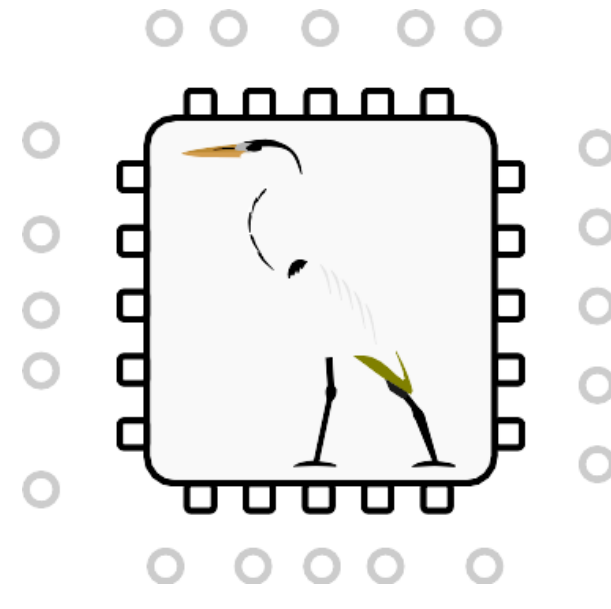




Parallel Functional Languages and Hardware

We aim to realise productivity and performance benefits from the pure semantic foundations of **functional languages**. Our research areas span the entire hardware / software / abstraction stack, including



- **high-level, parallel and distributed coordination abstractions**, such as skeletons or parallel patterns, to simplify the orchestration of massively parallel code;
- **parallel language extensions**, such as GpH, to simplify the task of parallel programming and to enhance programmer productivity;
- **parallel hardware for functional languages**, developing special purpose processors for accelerating functional programming languages, by implementing runtime components in hardware using the latest FPGA technology.

Our industry partners include 123-Invest (FinTech), QBay-Logic (Hardware), and Codethink (OpenSource).

People: HWL, RJS

Projects: HAFLANG (EPSRC), Hybrid ML for FinTech (BA/Leverhulme)

URL: <https://haflang.github.io/>

LAIV: Laboratory for AI Verification



LAIV is a team of researchers working on a range of interdisciplinary problems that **combine AI and Formal Verification**, in order to establish trust in AI-supported systems.

For example, we seek answers to the following questions:

- How do we establish safety and security of AI applications?
- What are the mathematical properties of AI algorithms?
- How can types and functional programming help to verify AI?
- How can we verify neural networks and other related machine-learning algorithms?
- How can machine learning improve software verification?

Our foundational research has applications in many areas of AI, such as trustworthy autonomous systems.

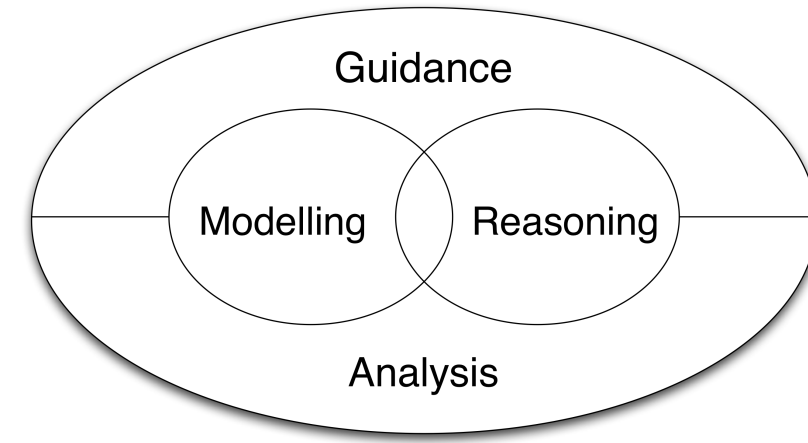
People: EK, RJS, ML, KS, LG, WP, MN, CW

Projects: AISEC: "AI Secure and Explainable by Construction" (EPSRC), CONVENER: "Continuous Verification of Neural Networks" (VETSS), SecConn-NN: "Neural Networks with Security Contracts" (NCSC).

URL: <https://laiv.uk/>

Automated Reasoning for Software Engineering

Software is woven into the fabric of modern life — from communications, entertainment and consumer electronics, to finance, healthcare and national infrastructure.



The proliferation of software brings with it serious risks — system failures and security vulnerabilities. To combat these risks calls for **rigorous methods** that enable us to reason precisely about the correctness of a software system. Mathematical logic and formal reasoning provide the foundations for such methods.

Our research focuses on the **foundations** for such reasoning and on the development of **automated reasoning** techniques and their application to verifying the correctness software systems — both at code and design level.

Our industrial collaborators have included Altran Praxis, QinetiQ and BAE Systems.

