MatCV

Let’s do Matrices Better

The Objective

Linear Algebra is all the rage

A language to simplify Matrices

Team Roles

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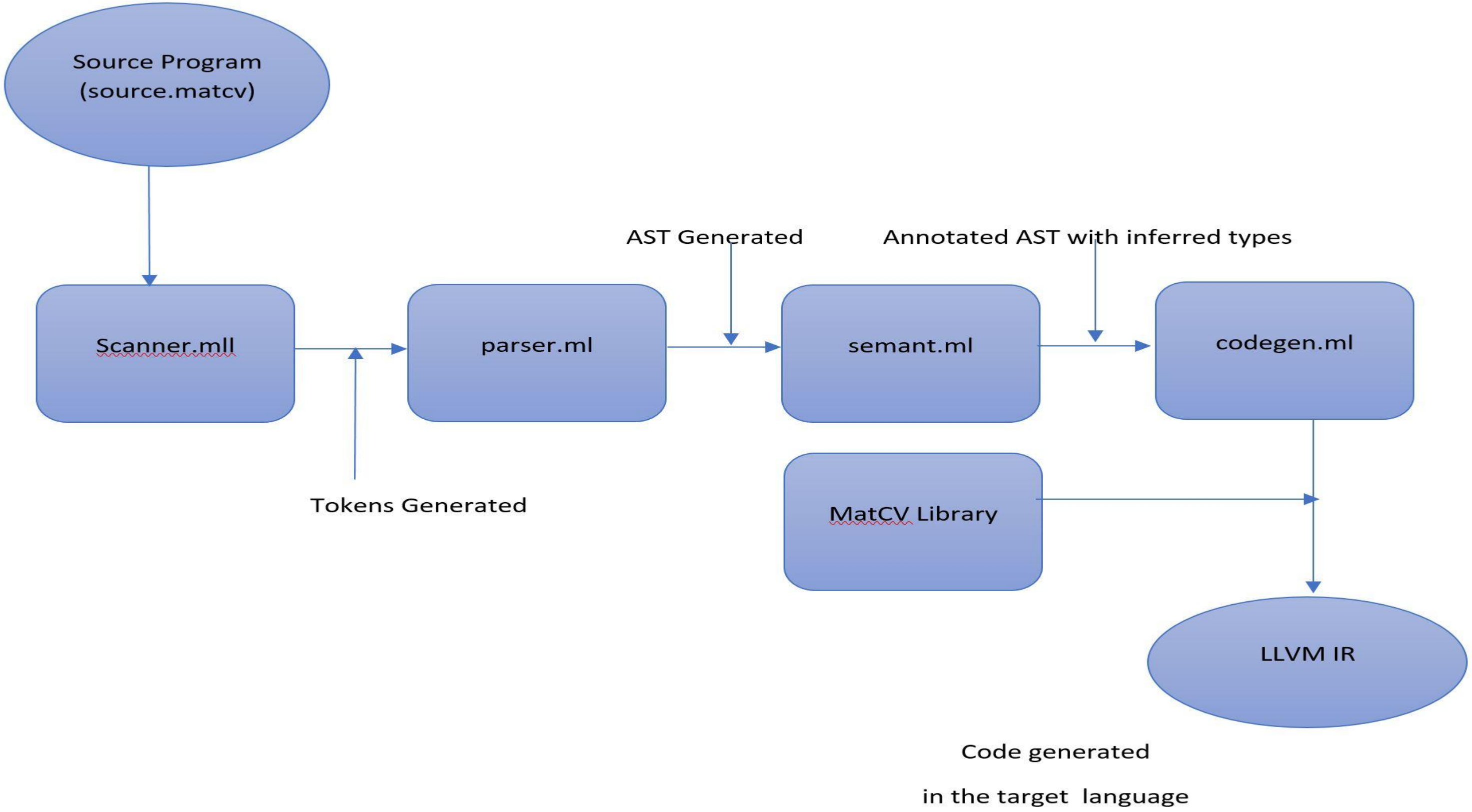
Matrix Hello World

```
function main( )  {
        a = 1;                    /*We also had /*nested comments*/ working */
        b = 2;
        print (a+b);
        return 0;
}
```

