YAMML

Yet Another Matrix Manipulation Language

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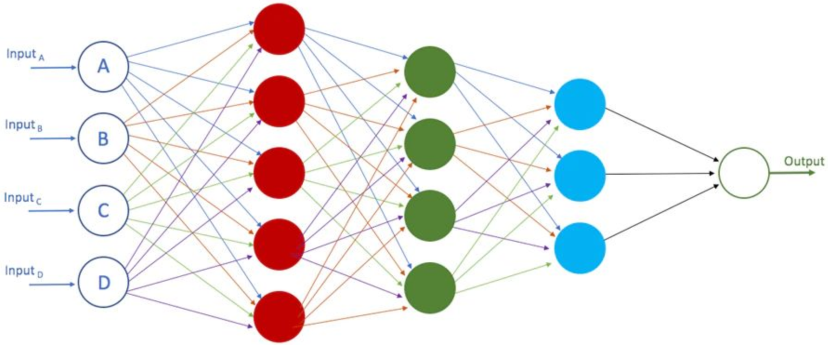
Motivation

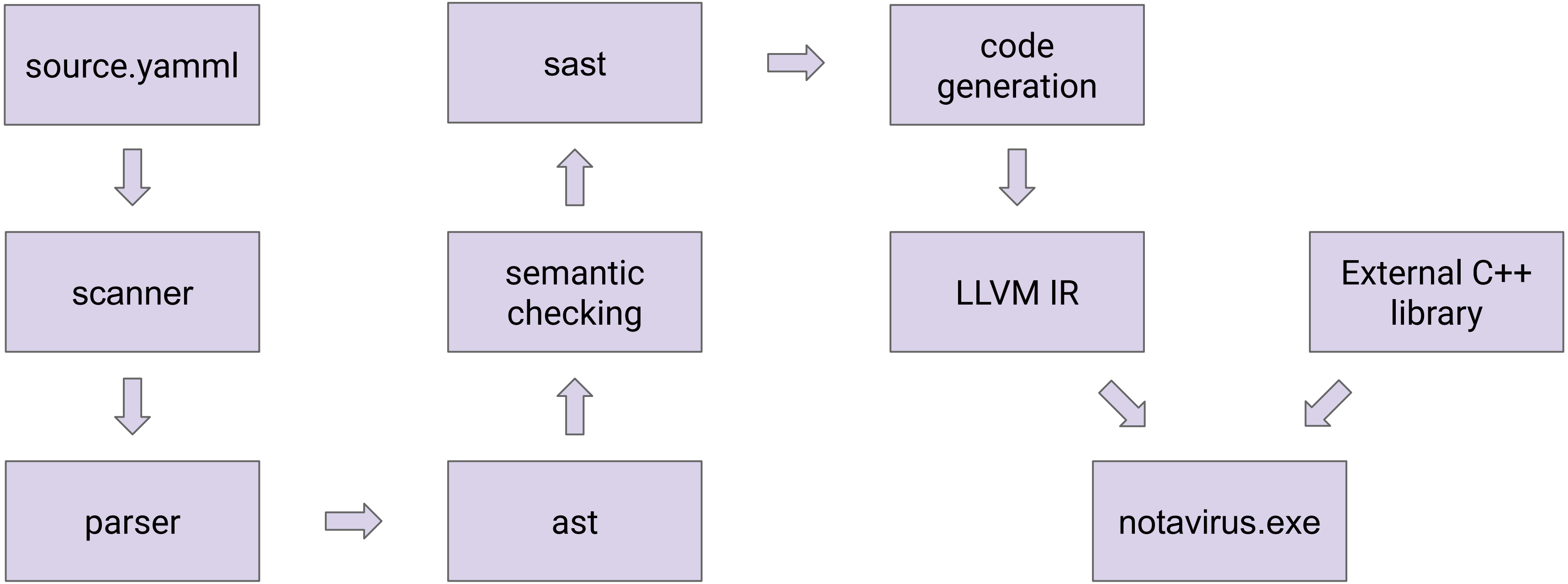
- As machine learning is becoming more prevalent, there is an increasing need for easier matrix-based computations

- YAMML harnesses the familiar syntax of C++ and adds built-in support for matrix creation and common matrix operations

- Machine learning engineers and architects can use YAMML to more efficiently and accurately perform matrix-based computations.



