Dmd as a Library – Myth & Reality

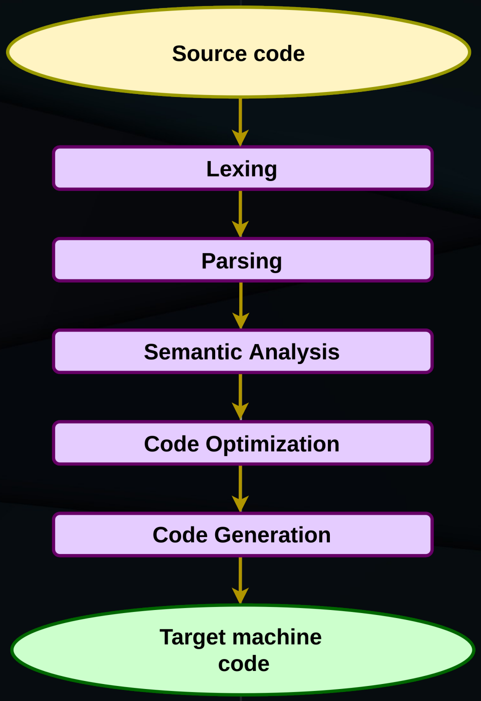
Razvan Nitu – Dconf 2023

Overview

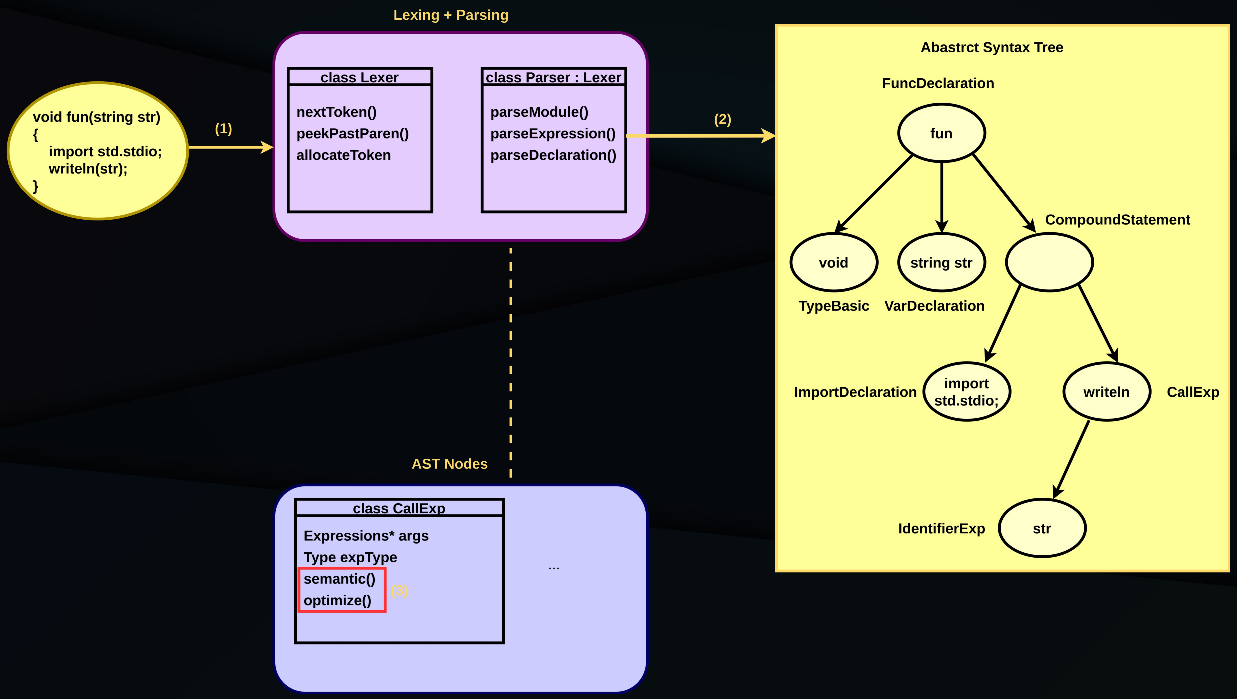
- Compiler Architecture
- Goals of Compiler Library
- Current status
- Limitations
- Future work
- Conclusions

Compiler Architecture

Compilation Phases



DMD Architecture



Goals for the Compiler Library

Goals for the Compiler Library

- Have a separation between compilation phases.
- Have the ability to modify AST nodes.
- Have the ability to modify the compilation phases.
- Have the ability to ask the compiler for any kind of information.
- Have the ability to use multiple instances of the compiler in the same program.
- Library and release compiler share the same code base.
- No performance penalty for the release compiler.

