Conabio Challenges Documentation

General observations

Solutions to Conabio Challenges by Nelly Selem
Oct 2018

Solutions to this challenges are delivered as executable *nix scripts. Details upon command lines to run them are provided below in the corresponding sections. Answers are attached as a zip file with password conabio. Internet conection will be needed to download docker container and R libraries.

Challenge 1 was solved in R using data from Gene Ontology.
Challenge 2 was solved in JS using Express framework with a docker container.

Challenge 1

Problem

A directed acyclic graph (DAG) is a directed graph with no cycles, nodes can have multiple parents and there is a single unique root node. The depth of a node is the minimum number of edges connecting the node with the DAG's root node r.

1. Provide a test that executes your solution and verifies, it works as expected.
   Then write the function that returns the depth of a node given the DAG and test it with your test.

Solution

The solution includes two R scripts: test_dag_ontology_depth.R that contains and runs the tests and dag_ontology_depth.R where the depth function is implemented.

Dependencies:

ontologyIndex
testThat

Data:

The Gene Ontology DAG.

Scripts

`dag_ontology_depth.R`
`test_dag_ontology_depth.R`

Usage:

command line 1 (to invoke depth)
`./dag_ontology_depth.R <GO:id1> ... <GO:idn>`
Example
```
cd Test
./dag_ontology_depth.R GO:2001316 GO:2001314
```

command line 2 (to invoke tests)
`./test_dag_ontology_depth.R` Runs the test

or to a more descriptive output and the possibility to run several tests use:
```
$ cd test
$ R
> library (testThat)
> test_dir(".")
```

Brief report of challenge 1 Test Driven development

The script `dag_ontology_depth.R` implements `depth(node)` a function to calculate the depth of nodes from the GAD formed by the Gene Ontology.

`dag_ontology_depth.R`
inputs a list of GO ids

```
---------------Sesion info   ----------------------
Error: Test failed: 'DAG_depth returns -1 in obsolete nodes'
* unlist(lapply(obsolete, depth), recursive = "TRUE", use.names = FALSE)
 not equal to unlist(rep(0, length(obsolete))).
2300/2300 mismatches (average diff: 1)
[1] -1 - 0 == -1
[2] -1 - 0 == -1
[3] -1 - 0 == -1
[4] -1 - 0 == -1
[5] -1 - 0 == -1
[6] -1 - 0 == -1
[7] -1 - 0 == -1
[8] -1 - 0 == -1
[9] -1 - 0 == -1
...
Ejecución interrumpida
```

Figure 1: Example of failed test

output a table of GO ids with its corresponding depths
Output is displayed in terminal among few information about the script status.

Several tests were implemented for testing `depth` function, to that end the library testThat was used. The general methodology of Test Driven development (TDD) is as follows. First a test is implemented such that the test fails. Then, there is a refactoring process where the code of tested function is developed until the test is passed. Finally, a new test is written and the code is refactored again.

In this case the tests were designed to test the `depth` function implemented in the script `dag_ontology_depth.R` with the GO data. The script test_dag_ontology_depth has a source command of the script dag_ontology_depth, after sourcing, all tests are run. An example of failed test before refactoring is shown in Figure 1.

Tests description

To run the tests script, testing script must be executed: `./test_dag_ontology_depth.R` When all test are passed there is no ERROR in the output. Another way to run the tests is using the command test_dir(), this command will provide information about every test instead of only show the first test that fails, Figure 2. To run the test_dir command, go to the directory with your tests and every file that starts with word test will be executed. (See command line 2, invoke tests)

