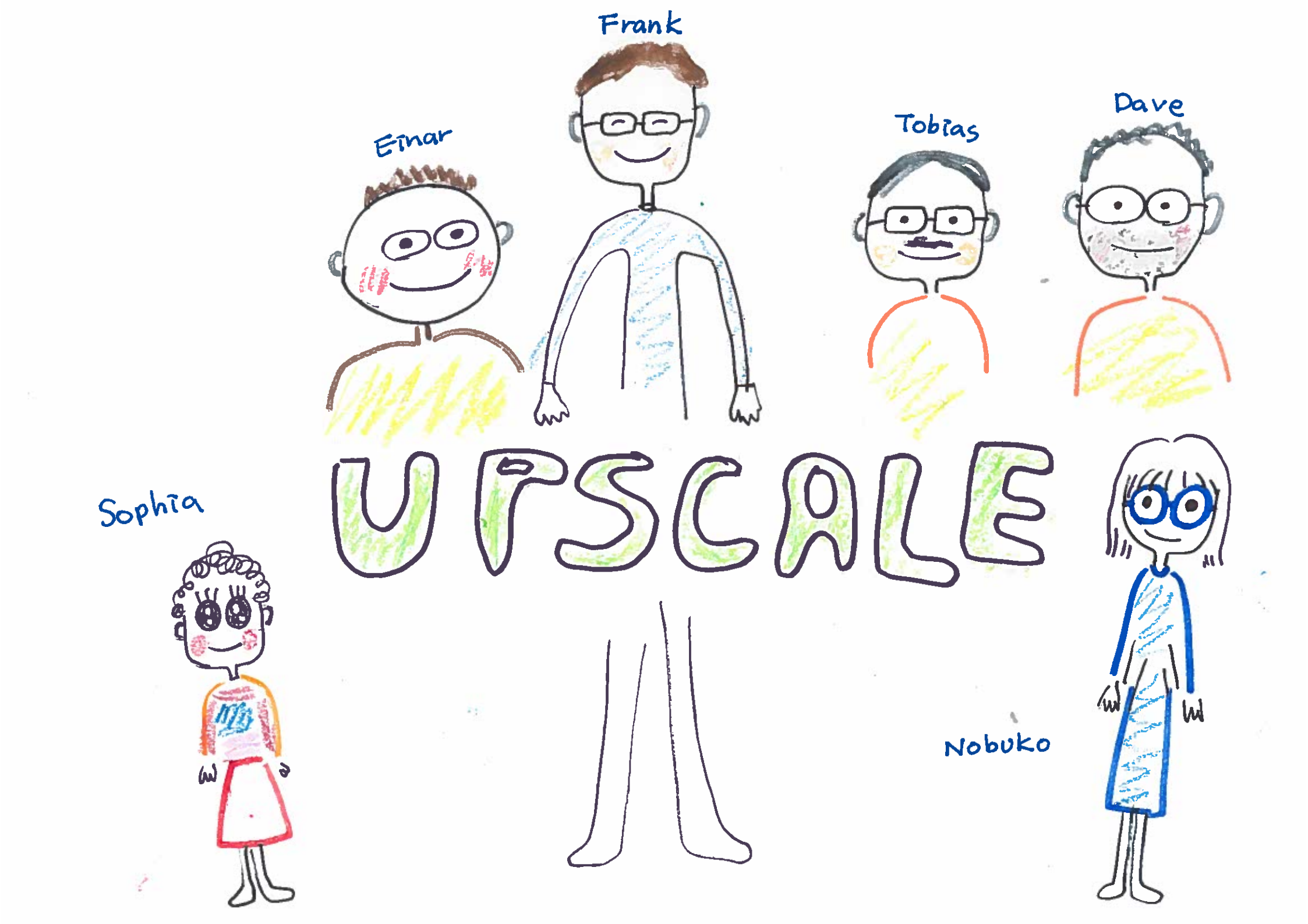

Frank
Einar
Tobias
Dave
UPSCALE
Sophia
Nobuko

UpScale Project (FP7)

- CWI, Imperial College London, University of Oslo and Uppsala University
- Study how an OO PL can support the development of applications that seamlessly scale to the available parallelism of manycore chips.
- Take an actor-based concurrency model as a starting point, rather than multi-threading, and use types to "open up the actors" for further parallelism, keeping the amount of concurrency implicit in the language.
- Capability types, Ownership types, Session Types, etc.

