Examination Advanced R Programming

Linköpings Universitet, IDA, Statistik

Course code and name:	732A94 Advanced R Programming
Date:	2020/02/28, 8–12
Teacher:	Krzysztof Bartoszek
Allowed aids:	The extra material is included in the zip file **exam_material.zip**
Grades:	A= $[18-20]$ points B= $[16-18)$ points C= $[14-16)$ points D= $[12-14)$ points E= $[10-12)$ points F= $[0-10)$ points
Instructions:	Write your answers in an R script file named **[your exam account].R** The R code should be complete and readable code, possible to run by copying directly into a script. Comment directly in the code whenever something needs to be explained or discussed. Follow the instructions carefully. There are **THREE** problems (with sub–questions) to solve.

Problem 1 (5p)

a) (3p) When using the S3 system of OO programming how can one implement different functions with the same name that exhibit different behaviour depending on the class of the input parameter? For example how to construct separate implementations of the function `my_fun(x)` so that different (appropriate) behaviour will be exhibited when `x` is of class `my_class1` and `my_class2`?
b) (2p) In an R package what is the correct way to make an S3 method associated with a particular class available to the user?

Problem 2 (10p)

READ THE WHOLE QUESTION BEFORE STARTING TO IMPLEMENT! Remember that your functions should **ALWAYS** check for correctness of user input!

a) (2p) In this task you should use object oriented programming in S3 or RC to write code that simulates a toy store. The toy store is to contain a data structure on its stock and also automatically provide suggestions of toys appropriate for the child age..

Your goal is to first construct an initial store. Depending on your chosen OO system you can do it through a constructor or by implementing a function `create_toy_store()`. The constructing function should take one argument, `max_number_toys`, the maximum number of toys the store can stock. The toy store object should contain for each toy item information describing it, in particular a unique id of the item, a text name (you may have the same one e.g. `"a"` for every item), its price, minimum age of child it is designed for and maximum recommended age. Provide some example calls to your code.

```
## example call to create_toy_store() function
toy_store <- create_toy_store(max_number_toys=5)
```

b) (3p) Now implement a function called `add_to_toy_store()` that allows one to add a new toy item to the store. The function should have four parameters: the text name of the item, its price, minimum and maximum age. The id is to be automatically generated. Do not forget that the store has a maximum capacity! Provide some example calls to your code.

```
## S3 and RC call
toy_store <-add_to_toy_store(toy_store,"car",100,3,10)

## if using RC you may also call in this way
toy_store$add_to_toy_store("car",100,3,10)
```

c) (4p) Now implement a function called `recommend_toy()` that provides recommendations for a potential customer. The function should take two parameters the child's age and maximum amount of money the toy may cost. Propose recommended toys for the child. Print the recommendations out. If there is only one toy that can be recommended, then it is bought and should be removed from the store. Provide some example calls to your code.

```
## S3 and RC call
toy_store <-recommend_toy(toy_store,6,90)

## if using RC you may also call in this way
toy_store$recommend_toy(6,90)
```

d) (1p) Implement a plot **OR (NO NEED TO DO BOTH!)** print function that informs about the stock available in the toy store. You are free to choose yourself how to report the content!

```
# Plotting and printing calls
plot(toy_store); print(toy_store)
```

Problem 3 (5p)

a) (2p) It is often important to calculate the exponential of a number, i.e. e^x. One way to do this is through the Euler formula (of course in an implementation one has to limit the number of terms of the continued fraction)

$$e^x = 1 + \cfrac{x}{1 - \cfrac{x}{x + 2 - \cfrac{2x}{x + 3 - \cfrac{3x}{x + 4 - \cfrac{4x}{x + 5 - \cfrac{5x}{x + 6 - \cfrac{6x}{x + 7 - \cfrac{7x}{x + 8 - \cdots}}}}}}}}.$$

Implement a function that takes as its input the value to which e should be raised, i.e. x in the above formula and the "depth" of the continued fraction. Do not forget that your function should check for correctness of input and react appropriately.

b) (1p) What is the computational complexity in terms of the number of division operations?

c) (2p) Implement a unit test that compares your implementation with R's direct exponential calculation, e.g. using `exp()`.