东北大学秦皇岛分校本科课程教学大纲

一、课程基本信息

<table>
<tr><td>开课单位</td><td colspan="3">悉尼智能科技学院</td><td>课程代码</td><td colspan="5">3100312004</td></tr>
<tr><td>中文名称</td><td colspan="8">概率论与随机变量</td></tr>
<tr><td>英文名称</td><td colspan="8">Probability and Random Variables</td></tr>
<tr><td>总学时</td><td>56</td><td rowspan="2">理论学时</td><td rowspan="2">56</td><td rowspan="2">实验学时</td><td rowspan="2">0</td><td rowspan="2">上机学时</td><td rowspan="2">0</td><td rowspan="2">设计学时</td><td rowspan="2">0</td><td rowspan="2">课外学时</td><td rowspan="2">0</td></tr>
<tr><td>学　分</td><td>3</td></tr>
<tr><td>课程类型</td><td colspan="8">☑理论课程　☐理论（含实验）课程　☐实践类课程</td></tr>
<tr><td>课程类别</td><td colspan="8">☐通识类　☐学科基础类　☑专业方向类　☐实践类</td></tr>
<tr><td>适用专业</td><td colspan="8">应用统计学</td></tr>
<tr><td>先修课程</td><td colspan="8">数学分析与建模、线性代数</td></tr>
<tr><td>建议开课学期</td><td colspan="8">☐1-1 ☐1-2 ☑2-1 ☐2-2 ☐3-1 ☐3-2
☐4-1 ☐4-2 ☐5-1 ☐5-2 ☐*（代表每学期都开设）</td></tr>
<tr><td>考核方式</td><td colspan="3">☑考试 ☐考查</td><td>成绩分制</td><td colspan="4">☑百分制 ☐五级制 ☐二级制</td></tr>
<tr><td>使用教材</td><td colspan="8">1、Geffrey Grimmett, Dominic Welsh, Probability An Introduction, Oxford, 2014</td></tr>
<tr><td>参考书及教学资源</td><td colspan="8">1、魏宗舒等，《概率论与数理统计教程》，高等教育出版社，2020（第三版）
2、盛骤、谢式千、潘承毅，《概率论及数理统计》，高等教育出版社，2019（第五版）
3、茆诗松、程依明、濮晓龙，《概率论与数理统计教程》，高等教育出版社，2019 （第三版）
4、Leonid B.Koralov, 《Theory of probability and random variables》，世界图书出版社出版, 2012（第二版）</td></tr>
<tr><td>其他说明</td><td colspan="8">无</td></tr>
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二、课程简介

中文描述

本课程为应用统计学的专业基础课。在模拟现实世界的问题时，我们需要处理不确定性，而概率则是量化和模拟不确定性的有效方法。本科目介绍概率的概念，如从属事件和独立事件以及条件概率。还介绍了用分布模拟随机事件的思想，包括独立事件的概率计算、期望、方差、生成函数和随机过程。最后，本课将讨论离散马尔可夫链。

English Description

This course is a specialised foundation course in applied statistics. When modelling real-world problems, we need to deal with uncertainty, and probability provides an effective way to quantify and model uncertainty. This subject introduces concepts in probability such as dependent and independent events as well as conditional probability. The idea of modelling random events with distributions is introduced, including probability calculation, expectation, variance, generating functions and stochastic processes. The subject concludes by considering discrete Markov chains.

