ACT 2019 Application

Adam Catto

1 Relevant Background

I am a 4^{th} year undergraduate at Stony Brook University studying applied mathematics & statistics and philosophy. While I do not have any formal training in category theory, I have independently studied from Spivak's "Category Theory for the Sciences", Awodey's "Category Theory", and Goldblatt's "Topoi: the Categorical Analysis of Logic", as well as from sparsely-positioned sources around the web, including various lecture notes, wikis (nLab and Wikipedia), Wisnesky's Categorical Informatics, and so forth, and have given a talk on an introduction to ologs and applied category theory at the weekly Stony Brook mathematical linguistics reading group. I have, however, been formally trained in mathematical & philosophical logic, analytic metaphysics, formal epistemology, computational linguistics (the last two at the 2018 CMU Summer School in Logic & Formal Epistemology, as well as reading groups and courses at Stony Brook). There are certainly many gaps in my knowledge, but I plan to go through a full, rigorous treatment of category theory (i.e. finish the entirety of Awodey; additionally, I plan to make more headway on categorical logic and topos theory via Goldblatt) leading up to the Summer School, and have written up a first draft of a paper on categorical approaches to worldview consistency, aporetics, and contextuality (included as an attachment to this email), in which I adopt basic ideas developed by Fong, Myers, and Spivak in their paper on "Behavioral Mereology" to formalize these notions. I hope to refine and greatly expand upon this project over the next several months as well. Additionally, I have done research on applications of the theory of computation to metaphysics and the philosophy of physics, which I presented at the 2017 Logic, Relativity, and Beyond conference at the Renyi Institute of Mathematics in Budapest, Hungary, and on which I wrote my undergraduate honors thesis in the same year. I've applied for Ph.D. programs in philosophy and logic, and hope to graduate from a Ph.D. program around the year 2024.

2 Why I'm Interested

My main areas of interest are in formal philosophy and philosophical engineering (particularly worldview formalisms and worldview engineering, as well as contextualism and systems philosophy). In other words, I would like to develop formal frameworks for representing all things related to the concept of a "worldview" and/or "system of philosophy", and furthermore develop tools & internet applications for allowing people to construct their own worldviews and debate with others, update/synthesize their worldviews, form communities, and so forth. At the same time, I want to develop tools for doing experimental philosophy, and to develop models/accounts of contextuality, approaching this from the vantage point of various domains, such as quantum mechanics, algebra, logic, phenomenology, and so forth. What really draws me to the ACT 2019 School is that I think category theory is by far the most appealing all-encompassing language/framework in which worldview/contextuality formalisms may be developed, and I would like to help build (1) the theoretical machinery underlying these formalisms, and (2) the necessary tools for translating these formalisms into usable tools and applications for improving argumentative discourse and social harmony. There has been interesting work done in categorical computational linguistics and NLP recently, and I hope to utilize this in my work as well. Most importantly, I hope to learn from the people who've developed the ideas that have inspired my research (especially David Spivak), to adopt their research habits in order to improve the quality of my own.

3 Order of Project Preference and Commitment

I hope especially to work with David Spivak, given that my research on formal contextualism largely overlaps with his work on behavioral mereology. Formal autopoiesis is also of great interest to me, given that worldviews are, on one hand, compressions of autopoietic organizations (more specifically, they are representations of the system of action of autopoietic organizations in general), and on the other hand they can be framed as autopoietic organizations themselves, interacting with other objects in worldview-space and meme-space. I suspect that there are fruitful topos-theoretic investigations to be made here, and would very much like to explore the ins-and-outs of this with experts on the subject.

If working with Prof. Spivak during this session is not doable, I would be delighted to work with Prof. Sadrzadeh on distributional semantics as well. I am not sure that it makes sense to work on any other projects, given my current research trajectory, but these two projects would be wonderful to work on.

Oh, and I can definitely commit to being at Oxford from July 22-26, should I be admitted to the ACT school.

January 2, 2019

Adam Catto

Contact Information

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Personal Information

DOB: June 1, 1997
Born: New York, USA
Citizenship: USA

Academic Overview

Fourth-year undergraduate in Mathematics and Philosophy at Stony Brook University. A big fan of autodidactism and antidisciplinarity / transdisciplinarity. Research interests are at the intersection of philosophy, systemics, communications, and computer science, broadly characterized by the name "worldview studies".

