

Parallel programming with Sklml

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Skeleton programming

Traditional approaches to parallelism (MPI, OpenMP)

- intrusive: **mix sequential** instructions **with parallel** primitives;
- **low level** notations and concepts;
- **fine tune** of parallelism; **very efficient** parallel programs;
- **error prone**: very demanding in programming/debugging effort.

SkIMl approach

- non intrusive: **parallel** code **is apart from sequential** code;
- skeleton combinators: **high level** parallel programming schemes;
- skeleton algebra: **compositional** description of parallelism;
- reliable: **deterministic** parallel execution;
- **D**omain **S**pecific **L**anguage embedded in OCaml.

Skeleton algebra

- skeletons are functions over data streams;
- coarse grain parallelism;
- task parallel combinators: `pipe`, `farm`;
- data parallel combinators: `prod`, `sum`, `farm_vector`, `rails`;
- control combinator: `loop`.

Safety

- **well defined semantics**: given by the sequential interpretation;
- **proof feasibility**: proofs for all basic combinators imply proofs for all programs;
- weak adequacy theorem: **sequential and parallel** versions are compiled from the **same source code**;
- strong adequacy theorem: **sequential and parallel** versions always give the **same results**.

Skeletons in practice

Development methodology

- **develop and debug** using the **sequential** semantics;
- run heavy computations in **parallel** after a simple **recompilation**.

Example

Deploy n_w independent workers computing f , then compose g :

```
farm (skl () -> f, nw) ||| skl () -> g;;
```

Abstraction over combinators

make_domain: **specialized combinator** for domain decomposition.

Foreign languages (C, C++, Fortran)

External communication layer: Pio (**polyglot I/O** library).

Skml is free software available at <http://skml.inria.fr/>.