We are not (yet) concerned about

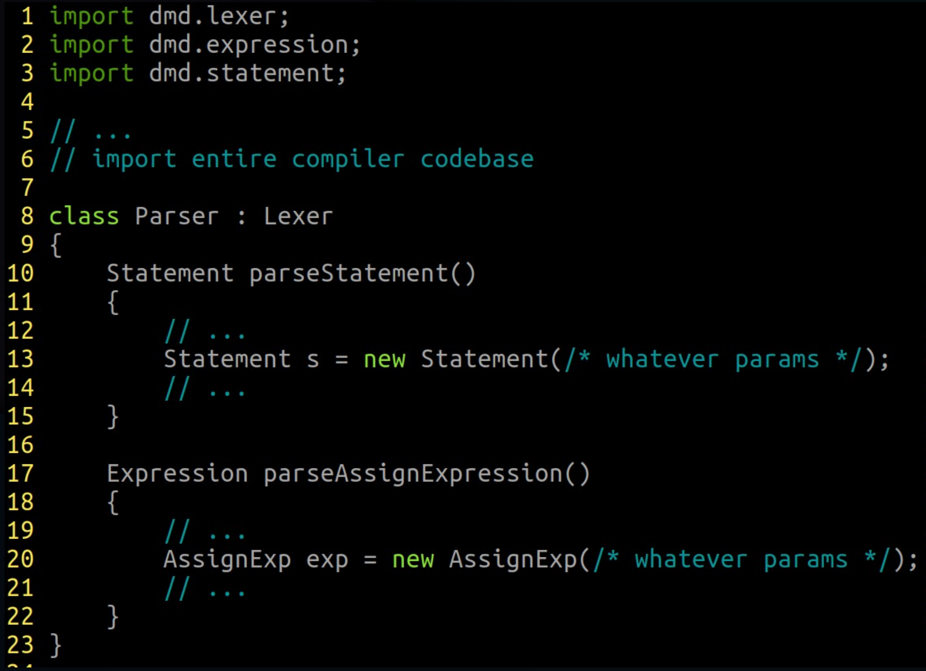
- Incremental compilation
- Compiler library performance
- Potential compilation slowdown when compiling the compiler

Current Status

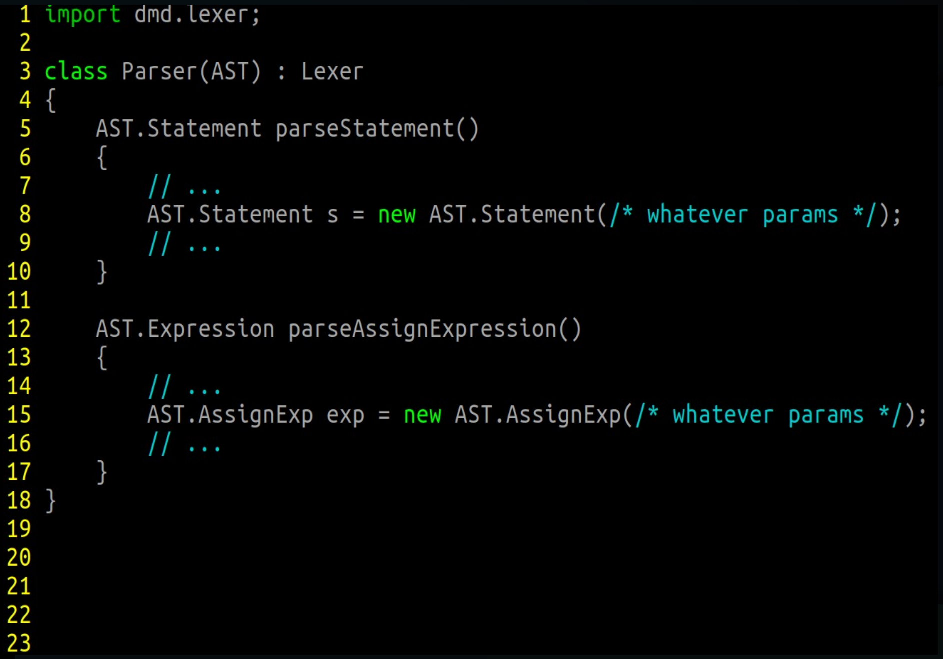
Progress

- Template parser with AST Family
- Extract semantic analysis from AST nodes
- Use dmdlib for existing projects
- Customize error handling

