nature, these environments might be geographic differences, climates, surrounding predators or prey, or other factors. In information science, we can simulate an environment by a fitness function.

Introduction-2

- With more evolved species, other properties that are harnessed by bio-inspired algorithms emerged. These include interactions of many small individual organisms, biological subsystems, and other emergent properties in nature.
- One of the root properties involved in all these processes are of random nature.

Random String Generator-1

- Write the following function to generate a random string.

Random String Generator v1

```
import random
import string
# Random String Generator v1
def randomword1(length):
    return ''.join(random.choice(string.ascii_lowercase) for i in range(length))
# String
# string.ascii_lowercase: abcdefghijklmnopqrstuvwxyz
# string.ascii_uppercase: ABCDEFGHIJKLMNOPQRSTUVWXYZ
# string.digits: 0123456789
```

Random String Generator-2

- There are many other ways to get to a similar result. The code might differ in performance, but it can enhance its understandability.

Random String Generator v2

```
# Random String Generator v2
def randomword2(length):
    x = ""
    for i in range(length):
        x = x + random.choice(string.ascii_lowercase)
    return x
```

Renaming the functions

Rename the functions to your liking and call them with the desired string length.

```
# returns a 10 characters long string by calling function v1
randomString1 = randomword1(10)
# returns a 15 characters long string by calling function v2
randomString2 = randomword2(15)
```

Exercise 1

- Write another random string generator function **(v3)** that draws upon a custom set of character in the following form:

Algorithm 1: Random String Sequence with Required Characters

Function randomword3(*desired string length*)

Provide a Set $Set_{ASCII\text{-}lowercasePlus}$ = {"*a*", "*b*", "*c*", … , "*z*", ".", ";"}

Create random integer number *r* within range of $Set_{ASCII\text{-}lowercasePlus}$

Select character out of $Set_{ASCII\text{-}lowercasePlus}$ at position *r*

while *string has not yet desired string length:* **do**

Create random integer number *r*

Select character out of $Set_{ASCII\text{-}lowercasePlus}$ at position *r*

Attach to previous string

Return string

Repeatable Random Sequences

- Random and Repeatable seems mutually exclusive. Yet this is exactly where algorithm based pseudo random numbers differ from true random numbers.
- Random Numbers and Pseudo Random Numbers: Due to the deterministic nature of computers, they cannot create true random numbers. The random number generators used in programming languages are called pseudo random number generators.

```
random.seed(1000)
print(random.random())
```

Exercise 2

- Research the differences in true random numbers and pseudo random numbers. Answer the following questions:

1. What sources can be used to generate true random numbers?

2. How can pseudo random numbers be detected?

Homework

- Due next Wednesday (17:00, 13th, Oct.), submit electronically to Manaba+R.
- File name: YourStudentID_W02_n.pdf (or *.py) (ID without hyphen, e.g., 12345678901_W02.pdf).
- Your code must include your own comments for all code sections. Go line-by-line. Comments in your program must be full sentences and reflect your understanding of the code.

Q1. Finalize your pseudo random number generator (v3).

Q2. What is an easy way to change your v3 algorithm so that the odd alphabet ("a", "c", "e" … "y", ".") has double the chance of getting selected?

Q3. Write a 300 words report about differences of true and pseudo random numbers.

- Q1 → YourStudentID_W02_1.py file
- Q2 → YourStudentID_W02_2.py file
- Q3 → YourStudentID_W02_3.pdf file

Systems Biology – Exercises

Week 3:Fractals