Code optimization in GCC

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FRANCE

Introduction

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Front-ends / back-end

GCC

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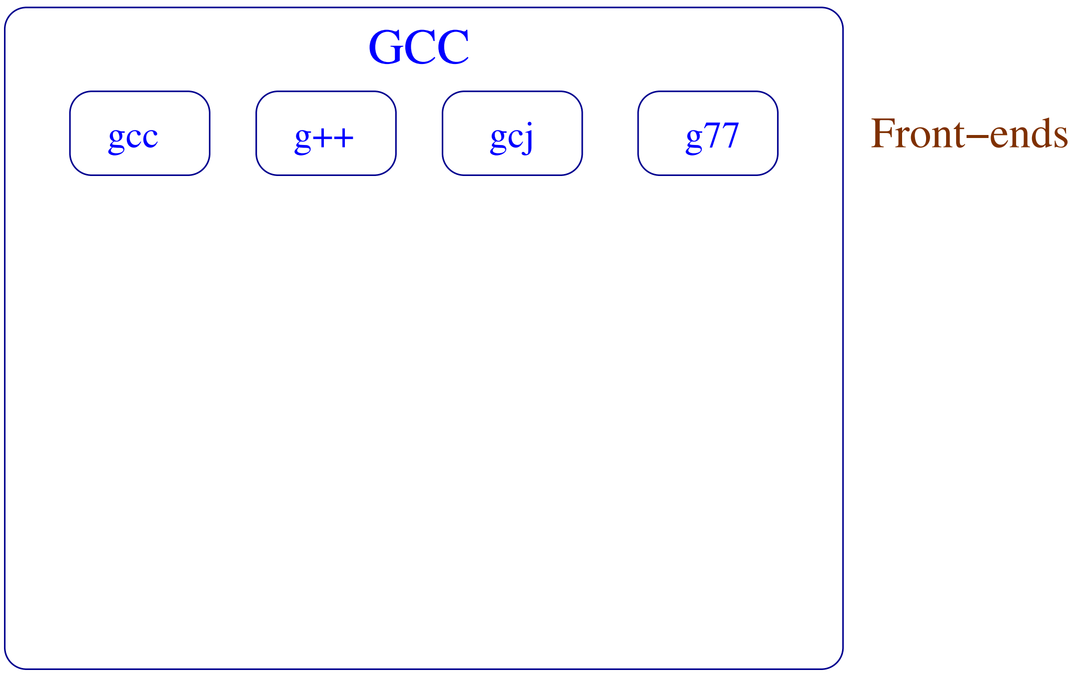

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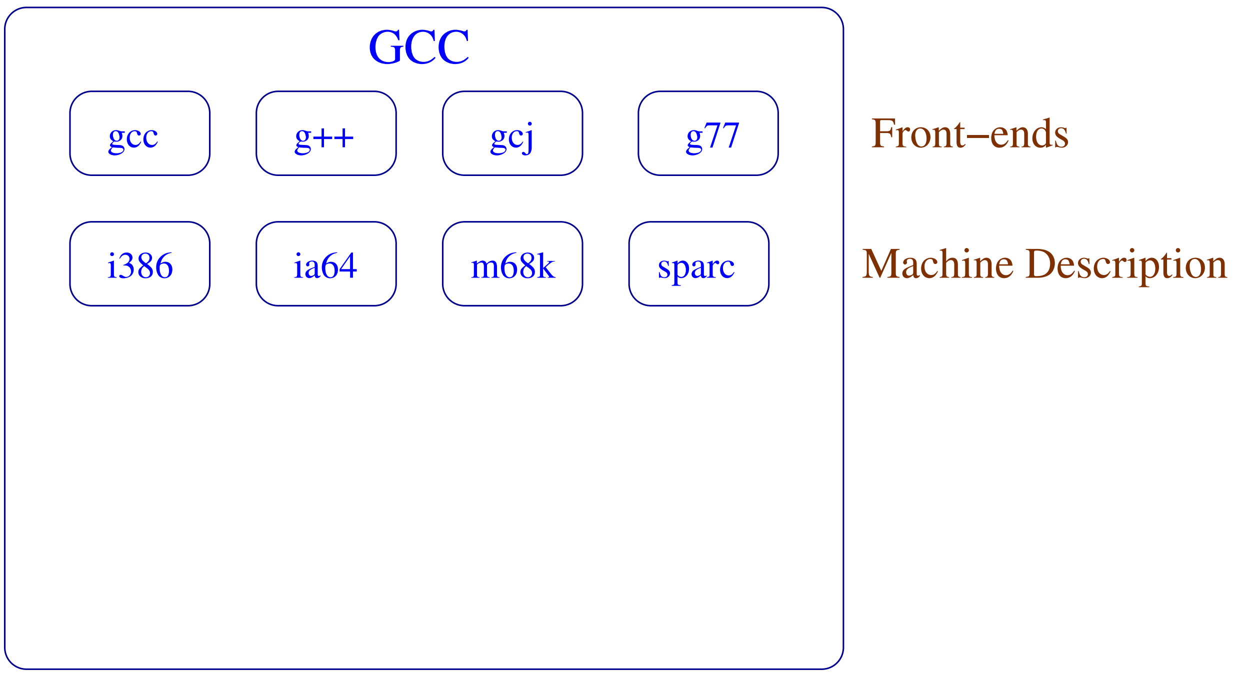

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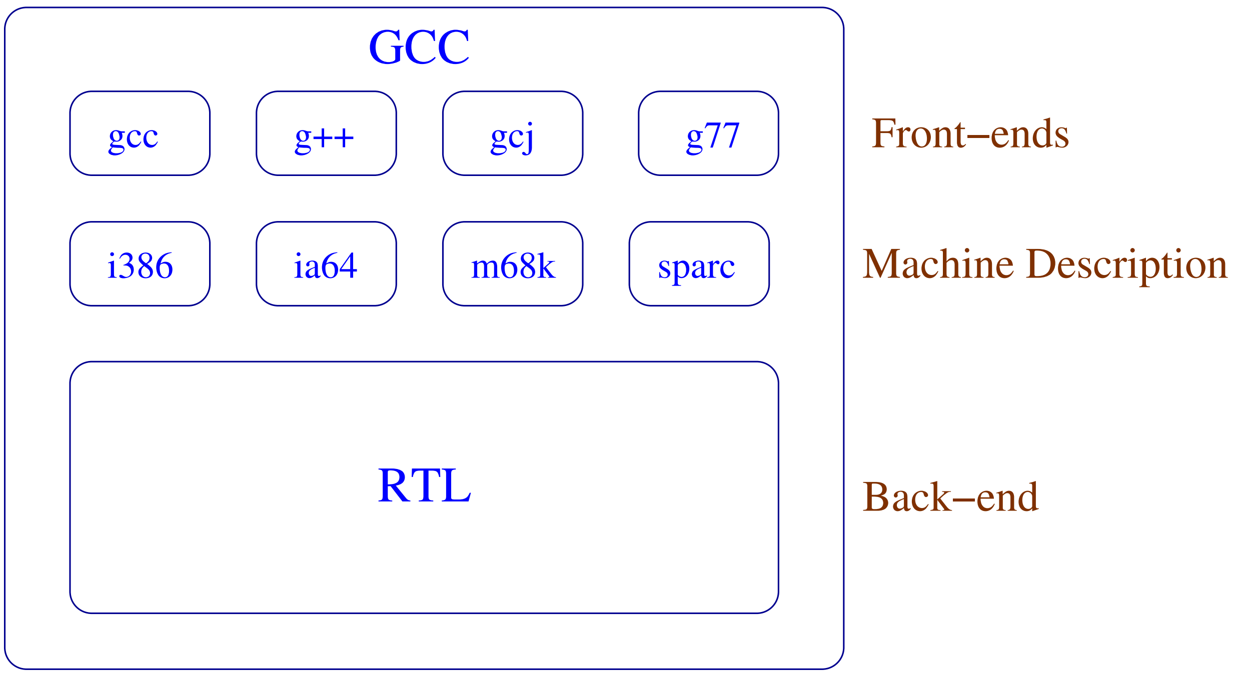

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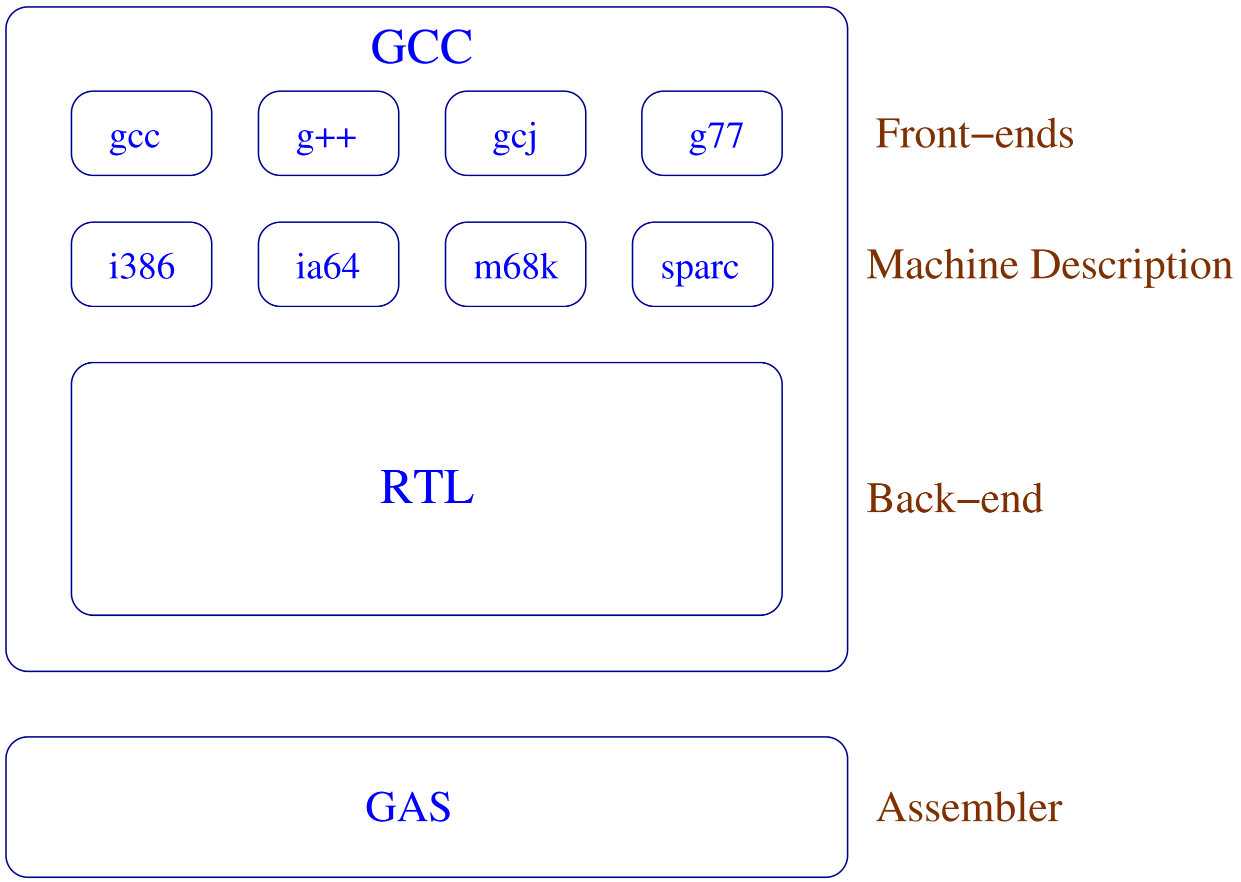

Exemple: cross-compilation

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```