Academic Areas of Specialization

Worldviews, Semantic Publishing, Social Structure of Science, Systems Philosophy

Academic Areas of Competence

Philosophy & Foundations of Mathematics; Ethics; Algorithmic Information Theory, History of Logic, History of Computation; Philosophy of Logic; Social Ontology; Mathematical Logic; Metaphilosophy

Academic Areas of Interest

Mathematical Linguistics; Analytic Metaphysics; Education Redesign; Abnormal Psychology; Educational Technology; Phenomenology; Foundations of Computer Science

Other Creative Interests

Creative Writing (especially poetry and scriptwriting); Low-Complexity Art; Sketch/Standup Comedy; Digital Humanities

Education

Stony Brook University, Stony Brook, NY. USA — August 2015 – May 2019
B.S. Applied Mathematics & Statistics and Philosophy (honors)
(GPA 3.49/4.0) **Relevant Coursework:** Honors Thesis in Philosophy, Epistemology, Philosophy of Language, Philosophy of Biology (Junior Seminar in Philosophy), Modal Logics, Philosophy of Mathematics, Graduate Analytic Philosophy Seminar, Combinatorics, Semantics, Syntax, Operations Research, Advanced Probability & Statistics

Carnegie Mellon University, Pittsburgh, PA. USA — June 2018
Summer School in Logic & Formal Epistemology. Topics: Computational Linguistics, NLP, Topological Methods in Formal Epistemology, Statistics

Awards, Grants, and Fellowships

- Stony Brook University URECA Summer Research Grant, $4,000 — May 2018 – August 2018
- IBM Thomas J. Watson Scholar, $2,000 annually — 2015 – Present
- ASM Materials Engineering Award Winner — March 2015
- Stony Brook University Presidential Scholar, $3,500 annually — 2015 – Present
- Dean's List, Stony Brook University — 2015 – Present
- Carl Zeiss Microscopy Award — May 2015

Research Experience

Undergraduate Researcher, Stony Brook Dept of Computer Science May 2018 – Present
Formalisms for the concept of "worldview" and how worldviews can be updated, synthesized, compared, and forecasted, using formal methods. Also explored new avenues for semantic publishing of scientific information and other research data, including category-theoretic and topological approaches to semantic publishing.

Undergraduate Honors Thesis in Philosophy 1 Jan 2018 – Present
In the process of writing a second honors thesis in the Stony Brook University Philosophy Department under the supervision of Professor Gary R. Mar. This thesis in at the intersection of the foundations of mathematics, knowledge representation & reasoning, and formal epistemology. More specifically, I am investigating potential avenues to a foundations of mathematics that captures not just what are mathematical objects and how to represent them, but also that captures how mathematicians actually *do* math.

Undergraduate Honors Thesis in Philosophy 2 Jan 2017 – August 2017
Wrote an honors thesis in the Stony Brook University Philosophy Department as a sophomore under the supervision of Professor Gary R. Mar. The thesis is in the fields of digital physics, theoretical computer science, philosophy of physics, and analytic metaphysics. I've come up with computational analogues of Max Tegmark's multiverse hierarchy, in a way that fits into the formal theory of digital physics. In the process, I also discovered several novel models of higher-order computational/mathematical structures, including higher-order cellular automata. I explore the mathematical properties of these structures, especially geometric and topological. Furthermore, I am extending digital physics to allow not only finite computational analogues of multiverses, but unify such concepts with the idea of wavefunction collapse in quantum mechanics.

Audio Analysis Tool with Applications to Automobile Engines Mar 2014 – Mar 2015
Worked with Speech Research Engineer at IBM Thomas J. Watson Research Center in Yorktown Heights, NY, to develop an audio analysis tool, in Python and MATLAB, which estimated RPM of car engines with high accuracy and precision in chaotic/dynamical environment. Used techniques from signal processing, computational linguistics, probability theory, dynamical systems, and dynamic programming, to accurately track the pitch of the chaotic signal, and using noise reduction techniques to generate the cleanest signal possible. Reference and poster available upon request.

