TUTORIAL

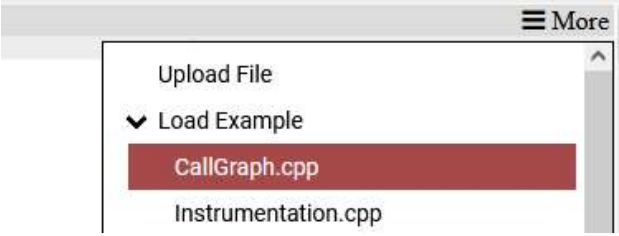
CLAVA

Tutorial - Preparation

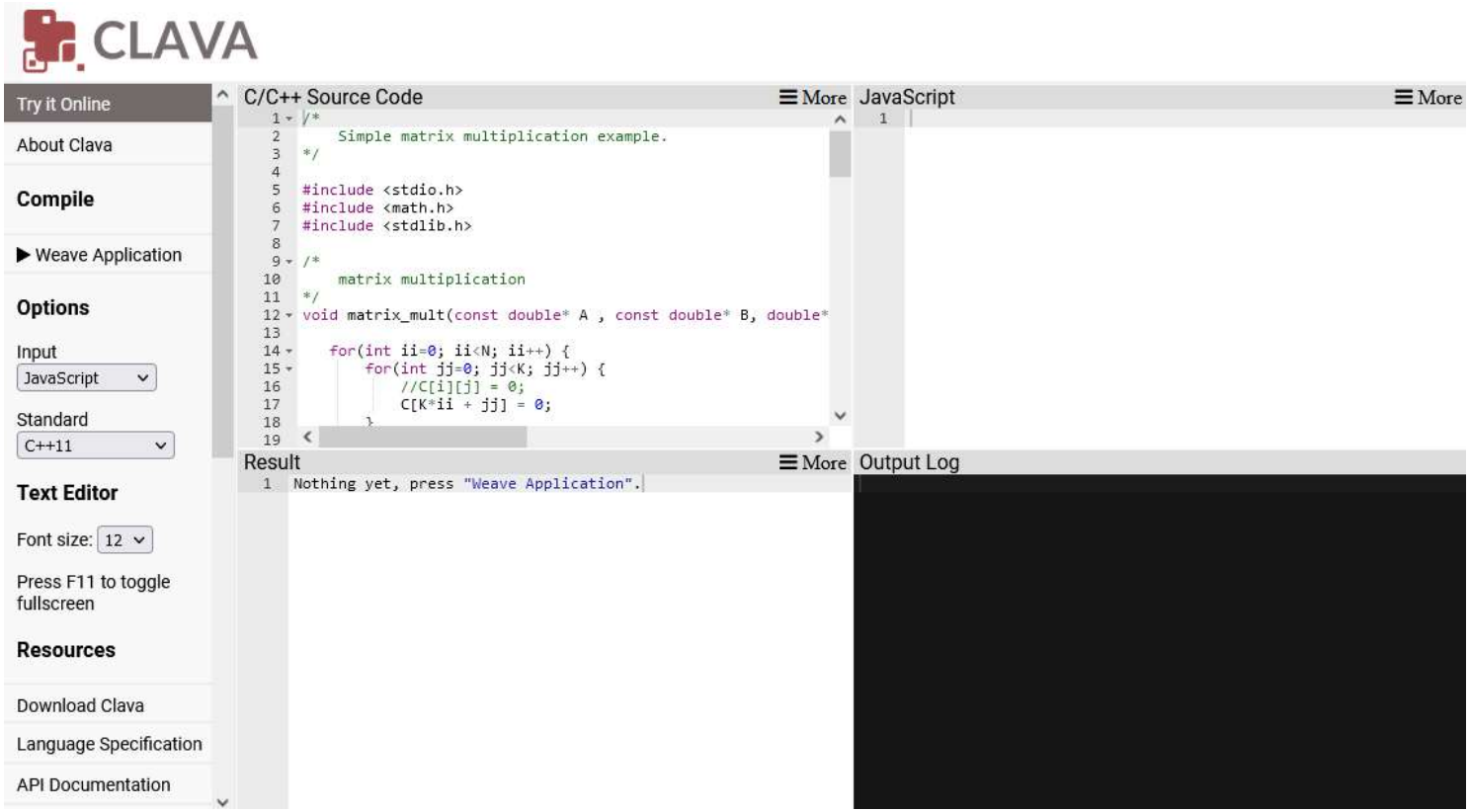
- Open Clava temporary demo website
  - **http://specs.fe.up.pt/tools/clava/**