../gcc/configure -target=sparc -build=i586
-host=i586
```

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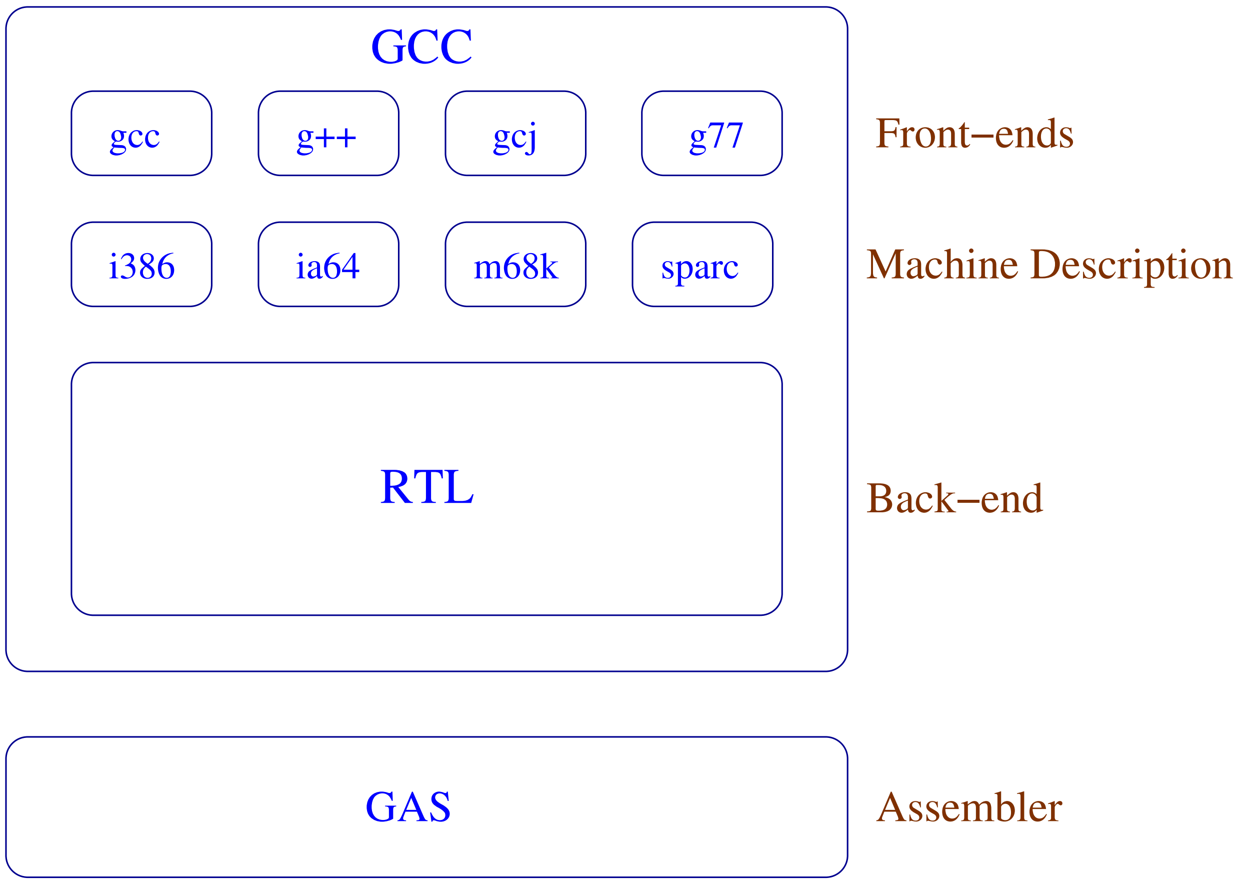

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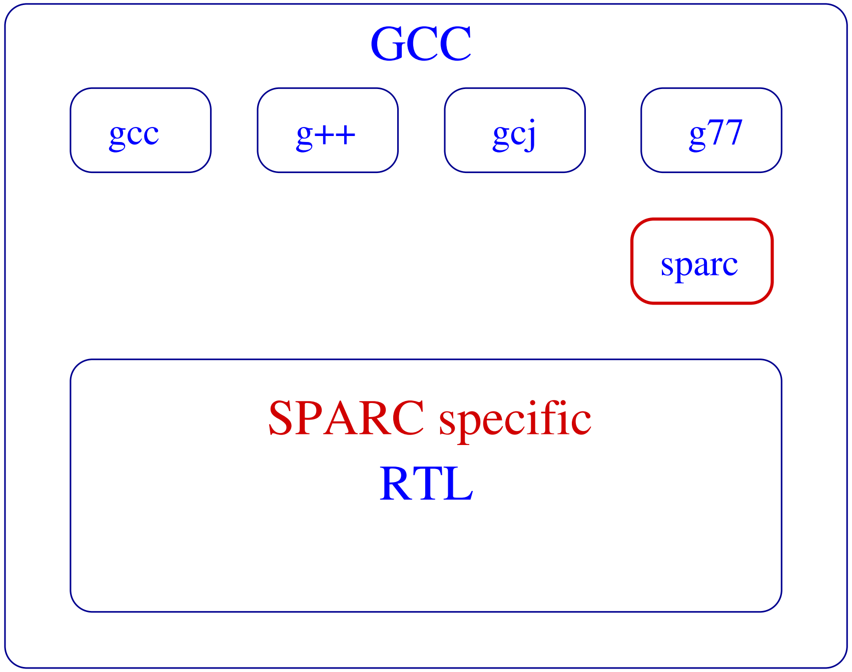


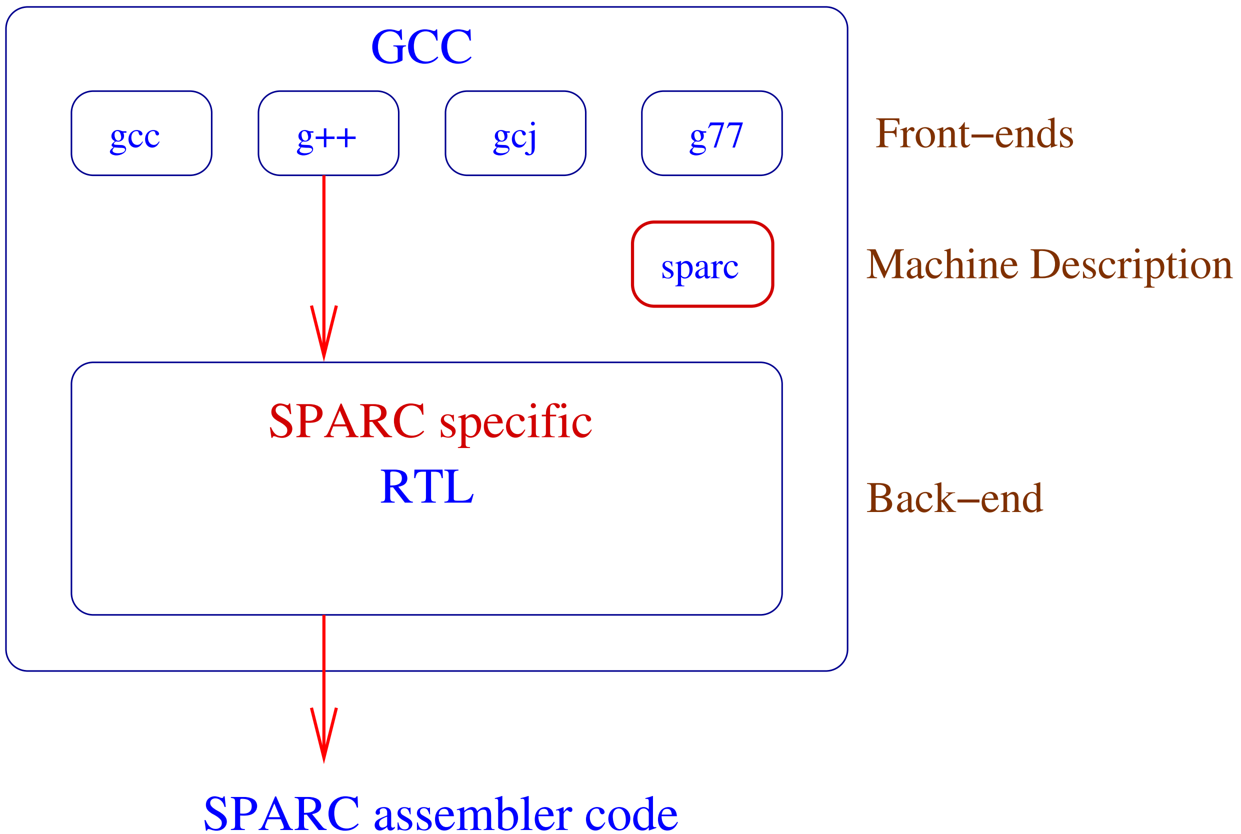
Front–ends

Machine Description

Back–end

1. Select SPARC machine description

Exemple: cross-compilation



1. Select SPARC machine description

2. Compile

RTL Optimizations

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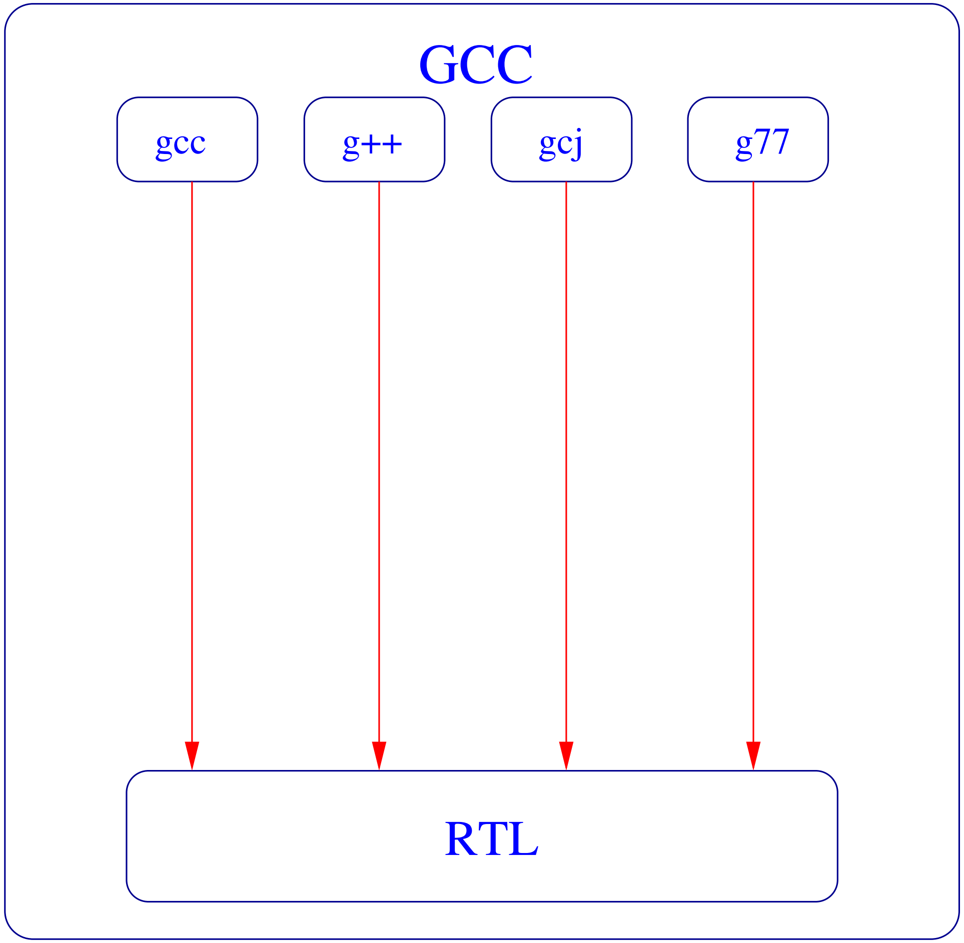
  - on high level representations.