Template Parser with AST Family

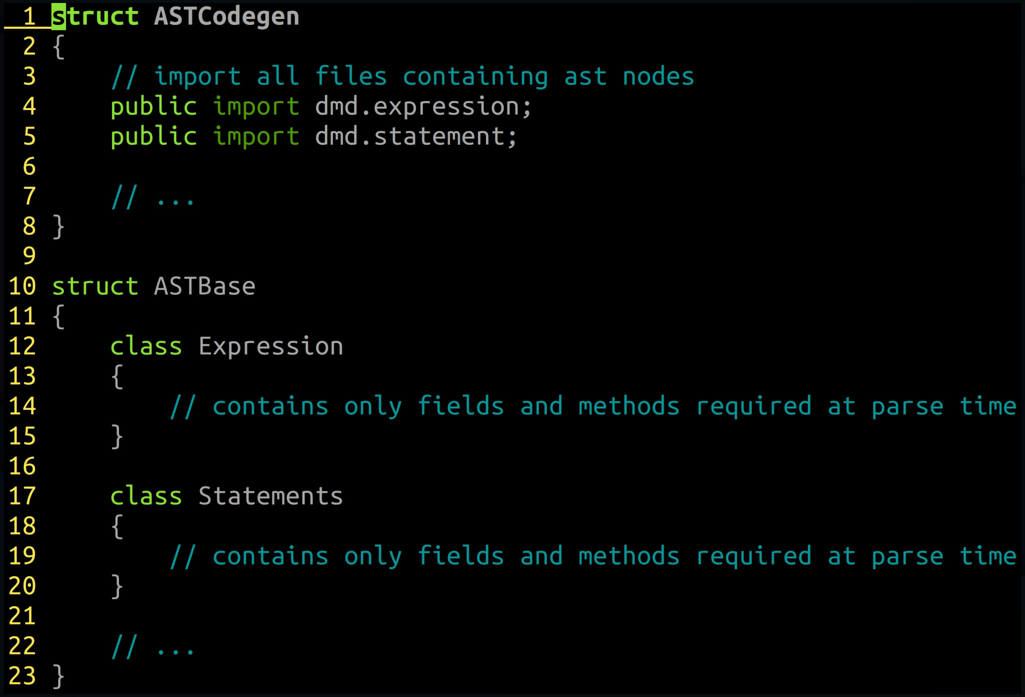


```
import dmd.lexer;
import dmd.expression;
import dmd.statement;

// ...
// import entire compiler codebase

class Parser : Lexer
{
    Statement parseStatement()
    {
        // ...
        Statement s = new Statement(/* whatever params */);
        // ...
    }

    Expression parseAssignExpression()
    {
        // ...
        AssignExp exp = new AssignExp(/* whatever params */);
        // ...
    }
}
```



```
import dmd.lexer;

class Parser(AST) : Lexer
{
    AST.Statement parseStatement()
    {
        // ...
        AST.Statement s = new AST.Statement(/* whatever params */);
        // ...
    }

    AST.Expression parseAssignExpression()
    {
        // ...
        AST.AssignExp exp = new AST.AssignExp(/* whatever params */);
        // ...
    }
}
```

