Programming computers with SkIml

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September 29, 2011

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Several kinds of parallelism

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In several cases, parallelism can be expressed with high level schemes:

- several data, one action (data parallelism);
- several actions, several data (instruction parallelism).

The kind of data and actions on these data can also be a source of parallelism:

- product parallelism: data are (α, β) pairs, actions are pairs of functions (f_α, f_β);
- sum parallelism: data are of two kinds α or β, and actions are specific f_α or f_β.

SkIml goals

The SkIml framework addresses the following problems:

- provide a uniform framework to express common forms of parallelism;
- provide a toolkit to compile and run programs in a fast and simple fashion;
- let the programmer quickly prototype the program to identify the bottlenecks;
- stay functional friendly (type safe, compositional);
- behave the same in parallel and sequential modes.

Sklml skeleton kinds

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As described above, Sklml provides three kinds of skeletons to express parallelism:

- data parallel skeletons;
- instruction parallel skeletons;
- control skeletons.

Complex skeletons are built by composing skeletons. A basic domain decomposition skeleton and a `if-then-else` skeleton has been written using this technique. Those composite skeletons are available in the library `sklml_extra`

The farm skeleton

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The `farm` skeleton performs the same action on a set of data.

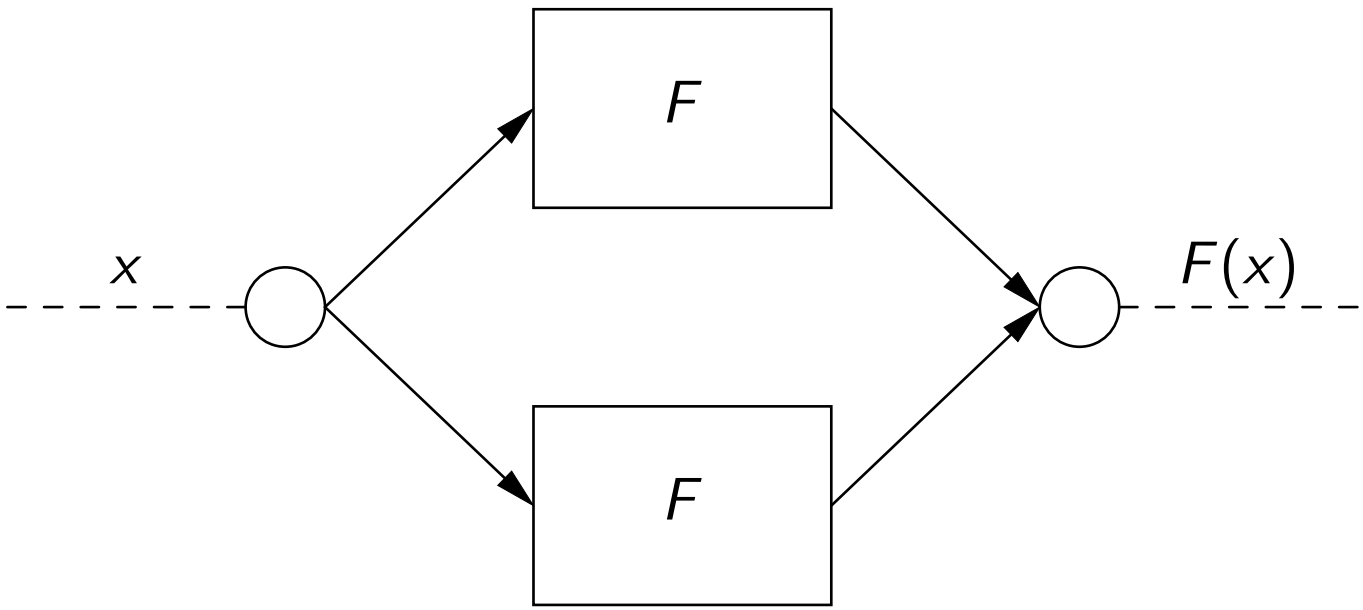

Figure: `farm` F skeleton graph

The product skeleton

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The ***, or product, skeleton applies a pair of functions to a pair of values in parallel.