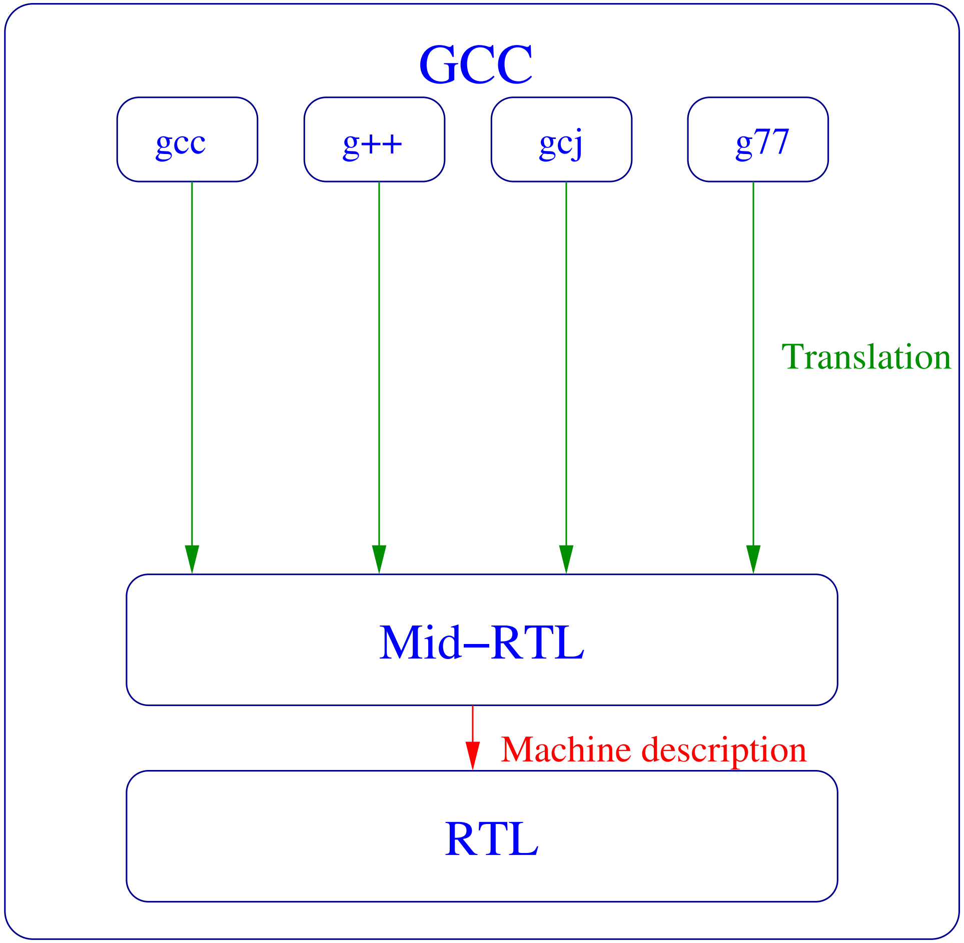
Intermediate Representations



Translation follows machines specificities

Machine description

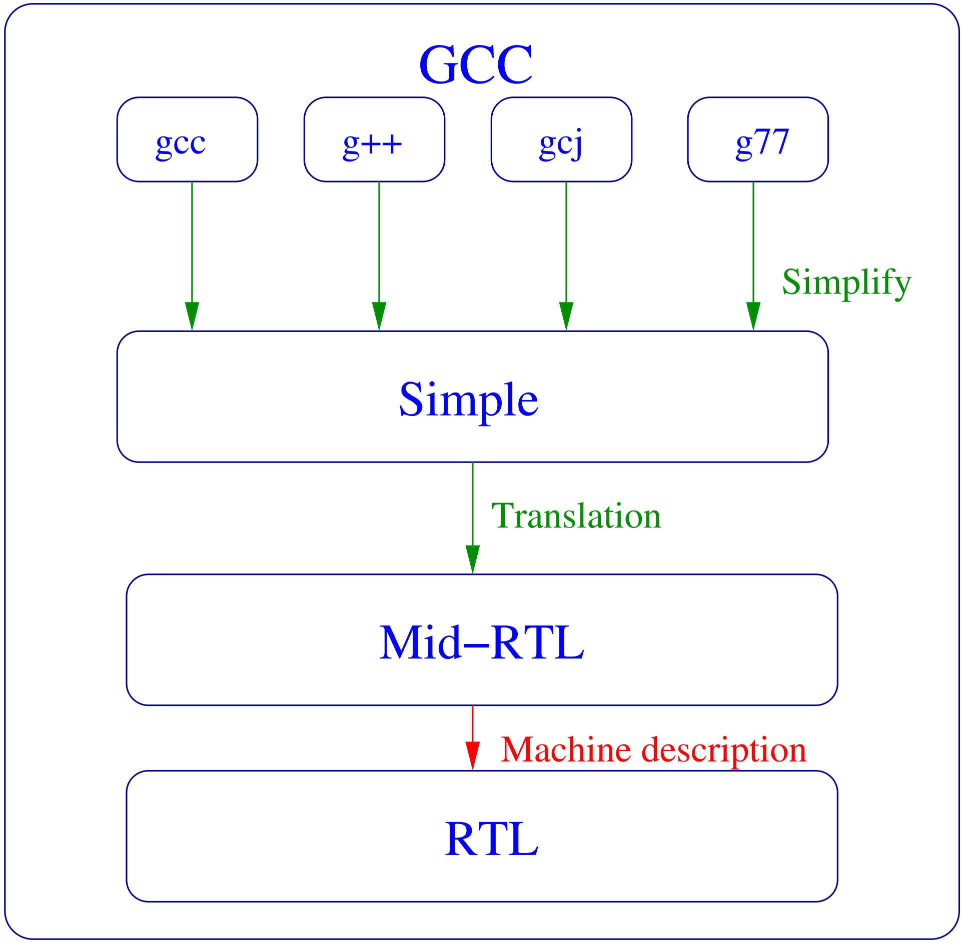
Intermediate Representations



Progressive transition from AST to RTL

Architecture independent IR

Intermediate Representations



Imperative Normal Form

Language independent representation

Progressive transition from AST to RTL

Architecture independent IR

Abstract Syntax Trees

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- Manipulation of nodes through a macro interface: `TREE_CHAIN, TREE_OPERAND, TREE_CODE, ...`
- Data structures hidden.
- AST nodes are typed:
  allows tree-checking during development.

AST: example

```
a = (−−b) * 7;
x = y+z;
```

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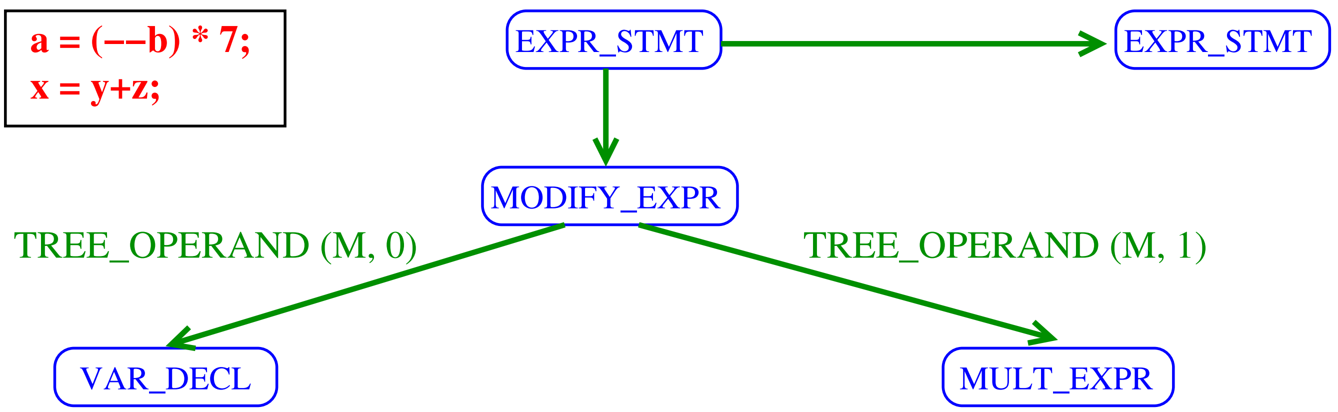

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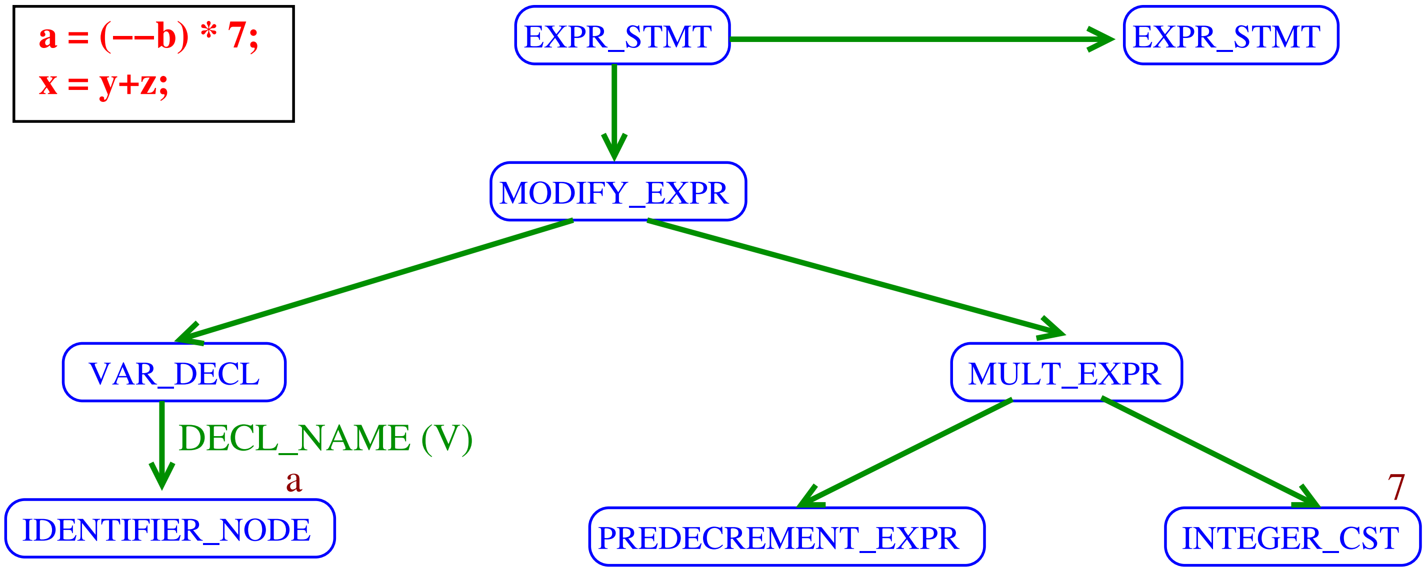
a = (−−b) * 7;
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EXPR_STMT
EXPR_STMT
MODIFY_EXPR
VAR_DECL
MULT_EXPR
DECL_NAME (V)
a
7
IDENTIFIER_NODE
PREDECREMENT_EXPR
INTEGER_CST

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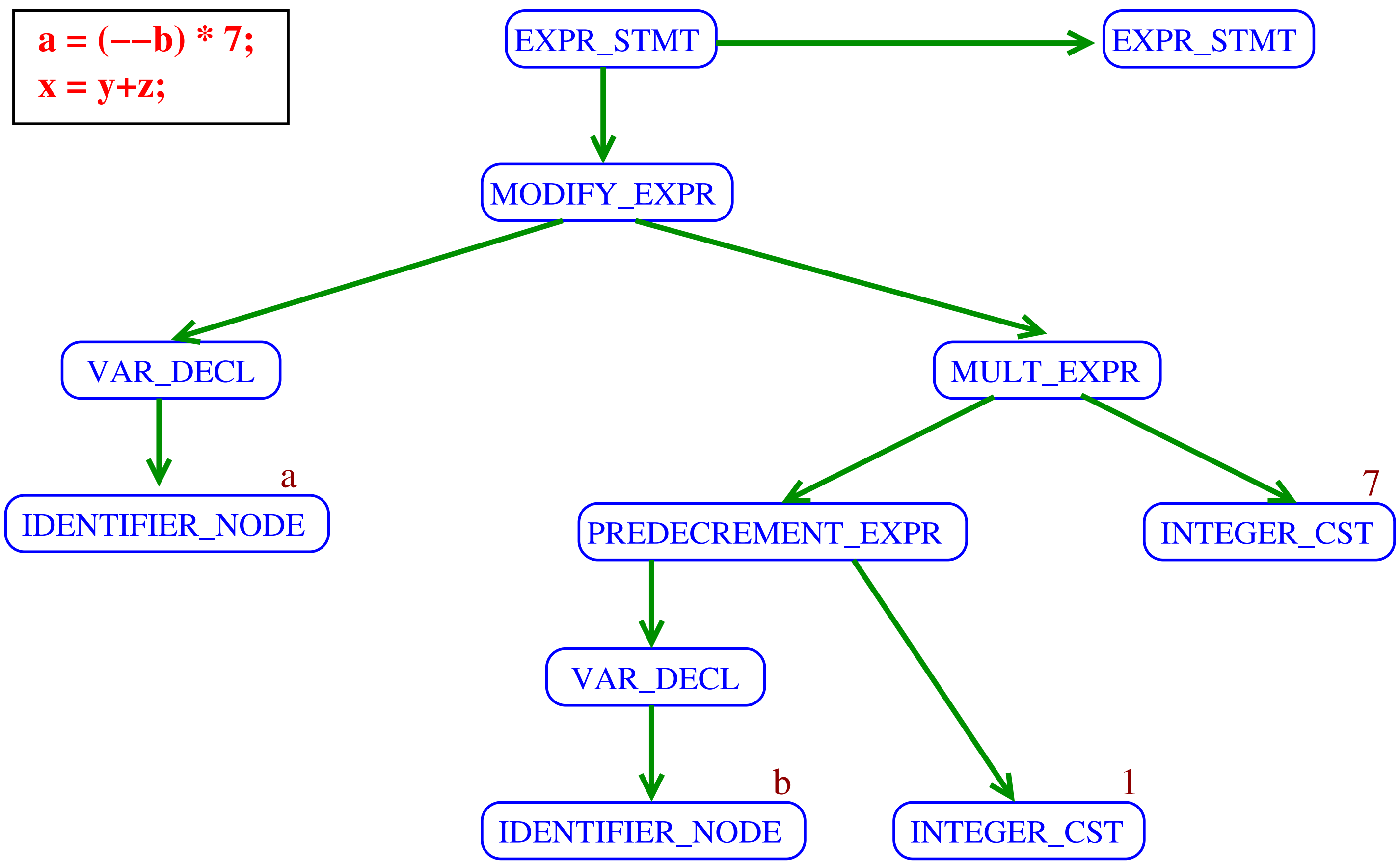

Simple: overview

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- SIMPLE's grammar defines an imperative normal form:
  - Reduced number of expressions.
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- SIMPLE AST has a regular structure.