Publications, Presentations, & Preprints

Towards a Formal Theory of Digital Physics: Digital Multiverses
Logic, Relativity, and Beyond 2017 Aug 2017

Invited Talks

Ologs: Category-Theoretic Knowledge Representation, *Mathematical Linguistics Reading Group – Stony Brook University* Apr 2018

Introduction to Inductive Logic Programming, *Stony Brook Machine Learning Lecture Series – Stony Brook University* Nov 2017

Towards a Formal Theory of Digital Physics: Digital Multiverses, *Logic, Relativity, and Beyond – Renyi Institute, Budapest, Hungary* Aug 2017

Introduction to Algorithmic and Quantum Information Theory, *Mathematical Linguistics Reading Group – Stony Brook University* Nov 2016

Invited Seminars

Graduate Seminar in Analytic Philosophy – Philosophy of Kurt Gödel,

Stony Brook University Aug '16 – Dec '16

Mathematical Linguistics Reading Group, *Stony Brook University* Aug 2016 – Present

Invited Conferences

FORCE11 – Future of Research Communications and e-scholarship Oct 2018
McGill University

North American Summer School in Logic, Language, and Informatics Jun 2018
Carnegie Mellon University

Gathering 4 Gardner – G4G Foundation, Georgia, USA Apr 2018

Logic, Relativity, and Beyond 2017 – Renyi Institute, Budapest, Hungary Aug 2017

Teaching Experience

As A Teaching Assistant:

Undergraduate TA, Stony Brook University Department of Philosophy Spring 2018
PHI 220 Intro to Symbolic Logic

Undergraduate TA, Stony Brook University Department of Philosophy Fall 2017
PHI 108 Intro to Logical Reasoning

Stony Brook University Depts of Mathematics and CS Fall 2017
CSE/MAT 371 Mathematical Logic
Topics: Syntax and semantics of classical and intuitionistic propositional and first-order logic; Automated (Gentzen) proof systems for classical and intuitionistic propositional and first-order logic

Recitation Instructor, Stony Brook University Dept of Computer Science Fall 2017
CSE 215 Foundations of Computer Science
Topics: Elementary logic + set theory; elementary number theory; recursion; properties of functions + relations; functional programming

As A Primary Instructor:

Instructor – **MIT Educational Studies Program** Nov 2016
Teaching 2-hour crash courses on logic, computability theory, Zeno's paradoxes of motion, and philosophy of Kurt Gödel

IgniteCS Mentor – EDUCodes 2016
Developed mathematics and computer science curricula for high school students; in particular, combinatorics, logic, and linear algebra

Technical Skills

Programming Languages/Technologies: Java, Python, HTML, CSS, LaTeX, Semantic Web (RDF, XML, OWL)
Operating Systems: Mac OS X, UNIX, Bash, Linux

Professional Experience

EDUCodes Stony Brook, NY. USA.
IgniteCS Mentor: EDUCodes April 2016 – December 2016

- Developing Curriculum in Mathematics and Computer Science, designed for high school students.
- Mentoring students across Long Island and Westchester County, NY, in Math and CS.

Simons Center for Geometry and Physics, Stony Brook, NY. USA.
Student Assistant September 2015 – Present

- Developing websites/web tools, using A/V tools to record talks, optimizing administrative workflow

Service

Stony Brook Chess Club
Secretary Aug 2017 – May 2018
Planning tournaments and coordinating with other on-campus organizations to host chess-themed and chess-adjacent events.

Students for Humanity
Co-Founder, Vice-President Dec 2016 – Present
We are a grassroots organization that is committed to the idea of helping those in poverty not only survive, but thrive. Our short-term goal is to collect food via excess meal swipes at the end of each academic semester at Stony Brook University, which will be donated to homeless shelters in the Greater New York City Metro Area. Our longer-term goal is to spread our organization to universities across the world. Our vision beyond this is to develop a system that collects clothes, books, and monetary donations from universities, and generate an equitable and uniform donation schemata for homeless shelters around the world. We will serve as a central hub that distributes assets to those in poverty.

References

Philosophy/Logic

Gary R. Mar, Ph.D.
Professor of Philosophy *Stony Brook University*

Computer Science / Engineering

Jason W. Pelecanos, Ph.D.
Senior Speech Scientist *IBM Research, TJ Watson Research Center*

Category-Theoretic Approaches to Worldview Consistency, Aporetics, and Contextuality

Adam Catto
Stony Brook University

January 7, 2019

Abstract

We investigate properties of worldviews and potential issues that may arise when formalizing them, especially in the areas of aporetic clusters and contextuality issues, and how they might be handled. Inspiration is taken in particular from Rescher's work on aporetics, Abramsky's work on formal contextuality for quantum information theory, and Vidal's work on worldviews.

1 Introduction

It is of (locally [to this paper]) terminal interest to me to address some aspects of worldviews, formalisms thereof, potential issues that one might face in dealing with these formalisms (especially in the form of apories and contextuality issues), and how to handle these issues. More specifically, in the context of this paper, I will be chiefly concerned with issues of consistency within worldviews / systems of belief and action, and how to handle these issues in formal representations of worldviews.

