– The Z Programming Language –

Development Log 2020

T1W10

In-line with the *Project Plan*, the development evironment was installed. This included installing the Deno runtime, and setting up the environment for working with the Visual Studio Code IDE. The primary image required, the 'Z' logo, was designed.

T1W11

11/12th April

To meet the T1W11 plan, the lexer, syntax-checker, and debugging messages were developed. These were developed as separate modules which in hind-sight probably slowed the implementation of the algorithms, due to module-importing complexities. By the end of the two days, the compiler could:

- read a source file,
- generate an ordered list of language tokens,
- and generate a syntax tree based only on the PROG ENDPROG and 'assignment' structures.

The Lexing was achieved using regular expressions, which tested each word input and returned a category (keyword, number, etc.).

Hol.W1

13th April

Today was spent attempting to create a special Syntax-Checker that could accept a list of rules and test given data. This was an interesting endeavour, however it proved fruitless due to difficulties managing recursion. It may be picked up during the later stages of development to make the code more flexible and easier to understand.
Part of the setback was due to complexities of JavaScript's function parameters. It is easy to forget that an Array being passed in is passed as a reference; this means that a change to it in an external function (such as one called to recurse) will change its contents back outside, causing headaches when trying to figure out where something went wrong. This is solved by print the value of the Object when it is passed in, and when that called function returns.

14th April

Today focused on implementing more syntax checks. This included parsing Input Statements, Conditions (which required recursion), Do Blocks, Pre-Tests and Output Statements. It also threw certain errors depending on where an invalid token was encountered. Each parser for a structure type was called, "popping" each token off of the Token-Array. If it threw a ParserError, the mistake was "mine" for calling it and so the Syntax-Checker attempted to parse the tokens with another parser. If a SyntaxError was discovered, the token was discarded and this meant that the user input was invalid, i.e. a malformed statement was provided.
At the end of the day, the program could reliably provide a Syntax Tree for more of Z's features.

15th April

Today focused on finishing the Syntax-Checker, and implementing the compiler to Python. An error was found in the syntax-checker regarding scopes. Some keywords end a scope, while others end a structure. A distinction was made and this solved an issue whereby the end of the program was reached because too many scopes were exited, thus leading to the end of the input by exiting the PROG scope.
The compiler included special functions for converting input from the user to numbers or strings depending on the input data. This was achieved by including a Python function in the outputed code.
As a test of the compiler, a fizzbuzz program was successfully written.

```
PROG FIZZBUZZ
  = X3 1:
  = X5 1:
  = I1 1:
  = M1 IN["MAX : "]:
  WHEN ≤ I1 M1 DO
    = O1 0:
    IF && ≥ X5 5 ≥ X3 3 DO
      OUT["FIZZ BUZZ"]:
      = X3 0:
      = X5 0:
      = O1 1:
    ENDDO ENDIF
    IF && ≥ X3 3 == O1 0 DO
      OUT["FIZZ"]:
      = X3 0:
      = O1 1:
    ENDDO ENDIF
    IF && ≥ X5 5 == O1 0 DO
      OUT["BUZZ"]:
      = X5 0:
      = O1 1:
    ENDDO ENDIF
    IF == O1 0 DO
      OUT[I1]:
    ENDDO ENDIF
    = X3 1 +:
    = X5 1 +:
    = I1 1 +:
  ENDDO ENDWHEN
ENDPROG
```

16th April

Today focused on polishing the compiler some more. The Python program was supplemented with another function, allowing variables of different types to be cast and used in assignment statements. This meant casting the value to be assigned to the data type of the variable to hold the value. This means that if `A1` holds the value `Hi`, then `= A1 2 +` will result in `A1` having the value `Hi2`.
To further test the compiler, Modulo, Fibonnaci and Squares programs were written and compiled and run successfully.

```
PROG MODULO
 = D1 IN["MODULUS : "]:
 = N1 IN["NUMBER  : "]:
 = N2 N1:
 WHEN ≧ N2 D1 DO
  = N2 D1 -:
 ENDDO ENDWHEN
 IF == N2 0 DO
  OUT[N1+"CAN BE EVENLY DIVIDED BY"+D1]:
 ENDDO OTHERWISE DO
  OUT[N1+"CANNOT BE EVENLY DIVIDED BY"+D1]:
 ENDDO ENDIF
ENDPROG
```

```
PROG FIBONACCI
 = N1 IN["NO. OF TERMS : "]:
 = C1 1:
 = F0 0:
 = F1 1:
 = F2 1:
 OUT[" F( 0 ) = 0"]:
 WHEN ≦ C1 N1
  DO
   OUT[" F( "+C1+" ) = "+F2]:
   = F2 0:
   = F2 F0+:
   = F2 F1+:
   = F0 F1:
   = F1 F2:
   = C1 1 +:
  ENDDO
 ENDWHEN
ENDPROG
```

```
PROG SQUARES
 FOR I1 FROM 1 TO 17 BY 1 DO
  = S1 I1:
  = S1 S1 *:
  OUT["INTR:"+I1]:
  OUT[" SQR:"+S1]:
 ENDDO ENDFOR
ENDPROG
```

Hol.W2

Work has been delayed by a week, but this is works with the Project Plan which allows for extra buffering should delays be encountered in development.