Template parser with AST Family

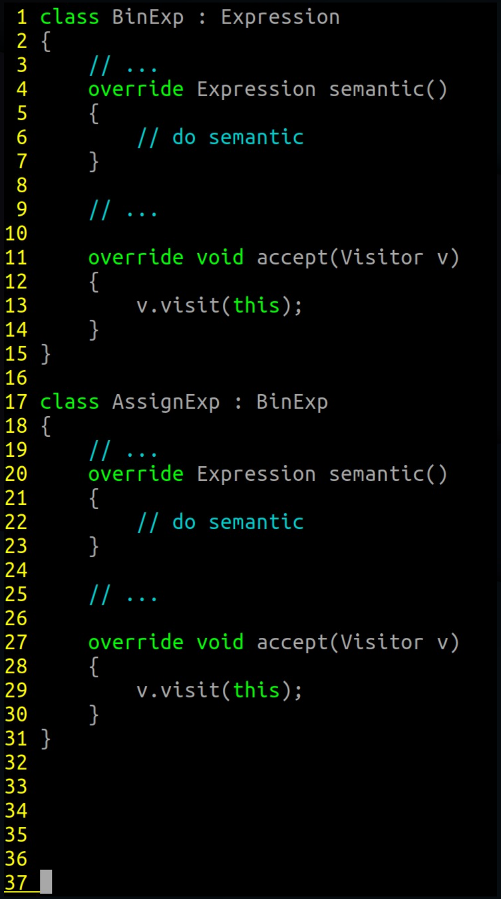


```
struct ASTCodegen
{
    // import all files containing ast nodes
    public import dmd.expression;
    public import dmd.statement;

    // ...
}

struct ASTBase
{
    class Expression
    {
        // contains only fields and methods required at parse time
    }

    class Statements
    {
        // contains only fields and methods required at parse time
    }

    // ...
}
```

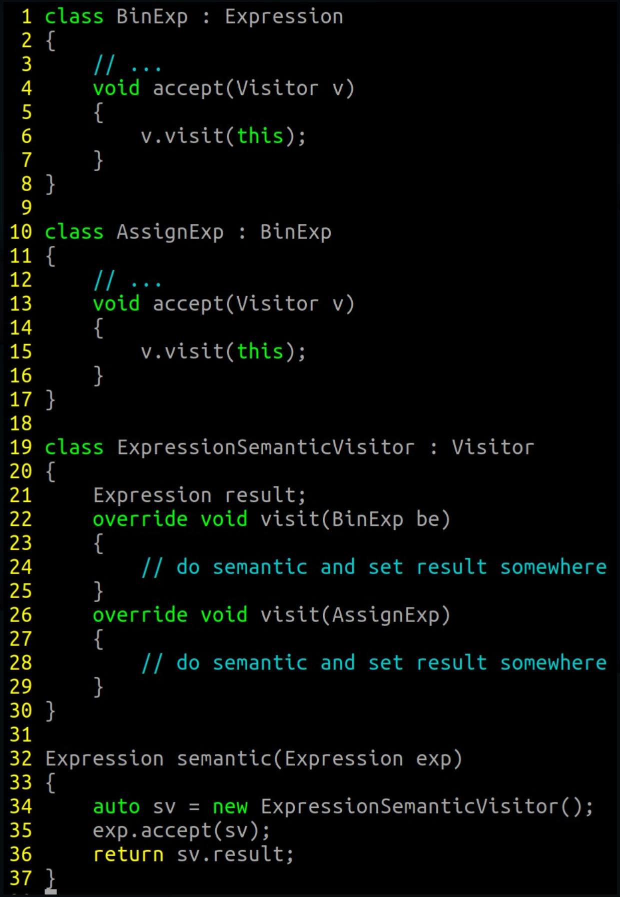
The problem of ASTBase

- Extract methods and fields that rely on semantic information so that ASTBase == ASTCodegen.
- Extract the common code for ASTBase and ASTCodegen into a mixin template. (PR: https://github.com/dlang/dmd/pull/6966)

Extract semantic analysis



```
class BinExp : Expression
{
    // ...
    override Expression semantic()
    {
        // do semantic
    }

    // ...

    override void accept(Visitor v)
    {
        v.visit(this);
    }
}

class AssignExp : BinExp
{
    // ...
    override Expression semantic()
    {
        // do semantic
    }

    // ...

    override void accept(Visitor v)
    {
        v.visit(this);
    }
}
```



```
class BinExp : Expression
{
    // ...
    void accept(Visitor v)
    {
        v.visit(this);
    }
}

class AssignExp : BinExp
{
    // ...
    void accept(Visitor v)
    {
        v.visit(this);
    }
}

class ExpressionSemanticVisitor : Visitor
{
    Expression result;
    override void visit(BinExp be)
    {
        // do semantic and set result somewhere
    }
    override void visit(AssignExp)
    {
        // do semantic and set result somewhere
    }
}

Expression semantic(Expression exp)
{
    auto sv = new ExpressionSemanticVisitor();
    exp.accept(sv);
    return sv.result;
}
```

