



Miking Workshop 2024

Digital Futures Hub

Stockholm, December 4, 2024

David Broman

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Head of Division, Software and Computer Systems (SCS)
Associate Director Faculty, Digital Futures

digital futures

WASP | WALLENBERG AI,
AUTONOMOUS SYSTEMS
AND SOFTWARE PROGRAM

Vetenskapsrådet
(VR)

TECOSA




Financially supported by the
Swedish Foundation for
Strategic Research.

Miking Contributors (Alphabetic Order)

David Broman	Viktor Palmkvist
Elias Castegren	Theo Puranen Åhfeldt
Gizem Çaylak	William Rågstad
Oscar Eriksson	Viktor Senderov
Mattias Grenfeldt	Linnea Stjerna
Lars Hummelgren	John Wikman
Jan Kudlicka	Marten Voorberg
Daniel Lundén	Anders Ågren Thuné
Didrik Munther	Joey Öhman
Asta Olofsson	



Part I
Workshop Overview

A black notebook with the word 'AGENDA' written in white capital letters on its cover, resting on a dark brown wooden surface.

Part II
Overview of the Miking Framework

A detailed black and white photograph of intricate wood carving, showing complex, swirling patterns and textures.



Part I

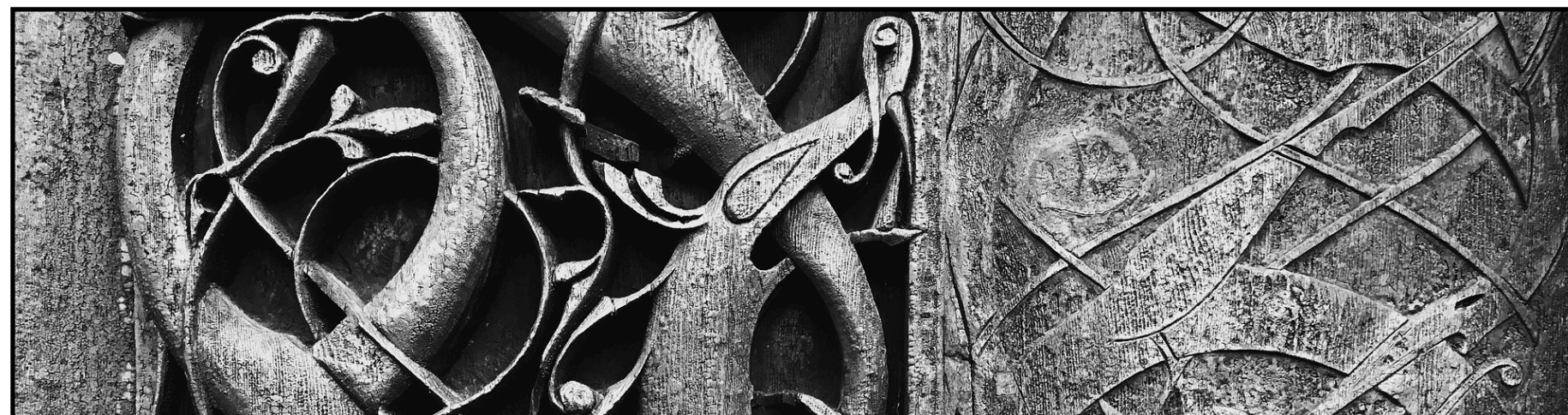
Workshop Overview





Agenda

Miking Workshop 2024



10.00 Registration and Coffee

10.30 Welcome and Introduction to Miking.

Speaker: David Broman

11.15 Coffee break

11:30 Tutorial: Parsing with Miking using Resolvable Ambiguity

Speaker: Viktor Palmkvist

12.00 Lunch

13:00 Session 1: Next generation of Miking: Types and Tool Support

- Title: *Language Composition through Product Extension and Its Use Cases for DSL Development*. Speaker: Marten Voorberg
- Title: *Empowering DSLs with Automated Language Server Generation*. Speaker: Didrik Munther

13:30 Hacking session 1: Getting started and playing around

Organizers: The Miking core team

14:15 Session 2: Optimized and Efficient Domain-Specific Languages

- Title: *Partial Evaluation of Automatic Differentiation for Differential-Algebraic Equations Solvers*. Speaker: Oscar Ericsson
- Title: *Trellis: A Domain-Specific Language for Hidden Markov Models with Sparse Transitions*. Speaker: Lars Hummelgren
- Title: *Automated Inference Optimizations in the Probabilistic Programming Language Miking CorePPL*. Speaker: Gizem Caylak

15.00 Coffee break

15:30 Session 3: TreePPL - Phylogenetic Inference using Miking

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16.30 Hacking session 2: Try out your favorite DSL or hack on the compiler

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17.00 Conclusions and more happy hacking!



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Use Cases for DSL Development. Speaker:

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-Algebraic Equations Solvers. Speaker: Oscar

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aming Language Miking CorePPL. Speaker:



Part II

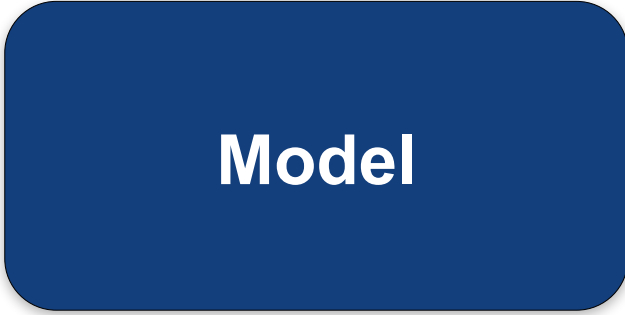
Overview of the Miking Framework





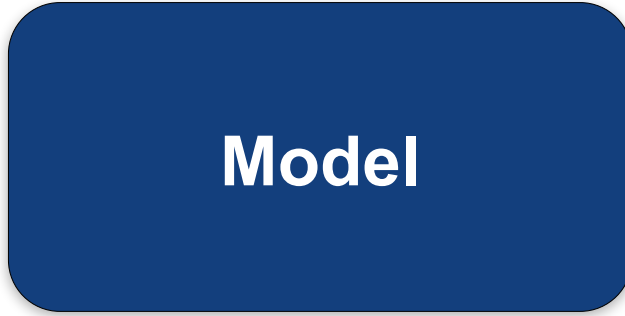
Why models?

