IICoMP Documentation

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Ruymán Reyes

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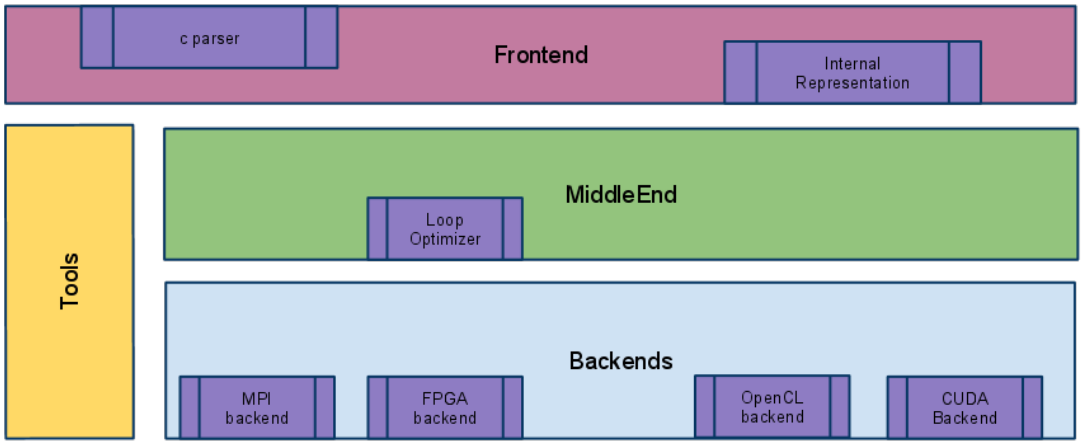
CONTENTS

llCoMP is a translator framework designed for *fast prototyping*. With little effort, you can build translators from OpenMP/C to different High Performance Computing languages, libraries and frameworks. Currently we have implemented the CUDA Backend, but we have plans to implement new ones.



In the diagram (layered_design), the different layers of the framework are exposed.

The uppermost level contains the `Frontend`, which gives the tools required to transform the source code into the internal representation.

The `MiddleEnd` module encapsulates transformations from the IR to the IR, for example, loop optimizations or type data conversions.

Finally `Backends` module contains all the implemented backends

Tools to manipulate the internal representation (and do some other stuff), are packaged on the `Tools` module.

In addition, some utils and examples are presented in order to show the capabilities of the framework.

Contents:

CHAPTER

ONE

FRONTEND

The frontend module builds the internal representation from a source file.

Two modules, representing the two phases of the code parsing, are written.

1.1 Parsing Tools

1.2 Internal Representation

CHAPTER

TWO

BACKENDS

The `Backends` module packages the different backends implemented on the compiler.

The `Common` module contains common classes for all backends.

The `DotBackend` module is able to translate the *Internal Representation* (IR) to *Dot language*, which may be printed with graphviz.

The `CBackend` module contains writers capable of converting the IR to C or OpenMP code.

Module `CudaBackend` encapsulates Mutators, Visitors and Writers, capable of translating the IR to CUDA code.

2.1 Common

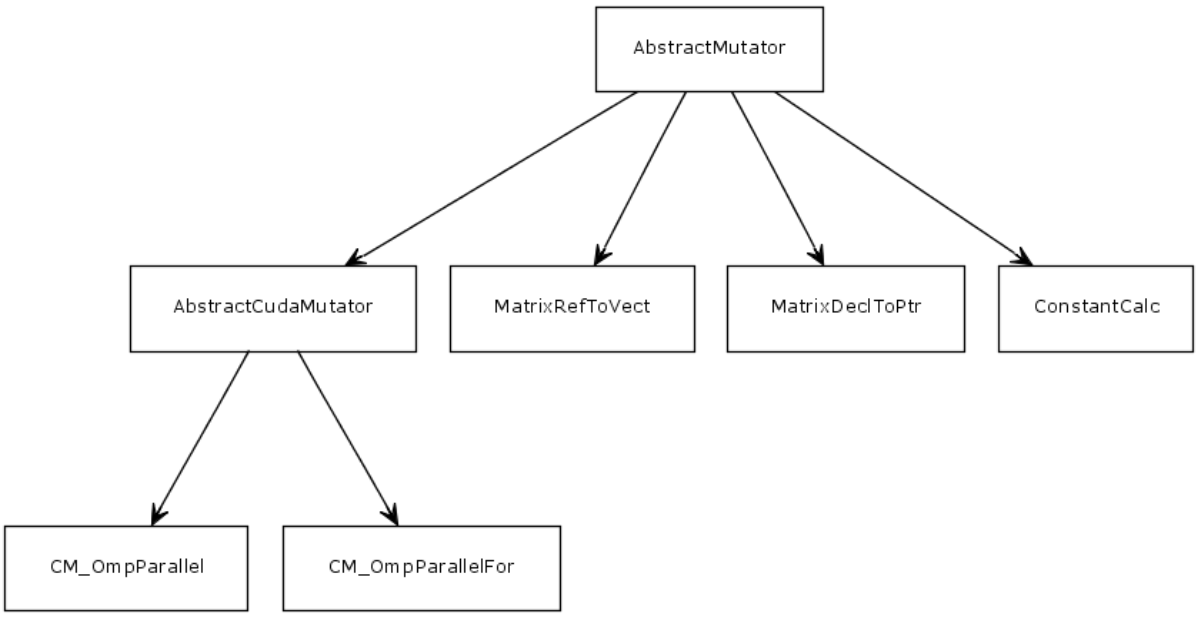
The Common module contains common operations to the different backends.

