

Details of Grant

EPSRC Reference:	EP/S013008/1		
Title:	A coalgebraic framework for reductive logic and proof-search (ReLiC)		
Principal Investigator:	Pym, Professor D		
Other Investigators:	Silva, Professor A		
Researcher Co-Investigators:	Dr S Docherty		
Project Partners:	Facebook UK		
Department:	Computer Science		
Organisation:	UCL		
Scheme:	Standard Research		
Starts:	01 November 2018	Ends:	31 October 2022
		Value (£):	974,936
EPSRC Research Topic Classifications:	Fundamentals of Computing		
EPSRC Industrial Sector Classifications:	Information Technologies		
Related Grants:			
Panel History:	Panel Date	Panel Name	Outcome
	04 Sep 2018	EPSRC ICT Prioritisation Panel September 2018	Announced

Summary on Grant Application Form

While the traditional, deductive approach to logic begins with premisses and in step-by-step fashion applies proof rules to derive conclusions, the complementary reductive approach instead begins with a putative conclusion and searches for premisses sufficient for a legitimate derivation to exist by systematically reducing the space of possible proofs.

Not only does this picture more closely resemble the way in which mathematicians actually prove theorems and, more generally, the way in which people solve problems using formal representations, it also encapsulates diverse applications of logic in computer science such as the programming paradigm known as logic programming, the proof-search problem at the heart of AI and automated theorem proving, precondition generation in program verification and more. It is also reflected at the level of truth-functional semantics --- the perspective on logic utilized for the purpose of model checking and thus verifying the correctness of industrial systems --- wherein the truth value of a formula is calculated according to the truth values of its constituent parts.

Despite the reductive viewpoint reflecting logic as it is actually used, and in stark contrast to deductive logic, a uniform mathematical foundation for reductive logic does not exist. Substantial background is provided by the work of Pym, Ritter, and Wallen, but this is essentially restricted to classical and intuitionistic logic and, even then, lacks an explicit theory of the computational processes involved. We believe coalgebra --- a unifying mathematical framework for computation, state-based systems and decomposition, for which Silva is a leading contributor and exponent --- can be applied to this end. Deduction is essentially captured by inductive constructions, but reduction is captured through the coalgebraic technique of coinduction, which decomposes goals down into subgoals.

Existing work shows that coalgebra generalizes truth-functional semantics and can represent basic aspects of search spaces. We will systematize this work to logics in full generality and, by utilizing the coalgebraic approach to the modelling of computation, also capture the control procedures required for proof-search. The algebraic properties of coalgebra should ensure that all aspects of this modelling, including the definitions of logics, their search spaces, and their search procedures, will be compositional.

Beyond this advance on the state of the art in semantic approaches to proof-search,

we can hope to utilize coalgebraic presentations of computation to achieve much more. By interfacing coalgebraic models of proof-search with coalgebraic models of, for example, probabilistic computation or programming languages, we can hope to give a clean, generic and modular presentation of applications of the reductive logic viewpoint as diverse as inductive logic programming and abduction-based Separation Logic tools such as Facebook's Infer.

Abstracting the key features of such systems into a modular semantic framework can help with more than simply understanding how existing tools work and can be improved. Such a framework can also guide the design and implementation of new tools. Thus, in tandem with our theoretical development, we will develop efficient, semantically driven automated reasoning support with wide application. In doing so we can thus hope to implement tools capable of deployment for a large range of reasoning problems and guide the design of theorem provers for specific logics.

Key Findings

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Potential use in non-academic contexts

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Impacts

Description	This information can now be found on Gateway to Research (GtR) http://gtr.rcuk.ac.uk
Summary	
Date Materialised	

Sectors submitted by the Researcher

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Project URL:	
Further Information:	
Organisation Website:	