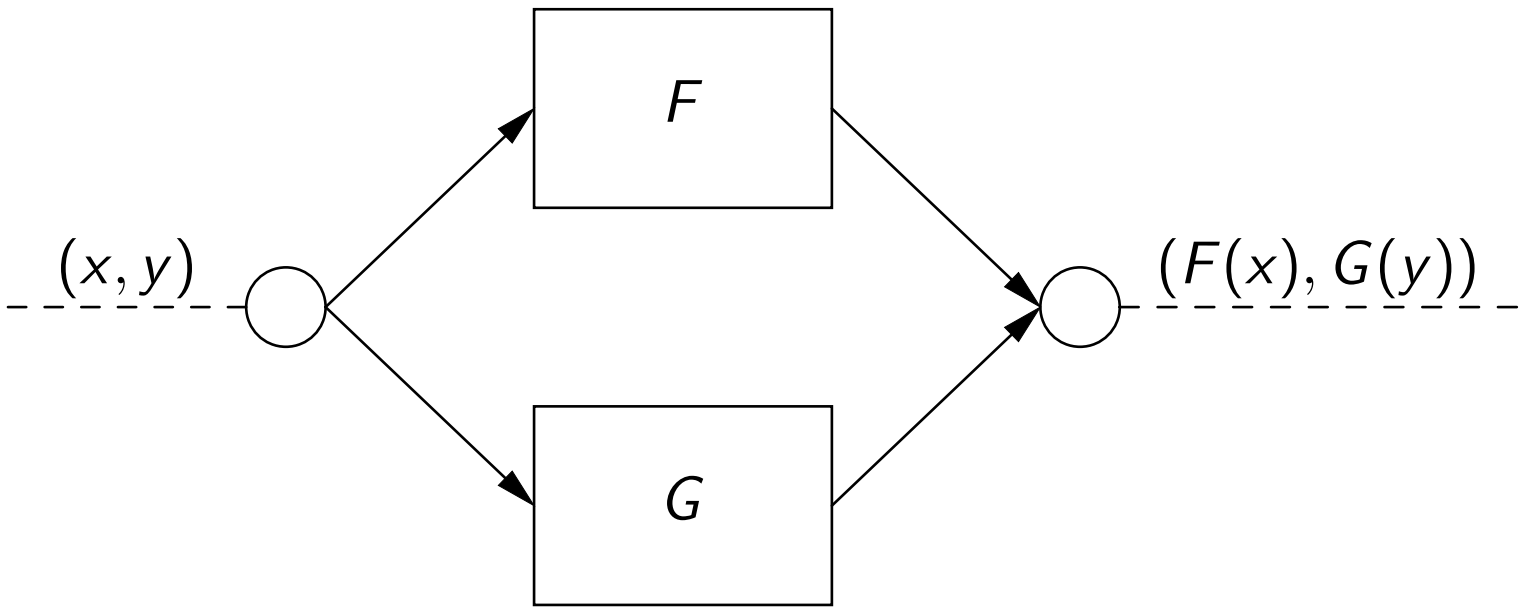

Figure: F *** G skeleton graph

The pipe skeleton

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The |||, or pipe, skeleton is the simplest instruction parallel skeleton: it implements the parallel composition of functions.

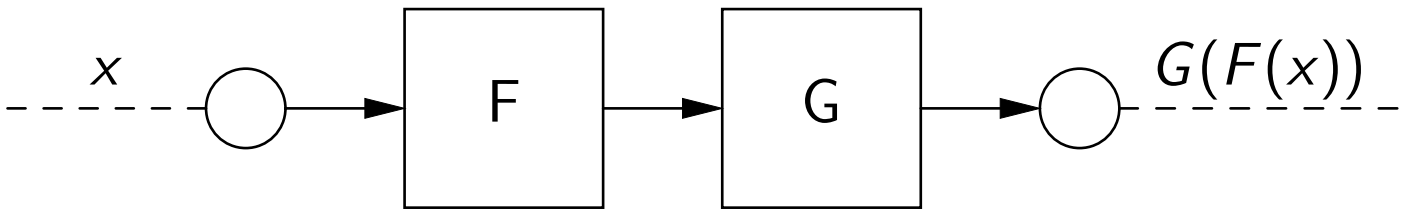

Figure: The F ||| G skeleton graph

The loop skeleton

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The `loop` skeleton is a control skeleton: it computes the fixpoint of a function (composing a function until some predicate becomes `false`).