Architecture



Source Program (source.matcv)

Scanner.mll

parser.ml

semant.ml

codegen.ml

MatCV Library

LLVM IR

Tokens Generated

AST Generated

Annotated AST with inferred types

Code generated

in the target language

Key Features

Just start writing code, no main function required!!

```
a = 2;
b = 2;
c =1+b;
d = [ 5 ] [ 6 ];
….
```

Types Supported

- Integer
- Boolean
- Matrices (N - Dimensional!)
- Void

But don’t worry about them, as they are inferred!!

Type Inference

Code:

```
b = foo();
function foo(){
    c={1,2,3;4,5,6;7,8,9};
    return c;
}
```

After semantic analysis:

```
 Mat(2) b =foo();
 Mat(2) Func_foo(){
   Mat(2) c = {1,2,3;4,5,6;7,8,9};
   return c;
}
```

Type Inference

- Construct an annotated parse tree.
- Collect constraints.
- Solve these constraints to infer types.

After semantic analysis:

```
 Mat(2) b =foo();
 Mat(2) Func_foo(){
   Mat(2) c = {1,2,3;4,5,6;7,8,9};
   return c;
}
```

Function

- We pass matrices by reference in functions, a design choice to make our language convenient for users.
- However, integers and booleans are passed by value.
- To declare a function the following syntax is use:

```
function foo(){

}
```

- “main( )” is not needed and is reserved and can not be used as a function.

Key Features

How many dimensions do you want in a matrix?

a = [5] [3] [2] [3]....

We support n dimensions along with key features like add, subtract, etc.

Want a different way to allocate matrices?

We support it: a = { 1 , 2 , c + d , 4 ; 5 , 6 , func() , a[0] ; 9 , foo + bar , 11 , 12}

It’s all an illusion

- We use only 1’D matrices but the user uses it as a normal n’D matrix, you ask how? Well, some pointer magic.

Want the index of an element?

Index 0: Number Of Dimensions	Index 1: Size along Dimension 1	Index 2: Size along Dimension 2	…….	Matrix content In Row major ->	

Scoping done right

Declare variables anywhere:

A local and global map are used to manage the scope for blocks.

Separate memory map to keep track of allocations

Key Features

Control Flow operations

If..else

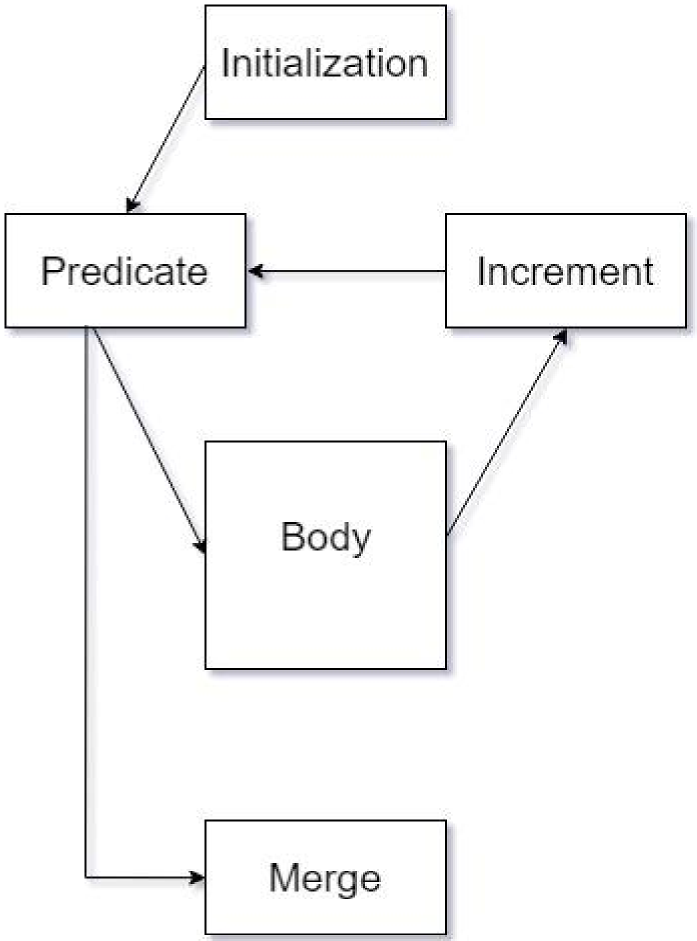
for(;;)