2.1.1 Mutators

Some *Mutator* are declared on the `Mutators` module.

AbstractMutator

As you may see on the diagram, all mutators inherits from `AbstractMutator`.



class `AbstractMutator`()
Abstract class representing a mutation.

`apply`(*ast, mutator_opt_arg=None*)
Apply a mutation

Returns filtered node

`apply_all`(*ast, mutator_opt_arg=None*)
Apply mutation to all matches

Returns pointer to last applied mutation

`fast_apply_all`(*ast*)
Apply mutation to all matches ignoring syntactic order

Returns pointer to last applied mutation

`filter`(*ast*)
Calls to a simple filter

`filter_iterator`(*ast*)
Calls an iterable filter

`mutatorFunction`(*ast*)
Mutates the AST

Returns Starting point of the mutation

AstSupport

Additional mutators are provided in order to easier the backend writing process.

class `DeclsToParamsMutator`()
DeclsToParams

`convert`(*node*)
Transform a type declaration to a parameter declaration

`filter`(*ast*)
Filter definition Returns the first node matching with the filter

`mutatorFunction`(*ast*)
Mutator code

class `FuncToDeviceMutator`(*func_call*)
Replace the definition of a FuncCall with a CUDAKernel with type __device__

`filter`(*ast*)
Find the declaration of the

class `IDNameMutator`(*old, new*)
Replace and ID name with another ID name

class `RemoveAttributeMutator`(*attr*)
Remove the child of the first apperance of an attribute inside a node

`apply`(*ast*)
Apply the mutation

2.1.2 Filter visitors

Warning: Mabye a name change is needed, *SearchVisitor* will be more clear.

Warning: Some cleaning needs to be done in this module.

In order to search nodes on the AST, the programmer needs to implements a *Filter*. `GenericFilterVisitor` is the parent of all filters, defining the commom methods of all filters.

This module has other members, which are concrete implementations of the `GenericFilterVisitor`.

class **`GenericFilterVisitor`**(*condition_func, prev_brother=None*)

Returns the first node validating a condition function

`apply`(*ast, ignore=, []*)

Searchs the node matching the condition_func in the AST

Parameters

- *ast* – Node to start search
- *ignore* – List of nodes to ignore

Returns First matching node not in ignore list

`dfs_iter`(*root, visited=None*)

Given a starting node, root, do a depth-first search. .. warning:

```
This method does not garantee to transverse the tree on the gramatically correct order
```

Returns Last match or raise StopIteration

`generic_visit`(*node, offset=0, ignore=, []*)

Called if no explicit visitor function exists for a node. Implements preorder (syntactically correct) node visit.

param node Node being visited

param prev Syntactically previous node

param offset Not used

param ignore List of nodes to ignore

return Result of the node visit

`iterate`(*ast*)

Iterate through matching nodes

Parameter *ast* – Node to start the search

`parentOfMatch`()

Parent of the node matched

Note: This is not needed because we have a .parent attribute now

`visit`(*node, prev, offset=1, ignore=, []*)

Finds a way to visit a node

Parameters

- *node* – Node to visit
- *prev* – Syntactically previous node
- *offset* – Not used
- *ignore* – List of nodes to ignore

Returns result of the node visit

2.2 Dot Backend

The `DotBackend` module contains a `DotWriter`, capable of produce Dot language code from the IR.

This backend is used in the `Tools.Debug` tool.