An overview of

UpScale @ Imperial College London

Nobuko Yoshida

Sophia Drossopoulou

Juliana Franco

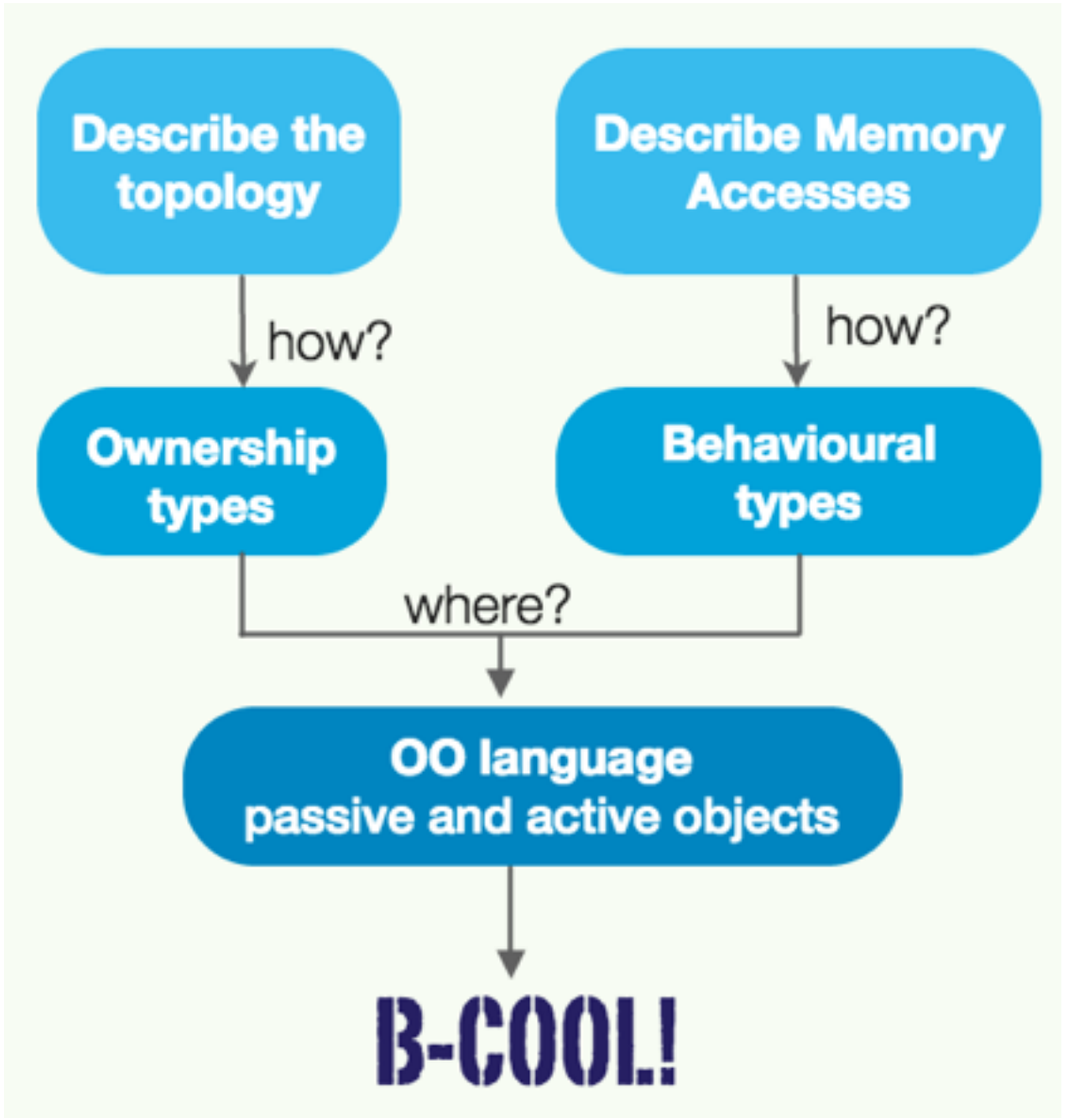
STOPS: Session Types + OwnershiP + Sizes

- A language that combines binary session types, ownership types and size annotations to calculate communication costs for OO distributed programs.
- The goal is to optimise performance of distributed programs by:
  - ✴ changing the topology of the participants,
  - ✴ change the order of messages sent and received,
  - ✴ avoid the serialisation of unnecessary data,
  - ✴ etc

Paper:

J. Franco, S. Drossopoulou and N. Yoshida Calculating communication costs with Sessions Types and Sizes, ICCSW'14.

B-COOL!: Behaviour for in Location-aware OO Code



- Behavioural and Ownership Types for Non Uniform Memory Access systems
- A small OO language that combines behavioural types with ownership types.
- Ownership types represent the topology.
- Behavioural types describe reads, writes and messages sent to remote locations.