Before delving into these issues in later sections, I will first explain the primary motivations for worldview formalisms (in the next section). After providing motivation for enumerating formalisms for worldviews, I will review some metaphilosphical considerations for worldview studies as pointed out by Vidal [11]. I will then focus particularly on worldview consistency and potential issues that may result from consistency requirements, as well as methods for overcoming these issues, with emphasis on the aporetic method and contextuality. From this standpoint, there are natural ways to formalize consistency issues using sheaf theory.

2 Worldviews and Formalisms Thereof

Worldviews are perhaps the most pervasive constructs among all agent-like subjects. In one sense, they are, at the very least, summaries of a particular agent's beliefs and attitudes towards other objects in the world, as well as the agent's system of goals and actions. While we may construe "beliefs" to be properties of epistemic or cognitive agents alone, note that the latter part of this definition subsumes non-cognitive agents as well, where goals and actions are not developed reflexively but are instead either programmed or, in a certain Kantian sense, assigned to objects or artifacts to be made intelligible by humans.

2.1 Motivation for Formal Methods

Why would we want to rigorously formalize the worldview concept, anyhow? After all, formalism can be difficult, tedious, and time-consuming, and is hard for humans to interpret. What gives? I'll stipulate four of the most important reasons to use formal methods here:

1. ***Explicating disagreement*** – People disagree as a result of having differences in their worldviews. Worldview formalisms (and visualization techniques) can help them understand why and on what points they disagree.

2. ***Enhancing argumentative efficiency and fruitfulness*** – The understanding provided by disagreement explication can lead to discussions in which, instead of talking past each other or being unable to cognitively empathize, people can develop better understandings of those with whom they are in disagreement and utilize this understanding to learn from others and synthesize their worldview with the other party's / parties' worldview(s).

3. ***Tracking and representing historical trends: cultural, philosophical, attitudinal, scientific, etc.*** – Formalism is about compression, [often relational] structure, translation, and interpretability; we can systematically map out compressed [1]

4. ***Forecasting future trends: cultural, philosophical, attitudinal, scientific, etc.*** – Tracking historical development with worldview formalisms can demonstrate likely future trends, and attaching value judgments to historical events/attitudes can inform our study of applied ethics and praxeology. Even though formalism may be

[1] Hopefully, the reader might see how this could be problematic; incomplete data about historical events/figures could end up mischaracterizingly painting these events/figures in positive or negative lights. This is especially important for the next point, which suggests that we may use these formalisms to inform how we ought to act and interpret events.

difficult for humans to interpret, it is the machine-interpretability aspect that is appealing, given the massive advances in machine learning and forecasting techniques developed recently.

It may seem like overkill to rigorously formalize this concept using mathematical machinery as abstract and as steep as topos theory, and may seem like an oddity to think that employing the use of formal representation techniques may actually be fruitful, or worth the tradeoff, but it will soon be apparent as a consequence of [6], as explained in section 5.

I should also note that it is not within the scope of this paper to propose detailed formalisms for worldviews, but it is certainly a cornerstone of the author's research agenda, as it is the basis for developing usable systems for practically tracking the progression of worldviews, the dialectical structure of worldview updating, the criteria that go into worldview comparison, and the ability to forecast future events as a function of interactions between artifacts, nature, agents, and their worldviews. It is noteworthy that, at least under systems-philosophical representations of worldviews [5], complete accounts of worldviews also require a catalogue of artifacts (in order to have a sufficient social ontology)

These beliefs, desires, and actions may often appear to be contradictory or mutually inconsistent. Simple collections of desires held by individual humans, for instance, are oftentimes mutually inconsistent; consider the following:

(Cluster 1)

1. I wish to be happy and to not be unhappy, so I wish to do things that bring me happiness and avoid things
2. Being healthy brings me happiness and being unhealthy brings me unhappiness, so I wish to do things that make me healthy and avoid things that make me unhealthy
3. Eating tons of ice cream brings me happiness, so I wish to eat tons of ice cream
4. Eating tons of ice cream makes me unhealthy

This is an instance of a *contingent aporetic cluster*. Aporetic clusters are sets of statements which, when taken on their own or in (some proper subset of the power set of the set representing the cluster of statements), are mutually consistent, but, when this set is considered globally, are mutually inconsistent. We will formalize this definition categorically later on. We use the term "contingent" to indicate that some of the statements are contingent upon some others, and to distinguish from maximally consistent aporetic clusters, in which any proper subset of cardinality $n-1$ of a cluster of n statements is consistent, but the global

set of statements is inconsistent. Aporetic clusters will be reviewed in the next section.

