

Code Generation

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FEM COMPONENTS (LOCAL)

- Discretization
 - FIAT
 - PySE
 - FiPy
- Equation
 - FFC
 - Expression AST

FEM COMPONENTS (GLOBAL)

- Topology
 - Sieve
- Numbering
 - Bundle
- Storage
 - SievedArray
- Restriction
 - Linear transform on arrows
- Control Flow
 - Sequence of restriction/assembly
- Algebraic solve
 - PETSc interfaces

CODE WE GENERATE

- Quadrature rules (FIAT)
- Integration (FFC)
- Element loop (Sieve)
- Boundary conditions
 - Forcing functions
- Mesh traversal/query (planned)

OPPORTUNITIES

- Structure discovery
 - Block structure
 - Equivalent blocks
 - BLAS operations
- Automatic differentiation
- Multilingual targets
 - Human readability
- Flexible coupling
 - Semi-implicit methods
 - Application-based preconditioning
 - Dynamic coupling

BUILDING GENERATED CODE

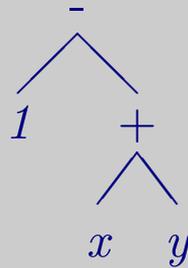
- Easily build generated code
- Build code on the fly
- Dynamically link in new code

WHAT IS AN AST?

A tree structure encoding the **syntactic** information in an expression. We may then associate **semantic** information with individual nodes or the tree itself. For example, our **Expression Trees** represent arithmetic expressions, so that:

- *Leaves* represent variables or constants
- *Internal* nodes represent operations on the leaves

Here is an example tree representing $1 - x - y$



WHAT IS A VISITOR?

The **Visitor** is a common CS pattern that arises during tree traversal. We want to separate code for managing tree nodes from code to traverse and decorate the tree. Each Visitor has:

- A **visitFoo**(Foo f) method for each node type Foo

Each Node has:

- An **accept**(Visitor v) method, which calls the appropriate visit method on v, passing itself

Thus a traversal will bounce back and forth between the visitFoo methods in the visitor, and the accept methods in the nodes. Since these are generic, the nodes need never be recompiled or relinked when a new visitor is added. This is ideal for a slowly changing set of node types, and rapidly changing set of visitors.