Model



Model

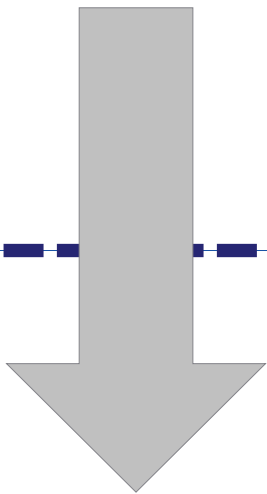
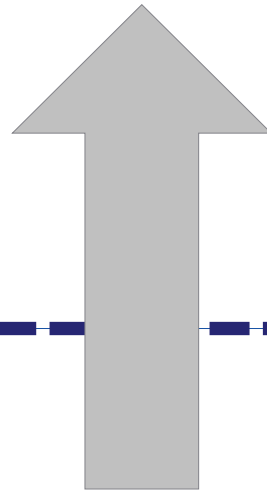
Perform experiments



Model

Why?

- Get insights
- Cheaper
- Too dangerous
- May not exist
- Easier



System



Scientists

Use of Miking

Develop domain-specific modeling languages and compilers

Overall Research Challenge

Combine:

- high-level of abstraction modeling with
- automatically generated efficient compilers



Engineers

Insights from (Lee, 2016) and (Cellier, 1996)



Miking (the Meta vIKING)



Objectives:

- Platform for constructing heterogeneous domain-specific modeling languages
- Polymorphic static type system (based on FreezeML).
- Bootstrapping compiler
- Target constrained real-time systems as well as offline distributed computations
- Efficient compiler - different target platforms
- Research platform
- Open source (MIT license)
- www.miking.org



Related Work

Compiler construction

- Standard Lex, Yacc (external DSL)
- JastAdd (Ekman & Hedin, 2007)

Preprocessing and template metaprogramming

- C++ Templates (Veldhuizen, 1995)
- Template Haskell (Sheard & Peyton Jones, 2002)
- Stratego/XP (Bravenboer et al., 2008)

Embedded DSLs

- Haskell DSEs, e.g., Fran (Elliott & Hudak, 1997), Lava (Bjesse et al. 1998, FHM (Nilsson et al., 2003)
- Scala, e.g. Lightweight modular staging (Rompf and Odersky, 2010)
- Shallow embedding and PE (Leißa et al., 2015)
- Modelyze, Equation-based modeling (2019)
- Python (untyped programming)

Language Workbenches and Languages for creating languages

- SugarJ, MPS, Spoofox, RASCAL, MetaEdit+, Enso⁺, Racket etc.