2.2 Metaphilosophical Considerations

In [11], Vidal provides nine criteria that factor into comparison of worldviews, which are broadly clustered into three sorts of criteria: in one cluster, objective, subjective, and intersubjective properties of worldviews. Each has three further criteria, totaling nine:

1. ***Objective Consistency*** – Is the worldview internally consistent?
2. ***Scientificity*** – Is the worldview compatible with the accepted scientific mosaic? [2]
3. ***Scope*** – Does it address a wide range of issues at various levels of explanation?
4. ***Subjective Consistency*** – Worldviews are tethered to agents; does the worldview fit the agent's knowledge & experiential history?
5. ***Personal Utility*** – Does the worldview benefit the agent in some way?
6. ***Emotionality*** – Does the worldview evoke emotions, making it more likely to propogate?
7. ***Intersubjective Consistency*** – Does the worldview promote social harmony?
8. ***Collective Utility*** – Does the worldview benefit the collective in some way?
9. ***Narrativity*** – Does the worldview fit with the cultural narrative in which it is embedded?

But, what *are* worldviews, exactly? Vidal [10] provides a six-part model description, consisting of an ontology (model of what is), explanation (model of the past), prediction (model of the future), axiology (theory of values), praxeology (theory of action), and epistemology (theory of belief/knowledge). This is similar to the partition that is given by e.g. Laszlo in the domain of systems philosophy [5]. Each of these contains a collection of statements: statements about what exists and how existing things are related (e.g. "God created the world" and "A caused B"), what is Good and what is Bad (e.g. "one ought to not lie" and "one ought to maximize expected utility or valence in a certain context"), et cetera.

For now, we will work in a proof-of-concept manner [2] and say simply that worldviews are collections of statements, without appealing to any sort of contextuality for the statements. We will now investigate a formal way of representing such a worldview description.

[2] In certain social clusters, this technique might be referred to as "move fast and break things".

2.3 A Toy Formalism for Worldviews

A natural, barebones means for describing collections of statements formally is via *semantic networks* (sometimes referred to as *semantic nets*), and more particularly in the form of RDF triples. RDF, or Resource Description Framework, is a semantic web standard for representing metadata in the subject-verb-object format. RDF data is stored in ordered triples; the first and third entries in the triple are objects, and the second (middle) entry is a directed relation between the objects. This should appear quite similar to the object-morphism paradigm in category theory, though semantic networks come with less machinery/restrictions than categories do. In fact, it is possible to construct categories out of collections of RDF statements, as done in [6]. The referenced paper constructed a very nice sort of category, called a *topos*, out of RDF data; categories have their own internal languages/logics, and topoi (or toposes) come with a very nice internal language, especially for computer science: intuitionistic type theory (AKA Martin-Löf type theory). This is particularly nice for computer science, since there is a correspondence between proofs and computer programs in this type theory (cf. Curry-Howard correspondence). It also is a cornerstone for homotopy type theory, etc.

In any case, semantic nets and categories are nice to work with, and we will keep them in mind when considering issues that may arise in the study of worldviews, aporetics, and contextuality, and try to formalize these issues in this language when we can.

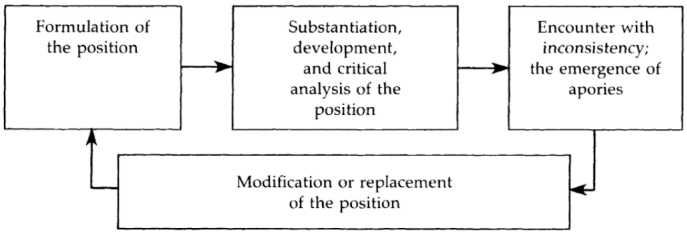
3 Aporetics and Contextuality

The goal of this section is to synthesize the concepts of apories and contextuality in order to later address apparent worldview consistency issues that result from certain contextuality fallacies. In particular, we will demonstrate the role that mereological misassimilation plays in resolution of apparent inconsistency in worldviews.