三、课程目标

1、知识目标：

1-1：了解确定性与随机性事件；理解随机试验，概率的定义，韦恩图；掌握条件概率，互斥，简单集合理论和德摩根定律，贝叶斯定理。

1-2：了解累积概率函数；理解离散随机变量的概念和性质；掌握概率质量函数，期望和方差。

1-3：掌握伯努利分布、二项式分布和几何分布， 卷积。

1-4：了解指数分布及其与泊松分布的关系；掌握条件分布和条件期望、随机变量的函数。

1-5： 掌握泊松分布，泊松过程，生成函数，随机变量之和。

1-6： 理解马尔可夫链的分类，马尔可夫链：稳态分布和状态图；掌握马尔可夫链的定义、马尔可夫链的性质、简单随机游走、瓮模型、随机游走的通过时间、遗传漂移。

2、能力目标：

2-1：理解、掌握和证明有关概率和随机变量研究的主要观点和结果。

2-2：应用概率和随机变量的概念解决简单问题，适当时使用计算技能。

2-3：利用图书馆和其他资料来源，查找和研究现实世界中有关随机实验（资产价格、 体育比赛成绩、选举结果）观察结果的实例。

2-4：适当结合公式和专业术语来解释问题的解决方案。

3、德育/素养目标：

3-1：培养学生的逆向思维能力、逻辑推理能力以及创新实践能力。

3-2：培养学生树立诚实守信的道德品质，弘扬社会主义核心价值观。

3-3：培养探求科学真理的责任感和使命感，增强学生的安全意识。

表 1 课程目标与毕业要求的对应关系

毕业要求	指标点	课程目标	关联 (H/M/L)
1、理学知识：具有扎实的数学基础，能够将数学、自然科学和专业知识用于解决复杂实际问题。	指标点 1-2：掌握统计调查、统计数据处理、统计分析、计算机与统计软件使用等应用统计学的基本理论、知识与方法，具备采集、处理、分析数据的能力，熟悉预研报告、可行性分析报告、研究方案等文档的撰写规范；	1-1 至 1-6；2-1、2-2、3-1	H
2、问题分析：能够借助应用统计学的基本原理、方法和手段，识别、表达、并通过文献研究分析复杂实际问题，以获得有效结论。	指标点 2-1：能够借助应用统计学的基本原理、方法和手段，分析、识别、表达本专业相关的复杂实际问题；	1-1 至 1-7；2-1 至 2-4；3-1 至 3-3	H
	指标点 2-2：能够应用数学、自然科学和工程科学的基本原理、方法和手段，针对实际复杂工程问题设计针对性的技术方案，并综合运用文献、科学理论和技术手段予以解决	1-1 至 1-7；2-1 至 2-4；3-1 至 3-3	M

四、主要教学内容

（一）理论教学

第 1 章： Random events and probability（支撑教学目标 1-1、2-1、2-2、2-3、3-1、3-2）

【1】知识点：

(1) Random experiments

(2) Definition of probability

(3) Mutual exclusivity

(4) Venn diagrams

(5) Conditional probability

(6) Simple set theory and de Morgan's laws

(7) Bayes Theorem

【2】学习目标：

理解：Random experiments; definition of probability; Venn diagrams.

掌握：Mutual exclusivity; conditional probability; simple set theory and de Morgan's laws; Bayes Theorem.

【3】重点内容：

(1) Random experiments

(2) Definition of probability

(3) Conditional probability

(4) Bayes Theorem

【4】难点内容：

(1) Conditional probability

(2) Mutual exclusivity

(3) Bayes Theorem

【5】思政案例：

There are m white balls and n black balls in the bag, do not put back the sample, each time to take a ball, find the probability that the kth time exactly to take the white ball? Through the fact that the draw has nothing to do with the order of students to inherit and carry forward the traditional virtues of the Chinese people, humility and friendliness, to build a harmonious society.

第 2 章： Discrete random variables （支撑教学目标 1-2、1-3、2-1、2-2、2-3、2-4、3-1、3-2、3-3）

【1】知识点：

(1) Discrete random variables

(2) Bernoulli, Binomial and Geometric distributions

(3) Probability mass functions

(4) Cumulative probability functions

(5) Expectation and variance

【2】学习目标：

理解：Discrete random variables; Cumulative probability functions.

掌握： Bernoulli, Binomial and Geometric distributions; probability mass functions, expectation and variance.

【3】重点内容：

(1) Bernoulli, Binomial and Geometric distributions

(2) Probability mass functions

(3) Cumulative probability functions

(4) Expectation and variance

【4】难点内容：

(1) Cumulative probability functions

(2) Probability mass functions

【5】思政案例：

Explain the case of 'A drop of water penetrates a stone' from the point of view of probability, or explain the following case. If the probability of *A* occurring in a given trial is *p*, no matter how small *p* may be, then if the trial is repeated independently, then A must occur once, and thus any number of times, sooner or later. The principle of small probability event tells us: although the probability of small events in a trial almost will not happen, but as the number of trials continue to increase, it will eventually happen. Through the small probability event, the image embodies the dialectical relationship between quantitative and qualitative changes. The accumulation of quantity causes qualitative change. We do things, we have to pay attention to the proportion, to maintain the principle of moderation; the principle of small probability event tells us: do not take the good small, do not take the evil small; when we face setbacks, do not change the original intention; even if the success of the difficult, as long as perseverance, will be successful.

第 3 章：Continuous random variables（支撑教学目标 1-4、1-5、2-1、2-2、2-3、2-4、3-1、3-2、3-3）

【1】知识点：

(1) Probability density functions

(2) Uniform distributions, exponential distributions and normal distributions

(3) Distributions of functions of random variables

(4) Properties of expectations

(5) Conditional expectation and variance

【2】学习目标：

理解：Uniform distributions, exponential distributions and normal distributions

掌握：Probability density functions, distributions of functions of random variables, properties of expectations, conditional expectation and variance

【3】重点内容：

(1) Probability density functions

(2) Distributions of functions of random variables
(3) Properties of expectations

【4】难点内容：

(1) Probability density functions

(2) Distributions of functions of random variables
(3) Conditional expectation and variance

第 4 章： Poisson Processes（支撑教学目标 1-5、2-1、2-2、2-3、2-4、3-1、3-2、3-3）

【1】知识点：

(1) Poisson distribution

(2) Poisson Processes

(3) Exponential distribution and its relation to Poisson distribution
(4) Generating functions
(5) Sums of random variables

【2】学习目标：

理解：Exponential distribution and its relation to Poisson distribution.
掌握：Poisson distribution; Poisson Processes; Generating functions; Sums of random variables.