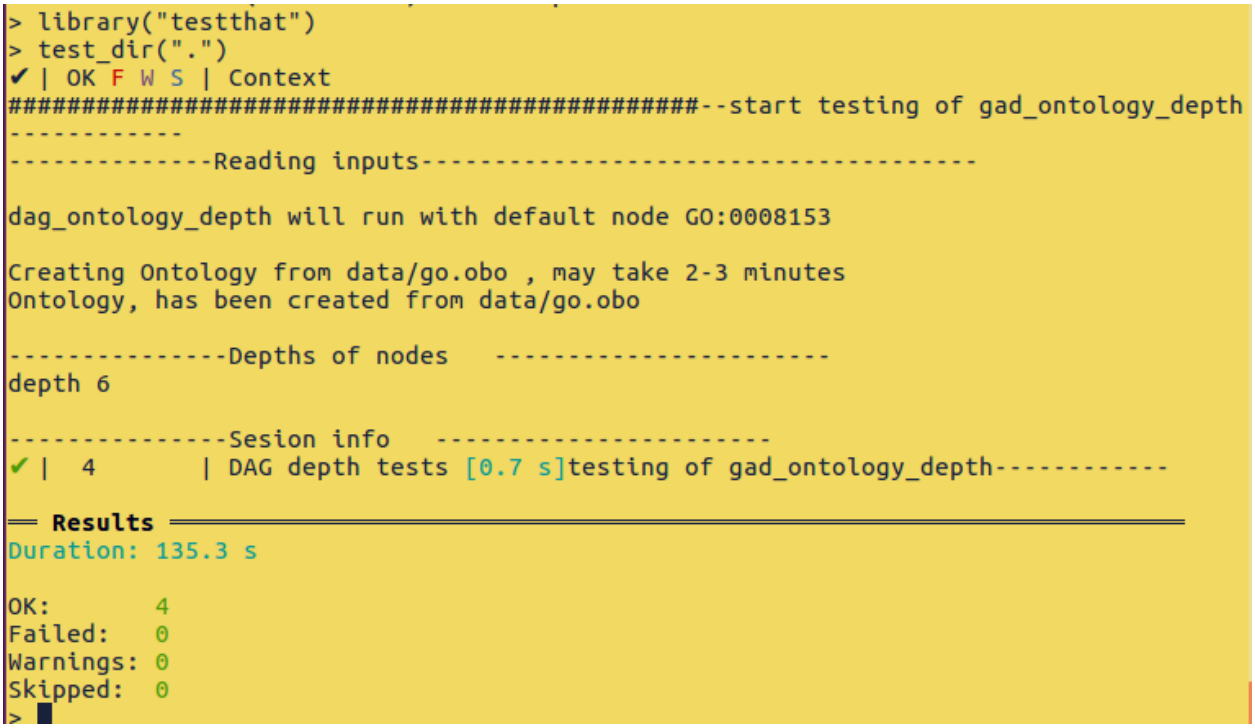


Figure 2: Passed test

Finally in this section I described the study cases selected for the tests

Test1: Roots must be of depth zero, there is no node connecting to a root.
Test2: Obsolete GOs has no parents, then it has not connection with any root, so they have no depth, to distinguish them from roots, they were assigned a depth of -1.
Test3: First children of roots must have depth 1. I took the first five of them and not all to save time. But It can be changed the test to assure that every GO with depth 1 is calculated as depth 1.

Test4: A random case was manually inspected, i.e. all pathways were printed and the minimum was observed. The GO:0008153 has depth 6. Then calculated depth must be 6, Figure 3.

To do:More test should be implemented, such as test node with depth three in a linear graph and nodes with depth three in a none linear graph, etc.

