

Module 4 Critical Thinking: List Based Stack

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This assignment designs and implements an experiment for the performance of stack and queue based on Python list and linked list. It implements the stack and queue data structures using both Python list and linked list, and uses simulation as well as a unit test to compare the performance. The stack and queue data structures are also discussed.

Performance experiment

This assignment uses the following simulation algorithm to test the runtime. The simulation requires the number of iterations and the number of sample size as inputs. For each iteration, it performs the push and pop operations, and records the runtime. The runtime is recorded *sampleSize* times and its sample mean is calculated. It is repeated many time and then statistics like mean and standard deviation is calculated from the sample of the sample mean. This simulation is based on sampling method and central limit theorem (Casella and Berger 2002).

Algorithm.

```

1. Function simulationStackQueue(s, iterSize, sampleSize, lengthExperiment):
2.     SampleMean <- [None]*iterSize
3.     for i in 1 to iterSize DO:
4.         timeSample <- [None]*sampleSize
5.         for j in 1 to sampleSize DO:
6.             start <- time.time()
7.             for k in 1 to lengthExperiment DO:
8.                 s.push(random.random()*5000)
9.                 for k in 1 to lengthExperiment DO:
10.                    s.pop()
11.                    timeSample[j] <- time.time() - start
12.            SampleMean[i] <- statistics.mean(timeSample)
13.    Calculate statistics (mean, standard deviation, ...)
```

One of the core operations of stack and queue is how to retrieve data. The difference in stack and queue is which one is first out: last-in or first-in. Stack and Queue can be constructed with several ways including Python list. The list methods make it very easy to use a list as a stack (Python Documentation 2022: 5. Data Structures). The code for linked list is a slightly revised one of Lysecky and Vahid (2019).

Conclusions

This assignment designs and implements a simulation-based experiment to compare stack and queue based on Python list and linked list. The simulation results show the average runtime with mean and standard deviation. A unit test is also provided.

References

- Casella, G. and Berger, R. L. (2002). *Statistical inference*. Belmont, CA: Duxbury.
- Lysecky, R. and Vahid, F. (2019). Design and analysis of algorithms. In Lysecky, R. and Vahid, F., editors, *Data structures essential: Pseudocode with python examples*. Zybooks.
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