- Systematic AST analysis is possible.
- Common intermediate representation for all front ends.

Simple: exemple

```
a = --b*7;
```

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`a = --b*7;`	`b=b-1;` `a=b*7;`

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```
if (i++ && --k)
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   j=f(i+3*k);
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`a = --b*7;`	`b=b-1;` `a=b*7;`

<pre>if (i++ && --k)
 {
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	<pre>if (i)
	  {
	   k=k-1;
	   if(k)
	     {
	      i=i+1;
	      T1=3*k;
	      T2=i+T1;
	      j=f(T2);
	     }
	   else
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	  }
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while(i++ && --k)
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	`if(i)`
	` {`
	`  k=k-1;`
	`  if (k)`
	`   while(1)`
	`    {`
	`     i=i+1;`
	`     T1=3*k;`
	`     T2=i+T1;`
	`     A[i]=A[T2];`
	`     if(i)`
	`      {`
	`       k=k-1;`
	`       if(k)`
	`        i=i+1;`
	`       else`
	`        break;`
	`      }`
	`     else`
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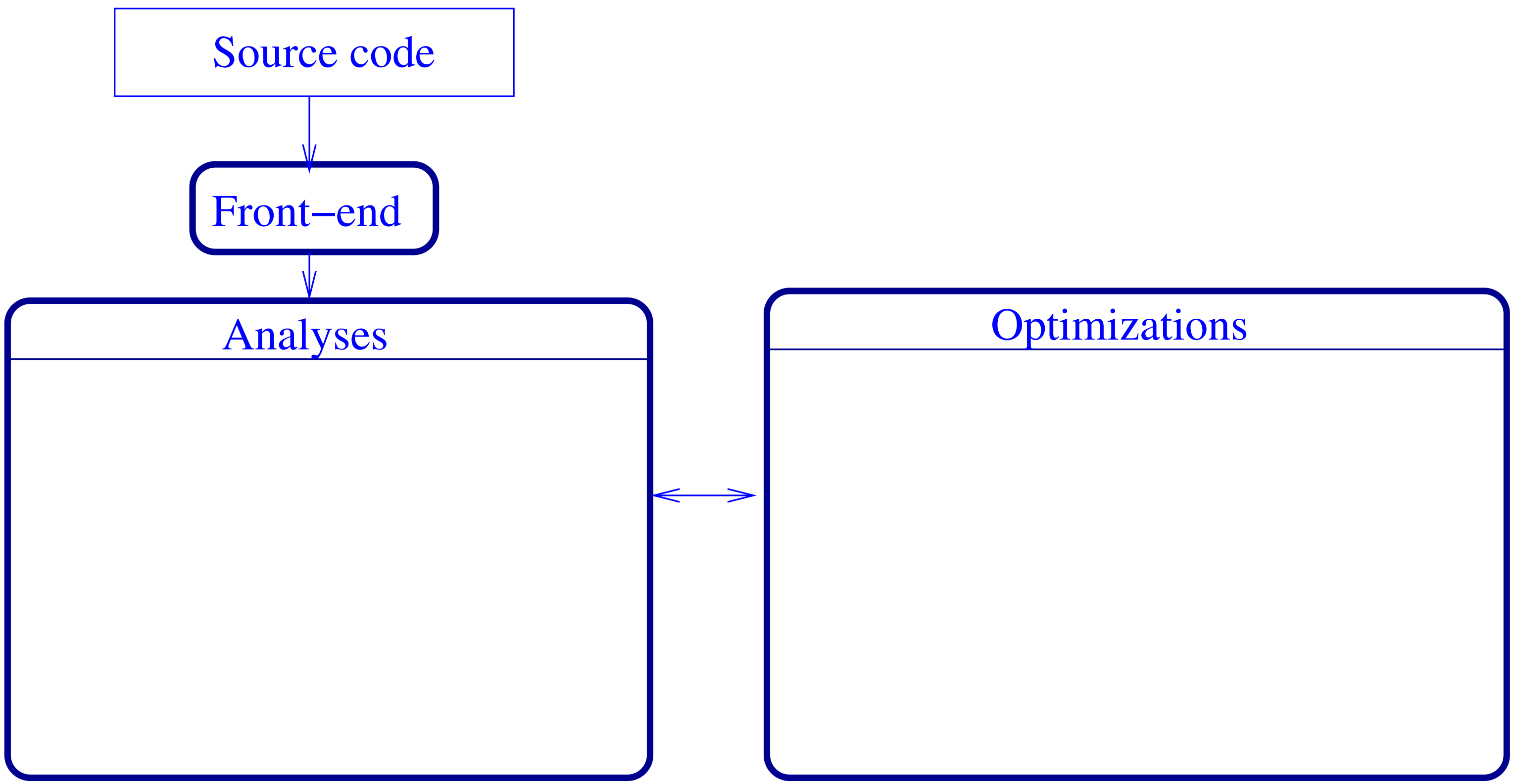
	`    }`
	` }`
	`i=i+1;`

An optimizing compiler



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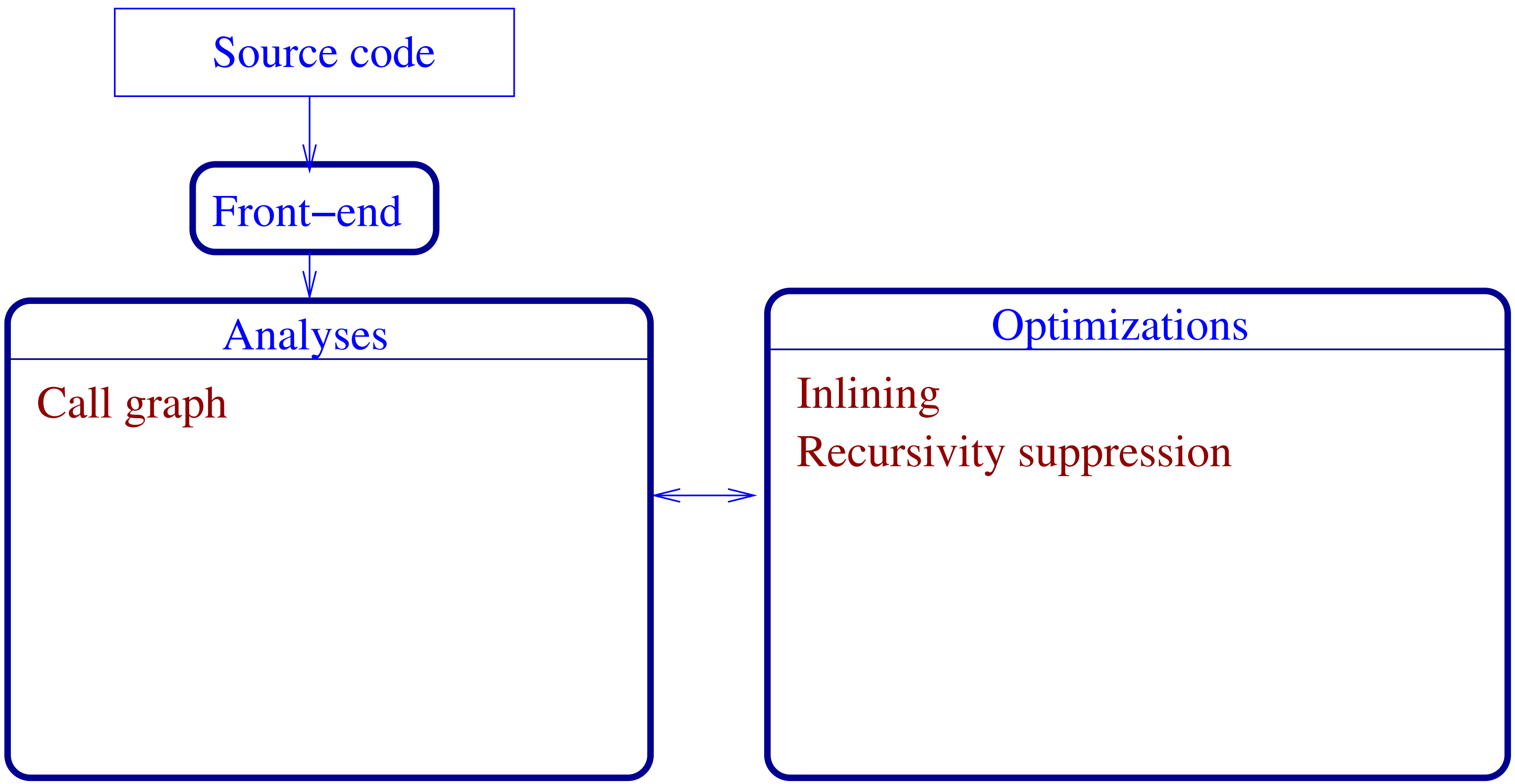

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- GCC's analysis is limited to a single translation unit.