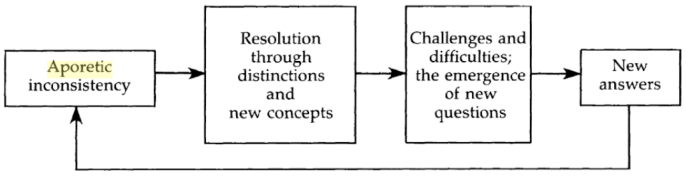
3.1 Aporetics

Aporetics is, loosely speaking, the study of paradox resolution. In Rescherian terminology, the study of aporetics is about rational deliberation in the face of inconsistency. It is a dialectical approach to paraconsistency – execption handling is done in two primary ways: *weakest link rejection* and *distinction*. Before getting into these methods, it is perhaps best to obtain a diagrammatic view of how apories fit into the philosophical methodology:

What Rescher calls "the dialectical cycle of philosophical complexification" [7]



What Rescher calls "the problem-dialectic of philosophy" [7]



A way to approach weakest link rejection is via *plausibility*. In philosophy, the statements we work with are often plausible, rather than matters of [empirical or logically derived] fact. Since there are varying degrees of plausibility of statements (grounded in various approaches, e.g. Bayesianism), we can perform weakest link rejection simply by removing the least plausible statement from the cluster (or the least plausible n statements, for degree=n inconsistent clusters).

The case of distinction is more interesting, and the distinction-making procedure is enumerated in the problem-dialectic of philosophy image above.

3.2 An Example of Formal Aporetic Resolution

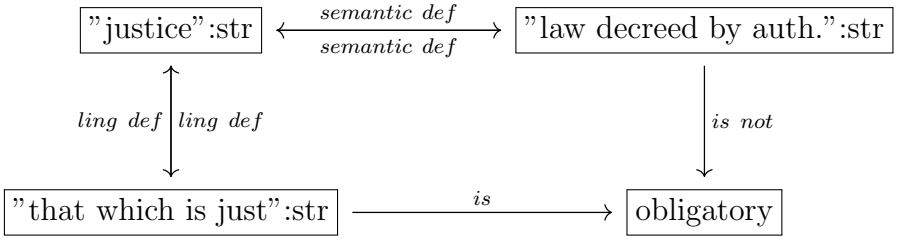
The following is an apory from Plato's Republic, as analyzed by Rescher [8]

1. What [people] call justice is simply what is decreed by the authorities as being in their own interest.

2. It is right and proper (obligatory, in fact) that [people] should do what is just.

3. [People] have no obligation to do what is in the interest of the authorities, particularly since those authorities may well themselves be mistaken about what these interests really are.

On a first pass, using ologs [9], this apory might look something like:



Where

$$(\text{ling} \;\; \text{def}) \circ (\text{ling} \;\; \text{def}) \;\; = \;\; id$$

and

$$(\text{ling} \;\; \text{def} \circ \text{semantic} \;\; \text{def}) = (\text{semantic} \;\; \text{def} \circ \text{ling} \;\; \text{def}) = \text{semantic} \;\; \text{def}$$

We should notice a few problems here. Firstly, we are using extensional semantics, mapping one string to another and stopping there, instead of getting to something more structural about the strings. This is the main clarification to be made: Secondly, the [semantic] definition of justice given here is not two-level, i.e. it does not allow for deliberation over law made by authorities, consideration of the space of laws, and choice of plausible laws. This is the distinction to be made on the upper-right object: we can instead change it from a string to a hom-set, particularly a subset:

$$S \subseteq hom(auth \;,\; law)$$

of the set of morphisms from $auth$ to law. We might also wish to clarify the senses of the terms "justice" and "that which is just". Perhaps the distinction is based in temporality – justice is a norm to be enforced in context c at time t, whereas that which is just is a limiting object in a diagram representing a dialectic between justice norms.

3.3 Contextuality and Mereological Misassimilation

In [1], Abramsky gives a definition of contextual data in a more general / expressive setting than apories: using the language of sheaf theory. The local vs. global consistency distinction is the difference between a presheaf and a sheaf; namely, the satisfaction of the gluing principle.

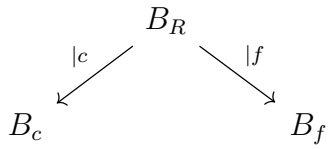
The misassimilation fallacy is an error in which one conflates two or more things that should be kept distinct from each other. A way to describe this formally is via behavior types in the context of behavioral mereology [4] developed by Fong, Myers, and Spivak. In a categorical setting, parts of a system are quotients of the system's whole (oftentimes parthood will satisfy mereological summativity, or, in a categorical setting, they will form a

partition), and a behavior type of a part of a system is the image of a restriction map from emanating from the behavior type of the whole system.