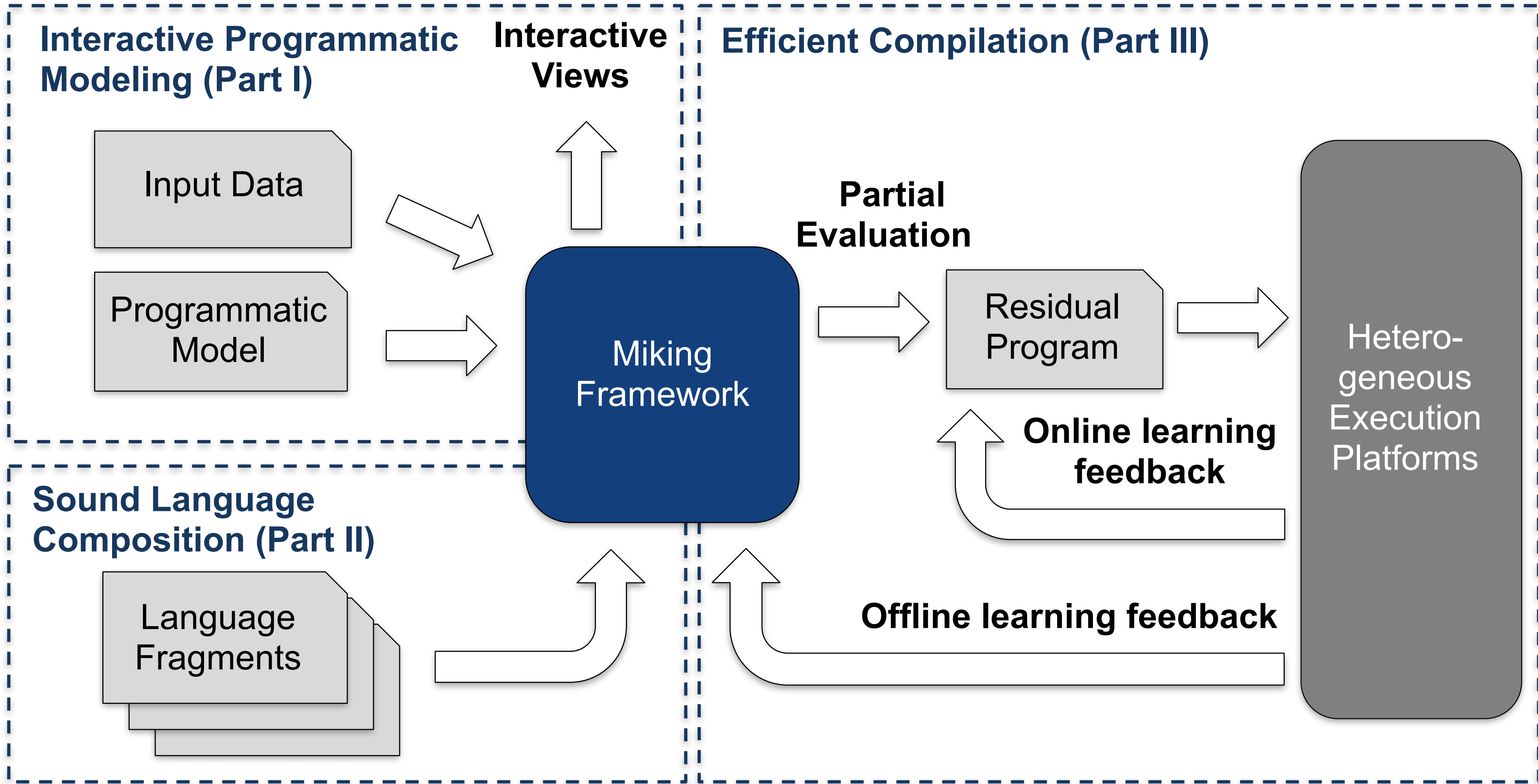
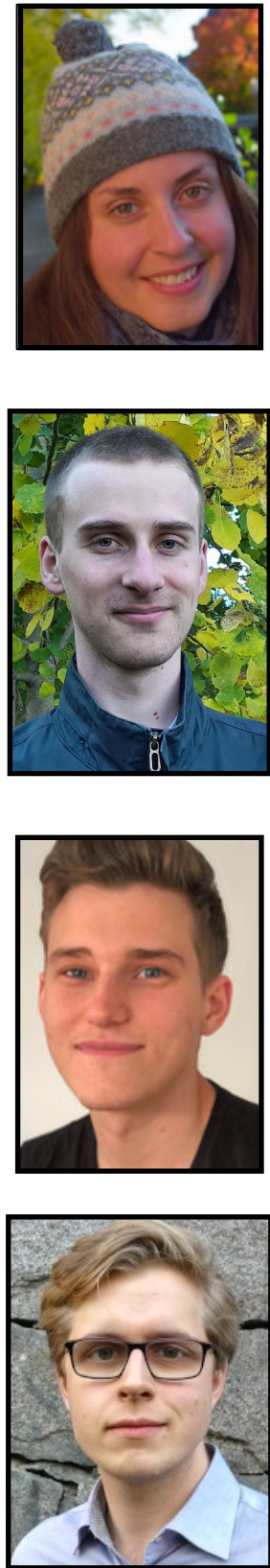
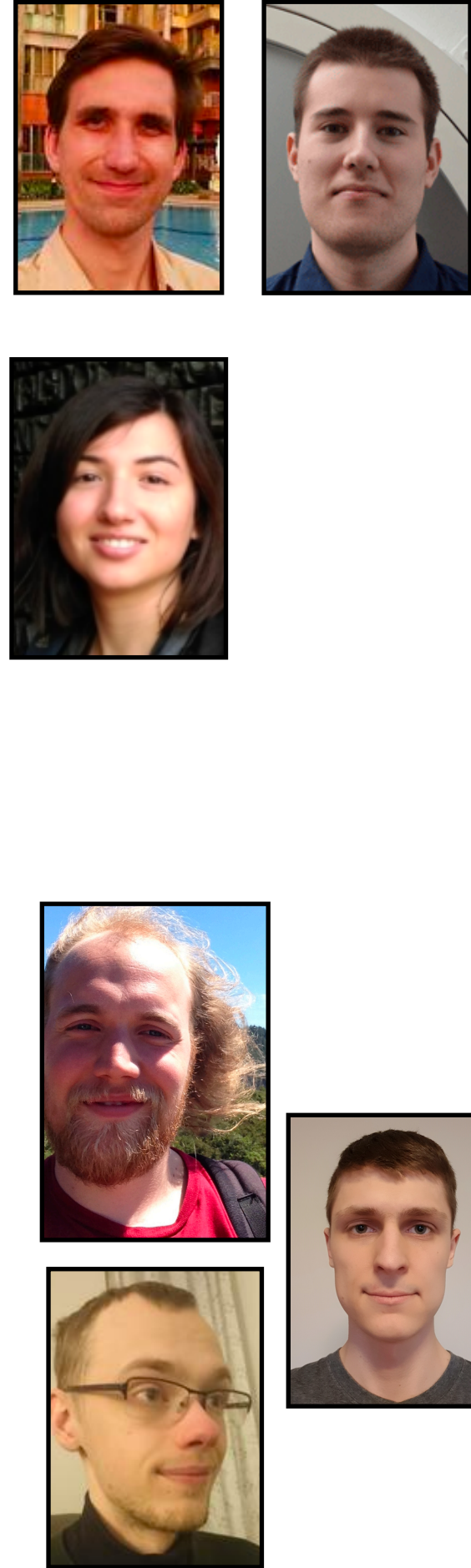




The Vision of Miking



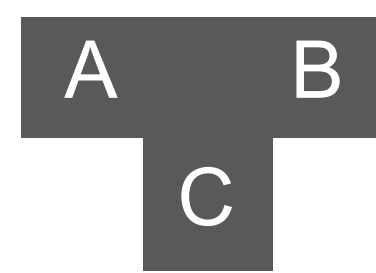
David Broman. **A Vision of Miking: Interactive Programmatic Modeling, Sound Language Composition, and Self-Learning Compilation.** In Proceedings of the 12th ACM SIGPLAN International Conference on Software Language Engineering (SLE 2019), Athens, Greece, ACM, 2019.