【3】重点内容：

(1) Poisson distribution

(2) Poisson Processes
(3) Generating functions
(4) Sums of random variables

【4】难点内容：

(1) Poisson Processes

(2) Generating functions
(3) Sums of random variables

【5】思政案例：

If a country with only a few export commodities at the beginning of its economic development, and over time the country's range of export commodities grows, creating a “Poisson process”. This example shows how the Poisson process can be used to explain globalization and international trade. By combining abstract mathematical concepts with practical economic problems, we can help students better understand the application and significance of these concepts in practice. At the same time, we can also guide students to think about deeper issues, such as how the country can cope with the challenges and opportunities brought about by globalization.

第 5 章： Markov Chains（支撑教学目标 1-6、2-1、2-2、2-3、2-4、3-1、3-2、3-3）

【1】知识点：

(1) Definition of Markov Chains

(2) Classification of Markov Chains

(3) Properties of Markov chains

(4) Simple random walks

(5) Markov chains: steady-state distributions and state diagrams

(6) Urn models

(7) Passage times for random walks

(8) Genetic drift

【2】学习目标：

理解：Classification of Markov Chains, Markov chains: steady-state distributions and state diagrams.

掌握：Definition of Markov Chains, properties of Markov chains, simple random walks, urn models, passage times for random walks, genetic drift.

【3】重点内容：

(1) Definition of Markov Chains

(2) Properties of Markov chains

(3) Simple random walks

(4) Urn models

(5) Passage times for random walks

(6) Genetic drift

【4】难点内容：

(1) Definition of Markov Chains

(2) Simple random walks

(3) Urn models

(4) Passage times for random walks

【5】思政案例：

Through the cases of “Urn models” and “Genetic drift”, students can have a deeper understanding of history through analyses and discussions, so as to form a correct outlook on history and values, thus enhancing patriotic passion.

五、教学安排与学时分配

This course is based on classroom instruction. Classroom teaching revolves around the basic concepts, basic theories and practical applications of this course. The course is centered on the fundamental task of establishing moral education, with the overall goal of cultivating socialist builders and successors with all-round development in morality, intelligence, physicality, aesthetics and aesthetics, and focuses on the transmission of knowledge in probability theory and stochastic process, solidifying basic knowledge, enhancing practical skills and innovative spirit, and establishing a correct outlook on

life, the world view and values. The allocation of credit hours is shown in Table 3.

表 3 学时分配表

讲 课 内 容		学时				
		讲课	实验	上机	设计	课外
第 1 章	Random events and probability	10	0	0	0	0
第 2 章	Discrete random variables	10	0	0	0	0
第 3 章	Continuous random variables	10	0	0	0	0
第 4 章	Poisson Processes	10	0	0	0	0
第 5 章	Markov Chains	16	0	0	0	0
小计		56	0	0	0	0
总计	56					

六、教学方法

1、Teaching basic concepts and principles, linking theory to practice, linking what is taught to the professional knowledge students have learned, and cultivating students' innovative ability.

2、The use of multimedia courseware, network teaching and traditional teaching combined with teaching methods, network Q&A and traditional Q&A combined with Q&A, improve classroom vitality and Q&A ability.

3、The combination of theoretical teaching and discussion forms to mobilize students‘ learning enthusiasm and cultivate students’ self-learning ability, teamwork ability and ability to solve practical problems.

七、成绩评定

1、Attendance: 20% of the total grade. All parts of this course require students to participate and sign in, no absence.

2、Classwork and after-class assignments: 30% of the total grade. Students who are missing more than 1/3 of the required homework, or who are missing more than 1/3 of the planned class hours, will be disqualified from the course assessment.

3、End-of-course examination: the end-of-course examination accounts for 50% of the total grade.

八、评价及持续改进

1、考核周期：4 年，修订周期：4 年。

改进措施：课程负责人组织课程团队所有教师讨论后提出改进意见，经教研室主任审核后由教学院长批准。

Assessment cycle: 4 years, revision cycle: 4 years.

Improvement measures: the subject coordinator shall be responsible for the syllabus discussion and improvement, and the revised version shall be submitted to deputy dean (teaching affairs) for reviewing then to executive dean for approval

2、成绩评定考核

考核周期：1 学年，评价依据：学生最终成绩综合分析。

改进措施：根据学生最终成绩的分布，进行相应的内容调整和优化，并改进教学方法。

Assessment cycle: 1 academic year. Evaluation basis: comprehensive analysis of students' final grades.

Improvement measures: the subject coordinator shall revise the syllabus based on the teaching content, effect and result distribution while optimize the assessment measures.

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