Government of the Russian Federation

Federal State Autonomous Educational Institution of Higher Professional Education
National Research University
“Higher School of Economics”

Faculty of Philosophy

Syllabus of the discipline Logic
(Section II: Inductive and Probability Logic)

for the Bachelor’s Program 47.03.01 - Philosophy

The course is read in English

Authors: *Makeeva L.B., doctor of philosophical sciences, professor*
lmakeeva@hse.ru

Approved by School of Philosophy
«___»_____ 2016
Head of the School *Porus V.N.*_____

Affirmed by the Academic Council of Bachelor’s Program ‘Philosophy’
«___»_____ 2016, record of proceedings No. _____
Academic Head of Bachelor’s Program ‘Philosophy’
Dragalina-Chernaya E.G. _____

Moscow, 2016

Title of the Course: **LOGIC (SECTION II: INDUCTIVE AND PROBABILITY LOGIC)**

Course type: compulsory

Lecturer and class teacher: Prof. L.B. Makeeva

Course description: Inductive and Probability Logic is a two-module course for philosophy students in their second year of learning. The course is a part of the general course on Logic and aims at acquainting students with the approaches to constructing Inductive logic and with some important philosophical issues surrounding the theoretical foundations of induction and probability. Special attention will be paid to the significance of Inductive logic for such philosophical disciplines as philosophy of science, epistemology and philosophical logic.

Course prerequisites: Students are required to be acquainted with Aristotelian, Propositional and Predicate Logics and have some knowledge of the mathematical theory of probability.

Learning Objectives: The course is aimed at introducing students to the basic concepts and tenets of Inductive and Probability Logics. It will enable students to:

- develop their skills of critical thinking and argumentative discourse;
- enhance their logical culture;
- recognize and identify logical fallacies and errors;
- understand the significance of logic for scientific and philosophical thinking;
- get acquainted with philosophical problems concerning induction and probability.

Learning outcomes: By the end of the course the students who pass the final exam will know

– the differences between deductive and inductive inferences;

– the key concepts of inductive logic, the criteria of strength and the main forms of inductive reasoning;

– the basic rules of the probability calculus and how to use them to calculate probabilities of some inductive inferences;

– the main philosophical accounts of the nature of induction and probability.

Course Plan:

The structure of the course is the following:

No	Topic titles	Total (hours)	Contact hours		Self-study
			Lectures	Classes	
Part 1. The Basics of Inductive Logic					
1.	The subject of inductive Logic	10	2	2	6
2.	Kinds of inductive arguments	20	4	4	12

3.	The problem of induction	14	2	2	10
4.	J.S. Mill's methods of experimental inquiry	14	2	2	10
Part 2. The basic ideas of probability and their application to inductive reasoning					
5.	Kinds of probability	10	2	2	6
6.	The probability calculus	18	4	4	10
7.	The main interpretations of probability and their application in the construction of probability logic	28	6	6	16
	Total:	114	22	22	70

The course will cover the following topics.

Part I. **The Basics of Inductive Logic**.

Topic 1. **The Subject of Inductive Logic**

The main stages in the development of inductive logic, its contemporary condition.

Reasoning as a truth-preserving process. An argument and its logical structure. Deductive and inductive arguments. Main features of correct deductive argument (the relation of entailment, validity, logical necessity of inference, demonstrative character). The criterion of valid deductive arguments. Sound arguments.

Main features of inductive argument (evidential link between premises and conclusion, the logical relation of probability, problematic, risky character of inference, inference from the known to the unknown). The criterion of strength of inductive arguments. Cogent arguments.

The relationship between deductive and inductive arguments. Inadequacy of the traditional definition of deductive arguments as inferences from the general to the specific and of inductive arguments as inferences from the specific to the general. Inductive arguments as a kind of invalid deductive arguments. Enthymematic character of some real deductive reasoning and the problem of demonstrative induction.

Two main approaches to constructing inductive logic based on the notions of demonstrative induction and probability.

Topic 2. **Kinds of Inductive Arguments**

The ideas of induction in Aristotle's logical works. Inductive generalization. Complete (perfect) and incomplete (imperfect, ampliative) induction. Universal and statistical generalization. Types of statistical inferences: from sample to population, from population to sample, from sample to sample. Fallacy of incomplete evidence. Representative and biased samples. Randomness and size of a sample. Statistical syllogism.

Predictive induction as an inference from past to future. Predictive and generalizing induction.