Bootstrapping the Miking Compiler

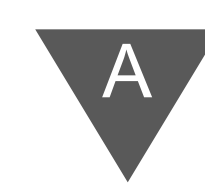
- New
- Generated
- Existing



Compiling language A to B, written in language C



Interpreter written in B, interpreting language A

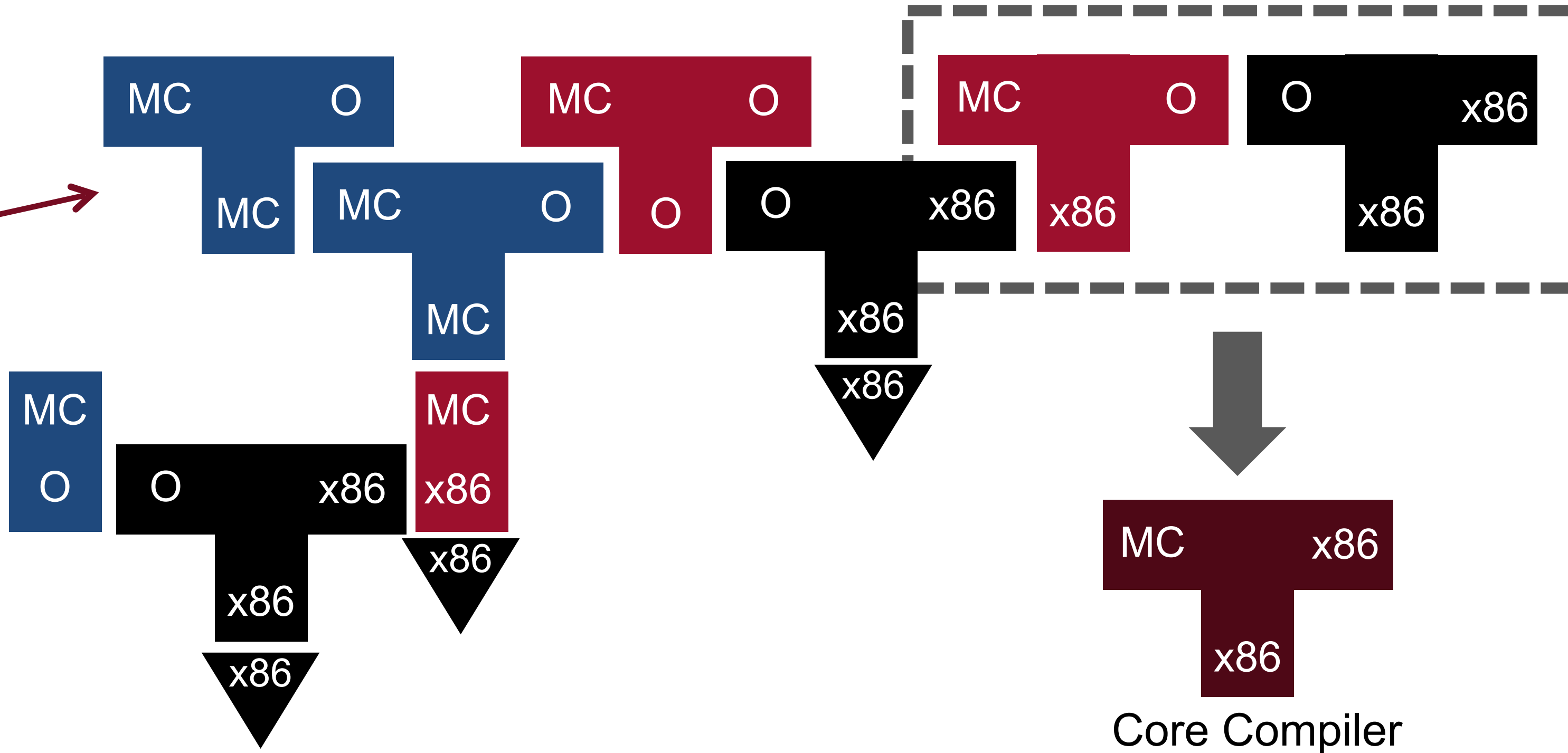


Machine executing language A

MC = MCore
O = OCaml

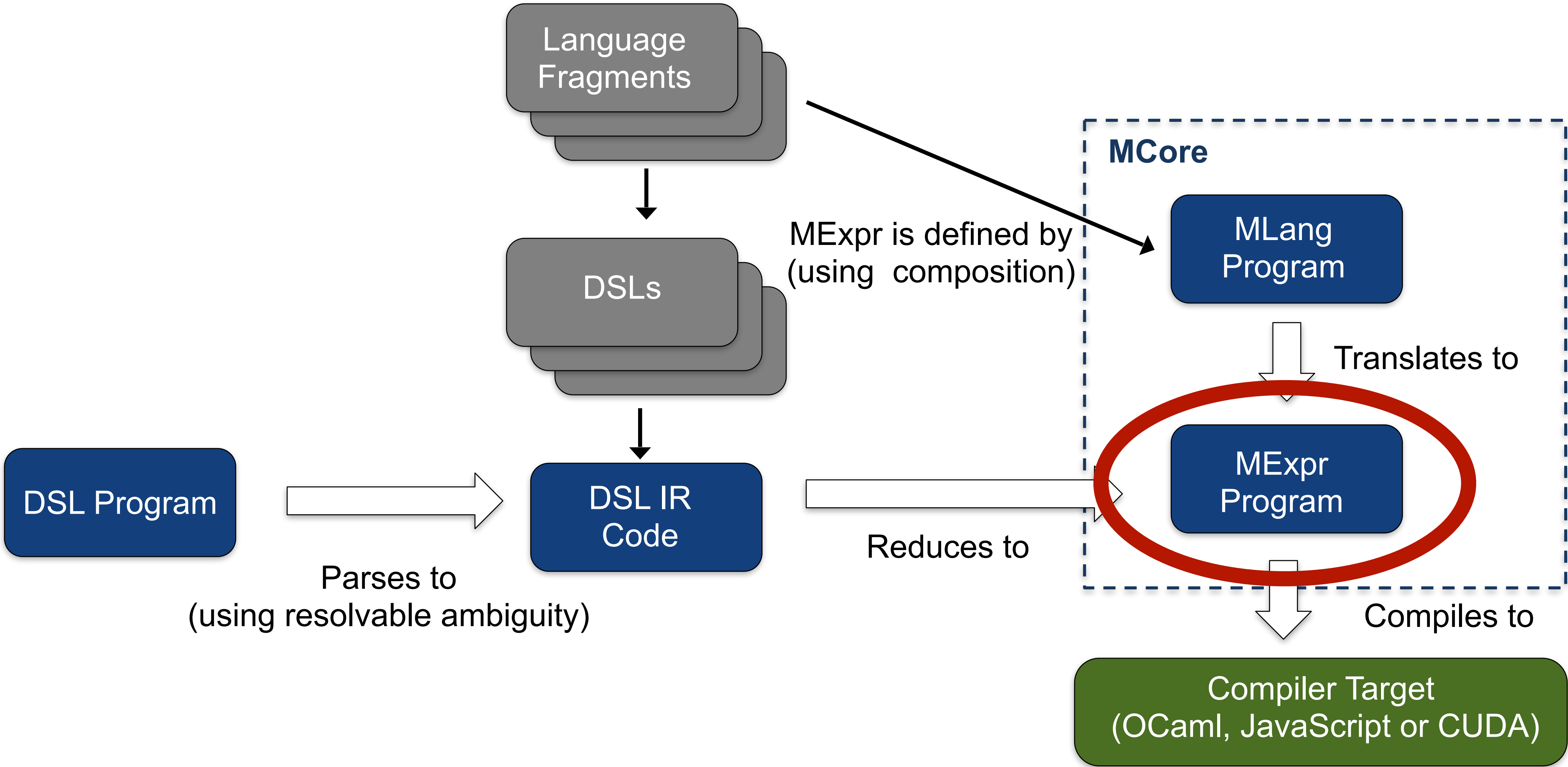
Miking Compiler

Bootstrap interpreter





Overview of the Toolchain





MExpr - the Miking IR