T2W1

28th April

Begin the process of cleaning up folder structure, and think about a pre-compile stage to filter lexical tokens.

1st May 2020

Convert to an Object based approach for parsing.
I re-wrote the parser and lexer, to be cleaner. Internal documentation is still lacking.
It runs surprisingly quick, almost instantaneously!

3rd May 2020

GUI in place, with File, Edit, Help buttons and menus visible but not functional.
The editor also supports syntax highlighting.

File | Edit | Help | The Z Programming Language

```
PROG FIZZBUZZ
  = X3 1:
  = X5 1:
  = I1 1:
  = M1 IN["MAX : "]:
  WHEN <= I1 M1 DO
    = O1 0:
    IF AND >= X5 5 >= X3 3 DO
      OUT["FIZZ BUZZ"]:
      = X3 0:
      = X5 0:
      = O1 1:
    ENDDO ENDIF
    IF AND >= X3 3 == O1 0 DO
      OUT["FIZZ"]:
      = X3 0:
      = O1 1:
    ENDDO ENDIF
    IF AND >= X5 5 == O1 0 DO
      OUT["BUZZ"]:
      = X5 0:
      = O1 1:
    ENDDO ENDIF
    IF == O1 0 DO
      OUT[I1]:
    ENDDO ENDIF
    = X3 1 +:
    = X5 1 +:
    = I1 1 +:
  ENDDO ENDWHEN
ENDPROG

```

4th May 2020

Minor tweaks to formatting page.

T2W3

13th May 2020

```
PROG TESTZED
  = A1 0:
  WHEN < A1 10 DO
    OUT["A1 : "+A1]:
  ENDDO ENDWHEN
ENDPROG
```

Error: Not parsing end of statement correctly.

```
Error :: Expected ':' near line 4.
```

```
$ false { type: "keyword", value: "WHEN", line: 3
@ { type: "keyword", value: "WHEN", line: 3 }
$ false { type: "keyword", value: "OUT", line: 4
@ { type: "keyword", value: "OUT", line: 4 }
$ true { type: "special", value: "]", line: 4 } :
# { type: "special", value: ":", line: 4 }
[
 { type: "keyword", value: "ENDDO", line: 5 },
 { type: "keyword", value: "ENDWHEN", line: 5 },
 { type: "keyword", value: "ENDPROG", line: 6 }
]
```

```
  }
  // shift the closing "]"
  t.shift();
```

Accidentally commented a line that removed the closing "]" for OUTPUT statement.

Error: Missing end of statement throws compilation.

```
Error :: Expected ':' near line 5.
Error :: Unhandled 'ENDWHEN' on line 5.
Error :: Unhandled 'ENDPROG' on line 6.
```

Turns out that t.shift() was removing the token on error, and not allowing a recovery. Replaced with t[0].

```
} catch {
  if (assert) throw new ParserErrors.ExpectedToken(":", t[0].line);
}
```

Considering re-doing to the parser again to present a clearer logic, and push errors to a list, rather than throw (and have to deal with messy try-catch blocks)

T2W4

22nd May 2020

After reviewing Web technologies, the "New" option is not needed in the "File" editor menu. A HTML input can be used to both open a file, and the native dialog also allows creating a new file.
The "Info" option is also seeming to be unnecessary, and so too will be removed.
The "Cut", "Copy", "Paste" menus are nice, but can be completed by the user using Right-Click and are thus unncessary. Thus, "settings" will be moved to the "File" menu, and the "Edit" menu removed.