F. Bacon on the difference between enumerative and eliminative induction. Bacon's criticism of syllogistic logic. Eliminative induction as a way of discovering causal links between phenomena. Bacon's tables of absence, of presence and of degrees as the first attempt to formulate methods of experimental research. Scientific and popular induction. Fallacy of hasty generalization.

Induction and analogy. Kinds of analogical arguments, their logical structure and functions. Strong and weak features of analogical arguments. Analogy as an element of any inductive inference.

Ch. Peirce on deduction, induction and abduction (inference to a plausible explanation). The Logical structure of abduction. The role of abduction in theoretical explanations.

Arguments based on testimony.

Induction as scientific method. Induction as a method of discovery and justification in classical inductivism (F. Bacon, J.S. Mill, etc.). Induction as a method of confirmation in the hypothetico-deductive model of scientific cognition (G. Galileo, G. Leibniz). Induction as the converse of deduction(S. Jevons). K. Popper's anti-inductivism.

Topic 3. **The Problem of Induction**

D. Hume on the impossibility of rational justification of reasoning from experience. The structure of Hume's argument. The impossibility of inductive logic as a consequence of Hume's skeptical argument. Hume's psychological justification of induction.

Main ways of justifying induction. The principle of uniformity of nature. B. Russell's principle of induction. The inductive justification of induction (R. Braithwaite, M. Black). The pragmatist justification of induction (H. Reichenbach). The analytic justification of induction (P. Strawson). K. Popper's anti-inductivism as a 'solution' of Hume's problem.

Paradoxes of confirmation as a new manifestation of Hume's problem. C. Hempel's raven paradox. N. Goodman’s new riddle of induction.

Topic 4. **Mill’s Methods of Experimental Inquiry**

The notion of causality. Cause and effect. Kinds of causes. The principles of causality (objectivity, universality, necessity and precedence of a cause in time). Mill's method of agreement, method of difference, joint method of agreement and difference, method of concomitant variation and method of residues. The problematic character of inferences based on Mill's methods, the sources of their problematic character.

Causation and the logic of necessary and sufficient conditions: cause as a necessary condition, cause as a sufficient condition, cause as a necessary and sufficient condition. Logical links between necessary and sufficient conditions.

G.H. von Wright's theoretical reconstruction of the methods of experimental inquiry. Possible conditioning properties and conditioned properties. Simple and complex conditioning properties. The direct method of agreement (for necessary conditions). The Inverse method of agreement (for sufficient conditions). The method of difference. The double method of agreement. The joint method of agreement and difference. The application of methods of experimental inquiry.

Part II. **The Basic Ideas of Probability and Their Application to Inductive Reasoning**

Topic 5. **Kinds of Probability**

The notion of probability and its interpretations. Empirical (descriptive) probability. Main features of statements concerning empirical probability. Epistemic probability. Main features of statements concerning epistemic probability. The relation between epistemic and inductive probability: inductive probability as a way of objective evaluation of epistemic probability. Main characteristics of inductive probability.

Topic 6. **The Probability Calculus**

The notion of calculus. Axiomatization of probability theory.

The main rules and definitions of the probability calculus for categorical statements. The concepts of conditional probability and independence of statements. The main rules and definitions of the probability calculus for conditional statements.

Bayes' theorem and its significance for Inductive logic. Bayes' theorem as an idea of learning from experience. Probability and causality.

Topic 7. **The Main Interpretations of Probability and Their Application in the Construction of Probability Logic**

The classical interpretation of probability. The notion of prior probability. Probability of an event as the ratio of the number of cases favorable to it, to the number of all cases possible.

The principle of equipossibility. The principle of indifference (insufficient reason). Bertrand's paradoxes.

The frequency interpretation of probability. The notion of posteriori probability. Probability as relative frequency. Probability as the limit of relative frequency. Statistical stability. Laws of large numbers. The difficulties of frequency interpretation of probability. G. Reichenbach's probability logic.

The personal (subjective) interpretation of probability. Probability as a degree of belief. Probabilities and betting rates. Fair bets and Dutch book. The principle of coherence. Bayes' theorem as a way of overcoming the subjectivism of personal probabilities. Bayesism as a new approach to philosophy of science.

The logical interpretation of probability. Probability as an objective relation between propositions (J.M. Keynes). Probability as a degree of confirmation of a hypothesis by empirical data. R. Carnap's probability logic, its key notions: state description, structure description, degree of confirmation (c-function), measure of a proposition. Two ways of defining the measure of a state description.