The `DotWriter` implements a visitor pattern.

class **DotWriter** (*filename=None, highlight=None*)
Generates Dot code from the IR

generic_visit (*node, offset=0*)
Called if no explicit visitor function exists for a node. Implements preorder visiting of the node.

get_name (*node*)
Get the name of a node

Note: This method requires further explanation

Parameter *node* – Node to get the name

visit (*node, offset=0*)
Visit a node

write_highlights ()
Write a label to highlight nodes

The nodes to highlight come from self.highlight

write_label (*node, name*)
Write a label for a node

Parameters

- *node* – Label of node
- *name* – Name of the line

write_line (*begin, name, end*)
Write a connection between two nodes

Parameters

- *begin* – Start node
- *end* – End node
- *name* – Name of the line

2.3 CBackend

The `CBackend` module contains two writers, `CWriter` and `OmpWriter`, which produces **C** and **OpenMP** code

Note: This backend is widely used on llCoMP.

class **CWriter** (*filename=None, stream=None*)
A visitor which translates the IR to plain C code

generic_visit_nodeList (*nodeList, separator, offset*)
Visit a list of nodes , writing values within a separator

class **OmpWriter** (*filename=None, stream=None*)
Visitor which translates the IR to C/OpenMP.

2.4 CUDA Backend

The `CudaBackend` module contains a set of Mutators, Filters and Templates which creates CUDA code from the IR.

2.4.1 Filters

class **`OmpForFilter`**(*prev_brother=None*)
Returns a OmpFor node , the parallel container and the function container

By defining specific visitor methods for *FuncDef* and *OmpParallel*, we can save the last node visited of this types. Giving the fact that the visit is done in syntax order, the last visited node will be the previous (parent) node of the wanted node.

`iterate`(*ast*)
Iterate through matching nodes

class **`OmpParallelFilter`**(*condition_func=None, prev_brother=None, device=None*)
Returns a OmpParallel node , the parallel container and the function container

By defining specific visitor methods for *FuncDef* and *OmpParallel*, we can save the last node visited of this types. Giving the fact that the visit is done in syntax order, the last visited node will be the previous (parent) node of the wanted node.

`parallel_condition`(*node*)
OmpParallel filter

`visit_OmpTargetDevice`(*node, prev, offset=1, ignore=, []*)
Save target device node

class **`OmpParallelForFilter`**(*prev_brother=None, device=None*)
Returns a *omp parallel for* construct

class **`OmpThreadPrivateFilter`**(*prev_brother=None*)
Returns the ThreadPrivate constructs

2.4.2 Templates

Currently, templates are held inside `Mutators` code.

2.4.3 Mutators

A separate Mutator have been written for each OpenMP construct. Their parent is `Backends.CudaBackend.Mutators.Common`

class **`AbstractCudaMutator`**(*clauses=None, kernel_name='loopKernel', kernel_prefix=''*)
Common methods to work with CUDA

`buildDeclarations`(*numThreads, reduction_node_list, shared_node_list, ast*)
Builds the declaration section @param numThreads number of threads @return Declarations subtree

`buildHostReduction`(*reduction_vars, ast*)
Instanciate the reduction pattern

@return Compound with the reduction code

`buildKernel`(*shared_list, private_list, reduction_list, loop, ast*)
Build CUDA Kernel code

`getThreadNum`(*node*)
Gets the maximum number of threads needed

get_names (*elem, ast*)
Return a list of names for a type

The following constructs have been implemented:

OpenMP Parallel **OpenMP Parallel For**

class CM_OmpParallelFor (*clauses=None, kernel_name='loopKernel', kernel_prefix=''*)
This mutator locates a omp parallel for reduction, and then translate the original source to an equivalent cuda implementation

apply_all (*ast*)
Apply mutation to all matches

@return last node changed

filter (*ast*)
Filter definition

@return first node matching with the filter

mutatorFunction (*ast, ompFor_node*)
Main mutator for OpenMP Parallel For construct

Writes the optimized code of an OpenMP Parallel For construct, building a kernel overwriting the for loop.

OpenMP for

automodule:: Backends.CudaBackend.Mutators.CM_OmpFor members:

CHAPTER

THREE

TOOLS

A set of tools have been developed in order to easier the work with the internal representation.

3.1 Tree Tools

Tree manipulation tools

3.2 Serialization Tools

3.3 Declarations Tools

Provide functionality to look for declarations on the AST

3.4 Debug Tools

CHAPTER

FOUR

GLOSSARY

Mutator A mutator is...

Filter A filter is...

Rest Rest is...

CHAPTER

FIVE

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