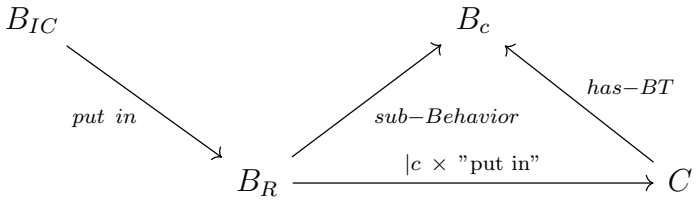
Consider, for instance, a refrigerator; refrigerators consist principally of two functional parts: a cooling container and a freezing container. A well-functioning cooling container is typically set between 35 and 40 degrees Fahrenheit, whereas a well-functioning freezing container is typically set at 0 degrees Fahrenheit (FDA standards). So the behavior type B_R of a refrigerator is

$$B_R := \{(c, f) : \mathbb{R} \times \mathbb{R} \mid (35 < c < 40) \wedge (f = 0)\}^3$$

We can construct the mereological structure of the refrigerator system using parthood restriction maps:



We turn now to an explication of what I will call the "mereological misassimilation fallacy". Informally, this is when one mistakenly references the system as a whole instead of one of its parts (while intending to reference one of its parts), and the system whole acts as a pointer to one of its parts, but a different part than the one that the agent had intended to reference. Formally, it is a composition of two functors between three distinct 2-categories, the objects of which are each isomorphic to the category **1**, and morphisms of which are functors mapping the object of the source category to the object of the target category, and identities to identities. The reason for this formulation is that it allows us to describe the 2-functors as forgetting a Kan extension structure, first by forgetting the parthood restriction maps (and composite morphisms involving them), and then introducing one parthood restriction map such that there exists an inconsistency between behavior types. More concretely, consider the following diagram:



[3]One could in principle define this behavior type in whatever way suits them, perhaps describing thermodynamical / statistico-mechanical properties of the refrigerator via differential equations and fuzzy set theory / topology, but that is unimportant for the goal of this example.

Where each object is isomorphic to the sub-zero category **1** with the usual behavior types and morphisms are functors between **1**-like objects. This diagram is the resultant diagram of the mereological misassimilation fallacy applied to the refrigerator case, where we define

$$B_{IC} := \{t : \mathbb{R} \mid t = 0\}$$

This is to be interpreted as "the ice cream should be stored at zero degrees Fahrenheit". The initial diagram includes the freezer restriction map and behavior type; the first 2-functor forgets the structure emanating from B_R, so at this intermediary case we only have (B_{IC}, "*put in*", B_R); then the next functor maps this category into the one drawn above. Given appropriate semantics, we can see that this leads to inconsistency: the behavior types B_IC and B_C are inconsistent. This could have been avoided if, instead of saying the equivalent of "put the ice cream in the refrigerator", we had said "put the ice cream in the freezing container that makes up part of the refrigerator".[4]

In general, we take the union of homsets into and out of some whole-system-like object, formulate it into a 2-category of (sub-zero) **1**-like categories, and demonstrate how lack of "morphism refinement" (i.e. giving a choice of parthood restrictions to compose with) can lead to the wrong selection of parthood map, by way of behavioral type inconsistency.

4 Applications to Worldview Consistency

The previous subsection is particularly important to worldviews that are formalized using the systems philosophy paradigm. Systems philosophy splits up worldviews into different sections or contexts, including ontology, epistemology, and axiology, among others, each of which may have its own sense in which terminology is interpreted. It is especially useful to have a way of distinguishing between different referents for terms here, because similar terminology used in different contexts can lead to global inconsistency; gluing satisfaction is not guaranteed, so we ought to denote the systemic context of each term used.

5 Future Research

In later projects, I aim to study:

- Distributional Compositional Semantics for categorical aporetics
- Topos-theoretic accounts of worldviews, study internal logics of worldviews

[4]Of course, we humans understand pragmatics, but sometimes it is possible to confuse freezer containers of a fridge with cooling containers. In fact, this happened to a friend of mine recently, which spurred the example.

- Bayesian network formalisms for worldviews and their categorical study [3]
- Approach mereological misassimilation fallacy form the viewpoint of behavioral mereology in more explicit toposes [4]

For the purposes of worldview consistency. This is only one small part of the worldview engineering / philosophical engineering roadmap.

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To Committee for the Applied Category Theory 2019 Adjoint School:

Adam Catto asked me for a letter of recommendation to your extraordinarily exciting program in applied category theory. Indeed, there is no other student that I have had in recent years who is more suited to benefit from, and contribute to, your unique program.