- Delete contents of top-right area

- To reload C/C++ example:
  - More->Load Example->CallGraph.cpp



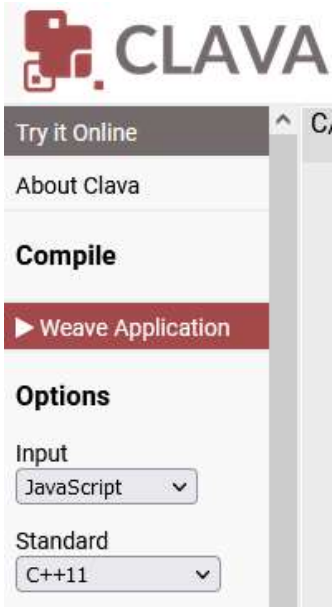
Tutorial - Preparation



Tutorial – Hello World

- JavaScript box
  - `println("Hello World")`

- Press “Weave Application”



Tutorial – Node types (Ex1)

Use Query API to get and print the AST root node

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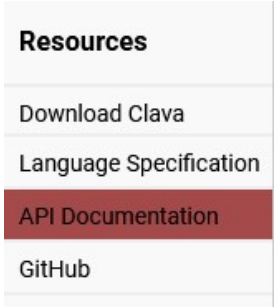
Use Query API to get and print the AST root node

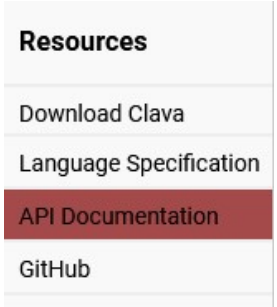
- Check API Documentation



Tutorial – Node types (Ex1)

Use Query API to get and print the AST root node

- Check API Documentation



- Find “Query” class

- Find out how to get the root node

Tutorial – Node types (Ex1)

Use Query API to get and print the AST root node

```
laraImport("weaver.Query");

println(Query.root());
```

Output Log

```
'program'
```

Tutorial – Node Attributes (Ex2)

Print code of root node

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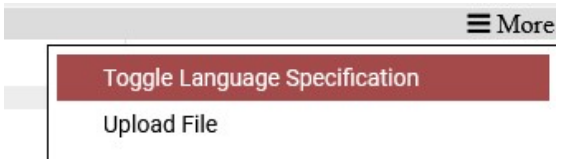
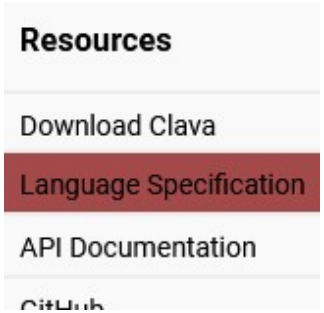
Print code of root node

- Language Specification
  - Toggle Language Specification
  - …or open Language Specification page
- Find attribute ‘code’
- To access attribute code: `node.code`





Tutorial – Node Attributes (Ex2)

Print code of root node

```
laraImport("weaver.Query");

println(Query.root().code);
```

Output Log

```
/**** File 'weaved.cpp' ****/

#include <stdio.h>
#include <math.h>
#include <stdlib.h>
/*
Simple matrix multiplication example.
*/
/*
matrix multiplication
*/
void matrix_mult(double const *A, double c
  for(int ii = 0; ii < N; iiit) {
```

Tutorial – Node Attributes (Ex3)

Print filenames of the files of the program

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Print filenames of the files of the program

- Get files from an attribute in program
- Get filename from an attribute in file

Tutorial – Node Attributes (Ex3)

Print filenames of the files of the program

```
laraImport("weaver.Query");

println(Query.root().files
  .map(file => file.filename))
```

Output Log

```
weaved.cpp
```

Tutorial – AST Structure (Ex4)

What are the types of the children of a 'function' node?