Paper:

Juliana Franco and Sophia Drossopoulou, *Behavioural types for NUMA*, PLACES'15.

ORCA: Ownership and Reference Count collector for Actors

- GC protocol for actor-based object oriented languages.
- Based on Ownership and Reference Counting
- It relies on the type system and on message passing
- No Stop the World Steps: the application does not need to stop in order to do object deallocation
- No Synchronisation mechanisms required for Heap Mutation

Papers:

- Sylvan Clebsch, Sebastian Blessing, Juliana Franco and Sophia Drossopoulou. *Ownership and Reference Counting based Garbage Collection in the Actor World.* ICOOOLPS'15
- Another paper in preparation.

Collaboration with:

An Overview of

UPSCALE @ UPPSALA

Stephan Brandauer, Dave Clarke, Elias Castegren,
Kiko Fernandez-Reyez, Phuc Vo, Tobias Wrigstad, Albert Yang

The Encore Language

A scalable programming language

Actors as the fundamental unit of concurrency

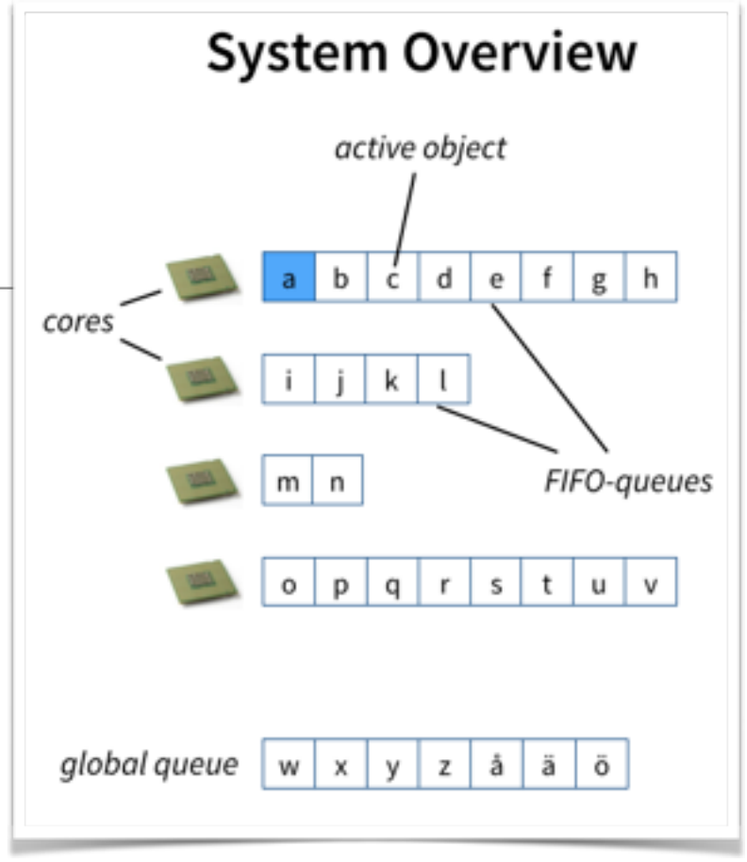
Asynchronous messages returning futures

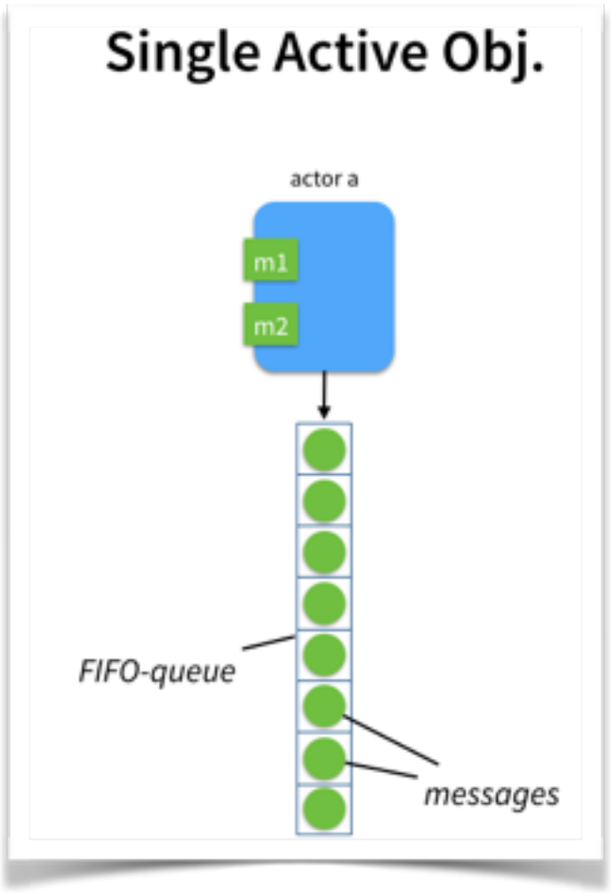
Support for millions of concurrent actors
that block or await future results