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  - What informations to be stored in KB?

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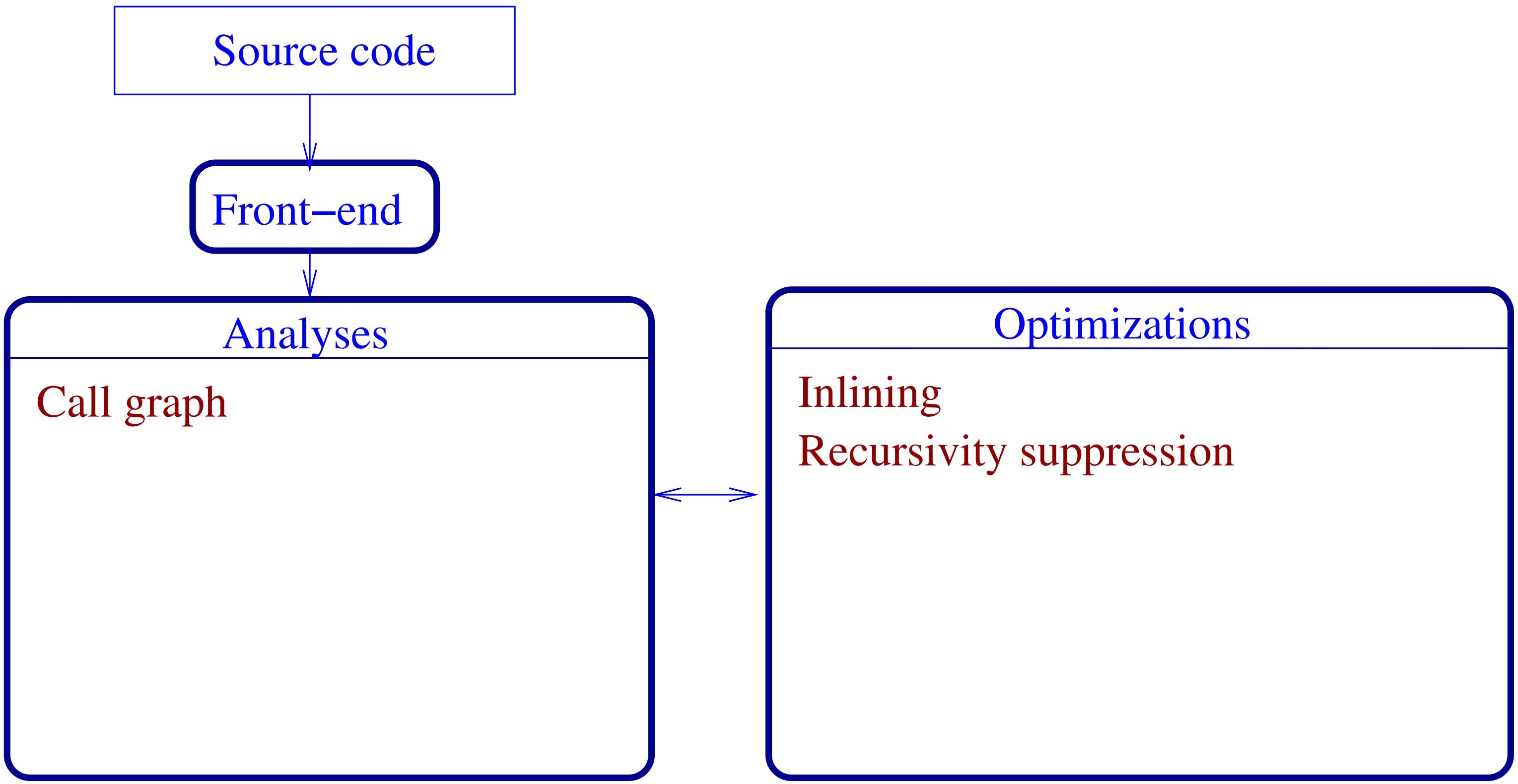

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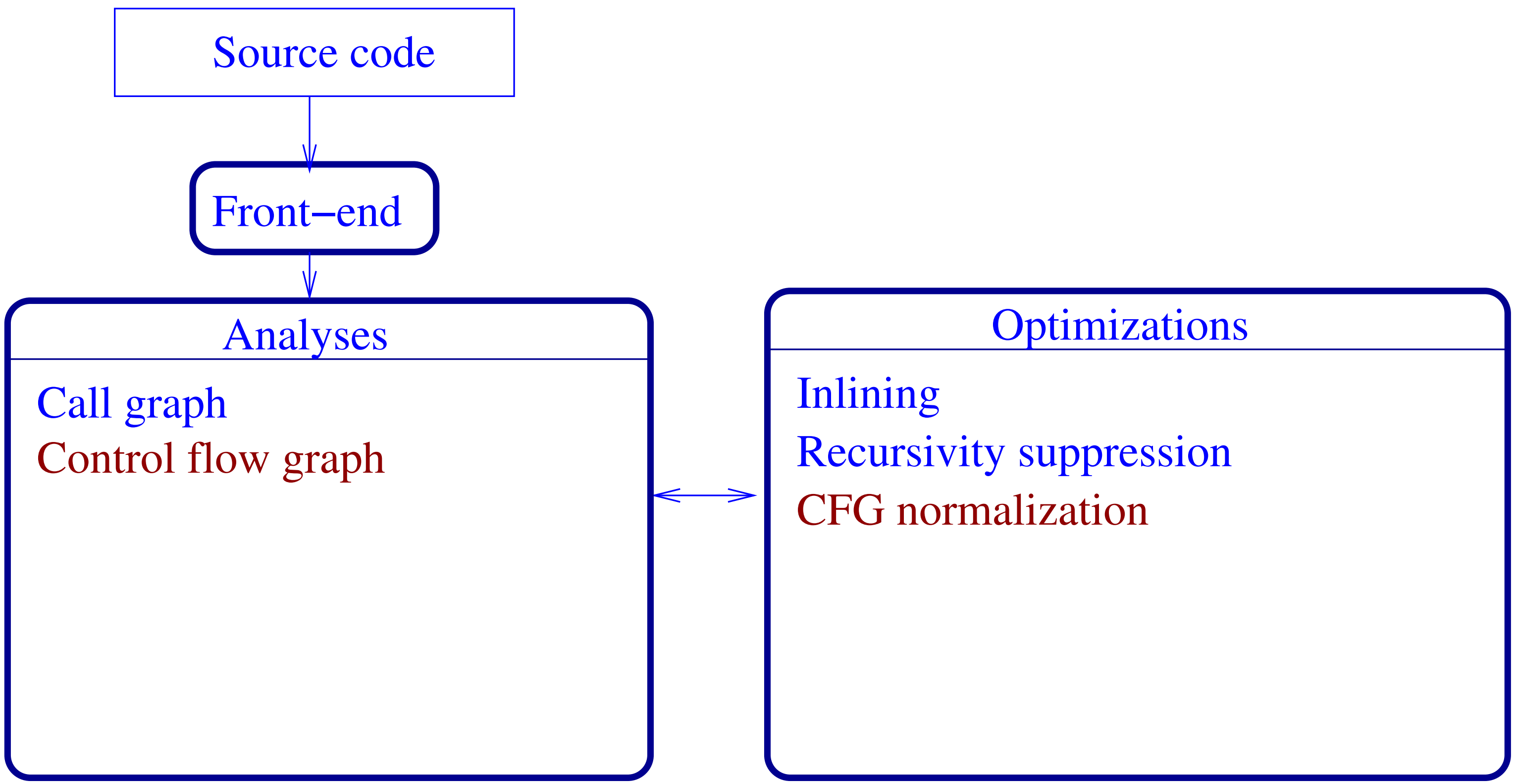

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  - Simplification generates irregular code.

