HERIOT WATT UNIVERSITY

2nd International Summer School on Advances in Programming Languages

19th-22nd August, 2014
Heriot-Watt University, Edinburgh

DG sicsa* codeplay

Overview

The **2nd International Summer School on Advances in Programming Languages**, hosted at Heriot-Watt University in Edinburgh by the Dependable Systems Group, offers four days of insightful lectures and lab sessions on an engaging blend of cutting-edge theoretical and practical techniques delivered by international experts. The topics include type systems and dependent types, novel programming models, and domain-specific languages, among others. The School is primarily intended for postgraduate research students and aims to foster international collaboration, and encourages a dialogue among early career researchers and renowned scientists.

Lunch

Lunch will be taking place at the College Lounge in the Hugh Nisbet Building (see map).

Lunch includes:

- Main course
- Soup or salad
- Hot or cold drink

Vegeterian option is available. We will provide lunch tickets for each day.

Social Dinner

The Social Dinner will take place at **The Caley Sample Room** on Thursday 21st at 19:30.

A group will leave from the main reception around 19:00. Bus service 34 stops just outside the pub and it is approx. a 15 minute ride.

The Caley Sample Room, 42 – 58 Angle Park Terrace, Edinburgh, EH11 2JR

Transport to and from Heriot-Watt University

Lothian Buses offers local bus services 25, X25, 34, 45 and N25/N34 (night bus) to the Edinburgh Campus. Service 25 is the most frequent, leaving the city centre every 10 minutes during the day, and every 15 minutes after 8.00pm. The journey takes about 30–40 minutes from the city centre, depending on what time of day you're travelling. Fares from the city cost £1.50 single/£3.50 day ticket. Note that exact money is required for Lothian Buses (with the exception of Airlink) but you can pay for tickets using your mobile phone, if preferred.

A number of taxi services, such as Central Taxis, are available at taxi ranks in the centre of Edinburgh, including Waverley and Haymarket rail stations and St Andrew Square bus station, as well as at Edinburgh airport. The journey to Heriot-Watt University takes about 20–30 minutes from the city centre, and about 10 minutes from Edinburgh airport. A return journey to the city centre costs about £30.

Residential student accommodation

Check-in is from 15.00 hrs on the day of arrival. You can pick up the keys at the Main Reception (open from 07.30-22.00 hrs). Check-out is before 10.00 hrs on the day of departure. Please hand in the keys at the Main Reception.

Breakfast will be available in Elements, Monday to Friday from 07.30-10.00 hrs and a continental breakfast will be available from Café Brio on Saturday/Sunday from 08.30-10.00 hrs.

Schedule

	Tue	*Wed*	*Thu*	*Fri*
09:30	Registration and coffee	Conor McBride (Dependent Types)	Rita Loogen (Eden Skeleton)	Fritz Henglein (Regular Expressions)
10:00				
10:30	Opening plenary	*Break*	*Break*	*Break*
11:00	Phil Wadler (Session Types)	Lab (McBride)	Lab (Loogen)	Lab / Lecture (Henglein)
11:30				
12:00	*Lunch*			
12:30		*Lunch*	*Lunch*	*Lunch*
13:00				
13:30	Lab (Wadler)			
14:00		Michele Weiland (PGAS)	Jeremy Gibbons (DSL)	Hans-Wolfgang Loidl (GpH)
14:30				
15:00	*Break*	*Break*	*Break*	*Break*
15:30	Hans Vandierendonck (Task Dataflow)	Lab (Weiland)	Lab (Gibbons)	Jeremy Singer (Memory Management)
16:00				
16:30	*Break*			Closing address
17:00	Lab (Vandierendonck)	*Break*	*Break*	
17:30		Sven-Bodo Scholz (tbc)	Lab (Scholz)	Lectures: PG201 (Postgraduate Centre)
18:00				Labs: EM250 (Earl Mountbatten Bdg)
				Lunch: College Lounge (Hugh Nisbet Bdg)
19:00	*Dinner*	*Dinner*	*Dinner*	