Cooperative scheduling at the implementation level
(also at surface level using suspend/await)

Runs on-top of the PonyRT extended with futures
and lightweight threading

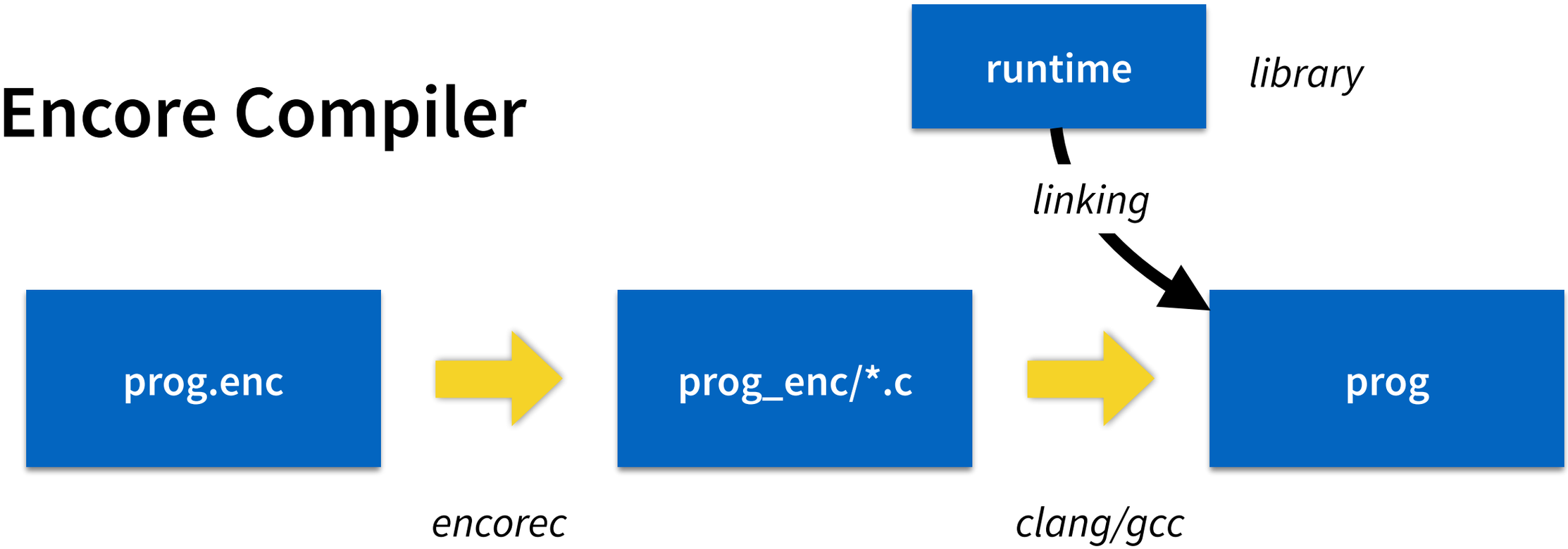
Extends a subset of the ABS family of languages
but not intended as a modelling language