```

type Tree in
con Node : (Tree,Tree) -> Tree in
con Leaf : (Int) -> Tree in

recursive
  let count = lam tree.
    match tree with Node (left,right) then
      addi (count left) (count right)
    else match tree with Leaf v then
      v
    else error "Unknown node"
  in

```

```

let tree3 = Node(Node(Leaf(3),Node(Leaf(2),Leaf(6))),Leaf(12)) in
utest count tree3 with 23 in
()

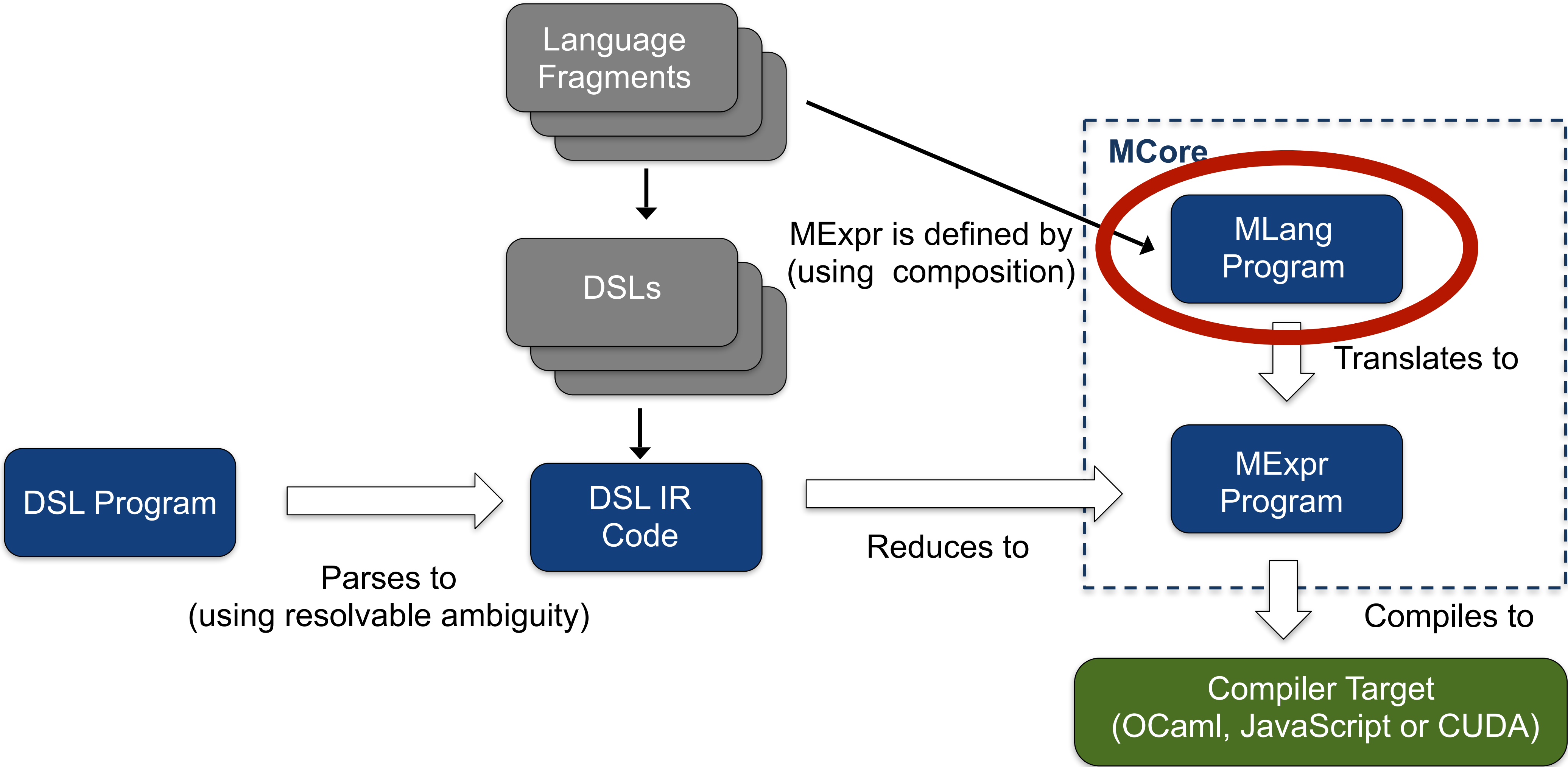
```

