YAGL

Yet Another Graphing Language

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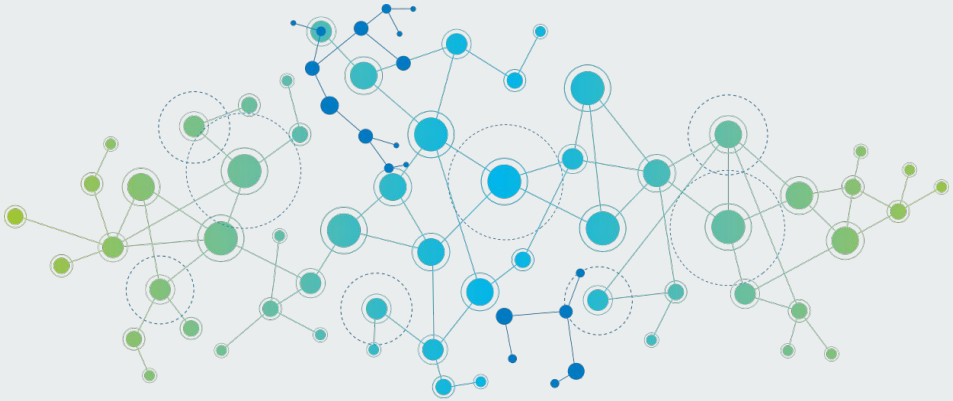

Final Presentation

Meet The Team

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Agenda

1. Target Audience & Motivation
2. YAGL In One Slide
3. Compiler Architecture
4. Cool YAGL Components
5. YAGL Standard Library
6. Built-in Functions (C)
7. Who Did What?
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About YAGL: Target Audience & Motivation

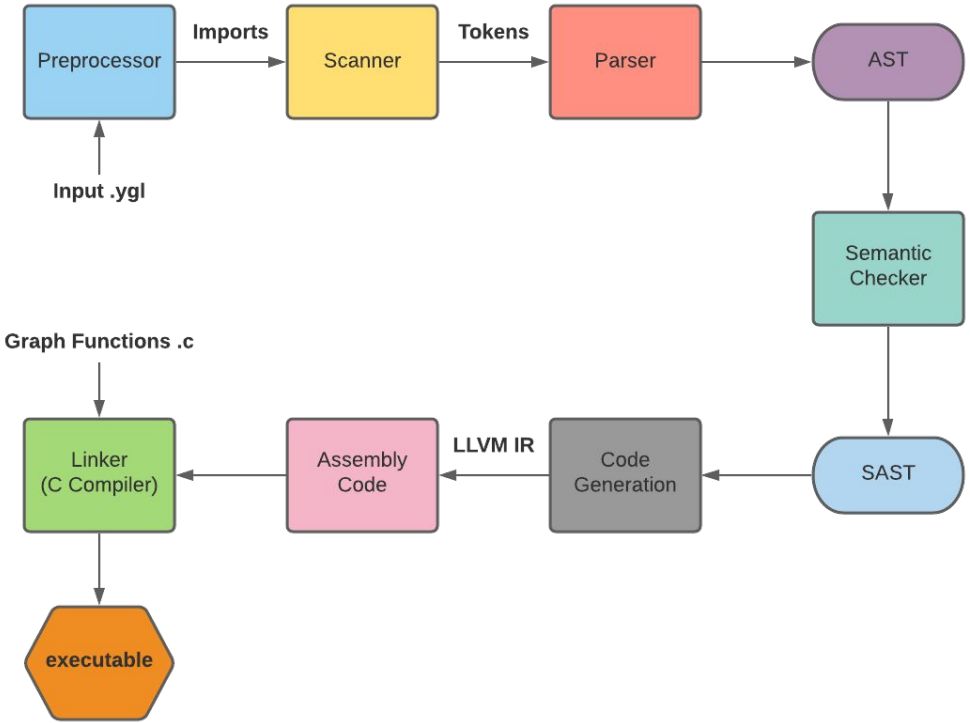
- Pervasiveness of graphs in CS ⇒ great candidate
  - fundamental in data structures & algorithms
- Aims to make implementing graphs & algorithms much simpler
- Ubiquitous with numerous applications:
  - social media connections
  - roads that connect cities
  - flights between cities
  - many other mathematical & logical problems
- Statically & Strongly typed, imperative language
- C-like syntax but adopted other languages features we appreciated