Compiler Architecture



Language Overview

Core Features

- Static scoping
- Mixed variable declarations and code
- Variable initializers (local and global)
- Explicit & implicit type casting
- Strongly & statically typed

Matrix Functions

Access	`M[0,0];`
Splice	`M[:,:]`
Element Assignment	`M[0,0] = 1.0;`
Matrix Operations	`M * M; M .* M; M * 2.0;`
Transpose	`trans(M);`
Convolution	`filter2d(M);`

Primitives

```
int, float, str, char, bool
```

Matrix

```
[ ];   [1.0, 2.0];   [1.0; 2.0];
[1.0, 2.0; 3.1, 4.1];
```

Control Flow Keywords

```
if, else, while, for, return, continue, break
```

Arithmetic Operators + Assignment

```
-    +    =    *    /    .*
```

Logical Operators

```
!    &&    ||
```

Conditional Operators

```
<   >   ==   !=   <=   >=   !=
```

Comments

```
/*... */   //
```

Language Overview: More C-based Features

Imports

```
#import <file.yamml>
```

Function Declaration

```
int main (){
     return 0;
}
matrix foo (matrix m){
     return m;
}
```

Implicit Casting

```
1+1.1 //2.1
```

Control Flow

```
int i = 0;
for (i ; i < 5; i = i + 1) {
     /* something */
}

int i = 0;
while (i < 5) { /* body */ }

int y = 5;
if (x == y) {
     /* something */
}
else {
     /* something */
}
```

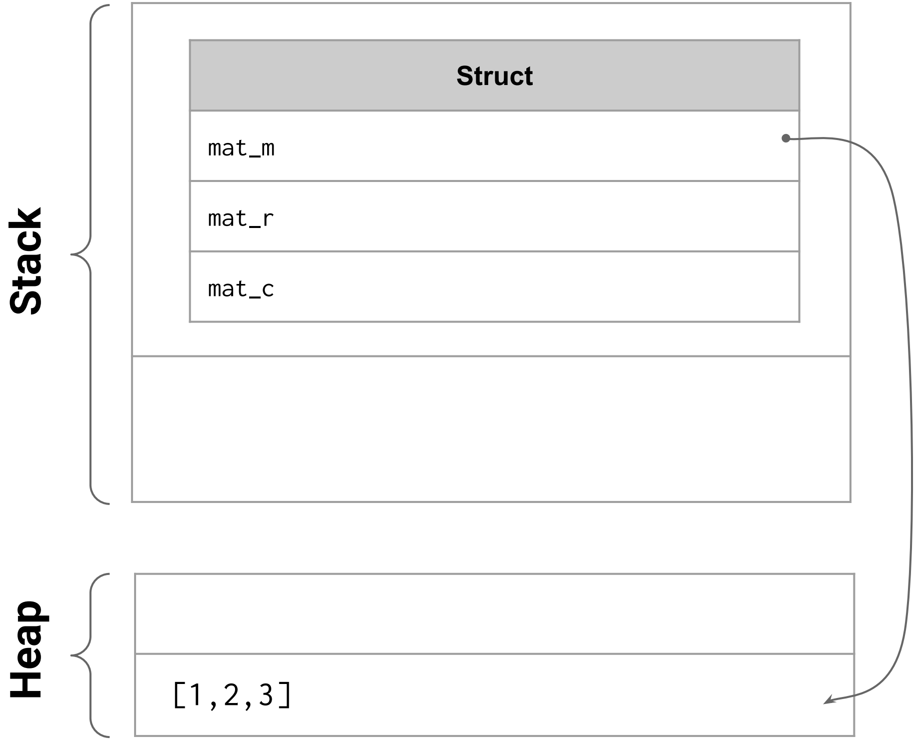
Scoping

```
{
int z;
int a = 5;
     {
     int a = 7;
     a = a + 1;
     print(a); //8
     }
a = a + 1;
print(a); //6
}
```

Implementation: Matrix

Code

```
int main() {
     matrix M = [1,2,3];
}
```



Stack

Struct

mat_m

mat_r

mat_c

Heap

[1,2,3]

Implementation: Standard Library and Built-ins

Printing Functions

```
print(int);
printf(float);
printb(boolean);
printStr(str);
printmat(matrix);
```

Matrix Functions

```
int height(matrix m);
int width(matrix m);
float sum(matrix m);
float mean(matrix m);
matrix trans(matrix m);
matrix filter2d(matrix m, matrix k);
matrix empty(int r, int c);
matrix imread(str filename);
matrix imwrite(str filename);
```

Demo: Matrix Operations

Matrix Declaration

```
matrix M = [1.1, 1.2, 1.3; 1.4, 1.5, 1.6; 1.7, 1.8, 1.9]; //3 row, 3 column matrix. index starts at 0
matrix N = [2.1, 2.2, 2.3; 2.4, 2.5, 2.6; 2.7, 2.8, 2.9];
```

Accessing Elements

```
M[1, 2]; //1.8
```

Slicing

```
M[0:1, 1:2]; //returns [1.2, 1.3; 1.5; 1.6]
```

Arithmetic Operations

```
M*N //matrix multiplication
M.*N //element-wise multiplication
M./N //element-wise division
M * 1.1 //returns a matrix of floats
```

Demonstration

Testing

- Run all unit tests: `./testall.sh`
- Tests:
  - Statements and expressions
  - Scope
  - Matrix operations
  - Functions
  - Standard library functions

- Run individual test:
  1. `./yammlc.sh ./tests/test-feature.yamml`
  2. `./test-feature.exe`

Future Directions

- Implement garbage collection

- Additional Matrix Operations
  - Colored Image Manipulation

- Additional Libraries

Questions