I have had the pleasure of having Adam in my logic courses Introduction to Symbolic Logic and Advanced Symbolic Logic, the Philosophy of Mathematics and Philosophy of Language and in a graduate seminar on the Philosophy of Kurt Gödel during his sophomore year. Adam is currently writing an honors thesis under my supervision on formal models of contextuality and metaphilosophy, from the perspective of applied category theory. Previously, I supervised a project of his which explored higher-order variants of cellular automata and their applications to digital philosophy. I can therefore comment knowledgeably on Adam's passion for and competence in the subjects at hand.

The above list of courses, however, doesn't do justice to Adam's unique qualifications to thrive in your program. Initially, I had given Adam permission to take my seminar because of his wide reading of the works of Chaitin, Wolfram, Deutsch, and others, with particular focus in algorithmic information theory, hypercomputation, and digital philosophy. After this seminar, while taking my upper division courses in logic and the Philosophy of Mathematics, Adam submitted a paper entitled "Higher-order cellular automata and digital multiverses" to the Renyi Institute of Mathematics Conference in Budapest to the *Logic, Relativity, and Beyond* 2017 at (c.f. https://www.renyi.hu//conferences/lrb17), which was accepted. Adam had the unique opportunity as an undergraduate to interact with like-minded scholars at that conference, and he remains in contact with Ph.D. candidates whom he met at the conference.

Adam enjoys interacting with students and faculty. Adam has been a TA for my courses in Logical & Critical Thinking and Symbolic Logic. The former class consisted of various modules—problem solving, deduction and logic, debate and ethical reasoning but also also a unit on scientific reasoning, which included elementary probability theory and a Bayesian model of the conditions for a good scientific test developed by *Ronald Giere in Understand Scientific Reasoning*. Adam's TA experience is not limited to Philosophy; He has also TAed two courses in computer science—one on the Mathematical Foundations of Computer Science and the other a Computer Science course in logic.

Adam is a warm and generous presence in my Logic Lab, where his ongoing conversations about logic, linguistics, and philosophy speak to his desire to contribute actively to the cooperative intellectual project and the broader community as a whole. Adam was also selected to give presentations for a program for high school students at MIT—one on the mathematics and philosophy of Kurt Gödel with some inspiration from Douglas Hofstadter's *Gödel, Escher, Bach* and another crash course in Logic and Computability. In addition, I might mention that Adam co-founded a nonprofit student organization at Stony Brook, called "Students for Humanity", whose focus is delivering food, clothes, books, and more, to homeless shelters across New York.

For the past two years, Adam and I have been attending a weekly workshop on mathematical methods in the Department of Linguistics for graduate students and faculty. Over the past few semesters, Adam gave presentations to the workshop on "Algorithmic and Quantum Information Theory" and "Ologs: Category-Theoretic Knowledge Representation". Having a strong back-

ground in mathematics and computer science, Adam is naturally drawn to approaching problems from an analytic and mathematical point of view. This was noted also by Adam's former junior seminar in philosophy instructor and chair of the Stony Brook philosophy department, Robert Crease, who, upon reading his final paper for the course, recommended him for the invite-only 2018 Gathering 4 Gardner conference, to which he was accepted and at which he was exposed to another interdisciplinary environment full of creative ideas.

Adam is currently working on an honors thesis under my direction. Taking an interdisciplinary approach, Adam's original approach is to model contextuality using category-theoretic machinery. This kind of project is exciting as it incorporates the modular tools of compositionality and knowledge representation, and the exciting recent developments that have gone on in the field of applied category theory, into metaphilosophy and seeks new ways to apply the formality of such knowledge representation techniques to other fields, such as the history of science, scientonomy, and collective intelligence. More recently, Adam has taken on a research project that aims to formalize the previously informal concept of a worldview, for which he received a Stony Brook URECA grant to conduct the project this past summer in 2018. The motivations for this project are to facilitate cooperation and collaboration amongst people coming from different backgrounds, provide new tools for studying the history of philosophy, science, and institutional change, track the historical development predominant worldviews, and forecast future trends and collective attitudes; he seeks to use category theory as an encompassing framework for this as well.

Therefore, I can recommend Adam Catto, with great enthusiasm, for the 2019 Adjoint School. Your unique program can provide the kind of intellectual guidance and creative collaboration in this area that Adam has been seeking. Not only is Adam the type of candidate you're looking for, but he is also the kind of interdisciplinary, rigorous and creative thinker who is a delight to have in discussions.

Sincerely,

Gary Mar
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