depth function

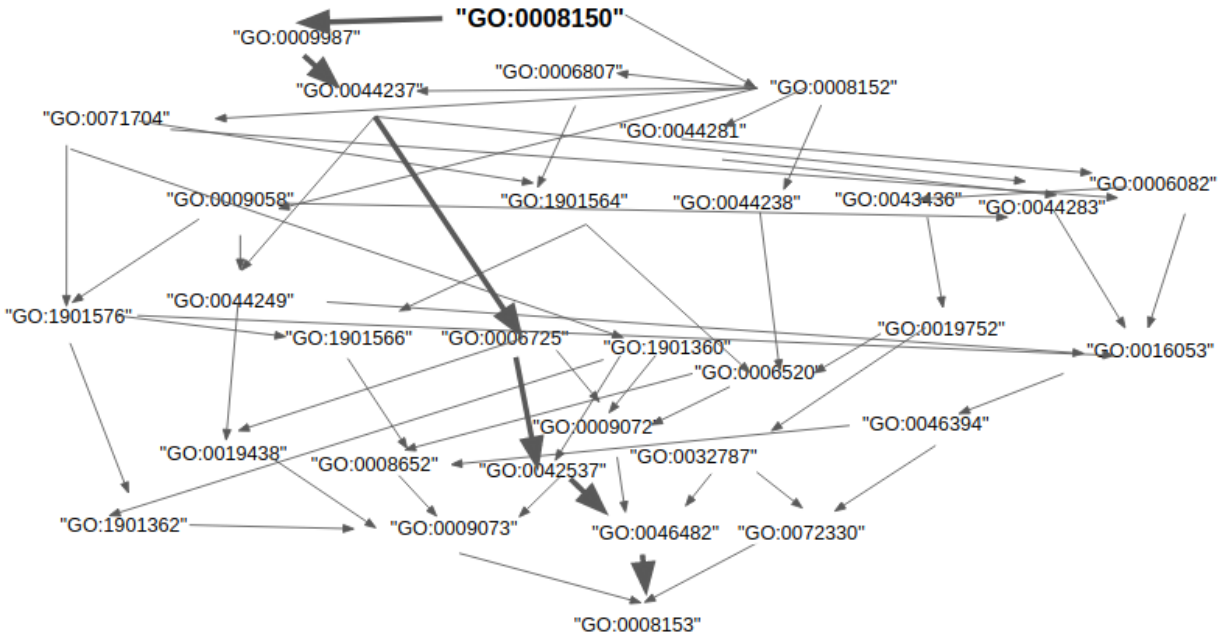
The depth function goes back step by step looking for the set of parents of a set of nodes.
Once the $parents \cap roots$ is not empty the backward search stops and return the depth. First I thought about using recursion, but since r does work with lists and the ontologyIndex has the parents list I solved this challenge with a while.

```
## Declare depth function
depth <- function(node){
    # start depth is 0 for roots or obsolete terms
    depth_val=0

    # if obsolete then depth is -1 because node is not conected at all with roots
    if (ontology$obsolete[node]=="TRUE") {
        depth_val=-1
    }else{# if not obsolete then the will will search backwards in the parents set until finding a root
        # node_back will store step by step a list of nodes and their parents
        node_back<-node

            while(length(intersect(node_back,roots))==0){
        # while set {{node}union{parents node}} intersection with set {root1,root2,root3} is empty
                depth_val=depth_val+1                    #add one to depth_val
                node_back=unique(unlist(ontology$parents[node_back]))
                }
        }
    return (depth_val)
  }
## For the future, would be better to also pass as variables ontology and roots but I didn't have time t
```

Note, this data contains three roots, the problem stablished to work with one root, but that is a particular case of this three roots and the function depth is still applying understood as the minimal set of nodes to the set of roots



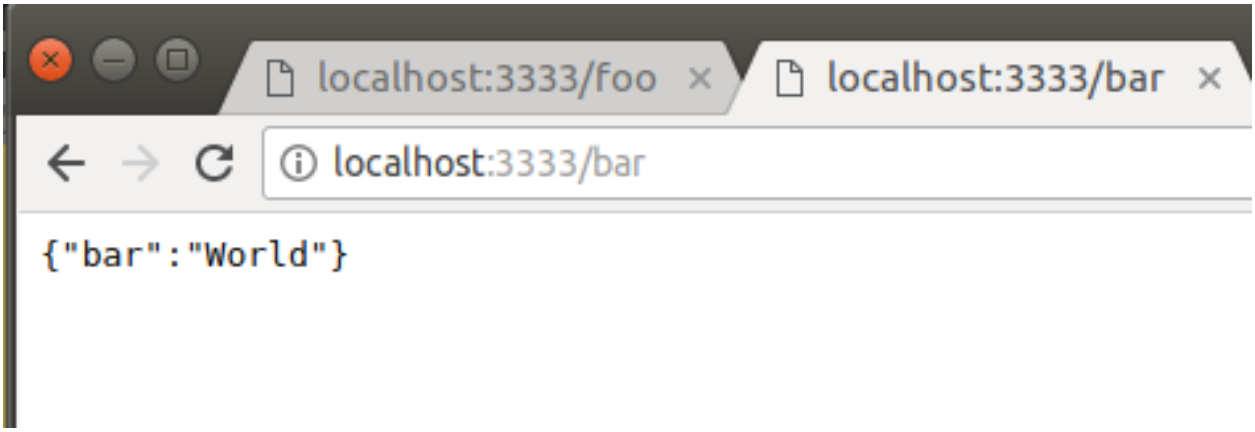


Figure 3: localhost routes:foo bar

Challenge 2

Problem

Write a simple Server in NodeJS using the Express Framework. The server should respond to two routes "/foo" and "/bar" in JSON format and configured with variables PORT and BASE_URL. Especific requirements of the problem will be addressed in the solution.

