Syllabus for 18-S996, “Category theory for scientists”

Basic information

Meeting Time: M, W, F: 10 – 10:50 am
Meeting Room: 2-131
First day: February 6, 2013

My Name: David Spivak
My Office: 2-230
My Office Hours: Tuesday, 4 – 4:50 pm
Friday, 11 – 11:50 am

Grading: Class participation: 33%
Homework: 33%
Final project: 34%

S. Awodey, *Category Theory.*

<table>
<thead>
<tr>
<th>Tentative schedule</th>
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</thead>
<tbody>
<tr>
<td><strong>Session</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2 – 7</td>
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<tr>
<td>8 – 13</td>
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<tr>
<td>14 – 21</td>
</tr>
<tr>
<td>22</td>
</tr>
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<td>23 – 29</td>
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<tr>
<td>30 – 39</td>
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1 The goal of this class

The goal of this class is to prove that category theory is a powerful language for understanding and formalizing common scientific models. The power of the language will be tested by its ability to penetrate into taken-for-granted ideas, either by exposing existing weaknesses or flaws in our understanding, or by highlighting hidden commonalities across scientific fields. Either of these will open up and clarify our thinking on a subject, and if category theory can help us do that consistently, then we should all be prepared to consider the class a success.

However, it is possible that the class will fail this test. That is, in order to be really honest we must be willing to acknowledge that maybe category theory is not useful in expanding scientific thinking. But we will only admit defeat if we first make a good faith effort to prove its usefulness to ourselves and find that we come up short.

To that end, I am requesting your help. I have written a book with several scientific applications, but it could use many more. Once you understand a mathematical topic we discuss, look into your field to see how it might apply there. Such an application might be obvious and “on the surface” or creative and “deep”, but anything of the sort will be useful to us. I want you to tell me what resonates with you, what works for you, what expands your thinking. You can express this in class or in written correspondence.

I also want to hear from you what is missing. If we are to make a powerful impact on our thinking, we should be on the lookout for what we’d hope to find but seem to miss. We admit from the beginning that category theory is not intended to provide formulas that take in initial data and make predictions about the future. This is the domain of differential equations, linear algebra, and other well-known subjects in applied mathematics; it is not something we are attempting to improve upon with category theory. Instead we look into the possibility that some of the very *structure of our thinking* can be adequately represented and articulated in the language of category theory. To the degree that it can, the infusion of mathematics into our thinking will afford additional rigor, which should lead us to new insights. Be on the lookout for such openings.

The overall point is that your engagement is very important for our success. Please speak up often in class and come to office hours.
2 What to do immediately

1. Make sure you’re signed up for 12 units.
2. Access the book online and read the introduction.
3. Introduce yourself to me after class or in office hours before Feb 16.

3 Grading

Attending lecture is mandatory. Class participation is 33% of your grade. It’s crucial that you ask questions when you don’t understand.

Homework is also worth 33% of your grade. It will be collected weekly on Mondays. Late homework will generally not be accepted. Just turn in what you have when the homework is due.

The rest of your grade is based on your final project. This can either be an oral presentation or a publishable document. We will discuss project possibilities in class at some point to clarify what will work. I am also happy to talk about projects with you in office hours.

3.1 Option 1: Oral presentation

You are encouraged to give an oral presentation to the class about a topic of your choosing (relating in some way to category theory of course). It could consist of:

- explaining to the class some scientific topic in terms of the techniques we develop in class,
- discussing how you think category theory might be valuable for new research in your field,
- teaching a difficult concept from class that you finally understood, or
- something else.

3.2 Option 2: Publishable document

Instead of an oral presentation, your final project can consist of handing in a well-typeset and accurate document relating to the class. It should be publishable, either on OCW or in some other form. That is, it should be something you would be proud to put your name on and make public. It must be complete and turned in by the end of classes.
One option is to write an essay. Such an essay may be intended to carefully explain the virtues and limitations of category theory in science, or it may be intended to dive deeply into a subject using a categorical approach.

A second option is to typeset a document in which you solve 80 of the exercises in the book. If more than one person chooses this “exercise write-up” option, the set of such people should consult each other to reduce overlap. If two people choose this option, their write-ups should span 120 problems; three people should span 160 problems; four people should span 200 problems.