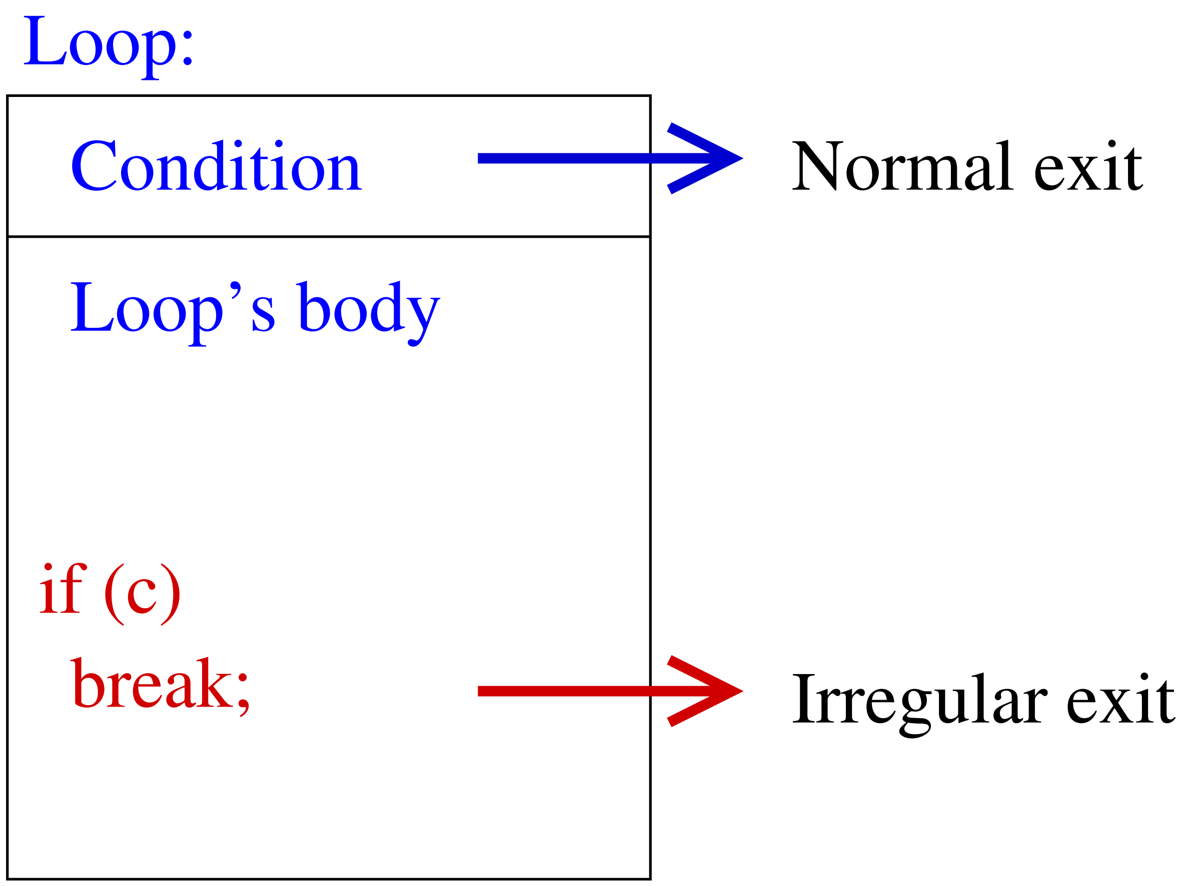
Flow Out

Loop:

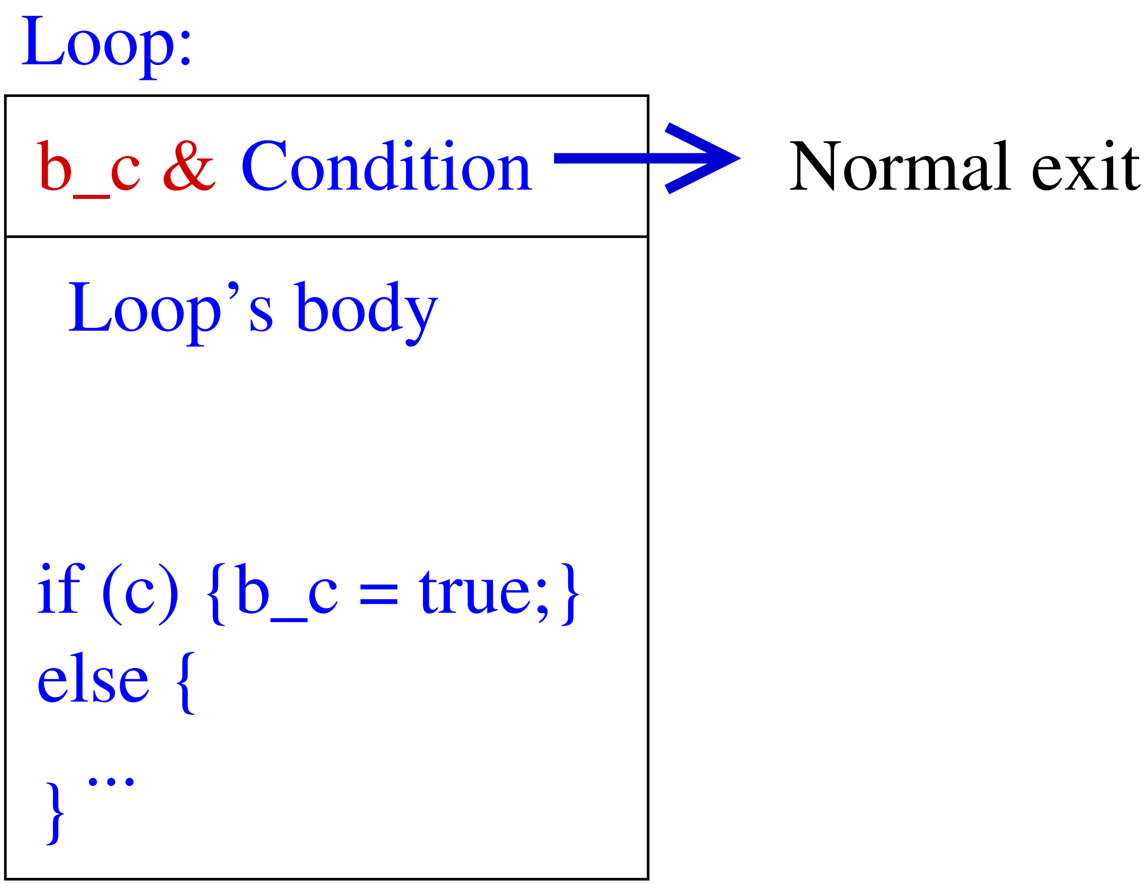
Condition

Loop's body

Flow Out


Loop:
Condition
Normal exit
Loop's body
if (c)
break;
Irregular exit

Flow Out



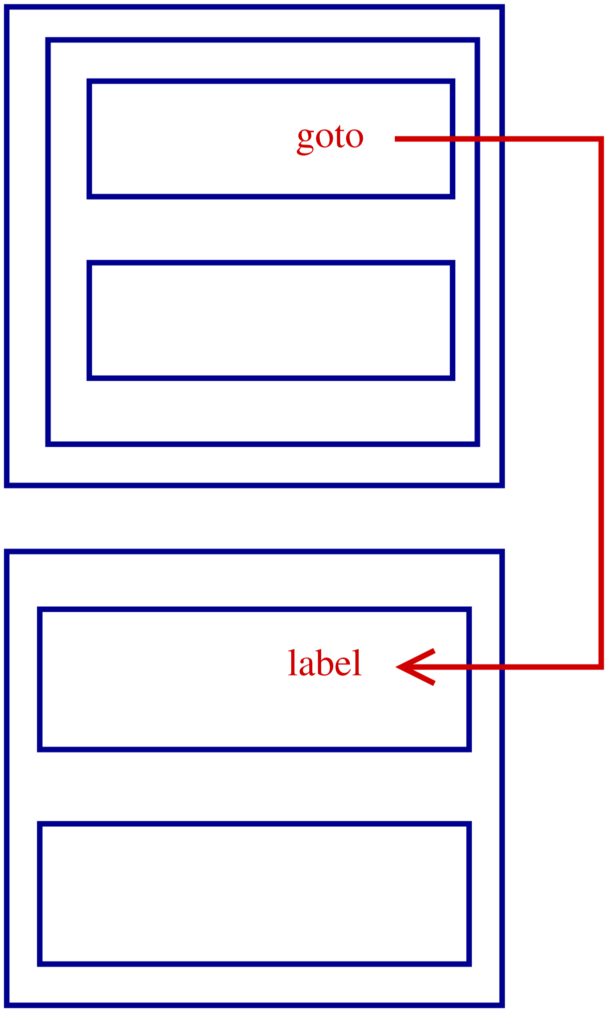
Break Elimination

```
while (a)
  {
    stmt1;
    if (b)
      break;
    stmt2;
  }
```

Break Elimination

```
int c_b = 0;
while (c_b == 0 && a)
  {
    stmt1;
    if (b)
      {c_b = 1;}
      else
        {
          stmt2;
        }
  }
```

Goto Elimination



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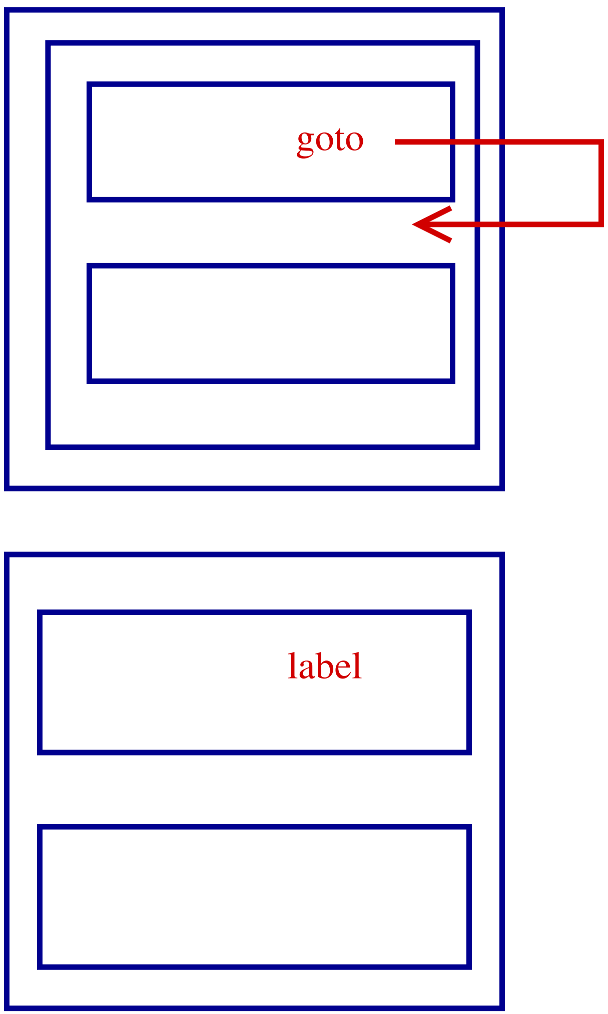