Features

- Functional Intermediate language
- Polymorphic Type System - statically typed with type inference
- Intermediate representation - concrete syntax very close to abstract syntax
- Small but complete. Eager, includes references, arrays, sequences, algebraic data types, pattern matching, etc.



Overview of the Toolchain





MLang: Language Fragments and Composition

**syn: defines
extensible
constructors**

```
lang Arith
  syn Expr =
  | Num Int
  | Add (Expr, Expr)
```

**sem: define
extensible
functions**

```
  sem eval =
  | Num n -> Num n
  | Add (e1,e2) ->
    match eval e1 with Num n1 then
      match eval e2 with Num n2 then
        Num (addi n1 n2)
      else error "Not a number"
    else error "Not a number"
  end
```

**use: using a language
fragment in an
expression**

```
mexpr
use Arith in
utest eval (Add (Num 2, Num 3)) with Num 5 in
()
```

Features

- Order-independent pattern matching composition

```
lang MyBool
  syn Expr =
  | True()
  | False()
  | If (Expr, Expr, Expr)
```

**Independent
language
fragment, using
the same syn and
sem names**

```
  sem eval =
  | True() -> True()
  | False() -> False()
  | If(cnd,thn,els) ->
    let cndVal = eval cnd in
    match cndVal with True() then eval thn
    else match cndVal with False() then eval els
    else error "Not a boolean"
  end
```

**Composing
together language
fragments**

```
lang ArithBool = Arith + MyBool

mexpr
use ArithBool in
utest eval (Add (If (False()), Num 0, Num 5), Num 2))
  with Num 7 in
()
```

- Many semantic functions, e.g. ANF transformation, CPS transformation, lambda lifting, symbolizer, etc.



Open Source, building a community

Miking
A framework for constructing efficient domain-specific languages

Development
The Miking framework is an open-source effort that is currently in Beta status. Please visit the Github pages if you would like to contribute to the development.

Vision
Our vision is that Miking will become the leading environment for rapid and efficient development of domain-specific languages. Please see the Miking vision paper for an overview.

Documentation
To learn more, please check out the online documentation for both the Miking core environment, and the domain-specific language for differentiable probabilistic programming, Miking DPPL.

www.miking.org

Miking

Overview | Repositories: 22 | Projects: 1 | Packages: 3 | Teams: 3 | People: 15 | Settings

Pinned

- miking** (Public) - Miking - the meta viking: a meta-language system for creating embedded languages. 38 stars, 22 forks.
- miking-dppl** (Public) - 12 stars, 10 forks.
- miking-benchmarks** (Public) - The general Miking benchmark suite. 5 stars, 6 forks.
- miking-dppl** (Public)

<https://github.com/miking-lang>

Miking Workshop 2022
December 14, 2022, KTH Campus, Digital Futures Hub, Stockholm, Sweden

Welcome to the first Miking workshop! Miking is an open-source project developed at KTH Royal Institute of Technology and is now released officially for the first time. The framework is a meta-language system for creating domain-specific languages and tools. Please see the vision paper, the Miking webpage, or the GitHub pages for more information. In this first workshop, you will learn how to code with the Miking core language and how to create your own domain-specific language using the framework. There will be many interesting hands-on tutorials, technical talks, and research talks. Please bring your laptop!