Abstracts

Propositions as Sessions

Prof. Phil Wadler, University of Edinburgh

Session types encode communication protocols. Typically, session types are constructed from the following primitives:

(a) write to a channel	(a') read from a channel
(b) offer a choice of actions	(b') select from a choice of actions
(c) provide a service	(c') request use of a service

The two columns are dual: when one end of a channel performs one of the actions on the left, the other end must perform the corresponding action on the right, and vice versa. Recent work by Caires and Pfenning (2010) and Wadler (2012) reveals a correspondence between the session types of Honda (1993) and the linear logic of Girard (1987). Under one version of this correspondence, each pair of actions above correspond to dual operators of linear logic. The talk will explain the basics of session types and their correspondence to linear logic, and the tutorial will offer students a chance to try out a new implementation of session types built on top of the Links programming language.

Dependent Type Systems

Dr. Conor McBride, University of Strathclyde

Dependent type systems allow us to manage the validity of data relative to other data. Using the programming language Agda, I shall demonstrate techniques for working with invariants of size, ordering and balancing, establishing advanced safety properties with minimal proof effort. The examples will mainly come from the ICFP 2014 paper “How to Keep Your Neighbours in Order”.

Partitioned Global Address Space

Dr. Michele Weiland, Edinburgh Parallel Computing Centre (EPCC)

Partitioned Global Address Space (PGAS) programming models are increasingly establishing themselves as an alternative to the message passing and shared memory models that are prevalent in the world of parallel programming. We will introduce the core concept of PGAS and its different implementations, focussing in particular on Unified Parallel C.

Folding Domain–Specific Languages: Deep and Shallow Embeddings

Prof. Jeremy Gibbons, University of Oxford

A domain-specific language can be implemented by embedding within a general-purpose host language. This embedding may be deep or shallow, depending on whether terms in the language construct syntactic or semantic representations. The deep and shallow styles are closely related, and intimately connected to "folds" (inductive structural recursion).

Parallel Programming with the Swan Task Dataflow Scheduler

Dr. Hans Vandierendonck, Queen's University Belfast

In the task dataflow approach to parallel programming, programmers do not declare or enforce parallelism. Rather parallelism is inferred from annotations that declare the side-effects of tasks on their arguments. As such, parallelism is always "correct" provided that the annotations are correct. Arguably, side-effects of tasks are easier to verify than parallelism. We will present the design of the Swan task dataflow language and the implementation of its runtime system.

Regular Expressions as Types

Prof. Fritz Henglein, DIKU, University of Copenhagen

A regular expression (RE) is usually interpreted as a decision problem (language): classifying strings into accepted and rejected ones. This is, however, inadequate for programming applications where extracting and transforming data, not just an accept/reject answer, is required.

We show how to interpret an RE as a type instead. This naturally captures the parse trees of a string, not just its acceptance. We develop type, automata and algorithmic theory to, e.g., functionally specify regular expression parsing where Kleene-star yields the list of all matches in the input; perform asymptotically optimal time- and space-efficient parsing without any backtracking; synthesize code for converting parse trees under one RE to another RE. The lecture emphasizes 'thinking' about a regular expression as a type rather than a language and illustrates the semantic, expressive and algorithmic mileage for stream processing applications one can get out of that.

Mathematical Garbage: Formal Models of Memory Management

Dr. Jeremy Singer, University of Glasgow

Garbage collection is no longer an esoteric research interest. Mainstream programming languages like Java and C# rely on high-performance memory managed runtime systems. In this talk, I will motivate the need for rigorous models of memory management to enable more powerful analysis and optimisation techniques. I will draw on a diverse range of topics including thermodynamics, economics, machine learning and control theory.