T2W5

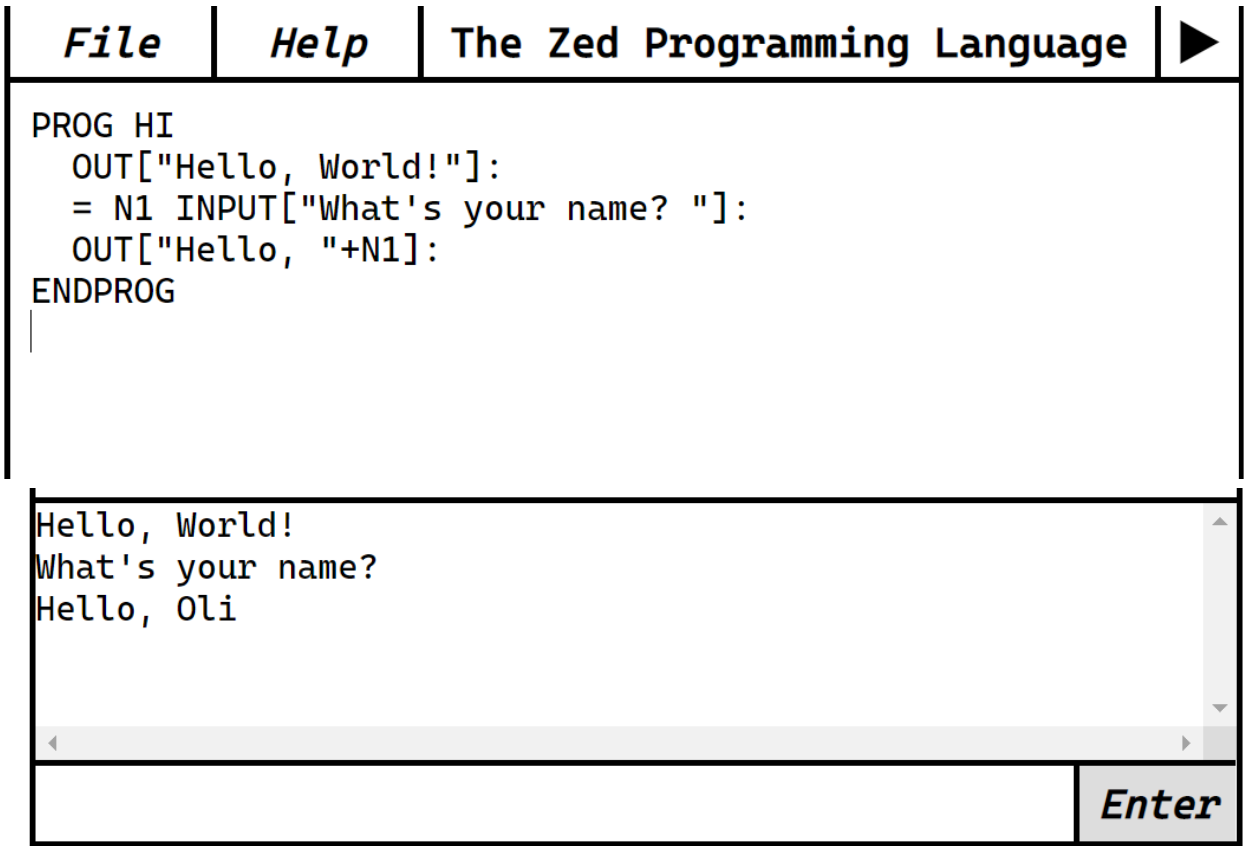
27th May 2020

The Web Editor is now capable of send a script to be run on the server. Next to be implemented is WebSockets between the browser and server.

T2W6

3rd June 2020

The WebSocket interface works at a basic level. A script can be compiled from user input on the editor, and run, accepting input and displaying output, in the program execution screen.



5th June 2020

Going through each part of compiler for refactor. Lexer improved/simplified.

6th June 2020

Reading up on compiler. Refactor In/Out, Assignment, Condition Code, simplification and following the single fail per statement rule.
Implementing Unit-Tests to test Zed Compiler without needing to compile a script. This was extremely valuable.

T2W7

13th June 2020

Research was done to better understand the intricacies of a compiler, and to understand the different phases. This was very valuable to beginning the re-write. How a compiler recovers.

T2W8

15th June 2020

Refactoring Parser, enabling code to be cleaner and easier to read. Remove duplication of parsing string/number/variable.
The follow were of great help in including file functionality into the editor. https://stackoverflow.com/questions/3582671/how-to-open-a-local-disk-file-with-javascript https://stackoverflow.com/questions/13405129/javascript-create-and-save-file

20th June 2020

Work was done on the usability of the editor, the Zed Programming Language manual was written, code comments were modified to become clearer in` the compiler source code and they were also added as a feature in Zed. Host.ts and Zed-Edit.js were created to further modularise code being used.

