

Computer Science 3MI3 – 2020 homework 5

“Fizzbuzz”-ing in Ruby

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Contents

Introduction

The “fizzbuzz” problem is a very simple programming task, sometimes used in interviews to check for a basic understanding of iterating and branching constructs.

We will investigate various possible approaches to this problem in Ruby, as a way to become comfortable with the language. We begin with the familiar looping statements, and then move to using “higher-order” methods, as well as solving a generalisation of the problem.

Boilerplate

Submission procedures

Submission method

Homework should be submitted to your McMaster CAS Gitlab repository in the `cs3mi3-fall2020` project.

Ensure that you have **pushed** the commits to the remote repository in time for the deadline, and not just committed to your local copy.

Naming requirements

Place all files for the homework inside a folder titled `hn`, where `n` is the number of the homework. So, for homework 1, use the folder `h1`, for homework 2 the folder `h2`, etc. Ensure you do not capitalise the `h`.

Unless otherwise instructed in the homework questions, place all of your code for the homework in a single file in the `hn` folder named `hn.ext`, where `ext` is the appropriate extension for the language used according to this list:

- For Scala, `ext` is `sc`.
- For Prolog, `ext` is `pl`.
- For Ruby, `ext` is `rb`.
- For Clojure, `ext` is `clg`.

If multiple languages are used in the homework, submit a `hn.ext` file for each language.

If the language supports multiple different file extensions, you must still follow the extension conventions above.

Incorrect naming of files may result in up to a 10% deduction in your grade.

Do not submit testing or diagnostic code

Unless you are instructed to do so in the homework questions, **you should not submit testing code with your homework submission.**

This includes

- any `main` function,
- any `print` statements which output information **that is not directly requested as console output in the homework questions.**

If you do not wish to remove diagnostic print statements manually, you will have to find a way to ensure that they are disabled in your final submission.

For instance, by using a wrapper on the `print` function or macros.

Due date and allowance for technical difficulties

Homework is due on the second Sunday following its release, by the end of the day (midnight). Submissions past 00:00 may not be considered.

If you experience technical difficulties leading up to the submission time, please contact Mark **ASAP** with the details of the problem and, if possible, attach the current state of your homework to the communication. This information will help ensure we are able to accept your submission once the technical difficulties are resolved.

Proper conduct for coursework

Individual work

Unless explicitly stated in the homework questions, all homework in this course is intended to be *individually completed*.

You are welcome to discuss the content of the homework in the public forum of the class Microsoft Teams team homework channel, though obviously solutions or partial solutions should not be posted or described.

Private discussions about the homework cannot reasonably be forbidden, but such discussions should follow the same guidelines as public discussions.

Inappropriate collaboration via private discussions which is later discovered by course staff may be considered academic dishonesty.

When in doubt, make the discussion private, or report its contents to the course staff by making a note of it in your homework.

To clarify what is considered appropriate discussions of homework content, here are some examples:

1. Discussing the language features introduced or needed for the homework.
 - Such as relevant builtin datatypes and datatype definition methods and their general use.
 - Code snippets that are not partial solutions to the homework are welcome and encouraged.
2. Questions of the form “What is meant by `x`?”, “Does `x` really mean `y`?” or “Is there a mistake with `x`?”
 - Of course, questions of those form which would be answered by partial solutions are not considered appropriate.
3. Questions or advice about errors that may be encountered.
 - Such as “If you see a `scala.MatchError` you should probably add a catch-all `_` case to your `match` expressions.”

Language library resources

Unless explicitly stated in the questions, it is not expected that you will use any language library resources in the homeworks.

Possible exceptions to this rule include implementations of datatypes we discuss in this course, such as lists or options/maybes, if they are included in a standard library instead of being builtin.

Basic operations on such types would also be allowed.

- For instance, `head`, `tail`, `append`, etc. on lists would not require explicit permission to be used.
- More complex operations such as sorting procedures would require permission before you used them.

Additionally, the standard *higher-order* operations including `map`, `reduce`, `flatten`, and `filter` are permitted generally, unless the task is to implement such a higher-order operator.

Part 0: Installing and using Ruby

If you are on a Unix based system (including the Windows Subsystem for Linux) you most likely already have Ruby installed on your system. Try `ruby -v` from your terminal of choice to confirm.

Otherwise, or if you want a different version, see the [Ruby installation guide](#).

The Docker images used for testing will be using Ruby version 2.7.2, but as usual, (small) differences in the version of Ruby you use should not matter for this course.