Skeleton-Based Parallel Programming in Eden

Prof. Rita Loogen, Philipps-Universität Marburg

Algorithmic skeletons are higher-order functions defining parallel computation schemes. Our parallel Haskell extension Eden provides a large skeleton library, ranging from simple parallel maps to sophisticated workpool or divide-and-conquer schemes. We will show that in the best of cases parallel programming in Eden reduces to the choice, appropriate instantiation and/or composition of skeletons.

The Powers of Array Programming

Prof. Sven-Bodo Scholz, Heriot-Watt University

Array programming enables programmers to manipulate their data in terms of n-dimensional address spaces. This does not only place a powerful set of advanced data manipulation operations at the fingertips of programmers it also enables compilers to produce highly efficient parallel codes that run on various multi-core architectures including GPUs without any further modification.

We give a brief introduction into the functional array programming language SaC and we provide a glimpse of how array programming empowers programmers to quickly reorganise potentially large data in sophisticated ways within the context of different application domains. The lab gives opportunity to experience the power of array programming first hand.

Glasgow parallel Haskell

Dr. Hans-Wolfgang Loidl, Heriot-Watt University

Parallel programming in a functional language provides a number of advantages: ease of parallelisation (in a side effect free language), high level of abstraction, clean separation of computation and coordination, a natural way of encoding skeletons, and deterministic parallelism. In this presentation I will give an overview of parallel programming in the Glasgow parallel Haskell extension of the non-strict, pure functional programming language Haskell. I will focus on evaluation strategies as the means of structuring and composing parallel code.

What's on?

1 – 25 AUGUST

EDINBURGH FESTIVAL FRINGE

The world's largest arts festival with just under 50,000 performances and more than 3100 shows packed into almost 300 venues across the city. The Fringe is open to all: anyone can perform and everyone does - from students to superstars.

8 – 31 AUGUST

EDINBURGH INTERNATIONAL FESTIVAL

Three exhilarating weeks of the very best in classical music, theatre, opera and dance.

9 – 25 AUGUST

EDINBURGH INTERNATIONAL BOOK FESTIVAL

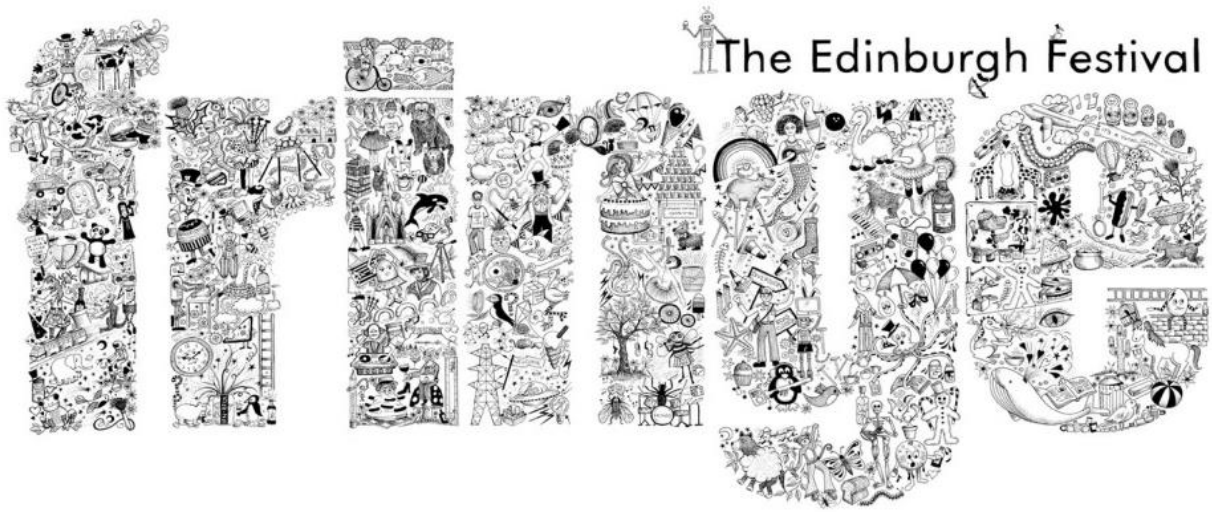
The largest celebration of the written word in the world, brings entertainment and inspiration to Edinburgh, where top-class writers discuss words and ideas with fellow writers, thinkers and, most importantly, you.