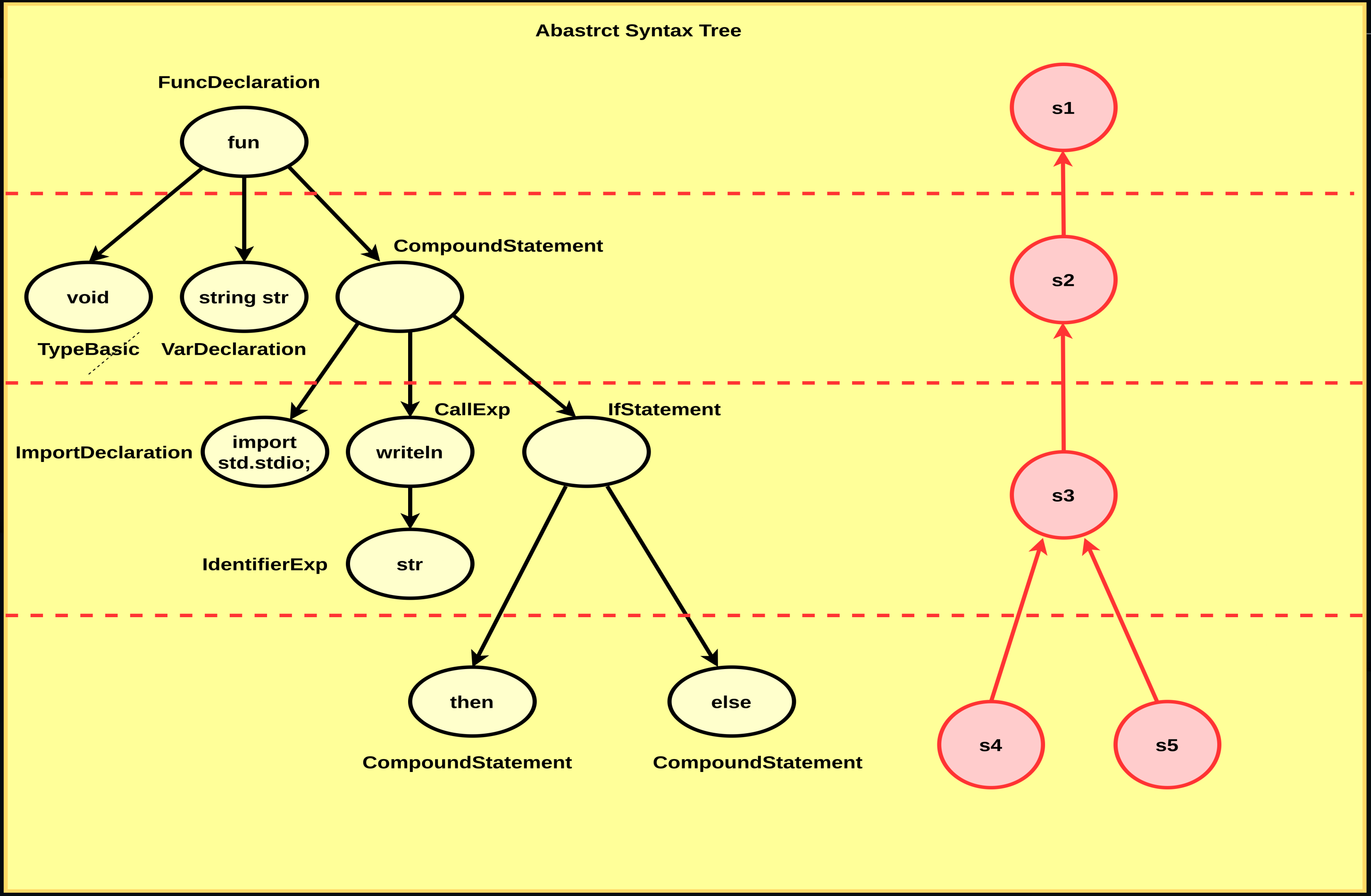
Use dmdlib in Existing Projects

- DCD
- D-Scanner

DCD

- D Completion Daemon
- Uses libdparse, dsymbol

Scope


Abastrct Syntax Tree
FuncDeclaration
fun
CompoundStatement
void
string str
TypeBasic
VarDeclaration
CallExp
IfStatement
ImportDeclaration
import std.stdio;
writeln
IdentifierExp
str
then
else
CompoundStatement
CompoundStatement
s1
s2
s3
s4
s5