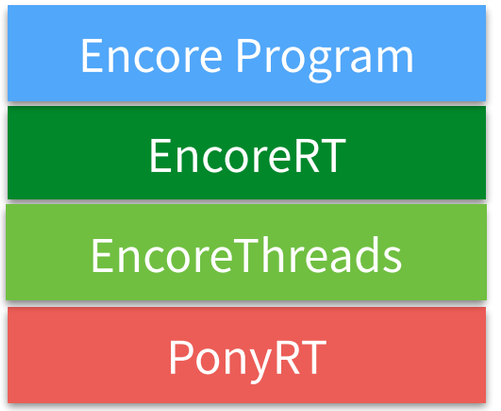
	Parallel Combinators	Reference Capabilities	Hot Objects	Disjointness Domains
Problem	Actors are **sequential**; need to abstractly specify parallel computations for **scheduler flexibility**	Avoiding **data-races**/ **copying**/**non-determinism** both at application level and in the run-time	Popular actors risk becoming bottlenecks—lowering **throughput**; increasing **latency**	Sharing semantics of object-oriented programs **misaligned** with language defaults
Approach	Strongly typed mini-DSL for **orchestrating parallel computation**	A **hierarchy** of **annotations** that express how programmers **share** objects **across computations**	New class of actors whose message processing semantics is **controlled from deployment spec**.	**Invert defaults** — track sharing instead of alias-freedom
Details	**Reify** pipeline; **operations** on pipeline for **forking**, **pruning**, **speculating**, etc.	Capabilities are tracked in **types** which are formed from **sharing modes** and **traits**	Several possible implementations: lock-based **synchronous** actors, **STM**, **lock-free** capabilities	Sharing is tracked through **types**; what parts of a program **may alias statically visible**
Difficulties	Integration with scheduling of actors; killing on-going computation	Balancing expressivity and syntactic overhead; capturing the relevant properties; polymorphism	Actor semantics sequential, difficult engineering to get good performance	Balancing expressivity and syntactic overhead; measuring how aliasing is used in practise
Deliver-ables	Submitted to COORDINATION'16 + UU Master Thesis *Implemented in Encore*	IWACO'14, submitted to ECOOP' 16, submission in prep for OOPSLA'16 *Partial impl. in Encore*	In prep. *Implementation on-going*	Published OOPSLA'15, submission in prep for OOPSLA'16

Encore Compiler



- Haskell front-end and C back-end
- **Currently:** Source-to-source translation from Encore to (readable) C
- **Future:** replace C back-end with LLVM back-end

- LLVM back-end will enable ”deep optimisations”, e.g.,
  - alias analysis
  - allocation analysis