while()

continue

For loop done right

Added an additional block to support continue.



Memory Management

- We malloc memory for the variable sized matrices on the heap and the integers and booleans are stored on the stack.
- A memory map is maintained which can be used to free the unused memory.

A powerful language with a powerful library

Supports matrix functions eg.

- Add
- Subtract

Result of the operation stored in the first operand

Supports Logic For Garbage Collection

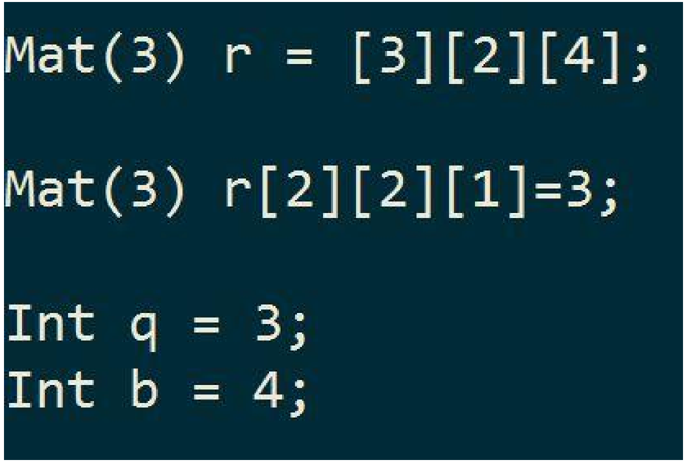
Local	Global	Put in memory map?	Action
Yes	Yes	Yes	Put, alloca, add to local map
Yes	No	Yes	Put, alloca, add to local map
No	Yes	No	Alloca
No	No	Yes	Alloca, Add to local map

Testing

Separate Testing for different modules

Pass and fail tests

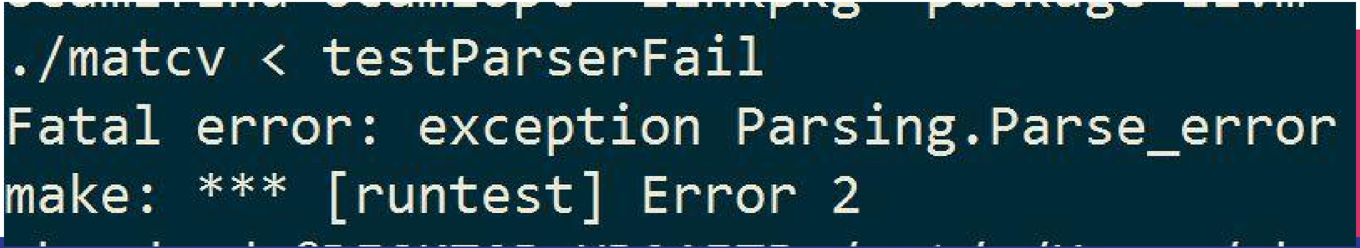
- Parser/Scanner tests
- Semant tests
- Codegen Tests
- AST Printing to ease debugging



```
Mat(3) r = [3][2][4];

Mat(3) r[2][2][1]=3;

Int q = 3;
Int b = 4;
```



```
./matcv < testParserFail
Fatal error: exception Parsing.Parse_error
make: *** [runtest] Error 2
```

Demo Time!