T2W9

22nd June 2020

A bug was encountered whereby a SWITCH WHEN was allowing values between the WHEN blocks that should have been labelled as errors.

```
PROG switch_selection
  = S1 IN["Choose a dog, cat, or rabbit: "]
  SWITCH S1
    WHEN "dog"
      DO
        OUT["Woof Woof!"]:
      ENDDO
    WHEN "cat"
      DO
        OUT["Meow!"]:
      ENDDO
    21
    WHEN "rabbit"
      DO
        OUT["Eheheh, what's up Doc!"]:
      ENDDO
  ENDSWITCH
ENDPROG
```

Looking at the tokens list, it is expected that the output should follow the pattern of keyword, string, keyword, string ...
But looking at the output below, it is clear that the "21" is not following a keyword. So something must be wrong.

```
{ type: "keyword", value: "WHEN", line: 4, position: 4 }
{ type: "string", value: ""dog"", line: 4, position: 9 }
{ type: "keyword", value: "WHEN", line: 8, position: 4 }
{ type: "string", value: ""cat"", line: 8, position: 9 }
{ type: "number", value: "21", line: 12, position: 4 }
{ type: "keyword", value: "WHEN", line: 13, position: 4 }
{ type: "string", value: ""rabbit"", line: 13, position: 9 }
```

Upon looking at the code, it was a messy while statement, that had logic all over the place. The main issue was the skipToNextWhen to next when which was interacting

unexpectedly with the condition in the javascript while loop. The fix was to simplify the loop logic, and keep any break conditions inside.

```
constructor(t: TokenArray) {
  // flag to fail fast to the next when if failure occurs
  let skipToNextWhen = false;
  t.read(syntaxTests.SWITCH);
  this.variable = t.readVariable();
  // keep looping until the ENDSWITCH keyword is met
  while (!t.check(syntaxTests.ENDSWITCH)) {
    console.log(t.peek());
    if (t.check(syntaxTests.WHEN)) {
      t.read(syntaxTests.WHEN);
      // no need to skip when we are about to parse a when block
      skipToNextWhen = false;
    }
    // skip and disregard input, but ensure we don't step into EOF space
    else if (skipToNextWhen) {
      t.advance();
      t.assertPeek();
    }
    // parse the value DO ENDDO after the WHEN
    else {
      try {
        this.whenValueThenCode.push([
          t.readValue(),
          new ZedDoBlock(t),
        ]);
      } catch (e) {
        // if we enconuter EOF, throw up the chain
        if (e instanceof UnexpectedEndOfProgram)
          throw e;
        // otherwise push the encountered error, and skip until next when
        else {
          this.errors.push(e);
          skipToNextWhen = true;
        }
      }
    }
  }
  t.read(syntaxTests.ENDSWITCH);
}
```

The new code is visually much easier to follow, and it is clear what drives the decisions the parser makes.

```
constructor(t: TokenArray) {
  // flag to fail fast to the next when if failure occurs
  let skipToNextWhen = false;
  t.read(syntaxTests.SWITCH);
  this.variable = t.readVariable();
  // keep looping until the ENDSWITCH keyword is met
  while (true) {
    // if we have a when keyword
    if (t.check(syntaxTests.WHEN)) {
      // remove it so we have read it
      t.read(syntaxTests.WHEN);
      try {
        // create a whenValueDO block
        this.whenValueThenCode.push([
          // read the value to switch on
          t.readValue(),
          // read the DO BLOCK
          new ZedDoBlock(t),
        ]);
      } catch (e) {
        // if we enconuter EOF, throw up the chain
        if (e instanceof UnexpectedEndOfProgram)
          throw e;
        // otherwise push the encountered error, and skip until next when
        else {
          this.errors.push(e);
          skipToNextWhen = true;
        }
      }
    }
    else if (t.check(syntaxTests.ENDSWITCH)) {
      break;
    }
    else {
      // throw an error, expected WHEN
      // get the toke that shouldnt be there
      const tokenThatShouldntBeThere = t.assertPeek();
      // effectively "read" that value, so we move onto the next token
      t.advance();
      this.errors.push(new ParserError(syntaxTests.WHEN, tokenThatShouldntBeThere));
    }
  }
  // read off the closing endswitch
  t.read(syntaxTests.ENDSWITCH);
}
```

The correctly shown error, as a result of the fix, is below.

```
PROG switch_selection
  = S1 IN["Choose a dog, cat, or rabbit: "]:
  SWITCH S1
    WHEN "dog"
      DO
        OUT["Woof Woof!"]:
      ENDDO
    WHEN "cat"
      DO
        OUT["Meow!"]:
      ENDDO
    21
    WHEN "rabbit"
      DO
        OUT["Eheheh, what's up Doc!"]:
      ENDDO
  ENDSWITCH
ENDPROG
```

Completion!

The project is now complete, and a documentation of the Zed Language and editor is provided in the manual, "The Zed Programming Language".