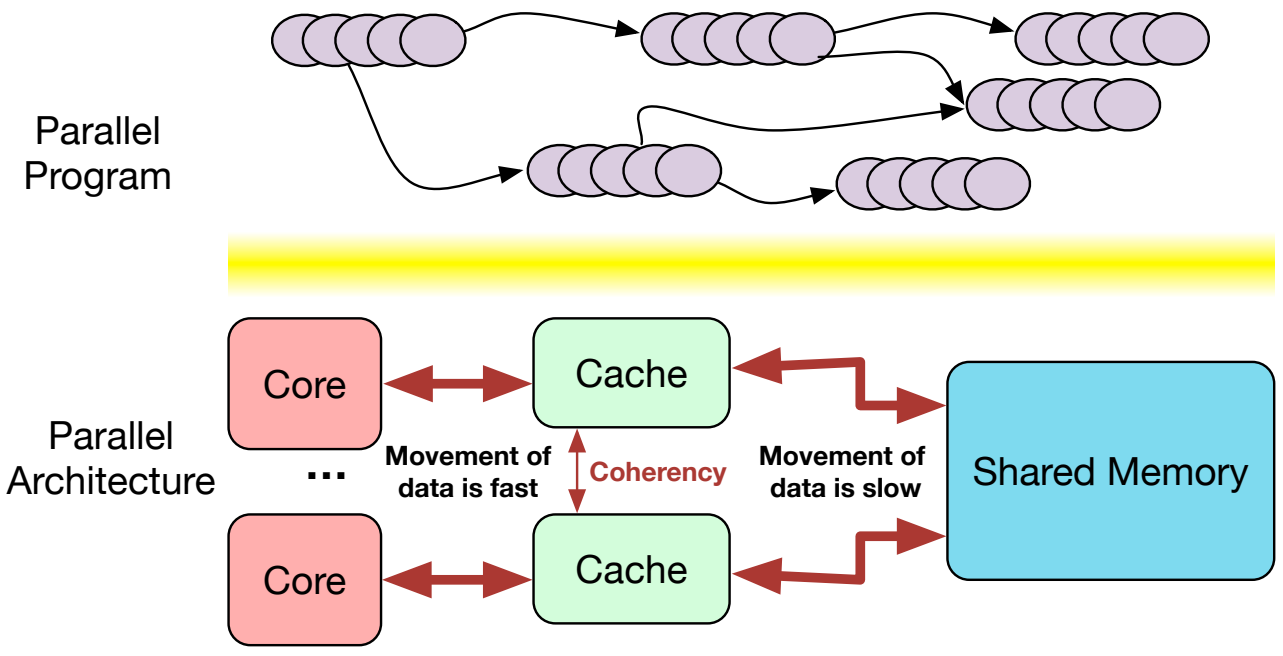
An Overview of UPSCALE @ OSLO

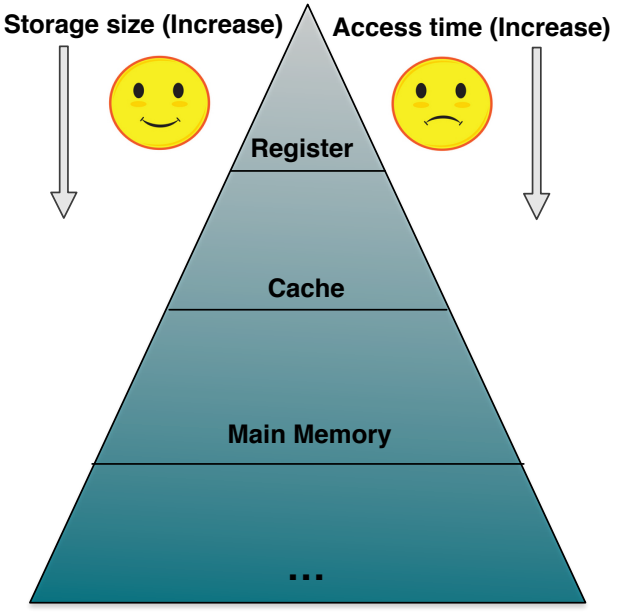
UiO : Department of Informatics
University of Oslo

Shiji Bijo, Einar Broch Johnsen, Violet Ka I Pun, S. Lizeth Tapia Tarifa

Modelling Execution of Programs in Parallel Architectures

UiO : Department of Informatics
University of Oslo





- Model-based exploration of deployment concerns for multicore architectures
- Guide decisions about scheduling, load-balancing and locality using abstract models of architectures

Achievements

Problem: Understand how data moves between caches and memory

- Approach: Formal model of multicore architectures with cores, caches and memory
- Details: SOS with labels for parallel communication between cores
- Difficulties: model the parallel communication, cache coherency
- Status: Accepted paper at SAC 2016, MUSEPAT track

Problem: Enable exploration in the abstract model

- Approach: Enable measurements and configurable parameters in the model
- Details: Executable model for simulations and analysis implemented in Maude
- Difficulties: Transform declarative aspects of the SOS to make the model executable
- Status: Accepted paper at WRLA2016

Problem: Establish a formal basis for the development of Encore

- Approach: SOS of a fragment of Encore via a calculus called μEncore
- Details: concurrency model of Encore with strong notion of locality
- Difficulties: SOS with sheep cloning and closures
- Status: Collaboration with Uppsala University. Book chapter at SFM 2015

Ongoing Work

Problem: Extend the model with multilevel caches in an abstract way

- Approach: Define an abstract notion of penalty to capture the distance to the data
- Details: Categorize tasks in classes reflecting average/worst-case data access
- Difficulties: Extract the worst-case abstract description from real programs
- Status: Ideas still in early phase

Problem: Scheduling decisions depending on data layout - model

- Approach: Make the scheduler in the model aware of where data is located
- Details: Annotations determine data layout, infer logical locations for data accesses
- Difficulties: Use behavioural descriptions to infer better scheduling
- Status: Collaboration with Imperial College London. Work in progress.

CWI

An Overview of UPSCALE @ CWI

Keyvan Azadbakht, Frank de Boer

CWI

Overview

- **Transferring parallelism from inter-object to intra-object level**
  - Notion of Multi-threaded Actors
- **Extending the notion of Cooperative Scheduling**
  - Efficient await on boolean conditions by means of Promises in Haskell

Cooperative Scheduling

- **Await on boolean conditions in a wait-notify manner by means of promises**
  - Extending ABS2Haskell to support the await
- **The Preferential Attachment case study**
  - Well-known problem in the context of social networks
  - The solution:
    - No need for explicit complex low-level synchronization mechanisms
    - Implemented in ABS and compiled in ABS2Haskell

Multi-threaded Actors

- **Active objects share a queue of messages**
  - A notion complementary to COG in ABS where the objects share the control
  - The Actor contains active objects and has an identity and the shared queue
  - The temporal order of the events with the same values of synchronized arguments is guaranteed on activation.
- **Operational semantics**
- **Type system**
- **Runtime system in Java 8**

HAPPY BIRTHDAY

FRANK