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- Use the attribute 'dump' to print the AST

Tutorial – AST Structure (Ex4)

What are the types of the children of a 'function' node?

R.: param and body

```
laraImport("weaver.Query");

println(Query.root().dump);
```

Output Log

```
'program'
   'file'
      'include'
      'include'
      'include'
      'comment'
      'comment'
      'function'
         'param'
         'param'
         'param'
         'param'
         'param'
         'param'
         'body'
            'loop'
               'declStmt'
                  'vardecl'
                     'intLiteral'
               'exprStmt'
                  'binaryOp'
                     'varref'
                     'varref'
```

Tutorial – AST Navigation (Ex5)

Print the name of all functions that start with the letter 'm'

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Print the name of all functions that start with the letter 'm'

- Check documentation of "Query" class
- Check the method "search()" of Query

Tutorial – AST Navigation (Ex5)

Print the name of all functions that start with the letter 'm'

R.: matrix_mult, main

Output Log
matrix_mult,main

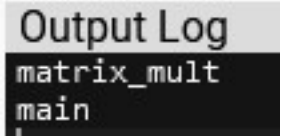
```
laraImport("weaver.Query");

println(Query.search("function", {name: /^m.*/})
              .get()
              .map(f => f.name))
```

Tutorial – AST Navigation (Ex5)

Print the name of all functions that start with the letter 'm'

R.: matrix_mult, main



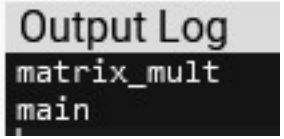

```
laraImport("weaver.Query");

for(const f of Query.search("function", {name: /^m.*/}))
{
    println(f.name)
}
```

Tutorial – AST Navigation (Ex5)

Print the name of all functions that start with the letter 'm'

R.: matrix_mult, main




```
laraImport("weaver.Query");

for(const f of Query.search("function",
                            {name: n => n.startsWith("m")})) {
    println(f.name)
}
```

Tutorial – AST Navigation (Ex6)

Print all <function> - <call> pairs

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Print all <function> - <call> pairs

- E.g. `main->test_matrix_mul, test_matrix_mul->matrix_mult,…`
- `Query.search()` returns a `weaver.Selector`
- Chained searches
  - Method 1: `Selector.search()` + `Selector.chain()`
  - Method 2: Nested `for` + `Query.searchFrom()`

Tutorial – AST Navigation (Ex6)

Print all <function> - <call> pairs

Output Log

```
init_matrix->rand,print_matrix_result->printf,
```

```
laraImport("weaver.Query");

println(Query.search("function")
             .search("call")
             .chain()
             .map(ch => ch.function.name
                      +"->"+ch.call.name)
)
```

Tutorial – AST Navigation (Ex6)

Print all <function> - <call> pairs

Output Log

```
init_matrix->rand
print_matrix_result->printf
test_matrix_mul->malloc
```

```
laraImport("weaver.Query");

for(const f of Query.search("function")) {
 for(const c of Query.searchFrom(f, "call")) {
   println(f.name+"->"+c.name)
 }
}
```

Tutorial – AST Transformation (Ex7)

Insert a comment before each call, with format "// <call_name>"

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Insert a comment before each call, with format "// <call_name>"

- "Actions" section in Language Specification

- Actions change the AST

- Actions for inserting code
  - `insertBefore(node|String)`
  - `insertAfter(node|String)`

Tutorial – AST Transformation (Ex7)

Insert a comment before each call, with format "// <call_name>"

```
int main() {
   // To make results repeatable
   // srand
   srand(0);
   // test_matrix_mul
   test_matrix_mul();
}
```

```
laraImport("weaver.Query");

Query.search("call").get()
     .forEach(c => c.insertBefore("// "+c.name))
```