You can get started with an interpreter session by running `irb` from your favourite terminal, or writing your code in a `.rb` file and running it with, for instance, `ruby h5.rb`. (You can also use `irb` to run your code; this will echo each line of your file as it is run, which you may find helpful for debugging purposes.)

Part 1: Fizzbuzzing by loops [5 points]

In Ruby, create a method `fizzbuzzLooper` which, given a list (presumably of integers, though it may contain any type) creates a new list whose elements are the elements of the original list converted into strings, unless they are

- an integer divisible by both 3 and 5, in which case they are replaced by "fizzbuzz",
- an integer divisible by 3 but not by 5, in which case they are replaced by "fizz", or
- an integer divisible by 5 but not by 3, in which case they are replaced by "buzz".

You may want to make use of the `to_s` method on integers; by convention, `to_s` on any type converts objects of that type into strings.

(Technically, your method should probably work given any type of collection, not just lists; but the result should be a list in any case.)

Your `fizzbuzzLooper` must make use of some manner of looping construct.

- Such as a `loop`, `while` loop or `for` loop.

Because this is a fairly trivial programming task, the marking of this question (and to some extent the marking of the remainder of the homework) *will take *elegance* more into account than usual. (meaning you are expected to follow good coding practices, especially *not repeating yourself*.)

Part 2: Fizzbuzzing by iterators (higher-order methods) [10 points]

Construct another method `fizzbuzzIterator`, whose behaviour is identical to `fizzbuzzLooper`, but which is defined using an “iterator” method rather than a looping construct.

See this online [tutorial](#) on collections and iterators. In particular, look into the iterators `each` and `collect`.

These iterators take a *block* as argument. A block is, essentially, Ruby’s “lambda” construct. Blocks are delimited by braces, `{}`, and may have arguments, which are listed at the beginning and delimited by pipes, `||`. So the anonymous function $x \rightarrow x + 1$ would be written `{ |x| x + 1 }` in Ruby.

So for instance,

```
[1,2,3].each { |x| puts(x) }
```

outputs each element of the list `[1,2,3]`.

Part 3: Generalising fizzbuzzing [20 points]

We now consider a slight generalisation to the fizzbuzzing problem, which we will call “zuzzing”.

To generalise the problem, we assume that we may have several rules which should be applied to the elements of this list, instead of just the two (if it’s divisible by 3, output “fizz”, if it’s divisible by 5, output “buzz”).

- If no rules apply, we still replace the element by its string conversion.

We want to create a method which accomodates any number of rules, and where the rules can be arbitrary predicates on the elements of the list (not just “ `x → x is divisible by ~k`”).

To represent this multitude of rules, we use a list of lists, assuming each of the lists within the list contain two elements;

- the first element being a `lambda` for the rule, and
- the second element being a `lambda` for the string associated with that rule.
 - We use a `lambda` here as well so that the resulting string may depend upon the element.

(The keyword `lambda` applied to a block allows you to store that block using a variable, or in our case, in a list; we are still essentially using blocks in this question.)

For instance, to get the original behaviour of “fizzbuzz” using this “zuzz”, we would use the rules

```
rules = [[lambda { |x| x % 3 == 0 }, lambda { |x| "fizz" }],  
         [lambda { |x| x % 5 == 0 }, lambda { |x| "buzz" }]]
```

as in

```
zuzzer([1,2,3,4,5,6,7,8,9,10,11,12,13,14,15],rules)
```

The reason we use a list of lists of lambdas here to encode the rules, rather than a hash table or other construct, is that *the order of the rules matters*. If more than one rule applies to an element, all such rules should be applied *in order* to build the resulting string. For instance, with the “fizzbuzz” rules above, notice that the “fizz” rule comes before the “buzz” rule so that if an element is divisible by both 3 and 5, the result is “fizzbuzz”, not “fizz”, “buzz” or “buzzfizz”.

Create the method `zuzzer`.

Part 4: Generalised fizzbuzzing in Scala [10 bonus points]

Implement the generalised fizzbuzzing operation from part 3 in Scala.

Make what you feel are necessary adjustments to the types or implementation details, and describe your choices in comments. Your solution may be (sometimes subjectively) judged based on the choices you make. The purpose of the comments is then for you to convince us your choices are appropriate.

Part 5: Generalised fizzbuzzing in Prolog [10 bonus points]

Implement the generalised fizzbuzzing operation from part 3 in Scala.