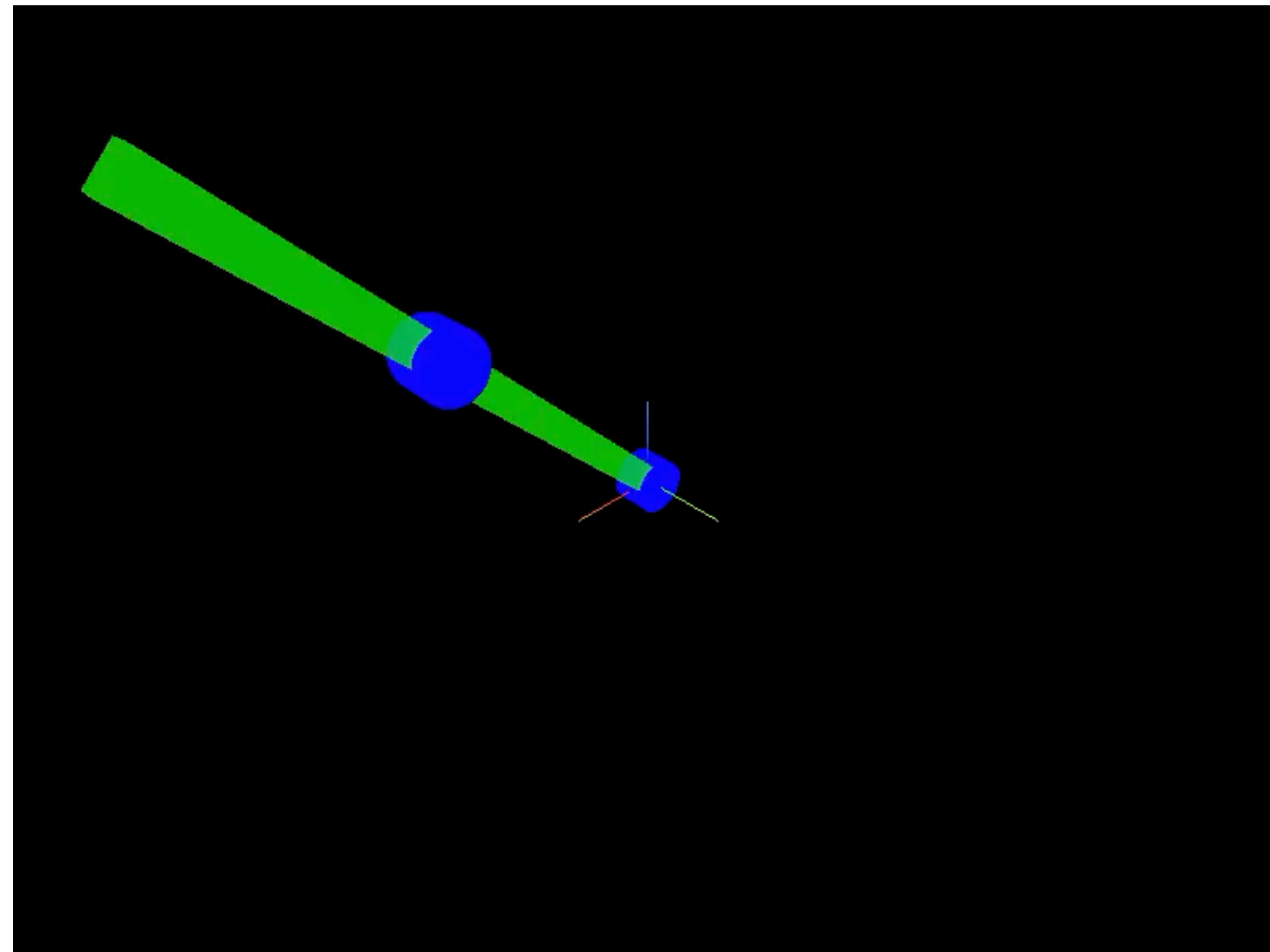
The workshop is free of charge and includes lunch, coffee, and dinner. The format is hybrid. That is, it is possible to attend both in person, and online using Zoom. In both cases, you need to register (first come, first served). The workshop is organized together with Digital Futures. Several organizations have been funding research projects related to the Miking framework, including the Swedish research council (VR), the Swedish Foundation for Strategic Research (SFR), and the Swedish Research Council (SFR).

The first Miking Workshop
(December, 2022, Stockholm)

