Strengthen the Programming Practice of Applying Stochastic Process and the Design of Teaching Examples

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Abstract：This paper points out the problems in the application of stochastic process teaching, changes the teaching mode based on computational thinking, strengthens the application of stochastic process programming practice, and highlights the case teaching of expertise integration, which has achieved better results.

Keywords：Application of Stochastic Process; Programming Practice; Markov Chain

Applied stochastic process is a professional elective course for computer majors. It has the characteristics of high abstraction, strong theory and logic. There are many basic concepts, theorems and proofs in the course. These factors make students feel that the learning of applied stochastic process course is difficult and dull. In order to teach this course well, enhance students' participation and exercise their practical ability, we have made some curriculum teaching reform. That is, some exercises are designed as programming questions and put on the online evaluation platform. Students log in to the platform to submit codes, and the system will automatically give test scores. The scores will be different according to the degree of solution. The advantage of this is that students should transform theoretical knowledge into the ability to solve practical problems. They should not only model and deduce, but also realize it through programming, so as to achieve the purpose of exercising their practical ability.

1. Problems in teaching

(1) The teaching time is not enough, and the practical application of applied stochastic process can not be taught in depth in combination with the knowledge points, which makes it difficult for students to understand the relationship between the knowledge points of applied stochastic process and the major in learning, but only mechanically learn the abstract theoretical knowledge.

(2) The application of random process contains miscellaneous contents, many concepts, many formula symbols, strong theory, relatively abstract and boring contents, and students' learning enthusiasm is reduced.

(3) It is divorced from the cultivation of practical ability, especially programming ability. The application of stochastic process has no computer class and programming practice, so it leads to the disconnection between theory and practice. The theoretical knowledge in the course is difficult to understand. If it is not applied to practice, it will make the mastery of theoretical knowledge not firm, which is not conducive to cultivating students' practical ability.

2. Teaching reform of applied stochastic process

Change the teaching mode based oncomputational thinking, strengthen the application of stochastic process programming practice, and highlight the case teaching of expertise integration. Programming ability is an important indicator of the professional ability of computer students, which needs to be continuously strengthened in all stages of the university. Therefore, the course teaching of applying random process and the training of programming ability can be organically combined to cultivate students' programming ability, and make students feel the immediate application effect of knowledge.

First of all, we revised the syllabus, added 8 class hours of computer experiment class on the basis of theoretical class hours, and arranged 4 computer experiments, 2 class hours each time. The four computer experiments correspond to: Markov chain, Poisson process, Brownian motion and comprehensive test. Each experiment usually has two questions, which are released to Luogu. During class, students do questions and submit codes on Luogu platform.

In this case, it is necessary to reasonably design the application stochastic process programming problem with moderate difficulty. For example, Markov chain, Poisson process and Brownian motion have many application scenarios, which can be realized through programming, so these knowledge points can let students practice programming. This process not only strengthens the cultivation of students' programming ability, but also enhances the intuition and interest of theoretical knowledge.

Many contents of applying stochastic process can understand knowledge points and algorithm ideas through programming practice. Combined with the programming practice of practical problems, it can not only train students' programming ability, but also cultivate students' ability to solve professional problems.

Before learning to apply random processes, students have learned C, Java or Python in class. The diversity and rapid development of programming language make it impossible to teach all development languages in class. Therefore, self-study of programming language is very important. In this course, the programming language is not limited. Students are encouraged to complete practice in unfamiliar new languages, which is also conducive to cultivating students' self-study ability.

3. Teaching examples

The following takes an application of Markov chain as an example.

Title Description: at the beginning, people A has a yuan and people B has b yuan. They conduct a series of gambling. The loser gives the winner one yuan. There is no draw until one of them loses. Because of their different technical levels, the probability of winning is not necessarily equal. We believe that in each game, the probability of a winning is p and the probability of losing is 1-p. Find the probability of nail losing light.

Input format: two positive integers a and b in one line, and a real number P with precision no more than 10^{-5}, representing the same meaning as the question surface.

Output format: a real number q per line, indicating the probability of light transmission by A.

Data range:

For 36% of data, $1 \leqslant a, b \leqslant 10$.

For 63% of data, $1 \leqslant a, b \leqslant 300$.

For 90% of data, $1 \leqslant a, b \leqslant 3 \times 10^6$.

For 100% data, $1 \leqslant a, b \leqslant 10^{13}$, $0 \leqslant P \leqslant 1$.

For 18% of the data, it meets the special properties: $P = 0.5$.

Note: in order to avoid the precision error of floating-point number calculation, the answer with the standard answer error of no more than 10^{-3} is accepted. Please keep at least 4 decimal places for output.

This is a gambler bankruptcy problem, that is, the two absorption wall random walk model, a typical Markov chain. We construct data according to the positive solution and submit it to the evaluation platform on the valley line. It supports many languages, including C, C＋＋, C#, Python, Java, Go, PHP, Rust and so on.

Of course, there are other solutions to this problem, such as direct simulation and thecombination of deriving some conclusions with simulation, but these two solutions can only get approximate solutions. Therefore, this factor will be considered in the design of the problem, which will have certain restrictions on time and space, have high requirements for the accuracy of the results, and the simulation method can only get some scores. In order to get full marks, students must keep trying and finally find the correct solution.

4. Effect

The benefits of such reform:

(1) Exercise the ability to analyze and solve problems;

(2) Training practical practical ability is of great benefit to job hunting;

(3) Breaking the boundaries of the classroom, students can use extra-curricular time for training;

(4) The mastery of theory is more profound through practice.

In the first computer experiment, even if it is a very simple topic, there are only individual students with AC, but in the subsequent experiments, the AC rate continues to improve. In the last comprehensive test, there are two students with AK, and the

progress of students' practical ability is very obvious. And a few students began to take the initiative to use the evaluation platform for self-training.

In terms of the training objectives of computer majors, cultivating students' programming ability is the basic requirement, which needs to be emphasized and exercised in various courses. Many knowledge points of this course can be combined with theory and practice. If the programming practice is assisted, it will not only enable students to understand and digest knowledge points from a professional perspective, but also exercise students' programming ability.

The code as follows:

```
# include< bits/stdc+ + .h>
using namespace std;
# define lld long double
# define ll long long
constlldeps= 1e-6;
lldp,q,sum,ans;
llda,b;
inteq(llda,lld b){
return (a-eps< = b&&a+ eps> = b);
}
lldqpow(llda,ll b){
if(eq(a,0.0)) return 0.0;
lldans= 1.0;
while(b){
if(b&1) ans= ans* a;
a= a* a,b> > = 1;
}
returnans;
}
int main(){
scanf("% Lf% Lf% Lf",&a,&b,&p);
sum= a+ b,q= 1.0-p;
if(eq(p,0.5)) ans= a/sum;
elseans= (1.0-qpow(q/p,a))/(1.0-qpow(q/p,sum));
printf("% .5Lf",1.00-ans);
return 0;
}
```

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