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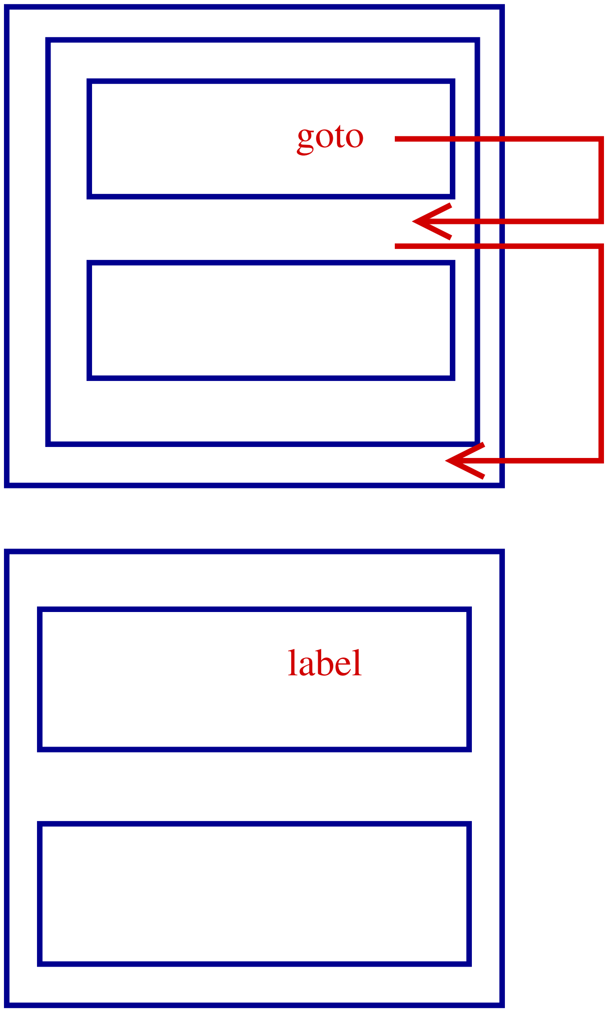

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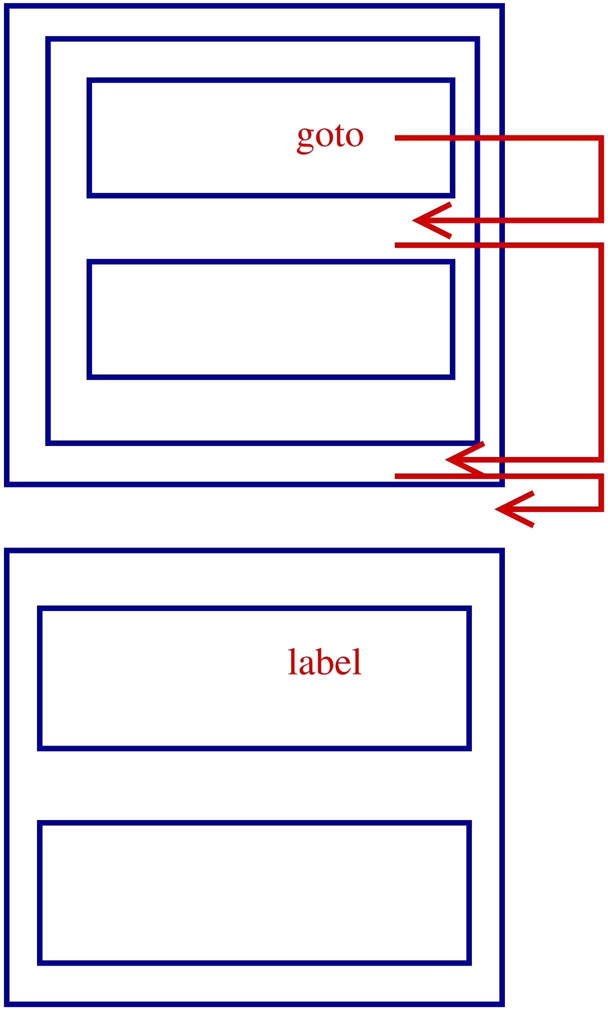

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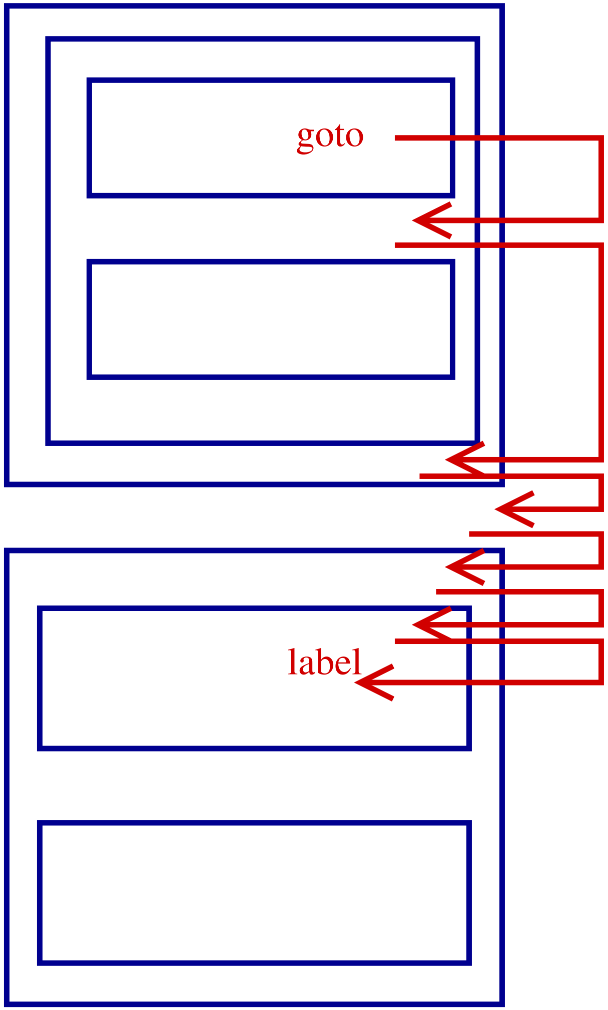

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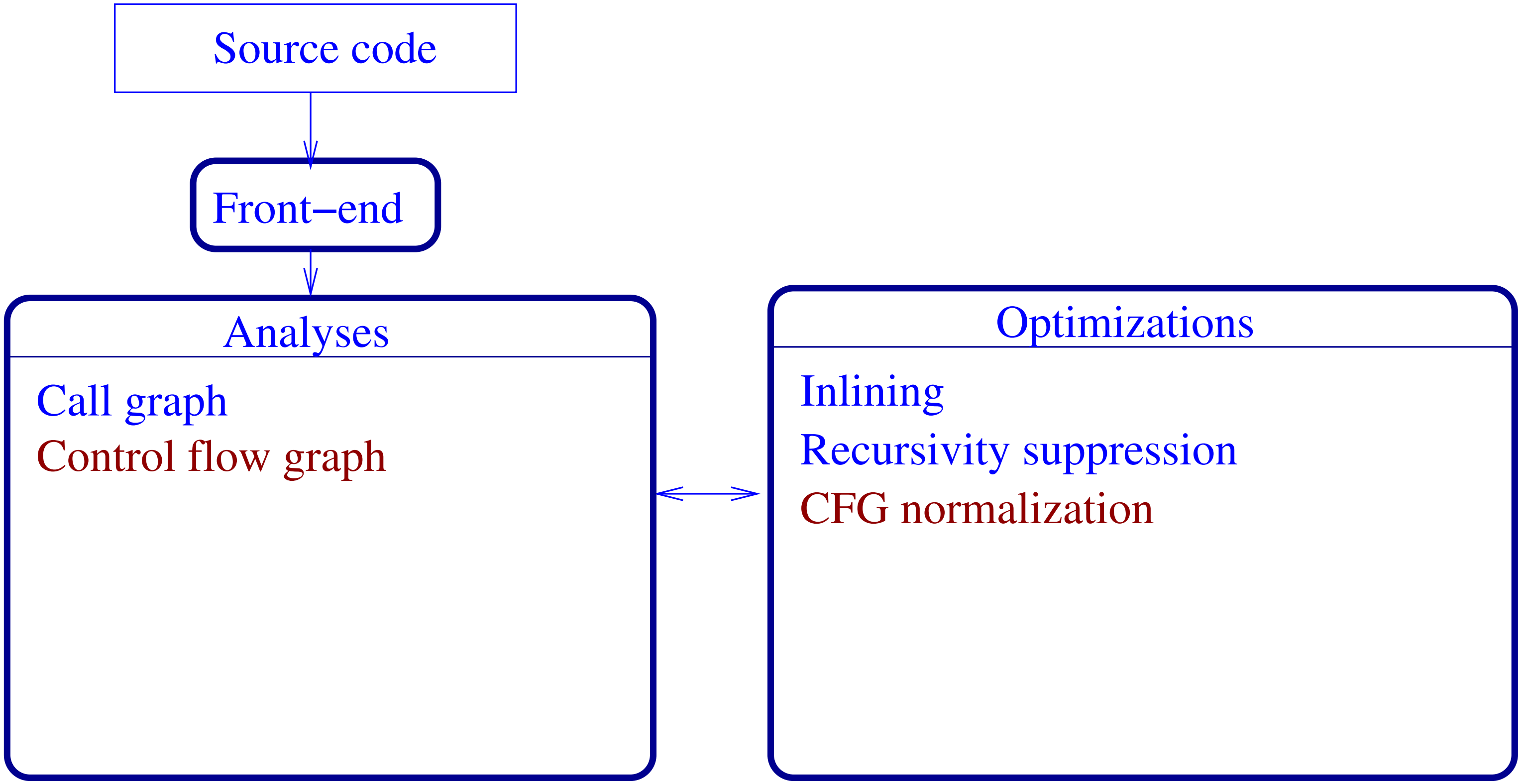

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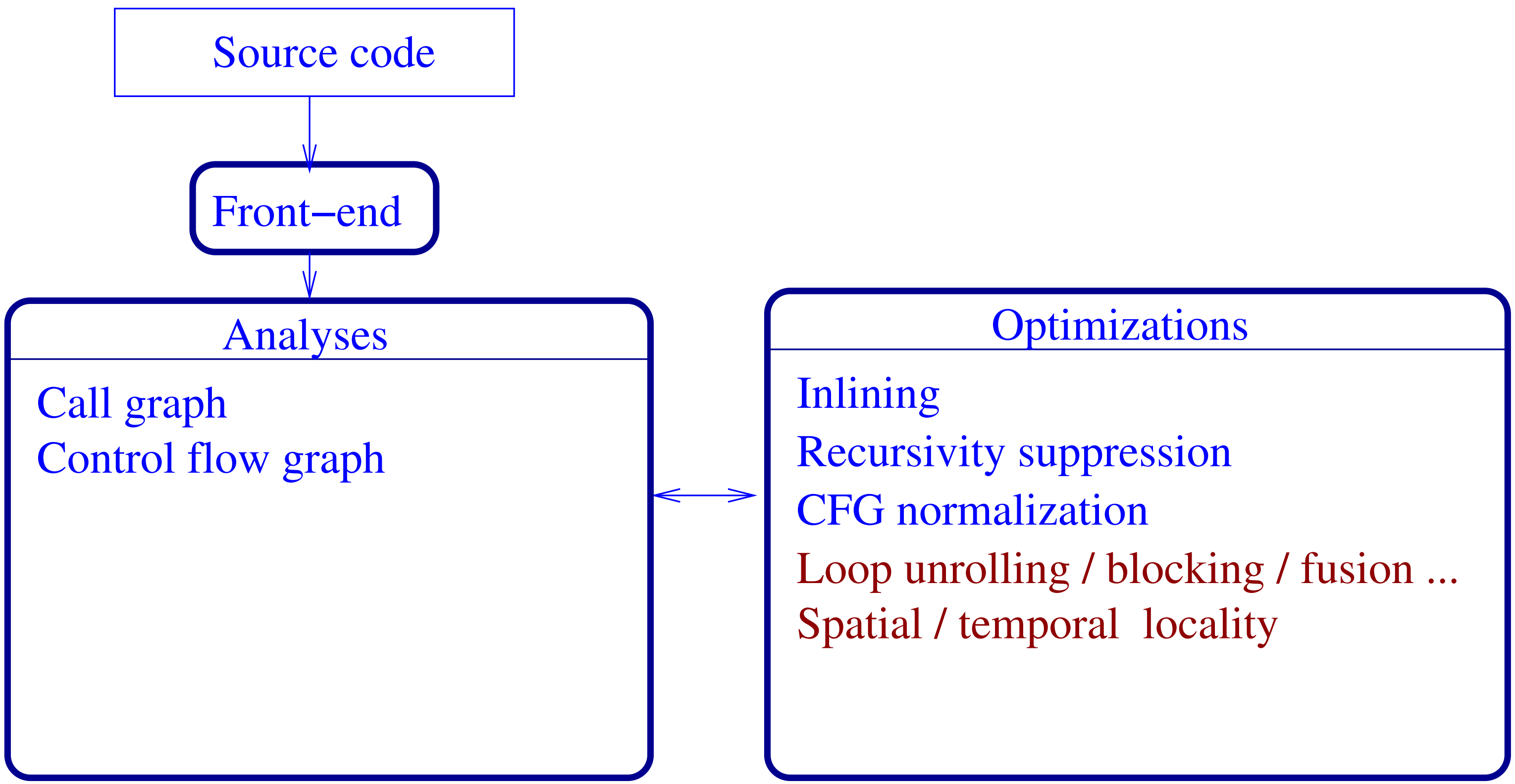

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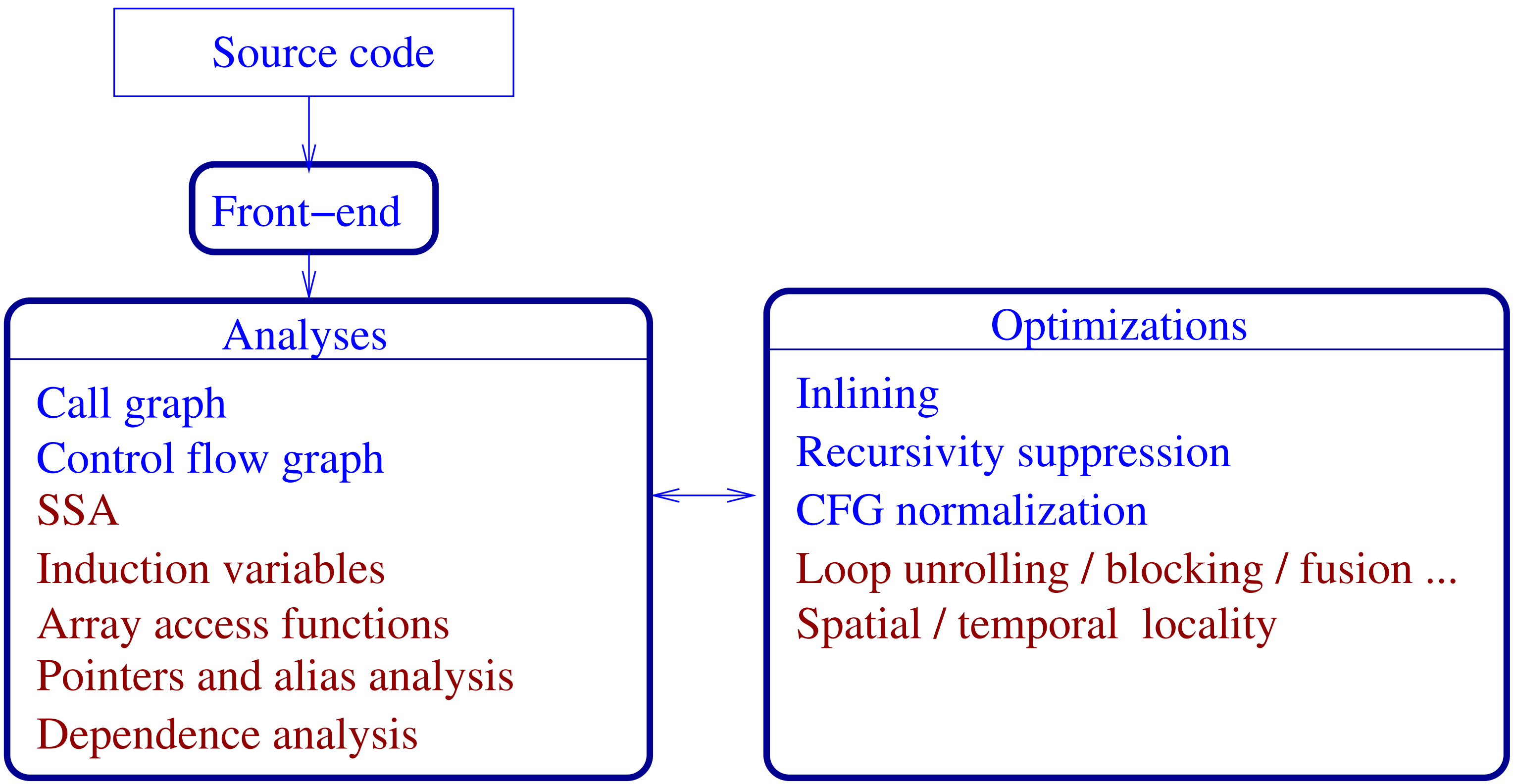

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- Dependence analysis is necessary for validating loop transformations.
