Syllabus: Philosophy of Applied Mathematics

Cian Dorr and Hartry Field

Fall 2015

COURSE DESCRIPTION

In science and everyday life, theories are often expressed using so-called 'mixed' predicates—predicates (or function symbols) which relate concrete objects or properties of concrete objects to mathematical objects such as natural numbers, real numbers, vectors at points, and co- ordinate systems. For example:

- We use natural numbers to talk about how many things there are of a certain kind, e.g. to say that the number of concrete objects of a certain kind is greater than seven, or even, or prime.
- We use real numbers to talk about quantities like mass, e.g. when we say that a material object has a certain mass in grams, or that the masses of two material object stand in a certain ratio.
- We use vectors to talk about quantities like velocity, e.g. when we say that a certain vector at a spacetime point gives the velocity of some fluid through that point.
- We use co-ordinate systems to talk about the geometrical structure of physical spaces, e.g. when we characterise the differential structure of spacetime in terms of a distinguished class of smooth co-ordinate systems.

These practices have prompted philosophers to engage in two kinds of reconstructive projects. The first project is to provide definitions of 'mixed' predicates in terms of 'pure' predicates all of whose arguments are concrete (like 'equally massive'), together with certain especially basic mathematical predicates (like set-membership), thereby sustaining the natural thought that the relevant relations between the concrete and mathematical realms are explained by the intrinsic structure of the concrete world. The second project is to state theories entirely about the concrete world, which can in some way substitute for, or explain the efficacy of, theories expressed in the usual way using 'mixed' vocabulary and quantification over mathematical objects. In this course, we will discuss several possible motivations for engaging in projects of these kinds—including, but not limited to, the nominalist thesis that there aren't any mathematical objects. We will also delve in to some of the details about the execution of particular projects of these kinds, with particular attention to cases where the projects have been used to motivate controversial claims about the ontology of concrete objects, such as the existence of spacetime points.

The seminar will not presuppose any prior familiarity with the philosophy of mathematics, although some background in logic will be helpful. Its topics will overlap metaphysics and the philosophy of science as well as the philosophy of mathematics.

REQUIREMENTS

1. Participation in classroom discussion. The seminar is designated as a 'small discussion seminar', and we intend to take this designation seriously. This means that if you want to attend, you should show up to each meeting prepared to discuss at least one of the assigned readings.
2. Those who want credit for the class should make this known to the instructors and discuss their options early in the semester.

READINGS

A substantial part of the seminar will be devoted to a careful reading and discussion of Hartry Field's *Science Without Numbers* (Oxford: Blackwell, 1980). Two other books are recommended as optional reading: *A Subject with No Object* by John Burgess and Gideon Rosen (Oxford: OUP, 1997), and *Mathematics and Reality* by Mary Leng (Oxford: OUP, 2010). These provide interestingly different perspectives on the material that we will be discussing.

With the exception of the books by Burgess and Rosen and Leng, all the readings (including a revised edition of *Science Without Numbers*) will be made available electronically via NYU Classes. If you do not have an NYU NetID, please email Anupum Mehrotra the following information: your first and last name, Social Security Number, date of birth, email address, and affiliation, and he will set on up for you.

TENTATIVE SCHEDULE OF TOPICS AND READINGS

The list of assigned readings and the division into weeks will certainly evolve as the semester progresses. We will try to keep the NYU Classes site up to date.

For each week we designate each reading as 'Primary' (if you are only going to read one thing, read this); 'Secondary' (will probably be discussed); 'Background' (might be discussed if people are interested; might be useful if you need more perspective on the other readings); or 'Additional' (interesting but we probably won't have time for it in class).

8 September **Is there scientific evidence for the existence of numbers?**

Primary: Hilary Putnam, *Philosophy of Logic*, sections V–VIII.
Secondary: Hartry Field, introduction to *Realism, Mathematics, and Modality*. (Discussion will focus on sections 1–3).
Background: Mark Colyvan, 'Indispensability Arguments in Mathematics' (SEP). Leng, chapter 1.
Additional: Elliott Sober, 'Mathematics and Indispensability'

15 September **The program of *Science Without Numbers***

Primary: SWN, Preliminary Remarks and ch. 1

Background: Cian Dorr and Frank Arntzenius, 'Calculus as Geometry', section 1.
Leng, section 3.1

22 September **Arithmetic**

Primary: SWN, ch. 2

Secondary: Harold Hodes, 'Logicism and the Ontological Commitments of Arithmetic'

29 September **Beyond first order logic?**

Primary: Hodes, op. cit.
Agustín Rayo and Stephen Yablo, 'Nominalism Through De-Nominalization'.

Secondary: A.N. Prior, 'Platonism and Quantification'

Background: George Boolos, 'To Be is to Be the Value of a Variable (Or Some Values of Some Variables'

6 October **Euclidean geometry and the theory of scalar quantities**

Primary: SWN, chs. 3, 4, and 7

Secondary: Alfred Tarski, 'What Is Elementary Geometry?'
David H. Krantz, R. Duncan Luce, Patrick Suppes, and Amos Tversky, *Foundations of Measurement vol. 1: Additive and Polynomial Representations*: excerpts TBD.

13 October **Conservativeness, representation theorems, and logical consequence**

Primary: SWN, ch. 9

Secondary: Stewart Shapiro, 'Conservativeness and Incompleteness'
Hartry Field, 'On Conservativeness and Incompleteness'

Additional: Burgess and Rosen, II.A.5.b.

20 October **Nominalism and the metaphysics of spacetime**

Primary: Hartry Field, 'Can We Dispense with Spacetime?'

Secondary: Frank Arntzenius, *Space, Time, and Stuff*, chapter 5

Additional: Tim Maudlin, 'Buckets of Water and Waves of Space'
Bradford Skow, 'Are Shapes Intrinsic?'

27 October **The metaphysics of quantity: absolutism and comparativism**

Primary: Shamik Dasgupta, 'Absolutism vs. Comparativism About Quantity'

Secondary: David Baker, 'Some Consequences of Physics for the Comparative Metaphysics of Quantity' (MS)

Background: Maya Eddon, 'Quantitative Properties'
Brent Mundy, 'The Metaphysics of Quantity'
Arntzenius and Dorr (op. cit), pp. 227–230.

3 November **Nominalising Newtonian gravitation**

Primary: SWN, chapters 5, 6, and 8
Background: Arntzenius and Dorr, *op. cit.*, sections 8.2 and 8.3
Additional: John Burgess, 'Synthetic Mechanics'
Burgess and Rosen, parts I.B and II.A

10 November **Beyond Newtonian physics**

Primary: Arntzenius and Dorr, *op. cit.*, sections 8.4–8.12.
Background: David Malament, review of *Science Without Numbers*
Leng, ch. 3
Additional: Glenn Meyer, 'Extending Hartry Field's Instrumental Account of Applied Mathematics to Statistical Mechanics'
Aidan Lyon and Mark Colyvan, 'The Explanatory Power of Phase Spaces'
R.W. Latzer, 'Nondirected Light Signals and the Structure of Time'.

17 November **"Easy" responses to indispensability arguments**

Primary: Leng, chs. 5–6
Stephen Yablo, 'The Myth of the Seven'
Secondary: Leng, ch. 7

24 November **Evaluating the easy options**

Primary: Cian Dorr, 'Of Numbers and Electrons'
Secondary: Mark Colyvan, 'There Is No Easy Road to Nominalism'
Background: Burgess and Rosen, I.A and III.C
Additional: Burgess and Rosen, II.B
Geoffrey Hellman, *Mathematics Without Numbers*

1 December ***Overflow***

8 December ***Overflow***