

Notes for Programming in C Lab Session #7

October 7, 2024

1 Introduction

The purpose of this lab session is to write a small program that makes use of arena-style allocation.

2 Overview

In this lab, you will define some functions to do match strings against a subset of regular expressions. In the `re.h` header file, we define the following data type

```
1 enum re_tag { CHR, SEQ, ALT };
2 typedef struct re Regexp;
3 struct re {
4     enum re_tag type;
5     union data {
6         struct { char c; } chr;
7         struct { Regexp *fst; Regexp *snd; } pair;
8     } data;
9 };
```

This is a data type for representing trees. We define an enumeration `enum re_tag`, which says that we have 3 possibilities, either a single-character `CHR`, an alternative `ALT`, and a sequential composition `SEQ`.

Next, we define a structure type `Regexp`, with two fields. The first is the `type` field, which is one of the tags from the enumeration above. The second is a union type `data`, which is either a character `chr`, or a structure containing a pair of pointers to two regular expressions. The `type` field determines which case of the union to use – a valid `Regexp` structure has a character if the `type` field is `CHR`, and a pair if the `type` field is `SEQ` or `ALT`.

The idea is that a `CHR`-regex matches a single character string, the `SEQ`-regex matches if the first part of the string matches the first element of the pair and the second part of the string, and the `ALT`-regex matches if the string matches either the first or the second element of the pair.

Below, I give a table of example regexps, strings and whether or not there is a match. Here, `x`, `a`, `b`, `c`, `u`, and `v` are characters, juxtaposition represents `SEQ`uential composition, and `(+)` denotes `ALT`ernative.

Regexp	"ab"	"xab"	"xba"	"axu"
<code>x(ab+ba)</code>	✗	✓	✓	✗
<code>(a+b+c)(x+y)(u+v+w)</code>	✗	✗	✗	✓

3 Instructions

1. Download the `lab7.tar.gz` file from the class website.

2. Extract the file using the command `tar xvzf lab7.tar.gz`.
3. This will extract the `lab7/` directory. Change into this directory using the `cd lab7/` command.
4. In this directory, there will be files `lab7.c`, `re.h`, and `re.c`.
5. There will also be a file `Makefile`, which is a build script which can be invoked by running the command `make` (without any arguments). It will automatically invoke the compiler and build the `lab7` executable.
6. As usual, a sanitized version of the executable can be built with `make sane`.
7. Run the `lab7` executable, and see if your program works. The expected correct output is in a comment in the `lab7.c` file.

4 The Types and Functions to Implement

- **struct arena**

The `re.h` file contains a declaration of the arena structure, but does not define it. Define an arena type for allocating pointers to `Regex` structures, following the pattern of lecture 6.

- `Regex *re_alloc(arena_t a);`

Given an arena `a`, the `re_alloc` function should allocate a new `Regex` and return a pointer to it. If the arena lacks room to allocate a new `Regex`, it should return `NULL`.

- `void arena_free(arena_t a);`

Given an arena `a`, the `arena_free` function should deallocate the arena and its associated storage. This should be a simple, non-recursive function!

- `Regex *re_chr(arena_t a, char c);`

Allocate a `regex` matching the character `c`, allocating from the arena `a`. Return `NULL` if no memory is available.

- `Regex *re_alt(arena_t a, Regex *r1, Regex *r2);`

Allocate a `regex` representing the alternative of `r1` and `r2` from the arena `a`. Return `NULL` if no memory is available.

- `Regex *re_seq(arena_t a, Regex *r1, Regex *r2);`

Allocate a `regex` representing the sequencing of `r1` and `r2` from the arena `a`. Return `NULL` if no memory is available.

- `int re_match(Regex *r, char *s, int i);`

Given a regular expression `r`, a string `s`, and a valid index into the string `i`, this function should return an integer. If the function returns a nonnegative `j`, then the regular expression should match the substring running from `i` to `j`, including `i` but not `j`. (So if the `re_match(r, s, 5)` returns 8, then the subrange `s[5]`, `s[6]`, `s[7]` should match the `regex` `r`.)

It may help to look at the `re_print` function to see how to switch between the alternative branches of the `regex` type.