Reading list:

(a) *Required reading*

1. Skyrms B. Choice and Chance. An Introduction to Inductive Logic. 4th Edition. Wadsworth, 2000;

2. Бочаров В.А., Маркин В.И. Введение в логику. М.: ИД «Форум»-ИНФРА-М, 2008;

3. Carnap R. Philosophical Foundations of Physics. N.Y., 1966;

4. Mill J.S. System of Logic, Ratiocinative and Inductive: Being a Connected View of the Principles of Evidence and the Methods of Scientific Investigation. Vol. 1. London: John W. Parker.

(b) *Optional reading*

1. Hume D. An Enquiry concerning Human Understanding. Oxford/New York: Oxford University Press, 1999;

2. Юм Д. Исследование о человеческом познании // Юм Д. Соч. в 2-х томах. Т. 2. М.: Мысль, 1996;

3. Hacking J. An Introduction to Probability and Inductive Logic. Cambridge: Cambridge University press, 2006;

4. Кайберг Г. Вероятность и индуктивная логика. Пер. с англ. Б.Л. Лихтенфельда. М.: Прогресс, 1978.

5. Пойа Д. Математика и правдоподобные рассуждения. Пер. с англ. И.А.Вайнштейна. М.: Наука, 1975;

5. Минто В. Дедуктивная и индуктивная логика. Пер. с англ. С.А.Котляревского. СПб: Комета, 1995;

6. Маковельский А.О. История логики. Жуковский-Москва: Кучково поле, 2004;

7. Russell B. The Problems of Philosophy. Wilder Publications, 2009;

8. Popper K. The Logic of Scientific Discovery. L.,1959;

9. Swinburne, Richard (ed.). Justification of Induction. Oxford: Oxford University Press, 1974;

10. Hacking I. Logic of Statistical Inference. Cambridge: Cambridge University Press,1965;

11. Hacking I. The emergence of probability: a Philosophical Study. Cambridge: Cambridge University Press, 1975;

12. Hempel C. Studies in the Logic of Confirmation // Mind. Vol. LIV. 1945, No. 213 ;

13. Nelson G. Fact, Fiction and Forecast. 4th ed. Cambridge: Harvard Univ. Press, 1983;

14. Howson C., Urbach P. Scientific Reasoning: The Bayesian Approach. 3rd edition, La Salle, IL: Open Court, 2005.

15. Ивин А.А. Логика. М.: Гардарики, 1999.

Themes for presentations in class

1. The Role of Analogy in Science and Philosophy
2. Analogy in Legal Reasoning
3. Bertrand Russell's Principle of Induction
4. John Stuart Mill's Criticism of Syllogistic Logic
5. John Stuart Mill's Method of Agreement
6. John Stuart Mill's Method of Difference
7. John Stuart Mill's Joint Method of Agreement and Difference
8. John Stuart Mill's Method of Concomitant Variations
9. John Stuart Mill's Method of Residues
10. Karl Popper's Anti-inductivism
11. Non-transitivity Paradoxes in Probability Theory
12. The Principle of Indifference and Its Paradoxical Consequences

Examination Questions

1. Deductive and Inductive Arguments, the Differences between Them. Deductive Validity and Inductive Strength.

2. Summative (Universal) Induction. Complete and Incomplete Induction.

3. Statistical Inductive Arguments, Their Types and Criteria of Evaluation.

4. Eliminative Induction.

5. Analogical Arguments, Their Structure and Criteria of Evaluation.

6. Abductive Arguments and Arguments Based on Testimony.

7. The Problem of Induction. The Negative and Positive Parts of Hume's Argument Concerning Induction.

8. The Inductive Justification of Induction (Richard Braithwaite and Max Black)

9. The Pragmatic Justification of Induction (Hans Reichenbach)

10. The Analytic Justification of Induction (Peter Strawson)

11. The Notion of Confirming Instance. The Equivalence Condition. Nicod's Criterion.

12. Hempel's Paradox.

13. Goodman's New Riddle of Induction.

14. J.S. Mill on the Notion of Cause as "the Root" of Theory of Induction. Mill's Method of Agreement.

15. Mill's Method of Difference and Joint Method of Agreement and Difference.

16. Mill's Methods of Concomitant Variation and Residues.

17. The Explication of the Notion of Cause in Terms of Necessary and Sufficient Conditions.

18. The Direct and Inverse Methods of Agreement in H.G. von Wright's Theoretical Reconstruction.

19. The Method of Difference in H.G. von Wright's Theoretical Reconstruction.

20. The Combined Methods of Experimental Inquiry in H.G. von Wright's Theoretical Reconstruction.

Exemplars of Exercises in Written in-Class *Test*

(A) Analyze the structure of the analogical argument in the following passage and evaluate its cogency in accordance with the main criteria.

