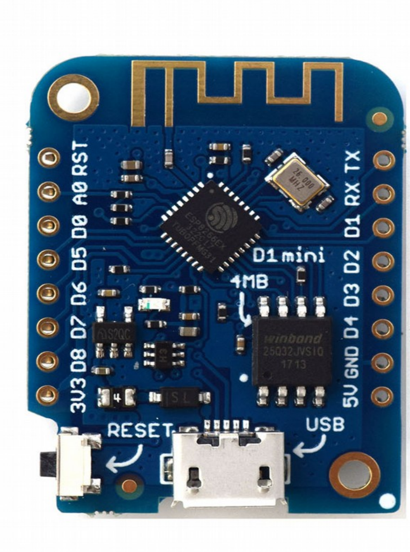
Handout

Project P01:

Fast Small In-Memory Triple Datastructures

1. Introduction

The goal of this project is to get accommodated with the C language and different targets it can be compiled to.



Learning goals are:

- Creating a C project from scratch.
- Working with C language concepts. (Arrays, Pointers)
- Incorporating resources from the internet.
- Autonomously figuring out how to compile C code to different targets (microprocessor, WebAssembly).

Your task is to implement a triple data structure in memory (Triplets always have exactly three values *S*, *P* and *O*). This structure shall be optimized for fast access with arbitrary matching patterns ({*S*}, {*P*},{*O*}, {*SP*}, {*PO*}, {*SO*}, {*SPO*}).

Finally we will test your data structure on a low cost microprocessor (ESP8266) and also as WebAssemly Code on any modern webbrowser.

Deliverables to be ready before the final course on Wed, 28. May 2019:

- The runnable code, including testing scripts provided on GitLab with working automated build scripts.
- One individual page report per participant (Approach chosen, Problems encountered, Lessons learned.).
- A short two pages documentation per group.
- Preparation of a final presentation per group (3min/Person).

2. Organization / Groups

For the project you can build up groups with 4 students. Create your **Group** on *diuf-gitlab.unifr.ch* with the name *SOP2019_P01_<group_name>*. Add everybody to your Group as **Owners**. Inside the groups **Namespace** you can create the project *SOP2019_P01* which will hold the code.

3. Minimal Feature Set

- Add new Triplets through a simple function with the following signature.

  ```
  int insert(char* s, char* p, char* o)
  ```

  The provided variables need to get copied over to memory allocated by your code. The return value of the function is `0` if there was no problem. (Errors can be specified at will.)

- Allocate the memory dynamically with malloc. (Every value in {*S*, *P*, *O*} can hold at least 1024 chars.)

- Provide a query function to find Triples in which one or multiple values can be fixed:

  ```
  int match(char* s, char* p, char* o, long result)
  ```

`char* s,p,o`	Specifies pointers for the query variables and the return variables. If we look for examples for all triples where *S* is set to a specific string, we only provide `s` and initialize the other strings with `0`s. (see example)
`long result`	Specifies which result shall be returned, counting from `0` upwards.

  The result is returned by writing the answers in the initialized variables.

  Then answer of the function is `0` if everything is working correctly and `1` if there is no result found. (Other errors can be specified at will.)

- Show that your code works on the *Wemos D1* microprocessor and also show that your code works as *WebAssembly* in the web browser.

- Integrate the provided benchmark with your code and measure the performance.

Example

```
insert("SOP2019", "has teacher", "PCM")          => returns 0
insert("SOP2019", "topic is", "C")               => returns 0
insert("PCM", "lastname", "Cudre-Mauroux")       => returns 0

match("SOP2019", p, o, 0)      => returns 0, sets p to "has teacher", sets o to "PCM"
match("SOP2019", p, o, 1)      => returns 0, sets p to "topic is", sets o to "C"
match("SOP2019", p, o, 2)      => returns 1 (no more matches found)
match(s, "topic is", "C", 0)   => returns 0, sets s to "SOP2019"
```

4. Additional Features (propositions)

- Implement a feature to delete triples.
- Optimize for speed of inserting.
- Allow dynamic size of values.
- Optimize for size in memory.
- Load data from N-Triples (https://en.wikipedia.org/wiki/N-Triples) files.
  (e.g. http://classifications.data.admin.ch/municipality/2196?format=nt)

On the microprocessor:

- Use the Wifi to make the store accessible on the network.
- Create a simple WebInterface.
- Insert values from a sensor (for example temperature) into the database.

For the WebAssembly project:

- Render the content as a Graph Drawing. (E.g. with d3js).
- Create the same functionality in JavaScript and compare the speed.

5. Implementation decisions

- Which data structure to hold the pointers / data. Array, Linked-List, ...
- Values inline or separated structures?
- How to access/query the data. Keeping indexes, multiple?
- The architecture of your code, structure of files.
- If there are multiple results for one match, how to assure that the order stays the same.

Report the advantages and disadvantages of your implementation decisions regarding write/read performance and memory usage.

6. Resources for the different targets.

Microprocessor: Wemos D1 mini

https://wiki.wemos.cc/products:d1:d1_mini
https://wiki.wemos.cc/tutorials:get_started:get_started_in_arduino

Webbrowser: WebAssembly

http://webassembly.org/getting-started/developers-guide/
http://kripken.github.io/emscripten-site/docs/getting_started/Tutorial.html

7. Evaluation Key

The following aspects of your work will be taken into account for the final mark with the according weights.

Implemented Features	**60%**
Minimal Feature Set	20%
Compiles and Runs on other Targets	10 %
Testing program / script	10%
Additional Features	20%
Code Quality	**20%**
Simple and Concise Code	10%
Architecture and Helperfiles (Makefile)	10%
Documentation	**20%**
Final 3 min/Person Presentation	10%
The time limit is respected.	
Content (show something exciting!)	
Short Documentation (max. 2 pages per Group)	10%
Usage of Store and Testing	
Architecture and Decisions	