31 JULY - 31 AUGUST

EDINBURGH ART FESTIVAL

The city's galleries, museums and visual art spaces present the most exciting and intriguing of the modern and contemporary visual arts world. See prize winners, agent provocateurs, world premiers, old masters and the next big thing.

For more information see *www.edinburghfestivals.co.uk*



Acknowledgments

We are grateful to **Heriot-Watt University** for providing in-kind support and to the **Scottish Informatics and Computer Science Alliance** (SICSA) for subsidising participants from Scottish Universities. Last but not least, we would like to thank our sponsor **Codeplay** for financial support.

Special thanks to Christine, Morag and Ashley for their help and Steve and Iain for the IT support.

With a history dating back to 1821, Heriot-Watt University has established a reputation for world class teaching and practical, leading edge research, which has made us one of the top UK universities for business and industry. We're a vibrant, forward-looking university, well known for the quality of our degrees with employers actively seeking out our graduates.

Studying at Heriot-Watt you'll benefit from high quality teaching and learning, established links to potential employers, modern facilities and excellent support services. You'll join a friendly student community on a beautiful, parkland campus with easy access to the world renown city of Edinburgh.

We pride ourselves on the student experience we offer and were ranked UK University of the Year for Student Experience 2012/13 in the Sunday Times University Guide.

sicsa*

The Scottish Informatics and Computer Science Alliance (SICSA) is a Scottish Funding Council Research Pool, comprising 14 of Scotland's Universities. Our goal is to develop Scotland's research excellence in Informatics and Computing Science (ICS) by supporting and facilitating collaboration among our members.

SICSA funding has enabled SICSA members to recruit over 90 high-quality Ph.D. students from across the world through our Prize Studentship Programme. Similarly, SICSA has provided SICSA member institutions with the opportunity to recruit some of the world's best researchers to their Schools.

SICSA programmes include:

- Funding for specific research themes in ICS
- The SICSA Graduate Academy Programmes
- A broad programme of Knowledge Exchange funding and events
- Support for activities aimed at developing Computing Science education in Scotland

codeplay

Codeplay are internationally recognized experts in advanced optimizing technologies, compilers and programmable graphics. We have been providing acceleration solutions that optimize performance for graphics semiconductor designers and AAA game developers since 1999.

In the semiconductor sector, Codeplay partners with leading chip manufacturers, such as Qualcomm and Movidius, helping them to exploit the full potential of their chipsets and accelerate time-to-market. Our high performance C/C++ compiler technology enables GPU product managers to bring breakthrough new technologies to their graphics processors, significantly reducing development time, costs and risks. Our compiler testing technologies enable the rapid testing of new compilers and languages, such as OpenCL™ and shader languages. And our expert compiler developers are ready to take on tough optimization and development projects, with years of experience working on graphics processor compilers.

Codeplay's consultancy services, optimization technologies and bespoke support enables semiconductor manufacturers and game developers to stay ahead in the continual race in both these competitive sectors, helping our customers set the standard for stunning graphics in visual computing and gaming.

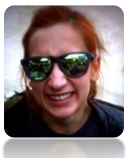
Course Directors

Prof. Greg Michaelson, School of Mathematical and Computer Sciences, HWU

Dr. Hans-Wolfgang Loidl, School of Mathematical and Computer Sciences, HWU

Organising Committee

Need help?



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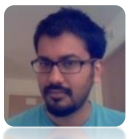

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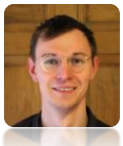

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