YAGL in One Slide

- No `main()`
- Import standard library for `print_graph_lib`
- Declaring and initializing graphs and nodes (more later)
- Adding nodes and edges to graphs
- Scoping

```
1  import stdgraph.ygl
2
3  Graph example;
4  Node n(gen_name("1"));
5  Node n2(gen_name("2"));
6
7  example: + n + n2, n -> n2 -> n;
8
9  print_graph_lib(example);
10
11 String gen_name(String n) {
12         String hidden = "ODE";
13         String total = "";
14         {
15                 String hidden = "N";
16                 total = total + hidden;
17         }
18         return total + hidden + n;
19 }
```

Compiler Architecture



Cool YAGL Features

No `main()`

- Each file has an implicit main function
  - Entry point

- Implemented via lifting all “orphaned” statements
  - Statements not within a function

```
printString("Hello World!");
```

Generic printing capabilities

```
1   Node n("hi");
2   print(n);
3   int x = 5;
4   print(x);
5   char s = 's';
6   print(s);
7   print('s');
8   Graph g;
9   g: + n;
10  print(g);
11  print("Hi!!!");
12  print(true);
```

```
in List.fold_left add_bind StringMap.empty [ ("print", Void);
```

```
| SCall ("print", [x]) -> (
            match x with
                (Node, _) -> (L.build_call print_node_func [| expr builder s_table x |] "print_node" builder)
              | (Graph, _) -> L.build_call print_graph_func [| expr builder s_table x |] "print_graph" builder
              | (Int, _) | (Bool, _) -> L.build_call printf_func [| int_format_str ; (expr builder s_table x) |] "printf" builder
              | (Char, _) -> L.build_call printf_func [| char_format_str ; (expr builder s_table x) |] "printf" builder
              | (Float, _) -> L.build_call printf_func [| float_format_str ; (expr builder s_table x) |] "printf" builder
              | (String, _) -> L.build_call printf_func [| string_format_str ; (expr builder s_table x) |] "printf" builder
              | _ -> raise (Failure("Not implemented print type.")))
```

Arrays

- Different syntax than C
  - int[10] foo vs int foo[10]
- Flexible in ways it can be used and accessed
  - Arrays of all types and any [expr] inside
- LLVM `getelementptr` understanding key

```
let indices =
  (Array.of_list [L.const_int i64_t 0; index]) in
let ptr =
  L.build_in_bounds_gep (lookup s s_table) indices (s^"_ptr_") builder
in L.build_store e' ptr builder
```

```
int bar;
bar = 9;

int[10] foo;
foo[0] = 0;
foo[2+3] = 123;
foo[bar] = 456;

printInt(foo[3-3]);
printInt(foo[5]);
printInt(foo[bar]);

int temp;
temp = foo[0];
printInt(temp);
```

Scoping

- Each block has his own scope
  - C-like scoping rules
- Variables not just declared at top
- Implemented via symbol tables
  - Semantic Checker & Codegen pass around a list of symbol tables

```
/* Every single variable is named foo */

String foo = "wins";
{
   String foo = "always";
   {
      bool foo = true;
      {
         if(foo) {
            int foo = 42;
            printInt(foo);
         }
      }
   }
   printString(foo);

}
printString(foo);
```

Preprocessing / Importing

- `import` keyword
  - Python inspiration
  - Acts similar to C's preprocessing directives
- File imported is "pasted" to provide access to all functions and vars
- Done prior to feeding to scanner

```
import stdalgo.ygl
import stdgraph.ygl

/* Social Media Application */

Graph fb;         /* Facebook  */
Graph tw;         /* Twitter   */
```

•

•

•

```
/* Find friends of friends */
dfs(fb, james, 2);           /* S
print(fb);
```

Graphs with Nodes & Edges

- Allocates room for empty Graph on the heap
  - Graphs dynamically grow to hold “infinite” nodes
- Allocates and initializes a node with given name
- Adds Node to the team Graph
  - Nodes can be placed in multiple graphs
- Recursively adds Edges to graph with default weight of 1

```
1
2   Graph team;
3
4   Node adam("Adam");
5   Node james("James");
6   Node tank("Tank");
7   Node jack("Jack");
8
9   team + adam;
10  team + james;
11  team + tank;
12  team + jack;
13
14  team: adam -> james -> tank -> jack -> adam;
15
16  printGraph(team);
```

```
Nodes:
Node (0) : Adam --- Node (1) : James --- Node (2) : Tank
Node (3) : Jack

Edges:
[(0) : Adam] ---(1)---> [(1) : James]
[(1) : James] ---(1)---> [(2) : Tank]
[(2) : Tank] ---(1)---> [(3) : Jack]
[(3) : Jack] ---(1)---> [(0) : Adam]
```