"An electron is no more (and no less) hypothetical than a star. Nowadays we count electrons one by one in a Geiger counter, as we count the stars one by one on a photographic plate. In what sense can an electron be called more unobservable than a star? I am not sure whether I ought to say that I have seen an electron; but I have the same doubt whether I have seen a star. If I have seen one, I have seen the other. I have seen a small disc of light surrounded by diffraction rings which has not the least resemblance to what a star is supposed to be; but the name "star" is given to the object in the physical world which some hundreds years ago started a chain of causation which has resulted in the particular light-pattern. Similarly in a Wilson expansion chamber I have seen a trail not in the least resembling what an electron is supposed to be; but the name "electron" is given to the object in the physical world which has caused this trail to appear. How can it possibly be maintained that a hypothesis is introduced in one case and not in the other?" (Sir Arthur Eddington. New Pathways in Science).

(B) Identity the type of the following arguments.

1. Eighty-two percent of randomly chosen sample of 600 American college students are sleep-deprived. Therefore, approximately 82 percent of American college students are sleep-deprived.

2. Duodecimal Research Corporation polled the students and found that 46% are living below the official government poverty line. Therefore, the students at Memorial University cannot afford a major fee increase.

3. Since 1986, only 11% of engineering school graduates have been women. That showing is particular poor considering that in other formerly male-dominated fields there are signs of real progress. Some examples from 1986: law, 48%; commerce, 44%; medicine, 45%; and in the biological sciences, nearly 50% of the graduates are women.

4. Galvani was dissecting a dead frog. By chance, he touched the nerves of the frog's leg with an instrument that conveyed an electrical impulse. The frog's leg muscles contracted suddenly. Galvani touched the frog's nerves many times with the instrument, and each time the frog's leg muscles contracted sharply. Galvani then touched the frog's nerves with a metal instrument that did not convey an electrical impulse. The frog's leg did not contract. Galvani concluded than an electrical impulse had caused the dead frog's muscles to contract.

(C) Identify which of Mill's methods (in their original formulation) is (or are) used in each of the following examples.

1. Dick and Jane took a history exam. Both did poorly, although both studied for many hours the night before the exam. They concluded that the cause of their poor performance on the exam was a lack of sleep.

2. An economist noted a correlation between the length of women skirts and the price of stocks. As fashion trends moved in the direction of shorter skirts, stock prices increased. But as fashion trends moved in the direction of longer skirts, stock prices fell. The economist concluded that fashion trends regarding the length of women's skirts cause stock prices to rise and fall.

3. Pasteur gave each of 25 farm animals a vaccination for anthrax. These animals, as well as 25 who had not been vaccinated, were subsequently given a large dose of anthrax germs. No one of the vaccinated animals came down with the disease, but all of the others died of anthrax. Pasteur concluded that his vaccine produced immunity to anthrax.

(D) A company has bought three software packages to solve accounting problems. They are called *Fox*, *Star*, and *Rainbow*. On their first trials, *Fox* crashes 10 percent of the time, *Star* 20 percent of the time, and *Rainbow* 30 percent of the time. Of a hundred employees, sixty are assigned *Fox*, thirty are assigned *Star*, and ten are assigned *Rainbow*. Mary was assigned a program at random. It crashed on the first trial. What is the probability that she was assigned *Rainbow*?

Methods of Instruction:

The following forms of instruction are used in the course:

1. lectures (2 hours a week);

2. classes (2 hours a week);

3. written in-class test (2 hours);

4. presentations in class;

5. home assignments (11 in total);

6. self-study;

7. oral examination.

Grading system

Final grades will be calculated in accordance with the following formula:

$$G_{final} = 0{,}4 \cdot G_{exam} + 0{,}3 \cdot G_{current\ control} + 0{,}3 \cdot G_{class}$$

where G_{exam} – a grade for the oral examination;

$G_{current\ control}$ – a grade for the written in-class test ;

G_{class} – a grade for work in class and for home assignments.

The highest positive grade is 10, the lowest positive grade is 4.

Guidelines for Knowledge Assessment:

Home assignments consist of questions for discussion on a particular topic and exercises. In class students are expected to be prepared to discuss questions from home assignments. In most cases exercises from homework assignments should be done in a written form and handed in to the teacher. Presentations in class are not compulsory but they are encouraged: students who make presentations get a higher (by one point) degree for work in class. Written in-class work includes a theoretical question and three exercises. Self-study plays a very important part in the course.