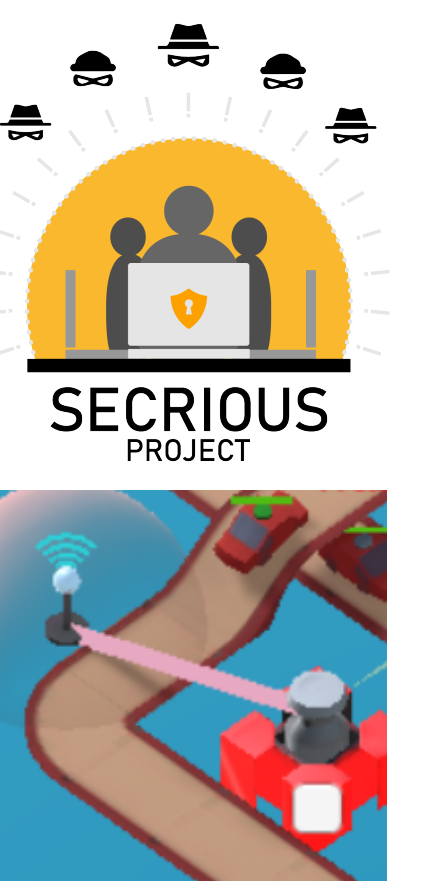
People: AI, MJG, LG, GG, EK, TLR, RM, ALA

Projects: Trustworthy Autonomous Systems Node in Governance and Regulation (EPSRC); DReM (EPSRC)

URL: <https://www.macs.hw.ac.uk/~dsg/public/researchareas/highintegritysoftwareintensivesystems/>

Cyber-security

The Cyber Security group at Heriot-Watt University brings together cyber security research and teaching activities taking place in the School of Mathematical and Computer Sciences at Heriot-Watt University, both in our Edinburgh UK and Dubai UAE campuses. The Heriot-Watt Cyber security group is a partner in the UK Cyber Security & Privacy Seminar Series.



Our inter-disciplinary research is applied in a range of domains, such as code security and serious games.

People: MM, HWL, RJS, AS

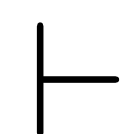
Projects: Secrious (EPSRC), Citadel Programming Lab (NCSC-RISCS, CyBOK)

URL: <https://www.macs.hw.ac.uk/~dsg/public/researchareas/cybersecurity/>

(Dependent) Types and Logic

Type systems are one success story of functional language design. Dependent types significantly expand their expressive power and meld programming with proving.

Our research covers a range of topics in the areas of type systems, static type analysis, type error diagnosis, logics for several aspects of program execution, interactive theorem proving, meta-programming, model checking, nominal logic, formalised mathematics, and other formal methods areas.

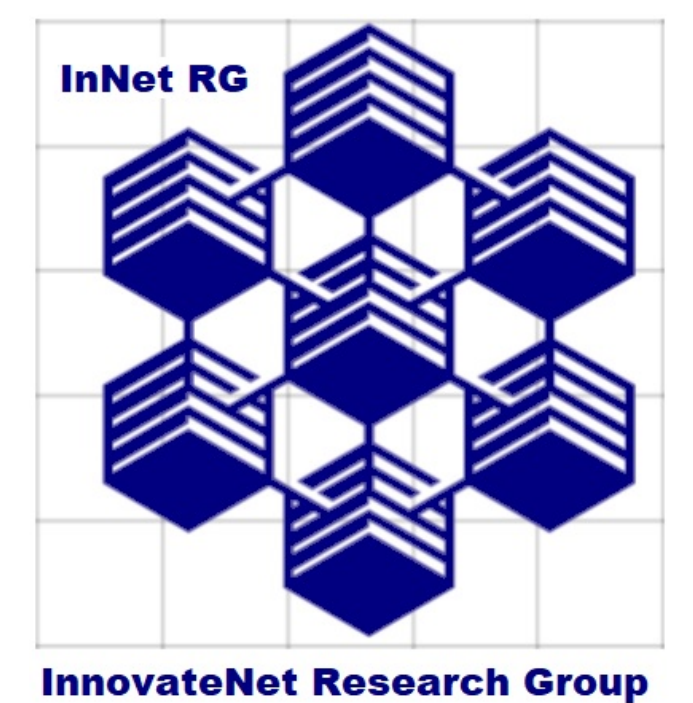


People: SD, MD, JH, JM, KS, FS, MJG, LG

URL: <https://www.macs.hw.ac.uk/~dsg/>

Networking, IoT, and their Applications

The InnovateNet Research Group (InNet RG) is dedicated to innovating in networking, IoT, and cloud technologies through our research projects. Our specialties include Software Defined Network-based MANETs (SDMANET) and integrating advanced wireless technologies and IoT devices into Vehicular Ad Hoc Networks (VANETs).



People: ISI

Projects: Software Defined Network-based MANETs (SDMANET)

URL: <https://www.macs.hw.ac.uk/~dsg/public/researchareas/networkingiot/>

UKRI AI Centre for Doctoral Training in Dependable and Deployable Artificial Intelligence for Robotics (CDT-D2AIR): <https://www.edinburgh-robotics.org/apply>

Prof. Jurriaan Hage (JH), Prof. Andrew Ireland (AI), Prof. Ekaterina Komendantskaya (EK), Dr. Swaraj Dash (SD), Dr. Marko Doko (MD), Dr. Jamie Gabbay (MJG), Dr. Lilia Georgieva (LG), Dr. Idris Skloul Ibrahim (ISI), Dr. Manuel Maarek (MM), Dr. James McKinna (JM), Dr. Muhammad Najib (MN), Dr. Hans-Wolfgang Loidl (HWL), Dr. Adam Sampson (AS), Dr. Filip Sieczkowski (FS), Dr. Kathrin Stark (KS), Dr. Rob Stewart (RJS),