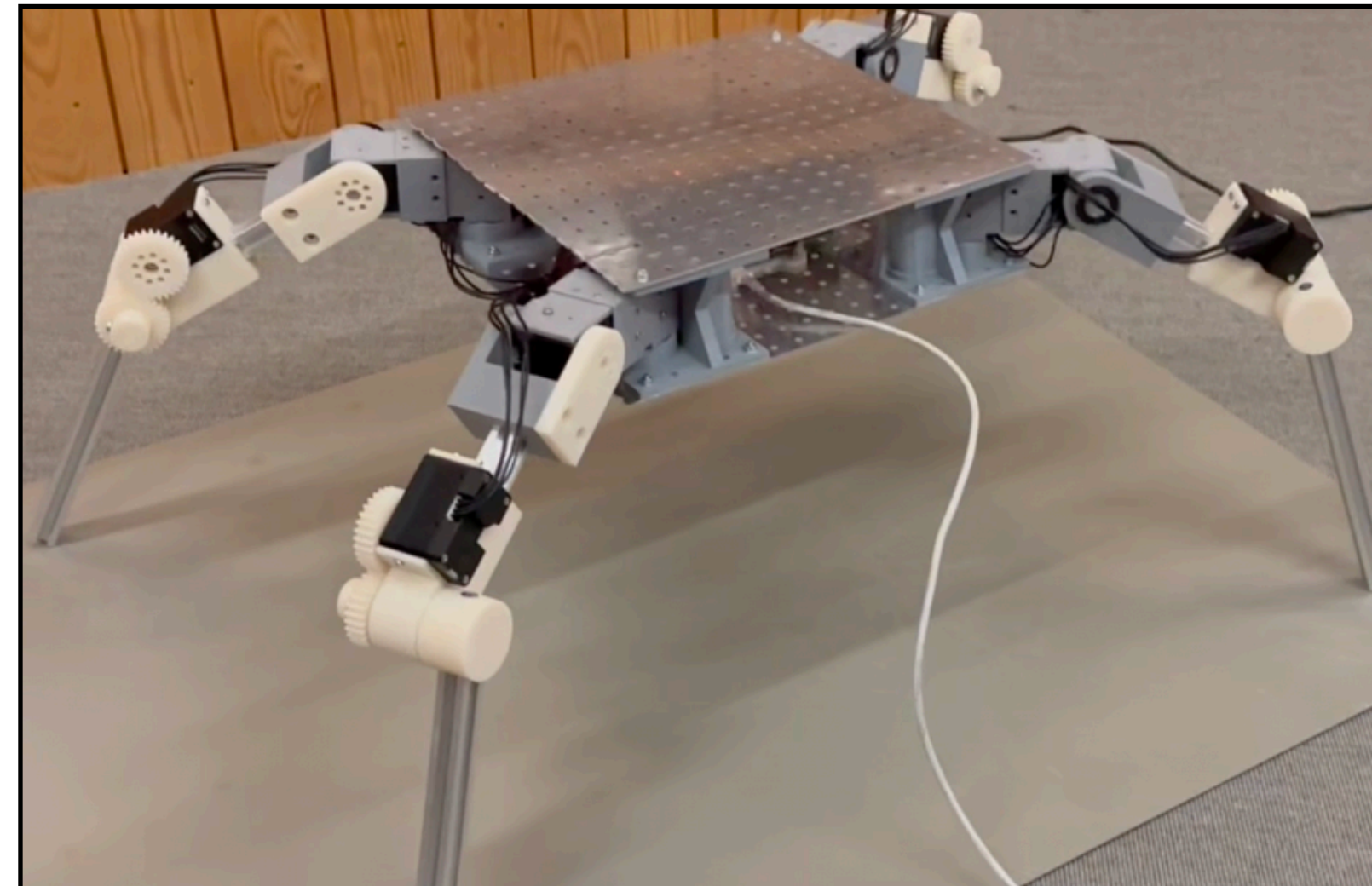


Ongoing Application Areas

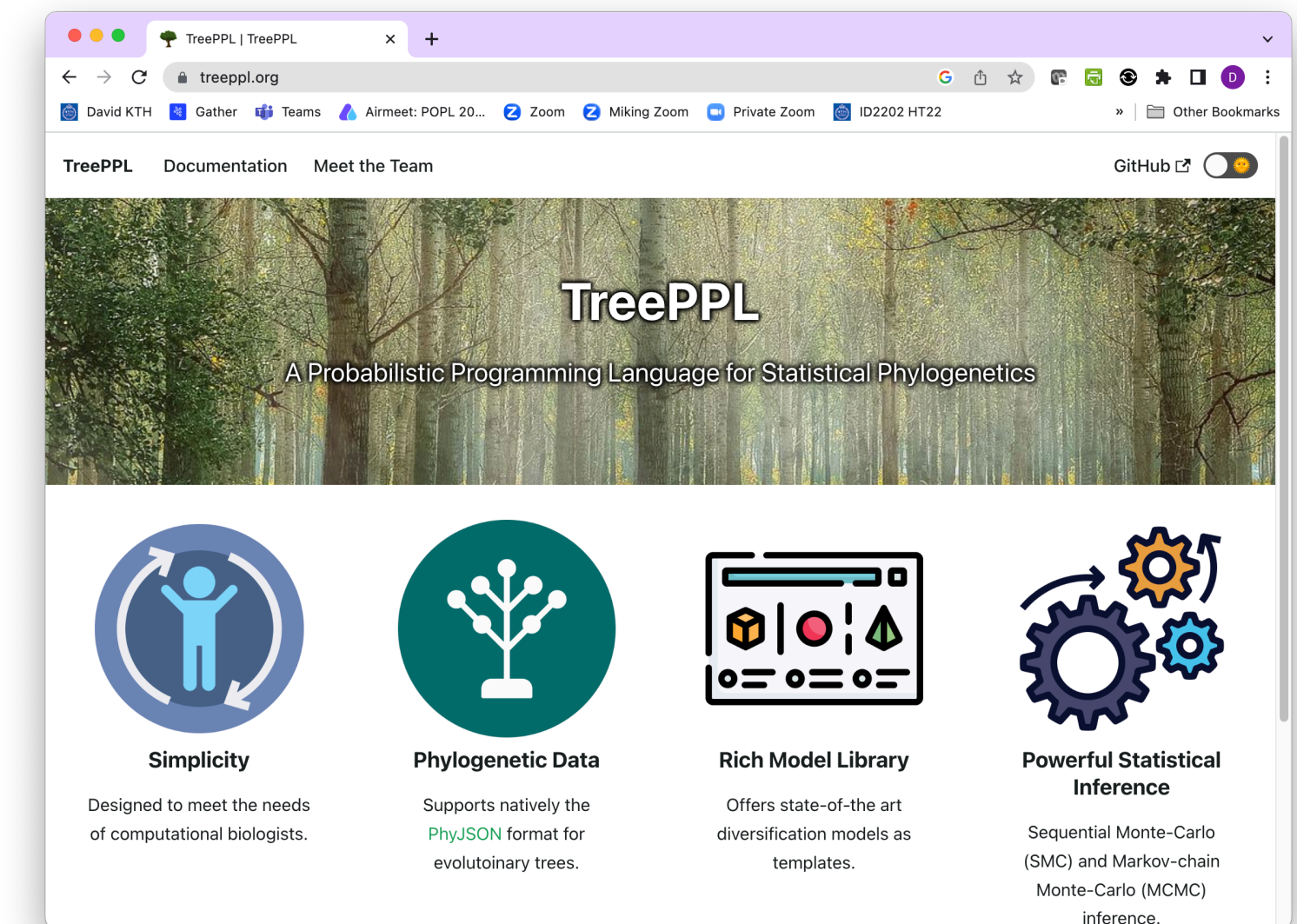
Equation-Based Modeling and Physical Simulation



Robotics and CPS



TreePPL - a DSL for phylogenetics



```
def model2 =
  world -- RevoluteJoint(yhat, q0_1) --
  Bar(1.5 * 1, q0_1) --
  RevoluteJoint(yhat, q0_1) -- Bar(1, q0_2) -- f1
```

Fredrik Ronquist, Jan Kudlicka, Viktor Senderov, Johannes Borgström, Nicolas Lartillot, Daniel Lundén, Lawrence Murray, Thomas B. Schön, and David Broman. **Universal probabilistic programming offers a powerful approach to statistical phylogenetics.** In Communications Biology volume 4, Article number 244, Nature Publishing Group, 2021.



Open Source - MIT license

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Monkey C 38 stars 22 forks 39 (1 issue needs help) 4 issues Updated 7 hours ago
- miking-benchmarks** Public
The general Miking benchmark suite
C++ 5 stars MIT 6 forks 2 issues 1 issue Updated 15 hours ago
- miking-dppl** Public

Top languages
OCaml JavaScript

<https://github.com/miking-lang>



Getting involved

- Thesis research project
- Extending standard library
- Examples and documentation
- Fixing issues

Thanks for listening!

