Design Document

Milestone 2

COMP 520: Compiler design

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Scoping Rules

```
type scope =
  {
    bindings: (string * typesDef) list;
    types: (string * typesDef) list;
    functions: (string * typesDef list * typesDef option) list;
    parent: scope option;
    children: scope list
  }
```

The symbol table of the compiler is in a tree form. Each node of the tree is a scope. Each scope has a reference to its parent scope and a list of references to its child scopes. The root scope is the scope englobing the top-level scope. It is where the base types are defined. Functions are defined in the top-level scope (the top-level scope is the only child scope of the root scope). Each time a new scope is created, it is added as a child of the current scope.

For each scope, variable bindings are stored in the `bindings` member as a list of type definitions associated with the variable's identifier. Types are stored in the `types` member as a list of type definition with the associated identifier. Functions are stored in the `functions` member as a list of function type definition. Each function type definition is a string (the function identifier), a list of type definition (the arguments) and an optional type definition (for the return type).

When the typechecker wants to find if a symbol is defined, it will search the current scope and its parent scopes recursively until it finds a definition. If the search reaches the root scope and no definition is found, the symbol is undefined. When a new symbol is defined, it is added to the current scope.

Events triggering the creation of a scope:

- Function declaration (the argument bindings are added to the new scope).
- Declaration of a block (including the body of `if`, `else`, `for`, `switch`, `case`).
- Init statement of a `switch`, `if`, `for`[1]

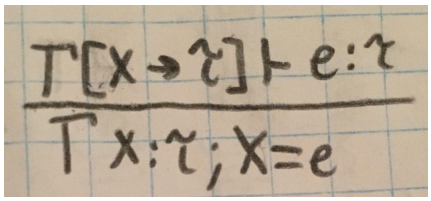
Event triggering the close of the scope opened by an init statement

- End of `if` body if there is no `else`
- End of `else`, `for`, `switch` body

[1] This means that, in a `switch`, `if`, `for` with an init statement, two scopes are opened. The scope of the init scope is opened first, then the scope of the body is opened.

Design of Test Program

1.2.2-different-array-size.go



Problems and Solutions

Type Inference

Since GoLite supports type inference (`var a = 3`), we couldn't build the complete symbol table without first evaluating expressions on the right side of variable declarations. To solve this problem, we decided to build the symbol table while typechecking the program. To accomplish this, we have a version of the symbol table that we keep updating while traversing the AST to typecheck it. Every time the program finds a declaration, it adds it to the symbol table. Every time a new block is opened, a new scope is added to the scope tree (see previous section for details of our implementation of scopes). Since GoLite does not support the utilization of an element before it is declared, the compiler can typecheck without the need of a complete symbol table.

Root Scope

We needed that the base types (int, float64, string, rune, bool) to be already defined in the top-level scope, but that could also be shadowed in the root scope. To do this, we decided to add a scope that would be the root of our symbol table and also the parent of the top-level scope. In this root scope, only the base types are defined.

Keep the Symbols for Code Generation

We wanted to keep as much information about the symbols of the code for the code generation phase of the compiler. To do so, we decided that each statement node of the AST would have a copy of the symbol table at the moment it was typechecked. Thus, when the code generation phase will receive the AST it will be able to know exactly which symbols are available on every statement.

Typechecking Done During Weeding

Some parts of the typecheck were easier to implement during the weeding phase.

Struct Member Redefinition
We checked if there was no members of a struct sharing the same identifier.

Function Call With Too Many Arguments
We checked that a call to a function can't have a different number of arguments than the function.

Post Statement of a For Loop
We checked that there is no declaration in the post statement of a for loop.

Team Organization

For this milestone, Maxence had a few personal problems that caused him to have less time to put into school work. Mathieu and Maxime put more work in this milestone to counter-balance it.

Maxence

- Removed tests from past teams from the GitHub repository.

Maxime

- Wrote the design document.
- Created the typechecking tests.
- Implemented the symbol table printer.
- Implemented the typechecking along with Mathieu.

Mathieu

- Created most of the typechecking code.