Programming in Python[1]

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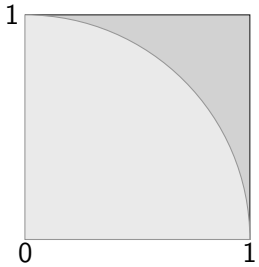
Lecture XI: Random numbers

Status of the homework

	accepted	done	ok
One triangle	22	13	11
Triangle kinds	18	18	7
Count chars	16	16	8
Newton square root	14	14	6
Pythagorean triplets	18	10	10
Sonar	16	16	6
DNA Hamming	16	16	7
DNA files	11	11	3
Pseudo Random	6	6	1

Example



- Blue square: 1
- Green area: $\frac{\pi}{4}$

The Monte Carlo method consists of choosing sample experiments at random from a large set and then making deductions on the basis of the probabilities estimated from frequency of occurrences.

Example


```
from random import random

def approx_pi(tries: int) -> float:
    """Return an approximation for pi.

    >>> from math import pi
    >>> from random import seed
    >>> seed(7897)  # Tests should be reproducible
    >>> abs(4*approx_pi(1000) - pi) < 10e-2
    True

    >>> abs(4*approx_pi(100000) - pi) < abs(approx_pi(1000) - pi)
    True
    """
    assert tries > 0
    within_circle = 0
    for i in range (0, tries):
        x = random() # range [0,1)
        y = random()
        if x**2 + y**2 < 1:
            within_circle += 1
    return within_circle / tries
```


Example

It's easy to extend to make this work for any function on $[0, 1)$.

```
from random import random
from collections.abc import Callable

def approx_fun(predicate: Callable[[float, float], bool], tries:
↪  int) -> float:
    """Return an approximation for pi.

    >>> from math import pi
    >>> from random import seed
    >>> seed(7897)  # Tests should be reproducible
    >>> within_circle = lambda x, y: x**2 + y**2 < 1
    >>> abs(4*approx_fun(within_circle, 1000) - pi) < 10e-2
    True
    """
    assert tries > 0
    true_cases = 0
    for i in range (0, tries):
        x = random() # range [0,1)
        y = random()
        if predicate(x, y):
            true_cases += 1
    return true_cases / tries
```


Simulations

Random number are useful also for *simulation*: for example, we could simulate evolutionary drift.

```
from random import seed, randint, getstate, setstate

class DriftSimulation:
    def __init__(self, sim_seed: int = 232943) -> None:
        self.population = ['\N{MONKEY}', '\N{TIGER}', '\N{BUTTERFLY}', '\N{LIZARD}',
        ↪  '\N{SNAIL}']
        seed(sim_seed)
        self.r_state = getstate()

    def offspring(self) -> None:
        setstate(self.r_state)
        new = self.population[randint(0, len(self.population)-1)]
        self.population[randint(0, len(self.population)-1)] = new
        self.r_state = getstate()

    def simulate(self, generations: int) -> None:
        for i in range(0, generations):
            self.offspring()

a = DriftSimulation()
b = DriftSimulation()
a.simulate(2)
b.simulate(2)
```