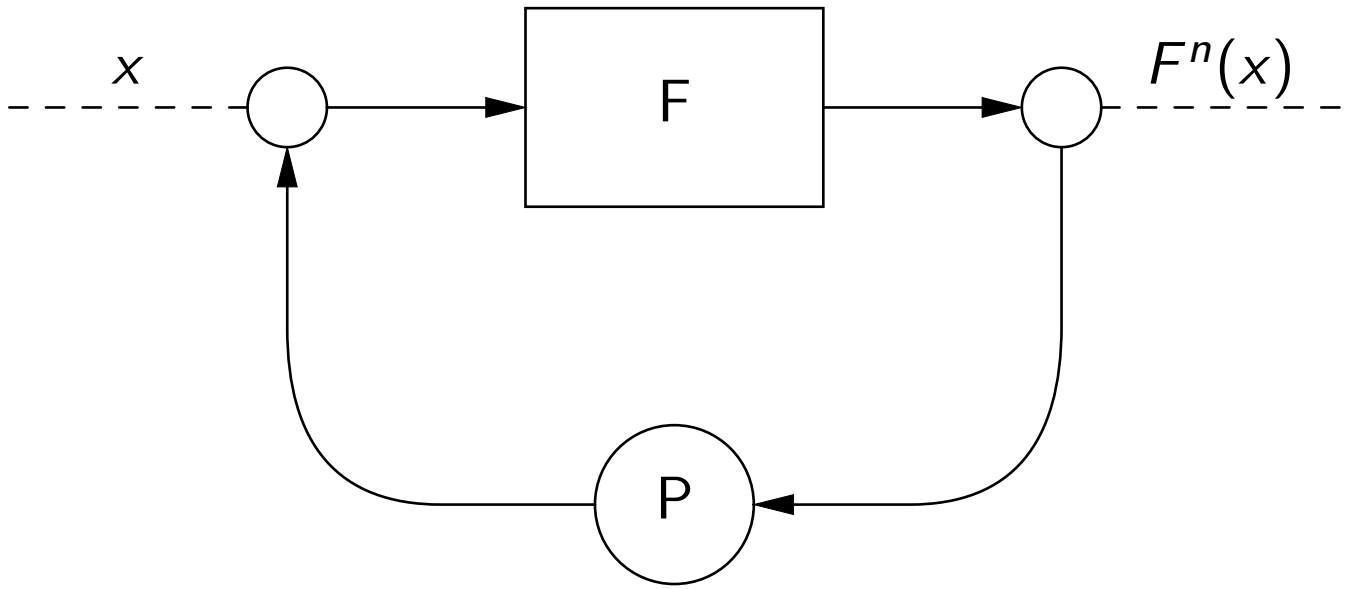

Figure: `loop` (P, F) skeleton graph

Simple skeleton example

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Let's define the skeleton computing the function $(x, y) \mapsto H(F(x), G(y))$.

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Let's define the skeleton computing the function $(x, y) \mapsto H(F(x), G(y))$.

```
let sk = (F *** G) ||| H;;
```

Compiling with `sklmlc`

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Sklml provides a compiler to compile programs either in parallel or sequential mode. This compiler wraps the relevant options to ultimately call the OCaml compiler.
The `-mode` option specifies the desired compiling mode.

```
$ sklmlc -mode seq -o hello.out hello.ml
```

Running Sklml programs

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Running sequential programs is as simple as running any program:

```
$ ./hello.out
```

Sklml provides the `sklrun` helper to run parallel programs:

```
$ sklrun ./hello.out
```