More Complex Augmentations

- Complicated example to show variety of graph operation in single LOC
  - Add Node +
  - Add Edge -> and <-
  - Add Bidirectional Edge <->

```
Graph demo;

Node portland("Portland");
Node pittsburgh("Pittsburgh");
Node nyc("New York City");
Node nj("New Jersey");

demo: + portland + pittsburgh ->2566 portland ->2566 pittsburgh
      + nyc [800<->800] pittsburgh, portland [2900<->2900] nyc,
      + nj <-13 nyc <-13 nj [2899<->2899] portland,
      nj [790<->790] pittsburgh;

print(demo);
```

```
Nodes:
Node (0) : Portland --- Node (1) : Pittsburgh --- Node (2) : New York City
Node (3) : New Jersey

Edges:
[(1) : Pittsburgh] ---(2566)---> [(0) : Portland]
[(1) : Pittsburgh] ---(800)---> [(2) : New York City]
[(1) : Pittsburgh] ---(790)---> [(3) : New Jersey]
[(0) : Portland] ---(2566)---> [(1) : Pittsburgh]
[(0) : Portland] ---(2900)---> [(2) : New York City]
[(0) : Portland] ---(2899)---> [(3) : New Jersey]
[(2) : New York City] ---(800)---> [(1) : Pittsburgh]
[(2) : New York City] ---(2900)---> [(0) : Portland]
[(2) : New York City] ---(13)---> [(3) : New Jersey]
[(3) : New Jersey] ---(13)---> [(2) : New York City]
[(3) : New Jersey] ---(2899)---> [(0) : Portland]
[(3) : New Jersey] ---(790)---> [(1) : Pittsburgh]
```

Accessors

- Graphs
  - graph.weight[node1, node2]
  - graph.num_nodes
  - graph.num_neighbors[A]
  - graph.node[n]
  - graph.neighbor[A, n]
- Nodes
  - v.name
  - v.curr_dist
  - v.visited
- Strings
  - string.length

```
| "num_nodes"          ->      let e' = expr builder s_table (Node, sId) in
                               ignore (L.set_alignment 4 e');
                               let ptr = L.build_struct_gep e' 1 "get_num_nodes" builder in
                               L.build_load ptr "num_nodes_ptr"
```

YAGL's Standard Libraries

- stdgraph.ygl
  - Graph copy_graph_lib(Graph g)
  - Graph reverse_graph_lib(Graph g)
  - void print_graph_lib(Graph g)
- stdalgo.ygl
  - void dfs(Graph G, Node vertex, int depth)
  - Node get_first_node_at_depth(Graph G, Node vertex, Node break, int depth)

Used in upcoming demo!

```
Node get_first_node_at_depth(Graph g, Node vertex, Node b, int depth) {
        reset(g);
        return get_first_node_at_depth_helper(g, vertex, b, depth);
}

Node get_first_node_at_depth_helper(Graph g, Node vertex, Node break, int depth){
   if (vertex.visited == true) {
       return break;
   }

   if (depth == vertex.curr_dist) {
       return vertex;
   }
   vertex.visited = true;

   int size = g.num_neighbors[vertex];
   int curr = 0;

   while (curr < size) {
      Node current;
      current = g.neighbor[vertex, curr];
      if (current.curr_dist == 0) {
          current.curr_dist = vertex.curr_dist + 1;
      }
      curr = curr + 1;
   }
   curr = 0;
   Node new; /* just a place holder */
   while (curr < size) {
      Node current;
      current = g.neighbor[vertex, curr];
      new = get_first_node_at_depth_helper(g, current, break, depth);
      if (new == break) {
      } else {
        return new;
      }
      curr = curr + 1;
   }
   return new;
}
```

Built-in Functions

- Graph Functionality
  - make_graph(int size)
  - insert_node(struct Graph *, struct Node *)
  - make_node(char *name)
  - get_neighbor(struct Graph *, struct Node *)
  - print_graph(struct Graph *)
  - insert_edge(struct Graph *, struct Node *, int, struct Node *)

Who did what?

- First half through Hello World: Together
- Second half: Distributed Feature Development
  - From scanner → … → codegen → tests
- Weekly meeting to merge code & features
- Process worked very well: all wanted to learn about the entire compiler!

Amazing Demo Time

Buckle up.

Q&A

Thank you!