- These points are still under development.

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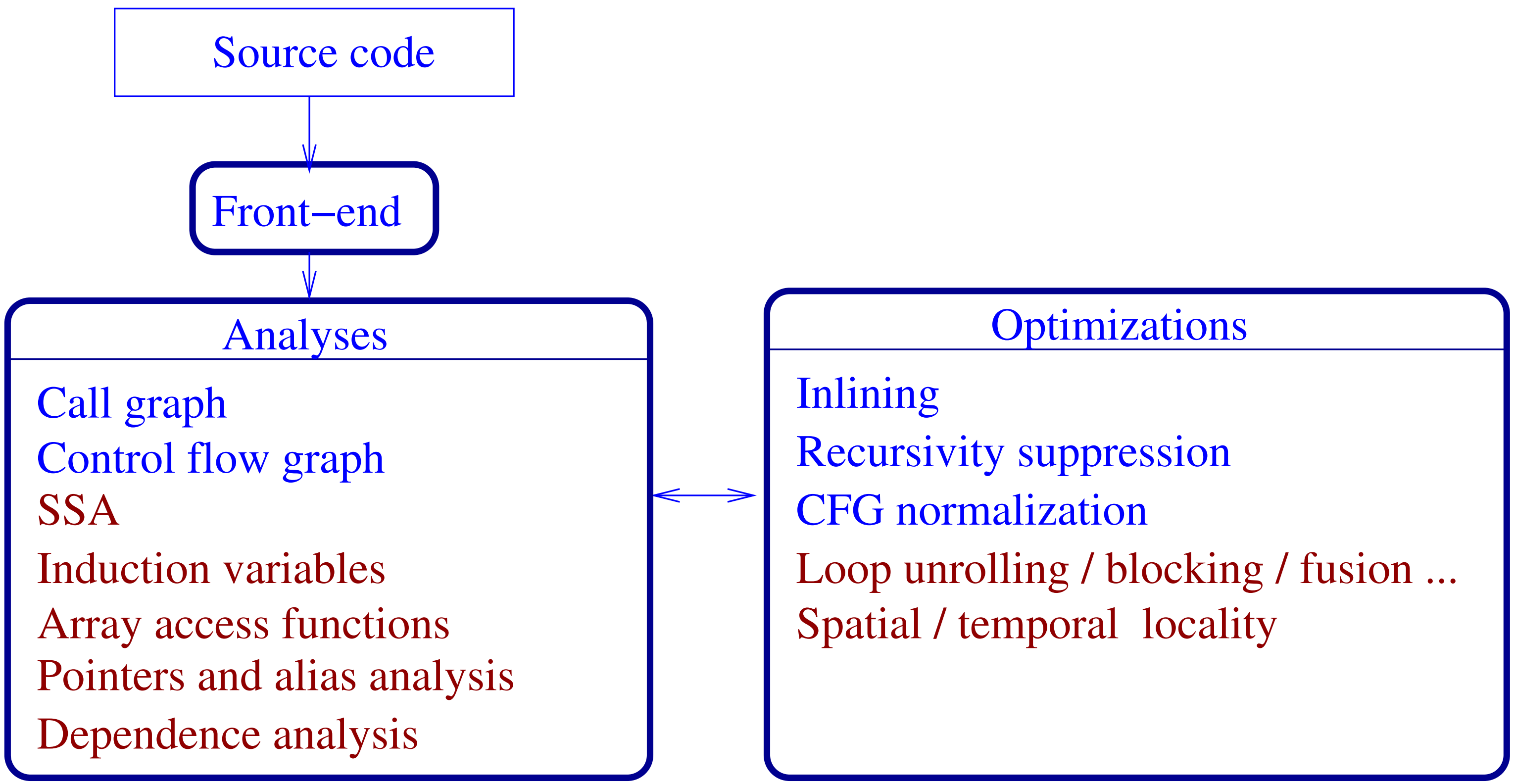

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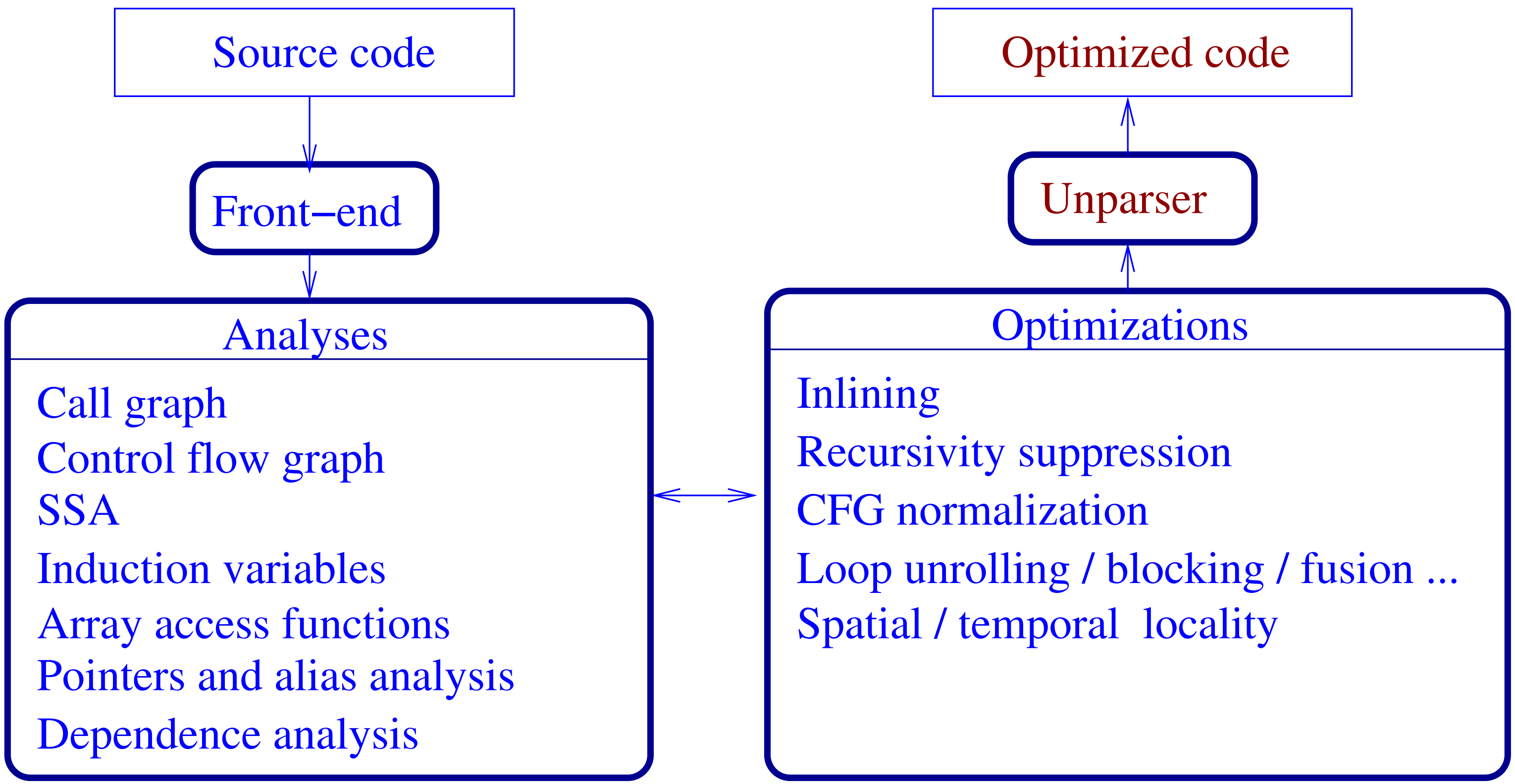

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- l'équipe ICPS pour l'excellente ambiance,
- Philippe Clauss, Vincent Loechner et Benoît Meister pour leur travail de recherche,
- Catherine Mongenet pour le cours de compil,
- Frédéric Wagner et Diego Novillo pour m'avoir accompagné dans ce projet,
- the FSF for GCC, Debian, Linux and Prosper
- et ma famille.