Make what you feel are necessary adjustments to the types or implementation details, and describe your choices in comments. Your solution may be (sometimes subjectively) judged based on the choices you make. The purpose of the comments is then for you to convince us your choices are appropriate.

Testing

Unit tests for the requested methods/functions are available [here](#). The contents of the unit test file are also repeated below.

The tests can be run by placing the `h5t.rb` file in the same directory as your `h5.rb` file, and running the following command.

```
ruby h5t.rb
```

You may also use `irb h5t.rb`, which will echo the script as it is run.

If you wish to add more tests yourself, see the [documentation](#) for Ruby.

Automated testing via Docker

The Docker setup and usage scripts are available at the following links. Their contents are also repeated below.

- [Dockerfile](#)
- [docker-compose.yml](#)
- [setup.sh](#)
- [run.sh](#)

Place them into your `h5` directory where your `h5.rb` file and the `h5t.rb` (linked to above) file exist, then run `setup.sh` and `run.sh`.

You may also refer to the README for this testing setup and those files [on the course GitHub repo](#).

Note that the use of the `setup.sh` and `run.sh` scripts assumes that you are in a `bash` like shell; if you are on Windows, and not using WSL or WSL2, you may have to run the commands contained in those scripts manually.

The tests

The contents of the testing script are repeated here.

`h5t.rb`

```
require_relative "h5"
require "test/unit"

# BEGIN constants for use in testing
↪ -----
# We use global variables, which is not recommended in Ruby,
# but which makes it simpler to share these values here.
$upto15 = [0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15]

$upto15_fizzbuzzed = ["fizzbuzz", "1", "2", "fizz", "4", "buzz",
                     "fizz", "7", "8", "fizz", "buzz",
                     "11", "fizz", "13", "14", "fizzbuzz"]

$fizzbuzz_rules = [[lambda { |x| x % 3 == 0 }, lambda { |x|
↪   "fizz" }],
                   [lambda { |x| x % 5 == 0 }, lambda { |x|
↪   "buzz" }]]
# END constants for use in testing
↪ -----

# BEGIN fizzbuzzLooper tests
↪ -----
class TestLooper < Test::Unit::TestCase

  def test_simple
    assert_equal($upto15_fizzbuzzed, fizzbuzzLooper($upto15))
  end
end
```



```

end
# END fizzbuzzLooper tests
↪ -----

# BEGIN fizzbuzzIterator tests
↪ -----
class TestIterator < Test::Unit::TestCase

  def test_simple
    assert_equal($upto15_fizzbuzzed,fizzbuzzIterator($upto15))
  end

end

# END fizzbuzzIterator tests
↪ -----

# BEGIN zuzzer tests
↪ -----
class TestZuzzer < Test::Unit::TestCase

  def test_simple
    ↪ assert_equal($upto15_fizzbuzzed,zuzzer($upto15,$fizzbuzz_rules))
  end

end

# END zuzzer tests
↪ -----

```

The Docker setup

The contents of the Docker setup files and scripts are repeated here.

[Dockerfile](#)

```
FROM ruby:2.7.2-buster
```

```

# Set the name of the maintainers
MAINTAINER Habib Ghaffari Hadigheh, Mark Armstrong
↪ <ghaffh1@mcmaster.ca, armstmp@mcmaster.ca>

```

```

# Set the working directory
WORKDIR /opt/h5

    docker-compose.yml

version: '2'
services:
  service:
    build: .
    image: 3mi3_h5_docker_image
    volumes:
      - ../opt/h5
    container_name: 3mi3_h5_container
    command: ['ruby', 'h5t.rb']

    setup.sh

docker-compose build --force-rm

    run.sh

# Run the container
docker-compose up --force-recreate
# Stop the container after finishing the test run
docker-compose stop -t 1

    README.md

# Instructions for automated testing using Docker

We have already created a `Dockerfile` here which specifies
all the necessary packages, etc., for compiling and running
↳ your code.
You only need to follow the instructions below to see
the results of unit tests designed to check your
↳ implementation.

## Setup
We use `docker-compose` and its configuration file to build
↳ the image.
Assuming you have `docker` and `docker-compose` installed,
simply execute
```shell script

```

```
./setup.sh
```

to generate the image.

## Prepare your code for the running the tests
You only need to place the `h5t.rb` unit test file and
the `run.sh` file in the same directory as your `h5.rb` source
↪ file.

## Running the tests
As with the build process, we have already put
the configuration needed for running the test inside
↪ `docker-compose.yml`.
Simply execute
```shell script
./run.sh
```

to run and see the results of the tests.
```