

Main Research Interests and Contributions. I am a logician, mathematician, and computer scientist. My research is mainly in logic, where I work in both pure logic and on developing logic-based methods as a mathematical modelling technology for reasoning about systems and behaviour, and in security, where I work in security policy and security economics.

My overall perspective unifies these aspects of my work: I am interested in developing frameworks, theories, and tools for understanding and reasoning about the complex socio-economic-technical systems that define and support our world.

Here are some specific topics of interest.

Logic

- The logical theory — particularly from the perspective of colgebra — of reductive logic and proof-search: semantics, proof theory, and control.
- Proof-theoretic semantics (also known as the theory of meaning), its connection to ideas from reductive logic and proof-search, and its (mathematical, coalgebraic) analysis/foundation.
- The semantics and proof theory of classical, intuitionistic, modal, epistemic, and substructural logics.
- Resource semantics: process algebra, bunched, and modal logics as a basis for mathematical systems and security modelling, including models of access control in systems contexts; logical theory and connections with game theory and strategic reasoning.
- Access control logics that account for system architecture (connects my work in logic and information security).
- Logics for behaviour, with application in systems/security/policy contexts.
- The philosophy and methodology of mathematical, and especially logical, modelling.

Modelling: Philosophy and Methodology

- What are the appropriate mathematical primitives for modelling the kinds of systems — that is, ecosystems of complex information-processing systems and analogous assemblies — that are the basis of the services upon which societies depend?
- How can we characterize the methodologies for constructing models that are appropriate for such systems? Methodologies must be able to incorporate the capture of human/agent behaviours as well as representations of policy and economic considerations, and must be inherently compositional, providing accounts of substitution, for abstraction and refinement, and local reasoning about component systems.

Security

- Access control logics that account for system architecture (connects my work in logic and information security).
- Information security economics: connecting economic models of security behaviour and investments to mathematical system models.
- Public policy in information security, including the concept of information stewardship.
- The philosophy and methodology of security.
- The philosophy and methodology of mathematical, and especially logical, modelling in the context of security and behaviour.

My scientific contributions to-date can be summarized as follows below.

Logic

- The semantics and proof theory of bunched logic: provided the basis for separation logic and its subsequent developments: resource semantics. Aspects of this work formed the basis of Separation Logic and the tools it supports.
- Resource semantics: process algebra, bunched, and modal logics as a basis for mathematical systems and security modelling, including models of access control in systems contexts; logical theory and connections with game theory and strategic reasoning.
The logic BI is the basis of Separation Logic, which is a specific model of a theory of data structures in BI.
- Categorical models of classical logic/sequent calculus and its theory of reduction: long-standing open problem solved.
- The logical theory of reductive logic and proof-search: summarized in an Oxford Logic Guide.
- Proof theory, computational logic, and categorical model theory for dependent type theory and logical frameworks.
- Unification for first-order dependently typed λ -calculus.

Security

- Access control logics that account for system architecture (connects my work in logic and information security).
- Information security economics: connecting economic models of security behaviour and investments to mathematical system models.
- The concept of information stewardship in security economics.