Tutorial – AST Transformation (Ex8)

Insert a printf before each call that prints “<call_name>@<line>”

Tutorial – AST Transformation (Ex8)

Insert a printf before each call that prints "<call_name>@<line>"

- JavaScript template literals/string might help

- Can use `Clava.rebuild()` to test generated code syntax
  - `laraImport("clava.Clava")`

Tutorial – AST Transformation (Ex8)

Insert a printf before each call that prints "<call_name>@<line>"

```
laraImport("weaver.Query");

Query.search("call")
      .get()
      .forEach(c => c.insertBefore(
         `printf("${c.name}@${c.line}\\n");`
         )
      )
```

```
int main() {
   printf("srand@86\n");
   // To make results repeatable
   srand(0);
   printf("test_matrix_mul@88\n");
   test_matrix_mul();
}
```

Tutorial – AST Transformation

- What about includes?

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  - `call.ancestor("file").addInclude("stdio.h", true)`

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  - `Clava.isCxx()`

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- What about includes?
  - `call.ancestor("file").addInclude("stdio.h", true)`
- What if C++?
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- Seems a lot of work, is there a better way?

Tutorial – AST Transformation

- What about includes?
  - `call.ancestor("file").addInclude("stdio.h", true)`
- What if C++?
  - `Clava.isCxx()`
- Seems a lot of work, is there a better way?
  - Encapsulate complex functionality in an API

Tutorial – AST Transformation (Ex9)

Insert a printf before each call that prints "<call_name>@<line>", using the Logger API (i.e. lara.code.Logger)

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Insert a printf before each call that prints "<call_name>@<line>", using the Logger API (i.e. lara.code.Logger)

- Instantiate a Logger object

- Methods `text()`, `ln()` and `log()` might be useful

Tutorial – AST Transformation (Ex9)

Insert a printf before each call that prints "<call_name>@<line>", using the Logger API (i.e. lara.code.Logger)

```
laraImport("weaver.Query");
laraImport("lara.code.Logger");
const logger = new Logger();

Query.search("call").get().forEach(c =>
      logger.text(`${c.name}@${c.line}`)
      .ln()
      .log(c, true))
```

```
int main() {
   std::cout << "srand@86" << "\n";
   // To make results repeatable
   srand(0);
   std::cout << "test_matrix_mul@88" << "\n";
   test_matrix_mul();
}
```

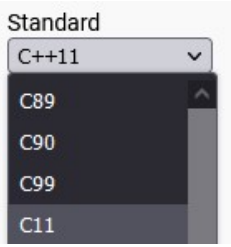
Tutorial – AST Transformation (Ex9)

Insert a printf before each call that prints "<call_name>@<line>", using the Logger API (i.e. lara.code.Logger)

```
int main() {
   printf("srand@86\n");
   // To make results repeatable
   srand(0);
   printf("test_matrix_mul@88\n");
   test_matrix_mul();
}
```

```
laraImport("weaver.Query");
laraImport("lara.code.Logger");
const logger = new Logger();

Query.search("call").get().forEach(c =>
      logger.text(`${c.name}@${c.line}`)
      .ln()
      .log(c, true))
```



Tutorial – AST Transformation (Ex10)

Use Timer API to measure execution time of `matrix_mult` calls

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Use Timer API to measure execution time of `matrix_mult` calls

- Import `lara.code.Timer`

Tutorial – AST Transformation (Ex10)

Use Timer API to measure execution time of `matrix_mult` calls

```
laraImport("weaver.Query");
laraImport("lara.code.Timer");
const timer = new Timer();

Query.search("call", "matrix_mult")
      .get()
      .forEach(c =>
              timer.time(c,`Time ${c.name}@${c.line}:`))
```

```
std::chrono::high_resolution_clock::
// do: C = A*B
matrix_mult(A, B, C, N, M, K);
std::chrono::high_resolution_clock::
auto clava_timing_duration_0 = std::
std::cout << "Time matrix_mult@77:"
```