The Applicability of Mathematics in Science

John Dougherty   WiSe 2021/2022

Meeting:	Fridays, 14:00–16:00 (c.t.)
	Ludwigstr. 31, Room 021
Office Hours:	Thursdays, 14:00–16:00 (c.t.)
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Overview

Description   Mathematics is a source of philosophical problems. Broadly speaking, these problems come from the tension between a picture on which knowledge of mathematics is certain and its objects abstract and a picture on which knowledge of the natural world is provisional and its objects concrete—a tension that arises because mathematics is used extensively and fruitfully in the exact sciences. This course is an introduction to the contemporary literature on this topic in its historical context. The first part of the course, running from Kant to Carnap, reviews the development of one strategy for explaining how the distinctive properties of mathematics could be compatible with its applicability to the world. Roughly speaking, this strategy attributes the necessary *a priori* nature of mathematics to facts about us—how our minds represent the world, or the structure of our conceptual scheme, or our conventions. The second part of the course looks at how the applicability problem was transformed in the general rejection of logical empiricism and the rise of holism, naturalism, and realism. In this new context, questions of applicability become questions about the nature of mathematical models and how they are used to represent the world. In the third and final part of the course we will discuss three topics in the contemporary literature on applicability: the role of analogical reasoning, whether mathematics is unreasonably effective in science, and whether mathematical models represent by "mapping" the structure of a physical situation.

Objectives   By the end of the course, you should be able to (i) formulate one or more philosophical problems that arise from the relationship between the natural and formal sciences and (ii) assess one or more strategies for solving these problems. Exhibiting ability (i) means giving a statement, in academic writing, of a question—or inconsistency, paradox, puzzle, or similar—along with an explanation of why it poses a problem for some particular philosophical tradition. Exhibiting ability (ii) means describing, again in academic writing, a new or existing attempt to answer this question and explaining why this is or is not a plausible answer.

Materials

All materials for this course will be posted to LSF.

Assessment

The evaluation for this course will be by means of a term paper submitted at the end of the semester. If you would like to submit a term paper, you must register through LSF during the registration period (17.01.2022–28.01.2022) and submit it to me by email by the term paper deadline (tbd). Please note that extensions of this deadline are not up to me; if you need an extension, please contact Corinna Triffo (Corinna.Triffo@lmu.de) at the Prüfungsamt für Geistes- und Sozialwissenschaften (PAGS).

Your paper should be on a topic related to the relationship between mathematics and the natural world. Near the end of the semester I will distribute a list of suggested questions and grading criteria. You may write your paper on topic not on that list; if you do, then I recommend speaking to me before writing the paper, so that I can advise on the topic and scope of your planned alternative. The term paper should be 3000 words for BA students and 6000 words for MA students. In either case, it should be written in 12pt font, with 1.5 spacing, 3cm margins on the left and right, and a standard academic typeface (e.g., Computer Modern, Times New Roman, Palatino, Calibri, etc.)

Resources

Questions about the administration of philosophy teaching at LMU should be directed to Thomas Wyrwich (thomas.wyrwich@lrz.uni-muenchen.de). The Erasmus coordinator for philosophy at LMU is Peter

Adamson (office.peter.adamson@lrz.uni-muenchen.de). The list of women's representatives (Frauenbeauftrage) for the Philosophy Faculty can be found on the Faculty's webpage (`https://www.philosophie.uni-muenchen.de/fakultaet/frauenbeauftragte/index.html`); the representatives for the MCMP are Silvia Jonas and Marianna Antonutti Marfori. Issues regarding the economic, social, and cultural aspects of student life—including studying with a child or studying with a disability—are the responsibility of the Munich Student Union (`https://www.studentenwerk-muenchen.de`).

Schedule and readings

Part I: From Kant to Carnap

22.10 Mathematics in Kant's critical philosophy

– §§6–13 of Kant, *Prolegomena to Any Future Metaphysics*

29.10 Measurement and real numbers:

– §§55–67, 138–147, and 156–164 of Frege, *Basic Laws of Arithmetic*

05.11 Revolutions in C19 geometry and logic

– §§IV.I–II of Cassirer, *Substance and Function*

12.11 The early analytics

– Lectures IV, XIV, XX, and XXIX of Wittgenstein's *Lectures on the Foundations of Mathematics*

19.11 The logical empiricists

– §§19–25 of Carnap, *Foundations of Logic and Mathematics*

Part II: The post-positivist landscape

26.11 The representational theory of measurement

– Wolff, The representational theory of measurement (from *The Metaphysics of Quantities*)

03.12 The semantic view of scientific theories

– van Fraassen, To save the phenomena (from *The Scientific Image*)

10.12 The debates over foundations

– Benacerraf, Mathematical truth

17.12 Indispensability arguments

– Maddy, Indispensability and practice

Part III: Contemporary (re)formulations

14.01 Analogical reasoning

– Steiner, The application of mathematics to natural science

21.01 The unreasonable effectiveness of mathematics in natural science

– Islami, A match not made in heaven: On the applicability of mathematics in physics

28.01 Unreasonable ineffectiveness?

– Wilson, The unreasonable uncooperativeness of mathematics in the natural sciences

04.02 The mapping account of applicability

– Pincock, A role for mathematics in the physical sciences

11.02 Against the mapping account

– Suárez, Scientific representation: Against similarity and isomorphism