Solution

The problem was solved and a docker container is provided. Solution include four files, Dockerfile, index.js, routes.js and challenge2.sh

Scripts

- index.js Javascript, create and start the Express server
- routes.js use Express Router in which the routes 'foo' and 'bar' are defined.
- Dockerfile From node, copy JSON packages and starts the with npm using CMD
- challenge.sh Bash file, starts docker container, controls PORT and BASE_URL environment variables and send them to docker container

Invoke command line

```
cd Node_Express
./challenge2.sh
```

For example the shell commands

```
export PORT="3000"
export BASE_URL="/conabio"
./challenge2.sh
```

Figure 4: environment variables

start a server that respondes to
localhost:3000/conabio/foo with “Hello” in JSON, and to
localhost:3000/conabio/bar with “World” in JSON.

challenge2.sh description

challenge2 is a bash script that reads environment variables PORT and BASE_URL Consider that the default values are PORT=3333 and BASE_URL=“” (empty string). Finally, challenge 2 calls the docker container node-web-app setting PORT and BASE_URL as environmental variables. The first time that this script is executed it will take some time while downloads the docker image.

```
if [[ -z $PORT ]]; then
    echo "PORT does not exist, it will be set PORT=3333"
    export PORT="3333"
else
    echo "PORT does have value = $PORT"
fi

if [[ -z $BASE_URL ]]; then
    echo "BASE_URL does not exist"
    export BASE_URL=""
else
    echo "BASE_URL does have value = $BASE_URL"
fi

echo docker run -p $PORT:$PORT --rm -e PORT=${PORT} -e BASE_URL=${BASE_URL} nselem/node-web-app

docker run -p $PORT:$PORT --rm -e PORT=${PORT} -e BASE_URL=${BASE_URL} nselem/node-web-app
```

index.js

In index.js the server is defined and the environment variables are used
> ‘use strict’;

> const express = require('express');

```
// App
const app = express();
var routes = require("./routes.js");

// Variables
var BASE_URL=(process.env.BASE_URL||"");
var PORT = (process.env.PORT || 3333);

console.log(Running on localhost:${PORT});
console.log(BASE URL:${BASE_URL});

// Passing variables to app
app.use(BASE_URL+"/", routes);
app.listen(PORT);
```

routes.js description

In the routes.js file are specified the following:
1 "foo" writes "Hello"
2 "bar" writes "World" to the response in JSON format.

```
// Constants
var express = require("express");

var appRouter = express.Router();
appRouter.get("/foo", function(req, res){
var oMyOBject = {foo:'Hello'};
res.json(oMyOBject);
});

appRouter.get('/bar', function(req, res) {
var oMyOBject = {bar:'World'};
res.json(oMyOBject);
});

module.exports = appRouter;
```

Web References as in Oct 30 - 2018

OntologyIndex
https://rdrr.io/cran/ontologyIndex/man/ontologyIndex-package.html

testThat
https://journal.r-project.org/archive/2011/RJ-2011-002/RJ-2011-002.pdf
https://www.johndcook.com/blog/2013/06/12/example-of-unit-testing-r-code-with-testthat/

JS tutorials
NodeJS https://github.com/nodejs/help/wiki/Installation

Aprendiendo basicos NodeJS
https://www.w3schools.com/nodejs/nodejs_get_started.asp

Tutorial1 app de NodeJs en docker OK
https://nodejs.org/en/docs/guides/nodejs-docker-webapp/

Tutorial Express
https://developer.mozilla.org/en-US/docs/Learn/Server-side/Express_Nodejs/routes

Docker
https://docs.docker.com/