EBERHARD KARLS
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Modellierung & Simulation I
WS 2018/2019
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Exercise 4

5. November 2018

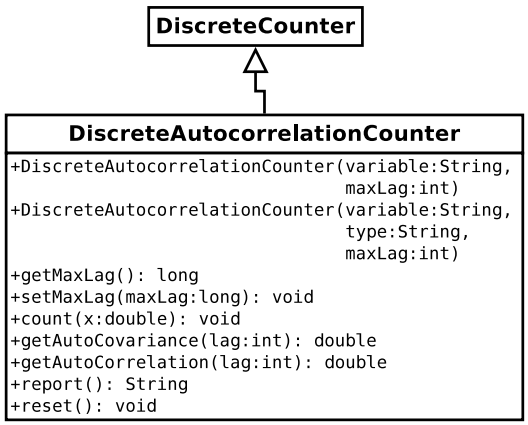
Abgabe: 12. November 2018, 12:00:00 Uhr

Briefly discuss your findings. Results without an explanation will not be assessed!

Problem 4.1: *Statistical counters for correlations*

Within this problem, counters for calculating the autocovariance and autocorrelation function for a series of discrete samples (see Chapter 5 in the course syllabus) will be implemented. Please download the sourcecode `exc4_sourcecode.zip` from Moodle and use it as basis for your own implementation!

1. Derive a subclass *DiscreteAutocorrelationCounter* of *DiscreteCounter* in *simulation.lib.counter* to implement the autocovariance and autocorrelation calculation functions according to the following UML class diagram: 35 Points



   The class methods *getAutoCovariance* and *getAutoCorrelation* for lags up to *maxLag* should be implemented according to Section 5.6 in the course syllabus. The class methods *count* and *reset* should be implemented to work as depicted in the documentation of the superclass. The function *report* should output the autocovariance and autocorrelation functions for each lag up to *maxLag*.

   The UML class diagram above does not show class attributes. To implement the desired functionality, you need to define appropriate data structures.

2. Provide a simple test for your implementation in *study.AutocorrelationTest*. Produce six adequate sample series for a simple validation of your implementation and briefly discuss the results!
   - 2, 2, 2, 2, 2, ...
   - 2, 2, -2, 2, 2, -2, ...

10 Points

Problem 4.2: *Use of random variables and autocorrelation counters in simulations*

In this problem, we extend the simulation of the $GI/GI/1-\infty$ queuing system of Problem 2.2 by introducing stochastic random variables. All modifications need to be done in the classes *simulation.lib.Simulator* and *study.SimulationStudy*! The relevant gaps in the sourcecode are marked with TODO tags.

1. Extend the sample simulation study (*study.SimulationStudy*) modelling an $GI/GI/1-\infty$ queuing system to simulate an $M/M/1-\infty$ queueing system. Introduce Exponential random variables (substituting the constant time in Problem 2.2) for modelling the interarrival time and service time of customers! 15 Points

2. Use a mean inter-arrival time of 1 s. Now adjust the mean of the random variable modelling the service time so that the mean utilization of the system is 80%. What is the required mean of the service time? 5 Points

3. Use the counters in *SimulationStudy* to measure the mean waiting time for the first $10^{\{1,5\}}$ customers! Explain the differences! 10 Points

4. Print a simple histogram of the waiting time of all customers and explain the results! 10 Points

5. Introduce a counter to output the autocorrelation functions for the lags 1 to 20 for the waiting time! Now change the system utilization from 80% to 95% and explain its effect on the autocorrelation functions! 15 Points

Total: 100 Points