DCD – Lesson Learned

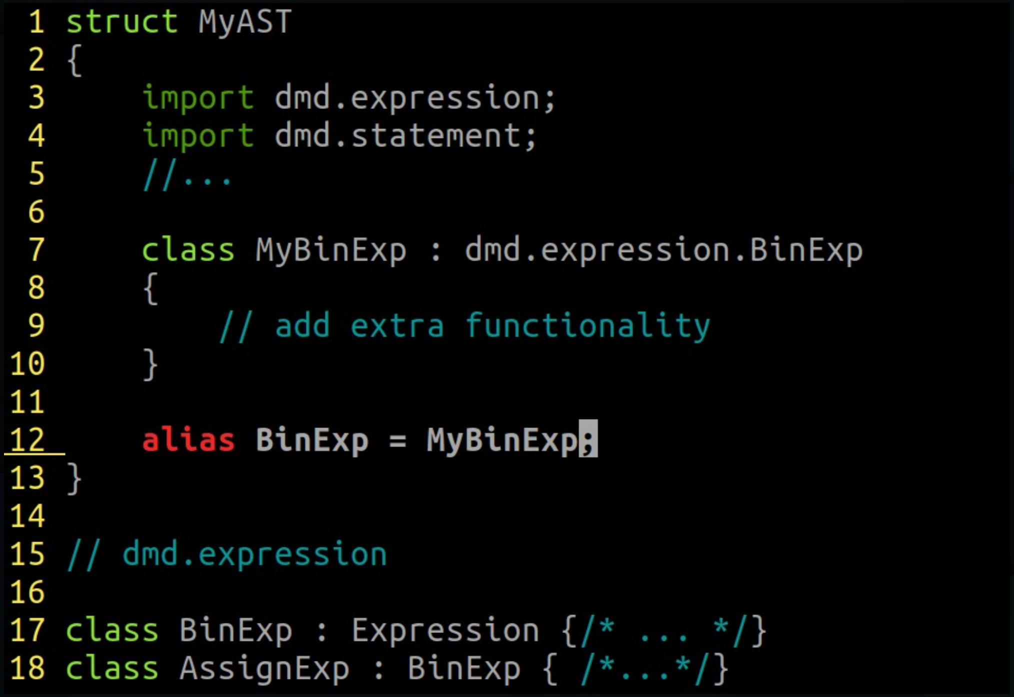
Need to publicize scopes

D-Scanner

- Replace libdparse
- Lexer modifications:
  - Range interface
  - Lex white spaces and newlines
  - Template parser with lexer
- Add location to AST nodes

Limitations

AST node insertion



```
struct MyAST
{
    import dmd.expression;
    import dmd.statement;
    //...

    class MyBinExp : dmd.expression.BinExp
    {
        // add extra functionality
    }

    alias BinExp = MyBinExp;
}

// dmd.expression

class BinExp : Expression {/* ... */}
class AssignExp : BinExp { /*...*/}
```

Other limitations

- Cannot obtain scope information
- Information gets lost during semantic passes
- Most classes/methods are `extern(C++)`
- Dmd uses null terminated strings

Moving Forward

- Finish D-Scanner integration of dmdlib
- SAoC – integrate dmdlib in dformat
- Unused import tool
- Extract more semantic information from AST nodes
- Get to: new Compiler(MyParser!(MyAST, MyLexer), MySemanticAnalysis).

Conclusions

Conclusions

- Have a separation between compilation phases.
- Have the ability to modify AST nodes.
- Have the ability to modify the compilation phases.
- Have the ability to ask the compiler for any kind of information.
- Have the ability to use multiple instances of the compiler in the same program.
- Library and release compiler share the same code base.
- No performance penalty for the release compiler.

Useful links

- Dmd as a library talk 2017
- Integrating dmd as a library in D-scanner 2022 talk
- DCD work
- Unused import tool

Questions